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KUCHING, SARAWAK
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ABSTRACT BOOK

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Contents

Symposia & General Session	1 – 522
Poster Presentation	458 – 523
Speed Presentation	524 – 531



SYMPOSIUM & GENERAL SESSION

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
1	142	Infrastructure Expansion and the Future of Tropical Forests	Colosseum 1	Symposium 1.1 - Built infrastructure and the future of tropical forests	William Laurance
2	122	Planning for biodiversity conservation needs to be a core value for China's 'Belt and Road Initiative'	Colosseum 1		Alex Lechner
3	212	Infrastructure Expansion and the Indonesian Borneo Tropical Forests	Colosseum 1		Mohammed Alamgir
4	982	Why did the elephant cross the road? Roads and megafauna in Peninsular Malaysia	Colosseum 1		Ahimsa Campos Arceiz
5	744	Infrastructure Development and Environmental Governance: Lessons from the Indonesian Leuser Ecosystem and the Global Tropics	Colosseum 1		Sean Sloan
6	170	Distributions of tigers and prey in the Thailand's world heritage site as baseline for strengthening connectivity for species recovery	Colosseum 1		Somphot Duangchantrasiri
7	399	Designing oil palm landscapes to optimise biodiversity and ecosystem functions	Colosseum 2	Symposium 2.1 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics	Jake Bicknell
8	129	Paying back the carbon and biodiversity debts from oil-palm plantations in Kalimantan, Indonesia	Colosseum 2		Sugeng Budiharta
9	215	Minimising the biological impacts of oil palm expansion in the Neotropics	Colosseum 2		David Edwards
10	465	Motivations, barriers, and impacts of RSPO certification: lessons from the Colombian oil palm sector	Colosseum 2		Paul Furumo
11	133	Optimising biodiversity and yield in smallholder oil palm plantations	Colosseum 2		Jane Hill
12	871	Improving soil greenhouse gas fluxes in oil palm plantations	Colosseum 2		Melissa Leduning
13	565	Quantifying the greenhouse gas balance of oil palm plantations on peat soil in northern Borneo	Colosseum 2		Yit Arn Teh
14	162	Tropical tree seedlings trade off shade and drought tolerance: a demographic approach	Petra 1	Symposium 3.1 - Tropical tree life-history strategies: Causes and consequences of demographic diversity	Stefan J Kupers
15	121	Differences in leaf thermoregulation and water-use strategies between two co-occurring Atlantic forest tree species	Petra 1		Sophie Fauset
16	160	Conspecific density dependence varies with species life-history strategy at multiple life stages in a Neotropical forest	Petra 1		Liza Comita
17	783	Functional traits predict seedling recruitment in relation to altered natural-enemy activity with edge-effects	Petra 1		Meghna Krishnadas
18	185	Diversity Takes Time: Temporal Dynamics of Seedling Demography in a Subtropical Rain Forest	Petra 1		Chia-Hao Chang-Yang

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
19	132	Termites in soil	Petra 2	Symposium 4 - The role of invertebrates in undisturbed tropical ecosystems	Cecilia Dahlsjö
20	127	Termites mitigate the ecological effects of drought in tropical rainforest	Petra 2		Louise Ashton
21	914	Quantifying the role of ants in tropical ecosystems: resource removal	Petra 2		Kate Parr
22	80	Vertical stratification of tropical ant assemblages: do ground ants restrict the foraging distribution of arboreal and subterranean ants?	Petra 2		Stephanie Law
23	458	Top-down effects of insect herbivores and seed predators on rainforest vegetation	Petra 2		Owen Lewis
24	79	Invertebrates in Tropical Forests: the Ultimate Baseline?	Petra 2		Paul Eggleton
25	91	Palaeo-Antarctic Rainforest Plant Lineages in Austral and Southeast Asia: Diversity, Abundance and Ecology	Taj Mahal	Symposium 5.1 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots	Robert Kooyman
26	526	The First Gondwanan Fagaceae: Early Eocene Castaneoids from Patagonia and the Paleo-Antarctic Component of Southeast Asian Tropical Rainforests	Taj Mahal		Peter Wilf
27	135	Paleobotany in tropical SE Asia: progress and opportunities	Taj Mahal		Tao Su
28	808	Forest tree community and biogeographic variation among five Indonesian islands	Taj Mahal		Sarah Mathews
29	826	Sino-Australasian Lauraceae: Disentangling Genomes, Islands and Time	Taj Mahal		Joeri Sergej Strijk
30	384	The likely contribution of vertebrate seed-dispersers to the Sunda-Sahul floristic exchange	Taj Mahal		Caroline Pannell
31	517	Linking Science Communication to Data Achievement in South America. Lessons from Available Platforms and Strategies for a long-term successful Global Biodiversity Monitoring Citizen Science Project.	Giza	Symposium 6 -Citizen Science: Global Biodiversity Monitoring and Science Literacy Empowerment	Sandro Von Matter
32	210	Potentials of a large scale citizen science platform for tropical plant species detection and phenological study	Giza		Pierre Bonnet
33	225	Building capacity for civic participation in conservation: Case study of the Klang Valley City Nature Challenge 2018	Giza		Benjamin Ong
34	711	How a Citizen Scientist and Alan Turing's Genius Inspired a New, Powerful, and Very Simple Species Richness Estimator	Giza		Robert Colwell
35	906	Community Aerobotany: using Unmanned Aerial Vehicles and online citizen science to monitor Amazon rainforest canopy trees	Giza		Varun Swamy
36	678	Every cloud has a silver lining – An interactive theatre experience and its effects on conservation awareness	Giza		Cedric Kai Tan

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
37	445	How information about predation in mixed-species bird flocks changes through the breeding cycle in a subtropical, limestone forest	Machu Pichu	General Session 1.1 - Bird Ecology & Conservation	Demeng Jiang
38	618	Mixed-Species Flocks And Climate Change: Towards A Mechanistic Understanding Of Avian Social Systems	Machu Pichu		Flavia Montano Centellas
39	937	Mixed-species flocking propensity and intraspecific sociality influence the colonization and extinction rates of bird species on islands.	Machu Pichu		Ari Martinez
40	377	Nest-site selection and nesting success of Scaly-crowned Babbler <i>Malacopteron cinereum</i> in seasonal evergreen forest in northeastern Thailand	Machu Pichu		Kanoktip Somsiri
41	219	The response of mixed-species bird flocks to altitudinal and anthropogenic change in southern and southwest China	Machu Pichu		Liping Zhou
42	610	Importance of keystone habitats in scrub forests of peninsular India; findings from population and ecological studies on endemic Yellow-throated Bulbul <i>Pycnonotus xantholaemus</i>	Machu Pichu		Ashish Jha
43	738	Responses of lowland tropical rainforest trees to drought	Chichen Itza	General Session 2.1- Plant Ecophysiology	David Tng
44	721	Impact of elevated temperature and atmospheric CO ₂ concentration on seedling growth and survival of species along a tropical wet forest-savanna gradient	Chichen Itza		Deborah Apgaua
45	284	Tree growth and stem carbon accumulation in human-modified forests following drought and fire	Chichen Itza		Erika Berenguer
46	712	Do High-Altitude Tropical Alpine Plants use Light with Maximum Photosynthetic Efficiency?	Chichen Itza		Juan Posada
47	903	How to play by a different set of rules: functional traits of <i>Rhododendron</i> species with a stress-tolerant ecological strategy along tropical elevation gradients	Chichen Itza		Melissa Whitman
48	345	Mapping the leaf economic spectrum across West African tropical forests using UAV-acquired hyperspectral imagery.	Chichen Itza		Eleanor Thomson
49	485	Guardians of the Wetlands: Using Fishing Cats for Urban Wetland Conservation in Colombo Sri Lanka	Eiffel 1	Symposium 7.1 - The Second International Symposium on Fishing Cat Conservation: Persistence of a tropical wetland specialist, Ecology, Activism and Conservation	Anya Ratnayaka
50	137	The Status Of Fishing Cat (<i>Prionailurus viverrinus</i>) Conservation In Human-Mediated Landscapes In Sri Lanka	Eiffel 1		Ashan Thudugala
51	973	Further Note of Fishing Cat, <i>Prionailurus viverrinus rhizoporeus</i> , in Java Island, Indonesia	Eiffel 1		Erwin Wilianto
52	516	Long term conservation of Fishing cats in the Godavari delta, Andhra Pradesh, India	Eiffel 1		Giridhar Malla
53	369	Study and conservation initiatives of Fishing cat in the human dominated landscape of Nepal	Eiffel 1		Sagar Dahal
54	89	Global Small Cat Conservation Update	Eiffel 1		James Sanderson

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
55	362	Superhighway Development Threatens Tropical Forest Conservation and SDGs in Equatorial Africa	Colosseum 1	Symposium 1.2 - Built infrastructure and the future of tropical forest	Mahmoud Ibrahim Mahmoud
56	981	Political Economy Of Infrastructure Development – A Heady Landscape	Colosseum 1		Cynthia Ong
57	331	When rubber hits the road: the interplay of planning, pretexts and policy on Manus Island, Papua New Guinea	Colosseum 1		Thomas Mutton
58	218	Does the upgraded Pan-Borneo highway project conflict with the Heart of Borneo aspirations in Sabah, Malaysia?	Colosseum 1		Mason Campbell
59	119	Identifying critical limits in oil palm expansion for the conservation of terrestrial mammals in Colombia	Colosseum 2	Symposium 2.2 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics	Lain E. Pardo-Vargas
60	547	Assessing the benefits of riparian reserves in oil palm landscapes: developing the science to inform environmental policy	Colosseum 2		Eleanor Slade
61	654	Does the oil palm industry help alleviate poverty? Lessons from Indonesia	Colosseum 2		Matthew Struebig
62	708	Can plantation management in oil palm increase biodiversity and pest control?	Colosseum 2		Edgar Turner
63	554	Using demographic trade-offs and a simple forest model to understand and predict tropical forest dynamics	Petra 1	Symposium 3.2 - Tropical tree life-history strategies: Causes and consequences of demographic diversity	Nadja Rüger
64	187	Functional traits, guilds, and the dynamics in tropical forests.	Petra 1		Vanessa E Rubio
65	111	Beyond the slow-fast continuum: A global analysis of demographic rates in forest trees	Petra 1		Jessica Needham
66	146	Global patterns in the slow-fast continuum of tropical tree demography: the roles of tolerance and responsiveness	Petra 1		Sabrina E. Russo
67	267	Invertebrates and disturbance in tropical rainforests.	Petra 2	Symposium 8.1 - Invertebrates and ecological processes in modified tropical landscapes	Roger Kitching
68	858	Insights into the diet composition of pygmy grasshoppers in Sabah, Malaysia, based on DNA metabarcoding	Petra 2		Jane Hardwick
69	226	How do El Nino droughts and fires interact with human forest disturbance to shape tropical biodiversity and associate functions? Evidence from Amazonian dung beetles	Petra 2		Filipe Machado França
70	196	Commensalism in a novel ecosystem: Converting degraded rainforest to oil palm plantation increases densities of a stem-excavating crabronid wasp in the ant-plant <i>Macaranga pearsonii</i> without fitness costs for mutualistic partners	Petra 2		Tom Fayle

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
71	100	Complex patterns of biodiversity across geologically even more complex tropical landscapes	Taj Mahal	Symposium 5.2 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots	Michael Balke
72	355	Should I stay or should I go – the impact of biogeographic history and dispersal dynamics on rainforest assembly.	Taj Mahal		Maurizio Rossetto
73	217	New Guinea as a major generator of Malesian and Australasian plant diversity: evidence from multi-lineage analysis of diversification through time	Taj Mahal		Elizabeth Joyce
74	359	Insights into the evolution of Australian rainforest through their biogeographic history, ecology and landscape attributes	Taj Mahal		Samantha Yap
75	12	Reef-to-ridge ecological perspectives of high energy storm events in northeast Australia: insights from Severe Tropical Cyclones Larry and Yasi	Giza	General Session 3 - Wind Disturbance	Stephen Michael Turton
76	626	To plant, or not to be, that is the question? Reforestation vs. natural regeneration within severely storm disturbed mangrove forests	Giza		Thomas Fickert
77	979	Twelve-year tree community dynamics following catastrophic wind disturbance in a tropical insular forest	Giza		Edward Webb
78	290	Wind and Trees - the mechanical strength of tropical trees and their resistance to wind damage.	Giza		Toby Jackson
79	568	Occurrence of avian in a threatened biodiversity hotspot: missing species and spatial distribution of ground-foraging bird community in the central Annamites	Machu Pichu	General Session 1.2 - Bird Ecology & Conservation	An Nguyen
80	570	Movement of the Near Threatened Orinoco Goose (<i>Neochen jubata</i>) in human-dominated landscapes in Eastern Amazonia	Machu Pichu		Lisa Davenport
81	477	Title : Social behavior and life-histories variation: A story of Neotropical birds.	Machu Pichu		Jenny Munoz
82	689	Activity patterns of Crestless Fireback <i>Lophura erythrophthalma</i> and Black Partridge <i>Melanoperdix nigra</i> in the Kampar Peninsula, Sumatra, Indonesia	Machu Pichu		Prayitno Goenarto
83	697	Leaf temperature regulation strategies of the plants from a hot dry and a hot wet habitat	Chichen Itza	General Session 2.2 - Plant Ecophysiology	Hua Lin
84	524	Relationships of Tree Growth and Mortality to Temperature and Rainfall in Hawaiian Forests	Chichen Itza		Rebecca Ostertag
85	943	Convergence in plant hydraulic strategies across plant lifeforms in severe water-stressed habitats	Chichen Itza		Yajun Chen
86	671	Estimating litter production with a metabolic scaling theory-driven approach in a near tropical montane forest	Chichen Itza		Cho-Ying Huang
87	197	Conservation of a newly recorded population of fishing cat (<i>Prionailurus viverrinus</i>) at a protected coastal mangrove area in south-west Cambodia.	Eiffel 1	Symposium 7.2 - The Second International Symposium on Fishing Cat Conservation: Persistence of a tropical wetland specialist, Ecology, Activism and Conservation	Vanessa Herranz Muñoz
88	651	The Distribution And Conservation Of Wild Felids In Sarawak, Borneo	Eiffel 1		Jayasilan Mohd-Azlan

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
89	964	Highway viaducts: Wildlife crossings or barriers to movement?	Colosseum 1	General Session 4 - Wildlife & Infrastructure	Tabitha Hui
90	357	Road kills and use of wildlife passages by mammals: a case study in the Sooretama Biological Reserve, Brazil	Colosseum 1		Helena Bergallo
91	779	Roadside monkeys: Anthropogenic impacts on moor macaque (<i>Macaca maura</i>) ranging patterns in Bantimurung-Bulusaraung National Park, Sulawesi, Indonesia	Colosseum 1		Erin Riley
92	733	Are bats vulnerable to roads in Southeast Asia? A case study of wildlife–vehicle collision mortalities in a biodiversity hotspot in Thailand	Colosseum 1		Inês Silva
93	308	A test of road edge effects on the nest survival and the post-fledging survival of a tropical forest passerine	Colosseum 1		Rongrong Angkaew
94	630	A hydroelectric dam in Peninsular Thailand has devastated the surrounding resident forest bird community	Colosseum 1		Gregory Irving
95	988	Recent Oil Palm Development in Brazil: Evaluating Expansion Dynamics and Constraints	Colosseum 2	Symposium 2.3 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics	Elinor Benami
96	730	Assessing the conservation value of riparian reserves for terrestrial mammals in oil palm plantation and highly degraded forest.	Colosseum 2		Esther Baking
97	397	Resident and migratory bird use of oil palm (<i>Elaeis guineensis</i>) plantations and native forest fragments in southern Mexico	Colosseum 2		Jessie Knowlton
98	475	Mammal diversity in oil palm plantations in Southern Mexico: a first assessment.	Colosseum 2		Ena E. Mata-Zayas
99	663	Carbon fluxes from oil palm plantations on peat soil	Colosseum 2		Frances Manning
100	650	Retaining riparian reserves in oil palm plantations mitigates the loss of native small mammal species	Colosseum 2		Henry Bernard
101	589	Complete carbon budget in selectively logged and old-growth tropical forests in Borneo	Petra 1	Symposium 9 - Land-use change impacts on ecosystem biogeochemistry and functioning in secondary forests	Terhi Riutta
102	608	Logging and soil nutrients independently explain plant trait expression in tropical forests	Petra 1		David Burslem
103	781	The impact of surrounding matrix trees on dipterocarp seedling growth and survival	Petra 1		Charles Marsh
104	255	Influence of environmental variables and mycorrhizal associations on soil carbon storage in a montane forest in Panama	Petra 1		Cecilia Prada
105	396	Rapid initial responses of forest carbon fluxes and nutrient cycling in a large-scale nutrient manipulation experiment in Central Amazonia	Petra 1		Kelly Andersen

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
106	848	Palatability and defence in seedlings of two species of dipterocarp experimentally planted across a fragmented landscape	Petra 2	Symposium 8.2 - Invertebrates and ecological processes in modified tropical landscapes	Lois Kinneen
107	965	Ants are key players in maintaining ecosystem functioning in oil palm plantations in Riau, Sumatra	Petra 2		Amelia Hood
108	788	How rapidly do invertebrate decomposers and litter decomposition rates recover during rainforest regeneration on disused pastures?	Petra 2		Marisa Stone
109	692	Phylogenetic and functional patterns in leaf-cutting ants diet at the edge and in the interior of a fragmented Atlantic rainforest	Petra 2		Joosep Sarapuu
110	616	Increasing aridity rather than human disturbance affects ant-mediated ecosystem services in Brazilian Caatinga	Petra 2		Inara Leal
111	829	Nitrous oxide and methane emissions from termites along a gradient of forest disturbance in Sumatra	Petra 2		Fitri Aini
112	590	Bloodsuckers for conservation - using iDNA from leeches for mammal biodiversity assessment and monitoring.	Taj Mahal	General Session 5 - Methodological Advances in Tropical Biology & Conservation	Andreas Wilting
113	435	Thermal Camera Vs Visual Counting: Evaluating A Comparison Of Techniques For Primate Census	Taj Mahal		Amaziasizamoria Jumail
114	541	Occupancy, local abundance and density: what can we estimate with camera-trapping data?	Taj Mahal		Azlan Mohamed
115	732	Combining Landsat time series and time-calibrated occupancy modelling to predict species distributions in tropical forests in space and time	Taj Mahal		Jürgen Niedballa
116	537	Influence of body mass, sociality, and movement behavior on improved detection probabilities when using a second camera trap	Taj Mahal		Seth Wong
117	277	Advancing the Rain Forest Conservation Toolkit – a new model for biodiversity surveys	Taj Mahal		Nadine Ruppert
118	392	Using community occupancy models for diversity profiles	Taj Mahal		Jesse F. Abrams

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
119	22	Biodiversity Under Threat in the Niassa National Reserve, What can be Done? Understand the Opinions of Professionals and Volunteers Engaged in Conservation	Giza	General Session 6 - Society & Conservation	Aires Mbanze
120	312	Conserving Mindoro's tamaraw: Integrating wildlife, landscape and indigenous communities in conservation and research	Giza		Alvaro Gonzalez Monge
121	206	Perceived barriers to and drivers of community participation in protected-area governance	Giza		Caroline Ward
122	481	Spatial dynamics of community landscape service values across the South West Mau Forest, Kenya	Giza		Ethan Miller
123	236	Do law enforcement and community outreach work? Comparing management and mammal diversity in a biodiversity hotspot in southwestern China	Giza		Cheng Chen
124	690	Local ecological knowledge of fish farmers reveals decline of Hong Kong otters and potential for conservation intervention	Giza		Sharne Mcmillan
125	204	Nested Approach towards Sustainable Landscape Management: a case study of Public, Private People in the KELOLA Sendang Project, South Sumatra Province	Giza		Bonie Fajar Dewantara
126	664	Inconsistent phenotypic syndrome in the evolution of poison frogs' aposematism	Machu Pichu	General Session 7 - Amphibian Ecology & Conservation	Adolfo Amezcuita
127	249	Local Environmental Factors Influence the Structure of Frog Communities on the Sandy Coastal Plains of Southeastern Brazil	Machu Pichu		Carlos Frederico D. Rocha
128	512	Natural history and conservation of a rare species of bromeliad-dwelling frog from the Brazilian highlands	Machu Pichu		Izabela Menezes Barata
129	295	Stream amphibian habitat associations and responses to reduced impact logging in the Deramakot forest reserve, Sabah, Malaysian Borneo.	Machu Pichu		Sami Asad
130	854	Amphibian conservation at the intersection of ecology, taxonomy, and biogeography.	Machu Pichu		Martha Hurley
131	467	Bioacoustics of the amphibian community in Kinabalu Park and the use of open source resources for passive acoustic monitoring.	Machu Pichu		Catharina Karlsson
132	15	Linking Traditional Ecological Knowledge and Biodiversity Conservation of Protected Areas through Thematic Interpretation	Machu Pichu		Victor Luna Amin
133	975	Carbon emissions from Southeast Asian peatlands will increase despite emission-reduction schemes	Chichen Itza	General Session 8 - Peat & Flooded Forests	Lahiru Wijedasa
134	652	Relationship between vegetation and peat depth in peat swamp forest of Kampar Peninsula, Riau, Indonesia	Chichen Itza		Arief Hamidi
135	707	El Niño carbon losses from human modified tropical forests are greatest near edges and on hilltops, shows repeat-LiDAR surveys	Chichen Itza		Matheus Nunes
136	3	Introduction to the Natural History and the Conservation of globally important forested freshwater wetlands	Chichen Itza		Pia Parolin
137	446	Determining regional-scale carbon losses from tropical peatlands using InSAR.	Chichen Itza		Martha Ledger

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
138	438	The Composition of Global Legal Wildlife Trade	Colosseum 1	Symposium 10.1 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods	Wilson Lau
139	98	Extent of the impact of the Chinese wildlife trade on the world's wildlife	Colosseum 1		Olivier Boissier
140	263	Caged in the city: Live bird trade in Southeast Asia	Colosseum 1		Serene Chng
141	404	An Assessment of Conservation Status of Critically Endangered Chinese Pangolins (<i>Manis pentadactyla</i>) in Community Forests amid Human-Dominated Landscapes of Nepal	Colosseum 1		Sandeep Shrestha
142	455	Monitoring the ASEAN rosewood trade using online seizure data: a 5-year case-study on Thailand's role as a source and transport country	Colosseum 1		Penthai Siriwat
143	294	Using stable isotopes to detect laundering in wildlife trade	Colosseum 1		Astrid Andersson
144	310	Trade-offs between multiple ecosystem services and tropical agriculture	Colosseum 2	Symposium 11.1 - Feeding the planet whilst minimizing environmental and socio-economic costs	L. Roman Carrasco
145	153	Crop-specific threats to biodiversity by 2050	Colosseum 2		Yuchen Zhang
146	234	Perverse market outcomes of conservation interventions: modelling market feedbacks of oil palm expansion in Indonesia	Colosseum 2		Felix Lim
147	749	Global Conservation Community Attitudes Regarding Oil Palm	Colosseum 2		Kimberly Carlson
148	233	The state of climate connectivity across the tropics	Colosseum 2		Rebecca Senior
149	388	How to better manage shifting cultivation to improve conservation outcomes	Colosseum 2		Joli Borah
150	123	The Decline and Fall of Cambodia's Tiger: lessons for global tiger recovery	Petra 1	Symposium 12 - Conservation-based recovery of large carnivores in Asia: technical and management insights	Thomas Gray
151	165	Challenges towards recovering Sumatran tiger populations in two UNESCO World Heritage Site protected areas	Petra 1		William Marthy
152	768	Making recovery possible: insights from tiger augmentation and reintroduction projects in India	Petra 1		Ramesh Krishnamurthy
153	579	Unraveling the complexity of human-tiger conflicts in the Leuser Ecosystem, Sumatra	Petra 1		Muhammad Irfansyah Lubis
154	527	Surveys reveal important tiger conservation landscape in southern Tanintharyi Region, Myanmar	Petra 1		Jackson Frechette
155	499	Spatial variation in the response of tiger gene flow to landscape features in Central India and Western Ghats, India	Petra 1		Anuradha Reddy

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
156	353	Access to Forest Resources and Effectiveness of Protected Areas in Malaysia: A Historical Perspective on the National Park and the Krau Reserve since the Colonial Era	Petra 2	Symposium 13.1 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes	Mathieu Guerin
157	186	The importance of mast fruiting for vertebrates in a faunally intact ecosystem	Petra 2		Alys Granados
158	90	Defaunation, seed predation, and seedling establishment of commercially important trees in an Afrotropical forest	Petra 2		Cooper Rosin
159	107	Seed dispersal of hemi-epiphytic figs by binturongs, gibbons and hornbills on Borneo	Petra 2		Miyabi Nakabayashi
160	513	Breeding-related differences in habitat use and home-range size influence seed dispersal effectiveness and potential for forest regeneration in an endangered frugivore	Petra 2		Henry Pollock
161	195	Do Japanese wood pigeons disperse seeds among islands? Foraging strategy estimated by observation and molecular ecological approach	Petra 2		Haruko Ando
162	508	Biodiversity and change: Comparative dynamics of southeast Asian forests	Taj Mahal	Symposium 14.1 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests	Stuart Davies
163	437	Species-specific drought effects: consequences for species and phylogenetic diversity of Bornean rain forest trees	Taj Mahal		Akira Itoh
164	175	Habitat-Related Tree Species Distributions And Diversity In A Peninsular Malaysian Rainforest	Taj Mahal		Tze Leong Yao
165	150	Long-term shifts in tree sapling abundance in multiple Southeast Asian rainforests	Taj Mahal		Matthew Scott Lusk
166	139	Short-term variation of tree growth rates in tropical forests of Singapore	Taj Mahal		Kang Min Ngo
167	971	Temporal Change In Species Composition And Abundance At Lambir Hills National Park, Sarawak, Malaysia	Taj Mahal		Mohizah Mohamad
168	261	Changes in stand structure and dynamics of trees in Pasoh Forest Reserve over 25 years	Taj Mahal		Musalma Nasardin
169	800	The freshwater mussels of Sundaland: towards protecting a unique fauna in a changing environment	Giza	Symposium 15 - Freshwater ecosystems and dams in Southeast Asia: Understanding human impacts and aligning science with decision making processes for conservation and sustainable development	Alexandra Zieritz
170	984	Dams and Dolphins: Investigating Impacts and Making Management Decisions	Giza		Lindsay Porter
171	374	Modeling the impact of hydropower dams on fish biodiversity and its synergistic effect with global warming in the Indochina region.	Giza		Yuichi Kano
172	336	Interlinking Science with Decision-making: Sustainable Development of Hydropower Dams in Sarawak	Giza		Karen Suan Ping Lee
173	333	Feasibility study of fish movement using a radio telemetry: implication for the conservation of Malaysian Mahseer, Tor (Gray, 1834) Species	Giza		Tonny Ganyai
174	597	System-scale planning for hydropower in Myanmar	Giza		Hannah Baleta

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
175	680	The Tapanuli Orangutan: Just described and under immediate threat	Machu Pichu	General Session 9.1 - Mammal Ecology & Conservation	Gabriella Fredriksson
176	410	The red ape in the red: Global demand for natural resources and Bornean orangutan decline	Machu Pichu		Maria Voigt
177	387	Fading stripes in the Annamite mountains of Vietnam and Laos: data for a little-known endemic lagomorph caught in the Southeast Asian snaring crisis	Machu Pichu		Andrew Tilker
178	976	Packs in peril? Metapopulation dynamics inform strategies to conserve dhole <i>Cuon alpinus</i> populations in the Western Ghats of India	Machu Pichu		Arjun Srivathsa
179	838	The Multiple States of Mammalian Communities in the Anthropocene	Machu Pichu		Mathias Mistretta Pires
180	417	Ecological correlates of mammal β -diversity in Amazonian land-bridge islands: from small to large-bodied species	Machu Pichu		Ana Filipa Palmeirim
181	356	Power of the People: Strengths, Weaknesses, Opportunities, and Threats in Ethiopian Orthodox Church Forest Conservation Institutions	Chichen Itza	General Session 10 -Community-Based Forestry	Jasmine Randle
182	834	Ethiopian Orthodox Tewahido Church Forest Locations and Extent: Applications of a New Dataset for Remote Sensing Studies of Afromontane Forest Patches in Northern Ethiopia	Chichen Itza		Travis Reynolds
183	933	Sustained From Within? Social and Ecological Drivers of Expanding Internal Clearings in Ethiopian Orthodox Church Forests	Chichen Itza		Wesley Zebrowski
184	862	Social Forestry Roles in Reducing Deforestation	Chichen Itza		Joseph Hutabarat
185	265	The Little-Known Stingless Bees: Diversity, Peculiarities and It's Potentials for Community-Based Forest Conservation	Chichen Itza		Hilario Padilla
186	864	Regeneration and Restoration Dynamics of a Tropical Forest Under Stress: The Case of the Mt Makiling Forest Reserve, Philippines	Eiffel 1	Symposium 16.1 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines	Leonardo Barua
187	850	Preliminary Assessment of the Forest Canopy Diversity of a 2-ha Long-Term Ecological Research (LTER) Plot in Molawin-Dampalit Watershed, Mt Makiling Forest Reserve	Eiffel 1		Karla Jane Gonzalvo
188	442	Patterns of Vertical Stratification and Herpetofaunal Diversity on Lowland Evergreen Forest in Mt. Makiling Forest Reserve, Philippines	Eiffel 1		Whizvir Gustilo
189	285	From Floor to Canopy Layer: Distribution and Diversity of Birds on Lowland Evergreen Forests in Mt. Makiling Forest Reserve	Eiffel 1		Judeline Dimalibot
190	390	Understorey versus Canopy Use by Bats and Non-volant Mammals on a Lowland Evergreen Forest in Mt Makiling Forest Reserve, Philippines	Eiffel 1		Anna Pauline De Guia
191	443	Ectoparasite diversity from canopy birds, bats and reptiles from the Molawin-Dampalit Watershed, Mt. Makiling Forest Reserve.	Eiffel 1		Khryss Pantua

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
192	483	Integrated technology for improving the effectiveness of anti-poaching in tropical protected areas	Colosseum 1	Symposium 10.2 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods	Antony Lynam
193	974	Using technology to tackle illegal wildlife trade in Asia	Colosseum 1		Sophie Adwick
194	130	Countering Poaching in Deep Forests: The Tiny Team vs. Large Landscape Problem	Colosseum 1		Wai Yee Lam
195	279	Changes in primates supplied and offers in Indonesian wildlife markets over the last 25-years	Colosseum 1		Hélène Birot
196	893	Gold, farms, and forests	Colosseum 2	Symposium 11.2 - Feeding the planet whilst minimizing environmental and socio-economic costs	Graham Prescott
197	653	Does land sparing or sharing agriculture best protect avian functional diversity?	Colosseum 2		Patrick Cannon
198	505	Agricultural expansion as a major driver of deforestation in conserved tropical landscapes	Colosseum 2		H Manjari Jayathilake
199	103	Shifting baselines provide over-optimistic assessments of the impacts of land-use change on biodiversity	Colosseum 2		Anderson Saldanha Bueno
200	116	Connecting Tigers' Habitats in A Multi-Use Landscape: A Case of Sembilang-Dangku Landscape, South Sumatra	Petra 1	General Session 11 - Carnivore Ecology & Conservation	Asep Adhikerana
201	39	Understanding the functionality of identified tiger dispersal corridors in the Terai-Arc landscape, India	Petra 1		Suvankar Biswas
202	766	Status of clouded leopards (<i>Neofelis nebulosa</i>) in mainland China	Petra 1		Kerry Huang
203	521	Estimated abundance and activity centres of the Sri Lankan leopard (<i>Panthera pardus kotiya</i>) in Horton Plains National Park, Sri Lanka	Petra 1		Yan Ru Choo
204	264	Are putty nosed monkeys saving the day? Little evidence for surrogate seed dispersal in a West African montane landscape.	Petra 2	Symposium 13.2 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes	Hazel Chapman
205	246	Significance of escape from the mother trees: comparison of post-dispersal seed fates between two lemur-dispersed plant species in northwestern Madagascar	Petra 2		Hiroki Sato
206	141	Bayesian posteriors identify the effect of disturbance on the plant-granivore interaction in ecosystems worldwide	Petra 2		Adrienne Contasti
207	491	An indirect test suggests that 'landscape of fear' influences spatial seed dispersal patterns of a tropical ruminant	Petra 2		Sachin Sridhara
208	437	Species-specific drought effects: consequences for species and phylogenetic diversity of Bornean rain forest trees	Taj Mahal	Symposium 14.2 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests	Akira Itoh
209	704	Topography shapes the structure, composition and function of tropical forest landscapes	Taj Mahal		David Coomes
210	724	Botanic gardens and the conservation of threatened trees in Southeast Asia: integrating in-situ and ex-situ strategies	Taj Mahal		Jean Linsky
211	641	Fine-scale genetic differentiation causes uneven fitness among seedlings in a dipterocarp species	Taj Mahal		Naoki Tani

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
212	557	Conserving the threatened fishes of a 'biodiversity coldspot' in India	Giza	General Session 12 - Freshwater Systems	Paromita Ray
213	553	Revisiting paradigms: Can anthropogenically-formed forest pools provide refugia for threatened freshwater biodiversity?	Giza		Movin Nyanasengeran
214	563	Conservation considerations of inter-basin fish species translocations in Sri Lanka: a genetic barcoding and taxonomic approach	Giza		Jayampathi Herath
215	420	Fish diversity loss affects ecosystem functioning in Southeast Asian fresh waters: impacts on nutrient cycling and trophic energy flows	Giza		Kenny Chua
216	923	Comparative population genomics of bird species from SE Asian hotspots using thousands of makers and historical DNA	Machu Pichu	General Session 13 - Genomics and Barcoding	Haw Chuan Lim
217	763	Genomics for forest genetic resources management in tropical areas: lessons learned from temperate and boreal forests	Machu Pichu		John Mackay
218	188	DNA barcoding and metabarcoding links natural history and conservation.	Machu Pichu		Alison Shapcott
219	200	Applying pollen DNA metabarcoding to the study of quantitative plant-pollinator networks in tropical ecosystems	Machu Pichu		Karen Bell
220	634	Rapid expansion and biodiversity impacts of the red devil cichlid (<i>Amphilophus labiatus</i> , Günther 1864) in Lake Sentani, Papua	Chichen Itza	General Session 14 - Biological Invasions	Henderite Ohee
221	172	Native plant and invertebrate communities of West African montane and lowland forests respond differently to siam weed (<i>Chromolaena odorata</i>) invasion.	Chichen Itza		Biplang Yadok
222	244	Importance of multidisciplinary approaches in tackling species introduction and hybridization between native and non-native species	Chichen Itza		Naiara Guimaraes Sales
223	755	Non-native rats have mixed ecological roles in a system devoid of native seed dispersers	Chichen Itza		Ann Marie Gawel
224	400	Microbial Diversity Assessment in Mt Makiling, Los Banos, Philippines: Morphological and Functional Characterization of Associated Microbes for Agri-industrial Applications	Eiffel 1	Symposium 16.2 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines	Jocelyn Zarate
225	370	Forest Biodiversity across a Vertical Stratification: Implications to Ecosystem Services, Conservation, Tourism and Climate Change Resilience	Eiffel 1		Juan Carlos Gonzalez
226	872	Inventory and Monitoring of Vertebrate Fauna in Three Long-Term Ecological Research (LTER) Sites in Mindanao, Philippines	Eiffel 1		Arturo Jr. Gracia

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
227	966	From Parrots to Songbirds: Tracking trends and attitudes related to the pet bird trade in Hong Kong.	Colosseum 1	General Session 15 - Wildlife Trade	Caroline Dingle
228	637	Pitfalls in the Ivory Trade: Missing Hippo Teeth and Mismatched Trade Bans in China and Hong Kong	Colosseum 1		Luke Gibson
229	684	Understanding urban bushmeat consumer profiles through human-centered design – A case study from Cambodia	Colosseum 1		Regine Weckauf
230	640	Interviews with bear bile farmers in Vietnam highlight negative conservation implications	Colosseum 1		Brian Crudge
231	118	Growth of illegal ivory trade network in Cambodia	Colosseum 1		Trang Nguyen
232	859	Review on prosecution against illegal wildlife trade in mainland China and Hong Kong	Colosseum 1		Anthony Lau
233	972	Using Technology to Combat Wildlife Trafficking in Indonesia	Colosseum 1		Dwi Nugroho Adhiasto
234	523	The importance of forested landscapes for food security and nutrition across agricultural transitions: a multi-country comparative analysis	Colosseum 2	Symposium 17 - Impacts of Tropical Landscape Change on Human Diet and Local Food Systems	Dominic Rowland
235	473	Landscape Change, Landscape Structure and Dietary Diversity in the Global Tropics	Colosseum 2		Laura Vang Rasmussen
236	935	Associations between dietary quality, biodiversity and landscape structure in the Eastern Arc Mountains	Colosseum 2		Bronwen Powell
237	441	From Growing Food to Growing Cash: Dietary consequences of transitions to oil palm in Borneo, Indonesia	Colosseum 2		Amy Ickowitz
238	403	Simulating impacts of rapid forest loss on population size, connectivity and genetic diversity of Sunda clouded leopards (<i>Neofelis diardi</i>) in Borneo	Petra 1	General Session 9.2 - Mammal Ecology & Conservation	Ewan Macdonald
239	948	The effect of natural habitat and human activities on large cat's predation risk in a tropical landscape: including spatial and temporal scales in a two-dimensional approach	Petra 1		Sophie Calme
240	890	Mammalian response to human dominated matrix reveals conditional opportunity for human-wildlife coexistence in the north-west Himalaya	Petra 1		Nimisha Srivastava
241	423	Survival strategies of the sun bear (<i>Helarctos malayanus</i>) in a forest-oil palm landscape.	Petra 1		Roshan Guharajan
242	682	Assessing ecological information of less charismatic species from camera trap data; Study cases of mammals in Kampar Peninsula	Petra 1		Ryan Avriandy
243	361	Ecology of Otters in the Lower Kinabatangan Wildlife Sanctuary	Petra 1		Leona Wai

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
244	282	Pines and needles: functional and phylogenetic diversity across elevational gradients in Mexican coniferous forests.	Petra 2	General Session 16 - Plant Ecology	Libertad Sanchez-Presa
245	220	Vertical gradient in bryophyte diversity and species composition in tropical and subtropical forests in Yunnan, SW China	Petra 2		Ting Shen
246	544	Dramatic loss of native fleshy-fruited plant diversity on recent lava flows of the Piton de La Fournaise volcano (Reunion, Mascarene islands)	Petra 2		Sébastien Albert
247	699	Spermatophyte flora of Yinggeling National Nature Reserve of Hainan, China	Petra 2		Rongjing Zhang
248	961	Generalizable principles of facilitation and mutualism from the phytotelmata of Nepenthes pitcher plants	Petra 2		Weng Ngai Lam
249	250	Mating system and fine-scale spatial genetic structure in the aggregated, self-compatible hermaphrodite mistletoe Dendrophthoe pentandra (Loranthaceae) in Xishuangbanna, SW China	Petra 2		Ling Zhang
250	794	Disentangling the mechanistic and functional trait drivers of spatial aggregation in tropical forest trees	Taj Mahal	General Session 17.1 - Forest Ecology & Conservation	Ian Mcfadden
251	248	Forest Integrity Assessment: testing a new field assessment tool for identifying and monitoring conservation set-asides	Taj Mahal		Jennifer Lucey
252	23	Decline in soil moisture availability elevate the effects of disturbances in tropical dry forest	Taj Mahal		Ravi Chaturvedi
253	68	Pushing the limits of plant communities resilience to human disturbance	Taj Mahal		Edicson Parra-Sanchez
254	480	Are blowdowns reducing forest carbon stocks in the Western Amazon?	Taj Mahal		John Terborgh
255	617	Resilience of a dry tropical forest in southern Mexico	Taj Mahal		Jorge A. Meave
256	845	Occupancy modeling for detecting potential hornbill nest trees in a secondary forest patch in the Kinabatangan Wildlife Sanctuary, Borneo, Malaysia	Giza	General Session 1.3 - Bird Ecology & Conservation	Ravinder Kaur
257	552	Habitat associations of great argus and Bornean crested fireback in three commercial forest reserves in Sabah, Malaysian Borneo	Giza		Robin Lietz
258	314	15 years of wintering waterbird survey in Hainan: so much land, so little bird...	Giza		Xi Zheng
259	293	Saving the last home of the Green peafowl	Giza		Wanrong Chen
260	777	Abundance of island avian predators in a heavily impacted tropical forest suggests that endemics face greatest risk from landscape changes	Giza		Camille Silvana
261	406	Response of insect and bird communities in tropical rainforests of Papua New Guinea to elevation and disturbance	Giza		Alfred Mani
262	318	The effects of habitat fragmentation on bird song characteristics in a neotropical forest	Giza		Patrick Hart

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
263	567	Male contest competition increases population resilience to habitat change: sexual selection enhances the survival and persistence of Bornean dung beetles within modified forest landscapes	Machu Pichu	General Session 18.1 - Invertebrate Ecology & Conservation	Jonathan Parrett
264	595	Beetles and Beta-Diversity at the SAFE Project	Machu Pichu		Adam Sharp
265	143	Dung beetles (Coleoptera: Scarabaeidae) along elevational and land use gradients on Mt. Kilimanjaro: Which factors predict species richness and abundance?	Machu Pichu		Friederike Gebert
266	833	Factors influencing the distribution of soil-transmitted helminths in a fragmented landscape in Sabah	Machu Pichu		Liesbeth Frias
267	14	Comparative ecology of geometrid moths from tropical Uganda	Machu Pichu		Sille Holm
268	947	Vertical stratification influences global patterns of biodiversity	Chichen Itza	General Session 19.1 - Biodiversity Patterns	Brett Scheffers
269	77	The hidden diversity of trap-jaw ants along elevational gradients in Borneo	Chichen Itza		Daniela Magdalena Sorger
270	613	How many sampling events per year are required to quantify biodiversity change?	Chichen Itza		Kingsly Chuo Beng
271	723	Water availability shapes the functional structure of lowland tropical forest tree communities at both regional and landscape scales in New Caledonia	Chichen Itza		Gregoire Blanchard
272	922	Differing strengths of density dependence between arbuscular mycorrhizal and ectomycorrhizal tree species do not explain the latitudinal diversity gradient	Chichen Itza		Jonathan Myers
273	429	Design, monitoring and evaluation of a direct payments approach for an ecotourism strategy to reduce illegal hunting and trade of wildlife in Lao PDR	Colosseum 1	General Session 20 - Hunting & Trade	Paul Frederick Eshoo
274	379	The trade dynamics of the Philippine Forest Turtle <i>Siebenrockiella leytenensis</i>	Colosseum 1		Emerson Sy
275	368	Impacts of enforcement on Indigenous Peoples and Local Communities: How current enforcement strategies impact communities?	Colosseum 1		Pei Hue Koh
276	342	Evaluating the Effectiveness of Efforts to Combat the Illegal Wildlife Trade	Colosseum 1		Hannah O'Kelly
277	228	Primate research and conservation in Penang: Introducing Langur Project Penang (LPP)	Petra 1	General Session 9.3 - Mammal Ecology & Conservation	Jo Leen Yap
278	296	An alternative approach to salvage a highly threatened ungulate population – a case study on Hainan Eld's Deer (<i>Rucervus eldii</i>)	Petra 1		Michelle Wong
279	341	Spatial patterns of mammalian diversity in Borneo, identified using leech-based molecular sampling	Petra 1		Rosie Drinkwater
280	816	Mammal Diversity in the Heart of Borneo	Petra 1		Boyd Simpson

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
281	985	National Framework for Protected Areas (NFA): Strengthening PA Governance to Fulfil PA Coverage Targets by 2025	Petra 2	General Session 21 - Key Conservation Issues in Malaysia	Sivananthan Elagupillay
282	866	Reaching high towards a UNESCO Biosphere Reserve (BR) status: Penang Hill and its surrounds	Petra 2		Siti Azizah Mohd Nor
283	967	Conservation of Ulu Muda forest for Ecotourism and Ecosystem Services	Petra 2		Ngai Weng Chan
284	601	Biodiversity Conservation in Sarawak, Malaysia	Petra 2		Malcom Demies
285	796	Uncovering karst endemism within Southeast Asia with an emphasis on Bornean Cyrtodactylus	Taj Mahal	General Session 22 - Karst Ecology & Conservation	Hayden Davis
286	791	Seasonal dynamics of stem radial growth of evergreen and deciduous tree species and their responses to microclimate in an Asian tropical dry karst forest	Taj Mahal		Ze-Xin Fan
287	726	Snails, Cement and Conservation: Bridging the science and management of limestone karst biodiversity in the most extensively quarried landscape in Peninsular Malaysia	Taj Mahal		Junn Kitt Foon
288	809	Impacts Of Wildfires On Forest Biodiversity In Indonesian Borneo	Giza		Mark Harrison
289	631	Long-term effects of forest fires on the ranging behavior of siamangs (Symphalangus syndactylus) in southern Sumatra, Indonesia	Giza	General Session 23 - Fire & Tropical Rain Forests	Susan Lappan
290	918	Future changes in Amazon's fire regimes	Giza		Paulo Brando
291	304	Flaming peat: a palaeoecological perspective on burning in tropical peatlands	Giza		Lydia Cole
292	70	The value of forest fragments in maintaining ecosystem services for subsistence farming in West - African Montane forest	Machu Pichu		Murna Tela
293	643	Coffee—can sustainability schemes really address threats to biodiversity conservation?	Machu Pichu	General Session 24 – Ecosystem Services	Matthew Bowie
294	382	The effect of temperature on insect flower visitor and its consequence to the quality and quantity of coffee fruit	Machu Pichu		Hafsah -
295	75	Ecosystem services in tropical agroforestry - opportunities for conservation, mainstreaming, and implementation	Colosseum 1		Bea Maas
296	987	Co-management of conservation area: Local government perspective on the management of conservation area in Banyuasin District, South Sumatra, Indonesia	Colosseum 1	Symposium 18.1 - Making Science Matter - from conservation research to implementation	Zulkifli Idrus
297	86	Promoting community-based bird monitoring in the tropics: Conservation, research, environmental education, capacity-building, and local incomes	Colosseum 1		Cagan Sekercioglu
298	199	Role of actors and conflict in building local capacity to implement conservation decisions on the ground	Colosseum 1		Maria J. Santos
299	173	Toward an open science platform for Asian Soundscape network	Colosseum 1		Joe Chun-Chia Huang
300	909	Translating Conservation Science into Conservation Action	Colosseum 1		Alice Hughes

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
301	456	Anthropogenic climate change in Southeast Asia and its impacts on biodiversity.	Colosseum 2	General Session 25 - Climate Change	Richard Corlett
302	193	Too hot to handle? Vulnerability of the Megapodes (Megapodiidae, Aves) to Climate Change.	Colosseum 2		Robert Davis
303	222	Multi-scale modeling of anthropogenic and climatic drivers of vegetation cover change in the Uttarakhand Himalaya	Colosseum 2		Sujata Upgupta
304	719	Using Open top chambers (OTC) to simulate future warming scenarios in the Paramos, a tropical alpine ecosystem of the Northern Andes	Colosseum 2		Eloisa Lasso
305	555	Complex occurrence changes in a tropical lowland moth community following a decade of warming	Colosseum 2		Wenda Cheng
306	560	Extensive range contraction predicted under climate warming for a gliding mammal in north-eastern Australia	Colosseum 2		Fathimah Handayani
307	335	Elephant messengers: mobiles for Asian elephant conservation in urbanized settings in south India	Petra 1	Symposium 19.1 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension	Anandakumar Mavatur
308	851	Movement responses of translocated elephants in Peninsular Malaysia	Petra 1		Jamie Wadey
309	386	Behavioural responses of Asian elephants to human disturbance in relatively undisturbed habitat	Petra 1		Nachiketha Sharma
310	466	Do new developments in insurance schemes represent a promising new way to facilitate human-elephant co-existence?	Petra 1		Simon Hedges
311	932	Breaking through "Us versus them": how cognitive psychology and hormones help to bridge the divide between humans and elephants	Petra 1		Ee Phin Wong
312	778	Principles of human dimensions in HEC mitigation processes	Petra 1		Alexandra Zimmermann
313	149	Regional scale analysis of bat-virus associations in Tropical Asia to support One Health surveillance	Petra 2	Symposium 20 - Novel techniques and emerging findings in tropical bat ecology and conservation	Heather Davies
314	531	Acoustic Diversity and Activity Pattern of Insectivorous Bats in a Riverine Forest of Gunung Mulu National Park, Malaysian Borneo	Petra 2		Ellen Mc Arthur
315	894	DNA barcoding allows novel insights into the diet of insectivorous bats in Sabah's logged and primary forest	Petra 2		David Hemprich-Bennett
316	216	Into the light: Atypical diurnal foraging activity of Blyth's horseshoe bat, <i>Rhinolophus lepidus</i> on Tioman Island, Malaysia	Petra 2		Marcus Chua
317	823	Home range and space use by the yellow-winged bat (<i>Lavia frons</i>) in a tropical desert	Petra 2		Irene Conenna
318	831	Optimising acoustic survey protocols for bat research in species-rich tropical forests	Petra 2		Adria Lopez Baucells

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
319	461	Developing protocols for locating seed trees by drone	Taj Mahal	Symposium 21 - Seeding resilient forest landscape restoration and its contribution to sustainable development goals	Stephen Elliott
320	892	Private-public partnerships to support conservation and restoration within Malaysia's Central Forest Spine Initiative	Taj Mahal		Dzaeman Dzulkifli
321	830	Diversity for restoration: Scaling up to fail or deliver sustainable development	Taj Mahal		Christopher Kettle
322	300	Capacity-building to promote coal mine site rehabilitation in Kalimantan (Indonesian Borneo)	Taj Mahal		Arbainsyah I
323	978	Gender Matters in Forest Landscape Restoration: A Framework for Design and Evaluation	Taj Mahal		Marlène Elias
324	977	Community mapping, forest restoration and sustainable development	Taj Mahal		Sophie Schwer
325	260	Is regeneration in tropical Afromontane forests declining? An assessment of seed rain and seedling composition and diversity in a Nigerian Montane forest	Giza	General Session 17.2 - Forest Ecology & Conservation	Iveren Abiem
326	82	Shift in community level traits across forest types in tropical Ghana, result of climate changes, phenology changes or both?	Giza		Jesús Aguirre Gutiérrez
327	166	Ecology and conservation of <i>Entandrophragma excelsum</i> , Africa's tallest tree species on Kilimanjaro	Giza		Andreas Hemp
328	323	Use of the spectral reflectance to study the diversity and ecological processes of plant tropical communities.	Giza		Mariana Y. Alvarez-Añorve
329	36	Tropical forests are hyper-diverse because of enemies	Giza		Taal Levi
330	252	Trade-offs between carbon stocks and timber recovery in tropical forests are mediated by logging intensity	Machu Pichu	General Session 26 -Impacts of Logging on Tropical Forests	Anand Roopsind
331	81	How does restoring logged tropical forests affect biodiversity?	Machu Pichu		Cindy Cosset
332	706	The effect of selective logging and topography on canopy tree stoichiometry	Machu Pichu		Tom Swinfield
333	880	Using airborne LiDAR to map the structural impacts of logging and land use change on forest canopies across a gradient of degradation in Sabah, Malaysian Borneo.	Machu Pichu		David Milodowski
334	737	Why are large trees vulnerable to drought, and can management help? The interactive roles of tree size, crown exposure, and logging in drought-induced tree mortality.	Machu Pichu		Alexander Shenkin
335	395	Pan-tropical comparisons of selective logging emissions and potential emission reductions from reduced-impact logging	Machu Pichu		Francis Putz

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
336	832	Fungal community structure along a tropical ultramafic altitudinal transect in Malaysia	Chichen Itza	Symposium 22 - Plant-soil-microbial interactions in the tropics	Francis Brearley
337	99	Plant-soil feedbacks and the dominance of conifers in a tropical montane forest in Borneo	Chichen Itza		Masayuki Ushio
338	878	Fungal and bacterial assembly across soil types and horizons at Lambir Hills, Malaysia	Chichen Itza		Krista McGuire
339	69	Stoichiometric niche shift at a biogeographic juncture: a comprehension of the Sulawesi edaphic mosaic	Chichen Itza		Liam Trethowan
340	92	Influence of soil characteristics on a Bornean heath forest (kerangas) structure, species composition and growth.	Chichen Itza		Giacomo Sellan
341	672	Assembly and consequences of root-fungal associations across a soil fertility gradient in a Bornean rainforest.	Chichen Itza		R. Max Segnitz
342	280	Seasonal waterholes support globally threatened species in the Deciduous Dipterocarp Forests of the Eastern Plains Landscape of Cambodia	Eiffel 1	General Session 27.1 - Miscellaneous Conservation	Chanratana Pin
343	274	Creating Wildlife-Friendly Water Retention Systems in Dry Forest Ecosystems	Eiffel 1		Joanne Li
344	62	Free-ranging livestock in forests encroach the habitat of threatened wildlife	Eiffel 1		Binbin Li
345	814	Sustaining rainforest bird communities in a deforested and heterogeneous landscape	Eiffel 1		Guohualing Huang
346	963	Conservation benefits of tropical multifunctional land-uses in and around a forest protected area of Bangladesh	Eiffel 1		Sharif Ahmed Mukul
347	900	AKECOP: Partnership between ASEAN and Korea towards a sustainable tropical forest ecosystem management	Eiffel 1		Ho Sang Kang
348	402	Strict protected areas are crucial for the conservation of threatened and larger mammal species in the Brazilian Cerrado	Eiffel 1		Guilherme Ferreira
349	21	How Just and Just How? Incorporating Social Equity Considerations into Conservation Research and Decision-Making	Colosseum 1	Symposium 18.2 - Making Science Matter - from conservation research to implementation	Rachel Friedman
350	960	Social media as a novel platform for direct and indirect conservation	Colosseum 1		Akiva Topper
351	549	Making Science Matter - from conservation research to implementation: integrating citizen science in income generation and site management at Veun Sai-Siem Pang National Park, Cambodia.	Colosseum 1		Naven Hon
352	759	Bridging the gap of science and policy: a look on community-based forest conservation approach in the Philippines "Last Ecological Frontier"	Colosseum 1		Rizza Karen Veridiano

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
353	64	Thinking beyond advancing low-carbon pathways to achieving multiple benefits from land-use through REDD+ in developing countries, the Nigeria experience.	Colosseum 2	General Session 28 - Impacts of Land Use Change	Edu Effiom
354	407	Biodiversity loss and carbon emissions from forest conversion to rubber in Asia: can carbon finance help, and what can rubber agroforestry offer?	Colosseum 2		Eleanor Warren-Thomas
355	582	Taking the temperature of human-modified tropical forest landscapes from a mile up using airborne laser scanning	Colosseum 2		Tommaso Jucker
356	381	Land-use change interacts with climate to determine elevational species redistribution	Colosseum 2		Fengyi Guo
357	440	Tool use by elephants - "implication for HEC mitigation" in Udawalawe National Park Sri Lanka	Petra 1	Symposium 19.2 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension	Ashoka Deegoda Gamage
358	574	Translocating "Problem" Elephants – What can we learn from their movement behaviour?	Petra 1		John Mcevoy
359	916	Expanding The Scope Of Conservation: Response To Asian Elephants In Large, Private Landholdings	Petra 1		Varun Goswami
360	338	Finding joint solutions for Human-Elephant Conflict in an intensifying plantation landscape in Sabah, Malaysian Borneo	Petra 1		Cheryl Cheah Phaik Imm
361	702	Scanning the underworld –the global distribution and conservation of cave-dwelling bats	Petra 2	Symposium 23 - Bat ecology and conservation: A pantropical perspective	Krizler Tanalgo
362	514	Effects of agricultural activities on bat community in Madre de Dios, Peru	Petra 2		Farah Carrasco - Rueda
363	688	How Rainforest Transformation to Rubber and Oil Palm affects Chiropteran Diversity at Multiple Dimensions: Insights from Sumatra, Indonesia and Palawan, Philippines	Petra 2		Neil Jun Lobite
364	827	Fungal pathogens and insect herbivores mediate seedling dynamics and diversity patterns along a tropical forest humidity gradient.	Taj Mahal	Symposium 24 - Tropical plant-pathogen interactions in a changing world	Lars Markesteijn
365	676	Understanding endophyte diversity using metagenomics: initial findings from a neotropical rainforest canopy	Taj Mahal		Julian Donald
366	713	How might altered plant-pathogen interactions reduce plant diversity in disturbed forests?	Taj Mahal		Robert Bagchi
367	520	Tropical rainforest fragmentation and plant susceptibility to pathogen attack.	Taj Mahal		Julieta Benitez-Malvido
368	775	Amazonian forest oligarchies are derived from Pre-Columbian unnatural selection	Giza	General Session 29.1 - Human Influence in Tropical Ecosystems	David Campbell
369	915	Fire, forests, and farms: linking pre-Columbian Amazonian legacies to modern forests	Giza		Ted Feldpausch
370	540	Examination of human influence on island biogeography in the Sunda Islands	Giza		Elsbeth Wilman
371	332	Human impacts on forest-savanna bimodality at continental scales in tropical Africa	Giza		Krishnapriya Tamma

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
372	144	Ant-trophobiont interactions inside nests in tropical trees: opening the black box	Machu Pichu	Symposium 25 - Exploring the consequences of anthropogenic change for symbiotic species in tropical ecosystems	Petr Klimes
373	391	Mutualistic ant partners go on 'Leave' in Borneo oil palm plantations	Machu Pichu		Mickal Houadria
374	231	Ant mosaics in tropical lowland forests: Finding drivers of spatial structure	Machu Pichu		Ondrej Mottl
375	202	Diversity and network structure of Crematogaster-Macaranga interactions in different habitats	Machu Pichu		Wanji Chua
376	669	Soil Nematode Community Shifted to Bacterial-Based Food Web in Response to the Tropical Agricultural Plants	Chichen Itza	General Session 30 - Plant-Soil-Microbial Interactions	Ardhini Maharning
377	865	Soil nutrients account for significant variation in species composition of secondary forests on a local, but not landscape scale	Chichen Itza		Michiel Van Breugel
378	500	Decomposition in surface soil in human-modified landscapes of tropical Singapore	Chichen Itza		Tze Kwan Fung
379	128	Soil phosphorus partitioning and species coexistence among arbuscular and ectomycorrhizal trees in tropical and subtropical forests	Chichen Itza		Xubing Liu
380	986	Decision making in the face of post-project impacts: the case of the Amur Falcon in Nagaland, India	Colosseum 1	General Session 31 - Making Science Matter	Neha Sinha
381	74	National Biodiversity Hotspot Identification – Importance of Unpublished Data	Colosseum 1		Naruemon Tantipisanuh
382	367	Evidence-based approaches for proactive protection of tropical wildlife in Southeast Asia	Colosseum 1		Jonathan Hunter
383	620	So where do we begin? Analysing conservation priorities for the Asia Pacific	Colosseum 1		Tasya Sarira
384	211	Harmonizing conservation and development: a tale from Cambodia	Colosseum 1		Jian-Huan Yang
385	578	The Legacy of the Organization for Tropical Studies in Enhancing Conservation Policy in the Tropics	Colosseum 1		Sandy Andelman
386	912	Endau-Rompin Johor National Park – Challenges and Lesson Learnt	Colosseum 1		Lili Tokiman
387	837	Linking life history to the conservation of Amazon River turtles: The effectiveness of conventional and community-based management approaches to turtle conservation at the Rio Trombetas Biological Reserve, Brazil	Colosseum 2	Symposium 26 - Role of Local Community in the Conservation of Tomorrow's Biodiversity	Lou Martini
388	376	Community Forest Management for Biodiversity Conservation and Sustainable Community Development	Colosseum 2		Tapan Kumar Nath
389	498	Our shared heritage, our shared responsibility: putting policy into practice – enabling community participation in the care and protection of vital natural areas	Colosseum 2		Justine Vaz
390	891	Monitoring Poverty in Social Forestry Areas	Colosseum 2		Ahmad Kusworo

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
391	317	Using fecal DNA to estimate Asian elephant population abundance in the Cardamom Mountain Landscape, Cambodia	Petra 1	General Session 32 -Asian Elephant Ecology & Conservation	Sam Un Eam
392	366	Conservation genetics of Asian elephants (<i>Elephas maximus</i>) in peninsula India	Petra 1		Priya Davidar
393	780	Dietary and Herbivory Impacts of Asian Elephants on Forest Structure in Peninsular Malaysia	Petra 1		Vivienne Loke Pei Wen
394	572	Modelling the combined effects of climate change and anthropogenic impact on the future distribution of the Asian Elephant (<i>Elephas maximus</i>) in South Asia	Petra 1		Jean-Philippe Puyravaud
395	486	Genetic Diversity of Sumatran Elephant Population in Bukit Barisan Selatan National Park, Sumatra	Petra 1		Athena Syarifa
396	855	Neotropical bats in a recovering fragmented landscape: effects of matrix regeneration on specialist and generalist species	Petra 2	General Session 33 - Bat Ecology & Conservation	Ricardo Rocha
397	968	Seasonal variation in bat species composition and activity in different habitat types at a humid forest of northeastern Taiwan	Petra 2		Chao-Lung Hsu
398	58	Drivers potentially influencing host-bat fly interactions in anthropogenic Neotropical landscapes at different spatial scales	Petra 2		Luis Daniel Avila Cabadilla
399	573	The impact of the Mauritian flying fox (<i>Pteropus niger</i>) on commercial fruit plantations through high resolution GPS tracking and orchard assessment	Petra 2		Ryszard Oleksy
400	930	Small islands pose big problems for the world's largest bats	Petra 2		Tammy Mildenstein
401	946	Mass-culling of a threatened island flying fox species fails to increase fruit-growers' profits and worsens conservation issues	Petra 2		F. B. Vincent Florens
402	169	Neotropical reforestation hotspots: Biophysical and socioeconomic typologies of contemporary forest expansion	Taj Mahal	Symposium 27 - Socio-ecological dimensions of forest transitions and second growth forests in tropical landscapes	Ana Sofia Nanni
403	413	Spatial models to link landowner decision-making with tree cover dynamics in Southwestern Panama	Taj Mahal		Trevor Caughlin
404	208	Reversals of reforestation in Latin America and the Caribbean between 2001 and 2014	Taj Mahal		Naomi Schwartz
405	320	Assessing the evidence base for nature's contributions to people through forest restoration and reforestation in the tropics	Taj Mahal		Robin Chazdon
406	536	Dynamics and meanings of tropical reforestation for rural livelihoods in Mexico	Taj Mahal		Elena Lazos-Chavero
407	421	Effectiveness of community forest enterprises in conserving biodiversity in Papua New Guinea	Taj Mahal		Micah Scudder
408	209	Ephemeral forests: rapid re-clearing of secondary tropical forests in southern Costa Rica	Taj Mahal		Leighton Reid

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
409	158	Characterizing changes in spatial metrics in expanding mangrove forests	Giza	General Session 34 - Mangroves and Coral Ecology & Conservation	Suyadi Suyadi
410	327	Benthic microalgae in Indonesian mangrove sediments: their nature to adapt unique environment	Giza		Ayu Lana Nafisyah
411	687	Cold tolerance in the black mangrove, <i>Bruguiera gymnorhiza</i>	Giza		Aidan William Short
412	765	Variation in structure, species composition and ecosystem carbon stocks in a deltaic versus estuarine mangrove forest	Giza		Jacob Bukoski
413	789	Dwarfing phenomenon and biomass estimation of a mangrove in the Philippines	Giza		Rempei Suwa
414	758	Exploring Coral Restoration at Dapeng Bay at Southeast China at the Northern Tip of the Coral Triangle	Giza		Yan Zhou
415	328	Zooxanthella expelled from giant clams (<i>Tridacna crocea</i>): possible symbiont source of coral reef ecosystem	Giza		Shin-Ya Morishima
416	311	Tree species and functional distribution in response to a rainfall gradient in Panama.	Machu Pichu	General Session 35 - Spatial Patterns of Tropical Biodiversity	Maria Natalia Umana
417	307	Using joint species distribution modelling to understand the factors that influence the distribution of a key ecological indicator group	Machu Pichu		Elizabeth Raine
418	980	Species-area relationships and biodiversity loss in fragmented landscapes	Machu Pichu		Ryan Chisholm
419	774	Scale-dependent interaction between niche and neutral processes gives rise to plant diversity gradients in tropical forest landscapes.	Machu Pichu		Boris Bongalov
420	412	Ecological drivers of species distribution in <i>Syzygium</i> (Myrtaceae), a hyperdiverse genus of trees in New Guinean forests	Machu Pichu		Kipiro Damas
421	638	Species differences or stochasticity: What drives successional trajectories in local and landscape scale diversities?	Machu Pichu		Gideon Lee
422	566	Borneo's Arboreal Mammals: Diversity and Vulnerability to Habitat Change	Chichen Itza	General Session 36 - Arboreal Mammals Ecology & Conservation	Jessica Haysom
423	887	Current diversity and status of tree squirrels and flying squirrels in Yunnan Gaoligongshan, China: a mega-hotspot for sciurid diversity	Chichen Itza		Li Fei
424	344	Into the canopy: camera traps as an efficient tool for arboreal mammals monitoring and conservation	Chichen Itza		Mariane Kaizer
425	824	Getting off the ground: Can drone-based surveys effectively estimate arboreal mammal populations? A case study for the Koala on Kangaroo Island.	Chichen Itza		Molly Hennekam
426	561	Glide performance and tree usage in the Sunda colugo (<i>Galeopterus variegatus</i>): implications for habitat connectivity	Chichen Itza		Norman Lim
427	535	Distribution and population densities of nocturnal arboreal mammals in Penang Island, Peninsular Malaysia	Chichen Itza		Priscillia Miard
428	463	First results on the status of the elusive Palawan binturong	Chichen Itza		Geraldine Veron

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
429	926	Restoring seed dispersal to an empty forest: a case study from the island of Guam	Colosseum 1	Symposium 28.1 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function	Haldre Rogers
430	83	Mutualistic networks in the Galápagos Islands and how alien species modify their structure	Colosseum 1		Anna Traveset
431	163	Slowed regeneration of native montane forests on Hawai'i: ecological thresholds and alternative stable states	Colosseum 1		Evan Rehm
432	164	Functional restoration attempts in Island forests: Why redundancy wins in the short term	Colosseum 1		Susan Cordell
433	45	Extinction-Driven Changes in Frugivore Communities on Oceanic Islands	Colosseum 1		Julia Heinen
434	140	The Small-Island Effect Revisited: Patterns and Drivers of Species Richness on Small Islands in a Tropical Archipelago	Colosseum 1		Julian Schrader
435	619	Filling the knowledge gaps for conservation of priority tree species: Introduction to the session	Colosseum 2	Symposium 29 - Spatial analysis to support conservation and restoration planning for tropical tree species	Riina Jalonen
436	944	Predicting Dipterocarp Distribution for Prioritizing Conservation Areas in Sabah	Colosseum 2		Yew Leung Lee
437	152	Plant material transfer guidelines of important tropical tree species and its application for forest rehabilitation	Colosseum 2		Kevin Kit Siong Ng
438	181	Life history approach to develop genetic conservation guidelines of forest tree species in the tropics	Colosseum 2		Soon Leong Lee
439	151	Genetic diversity assessment of <i>Intsia palembanica</i> and its implications for conservation	Colosseum 2		Chin Hong Ng
440	459	Functional diversity is a poor representation of ecosystem functioning changes caused by habitat disturbance	Petra 1	Symposium 30.1 - Trophic interactions in human-modified tropical landscapes	Cristina Banks-Leite
441	257	Dung Beetle And Mammal Interaction Networks Across A Multi-Use Landscape In Sabah	Petra 1		Li Yuen Chiew
442	493	Tree and bird communities show parallel responses to loss of forest cover in a human-modified landscape in central Panama	Petra 1		Daisy Dent
443	378	Effect of tropical forest disturbance on the competitive interactions within a diverse ant community	Petra 1		Ross Gray
444	346	Diet shift of mobile predators in response to habitat disturbance	Petra 1		Victoria Kemp

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
445	176	Role of specialized and facultative nectar-feeding bats in the pollination network in the agricultural system	Petra 2	Symposium 31 - Advances in the understanding of tropical bats as pollinators and seed dispersers	Tuanjit Sritongchuay
446	102	Flying foxes, plants, and people: conserving an uncharismatic animal of ecological and economic importance	Petra 2		Sheema Abdul Aziz
447	145	Big roles from big bats! From the world's smelliest fruit to the lush forests of Indonesia	Petra 2		Sheherazade Sheherazade
448	628	Utilisation of DNA Barcoding in Assessing the Diversity of Bats and Their Phytophagous Diet in Peninsular Malaysia	Petra 2		Voon Ching Lim
449	905	Reproductive biology of a critically endangered mangrove, <i>Sonneratia griffithii</i> Kurz 1871, in Satun province, Thailand	Petra 2		Christine Ely Nuevo Diego
450	120	Knowledge, Attitude and Perception among Durian Growers toward Bats Visiting Their Durian Orchards in Kuala Nerus, Terengganu, Malaysia	Petra 2		Nor Zalipah Mohamed
451	920	Are there synergistic effects of drought and fragmentation on the demography of tropical understory plants?	Taj Mahal	Symposium 32.1 - Frontiers in demographic modeling for tropical forest ecology and conservation	Emilio Bruna
452	272	Relating demography and primary productivity among tree species and across forests	Taj Mahal		Takashi Kohyama
453	559	Using Integral Projection Models to study the effects of forest fragmentation on the population dynamics of a late-successional tropical tree	Taj Mahal		Jenny Zambrano
454	924	Variation in germination and survival of early life history stages affects the population growth of palms across their elevational ranges.	Taj Mahal		Rachel Hillyer
455	37	Low reproductive values confer resilience of mangrove species to harvest	Taj Mahal		Orou Gaoue
456	457	Beyond density-dependence alone: How density-dependent and independent mechanisms together determine species abundance in a common tree species.	Taj Mahal		Marco Visser
457	161	Pervasive decline in lianas in Congo basin contrasts with global patterns	Giza	Symposium 33 - Lianas and their impact on ecosystem processes	Frans Bongers
458	258	Linking landscape-scale liana infestation to carbon storage using airborne hyperspectral imagery	Giza		Chris Chandler
459	658	Branch development helps explaining the greater success of lianas over trees in dry compared to wet forest.	Giza		Frank Sterck
460	593	LIANAS DECREASE BIOMASS ACCUMULATION IN EARLY SUCCESSIONAL TROPICAL FORESTS	Giza		Sergio Estrada Villegas
461	959	Forest resilience to global liana proliferation	Giza		Andrew Marshall
462	436	Assessing the impact of lianas on tree growth in tropical forests	Giza		Elizabeth Kearsley
463	134	Lianas and trees: insect folivory and leaf traits in an Australian subtropical rainforest	Giza		Erica Odell

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
464	292	The most marketable wild edible mushrooms in the northern lowland of Papua, Indonesia	Machu Pichu	General Session 29.2 -Human Influence in Tropical Ecosystems	Supeni Sufaati
465	884	Linking RSPo Compensation to Village Forest. Case Study: Laman Satong Village Forests	Machu Pichu		Tito Indrawan
466	844	The legal basis for Forest Management Units as Conservation practitioners in Aceh Province, Indonesia	Machu Pichu		Silfi Iriyani
467	675	The cultural significance and conservation of <i>Dipterocarpus hasseltii</i> Blume in sacred groves in Bali, Indonesia	Machu Pichu		Ni Kadek Erosi Undaharta
468	276	Conservation of sacred groves of the Western Ghats: contrast in perception among rural and urban neighborhood communities	Machu Pichu		Prashanth Ballullaya U
469	326	Are perceptions of biodiversity and ecosystem service provision linked with attitudes towards conservation? Evidence from eastern Amazon, Brazil	Machu Pichu		Sergio Milheiras
470	20	A Family Resilience Conceptual Model for Exploring the Sustainability of Forest Adjacent Communities in Africa.	Machu Pichu		Ian Munanura
471	603	Morphological and behavioral specialization of tropical butterflies permits persistence in marginal environments	Chichen Itza	General Session 18.2 - Invertebrate Ecology & Conservation	Timothy Bonebrake
472	846	Species and trait diversity of an insular tropical Lepidoptera assemblage across space and time	Chichen Itza		Catherine Hulshof
473	849	Inter-annual Monitoring Improves Capture of Regional Tropical Butterfly Assemblages	Chichen Itza		Chung Lim Luk
474	539	Treading the Wallacean shortfall for an endangered, iconic and in-demand tropical butterfly (<i>Teinopalpus aureus</i>)	Chichen Itza		Shuang Xing
475	691	Altitudinal filtering of Planthopper (Insecta Hemiptera Auchenorrhyncha) on Mont Wilhelm (Papua New Guinea)	Chichen Itza		Eric Guilbert
476	962	Diversity of the <i>Onchocerca</i> genus and emergence of zoonotic infections	Chichen Itza		Coralie Martin
477	591	A nuanced insight into the impacts of tropical forest degradation on medium-large mammals	Eiffel 1	General Session 9.4 - Mammal Ecology & Conservation	Nicolas Deere
478	448	Surviving in a degraded forest environment: foraging strategies and space use of northern pigtailed macaques (<i>Macaca leonina</i>) in Sakaerat Biosphere reserve, Northeastern Thailand.	Eiffel 1		Eva Gazagne
479	288	Passive acoustic monitoring unveil howler monkeys' vocal repertoire and call functions	Eiffel 1		Leandro Do Nascimento
480	897	A Test Of Species Delimitation And Biogeography Hypothesis Using Southeast Asian Round-Leaf Bats (Genus <i>Hipposideros</i>)	Eiffel 1		Faisal Ali Anwarali Khan
481	752	A Preliminary Observation on Activity Patterns of Two Porcupine Species using Camera Traps in Sarawak, Malaysia	Eiffel 1		Marina Mohd. Top @ Mohd. Tah
482	125	Modelling spatial distribution of northern swamp deer subspecies <i>Rucervus duvaucelii duvaucelii</i> across upper Gangetic plains, India using survey and molecular data	Eiffel 1		Shrutarshi Paul
483	330	Fragmented forests: overlooked avenues for tropical small carnivore conservation?	Eiffel 1		Wyatt Petersen

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
484	183	When effective conservation of oceanic island plant species depends on systematic understanding of natural history: Case of Mauritius endemic <i>Roussea simplex</i> (Rousseaceae)	Colosseum 1	Symposium 28.2 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function	Prishnee Bissessur
485	715	Divergence in carotenoid pigments and resultant island endemism of flameback woodpeckers in a tropical island	Colosseum 1		Sampath Seneviratne
486	35	Introduction of Barn Owls in a Tropical Island in the South China Sea for the Control of Rodent Pest Population and for Ecology Studies	Colosseum 1		Shakinah Ravindran
487	945	Major positive benefits of mechanical control of invasive alien plants on the woody plant community of an oceanic island	Colosseum 1		Claudia Baider
488	530	Evaluating the social and ecological factors behind the 2015 extreme fire event in Sumatra, Indonesia	Colosseum 2	Symposium 34 - Integrating perspectives to address social-ecological challenges in conservation	Janice Ser Huay Lee
489	324	Taking a multi-dimensional approach to human-wellbeing - impacts of community forest management in Indonesian Borneo	Colosseum 2		Kerrie Wilson
490	213	Intention to kill: Tolerance and illegal persecution of Sumatran tigers and sympatric species	Colosseum 2		Freya St John
491	501	Surveys for Exotic and Rare Native Pigs in Baluran National Park and Adjacent Areas, East Java	Colosseum 2		Betty Millyanawati
492	489	Freshwater fish suffer large reductions in species and functional richness while maintaining provisioning ecosystem service across a land use gradient in Borneo	Petra 1	Symposium 30.2 - Trophic interactions in human-modified tropical landscapes	Clare Wilkinson
493	101	Ant assemblage composition explains high predation pressure on artificial caterpillars during early night	Petra 1		Zhenghong Wang
494	365	Freshwater food webs in the tropics: drivers of structure and responses to anthropogenic habitat modification	Petra 1		Jia Huan Liew
495	836	Mini-cascade: ants exert top-down control on hemipteran herbivores and predators	Petra 1		Anna Goldman
496	136	Alley-cropping System Can Boost Arthropod Biodiversity in Oil Palm Production Landscapes	Petra 2	General Session 37 - Oil Palm & Sustainability	Mohamad Ashraf Abdul Mutalib
497	686	Fish Fauna From Conservation Area In Oil Palm Plantation On Peat	Petra 2		Ella Michael Dosi
498	861	The value of riparian buffers for conservation in oil palm plantations	Petra 2		Sarah Luke
499	502	Effects of leaf litter quality and riparian buffer structure on community dynamics of bacterial decomposers in oil palm plantations	Petra 2		Darshanaa Chellaiah

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
500	496	When seed dispersal matters: extracting information of diversity maintenance mechanisms and demography from spatial-point patterns and seed dispersal networks	Taj Mahal	Symposium 32.2 - Frontiers in demographic modeling for tropical forest ecology and conservation	Wirong Chanthorn
501	247	Individual heterogeneity drives population growth and induces functional equivalence in Malaysian rainforest trees	Taj Mahal		Pieter Zuidema
502	504	Demography of Javanese Edelweiss (<i>Anaphalis javanica</i> (DC.) Sch.Bip.) on Selo Hiking Track, Semuncar Resort, Merbabu Mountain National Park: A Baseline Measurement for Population Management	Taj Mahal		Umi Purn amasari
503	642	Density-Dependent Mortality of Dipterocarp Seedlings within the Degraded Forest of Sungai Tiagau Forest Reserve	Taj Mahal		Thian Yew Loke
504	148	Frequent hybridization and obligate pollination may facilitate species diversification of <i>Ficus</i> plants	Giza	General Session 38 - Pollination & Ecosystem Services	Jin Chen
505	739	The relative importance of herkogamy and reciprocity in determining disassortative pollen transfer and fruit set in a stigma height dimorphic species	Giza		Shatarupa Ganguly
506	769	Seed and pollen dispersal of African timber tree species - implications for sustainable forest exploitation	Giza		Olivier Hardy
507	474	The birds, the bats, the bees and the chocolate trees: Achieving sustainable agriculture in the Afrotropics through DNA metabarcoding and network analysis	Giza		Luke Powell
508	581	Habitat use by king cobras in a palm oil plantation in southern Borneo	Machu Pichu	General Session 39 - Reptile Ecology & Conservation	Muhammad Silmi
509	835	Varanus Salvator Population Dynamics And Parasite Diversity: A Fast Food Effect In A Fragmented Landscape	Machu Pichu		Sergio Guerrero
510	278	Habitat-specific warming responses in an Afrotropical skink	Machu Pichu		Felix Landry Yuan
511	767	Movement ecology and natural history predict human-snake conflict patterns	Machu Pichu		Anne Devan-Song
512	722	The home range and movement behaviours of a pack of free-roaming dogs in Singapore.	Chichen Itza	General Session 40 - Altered Ecosystems Ecology & Conservation	Dajun Wang
513	115	Species composition of native mammals in urban forest patches in Selangor, Malaysia	Chichen Itza		Sze Ling Tee
514	340	Resilience of heronry birds to urbanization	Chichen Itza		Roshnath Ramesh
515	674	Temporal changes and compositional organization of ant communities along vegetation succession in Hong Kong	Chichen Itza		Ho Lee
516	281	Assessment of plant phenological responses in the tropics based on gene expression analyses and mathematical modeling	Eiffel 1	General Session 41 - Plant Phenological Patterns	Akiko Satake
517	585	Toward establishing detailed baseline tree phenology responses to climate drivers for the central Congo Basin	Eiffel 1		Koen Hufkens
518	729	Quantitative indices of leafing phenology in woody tree species from a seasonally dry tropical forest	Eiffel 1		Souparna Chakrabarty

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
519	659	How do we decide which wildlife corridors to conserve? Prioritizing connections to maximize regional biodiversity persistence	Colosseum 1	Symposium 35 - Connectivity in Tropical Landscapes	Jedediah Brodie
520	792	Growing a corridor: incorporating simulated animal movement and location weighting into iterative connectivity optimization	Colosseum 1		Sara Williams
521	214	Decision support for restoring ecological networks in tropical developing countries using Condatis	Colosseum 1		Jenny Hodgson
522	657	Species traits predict variation in environmental thresholds across logged forests and riparian reserves	Colosseum 1		Simon Mitchell
523	852	Human behaviour as a spatio-temporally varying barrier to species connectivity	Colosseum 1		Divya Vasudev
524	548	Cultural and biological connectivity in a massive conservation corridor in the Putumayo watershed in South America	Colosseum 1		Corine Vriesendorp
525	283	Global map on the ecological uncertainty of forest landscape restoration success	Colosseum 1	General Session 42 - Disturbance, Succession & Restoration	Renato Crouzeilles
526	785	Evaluating Tropical Dry Forest Responses to Landscape Degradation and Forest Succession Based On Sounds Of Nature	Colosseum 1		Natalia Norden
527	430	Comparing the recovery trajectories in taxonomic and functional composition between young secondary and old-growth forests after an extensive tree fall event	Colosseum 1		Kwek Yan Chong
528	93	Ecological recovery of soil quality through intercropping of rubber plantation	Colosseum 1		Zhila Hemati
529	509	Rainforest regeneration and restoration investigated using DNA barcoding in the Lower Kinabatangan Floodplain, Sabah, Malaysian Borneo.	Colosseum 1		Natasha De Vere
530	96	Tropical secondary forest enrichment using giant stakes of keystone figs	Colosseum 1		Rakan Zahawi
531	741	Rethinking the tropical sustainable-use protected area paradigm	Colosseum 2	General Session 27.2 - Miscellaneous Conservation	
532	673	Multinational collaborations in ecology and environmental science within Asia: current status and pathways forward.	Colosseum 2		Eben Goodale
533	772	Dynamic biodiversity management at range edges	Colosseum 2		Alison K.S. Wee
534	714	Training Indigenous Scientists to Build a Base for Conservation in the Baram River Basin, Malaysian Borneo	Colosseum 2		Fiona Mcalpine
535	546	Tambora Muda: Enhancing the capacity building and networking among young conservationists to aid biodiversity conservation in Indonesia	Colosseum 2		Marsya Sibarani
536	750	Status and Distribution of Forest Partridge in the Thai Peninsula: a worrying situation	Colosseum 2		Tiwa Ong-in

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
537	287	The short lived haven of plantation forests for <i>N. bengalensis</i>	Petra 2	General Session 43 - Ecology & Conservation in Tropical Tree Plantations	Katie Oliver
538	857	Bearded pig (<i>Sus barbatus</i>) utilisation of a fragmented forest–oil palm landscape in Sabah, Malaysian Borneo	Petra 2		David Kurz
539	868	Biodiversity Conservation Value of Forest Fragments for Birds in Swidden vs. Oil Palm Plantations in West Kalimantan, Indonesia	Petra 2		Trifosa Iin Simamora
540	701	Rubber plantations replace forest ant species with habitat generalists with larger geographic distributions: a case study in Xishuangbanna, China, and a global meta-analysis.	Petra 2		Mark Jun Alcantara
541	817	Do ecosystem services benefit from intercropping in oil palm smallholdings?	Petra 2		Peter Van Der Meer
542	760	Effect Of Biochar Application To Nitrous Oxide Emission From Oil Palm Cultivation	Petra 2		Norliyana Zin Zawawi
543	428	Biodiversity of ecological communities in three isolated hills in Sri Lanka	Taj Mahal	General Session 17.3 - Forest Ecology & Conservation	Nimal Gunatilleke
544	646	Seedling Diversity and Dynamics across Multiple Land Uses in South Central Sabah	Taj Mahal		Richard Bryan Sebastian
545	205	Can variation in seed removal patterns of Neotropical pioneer tree species be explained by local ant community composition?	Taj Mahal		Selina Ruzi
546	268	Functional traits moderate plant recruitment in a wind-disturbed tropical lowland rainforest in Singapore	Taj Mahal		Hao Ran Lai
547	927	A proposed correction formula for litterfall production measurements in a tropical lowland forest	Taj Mahal		Sara Fern Leitman
548	242	Stand structural components and species richness across four land-use systems in Sumatra	Taj Mahal		Katja Rembold
549	401	Population census and conservation status of the Skywalker hoolock gibbon (<i>Hoolock tianxing</i>) in China	Giza	General Session 44 - Gibbon Ecology & Conservation	Lu Yan
550	223	Habitat assessment and population viability analysis for the Cao-vit gibbon (<i>Nomascus nasutus</i>) in Trung Khanh Forest, Northern Vietnam	Giza		Hoang Trinh Dinh
551	117	Home range use by Javan Gibbons (<i>Hylobates moloch</i>) in Submontane Tropical Forest, Indonesia	Giza		Rahayu Oktaviani
552	472	Assessment of Community-based Initiatives in conservation project for the World's Most Critically Endangered Primate	Giza		Wing Yee Fok
553	958	Immatures grow too fast? Age difference in activity budget, feeding and ranging behavior of wild Javan gibbons (<i>Hylobates moloch</i>) is not obvious	Giza		Ahyun Choi
554	882	Do seasons and reproductive status affect foraging time and diet composition in wild Javan gibbon (<i>Hylobates moloch</i>)?	Giza		Saein Lee

No	Paper Number	Paper Title	Session - Location	Session Name	Presenting Author Name
555	313	How we measure diversity matters: assessing variation in biodiversity indicators across a gradient of human disturbance in tropical forest.	Machu Pichu	General Session 19.2 - Biodiversity Patterns	Laura Allen
556	364	Scaling up latitude beta-diversity relationships using ForestGEO plots	Machu Pichu		Rachakonda Sreekar
557	734	Discovering the shape of biodiversity of dominant tree family Dipterocarpaceae from the edge to the core of the distribution	Machu Pichu		Tijana Cvetkovic
558	408	How much of the global spatiotemporal variation in tropical woody net primary productivity is attributable to meteorological conditions?	Machu Pichu		Sami Rifai
559	667	Spatial patterns in the vegetation of a tropical montane cloud forest in Horton Plains, Sri Lanka in relation to disturbance	Machu Pichu		Tithira Lakkana
560	727	Taxonomic diversity pattern of tropical woody plant species across the globe	Machu Pichu		Junichi Fujinuma
561	270	Effects of forest fragmentation on gene flow in two dipterocarp tree species in tropical rain forests in Sarawak, Malaysia	Chichen Itza	General Session 45 - Forest Fragmentation	Satoshi Nanami
562	375	The conservation value of small forest fragments within monoculture rubber plantations in Xishuangbanna, China.	Chichen Itza		Salindra Dayananda
563	562	Fern and tree communities in the fragmented tropical forest of China	Chichen Itza		Daniele Cicuzza
564	694	Genome-wide data reveal patterns of small scale connectivity across fragmented landscape in six songbird species	Chichen Itza		Emilie Cros
565	354	Regional context drives the spatial scale that best predicts seed rain responses to landscape structure in fragmented rainforests	Chichen Itza		Miriam San José

SYMPOSIUM 1.1

Built Infrastructure and the Future of Tropical Forests

Infrastructure Expansion and the Future of Tropical Forests

William F. Laurance, PhD, FAA, FAAAS, FRSQ

Distinguished Research Professor & Australian Laureate
Director of the Centre for Tropical Environmental and Sustainability Science
James Cook University, Cairns, Queensland, Australia

The 21st century will see an unprecedented expansion of roads, dams, power lines, and gas lines, as well as massive investments in mining and fossil fuel projects. At least 25 million kilometers of new roads are anticipated by 2050. Nine-tenths of all road construction is projected to occur in developing nations, including many that sustain tropical ecosystems with exceptional biodiversity and ecosystem services. The penetration of roads and other infrastructure into remote or frontier areas is a major proximate driver of habitat loss and fragmentation, overhunting, and other environmental degradation. Unfortunately, much road proliferation is poorly planned, chaotic, or illegal, and the rate of expansion is so great that it often overwhelms the capacity of environmental planners and managers. Even for high-profile road and infrastructure projects, cost-benefit analyses and environmental assessments are generally inadequate—or, worse, systematically biased—leading to serious long-term economic, social, or environmental impacts. I will sketch ongoing efforts to plan, prioritize, and mitigate rapid infrastructure expansion in tropical developing nations.

Paper Number: 142

Monday, 02 July 2018 | Colosseum 1

Symposium 1.1 - Built infrastructure and the future of tropical forests

Planning for biodiversity conservation needs to be a core value for China's 'Belt and Road Initiative'

Alex Mark Lechner, Faith Ka Shun Chan and Ahimsa Campos-Arceiz

China's Belt and Road Initiative (BRI) (also known as "One Belt One Road") is potentially the largest infrastructure development initiative in our lifetime. Costing more than four trillion US dollars, BRI will connect roughly half of the world's population across 65 countries throughout much of the Old World with land and marine routes, potentially having immense impacts on biodiversity at a global scale. While the economic and geopolitical implications of BRI have been discussed there is a need to address the implications for biodiversity, particularly in Asia.

Infrastructure and its impacts, such as disruption of ecological connectivity, are key drivers of biodiversity loss in the Anthropocene. BRI will cross a number of the world's terrestrial and marine biodiversity hotspots creating obvious and very important threats for biodiversity. Roads, for example, open a Pandora's box of environmental impacts such as habitat loss, fragmentation, invasive species, and illegal activities such as poaching and logging. In the marine environment, increased sea traffic exacerbates the movement of invasive species and pollution, which is especially concerning as BRI's maritime routes cross the coral reef triangle, often described as the Amazon of the seas.

In this presentation we discuss the potential range of impacts from BRI and present preliminary mapping describing its potential impacts on biodiversity. We then go on to discuss possible ways of mitigating BRI's negative impacts and identify opportunities for biodiversity. If BRI adopts conservation as one of its core values, it could be a positive force for biodiversity, and for example, plan and implement a network of protected areas across Eurasia. Conservationists, planners, and decision-makers need to think outside of the box about BRI's biodiversity implications to ensure that biodiversity is at the core of BRI's values rather than an afterthought.

Paper Number: 122

Monday, 02 July 2018 | Colosseum 1

Symposium 1.1 - Built infrastructure and the future of tropical forests

Infrastructure Expansion and the Indonesian Borneo Tropical Forests

Mohammed Alamgir*, Mason J. Campbell, Sean Sloan, William F. Laurance

Centre for Tropical Environmental and Sustainability Science
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Abstract Indonesian Borneo (Kalimantan) houses ~41 million hectares of tropical forest with global environmental significance. Currently, numerous infrastructure expansion projects are occurring in the region aiming to boost economic growth. We spatially analyzed the potential impacts of this infrastructure expansion on tropical forests and agro-economic development in the region. We found that many routes will entail numerous detrimental ecological impacts, including limiting faunal movement, reducing habitat connectivity, creating isolated forest patches, fragmenting current intact forests, substantially increasing forest edge effects, and reducing core forests habitat area. Furthermore, several routes will dissect a number of current protected areas, potentially undermining Indonesian efforts to achieve the Aichi target 11 of the Convention on Biological Diversity (CBD) i.e. 17% terrestrial protected area connectivity by 2020. These infrastructure expansions are likely to facilitate the further development of extractive industries, namely, mining, logging, and oil palm estate agriculture but they are highly unlikely to generate the envisioned agro-economic development. Our study suggests that the current increasing trend of infrastructure expansion- ignoring the environmental values at the core of the approach- sharply increases the likelihood of serious ecosystem decay in the tropical forests of Indonesian Borneo.

Paper Number: 212

Monday, 02 July 2018 | Colosseum 1

Symposium 1.1 - Built infrastructure and the future of tropical forests

Why did the elephant cross the road? Roads and megafauna in Peninsular Malaysia

Ahimsa Campos-Arceiz, Jamie Wadey, Hawthorne L. Beyer, Salman Saaban,
Nasharuddin Othman, Shiori Yamamoto-Ebina, Peter Leimgruber

Terrestrial megafauna – with their large spatial requirements – are particularly sensitive to the negative impacts of roads, which destroy their habitats, constrain their movements, and may increase mortality risk. Here we present ongoing work to understand the impact of a road that bisects prime Asian elephant (*Elephas maximus*) habitat in the Belum-Temengor Landscape, northern Peninsular Malaysia. We used GPS telemetry and a mechanistic modelling framework to analyse the response of 17 wild elephants to the road. Elephants crossed the road on average 3.9 ± 0.6 times a month, mostly (81% of times) at night, and crossing was not evenly distributed in space. The road caused a strong and consistent barrier effect for elephants, reducing permeability an average of 79.5%. Elephants, however, were attracted to the proximity to the road. We also analyzed the micro-histological plant content of 30 fresh elephant dung piles from the roadside (10 dung piles) and from the forest far away from the road (20 piles). These analysis showed very different diet of elephants living by the road, compared with elephants staying in the forest. Roadside elephants have a grass-dominated diet while other elephants have a more diverse diet and consume few grasses. Abundant food (grasses, early succession plants) seems to be what attract elephants to the roadsides. Given that risk of mortality (from poaching and vehicle collisions) increases near roads, roads may, therefore, create attractive sinks for elephants. We provide specific recommendation to mitigate the impact of this particular road on elephants and conclude the talk speculating with the potential impact of roads on elephants' ecological function and the risk that expected Belt and Road Initiative developments will bring to terrestrial megafauna in Southeast Asia.

Paper Number: 982

Monday, 02 July 2018 | Colosseum 1

Symposium 1.1 - Built infrastructure and the future of tropical forests

Infrastructure Development and Environmental Governance: Lessons from the Indonesian Leuser Ecosystem and the Global Tropics

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INTRODUCTION: Major transportation infrastructure development projects are increasingly prominent in the global tropics, including Indonesia. While not new, their scale, context, and implications deviate from historical norms in key respects.

OBJECTIVE: This presentation synthesises these deviations and their implications for environmental governance and conservation planning. Specific reference is made to infrastructure developments in Indonesia's Leuser Ecosystem. The Leuser Ecosystem is a globally-significant conservation landscape threatened by infrastructure development, partly enabled by shifts in forest governance between Indonesia's central and regional governments.

METHODS: Pantropically, various recent and historical major transportation infrastructure development projects were surveyed to observe differences in the following key criteria: scale, financing, rationale (e.g., commerce, nation-building), environmental and economic context, and conservation implications. In northern Sumatra, host to the Leuser Ecosystem, a spatial index of planning conflict between environmental values and agricultural development potential was defined. Additionally, unofficial road developments as well as official planned road, electrical generation, and electrical transmission developments were mapped to quantify their coincidence with forest corridors, core forest areas, and forests designated for protection, production, or conversion.

RESULTS: In northern Sumatra, planning conflicts concentrate in the Leuser Ecosystem due to high agricultural potential and activities in protected forests, often formerly exploited and now undergoing de facto conversion. Unofficial roads in the Leuser (6818 km) were nearly double official roads (3597 km), and half of all roads occurred in forests, particularly exploited forests. Resultant small forest fragments and forest corridors comprise 27% of the ecosystem, and most are subject to degradation and conversion. Eight conservation priority areas are identified by concentrations of road developments producing vulnerable corridors and fragments. Planned infrastructure developments, which coincide with planning conflicts and forest incursions, would threaten these priority areas, contradicting national planning directives. These results resonate with pantropical trends. Current developments are distinguished from historical precedents in that they often explicitly consolidate the economic and agricultural activities of already degraded, often weakly-governed landscapes, including those established by earlier developments and subsequent illegal incursions.

IMPLICATIONS: Infrastructure developments in the Leuser Ecosystem are framed by a recent, assertive posture towards decentralised forest governance, itself facilitated by volatile forest governance. Such assertive decentralisation is poised to become more common in Indonesia following shifts to forest governance, coincident with major transportation infrastructure developments in its other forested regions. In Indonesia, as pantropically, the consolidative nature of current developments is especially poised to threaten remnant habitats and their isolated, threatened species.

Paper Number: 744

Monday, 02 July 2018 | Colosseum 1

Symposium 1.1 - Built infrastructure and the future of tropical forests

Distributions of tigers and prey in the Thailand's world heritage site as baseline for strengthening connectivity for species recovery

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¹ Department of National Parks, Wildlife and Plants Conservation, Thailand

² Wildlife Conservation Society (Thailand Program)

Conservation of large mammals such as tigers and their main prey; gaur, banteng, sambar, wild pig, and muntjac requires a systematic and statistically rigorous monitoring system that accounts for imperfect detection. To conserve a large, wide-ranging carnivore like the tiger, it is critical not only to maintain populations at key habitat sites, but also to enable the persistence of their main prey species across landscapes. It is essential to benchmark and monitor the process by which anthropogenic pressures, landscape features determine tiger and prey distribution and habitat use. This is necessary to enable a recovery of tigers, their prey and their habitats. In this study, we report an occupancy study from the world heritage site, Dong Phrayayen-Khao Yai (DP-KY) Forest Complex. With five contiguous protected areas, the landscape qualified as the second "tiger source site" of Thailand. To determine factors that affect distribution patterns of tiger and its prey, we conducted occupancy surveys throughout the DP-KY landscape during April-September 2017, covered 33 grids of 256 km² with total of 1,370 km. Using Correlated-detections model (Hines et. al., 2010); we estimated that tigers occupied 51.8% of the landscape. Occupancy models revealed that tiger mostly occupied in Thap Lan and Pang Sida National Park whereas our survey yielded no signs of tiger in Khao Yai National Park. The probability of occupancy estimates for gaur, banteng, sambar, wild pig, and muntjac are 38.12%, 2.42%, 13.49%, 44.19%, and 21.92%, respectively. Occupancy models have shown uniform distributions of gaur and wild pig across the landscape, which is an important finding to provide a quantitative assessment of prey availability as the potential in habitat recovery for tiger. Large prey availability together with the on-going habitat corridor project as well as protection efforts will support discrete tiger populations in Thap Lan and Pang Sida National Parks move through habitats in the landscape. The approach used in this study highlights an extraordinary opportunity to attain recovery goals and sustain viable populations of large, endangered wildlife like tigers and their prey in the DP-KY landscape.

Paper Number: 170

Monday, 02 July 2018 | Colosseum 1

Symposium 1.1 - Built infrastructure and the future of tropical forests

SYMPOSIUM 2.1

Environmental Sustainability in Oil Palm: Linking Science to Policy and Practice Across the Tropics

Designing oil palm landscapes to optimise biodiversity and ecosystem functions

Jake E. Bicknell

Durrell Institute of Conservation and Ecology, University of Kent

Agricultural production for palm oil is the primary driver of tropical forest loss in southeast Asia. This has led to concerns that in order to meet the increasing demand for palm oil, biodiversity and ecosystem functions are being eroded, and greenhouse gas emissions elevated. Consequently, climate change and the long-term persistence of biodiversity in this area are dependent on the manner in which agricultural landscapes are established and managed. Within oil palm plantations, conservation set-asides are a requirement of some national legislations and certification schemes, however these differ in the area and manner in which set-asides are achieved. For example, when establishing plantations, riparian buffer zones are often retained as forest, however, the required width of these vary and are not necessarily based on scientific evidence. Consequently, there is scope for policies to change, particularly where certification schemes may have greater set-aside targets than do national regulations. To assess the impacts of changing policies, we draw on a large dataset of biodiversity and ecosystem function metrics from Sabah, Malaysian Borneo, in combination with commercial plantation data. We use these to conduct an optimisation exercise to consider the trade-offs between policies and their outcomes regarding securing ecosystem functioning and biodiversity while minimising impacts to oil palm plantations. We worked closely with industry stakeholders to develop realistic policy change scenarios, and use these to test and identify optimal scenarios. Among the best performing scenarios, we demonstrate that increasing the width of riparian buffer zones is highly beneficial for biodiversity and forest functioning, at only minimal cost to oil palm producers.

Paper Number: 399

Monday, 02 July 2018 | Colosseum 2

Symposium 2.1 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Paying back the carbon and biodiversity debts from oil-palm plantations in Kalimantan, Indonesia

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Purwodadi Botanic Garden-Indonesian Institute of Sciences, Indonesia

In global market, consumers demand environmentally-sustainable products. With oil-palm development recognized as contributor to deforestation with impacts on carbon emissions and biodiversity, the palm-oil industry is required to become more environmentally sustainable. Environmental offsetting is an emerging policy to mitigate the impacts of development. I will present our collaborative work on the potential of carbon and biodiversity offsetting by oil-palm plantations in Kalimantan. Using a backcasting approach combined with spatial decision analyses, we identify cost-effective areas for restoration offsetting. Our study reveals that restoring degraded peatlands is the most cost-effective strategy for offsetting carbon emissions. Far larger areas to restore with higher costs are required to offset biodiversity losses. We therefore suggest that future oil-palm expansion should target degraded lands on mineral soils to minimise offset liabilities. Our findings clarify the importance of conserving tropical peatlands and primary forests, and the high costs associated to replace these areas when destroyed.

Paper Number: 129

Monday, 02 July 2018 | Colosseum 2

Symposium 2.1 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Minimising the biological impacts of oil palm expansion in the Neotropics

David Edwards

Oil palm is rapidly expanding from its Southeast Asian epicentre of production into Africa and Latin America. Key to the sustainable expansion of oil palm is to identify locations where it can replace land-uses with minimal impact on biodiversity-rich habitats of conservation concern. Focusing on the Llanos grasslands, which span Colombia and Venezuela, and on birds, herpetofauna, dung beetles and ants, we ask whether this region can be a centre of sustainable Neotropical oil palm expansion. We investigate the potential impacts of oil palm replacement of intensive pasturelands, native grasslands and forest, to identify the high conservation values of native grassland and forest, but the low conservation value of intensive pasturelands. Our findings hold across taxa and when considering three levels of diversity: species, phylogenetic, and functional. With careful spatial planning, oil palm can be considerably expanded within the Llanos region at limited cost to conservation.

Paper Number: 215

Monday, 02 July 2018 | Colosseum 2

Symposium 2.1 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Motivations, barriers, and impacts of RSPO certification: lessons from the Colombian oil palm sector

Paul Furumo

The Roundtable on Sustainable Palm Oil (RSPO) has become the standard for sustainability across the oil palm sector with the goal of transforming the industry to adopt better production practices. Indeed over 20% of the world's palm oil supply is now RSPO certified. Despite recent uptake in the adoption of RSPO principles and criteria, we still do not know how effective these standards are in practice. While RSPO certification has been shown to reduce deforestation and use of fires at the landscape scale, there is still little evidence to suggest that certification actually transforms social and ecological production practices on the plantation. We evaluated the effectiveness of certification in situ, using field surveys to compare practices between 44 paired certified/non-certified smallholder producers (n=88) in northern Colombia. We also surveyed medium and large producers (n=12). The survey included questions on the agronomic, environmental, and social aspects of production. Palm oil extraction plants (mills) typically implement RSPO certification among regional producers, thus to gauge the motivations and barriers to certification, we also conducted open interviews with certified and non-certified mills (n=14) from two main production zones featuring very different growing conditions and market access: 1) the Caribbean coast, and 2) the landlocked eastern plains, or Llanos. We found that overall, certified producers had slightly better production practices. However, most of the differences observed were in social and organizational aspects, and not necessarily environmental or agronomic ones. In Colombia, certification is aligned with final market and there is little national demand for certified palm oil, despite a large biofuels sector that relies on palm oil as feedstock. We found a strong correlation between certification and exports; a greater proportion of companies on the coast are certified than in the eastern plains—where transport costs to ports are prohibitive and most production is therefore sold on the Colombian national market. Interviewees identified the saturation of the local market combined with factors such as the devaluation of the Colombian peso against the dollar as underlying causes that have contributed to certification, while the proximate cause is the need to gain access to international markets for export. These dynamics reveal the strong ties between the Colombian oil palm sector and global markets, but also highlight the importance of local conditions such as economic geography and distance to market as critical factors that can determine the outcome of sustainability initiatives on national or regional scales.

Paper Number: 465

Monday, 02 July 2018 | Colosseum 2

Symposium 2.1 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Optimising biodiversity and yield in smallholder oil palm plantations

Jane Hill

Introduction: Palm oil is a globally important edible oil. However, oil palm is cultivated in areas where highly diverse tropical rainforest occurs, and so it is important to develop more sustainable methods of producing palm oil that optimise yields and reduce biodiversity declines. Most research has focused on industrial plantations of SE Asia, and far less is known about smallholders, especially in West Africa where oil palm is native. West African smallholder farmers rely on cultivation of oil palm for both income and household consumption; e.g. in Ghana, about 90% of the land cultivated for oil-palm comprises smallholdings. Ghana also supports many globally threatened and endemic species, which are threatened by forest loss, making it important to examine the impacts of oil palm cultivation.

Objective: The aim of our study is to help smallholder palm oil farmers in West Africa develop more sustainable agricultural practices that optimise economic returns, reduce biodiversity losses and environmental threats, and ensure the protection of high conservation value rainforest.

Methods: I present results from 31 smallholder farms in the central region of Ghana, where we surveyed key groups of animals with important ecosystem functions (ants, termites, birds, moths and butterflies) in relation to intensity of farm management and palm oil yields. We also surveyed nearby areas of protected forest in Kakum National Park. We examined relationships between species richness, vegetation structure (our measure of management intensity), and palm oil yields on farms.

Results: As expected, smallholder farms supported lower diversity than areas of rainforest. But our results also reveal relatively high diversity on farms compared with industrial plantations, but lower yields.

Conclusions & Implications: Our results highlight the pros and cons for biodiversity of different management practices by farmers (e.g. weeding, regular harvesting of fruit, and other farm management practices), including those supported by RSPO for sustainable certification. We are using our findings to make recommendations for smallholders to help them maximise biodiversity of their farms without compromising their yields, or incomes.

Paper Number: 133

Monday, 02 July 2018 | Colosseum 2

Symposium 2.1 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Improving soil greenhouse gas fluxes in oil palm plantations

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Development in oil palm production has been a main element of meeting growing global demand for edible oil and biofuels. This growing demand has caused an increase in areas utilized for the industrial cultivation of oil palm. The consequence to this is the conversion of large areas of forest and plantation landscapes throughout Southeast Asia. Forest degradation and conversion to oil palm changes exchange of soil GHG fluxes and contributes to changes in local air quality and the radiative forcing of climate at global scales. The physical process of landuse change, such as felling, drainage, and ploughing can significantly increase emissions of N₂O and soil CO₂ respiration and decrease CH₄ oxidation rates in the short term; and in the long-term regular nitrogen applications will impact in particular soil N₂O fluxes. However, the understanding of the consequences of landuse change on soil GHG fluxes is still insufficient. To further gather significantly sufficient data, a total of 56 flux chambers were installed in logged forests, forest fragments, and different ages of oil palm plantations within the SAFE landscape in SE Sabah, Borneo. Soil respiration rates, N₂O, and CH₄ fluxes together with soil moisture, pH, mineral and total C and N were measured over a total duration of 2 years. It is expected that the increment of GHGs fluxes after deforestation and conversion to oil palm are correlated to the change in land cover and management.

Paper Number: 871

Monday, 02 July 2018 | Colosseum 2

Symposium 2.1 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Quantifying the greenhouse gas balance of oil palm plantations on peat soil in northern Borneo

Yit Arn Teh

Human modification of tropical peatlands, especially in Southeast Asia, has the potential to alter the source-sink potential of tropical peatlands for carbon, and the composition of greenhouse gas emissions. Given the large scale of tropical peatland conversion in Southeast Asia and the key role that these types of ecosystems play in local communities' livelihoods, it is imperative that we find means of improving the sustainability of these managed peatland landscapes to mitigate climate change and environmental pollution. Here we report preliminary data on net ecosystem CO₂, CH₄ and N₂O fluxes from a mature oil palm plantation (7-10 years old) grown on peat soils in Sarawak in northern Borneo. Fluxes of CO₂, CH₄ and N₂O were determined using a combination of top-down and bottom-up approaches, which include eddy covariance, intensive C plot measurements, process-based chamber observations, and measurements of aquatic exchange. Eddy covariance, intensive C plot, and fluvial measurements suggest that these ecosystems are atmospheric sources of CO₂ or approaching net atmospheric balance. Eddy covariance measurements suggest that mature plantations emit approximately 1.5 Mg C ha⁻¹ yr⁻¹, which is roughly on par with natural, unmanaged ecosystems. Net ecosystem exchange was strongly linked to water table position, with reduced CO₂ loss at higher water table levels. This plantation was also a relatively large atmospheric source of CH₄ and N₂O. Temporally-resolved, area-weighted chamber flux measurements suggest that these ecosystems emit approximately 64 kg C ha⁻¹ yr⁻¹; a flux comparable to unmanaged swamp forest. In contrast, N₂O flux from these managed ecosystems were greater than unmanaged swamp forest, with a large range of emissions spanning one order of magnitude (i.e. 192 ± 224 to 1021 ± 1849 mgN m⁻² d⁻¹). Fluxes of CH₄ and N₂O were spatially and temporally heterogeneous. However, CH₄ showed greater spatial rather than temporal heterogeneity, while N₂O flux showed relatively weak spatial heterogeneity and very high temporal variability. For example, CH₄ fluxes were greatest from water-logged microforms (e.g. drainage ditches) and lowest from non-vegetated microforms. In contrast, N₂O flux was relatively evenly distributed among different microforms, but showed a dramatic spike in emissions immediately after N fertiliser application. These findings suggest that important mitigation strategies for reducing greenhouse gas emissions from these peatland plantations include improved water table management to reduce peat oxidation, more efficient fertiliser practices to suppress N₂O flux, and innovative methods of reducing CH₄ flux from emission hotspots.

Paper Number: 565

Monday, 02 July 2018 | Colosseum 2

Symposium 2.1 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

SYMPOSIUM 3.1

Tropical Tree Life-History Strategies: Causes and Consequences of Demographic Diversity

Tropical tree seedlings trade off shade and drought tolerance: a demographic approach

Stefan J. Kupers, Christian Wirth, Bettina M.J. Engelbrecht, Andrés Hernández, S. Joseph Wright, Nadja Rüger

The contribution of niche differentiation along resource gradients to the maintenance of high local diversity of tropical tree species continues to be debated. Scarcity of light and water strongly limit the performance of tree species, but the relative importance of these resources remains unsettled. Moreover, the relationship between shade and drought tolerance among species remains unclear.

We quantified spatiotemporal variation in shade (annual canopy censuses) and spatial (inverse of soil water potential) and temporal (dry season intensity) drought variation in the seasonal moist tropical forest on Barro Colorado Island, Panama, and estimated tolerance of naturally regenerated seedlings to shade and drought in terms of relative height growth and first-year survival. We compared the impact that shade and drought had on seedling demography across the community, and investigated the relationship between the shade and drought tolerance of species.

Growth was most limited by shade, while survival was most limited by temporal drought. Species traded off in their tolerance to shade and temporal drought; species that were more shade tolerant were less drought tolerant and vice versa, indicating that strategies of species to cope with shade and drought are limited. In contrast, shade tolerance was independent from spatial drought tolerance.

The trade-off in tolerance to strong shading versus severe droughts in this forest constrains the potential for niche differentiation along two major resource axes (light and water). As light and water availability are both expected to change in the face of global climate change, the composition of tropical forest tree communities is likely to change considerably.

Paper Number: 162

Monday, 02 July 2018 | Petra 1

Symposium 3.1 - Tropical tree life-history strategies: Causes and consequences of demographic diversity

Differences in leaf thermoregulation and water-use strategies between two co-occurring Atlantic forest tree species

Sophie Fauset, Helber C. Freitas, David R. Galbraith, Martin J.P. Sullivan, Marcos P.M. Aidar, Carlos A. Joly, Oliver L. Phillips, Simone A. Vieira, Manuel U. Gloor.

Given anticipated climate changes, it is crucial to understand controls on leaf temperatures including variation between species in diverse ecosystems. In the first study of leaf energy balance in tropical montane forests, we observed current leaf temperature patterns on two tree species in the Atlantic forest, Brazil, over a 10-day period, and assessed whether and why patterns may vary among species. We found large leaf-to-air temperature differences (maximum 18.3°C) and high leaf temperatures (over 35°C) despite much lower air temperatures (maximum 22°C). Leaf-to-air temperature differences were influenced strongly by radiation, while leaf temperatures were also influenced by air temperature. Leaf energy balance modelling informed by our measurements showed that observed differences in leaf temperature between two species were due to variation in leaf width and stomatal conductance. The results suggest a trade-off between water-use and leaf thermoregulation; *Miconia cabussu* has more conservative water-use compared to *Alchornea triplinervia* due to lower transpiration under high vapour pressure deficit, with the consequence of higher leaf temperatures under thermal stress conditions. We highlight the importance of leaf functional traits for leaf thermoregulation, and also note that the high radiation levels which occur in montane forests may exacerbate the threat from increasing air temperatures.

Paper Number: 121

Monday, 02 July 2018 | Petra 1

Symposium 3.1 - Tropical tree life-history strategies: Causes and consequences of demographic diversity

Conspecific density dependence varies with species life-history strategy at multiple life stages in a Neotropical forest

Liza Comita

Introduction / Background / Justification: Explaining species coexistence in diverse tropical tree communities has long been a challenge for ecologists. Accumulating evidence suggests that tropical tree species coexistence likely results from multiple mechanisms. One such mechanism is conspecific negative density dependence (CNDD), i.e. when individual performance declines with increasing density of conspecific neighbors due to host-specific natural enemies or strong intraspecific competition. In tropical forests, there is also evidence that coexistence is fostered by species' niche partitioning related to light availability, driven by a trade-off between a species' ability to grow fast under high light vs. survive in deep shade. It is likely both CNDD and growth-mortality trade-offs contribute to diversity, but it is unclear how these mechanisms interact, as well as how they vary across different life stages.

Objectives: We sought to assess the interaction between CNDD and species life-history strategy, based on growth-mortality trade-offs, from seedling to adult tree stages for 47 species in a lowland tropical moist forest. We asked (1) does a species' life-history strategy (i.e. its location along the growth-mortality trade-off axis) influence species' sensitivity to conspecific neighbor effects? and (2) how does the relationship between species life-history strategy and strength of CNDD change with life stage?

Methods: We used data on seedling and tree growth and survival from multiple censuses of the 50-ha forest dynamics plot on Barro Colorado Island (BCI), Panama. We first divided stems into four life stages (seedlings, saplings, juveniles, and adults) based on size cutoffs. For each life stage, we calculated each species' relative growth rate under optimal conditions (RGR_{opt}). We then used generalized linear mixed-effects models to model the probability of survival at each life stage as a function of conspecific and heterospecific neighbor densities and RGR_{opt}, as well as their interactions.

Results: Fast-growing species had higher mortality than slow-growing species at all stages. In contrast, mean CNDD was strongest at early life stages (i.e. seedling, sapling). Fast-growing species tended to suffer greater CNDD than slow-growing species at some, but not all life stages.

Implications and conclusions: Our results show that while species' life-history strategies remain consistent across stages, the impact of conspecific neighbors becomes weaker at later stages. Overall, our study demonstrates that coexistence mechanisms interact across multiple life stages to shape diverse tropical tree communities, illustrating the need to include multiple stages when assessing species coexistence mechanisms in tropical forests.

Paper Number: 160

Monday, 02 July 2018 | Petra 1

Symposium 3.1 - Tropical tree life-history strategies: Causes and consequences of demographic diversity

Functional traits predict seedling recruitment in relation to altered natural-enemy activity with edge-effects

Meghna Krishnadas

Edge-effects in fragmented forests can reduce seedling diversity by dampening plant-natural enemy interactions. Tree species' response to natural enemies varies with life-history; slower-growing, conservative species tend to be better defended than faster-growing, acquisitive species. Weaker natural-enemy effects could allow acquisitive species to outcompete conservative species, particularly if light availability increases closer to forest edges, thus providing one mechanism for change in species recruitment with edge-effects. In a human-modified tropical forest in the Western Ghats Biodiversity Hotspot in southern India, we first examined whether functional traits explained differences in species recruitment at increasing distances from the forest edge and in relation to light availability. Then, we tested how controlling natural enemies (with insecticide and fungicide) altered seedling recruitment success in relation to species' functional traits. Finally, we examined whether change in recruitment due to edge-effects and pesticide treatment explained changes in functional diversity of recruiting seedlings.

Contrary to expectation, species with lower SLA and leaf N, and higher LDMC, wood density, and seed size (i.e. traits indicative of conservative species) had higher recruitment at edges compared to all other distance categories. From 30-40 m through 90-100 m from the edge, for SLA and leaf N, pesticides reversed the direction of trait effects on recruitment success. However, for LDMC, wood density and seed size, pesticides reversed recruitment patterns only at 90-100 m from forest edges. Moreover, functional diversity of seedling recruits—after controlling for species richness—increased progressively from forest edge to interior. At > 60 m from the forest edge, pesticides reduced mean pairwise distances of recruits but had less marked effects on mean nearest neighbor distance. In comparison, light did not explain changes in recruitment rates or functional diversity of seedling recruits. Our results indicate that dampened plant-natural enemy interactions contribute to the differential impact of edge-effects on seedling recruitment of species based on their life-history strategies.

Paper Number: 783

Monday, 02 July 2018 | Petra 1

Symposium 3.1 - Tropical tree life-history strategies: Causes and consequences of demographic diversity

Diversity Takes Time: Temporal Dynamics of Seedling Demography in a Subtropical Rain Forest

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Seedling is one of the critical bottleneck in tree life cycles. The seedling stage represents a filter from the seeds to the established saplings, which can last a few years or many decades and may contain critical mechanisms that drive forest diversity. Despite there are many studies that focused on the seedling dynamics using spatially explicit approach, most of these studies only spanned three to four years. The temporal dynamics of this stage are less well understood. As seedling recruitment may be controlled by external forcings of diverse temporal scales, linking these drivers to passage times from newly recruited seedlings to established saplings would have great implications for species coexistence and community dynamics. We used a 15-year data of seedling demography from a subtropical rain forest to construct population models that reflect temporal access to environmental resources for eight abundant tree species. We then predicted passage times from newly germinated seedlings to saplings of 200-cm height. For most species, seedlings required relatively high transition probabilities to fast growth (frequent access to light) to escape from high early-stage mortality. Once established, the data indicated passage times of decades (from 9 to 130 years) to attain 2-m high. The probabilities of staying/moving in fast growth group may be associated with strong but relatively short climate anomalies, or episodic events of multidecadal or centennial scales. Thus, it is essential to incorporate the impacts of episodic events with long return periods on recruitment dynamics to accurately understand the temporal assembly mechanisms that structure the diversity and abundance patterns of forest communities.

Paper Number: 185

Monday, 02 July 2018 | Petra 1

Symposium 3.1 - Tropical tree life-history strategies: Causes and consequences of demographic diversity

SYMPOSIUM 4

The Role of Invertebrates in Undisturbed Tropical Ecosystems

Termites in soil

Cecilia Dahlsjö

Soils are complex, heterogeneous and highly speciose environments which are vital components of most terrestrial habitats. Soil biota are essential for soil functioning as they contribute to soil bioturbation and decomposition of organic matter. Termites are one of the most prominent decomposer invertebrates in lowland tropical rain forests where they are often present at high densities. While the contribution of termites to nutrient cycling has been studied, the understanding of the relative role that termites and other macrofauna play in nutrient cycling compared with microorganisms is limited. I will present the results from two independent studies where we conducted a soil macrofauna exclusion experiment in undisturbed lowland tropical rain forests in the regions of Tambopata and Pucallpa in Peru. We found that macrofauna played a major role in carbon and nitrogen depletion rates in Tambopata in southern Peru while no macrofauna effect was detected near Pucallpa in the north. The main difference between the two sites was the high rate of degradation due to an expansion of agriculture around Pucallpa while the region of Tambopata was relatively undisturbed. This was further showcased in the number of termite species found in each site with 43 species recorded in Tambopata and 9 species recorded near Pucallpa. Our results suggest that regional degradation may have a major impact on invertebrate diversity which in turn affects ecosystem processes such as nutrient cycling even in undisturbed habitats.

Paper Number: 132

Monday, 02 July 2018 | Petra 2

Symposium 4 - The role of invertebrates in undisturbed tropical ecosystems

Termites mitigate the ecological effects of drought in tropical rainforest

Louise Ashton

Climate change and habitat modification threaten tropical rainforest biodiversity and associated ecosystem processes. Earth system models are increasingly able to predict the direct physical effects of climate change on forest systems but we know little about the indirect consequences for animal-mediated processes. Termites are major players in tropical ecosystems, where they carry out decomposition, retain soil moisture and influence soil nutrient heterogeneity, and are strongly affected by variation in rainfall. Yet termite responses to droughts, which are projected to increase in frequency and severity, are unknown. Here we show, for the first time, that termites enhance ecosystem resistance to drought, with far reaching implications for the tropical soil processes. Our findings strongly indicate that the dual stressors of climate change and biodiversity loss will have negative, synergistic consequences for the maintenance of functioning rainforest ecosystems. These conclusions are based on a novel, large-scale termite suppression experiment in Malaysian Borneo, spanning the extreme 2015-2016 El Niño drought. As predicted, ecosystem processes were suppressed during drought, compared with non-drought conditions, but these effects were buffered significantly by the presence of termites. Termite activity was greater in the drought, leading to improvements in soil moisture, leaf litter decomposition, soil nutrient heterogeneity and seedling survival. Strikingly, these results demonstrate that termites mitigate the ecological effects of drought in tropical rainforest. We provide the first evidence that termites will have an increasingly important role in maintaining terrestrial nutrient cycling and structuring vegetation communities under climate change.

Paper Number: 127

Monday, 02 July 2018 | Petra 2

Symposium 4 - The role of invertebrates in undisturbed tropical ecosystems

Quantifying the role of ants in tropical ecosystems: resource removal

Parr, Catherine (Kate), Griffiths, Hannah, Ashton, Louise, Walker, Alice, Hasan, Fevziye, Evans, Theo, Eggleton, Paul

Resource location and removal is an essential process for dispersing nutrients across ecosystems and a key energetic link between higher trophic levels, decomposers and primary producers. Resources are very varied (e.g. seeds, fruits, dead animal carcasses) and consequently many different animals play a role in their location, dispersal and consumption. In tropical forests ants are dominant in terms of both biomass and abundance. Ants have long been considered important scavengers removing a variety of resources for food, yet, despite this, their role in this process has not been quantified. Using a novel large-scale ant suppression manipulation in undisturbed old growth forest, we investigated the role of ants in resource removal (carbohydrate, protein and seed baits) to determine (1) the proportion of resources removed by ants, and (2) whether in their absence, other taxa compensate for their actions. We were able to partition bait removal into ants, non-ant invertebrates and vertebrates. We found that ants were responsible for moving the majority of resources and that increases in other taxa in the absence of ants were not sufficient to compensate for the removal of ants. Our study demonstrates the functionally important role of this taxon group in the tropics as ecosystem engineers.

Paper Number: 914

Monday, 02 July 2018 | Petra 2

Symposium 4 - The role of invertebrates in undisturbed tropical ecosystems

Vertical stratification of tropical ant assemblages: do ground ants restrict the foraging distribution of arboreal and subterranean ants?

Stephanie Law

In tropical rainforests ants dominate arthropod fauna in their ecological impact, diversity and abundance. Primary tropical rainforest is vertically stratified into the forest floor, subterranean layer, understory and canopy. A growing body of research has shown that the distribution of ant species in tropical rainforests corresponds with this vertical stratification. Ants are abundant in all strata yet species distributions between ground, canopy and subterranean ants show little overlap, with many species occupying only one strata. Community structure of ants within a stratum has been explained by habitat complexity, associated microhabitat specialisations and by competitive interactions. However reasons behind the existence of vertical stratification and differences among strata are less comprehensive. This research aims to look at how removing competitive interactions influences vertical stratification.

We quantified the contribution that ground foraging ants have on the vertical stratification of ant species above and below the ground. We investigated this using a novel, large-scale manipulative field experiment in an old growth tropical rainforest in Malaysian Borneo where ground ants had been suppressed in treatment plots. By eliminating a whole assemblage of ants and the associated competitive interactions the degree to which it influences the composition of other ant assemblages can be determined. In order to survey ants vertically, baited traps were placed at 5 m vertical intervals from the ground to the canopy on 3 emergent trees in each experimental plot (4 ant suppression and 4 control plots). Subterranean ants were collected by burying 30 baited traps within each plot and ground ants were collected using Winkler bag extractions. Species richness, ant abundance and assemblage composition were compared among strata and between suppression and control plots.

Suppression of ground ants significantly impacted arboreal and subterranean ant assemblages; both ant abundance and species richness in arboreal and subterranean assemblages were significantly lower in suppression plots compared with control plots. Furthermore, ant assemblages in suppression plots showed greater overlap in species composition among strata and a loss in stratification. To conclude, our results imply that arboreal and subterranean ants increase their foraging distribution in the absence of ground ants. By doing so ants take up poison baits on the ground leading to the reduction in abundance and richness. We suggest that the competitive dominance of ground ants helps to maintain vertical stratification of ant assemblages.

Paper Number: 80

Monday, 02 July 2018 | Petra 2

Symposium 4 - The role of invertebrates in undisturbed tropical ecosystems

Top-down effects of insect herbivores and seed predators on rainforest vegetation

Owen Lewis

Insects that consume plants are a species-rich and abundant component of tropical forest communities, and can have profound functional consequences for rainforest vegetation. Most research on herbivory and seed predation in tropical forests has focused on specialized consumers associated with particular plant species. However, many rainforest insects have broader diets, which may link the dynamics of their host plant species through foodweb-level effects such as apparent competition. Focusing on seeds and seedlings in Panama and Belize, I will describe manipulative field experiments and observations investigating the effects of insect herbivores and seed predators on the diversity, composition and spatial distribution of co-occurring forest plants. Our experiments reveal that phytophagous insects as a guild can alter the composition and diversity of seedling assemblages, and our food web surveys highlight sets of plant species that are expected to interact indirectly via shared consumers. For two of these species, *Cordia alliodora* and *Cordia bicolor*, we found that herbivory was significantly higher at high plant densities, and that it significantly increased seedling mortality. Furthermore, high local densities of *C. alliodora* increased herbivory on co-occurring *C. bicolor*. Our data add to the evidence that insects can impose important top-down effects on plant communities, and that shared seed predator or herbivore species can provide a mechanism influencing their diversity and composition.

Paper Number: 458

Monday, 02 July 2018 | Petra 2

Symposium 4 - The role of invertebrates in undisturbed tropical ecosystems

Invertebrates in Tropical Forests: the Ultimate Baseline?

Paul Eggleton

Tropical rain forests are thought to be something very special. They are held up to be the most diverse biomes in the world and most of that diversity is in invertebrates. Because of this they are often thought to be the baseline by which all other invertebrate communities are judged. But how far is this true? Here, I will review what is known about the species density of tropical rain forests, their community structure and the processes that go on in them. Are they really all that different from other tropical biomes? And if they are so different, how far do their idiosyncrasies tell us anything useful about the wider world?

Paper Number: 79

Monday, 02 July 2018 | Petra 2

Symposium 4 - The role of invertebrates in undisturbed tropical ecosystems

SYMPOSIUM 5.1

Origins, Assembly and Evolution of the South and SE Asian Biota: Insights from Rocks, Fossils, Genes and Plots

Palaeo-Antarctic Rainforest Plant Lineages in Austral and Southeast Asia: Diversity, Abundance and Ecology

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Palaeo-Antarctic rainforest lineages (PARLs) are living plants with fossil records in the mid-high latitude palaeo-forests of the Cretaceous and Paleogene Southern Hemisphere. This is the time before the final breakup of the supercontinent Gondwana, and the separation of Antarctica, Australia and South America in the Eocene. Over geologic time, PARLs have demonstrated remarkable biome and trait conservatism. The tendency to conservatism rather than adaptation means that PARLs have generally tracked the environmental conditions to which they were adapted and have shifted their ranges dramatically in response to continental plate movements and changes in climate.

To track the movement of lineages through time we used a compilation of carefully vetted and taxonomically verified palaeobotanical (fossil) data representing 63 Gondwanan 'rainforest' sites, 396 taxonomic occurrences from Patagonia, Antarctica, Australia and New Zealand, and three time bins. We then filtered out the 'survivor' PARL distributions in those locations and the extant floras of New Guinea, Southeast Asia, and the Pacific to evaluate their relative contribution to current day floras. This left 56 assemblages from fossil locations, and 87 rainforest PARL 'survivor' genera, including in living floras.

Results show the movement of PARLs through deep time, identifies their distribution in modern floras, and traces the history of the Gondwanan flora into modern Southeast Asia. The legacy of the ancient southern (Gondwanan) biome can now be found in the scattered modern PARL distributions in mostly large, mesic, biodiverse, and often highly threatened areas of Australasia and Southeast Asia.

In the cool, wet, sub-montane and montane tropical forests of Southeast Asia PARLs can be abundant, forming a critical component of the vegetation protecting watersheds and catchments, and providing essential habitat for myriad species.

Paper Number: 91

Monday, 02 July 2018 | Taj Mahal

Symposium 5.1 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots

The First Gondwanan Fagaceae: Early Eocene Castaneoids from Patagonia and the Paleo-Antarctic Component of Southeast Asian Tropical Rainforests

Peter Wilf

The beech family (Fagaceae s.s.), with eight genera and over 900 species, is one of the most ecologically and economically important plant groups in the world. The known extant and fossil distributions of the family have been confined to the Northern Hemisphere and the tropics. In montane, aseasonal areas of SE Asia, the diverse castaneoid genera *Castanopsis* and *Lithocarpus* often form co-dominant associations with several conifer taxa that have well-known Gondwanan origins. Based on the fossil record, these living associations were classically considered as a mix of Laurasian and Gondwanan elements (castaneoids and conifers, respectively). Here, I report the first Gondwanan Fagaceae s.s., early Eocene (52.2 Ma) castaneoid fossils from Laguna del Hunco in Patagonian Argentina. Notably, this site has produced rare South American fossil records of several genera whose extant ranges include SE Asian rainforests and associations with castaneoids, such as *Agathis* (Araucariaceae); *Dacrycarpus*, *Phyllocladus*, and *Podocarpus* (Podocarpaceae); and *Gymnostoma* (Casuarinaceae). The new castaneoid fossils include ca. 90 leaves, a spike-like infructescence bearing dozens of immature solitary fruits, and an axis with four maturing solitary fruits. The leaves have several fagaceous features, including long petioles with expanded bases; bristle-tipped, regular teeth each associated with a single craspedodromous secondary vein; and fine, closely spaced, strongly percurrent tertiary veins. The immature fruits show early stages of cupule and scale development and bear three styles with punctiform stigmas as in *Castanopsis* and *Lithocarpus*. The maturing fruits have asymmetrical, two-cuspidate-valved cupules that fully enclose a single nut, a characteristic combination today for *Castanopsis*. However, the cupule ornamentation of helically arranged, imbricate, symmetrical scales without spines or tubercles is more similar to *Lithocarpus*. The cumulative evidence indicates the presence of castaneoid Fagaceae in Eocene Patagonia with close affinity to *Castanopsis* (Asia and New Guinea, ca. 140 living species). Thus, the castaneoid Fagaceae had a previously unknown Gondwanan history. Castaneoids have associated with the same conifer and other taxa for tens of millions of years, apparently tracking mesic rainforest environments together in response to climate change and plate movements over thousands of kilometers. Other fossil occurrences of castaneoids, all from the Northern Hemisphere, do not include any of the same characteristic associations. Thus, today's SE Asian rainforests co-dominated by castaneoids and "southern" conifers appear to indicate considerably more Gondwanan historical connections than previously thought, and this surviving floral association from the paleo-Antarctic represents a significant piece of SE Asian tropical biomass and biodiversity.

Paper Number: 526

Monday, 02 July 2018 | Taj Mahal

Symposium 5.1 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots

Paleobotany in tropical SE Asia: progress and opportunities

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Plant fossils are vital for understanding the evolutionary history and biodiversity of SE Asian tropical forests; however, paleobotanical research in this region still lags many other parts of the world. Paleobotanists active in the area remain quite few, and it is not easy to find well-exposed sedimentary rocks because of the dense forest cover. Progress over the last decade sheds light on paleobotanical studies in this fascinating region. First, the geological ages of many fossil floras have been updated using radiometric dating, which often indicates a much earlier origination of floral associations than previously thought. For example, the age of the Lühe flora in Yunnan was previously considered as late Miocene based on lithostratigraphic correlation, but it is now earliest Oligocene according to recent U-Pb geochronologic results. Second, many new fossil sites have been found with abundant and well-preserved plant fossils. These include amber deposits with flowers/fruits and leaves from the early/middle Cretaceous of Kachin Province in northeast Myanmar and new reports of fossil Arecaceae, Dipterocarpaceae, Fagaceae, and Lauraceae from tropical regions of Guangxi, Guangdong, and Hainan Island, south China. Moreover, we recently found several new plant-fossil sites in Guang Ninh Province, Lang Son Province, and Yen Pei Province of northern Vietnam together with colleagues from the Vietnam National Museum of Nature. In the Malay Archipelago, we have discovered new fossil-plant sites in the Eocene-Oligocene Sawahlunto Formation of West Sumatra and Tanjung Formation of South Kalimantan (Indonesia, in collaboration with Institut Teknologi Bandung) and in late Neogene deposits of Brunei (in collaboration with Universiti Brunei Darussalam). Third, new paleoclimate reconstructions using paleofloras from south China suggest the gradual intensification of the Asian monsoon during the Cenozoic. All these ongoing studies are significantly enhancing our understanding of plant diversity and evolution through paleoenvironmental changes during the geological past in SE Asia. Because many Cenozoic coal-bearing basins are distributed across SE Asia, there is considerable potential for novel paleobotanical investigations. International, multidisciplinary cooperation is urgently needed to study these fossil floras and to reveal the origins and evolution of tropical forests in SE Asia.

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Paper Number: 135

Monday, 02 July 2018 | Taj Mahal

Symposium 5.1 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots

Forest tree community and biogeographic variation among five Indonesian islands

Sarah Mathews

Indonesia is renowned for its complex biogeography. The roles of both ancestral migration and contemporary ecological forces in shaping the distribution of extant taxa are clearly apparent in this island nation. Trees are hard to collect in fertile condition, and their species variation and distribution are poorly documented, especially in eastern Indonesia. Additionally, relatively few tree sample plots exist for which vouchers have been collected and matched among islands. Thus our knowledge of comparative tree biogeography and community composition across much of Indonesia is still rudimentary. To help address this problem, we sampled trees in one hectare of lowland forest on five islands (Borneo, Sulawesi, Flores, Seram, and Waigeo, near Papua), representing land on both sides of Wallace's line and a range of climates from ever-wet to strongly seasonal, in collaboration with Indonesian botanists and members of local villages and local government. We collected voucher specimens, physiological measurements, and generated DNA barcodes and phylogenies. Abundant high-resolution photographs contributed to a growing resource of images for plant identification and site-to-site morphotype matching. Using molecular data for the more diverse clades, we asked where ancestral taxa originated, how they may have spread across the archipelago, diversified within islands, and assembled into communities. Less diverse clades were included in community-wide analyses of floristic and phylogenetic structure. Analyses of phylogenetic floristic structure suggest that the presence and absence of major clades such as palms and lowland conifers drives the deep phylogenetic structure of Indonesian islands. These analyses also provide some evidence that Seram has an overabundance of locally diversified clades, but provide little evidence of within-community phylogenetic structure. Our research contributes significantly to the understanding of forest composition and biogeography of eastern Indonesia.

Paper Number: 808

Monday, 02 July 2018 | Taj Mahal

Symposium 5.1 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots

Sino-Australasian Lauraceae: Disentangling Genomes, Islands and Time

Joeri Sergej Strijk

Lauraceae are a major pantropical family of mostly trees and shrubs with an estimated 3000-3500 species. Exact numbers are unclear as the family has historically been poorly studied due to its wide distribution, high species richness but generally poor diagnostic morphology complicating identification and assessments. The majority of species is restricted to Asia (60%). Traditional studies have applied standardized phylogenetic and/or barcode markers in an attempt to resolve intra- and intergeneric relationships. More often than not, these have not provided sufficient resolution to confidently establish relationships between and within genera, leading to repeated and sometimes confounding taxonomic rearrangements over time. With the rise of NGS techniques, dropping operational costs and increasing availability of species data, it is possible to make a large assessment of genomic diversity and evolutionary connections throughout Lauraceae on a global scale. As a first step towards that goal, our study aims to construct a well-supported genome-based phylogenomic backbone for the genera occurring in tropical Asia (50% of global). This allows a first assessment of the distribution of genomic diversity, the evolutionary position of key taxa and biogeographic history in the center of diversity for the family. Applying a combination of genome skimming and targeted sequencing of nuclear genome regions, we compiled a genomic dataset of more than 200Kbps. Genomic intra- and intergeneric variation was analyzed using custom-made bioinformatic scripts. Phylogenomic analyses and molecular dating were employed to reconstruct the spatiotemporal evolutionary history of Lauraceae with a focus on the Asian distribution range. We establish a highly resolved, dated phylogenomic hypothesis for evolutionary relationships. In two major genera (and several smaller ones), results indicate taxonomic rearrangements will be needed to resolve cases of para- and polyphyly. Results further support the sinking of several minor monotypic genera, and age estimates provide a first rough view of the speed of diversification in the historically dynamic region between China, SE Asia and the Sahul. Our results suggest that the taxonomic conundrum in Lauraceae can only be confidently resolved using a genomic approach, and that even an approach incorporating only a part of its pantropical range, points to exciting taxonomic avenues for follow-up investigation. These initial results will provide a solid foundation for expansion with representative African and Neotropical datasets to complete a global phylogenomic framework. This will be then made available to the scientific community to serve as a backbone for generic treatments and to support conservation assessments.

Paper Number: 826

Monday, 02 July 2018 | Taj Mahal

Symposium 5.1 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots

The likely contribution of vertebrate seed-dispersers to the Sunda-Sahul floristic exchange

Caroline Pannell

Many plant groups in the Indo-Malayan and Australasian region are more widespread than their vertebrate seed-dispersers. Understanding the factors that explain this phenomenon is of great interest to biogeographers and evolutionary biologists. In this talk, I discuss switches in dispersers that take place when one plant group transgresses faunal boundaries, and the evolutionary response of these vertebrate-dispersed plants.

An overview of the distribution of vertebrate dispersers across the Indo-Malayan Australasian region will be presented, with emphasis on the two major faunal boundaries, Wallace's Line and Lydekker's Line, that delimit the Sunda and Sahul continental shelves. These two continental shelves are separated by a region known as Wallacea, a deep oceanic trench, where the sea bed has never been fully exposed as dry land, punctuated by hundreds of islands.

A case study of *Aglaia*, the largest genus in the mahogany family, will serve to illustrate the evolutionary response of plant groups that cross Wallacea and diversify in newly colonized territory. Time-calibrated molecular phylogenies indicate that *Aglaia* arose in Sundaland about 24 million years ago and colonized Australasia less than 12 million years ago. Colonization was followed by species radiations that gave rise to endemic species on large islands and on island groups. The most recent colonization identified so far is Fiji, where endemism in the genus is at its highest at 80%.

Aglaia trees exhibit adaptations for dispersal by different vertebrates. Dispersal syndromes for various fruit types will be described: primate dispersal for indehiscent fruits in Sundaland, arboreal bird-dispersal for dehiscent fruits that remain on the tree across the region and terrestrial cassowary-dispersal for dehiscent fruits that fall to the ground in Australasia on ripening. The dispersers of indehiscent fruits in Australasia are unknown, even though many species with this fruit type are endemic to the region.

Two groups of vertebrate seed-dispersers, flying foxes and fruit-pigeons are widespread across the Indo-Malayan and Australasian region and are candidates for long-distance dispersal of seeds across faunal boundaries. Of these, fruit-pigeons are more likely to be effective, because they swallow large seeds and fruits, have the capacity to carry them internally, and are strong fliers that are known to traverse seas.

Paper Number: 384

Monday, 02 July 2018 | Taj Mahal

Symposium 5.1 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots

SYMPOSIUM 6

Citizen Science: Global Biodiversity Monitoring and Science Literacy Empowerment

Linking Science Communication to Data Achievement in South America. Lessons from Available Platforms and Strategies for a long-term successful Global Biodiversity Monitoring Citizen Science Project.

Sandro Von Matter

In the Anthropocene era, one of the biggest challenges of Biodiversity Conservation is to rapidly assess changes in the status of global biodiversity.

Citizen Science has become essential in, terms of data achievement, especially, for large-scale projects, becoming an indispensable tool to be accounted into conservation planning.

In this context, it is highly relevant to analyze the potential audience, targets, and other factors that may influence a potential citizen science program.

Aiming to better understand the contribution of volunteers in Brazil and to improve it, was used Essential Biodiversity Variable framework to check data achievement in the country and, through social media and interviews, was analyzed engagement factors and motivations. In addition, it was quantified the amount and openness of biodiversity observation data in GBIF.

The results showed that only birds are monitored at a country scale (100%). In fact, our analysis for a global scale showed that most projects providing data to GBIF focus on animals (85%), non-lepidopteran insects (32%), birds (30%), Lepidoptera (22%), or mammals (16%).

On the other hand, citizen science projects lack the openness of their data (1,54 n = 33) compared with other sources.

Results for engagement factors, both from interviews (n = 4532), pointed that volunteer motivations include an interest in a specific taxon species or question (53%), involvement in a community with similar interests (22%), recognition for personal achievements (20%), learning new skills and contributing to environmental activism (5%).

Concerns about participation were, 100% associated with the full openness or not, of biodiversity observation data and 87% of participants would like to choose whether or, not, their data could be used for a specific project or under a specific license.

Moreover, the results point out that one of the major factors addressing volunteer's loyalty to programs may be, in long-term, transparency and data openness. While the first time engagement strategies should focus on fair play competitions and platforms gamification designed for a specific group rather than to a much larger audience or to an environmental issue or question that involves the concerns of the public opinion in a specific timescale.

The study strongly suggests that citizen science programs should review their licensing systems and invest in science communication to strengthen the relationship between organizations and volunteers. Projects should carefully prioritize a deep analyze of potential volunteer's motivations enabling the program coordinator to choose the right approach and platform to the right public.

Paper Number: 517

Monday, 02 July 2018 | Giza

Symposium 6 -Citizen Science: Global Biodiversity Monitoring and Science Literacy Empowerment

Potentials of a large scale citizen science platform for tropical plant species detection and phenological study

Pierre Bonnet, Alexis Joly, Hervé Goëau, Jean-Christophe Lombardo, Antoine Affouard, Remi Knaff, Sebastien Breton, Mathias Chouet

Recent developments of mobile computing and machine learning technologies have allowed the growth of large citizen science platforms worldwide. Some of them, such as iNaturalist or eBird, enable large networks of professional and non-professional naturalists to produce, share and review huge volumes of biodiversity observations. PI@ntnet is one of these platforms, specifically dedicated to the plant domain. Developed since 2009, it has the particularities to (i) offer an automatic species identification service based on image recognition techniques at large taxonomical scale, (ii) permit phenological stage records at large geographical scales. This platform, which has been adapted to different regions of the world (North and South America, Western Europe, Tropical Africa, Indian Ocean Region, and recently Asia), is used in a large variety of contexts ways. For instance, Professors at the university level use it for biodiversity surveys, whereas teachers at middle school use it to promote collaborative knowledge production and citizen science methodologies, etc.

Based on the project impact study, a profile survey analysis, and the presentation of some case studies, we will present (i) methodologies used by educators and citizen scientists to invest the platform and adapt it to their needs, (ii) results obtained for plant species detection and phenological studies of pantropical species. According to the important number of daily users (around 25,000 people per day in 2017), and the important number of plant observations aggregated in few years (around 24 millions observations), we will discuss the impact of such citizen science platform for biodiversity monitoring, conservation, taxonomic purposes and environmental education. This will be discussed based on different points of view, from scientist who can access to original, large and recent datasets, to citizen scientists who can use and customize innovative services for environmental studies or pedagogical contexts.

Paper Number: 210

Monday, 02 July 2018 | Giza

Symposium 6 -Citizen Science: Global Biodiversity Monitoring and Science Literacy Empowerment

Building capacity for civic participation in conservation: Case study of the Klang Valley City Nature Challenge 2018

Benjamin Ong

Malaysia is one of the world's megabiodiverse countries. However, while the bulk of biodiversity research and conservation takes place in remote areas far from towns and cities, 75 per cent of Malaysians now live in urban areas. There is increasing recognition among conservation practitioners worldwide that, unless urban communities care about nature where they live, the wider goals of biodiversity conservation will not be met. In spite of this, biodiversity documentation efforts in Malaysian cities are few and far between. Baseline data for urban biodiversity is lacking: while scientific studies are undertaken from time to time, the results of these studies are seldom, if ever, made available to the public. To address this, the Klang Valley City Nature Challenge (KV CNC) was organised in April 2018 to help establish a publically-accessible biodiversity baseline, and to involve the general public in the process of collecting scientific data. As part of the global CNC movement, this bioblitz-style event's citizen science approach aimed to increase awareness and participation across all levels of expertise and experience. In mobilising not only scientific communities and enthusiasts, but also community groups and the general public, the event was intended to help build capacity for urban conservation by complementing the work of professional scientists. This presentation will report the results of the KV CNC, including participation rates and species observations. Secondly, it will evaluate participant experience through questionnaires and in-depth interviews. Finally, it will assess the effectiveness of the KV CNC by comparing results with CNCs in other countries. The Klang Valley is the first Southeast Asian urban metro area to participate in the CNC, and this presentation will identify pitfalls and opportunities for further developing urban citizen science initiatives. It will conclude by considering the value of strategic interdisciplinary and regional partnerships for strengthening urban conservation.

Paper Number: 225

Monday, 02 July 2018 | Giza

Symposium 6 -Citizen Science: Global Biodiversity Monitoring and Science Literacy Empowerment

How a Citizen Scientist and Alan Turing's Genius Inspired a New, Powerful, and Very Simple Species Richness Estimator

Robert Colwell

Estimating the species richness of a natural community from sampling data is often a daunting challenge, especially for hyperdiverse tropical communities, because many species remain undetected by the samples. Statistically rigorous, non-parametric methods have proven their worth in estimating minimum asymptotic richness, with confidence limits, for a given level of sampling effort. These estimators require a species list and the number of the species on the list that were found only once (singletons or uniques) and only twice (doubletons or duplicates). The most widely used minimum richness estimators are Chao1 and Chao2. Inspired by citizen scientist Ditch Townsend, using cryptographical statistical tools developed by Alan Turing and extended by Anne Chao, we developed a novel estimator of species richness that requires knowing only the length of a species list and the number of species seen only once. After proving its value by confronting the new estimator with a large and varied battery of simulated communities, we applied it to estimate the true richness, including undetected species, of the reef fish fauna of Tunku Abdul Rahman Marine Park in the South China Sea, in Malaysian Borneo. You can use our simple, online tool to compute the estimator, with confidence intervals.

Paper Number: 711

Monday, 02 July 2018 | Giza

Symposium 6 -Citizen Science: Global Biodiversity Monitoring and Science Literacy Empowerment

Community Aerobotany: using Unmanned Aerial Vehicles and online citizen science to monitor Amazon rainforest canopy trees

Varun Swamy

Community Aerobotany is geared towards harnessing the enormous potential of combining new technology with the collective efforts of public citizens to support conservation efforts, monitoring and sustainable use of ecological resources in lowland Amazon rainforests. This project combines the innovative use of mini-drones and online citizen science to monitor and collect ecological data on ecologically and economically important tree species in Peru's Madre de Dios River basin (MDDDB). Since its launch in December 2016, the project has successfully conducted automated drone flights to monitor the demography and phenology of a 400-hectare area of rainforest and 150 individual brazil nut trees within an ecotourism concession. The collected imagery formed the basis of an online citizen science project, hosted on the popular platform The Zooniverse.

Here, we present results on the inaugural run of the project, where the objective was to census canopy trees in flowering or leafless condition, as well as Huasai palms (*Euterpe precatoria*) from ≈ 5700 images encompassing a ≈ 400 -ha area of tierra firme forest, captured during the month of October 2016. Over a 3-month period, ≈ 3000 online citizen science volunteers contributed $\approx 92,000$ classifications of the images; of these, 1139 users classified ≥ 10 images, 127 users classified ≥ 100 images, and 22 users classified ≥ 500 images. Based on their efforts and subsequent analyses, the 400-ha study area was determined to contain ≈ 1600 flowering tree crowns and ≈ 3770 canopy trees in leafless state during the study month, and ≈ 5300 crowns of the Huasai palm.

We are currently in the process of implementing a second iteration of the project, with an explicit focus on monitoring the health and phenology of the castaña tree (*Bertholletia excelsa*), a critically important species in the region from ecological and economic standpoints.

Based on our experience to date, we discuss the insights we have gained regarding the potential and limitations of combining drone-captured imagery and online citizen science to collect high-quality data on the phenology and demography of Amazon rainforest canopy trees.

Paper Number: 906

Monday, 02 July 2018 | Giza

Symposium 6 -Citizen Science: Global Biodiversity Monitoring and Science Literacy Empowerment

Every cloud has a silver lining – An interactive theatre experience and its effects on conservation awareness

Cedric Kai Wei Tan, Jennifer Spencer, Moreangels Mbizah, Laurie Hedges, Kim Jacobsen, Lovemore Sibanda, Andy Tran, Xinyang Hong

Conservation of endangered species in Southeast Asia is a multi-faceted issue which lacks awareness, particularly in developed countries which are at the demand end of the supply chain. We created an interactive theatre piece showcasing the issues behind conservation in Southeast Asia with the focus on the clouded leopard as the main character. The audience voted on decisions to be made by the actors and the decision with majority votes played out. The final fate of the actors and the play varied as the audience “choose their own adventure”. Our piece was delivered live at two science festivals. We altered the messages in different performances: loss- versus gain-framed in combination with concrete (how) or abstract (why) activated mindset, and examined the effectiveness of different types of messages in influencing the audience decision on tree harvesting in Malaysia. Contrary to our hypothesis, a pairing of loss- (gain-) framed messages that activates more abstract (concrete) mind-sets led to more tree harvesting intentions. Our findings can help improve the delivery of theatre-based science communication and contribute to a generation of new conservation education approaches.

Paper Number: 678

Monday, 02 July 2018 | Giza

Symposium 6 -Citizen Science: Global Biodiversity Monitoring and Science Literacy Empowerment



GENERAL SESSION 1.1

Bird Ecology & Conservation

How information about predation in mixed-species bird flocks

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Background: Conservation strategies that incorporate species interactions, including mutualisms, have the potential to protect multiple species simultaneously. Mixed-species bird flocks (MSF) are a subset of most bird communities and prevalent in a variety of terrestrial habitats. In many MSF, there are “nuclear” species that can produce calls that encode information about predation, so that “following” species in flock can eavesdrop and consequently adjust their anti-predator behavior. Yet how dependent are following species on information derived from nuclear species, and how do they adapt when it is missing? We studied this question by investigating seasonal fluctuations in flocking, and nuclear species participation, in a forest on the northern border of the tropics, a hotspot of biodiversity for China.

Methods: We setup 6 1-km transects in the Nonggang National Nature Reserve, Guangxi Province, and monitored each transect 2-3 times each month from Jan. 2017 to Feb. 2018, collecting information on flock, and overall avifauna density and composition. In addition, we also observed bird responses to two kinds of predator threats: an imminent attack by a moving predator, as simulated by a thrown stick, and the presence of a stationary predator, as simulated by a Collared Owlet (*Glaucidium brodiei*) model and playback (control experiments used the model and playback of the Spotted Dove, *Streptopelia chinensis*). Flocks in this forest are led by the nuclear species, the Grey-cheeked Fulvetta (*Alcippe hueti*).

Results: Flock density decreased dramatically from 2.1 flocks/km ($n=27$) in non-breeding seasons (NBS) to 0.5 flocks/km ($n=38$) in breeding season (BS), and the individuals of the nuclear species in flocks also decreased from 4.8 per flock to 1.9 per flock. Consequently, the amounts of vocalization provoked by nuclear species in playback experiment and moving predator experiment decreased significantly from NB to BS. However, follower species showed an opposite strategy. When tested in the flock, more following species responded to playback at BS (6.4/ trial, $n=9$) than NBS (2.5/ trial, $n=28$). Similarly, when tested outside of the flock, more species responded to playback at BS (4.5/ trial, $n=90$) than NBS (2.2/ trial, $n=59$).

Conclusion: We found strong seasonal changes in both flocking (decrease in BS) and mobbing intensity (increase in BS). The flow of information among birds thus undergoes a profound transformation from a system in which information is made mostly by one nuclear species, to one in which many species must produce their own information.

Paper Number: 445

Monday, 02 July 2018 | Machu Pichu

General Session 1.1 - Bird Ecology & Conservation

Mixed-species flocks and climate change: towards a mechanistic understanding of avian social systems

Flavia Montano Centellas

Mixed-species flocks represent a prevalent social system of most tropical forests on which species of several taxa move and forage together. In the Neotropics, mixed-species flocks include several understory insectivores, a group with current trends of population decline worldwide. Despite the importance of understanding flocking dynamics, the underlying processes that drive the structure and assembly of mixed-species flocks are still poorly understood.

Based on extensive field data collected in the Andes of Bolivia, I use functional and phylogenetic analyses, a species pairwise-interaction approach and network theory to assess: (1) how mixed-species flocks are structured in the Andes of Bolivia, (2) how the characteristics of these ecological networks change across elevations, (3) what mechanisms explain species' roles in mixed-species flocks, and (4) how the relative importance of these mechanisms changes across elevations. Finally, I model how mixed-species flocks might respond to changes in environmental conditions, such as those expected by climate change.

Overall, I found that positive interactions were more important in the assembly of flocks than negative associations. Positive interactions were more frequent in high elevation flocks, whereas negative interactions were more common at lower elevations. This result highlights the understudied role of positive interactions in promoting and maintaining diversity in harsh conditions, such as those at high elevations. Networks changed across elevations in two ways: they differed in species richness and in the nature of their interactions. Networks with fewer and more even pair-wise interactions were found at high elevations, whereas more modular and complex networks were found at lower elevations. As predicted, species with low dispersal capacities and more specialized niches tended to be central in networks, whereas generalist species tended to be facultative. Interestingly, networks in the highlands presented less skewed degree distributions suggesting that high elevation networks in the Andes are more resilient to species loss than lower elevation networks. This is important when considering community responses to climate change scenarios, where some species will be unable to persist locally due to environmental conditions. Based on these findings, I present examples of species, pairs of species and subgroups within flocks that might be affected by climate change scenarios, and the potential cascading effects. Finally, I highlight the role of mixed species flocks, and positive interactions, as a key for promoting high species diversity in the hyper diverse Andean forests.

Paper Number: 618

Monday, 02 July 2018 | Machu Pichu

General Session 1.1 - Bird Ecology & Conservation

Mixed-species flocking propensity and intraspecific sociality influence the colonization and extinction rates of bird species on islands.

Ari Martinez

Introduction

Island Biogeography Theory (IBT) posits that island area and isolation influences community dynamics and has led to a proliferation of empirical and theoretical developments since its inception. A major tenet of IBT is that increasing island area lowers extinction rates while increasing isolation lowers colonization rates, with the two factors interacting to produce a dynamic equilibrium of the number of species on islands. More recent developments have sought to incorporate functional traits of species to refine predictions from IBT. Traditionally, the predictions that result have been derived from using functional traits to predict competitive outcomes. However, functional traits may contribute to, or be influenced by, alternative ecological processes such as facilitation or mutualism. Facilitation amongst individuals of the same species or among individuals of different species may manifest itself in terms of dispersal, where movement in monospecific or mixed-species groups may provide for safer or more energetically efficient movement among patches. Or, facilitation's effects could be seen in lowering extinction rates, if the interactions between species on islands improves their mutual fitness and hence population sizes.

Methods

We use flocking propensity (in both mono-specific and heterospecific groups of birds) from field surveys and the literature, as a functional trait to evaluate how sociality might influence IBT in a long-term study system of community dynamics in Thousand Island Lakes in Zhejiang Province, China. We evaluated the colonization and extinction rates of sub-communities based on their flocking propensities. We predicted that species with both high heterospecific and monospecific flocking propensities would have higher colonization rates and lower extinction rates than species with lower flocking propensities.

Results

Indeed, our analyses confirmed that communities of species with higher flocking propensities had higher colonization rates and generally had lower extinction rates. These patterns are consistent with the hypothesis that interactions amongst individuals and/or species can facilitate movement among islands possibly by minimizing predation risk or facilitating the finding of food or minimizing predation risk while on islands. Disentangling the relative contributions of these different mechanisms potentially driving the observed patterns will be a fruitful area of future research.

Paper Number: 937

Monday, 02 July 2018 | Machu Pichu
General Session 1.1 - Bird Ecology & Conservation

Nest-site selection and nesting success of Scaly-crowned Babbler *Malacopteron cinereum* in seasonal evergreen forest in northeastern Thailand

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Tropical forest understory birds are useful ecological indicators because they are diverse and are often sensitive to human disturbance. Nest-site characteristics are likely to have a significant impact on reproductive success; however, there is little baseline data on nest-site selection and reproductive success of such species, especially in Southeast Asia which is undergoing intensive infrastructure development. We studied nest site selection and nesting success of Scaly-crowned Babbler (*Malacopteron cinereum*) in a seasonal evergreen forest in northeastern Thailand. We video monitored nests to identify nest predators and to assess relationships between vegetation at nest sites and predation by particular predators. During a four-year period (2014–2017), we monitored 79 nests for reproductive success and nest-site selection during the breeding season (January to August). The nesting period was 24–25 days; daily nest survival and nest success were low (0.92 ± 0.31 and 0.12 ± 0.04 SE, respectively). Nest sites had a significantly higher percentage of concealment directly above points at nest height (~1 m) and in the four cardinal directions at points at nest height than random sites. Nests also had a higher density of lianas than random sites; however, random sites had a higher density of vegetation above 10 m. We video-monitored the outcomes of 71 nests of which 11 were successful and one failed due to rain. The remaining 59 nests failed due to predation by 9 predator species. The two most frequent predators were Northern Pig-tailed Macaque (*Macaca leonina*) (47.5 %, $n = 28$) and snakes (18.6 %, $n = 11$). Density of small saplings was significantly higher for nests depredated by Pig-tailed Macaque compared to other predators while density of vegetation 5–10 m was significantly higher for nests depredated by snakes. The results suggest that changes in vegetation structure may greatly alter which predators are likely to find nests, and this may affect overall predation rates on nests of tropical forest understory birds.

Paper Number: 377

Monday, 02 July 2018 | Machu Pichu
General Session 1.1 - Bird Ecology & Conservation

The response of mixed-species bird flocks to altitudinal and anthropogenic change in southern and southwest China

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As habitat fragmentation, and climate change threaten biodiversity, conservation strategies often focus on species with small and dwindling populations. In birds however, many species interact in mixed-species flocks and these flocks have repeated patterns of inclusion and organization throughout the world, posing the question of whether they can be protected as biological systems. We investigated the response of mixed-species flocks of southern and southwestern China to anthropogenic disturbance and altitudinal variation. We sampled 384 flocks over two years in five nature reserves in Guangxi and Yunnan Provinces, with transects in protected forest, buffer areas, or agriculture, and ranging from 300 to 3200 m. We also systematically studied leadership in these flocks, at the whole flock and the individual level. We found that flock size (species, individuals) is not greatly affected by either habitat disturbance or elevation, but that flock encounter rate declines by as much as 50% in agriculture. Flock size and encounter rate remains high in buffer areas (degraded forests, timber plantations), although species composition shifts. Flock leading species also change in disturbed habitats with several species replacing the Grey-cheeked Fulvetta (*Alcippe morrisonia*)- primary leader of forest flocks. Flock composition changes with altitude, but fulvetta-led flocks are found along the entire gradient up to the most wind-swept ridge tops at the highest elevation site. Future studies should assess how vegetational characteristics in buffer habitats allow flocks, and particularly fulvetta-led flocks to persist in them.

Paper Number: 219

Monday, 02 July 2018 | Machu Pichu

General Session 1.1 - Bird Ecology & Conservation

Importance of keystone habitats in scrub forests of peninsular India; findings from population and ecological studies on endemic Yellow-throated Bulbul *Pycnonotus xantholaemus*

Ashish Jha and Karthikeyan Vasudevan, LaCONES-CCMB, Hyderabad, India

Aeons of tectonic collisions, volcanic eruptions, evolving seasons and subsequent weathering of land forms in India have created a myriad of habitats, each occupied by multitude of species. In the anthropocene, biodiversity hotspots have received their due share of conservation, less biodiverse habitats such as scrub forests face neglect, thus endangering the survival of several endemics. The yellow-throated bulbul, a tropical frugivorous bird, endemic and vulnerable species is resident of scrub habitats in the Eastern Ghats and inland hillocks. Our phylogenetic study placed the species to an ancient lineage containing Bulbul species spanning from Asia to Arabia. We compared morphometric, phylogenetic data, and performed a species distribution model of yellow-throated bulbul and sympatric bulbuls to understand the factors that might have caused endemism and understand the conservation implications.

We collated data from field, Maxent and literature to outline niche requirement, niche breadth and niche overlap of Yellow-throated Bulbul and sympatric Bulbuls. Presence points and covariates were obtained from online sources and field work, ecological data on Bulbul species were collated from online and published sources and morphometric measurements were obtained from field and museum specimens. Maxent software was used for modelling the species distribution, ArcGIS was used for handling the raster files and shape files, R software was used for Discriminant Function Analysis of morphometric of 20 species of Bulbuls found in mainland India, ENMTools was used for the niche analysis and Generalized Linear Models were run to identify key variables affecting the distribution and evolution of Bulbuls in India.

Results indicate that Yellow-throated Bulbul is a habitat specialist species with its distribution defined by the mesic patches in Scrub forests of Eastern Ghats. A reminiscent of an ancient lineage of Bulbul, Yellow-throated Bulbul has highly fragmented habitat and can play flagship role in garnering conservation attention towards such fragmented critical habitats. Conservation measures involve habitat protection by means of setting aside conservation reserves and reducing human foot-fall in areas of tourism within Yellow-throated Bulbul habitat.

Paper Number: 610

Monday, 02 July 2018 | Machu Pichu

General Session 1.1 - Bird Ecology & Conservation

GENERAL SESSION 2.1

Plant Ecophysiology

Responses of lowland tropical rainforest trees to drought

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Increased drought is forecasted for tropics, which will create a water deficit condition for tropical trees with severe implications for forest ecosystems. However, the responses of tropical trees to water deficit are poorly understood. We investigated wood anatomy and leaf traits in lowland tropical forest trees after 24 months of experimental rainfall exclusion. Sampling sun-exposed young canopy branches from target species, we found responses that are species specific, systematic and hydraulic safety oriented, including narrower or less water conducting tissues (vessels), reduced vessel groupings, lower theoretical water conductivities, less water storage tissue and more abundant fibre in their wood, and more occluded vessels. Drought-affected trees also had lower leaf to twig dry mass ratios, thinner leaves, and more negative pre-dawn or mid-day leaf water potentials. This study explains the wide-ranging hydraulic responses of different tree species to drought. As such, our findings will assist fine-tune predictions of how future climate changes will affect tropical forests globally.

Paper Number: 738
Monday, 02 July 2018 | Chichen Itza
General Session 2.1- Plant Ecophysiology

Impact of elevated temperature and atmospheric CO₂ concentration on seedling growth and survival of species along a tropical wet forest-savanna gradient

Deborah M.G. Apgaua, David Y.P. Tng, Samantha J. Forbes, Yoko F. Ishida, Nara O. Vogado,
Lucas Cernusak, and Susan G.W. Laurance

Tropical wet forest and savanna woodland are biomes distributed along a gradient of water availability. Species occurring along this gradient are likely to have divergent growth and physiological responses to the elevated temperatures, [CO₂], and drought stresses predicted under climate change scenarios. In particular, while the effects of these individual environmental factors on plants are well-established, how these factors in combination affect plants is comparatively less well studied. Additionally, in the context of species distributed along an ecological gradient, it is instructive to examine relative responses of such species to changed environmental factors. To address this, we conducted a common garden experiment using seedlings of three tree species from the same genus (*Eucalyptus*), which occur naturally along a wet forest (*E. grandis*) - ecotone (*E. resinifera*) - savanna (*E. platyphylla*) vegetation sequence in tropical northeast Queensland, Australia. We monitored the growth, biomass change, physiological performance (photosynthesis) of the seedlings to various combinations of ambient, and elevated [CO₂] and temperature within growth chambers configured to deliver these different growth conditions. Also, within each chamber, we subjected half of the seedlings of each species to a dry-down (drought) treatment to create soil water deficit, and monitored their survivorship and physiological responses.

Our results demonstrate that singly, elevated temperatures lowered the growth and photosynthesis of well-watered seedlings, and hastened seedling mortality consistently across all species in individuals subjected to drought. Relative to controls in ambient temperatures, elevated temperatures also lowered overall biomass gain of well-watered forest and ecotone species, but enhanced that of the savanna species to a point. Elevated [CO₂] enhanced growth, biomass gain, and photosynthesis across well-watered seedlings of all species, most prominently in savanna seedlings. In the drought experiment, elevated [CO₂] also enhanced survivorship and ameliorated physiological performance of all species, most strongly in savanna seedlings. On the overall, our data suggests that elevated temperatures and [CO₂] in combination may favor the plant growth and physiological performance of savanna relative to forest and ecotone species. These results have important implications for understanding the resilience of habitats, and for contextualizing future biome boundary dynamics.

Paper Number: 721
Monday, 02 July 2018 | Chichen Itza
General Session 2.1- Plant Ecophysiology

Tree growth and stem carbon accumulation in human-modified forests following drought and fire

Erika Berenguer

In this century, extreme droughts are likely to become more frequent in Amazonia. As a consequence, drought-mediated understory fires are also likely to become more frequent, burning millions of hectares of forests that did not co-evolve with this stressor, as seen during the 2015-2016 El Niño. However, we have little understanding of how extreme droughts and fires impact growth and carbon accumulation in the surviving trees. We first investigate tree growth and carbon accumulation over three years in stems distributed along a gradient of drought-affected human-modified forests. Then we assess whether the El Niño-mediated drought had any impact on growth rates, comparing 2015 to non-El Niño years. Finally, we examine if trees in burned forests have similar growth and carbon accumulation rates to trees in unburned forests, looking at factors that could influence these processes. We used monthly-measured dendrometer data from c.1000 stems distributed in undisturbed, selective logged, logged-and-burned, and secondary forests in eastern Amazonia. We compared data from before, during and after the 2015-2016 El Niño to address our objectives. Over the three-year period secondary forests grew significantly more than undisturbed and disturbed primary forests. Although disturbed primary forests presented higher stem growth, they accumulated less carbon than undisturbed forests. Surprisingly, we found no significant effect of the El Niño-mediated drought on tree growth. Still, undisturbed forests seemed to be more resistant to extreme droughts than any other forest class. Growth and carbon accumulation rates were significantly higher in surviving trees in burned forests than in trees in plots only subjected to drought. Neither variation in locally measured proxies of liana loads, competition release, nor fire intensity seemed to explain this increase in growth rates. Surviving trees in undisturbed forests appeared to be resistant to extreme droughts, which is good news given that these events are becoming more frequent across the Amazon Basin. Furthermore, these forests also seemed to be accumulating more carbon than their disturbed counterparts. These results highlight the vital importance of protecting our last remnants of undisturbed forests in Amazonia.

Paper Number: 284
Monday, 02 July 2018 | Chichen Itza
General Session 2.1- Plant Ecophysiology

Do High-Altitude Tropical Alpine Plants use Light with Maximum Photosynthetic Efficiency?

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Background. Optimality theory predicts that individual leaves should be exposed to a light (PPFD, photosynthetic photon flux density) that maximizes photosynthetic light use efficiency ($l_{e_{max}}$). Two main mechanisms allow leaves to be exposed to $l_{e_{max}}$: acclimation of leaf maximum photosynthetic capacity (A_{max}) and adjustments in the angle of inclination of leaves. Yet, steeper leaf inclination also causes a reduction in PPFD absorption at the leaf scale that can potentially affect photosynthesis at the plant scale. Plants can grow several layers of leaves to compensate for the cost of reducing PPFD absorption at the leaf scale. However, it is not clear if optimal photosynthetic PPFD use efficiency can occur in high-altitude tropical ecosystems due to extreme climatic conditions and low soil fertility, which can reduce leaf photosynthesis and constrain canopy development.

Objective. Our goal was to determine if tropical Páramo plants (3600 m of elevation) with contrasting architecture can use PPFD with maximum efficiency. Given the theoretical fitness advantages of optimizing PPFD use, we expected that most photosynthesis will occur at a PPFD that matches $l_{e_{max}}$ in leaves of different species.

Methods. Measurements were done in the Páramo of Chingaza, Colombia, on *Espeletia grandiflora* and *Chusquea tessellata*, two dominant species in the area. We measured PPFD incident on exposed leaves every five seconds for several days using small GaAsP photodiodes during the dry and wet seasons. Light response curves of photosynthesis were measured in situ on the same leaves. We obtained distribution of photosynthesis (A_w) by weighting photosynthetic light response curves by the frequency distributions of PPFD incident on leaves.

Results and Conclusions. Contrary to our expectations, the modes of A_w were poorly aligned with $l_{e_{max}}$ and average photosynthetic efficiency was lower in *C. tessellata* than in *E. grandiflora*. Leaf angle was also steeper and A_{max} lower in *C. tessellata* than in *E. grandiflora*. Yet, steep leaf angle was not sufficient to compensate for low A_{max} (and low $l_{e_{max}}$) in *C. tessellata*, resulting in lower overall efficiency. Although *E. grandiflora* had higher efficiency and carbon gain at the leaf level, its more open-canopy rosette architecture indicates that it may have captured less PPFD at the plant scale than *C. tessellata*, which had a very dense leaf canopy. Future studies should scale the performance of individual leaves to the whole crown to determine if dense crowns can compensate for lower photosynthetic efficiency in these extreme environments.

Paper Number: 712
Monday, 02 July 2018 | Chichen Itza
General Session 2.1- Plant Ecophysiology

How to play by a different set of rules: functional traits of *Rhododendron* species with a stress-tolerant ecological strategy along tropical elevation gradients

Melissa Whitman and Sabrina E. Russo, University of Nebraska-Lincoln

Background: Examination of plant functional traits along environmental gradients often reveal a shift in trait space, thus implying that ecological strategies may also change based on the environmental context. For instance, specific leaf area (SLA) for most plants declines with elevation, a pattern often attributed to a shift in levels of biotic competition relative to increasing abiotic stressors along a gradient. Here, we address the question, what happens to patterns in trait space with elevation when considering plant species with a stress-tolerant ecological strategy? Is it possible to maintain a narrow, or highly specialized, trait space regardless of location along an elevation gradient?

Methods: We used the highly diverse genus *Rhododendron* (Ericaceae) from the tropics of South-East Asia as the model taxonomic group. *Rhododendron* species can be found within many different habitats, ranging from sea-level to mountain summits (> 4000 m), and are characterized as having a stress-tolerant ecological strategy. We collected leaf functional trait data (such as SLA, % N, LDMC, density, succulence) on 169 tropical *Rhododendron* species of known provenance grown in botanical garden greenhouses, combined habitat information from botanical monographs and collection records. First, we examined the functional trait space and diversity of *Rhododendron* species along elevation gradients, as well as how they compared to a meta-analysis of woody tropical plants. Next, we contrasted the trait space of epiphytic versus terrestrial growth forms, as well as species associated with ultramafic (serpentine) soil.

Results: The trait space of *Rhododendron* species was remarkably consistent mean and variance regardless of location along elevation gradients. Individual traits, such as SLA, had minimal change, which is in stark contrast to trends noted for other taxonomic groups. In addition, there was little difference in *Rhododendron* trait space based on growth form or edaphic association, despite leaf sizes that dramatically differed in area, shape, or rugosity.

Discussion/Conclusion: *Rhododendron* species are able to maintain a very narrow trait space, and consistent ecological strategy (stress-tolerance), across a broad suite of environmental contexts. Such stability may be facilitated by avoidance of biotic competition pressures by utilizing novel or unique habitat types, or from flexibility in habitat association or growth form, especially within lower elevation areas.

Paper Number: 903

Monday, 02 July 2018 | Chichen Itza
General Session 2.1- Plant Ecophysiology

Mapping the leaf economic spectrum across West African tropical forests using UAV-acquired hyperspectral imagery.

Eleanor Thomson

Many questions regarding the feedbacks between vegetation and climate can be addressed with a better understanding of plant functional traits and how these traits scale with ecological processes. Remote sensing offers enormous potential for generating large-scale trait data. Yet so far, canopy studies have been limited to imaging spectrometers on board aircraft, which are rare, expensive to deploy and lack fine-scale resolution. In this study we measured VNIR (visible–near infrared (400–1050nm)) reflectance of individual sun and shade leaves in 7 one-ha tropical forest plots located along a 1200–2050mm precipitation gradient in West Africa. We collected hyperspectral imaging data from 3 of the 7 plots, using an octocopter–based unmanned aerial vehicle (UAV), mounted with a hyperspectral mapping system (400–950nm, 9nm resolution). Using partial least squares regression (PLSR), we found that the reflectance spectra of individual sun leaves demonstrated significant correlations with leaf mass per area (LMA) and leaf chemical traits: $r^2 = 0.60$ (LMA), $r^2 = 0.78$ (leaf nitrogen (N)), $r^2 = 0.64$ (leaf phosphorus (P)), $r^2 = 0.43$ (leaf potassium (K)), $r^2 = 0.50$ (leaf calcium (Ca)) and $r^2 = 0.37$ (leaf magnesium (Mg)). At the airborne level, four of the six leaf traits demonstrated significant correlations with the UAV-collected spectra of 58 tree crowns: $r^2 = 0.45$ (LMA), $r^2 = 0.38$ (N), $r^2 = 0.38$ (P), and $r^2 = 0.43$ (Ca). From the airborne imaging data we derived one-ha maps of canopy LMA, N, P and Ca, revealing precipitation and substrate as co-dominant drivers of trait distributions and relationships. Overall, this study demonstrates the application of UAVs to generating high quality spatial and temporal information on plant functional traits and advancing the study and monitoring tropical forest functional diversity.

Paper Number: 345

Monday, 02 July 2018 | Chichen Itza
General Session 2.1- Plant Ecophysiology

SYMPOSIUM 7.1

The Second International Symposium on Fishing Cat Conservation: Persistence of a tropical wetland specialist, Ecology, Activism and Conservation

Guardians of the Wetlands: Using Fishing Cats for Urban Wetland Conservation in Colombo Sri Lanka

Anya Ratnayaka

The fishing cat, locally known as the “handun diviya” is the country’s second largest wild cat. The species’ classification was upgraded to Vulnerable in 2016 by the IUCN RedList, and the animal is locally classified as Endangered by the National Red List, Sri Lanka. Often mistaken for young leopards, the species is a highly elusive predator, and is found almost exclusively in wetland habitats.

Further, Colombo is the only known large city in the world where wild fishing cats have been recorded. As a habitat specialist the fishing cat requires riparian habitats, swamps, and wetlands; critical ecosystems for preserving watershed and drainage functions, but among the first to be reclaimed or converted during urbanisation. However, as post war urban development takes a toll on Colombo’s urban wetland habitats, there is a realisation among policy makers of the need for urban ‘green areas’ for aesthetic and practical considerations such as flood control, recreation, and biodiversity conservation. If conservation plans can be infused into city plans, green refuges can be more effective for biodiversity conservation, including for conserving ecological functions.

So far, the project has collared three fishing cats: one residents and two translocated animals, and has 10 camera traps running at selected urban wetlands in Colombo. Preliminary findings show a difference in the behaviour and ecology of resident versus translocated fishing cats, and the study hopes to further study these differences, as well as the understand how the species is adapting to the ever changing urban environment.

The movement data gathered from the collared fishing cats is constantly fed to government stakeholders and we hope to work with them to develop a set of guidelines that can be used to help elevate urban wetland conservation strategies and feed into a national small wild cat conservation strategy.

Paper Number: 485

Monday, 02 July 2018 | Eiffel 1

Symposium 7.1 - The Second International Symposium on Fishing Cat Conservation:
Persistence of a tropical wetland specialist, Ecology, Activism and Conservation

The Status Of Fishing Cat (*Prionailurus viverrinus*) Conservation In Human-Mediated Landscapes In Sri Lanka

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The Fishing cat (*Prionailurus viverrinus*) is the second largest (locally endangered) small wild cat in Sri Lanka. They can also be found in south and south East Asian countries including India, Nepal, Cambodia and Pakistan. Fishing cats prefer water rich habitats like coastal and inland wetlands such as riverbanks, marshlands, reed beds, tidal creeks and mangrove forests. The local populations are highly threatened due to road kills, poaching, poisoning, misconception and habitat loss. Even the in-country protected areas are in great danger from the continuous human disturbance and habitat alteration. This study aims to find out the threats these cats face in human mediated landscapes and take necessary conservation actions to reduce them. Initial study was carried out in Minneriya -Girithale nature reserve in the dry zone of Sri Lanka. Population trends and abundance of fishing cats were monitored by camera trapping, scat collections and pug mark analyses. Threats were recorded by monitoring road kills, interviewing villagers and using veterinary records in the study area. Additions to that, threats were monitored in district basis throughout Sri Lanka to identify the most potential areas for conservation. A total number of 11,055 photographs were recorded during 869 trapping days in Minneriya-Girithale Nature Reserve. Six individuals have been identified by comparing body patterns in 4.20 km² area from September 2015 to November 2017. Island wide study provided 102 occurrence records in 21 districts from July 2013 to January 2017. More than 90% of the data associated with threats included road kills and accidents. Road kills is the main threat that fishing cats face in Sri Lanka. Hill country districts hold the highest reputation for road kills. Additionally poaching, habitat loss due to fragmentation and degradation were most common threats. Poisoning, electric fencing, use of their flesh in indigenous medicine are occurring due to misunderstanding and misconception about fishing cats. As threat mitigation, awareness programmes and youth camps were organized for school children and local villagers in target areas. Road signs were placed at most vulnerable road kill places. So far, it seems the above conservation strategies have paid off, thus conservation action should further be implemented, and regular observations are crucial.

Paper Number: 137

Monday, 02 July 2018 | Eiffel 1

Symposium 7.1 - The Second International Symposium on Fishing Cat Conservation:
Persistence of a tropical wetland specialist, Ecology, Activism and Conservation

Further Note of Fishing Cat, *Prionailurus viverrinus rhizoporeus*, in Java Island, Indonesia

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Indonesia is known as one of country in the world with mega biodiversity, numerous of endemic species but also threatened and in the brink of extinction. The evil quartet was believe to be the one that affecting extinction. But there is something important behind that, data and information.

The javan fishing cat, *Prionailurus viverrinus rhizopores*, is one of endemic species to Java island, Indonesia but the last know scientific publication was in 1995 and state six (of 20) area inference has positive record of fishing cat existence in west java. And in this almost three decades, there is only a single photograph from wildlife been recorded in 2000 in Pulau Dua.

Since 2015, author conducting occupancy and camera trapping in three of six sites that has fishing cat records, try to reconfirm fishing cat existence record, but found nothing from three site surveyed. Most of mangrove habitats in Java were converted into fishpond, paddy rice filed and settlement. In certain area fishing cat was hunted by people due to conflict with fisherman. Author didn't study any ecological catastrophe that influence to the extirpation of fishing cat during this research. We found little evidence of co-existence factor to the fishing cat occurrence, we found out in two site the presence of leopard cat and stray cat which are never been recorded previously.

This research is still under go and planned to reach other site in central and east java. And it is urging to have more support and action. We are racing with time. The more information and data could be provided; it will help the management of biodiversity conservation in java, especially small carnivores.

Paper Number: 973

Monday, 02 July 2018 | Eiffel 1

Symposium 7.1 - The Second International Symposium on Fishing Cat Conservation:
Persistence of a tropical wetland specialist, Ecology, Activism and Conservation

Long term conservation of Fishing cats in the Godavari delta, Andhra Pradesh, India

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Fishing cat *Prionailurus viverrinus* is one of the most threatened small cat species in the world and it is listed as vulnerable in IUCN Red list. These small cats are wetland specialists occurring in both coastal habitats like mangroves and inland wetlands like swamps, lakes etc. A very little information is available on their behaviour and vocalisations from the wild. In India, mangroves are well-known ecosystems which play an important role in protecting against coastal erosion, natural calamities such as cyclones, tsunamis and provide good refuge to some of the most endangered fauna such as tiger, fishing cat, salt water crocodiles etc. So, this long-term project was aimed to understand the behaviour of the Fishing Cat in a tropical mangrove forests in Godavari delta of South India. Methodology included camera trapping inside the sanctuary to estimate the population of fishing cats with a total of 198 camera trap stations and we deployed 3 acoustic recorders in one of the main river Coringa of the study area to study the vocal behaviour as well. Results shows an abundance of 75.0 +/- 7.7 (SE) (62.8 + 94.3) individuals, with 107 captures of 54 different individual cats. The density estimate using SECR framework was 0.53 +/- 0.94 (SE)/km². The temporal activity of Fishing Cats shows a cathemeral activity with much activity during the day and night but considerable dips during dawn and dusk ($\chi^2_1 = 12.3$, $p < 0.01$) and their activity also varied significantly with lunar phases and lunar illumination ($\chi^2_{16} = 651.78$, $p < 0.05$; χ^2_4 , $p < 0.05$ respectively). The results also showed that they increased activity when the moon was at waning gibbous phase (with 35.5 % captures) followed by full moon days (with 24% captures). Coming to the vocal behaviour a total of 39 fishing cat calls have been recorded and are classified into 5 types like 1) Chuckling 2) Growling 3) Screaming 4) Meow 5) Hissing, based on their spectral and temporal features. Of all these call types screaming and hissing were mostly recorded which shows that territorial fighting is more frequent in fishing cats. Chuckling calls are recorded mostly during the low tide timings and could be a main communicating call used in searching partners and kittens. Thus, this long-term study helped us to understand the behaviour of Fishing Cats with respect to its habitat which were not observed previously in the wild. Keeping in mind the global importance of mangroves as an important ecosystem this study revealed the ecology of Fishing Cats for the first time in relation to its habitat, intra and inter-specific competition. At the same time being the top predator, fishing cats can act as a flagship species for enhanced protection of the Godavari mangroves. This study is also important in terms of understanding the importance of healthy mangrove forests in conservation of the threatened small cat since the likelihood of occurrence of fishing cat was higher in dense mangrove patches and lower in the human-modified habitats such as, agricultural farms, aquaculture ponds etc.

Paper Number: 516

Monday, 02 July 2018 | Eiffel 1

Symposium 7.1 - The Second International Symposium on Fishing Cat Conservation:
Persistence of a tropical wetland specialist, Ecology, Activism and Conservation

Study and conservation initiatives of Fishing cat in the human dominated landscape of Nepal

Sagar Dahal

Small Mammals Conservation and Research Foundation

Fishing Cat is a good swimmer and is mostly associated with wetlands and marshy areas where it preys upon fish and other riparian or aquatic species. Fishing cat is known as “Pani Biral” (Paani=Water, Biral= Cat, i.e. Water Cat) in Nepali. The Fishing cat was recorded for the first time in Nepal in early 19th century by Brian Hodgson. Fishing Cat is categorized as a vulnerable species in IUCN Red List with decreasing population trend and do not fall under the list of legally protected species of Nepal government. Before 2014, Fishing Cats were known to occur only within the protected areas of Terai with indeterminate status but after 2014 I carried out Fishing Cat targeted studies at seven sites namely Jagadishpur Reservoir and Banganga river of Kapilvastu district, Ghodaghodi Lake of Kailali district, Halkhorla Lake of Parsa district, private fish ponds at Bodhban of Bara district, Sunari river at Ramdhuni forests and private fish ponds of Prakashpur at Sunsari district using camera traps. During three years of study we recorded Fishing Cats from Jagadishpur reservoir, Banganga river, Ramdhuni forest near Sunsari river, and Bodhban. Within these sites, we also recorded that Fishing Cats face several threats such as retaliatory killing using electrocution, poisoning and hunted down by watch dogs for taking away fish and poultry from the private fish ponds and local community. Fishing Cats are also consumed as bush meat after poaching. Local community poison natural waters for fishing which is also killing the animal. All these threats are due to lack of awareness about the species, habitat encroachment, prey base depletion and lack of strong legal provision. As conservation initiative to mitigate threats to the Fishing cats I along with my team conducted extensive conservation awareness programs to the school children and adults and distributed posters and booklets that were produced during the projects as an education materials. In addition to that we provided ten strong poultry coop to the local community of Bodhban as an incentive to conserve Fishing cats and save them from retaliatory killing. We are also working with local government and have produced policy brief on the conservation of Fishing Cat with recommendation to keep the cat under protected category on the new amendment of protected list of species of Government of Nepal. Besides that I am also producing new generation of Fishing Cat conservationist by supervising and mentoring university students doing researches on Fishing Cats. We believe all these combined efforts of conservation and research for extended period of time have short and long term effect to secure the better future of Fishing cats in the wetlands and riverbanks of Terai of Nepal.

Paper Number: 369

Monday, 02 July 2018 | Eiffel 1

Symposium 7.1 - The Second International Symposium on Fishing Cat Conservation:
Persistence of a tropical wetland specialist, Ecology, Activism and Conservation

Global Small Cat Conservation Update

Jim Sanderson, Ph.D.

Global wildlife Conservation

In the last few years, small wild cat conservation has received a boost from various funding sources. These funding sources have allowed the operation of sustained conservation efforts for several species. Two approaches are being used: targeted species conservation, and increased protection for areas that support an unusually high diversity of wild cats. Since 2004 Alianza Gato Andino has been a self-sustaining organization dedicated to the conservation of Andean cat, IUCN Red List Endangered, throughout its range. More recently, the Fishing Cat Working Group is running sustained conservation efforts on behalf of fishing cats (IUCN Red List Endangered) in Bangladesh, Cambodia, India, Nepal, and Sri Lanka. Surveys are underway in Pakistan. Efforts on behalf of the Guigna in Chile, two tigrina species in Brazil, and most recently for manul in Mongolia have been supported. Area conservation efforts include the Talamancas Mountains in Costa Rica and Panama, Mirador State Park in Maranhão, Brazil, Way Kambas National Park in Sumatra, and Sungai Wain Protection Forest in Kalimantan. Many of these efforts are supported by Global Wildlife Conservation's Guardians program whose goal is to provide employment opportunities and raise the status of young in-country conservationists. Each of the above will be discussed in more detail.

Paper Number: 89

Monday, 02 July 2018 | Eiffel 1

Symposium 7.1 - The Second International Symposium on Fishing Cat Conservation:
Persistence of a tropical wetland specialist, Ecology, Activism and Conservation

SYMPOSIUM 1.2

Built Infrastructure and the Future of Tropical Forest

Superhighway Development Threatens Tropical Forest Conservation and SDGs in Equatorial Africa

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Centre for Tropical Environmental and Sustainability Science, College of Science and Engineering, James Cook University, Cairns, Queensland 4878, Australia

To promote the role of scientists in providing evidenced-based reasoning in realizing SDGs, viable human actions must be encouraged through smart road infrastructure provisioning to optimize conservation planning, minimize environmental damages and maximize socioeconomic benefits. The African case study presented in this study show how re-routing poorly planned highways can reduce negative environmental impacts. Examining the proposed 260 km superhighway in Cross River State, south-eastern Nigeria illustrate how human actions threatens frontiers of biodiversity and wildlife conservation in equatorial Africa. The examined proposed highway by the Cross River State Government in Nigeria would have intersected ~115 km of intact tropical rainforest or protected areas, and would cost ~ US\$2.5 billion to construct. The two alternative routes 1 and 2 we offered and evaluated would be less damaging to the Cross River National Park, unprotected forests, and biodiversity habitats. Although, the alternative routes are slightly longer (~290 and ~353 km), yet costing less (~ US\$0.9 billion) to construct, compared to the state government proposed superhighway. The first alternative suggested, entirely avoids intact forest while aiming to provide maximum benefits to farmers and settlers. In the context of achieving SDG, smart infrastructure provisioning and sustainable land-use management suggestions from research outcomes should be incorporated as strategic tools for developing an informed conservation economy policy and decision-making in Africa. If optimized conservation, reduced environmental impacts and maximal socioeconomic benefits are to be achieved Africa wide, lessons, trade-offs and synergies from the illustrated African case study on road planning and forest landscape management should be promoted and integrated in the spatial infrastructure and land-use planning process towards attaining local-scale SDGs.

Paper Number: 362

Monday, 02 July 2018 | Colosseum 1

Symposium 1.2 - Built infrastructure and the future of tropical forest

Political Economy Of Infrastructure Development – A Heady Landscape

Cynthia Ong

How can infrastructure development be more sensitive and sensible? How do we transform an exclusive decision-making process in board rooms into an alternative one which is more collaborative to consider the impacts on flora, fauna and affected communities? The Sabah state government envisions that, by 2035, “the people of Sabah will lead productive and meaningful lives in harmony with nature, conserving it for future generations and supported by a vibrant and sustainable economy.” A crucial part of achieving this vision is ensuring that large-scale infrastructure projects such as the Pan Borneo Highway limit risks and optimize benefits for people, the environment and the economy. Sabah is well placed to become a leader within Malaysia and Southeast Asia in the development of infrastructure projects that do just that.

This presentation explores the intricate interactions between politics and economy, and at the same time trying to conserve the natural terrestrial and aquatic environment that provides the much needed ecosystem services for the people and key economic activities such as ecotourism, fishery and agriculture. To enrich the discourse, two examples will be cited, namely the Lahad Datu coal-fired power plant and the Sukau Bridge which threatened the ecosystems while promising progress. Although both projects have been cancelled, were the long and damaging public battles necessary? Who won, who lost, and what did we learn? Can we move away from civil society vs government or industry? Is it possible to turn away from adversarial towards a more collaborative approach as a resolve? There is an urgent need to start reaching out to each other to find the answers.

Paper Number: 981

Monday, 02 July 2018 | Colosseum 1

Symposium 1.2 - Built infrastructure and the future of tropical forest

When rubber hits the road: the interplay of planning, pretexts and policy on Manus Island, Papua New Guinea

Mutton T, Seri L, Noble S, Brenier A, and Whitmore N

For villagers in Papua New Guinea (PNG) roading is seen as synonymous with development. However, despite having only a small number of national highways these roads are not well maintained. Additionally, due to a culturally enshrined practice of political clientism local roading developments are usually under political influence. As a result comparatively few rural communities are serviced by good roads. As virtually all land in PNG is under customary ownership, access to natural resources will always require some form of community consent. As part of a strategy to gain such consent foreign logging interests will often exploit the local desire for roads by offering to build roads in order to gain access to timber resources. On Manus Island, a 100 km long offshore island to the north of the PNG mainland, repeated attempts have been made by foreign logging companies to access the island's valuable timber stocks under pretexts of building roads and developing large scale agricultural initiatives. Information about these planned activities are typically vague, generally not made public and often not accurately explained to local communities. Consequently, few if any people are aware of their existence, scale, or potential impact. Here we examine the interplay between logging, roading and agro-forestry developments in Manus Island from 2011 to 2018. We conclude that roading issues are symptomatic of wider planning issues in PNG, and suggest that the training of provincial officers in spatial tools (such as QGIS) is likely a useful step in ameliorating some of the most egregious elements of current practices.

Paper Number: 331

Monday, 02 July 2018 | Colosseum 1

Symposium 1.2 - Built infrastructure and the future of tropical forest

Does the upgraded Pan-Borneo highway project conflict with the Heart of Borneo aspirations in Sabah, Malaysia?

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Roads expansion is occurring at an unprecedented rate across the planet. Globally, at least 25 million kilometers of new paved roads are anticipated by 2050 with the total length of paved roads in Asia alone expected to double over the next three years. Much of this road construction is projected to occur in tropical regions including those that currently sustain exceptional biodiversity and provide vital ecosystem services. In Malaysia, for instance, the road network expanded by 87% between 2002-2013 (~116,000 km) and a further 68% (an additional ~93,000 km) over the period 2010 to 2015. Under the Eleventh Malaysia Plan (2016-2020) this rapid expansion of road infrastructure is slated to continue including upgrades and extensions to the Pan-Borneo Highway and its feeder roads. If this highway development were to proceed as planned, much of the routes will crisscross currently forested areas of Sabah, potentially imperiling some of Malaysia's most important wildlife habitats. Further, they will penetrate some of the last remote wilderness areas in Sabah including forests currently found within the Heart of Borneo area; an area slated for protection, production and sustainable land use under a trilateral agreement between Malaysia, Brunei Darussalam and Indonesia. Using spatial analyses we show that the Pan-Borneo highway upgrade in Sabah threatens multiple ecologically sensitive regions and conflicts with the conservation-based aspirations listed in the Heart of Borneo agreement.

Paper Number: 218

Monday, 02 July 2018 | Colosseum 1

Symposium 1.2 - Built infrastructure and the future of tropical forest

SYMPOSIUM 2.2

Environmental Sustainability in Oil Palm: Linking Science to Policy and Practice Across the Tropics

Identifying critical limits in oil palm expansion for the conservation of terrestrial mammals in Colombia

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As oil palm plantations continue to expand in Neotropical regions, identifying critical transitions in land use, at which animal communities can be drastically altered, is crucial for conservation planning. Here, we investigated potential unexpected change points (thresholds) in the response of terrestrial mammal's richness and community composition to increasing oil palm cover (%) in the Llanos region of Colombia. For the identification of these points, we used segmented regression and Threshold Indicator Taxa Analysis (TITAN). The identified community threshold was then used to evaluate the conservation status of the four main oil palm production landscapes in Colombia. We found a negative linear relationship between the proportion of oil palm and species richness, but no evidence of a significant threshold. In contrast, we found strong signs of a community threshold in landscapes composed of 45-75% oil palm cover, beyond which mammalian species community composition (occurrence and relative abundances) drastically declined. Moreover, a significant change point in species composition to the gradient of oil palm cover was found to occur in 10 of the 15 examined species, with four (squirrel, agouti, spiny rat, common opossum) having a synchronous response at approximately 45 % oil palm cover. Five species showed no evidence for any critical threshold (giant and lesser ant eater, jaguarondi, white tailed deer and raccoon). Using the results from this analysis, we found that approximately 41% of Colombian oil palm landscapes have crossed the identified threshold, suggesting urgent need for restoration programs in order to avoid the potential collapse of their resident mammal communities. These findings provide guidance for the design of sustainable landscapes within production areas in Colombia to promote the conservation of terrestrial mammals.

Paper Number: 119

Monday, 02 July 2018 | Colosseum 2

Symposium 2.2 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Assessing the benefits of riparian reserves in oil palm landscapes: developing the science to inform environmental policy

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There is growing recognition of the role that riparian reserves may play in biodiversity conservation within oil palm estates. However, there is little information about how these conservation set-asides might best be designed and managed to maintain biodiversity. We have established a research programme in Sabah to investigate the biodiversity value of riparian zones in oil palm plantations. We are particularly interested in the influence of riparian zone width and forest quality on biodiversity levels so that meaningful recommendations can be made to the industry and government policy-makers. We find that riparian reserves typically support more species of mammals, birds, and invertebrates than oil palm plantations, and levels of diversity in large riparian reserves can be similar to that found in continuous rainforest. A detailed study of birds and dung beetles reveals that reserves need to be at least 40 m wide on each bank (i.e. 80 m total width) to support equivalent numbers of species to forest river habitats, but to protect all species of conservation concern reserves would need to be >100 m wide on each bank (200 m total). Moreover, there is no evidence that riparian reserves increase pest species, and may have commercially important carbon stocks if not disturbed. The biodiversity and carbon values of riparian reserves will become increasingly important for plantations seeking environmental certification such as RSPO, and could also be useful to mitigate against climate change. The results of this review have been synthesised into a policy brief and poster for policy-makers in Sabah, Malaysia as they review their riparian guidelines in the coming years. This collaboration is an excellent example of how scientists and policy-makers can work together to synthesise current knowledge and make it accessible and relevant.

Paper Number: 547

Monday, 02 July 2018 | Colosseum 2

Symposium 2.2 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Does the oil palm industry help alleviate poverty? Lessons from Indonesia

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Oil palm continues to be promoted as a way to improve the social welfare of rural communities in tropical countries. However, efforts to quantify the social impacts of this crop typically focus on single economic dimensions, and have been limited in spatial scale.

Here we assess the contribution of industrial-scale oil palm plantations on multiple aspects of wellbeing in Indonesian villages of Borneo between 2000 and 2014. Our counterfactual analysis of government census data demonstrates that the social impact of oil palm expansion has not necessarily been positive in Kalimantan, and has varied with locations and baseline community livelihoods of villages. Plantations developed in semirural areas where communities rely on market-oriented livelihoods are associated with improved basic, physical and financial wellbeing. However, we found the opposite for plantations developed in remote areas where communities previously rely on subsistence livelihoods. Across the whole of Kalimantan, oil palm growing areas were typically more associated with reduced social and environmental wellbeing compared to non-growing areas, regardless of locations and baseline livelihoods.

Additional efforts to alleviate poverty via Indonesia's community forestry schemes (e.g. hutan desa) have so far proven futile in oil palm growing areas, especially on peatland. In the short timeframe that these policies have been operational, overall levels of human wellbeing has improved in villages with community forest. However, in permanent or convertible production zones where large oil palm plantations dominate, basic and environmental wellbeing has declined.

While there have been positive outcomes for rural people involved in oil palm agriculture the industry still has some way to go to deliver on its promises to alleviate poverty. Efforts to improve village welfare via community forestry schemes are likely to need substantial assistance in oil palm growing areas to ensure people are not negatively affected by externalities associated with industrial agricultural production.

Paper Number: 654

Monday, 02 July 2018 | Colosseum 2

Symposium 2.2 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Can plantation management in oil palm increase biodiversity and pest control?

Edgar Turner

It is clear that oil palm expansion across Southeast Asia has come at a significant cost to tropical biodiversity, but much less is known about the communities of species that survive within oil palm ecosystems, their potential in supporting important ecosystem functions, such as pest control, or the potential of plantation management to enhance these functions and, therefore, potentially increase yield.

The BEFTA Programme is a long-term experimental project based in Riau, Indonesia, that investigates the impacts of different plantation management techniques in established oil palm plantations on biodiversity, ecosystem functioning, and oil palm yield. In particular the programme is working with the oil palm industry to trial more biofriendly management options, such as reduced herbicide applications within the understory of plantations and the re-establishment of forest margins around rivers.

Here we present findings from the project that have implications for Integrated Pest Management practices. In particular, we show that higher levels of understory vegetation cover leads to higher abundance of a range of predatory groups and more effective pest control within plantations. As a collaborative project between Sinar Mas Agro Resources and Technology Research Institute and the University of Cambridge, this project demonstrates the value of collaboration between industry research organisations and academic institutions to identify strategies that benefit both the environment and yield within agricultural systems.

Paper Number: 708

Monday, 02 July 2018 | Colosseum 2

Symposium 2.2 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

SYMPOSIUM 3.2

Tropical Tree Life-History Strategies: Causes and Consequences of Demographic Diversity

Using demographic trade-offs and a simple forest model to understand and predict tropical forest dynamics

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Tropical forests worldwide suffer from human alterations, e.g. through climate change or timber extraction, with profound consequences for biodiversity and carbon retention. To understand and predict how forests change in response to these drivers, we need to understand the demographic strategies of tropical tree species and how they respond to resource availability. Our goal is to explore how demographic strategies of 282 tree and shrub species in the tropical moist forest of Barro Colorado Island, Panama, combine to determine forest dynamics. We apply the PPA (perfect plasticity approximation) model that simulates height-structured competition for light based on growth and survival of each species in four canopy layers. Model parameters were derived from a PCA of species-specific growth and survival rates, as well as recruitment rates per basal area of reproductive trees, to capture essential dimensions of demographic variation. We parameterized the model either for each species separately or for five virtual species representing different demographic strategies (fast, slow, long-lived pioneers, short-lived breeders, intermediate).

The model correctly reproduced observed old-growth forest structure and species composition, as well as species' maximum sizes. The model also correctly predicted the dynamics of secondary forest (as compared to chronosequence data) although it was parameterized only based on demographic rates observed in old-growth forest. Slow species and long-lived pioneers accounted for most of the biomass in old-growth forest, while fast species dominated the early succession (<70 years). The PPA is a simple model that is easily parameterized from inventory data without any need for parameter tuning. It allows to scale up from demographic rates of individual species to community structure and dynamics. Thus, it is a promising tool to predict consequences of anthropogenic impacts on tropical forests worldwide.

Paper Number: 554

Monday, 02 July 2018 | Petra 1

Symposium 3.2 - Tropical tree life-history strategies: Causes and consequences of demographic diversity

Functional traits, guilds, and the dynamics in tropical forests.

Rubio, Vanessa E. and Swenson, Nathan G.

University of Maryland

Unraveling the drivers of forests dynamics is one of the main challenges in tree community ecology. Important drivers of forest dynamics include niche differentiation, dispersal limitation and stochasticity. Here, we build off recent empirical evidence and an early iteration of the neutral theory of biodiversity that included guild structure, to elucidate whether realistic forest dynamics can be simulated under a guild-based model and whether additional parameters (e.g. immigration rates, niche differences within guilds) may provide more realistic outcomes. We define guilds as groups of species that cluster together based upon continuous functional trait measurements that are believed to reflect key life-history tradeoffs typically relating to resource capture. Despite the original arguments for the importance of guilds and the potential for demographic stochasticity within guilds, they remain poorly understood and are not well-integrated with the strong empirical evidence of niche differences via intra-specific negative density dependence.

We developed a computational model integrating guilds, demographic stochasticity and negative density dependence to study the structure and dynamics of a tropical rain forest. We parameterized and compared the model against data from the Barro Colorado Island forest dynamics plot in Panama. Species-level functional traits were used to separate species into functional guilds. The model includes replacement, turnover, extinction, and migration while maintaining a zero-sum multinomial distribution.

We found that we can maintain a stable species diversity equilibrium and a conserved log normal species abundance. Furthermore, we show a temporal decay in species compositional similarity in subplots as found in empirical data, but a constant functional guild structure through time indicating functional stasis and species composition drift. Temporal decay in species compositional similarity asymptotes when immigration is ignored, but reaches complete turnover when immigration is considered. The results were maintained when species were unable to replace themselves through time (i.e. strong intra-specific negative density dependence). Ultimately, we show that a realistic model of forest community dynamics can be generated via an integration of neutrality within guilds and intra-specific negative density dependence.

Paper Number: 187

Monday, 02 July 2018 | Petra 1

Symposium 3.2 - Tropical tree life-history strategies: Causes and consequences of demographic diversity

Beyond the slow-fast continuum: A global analysis of demographic rates in forest trees

Jessica Needham

Understanding the evolution of life-history strategies is critical to identifying how differences in demographic rates, within and between species, influence co-existence and community structure. In this talk, I will present results from a global analysis of demographic rates in forest trees. Using data from 23 permanent forest dynamic plots, distributed across the globe, we fit growth and survival models to over 2400 species. These models account for variation in vital rates within populations and through ontogeny, enabling us to uncover how species differ in their response to resource availability and the trade-off between growth and survival through the life-cycle. We clustered species into 'demographic modes' according to life-history strategies and compared the relative abundance of modes across sites.

We find considerable variation in growth and survival rates between species, but no relationship between diversity in demographic rates and species diversity across sites. Clustering algorithms revealed eight 'demographic modes' with life-history strategies that reflect strategies of collections of species. Interestingly, there were clear departures from the slow-fast continuum, with several modes having either fast growth and high survival or vice versa. Accounting for ontogenic shifts in demographic rates, along with population heterogeneity is essential for revealing the range of life-history strategies exhibited by forest trees. By uncovering these strategies and how they relate to environmental covariates and disturbance regimes, we can further our understanding of the forces structuring forest communities and how those communities might respond to global change.

Paper Number: 111

Monday, 02 July 2018 | Petra 1

Symposium 3.2 - Tropical tree life-history strategies: Causes and consequences of demographic diversity

Global patterns in the slow-fast continuum of tropical tree demography: the roles of tolerance and responsiveness

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Life history tradeoffs are important for explaining the diversity of tree species in forests. A key manifestation of trade-offs is the interspecific slow-fast continuum, in which fast-growing species tend to have high mortality. Attempts to identify mechanisms underlying the continuum using functional traits, however, have not always yielded the expected relationships, so here we reconsider the focus on them and assess what can be learned about the slow-fast continuum from the demographic data themselves. Using an unprecedented dataset of pantropical forest demography, including 1111 species from eleven plots, we explored this continuum and its underlying drivers across diverse forest types. To characterize species-specific mortality-growth strategies, we defined two functionally meaningful parameters: tolerance of resource limitation (mortality at zero growth) and responsiveness (reduction in mortality associated with faster growth, and hence, greater access to resources). We analyzed both global patterns in the slow-fast continuum and these estimates of relative tolerance and responsiveness and explored how they differ across forests in Asia, Africa, and the Neotropics. While we found overall support for it, the slow-fast continuum was not observed in seven of the 11 forests. Different forests occupied distinct regions of this global growth-mortality space, patterns that may be explained by ecological processes as diverse as disturbance, seasonality, soil fertility, and, to a lesser extent, biogeography. The slow-fast continuum was more defined by tolerance of resource limitation than by responsiveness to resource access. Comparing mortality-growth responses of species through time in a forest, tolerance emerged as a more consistent life history trait, whereas responsiveness was more variable, suggesting it was more ecologically determined. In disturbance-prone forests, fundamentally different demographic strategies were favored, relative to less disturbed forests, in which soil fertility and seasonality played defining roles. Despite this dichotomy, the substantial variation among disturbed forests in mortality-growth strategies could be traced to differences in disturbance regime defined by type, scale, and frequency. Global variation in the slow-fast continuum across forests may thus reflect the degree to which ecologically determined mortality-growth responses obscure the manifestation of fundamental trade-offs shaping the demographic strategies of tropical tree species.

Paper Number: 146

Monday, 02 July 2018 | Petra 1

Symposium 3.2 - Tropical tree life-history strategies: Causes and consequences of demographic diversity

SYMPOSIUM 8.1

Invertebrates and Ecological Processes in Modified Tropical Landscapes

Invertebrates and disturbance in tropical rainforests.

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We review major types of disturbance, the ecological agencies that respond to them, and the consequential known or likely impacts on terrestrial invertebrates. This Overview forms the introduction to the Symposium 'Invertebrates and ecological processes in modified tropical landscapes'.

In undisturbed tropical forests invertebrates are the dominant multi-celled organisms both in terms of richness and abundance. Within 'green' webs they play key roles in energy transfer as herbivores, predators, parasitoids and top predators forming complex trophic and mutualistic networks. Within 'brown' webs they are primary macro-decomposers.

In undisturbed forests ecosystem-wide webs are partitioned into near discrete components associated with particular plant functional groups, plant parts and non-plant microenvironments. These include distinct arthropod-dominated faunas associated with:

- tree canopies, inflorescences, infructescences, bark and roots;
- herbs, grasses, palms, shrubs, epiphytes, lithophytes, lianas and creepers;
- fungi, dung and carrion;
- ground based and perched leaf litter; and,
- phytotelmata.

Arthropods structure the communities within each of these habitats and are species- and/or stage-specific. We can categorize likely impacts on arthropods and their ecological roles by considering how modifications impact particular habitat units. Some disturbances are natural leading to (botanically) well known patterns of primary and secondary succession. The responses of these natural disturbances on invertebrate communities still poorly investigated although well known to naturalists and collectors. Burgeoning of herbs, grasses, seedlings within disturbed and the creation of irregular 'edges' around disturbed areas change both vertical distribution and composition of the arthropod faunas as well as having restricted specialized faunas.

Anthropogenic disturbances range from highly selected logging for high value timber –not unlike 'natural' secondary successions – through to clear felling for road construction or plantation establishment. We identify the set of major disturbance types in this context and how structure may change in response, noting characteristic spatial and temporal scales of impact and recovery of invertebrate assemblages.

In addition, we identify ecological 'agents of change' which respond differentially to the particular disturbance types. These include, among others, human foragers (hunters, gatherers, scientists, plant and animal collectors etc), invasive plants (herbaceous and woody weeds, scramblers), generalist animal invaders (feral pigs, cattle, predators, tramp ants, earthworms), polluting chemicals (herbicides, nutrient run-off, insecticide), other pollutants (noise, thermal) and geographical barriers (roads, water flows, dams). Anthropogenic climate change and fragmentation act as catalysts to all of these changes

Disturbance types form a matrix with these agencies of change allowing predictions to be made on likely invertebrate –mediated changes.

Paper Number: 267

Monday, 02 July 2018 | Petra 2

Symposium 8.1 - Invertebrates and ecological processes in modified tropical landscapes

Insights into the diet composition of pygmy grasshoppers in Sabah, Malaysia, based on DNA metabarcoding

Jane Hardwick

Insects play an important role in the interactions between plants and the soil by accelerating the transition from living biomass to detrital biomass. However, they can also be highly susceptible to habitat degradation. Tetrigidae (pygmy grasshoppers) are a basal group of Orthoptera, abundant within tropical habitats, and have been recognised for their unusual diets mainly consisting of detritus and lower plants. Diet assessments in the past have found that both temperate and tropical species exhibit very similar feeding patterns, consisting of approximately 80% detritus, 15% mosses and 5% other food particles. Here, we examine whether tropical habitat degradation affects Tetrigidae in terms of their species composition and diet. We present results from the first dietary DNA metabarcoding study for this family. Tetrigidae were collected across a total of 48 sites in primary forest, logged forest and oil palm (*Elaeis guineensis*) plantations across the Stability of Altered Forest Ecosystem project sites in Sabah, Malaysia. Experimental feeding trials confirmed preferred food types and 96 individuals from six morpho-species were selected for gut-content analysis. DNA was extracted from whole insects, amplified using two plant gene markers (ITS2 and trnH-psbA) and sequenced using an Illumina Miseq. Community composition of Tetrigidae was significantly affected by habitat type, but neither observed species richness nor diversity were altered. During feeding trials, all six species only fed on leaf litter, soil detritus and mosses, with no instances of fresh angiosperm material recorded. Metabarcoding revealed that dietary composition varied across habitat types; both logged and primary forest species had between 80 – 100% angiosperm materials (assumed to be dead leaves and/or soil detritus) and 0-20% mosses in their diets. The diets of oil palm species had much greater proportions of mosses (approximately 80%), with ferns and angiosperm species making up the remaining 20%. Results from our metabarcoding data are consistent with other studies, with our findings indicating that leaf litter and detritus likely dominates the diets of Tetrigidae from logged and primary forest habitats. However, we found the opposite pattern with species from oil palm plantations, where mosses are the predominant food source. Tetrigidae have been described as detritio-bryophagous (detritus and moss feeders), but their contribution to leaf litter decomposition is seldom reported. Our study suggests members of this family are likely to be important decomposers in tropical forests and highlights the importance of gaining a better understanding of insect-plant interactions in habitats that are rapidly degrading.

Paper Number: 858

Monday, 02 July 2018 | Petra 2

Symposium 8.1 - Invertebrates and ecological processes in modified tropical landscapes

How do El Niño droughts and fires interact with human forest disturbance to shape tropical biodiversity and associate functions? Evidence from Amazonian dung beetles

Filipe Machado França

Justification: Tropical forests are increasingly affected by the combination of anthropogenic forest disturbance such selective logging, and climate associated stressors such as droughts and wildfires linked to El Niño events. However, our knowledge of how tropical forest biodiversity and ecosystem functions respond to these different stressors is limited. First, few studies explore the El Niño impacts, and even fewer of these assess forests that have already been affected by other previous disturbance. Second, most studies lack pre-El Niño data.

Objective: Focusing on dung beetles, address the question: what are the impacts of El Niño-mediated drought and fires on forest biodiversity and ecosystem functioning along a gradient of human-modified tropical forests?

Methods: We used a before-and-after control-impact approach to investigate the 2015-16 El Niño impacts on dung beetle community attributes (species richness, abundance, and biomass) and associated ecological functions (dung removal, soil bioturbation and seed dispersal). Beetles were sampled with pitfall traps, while we used mesocosm arenas to evaluate associated ecological functions. Data was sampled in 2010, 2016 and 2017 – six years before, and six and 18 months after the 2015-16 El Niño, respectively – within 30 permanent forest plots distributed across a gradient of previous human-driven disturbance in eastern Amazon (10 undisturbed forests, 10 logged forests and 10 logged-and-burned forests). All forests were affected by the 2015-16 El Niño drought, while fires burnt only half of them within each forest category.

Results: We sampled 17,712 dung beetles from 103 species, and quantified the removal of >19,900 g of dung, >80,300 g of soil and dispersal of >8500 seed mimics. Irrespective of previous forest disturbance, all community and functional attributes declined after the El Niño at both burnt and unburnt forests. A slight recovery was observed in beetle communities from unburnt forests that were previously undisturbed, and in functional processes within burnt forests.

Implications/Conclusions: Our research shows that both El Niño drought and fires bring drastic consequences for the biodiversity and ecosystem functions of human-modified tropical forests, but burnt forests may recover part of the ecosystem processes even when highly negative impacts are observed in biodiversity. Our data suggest that beetle communities in undisturbed tropical forests may be more resilient to extreme droughts; therefore losing the remaining intact forests may exacerbate climate change effects on Amazonian biodiversity and ecosystem functioning. Proactive policies, focused on maintaining intact forests and reducing sources of ignition are needed to promote more effective conservation of tropical forests.

Paper Number: 226

Monday, 02 July 2018 | Petra 2

Symposium 8.1 - Invertebrates and ecological processes in modified tropical landscapes

Commensalism in a novel ecosystem: Converting degraded rainforest to oil palm plantation increases densities of a stem-excavating crabronid wasp in the ant-plant *Macaranga pearsonii* without fitness costs for mutualistic partners

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Anthropogenic habitat change is a major threat to animal and plant communities around the world. The tropics, which tend to be highly species-rich, are particularly vulnerable to these changes, since they host many rapidly developing countries. Although the impacts of habitat change on the persistence of species is now relatively well known, the consequences for the way that species interact remains unclear. Oil palm is a highly productive and rapidly expanding tropical crop, often being planted in place of more degraded areas of logged forest. Here we explore how this process of habitat conversion affects the abundance of a newly reported stem-excavating crabronid wasp (*Dasyproctus cf. agilis*) in the ant-plant *Macaranga pearsonii*. Because *M. pearsonii* has stems that can be hollowed out by ants to provide living space, the wasp is a potential parasite of this mutualism, as it could occupy plant-provided ant living space. Reductions in ant colonisation and interference by wasps with ant patrolling might also affect one of the benefits provided by ants for *Macaranga* plants: defence against herbivorous insects. Field surveys for wasps on *M. pearsonii* showed that wasp colonisation was significantly higher in oil palm plantation (12 of 43 plants colonised) than in recently clear-felled rain forest (1 of 41 plants colonised). However, wasp colonisation did not correlate negatively with ant colonisation, and plants that hosted wasps did not experience higher levels of herbivore damage than those that remained uncolonised, even when accounting for plant size. We conclude that although conversion of highly degraded forest to oil palm plantation increases colonisation rates of *M. pearsonii* by *D. cf. agilis*, this wasp is commensal with both partners of the existing mutualistic symbiosis. We speculate that the proportion of the stem occupied by wasps is not large enough to reduce ant colonisation and subsequent colony growth, and hence the wasp does not interfere with the functioning of the mutualism. Our study adds to a growing body of work showing that as the natural world becomes increasingly modified by humans, species are forming new connections to create novel ecosystems.

Paper Number: 196

Monday, 02 July 2018 | Petra 2

Symposium 8.1 - Invertebrates and ecological processes in modified tropical landscapes

SYMPOSIUM 5.2

Origins, Assembly and Evolution of the South and SE Asian Biota: Insights from Rocks, Fossils, Genes and Plots

Complex patterns of biodiversity across geologically even more complex tropical landscapes

Michael Balke

Background. The Indomalayan-Australasian archipelago is one of the World's most diverse regions in terms of flora, fauna, geological history, geography and climate. In fact, Sir Alfred Russel Wallace has here established biogeography as a scientific discipline in the late 19th century and Wallace's line, one of the best known biogeographic borders, was named after him. However, biogeographic patterns have mostly studied based on few taxa, and often in a more descriptive framework. The hyperdiverse, and mostly undescribed arthropods for example have only received more attention rather recently.

Objective and methods. Here, we use comprehensively sampled molecular phylogenies and ancestral area reconstructions of insects combined with recent geological evidence to contribute to a better understanding of the faunal evolution of the region in space and time. We also investigate the directionality of range expansions (or colonisations) as well as faunal exchange across biogeographic lines in the region.

Results. We present results from two case studies. Exocelina diving beetles of Melanesia have colonised islands such as New Guinea and New Caledonia out of Australia but never in the opposite direction. Diversification in New Guinea was strongly driven by the central orogeny and multiple complex exchanges with accreted northern mountain ranges. This did most likely occur after most of New Guinea had its present-day configuration, i.e. diversification on an existing landmass. Flightless Trigonopterus weevils have colonised the Indomalayan archipelago incl. Sundaland out of Australia and New Guinea. Major diversification events align relatively well with major geological change in the region. The directionality of colonisation / faunal exchange is not intuitive, but rather complex with for example Bali having been colonised from the east, via Wallace line, and not from east Java as expected.

Conclusion. Our work not only highlights the very complex origin of species diversity in the region. It should also serve as a launching pad for analyses of ecological factors that might have contributed to the biogeographic patterns revealed.

Paper Number: 100

Monday, 02 July 2018 | Taj Mahal

Symposium 5.2 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots

Should I stay or should I go – the impact of biogeographic history and dispersal dynamics on rainforest assembly.

Maurizio Rossetto

Introduction: Dispersal is a key process in plant spatial dynamics impacting on the distribution of species as well as the assembly of communities. Efficient dispersal impacts on floristic exchanges and is one of the key factors facilitating the spread of Sunda lineages into the Australian continent. This is particularly true within more disturbed habitats, while stable communities include greater proportions of persistent Sahul lineages. **Objectives / Methods:** Based on these premises we combine genetic (using cpDNA derived from whole genome skimming), ecological (functional traits and distributional patterns) and environmental (Environmental Niche Models) data to investigate the impact of dispersal and persistence on rainforest assembly and continental floristic exchange. **Results:** Community-level genetic signatures identify faster dispersal of Sunda-derived lineages, prolonged persistence of Sahul-derived ones, and the absence of poorly dispersed species within temporally disturbed habitats. **Implications:** Understanding temporal community exchange dynamics expands our understanding of assembly patterns, as well as support biodiversity management strategies by identifying relative vulnerabilities to change.

Paper Number: 355

Monday, 02 July 2018 | Taj Mahal

Symposium 5.2 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots

New Guinea as a major generator of Malesian and Australasian plant diversity: evidence from multi-lineage analysis of diversification through time

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Understanding the processes that generate biodiversity in tropical ecosystems is vital for informing conservation decisions. Megadiverse Malesia is one of the most biogeographically interesting places on Earth. It lies at the convergence of the Sunda and Sahul continental shelves, which collided from c. 23 Mya. This convergence wrought profound geological change including emergence of many of the islands of Wallacea, and the rapid uplift of the spine of New Guinea since c. 12 Ma to in excess of 4500 m elevation. Yet how this dramatic orogeny influenced the evolution of the Malesian flora remains unclear. To investigate this, we conducted a meta-analysis of patterns in diversification across 13 plant clades distributed disjunctly across the Sunda and Sahul shelves and for which molecular chronograms were available. Log lineage-through-time (LTT) plots were constructed for each clade, and the patterns in diversification between each clade were compared in the context of the timing of Sunda-Sahul disjunctions and the geological history of New Guinea. To test the effect of Sunda-Sahul disjunctions on diversification, a linear mixed model was applied. We found that the pattern of diversification was highly variable between clades, but that each disjunction was associated with a significant increase (19%) in diversification across the clades. Furthermore, the timing of the disjunctions broadly coincides with the timing of the emergence of New Guinea, suggesting that New Guinea facilitated stepping-stone dispersal between Sunda and Sahul. Additionally, the LTT plots of *Begonia* and *Pseuduvaria* indicate that New Guinea orogeny is correlated with the timing of rapid diversification in these New Guinea-centric clades. Our results indicate that New Guinea may be an important driver of diversity for the Malesian region by facilitating Sunda-Sahul floristic exchange, and by supporting rapid in-situ diversification through the orogenesis of the Late Miocene.

Paper Number: 217

Monday, 02 July 2018 | Taj Mahal

Symposium 5.2 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots

Insights into the evolution of Australian rainforest through their biogeographic history, ecology and landscape attributes

Samantha Yap

Despite representing <1% of the Australian land surface, rainforests have high biodiversity and biogeographic significance. Of interest, the Australian rainforest is of mixed biogeographical histories, resulted from past biotic exchange between the two floras on Sahul (Australia) and Sunda shelves that led to extensive immigration of Indo-Malesian rainforest lineages (i.e. with Sunda ancestry) to Australia.

Due to the comprehensive knowledge of Australian rainforest species ancestries, I present the outcomes from my recent investigation comparing their traits and species distributions that showed how biogeographic history contributes to the overall evolution and ecology of Australian rainforest flora. Following this, I present a fine-scale population genetics case study that showcases the genetic signatures of the long-term persistent Sahul species and the recently arrived Sunda species, with further exploration of the role of biogeographic history by integrating information about their distributional changes through time. The genetic outcomes were determined from a high throughput SNP discovery method (DArTseq) to generate a reduced representation of a genome, and I conclude that this method can be applied to multiple rainforest taxa, and when used in combination with stacked species distribution modelling outputs, can produce broader insights into the historical and evolutionary processes that led to the present rainforest communities.

Paper Number: 359

Monday, 02 July 2018 | Taj Mahal

Symposium 5.2 - Origins, assembly and evolution of the South and SE Asian biota: insights from rocks, fossils, genes and plots



GENERAL SESSION 3

Wind Disturbance

Reef-to-ridge ecological perspectives of high energy storm events in northeast Australia: insights from Severe Tropical Cyclones Larry and Yasi

Stephen Michael Turton

Background

Tropical cyclones (TCs) are the dominant high energy storm (HES) events affecting ecosystems in northeast Australia. The study area is one of only a few places in the world where more-or-less intact ecosystems occur along a full reef-to-ridge gradient. This gradient includes outer-, mid-shelf and nearshore coral reefs, seagrass communities, mangrove forests, and littoral, lowland and upland rain forests. There are also significant areas of other types of land uses, notably agriculture, within an otherwise forested landscape.

Objectives

The main objective of my study is to compare and contrast the large-scale 'wind energy effects' of Severe TCs Larry and Yasi on natural ecosystems and other types of land uses along reef-to-ridge gradients in northeast Australia.

Methods

Large-scale ecological effects of two severe—but contrasting— HES events were examined along the ridge-to-reef gradient in the study area. TC Larry (March 2006) was a severe Category 3 storm, but with a small circulation, while TC Yasi (February 2011) was a severe Category 4 storm with an unusually large circulation. This included an evaluation of resistance and resilience of coral reef and rain forest ecosystems to the two TCs. Only coral reefs and rain forests have received intensive post-TC research efforts, so form the focus of my synthetic analysis.

Results

Both TCs shared similar forward motions as they tracked along the reef-to-ridge gradient from east to west. Large-scale wind effects of both TCs on ecosystems along their paths were a function of storm intensity, circulation size, trajectory and persistence of high winds over reef and forest areas. At landfall, TC Larry's diameter of very destructive (10-min av. Winds: >118 km/h) to damaging winds (10-min av. Winds: 89-117 km/h) spanned a distance of about 300 km, compared with TC Yasi's 700 km. Peak wind speeds for TC Larry declined by 31% as the storm transited the reef-ridge gradient over 5.8-h, compared with a 22% decline for TC Yasi during its 6.6-h transit. For both TCs, distance from the storm track, side of track, reef shelf position, topography and habitat all significantly influenced the severity of physical damage observed. TC Larry produced structural damage to about 5% (1,281 km²) of the Great Barrier Reef, compared with about 15% (3,843 km²) for TC Yasi. TC Larry directly affected about 30% of forests in the study area (3,600 km²), while about 75% (9,000 km²) were affected by TC Yasi.

Much less is known about the resilience of ecosystems along the reef-to-ridge gradient for TCs Larry and Yasi compared with studies documenting their resistance. Overall, ecosystems have recovered well in the aftermath of both HES events, showing a high degree of resilience that would be expected in a part of the world where TCs are part of the evolutionary history of marine, coastal and terrestrial ecosystems.

Implications

Overall, ecosystems along the reef-to-ridge gradient have recovered rapidly in the aftermath of both HES events. However, projected climate change poses a significant threat to the resistance and resilience of ecosystems to HES events in the study area.

Paper Number: 12
Monday, 02 July 2018 | Giza
General Session 3 - Wind Disturbance

To plant, or not to be, that is the question?

Thomas Fickert

Physical Geography, University of Passau

Background: Mangroves provide many fundamental ecosystem services, amongst others the protection of tropical coasts against storms or tsunamis.

Objective: While effectively reducing damage to infrastructure and number of victims, mangroves periodically experience severe disturbances once such natural phenomena happen. Hence, after disturbances reforestation efforts are widespread, intending to accelerate the return to vital mangroves being able to provide their ecosystem services to humans once again. Most of these labor-intensive initiatives, however, fail for a variety of reasons and the question arises whether natural grow back wouldn't be a much easier and probably equally or even more successful way back to intact mangroves.

Methods: The Caribbean island of Guanaja (Honduras) was severely hit by hurricane Mitch – one of the most intense Atlantic storms ever – in October 1998. Immediately after the storm 97% of the mangroves were classified dead. Repeated surveys on regeneration dynamics and vegetation development were carried out during the two decades after the storm impact (2005, 2009, 2016), employing permanent line-transects in several mangrove areas on Guanaja, including those where reforestation measures were undertaken and those without. Along transects all plant species, seedling numbers and amount of woody debris are quantitatively recorded (in % ground cover) for statistical analyses.

Results: Destruction and regeneration of the mangroves on Guanaja vary depending on locality, with, unsurprisingly, the most severely hit areas on the windward side. Here, three sample sites are located which had few living mangrove trees present at the initial survey in 2005 (mean groundcover $\leq 10\%$). In two of these areas reforestation measures by governmental (2004) or private initiatives (several times since 2008) were undertaken, while the third area was subject to natural regeneration without human intervention. Planting efforts, in general, were characterized by a high degree of die-back of the planted *Rhizophora* mangle propagules, some, however, surely survived and have grown up into diaspore producing stage. Interestingly, also the area without any planting developed into a regeneration state equal or even advanced compared to the reforested areas by 2016.

Conclusion: Results from the island of Guanaja confirm lessons learned from other mangrove planting initiatives: planting often fails and rarely enhances grow back of mangrove forests, while natural regeneration of mangroves might show a certain time lag if few diaspore sources survived in the surrounding, but once established individuals are propagule-bearing a swift return to true mangrove forests occurs, indicating a high resilience of mangroves.

all three sites were in comparable conditions, irrespective of whether natural regeneration or planting took place.

Paper Number: 626
Monday, 02 July 2018 | Giza
General Session 3 - Wind Disturbance

Twelve-year tree community dynamics following catastrophic wind disturbance in a tropical insular forest

Edward Webb

National University of Singapore

Disturbance is a predominant driver of long-term tropical forest dynamics. In many parts of the tropics, particularly oceanic islands, catastrophic wind disturbance (cyclones, hurricanes) is a frequent occurrence and considered the fundamental disturbance regime. Here I report the results of a 12-year longitudinal study in which we monitored forest damage and recovery following a (catastrophic) Category 5 cyclone on the island of Ta'u in the Samoan archipelago. Rates of initial damage to the tree community were high overall but highly variable across species. Survivorship curves for both trees (stem diameter ≥ 10 cm) and saplings (stem diameter 1.0-9.9 cm) revealed that the cyclone affected species survivorships for up to 12 years. Within two years of the cyclone, massive changes in species vital rates were seen for early successional species, but surprisingly, most species experienced only small changes in vital rates. As a result, relative abundances of most species over 12 years post-cyclone varied little, with a few exceptions. We tested three hypotheses regarding the drivers of post-disturbance vital rates: (1) functional traits, (2) abundance, and (3) compensatory recruitment. We found evidence to support (1) and (2), but for (3) found evidence contrary to our expectation. Our results demonstrate very high community resilience in the face of single catastrophic events; however resilience to repeat disturbances requires longer-term studies.

Paper Number: 979

Monday, 02 July 2018 | Giza

General Session 3 - Wind Disturbance

Wind and Trees - the mechanical strength of tropical trees and their resistance to wind damage.

Toby Jackson

The susceptibility of trees to wind damage is an important driver of the terrestrial carbon cycle. It has been extensively studied in plantation forests, but is poorly understood in tropical forests because of the much larger range of tree architectures. The dipterocarp dominated forests of Malaysian Borneo contain the tallest trees in the tropics, reaching up to 95m! Whether the height of these trees is limited by hydraulics or by mechanics remains to be seen. We apply techniques developed for conifer plantations to study the mechanical strength of tropical trees, and how they respond to wind forcing.

We use terrestrial laser scanning to characterise the architectures of broadleaf trees from across the tropics. We then apply finite element analysis to model the resonant frequencies of these trees, which determine their response to wind forcing. A preliminary validation of this technique shows a reasonably good fit to field data ($R^2=0.38$ and $CCC=0.65$, $N=20$). One key limitation to this analysis is the limited information available on the modulus of elasticity of tropical trees. However, this analysis shows that the resonant frequencies of broadleaf trees are mainly driven by crown size, crown symmetry and aspect ratio. Understanding this will allow a better prediction of tropical trees response to wind forcing and thus more accurate models of wind damage in tropical forests.

In 2017 we measured wind speeds and the resultant bending strains produced in 20 trees in Danum Valley, Malaysia. This data shows how close to its breaking point each tree is during the strong winds associated with storms. This data also shows that bending strains, and even resonant frequencies, can be detected even in the buttresses of large trees. Overall, this work emphasises that mechanical stability is a key limitation on tree height, and tree architecture has a strong effect on the risk of wind damage.

Paper Number: 290

Monday, 02 July 2018 | Giza

General Session 3 - Wind Disturbance

GENERAL SESSION 1.2

Bird Ecology & Conservation

Occurrence of avian in a threatened biodiversity hotspot: missing species and spatial distribution of ground-foraging bird community in the central Annamites

An Nguyen, Andrew Tilker, Jürgen Niedballa, Jesse F. Abrams, Rahel Sollmann, Tejas Bhagwat, and Andreas Wilting

The central Annamites landscape is an area of exceptional avian richness and endemism. Avian diversity in the Annamites has been negatively impacted by both habitat loss and overharvesting. Poaching is the most pervasive threat to the bird community: songbirds are caught to sell in local markets, and galliforms have been decimated through industrial snaring. Our objectives were to first assess the status of the ground-foraging (including ground-dwelling) bird community in the central Annamites, and second, to understand the factors influencing their distribution at the landscape-scale. We collected data on the bird community using systematic camera trapping across five areas in Vietnam and Laos. To assess factors that influence avian distribution, we built a community occupancy model for ground-foraging birds, incorporating both anthropogenic and environmental covariates. Anthropogenic covariates included distance to nearest road and level of active snare removal efforts. Environmental covariates included elevation and a measure of habitat quality derived from high-resolution RapidEye® satellite imagery. Furthermore, we used the parameter estimates from the community occupancy model to predict avian species richness across the study areas. In 17,042 camera trapping nights across 136 stations, we detected 22 bird species of which we included 12 ground-foraging species in the community model. Of the four covariates, elevation had the strongest influence on the occurrence of the 12 species. Three species were found to occur more frequently in lowland areas, and two species were associated with higher elevations. Crested argus *Rheinardia ocellata*, a large ground-dwelling galliform known to be especially sensitive to snaring, showed a strong positive response to areas with higher snare removal efforts. Apart from the rare crested argus we failed to detect four other large galliforms that historically occurred in this area, including the Critically Endangered Edwards's pheasant *Lophura edwardsi*. This suggests that, without effective snare removal efforts, crested argus will follow other large galliforms in the landscape to local extirpation. Our results provide an updated account of ground-foraging avian diversity in the central Annamites. The avian species richness map for these study sites provide a useful visualization to direct anti-poaching efforts and a community-level baseline to monitor future population trends in the ground-foraging avian community.

Paper Number: 568
Monday, 02 July 2018 | Machu Pichu
General Session 1.2 - Bird Ecology & Conservation

Movement of the Near Threatened Orinoco Goose (*Neochen jubata*) in human-dominated landscapes in Eastern Amazonia

Lisa Davenport

Previous studies using satellite telemetry to study the movement ecology of waterbirds in the western and central Amazon have shown that those populations of the Orinoco Goose (*Neochen jubata*) undertake long-distance, annual round-trip migrations. We compare earlier results with new tracking data from 2 birds tagged in the breeding season in Araguaia National Park (Tocantins state, Brazil), a huge fluvial island situated near the eastern limit of Amazonian habitats, in the transition zone between rain forest and savanna. The region is under considerable settlement pressure, with extensive grain plantations rapidly covering the landscape outside of protected areas. Unlike birds tracked from the more western populations, the two newly tagged geese have been largely sedentary, spending most of their time near to the breeding grounds where they were captured, and, in the non-breeding season, rarely leaving a small area just outside of Araguaia National Park. Tracking data, combined with site visits that allowed us to ground-truth the habitats used, showed them primarily using irrigated rice fields. In this portion of the basin, irrigated rice plantations almost continuously cover ~80,000 ha around Lagoa da Confusão town. In fact, site visits uncovered an unexpectedly large concentration of geese in these rice fields (approximately 1,000 individuals censused within 650 ha). This is one of the species' largest congregations ever recorded. They were found either in single-species flocks (with other Orinoco Geese) or in mixed congregations with many (up to tens of thousands) whistling-ducks, dominated by the Black-bellied Whistling-duck *Dendrocygna autumnalis* (some 90% of the animals observed). Illegal persecution of whistling ducks damaging rice crops has been known in this area, including both poaching and poisoning. The major illegal control measure has been pesticide spraying on bait rice (through the 1980's with organochlorines, and subsequent to their ban, with organophosphates). Use of these poisons could affect this population of Orinoco Geese, a species currently considered by IUCN to be Near Threatened globally. Human-wildlife conflict management will be increasingly needed to conserve this important eastern breeding population of the species. In addition to human wildlife conflict, another concern of such concentrations of the Orinoco Geese is the potential spread of epizootic diseases, which could be contracted from wild Anatidae or from domestic stocks.

Paper Number: 570
Monday, 02 July 2018 | Machu Pichu
General Session 1.2 - Bird Ecology & Conservation

Title : Social behavior and life-histories variation: A story of Neotropical birds.

Jenny Munoz

Social behavior takes diverse forms across different taxa and covers a broad spectrum of interactions ranging from short-term and dynamic to stable and highly coevolved associations. One of the most complex and interesting social systems in group-living animals occurs in mixed-species bird flocks, in which individuals of several different species move and forage as a cohesive group. Recently, mixed-species bird flocks have been recognized as a worldwide phenomenon, with flocks occurring in most terrestrial habitats, comprising up to half of the local species assemblage in a given community throughout the year, and establishing highly coevolved associations among members. As a result of these strong, potentially life-long relationships, species participating at different degrees in mixed-species flocks are exposed to different selection pressures compared to those that live solitary. Although ecologists have studied these flocks for at least two centuries, the majority of research has focused on describing basic information on flocks composition, presence, and persistence across different tropical and temperate landscapes. Yet comparatively little attention has been given to mixed-species flocks from an eco-evolutionary perspective.

In this study, we integrated data on Neotropical mixed-species bird flocks observations and breeding behavior to test the effect of group living on life-history traits variation. We also aimed to identify ecological constraints that shape avian life-history traits in Neotropical birds. We found that mixed-species flock participation imposed restrictions on the time individuals invested in nest attendance and parental care, with consequences on several life-history traits including development rates, length of the incubation/nesting periods and reproductive success. These generalizable patterns have important implications in our understanding of the variation in species life-history traits and fitness. Furthermore, this study is an important step toward exploring the eco-evolutionary implications of multi-species group living in animals.

Paper Number: 477

Monday, 02 July 2018 | Machu Pichu
General Session 1.2 - Bird Ecology & Conservation

Activity patterns of Crestless Fireback *Lophura erythrophthalma* and Black Partridge *Melanoperdix nigra* in the Kampar Peninsula, Sumatra, Indonesia

Prayitno Goenarto, Muhammad Iqbal

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The Kampar Peninsula hosts some of the largest remaining contiguous areas of peat swamp forest in Sumatra; camera traps provide a unique opportunity to observe cryptic species, such as galliformes, through difficult weather conditions and for long periods of time. The application of camera traps to study galliformes in South East Asia is steadily increasing, however many have focused on spatial studies and there have been limited temporal studies aimed at verifying species behavior and determining peak activity times. The Black Partridge is listed as Vulnerable by the IUCN, with limited information on its range, diet and behavior, greater information is needed. This study seeks to quantify the temporal overlap in activity patterns between two sympatric species the Black Partridge *Melanoperdix nigra* and Crestless Fireback *Lophura erythrophthalma*. Camera traps were deployed in 2015 and 2017 across three Ecosystem Restoration Concessions encompassing 92,000 ha area on the Kampar Peninsula, Riau, Sumatra. All recorded photos and videos of the species were analysed using the R-package OVERLAP to plot diel activity patterns of the two species and to calculate the temporal overlap. A total of 416 records were captured by camera trap with Black Partridge (n=44) and Crestless Fireback (n=372) being active during the day between 5:00-18:00 with peaks in the early morning and late afternoon. Clear temporal overlap exist between the two species with the coefficient of overlapping 95% confidence interval ranging from 0.72-0.91. Mann-Whitney U Test between the two species activity pattern were not statistically different (p-value 0.82). Interestingly both sympatric galliformes share large temporal overlap which suggests that coexistence of the two species might be facilitated through niche differentiation of other factors. Some camera traps managed to record both species in the same location suggesting partial spatial overlap, however further studies with finer scale habitat examination is needed to determine the extent of interspecific niche differentiation along a spatial axis.

Paper Number: 689

Monday, 02 July 2018 | Machu Pichu
General Session 1.2 - Bird Ecology & Conservation

GENERAL SESSION 2.2

Plant Ecophysiology

Leaf temperature regulation strategies of the plants from a hot dry and a hot wet habitat

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Leaf temperature exerts an important impact on the microenvironment and physiological processes of leaves. Plants from different habitats have different strategies to regulate leaf temperature. The relative importance of physical traits and transpiration for leaf temperature regulation in the hot habitat is still unclear. We investigated 22 leaf physical traits, transpiration, and thermal properties of 38 canopy species of seedlings in a greenhouse, including 18 dominant species from a hot wet habitat (HW) and 20 dominant species from a hot dry habitat (HD). To separate the impact of transpiration and leaf physical traits on leaf temperature, we measured the diurnal courses of leaf temperatures with and without transpiration. The temperature of a reference leaf beside each individual was measured simultaneously to render temperatures comparable. Generally, the species from HD showed lower leaf temperatures than the species from HW under the same conditions. Both transpiration capacity and cooling effect of leaf physical traits were stronger for the plants from HD. Active transpiration provides a suitable thermal environment for photosynthesis, while xeromorphic leaves can dampen heat stress when transpiration is suppressed. Higher vein density and stomatal pore area index (SPI) facilitated higher transpiration capacity of the plants from HD. Meanwhile, shorter leaves and thinner lower epidermis of the plants from HD were more efficient in heat transfer, although relationships were much weaker than the synergic effect of all the physical traits. Our results confirmed that transpiration and leaf physical traits provided double insurance for avoiding overheating, particularly for plant from HD. We emphasize that transpiration is a more effective way to cool leaves than physical traits when water is sufficient, which may be an important adaptation for plant from HD where rainfall is sporadic. Our results provide further insight into the relationship between physical traits and transpiration for the regulation of leaf temperature, and the co-evolution of gas exchange and thermal regulation of leaves.

Paper Number: 697

Monday, 02 July 2018 | Chichen Itza
General Session 2.2 - Plant Ecophysiology

Relationships of Tree Growth and Mortality to Temperature and Rainfall in Hawaiian Forests

Rebecca Ostertag

Background: Hawaii provides a unique and tractable combination of low diversity forests and variable climate. Hawaii has already experienced upward shifts in temperature, and changes in rainfall patterns are predicted to accelerate in this century.

Methods: To better understand and predict the response of Hawaiian forests to climate change we developed the Hawaii Ecosystems-Climate Observatory.

The observatory consists of a series of climate stations and permanent forest plots using methodology of Center for Tropical Forest Science Forest Geo. The plots represent broad climate conditions associated with representative vegetation types: lowland dry forest (LDF, Palamanui), lowland dry woodland (LDW, Mamalahoa), montane mesic forest (MMF, Puuwaawaa), and montane wet forest (MWF, Laupahoehoe). Measured environmental variables determined using climate towers included temperature, rainfall, shortwave radiation, cloudiness, soil moisture, and windspeed. To examine inter- and intra-annual climate variation and vegetation dynamics, up to five census periods are represented, depending on the site.

Results: Across the sites, monthly rainfall and temperature varied up to two-fold from year-to-year, with up to a five-fold difference in rainfall and more than 2 degrees C difference between years. The temperature patterns were most strongly driven by consistently warmer temperatures in summer months, which was consistent across years (i.e., increase in night-time temperatures (minimum temperature). Tree mortality rates for a site were extremely variable among censuses, especially in the LDF and the MWF. Growth rates were highest in the MMF because this forest is dominated by the fastest growing native tree species in Hawaii (Acacia koa). Annual diameter growth was best predicted by photosynthetically active radiation, minimum temperature, and rainfall, based on multiple regression using data from all sites.

Conclusions: Strong associations of tree mortality and growth with climate indicates the sensitivity of these systems to ongoing shifts in climate. A longer time record is required to confirm patterns and make predictions about the effect of climate change on Hawaii's forests. An increase in night-time temperatures may lead to decreased net primary productivity, a result seen in other tropical forests.

Paper Number: 524

Monday, 02 July 2018 | Chichen Itza
General Session 2.2 - Plant Ecophysiology

Convergence in plant hydraulic strategies across plant lifeforms in severe water-stressed habitats

Yajun Chen

Background-Drought-induced tree death or “die-off” is the common phenomenon in areas where have extreme drought and is projected to be exacerbated due to the increasing drought intensity and frequency in the future climate change scenarios. However, the occurrence of tree death under drought event often differs in cooccurring species with different phenology or life-forms. The underlying mechanism is still unclear although was often attributed to differentiated hydraulic properties.

Objective and methods-In the present study, we investigated a combination of hydraulic properties and related traits of stems and leaves for 37 common woody species in a hot-dry savanna valley southwest China, including 15 trees, 15 shrub and 7 lianas. Species were classified into evergreen, short-deciduous and long deciduous according to the leaf phenology. We also monitored the seasonal changes of water status and tree mortality.

Results-The results showed phenology had significant effect on wood density (ρ), stem cavitation resistance, as well as leaf drought tolerance. By contrasts, life-forms have no effect on any of the traits. Specifically, there were no difference in hydraulic efficiency, vessel length among the phenologic types. However, the long-deciduous species tend to have lower stem cavitation resistance and leaf drought tolerance compared to those of evergreen and short-deciduous, which were along with their higher leaf and stem water storage, lower ρ , leaf mass per area (LMA), and mechanical stability and cell rigidity (ϵ). Evergreen had comparable stem traits with short-deciduous but highest leaf drought tolerance, ϵ , and LMA among the three groups. Although long-deciduous generally had larger and positive hydraulic safety margin (HSM) than others, most species had narrow (10/25) or negative (13/25) HSM which partly account for the high mortality in this region.

Conclusion-We show that phenology dominant the hydraulic design of plants in severe water-stressed regions, where plants show convergence across the life-forms. We conclude a potential shifting from evergreen, short-deciduous into long-deciduous in these areas under future climate scenarios.

Paper Number: 943
Monday, 02 July 2018 | Chichen Itza
General Session 2.2 - Plant Ecophysiology

Estimating litter production with a metabolic scaling theory-driven approach in a near tropical montane forest

Cho-ying Huang

Litter production, or litterfall, is a predominant part of the carbon and nutrient cycles of forest ecosystems. As a proportionally relatively invariant part of the primary production, litterfall could be a salient variable to estimate total plant carbon net uptake. The data acquisition is often limited to the small field scale, and remote sensing may stretch the observation ability over a vast region. Recent studies indicated that, in the metabolic scaling theory (MST), the productivity of whole plant is directly proportional to the mass of the photosynthesis organ-leaf. Since plant production also scales isometrically with the size of the largest individual in an ecosystem, it could be a reasonable assumption that the maximum leaf abundance could be a key determinant of the total litter production. This relationship between leaf mass and litterfall could facilitate large-scale litterfall mapping because leaf area index (LAI), a potential indicator of leaf abundance, can be indirectly estimated through a remotely sensed greenness index, such as the mostly commonly used Normalized Difference Vegetation Index (NDVI). To investigate these relationships, we acquired annual (2017) litterfall from a monitoring network (plot size = 0.09 ha, n = 16) located in hinoki (*Chamaecyparis* spp.) dominant montane forests in the northeastern Taiwan (23.98 N, 120.97 E) across the elevation range of 1267–2080 m a.s.l., and spatially corresponding LAI and NDVI in the peak growing period (July and August). Within each field plot, monthly litterfall was collected from four randomly placed 0.5 m² litterfall traps. LAI was estimated using the LAI-2200 plant canopy analyzer, and the NDVI was derived from Landsat Enhanced Thematic Mapper plus (ETM+) imagery. We found that there was a significant log-log relationship between annual litter production and the peak growing season LAI ($r^2 = 0.56$, $p < 0.001$). In addition, annual litter production revealed a significant increase with the peak growing period NDVI (linear fit, $r^2 = 0.52$, $p < 0.001$), thereby indicating the potential of using a satellite-derived greenness to estimate litter production at the regional scale. This study provides an empirical evidence of utilizing MST to estimate annual litterfall using only peak growing season canopy abundance metrics of different scales. This may facilitate further quantification of ecosystem carbon and nutrient cycles in humid tropical and near tropical regions where reliable seasonal canopy data are scarce.

Paper Number: 671
Monday, 02 July 2018 | Chichen Itza
General Session 2.2 - Plant Ecophysiology

SYMPOSIUM 7.2

The Second International Symposium on Fishing Cat Conservation: Persistence of a tropical wetland specialist, Ecology, Activism and Conservation

Conservation of a newly recorded population of fishing cat (*Prionailurus viverrinus*) at a protected coastal mangrove area in south-west Cambodia

Vanessa Herranz Muñoz

In Southeast Asia, Vulnerable fishing cat (*Prionailurus viverrinus*) populations could be approaching extinction. In 2015, fishing cats were photo-captured for the first time in Cambodia since 2003 at two coastal sites : Peam Krosaop Wildlife Sanctuary (PKWS) and Ream National Park. PKWS overlaps with Koh Kapik Ramsar Site (KKRS) and holds one of the largest and densest mangrove forests in Southeast Asia but both unique habitats and wildlife are highly threatened by overexploitation, habitat destruction and direct persecution. The Cambodian Fishing Cat Project has been conducting camera-trap, habitat and threat research, community awareness and stakeholder engagement activities in PKWS since February 2017. Over 11 months, camera-traps have been deployed at a total of 49 locations, providing data over 4195 trap days. Fishing cats were recorded on 29 occasions at 10 locations throughout Koh Kapik islet, the largest and most dominated by dense mangrove forest. Attempted individual identifications indicate we may have photo- captured between 5 and 9 individuals including one young cat. Assigning (the least uncertain) seven identifications, Spatially Explicit Capture-Recapture (SECR) methods applied on R secr package, provided an estimated density of 0.19 (SE±0.09) fishing cats per hectare within Koh Kapik islet. Endangered (EN) large- spotted civet (*Viverra zibetha*) was photographed at seven locations; EN hairy-nosed otter (*Lutra sumatrana*) and hog deer (*Axis porcinus*) were recorded at one each. We conducted threat research interviews and awareness raising workshops on 7 occasions at 5 villages within PKWS; established collaboration with PKWS authorities and direct contact with provincial and central Ministry of Environment (MoE); and head started eco-tourism activities to seek financial sustainability of conservation actions. We found a largely positive response from the communities within mangrove areas, where retaliation killings and poaching currently seem to be rare. However, lack of law enforcement allows for high levels of indiscriminate snaring in mainland areas and smaller islets. Results showed there is a breeding population of fishing cat in Koh Kapik islet and its density seems to be high, suggesting this is a resource rich and safe habitat. Investigation of smaller islets and mainland areas to ascertain fishing cat presence and status is ongoing. It is possible that young fishing cats trying to disperse from Koh Kapik islet are facing severe threats to reach safe areas to settle in a new territory. Considering these results the next steps of the project encompass further ecological and social research, outreach activities and active support for law enforcement.

Paper Number: 197

Monday, 02 July 2018 | Eiffel 1

Symposium 7.2 -The Second International Symposium on Fishing Cat Conservation: Persistence of a tropical wetland specialist, Ecology, Activism and Conservation

The Distribution and Conservation of Wild Felids in Sarawak, Borneo

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Bornean felids are enigmatic and distributed in many protected forest fragments in Sarawak. These five species includes *Catopuma badia* (Gray, 1874) (Bornean Bay Cat), *Neofelis diardi* (G. Cuvier, 1823) (Clouded Leopard), *Pardofelis marmorata* (Martin, 1837) (Marbled Cat), *Prionailurus bengalensis* (Kerr, 1792) (Leopard Cat) and *Prionailurus planiceps* (Vigors & Horsfield, 1827) (Flat-headed Cat). These cats receive protection in Sarawak and considered species of conservation importance by the IUCN Red List 2018. With continuous deforestation and land conversion to oil palm many of these species are now confined to protected areas. Many of these species being elusive, cryptic, occurs at low densities, prone to anthropogenic activities and highly rely on undisturbed habitats are difficult to study using conventional techniques where little is known on their ecology and distribution. Here we examine the distribution of these species in protected areas in Sarawak using infra-red camera traps from 2011 to 2017. This has accumulated over 78,000 trap days from more than 600 camera trap sites with approximately 200,000 images yet only 0.4% (N = 921) of images captured felids. *C. badia*, *N. diardi* and *Prionailurus planiceps* were detected less than other species during the sampling period, which suggest scarcity and rarity of these species. *N. diardi* were sparsely recorded in the northern and western region of Sarawak while *Prionailurus planiceps* is habitat specialist that was only recorded in peat swamp forests. The most common species is *Prionailurus bengalensis* that have been recorded from various elevation and habitats. Continuous enforcement activities are suggested to curb illegal activities in the protected areas.

Paper Number: 651

Monday, 02 July 2018 | Eiffel 1

Symposium 7.2 -The Second International Symposium on Fishing Cat Conservation: Persistence of a tropical wetland specialist, Ecology, Activism and Conservation



GENERAL SESSION 4

Wildlife & Infrastructure

Highway viaducts: Wildlife crossings or barriers to movement?

Tabitha Hui

Introduction

Fragmentation is occurring rapidly in Malaysia where land use change and the expansion of road networks are increasing with economic growth. In rainforests, even narrow clearings such as roads can impede animal movements, thereby fragmenting populations. One popular way of reducing the impacts of fragmentation is the use of wildlife crossings such as viaducts to link disconnected habitat patches. The paucity of information about barrier effects on rainforest animals makes drawing conclusions about the effectiveness of crossings in mitigating the impacts of fragmentation difficult however.

Objectives

We addressed these gaps in knowledge by examining the community structure and movements of small mammals in rainforests fragmented by highways, but connected at some points by viaducts in Kenyir, Terengganu and Sungai Yu, Pahang. We sought to determine how and what kinds of species use crossings, what features encourage them to do so and what impacts these have on community structure.

Methods

Trapping was conducted at 18 sites, 6 each in fragmented (roadside), connected (viaduct) and intact forest habitats (>300 m from any roads). Vegetation and habitat structure was also described quantitatively at each site.

Results

Species diversity was higher in fragmented and connected (beside the viaducts) habitats, lower in forest interiors and lowest in the viaducts. However, abundance was highest in the viaducts. Community structure was associated more with habitat structure than whether the habitats were connected or fragmented. Fragmented habitats had more logs and greater variation in vegetation density in different vertical strata, providing hiding and dwelling places for a variety of small mammals. Vegetation in viaducts consisted almost exclusively of ferns and grasses.

Conclusions

We suggest that the habitat structure of both the viaducts and surrounding areas be taken into account, in addition to the location and physical characteristics of the viaducts, if the viaducts are to be useful for connecting small mammal populations.

Paper Number: 964
Monday, 02 July 2018 | Colosseum 1
General Session 4 - Wildlife & Infrastructure

Road kills and use of wildlife passages by mammals: a case study in the Sooretama Biological Reserve, Brazil

Helena Bergallo

Roads are one of the major cause of biodiversity loss in landscapes around the world. The wildlife passages (tunnels) prevents or reduces road-kills and help to reconnect fragmented environments. We analyzed the effect of the BR-101 road on the composition and records of medium and large mammals and the effectiveness of the tunnels to mitigate road-kills and to reconnect fragmented environments. The study was carried out in the Sooretama Biological Reserve (RBS), Brazil. RBS has a 5.1 km section cut by the BR-101 and has six water drainage structures that function as tunnels. We used 17 camera-traps installed in four trails transverse to BR-101 in distances varying from 0 to 5000 m; and six pairs of camera-traps at the entrances/exits of the tunnels. Different monitoring teams obtained the road-kills data. We obtained 614 records of 24 medium and large mammal species using the camera-traps. There was a significant difference between both sides of the highway in relation to the composition and number of records ($F=10,552$, $R^2=0,413$, $p=0.005$). The difference was mainly due the exclusive occurrence of collared and white-lipped peccaries (*Pecari tajacu* and *Tayassu pecari*) only on the eastern side of RBS, and by higher records on the same east side of red-rumped agouti (*Dasyprocta leporina*) and nine-banded armadillo (*Dasypus novemcinctus*). We recorded 286 events of road-kills from 30 mammal species. The tunnels were particularly useful for avoiding road-kill of lowland tapir (*Tapirus terrestris*), ocelot (*Leopardus pardalis*) and coati (*Nasua nasua*). The opossum (*Didelphis aurita*), anteater (*Tamandua tetradactyla*) and crab-eating fox (*Cerdocyon thous*) had their road-kill rates significantly higher than the rate of their use of tunnels. Our results showed a high rate of road-kills of medium and large mammals in the RBS section on the influence of the BR-101. The presence of the tunnels proved to be effective for the prevention or reduction of road-kills for some mammal species. The absence of records of the occurrence of collared peccary and white-lipped peccary on the western side of RBS and the absence of road-kills of these species indicate that the BR-101 seems to constitute a physical barrier for both species. Therefore, the fact that some species do not use the tunnels for crossing and others avoid the road, suggests that additional measures should be adopted to protect the larger range of species from being hit by cars and to reconnect environments, avoiding the isolation of some species.

Paper Number: 357
Monday, 02 July 2018 | Colosseum 1
General Session 4 - Wildlife & Infrastructure

Roadside monkeys: Anthropogenic impacts on moor macaque (*Macaca maura*) ranging patterns in Bantimurung-Bulusaraung National Park, Sulawesi, Indonesia

Erin P. Riley, Joshua S. Trinidad, Kristen S. Morrow, Cristina Sagnotti, Monica Carosi, and Putu Oka Ngakan

A growing body of research focuses on how roads, an increasingly pervasive form of infrastructural development, affect wildlife and ecosystems. At our field site in Bantimurung-Bulusaraung National Park, Sulawesi, Indonesia, a major provincial road bisects the home range of multiple groups of moor macaques (*Macaca maura*). One of these groups has been habituated to human presence for many years, but it has never been observed interacting with people traveling on the road. Recently though, we observed a behavioral shift by this group involving them spending approximately 30% of the day along the road where they wait for motorists to toss them food and forage in trash pits. Our research focused on how this behavioral shift has affected their use of space. We compared spatial use data collected before the shift (2010-2011) with data collected after the shift began (2016-2017) to assess changes in ranging patterns. The spatial location of the group was recorded every 30 min during 6-h behavioral observation blocks using Garmin 60Csx and MAP 64s units. We analyzed the spatial data using ArcGIS v. 10.3 and Geospatial Modeling Environment (GME). We used the minimum convex polygon (MCP) tool to calculate home range size and the Kernel Density Estimation (KDE) tool to generate core areas for both time periods. We generated daily path lengths (DPL) by using the points-to-line tool for each individual day per time period. Daily path length was significantly longer in 2016-2017 (mean $\pm$ SD: 1430 $\pm$ 154 m) compared to 2010-2011 (mean $\pm$ SD: 1089 $\pm$ 85 m) ($Z = -2.857$, $p = .004$). Total home range size increased from 2010-2011 (MCP = 33.7 ha, KDE 95% = 29.4 ha) to 2016-2017 (MCP = 57.9 ha, KDE 95% = 42.7 ha), as did core area size (8.6 ha to 11.7 ha). The percentage of GPS points from the KDE 95% located within 15 m of the road increased from 2010-2011 (12.9%) to 2016-2017 (18.7%). Our results suggest that access to human foods on the road has resulted in the group increasing their daily travel and expanding the size and adjusting the location of their range to include more area in proximity to the road. These changes could negatively affect the group's ability to maintain access to its original core area and increase the likelihood of injury from motorists and vehicles.

Paper Number: 779
Monday, 02 July 2018 | Colosseum 1
General Session 4 - Wildlife & Infrastructure

Are bats vulnerable to roads in Southeast Asia? A case study of wildlife–vehicle collision mortalities in a biodiversity hotspot in Thailand

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Road effects on wildlife are major contributors to the global biodiversity crisis. In addition to direct mortalities caused by traffic, roads can reduce populations indirectly through habitat fragmentation and loss, leading to loss of genetic diversity or local extinction. Bats in particular pose an intriguing challenge to road mitigation as common prevention measures such as underpasses and fences are not effective solutions. Additionally, little is known about the impacts of roads on tropical and sub-tropical bats. To address this concern, we conducted standardized road surveys on a highway transect that bisects two national parks (a UNESCO world heritage site) and a UNESCO biosphere reserve, in Northeastern Thailand. We collected data on all the main vertebrate groups (mammals, birds, reptiles and amphibians) for comparison purposes. We used GIS to conduct spatial analyses and visualize wildlife–vehicle collision hotspots, particularly for bat mortalities. Over the course of 110 sampling days, and omitting domestic animals, we detected 1395 new mortalities. Of the 212 mammals, 81.6% were bats (12.4% of all vertebrate mortalities), representing 21 species and five families. The highest mortality peak was between June-August, with 72% of all bat mortalities. Other road ecology studies in the Palearctic have reported very low numbers of bat mortalities (<1%), but it might be due to methodology bias (not specifically looking for small species, e.g. bats). Road impacts on Southeast Asian bats are an important research priority, as over 21% of bat species in the region are listed as Near Threatened or higher. We need to determine the extent of the road impacts on population viability and species conservation in Southeast Asia.

Paper Number: 733
Monday, 02 July 2018 | Colosseum 1
General Session 4 - Wildlife & Infrastructure

A test of road edge effects on the nest survival and the post-fledging survival of a tropical forest passerine

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Road edges are widely regarded as having a negative influence on the breeding success of forest birds through the enhancement of nest predator populations associated with edge habitats at least in the temperate zone where the clear majority of studies have been conducted. The post-fledging period is a critical period of the avian lifecycle and thought to be strongly influenced by predation, yet little research on post-fledging survival has been conducted especially in the tropics. We investigated the influence of a road edge on the nest success and the post-fledging survival of a forest passerine, White-rumped Shama (*Kittacincla malabarica*), in a dry evergreen forest in northeastern Thailand. White-rumped Shama was chosen owing to their propensity to use nest boxes

Paper Number: 308
Monday, 02 July 2018 | Colosseum 1
General Session 4 - Wildlife & Infrastructure

A hydroelectric dam in Peninsular Thailand has devastated the surrounding resident forest bird community

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The Khlong Saeng – Khao Sok Forest Complex is the largest contiguous forest remaining in southern Thailand; however, the Rajaprabha Hydroelectric Dam, opened in 1987, flooded 165 km² of the ecologically important lowland riparian ecosystem at the heart of the complex, transforming high canopy seasonal evergreen forest into a fragmented island landscape. Thirty years after inundation, little is known about the ecosystem's recovery. This study explored avian diversity among resident forest species, comparing richness, abundance, and dietary guild patterns in relation to forest structure and fragment size, including comparison of islands with adjacent contiguous mainland forest. Avian point counts were undertaken on 23 islands (0.7 to 49.0 hectares) and nearby mainland, with three temporal replicates, from January – May 2016. Bayesian hierarchical analysis and simultaneous audio recording were used to correct for differences in detection probability among species. 108 habitat structure surveys were conducted using 10m radius plots (71 on islands, 37 on mainland). Mainland (≤500m from the shoreline) and island forests had identical mean bamboo counts ($p>0.99$), ground cover ($p>0.93$), and canopy cover ($p>0.73$). Both were dominated by successional species such as bamboo. $\log_{10}$ Area alone described 87.9% of the variance in avian species richness (Bray-Curtis two-dimensional NMDS, stress = 0.125, $p<0.001$), also indicating habitat homogeneity. 80 (of 162) resident forest species were observed, with similar richness on mainland ($S_{\text{obs}} = 75$) and islands ($S_{\text{obs}} = 72$); however, effective richness was higher on the mainland, e^H 35.9 vs. e^H 24.3 ($p<0.001$). Overall Inverse Berger-Parker was 5.36, showing an uneven avian assemblage dominated by a handful of disturbance-tolerant species. Encroachment of edge into mainland areas surrounding the reservoir exceeded expectation. Islands exhibited decreasing diversity following a classic species-area relationship. Forest interior ground-dwelling and understorey bird species were largely absent and few frugivores were present, particularly on islands. In addition, species of conservation importance were largely missing from the study site. Though touted as an endless source of 'renewable energy', hydroelectric dams often inundate irreplaceable lowland habitat, causing permanent harm to ecosystems. Three decades after construction, areas affected by Rajaprabha Hydroelectric Dam have clearly not recovered in terms of vegetative structure or avifauna – including islands and large swaths of the adjacent mainland. This should be considered in on-going and future hydropower-related decision-making processes.

Paper Number: 630
Monday, 02 July 2018 | Colosseum 1
General Session 4 - Wildlife & Infrastructure

SYMPOSIUM 2.3

Environmental Sustainability in Oil Palm: Linking Science to Policy and Practice Across the Tropics

Recent Oil Palm Development in Brazil: Evaluating Expansion Dynamics and Constraints

Elinor Benami
Stanford University

Over the last forty years, oil palm cultivation has expanded at the expense of many forested areas across the tropics. Among biophysically suitable lands for oil palm, Brazil maintains the greatest area, estimated at as much as ~30Mha (excluding forested areas) and ~238Mha (including forested areas). Furthermore, in 2010, to promote oil palm development without deforestation, Brazil launched the Sustainable Palm Oil Production Program (SPOPP) in 2010 and delineated ~30 million ha for its growth that excluded forested areas and indigenous reserves. In the first part of this talk, I discuss oil palm expansion and conversion dynamics in the four years before and after the launch of this program (2006-2014). Through analyzing satellite imagery, land registration data, and site based interviews, we find that oil palm area in Brazil tripled with the lowest known direct forest conversion rate (<5%) globally, although >50% of oil palm parcels were located within 0.5 km of forested areas. However, <1% of the 30 million ha promoted for oil palm was developed by 2014, with decelerated growth occurring thereafter. To explore the factors associated oil palm expansion and its prospects for continued growth, in the second part of this talk I simulate the economic returns to oil palm production from oil palm plantation to delivery at mill in Pará, Brazil. Changing yields, international oil palm prices, and certification premia each influence the returns to oil palm production. However, only in a limited, select configuration of values does oil palm present positive returns. I conclude by discussing the implications this work has on developing programs to increase oil palm production without deforestation.

Paper Number: 988

Monday, 02 July 2018 | Colosseum 2

Symposium 2.3 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Assessing the conservation value of riparian reserves for terrestrial mammals in oil palm plantation and highly degraded forest

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The rapid expansion of oil palm (*Elaeis guineensis*) plantations across the tropics has resulted in habitat destruction and loss of biodiversity. This shift from forest to oil palm plantation is particularly noticeable in Sabah, Malaysian Borneo. Here, forest loss and degradation has reduced the vegetation cover and altered the structure of landscapes through the process of fragmentation. This process reduces habitat area and resources for many species, especially mammals. Retaining buffer zones of natural forest vegetation in the oil palm estates might provide important habitat for tropical mammals, and facilitate animal movements between forests and surrounding agricultural areas. However, this remains untested. This study used camera trapping sampling methods to compare species richness, diversity and community composition of mammals in 39 grid sites of riparian within logged forest, repeatedly logged forests and oil palm plantation in northern Borneo. We found that the riparian reserves within the oil palm plantation supported comparable levels of mammal diversity to continuous forest, although they contained fewer forest-dependent species and threatened species. If designed and protected appropriately, riparian reserves could also be acting as movement corridors between larger and higher quality areas of forest. Although mammal diversity is lower in oil palm plantation we find that some forested riparian reserves are used by some highly threatened and protected species, including orang-utan, sun bear and clouded leopard.

Paper Number: 730

Monday, 02 July 2018 | Colosseum 2

Symposium 2.3 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Resident and migratory bird use of oil palm (*Elaies guineensis*) plantations and native forest fragments in southern Mexico

Jessie Knowlton

In Latin America, oil palm plantations are among the most rapidly expanding tropical agroecosystems, yet little data is available about resident and migratory bird use of these habitats. Populations of many Neotropical migratory birds have declined in the past several decades, and research suggests that conditions on the wintering grounds can strongly influence survival, reproductive success, and hence population dynamics. We conducted 203 point counts in forest fragments, oil palm plantations and pasture between June 2016 and March 2017 in Tabasco, Mexico to examine resident and migratory bird use of these habitats. From December 2017 to April 2018 we also captured birds in oil palm and forest fragments, and compared species composition, abundance, sex ratios, muscle condition and fat levels. The point counts recorded 100 resident and 24 migratory bird species. Total bird species richness was greatest in pasture and forest fragments, and lowest in oil palm (83, 79, and 49 species, respectively). We captured 375 individuals of 24 species of migratory birds; 259 individuals and 21 species in forest fragments and 116 individuals and 15 species in oil palm; 12 species were found in both habitats. The overall sex ratio of migrants in forest fragments was 10.4 males per female, while in oil palm it was 2.4 males per female. Average fat and muscle scores did not differ significantly across the two vegetation types. Our study suggests that oil palm plantations are used more by migratory than resident birds. Further, while some migratory species are abundant in oil palm plantations during the non-breeding season, overall species richness and abundance of migratory individuals are lower in oil palm compared to native forest fragments and females may be forced by competition to use this lower quality habitat. As oil palm continues to expand throughout the humid tropics, it is important to more fully understand both resident and migratory bird use of this habitat and the consequences for bird populations.

Paper Number: 397

Monday, 02 July 2018 | Colosseum 2

Symposium 2.3 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Mammal diversity in oil palm plantations in Southern Mexico: a first assessment.

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The Sierra of Tabasco Region, in southern Mexico, is a biological and ecologically important area due to its high biodiversity value. However, the primary vegetation, i.e. the tropical forest, has been highly modified and replaced by crops and pasture. Some of these pastures have more recently been transformed into oil palm plantations. The impact that these plantations have on biodiversity has been poorly studied. This study represents the first inventory of mammal communities that occur in oil palm plantations and surrounding secondary forest patches in this region. We selected six sampling sites: three oil palm plantations and three secondary forest fragments, each of which was at least 5 km from any another. We installed a total of 24 camera traps, four in each site, and at a minimum distance of 200 m from one another. The cameras were active from December 2017 to February 2018. A total of 1079 photo trapping events were recorded, on 1080 days/camera sampling effort. Fifteen mammal species were recorded (from seven Orders and 10 Families): 14 species in forest fragment and 8 in oil palm. Shannon's diversity was higher in forest than oil palm; however, no significant difference in species richness or abundance was found between the land uses. Forested sites had the highest densities of mammals and were the most important in terms of diversity. Similarity analysis (ANOSIM) indicated that the two sites were significantly different in their overall mammal community. A SIMPER analysis showed that Black-eared opossum (*Didelphis marsupialis*) and Northern raccoon (*Procyon lotor*) are the species that contributed most to that difference – both were much more common in oil palm than in the forest fragments. Three species observed are considered at risk by Mexican Federal law: the Jaguarundi (*Puma yagouaroundi*) is listed as Threatened, whereas Northern Tamandua (*Tamandua mexicana*) and Ocelot (*Leopardus pardalis*) are listed as Endangered. These three species except the two cats were only observed in the forest fragments, not in oil palm.

This is the first study to provide data about the mammal community using oil palm plantations and patches of secondary forest in this important, but highly modified, region. This information is increasingly important as the region continues to face strong pressure of further land use change and hunting.

Paper Number: 475

Monday, 02 July 2018 | Colosseum 2

Symposium 2.3 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Carbon fluxes from oil palm plantations on peat soil

Frances Manning

Oil palm plantations have increased in extent in tropical SE Asia since 1970. 7.8 Mha of these plantations are currently situated on tropical peat soils, which are a globally important carbon store. 1.56 million people currently depend on these plantations for their income, both from industrial plantations and small-holder farmers. Understanding how management impacts the carbon fluxes from tropical peat soils is therefore essential to a) inform global climate models of the resulting CO₂ and CH₄ fluxes and b) to devise management strategies that seek to reduce these fluxes.

Carbon fluxes were measured from the soil, drainage ditch and stem surfaces every month for a year. Soil measurements were taken from different management surface microforms, including the bare soil harvest path, under frond piles, under cover plants and next to the palms. CO₂ fluxes were partitioned into heterotrophic respiration using four different techniques. Surface CO₂ and CH₄ fluxes were upscaled using area-weighted upscaling – based on the sizes of the surface microforms.

CO₂ fluxes were highest next to the palms, followed by the drainage ditches, and lowest from the bare soil. Partitioning CO₂ into heterotrophic respiration gave plantation estimates of peat oxidation ranging between 10 to 17 Mg C ha⁻¹ yr⁻¹ – in the range of the IPCC emission factors for oil palm plantations. Stem fluxes and soil autotrophic respiration were both higher in the dry season and lower in the rainy season.

Annual CH₄ fluxes were estimated to be 64 kg C ha⁻¹ yr⁻¹. CH₄ fluxes were highest from the drainage ditches and lowest from the bare soil. CH₄ fluxes were measured from the palm stems but only made up 0.4 % of the plantation footprint. Including CH₄ fluxes from the drainage ditches made the oil palm plantations comparable to forest CH₄ fluxes.

CO₂ and CH₄ correlated with environmental parameters. Soil moisture was the most important factor determining the rate of CO₂ efflux and water table depth was the most important factor determining the rate of CH₄ efflux. Different variables impacted the soil and drain comparatively, with soil moisture having a greater influence on soil fluxes, and drain depth and water temperature on drain fluxes. Maintaining high water table depths was seen as the most important factor to reduce these emissions.

Paper Number: 663

Monday, 02 July 2018 | Colosseum 2

Symposium 2.3 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

Retaining riparian reserves in oil palm plantations mitigates the loss of native small mammal species

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Retaining riparian reserves, i.e. narrow strips of natural forests flanking rivers, within disturbed and converted habitat matrix, is considered a useful way to enhance biodiversity or mitigate biodiversity loss in farmland. However, little is documented for non-volant small mammals in the tropics. We used standardised grid-based sampling to compare small mammal species richness, abundance and community composition in 14 riparian reserves in old growth forest, logged forest and oil palm plantations, with that found alongside oil palm rivers with no riparian vegetation. We also investigated whether the small mammal communities were associated with riparian habitat covariates to gain an insight into possible optimum characteristics of riparian reserves for biodiversity conservation.

On average riparian reserves in logged forest and oil palm plantations had significantly more specialist species but fewer generalist species than areas in oil palm without reserves. All sites had comparable capture rates, but the abundance of specialist species was higher in logged forest riparian and riparian in oil palm plantation compared to oil palm without riparian. The opposite trend was observed for generalist species. Two invasive rats, *Rattus rattus* and *R. exulans*, dominated oil palm plantation sites, but were near absent from riparian reserves, indicating that reserves do not harbor pest rats.

Higher overall small mammal species richness was generally positively associated with closed canopy forest, albeit with slightly lower vegetation biomass. While higher small mammal abundance was generally associated with taller canopies and slightly lower biomass. The abundance of generalist and invasive species was negatively associated with canopy closure and understorey vegetation cover. The proportion of forest alongside rivers did not explain the variations in the overall species richness and abundance, but it was significantly positively associated with variations in the richness of forest species.

In conclusion, retaining forest-like remnants along rivers in oil palm plantations is a useful way to enhance small mammal diversity, including forest specialists, and does not appear to promote pest rats in the plantation.

Paper Number: 650

Monday, 02 July 2018 | Colosseum 2

Symposium 2.3 - Environmental sustainability in oil palm: linking science to policy and practice across the tropics

SYMPOSIUM 9

Land-Use Change Impacts on Ecosystem Biogeochemistry and Functioning in Secondary Forests

Complete carbon budget in selectively logged and old-growth tropical forests in Borneo

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The area of human-modified tropical forests exceeds that of undisturbed forests, making them an important component of the global carbon budget. However, carbon dynamics in human-modified tropical forests remain poorly quantified. Here, we present the first comparison of the complete carbon budgets in selectively logged and old-growth forests in Malaysian Borneo.

We had permanent 1ha plots in selectively logged (n=5) and old-growth (n=6) forest with at least three years of carbon dynamics measurements in each plot. To quantify net primary productivity (NPP), we measured canopy NPP (methods: litter traps and hemispherical photos), woody NPP (repeated tree censuses and dendrometer bands) and fine root NPP (root ingrowth cores). To quantify ecosystem respiration, we measured autotrophic respiration (Ra) from leaves, stems and roots, and heterotrophic respiration (Rh) from deadwood, litter, mycorrhiza and soil organic matter (gas flux measurements with leaf cuvettes and closed chambers). Ecosystem carbon balance was estimated as the difference between NPP and Rh, and gross primary productivity (GPP) was estimated as the sum of NPP and Ra. The methods follow the protocols of the Global Ecosystem Monitoring (GEM) plot network, and the study is part of the Stability of Altered Forest Ecosystems (SAFE) Project.

GPP and Ra were higher in logged forest than in old-growth forest, while NPP and carbon use efficiency (NPP/GPP) in both forest types was similar. However, the NPP allocation differed between the forest types, logged forests allocating more to woody NPP and less to canopy NPP than old-growth forests. Rh was higher in logged forest due to the higher fluxes from deadwood and soil organic matter. The old-growth plots were a small carbon sink of 1.1 ± 1.2 Mg C ha⁻¹ year⁻¹ (given the uncertainties, not different from zero), while the logged plots were a small source (1.6 ± 1.5 Mg C ha⁻¹ year⁻¹) of carbon to the atmosphere. Carbon sequestration via the high growth rate of trees in logged forest did not offset the carbon emissions from the excess organic matter and higher tree mortality, which were legacies of the logging.

Given that the majority of tropical forest biome has experienced some degree of logging, accurate assessments of logged forest carbon sink and source strengths are crucial for estimating the carbon balance of the tropical biome.

Paper Number: 589

Monday, 02 July 2018 | Petra 1

Symposium 9 - Land-use change impacts on ecosystem biogeochemistry and functioning in secondary forests

Logging and soil nutrients independently explain plant trait expression in tropical forests

David Burslem

Plant functional traits are crucial for regulating tropical ecosystem functions but little is known about how co-occurring gradients of land use and edaphic conditions influence trait expression for tropical trees. We test how gradients of logging disturbance and soil properties relate to community-weighted mean (CWM) values of 32 physical, chemical and physiological traits of leaves and wood from 284 tree species in logged and old-growth tropical forest in Borneo. Logged plots had greater CWM values for traits that drive carbon capture and growth, whilst old-growth forests predominantly had greater CWM values for structural and persistence traits. Although disturbance was the primary driver of trait variation, soil nutrients explained a statistically independent axis of variation linked to leaf size and nutrient concentrations. The finding that functional traits have contrasting responses to land use and soil resource availability highlights the multi-dimensionality and context dependency of trait expression, with likely implications for ecosystem functions across human-modified tropical forests.

Paper Number: 608

Monday, 02 July 2018 | Petra 1

Symposium 9 - Land-use change impacts on ecosystem biogeochemistry and functioning in secondary forests

The impact of surrounding matrix trees on dipterocarp seedling growth and survival

Charles J. Marsh, Martin Svátek, Jakub Kvasnica, Martin Rejžek, Radim Matula, Michael J. O'Brien, Christopher D. Philipson, Andy Hector

Enrichment planting of tropical forest seedlings is an important tool for regenerating logged forest, in particular dipterocarp forests in south-east Asia. Much work has examined survival and growth of different species in response to environmental conditions, such as drought and temperature. However, we know little of the impact of competition from the surrounding matrix vegetation.

We examined the growth and survival of 16 species of dipterocarp as part of the Sabah Biodiversity Experiment in Sabah, Borneo. For 734 seedlings we mapped the position and size of all trees within 10m of each seedling at very high resolution in 3D space using a terrestrial laser mapping system. We then calculated the number of trees, the size of the biggest tree, and the sum of DBH of trees at near (0-5m) and medium (5-10m) distances surrounding each seedling, along with the canopy openness. Variable importance was determined through multi-level lasso modelling, a variable selection procedure in the generalised linear mixed-model framework.

Canopy cover was an important driver of both seedling survival and growth, along with seedling age. We also saw positive relationships with the size of the largest tree 5-10m from seedlings. A large tree near a seedling may indicate suitable growing conditions. We saw no such relationship at smaller distances, although planting lines are regularly cleared within 2m of seedlings which may limit their impact. Enrichment planting may therefore be more successful if seedlings are located within areas of high tree density or close to larger remaining trees. Areas with few remaining trees should be avoided, even though competition may be lower, as this may indicate unsuitable conditions.

Paper Number: 781

Monday, 02 July 2018 | Petra 1

Symposium 9 - Land-use change impacts on ecosystem biogeochemistry and functioning in secondary forests

Influence of environmental variables and mycorrhizal associations on soil carbon storage in a montane forest in Panama

Cecilia M Prada, M Juliana Pardo, Benjamin L Turner & James W Dalling

Tropical forests capture more carbon than any other terrestrial ecosystem. Understanding how environmental conditions in the tropics impact carbon cycling is therefore critical to predicting the consequences of climate change. Soil carbon has an especially important role in this cycle as it accounts for almost two-thirds of the carbon in terrestrial ecosystems. Here we explored how environmental variables and mycorrhizal associations impact soil carbon storage in tropical montane forests, an ecosystem that is especially sensitive to climate change. We established four 1-ha permanent plots along an elevational gradient from 1987 to 2923 m on Volcan Baru in western Panama. We measured soil nutrient and carbon content, and we censused all trees ≥ 5 -cm DBH classifying them according to mycorrhizal type. The depth of the soil organic layer ranged from 1 to 33 cm across plots, and accounted for 0.32 - 6.43 kg C m⁻². Soil carbon storage to 1 m depth in mineral soil varied across plots from 26.0 to 74.83 kg C m⁻². A multiple regression showed that soil C was positively correlated with elevation, and negatively correlated with soil P. Mycorrhizal association was also an important predictor of the soil C:N ratio; sample sites with more ectomycorrhizal (EM) oak trees surrounding them stored significantly more soil carbon, while inorganic N was negatively correlated with EM abundance. Soil enzymatic activity showed that at low C:N levels, the activity of b-glucosidase and sulfatase was higher in samples with lower EM abundance. However, sites with high C:N levels, and which therefore had high EM abundance, also had high b-glucosidase activity, meaning that EM may have a decomposer role, although this interaction between C:N ratio and enzymatic activity was not significant. Previous studies of tropical montane forests report soil C storage values of 70 to 280 Mg C ha⁻¹. We found that soil C storage in our oak dominated forests vary from 260 to 748 Mg C ha⁻¹, among the highest values reported in these ecosystems and comparable to mangrove ecosystems that are known to have an important soil carbon storage capacity (80 to 647 Mg C ha⁻¹). Overall, we found that elevation, resin-extractable P and mycorrhizal associations influenced soil C storage at a local scale. Understanding the factors influencing the storage of these large soil carbon pools is essential to modeling the global carbon cycle, and to predicting how montane forests respond to environmental variation, and therefore climate change.

Paper Number: 255

Monday, 02 July 2018 | Petra 1

Symposium 9 - Land-use change impacts on ecosystem biogeochemistry and functioning in secondary forests

Rapid initial responses of forest carbon fluxes and nutrient cycling in a large-scale nutrient manipulation experiment in Central Amazonia

Kelly Andersen

Soil nutrients influence plant productivity and carbon cycling. According to biogeochemical theory, throughout soil development, nitrogen (N) accumulates due to biological nitrogen fixation, whereas rock-derived nutrients, such as phosphorus (P) and cations, decrease due to losses from leaching and weathering processes. In geologically old soils, such as many tropical soils, phosphorus is hypothesized to limit forest productivity and ecosystem processes. In the World's largest rainforest, the Amazon, only gradient studies have tested this hypothesis, with results demonstrating that wood production rates are highly correlated with total soil phosphorus. However, tree species composition, soil type and climate also change across the Amazon. Thus, large-scale, long-term experiments are necessary to disentangle these factors from the effects of soil nutrients on forest carbon cycling. We test the P-limitation hypothesis in the first large-scale nutrient manipulation experiment in a mature forest in the Central Amazon, at a site representative of the most abundant soil type in Amazonia (Amazon Fertilisation Experiment, AFEX). Since April 2017, we have been applying nitrogen, phosphorus, and a combined cation fertilizer in a replicated factorial design. Here, we report rapid initial responses of key above and belowground ecosystem processes to nutrient addition treatments in the first six months post-fertilization.

Cumulative leaf litterfall production varied from 9.86 to 17.78 Mg ha⁻¹ yr⁻¹ but did not differ significantly among treatments. However, P addition increased the total amount of P in leaf litter inputs during the period of peak litterfall, demonstrating the additions had already increased the amount of P already cycling through the ecosystem (34.8 ± 1.55 g P ha⁻¹ in the treatments receiving P and 27.6 ± 1.77 g P ha⁻¹ in the treatments not receiving P; $F_{1,27} = 11.58$, $P < 0.01$). Calcium (Ca) and Magnesium (Mg) litterfall inputs also increased in the P and N+P addition treatments (Ca model: $F_{7,21} = 2.74$, $P < 0.05$; Mg model: $F_{7,21} = 3.90$, $P < 0.01$). Total soil respiration ranged from 5.04 to 7.41 mol CO₂ m⁻² s⁻¹ and was significantly higher in the treatments receiving P compared to treatments without added P, indicating that root and microbial activity was stimulated by P addition ($F_{1,27} = 6.23$, $P < 0.05$). Together, our initial results indicate that phosphorus additions alone and in combination with other nutrients stimulated both belowground carbon fluxes and the amount of nutrients cycling through litter pools in this low fertility tropical forest.

Paper Number: 396

Monday, 02 July 2018 | Petra 1

Symposium 9 - Land-use change impacts on ecosystem biogeochemistry and functioning in secondary forests

SYMPOSIUM 8.2

Invertebrates and Ecological Processes in Modified Tropical Landscapes

Palatability and defence in seedlings of two species of dipterocarp experimentally planted across a fragmented landscape

Lois Kinneen

Understanding the mechanisms that drive tropical forests is imperative as they are experiencing high rates of degradation. Forest loss and fragmentation disrupts plant-animal interactions and reduces ecosystem functioning. Herbivory is a fundamental ecosystem process which, in the tropics, is predominately carried out by invertebrate species. Insect herbivores not only make up an important aspect of biodiversity in these speciose areas, but also contribute greatly to their functioning. They mediate the transfer of energy between primary production and higher trophic levels and are governed by both bottom-up and top-down factors. Plants exhibit plasticity in their traits depending on their environment and are therefore vulnerable to abiotic changes caused by forest fragmentation. Consequently, it is useful to perform analyses of leaf traits in studies of herbivory to detect local adaptations. This study aimed to investigate the effects of fragmentation on bottom-up controls of insect herbivory through changes in foliar defensive traits. It is hypothesised that fragmentation can cause morphological and phytochemical changes leading to shifts in defence mechanisms, which may in turn have an effect on insect herbivory.

Seedlings of two species of endemic dipterocarp were planted in twelve 1-hectare fragments and twelve continuous forest sites across the Stability of Altered Forest Ecosystems project in Sabah, Malaysia. Herbivory damage was measured over an eighteen month study period, after which a traits analysis was performed on surviving seedlings. Three common indicators of leaf quality were measured; total foliar phenolics, acid-detergent fibre and leaf toughness.

Leaf traits varied significantly between species, with one having higher phenolic but lower fibre content, suggesting this species relies on chemical rather than mechanical defence. Overall, lower foliar phenolics were recorded in forest fragments than continuous forest, however, this relationship was only significant for one species. Neither fibre content nor leaf toughness varied with forest fragmentation; however fibre did show a positive relationship with canopy cover.

Results of this study contribute to understanding the effects of fragmentation on insect herbivory, which remain uncertain. Our findings indicate a reduction in phytochemical defence in forest fragments, therefore seedlings in these habitats may be more susceptible to herbivory. Since as little as 10% defoliation has been found to reduce plant fitness this may have cascading consequences at population and community levels and implications for the regeneration success in fragments. In turn, changes in plant resources directly impact insect herbivore communities and due to their trophic position; stand to have impact whole ecosystems.

Paper Number: 848

Monday, 02 July 2018 | Petra 2

Symposium 8.2 - Invertebrates and ecological processes in modified tropical landscapes

Ants are key players in maintaining ecosystem functioning in oil palm plantations in Riau, Sumatra

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The expansion of oil palm plantations is a primary cause of land-use change in Southeast Asia. Ants are an important component of tropical ecosystems, playing roles as predators, seed dispersers, disease regulators, and drivers of soil properties. We established 24 manipulative exclusion plots to assess their role in oil palm plantations in Riau, Sumatra. These plots were based in four habitat types at the Biodiversity and Ecosystem Function in Tropical Agriculture Project. One was in replanted oil palm, and three were in mature plantations where understory vegetation structure has been altered by applying three different management strategies. We measured the impact of excluding ants on invertebrate biodiversity, herbivory, herbivore and seed predation, soil bioturbation, soil physical and chemical properties, decomposition rates, and oil palm yield.

We found that excluding ants compromised important ecosystem functions. For example, exclusion plots had lower rates of herbivore predation and greater herbivory damage. Excluding ants also reduced rates of seed predation, and increased rates of worm bioturbation. Our results were not consistent across habitat types, indicating that management practices significantly affect the role of biodiversity. These results highlight the value of insect biodiversity for the production of tropical agriculture, and the importance of developing and implementing ecofriendly management practices to support the development of more sustainable oil palm.

Paper Number: 965

Monday, 02 July 2018 | Petra 2

Symposium 8.2 - Invertebrates and ecological processes in modified tropical landscapes

How rapidly do invertebrate decomposers and litter decomposition rates recover during rainforest regeneration on disused pastures?

Marisa Stone, Luke Shoo, Nigel Stork, Fran Sheldon & Carla Catterall

Converting rainforest to pasture can have large impacts on many ecological processes. It could be expected that these processes could be recovered by restoration of native vegetation communities. However, there is little available evidence to clarify such recovery patterns. We deployed open mesh bags containing forest leaves across a network of 25 sites to experimentally quantify the decomposition rates (mass loss) of litter in old growth forest, grazed pasture and two pathways of vegetation recovery: unassisted regeneration aged five years to several decades since livestock removal, and assisted regeneration 1-10 years after interventions to accelerate vegetation development in sites which had previously regenerated naturally for five years to several decades post post-livestock. We found that decomposition occurred more slowly when rainforest had been converted to pasture, but that faster decomposition had returned within a few years following commencement of both unassisted and assisted regeneration. Invertebrates are known to play an important role in decomposition processes. So, to investigate this role we also sampled the potential decomposer community at each site by using extraction funnels to separate the invertebrates from the remaining litter in the bags and also from independently collected samples of ground surface litter at all sites. The overall abundance of litter invertebrates in pasture sites was much lower than in old growth forest but had substantially recovered in all regenerating sites. Further results will be presented that target invertebrate feeding guilds to assess the effect of excluding macro-detritivores on the litter decomposition rate, by looking more closely at the abundance and functional composition of invertebrates within feeding guilds, in open versus closed 1mm mesh bags across the different habitats. It is possible that decomposition in regenerating sites occurs through different trophic pathways from those in old growth forest. Irrespective of possible variation in invertebrate contribution and composition, leaf litter decomposition was an ecological process to recover faster than vegetation structure and composition.

Paper Number: 788

Monday, 02 July 2018 | Petra 2

Symposium 8.2 - Invertebrates and ecological processes in modified tropical landscapes

Phylogenetic and functional patterns in leaf-cutting ants diet at the edge and in the interior of a fragmented Atlantic rainforest

Joosep Sarapuu

Leaf-cutting ants (LCA) are dominant herbivores in Neotropical rainforests, and their colony densities increase in disturbed habitats such as forest edges. On one hand, LCA prefer softer leaves, on the other hand, they prefer disturbed habitats. We studied LCA foraging in the edge and interior of an Atlantic forest fragment to elucidate the forces regulating foraging in human-modified landscapes. We applied phylogenetic signal analysis to investigate LCA diet across plant lineages and performed phylogenetic generalized linear models to analyse the diet in both habitats. We found a phylogenetic signal in LCA diet and in leaf toughness which means that LCA prefer closely related plants with softer leaves. We also found that irrespective of phylogeny, LCA prefer softer leaves, both in edge and interior. However, LCA prefer more abundant plants only in edges. High abundance of optimal diet makes LCA foraging easier in edges and supports why LCA colony densities increase in disturbed habitats. It is also worth to mention that phylogenetic signal in diet might result in LCA vulnerability in the case of their preferred clades are reduced in abundance or even locally extinct due to LCA herbivory or other changes in the habitat.

Paper Number: 692

Monday, 02 July 2018 | Petra 2

Symposium 8.2 - Invertebrates and ecological processes in modified tropical landscapes

Increasing aridity rather than human disturbance affects ant-mediated ecosystem services in Brazilian Caatinga

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Introduction: The Caatinga is the largest and most diverse of the world's seasonal dry tropical forests. However, it is the third most-threatened Brazilian ecosystem, due to the historical unsustainable exploitation of natural resources. Climate change effects may even intensify the negative effects of human disturbance. Ants are important for the maintenance and functioning of many basic ecosystem services. Particularly, ants have been considered crucial for seed dispersal, plant protection and soil fertility, which clearly improve plant performance.

Objectives: Here we examine the individual and combined effects of chronic anthropogenic disturbance (CAD) and climate change (particularly, increase in aridity) on basic ecosystem services mediated by ants (i.e., seed dispersal, plant protection and soil fertility) in the Caatinga.

Methods: We characterized ant-plant interactions in 20 plots that varied in CAD intensity and aridity in Catimbau National Park, northeastern Brazil. Ant seed removal experiments, ant attack to simulate herbivore tests, and analyses of soil properties at leaf-cutting ant nesting sites have been done to estimate the service quality.

Results: Our results indicate that the total number of ant-seed interactions, rates of seed removal, mean distance of seed removal, ant protection effectiveness and the nutrient content of leaf-cutting ant nesting sites all declined with increasing aridity, but were not related to CAD. We found little evidence for interactive effects of aridity and CAD on ant-mediated services. The mechanisms underlying these changes involved variations along the aridity gradient in both the behavior and population density of the ecosystem service-providing ant species as well as in plant morphology and physiology.

Implications: Given the large number of plant species dependent on ants for seed dispersal, protection and soil fertility, this has important implications for future plant recruitment and growth, and consequently, for the composition of Caatinga plant communities. An impoverishment of the ant-mediated ecosystem services provided by ants may compromise the future use that humans can make of the Caatinga.

Paper Number: 616

Monday, 02 July 2018 | Petra 2

Symposium 8.2 - Invertebrates and ecological processes in modified tropical landscapes

Nitrous oxide and methane emissions from termites along a gradient of forest disturbance in Sumatra

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Termites are strong methane (CH₄) emitters, but much less are known about their contribution to nitrous oxide (N₂O) emissions. To determine the N₂O and CH₄ emissions driven by termites and how these would affect soil annual fluxes, a series of field and laboratory measurements were conducted. The field measurements took place in an undisturbed forest, a disturbed forest, a one year old rubber plantation, a twenty year old rubber plantation and an eight year old oil palm plantation, located in Pasir Mayang, Sumatra, Indonesia. The soil N₂O, CH₄ emissions were measured using the static chamber method and concomitantly, the termite relative abundance and the number of termite species were determined. All of those measurements were conducted “in situ” along 100 m transects in dry and wet months in each land-use system. Ex situ, the mounds alone, termite workers alone and with mound, termite soldiers alone and with mound were collected from the field, incubated in the laboratory and the gas samples were evacuated to determine the N₂O and CH₄ emissions from termites. The soil N₂O fluxes followed a gradient from the one year-old rubber plantation < the oil palm plantation < the disturbed forest ≤ the undisturbed forest ≤ the twenty year-old rubber plantation. The soil CH₄ fluxes followed a gradient from the disturbed forest < the undisturbed forest < the oil palm plantation = the twenty year-old rubber plantation = the one year-old rubber plantation. We observed a shift from methanotrophy in the forested systems (-2.7 ± 2.4 g C-CH₄ ha⁻¹ d⁻¹) to methanogenesis in the plantation systems (1.2 ± 3.2 g C-CH₄ ha⁻¹ d⁻¹). The numbers of termite species were similar in the undisturbed and disturbed forest and higher than in the one, twenty year-old rubber plantations and the eight year-old oil palm plantation; the forested systems shifting to plantation systems significantly decrease the average number of termite. We found that the termite workers emitted significantly higher rates of CH₄ than the soldiers, whereas emissions of N₂O were similar. The presence of termites decreased the uptake of CH₄ fluxes from the soil in the undisturbed forest and one year-old rubber plantation, did not change cumulative CH₄ fluxes in the twenty year-old rubber plantation and increased CH₄ in the oil palm plantation. The presence of termites increased cumulative N₂O fluxes from soil and termite in all land-use systems except the oil palm plantation. Considering the potential contribution of termite to the total cumulative CH₄ emissions (10-53%) and N₂O (2.7-14.9%) from soil and termites, the contribution of termites should be included to refine the recent calculation of global N₂O and CH₄ emissions, especially in tropical ecosystems where termites are abundance

Paper Number: 829

Monday, 02 July 2018 | Petra 2

Symposium 8.2 - Invertebrates and ecological processes in modified tropical landscapes

GENERAL SESSION 5

Methodological Advances in Tropical Biology & Conservation

Bloodsuckers for conservation - using iDNA from leeches for mammal biodiversity assessment and monitoring

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Globally, biodiversity is declining at an alarming rate and the conservation of vulnerable species is of crucial importance. Monitoring threatened populations, particularly in tropical rainforests where the species of interest are often secretive and occur in remote areas, is challenging. In recent years, invertebrate-derived DNA (iDNA), in combination with high throughput sequencing, has been proposed as a cost-efficient and powerful method to survey vertebrate species. However, so far, no studies have used iDNA for systematic surveys and previous studies have only provided a proof of concept that vertebrate DNA can be derived from blood-sucking invertebrates. Our study goes beyond the mere detection of vertebrate species based on opportunistic, ad-hoc invertebrate collections and makes the needed shift to a systematic biodiversity assessment and monitoring tool. To test the efficiency of the iDNA approach, we conducted standardized and repeated collections of terrestrial haematophagous leeches in the vicinity of camera trap stations of a systematic camera trap survey in Sabah, Malaysian Borneo. We analyzed 1532 leeches according to a rigorous laboratory and bioinformatic workflow. In combination with the repeated field sampling, this reduced the likelihood of false positive detections and allowed for the application of modern occupancy modelling which accounts for imperfect detection. Overall, more species were detected by camera traps than by the iDNA method. However, the species accumulation curve suggests that with increased leech collection effort more species could be detected. Although we were also able to detect small vertebrates through iDNA, we found a much stronger detection bias to larger bodied vertebrates in the leeches than in the camera-trapping. This highlights the importance of accounting for varying detection probabilities in iDNA studies. While accounting for varying detectability between species, occupancy models from camera-trapping and iDNA resulted in highly consistent predictions of species occurrence probabilities. Our results provide the first rigorous evidence that iDNA from sanguivorous invertebrate species can help overcome difficulties in surveying and monitoring biodiversity, particularly for secretive species in tropical rainforests. We also see great potential in combining more traditional approaches such as camera-trapping with new tools such as iDNA analysis, as long as the collection of invertebrates follows a similarly robust and standardized sampling scheme.

Paper Number: 590

Monday, 02 July 2018 | Taj Mahal

General Session 5 -Methodological Advances in Tropical Biology & Conservation

Thermal Camera VS Visual Counting: Evaluating a Comparison of Techniques for Primate Census

Amaziasizamoria Jumail, Liew Thor Seng, Milena Salgado Lynn, Kimberly Fornace & Danica Stark

Estimating the number of individuals in a primate group accurately is very important for primates' ecology, population density and abundance studies. Various primate census techniques have been developed over the past 35–40 years and each of the techniques has its advantages and disadvantages in terms of resource requirements (times and costs), availability of technologies, and effectiveness at different habitats. This study aims to explore the effectiveness of a thermal imaging technique to estimate the group size of different primate species populations in the Lower Kinabatangan Wildlife Sanctuary, Sabah. We compared this survey technique with the conventional visual counting along the riverbank. For 38 days, a total of 138 primate groups were detected throughout the study. A Wilcoxon signed rank test showed that the use of a hand held thermal camera counted or detected more primates than counting by eye despite of a few limitations of using the thermal camera ($p=0.000$). This result shows the possibilities of thermal camera to be used as an important tool in primate survey.

Paper Number: 435

Monday, 02 July 2018 | Taj Mahal

General Session 5 -Methodological Advances in Tropical Biology & Conservation

Occupancy, local abundance and density: what can we estimate with camera-trapping data?

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Abundance and density are important measures of the state of a wildlife population and are fundamental to evaluate the effectiveness of a conservation programme or the sustainability of land management. Nonetheless, abundance and density are difficult to estimate for many species, particularly those occurring in tropical rainforests. In such environments research mainly relies on remote camera traps to survey wildlife populations. Camera traps allow researchers to estimate density of individually identifiable species, including many felids, using spatial capture-recapture (SCR) frameworks. However, for most species individual identification is difficult or impossible, therefore, researchers are often left to rely on species level presence/absence data to assess habitat associations and distribution. Although, in certain cases occupancy and abundance are correlated, studies have also shown cases where this relationship does not hold true. Royle-Nichols and N-mixture models are two approaches to estimate local abundance without the need of individual identification. Here, we used a large scale camera trapping survey that was conducted in two forest reserves in Sabah, to investigate the relationship between occupancy, local abundance and density for the Malay civet (*Viverra zibellina*) and the banded civet (*Hemigalus derbyanus*). Both are individually identifiable species, thus allow us to do SCR analyses and compare the unmarked approaches with proper density estimates. The analyses show that for Malay civet the top three covariates selected as important in occupancy, Royle-Nichols and N-mixture models are consistent but not for banded civet where only two of the top three are shared between model frameworks. Counter to our assumption, the local abundance models did not improve our ability to detect differences between our study sites. Occupancy models produced more precise estimates of site difference, although these differences were not significant in all three approaches. However, SCR analyses for the Malay civet showed that density in Deramakot was significantly higher than in Tangkulap-Pinangah. We acknowledge that the relationships between the measures are species and maybe even site specific and, thus, our findings are likely not representative of other species or locations. However, our results indicate that although occupancy models do not provide information about the abundance of species, this measure can be as powerful as local abundance models to assess habitat associations and compare species status among different areas. Repeated sampling in combination with dynamic occupancy models will likely allow conservationists and forest managers to monitor species trends over time and, thus, evaluate their forest management practices.

Paper Number: 541

Monday, 02 July 2018 | Taj Mahal

General Session 5 -Methodological Advances in Tropical Biology & Conservation

Combining Landsat time series and time-calibrated occupancy modelling to predict species distributions in tropical forests in space and time

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Understanding species' distributions, how they vary over time, and how they are affected by human factors are central questions in ecology and conservation. Species distribution models explain species occurrences with environmental information via habitat-related covariates. These covariates describe the species' environment and are commonly derived from satellite imagery, but rarely match the study period exactly (time-invariant), leading to potentially biased inferences. To overcome this limitation we propose a time-calibrated occupancy modelling approach that matches covariates generated from Landsat data to the time when species were recorded.

We used a recent systematic camera trapping data set of 11 forest-dependent terrestrial mammal and ground-dwelling bird species from three commercial forest reserves in Sabah, Malaysian Borneo. The study areas differ in land use history and cover a gradient of logging intensities from reduced impact logging to conventional logging at different stages of recovery, and consequently vary considerably in forest structure. A 30-year time series of Landsat-derived vegetation indices was applied to 1) characterise past logging and present habitat conditions of the study areas and to 2) explain present species distribution patterns with time-calibrated habitat covariates in single-species occupancy models.

The vegetation indices were sensitive to logging-related habitat changes and allowed the characterisation of past logging in time and space. Occupancy of forest-dependent species was related to these indices. On average, we found considerably more support for models using time-calibrated covariates than for time-invariant covariates, even though the time-invariant covariates matched the study period approximately. Based on the species-habitat relationships derived from occupancy models using time-calibrated covariates, we were able to predict species distributions for the past 30 years, showing that conventional selective logging activities negatively impacted distributions of forest-dependent species, whereas RIL greatly reduced these impacts. Furthermore, predicted occupancy of forest-dependent species increased after the cessation of logging activities.

Our work suggests that time-calibrated habitat covariates can improve estimates from species occupancy models in major ways. Likewise, our study highlights the power of the Landsat archive for reconstructing habitat dynamics, such as from past logging. Thus, combining time-calibrated satellite data with biodiversity data is a powerful method to understand species distributions and responses to past and present habitat conditions and anthropogenic changes, particularly in challenging habitats such as tropical rainforests.

Paper Number: 732

Monday, 02 July 2018 | Taj Mahal

General Session 5 -Methodological Advances in Tropical Biology & Conservation

Influence of body mass, sociality, and movement behavior on improved detection probabilities when using a second camera trap

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Maximizing detection probability is a common goal for occupancy studies using remote cameras for data collection. Detectability may be improved by setting additional cameras oriented towards different directions at a survey station, improving precision of occupancy and detection estimates. However, these benefits may incur additional cost and are potentially influenced by species physical characteristics and behavior. We estimated null occupancy and detection probabilities for 20 mammalian species with >10 detections at multiple sites from one- and two-camera data sets from 63 stations set in a commercial forest reserve in Sabah, Malaysian Borneo during October–December 2015. We used a cross-validated absolute shrinkage and selection operator approach to model the effects of species' body mass, social behavior, dietary niche, and foot posture on detection probability using one- and two-camera designs. The number of species detections, sites where species were detected, detection probability estimates, and model precision for all species improved using two cameras. Our results showed that species exhibiting an unguligrade type foot posture had high detection probability estimates with one camera, and these species also had the greatest improvements in detection probability using the 2-camera design compared to all other species. The greatest improvements in precision of estimated model parameters from 2-camera designs were observed in species detected less frequently. We did not observe any relationship between improvements in detections or model precision with differences in species body mass, social behavior, or dietary niche. Our data suggests that a two-camera study design benefits the detectability of unguligrade species, whereas one camera may be sufficient for the detection of all other non-ungulate species. Additionally, a second camera may only benefit less frequently detected species by improving precision of model estimates. We advise that occupancy studies first conduct a pilot study to gather preliminary information on species detection rates, to improve study efficiency and help ensure that reliable information is obtained to meet project objectives.

Paper Number: 537

Monday, 02 July 2018 | Taj Mahal

General Session 5 -Methodological Advances in Tropical Biology & Conservation

Advancing the Rain Forest Conservation Toolkit – a new model for biodiversity surveys

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We report on a biodiversity survey that collected information in a Malaysian tropical rain forest. Here, we share our process that advanced the methodology of biodiversity surveys in several ways. First, we prioritized inclusivity by recruiting a team of over 115 scientists of which 65% were female, and all teams engaged both local and international biodiversity experts plus student interns. Second, we surveyed the whole forest, from the uppermost canopy to the soils on the forest floor, by deploying a dedicated team of canopy-access experts to assist the scientists. Third, we surveyed all taxa, including algae, tardigrades, epiphytes, vertebrates and many more. And fourth, we included a STEM education team that live-streamed to student classrooms around the world, as well as recruited field teams of middle and high school students to participate. This overlay of science education with biodiversity science doubled the value of our efforts. Such whole-forests approaches that engage diverse stakeholders to survey rain forests is relatively inexpensive, but can contribute significant conservation outcomes.

Paper Number: 277

Monday, 02 July 2018 | Taj Mahal

General Session 5 -Methodological Advances in Tropical Biology & Conservation

Using community occupancy models for diversity profiles

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Estimates of species richness and diversity are central to community ecology and conservation planning. Diversity, however, is a generic term used for a variety of measures that try to incorporate the complex multidimensional properties of a community. Different statistical diversity metrics weigh species richness and evenness differently. It is not uncommon to find that diversity has increased according to one index, but decreased according to another. This problem can be alleviated through the use of diversity profiles, which show diversity from multiple vantage points by considering a gradient in the weight they assign to evenness over richness. Thus, they are able to simultaneously capture all the common indices such as Shannon's H and Simpson's D.

Diversity profiles, similar to most measurements of diversity, require information on species abundance which is difficult to estimate for elusive wildlife species. Occurrence, which can be estimated from detection/non-detection data using occupancy models, is a more feasible quantity for wildlife surveys. Here, we use simulated data of animal communities with varying levels of habitat disturbance to explore the accuracy of occupancy-based diversity profiles. We simulated species abundances, from which we generated detection/non-detection data, subsequently analyzed within a community occupancy framework. We then used the predictions of species occupancy as a proxy for abundance to construct occupancy-based diversity profiles. The simulation study showed that estimates of occupancy were positively biased in species with low detection rates which resulted in an overestimation of species richness. This bias is caused by the structure of the community occupancy framework, as rare species borrow information from common species and, thus, their distribution may be overestimated. We overcame this problem by exploiting the occupancy-abundance relationship in our simulated data. We found that when setting a threshold value for occupancy, diversity profiles based on occupancy match well to true abundance based profiles. Application of the threshold greatly helped to distinguish the differences between our simulated communities. Our results show that under conditions representative of camera-trap studies we are able to glean similar diversity information from distribution data as from abundance data. Diversity profiles are a useful tool to compare multiple areas or to monitor diversity trends over time. Therefore, the application of these measures using an occupancy framework is of great interest for forest and landscape management.

Paper Number: 392

Monday, 02 July 2018 | Taj Mahal

General Session 5 -Methodological Advances in Tropical Biology & Conservation



GENERAL SESSION 6

Society & Conservation

Biodiversity Under Threat in the Niassa National Reserve, What can be Done? Understand the Opinions of Professionals and Volunteers Engaged in Conservation

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The Niassa National Reserve (NNR) is one of the few remaining intact savannas of global importance. The reserve is rich in biodiversity, mostly endemic. Although efforts are being made to maintain the reserve, there are several problems that threaten biodiversity, mostly related to human drivers. To understand what can be done in order to improved conservation in the NNR, we conducted an online interview to 55 professionals engaged in conservation, being mainly male 43(78.2%) and the rest 12(21.8%) female, the majority holding higher education degree 34(61.8%) in Agriculture and environmental sciences 32(58.2%). We performed Principal Component (PC) and Cluster analysis to group respondents according to their opinions in relation to the current and new proposed compensations that can be placed to improve conservation and Ecosystem Services (ES) in the Reserve. Relationship between the opinions of respondents and its socio-economic profile was tested based on Fisher's Exact and Post Hoc test. Results shows that the mains threats for conservation in the reserve are poaching, illegal mining and shifting cultivation. The responsible for those problems that threaten conservation in the reserve are local people and government authorities. With the adoption of news proposed incentives such, help local people to adopt environmentally-friendly cultivation practices, give alternative sources of animal proteins and provide education for local people (scholarships), would greatly improve the ES under threat and would also raise the awareness of local people in relation to the importance of conservation in the Reserve.

Paper Number: 22
Monday, 02 July 2018 | Giza
General Session 6 - Society & Conservation

Conserving Mindoro's tamaraw: Integrating wildlife, landscape and indigenous communities in conservation and research

A.Gonzalez-Monge, E. Schütz

The Philippines contain high diversity of endemic wildlife and cultures, many of them found only in particular islands of the archipelago. Such is the case of Mindoro, where apart from eight different Mangyan tribes, indigenous peoples native to the island, we can find the only wild cattle species of the Philippines, the tamaraw (*Bubalus mindorensis*), which is considered Critically Endangered by the IUCN. While tamaraw had an island-wide distribution at the beginning of the 20th century, its population collapsed by the middle of the last century due to continuous human encroachment. The 1980s brought a paradigm shift and increased law enforcement, community involvement and conservation steps were taken so that the species steadily recovered. The tamaraw is a key species as being the largest terrestrial animal of the country, the emblem of Mindoro and surviving in few areas where indigenous communities maintain traditional lifestyle. As of 2018, tamaraw survives in three separate sub-populations numbering less than 500 individuals, across all three areas: Mounts Iglit-Baco National Park, Aruyan-Malati Game Reserve, and the Upper Amnay Watershed. Of these, only the first one is officially protected. As tamaraw population numbers are still low and there is a dearth of information on its ecology and behaviour, it is vital to undertake further research and monitoring efforts to draft well informed protection plans. In this talk we will discuss the latest knowledge we have on tamaraw biology, their current population numbers and composition and the different habitats in which they are found in Mindoro; we will also provide an overview of currently undertaken research projects and monitoring efforts improving our knowledge on the species and its habitat, law enforcement activities focused on protecting the tamaraw, as well as efforts to involve local Mangyan communities in complementing conservation policies with maintaining their traditional culture and lifestyle. Additionally, we will give an outline on upcoming developments that will further advance and strengthen conservation policies, such as a Population and Habitat Viability Assessment to be carried out at the end of this year.

Paper Number: 312
Monday, 02 July 2018 | Giza
General Session 6 - Society & Conservation

Perceived barriers to and drivers of community participation in protected-area governance

Caroline Ward

Protected areas (PAs) are a frequently used conservation strategy, yet their socioeconomic impacts on local communities remain contentious. A shift toward increased participation by local communities in PA governance seeks to deliver benefits for human well-being and biodiversity. Although participation is considered critical to the success of PAs, few researchers have investigated individuals' decisions to participate and what this means for how local people experience the costs and benefits of conservation. We explored who participates in PA governance associations and why; the perceived benefits and costs to participation; and how costs and benefits are distributed within and between communities. Methods included 3 focus groups, 37 interviews, and 217 questionnaire surveys conducted in 3 communities and other stakeholders (e.g., employees of a nongovernmental organization and government officials) in PA governance in Madagascar. Our study design was grounded in the Theory of Planned Behaviour (TPB), the most commonly applied behaviour model in social psychology. Participation in PA governance was limited by miscommunication and lack of knowledge about who could get involved and how. Respondents perceived limited benefits and high costs and uneven distribution of these within and between communities. Men, poorer households, and people in remote villages reported the highest costs. Our findings illustrate challenges related to co-management of PAs: understanding the heterogeneous nature of communities; ensuring all households are represented in governance participation; understanding differences in the meaning of forest protection; and targeting interventions to reach households most in need to avoid elite capture.

Paper Number: 206
Monday, 02 July 2018 | Giza
General Session 6 - Society & Conservation

Spatial dynamics of community landscape service values across the South West Mau Forest, Kenya

Ethan Miller

Increasingly, forest managers and policymakers are seeking to conserve forests for the landscape services they provide. This is especially true in the Mau Forest of Kenya where national and international attention has focused on preserving watershed services and livelihoods through forest conservation. Understanding what drives people to value landscape services where they do is critical for crafting policies that reflect peoples' needs and perspectives. This research analyzes the drivers of the geography of landscape service value through a case study of two communities—Kedowa and Kuresoi—within the South West Mau Forest of Kenya. The study utilized a mixed-methods approach in which participatory mapping and spatial statistics were performed to map the distribution of values for individual landscape services and then semi-structured interviews were analyzed to distill themes that explain the spatial distribution of these values. In total, 55 village residents were interviewed across the two communities; the sample was disaggregated by gender and age. The most-commonly listed landscape services were water, firewood, farming, grazing, timber, and medicine and values for these services were distributed across the forest and village land and vary over time. Interview analysis revealed that four main factors determined the locations from where these services were derived: land use history and tenure, social relations, market access, and biophysical conditions. These drivers affect the geography of value for landscape services differently based on the service and community in question. This study demonstrates that people in nearby communities can use and value the same services in dramatically different ways and that the spatial distributions of these services stem largely from a few overarching drivers. Understanding this heterogeneity can lead policymakers and managers to create forest plans that are adaptive to local contexts and account for temporal and spatial dynamics of value.

Paper Number: 481
Monday, 02 July 2018 | Giza
General Session 6 - Society & Conservation

Do law enforcement and community outreach work? Comparing management and mammal diversity in a biodiversity hotspot in southwestern China

Cheng Chen

Protected areas have long been considered the backbone of biodiversity conservation strategies, but their efficacy varies considerably for reasons that remain unclear. Management activities such as law enforcement and community outreach are thought to affect conservation outcomes in parks, but their importance relative to intrinsic environmental characteristics of the park and extrinsic human pressures surrounding the park have not been explored. Here we measured how community outreach and perception of law enforcement related (based on 354 questionnaire surveys) in communities surrounding protected areas was associated with wildlife within the protected areas in Xishuangbanna, southern China, a biodiversity hotspot with high hunting and land conversion pressures. We used motion-triggered camera traps (12,148 camera-trap days in total) and Bayesian hierarchical statistical models to estimate occupancy rates for four commonly hunted mammal species, as well as the species richness of medium- to large-sized mammals in six protected. We found that Law enforcement, measured as the number of punishments that parks meted out for law violations, was positively related to the local abundance of two large, hunted species, wild boar (*Sus scrofa*; $\beta = 6.78$) and muntjac (*Muntiacus vaginalis*; $\beta = 5.94$), but unrelated to the abundance of smaller, less-hunted mammals. The frequency of outreach by park staff to the local communities ($\beta = 1.61$) and park size ($\beta = 1.18$), were significantly related to mammal species richness, while elevation, human population density, and law enforcement were not. This study provides some of the first empirical evidence that biodiversity in protected areas can be more strongly related to park management than to intrinsic (e.g. elevation) or extrinsic (e.g. human population density) environmental factors. Frequent community outreach may benefit the entire mammal assemblage, while law enforcement is particularly important for the conservation of large, hunted species. Our study highlighted the importance of reserve size, adequate habitat is the key of maintaining wildlife population in this area. Our study provides insights that protected areas that have stricter enforcement as well as more frequent outreach activities could be more effective and our approach is applicable to assess effects of conservation actions on wildlife.

Paper Number: 236
Monday, 02 July 2018 | Giza
General Session 6 - Society & Conservation

Local ecological knowledge of fish farmers reveals decline of Hong Kong otters and potential for conservation intervention

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The Eurasian Otter (*Lutra lutra*) has managed to persist amongst the densely populated environment of Hong Kong. It is a rare species, restricted to wetland habitats dominated by commercial fishponds in the north-west New Territories (NWNT). There is limited knowledge of this species' population status and distribution, resource requirements, and potential threats. Therefore, as part of the development of a conservation strategy, scientific research has been initiated to fill information gaps. However, given the otters' restricted distribution to human-dominated wetlands, understanding and applying human dimensions considerations, particularly with respect to fish farmers living/ working in the area, is also important when developing a conservation approach. This study therefore aimed to understand the human dimensions of otter management, through the collation of local ecological knowledge (including past and present otter population size and distribution, attitudes of local people toward otter, and potential threats affecting otter survival), to facilitate the development of an integrated conservation strategy for otter in Hong Kong.

Interviews were undertaken between May 2017 and February 2018, largely using a semi-structured interview approach. The study area included wetland areas dominated by fishponds with a focus on the NWNT. Commercial fish farmers and recreational fishermen were the main subjects of the study.

A total of 215 interviews were conducted across the study area. Ninety-five interviewees (44.19%) had sighted otter at least once between the 1950s to present, and many (70.84%) believed that the otter population had declined over time. More than half (57.95%) of the interviewees who had sighted otter believed that otters should be protected; however, their attitude toward protection appeared to be related to their perceptions of whether otter affects their fish stocks. Attitudes to the implementation of management were more complex, with 45.35% unsure about management implementation, 39.53% agreeing to management implementation, and no clear relationship observed between management implementation and perceived impacts to fish stocks.

While support for otter conservation amongst local people was observed, this study has revealed the potential for negative interactions if otter numbers increase in the future. It also demonstrates the potential difficulty of developing management actions which, to be successful, are likely to require support from local fish farmers. This study highlights the benefits of the timely consideration of human dimensions in wildlife management, thereby allowing an opportunity to identify potential issues early and integrate respective management actions into conservation strategies.

Paper Number: 690
Monday, 02 July 2018 | Giza
General Session 6 - Society & Conservation

Nested Approach towards Sustainable Landscape Management: a case study of Public, Private People in the KELOLA Sendang Project, South Sumatra Province

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Sustainable landscape management requires the integration of science and policies that should be the basis for management practices from the sub-national to national level and cuts across jurisdictions. Linking conditions and policies in Indonesia, nested approach is the most suitable approach for implementation of the national commitment of GHG reduction to sub-national implementation. The magnitude of mitigation levels for the various parts of the sub-national level from the land-based sector should be developed through a nested approach. GHG emission reduction and green growth as a part of sustainable landscape management can be precisely calculated by inclusive process at the different sub national administration levels and management unit of private concession, people area, and public area for biodiversity conservation allocation. Indonesia has a diverse set of characteristics at different scale across national, province and district level. There are different circumstances that encompass different biophysical characteristic and natural resources potential, and also different economic growth that can be mutually complementing to contribute to emission reduction and economic gain (common but differentiated responsibilities).

Nested approach is a spatially explicit method for measuring the effort of parties in reducing GHG, by integrating measures in different management units within the administrative area. Measures were calculated for keeping the carbon stock balance as the performance of the management units which are combined and becomes the accumulated performances of the administrative area. The sum of negative and positive contribution (net) as the carbon stock balance is the value of tCO₂ absorbed or released during the management of land-based activities and influence the scale of administrative boundary target of GHG emission and carbon sequestration. Carbon stock balance from each management unit is the decision-based negotiation for economic growth target in provincial level.

KELOLA Sendang Project in the South Sumatra Province is used as a pilot project for learning to define inclusively parties of private, people and public as the land-based decision maker to manage the complexity of land cover and land use of conservation area, peat land, concessions, community forest.

Paper Number: 204
Monday, 02 July 2018 | Giza
General Session 6 - Society & Conservation

GENERAL SESSION 7

Amphibian Ecology & Conservation

Inconsistent phenotypic syndrome in the evolution of poison frogs' aposematism

Adolfo Amezcuita

The aposematism is often described as an evolutionary syndrome involving traits beyond toxicity and conspicuousness. In poison frogs, aposematism is allegedly correlated with dietary specialisation, active foraging, higher aerobic performance, and higher metabolic rate. The comparison with non-aposematic frogs has led to a duality crypsis-aposematism that summarises the phenotypic correlations; this simple concept has been used to infer the adaptive value of individual traits and the evolutionary route of this antipredator strategy. We measured a combined set of phenotypic (toxicity, conspicuousness, dietary specialisation, metabolic rate, body size, wariness, foraging activity) and genotypic (aminoacid sequences for sodium channels) traits and estimated their correlations using subsets of phylogenetically related frogs (phenotypic) and their predators (genotypic). Our results strongly challenge the current beliefs. Inconspicuous frogs can be more toxic than conspicuous frogs and toxicity is highly variable within a single species, which might well lead to systems of intraspecific mimicry. Toxicity is not only an attribute of the frog species; it necessarily involves the degree of resistance to toxins by the potential predators, as evidenced by the correlation between aminoacid substitutions and diet. Neither dietary specialisation nor metabolic rate are correlated with toxicity. And toxic frogs may escape as fast as non-toxic frogs. Altogether, our evidence implies a more complex scenario for the evolution of aposematism than currently thought. For instance, mimicry might occur within species and there is no predictable pattern of steps in the evolution of aposematism. These views may contribute to solve some of the remaining questions on the evolution of aposematism.

Paper Number: 664

Monday, 02 July 2018 | Machu Pichu

General Session 7 - Amphibian Ecology & Conservation

Local Environmental Factors Influence the Structure of Frog Communities on the Sandy Coastal Plains of Southeastern Brazil

Carlos Frederico D. Rocha

Environmental factors play important roles in structuring communities. In heterogeneous environments, where habitat structure might vary considerably, understanding how these factors shape communities is one of most important issues in community ecology. We investigated how environmental factors affect the composition of five frog communities in sandy coastal plains ("restingas") in southeastern Brazil. We sampled restingas over a 2-yr period comparing five sites in terms of habitat structure, frog species composition, species abundance and distribution in different mesohabitats. Effects of habitat structure on anuran communities were characterized at each study site using 20 circular plots (2 m-diameter) at 20-m intervals along linear transects established within each vegetation type. In each plot we recorded the height (m) of the vegetation, distance to the nearest shrubby vegetation, stem diameter of central plant in each plot, presence/absence and number of cacti and bromeliads, leaf litter layer depth, % canopy, ground cover and number of wetland habitats (streams, rivers, swamps and ponds) along mesohabitats surveyed for amphibians. We compared frog abundance among sites and habitat structure differences among the studied sites using PERMANOVA (10,000 iterations). We evaluated beta diversity among study sites and within sites, based on differences among mesohabitats using Morisita's overlap index. We evaluated if beta diversity was correlated with habitat structure using Mantel test with Pearson correlation. We used a matrix correlation (Mantel test with Pearson's dissimilarity [1-Pearson]) for analysis of two presence/absence matrices: reproductive modes at each site and other with reproductive sites. We recorded 3364 individuals from 32 frog species (six families). Sites differed significantly in the occurrence and abundance of individuals representing the different species (PERMANOVA; $F=2.88$; $P<0.001$), although species composition was not explained by geographical distance between sites (Mantel test; $r=0.62$; $P=0.11$). Wetlands and open *Clusia* formations were mesohabitats richest in anuran species; no anurans were found in beach vegetation zone. Habitat structure varied significantly among sites (PERMANOVA; $F=3.01$; $P=0.01$). Species composition was not related to habitat structure (Mantel test; $r=-0.02$; $P=0.42$), but rather to the availability of spawning sites (Mantel test; $r=0.44$; $P<0.001$). We identified eight different reproductive modes among the 32 frog species and most ($n=24$; 81.3%) were associated to aquatic environments (ponds, rivers, and streams) reproduced exclusively in bromeliads. We concluded that composition of amphibian communities was not related to habitat structure, but rather to the availability of spawning sites (sources of freestanding water), which appeared to be the most important ecological factor structuring these communities.

Paper Number: 249

Monday, 02 July 2018 | Machu Pichu

General Session 7 - Amphibian Ecology & Conservation

Natural history and conservation of a rare species of bromeliad-dwelling frog from the Brazilian highlands

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Crossodactylodes are small frogs living on highlands of Atlantic Rainforest of Brazil and are strictly dependent on bromeliads. There is little information on their ecology, distribution and natural history. Although tank bromeliads are used by many anuran species, bromeligenous frogs (species that lay their eggs and complete their life cycle without leaving the plant) occur less frequently and are poorly understood. Crossodactylodes itambe lives in a single location, using a single species of bromeliad. The species is confined to a single mountain summit in the Espinhaço Mountain Range of Brazil ranging only between 1700 and 2000 m above sea level and over an area of less than 0.5 km². We aimed to investigate the drivers of abundance for the only known population of C. itambe. We surveyed frogs in 75 individual bromeliads during two consecutive years and we used a Generalized Linear Model to investigate the influence of habitat structure and local climate on species abundance. We recorded 446 adults, 267 tadpoles and 40 juveniles over the two years. Most bromeliads contained just one adult frog and the average number of tadpoles was 2-3. The structure of bromeliads influenced species abundance more than local climate. We found that bromeliad volume and presence/absence of water and invertebrates influenced the abundance of frogs. Abundance increased in larger bromeliads at higher elevation. Changes in the structure and size of bromeliads could affect Crossodactylodes abundance and might have a negative effect on this population. Based on our data we provide the first status assessment according to the IUCN guidelines for the species and recommend this rare bromeliad-dwelling frog to be classified as either Vulnerable under criteria A1c and D2 or Critically Endangered under criteria B1ab(iii) and B2ab(iii).

Paper Number: 512

Monday, 02 July 2018 | Machu Pichu

General Session 7 - Amphibian Ecology & Conservation

Stream amphibian habitat associations and responses to reduced impact logging in the Deramakot forest reserve, Sabah, Malaysian Borneo.

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Amphibians are currently suffering massive global declines, primarily driven by habitat loss. These declines are particularly troubling in South East Asia, where heavy commercial logging is coupled with diverse, understudied amphibian communities. Understanding amphibian habitat associations is invaluable for assessing the impacts of logging on this taxa. Here, we determined the habitat associations of stream amphibians, and the effects of Reduced Impact Logging (RIL) on their community composition within the Deramakot forest reserve, Malaysian Borneo. We utilized visual and acoustic transect sampling of stream amphibians in forests at varying stages of regeneration. Resulting data were incorporated into an occupancy modelling framework. Our preliminary results indicate that stream anuran occurrence is associated with stream slope and stream width. These associations divide the species into small-steep stream and flat-wide stream community guilds. These guilds remained similar across sites of varying logging history (4 – 21 years since RIL). Furthermore, we found that amphibian diversity within the reserve is comparable to two neighboring unlogged, protected areas. Although preliminary, these results provide baseline information on Bornean amphibian habitat associations, and the potential of RIL forests for balancing amphibian conservation with sustainable, economically viable logging.

Paper Number: 295

Monday, 02 July 2018 | Machu Pichu

General Session 7 - Amphibian Ecology & Conservation

Amphibian conservation at the intersection of ecology, taxonomy, and biogeography.

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Effecting successful conservation at the species and landscape level in the face of both limited data and rapidly advancing threats is a challenge across the globe. This is particularly true for amphibians in Indochina (Cambodia, Lao PDR or Laos, and Cambodia) where new species discoveries have occurred at an increasing rate over the past two decades against a backdrop of rapid agricultural conversion, deforestation, and wildlife hunting. Our objective was to look at the ecological correlates of endemism in amphibians and their distribution to identify endemic foci and natural history traits associated with restricted distribution. We reviewed all vouchered records of amphibians from the region that had associated locality data (> 175 species) along with any available information on habitat, elevation, and breeding requirements. Two areas of heightened endemism were identified: the Annamite Range (including differentiation between northern, central, and southern sections) and the subtropical region of northern Vietnam and southern China. Overall, amphibians are more likely to be found in upland, forested areas. However, this correlation is significantly stronger among endemic species, who are more ecologically restricted, utilizing a smaller range of habitats and elevations, and have more constrained breeding requirements than more widespread species. We hypothesize this association may result from specialized breeding requirements limiting habitat availability and opportunities for effective dispersal. However, two additional factors complicate this pattern. First, breeding requirements appear to be highly conserved at the genus level, leading to the concentration of endemism within a subset of genera (e.g., *Amolops*). Second, not all regional zones hosting this subset of ecological requirements are foci of amphibian endemism (e.g., Cardamoms, Hoang Lien Son) suggesting that Indochina's complex biogeography (paleo- and current climate, vegetation, geography) also influences endemic species distribution. We conclude that ecological requirements, at least for smaller-sized species with more limited ranges, can act as a proxy for identifying species (and potentially lineages) of conservation concern. However, at the landscape level, these characteristics must be viewed in the context of regional biogeography and higher-level taxonomy. We discuss current data limitations and recommend targeted surveys (under-surveyed areas; relevant habitats; biogeographic subregions) coupled with increased international cooperation on taxonomic resolution to further clarify the natural history and distribution of Indochina's endemic amphibians.

Paper Number: 854

Monday, 02 July 2018 | Machu Pichu

General Session 7 - Amphibian Ecology & Conservation

Bioacoustics of the amphibian community in Kinabalu Park and the use of open source resources for passive acoustic monitoring.

Catharina Karlsson

Southeast Asia is facing a high level of land clearance and modification whilst being one of the most bio-diverse regions in the world. Despite this a large number of species are as of yet undescribed and monitoring the effects of habitat and environment changes on species in this region is scarce in proportion to the issue. Large scale acoustic monitoring and soundscape projects provide a possible avenue to overcome the shortfall in funds and trained staff that currently plagues the field. In this study we trialled a self-built acoustic monitoring station using open source hardware and software to assess its viability in tropical settings. We collected non-continuous data for amphibian monitoring purposes on Mount Kinabalu to determine how this compares to classically collected monitoring data. We also collected continuously recorded data over a few days to use in soundscape analysis as this allows for easier inferences about the relationship between different acoustically active taxonomic groups. The acoustic monitoring stations provide a cost-effective solution that can be viable for large scale acoustic monitoring projects in tropical countries given the correct configuration and circumstance. The acoustic monitoring data indicate that the amphibian species detected in Kinabalu Park varies considerably despite all of our sites being located in the same type of habitat. Some species were frequently picked up by the acoustic data despite not being reported in previous human surveys, certain species were also missed showcasing the need to validate acoustic data for monitoring purposes before use. The results from the soundscape analysis show that overall there are considerable differences between the overall acoustic environment between these sites and that a lot of amphibian species were missed by the acoustic indices used.

Paper Number: 467

Monday, 02 July 2018 | Machu Pichu

General Session 7 - Amphibian Ecology & Conservation

Linking Traditional Ecological Knowledge and Biodiversity Conservation of Protected Areas through Thematic Interpretation

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A traditional ecological knowledge (TEK) represents knowledge or experience acquired over thousands of years by indigenous peoples through direct human contact with the environment. A plethora of studies for past decade believed that the application of TEK can help improved natural resource management and biodiversity conservation practices. Despite its much erosion worldwide, there has been little efforts in promoting and reviving the TEK in the context of ecotourism and biodiversity conservation, particularly in national parks. In national park management, thematic interpretation is commonly regarded as a strategic communication tool in helping to achieve desired educational, behavioural and conservation outcomes. An experimental quantitative research, underpinned by the TORE model of interpretation was employed to investigate the efforts of purposively selected trained park guides to examine whether their planned TEK theme-based interpretive guided walks in four selected Sarawak national parks could make a difference in influencing tourists' cognitive, affective and behavioural outcomes of interpretation. Data was collected through post self-assessment questionnaire from the survey of 380 tourists of park guides' clients immediately after the conclusion of their TEK-themed interpretive guided walk. A descriptive and inferential statistics analysis of various sub-indicators revealed strong measurements and correlation of tourists' overall quality of guided tours effecting their knowledge, beliefs and experiences. The results indicated that TEK theme-based interpretive guided walks produced significant levels of cognitive, affective and behavioural outcomes among tourists. Results suggest that well-planned and organisedly delivered TEK theme-based interpretive guided walks can make a difference in how tourists think, feel and behave with respect to things or natural history of the national parks the park guides interpreted. The study concluded that the linking of TEK through thematic interpretation can help park managers, interpretive planners and park guides improve visitors' experience and better achieve the protection and conservation objectives of protected area management. The study also helps to promote and revive some of the elements of much eroded TEK of local communities.

Paper Number: 15

Monday, 02 July 2018 | Machu Pichu

General Session 7 - Amphibian Ecology & Conservation

GENERAL SESSION 8

Peat & Flooded Forests

Carbon emissions from Southeast Asian peatlands will increase despite emission-reduction schemes

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Carbon emissions from drained peatlands converted to agriculture in Southeast Asia (i.e. Peninsular Malaysia, Sumatra and Borneo) are globally significant and increasing. Here, we map the growth of Southeast Asian peatland agriculture and estimate CO₂ emissions due to peat drainage in relation to official land-use plans with a focus on the Reducing Emissions from Deforestation and Degradation (REDD+) related Indonesian moratorium on granting new concession licenses for industrial agriculture and logging. We find that, prior to 2010, 35% of Southeast Asian peatlands had been converted to agriculture, principally by smallholder farmers (15% of original peat extent) and industrial oil palm plantations (14%). These conversions resulted in 1.46-6.43 GtCO₂ of emissions between 1990 and 2010. This legacy of historical clearances on deep peat areas will contribute 51% (4.43-11.45 GtCO₂) of projected peatland CO₂ emissions over the period 2010-2130. In Indonesia, which hosts most of the region's peatland and where concession maps are publicly available, 70% of peatland conversion to agriculture occurred outside of known concessions for industrial plantation development, with smallholders accounting for 60% and industrial oil palm accounting for 34%. Of the remaining Indonesian peat swamp forest (PSF), 45% is not protected, and its conversion would amount to CO₂ emissions equivalent to 0.7-2.3% (5.14-14.93 Gt) of global fossil fuel and cement emissions released between 1990-2010. Of the peatland extent included in the moratorium, 48% was no longer forested, and of the PSF included 40-48% is likely to be affected by drainage impacts from agricultural areas and will emit CO₂ over time. We suggest that recent legislation and policy in Indonesia could provide a means of meaningful emission reductions if focused on revised land-use planning, PSF conservation both inside and outside agricultural concessions, and the development of agricultural practices based on rehabilitating peatland hydrological function.

Paper Number: 975

Monday, 02 July 2018 | Chichen Itza

General Session 8 - Peat & Flooded Forests

Relationship between vegetation and peat depth in peat swamp forest of Kampar Peninsula, Riau, Indonesia

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Studies on peat ecosystem in Sumatra is limited. Restorasi Ekosistem Riau (RER), as a long-term, private-sector initiative towards sustainable forest management in the Kampar Peninsula, Sumatra, invests on peat ecosystem study to design best management practice in Kampar Peninsula ecosystem restoration. This study aims to investigate vegetation changes on different peat depth within RER concession with a total size of 92,507 ha. A total of 145 nested sampling plots (125 x 20 m each) were used to collect vegetation parameters of tree species, diameter at breast height (dbh), heights (h), and canopy stratum. A total of 294 sampling plots on 62 transects (205 km long) were used to acquire data on peat depth which were then as shallow (2-<5m), medium (5-<7m), deep (7-10m), and very deep (>10 m). Pearson Correlation test was used to investigate the relationships between structure and composition of vegetation with each peat depth class. General finding shows that peat depth has positive correlation with pole trees (dbh 5-15cm) ($r=0.46$, $p<0.01$) and sub-canopy cover ($h<10$ m) ($r=0.28$, $p<0.01$), but negative correlation with large trees (dbh >30cm) ($r=-0.37$, $p<0.01$). The composition of vegetation in shallow, medium, and deep peat was dominated by *Madhuca motleyana* – *Shorea teysmanniana*, *Pandanus cf. tectorius* – *Shorea teysmanniana*, and *Shorea teysmanniana* – *Campnosperma coriaceum* respectively. *Shorea teysmanniana* dominated all peat depth classes, particularly in deep peat. This first documented study prove significant changes in vegetation structure with respect to peat depth from tall intact forest in shallow peat to smaller intact forest and pole forest in medium and deep peat respectively. This ongoing study helps RER management in predicting peat depth by its vegetation characteristics and vice versa. Furthermore, this information also important in determining degraded or natural intact forest as well as how to set its management.

Paper Number: 652

Monday, 02 July 2018 | Chichen Itza

General Session 8 - Peat & Flooded Forests

El Niño carbon losses from human modified tropical forests are greatest near edges and on hilltops, shows repeat-LiDAR surveys

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Droughts associated with El Niño Southern Oscillation (ENSO) events can increase tree mortality, but it remains unclear whether some forest types are more susceptible than others. Here, we use LiDAR surveys made in 2014 and 2016 to produce high-resolution maps of carbon density change across 300 km² of highly heterogeneous human-modified landscape in Malaysian Borneo. The region was affected by an El Niño drought during this period, and we hypothesised that heavily logged and edge forests would be particularly affected, while mature forests in damp valley bottoms would remain unscathed. On average, we found that forests in the human-modified landscape lost 3.0 Mg ha⁻¹ yr⁻¹ of carbon. Topography had a major influence on drought response - exposed hilltop forest lost 4.8 Mg ha⁻¹ yr⁻¹ of carbon while damp valley-bottom forests accumulated 0.30 Mg ha⁻¹ yr⁻¹ - consistent with our hypothesis. Forests close to oil-palm plantations incurred the greatest losses of carbon and we found evidence of topographic effects only on forests with high carbon density in these edge fragments. The study demonstrates the power of repeat-survey LiDAR to uncover environmental controls on forest carbon storage at unprecedented scales. We provide evidence that the El Niño drought caused forests to become net sources of carbon, but the drought's impact was highly variable across landscapes, being greatest near edges and on hilltops.

Paper Number: 707

Monday, 02 July 2018 | Chichen Itza
General Session 8 - Peat & Flooded Forests

Introduction to the Natural History and the Conservation of globally important forested freshwater wetlands

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Forested freshwater wetlands around the world share high ecological and economical importance. However, tree ecology in tropical forested wetlands along major rivers is often almost unexplored. In order to highlight the status quo and the major needs for future research and conservation, available data of tree growth, phenology, photosynthetic performance and seedling regeneration is brought together in a comparative review of three major tropical freshwater wetlands on three continents, (i) Central Amazonian floodplains in South America, (ii) the Okavango Delta region in Africa, and (iii) the Mekong floodplains of Asia. They all have a predictable "flood pulse" as major driving force influencing all living organisms in the floodplain, however also as source of stress for which specialized adaptations for survival are required. Ecophysiological measurements, ecological observations and literature reviews were taken as basis for the comparison presented. The little available data show that e.g. morphological adaptations and phenological responses to the flood are similar in the three ecosystems. Many deciduous species and also many 'evergreens' respond with leaf shedding. Floodplain trees are found to have active sap flow for most of the year and their growth is not inhibited by the flooding. This growth depends on adequate carbohydrate supplies and physiological adaptations. Seedlings are tolerant of waterlogging and submergence. Seed dispersal is linked to water. With the ongoing climatic changes, drought and extreme flood events increase, groundwater availability decreases and flooding periodicities change. The understanding of floodplain tree responses to the regular dynamics is fundamental for the conservation and appropriate management of wetland ecosystems underlying large-scale environmental changes.

Paper Number: 3

Monday, 02 July 2018 | Chichen Itza
General Session 8 - Peat & Flooded Forests

Determining regional-scale carbon losses from tropical peatlands using InSAR.

Martha Ledger

80% of peatlands in Indonesia and Malaysia (15% of Earth's soil carbon) are now drained for production of pulp wood and palm oil. Associated increased peat decomposition and large scale forest fires are now significant contributors to global greenhouse gas emissions. However, carbon losses from these processes and the impact of peatland drainage remain poorly quantified across SE Asia because of the challenging scale and inaccessibility of dense tropical peatland forests.

Field-based subsidence measurements are therefore a spatially limited approach for assessing carbon losses from tropical peatlands. Space-based platforms offer the opportunity for regular and efficient pan-regional monitoring. A development in satellite interferometric synthetic aperture radar (InSAR), a technique that measures surface motion, has the potential to solve this problem. A new 'intermittent small baseline subset' (ISBAS) modelling technique, developed at the University of Nottingham, provides excellent coverage across almost all land surfaces irrespective of ground cover. This enables long term measurement of peatland surface motion across whole catchments, regions and countries. Importantly, the ISBAS technique is able to determine surface deformation under tropical forest canopy using C-band InSAR data, enabling continuous monitoring of surface motion ranging from 0.1 – 40 cm/yr at spatial scales $\geq 90 \times 90$ m. Thus, space-based InSAR-derived motions should directly relate to tropical peatland carbon loss, allowing pan-regional assessment of carbon loss from otherwise inaccessible tropical peatlands. This is a novel approach as InSAR is yet to have been used to determine subsidence of tropical peatland sites.

This project aims to determine whether rate of subsidence of the peat surface measured by InSAR is a proxy for rate of carbon loss in tropical peatlands in SE Asia. InSAR and field measurements of subsidence will be combined with peat carbon stock data using statistical regression modelling techniques to validate the use of subsidence as a proxy for carbon loss.

Paper Number: 446
Monday, 02 July 2018 | Chichen Itza
General Session 8 - Peat & Flooded Forests

SYMPOSIUM 10.1

Tackling Illegal Wildlife Trade: Extent, Tools and Technologies, and Field Monitoring Methods

The Composition of Global Legal Wildlife Trade

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Biodiversity is a crucial planetary life support system, and its erosion through wildlife trade is one of the greatest threats to human survival. Understanding global wildlife trade connections – both legal and illegal – is critical for detecting sustainable limits and overexploitation of traded species. We provide an overview of global legal wildlife trade using UN Comtrade data from 1997-2016, and review the scale and composition of wildlife trade in 8 categories: seafood, jewellery and ornaments, medicine, furniture, fashion, exhibition, pets, and wild meat.

The value and quantity (kg) of global wildlife trade has doubled over the last two decades. In 2016, animal products worth USD 220 billion were traded internationally. The most lucrative wildlife commodity group in trade is seafood. For 155 countries, seafood was the top commodity exported – and comprised more than 50% of these countries' total wildlife exports. The world's three biggest economies – USA, China and Japan – were the leading traders of wildlife products. Hong Kong SAR is also noteworthy as having an outsized wildlife trade footprint, with an average 85 kg of wildlife traded each year per capita, and being the fourth largest trader of wildlife products globally – despite its relatively small size.

Even with a global system where codes for trade declarations are harmonised, there persist considerable gaps in data. This is in part due to inconsistent self-reporting and unsystematic record keeping in different countries. The lack of granularity in trade codes, coupled with the sheer scale and volume of global wildlife trade, has created fertile grounds for misclassification and even laundering of regulated items. A concerted international effort is needed to improve precision in data collection and collation. This would allow better knowledge and monitoring of actual wildlife trade levels, and nuances therein. Nevertheless, global wildlife data provides ample opportunities for future research, especially to understand global trade flows, and identify parallels with data on illegal wildlife trade.

Paper Number: 438

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.1 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

Extent of the impact of the Chinese wildlife trade on the world's wildlife

Olivier Boissier

Overharvesting is one of the key drivers of tropical biodiversity loss. With rising human population and standards of living in many emergent and developing countries, demand for wildlife is on the increase. As it endangers such charismatic and evolutionarily distinct species as elephants, rhinoceroses or pangolins, the particular case of China has been in the spotlight in recent years. The number of species impacted by the Chinese wildlife trade seems to be very high, and numerous taxonomic groups to be affected. Species targeted originate from many places worldwide beyond the mere borders of China or its neighboring countries. I therefore aimed to quantify the exact extent of the impact of the Chinese wildlife trade on species endangerment worldwide. I focused on Amniotes ('Reptiles', Birds and Mammals) and used the IUCN Red List of Threatened Species (version 2017-1) and market surveys from the literature to review which Amniote species threatened by biological resource use were affected by the Chinese wildlife trade. CITES databases and IUCN/SSC specialist groups provided further information. I found a total of 267 threatened or near-threatened Amniote species to be affected by the Chinese wildlife trade. Of these, 45% are turtles and tortoises. In this group, 50% of all evaluated species are (near-) threatened by the Chinese wildlife trade. Of all traded species, 62% are imported and 48% originate from China. Myanmar and Viet Nam are the main source countries, followed by Indonesia. Food is the primary use, followed by pet and traditional Chinese medicine. Finally, a minimum of 74% of species are illegally traded; 84% of imported species are listed on CITES Appendix I or II. I aim to emphasize how better regulations and law enforcement at a single country scale could significantly reduce threats over a wide range of taxons worldwide.

Paper Number: 98

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.1 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

Caged in the city: Live bird trade in Southeast Asia

Serene Chng, TRAFFIC

Southeast Asia is home to over 850 avian species. Birds are desired as pets for their song, their beauty, for cultural beliefs, and a multitude of reasons other reasons. Unfortunately, this high demand for domestic and international bird trade, involving hundreds of species and thousands of individual birds, has resulted in many sought-after species facing dramatic declines. This presentation gives an overview of the scale of the trade across Southeast Asia and highlights some of the most pressing issues. From June 2014 onwards, we carried out one-off full inventories of markets and pet shops where birds are sold in major cities in Indonesia, Singapore, Thailand and Viet Nam. This allowed us to comprehensively document bird species and volumes available for sale in these hotspots in a snapshot in time. Over 76,000 individuals were recorded in 13 cities. We uncovered trends and insights from surveys, including the displacement of mass demand from rarer and more expensive species to previously less popular species such as Greater Green Leafbirds. We were also able to gain a better understanding of the origins of animals, particularly for range-restricted taxa. In Indonesia and Viet Nam, although almost all the birds recorded are native to the country, movement of birds across provinces (across the Indonesian archipelago; from northern Viet Nam to southern Viet Nam) and countries (Malaysia to Indonesia) was uncovered. On the other hand, approximately 80% of birds in Singapore were non-native. Conservation challenges include the cultural importance of birdkeeping, demand from songbird competitions especially for new competition class species, and complications of captive breeding fraud. For such a complex problem, a multi-faceted approach is required. This is aimed to be synergised under the Asian Songbird Trade Specialist Group's main themes of work: field and genetic research, conservation breeding and reintroduction, trade and legislation regulation, community engagement and education.

Paper Number: 263

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.1 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

An Assessment of Conservation Status of Critically Endangered Chinese Pangolins (*Manis pentadactyla*) in Community Forests amid Human-Dominated Landscapes of Nepal

Sandeep Shrestha

The Chinese pangolin (*Manis pentadactyla*; hereafter referred to as a pangolin) is a "Critically Endangered" insectivorous mammal scarcely distributed in foothills of eastern and Central Himalayas of Nepal. Although forest patches in Bhaktapur district including our study area Sepilopakha community forest (SCF) represent critical refuge for pangolins in human dominated landscapes, there is a serious knowledge-gap regarding pangolin populations in this region. Our study aimed to fill in this knowledge-gap on pangolins in the SCF by generating information on various ecological attributes of their population and habitat.

To accomplish our aim, we: (a) divided SCF (34 hectares) into grids of 100 X 100 meters (m) and surveyed all such grids exhaustively looking for direct encounter with pangolins and/or occurrence of their burrows, (b) characterized pangolin habitat by assessing soil types, vegetation, ground and crown cover, altitude and slope etc. of sites where pangolin burrows were encountered, and (c) conducted direct field survey as well as focus group discussions and interviews to identify and characterize current and potential threats to pangolins.

We recorded a total of 61 pangolin burrows comprising of 29 new and 31 old. Average widths and breadths of these burrows were 19.25 ± 3.03 centimeters (cm) and 19.52 ± 4.76 cm respectively. All 61 burrows were located in altitudinal range of 1650-1980 m and slope ranging from 12 to 41°. Our findings suggested that pangolins preferred crown cover range of 0-25% ($n=48$), ground cover range of 0-50% ($n=38$) and brown soil ($n=57$) to dig their burrows. Similarly, average soil moisture around these burrows was 8.96 ± 2.91 . Based on the number of new/active pangolin burrows, we estimated pangolin density in SCF to be 0.85/hectare. We also identified illegal poaching, habitat modification for farming and deliberate forest fires as major threats to pangolins and their habitats.

Our study generated previously non-existent baseline scientific information of population and habitat ecology as well as threats to pangolins in SCF. We are currently working together with the Ministry of Forestry and SCF management committee to design site-specific action plan for pangolins in the hope that this action plan will serve as a road map to ensure long-term conservation of pangolins in the SCF and its surroundings.

Paper Number: 404

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.1 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

Monitoring the ASEAN rosewood trade using online seizure data: a 5-year case-study on Thailand's role as a source and transport country

Penthai Siriwat

Rosewoods are a group of timber species exploited heavily in the region of Southeast Asia as 'hongmu' or 'precious woods,' targeted mainly for the luxury furniture consumption in China. This demand for hongmu or redwood has exploited several species of *Dalbergia*, *Pterocarpus*, and *Machaerius* genera across the globe, making it the world's most trafficked wild item according to the UNDOC (2016). In my talk, I present my findings in using online media-sourced seizure data to study the trade of three rosewood species found in Southeast Asia: Siamese rosewood (*Dalbergia cochinchinensis*), Burmese rosewood (*D. bariensis*) and Burmese paduak (*Pterocarpus macrocarpus*). The 3 species were monitored over a 5-year period from January 2013 to December 2017, where temporal and spatial trends are analysed. Thailand's role as a source and transport country in the ASEAN rosewood trade makes it an excellent case-study to examine the crucial initial stages of the trade using a replicable, publically available real-time monitoring approach.

We find that in the five-year period, there was at least one hongmu seizure every single day. Siamese rosewood still accounts for most of the trade, however, the two remaining species are still consistently traded in substitution, through loopholes in legislation, utilising the same illegal trade channels. The analysis suggests that while the border regions are key activity zones, industrial shipping ports and sea-routes are also used to illegally export timber. The international scope of the trade in terms of unregulated movement of timber and humans poses regional security concerns. Furthermore, the imbalance of the legislation domestically and within the region also draws concern for the implementation of CITES and highlight the potential impact of regional economic integration with respect to CITES and the illegal wildlife trade. Finally, I conclude by assessing the methodologies of use of online media-sourced seizure data as a novel and topical approach to tackle and address the complex issues of the illegal trade of wildlife species.

Paper Number: 455

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.1 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

Using stable isotopes to detect laundering in wildlife trade

Astrid Andersson

Forensic tools are increasingly being applied to tackle illegal wildlife trade. Mass legal trade in myriad wildlife products – including live reptiles, ivory, shark fins, pet birds, and more – creates an opportunity for poached, trafficked wildlife to be laundered and sold as legal. In this 'grey area' it is often difficult to discern the legal from the laundered items. By analysing stable isotope ratios relating to diet (Carbon ^{13}C : ^{12}C and Nitrogen ^{15}N : ^{14}N) in animal tissues, it is often possible to identify where in the world an organism has been feeding and if it was consuming food typical of a life in the wild or in captivity. This can help enforcement officers detect if an animal or product was harvested from a protected area, for example, or if a wild-caught individual is being fraudulently sold as captive bred. We have for the first time applied this to the pet bird trade, conducting stable isotope analysis on wild ($n=25$) and captive ($n=22$) feathers from Yellow-crested Cockatoos (*Cacatua sulphurea*), which are now Critically Endangered in their native Indonesia due to over-exploitation for the pet trade in the 1980s and 90s. Having been listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 2002, trade in wild-caught Yellow-crested Cockatoos is prohibited; only captive-bred individuals can be traded. Comparison of import data and our year-long market survey results shows that Hong Kong markets contain more Yellow-crested Cockatoos ($n=32$) than have been reported to have been imported in the last 10 years ($n=8$). There have been at least 2 recorded incidences of poaching from Hong Kong's introduced Yellow-crested Cockatoo population, and there is evidence of unregulated and unlicensed home-breeding. It is currently not possible to reliably detect whether the surplus Yellow-crested Cockatoo individuals in the market have come from home breeders, or if they have been poached from wild populations. Our stable isotope analysis shows that both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values differ significantly between wild and captive Yellow-crested Cockatoos, suggesting that this type of analysis can be used by enforcement officials in Hong Kong and Indonesia to combat laundering of wild Yellow-crested Cockatoos. This work can also be expanded to include other species of parrots and songbirds threatened by wildlife trade.

Paper Number: 294

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.1 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

SYMPOSIUM 11.1

Feeding the Planet Whilst Minimizing Environmental and Socio-Economic Costs

Trade-offs between multiple ecosystem services and tropical agriculture

L. Roman Carrasco

Background

Tropical forests are often destroyed to clear land for agriculture or to harvest forestry products, such as timber. However, the benefits derived from agriculture and these products are countered by the costs to the environment and the loss of ecosystem systems (the benefits that nature provides to humans). Little is known about how the economic benefits and costs of deforestation vary on a global scale. Knowing the distribution of benefits and costs would help identify regions where deforestation is most and least beneficial and thus could help select areas to focus conservation efforts.

Objective

We studied the trade-offs between agricultural benefits, carbon emissions, and losses of multiple ecosystem services (ESs) in tropical deforested areas around the world.

Results

We find large differences between costs and benefits globally. For instance, we identify the Caribbean, Sumatra, and the south of Thailand as areas where the benefits from agricultural conversion are far greater than environmental costs, which could make it difficult to incentivize and implement biodiversity conservation strategies that are based on payments to farmers. By contrast, Latin America, Indochina, the Philippines, and Madagascar represent areas with low agricultural benefits and high environmental costs.

Conclusion

We find that these regions are economically viable conservation targets. Our study helps identify strategies to enhance the sustainability of land-use policies in the tropics.

Paper Number: 310

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.1 - Feeding the planet whilst minimizing environmental and socio-economic costs

Crop-specific threats to biodiversity by 2050

Yuchen Zhang, Melissa Pang, L. Roman Carrasco

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In the near future, agricultural production will expand in order to meet the demand of a steadily increasing global population that might exceed 9 billion by 2050. Expanding the area of agricultural cropland is expected, but little is known about how it will unfold. We model the pattern of global agricultural expansion of 17 important crops from 2015 to 2050 based on a new contagion von Thünen model. We estimate that more than 295 million hectares of new agricultural cropland will be added by 2050. Around 70% of these conversion is expected to occur at the expense of existing forests. We find that many of the crops that will have the largest increase in area of cropland are sub-tropical/tropical crops such as sugarcane and oil palm. Consequently, tropical forests are at the greatest risk of agricultural conversion. The threat is particularly great for the Southeast Asian region encompassing Indonesia and Malaysia, and the Middle Africa region including Nigeria, Central African Republic, and Congo. In addition, forests in China are projected to be under high pressure of cropland expansion. We also find that model-projected future agricultural cropland has substantial overlaps with existing biodiversity hotspots and key biodiversity areas, especially in the tropical belt. Our results help project the spatial distribution of losses of ecosystem services and carbon emissions globally. This deserves attention from conservation scientists due to the high ecological value associated with.

Paper Number: 153

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.1 - Feeding the planet whilst minimizing environmental and socio-economic costs

Perverse market outcomes of conservation interventions: modelling market feedbacks of oil palm expansion in Indonesia

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With agriculture as the main driver of global forest loss and extinction, research and policies are increasingly focused on implementing sustainable and more efficient practices to reduce rates of deforestation whilst meeting rising global food demands. However, we often do not consider market feedbacks to these policies. Given the inherently economic nature of these issues, overlooking these economic responses could result in conservation policies backfiring. Using oil palm expansion across Indonesia as an example, we examine how markets could respond to conservation interventions. We build a crop-expansion model based on crop suitability, changes in production costs and commodity prices, to identify areas vulnerable to further expansion due to profitability, and explore how palm oil supply varies with prices and with production costs. We then explore how crop expansion and palm oil supply change under different land-management scenarios, and identify their impacts on land use. Agricultural intensification and improving production cost efficiencies allows a greater area to profit from land conversion, thereby incentivising further expansion and encroachment of plantations into forests. Our study emphasises the role of production costs and profit incentives in determining oil palm distribution and spread: accounting for potential market responses allows us to anticipate perverse outcomes of our conservation interventions and, ultimately, to develop more effective policy interventions.

Paper Number: 234

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.1 - Feeding the planet whilst minimizing environmental and socio-economic costs

Global Conservation Community Attitudes Regarding Oil Palm

Kimberly Carlson

To support growing demand for edible oils and biofuels, large-scale oil palm plantations and smallholder oil palm farms have expanded rapidly throughout Southeast Asia's humid tropics. The palm oil industry has been heavily criticized by civil society for causing deforestation, reducing biodiversity, and negatively affecting local communities. Yet, little attention has been given to the conservation community's knowledge of and attitudes toward oil palm's impact on biodiversity. Characterizing attitudes and evaluating knowledge is critical to understanding the mechanisms through which information is processed and eventually manifests as behavior. At the International Union for Conservation of Nature (IUCN) World Conservation Congress in September 2016, IUCN members passed a resolution calling for the establishment of a taskforce to undertake a situation analysis on oil palm and biodiversity conservation in the context of sustainable development. In December 2017, the IUCN Oil Palm Task Force distributed a draft situation analysis and survey of knowledge of and attitudes toward oil palm and biodiversity. Around 800 respondents from the global IUCN network, residing in 82 nations, answered questions related to their knowledge and attitudes toward oil palm and biodiversity. They were also asked about their underlying environmental attitudes and purchasing behavior and provided basic demographic information. Here, we present results from analysis of these survey responses. Initial analyses suggest that respondents thought that oil palm had negative impacts on biodiversity and community land rights, but positive benefits for economies in oil palm growing countries. They identified trade regulation and lending standards as the most effective at conserving biodiversity in oil palm producing regions. However, respondents thought that government regulations in Southeast Asia and Africa were ineffective at protecting biodiversity. Findings are expected to inform how knowledge, demographics, and underlying environmental attitudes affect attitude and behavior toward the environmental impact of oil palm, a major global commodity crop.

Paper Number: 749

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.1 - Feeding the planet whilst minimizing environmental and socio-economic costs

The state of climate connectivity across the tropics

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To survive in a warming world the range of many species will shift polewards or upwards. Tropical rainforests harbour most of the world's remaining terrestrial biodiversity, included many thermally restricted forest specialists. Despite this, we currently lack a pantropical assessment of the physical potential for tropical species to reach climate analogues within existing forest cover – so-called 'climate connectivity'. Moreover, no study to date has empirically tested how recent deforestation has impacted this connectivity. We combined global temperature and forest cover datasets to quantify climate connectivity across the tropics in the present day (year: 2012) and in the recent past (year: 2000). Across the tropics, climate connectivity was poor and most tropical forests will not facilitate range shifts to analogous future climates. Climate connectivity was particularly low in the Afrotropical and Indomalayan realms. Remaining forest cover between the Andes and the Amazon means that large parts of the Neotropics still achieve high climate connectivity, although in some cases the distances required to reach analogous climates are vast. In only 12 years, forest cover change has caused severe loss of climate connectivity in some places – particularly the Southern Amazon, Congo Basin and Southern New Guinea – whereas connectivity gains have been limited. Range shifts are a crucial mechanism by which species avoid warming under climate change, but loss and fragmentation of tropical forests makes range shifts alone an increasingly inadequate solution. To maintain and enhance climate resilience, changes in forest cover and forest protection should be considered in the context of climate gradients that species would need to follow to avoid the negative effects of future climate change.

Paper Number: 233

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.1 - Feeding the planet whilst minimizing environmental and socio-economic costs

How to better manage shifting cultivation to improve conservation outcomes

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Shifting cultivation is a dominant land use regime across 2.6 million km² in 64 developing countries, and it continues to be a major driver of tropical deforestation and biodiversity loss. With growing demands for food production as human populations increase, it is vital to formulate strategies that better manage shifting cultivation to minimize its impacts on carbon storage and biodiversity without affecting crop production. Carbon-based payments for ecosystem services, especially REDD+ (Reducing Emissions from Deforestation and Forest Degradation) offer one particularly exciting prospect. Focusing on carbon stocks and bird communities in Nagaland, Northeast India—a global hotspot of biodiversity and shifting agriculture—we modelled landscape-level carbon stocks and bird species richness to assess optimal management scenarios under REDD+ that provide co-benefits for both carbon and biodiversity. Sparing old-growth forests from deforestation while intensifying cropping in the remaining area of shifting cultivation was the most optimal strategy. In areas lacking old-growth forest, carbon stocks are higher when fallows are spared for permanent forest regeneration. Our results suggest explicit pathways for optimally implementing REDD+ to reduce deforestation and forest degradation from shifting cultivation. Successful implementation of these interventions under REDD+ in shifting cultivation landscapes can help avert global climate change by protecting forest carbon, with co-benefits for biodiversity.

Paper Number: 388

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.1 - Feeding the planet whilst minimizing environmental and socio-economic costs

SYMPOSIUM 12

Conservation-Based Recovery of Large Carnivores in Asia: Technical and Management Insights

The Decline and Fall of Cambodia's Tiger: lessons for global tiger recovery

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In 1998 a study proclaimed Cambodia supported the second highest tiger population in the world with an estimate of 500 to 700 adult individuals. International conservation NGOs, including WWF and the Wildlife Conservation Society, initiated major tiger conservation programs. But by 2010 tiger were likely extinct in Cambodia. What happened? And what lessons can the fall and decline of Cambodia's tigers provide for carnivore conservation globally?

Whilst the 1998 study clearly overestimated the country's tiger populations there were at least 77 confirmed tiger records from four landscapes across Cambodia between 1996 and 2007. Interviews with known hunters estimated 85 tigers were poached nationwide in 1998 and 50 in 1999. Between 2000 and 2005 an additional 26 tiger poaching incidents were clearly documented: the last of these was from the Cardamom Rainforest Landscape in May 2005. Applying a non-parametric extinction date estimator to the confirmed tiger records estimates extirpation in Cambodia by July 2008 with a 95% upper confidence interval for extinction by August 2015. The rapid decline of Cambodia's tigers is a cautionary tale demonstrating that in low density tiger landscapes, and a governance vacuum, tiger populations can be rapidly and effectively depleted. There are thus clear lessons for other low density tiger landscapes in South East Asia with the Cambodian situation particularly pertinent to Myanmar.

Cambodia opened to conservation in the late 1990s and major roads were built through two of the tiger landscapes (the Cardamom Rainforest and Eastern Plains) in the mid-2000s. During this period there were very limited resources for protected area management, insufficient legislation protecting threatened species, insecurity, widespread availability of firearms, and pervasive corruption. Many of these factors apply to Myanmar currently. Without strong on-the-ground protected area management and law enforcement in Myanmar, and other South East Asian countries, it is likely Cambodia's tiger story will be repeated and there will be the need to plan and develop further expensive and ambitious reintroduction programs.

Paper Number: 123

Tuesday, 03 July 2018 | Petra 1

Symposium 12 - Conservation-based recovery of large carnivores in Asia: technical and management insights

Challenges towards recovering Sumatran tiger populations in two UNESCO World Heritage Site protected areas

William Marthy

Gunung Leuser National Park (GLNP) and Bukit Barisan Selatan National Park (BBSNP) are two of the three of large protected areas in Indonesia that form the Tropical Rainforest Heritage of Sumatra, a UNESCO World Heritage Site cluster. The 870,161 ha GLNP, which is part of the 2.5 million ha Leuser Ecosystem, and 313,572 ha BBSNP contain approximately 40% of the entire Sumatran tiger population. However similar to other Sumatran protected areas they face multiple threats, especially from poaching and forest habitat loss that jeopardize the subspecies's population viability. Here, we report on the camera trap surveys that were conducted in GLNP (2010 and 2013) and BBSNP (2002 and 2015). For GLNP, the tiger population was found to be marginally increasing from 0.24 to 0.53 tigers/100 km², but this is still a very low density and should be higher for the forest type surveyed. In BBSNP, there was a much more significant change with tigers increasing from 1.6 to 2.8 tigers/100 km², which is indicative of a healthy tiger population in evergreen rainforest. Whilst the results are encouraging, there are several important points to note. Firstly, the BBSNP study area received much higher levels of ranger patrolling than the GLNP study area, which may partly explain the differences in tiger densities and the need to intensify enforcement efforts in GLNP to enable further population recovery. Secondly, both study areas received disproportionately high levels of protection than the surrounding areas of the national parks but, despite this, still had poaching and other human disturbance. So, the threats in these other areas may be higher and the tiger population trends may be in decline. Thus greater effort is needed to boost the law enforcement more widely so that tigers can begin to recovery across the landscapes. Finally, a recent population viability analysis highlighted the grave dangers of the tiger populations being fragmented by planned roads and other infrastructure developments, which another area for urgent attention, especially if BBSNP and GLNP are to be removed from the UNESCO World Heritage Site 'in danger' list.

Paper Number: 165

Tuesday, 03 July 2018 | Petra 1

Symposium 12 - Conservation-based recovery of large carnivores in Asia: technical and management insights

Making recovery possible: insights from tiger augmentation and reintroduction projects in India

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Introduction: India has largely been the front-runner in tiger conservation efforts, on account of its national identity, ecological functionality and economic benefits across wide section of the people. It is noteworthy that the tiger population status has been put on positive trajectory by the popular conservation measure such as 'Project Tiger'. The number of Tiger Reserves has multiplied five times since 1973 when the "Project Tiger" was launched. On the contrary, there are several areas where tiger population has been wiped out or reduced to sub-optimal or non-viable state. In such situation, active recovery efforts by augmentation and reintroduction of tiger in these areas present unique opportunity for habitat restoration, population growth and its long-term viability.

Objective(s): To analyze and update the state of tiger augmentation and recovery efforts in India, focusing on key lessons and future perspectives linked to realistic success rates.

Method(s): Local extinctions of tiger populations in Sariska Tiger Reserve (western India) and Panna Tiger Reserve (central India) have swiftly been mitigated by reintroduction efforts by translocation of tigers from other source sites. This involved implementation of species recovery plan including continuous post-release monitoring based on telemetry technologies. Efforts are underway in other low density and locally extinct areas in India.

Result(s): The recovery efforts resulted in positive outcome with population growth in both the places, although the tiger population grew rapidly in Panna Tiger Reserve, reaching expected carrying capacity well before the stipulated timeframe. A cursory look at the national level tiger population estimation suggests that such areas bring dynamism to the population estimation (with these sites adding 50 tigers), since well-established reserves arguably have stabilized the population size. It is likely that the national and state level strategies for augmentation and recovery of tigers are likely to be the major driver of tiger population growth in the current context, without increasing the human-tiger conflicts. The process of tiger augmentation and recovery are currently underway in Sanjay Tiger Reserve (Madhya Pradesh), Sahyadri Tiger Reserve (Maharashtra), Buxa Tiger Reserve (West Bengal), Satkosia Tiger Reserve (Odisha), Mukundara Hills Tiger Reserve (Rajasthan) and Rajaji Tiger Reserve (Uttarakhand). Given the core areas of 500 km² and large buffer areas in these reserves, successful efforts would increase the tiger count by at least 200 tigers and would help consolidate over 5000 km² of wildlife habitats.

Implications and conclusions: Tiger conservation in India has stepped into the paradigm shift, integrating proactive interventions and sophisticated monitoring tools. While there exist broad contours of scientific and management protocols, site-specific strategies and indicators are required for effectively undertaking the process. Such proactive management actions provide options for population management and recovery of tiger at national and international contexts.

Paper Number: 768

Tuesday, 03 July 2018 | Petra 1

Symposium 12 - Conservation-based recovery of large carnivores in Asia: technical and management insights

Unraveling the complexity of human-tiger conflicts in the Leuser Ecosystem, Sumatra

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Conserving large-bodied carnivores that live in close proximity to people depends on a variety of socio-economic, political and biological factors. These include local tolerance towards potentially dangerous animals, efficacy of human-carnivore conflict mitigation schemes and the ability to identify and address the underlying causes of conflict. The Leuser Ecosystem is the largest forest habitat for the Critically Endangered Sumatran tiger and its extensive forest edge is abutted by farming communities. Across this landscape, rates of habitat conversion, livestock abundance and poaching of tiger and their wild prey vary, suggesting that the occurrence of human-tiger conflict (HTC) should also vary. To investigate which of these drivers of conflict, as well as other biophysical factors, best explain observed patterns of conflict, we used a MaxEnt approach to develop a predictive spatially-explicit HTC model. From 138 incidences recorded from 2008-2014, areas with higher livestock densities and a lower presence of wild prey in nearby forests were more susceptible to tiger attacks. Several districts stood out for having disproportionately high levels of HTC. Here, we recommend that they be prioritized by: Conflict mitigation teams to prevent further injuries to people, livestock or tigers; District governments to address one of the underlying cause of HTC by supporting improved animal husbandry practices, such as tiger-proof livestock pen construction; and, National park ranger to conduct more desnaring patrols in the surrounding forests to enable tiger prey base recovery. We also recommend integrating social information into such conflict models to gain an even deeper understanding of HTC.

Paper Number: 579

Tuesday, 03 July 2018 | Petra 1

Symposium 12 - Conservation-based recovery of large carnivores in Asia: technical and management insights

Surveys reveal important tiger conservation landscape in southern Tanintharyi Region, Myanmar

Jackson Frechette, Aung Si Hein, Grant Connette, Mark Grindley, La Min Nyi Nyi, Nay Myo Shwe, Saw Marlon Brando, Saw Moe San, Saw Soe Aung, Zaw Myint Win

Located at the southern extent of the globally important Dawna Tenasserim Landscape (DTL), Myanmar's Tanintharyi Region sits at the convergence of the Indo-Burma and Sundaland biodiversity hotspots. Decades of armed conflict and political instability made biological surveys almost impossible in these unique forests until recently. Since 2014, Fauna & Flora International, along with local and international partners, have been working to determine the conservation value of about 5,000 km² of southern Tanintharyi that primarily falls within the Lenya and Ngawun Reserved Forests. This effort has focused on better understanding the distribution and conservation status of tiger and tiger prey species. To do this, we have been working with local community groups to systematically deploy paired camera traps at the center-points of a 4 x 4 km grid covering the entire 5,000 km² area. We also opportunistically deployed cameras in areas with tiger sign. Due to access restrictions, security concerns and logistical reasons, we have so far been able to deploy cameras across 1,328 km² (279 camera trap locations in 83 grid cells). Our data suggest that southern Tanintharyi is an important area for tiger conservation. From our camera traps we were able to identify eight individual tigers and a solid prey base. Eurasian wild pigs were observed at almost 70% of our camera locations, gaur at 12%, sambar at 5%, and banteng at 3%. We also captured evidence of tiger breeding, which indicates that sufficient prey and resources remain in the area. Although tigers were absent from a large part of the survey area (present at only ~9% of camera trap locations), the two reserved forests together cover 3,680 km², which means with sufficient conservation measures, there is significant potential for tiger population recovery. However, hunting is a threat in the landscape, as almost 20% of our camera trap locations detected hunters. Additionally, there are significant threats arising from the development and improvement of roads. Our study fills important knowledge gaps concerning tiger presence and recovery potential in Myanmar, and provides further evidence for the global importance of the southern portion of the Dawna Tenasserim Landscape as a tiger conservation landscape.

Paper Number: 527

Tuesday, 03 July 2018 | Petra 1

Symposium 12 - Conservation-based recovery of large carnivores in Asia: technical and management insights

Spatial variation in the response of tiger gene flow to landscape features in Central India and Western Ghats, India

P. Anuradha Reddy, Samuel Cushman, J. P. Puyravaud

Integrated landscape management of key population areas and the corridors linking them is important for tiger conservation in the Indian subcontinent. Relationships between gene flow and landscape patterns, however, cannot be generalized given that different limiting factors influence movement in different spatial contexts. We studied landscape features affecting tiger gene flow in Central India and the Western Ghats, and examined how and why limiting landscape features which affect gene flow differ between these two tiger landscapes. Our study area covers 697,000 km² in Central India, and 30,000 km² in the Western Ghats in India. We used genetic data of 424 tigers and landscape resistance model optimization to create a resistance surface to gene flow in both the landscapes. We evaluated limiting landscape features which affect gene flow and why these differ between Central India and the Western Ghats with FRAGSTATS. Gene flow is primarily related to topographic roughness and secondarily to diffuse disturbance, however these relations are inverted in the two landscapes. In Central India, gene flow correlates with rough terrain, whereas in the Western Ghats, it correlates with smooth, forested terrain with minimal human disturbance. Topographical roughness is an important factor affecting tiger dispersal, but tiger's response to topography seems to be dependent upon interactions with human-related disturbance. Tigers in Central India favor rough terrain for dispersal primarily because it is the only part of the landscape without heavy human footprint and the last refuge for natural vegetation, whereas in the Western Ghats, forest cover is more extensive in flatter terrain and human footprint is generally lower. Empirical data generated from such studies will help in landscape management, especially in protecting and preserving wildlife corridors in forested areas with low human densities.

Paper Number: 499

Tuesday, 03 July 2018 | Petra 1

Symposium 12 - Conservation-based recovery of large carnivores in Asia: technical and management insights

SYMPOSIUM 13.1

The Future of Frugivory, Seed Dispersal, Seed Predation, and Fate in Changing Tropical Landscapes

Access to Forest Resources and Effectiveness of Protected Areas in Malaysia: A Historical Perspective on the National Park and the Krau Reserve since the Colonial Era

Mathieu Guerin

In the 20th century, protected areas have become a major tool in conservation. A number of factors affecting their efficiency have been identified: location, size, boundaries and buffers, laws and regulations enforcement, involvement of local communities... This paper looks on how the context and processes of the creation of two protected areas during the colonial era in Malaysia had an impact on the protection of tropical forest ecosystems.

This historical study is based on the critical analysis of colonial sources and correspondence of the sultans in the 1920s and 1930s, and a review of existing literature on the ecology of Malaysian forests.

When in the early 20th century, conservation of the wildlife of the Empire became a concern for the British government, steps were taken in Malaya. A Game Department was set up, but with inadequate means to fulfil its missions. In the 1920s, Game Warden Hubback was instrumental in the creation of two important reserves in Pahang, the Krau and the Gunung Tahan Game Reserves. In 1939, the latter was incorporated into the much larger King George V National Park. Hubback's projects were based on the "Yellowstone model" and affected the local populations' rights on forest use. However, sources available show that the sultans and some British officials supported the claims of the Malay villagers and of the Batek and Che Wong forest people, especially on fruit trees, collection of NTFPs and right of way. Far from being colonial diktats, the gazetting and regulation of these protected areas was the result of intense negotiations between different parties within the colonial administration, the local inhabitants, the sultans and their courts. Proponents of the preservation of wildlife were forced to make concessions, that, on the long term, appear to have been beneficial for conservation, especially in the National Park.

Size and rights of the local communities that were decided when the protected areas were set up, seem to have been important factors of effectiveness. The smaller size of Krau reduced its capacity in providing adequate shelter for endangered species in a context of forest fragmentation. However, Krau remains an important spot for lowland evergreen forest, while Taman Negara is still a stronghold for Southeast Asian biodiversity.

Paper Number: 353

Tuesday, 03 July 2018 | Petra 2

Symposium 13.1 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

The importance of mast fruiting for vertebrates in a faunally intact ecosystem

Alys Granados

Periods of extreme food abundance, such as irregular masting events, can dramatically affect animal populations and communities, but most documentation of such effects comes from systems where wide-ranging mast specialists have been extirpated. When present, specialist consumers may pre-emptively consume most of the mast in a given area, potentially affecting interacting species. Animal responses to masting may also be affected by human activity yet our understanding of how altered habitat structure affects animal communities in mast years is limited. We used camera traps and regular counts of fruit biomass from 65 plant families to assess the effects of high interannual variability in fruit availability on vertebrate consumers in a faunally intact forest in Sabah, Malaysia. Our study encompassed major (2014), minor (2015), and non (2013) dipterocarp mast years. Selective logging reduced masting intensity so we also evaluated the influence of logging on animal responses to mast fruiting. Overall, animal occurrence rates were highest in unlogged forest in the year following the major mast, suggesting that for some species (e.g. bearded pigs, chevrotains, and murid rodents), increased dipterocarp fruit availability might facilitate increases in reproduction. At the local spatial scale, resource tracking of dipterocarp fruit was mostly restricted to bearded pigs - the most wide-ranging mast consumer. In contrast, vertebrates in logged forest showed limited responses to spatial or temporal variation in fruit availability. Our findings suggest that community-wide responses to masting can still occur in systems with extant large mast specialists. However, continued selective logging of dipterocarp trees in Sabah could alter responses to resource pulses, and could subsequently affect species interactions, animal abundances, and tree recruitment.

Paper Number: 186

Tuesday, 03 July 2018 | Petra 2

Symposium 13.1 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

Defaunation, seed predation, and seedling establishment of commercially important trees in an Afrotropical forest

Cooper Rosin

Human hunting is widespread in tropical forests and can substantially alter the plant-animal interactions that drive tree recruitment. Seed predation is a strong determinant of plant reproductive success, but it remains unclear how defaunation modifies this process. We examined the effects of hunting-induced defaunation on seed predation and seedling establishment, using replicated enclosure treatments at six sites across a defaunation gradient in northeastern Gabon. We monitored 5580 seeds of eight commercially important tree species that varied in seed traits such as size and dispersal mode. Rodents caused the greatest seed mortality for all species, removing ~60% of accessible seeds. In comparison, invertebrates and fungi together caused just 6% of seed mortality. With protection from rodents, more than twice as many seeds established as seedlings, demonstrating that vertebrate seed predation was a strong filter on recruitment. With increasing defaunation, the proportion of seeds removed by rodents increased significantly, and seedling establishment decreased significantly, for most species. In heavily defaunated sites, with the lowest abundances of large mammals, seed removal by rodents increased by 63% and seedling establishment decreased by 42% compared to sites with intact fauna. Diminished seedling establishment is likely to reduce the regeneration of many tree species – including some with commercial importance – in hunted forests, with detrimental economic consequences. In turn, declines in timber regeneration may increase the likelihood that selectively logged forests are converted to non-forest land uses with little conservation value. Appropriate management could preclude these outcomes, to the benefit of both wildlife and natural timber regeneration.

Paper Number: 90

Tuesday, 03 July 2018 | Petra 2

Symposium 13.1 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

Seed dispersal of hemi-epiphytic figs by binturongs, gibbons and hornbills on Borneo

Miyabi Nakabayashi

We evaluated the contribution of three arboreal or volant frugivores in the seed dispersal of hemi-epiphytic figs using the seed dispersal effectiveness landscape. Hemi-epiphytic figs occupy one third to over half of the fig species in different communities and are considered to be keystone food resources for many animals due to their large crops and a continuous fig availability. Despite their ecological importance, little has been reported on their seed dispersal systems.

Hemi-epiphytic figs' seeds germinate in the crowns of host trees, and thereby the seed dispersers must be arboreal or volant animals. The seeds require consistently moist condition for germination rather than certain light levels. Therefore, defecation habits of dispersal animals are relevant to their seed fates. In this study, we focused on three relatively large frugivores, East Bornean grey gibbons *Hylobates funereus*, binturongs *Arctictis binturong*, and helmeted hornbills *Rhinoplax vigil*, and investigated both quantitative and qualitative effectiveness of these seed dispersers for hemi-epiphytic figs on Borneo.

Our results suggest that binturongs are by far the most effective seed dispersers of hemi-epiphytic figs especially when they defecate on tree forks. Gibbons and helmeted hornbills provide similar seed dispersal services. Even though binturongs exhibit high quantity effectiveness, the seed dispersal effectiveness differed across the defecation sites. Gibbons and hornbills are usually considered as effective seed dispersal agents in South-eastern Asian rainforests. However, this study indicates that binturongs are the most effective seed dispersers of the three taxon studied so far. Binturongs are not the only one effective dispersers in the forests, but they are critically important for large figs that small animals cannot disperse seeds. They are categorised as Vulnerable on the IUCN Red List because of a population decline. Given that figs are effective forest restoration agents, proper conservation of binturongs is needed.

Paper Number: 107

Tuesday, 03 July 2018 | Petra 2

Symposium 13.1 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

Breeding-related differences in habitat use and home-range size influence seed dispersal effectiveness and potential for forest regeneration in an endangered frugivore

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Seed dispersal is a critical ecosystem process, and loss of seed dispersers can impede forest regeneration and cause a deterioration of forest health. A prime example of the impact of seed disperser loss comes from the tropical island of Guam, where most native frugivores were extirpated due to predation by the invasive brown treesnake (*Boiga irregularis*). The absence of dispersers has had cascading impacts on ecosystem functioning, such as reduced seedling recruitment and altered plant distributional patterns. The only remaining frugivore and best candidate for restoring seed dispersal on Guam is a remnant population of the Micronesian starling (*Aplonis opaca* – MIST). To determine the role of MIST as a seed disperser and its potential to contribute to forest regeneration, we characterized seed dispersal effectiveness (SDE) of both juvenile ($n = 8$) and breeding adults ($n = 9$). We used radio-telemetry to investigate MIST movement, home-range size and habitat use and coupled these data with gut passage times to determine where MIST were depositing seeds on the landscape (i.e. forest vs. urban habitat). We then modeled habitat-specific seedling recruitment probabilities for a common fleshy-fruited tree species (*Premna serratifolia*) to compare SDE between juveniles and breeding adults. Because breeding was restricted to urban habitats where snake densities are lower, breeding adults deposited most seeds into areas where seedling recruitment was negligible due to anthropogenic activities (i.e. heavy mowing, construction). In contrast, juvenile MIST were far more effective seed dispersers than breeding adults – they had significantly larger home-ranges and used forest habitat more frequently than adults, resulting in higher seed deposition rates in forests. Our results demonstrate that the presence of an invasive predator can have cascading effects on seedling recruitment by altering the behavior of the seed disperser. Furthermore, we show that SDE can vary drastically based on life-history stage and that functional outcomes of seed dispersal are not uniform within a species, illustrating the importance of accounting for intraspecific heterogeneity in behavior and ecology to fully understand seed dispersal dynamics.

Paper Number: 513

Tuesday, 03 July 2018 | Petra 2

Symposium 13.1 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

Do Japanese wood pigeons disperse seeds among islands? Foraging strategy estimated by observation and molecular ecological approach

Haruko Ando

Long-distance seed dispersal among islands is essential for vegetation development in oceanic island ecosystems. Pigeons possibly contribute to long-distance seed dispersal in tropical oceanic islands due to their large body size, strong flying capacity and relatively long gut-passage time. The Japanese wood pigeon *Columba janthina* is distributed across remote islands around the Japanese main islands and Korean Peninsula. This pigeon is thought to be a seed predator, but some small seeds (<3 mm in diameter) have been found to remain in their feces. Recent studies based on direct observations and genetic analyses indicate the pigeons are highly mobile and can fly among islands up to 150 km apart. At the short-distance scale, more than 2,000 pigeons can move between islands approximately 4 km apart within a day. The pigeons might move among these islands to use available food resources, reflecting limitations in the food resources of a single island habitat, as indicated by differences in the composition of their diet and the availability of food resources among islands. Although Japanese wood pigeons have shown a potential as long-distance seed dispersers, direct evidence of inter-island seed dispersal by the pigeons has never been detected. The estimation of seed dispersal patterns by Japanese wood pigeons in relation to their foraging strategy is a future challenge to understanding the ecological function of highly mobile island pigeons, most of which are threatened.

Paper Number: 195

Tuesday, 03 July 2018 | Petra 2

Symposium 13.1 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

SYMPOSIUM 14.1

Changing Environments & Changing Forests: Spatial and Temporal Variation in the Dynamics of Southeast Asian Forests

Biodiversity and change: Comparative dynamics of southeast Asian forests

Stuart Davies¹, Sabrina E. Russo²

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Forests are continually changing, but the rapid environmental changes occurring in Southeast Asia are reshaping the forests of this region. Shifts in patterns of land-use are fragmenting once continuous tracts of forest, causing habitat loss and making remaining forests vulnerable to a host of stressors. Increased hunting and poaching pressures affect patterns of seed dispersal, seed and seedling predation, and, ultimately tree recruitment. Climate change is causing shifts in rainfall regimes and altering the frequency and severity droughts. These anthropogenic drivers of change operate on top of existing natural environmental gradients, causing the responses of forests to these drivers to be complex. This Symposium will integrate results from a network of long-term forest monitoring plots across Southeast Asia in order to quantify these responses and reconcile natural versus anthropogenically driven reasons for forest change. These diverse drivers of forest change have different effects on tree species' growth, recruitment, and mortality, as well as the spatial and temporal variation in these vital rates. This variation arises because these drivers have their greatest effects at different tree life stages and sizes and on tree species with, for example, particular functional and physiological properties, with particular kinds of interactions with animals, or with particular habitat associations. As a result, some tree species are favored over others in the novel environments currently forming, which can result in dramatic changes in forest composition and structure. The research to be presented in this Symposium quantifies contemporary changes in the composition and structure of a wide range of forest types, including lowland mixed dipterocarp, typhoon, and pre-montane forests across six countries in Southeast Asia. The presentations analyze the potential role of anthropogenic drivers of change, including altered patterns of plant-animal interactions, as well as responses to shifting rainfall regimes and disturbances like typhoons and stand-replacing fires, and their consequences for forest function and carbon storage. By examining how the responses of tree species to these drivers depend on natural environmental gradients (e.g., soil fertility, elevation), the Symposium will uncover functional and demographic bases of forest change and contribute a synthetic understanding of the urgent challenges facing Southeast Asian forests now and in the future.

Paper Number: 508

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.1 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests

Habitat-Related Tree Species Distributions And Diversity In A Peninsular Malaysian Rainforest

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Understanding the distributions of tree species and their underlying drivers is not only fundamental to ecology, but also critical to biodiversity conservation. Environmental heterogeneity shapes tree distributions, but how it influences diversity in forests with restricted topographic variation is not well understood. We examined the effects of soil and topographic variation on spatial patterns of alpha diversity (within-habitat species richness) and beta (turnover in species composition between habitats) diversity of trees using data from a 50-ha plot located in Pasoh Forest Reserve, Negeri Sembilan, which has little elevational variation. In the plot, every tree with ≥ 1 cm diameter at breast height has been measured, mapped, and identified to species, along with detailed spatial data collection on soil types and topography. We addressed two research questions: What are the patterns of tree species specialisation across soil and topographically defined habitats? Do alpha- and beta-diversity vary in different habitats? The Torus Translation Test (TTT) was used to determine associations of tree species with four habitats defined by topographic and soil attributes (periodic-swamp, alluvial, slope, and ridge). Of all the species tested, 24% were specialists of the periodic swamp, which made up the largest portion of all habitat specialists. Occasional standing water may limit species composition to trees that tolerate periodically anoxic soil conditions, which would be indicative of niche specialisation. In contrast, the alluvial habitat had little evidence of habitat filtering, with the lowest proportion of trees and species being specialists. We calculated the average species richness in each 20 by 20 m quadrat and analysed rarefied richness among habitats. Alpha diversity was greatest on the slope habitat, followed by ridge, periodic-swamp, and alluvial. Permutational multivariate analysis of variance was used to quantify beta-diversity, as compositional differences between habitats. Overlap in species composition between habitats was minimal, with ridge and periodic-swamp having the greatest difference. These showed that high beta-diversity is driven by niche specialisation. Thus, even for the relatively flat Pasoh forest, soil and microtopographic heterogeneity significantly affect tree species distributions, thereby contributing to variation in alpha- and beta-diversity among habitats.

Paper Number: 175

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.1 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests

Long-term shifts in tree sapling abundance in multiple Southeast Asian rainforests

Matthew Scott Luskin, Matteo Detto, Sabrina Russo, Yu-Yun Chen, Yao Tze Leong, Sylvester Tan, and Stuart Davies

There are three main hypotheses to explain persistent decadal shifts in community-wide tropical tree sapling abundances in Southeast Asia: (1) natural recruitment cycles from community-wide mast fruiting, (2) natural disturbances (landslides and tree falls) associated with high densities of new saplings in clumps in gaps (usually dominated by pioneers), and (3) altered wildlife communities (herbivores and seed predators and dispersers), which may show trait-specific shifts relating to seed size and dispersal mechanisms. We analyzed changes in the tree sapling demographics at three long-term forest dynamics plots in Southeast Asia, which together contain a million observations. We found persistent and divergent shifts in the abundances of saplings over the 20-year study period, which does not provide support for shared regional masts driving the trends. There were large changes in the abundances of pioneer saplings Khao Chong in Thailand and Lambir Hills in Borneo, while changes Pasoh in Peninsular Malaysia were shared among pioneer and later successional species. Species with lower initial abundances consistently increased their abundances more than common species and both small (<15mm length) and large-seeded trees (>30mm length) showed greater changes than trees with medium-sized seeds. I will discuss the potential roles of altered wildlife communities and natural disturbances (landslides and tree falls) in explaining the unique shifts observed at each site.

Paper Number: 150

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.1 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests

Short-term variation of tree growth rates in tropical forests of Singapore

Kang Min NGO, Nik Faizu NIK HASSAN, Mohamad Fairoz B MOHAMED, Shawn LUM

Tree growth rates from plot-based studies are often calculated from supra-annual measurements of trunk diameter, but tree growth rates in the tropics are strongly influenced by intra-annual phenology events and short-term environmental variation. These short-term changes may have long-term effects on the forest community, such as species turnover and carbon sequestration rates.

We installed dendrometers on 482 trees in a primary and secondary forest plot in Singapore, and measured tree diameters and the dendrometers twice a year for about 8 years. Rainfall data for the study period was collected from the nearest weather station about 2.5 km away from the plots.

There were no directional trends in growth rates for both primary and secondary forests. Temporal variation in growth rates were inconsistent within family, without clear phylogenetic patterns. Mean growth rates were significantly higher in the primary forest during some measurement intervals, although growth rates of trees ≥ 20.0 cm were significantly higher in the secondary forest during a few intervals. Mean daily rainfall within measurement intervals was significantly positively correlated with tree growth rates, but not maximum daily rainfall and total rainfall within intervals. *Shorea curtisii*, the most abundant dipterocarp in the primary forest, had consistently high growth rates for all size classes throughout all intervals. The differing growth patterns between primary and secondary forests may be due to differences in species composition and traits. Determination of species traits in both forest types will shed light on the relationship between plant characteristics and their short-term growth rates.

Paper Number: 139

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.1 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests

Temporal Change in Species Composition and Abundance at Lambir Hills National Park, Sarawak, Malaysia

Mohizah, M., Russo, S.E., Chisholm, R., Davies, S.J., Tawan, C.

Long-term studies have shown that the structure and dynamics of tropical forests are changing, but whether these changes are stochastic or deterministic remains debated. Environmental drivers leading to fluctuations in tree populations include abiotic factors, such as droughts, fires, and storms, but also biotic factors, such as insect and fungus outbreaks, and the severity of these drivers may be habitat-dependent. We used 15 years of tree census data from a long-term forest plot in Lambir Hills National Park, Borneo, to test whether habitat-related population changes from 1992 to 2007 were stochastic or showed evidence of being driven by environmental change. We quantified the scaling of squared abundance changes through time versus the initial abundance for each tree species and analysed variation with respect to four soil habitats. At the forest-stand scale, there were significant changes in the abundance of stems across census intervals and different dbh size classes. We found that late successional species changed both neutrally and non-neutrally, whereas most of the pioneer species changed non-neutrally: 14% of the species displaying non-neutral dynamics were pioneers, whereas 53% of the pioneer species changed non-neutrally. Among soil habitats, most of the non-neutral species were found on the less fertile sandy loam, but the more fertile clay had the fewest non-neutral species. *Dryobalanops aromatica*, a sandy loam specialist, is the most abundant species in the plot, with the mortality rate of 0.016 %/year. Its abundance changes were neutrally driven. *Eurya acuminata* is the fastest declining species with a mortality rate of 0.09 %/year and recruitment rate of -0.06 %/year. On the other hand, *Ficus megalia* is the species increasing the fastest, with a recruitment rate of 0.22 %/year. Further examination of the characteristics of species that display non-neutral changes in abundance will reveal the drivers of population change.

Paper Number: 971

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.1 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests

Changes in stand structure and dynamics of trees in Pasoh Forest Reserve over 25 years

Musalmah, N., Russo, S.E., Yao, T.L. and Davies, S.J.

Southeast Asian forests are experiencing environmental changes, but how forests are responding to these drivers through time has not been quantified. Using 25 years of census data (1985 to 2010) from the 50 ha plot in the Pasoh Forest Reserve (FR), we examined changes in stand structure and dynamics of trees in relation to habitats in Pasoh FR, Negeri Sembilan, Peninsular Malaysia. We found that the abundance of trees decreased by 13%, with the greatest declines seen in trees <2 cm in diameter, which decreased by 43%. Species richness declined from 813 species in 1985 to 809 species in 2010, with 10 species lost and six new species. There were no significant changes in aboveground biomass, with a mean across years of 332.59 t/ha. Mortality rates ranged from 1.16% to 2.46% per year while recruitment rates ranged from 0.59% to 2.32%, with the highest rates recorded from 2000 to 2005. There was general flowering event took place in 2002 that likely caused high recruitment in the 2005 census. A drought in mid-2004 and early 2005 likely contributed to the high mortality rate in 2005. Large trees (diameter $\geq$ 60 cm) had the highest mortality rate throughout the 25-year census period. Growth rate decreased significantly in the first 15 years, but increased from 2000 to 2010, perhaps due to a more open canopy resulting from tree mortality. Trees growing on the alluvial soil habitat had the highest mortality and growth rates compared to other habitat types in the plot. Recruitment rate was significantly higher in alluvial soil habitat in 1995 census, but in the 2005 census it was higher in the slope and ridge habitats. The forest within the Pasoh 50 ha plot is often considered to be homogenous. However, our analysis shows that there is considerable heterogeneity in demographic dynamics that may be attributable to interspecific and size-related variation in the responses of trees to interactions between climate and habitat, which may produce directional changes in forest processes and ultimately shift its species composition.

Paper Number: 261

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.1 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests

SYMPOSIUM 15

Freshwater Ecosystems and Dams in Southeast Asia: Understanding Human Impacts and Aligning Science With decision Making Processes for Conservation and Sustainable Development

The freshwater mussels of Sundaland: towards protecting a unique fauna in a changing environment

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¹ University of Nottingham Malaysia Campus

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Introduction

Freshwater ecosystems are crucial for people, providing water, food and energy. Freshwater invertebrates, including mussels (Bivalvia: Unionida), are poorly studied but provide important services, including water purification and sediment stabilisation. This biodiversity is rapidly declining due to habitat destruction, pollution, dams, overexploitation, climate change and biological invasions. Effective conservation requires a clear understanding of the spatial and temporal patterns of biodiversity and threats. However, for freshwater mussels in Sundaland - one of the most biodiverse regions of the world - these data are currently not available.

Objectives

The objective of this project was to improve our ability to protect freshwater mussel biodiversity in Sundaland by (1) assessing past and present freshwater mussel diversity and distribution; (2) quantify genetic diversity and described population genetic patterns of species; and (3) identify the drivers of distribution and threats to freshwater mussel species.

Methods

Past and present patterns of freshwater mussel biodiversity were assessed and monitored through museum collections and field expeditions across all major river basins of Malaysia and Brunei. Species were identified through integrative morphological molecular approach and sequencing of the COI gene. Environmental requirements and drivers of changes in species distribution were identified using modelling approaches.

Results

Our results indicate that due to human disturbance, including deforestation, at least five out of 17 native freshwater mussel species present in the region are possibly extirpated. Populations of at least nine species have declined in the past decades and are threatened by eutrophication, sedimentation and other anthropogenic factors. In the same time span, *Sinanodonta woodiana*, a species native to Southeast China, has been introduced and dispersed across Peninsular Malaysia, Sabah and parts of Sarawak.

Implications

Remaining populations of threatened native species should be protected by establishing riparian buffers and improving wastewater treatment for rivers running through agricultural and residential land. Targeted surveys – particularly in the Kinabatangan and Sarawak basins, which were not extensively surveyed in the current project – should urgently be carried out to locate any remaining populations of the five potentially extirpated species. If surviving populations would be found in the future, the respective reaches and river basins should be placed under immediate protection. Finally, information regarding all the species' basic biological and ecological traits, detailed distribution, population trends and threats should be collected to enable effective protection, and eventually, propagation and re-introduction of native mussel species in their natural habitats.

Paper Number: 800

Tuesday, 03 July 2018 | Giza

Symposium 15 - Freshwater ecosystems and dams in Southeast Asia: Understanding human impacts and aligning science with decision making processes for conservation and sustainable development

Dams and Dolphins: Investigating Impacts and Making Management Decisions

Lindsay Porter

School of Biology, University of St Andrews

The Yangtze River Dolphin or Baiji (*Lipotes vexillifer*) disappeared in 2002 just when scientists were beginning to glimpse its ecology. A handful of cetacean species remain that rely exclusively on riverine habitats and yet, little is known of critical habitat needs or man's impact. Hydrological management, in the form of dams, barrages, irrigation diversion and sand extraction have profound impacts on riverine habitats and all riverine dolphins, like the Baiji, are feared to be on the brink of extinction.

The Amazon river dolphin (*Inia geoffrensis*) occurs throughout the Amazon and Orinoco River Basins, over 10'000's of kilometres of complex, convoluted and, at times, impenetrable rainforest habitat making a comprehensive study challenging. The tucuxi (*Sotalia fluviatilis fluviatilis*) overlaps some of the river dolphins habitat and shares the same threats. Damming has already isolated some individuals, that may require translocation back to a larger population, in addition to diminishing prey resources. A proposed programme of riverine modification, from dams to hydrovias, is increasing the threats to these dolphins.

The Ganges river dolphin (*Platanista gangetica*) and the Indus river dolphin (*P. g. minor*) once ranged throughout the entire Ganges and Indus River systems. Today, this range has been severely restricted and each remaining population numbers just a few thousand individuals. The habitat has been fragmented by dams and barrages, diminishing each populations reproductive functionality. The Indus river dolphin is the only population that has shown some adaptation to navigating barrages.

The Irrawaddy dolphin (*Orcaella brevirostris*) only occurs in three rivers: the Mekong River in Lao and Cambodia; the Mahakam River in Indonesia; and the Ayeyarwady River in Myanmar. All populations number less than 100 individuals and each is impacted by extensive river habitat modification, including dam development that has led, in part, to illegal electro-fishing which is lethal to dolphins.

The Yangtze finless porpoise (*Neophocaena asiaeorientalis asiaeorientalis*) population once existed alongside the Baiji and has been impacted by the same threats which drove that species to extinction. Rigorous ex situ management actions in oxbow lakes appear to have halted the decline of this species.

Habitat alteration such as damming, can have severe impacts on populations which occur 1000's of kilometres downstream. Although some management actions appear to have had a positive impact, riverine cetacean populations are in decline. Remaining pristine riverine habitats must be protected and those which have been degraded must be rejuvenated if there is any hope for the remaining species.

Paper Number: 984

Tuesday, 03 July 2018 | Giza

Symposium 15 - Freshwater ecosystems and dams in Southeast Asia: Understanding human impacts and aligning science with decision making processes for conservation and sustainable development

Modeling the impact of hydropower dams on fish biodiversity and its synergistic effect with global warming in the Indochina region.

Yuichi Kano

Hydropower dams pose threats to freshwater fish diversity. We made ecological models that shows how the dams impact to the fish biodiversity of the Indochina region, including the lower Mekong Basin and Chao Phraya River, in another term, the Indo-Burma Hotspot. Species distribution models were made by MAXENT with using a dataset of 363 fish species from 1571 locations, which was obtained in the region by Nagao Natural Environment Foundation Japan and associate local institutes for 8 years (2007-2014). For the environmental factors of the MAXENT, 14 layers that included dam (both constructed and planned dams) and climate factors were used. As results, decline in the species richness was most apparent over the 7600 MW (current condition) to 15,000 MW range, especially in Lao PDR. The dams on the Mekong mainstreams (e.g., Xayaburi dam) showed higher negative impacts than those on tributaries, even though the same electrical output. According to the global warming, fishes need to immigrate upstream, cooler habitats. In the models, we also calculated the synergistic effect of dams and global warming in which fish upstream immigration was prevented by the dams. The models considering the synergistic effect showed 10–20% higher negative impact than those models that excluded synergistic effect.

Paper Number: 374

Tuesday, 03 July 2018 | Giza

Symposium 15 - Freshwater ecosystems and dams in Southeast Asia: Understanding human impacts and aligning science with decision making processes for conservation and sustainable development

Interlinking Science with Decision-making: Sustainable Development of Hydropower Dams in Sarawak

Karen Lee Suan Ping and Tonny Ganyai

Hydro Environmental Sciences Division, Research and Development Department, Sarawak Energy Berhad, 93050 Kuching, Sarawak, Malaysia

Development of hydropower dams in Sarawak has been staggered over the last 35 years, with the commissioning of Batang Ai in 1985, followed by Bakun in 2011 and Murum in 2014. In earlier days, particularly in the case of Bakun and Murum, the need to conduct environmental baseline studies as part of Environmental Impact Assessments (EIA) was mainly for regulatory compliance. However, realising the need to go above and beyond compliance requirements prompted Sarawak Energy to initiate studies in various environmental topics, such as those in the International Hydropower Association (IHA) Hydropower Sustainability Assessment Protocol.

Sarawak Energy has since undertaken studies in Aquatic and Terrestrial Ecology, Geomorphology, Water Quality and Climate Change in collaboration with local academic institutions, on an extended time-scale basis, aiming to derive advantages from data volume availability to support trending and projection. Emphasis is placed on understanding the pre-development conditions and continuously assessing them against post-development conditions throughout the project life-cycle, aiming to provide solutions to avoid, mitigate or compensate those differences.

The research work undertaken have produced significant volume and detail of scientific data that were non-existent in the selected study areas before the collaborative research projects were conducted. These scientific baseline data will form the core information in creating GIS maps of various project river basins, for the purpose of strategizing effective decision-making for hydropower management. New technical knowledge and research methodology are also expected to be created throughout the continuation of existing projects and initiation of new collaborative research projects.

Paper Number: 336

Tuesday, 03 July 2018 | Giza

Symposium 15 - Freshwater ecosystems and dams in Southeast Asia: Understanding human impacts and aligning science with decision making processes for conservation and sustainable development

Feasibility study of fish movement using a radio telemetry: implication for the conservation of Malaysian Mahseer, Tor (Gray, 1834) Species

Tonny Ganyai¹, Lee Nyanti², Jongkar Grinang³, Karen Lee Suan Ping¹, Noor Iskandar Noor Azahar² and Amar Ma'aruf¹

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Fish movement study in Sarawak is currently not available despite high species diversity. Lack of information on movement patterns and behaviour of local fish species has resulted in uncertainty on the requirements for fish passage in hydroelectric dam developments in the State. This study aims to determine the feasibility of using radio telemetry for investigating the movement of Tor species. The present assessment shows that radio telemetry is a feasible method for studying the movement of fish but adjustments are needed to solve the technical and field challenges. The challenges encountered during the present assessment include difficulty in obtaining suitable sizes of fish, undetectable transmitters possibly due to by-catch from fishing activities, and transmitter attachment techniques. This study produced a potential research solution to establish permanent monitoring station for continuous monitoring of fishes that have been tagged. In addition, this is considered a pioneer research using radio telemetry to study freshwater fish movement in Sarawak and more sampling strategies and factors are yet to be explored in order to improve the research.

Paper Number: 333

Tuesday, 03 July 2018 | Giza

Symposium 15 - Freshwater ecosystems and dams in Southeast Asia: Understanding human impacts and aligning science with decision making processes for conservation and sustainable development

System-scale planning for hydropower in Myanmar

Hannah Baleta

Justification:

Myanmar boasts some of the most diverse and intact river systems in the world. Two of the largest free-flowing rivers in Southeast Asia flow through Myanmar. These rivers serve as economic and cultural lifelines for Myanmar, with up to 70% of the people depending directly or indirectly on the river for their livelihoods[WWF forthcoming, Rivers in the Economy Report]. The rich ecosystems of Myanmar's rivers are not only supporting the economy, but also supporting natural resilience and national conservation targets.

However, Myanmar is currently developing rapidly, and in particular exploring options for increasing energy production to meet the 70% deficit that currently exists. Some of the options in the energy mix include hydropower. For instance, the former government issued permissions to develop over 50'000 MW of additional hydropower capacity; 15 times more than what is currently installed. Development at this scale, without the necessary safeguards in place, could be detrimental to the environmental, social and economic benefits accrued from the Ayeyarwady River.

Myanmar's newly formed government is seeking to reform its planning and policies and improve the capacity of its staff to implement them, all within an overarching commitment to sustainable development. In absence of a clear hydropower policy or plan, the current government entered a Strategic Environmental Assessment (SEA) for the hydropower sector.

Objective:

The objective of carrying out system scale planning in Myanmar was to highlight the trade-offs associated with a series of hydropower investments in the river. The ultimate goal is to show that a wider, system-scale view of a catchment may lead to better outcomes for the entire basin, rather than localised, project-based outcomes related only to energy generation.

Results:

Multi-criteria modelling together with trade-off analysis and stakeholder engagement were used in a pilot process on the Myitgne River. The modelling technique was able to show the trade-offs between environmental, economic and social factors associated with development of hydropower in the basin.

Conclusion:

This is a powerful tool for energy development to identify where the best possible suite of investment opportunities lie within a basin. This is also a powerful tool for sectors that are impacted by hydropower development to show in a tangible and graphic way how they are impacted, and how alternative options may exist that provide a better outcome for both energy and other values attributed to the river system.

Paper Number: 597

Tuesday, 03 July 2018 | Giza

Symposium 15 - Freshwater ecosystems and dams in Southeast Asia: Understanding human impacts and aligning science with decision making processes for conservation and sustainable development

GENERAL SESSION 9.1

Mammal Ecology & Conservation

The Tapanuli Orangutan: Just described and under immediate threat

Gabriella Fredriksson

In November 2017 a new species of orangutan (*Pongo tapanuliensis*) was described from the Tapanuli area in North Sumatra, Indonesia. This orangutan is more closely related to the Bornean orangutan than it is to the Sumatran orangutans living further north, in and around the Leuser Ecosystem in Aceh and North Sumatra Provinces. The three orangutan species —Bornean, Sumatran and Tapanuli—began to diverge from their common ancestor about 3.4 million years ago. Tapanuli orangutans are now only found in the Batang Toru Ecosystem south of Lake Toba. This small remnant population of Tapanuli orangutans survives in only about 1,100 square kilometers of remaining habitat. With less than 800 individuals left, and the population already divided over 3 forest blocks separated by roads and agricultural land, urgent conservation efforts are needed now to ensure the survival of the Tapanuli Orangutan. Mining concessions, a proposed hydrodam, encroachment, and illegal logging all continue to threaten the Tapanuli orangutans' habitat, and hence the existence of this new species. The Tapanuli orangutan is now the most endangered Great Ape species in the world, and was listed as Critically Endangered on the IUCN Red List. We discuss here the conservation efforts that have been carried out the last decade to protect the remaining habitat of this species, and what urgent steps need to be taken in the immediate future to save this species.

Paper Number: 680

Tuesday, 03 July 2018 | Machu Pichu

General Session 9.1 - Mammal Ecology & Conservation

The red ape in the red: Global demand for natural resources and Bornean orangutan decline

Maria Voigt, Serge A. Wich, Marc Ancrenaz, Erik Meijaard, Nicola Abram, Graham L. Banes, Gail Campbell-Smith, Laura J. d'Arcy, Roberto A. Delgado, Andi Erman, David Gaveau, Benoit Goossens, Stefanie Heinicke, Max Houghton, Simon J. Husson, Ashley Leiman, Karmele Llano Sanchez, Niel Makinuddin, Andrew J. Marshall, Ari Meididit, Jukka Miettinen, Roger Mundry, Musnanda, Nardiyono, Anton Nurcahyo, Kisar Odom, Adventus Panda, Didik Prasetyo, Aldrianto Priadjati, Purnomo, Andjar Rafiastanto, Anne E. Russon, Truly Santika, Jamartin Sihite, Stephanie Spehar, Matthew Struebig, Enrique Sulbaran-Romero, Albertus Tjiu, Jessie Wells, Kerrie A. Wilson, and Hjalmar S. Kühl

Global demand for natural resources and their unsustainable exploitation is increasingly affecting the highly biodiverse tropics. Although rapid developments in remote sensing technology have permitted more precise estimates of land cover change over large spatial scales, our knowledge about the effects of these changes on wildlife is much more sparse. In our study we use field survey data, predictive density distribution modeling, and remote sensing to investigate the impact of resource use and land use changes on the density distribution of Bornean orangutans (*Pongo pygmaeus*). Our predictions of orangutan abundance loss across Borneo suggest that the population decreased by more than 100,000 individuals between 1999 and 2015, corroborating recent estimates of decline. While land clearance caused the most dramatic rates of decline, it accounted for only a small proportion of the total loss. A much larger number of orangutans were lost in selectively logged and primary forests, where rates of decline were less precipitous, but where far more orangutans are found. This indicates that further drivers, independent of land use change, contribute to orangutan loss and is consistent with studies reporting killing for food and in conflict as a major cause of the decrease in orangutan numbers. Solutions to prevent future orangutan loss can only be realized by addressing its complex causes holistically across political and societal sectors, integrating land use planning, resource exploitation, infrastructure development, and education to achieve long-term sustainability. Concrete measures include maintaining and protecting forest areas and stopping the killing of orangutans through awareness raising, support for communities in conflict situations and strict law enforcement.

Paper Number: 410

Tuesday, 03 July 2018 | Machu Pichu

General Session 9.1 - Mammal Ecology & Conservation

Fading stripes in the Annamite mountains of Vietnam and Laos: data for a little-known endemic lagomorph caught in the Southeast Asian snaring crisis

Andrew Tilker, An Nguyen, Jesse F. Abrams, Tejas Bhagwat, Minh Le, Thanh Van Nguyen, Anh Tuan Nguyen, Jürgen Niedballa, Rahel Sollmann, and Andreas Wilting

Southeast Asia is undergoing an extinction crisis from widespread poaching. The most pervasive threat comes from industrial-level snaring, which has already defaunated entire forest complexes across the region. Snaring is particularly pervasive in Indochina and has caused the decline of all terrestrial large mammal species. Two striped species embody this crisis: Tigers *Panthera tigris* are now almost extinct in Indochina, and the Owston's civet *Chrotogale owstoni* was recently downgraded to Endangered on the IUCN Red List of Threatened Species. Although the decline of species like tiger and Owston's civet has been well-documented, other species suffering from snares have received far less attention. To date, no comprehensive work has been conducted on the Annamite striped rabbit *Nesolagus timminsi*, a recently-discovered and little-known lagomorph restricted to the Annamites mountain on the border of Vietnam and Laos. Without basic information on its ecology, distribution, and status in key areas, conservation stakeholders cannot make informed decisions for its protection. We present the first detailed information on the Annamite striped rabbit. We used a systematic camera trapping design to study the species in five areas in Vietnam and Laos. In 29,180 camera trap nights, we recorded 152 independent events ($\Delta=60$ min) at 36 of 266 stations, representing the largest dataset ever collected for the species. We obtained an additional 143 independent detections across 12 stations from a supplementary nonsystematic survey. We found Annamite striped rabbit to be nocturnal and primarily solitary. Occupancy was best explained by a proxy for past hunting pressure, with no significant relationships to current anthropogenic or environmental factors. Local abundance was 0.57 individuals per camera trap station for one of our sites, and estimated to be zero at the other site, where hunting has been more severe. Our results provide information on priority areas for targeted snare-removal efforts. Furthermore, we establish the first conservation baseline species, which will allow conservation practitioners to assess population trends in this landscape. We call attention to the fact that, without a significant reduction in industrial snaring levels in Vietnam and Laos, the Annamite striped rabbit will follow the tiger and Owston's civet into local—and even global—extinction.

Paper Number: 387
Tuesday, 03 July 2018 | Machu Pichu
General Session 9.1 - Mammal Ecology & Conservation

Packs in peril? Metapopulation dynamics inform strategies to conserve dhole *Cuon alpinus* populations in the Western Ghats of India

Arjun Srivathsa

With global-scale increase in anthropogenic changes to natural systems, most large-bodied wildlife species occur in highly heterogeneous landscapes, typically with source populations embedded in a matrix of human-dominated habitats. Metapopulations of many large carnivore species currently thrive in such landscapes, while their populations continue to decline. Understanding metapopulation dynamics of threatened and endangered carnivores is therefore critical for prioritizing and implementing management strategies. The endangered dhole *Cuon alpinus* is pack-living wild canid found in forests of south and southeast Asia. We conducted indirect sign surveys to examine distribution and dynamics of a dhole metapopulation across c. 38,000 sq. km area in the Western Ghats landscape of India. We adopted a grid-based design, overlaying an array of 197 188-sq. km cells across the landscape. We assessed patterns of dhole distribution in 2007 and 2015, and, local colonizations and extinctions between the eight-year period using multi-season dynamic occupancy models. Dhole occurrence was influenced by relative abundance of primary prey species and anthropogenic disturbance. Dhole occupancy in the landscape reduced from 62% in 2007 to 54% in 2015. Local extinctions were driven by loss of forest cover, and persistence was facilitated by presence of protected reserves. Perturbation analysis indicated that dhole occupancy was more sensitive to extinction than to colonization, and allowed us to identify areas for targeting management interventions. While protected reserves are crucial, dholes continue to occur outside parks where host of factors threaten their survival. Ongoing infrastructure development projects and diversion of forest lands for commercial use could adversely impact source populations through geographic and demographic isolation. We discuss how sociality in dholes, ecological constraints of the species, and, exclusive conservation focus on a co-predator (the tiger) could affect their long-term persistence in the landscape. The Western Ghats can serve as a stronghold for dholes, provided future colonizations are facilitated through habitat expansion outside reserves and extinction rates are offset by increasing protection measures. We propose that wildlife managers adopt a metapopulation-centric approach to monitor and conserve dholes and other large carnivores threatened with endangerment.

Paper Number: 976
Tuesday, 03 July 2018 | Machu Pichu
General Session 9.1 - Mammal Ecology & Conservation

The Multiple States of Mammalian Communities in the Anthropocene

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Top predator extirpation, hunting, habitat loss and fragmentation have been shown to affect natural ecosystems in different ways. However, in most regions these different processes act simultaneously, reshaping ecological communities into novel and generally more depauperate configurations. We present a conceptual model proposing that Anthropocene mammalian assemblages where top predator control is absent are pushed towards one of three main states, depending on the incidence and magnitude of anthropogenic drivers. The three main states of mammalian assemblages are (1) assemblages dominated by large herbivores due to top predator loss, (2) assemblages dominated by rodents due to hunting of competing ungulates or habitat reduction, and (3) assemblages dominated by mesopredators, which succeed in fragmented landscapes subsidized by prey that rely on human subsidies. As a proof of concept, we built a model simulating the dynamics of each guild and show that depending on the prevailing driver, assemblages are pushed into one of these three main attractors. We then tested the empirical support of the multiple states hypothesis using the mammalian assemblages of the Atlantic Forest as a study case. Using camera trap data from ATLANTIC Camtraps we examined the relative frequency of the three different guilds in 30 sites encompassing varying preservation degrees. As predicted, we found that sites with continuous forests where top predators are present tend to have more balanced proportions among the three guilds. Conversely, areas that share a similar history of anthropogenic impacts tend to group together, with any of the three guilds being more dominant depending on the main anthropogenic driver acting locally. These different states have profound effects on ecological processes, threatening ecosystem services and human well-being. These altered states will be the dominant scenario in the Anthropocene and we must learn more about their structure and dynamics to be able to manage them properly.

Paper Number: 838

Tuesday, 03 July 2018 | Machu Pichu

General Session 9.1 - Mammal Ecology & Conservation

Ecological correlates of mammal β -diversity in Amazonian land-bridge islands: from small to large-bodied species

Ana Filipa Palmeirim

Hydropower development has become one of the main drivers of biodiversity loss in the lowland tropics. In hydroelectric reservoirs, vertebrate studies have focused on local (α) diversity measures, whereas between-site (β) diversity remains poorly assessed despite its pivotal importance in understanding how species diversity is structured and maintained. Here, we have evaluated the patterns and ecological correlates of mammal β -diversity, including both small (SM) and mid-sized to large mammal species (LM) across 23 islands and 2 continuous forest sites within one of the largest hydroelectric reservoirs in South America, the Balbina Hydroelectric Dam. Small mammals were sampled using live and pitfall traps (48,350 trap-nights), and larger mammals using camera traps (8,160 trap-nights). β -diversity was examined for each group using multiplicative diversity decomposition of Hill numbers, which considers the importance of rare, common and dominant species. We further tested to what extent each order of β -diversity was related to a set of environmental characteristics measured at different spatial scales. β -diversity for both mammal groups was higher when considering species presence-absence. When considering species abundance, β -diversity was significantly higher for SM than for LM assemblages. Habitat variables, such as differences in tree species richness and percentage of old-growth trees, were strong correlates of β -diversity for both SMs and LMs. Conversely, β -diversity was weakly related to patch and landscape characteristics, except for LMs, for which β -diversity was correlated with differences in island sizes. The lower β -diversity of LMs between smaller islands suggests subtractive homogenization of this group. Although island size plays a major role in structuring mammal δ -diversity in several land-bridge islands, local vegetation characteristics were additional key factors determining β -diversity for both mammal groups. Maintaining the integrity of vegetation characteristics and preventing the formation of a large set of small islands within reservoirs should be considered in long-term management plans in both existing and planned hydropower development in lowland tropical forests.

Paper Number: 417

Tuesday, 03 July 2018 | Machu Pichu

General Session 9.1 - Mammal Ecology & Conservation



GENERAL SESSION 10

Community-Based Forestry

Power of the People: Strengths, Weaknesses, Opportunities, and Threats in Ethiopian Orthodox Church Forest Conservation Institutions

Jasmine Randle

Introduction/Background/Objective

In Ethiopia followers of the Ethiopian Orthodox Tewahido Church (EOTC) have a centuries-old tradition of conserving forest patches around churches; today these “church forests” are home to some of the most complex social-ecological systems in the world. Community-based regulations, rooted in religious values and supported by governmental policies, have helped to conserve church forests as cultural treasures and libraries of biodiversity. However, scholarly literature is limited concerning how local church forest institutions function. The overarching question motivating my research is: In the face of economic and political instability compounded by climate change, what conservation insights do church forest institutions in northern Ethiopia provide?

Methods

I conducted a SWOT (strengths, weakness, opportunities, and threats) analysis, drawing on a thorough literature review of Ethiopia's past and present national political context and economy, and analyzed household survey data on general church community characteristics in selected church forest communities in northern Ethiopia from 2015 and 2017. By assessing the strengths, weaknesses, opportunities, and threats of church forest institutions, I am able to provide useful information on what church forests should continue doing, identify areas of improvement, and provide suggestions on how to maximize the opportunities and diminish the downfalls.

Conducting a SWOT analysis allows us to view church forests within their greater social-ecological contexts.

Results/Implications

Findings from this study suggest that while Ethiopian Orthodox Church communities are currently conserving the last few remnants of native Afromontane forest, there are still many institutional barriers, both internal and external, to the effectiveness of these religion-based conservation institutions. Moreover, my research found that while there is a growing wealth of scholarly literature that examines the ecological importance of church forests, there is little research to date on how religion-based conservation functions in this developing country context. There is an urgent need to better understand the goals and relative effectiveness of alternative church forest conservation strategies within the Ethiopian context – a context that is constantly changing, socially, economically, politically, and environmentally.

Paper Number: 356
Tuesday, 03 July 2018 | Chichen Itza
General Session 10 -Community-Based Forestry

Ethiopian Orthodox Tewahido Church Forest Locations and Extent: Applications of a New Dataset for Remote Sensing Studies of Afromontane Forest Patches in Northern Ethiopia

Travis Reynolds

Background. Followers of the Ethiopian Orthodox Church have a centuries-old tradition of conserving patches of native Afromontane forest vegetation around Orthodox church buildings; today these “church forests” represent some of the only remaining natural vegetation across the heavily degraded northern Ethiopian landscape. The increasing availability of high-resolution satellite imagery allows for cataloguing and monitoring the number and extent of church forests in Ethiopia, as well as church forest attributes including vegetation density and edge-area ratio – which relate to biodiversity and other ecosystem services – both across space and over time.

Objectives. This paper describes a new dataset representing the first large-scale effort to document the locations and extent of church forests across Ethiopia’s northern highlands. This dataset contains the geospatial coordinates and boundary tracings for over 12,000 church forests across the 159,174 square kilometer Amhara Peoples National Regional State. The presence of church forests in northern Ethiopia at almost every latitude and longitude provides a unique opportunity to study native forests across multiple abiotic, biotic, and human management gradients.

Methods. We describe and illustrate applications of this new Ethiopian Orthodox church forest dataset including training automated land use classification algorithms for indigenous Afromontane forest detection, estimating changes over time in natural forest cover (both size and vegetation density as proxied by NDVI), and undertaking analyses of the socioeconomic correlates of church forest extent, density, and change.

Results. We find that church forest vegetation productivity increases with size and decreases with amount of edge; productivity also increases with rainfall with tree species diversity. But both church forest size and productivity are also associated with local economic and demographic factors. Higher human and livestock population density are associated with smaller church forests. Higher levels of wealth and market access, meanwhile, are associated with more dense vegetation as measured by NDVI. Some of this vegetation density, however, is attributable to planting of non-native *Eucalyptus* spp. in church forest groves to supplement local incomes.

Implications. Our dataset allows for a greater appreciation of ecological complexity in northern Ethiopia. Indigenous forests provide an array of ecosystem services, thus there is value in distinguishing forest types (native versus plantation), and in understanding the ecological, economic, and cultural contexts under which native forests are being sustained. This dataset is a product of an NSF-funded Research Experience for Undergraduates (REU) Site in Ethiopia (<http://www.colby.edu/reu-in-ethiopia/>). Our original church forest dataset is being made publicly available for other researchers.

Paper Number: 834
Tuesday, 03 July 2018 | Chichen Itza
General Session 10 -Community-Based Forestry

Sustained From Within? Social and Ecological Drivers of Expanding Internal Clearings in Ethiopian Orthodox Church Forests

Wesley Misna Zebrowski, Travis Reynolds, Alemayehu Wassie

Background: In a largely deforested landscape, thousands of small pockets of indigenous forest remain in Ethiopia's northern highlands. These "church forests" are maintained by Ethiopian Orthodox church communities, and they serve as striking examples of centuries-old religion-based natural resource conservation institutions. Church forests provide valuable reserves of indigenous species diversity and ecosystem services. However there are important tradeoffs between ecological ecosystem services and cultural ecosystem services, especially in community-made clearings within church forests, which provide room for church buildings, prayer spaces and burial grounds. These clearings vary in number and size across church forests—leading to dramatic variation in total forest cover (and resultant ecosystem services) reflecting church community preferences surrounding church forest uses.

Objectives: Our research examines the degree to which differences in prayer space clearing size impacts church forest vegetation density. We further consider how socioeconomic characteristics of church communities, including income and remoteness, relate to the size of clearing space.

Methods: We digitized the extent and clearing size of 3,185 church forests using modern high-resolution satellite imagery, and we further utilized Sentinel 2 data to calculate the vegetation density (as measured by normalized difference vegetation index (NDVI) of forests. We then analyzed possible relationships between church forest clearing size and sociodemographic variables provided by the Ethiopian Rural Household Survey. We constructed two ordinary least squares regression models to predict the vegetation density (NDVI) of forests as a function of landscape and forest extent variables, with one model incorporating internal clearings and one without.

Results: Clearings on average constitute 10% of church forest area, and only 49 churches have clearings greater than 50% of their respective forest's area. In models of church forest NDVI, incorporating church clearings significantly improves the accuracy and reliability of vegetation density prediction models. The size and jaggedness of clearings significantly increase as community wealth and assets increase, although electric stove ownership moderates the jaggedness of clearings.

Conclusion: Our findings suggest that incorporating church clearings into remote sensing estimates leads to ecologically meaningful differences in church forest vegetation density estimates. Findings ultimately suggest that even as church forests have proven remarkably resilient over the past several centuries, they may now be threatened from within. In order to support the resiliency of forests in the face of economic development, we recommend further community-level research on what socioeconomic factors are associated with stronger conservation practices.

Paper Number: 933
Tuesday, 03 July 2018 | Chichen Itza
General Session 10 -Community-Based Forestry

Social Forestry Roles in Reducing Deforestation

Joseph Hutabarat¹, Ahmad Kusworo¹, Tito Indrawan¹, Truly Santika², Rachel Friedman², Sugeng Budiharta³, Erik Meijaard⁴, Freya St. John⁵, & Matthew Struebig⁶

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The government of Indonesia is targeting 12.7 million hectares of forests to be allocated as social forestry by 2020 for reducing deforestation while improving the welfare of rural communities. Compared to the exponential rate of forest become social forestry, the impact of the extent to which deforestation has been avoided under social forestry remains unclear. This study aims to assess how effective village forest (Hutan Desa), as one of the social forestry schemas, in reducing deforestation. We used annual data on deforestation rates between 2012 and 2016 from Kapuas Hulu and Ketapang Districts against forest areas with and without Hutan Desa tenure. Our study suggests that overall Hutan Desa is able to avoid deforestation albeit the performance varies through time. Hutan Desa on limited production forest avoids less deforestation compare to the protection forest. This study contributes to the step in evaluating the effectiveness of government target, especially in achieving social and environmental goals.

Paper Number: 862
Tuesday, 03 July 2018 | Chichen Itza
General Session 10 -Community-Based Forestry

The Little-Known Stingless Bees: Diversity, Peculiarities and It's Potentials for Community-Based Forest Conservation

Hil Padilla & Joanne Li

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Most people have almost no awareness about stingless bees (Meliponini) with 500 species described worldwide compared to honey bees (*Apis* spp.) with only 11 species. Stingless bees are considered to be among the major pollinators in the tropics and hence, it is important to have a better understanding and to conserve these little-known insects. South America is the center of speciation of these highly diverse tribe with Brazil supporting 300 species. Honey bees store their honey in combs made of wax while stingless bees store their honey in jars made of propolis. Stingless bee honey is slightly sour as it ferments in the propolis jar increasing its anti-oxidant properties. Meliponine mass provision their larvae allowing self-determination of roles in contrast to honey bees that are progressively fed wherein the larvae queen is fed more. They are great pollinators and have high potential for commercial crop pollination easing the total reliance of world agriculture on honey bees. They have short flight ranges with excellent ability to work in glasshouses, and are more resistant to the diseases and parasites that attack honey bees. These properties make them easier to manage compared to the highly absconding Asiatic honey bees. People are now starting to realize the potential of stingless bees but the domestication technique is still in its infancy. The current way of honey harvesting is not sustainable and wild colony collection destroys their natural habitat. On Hainan Island, we introduced innovative techniques for forming new colonies from the wild without destroying the goose that lays the egg, tricks in splitting colonies and promoted low-costs bee boxes that allows easy harvesting of honey without disturbing the brood. Stingless bees are highly dependent on forests, and farmer that keep stingless bees are realizing the need to conserve adjacent forests to have these bees better managed. They are changing their attitude on forest protection and agriculture. They now diversify their mono-crop rubber plantation to mimic the forest structure. The high value and native rubber under-storey crop, bitter cardamom (*Alpinia oxyphylla*), is pollinated by the stingless bees. The high prices of stingless bee honey (2x higher) and colonies (US\$ 200/hive) are driving farmers to conserve the bees and the flowers and the trees.

Paper Number: 265

Tuesday, 03 July 2018 | Chichen Itza

General Session 10 -Community-Based Forestry

SYMPOSIUM 16.1
Natural History and Canopy
Dynamics of Lowland Evergreen
Forests on Mt Makiling Forest
Reserve and ASEAN Heritage Park,
Philippines

Regeneration and Restoration Dynamics of a Tropical Forest Under Stress: The Case of the Mt Makiling Forest Reserve, Philippines

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The regeneration and restoration dynamics of a tropical rainforest that has undergone a catastrophic super typhoon (Category 5) event like Rammasun (local name Glenda) with winds up to 259 kph are investigated. Further, the use of unmanned aerial systems (UAS) imagery is explored in characterizing changes in forest canopy following a typhoon disturbance within a 2-hectare Long-term Ecological Research Plot (LTERP). UAS provide on-demand imaging supplementing satellite imagery which offer more limited temporal resolution. Orthorectified UAS imagery over dense vegetation provide snapshots representing canopy condition when imagery is taken. Images were captured in May 2014, August 2014, and January 2017 representing the forest vegetation condition before, immediately after, and 3 years after typhoon Rammasun devastated portions of Mount Makiling Forest Reserve (MMFR), respectively. Our analysis of the vegetation soon after the typhoon event showed that Malvaceae incurred the most damage (ca. 39%) specifically *Diplodiscus paniculatus* and *Microcos stylocarpa*. About 7% of the Dipterocarpaceae and Moraceae families were damaged (eg. detopped). Object-based image analysis allowed for the creation of visually homogenous areas within orthorectified images called segments. Visual qualities including brightness and darkness of segments were used to identify canopy gaps. Analysis shows that prior to the typhoon, there were approximately 3,600 square meters of perceived canopy gaps within the LTERP. This nearly doubled to about 6,200 sq.m. immediately after the typhoon. Gaps apparently normalized two years after to an estimated 2,700 sq.m., indicating the rate of recovery of the forest canopy at about 1,750sq.m./year inside the 2-ha plot. Spatial reconfiguration of canopy gaps was observed across the three time periods owing to the disturbance generated by the typhoon event.

Paper Number: 864

Tuesday, 03 July 2018 | Eiffel 1

Symposium 16.1 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines

Preliminary Assessment of the Forest Canopy Diversity of a 2-ha Long-Term Ecological Research (LTER) Plot in Molawin-Dampalit Watershed, Mt Makiling Forest Reserve

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The study is under the Project 2 of the Forest CANopy Observation, Positioning and Investigation (CANOPI) Program that aims to provide information on forest canopy biodiversity in Mt. Makiling Forest Reserve with a focus on flora and invertebrate fauna. For the floral component, plant specimens are collected in the field from the canopy of the different trees in the area; such as Narra (*Pterocarpus indicus*) Bagtikan (*Parashorea malaanonan*), Balete (*Ficus* sp.), Tiaui (*Crypteronia paniculata*), and Baleteng tilos (*Ficus pellucidopunctata*) using installed scaffoldings or rope ascension. Distance of the sample from the trees' axis, direction of the branches, temperature, and relative humidity is also observed. As of writing, the team have collected 42 samples of ferns belonging to 6 families, 16 samples of moss belonging to 6 families, 12 samples of orchid belonging to 4 families, 27 samples of vine belonging to 9 families and 26 samples of epiphyte belonging to 7 families. For the invertebrate fauna, specimens are obtained via trapping and opportunistic sampling. Yellow pan trap and malaise traps are used for trapping while handpicking, soil and bark litter, and sweeping are conducted for opportunistic sampling. The obtained samples are sorted, identified, and are then preserved and stored in insect jars and insect boxes. There are about 11 orders of insects collected.

Paper Number: 850

Tuesday, 03 July 2018 | Eiffel 1

Symposium 16.1 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines

Patterns of Vertical Stratification and Herpetofaunal Diversity on Lowland Evergreen Forest in Mt. Makiling Forest Reserve, Philippines

Whizvir O. Gustilo (speaker)¹, Juan Carlos T. Gonzalez^{1,2}, Anna Pauline O. de Guia^{1,2}, Judeline C. Dimalibot^{1,2}, Khryss V. Pantua¹

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Many studies had been done on distribution and diversity of Philippine herpetofauna along an elevation gradient; yet in terms of vertical stratification, only few studies exist. Our project studied the forest canopy vertebrate fauna of a 2-hectare permanent ecological plot in Mt. Makiling Forest Reserve which includes herpetofaunal diversity along vertical stratification. Three sampling periods were done from 2016 to 2018 for each strata: understorey, sub-canopy, and canopy. The plot was divided into four quadrats and area-constrained sampling was employed. Percent similarity between two strata was computed and expressed as Sørensen's similarity coefficient (SS). We captured a total of 87 individuals for amphibians belonging to four families, seven genera and 11 species; for reptiles, we captured 69 individuals from six families, 15 genera and 15 species. For amphibians, both canopy and sub-canopy strata had one exclusive species observed, while understorey had six exclusive species. For the exclusive reptile species present, one species was observed in the canopy, three species in sub-canopy, and two in the understorey. Only *Platymantis luzonensis*, *Ahaetulla prasina*, *Cyrtodactylus philippinicus* and *Pinoyscincus jagori* were present in all strata. Canopy level had the lowest percent endemism (<56%), while understorey had high endemism for both Classes (>71%). Sub-canopy and canopy strata had the highest percent similarity for both amphibians and reptiles (SS, amphibians = 0.6667; SS, reptiles = 0.70). We observed that understorey had higher endemism and higher number of exclusive species compared to sub-canopy and canopy. Our results suggest that there is a species overlap with canopy and sub-canopy, and that both amphibians and reptiles move from one strata to another. Also, our findings support that it is necessary for sampling techniques to include all three strata in order to prevent underestimation and obtain a more comprehensive inventory on herpetofauna.

Paper Number: 442

Tuesday, 03 July 2018 | Eiffel 1

Symposium 16.1 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines

From Floor to Canopy Layer: Distribution and Diversity of Birds on Lowland Evergreen Forests in Mt. Makiling Forest Reserve

Judeline Dimalibot

A survey of birds occupying different forest strata was conducted within the Molawin-Dampalit 2-hectare permanent plot at the Mt. Makiling Forest Reserve. The surveys were conducted in the understory on July 2016, the sub-canopy on April 2017, and the canopy on February to March 2018. The survey was done through mist-netting arrays. Mist nets were set from the ground up to 5 meters from the forest floor for the understory observation, while for the sub-canopy 10-25 meters above ground, and 17-43 meters above ground for the canopy where nets were set resembling curtains. Nets were checked every morning and before dusk for captures. A total of 26 species of birds were documented from the different strata; 6 from the understory, 16 from the sub-canopy, and 14 at the canopy. Seventy seven percent of the birds documented are Philippine endemics. The higher number of bird species at the sub-canopy and canopy levels imply that food may be more abundant, available and varied in the upper strata than the understory. The higher forest strata may have provided more space for the birds to feed and forage, nest and roost. In addition, there may also be fewer anthropogenic disturbances in the upper levels compared to the understory. The result of the study is not yet conclusive considering that only one methodology (mist-netting) has been applied to observe and document the species of birds in the study site. Further field work will be conducted using other methods and equipment to gather more data.

Paper Number: 285

Tuesday, 03 July 2018 | Eiffel 1

Symposium 16.1 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines

Understorey versus Canopy Use by Bats and Non-volant Mammals on a Lowland Evergreen Forest in Mt Makiling Forest Reserve, Philippines

Anna Pauline O. de Guia^{1,2}, Juan Carlos T. Gonzalez^{1,2}, Judeline C. Dimalibot^{1,2},
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We examined the vertical stratification of bats and non-volant mammals, from the ground up to the sub-canopy and canopy layers of a 2-hectare permanent plot within the Lowland Evergreen Forest. Our aim was to determine the species richness of the rainforest and its associated layers, and evaluate the importance of their ecosystems services. Understorey, sub-canopy and canopy sampling were conducted during April 2017, November 2017 and March 2018, respectively. Netting was done to record bats while trapping was conducted to survey non-volant mammals. Our results suggest that habitat use of mammals both in terms of species richness and abundance, increases the higher the forest strata. Differences in stratification was seen in bats wherein insectivorous bats decreased the higher the forest strata while frugivorous bats increased the higher the forest strata. For non-volant mammals which were generally omnivores, habitat use was restricted to the sub-canopy to canopy layers.

Paper Number: 390

Tuesday, 03 July 2018 | Eiffel 1

Symposium 16.1 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines

Ectoparasite diversity from canopy birds, bats and reptiles from the Molawin-Dampalit Watershed, Mt. Makiling Forest Reserve.

Khryss V. Pantua¹, Darlene P. Lovina^{2,3}, Deolito M. Bicua, Jr.², Jeremy Carlo B. Naredo¹, Juan Carlos T. Gonzalez^{1,2},
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Ectoparasites can influence the fitness and behavior of its host, subsequently playing a vital role in regulating its host population size. Host-ectoparasite interactions often have significant consequences in ecological communities. It is therefore important to identify ectoparasites infesting wildlife populations. Our team conducted a preliminary investigation to identify ectoparasites of canopy birds, bats and reptiles of the Molawin-Dampalit Permanent Plot, Mt. Makiling Forest Reserve. Individuals were captured using 6- and 12-meter mist nets set at an average of 30 meters above the ground for birds and bats; and area-constrained sampling for reptiles. All captured animals consisting of 39 birds, 274 bats and 44 reptiles, were examined for ectoparasites which were then collected and stored in 70% ethyl alcohol. Out of the 357 animals examined, 20.45% (n = 73) were infested with ectoparasites, specifically 43.59% for birds, 17.88% for bats and 15.91% for reptiles. A total of 569 samples were collected and identified to be mostly flies, lice and mites. For birds, 409 samples were collected from six host species – where-in the highest ectoparasite load was observed in *Collocalia* sp. Identified avian ectoparasites belong to the families Cheyletidae, Syringophilidae, Philopteridae and Menoponidae. For bats, 132 samples were collected from five host species. *Ptenochirus jagori*, a Philippine endemic fruit bat, was observed to have the highest ectoparasite load compared to other bat species examined. Most of the identified ectoparasites were bat flies belonging to families Nycteribiidae and Streblidae. For reptiles, 29 samples from six host species were collected. Mite larva from families Pterygosomatidae and Trombididae were identified from gekkos and skinks, respectively. A single sample of a hard tick belonging to the genus *Amblyomma* was also collected from a single individual of *Boiga dendrophila*. Further knowledge in the taxonomy and distribution of ectoparasites in wildlife populations will lead to further understanding of the complex roles ectoparasites play in the structure and dynamics of tropical forest ecosystems.

Paper Number: 443

Tuesday, 03 July 2018 | Eiffel 1

Symposium 16.1 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines

SYMPOSIUM 10.2

Tackling Illegal Wildlife Trade: Extent, Tools and Technologies, and Field Monitoring Methods

Integrated technology for improving the effectiveness of anti-poaching in tropical protected areas

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Tropical landscapes and seascapes are facing degradation and loss from forest encroachment, land conversion, poaching, overfishing, pollution and other unsustainable human practices. At the same time resources available for the management of protected areas on land and sea are limited so that tools are needed to help managers prioritize where to allocate resources, enforce staff accountability, assess threats, or evaluate success and failure. The SMART Approach combines standardized patrol data collection, site-based database management, and decision-making, with an emphasis on capacity building and best practices for protection. The SMART approach now adopted in >600 sites around the world, provides protected area managers and community groups the ability to empower staff, boost motivation, increase efficiency and promote credible and transparent monitoring of the effectiveness of anti-poaching efforts. Here we present case studies from tropical Asia, Africa and Latin America showing how implementation of law enforcement monitoring under a SMART framework has led to measurably improved levels of protected area effectiveness as measured by increased ranger patrolling coverage and activity, improved patrol quality and reduced levels of threat. Combining SMART with other tools such as mobile data collection and SMART Connect, a new cloud-based application allowing users to leverage real-time information sharing and centralized management capabilities, are now further improving effectiveness of management efforts, and providing standardized measures of threat levels and enforcement efforts across sites critical to combatting the poaching and other threats to wildlife.

Paper Number: 483

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.2 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

Using technology to tackle illegal wildlife trade in Asia

Sophie Adwick

Asia Conservation Programme, Zoological Society of London

Illegal commercial wildlife trade poses one of the most significant threats to biodiversity in Asia. While this region boasts some of the highest global levels of biodiversity, countries within Asia also face the pressure of being source, transit and consumer hubs for the trade. Safeguarding wildlife in such a perilous situation presents a major challenge for conservationists.

Technology is becoming a critical tool for the fight against illegal wildlife trade in the face of considerable conservation challenges such as a need to monitor hard-to-reach locations, facilitate information access to very large and/or disparate audiences, and more effectively prosecute criminals.

The Zoological Society of London (ZSL) is a UK-registered charity devoted to the worldwide conservation of animals and their habitats. Working closely with local governments and partners, ZSL undertakes field conservation projects in 50 countries including more than 20 sites across Asia.

With partners, ZSL is employing technology as a vital component of holistic conservation programmes. This technology varies in scale and focus depending on location and need. This presentation will provide an overview of the tools being implemented, ranging from satellite and GSM-based surveillance of protected areas using camera traps and other sensors (e.g. ZSL's Instant Detect); to developing software and systems that improve access to vital information for and between customs and law enforcement officers as well as the general public.

Where such technology has been implemented, we have seen evidence of increased apprehensions, confiscations and prosecutions, increased knowledge reach to target audiences, as well as improvements in status of focal species. While these changes cannot be attributed solely to technology due to other concurrent interventions, it can and will be argued that the former has an important role to play in wildlife conservation initiatives.

Paper Number: 974

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.2 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

Countering Poaching in Deep Forests: The Tiny Team vs. Large Landscape Problem

Wai Yee Lam

Protected areas in Southeast Asia are losing wildlife at alarming rates fueled by the demand for wildlife products for the illegal trade. Limited resources to patrol large swathes of dense jungles, coupled with the lack of clear direction for deep forest patrolling, warrants a rethink in current wildlife law enforcement strategies. Here, we analysed data from patrols and surveillance cameras in a Malaysian forest and incorporated expert knowledge from senior wildlife protection officers to develop a risk map and a refined understanding of poacher modus operandi. In addition, we created a sector map to increase the likelihood of spatial overlap of patrollers with poachers and developed a novel metric 'vigilance' that indicates security presence in space and time. Ultimately, this practical framework can be used to guide fine-scale planning of anti-poaching patrols in protected areas within the region.

Paper Number: 130

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.2 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

Changes in primates supplied and offers in Indonesian wildlife markets over the last 25-years

Hélène Birot, Abdullah Langgeng, Vincent Nijman, Muhammad Ali Imron, K.A.I Nekaris

Indonesia is a hotspot of primate diversity, with approximately 40 different species. Many of these species are included on the IUCN Red List and recorded on country's protected species list, partially to prevent over-exploitation and long-term extinction. Nevertheless traders continue to catch primates from the wild and to sell individuals in open wildlife markets, especially on the islands of Java and Bali. The objectives of this study were to monitor the prevalence of different primate species in wildlife markets across Java, understand trends over time and to report our results to local wildlife officers. We surveyed 15 wildlife markets and extended our investigation to include online trade. We combined our results with previous surveys from 1990-2009. The data shows that the diversity of species in trade decreased over time, shifting from rare rainforest-dwelling primates traded alongside more widespread species that are not confined to forest to the latter type only. In the 1990s and early 2000s orangutans, gibbons and langurs were commonly traded alongside macaques and slow lorises but in the last decade macaques and slow lorises comprised the bulk of the trade. In 2012-2014 we monitored six wildlife markets in Jakarta, Bandung and Garut (all on Java), and Denpasar (Bali). During 51 surveys we recorded 1,272 primates of eight species. Traders offered long-tailed macaque (total 1,007 individuals) and three species of slow loris (228 individuals) in five of the six markets, whereas they traded ebony langurs (18 individuals), and pig-tailed macaques (14 individuals) mostly in Jakarta. Pramuka and Jatinegara markets, both in Jakarta, stood out as important hubs for the primate trade, with a clear shift in importance over time from the former to the latter. Slow lorises, orangutans, gibbons and some langurs are protected under Indonesian law, which prohibits all trade in them; of these protected species, only the slow lorises remained common in trade throughout the 25-year period. Trade in non-protected macaques and langurs is subject to strict regulations, which market traders did not follow-making all the market trade in primates that we observed illegal. Trade poses a substantial threat to Indonesian primates, and without enforcement and conservation education, the sheer volume of trade may mean that species of Least Concern to Critically Endangered may rapidly decline or become extinct.

Paper Number: 279

Tuesday, 03 July 2018 | Colosseum 1

Symposium 10.2 - Tackling illegal wildlife trade: extent, tools and technologies, and field monitoring methods

SYMPOSIUM 11.2

Feeding the Planet Whilst Minimizing Environmental and Socio-Economic Costs

Gold, farms, and forests

Graham Prescott

Mining and agricultural expansion are major drivers of deforestation. Myanmar has the largest remaining area of forest in the Indo-Burma biodiversity hotspot, but is experiencing high rates of deforestation. Minimizing deforestation and other environmental and social problems caused by gold mining is a policy priority of the regional government of Sagaing (northern Myanmar) which includes large areas of forest in such as Htamanthi Wildlife Sanctuary. Discussion with policy-makers suggested that increased law enforcement and livelihood-based interventions (such as bamboo plantations) are the key policy approaches under consideration. We interviewed 226 respondents in the agricultural and gold mining sectors, including both the formal and informal mining sectors, to understand the context for livelihood-decision making and the likely effect of proposed policy interventions. Low agricultural incomes were a key driver of mining participation, with many respondents reporting that gold mining was their best, or only, livelihood option. However, among farmers that did not participate in mining, the most popular reason for not mining was insufficient money to invest into mining. The informal mining sector had its own parallel governance system, whereby miners paid fees for village and monastic development and for village authorities to pay law enforcement—resulting in law enforcement being viewed as a tax or cost of business, rather than an effective deterrent. Livelihood-based approaches alone are unlikely to succeed as they may simply enable more people to invest into gold mining. Likewise, increased law enforcement intensity alone is unlikely to succeed without governance reform to reduce corruption.

Paper Number: 893

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.2 - Feeding the planet whilst minimizing environmental and socio-economic costs

Does land sparing or sharing agriculture best protect avian functional diversity?

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Global food production may need to double by 2050, with the conservation of tropical biodiversity thus increasingly placed in the hands of agricultural policy makers. A key question is whether it would be best to protect wildlife within low intensity farmland (sharing) or to farm more intensively, meeting yield needs on a smaller land area and enabling protection of wildlife within spared land elsewhere (sparing). Focusing on cattle production in Latin America, we investigate whether such land sharing or land sparing farming will best protect avian functional diversity. The retention of functionally important species and their associated ecological roles can strengthen the resilience and stability of communities to future land-use change whilst potentially enhancing ecosystem service provision and productivity. Using bird biometric data and landscape simulations, our results point strongly towards land sparing as being the best approach for protecting the functional structure of species' assemblages. To ensure the retention of functionally diverse communities, our work indicates an urgent need to couple higher intensity farming with legally spared lands for nature.

Paper Number: 653

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.2 - Feeding the planet whilst minimizing environmental and socio-economic costs

Agricultural expansion as a major driver of deforestation in conserved tropical landscapes

H Manjari Jayathilake

Earth's land surface continues to experience human pressures that rapidly intensify in high biodiversity areas. Agricultural expansion, a major driver of deforestation, is increasingly affecting such protected landscapes globally. We surveyed 29 of Wildlife Conservation Society (WCS) global tropical landscapes using the Driver-Pressure-State-Impact-Response framework to identify the current major drivers of deforestation, most relevant threats and opportunities available for improvement. We collected this information from WCS landscape managers with a targeted structured survey questionnaire, a quick and inexpensive method. The current main driver of deforestation in the considered landscapes is agriculture, in both commercial and subsistence scales, followed by settlement expansion and infrastructure development. Asian and African landscapes are the most affected by ongoing deforestation activities with higher percentage deforestation rates compared to the Americas. Rice, rubber and cassava are the top three commercial crops listed as drivers while rice, cassava and maize are the top three subsistence crops. Respondents expect current deforestation to continue at equal or greater magnitude in the majority of surveyed landscapes. The findings suggest that more effective management responses are needed to maintain the viability of these biodiversity-rich, largely protected areas.

Paper Number: 505

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.2 - Feeding the planet whilst minimizing environmental and socio-economic costs

Shifting baselines provide over-optimistic assessments of the impacts of land-use change on biodiversity

Anderson Saldanha Bueno and Carlos A. Peres

Environmental impact assessments largely rely on comparing control sites with impacted sites, so that greater site contrasts result in higher impact diagnostics. The intactness of control sites as a baseline condition is therefore likely to affect the outcomes of such assessments and the conservation strategies proposed to mitigate the impacts. Degraded baselines experiencing previous extinction filters or the proliferation of disturbance-adapted species are expected to yield lower contrasts with impacted sites, compared to intact baselines. We surveyed understorey birds in five continuous intact forest sites (control) and 33 forest islands (impacted sites) within a large hydroelectric reservoir in Brazilian Amazonia, and defined two types of species assemblages derived from 2,115 captures representing 130 species. The first includes only those intact species assemblages occurring within control, whereas the second comprises all species occurring in both control and impacted sites (overall species assemblage). We then compared the slopes of species-area relationships for these two species assemblages to assess the degree to which estimated impact of habitat loss on the number of species differs between them. We also used a complementary approach to define the minimum set of forest island retaining the maximum combined number of species for each species assemblage. Furthermore, we produced a gradient of baseline degradation to assess the extent to which estimated conservation values of forest islands are affected by baseline intactness. This gradient was based on the forest area of five sets of reference sites, namely continuous forest, 1,000 ha, 500 ha, 250 ha and 100 ha. We show that a focus on intact species assemblages not only reveals a greater impact of habitat loss on the number of species but also reduces conservation investments in terms of the number of forest islands to be protected. Finally, we provide empirical evidence that degraded baselines over-inflates the estimated conservation value of impacted sites in relation to "true" estimates based on intact baselines.

Paper Number: 103

Tuesday, 03 July 2018 | Colosseum 2

Symposium 11.2 - Feeding the planet whilst minimizing environmental and socio-economic costs

GENERAL SESSION 11

Carnivore Ecology & Conservation

Connecting Tigers' Habitats in A Multi-Use Landscape: A Case of Sembilang-Dangku Landscape, South Sumatra

Asep Adhikerana

Senior Conservation Biologist
Zoological Society of London – Indonesia Country Program

The concept of Sumatran tiger's habitat connectivity between Dangku Wildlife Reserve and Hutan Harapan has been put forward since 2013, and KELOLA Sendang Project seeks to materialize this concept. Since the landscape between Dangku WR (and Meranti Forest Management Unit) consists of a number of multi-use land management, a multi-stakeholder collaboration is very crucial for developing the habitat connectivity. A stakeholder analysis in this landscape showed different perceptions among the relevant stakeholders. However, the following milestones will be necessary to promote enabling conditions for habitat connectivity: clarification of land use and land cover; identification of important ecosystems, habitats, and species and their threats; identification of priority areas for species to disperse and migrate across this landscape; engagement of all stakeholders in the planning of land use re-arrangement, which should result in the action plans for restoring damaged parts of the key wildlife habitats and ecosystems, and maintaining the habitats large enough to conserve priority species, as well as plans for the prevention of potential threats on those key ecosystems; engagement of district, provincial and national governments in endorsing the appropriate policies on the land use re-arrangement of Meranti-Hutan Harapan landscape; and promotion of local livelihood improvement in the relevant villages.

Paper Number: 116

Tuesday, 03 July 2018 | Petra 1

General Session 11 - Carnivore Ecology & Conservation

Understanding the functionality of identified tiger dispersal corridors in the Terai-Arc landscape, India

Suvankar Biswas

Introduction: Terai-Arc landscape (TAL) is one of the few remaining strong-holds of wild tigers across the globe, where their future survival is dependent on conservation actions at landscape level. The Indian part of this landscape retains about 15000 km² potential tiger habitat and 20% of current Indian wild tiger population, mostly restricted within its fragmented protected areas (PAs) boundaries. Earlier study identified 13 tiger dispersal corridors which connects these fragmented tiger habitats.

Objectives: This study aims to combine molecular and GIS tools to investigate tiger connectivity, at various scale across the corridors, and what landscape features facilitate or hinder such movements. We will focus on our initial understanding of habitat fragmentation, corridor functionality and its effect on current tiger populations at a landscape level.

Methods: To understand the corridor functionality across TAL, we extensively collected large carnivore faecal samples and identified tiger samples using species-specific molecular approach. Further, to characterize the genetic signatures of current tiger population we identified unique individual tigers and generated allele frequency data using 13 microsatellite loci.

Result: So far, we have ascertained 462 tiger and 364 leopard scats from our field-collected feces, and identified 127 unique tiger individuals across western and central TAL. The calculated PID(sibs) value was 7×10^{-6} , assuring unambiguous individual identification of tigers with high statistical support from faecal samples. Our subsequent analysis revealed two distinct genetic sub-populations with three admix individuals and the dysfunctionality of Gola river corridor.

Conclusion: In this study, we have conducted probably the most extensive non-invasive sampling for tigers across its distribution in the subcontinent. This genetic data clearly shows two genetic subpopulations of tiger in this landscape. The Gola river corridor seems to be the barrier of gene flow between these two subpopulations, which is corroborated with earlier study showing low tiger occupancy along both banks of river Gola. Anthropogenic activities like human settlement, urbanization and sand/boulder mining on the Gola river corridor could be the major reasons behind this barrier. However, it is important to point out the eastern cluster including Haldwani or Nandhour landscape along with Pilibhit-Dudhwa landscape forms a single genetic cluster indicating potential connectivity between these populations. Such fine scale movements can be understood through more intense sampling and analyses. Our future work will definitely give better insight into this connectivity and corridor functionality questions in this landscape.

Paper Number: 39

Tuesday, 03 July 2018 | Petra 1

General Session 11 - Carnivore Ecology & Conservation

Status of clouded leopards (*Neofelis nebulosa*) in mainland China

Kerry Huang

Outreaching Officer of Chinese Feline Conservation Alliance (CFCA), the only Chinese NGO dedicated to wild feline surveys and conservation.

Clouded leopards, the smallest of the big cats, are secretive and rare in the wild. They prefer to remain alone and hidden from view, which make studying them a unique challenge. Clouded leopards remain elusive and poorly understood. Once widespread across southern China (south of the Yangtze River), there are limited confirmed sightings in the past few decades.

During 2013-2017, we carried out camera trapping surveys throughout southern China, and collected less than 20 reliable records on clouded leopards from our surveys and other studies. Clouded leopards' presences were confirmed in four areas in mainland China, including (1) Mt. Huangshan in Anhui Province (Huangshan Mountain Scenic Spot and Jiulongfeng Provincial Natural Reserve; (2) The Yarlung Zangbo Grand Canyon National Nature Reserve in Tibetan Autonomous Region, (3) Xishuangbanna National Natural Reserve in Yunnan Province, and (4) The Tongbiguan Nature Reserve and Yingjiang County in Yunnan Province. Besides, we also conducted a transboundary survey in Phongsali province in Laos, which is adjacent to Xishuangbanna of Yunnan province, and obtained the first camera photos of clouded leopard only 8 km away from the international boundary in October 2017. Apart from the Mt. Huangshan records, clouded leopards were found in forests in border areas, no more than 8km from neighboring country towns, which means that they are likely to be transboundary populations. The findings suggest that clouded leopards might be the most endangered cat species in China, even compared to the tiger.

The species has been threatened by habitat loss, prey depletion and direct poaching. The conversion of natural forests to plantations has created compound impacts. Our surveys suggest that poaching is still common in Yunnan Province, even inside nature reserves. Poor firearm control in Laos and Myanmar also contributes to the rapid decline of prey populations. Therefore, it is pressing need for Sino-Laotian and Sino-Burmese transboundary collaborations to prevent the remnant populations of clouded leopards from extinction.

Paper Number: 766

Tuesday, 03 July 2018 | Petra 1

General Session 11 - Carnivore Ecology & Conservation

Estimated abundance and activity centres of the Sri Lankan leopard (*Panthera pardus kotiya*) in Horton Plains National Park, Sri Lanka

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Despite its protected status, the Sri Lankan leopard is threatened by habitat degradation and fragmentation, as well as trapping and hunting. Thus it is critical to get robust estimates of both population densities and zones of higher leopard activity to inform conservation and management decisions. Horton Plains National Park (HPNP, 31.6 km²) is part of the Central Highlands of Sri Lanka World Heritage location and a critical repository of mammal populations in the montane highlands. We developed a leopard identification library based on a large camera trap data set obtained from 18 camera trap stations, 5538 trap nights, and 417 leopard captures. We overcame the challenge associated with a large number of leopard captures by developing a systematic protocol to classify individual leopards into a leopard library. We then expanded the camera trap survey to 32 stations; in this talk we present preliminary estimates of leopard abundances and activity centres based on approximately 1900 trap nights, analyzed using a Bayesian spatially-explicit capture-recapture model. Leopard density estimates were very high, likely the result of correspondingly high prey densities. Our research is designed to contribute spatially-explicit information on leopard densities and activities for enhanced management of this biologically critical, but heavily visited, protected area of Sri Lanka.

Paper Number: 521

Tuesday, 03 July 2018 | Petra 1

General Session 11 - Carnivore Ecology & Conservation

SYMPOSIUM 13.2

The Future of Frugivory, Seed Dispersal, Seed Predation, and Fate in Changing Tropical Landscapes

Are putty nosed monkeys saving the day? Little evidence for surrogate seed dispersal in a West African montane landscape.

Hazel Chapman

The large bodied frugivores of the Cameroon highland forests in West Africa comprise a range of primate taxa, the largest being the rare and endangered Nigerian/Cameroon chimpanzee, *Pan troglodytes ellioti*. Recently, chimpanzee numbers have declined dramatically, negatively affecting dispersal of some tree species. In contrast, other large seeded species continue to be dispersed, presumably by other large bodied frugivores. In this study we explored the possibility that the putty nosed monkey, *Cercopithecus nictitans*, is acting as a surrogate disperser to large seeded tree species adapted for dispersal by chimpanzees.

We first documented the fruit diets of the chimpanzees and *C. nictitans* in Ngel Nyaki forest and from those data, compared chimpanzee preferred fruit species with the preferred fruit species in the *C. nictitans* diet. From this comparison we aimed to identify tree species which are potentially vulnerable to chimpanzee decline but which are handled and potentially dispersed, by *C. nictitans*.

We then explored to what extent *C. nictitans* is able to effectively disperse large seeded species; we estimated i) dietary overlap (consistency) among years and ii) positive selection for fruits with large seeded characteristics.

Because chimpanzees are very hard to observe feeding in the field, we estimated seed diet from faeces. In contrast, it is logistically difficult to extract seeds from *C. nictitans* faeces and *C. nictitans* spit some seeds. Consequently our *C. nictitans* feeding data were from feeding observations.

Based on Chesson's index of selectivity, we found limited overlap between chimpanzee and *C. nictitans* diets. Chimpanzees actively selected for six large seeded fruit species and *C. nictitans* two species; the only fruit species with large seeds actively sought after by both primate taxa was *Santiria trimera*.

While *C. nictitans* has a broad diet niche, consuming up to 17 fruit species with seeds > 15mm in diameter during the three years of this study, only a small subset, *Parkia filicoidia*, *Pouteria altissima* and *Strombosia scheffleri* comprised >1% of the diet on each of the three years. The only fruit characteristic positively selected for by *C. nictitans* that we measured was fruit shape; they preferred oval to round fruits.

Overall our results suggest that *C. nictitans* is not effective surrogate disperser of chimpanzee dispersed seeds. However, because of their wide diet niche, in some years they may disperse such seeds. Considering the difference in home range between the two taxa, this dispersal is unlikely to compensate for chimpanzee dispersal.

Paper Number: 264

Tuesday, 03 July 2018 | Petra 2

Symposium 13.2 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

Significance of escape from the mother trees: comparison of post-dispersal seed fates between two lemur-dispersed plant species in northwestern Madagascar

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Conservation of large-bodied frugivores is considered important for avoiding cascading extinctions of large-seeded plants. An integral part of this argument is the assumption that escape from the mother trees via zoochory will improve seed fates at the post-dispersal phase. However, the escape hypothesis has rarely been examined in zoochorous systems involving large frugivores and large-seeded plants. I studied two large-diaspored plant species that depend on the largest seed disperser, the brown lemur (*Eulemur fulvus*), in northwestern Madagascar. The Malagasy-endemic tree species *Astrotrichilia asterotricha* (Meliaceae) bears large fruits during the dry season, and the fruit includes a hard diaspore protecting 1-3 small seeds inside. Another Malagasy-endemic tree species *Abrahamia deflexa* (Anacardiaceae) bears large fruits during the rainy season, and the fruit includes a single large seed without physical protection. Through an experimental comparison of seed fates at the post-dispersal phase between those two species, I examine the significance of escape from the mother trees via lemur-mediated seed dispersal. For 10 trees of *Astrotrichilia asterotricha* and 8 trees of *Abrahamia deflexa*, I established two 50×50cm quadrats under the mother trees, in which 20 pulp-covered diaspores were placed (representing seeds dropped). Two quadrats containing 5 diaspores covered with lemur dung were established at 20 and 100 m from the mother trees (representing seeds dispersed by lemurs). The total sample size was 600 seeds of *Astrotrichilia asterotricha* and 480 seeds of *Abrahamia deflexa*. Seed fates were monitored over one year from July 2015 to March 2017. For *Astrotrichilia asterotricha*, seedling survival rates were 0%, 1%, and 1% at 0, 20, and 100 m from the mother trees respectively. The small seedlings were very vulnerable to predation by rodents and insects at the all distances. For *Abrahamia deflexa*, the unprotected large seeds allowed intensive predation by rodents and insects under the mother trees (survival rate: 2%), whereas their rapid germination and growth to large seedling improved survival rates at 20 and 100 m from the mother trees (11% and 22% respectively). These findings suggest that the functional traits of seedling establishment in like *Abrahamia deflexa* enhance the significance of escape from the mother trees. In tropical landscapes with reduction of large frugivores, plant species threatened by extinction cascades take priority for conservation. To identify the vulnerable species to loss of seed dispersers, the analysis on functional traits depending on the escape effects will be effective in future studies.

Paper Number: 246

Tuesday, 03 July 2018 | Petra 2

Symposium 13.2 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

Bayesian posteriors identify the effect of disturbance on the plant-granivore interaction in ecosystems worldwide

Adrienne Contasti

Seed predation – a process essential for maintaining ecosystem structure and diversity – is notoriously vulnerable to human disturbance. But how can we use experimental evidence to inform management of impacted areas, particularly for the hyperdiverse tropics? We develop a Bayesian hierarchical model that serves as a powerful tool for granivory-based ecosystem management by modifying network meta-analysis and multiple treatment comparison techniques from medical statistics. We fit our mega-regression model to data from 103 studies in 40 ecosystems exposed to 15 disturbances and use causal inference to show how seed predation responds to any disturbance-ecosystem combination. We communicate results as comprehensive probability rankings and highlight situations where: (1) the disturbance with the worst negative effect does not rank second worst and (2) it is imperative to include information on latitude, climate, and seed volume in decision-making. We conclude with a case study in which a manager must balance trade-offs between ecosystem conservation and human livelihoods for two tropical rainforests: one exposed to hunting and the other to agriculture. Our approach is innovative because it treats disturbance as external to the system and uses direct comparisons to estimate effects for never before investigated disturbance-ecosystem combinations. This not only advances our current understanding of the effect of disturbance on granivory, but also provides a valuable evidence-based management tool that is easily transferrable among plant-animal interactions, disturbances, and ecosystems.

Paper Number: 141

Tuesday, 03 July 2018 | Petra 2

Symposium 13.2 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

An indirect test suggests that 'landscape of fear' influences spatial seed dispersal patterns of a tropical ruminant

Sachin Sridhara

Introduction: Behaviour is a key influence on the spatial patterns of seed dispersal by animals and is often mediated by distribution of fruits. However, when dispersers are not very frugivorous (e.g. non-obligate frugivores), behaviours contributing to seed deposition patterns (e.g. movement and habitat-use) are likely to be governed by processes not linked to fruit availability and distribution.

Objective: Many large mammalian herbivores such as ruminants (deer, antelope, chevrotains etc) disperse seeds although they are predominantly grazers. Because these ruminants are highly risk averse we predicted that the seed rain patterns they generate will reflect the underlying trade-offs between predator avoidance and forage (grass, leaves etc.) tracking behaviour. Specifically, we wanted to test whether seed deposition by a risk averse ruminant is higher in habitats that not only have lower perceived predation risk and higher forage availability, but also provide access to refuges to escape from predators.

Methods: We tested this prediction on spatial seed dispersal patterns of a deer (Chital, *Axis axis*) for a deciduous tree, *Ziziphus mauritiana*, using a combination of empirical data collected from India and simulations. First, we collected seed rain data by intensively sampling 400 plots systematically laid in an area of 25 Ha. All the plots and fruiting trees within the 25 Ha were monitored 4 times during the fruiting season. Next, we constructed stochastic, individual-based simulation models to incorporate different Chital behaviour (grazing and frugivory, with and without perceived predation risk) and generated seed rain. These simulations incorporated ranging and foraging behaviour relevant to seed dispersal. We then examined to what extent observed seed rain patterns were explained by our simulation models.

Results: We found that simulation of seed rain generated by assuming grazing behaviour in the presence of perceived predation risk had the highest spatial concordance with observed data, followed by simulation assuming grazing in the absence of perceived predation risk. Assuming strong fruit tracking behaviour, with or without perceived predation risk, matched poorly with observed data.

Conclusions and implications: Our study provides preliminary evidence that inter-trophic interactions, specifically predator-prey, can have downstream consequences beyond just abundances, especially in the context of seed dispersal. Further, our study underscores the need to examine disperser behaviour in a context broader than their interaction with fruiting plants alone. Although preliminary, our results have implications for ongoing global declines in predator populations.

Paper Number: 491

Tuesday, 03 July 2018 | Petra 2

Symposium 13.2 - The future of frugivory, seed dispersal, seed predation, and fate in changing tropical landscapes

SYMPOSIUM 14.2

Changing Environments & Changing Forests: Spatial and Temporal Variation in the Dynamics of Southeast Asian Forests

Species-specific drought effects: consequences for species and phylogenetic diversity of Bornean rain forest trees

Akira Itoh

Introduction: Global climate change is predicted to alter the spatial and seasonal distribution of rainfall over the next 50 years. Consequently, the frequency of severe drought incidents may increase in the Southeast Asian tropics. This change may alter the local species composition of tropical forests because of the varying extent drought effect has on the different tree species. However, details of the drought effects are yet to be clarified for accurate predictions. Here, we evaluated the effects of a severe drought on various species of trees of a Bornean.

Methods: The drought effect was evaluated using a 15-year demographic dataset for trees with DBH > 1 cm of a 52 ha forest dynamics plot in a tropical rain forest in Malaysian Borneo. We evaluated the effect on each species based on the difference in mortality and recruitment rates between drought and drought-free periods. The drought period included a severe drought episode caused by the 1998 El Nino event. The community phylogeny of the study forest was estimated based on sequences of cpDNA (rbcL, matK, trnH-psbA) in order to evaluate the phylogenetic signal of drought effect. We also analyzed the relationship between habitat association and drought effect.

Results and Discussion: Drought increased both mortality and recruitment rates in many species. The increase in recruitment rate may be explained by reduced competition and increased light availability following the drought-induced mortality. Although there were no significant phylogenetic signals of the drought effect, there was a relationship between habitat association and the degree of drought effect. For species growing in wetter habitats, the positive effect (increase in recruitment) was greater than the negative effect (increase in mortality); while the positive effect was smaller than the negative effect for species in drier habitats. Mortality rate during the drought-free period was also related to the degree of drought effect. The positive effect was larger for species with higher mortality rates, many of which were pioneer species. These results suggest that severe drought has a negative effect on the demography of shade-tolerant species occupying drier habitats, while having a positive effect on pioneer species occupying wetter habitats.

Conclusion: This study suggested that severe drought events, owing to climate change, may alter the species composition of the Bornean forest. However, it should be noted that increase in recruitment rate will occur only when the environment returns to the current level after a severe drought episode.

Paper Number: 437

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.2 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests

Topography shapes the structure, composition and function of tropical forest landscapes

David Coomes

Topography is a key driver of tropical forest structure and composition, as it constrains local nutrient and hydraulic conditions within which trees grow. Yet we do not fully understand how changes in forest physiognomy driven by topography impact other emergent properties of forests, such as their aboveground carbon density (ACD). Working in Borneo – at a site where 70-m-tall forests in alluvial valleys rapidly transition to stunted heath forests on nutrient-depleted dip-slopes – we combined field data with airborne laser scanning and hyperspectral imaging to characterize how topography shapes the vertical structure, wood density, diversity and ACD of nearly 15 km² of old-growth forest. We found that subtle differences in elevation – which control soil chemistry and hydrology – profoundly influenced the structure, composition and diversity of the canopy. Capturing these processes was critical to explaining landscape-scale heterogeneity in ACD, highlighting how emerging remote sensing technologies can provide new insights into longstanding ecological questions.

Paper Number: 704

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.2 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests

Botanic gardens and the conservation of threatened trees in Southeast Asia: integrating in-situ and ex-situ strategies

Jean Linsky

Southeast Asia is one of the world's plant diversity hotspots, both in terms of its plant species and vegetation types. However, keystone tree species, such as taxa in the Dipterocarpaceae and Fagaceae families are facing ever growing pressure from overuse, land clearance and habitat degradation. This situation is not irreversible and botanic gardens have been at the forefront in acting to document, conserve and manage threatened plant species. The integration of in situ work including surveys and monitoring and ex situ methods for the conservation of threatened plants such as living collections in botanic gardens is needed to address the growing threat of extinction to the flora of Southeast Asia. A case study on the conservation of *Glyptostrobus pensilis* (water pine), a Critically Endangered tree, threatened through low natural regeneration and wetland habitat conversion in China, Vietnam and Laos is presented as a framework for the development of regional networks for threatened tree conservation.

Coordinated field surveys in China and Vietnam were carried out to assess size and structure of the remaining subpopulations and to gather material for analysis of genetic diversity at South China Botanical Garden. Collection of seed and wildlings from 5 populations in Jiangxi and Guangdong Provinces and propagation via grafting in Vietnam led to the development of a propagation protocol and the initiation of conservation collections. These efforts were consolidated through regular exchanges among project partners from Pha Tad Ke Botanical Garden and the National University of Laos, Bidoup-Nuiba National Park in Vietnam; Zhuhai Nursery and South China Botanical Garden on the status of the species across its range and on propagation techniques of *G. pensilis*.

The structure of the subpopulations in China and Vietnam represent an 'inverted pyramid' shape with a greater number of old trees, which are either producing no or poor-quality seed. Initial genetic analysis indicates low genetic diversity and high inbreeding within the Chinese trees. Additional surveys in Laos will reveal further genetic information. The successful propagation protocol will be trialed in Vietnam and Laos to establish further conservation collections of the species in those countries. Given the low genetic diversity exhibited within the individuals in China, ex situ collection across the species entire range is key to capturing maximum diversity. This collaborative work represents a unique effort amongst botanic gardens in Asia to share data and expertise and to coordinate the development of a genetically representative living collection network.

Paper Number: 724

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.2 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests

Fine-scale genetic differentiation causes uneven fitness among seedlings in a dipterocarp species

Naoki Tani

To assess genetic factors to affect fitness of seedling of *Shorea curtisii*, a dominant species of hill dipterocarp forest in Peninsular Malaysia, fine-scale genetic differentiation of individuals with reproductive stage and survivorship and growth performance of their seedling were studied. A genetic clustering analysis revealed that three genetic clusters optimally identified to explain genetic structure of 182 individuals with more than 20 cm diameter breast height at two permanent plots of Semangkok forest reserve, Peninsular Malaysia. The genetic differentiations between the three clusters and supposed admixture population (F_{ST}) were 0.0812, 0 and 0.0854, respectively, which indicated individuals with highly genetically differentiated were co-existed without reproductive isolation. Totally 460 seedlings derived from six mother trees in the plot were grown in nursery, whose paternal donors were identified by genetic markers and paternity assignment. Genetic relatedness and genetic distance based on attributive probability to the clusters between the parents of each seedling were calculated. Cox proportional hazards model with random effects showed that seed weight and genetic relatedness did not significantly affect seedling survival, however, larger genetic distance between parents significantly represented higher probability of survivorship of the seedlings. The genetic distance between parents was also significantly influenced to initial growth rate (until 1.2 year after germination) of the seedlings. These evidences suggested that mating between the individuals belonging to different clusters contributed to adaptive evolution through the fitness of the seedling at initial growth stage.

Paper Number: 641

Tuesday, 03 July 2018 | Taj Mahal

Symposium 14.2 - Changing environments & changing forests: spatial and temporal variation in the dynamics of Southeast Asian forests



GENERAL SESSION 12

Freshwater Systems

Conserving the threatened fishes of a 'biodiversity coldspot' in India

Paromita Ray

Unlike the biodiversity hotspots of India, Eastern Ghats seemingly has lower species richness and endemic species. Yet this 1450 km-long discontinuous chain of mountains plays an important role in the biogeography and maintenance of freshwater fish diversity in peninsular India. Considering this, through a project initiated in two river basins of northern Eastern Ghats, we are attempting to improve conservation status of threatened fishes by identifying their crucial habitats and engaging with different stakeholders through training programs and community based approach.

Six threatened species of fishes have been recorded from the study area of which *Tor khudree* is an 'Endangered' species while *Hypselobarbus kolus* and *Cirrhinus cirrhosus* are listed as 'Vulnerable' in the IUCN Red List. These species are also commercially important for the local fishermen in the region. Based on the results of our study till now, streams with presence of *T. khudree* and *H. kolus* have been identified. One of these streams also qualifies as a critical habitat for these threatened species since large numbers of juveniles were recorded from two of its stretches. Major threats such as damming and regulation of rivers along with mining and deforestation act on a broader scale of a river basin. However, activities such as diversion of streams for irrigation and destructive fishing practices are acting on a local scale but with profound impacts on the entire aquatic community.

To mitigate the impacts of these threats we are conducting awareness campaigns and outreach programmes for the local communities. A training program for young researchers and students from this landscape was also conducted to improve their capacity to conserve the freshwater ecosystems. We consider this project as a first step towards long-term conservation of threatened fishes of Eastern Ghats. Our study also highlights the crucial need to protect and explore the 'Biodiversity Coldspots' such as Eastern Ghats, which are often overlooked by the community of scientists and conservationists.

Paper Number: 557
Tuesday, 03 July 2018 | Giza
General Session 12 - Freshwater Systems

Revisiting paradigms: Can anthropogenically-formed forest pools provide refugia for threatened freshwater biodiversity?

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Anthropogenic habitat modification and destruction are major drivers of extinctions. Freshwater ecosystems are especially vulnerable to these threats, with habitat degradation often leading to severe population declines in native taxa and increased likelihood of invasions by alien species. However, recent studies have demonstrated that native freshwater biodiversity can persist, and even thrive, in some anthropogenically-modified water bodies (e.g., fire dams, rice fields), though there have been no studies specifically examining such habitats occurring within tropical forests. In this study, we compared differences in environmental attributes and freshwater communities (specifically, fishes and decapods) between anthropogenically-formed pools and natural streams within Singapore's tropical forests. In general, both habitat types had different physical characteristics, with pools being characterised by greater cross-sectional area, leaf litter cover and depth. We also found significant differences between the aquatic communities of both habitat types, largely driven by four species (three fishes—*Pangio muraeniformis*, *Hemirhamphodon pogonognathus*, *Trigonostigma heteromorpha*; one shrimp—*Macrobrachium sundanicum*), and two functional groups (schooling, benthic fish; schooling, pelagic fish). Anthropogenic pools were found to harbour significantly greater numbers of locally-threatened fishes, and possess higher species richness than streams. In present conservation paradigms, anthropogenic fresh waters are viewed as poor analogues for natural habitats and are often excluded in management schemes for conserving freshwater communities. However, the results of this study demonstrate that they can be valuable refugia for threatened native species; and that holistic management strategies, integrating both anthropogenically-modified and unmodified habitats, are necessary to conserve increasingly imperilled freshwater ecosystems, particularly in the rapidly developing/urbanising tropics where we can ill-afford to focus solely on pristine habitats.

Paper Number: 553
Tuesday, 03 July 2018 | Giza
General Session 12 - Freshwater Systems

Conservation considerations of inter-basin fish species translocations in Sri Lanka: a genetic barcoding and taxonomic approach

Jayampathi Herath

Translocations of freshwater fish, especially across major river basins could engender issues such as interference of ongoing evolutionary processes, endangering native populations, translocating unintended species, hybridization of closely related species, and giving rise to inbred populations. However, imminent threat of extinction sometimes justifies translocation in to carefully selected habitats. In 1981 four species of freshwater fish endemic to streams of southwestern Sri Lanka, referred to as Cuming's barb: *Puntius cumingii* (*Pethia reval* now), Black ruby barb: *Puntius nigrofasciatus* (*Pethia nigrofasciata* now), Cherry barb: *Puntius titteya* and Sri Lanka golden rasbora: *Rasbora vaterifloris* (*Rasboroides pallidus* now), were translocated from several river basins (specific basins unreported for some species) into several streams confluencing Mahaweli river. These inter-basin translocations were conservation intended to boost dwindling populations in their native habitats. A follow up study a decade later reported the establishment of their populations and even spreading to a few adjacent streams. A quarter century later, we evaluate the status of this translocation by sampling the original sites of introduction and adjacent habitats. Seining with equal effort at Kahawaturaela, Ceypothaela, Koladeniyaela, Balantotaela, Horakadaela and Walapitaela. *Pethia nigrofasciata* is present in all 5 original streams of introduction and spreading to one new stream; *P. reval* is present in the stream it was first introduced to and spreading to a new streams and the Mahaweli river; *P. titteya* is present in only one of the four original streams while failing to spread to new streams; *R. pallidus* is present only in one of the three original streams of introduction but spreading into one new stream. We also report *Channa orientalis*, a carnivorous species, may have been introduced as a non-target species through the translocation. DNA barcoding for two mitochondrial gene fragments (coding Cyt b; non-coding 16S rRNA fragments) helped in confirming species identity while also helping in predicting the original basin from which they could have been translocated. Even from this small sample of species, one can observe variation in dispersal abilities and the potential to become invasive. Systematics work based on phylogenies on Sri Lankan freshwater fishes suggests lineages, often at species level, specific to river basins, especially those of the wet zone, which suggests at the inimical effects of interbasin translocation within Sri Lanka. Hence we conclude that freshwater fish translocation can be a risky endeavor especially in tropical islands harboring high species diversity, often where cryptic species or populations on the verge of becoming independent evolutionary lineages abound.

Paper Number: 563
Tuesday, 03 July 2018 | Giza
General Session 12 - Freshwater Systems

Fish diversity loss affects ecosystem functioning in Southeast Asian fresh waters: impacts on nutrient cycling and trophic energy flows

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The Anthropocene has seen massive habitat conversion, driving alarming losses in biodiversity. This phenomenon is exemplified in the tropical fresh waters of Southeast Asia, a global centre of fish diversity imperiled by rapid and large-scale land-use change. Beyond the loss of irreplaceable genetic diversity, declines in freshwater fish species richness in the region could have even more far-reaching impacts through alterations of ecosystem functioning—pools and fluxes of biogeochemical resources driven by the biological activity of organisms. In this study we aimed to quantify the effects of fish diversity loss on two aspects of ecosystem functioning—nutrient cycling and trophic energy flows—in Southeast Asian lotic waters. We applied nutrient analyses and compound-specific isotope analysis of amino acids at sites spanning land-use gradients within multiple river drainage basins in the region. Along anthropogenic species richness gradients, our preliminary investigations have uncovered evidence of corresponding shifts in aggregate nitrogen and phosphorus excretion, and in energy transfer along trophic levels. These reveal ecosystem-level impacts of freshwater fish diversity loss, suggesting fundamental alterations to the functioning of impacted freshwater ecosystems, with potential implications for associated ecosystem services.

Paper Number: 420
Tuesday, 03 July 2018 | Giza
General Session 12 - Freshwater Systems

GENERAL SESSION 13

Genomics and Barcoding

Comparative population genomics of bird species from SE Asian hotspots using thousands of makers and historical DNA

Haw Chuan Lim

Despite the importance of the tropics as earth's biodiversity storehouse, evolutionary and population divergence processes of tropical taxa, as driven by earth history, spatial features and environmental variation, are poorly known. In this study, I used sequence capture to genotype five species of SE Asian birds at thousands of ultraconserved element (UCE) loci. The five species are: Little spiderhunter, Asian fairy bluebird, Large niltava, Grey-throated babbler and Black-headed bulbul. A combination of modern and historical museum (27-142 years old) samples were used. After stringent data filtering, the number of high confidence single nucleotide polymorphisms per species ranged from 3864 to 18467 (maximum of 50% missing data). Using a range of model-free (eg, PCA) and model-based (eg, Structure) analyses, I was able to discern a range of population structures across the study species. The Black-headed bulbul shows little genetic differentiation across its range. In contrast, the Grey-throated babbler exhibits deep divergence between populations from the following four regions: western Myanmar, eastern Indo-Burma, Malay Peninsula and Sumatra, and Borneo. For the Asian fairy bluebird, a distinct genetic transition (with potential admixture) occurs at the Isthmus of Kra, which interfaces the Indo-Burma and Sundaland biodiversity hotspots. Using a combination of Bayes factor delimitation and species tree reconstruction, population divergence history of each species was estimated. I then combined these with an estimated UCE substitution rate and coalescent analyses to simultaneously estimate, for each species, timings of population divergence and gene flow rates.

Paper Number: 923
Tuesday, 03 July 2018 | Machu Pichu
General Session 13 - Genomics and Barcoding

Genomics for forest genetic resources management in tropical areas: lessons learned from temperate and boreal forests

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Background

Forest genetic resources (FGRs) in tropical regions encompass highly diverse and numerous tree species, which often occur in discontinuous and poorly characterized populations that may be unsustainably managed or threatened by human activities. Filling knowledge gaps on genetic diversity, gene flow, and adaptability is one approach to help develop and conserve tropical FRGs.

Objective

This paper will present recent work in forest genomics aiming to identify lessons and approaches for enhancing tropical FGRs. Forest genomics research has focused on trees for production or conservation in temperate and boreal areas, shedding insights into the genetics and evolution and, helping to develop molecular breeding. Here, we present opportunities that arise from genomics for FGRs in tropical areas including forest landscape restoration.

Methods

Results will be presented from two complementary investigations. We have developed a genetic diversity discovery platform in 13 species among the Pinaceae, Taxaceae and Cupressaceae by using transcriptome analysis and resequencing. We also develop a low cost Sequenom DNA fingerprinting method for analyses of genetic diversity and kinship based on the analyses of single nucleotide polymorphisms (SNPs) in natural populations.

Results

We used our transcriptome sequencing data to develop comprehensive genomic information for 30-40,000 thousand genes in each of the 13 species studies. Population surveys in seven of them allowed to identify an average of 115,000 DNA sequence polymorphisms. We used large data SNP sets enable the development of a DNA fingerprinting tool with less than 50 SNPs that combines low cost and high genetic resolution, which we used for tracking forest genetic resources. We illustrate its utility by tracking plant reproductive material along the production of chain and determine the error rates at each of the steps, as means for delivering the desired genotypic diversity.

Conclusions

We report approaches for developing genomic information simultaneously in several species and for developing DNA fingerprinting tools that are suitable for traceability, population genetic studies, and production of plant reproductive materials. We propose that developments in genomics and international collaboration could play a major role in enhancing FGRs in widely distributed species groups of forest trees such as Dalbergia and Dipterocarps and produce global benefits for forests.

Paper Number: 763
Tuesday, 03 July 2018 | Machu Pichu
General Session 13 - Genomics and Barcoding

DNA barcoding and metabarcoding links natural history and conservation.

Alison Shapcott, Rachele Wilson, Jane Hardwick, Shahla Hosseini Bai, Marion Howard, Bill McDonald, Alex Keller, John Kress, Helen Wallace

When molecular approaches are linked with field data we can gain greater insights and better conservation targets. DNA barcoding is increasing being used to target conservation priorities but for this to work, we need both field data as well as molecular data. Likewise, there is great interest in the emerging field of metabarcoding especially to understand plant animal interactions and ecological networks but the results are limited by the extent and quality of the DNA barcoded reference library and enhanced by good quality field data and understanding of natural history. This talk will highlight results from several case studies as well as identify pitfalls and possibilities of these emerging technologies and emphasises the importance of linking these with field and natural history data. Building DNA barcoding reference libraries needs good quality taxonomic identification and a high level of quality control of the sequences generated at standard barcoding loci. Results of case studies of rainforest in SE Qld Australia demonstrate the utility of phylogenetic measures based on phylogenies generated from DNA barcode reference libraries to target conservation priorities. In metabarcoding mixed composition unknown samples are sequenced for specific target markers and matched against known sequence reference libraries. The resolution possible depends on the quality and extent of the reference library for the markers that are sequenced. We show examples of how local DNA barcode reference libraries can be enhanced to target specific metabarcoding study questions. Preliminary results from several metabarcoding studies from our international research team illustrate different applications; including diets of rainforest grasshoppers, and beetles and pollen networks of stingless bees. Metabarcoding has also enabled root competition in tropical orchards to be studied. The results of studies highlight the importance of large well curated voucher reference libraries as well as the importance of using a consistent set of several barcode markers rather than single barcode markers. The importance of field data and understanding natural history are key to reducing unrealistic results and value adding to the scope and conservation significance of results.

Paper Number: 188
Tuesday, 03 July 2018 | Machu Pichu
General Session 13 - Genomics and Barcoding

Applying pollen DNA metabarcoding to the study of quantitative plant-pollinator networks in tropical ecosystems

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Pollination networks are typically constructed with visitation data, i.e. recording of visual observations of flower visits. Prior work has confirmed the advantages of an alternative approach: identifying pollen carried by flower visitors, which integrates information from multiple flower visits by each visitor and thus can allow for better-resolved networks with less field time. This approach can be further streamlined by using DNA metabarcoding, rather than microscopy, to identify the pollen. Pollen in mixed-species samples can be identified through mixed-amplicon sequencing of standard DNA barcoding markers (e.g. chloroplast *rbcl* or ribosomal ITS2) on the Illumina MiSeq platform. A handful of studies have used this method in the analysis of plant-pollinator interactions. The objective of this study was to use pollen DNA metabarcoding to construct a quantitative plant-pollinator network for a habitat mosaic, including multiple forest management types, in Florida, USA. Trials on pollen samples of known species composition and proportions showed that the proportion of sequencing reads is not an accurate representation of the proportion of pollen grains in a mixture. We therefore quantified the intensity of interactions based on frequency, rather than abundance. We successfully constructed a plant-pollinator network using these methods, demonstrating proof-of-concept for the construction of frequency-based quantitative plant-pollinator networks. Ongoing methodological advances in this work, such as standardization of the bioinformatics pipeline, development of methods to allow quantification of species proportions within a sample, and development of full genome or reduced-representation genome methods for DNA metabarcoding, are likely to further increase the applicability of these methods to the study of plant-pollinator interactions in tropical ecosystems, and elsewhere.

Paper Number: 200
Tuesday, 03 July 2018 | Machu Pichu
General Session 13 - Genomics and Barcoding

GENERAL SESSION 14

Biological Invasions

Rapid expansion and biodiversity impacts of the red devil cichlid (*Amphilophus labiatus*, Günther 1864) in Lake Sentani, Papua

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The red devil cichlid (*Amphilophus labiatus*, Günther 1864) is one of ten exotic fish species inhabiting Lake Sentani. This cichlid was accidentally introduced into Lake Sentani around 2008 and has since become widespread in the lake. It is believed to be one of the most important threats to the native and endemic fish of Lake Sentani whose populations are already at risk from land use change and changes in water quality. This study aims to document the distribution of red devil cichlids in Lake Sentani and the impacts of this species on native fish fauna. Fish were sampled in six locations in Lake Sentani using gill nets during February and March 2018. Fish species and abundance were recorded and used to calculate the relative abundance, dominance, species evenness and Shannon Wiener Index (H'). A total of 836 fish belonging to 12 species were recorded across Lake Sentani. Mean fish diversity ($H'=0.63$) and evenness ($E=0.25$) were low. The red devil cichlid is the most abundant fish recorded during our surveys (87.2% of total fish collected) and is now the most dominant fish in the lake ($C=0.76$). One endemic fish, *Glossogobius sentaniensis* was found to be very rare in the lake (0.60%). Four native fish were also found to have low abundance in the lake: *Oxyeleotris heterodon* (2.52%), *Neogobius velutinus* (1.79%), *Giuris margaritaceus* (0.24%) and *Glossamia beauforti* (0.12%). An earlier study conducted shortly after the introduction of the cichlid found that *Oxyeleotris heterodon*, *Neogobius velutinus* and *Glossamia beauforti* were already rare in 2009-2011 however *Giuris margaritaceus* was previously a relatively common species in Lake Sentani (22.4% of total fish collected during 2009-2011). The red devil cichlid population has increased very rapidly in Lake Sentani during the 10 years since it was introduced to the lake. It has colonized all areas sampled within the lake and is associated with declining populations of endemic and native fish species because of its ability to colonize new habitat and to successfully exploit a large diversity of trophic niches. The conservation of rare endemic and native fish in Lake Sentani, and potentially in other lakes in Papua, is now seriously threatened by the presence of the red devil cichlid (*Amphilophus labiatus*, Günther 1864).

Paper Number: 634

Tuesday, 03 July 2018 | Chichen Itza
General Session 14 - Biological Invasions

Native plant and invertebrate communities of West African montane and lowland forests respond differently to siam weed (*Chromolaena odorata*) invasion.

Biplang Yadok

The impact of alien invasive plants species on native community structure and processes can be better understood by investigating the response of multiple trophic levels to invasion. While numerous studies have shown the negative impacts of invasive plant species on many native flora and fauna species in different parts of the world, little is known about the effects of invasive plant species on multiple trophic levels in tropical Africa. In this study, we simultaneously assessed the impact of the invasive siam weed (*Chromolaena odorata*) on plants and invertebrate communities in two natural forest reserves; montane and lowland forests. Plants and invertebrate species were sampled in ten (20m x 20m) plots in *C. odorata*-invaded and uninvaded sites. We hypothesized that the presence of *C. odorata* will significantly reduce the abundance, species richness and diversity of plants and invertebrates in both forest types. We found that *C. odorata* presence differentially affects the plant and invertebrate species diversity in the two forest types. Forest sites with high *C. odorata* abundance were associated with low species diversity of both non-woody plant species and invertebrate species. However, the diversity of invertebrates was higher in the invaded sites of the montane forest. Although canopy cover, tree size and abundance of grass species have negative effects on the abundance of *C. odorata*, the diversity of woody species had a significant positive effect on the abundance of *C. odorata*. It is likely that *C. odorata* invasion on the non-woody plant community is indirectly affecting the invertebrate community. The diversity of woody species in relation to *C. odorata* abundance suggests that wild animals are potential inadvertent dispersers of *C. odorata* in lowland forests. To our knowledge, this is the first quantitative study evaluating the impact of the highly invasive trifid weed (*C. odorata*) on both fauna and flora communities in montane and lowland forests of Nigeria.

Paper Number: 172

Tuesday, 03 July 2018 | Chichen Itza
General Session 14 - Biological Invasions

Importance of multidisciplinary approaches in tackling species introduction and hybridization between native and non-native species

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With the increase of biological invasions, avoiding hybridization between native and non-native species has become a key concern for conservationists. However, to address this issue, an early and precise identification of non-native species is required at different developmental stages, including eggs and larvae. Identification of ichthyoplankton based solely on morphological characters is less accurate than when using molecular tools (e.g. DNA barcoding). Extensive hybridization after introduction of non-native congeneric species was reported as a hidden threat to the native species *Prochilodus hartii* in the Jequitinhonha river basin (Southeast Brazil). Information on the viability and fitness of both introduced and hybrid fish could offer insights into the potential success of a hybrid swarm. One low-cost approach to assess viability and reproductive success of introduced species is to record incidence of invasive maternal lineages in developing embryos and larvae. Here we combined DNA barcoding (650bp of the mitochondrial gene COI) of ichthyoplankton with examination of gonadal tissue in the adults. We obtained 81 eggs and larvae from 5 sample sites in the Jequitinhonha river basin and detected 13 species, of which 48.2% were non-native. Eggs and larvae from the native *P. hartii* were detected in 15.4% of the samples, with the non-native *P. argenteus* and *P. costatus* amounting to 69.2%, and 15.4%, respectively. Molecular identification of adult fish (N=63) allowed the detection of haplotypes from *P. hartii*, *P. argenteus* and *P. costatus*, and also the incongruence between morphological and molecular identifications, suggesting the presence of hybrids. Specimens from native and non-native species (including putative hybrids) showed an advanced stage of gonadal maturation (i.e. spawning or just spawned). However, all individuals collected at the Irapé reservoir and downstream the Irapé dam were still immature. This data provided the first indication that non-native species are reproducing in this basin and likely generating a mixed gene pool and also demonstrated the interplay between reproductive aspects and the impact of the dam on these migratory species.

Paper Number: 244
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General Session 14 - Biological Invasions

Non-native rats have mixed ecological roles in a system devoid of native seed dispersers

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Non-native species are normally considered harmful for native ecosystems. However, non-native species have been observed in other systems to take on ecological roles from rare or extinct species. Our study takes a closer look the roles that non-native species play in a system that has suffered a large amount of functional loss. The invasive brown treesnake (*Boiga irregularis*) is responsible for the functional extinction or extirpation of the island of Guam's native forest birds, and as a result, the loss of native seed dispersers. Non-native mammals are also controlled by snakes in Guam. We conducted feeding trials with rats (*Rattus rattus*) caught in the wild in Guam to determine their role in either seed dispersal or seed predation. We fed rats fruits from over 20 species of native and non-native plants. We removed intact seeds from their scats, and removed any seeds that were handled by the rats and not ingested. These seeds were planted along with control seeds that were not gut-passed or handled by rats.

Rats destroyed most of the seeds from the species that we tested. However, they consistently cleaned the flesh off of a number of fruit species, resulting in higher germination percentages for these seeds than control seeds planted in whole fruits. Of the few species of very small seeds that did survive gut passage, a higher proportion germinated than control seeds planted in whole fruit, but not control seeds that we had cleaned by hand. Thus, rats do not appear to play a role in seed dispersal by gut passage. However, rats clean the flesh off of many larger seeds, which may enable dispersal in a system devoid of native vertebrate dispersers. These nuanced effects of non-native species need to be considered, especially as plans develop to control invasive snakes and restore forests. Control of snakes will result in increased abundances of rats, which will negatively impact many species of plants through seed predation. However, controlling rats without introduction of seed dispersers such as birds may hinder some species that will have no modes of dispersal. Functional roles and traits, rather than identity as native or non-native, are crucial to consider in managing novel ecosystems.

Paper Number: 755
Tuesday, 03 July 2018 | Chichen Itza
General Session 14 - Biological Invasions

SYMPOSIUM 16.2
Natural History and Canopy
Dynamics of Lowland Evergreen
Forests on Mt Makiling Forest
Reserve and ASEAN Heritage Park,
Philippines

Microbial Diversity Assessment in Mt Makiling, Los Banos, Philippines: Morphological and Functional Characterization of Associated Microbes for Agri- industrial Applications

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Bacteria and fungal communities control many important processes that dictate maintenance and survival of tropical forests. We describe herewith the cultural microbial diversity associated with flora (trees and associated epiphytes) from Mt. Makiling Forest Reserve. Since it was impossible to identify all isolates, we describe morphological and functional characteristics to determine potential use in agriculture and industry, due to beneficial attributes of the isolates. Out of 228 characterized bacterial isolates from bark, canopy leaves, associated epiphytes, majority (68%) were Gram positive; 30% were potentially nitrogen fixing, 14% able to solubilize phosphorus and 10% with both characteristics. These bacterial isolates will be further screened for potential use as biological fertilizers. There were more fungal isolates collected from soil around trees (98) compared with those collected from tree barks (28). Majority were found positive for ability to secrete cellulose and degrade agricultural waste material such as rice straw and wood chips. However a lower percentage was positive for laccase enzyme secretion. Microscopic observation showed predominance of *Penicillium* sp., *Aspergillus* sp. and *Accremonium* sp. and many unidentified samples. Separate group of fungal collections from canopy leaves and epiphytes were screened for ability to secrete lipase and esterase. Results showed that all fungal isolates were positive in the Tributyrin assay, and these microbial isolates vary in their ability to degrade or utilize plastic as substrate. BIOLOG ecoplate analysis of bark samples showed positive color development in wells amended with Tween 80, in the first 12 hours. Thus, assays were done to screen for lipase secretors, ability to survive in waste oil and produce biosurfactants. Floral samples were also incubated in diffused light and assayed for presence of green algae and cyanobacteria. Microscopic observation showed predominance of algae with possible genus of *Trentepohlia*, *Cladophora*, *Chlorella*, and cyanobacterial genus such as *Microcystis*, *Synechococcus*, and *Klebsormidium*. There is a high probability in finding new isolates specially from the upper canopy samples. There were 141 putative yeast isolates and were characterized based on enzymes secreted e.g cellulase, laccase and amylase as well as ability to produce ethanol and serve as oleaginous yeasts. Ability to secrete enzymes makes the isolates candidate for industrial use. Taxonomic identification of isolates with beneficial traits are being done using molecular methods for confirmation.

Paper Number: 400

Tuesday, 03 July 2018 | Eiffel 1

Symposium 16.2 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines

Forest Biodiversity across a Vertical Stratification: Implications to Ecosystem Services, Conservation, Tourism and Climate Change Resilience

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Forest biodiversity studies in the Philippines are often limited to the understory and lacks a comprehensive vertical assemblage of species from the ground towards the canopy layer. To understand how terrestrial vertebrates are distributed across this vertical stratification, a survey was conducted within a tropical lowland evergreen rainforest permanent plot on Mt Makiling Forest Reserve and ASEAN Heritage Park, Luzon Island, Philippines. A total of 68 species were recorded collectively on three stratifications (understory, subcanopy and canopy), using the SkytrapHV method and opportunistic sampling, as represented by 11 amphibians, 15 reptiles, 26 birds and 17 mammals. We noted the implications of tetrapod diversity and distribution along the three forest strata to ecosystem services, biodiversity conservation, eco-tourism and climate change resiliency. Feeding guilds and trophic groups served as proxy for ecosystem services, from which 11 species were classified as carnivores and 32 as insectivores, thus important for pest control; with 16 species as frugivores and 8 as omnivores (ex. nectivores), thus important for seed dispersal and pollination. Conservation was least of an issue due to the lack of any threatened species listed from the site based on current IUCN evaluation. For Eco-tourism, the high degree of endemism (66%) referring to the number of species unique to the Philippines would serve as an ideal flagship for tourism, and for fauna that are either endemic to Luzon (13%, 9 species) or iconic for Mt Makiling can be regarded as important for MMFR by naturalists and bird-watchers. Climate change resilience was based on distribution across the 3 strata, with species considered as cosmopolitan or occur across multiple layers (6 species for 3 strata, 29 for 2 strata) to be more adaptive and capable to withstand drastic changes in forest microclimate. Whereas, strata uniqueness (33 species) refer to species with restricted vertical distribution, thus regarded to be more at risk from severe changes, such as high thermal exposure of strictly understory fauna. Further observations are needed to record in detail the adaptations made by species uniquely linked to a strata and determine strategies to help mitigate impacts from reduced stratification.

Paper Number: 370

Tuesday, 03 July 2018 | Eiffel 1

Symposium 16.2 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN Heritage Park, Philippines

Inventory and Monitoring of Vertebrate Fauna in Three Long-Term Ecological Research (LTER) Sites in Mindanao, Philippines

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The vertebrate fauna of Mindanao exhibit high diversity and endemism. However, this treasure is under great threat from unregulated anthropogenic activities. Thus, this study was conducted to monitor and assess the diversity, population, and current status of vertebrate fauna in three Long-Term Ecological Research (LTER) sites namely: Mt. Apo, Mt. Hamiguitan, and Mt. Musuan for 2 years with a 1-year interval. A combination of sampling methods such as mist-netting, point survey, live trap sampling, visual encounter, trenching, and opportunistic sampling were performed inside and along the periphery of a two-hectare permanent plot in each LTER site to document the species. Results in the second year of the survey revealed the existence of 144 vertebrate species comprising of 21 mammals, 84 birds, 19 reptiles, and 20 anurans which is higher than the previous record (year 1) of 15 mammals, 76 birds, 21 reptiles and 20 anurans. The population of vertebrate species generally increased. Diversity value was higher in the 2nd year of sampling as compared with the 1st year of sampling. The diversity rank across sites was still the same with Mt. Hamiguitan as the most diverse mountain ecosystem ($H'=1.515$), followed by Mt. Apo ($H'=1.129$), and lastly, by Mt. Musuan ($H'=1.066$). The high richness and diversity in Mt. Hamiguitan were associated with the habitat's heterogeneity wherein it offers various micro/macro-ecosystem leading to the so-called ecological event, the edge effect. A total of 19 species were newly observed in Mt. Apo, 48 species in Mt. Hamiguitan, and 18 species in Mt. Musuan. While the 30 species in Mt. Apo, 40 species in Mt. Hamiguitan and 23 species in Mt. Musuan were observed to be concordant species between the 1st and the 2nd year of sampling. Seventy-two endemic vertebrate species consisting 3 mammals, 42 birds, 8 reptiles, and 9 anurans, were observed in the 2nd sampling. *Hydrosaurus pustulatus* was the only threatened species out of the five species recorded in the 1st year of sampling that was not recorded in the 2nd year of sampling. Additional 3 threatened species (*Gallicolumba crinegera*, *Groschius goisagi*, and *Phapitreron cirineiceps*) were observed in the current survey. Results indicate that the three LTER sites are home to various vertebrate species with high endemism. The fluctuation in the species composition, richness, and abundance of vertebrates between the 1st and 2nd sampling was a manifestation of the temporal distribution of the species in relation to climatic condition and food availability.

Paper Number: 872

Tuesday, 03 July 2018 | Eiffel 1

Symposium 16.2 -Natural History and Canopy Dynamics of Lowland Evergreen Forests on Mt Makiling Forest Reserve and ASEAN
Heritage Park, Philippines



GENERAL SESSION 15

Wildlife Trade

From Parrots to Songbirds: Tracking trends and attitudes related to the pet bird trade in Hong Kong

Caroline Dingle

Hong Kong is a major hub for both legal and illegal wildlife trade. Songbird trade is decimating populations of wild birds, particularly in Indonesia. Birds are traded in high volumes with many species kept as pets or released as part of religious ceremonies. While SE Asian markets have been extensively surveyed to determine species and abundance of birds traded, as well as attitudes towards the trade, relatively little attention has been paid to markets in Hong Kong and China, which could be an end market for some Indonesian species and where buyer motivation may differ. We collected data on species, abundance and price of birds available in the Yuen Po bird Market (Hong Kong) over a 1.5 year period, with an emphasis on three groups: parrots (high value species) and two songbirds both native to Hong Kong commonly found in the markets: Oriental magpie-robins (*Copsychus saularis*), and Japanese white-eye (*Zosterops japonicus*). We conducted surveys of sellers and buyers to better understand motivations for purchasing these species. For parrots, we found that of ~77,000 imported between 2006-2016, 45% were wild caught. While similar trade records were not available for the songbirds, it is clear from observed behavior that most individuals in the market were wild caught. Parrots were purchased by people of all age ranges and represent “prestige” species. While 85% of the pet owners surveyed owned CITES protected species, less than 30% were aware of this and kept documents on origin of their pets. In songbirds in contrast are primarily purchased by older males, and are prized particularly for their distinctive blue-black coloration and for fighting, not primarily for their song as in other Asian countries. White-eyes are purchased singly for first time bird owners or in large numbers for religious release. Most songbirds are reported to be imported from China, with the exception of magpie-robins which come from Singapore. However, a distinctive subspecies from Indonesia is occasionally spotted in the Hong Kong market, so further work to determine origin is warranted. We are currently conducting genetic analyses to determine origin of traded birds and impact of release of exotic individuals into native populations. Our results will improve our understanding of the role of Hong Kong and China in driving the trade for wild songbirds.

Paper Number: 966
Tuesday, 03 July 2018 | Colosseum 1
General Session 15 - Wildlife Trade

Pitfalls in the Ivory Trade: Missing Hippo Teeth and Mismatched Trade Bans in China and Hong Kong

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Ivory trade remains a paramount threat to some of the planet's most iconic wildlife, including elephants (*Loxodonta africana*) and hippos (*Hippopotamus amphibius*). Regulation through trade quotas or bans has advanced in recent decades, but gaps in enforcement have exposed wildlife populations to unsustainable levels of harvesting and triggered precipitous population declines. Here, we examine two measures of enforcement and associated problems. First, we examine trade quotas for hippo teeth between Africa and Asia. Scrutinizing trade records from the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), we found that more than 90% of global hippo teeth trade has moved through Hong Kong, a global hub for wildlife trade. Of that imported to Hong Kong, >75% originated in Tanzania or Uganda, but there were notable disparities in trade volumes declared by the exporting and importing countries. Overall, Uganda declared the export of >14,000 kg more hippo teeth than declared imported by Hong Kong, which remains unaccounted for and represents more than 2,700 individual hippos – 2% of the global population. This gross discordance in trade data could undermine regulatory measures and challenge the persistence of hippo populations in Africa. Second, we examine trade bans for elephant ivory in China and Hong Kong, which have recently taken essential steps towards the conservation of African elephants. China implemented a nationwide ban on ivory trade at the end of 2017, and in January 2018, Hong Kong passed a law to ban all ivory trade by the end of 2021. However, the offset in timing could expose African elephants to continued poaching to supply the ivory trade, laundered through the existing legal trade in Hong Kong. We found that recent seizures of illegal shipments of ivory in China and Hong Kong are negatively correlated, and consequently the ivory ban in China could push the trade to Hong Kong's poorly regulated market. Improved trade records and coordinated trade bans are needed to make effective efforts towards the preservation of these globally threatened ivory species.

Paper Number: 637
Tuesday, 03 July 2018 | Colosseum 1
General Session 15 - Wildlife Trade

Understanding urban bushmeat consumer profiles through human-centered design – A case study from Cambodia

Regine Weckauf

Illegal commercial hunting is the greatest immediate threat to wildlife in Cambodia as well as in Southeast Asia. A significant driver of hunting is the escalating demand for bushmeat consumed in towns and cities. Most bushmeat is hunted using wire snares, killing indiscriminately a wide range of species. Between 2010 and 2015, the number of snares removed by law enforcement patrols in the Southern Cardamom National Park nearly doubled to 27,714. Despite these significant demand-driven threats to a range of endangered species, there are currently no actions aiming to reduce the demand for wildlife products in Cambodia.

To fill this gap, we carried out research in late 2017 to identify the main bushmeat consumer profiles and behaviours of Phnom Penh citizens to define a behaviour change campaign. Ultimately, by reducing consumption we aim to reduce demand for bushmeat and by extension the practice of wildlife snaring in Cambodia.

Using human-centered design methodology (HCD), a methodology widely used in the marketing of consumer products, the research phase focused on acquiring a deep understanding of individuals, their environment and their routines. This phase, which is the first phase of the HCD methodology, involved exploratory research using ethnographic and anthropological tools to define the scope of the problem and translate this into recommendations for subsequent actionable steps in the form of opportunities.

Our research revealed two main bushmeat consumer groups (holding six key consumer profiles): occasional consumers and regular consumers. For the occasional group, consumption takes place exclusively in the provinces. For regular bushmeat consumers, consumption takes place both in the provinces and in Phnom Penh. The main triggers that prompt individuals across all profile types to eat bushmeat for the first time were identified as 'curiosity', 'breaking the routine' and 'social pressure'. Research findings also revealed different types of drivers (factors that contribute to an increase in overall bushmeat consumption). Drivers applicable to occasional consumers include 'lack of knowledge' and 'cognitive dissonance', while drivers applicable to regular consumers are related to the social act of bushmeat consumption.

These findings allowed us to frame general and profile-specific opportunities, which are analysed and refined with the support of a social marketing firm who will create a short, medium, and long-term BCC strategy to reduce bushmeat consumption in Phnom Penh.

Paper Number: 684
Tuesday, 03 July 2018 | Colosseum 1
General Session 15 - Wildlife Trade

Interviews with bear bile farmers in Vietnam highlight negative conservation implications

Brian Crudge

Legalised trade in commercially farmed wildlife products is sometimes promoted as a conservation strategy. Overhunting to supply the demand for bears and their parts has led to declining populations across Southeast Asia. Bear bile farming was established to help supply the demand for bear bile which is highly sought-after for use in traditional medicine. We conducted semi-structured interviews with 66 bear bile farmers and former bear bile farmers in Hanoi, Nghe An Province, Ho Chi Minh City, and Binh Duong Province between March and July 2016, in order to examine the conservation implications of bear bile farming.

The majority of surveyed farms were established over a ten-year period, from 1996 to 2005. All respondents reported that at the height of the industry the supply of farmed bear bile could not meet the demand but that the consumer demand for farmed bear bile is now decreasing. Poor quality bile was the primary reason given for decreasing consumer demand, reported by 76% of respondents. The results show that demand for wild bear bile was not satisfied by the widespread availability of farmed bear bile. Farmers report a strong consumer preference and willingness to pay more for wild-sourced products. Interviewees reported an 82% average decrease in the amount consumers are willing to pay for farmed bear bile in recent years. The average stated price for wild bear bile was 12 times higher than that of farmed bear bile. The results indicate that bear bile farming in Vietnam is heavily reliant on restocking from wild populations. Most respondents (94%) report that breeding bears in farms is difficult, and the majority (91%) report that they do not know of anybody that has successfully bred bears on farms.

The existence of bear bile farms presents considerable challenges to law enforcement. Farms fail to meet minimum husbandry standards, and farmers openly admit to restocking from the wild and to extracting and selling bear bile – clear violations of national legislation. The case of bear bile farming in Vietnam provides an example of wildlife farming failing to reduce pressure on a once widely distributed and relatively abundant species. Research into consumer values, attitudes and behaviours will help to improve understanding of market drivers and help inform the design of effective species conservation and management strategies.

Paper Number: 640
Tuesday, 03 July 2018 | Colosseum 1
General Session 15 - Wildlife Trade

Growth of illegal ivory trade network in Cambodia

Trang Nguyen

African elephant (VU) populations have declined by 30% between 2007 and 2014, primarily due to global increase in poaching for ivory. Illegal trade in ivory is also a threat to Asian elephants (EN), of which fewer than 52,000 remain. Global illegal ivory trade, driven by organised crime networks, benefits the few whilst impoverishing communities local to source populations who bear the costs of poaching activities and enforcement responses, e.g. insecurity, ecosystem degradation. Previous market surveys suggest Cambodian ivory trade networks are linked to other IWT networks, amplifying unsustainable harvest of wildlife species.

This project repeated market surveys in the same three cities to monitor trends in ivory markets and research the trade networks – including exploring gender roles, links to wider IWT networks and poverty – through interviews with ivory vendors and key informants. We also conducted the first ivory online trade survey on Cambodia social media over 3 years period, from 2015 - 2018. Number of advertised products, sale price, detail of sellers and buyers were recorded. In addition, we also genetically tested 11 market samples of ivory for species identification and geographic locations.

Results show that there is a persistent domestic market for ivory in Cambodia, which may be driven largely by Chinese consumers and traders. The current Cambodian ivory trade market is worth 11 times higher than that recorded in 2015-2016. Over 20 accounts were identified trading ivory openly on Cambodian Facebook, with more than 2000 advertises and approximately 10,000 items - both worked and raw ivory. Our DNA tests show ivory for sale in Cambodia are mostly originated from African forest and savannah elephants. It is clear that the illegal trade network of ivory in Cambodia is growing rapidly, with direct connection with African elephant poaching crisis in Africa.

Paper Number: 118
Tuesday, 03 July 2018 | Colosseum 1
General Session 15 - Wildlife Trade

Review on prosecution against illegal wildlife trade in mainland China and Hong Kong

Anthony Lau

Illegal trade of endangered species is one of the greatest threats to global biodiversity. Despite countries around the world increasing their efforts in curbing illegal wildlife trade, monetary values and volumes of illegal wildlife trade continued to rise. Effective legislation and penalty scheme could deter future offenders and act as an indispensable step in stopping illegal wildlife trade. Mainland China and Hong Kong are well recognized as two of biggest trade hubs of illegal wildlife products. Here, to determine the differences between these two judicial systems in regulating illegal wildlife trade, we reviewed existing legislations involving trade of illegal wildlife products in mainland China and Hong Kong. We reviewed a total of 372 cases identified from the literature and publicly accessible database, involving trafficking of endangered species and compared the trade volume, traded species, and enforcement actions (i.e. fine or prison time). Comparison of enforcement actions indicated that, on average, offenders in mainland China were fined 1.9 times more in fines and sentenced to 18.4 times more in prison time than those in Hong Kong. For both systems, heavier fines and longer prison sentences were associated with greater product total volume (i.e. weight ivory/pangolin scales confiscated). Our findings indicate an unequal penalty scheme for wildlife trade crime between Mainland China and Hong Kong. As Hong Kong is one of the main nodes in the global wildlife trade network, increasing the penalty against illegal wildlife trade could have an exemplified and significant effect in deterring wildlife trafficking.

Paper Number: 859
Tuesday, 03 July 2018 | Colosseum 1
General Session 15 - Wildlife Trade

Using Technology to Combat Wildlife Trafficking in Indonesia

Dwi Nugroho Adhiasto

Wildlife Conservation Society-Indonesia Program

The Scale of Online Illegal Wildlife Trade

Wildlife trade is any sale or exchange of wild animal and plant resources by people that involve live animals and plants or a diverse range of products needed or prized by humans (TRAFFIC, 2008). The value of illegal, unreported and unregulated fisheries alone has been estimated as between USD 10-23 billion per year (MRAG & FERR, 2008), while the illegal wildlife trade, excluding timber and fisheries as USD 7.8 – 10 billion per year worldwide (GFI, 2011).

The scale of illegal wildlife crime through online trade is also devastating. IFAW's (International Fund for Animal Welfare) report titled Wanted-Dead or Alive-Exposing Online Wildlife Trade (2014), revealed that 33,006 live wild animals and their parts and products were available for sale on 280 online marketplaces (open source website) in 16 different countries in only six week in early 2014. The Environment Intelligence Agency (EIA) surveyed a Google Japan Shopping site from February 4-22, 2013 and found approximately 1,400 advertisements offering whale products for sale and around 10,000 advertisements offering ivory products for sale.

Online Wildlife Trade in Indonesia

The Wildlife Crimes Unit (WCU), a special collaboration unit between The Wildlife Conservation Society (WCS) and the Indonesian Ministry of Forestry was established in 2003 to provide technical assistance to the Indonesian government in combating wildlife crime through investigation and law enforcement. In 2011 – 2017, the WCU supported the officers to conduct more than 150 sting operations related to the illegal trade of protected tigers, sun bears, elephants, leopards, gibbons, or birds. In 2017, WCS detected more than 1,200 online trade advertisement, and the suspects illegally traded wildlife products and live animals through Facebook, BlackBerry Messenger (BBM), Short Messaging Service (SMS), and online store communities. The number of online cases has increased since 2011 as a change of strategy from conventional transactions to avoid detection by the police. The increased market demand for mobile phones also supports the online trade in Indonesia. AC Nielsen's Global Survey of E-Commerce (2014) reported the ownership of mobile phones increased three times while landline ownership has dropped 50% between 2005 – 2010. Mobile phones and computers are devices most frequently used by Indonesians for online shopping; 61% people use mobile phone and 58% computer. The Indonesian Minister of Communication and Information (MCI) stated that Indonesia has the 4th largest number of Facebook users in the world. According to E-Marketer's report, Indonesia has 83.7 million Internet users in 2014, placing Indonesia as the 8th largest Internet user in the world. Therefore, there is a huge potential market in Indonesia for online trade, including online trade of illegal wildlife.

The Stages of Online Wildlife Trade Investigation

A. Desk research

WCU investigators use Internet browsers such as Firefox and Internet Explorer and search engines e.g. Google to find online wildlife traders. Most traders use popular Electronic Commerce (e-commerce) websites or social network including indonetwotk.co.id, www.kaskus.co.id or Facebook. Traders offer protected wildlife or wildlife products with photos, and mobile contact numbers. Intensive communication between an investigator posing as a buyer and a trader is then established through SMS, BBM, Whatsapp, or email. During this communication, traders will provide detailed information on the wildlife and then prompts the buyer to transfer a down payment. WCU is using i2 Intelligence to find the connection among the targets, map criminal network, and define the most important targets.

B. Defining target

Intensive communication between the WCU investigators and a target is crucial to ensure and verify that the live wildlife or wildlife product meets the expectation. At least 25% of animal products such as ivory, tiger bones, or rhino horns being sold in the online market are fake or originate from a different species from the one promoted. Sometimes, the mobile phone numbers provided by traders are unreachable or they only provide an email address. There are also cases where the same trader uses more than 1 account to promote the same wildlife, therefore the verification step is beneficial to verify the trader's identity and define potential traders to be followed up.

C. Sting operation

The police and the WCU will set up a sting operation if the evidence provided by the trader fits with the expectation. The trader usually asks for a 10-30% down payment to guarantee the transaction or to avoid buyers who are not serious about buying. To define the trader's location during the sting operation, the police will ask a prosecutor to issue a permit to tap a suspect's mobile phone. Knowing the location of the trader is important to ensure that the trader brings the animal by himself and not send someone else / a courier.

F. Providing digital evidence recovery

The police and the WCU using Oxygen Forensic Software to download data and information from the suspect's mobile phone or computer after the arrest takes place. The data is very important to understand the conversation among the criminals, and also to target the next operation. The information from suspect interrogation/interview is important to cross check the data from digital evidence (suspect's cellphone/computer). The police often provided the electronic evidence to the prosecutor, which shows the suspect dealing in the illegal trade or carrying out a transaction using the Internet. The electronic evidence will be showed to the prosecutor and judge during legal process and courtroom. The electronic evidence strengthens the indictment in addition to the suspect's confession or information from witnesses. The police must provide three components to process the suspect's legal documents, which include the evidence, witness, and the suspect himself. The indictment will be stronger if the police provide a number of evidence and more than two witnesses in court.

Conclusion

The increasing number of e-commerce and social media transactions of protected wildlife and wildlife products showed that traders see the benefit of using the Internet to boost their business. With 83.7 million Internet users in Indonesia and millions more abroad, e-commerce or social media are cost-efficient ways to promote their products. Conventional trade of illegal wildlife is more complicated as the trader and the buyer need to meet in a discreet location. By using the Internet, the traders are able to conceal their identity and transaction. The trader can also send the wildlife products through cargo expedition, which is a safe way to avoid police monitoring. The risk of Internet transaction is the buyer losing money if they happen to come across a fake trader, but the percentage of fake traders is less than 5%.

Both Internet operators and the police should work closely to identify illegal traders using e-commerce facilities. Internet operators should coordinate with the police to track a trader's history in selling protected animals and their by-products. Internet operators or telecommunication experts could testify as witnesses in court if needed.

Paper Number: 972
Tuesday, 03 July 2018 | Colosseum 1
General Session 15 - Wildlife Trade

SYMPOSIUM 17

Impacts of Tropical Landscape Change on Human Diet and Local Food Systems

The importance of forested landscapes for food security and nutrition across agricultural transitions: a multi-country comparative analysis

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Introduction:

Agriculture is the primary driver of tropical deforestation having significant impacts upon local smallholder communities. Tropical deforestation and the conversion land to agriculture also precipitates a transition for smallholder family farms which become increasingly commercialized and transition away from diverse subsistence systems towards specialized market orientated operations leading to dramatic shifts in the scale and nature of agricultural landscapes and the associated effects on; the environment, ecosystem service provisioning, livelihoods, well-being and health of local populations. We examine how changes in agricultural landscapes manifest themselves as dietary transitions which represents an often overlooked social dimension of tropical conservation.

Methods:

We have applied a novel methodological approach as part of the Agrarian Change Project which aims to explore the nature of forest loss and landscape-scale agricultural transitions in tropical forested areas across seven landscapes in different countries (Indonesia, Burkina Faso, Ethiopia, Nicaragua, Bangladesh, Cameroon and Zambia). Each landscape has historically undergone and is currently undergoing agriculture driven landscape transformation and three experimental zones we established within each landscape representing increasing levels of deforestation and transition away from forest based livelihoods. Zones represented different stages of transition and were paired with household surveys (n=1904) exploring the diets and livelihoods of local people. We conducted a comparative analysis by using a mixed model approach that allowed us to draw some broad conclusions about the impacts of agricultural intensification, forests and diets at the landscape scale.

Results:

After controlling for a wide range of variables known to contribute to the status of a household's nutritional status, we found that a household's position along the forest transition/agricultural intensification curve and their reliance on forests can have large impacts on their food security, and nutrition. Dietary diversity is significantly better for those who have an intermediate level reliance on forests. Furthermore, the size of the effects of forest use are mediated by an interaction with landscape configuration. The impact of reduced reliance on forests for food security is amplified for those who remain forests dependent in the highly modified agricultural zones

Conclusion:

The study confirms the highly important role that forest access and forest food use has upon nutrition within smallholder communities living in tropical forested regions. It also suggests – counterintuitively – that the importance of forests for food security and nutrition may in fact increase as landscapes are deforested and agricultural land use and livelihoods become increasingly intensified and market orientated. Confirmation by other studies may disabuse the notion that forests are important only for traditional forest-dwelling societies by demonstrating that trees and forests within agricultural landscapes are of paramount importance when designing nutrition-sensitive landscapes. Thus, the definition of forest-dependence itself should be expanded beyond its traditional domain of high-level forest users in primary forest to incorporate the continued use of forests and trees within modified agricultural landscapes.

Paper Number: 523

Tuesday, 03 July 2018 | Colosseum 2

Symposium 17 - Impacts of Tropical Landscape Change on Human Diet and Local Food Systems

Landscape Change, Landscape Structure and Dietary Diversity in the Global Tropics

Laura Vang Rasmussen

Across the planet, expansion of agriculture is rapidly increasing due to rising global demand for food, fiber, and biofuels. Although the very point of agricultural expansion is to create more food to reduce hunger, paradoxically it may lead to reduced food security. This is because expansion is the leading cause of forest loss which can shrink wild food availability. Also, forest loss may lead to lower agricultural productivity as forests, for example, provide nutritional subsidies to grazing animals, which in turn replenish nutrients to farms. Despite these potential repercussions for rural people's food security, and dietary diversity in particular, rhetoric in food security policy has focused on high yields as the solution to perennially rising food demands while leaving the role of forests relatively unexplored. In this study, we examine associations between forest cover and the spatial arrangement of forests and rural people's dietary quality. We use the World's Bank Living Standard Measurement Survey data from Malawi (n= 10,037 rural households) on food consumption, while forest cover and configuration metrics are based on Hansen tree cover data. In multiple regression analysis, controlling for the effects of several covariates on household dietary diversity, we find a weak positive association between the percentage forest cover and the number of food groups that households consume. The results also show that while the density of forest edge, a key metric of the spatial arrangement of forests, is weakly negatively associated with the total number of food groups consumed, the association becomes positive for the consumption of certain individual food groups, such as animal sourced food and dark green leafy vegetables. These results should be of interest to stakeholders, such as land use planners and governments, pursuing food security for rural populations.

Paper Number: 473

Tuesday, 03 July 2018 | Colosseum 2

Symposium 17 - Impacts of Tropical Landscape Change on Human Diet and Local Food Systems

Associations between dietary quality, biodiversity and landscape structure in the Eastern Arc Mountains

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Introduction: There is growing evidence that biodiversity can contribute to dietary quality (Powell et al. 2015). Biodiversity includes both wild and cultivated diversity, as well as diversity across various scales (crop variety, species, farm, and landscape). A recent review has highlighted a number of studies that show positive associations between diet quality and various aspects of biodiversity (agrobiodiversity, wild foods, forests). However, to date virtually no studies have attempted to examine more than one aspect of biodiversity simultaneously.

Methods: We examined relationships between dietary quality of 274 children between the ages of 2 and 5 years and various measures of biodiversity in the landscape around their homes. Repeat 24 hour recall were used to generate dietary diversity scores and a Mean Probability of Adequacy (across 11 nutrients). Measures of biodiversity included: crop diversity (agrobiodiversity) and wild food diversity (at the species level); number of fields, presence of livestock on farm (at the farm level); and, forest cover, slope (assuming that areas with greater slope have greater diversity of microclimate around the home). Landscape structure metrics included: amount of edge, distance to patch and landscape diversity. Correlation and linear regression models, controlling for child's age, sex and breastfeeding status, household wealth and size, sex of the household head and size of the household farm were used to assess the relationships between metrics of diet quality and metrics of biodiversity and landscape structure.

Results: Children's dietary diversity was positively correlated with: crop diversity, wild food diversity, presence of livestock on farm, number of fields farmed, average slope and forest cover. Children's MAR was positively correlated with: crop diversity, number of fields farmed, and forest cover. In a regression model with dietary diversity as the dependent variable forest cover was the only measure of biodiversity that was significant. For the regression model with MAR as the dependent variable crop diversity, number of fields farmed and forest cover were significant.

Discussion: The results support the growing body of evidence suggesting that biodiversity plays an important role in dietary quality. These results suggest that in rural areas of developing countries, the natural environment is an important aspect of the food environment. Efforts to make agricultural systems and landscapes more nutrition-sensitive should not overlook the importance of biodiversity, landscape diversity and landscape structure.

Paper Number: 935

Tuesday, 03 July 2018 | Colosseum 2

Symposium 17 - Impacts of Tropical Landscape Change on Human Diet and Local Food Systems

From Growing Food to Growing Cash: Dietary consequences of transitions to oil palm in Borneo, Indonesia

Amy Ickowitz

While the ecological effects of oil palm production in Indonesia have received global attention, the transformation of rural landscapes across Indonesia also has profound impacts on local food security and nutrition. The transition away from traditional agricultural production practices producing a myriad of foods in complex landscapes to monocultures of oil palm are changing diets profoundly. We present preliminary findings from a project carried out in Borneo, Indonesia to show how these changes in land use, social organization, and market integration are affecting local diets and health of women and young children.

West Kalimantan, Borneo, has experienced high rates of recent deforestation as its landscapes are being transformed by oil palm production. We randomly selected approximately 250 households with children between the ages of 12 and 59 months across 15 traditional swidden villages and 250 households across 18 oil palm villages in the same districts. We carried out dietary and anthropometric surveys of mothers and their oldest children under 59 months in three seasons throughout 2017. We documented the source of each food/ingredient consumed so that we can determine the relative contributions of forests, fallows, farms, and markets to local diets across the two groups and the nutritional quality of the foods coming from each source.

Preliminary results suggest that children who live in households which practice swidden cultivation eat more green leafy vegetables, meat, and fish than those who live in oil palm households. Children whose parents work in oil palm eat more packaged and processed foods purchased in the market. Preliminary findings suggest that these changes are due to a combination of factors including: less availability of wild foods in oil palm communities, less time available for mothers to cultivate green leafy vegetables, less time and area available for hunting in oil palm communities, and preferences for processed foods. Nutritional status data are still being analyzed.

A transition from traditional agriculture to modern cash crop systems is advocated by development professionals, conservationists, national governments, as well as international donors. Indeed this is one of the key changes that defines economic development. The preliminary results presented here as well as from other studies (Isaacs et al., 2016; Broegaard et al 2017; Ickowitz et al. 2017) suggest that there may be unintended negative consequences of these transitions in terms of diet and in addition to the positive changes of higher incomes and enhanced economic opportunities.

Paper Number: 441

Tuesday, 03 July 2018 | Colosseum 2

Symposium 17 - Impacts of Tropical Landscape Change on Human Diet and Local Food Systems

GENERAL SESSION 9.2

Mammal Ecology & Conservation

Simulating impacts of rapid forest loss on population size, connectivity and genetic diversity of Sunda clouded leopards (*Neofelis diardi*) in Borneo

Ewan Macdonald

Habitat loss is the greatest threat to biodiversity in Borneo, and to anticipate and combat its effects it is important to predict the pattern of loss and its consequences. Borneo is a region of extremely high biodiversity from which forest is being lost faster than in any other. The little-known Sunda clouded leopard (*Neofelis diardi*) is the top predator in Borneo and is likely to depend critically on habitat connectivity that is currently being rapidly lost to deforestation. In this paper we modelled the effects of landscape fragmentation on population size, genetic diversity and population connectivity for the Sunda clouded leopard across the full extent of Borneo. We modelled the impacts of land use change between the years 2000, 2010 and projected forwards to 2020. We found substantial reductions across all metrics between 2000 and 2010: the proportion of landscape connected by dispersal fell by approximately 12.5% and the largest patch size declined by around 15.1%, leading to a predicted 11.4% decline in clouded leopard numbers. We also predict that these trends will accelerate greatly towards 2020, with the percentage of the landscape being connected by dispersal falling by about 57.8%, the largest patch size falling by around 62.8% and the predicted clouded leopard population falling by 62.5% between 2010 and 2020. We predicted that these large declines in clouded leopard population size and connectivity will also substantially reduce the genetic diversity of the remaining clouded leopard population.

Paper Number: 403
Tuesday, 03 July 2018 | Petra 1
General Session 9.2 -Mammal Ecology & Conservation

The effect of natural habitat and human activities on large cat's predation risk in a tropical landscape: including spatial and temporal scales in a two-dimensional approach

Sophie Calme

Livestock predation by large cats represents a threat both to livestock production and to large cat conservation when retaliation occurs. Therefore, understanding the factors that influence the occurrence of attacks and their spatial distribution has become an important task for conservation managers. However, the importance of spatial and temporal scales has often been overlooked. In this study, we investigated the risk of attack on livestock by large cats while selecting the appropriate temporal and spatial scales at which these attacks occur. We collected data on sites where attacks had occurred and on sites where attacks had not occurred between 2011 and 2015 in the region of Calakmul, which hosts the largest population of jaguars in Mexico. We also obtained additional information relative to livestock management through 165 interviews with the ranchers managing these sites. We derived ecological and anthropogenic variables from two land-use maps (2000 and 2015) at four scales relevant for large cats (0,5 km, 2,5 km, 5 km and 10 km-radius). We built two sets of models, one expressing the potential effects of landscape characteristics (structural and functional), and the other expressing the potential effects of human pressure (human population, land use, and livestock production). Following an information-theoretic approach that integrates spatial correlation, we selected the appropriate temporal and spatial scales and then applied a hierarchical selection of our models. Five variables were best explained at a specific spatial scale, while the amount of forest in 2000 appeared more important than the amount of forest in 2015. The species of livestock raised was by far the main determinant of attack in the region, with sheep particularly at risk, which prompted us to integrate this variable into every models. Attack occurrence in the region was best explained by the functional characteristics of the landscape that included the fragmentation process; the effect of human pressure was of lower importance. This study, based on a robust approach using state of the art procedures in landscape ecology, shows the importance of incorporating multiple spatial and temporal scales. It also highlights the benefits of using a two-dimensional approach to support conservation management measures at the appropriate organizational level. For instance, livestock management might be better addressed at a community level, whereas landscape fragmentation will be better tackled at a regional or state level.

Paper Number: 948
Tuesday, 03 July 2018 | Petra 1
General Session 9.2 -Mammal Ecology & Conservation

Mammalian response to human dominated matrix reveals conditional opportunity for human-wildlife coexistence in the north-west Himalaya

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The Himalayan mountain system, a global biodiversity hotspot, is under significant human modification. The aims to develop the “not-so developed”, areas in the Himalayas pose direct and indirect threats to its biodiversity values. Ever increasing modification of natural areas and expected severity of climate change effects in this mountainous system warrant constant scientific inputs for effective conservation practice.

With the aim of understanding the response of wildlife to human-modified systems and how they negotiate human presence, we investigated the proximate patterns of co-occurrence of humans and mammalian communities at mid-elevation zone of the Himalaya. We also documented the perception of local communities to understand co-existence and conflict resolution options. The research methods involved robust digital camera trap sampling (n=131) across the target area that includes a gradient of human population densities. We also did sample survey of people (n=105) based on interviews. We designed a sampling protocol such that it captured spatial variations and community composition in the landscape in relation to the juxtaposition of human habitations.

Our results revealed 16 wild mammalian species that used human-dominated areas, with significant variations in occupancy and frequency of occurrence amongst the habitat types. The spatial and temporal pattern of different species reflected specific sensitivity to human activities, thereby either negotiated or avoided conflict situations. This pattern seems to be governed by the diet of animals where omnivores were the most tolerant species, followed by carnivores and least tolerated by ungulates. People perception survey (n=105) also supported the co-occurrence situation, provided the current functional status quo is maintained. It was suggested that the compensation scheme needs to provide quick relief for livestock loss and preventing mechanism to be placed to protect crops.

Given the increasing focus on landscape approach and new findings highlighting importance of such systems for biodiversity conservation, the results open up new frontiers with empirical evidence for conservation management in human-dominated landscapes of mountain systems. We recommend that the land use pattern of the people is integrated in mainstreaming biodiversity conservation so that the current co-existence strategy may become viable. Also, devising alternate livelihood options will enhance the social carrying capacity of the people to deal with wildlife in the human dominated landscape in positive context.

Paper Number: 890

Tuesday, 03 July 2018 | Petra 1

General Session 9.2 -Mammal Ecology & Conservation

Survival strategies of the sun bear (*Helarctos malayanus*) in a forest-oil palm landscape.

Roshan Guharajan

Borneo has seen accelerated clearing of forests for oil palm expansion, leaving fragmented islands of degraded forests amidst a sea of monoculture, negatively affecting a host of forest-dependent species. Borneo is an important stronghold for the sun bear (*Helarctos malayanus*), a forest-dependent species that feeds on fruits and insects. Sun bears have been reported to select for primary forests with a high abundance and diversity of fruits, large trees, dense cover, and low human activity. Our study site in the Lower Kinabatangan floodplain in Sabah, Malaysian Borneo, was just the opposite: a matrix of riverine fragmented forests and extensive oil palm development, which has existed as such for at least 15 years. We thus hypothesized that sun bears would have difficulty surviving there. We used camera traps and sign surveys (sun bears leave distinctive claw marks on trees) to examine patterns of habitat use within forest fragments, squeezed between a major river and oil palm plantations. We found that bears exhibited strong selection for areas farther from human activity, and were rarely active during the day, demonstrating both spatial and temporal avoidance of potential human-related threats. They also selected to feed and rest in the largest trees. Based on bear sign densities, forest fragments served as important refuges for bears after feeding forays into adjacent oil palm plantations. Our study indicates that human activities are the single greatest factor influencing sun bear habitat use in the Lower Kinabatangan. We highlight that sun bears can survive even in relatively small forest fragments (~2,000 ha) within large oil palm landscapes. Sun bears have employed remarkable adaptations in order to live in such a drastically modified landscape, but their long-term persistence here remains uncertain in the face of continuous human-caused threats.

Paper Number: 423

Tuesday, 03 July 2018 | Petra 1

General Session 9.2 -Mammal Ecology & Conservation

Assessing ecological information of less charismatic species from camera trap data; Study cases of mammals in Kampar Peninsula

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The use of camera traps for assessing the species richness, distribution and abundance, especially for charismatic species such as the large carnivore had been widely conducted. However, less charismatic species from non-target species which likely being discarded during stage analysis could contributed to fill the gap of ecological information on this species.

We deployed 220 camera trap stations in Kampar Peninsular for more than 10,000 trap days from study of sumatran tiger densities. The temporal replication of captured images allows the data to be used in estimation of occupancy and activity levels of non-target species. We consider human activities, tree cover and water sources as environmental variables. We used 13 non-charismatic species as study cases. Analysis were prepared in R software with “unmarked” package. This modelling could predict the geographical range and habitat characteristic species. We also use the time stamps recorded in photographs to quantify activity level and temporal overlap among species.

Each species responses varied to environmental variable and some species shows the overlap either by spatial or temporal with other species. This results, outline the uses of by-catch data as a valuable data to assess less known charismatic species ecology aspect through statistical robust interferences and the limitation of this approach.

Paper Number: 682
Tuesday, 03 July 2018 | Petra 1
General Session 9.2 -Mammal Ecology & Conservation

Ecology of Otters in the Lower Kinabatangan Wildlife Sanctuary

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Very little is known about the Bornean otter species and otter research is sorely lacking in this biodiverse region. Set in Kinabatangan River, Sabah, Malaysia, this study sought to (1) determine the presence and absence of otter species, including their distribution across different habitat structures in a secondary lowland fragmented forest; (2) investigate the activity pattern of otter; and (3) identify and understand better human-otter conflict and villager's perceptions towards otter. The presence of otters is strongly associated with the presence of holts, spraints, grooming sites and footprint tracks, therefore an otter sign survey was conducted. 25 sites were surveyed for 12 months, each spaced in 1km intervals along Kinabatangan river within 40 km of the Lower Kinabatangan Wildlife Sanctuary (LKWS). A total of 80 otter signs were found and all belong to *Lutrogale perspicillata*. In this study, the presence of otter sign is associated with the number of bank trees, the percentage of canopy vegetation cover, as well as close proximity to lake and plantation. Oil palm plantation has higher otter occupancy compared to a logged forest, which shows that otter is still using oil palm habitat, despite the habitat conversion. Camera trap was set up for species identification and to record activity pattern of an otter. Four camera traps were deployed in front of two fresh otter holts for 15 non-consecutive months. The result showed that otter mostly active during early morning and late evening, which was associated with prey abundance and visibility, as well as environmental temperature. A total of 58 people was interviewed in Batu Puteh village, Kinabatangan to understand the local perceptions of otters and to identify any human-otter conflict that might be occurring around LKWS. Most of the respondent were fishermen since they are the main focus group. Based on the interview, more than half of the respondent have positive perceptions towards otters and the level of human-otter conflict is relatively low in Batu Puteh village. The results of this study will be important in determining the status of Bornean otter in the future and informing conservation actions.

Paper Number: 361
Tuesday, 03 July 2018 | Petra 1
General Session 9.2 -Mammal Ecology & Conservation



GENERAL SESSION 16

Plant Ecology

Pines and needles: functional and phylogenetic diversity across elevational gradients in Mexican coniferous forests.

Libertad Sanchez-Presa

Mexican montane forests contain a high diversity of conifer species. Their distribution is determined locally by environmental filtering, but also regionally by climatic and geological history. In this study we investigated the functional and phylogenetic diversity patterns of Mexican conifers along the elevational gradients of six mountain ranges in Mexico, incorporating species richness, functional traits, and a phylogenetic approach. Additionally, we tested how environmental variables explain the functional and phylogenetic diversity patterns in our study system.

We used georeferenced data on Mexican conifer species from a national forest survey. A trait matrix was constructed using morphological characteristics of the species extracted from literature descriptions and online databases. We used a resolved global conifer phylogenetic tree to construct the phylogeny for Mexican coniferous tree species. Within Mexico 6,963 plots, each 0.4 ha in size, distributed in six montane areas were assessed, and their altitudinal gradients divided into 500 m elevation belts. Species, functional and phylogenetic alpha diversity were quantified within each altitudinal band, and the beta diversity between altitudinal bands and montane ranges.

Our results show that species turnover increases with altitude and geographic distance between mountain ranges, whereas functional and phylogenetic diversity decrease with altitude. There is an increase in phylogenetic relatedness within and between altitudinal bands at higher altitudes, which indicates that the assembly of communities is mainly determined by environmental filtering processes, as related species with adaptive traits suited to low temperatures and environmental seasonality are selected. At lower altitudes, a decrease in phylogenetic relatedness might be driven by more intense competition between species with similar traits. We found that for the six regions in our study system, phylogenetic similarity decreases with the spatial distance separating them.

Paper Number: 282
Tuesday, 03 July 2018 | Petra 2
General Session 16 - Plant Ecology

Vertical gradient in bryophyte diversity and species composition in tropical and subtropical forests in Yunnan, SW China

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Forest canopies in tropical and subtropical forests are one of the most species-rich habitats in the biosphere, harboring a variety of epiphytes, especially epiphytic bryophytes. Epiphytes play an important ecological role in maintaining water and nutrient cycles in the forest ecosystem, and contributing to canopy species and habitat diversity, so they have a high protection value. However, the biodiversity, community structure, and ecological processes of epiphytes are still understudied because of the three-dimensional spatial complexity of forests and the limitations of canopy access techniques. Canopy cranes have broken through the bottleneck of easy access to the different positions in the treetops. Using two newly established cranes, we systematically collected 639 vertical segments from 1600–2400 cm² of bark surface along the vertical gradient from tree base to tree crown on 142 trees (46 canopy trees, 48 subcanopy trees, and 48 understory trees) in tropical and subtropical forests in Yunnan, southwest China, in the Indo-Burma biodiversity hotspot. In total, 186 epiphytic bryophyte species (111 mosses and 75 liverworts) were recorded, belonging to 106 genera and 40 families. Notable findings include the very high species diversity in both forest types, with few species shared between the two sites, the higher diversity in the subtropical montane site, the greater diversity in the canopy than in the lower layers at both sites, the many species restricted to specific microenvironments, the presence of seven red-listed species, and the fifteen new bryophyte records for Yunnan. This project is the first to systematically explore canopy epiphytes in China and reveal the spatial distribution patterns and their drivers for epiphytic bryophytes in Yunnan. Therefore, it not only demonstrates the value of canopy cranes for complete sampling of the epiphytic bryophyte flora in complex forests, but also highlights the necessity of protecting mature forests along the full altitudinal and latitudinal gradient in order to better conserve this exceptionally rich bryoflora.

Paper Number: 220
Tuesday, 03 July 2018 | Petra 2
General Session 16 - Plant Ecology

Dramatic loss of native fleshy-fruited plant diversity on recent lava flows of the Piton de La Fournaise volcano (Reunion, Mascarene islands)

Sébastien Albert

Introduction

Fruit traits are major determinants to understand vegetation recovery during primary succession. As most tropical woody plants are fleshy-fruited, one may expect that historical frugivore defaunation have drastic consequences on plant succession in tropical ecosystems. Here, we compare native vegetation composition and richness according to fruit traits of woody species across a 1100-yr chronosequence of lava flows in Reunion island (Mascarene archipelago), colonized by humans since 1665 only.

Methods

We use 84 vegetation surveys located below 500 m a.s.l. on 20 basaltic lava flows dated between 845 AD and 1943 AD. Four classes of chronosequence are defined according to the chronology of native frugivore defaunation documented by subfossils records and historians archives: [845, 1665[when frugivores were abundant and diverse; [1665, 1800[when large frugivore populations were strongly reduced in size; [1800, 1900[when large frugivores went extinct and small frugivores still abundant; [1900, 1943] on going population crash of remaining small frugivores. Fruit type of each woody species is categorized as anemochorous dry-fruited, small fleshy-fruited or large fleshy-fruited, i.e. plant of which fruit cannot be dispersed by remaining small frugivores.

Results

Preliminary results show that fruit traits variation within woody plant communities is strongly correlated to the chronology of defaunation during the last four centuries. Rainforest vegetation on lava flows before human settlement converges in composition and is strongly dominated by fleshy-fruited species. The richness of large fleshy-fruited plants shows a strong depletion between 1665 and 1800 and is almost null on lava flows posterior to 1800. The richness of small fleshy-fruited plants decreases less rapidly, but becomes very low after 1900. Conversely the richness of anemochorous plants remains unchanged across the chronosequence.

Conclusion

Primary succession processes on recent lava flows will never conduct to a native canopy rainforest. Frugivory disruption combined with non native plant invasion is shaping novel ecosystems with extremely low taxonomic and functional diversity. The dramatic loss of native fleshy-fruited plant diversity on recent lava flows emphasizes the urgency to incorporate the lack of native vegetation recovery in conservation strategies in the Mascarenes and at larger scale in most tropical archipelagoes.

Paper Number: 544
Tuesday, 03 July 2018 | Petra 2
General Session 16 - Plant Ecology

Spermatophyte flora of Yinggeling National Nature Reserve of Hainan, China

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Hainan is a mountainous island at the northern margin of tropical Southeast Asia, it is part of the Indo-Burma Biodiversity Hotspot and is China's second largest island after Taiwan. Yinggeling National Nature Reserve is located in the mountainous interior of the 33,920 km² island, with an altitude range from 180m to 1812m. The area has a tropical oceanic monsoon climate, and Yinggeling is the major headwater for Hainan's two largest rivers. Prior to our preliminary survey in 2003, the forest has never been scientifically explored, but our rapid survey and GIS analysis revealed that Yinggeling retains the largest tract of old-growth tropical rainforest in South China.

In order to identify the floristic elements and the importance of the spermatophyte flora, we carried out extensive fieldwork during 2003-2006. A total of 1,706 seed plant species were recorded, belonging to 825 genera and 173 families, based on more than 6000 specimens collected. Plant specimens have been deposited mainly at the herbarium of South China Botanical Garden, the Chinese Academy of Sciences.

At the generic level, tropical elements were the dominant components, in which pantropical genera and tropical Asian genera contributed 25.28% and 32.36% of the total (excluding cosmopolitan genera), respectively. There were eight genera endemic to China, including two genera (*Pyrenocarpa* and *Metapetrocosmea*) endemic to Hainan Province. At the species level, tropical elements contributed to 70.50% of the total number of species (excluding the cosmopolitan ones). There were 474 species endemic to China, accounting for 28.42% of the noncosmopolitan species. Among them, 149 species (31.44%) were endemic to Hainan.

Yinggeling Mountain has a unique flora, exhibited not only by newly recorded (2 new species; 7 species new to China; one family, 10 genera and 45 species new to Hainan) and unusual species (*Trigonobalanus verticillata*, *Bretschneidera sinensis*, etc.), but also by being a geographical nexus of subtropical flora with typical tropical species, xerothermic with humid and warm species. Compared with the flora of four neighboring areas, the flora of Yinggeling Mountain showed high similarity with that of Diaoluo Mountain, but contained more tropical elements than Dinghu Mountain of Guangdong and Xishuangbanna of Yunnan.

Paper Number: 699
Tuesday, 03 July 2018 | Petra 2
General Session 16 - Plant Ecology

Generalizable principles of facilitation and mutualism from the phytotelmata of *Nepenthes* pitcher plants

Weng Ngai Lam

Positive species interactions are a ubiquitous element of natural communities, but tend to be highly variable in their outcomes. That is, the outcomes of interactions may change from positive to neutral to negative, depending on environmental conditions in which the interactions take place. The lack of generalizable principles concerning conditionality, as well as a lack of mechanistic syntheses in the study of taxonomically disparate systems of mutualism/facilitation, are likely to be significant barriers to the integration of positive species interactions into larger ecological theory. The stress gradient hypothesis (SGH) predicts that facilitative interactions are stronger and more abundant in environments experiencing high stress. However, studies have yielded conflicting evidence for hump-shaped versus linear relationships between facilitation and environmental stress gradients. *Nepenthes* tropical pitcher plants are carnivorous plants which trap insect prey using fluid filled modified leaves. Pitchers are also phytotelmata (plant held water bodies) which are inhabited by aquatic dipteran larvae known as inquilines. Inquilines are known to facilitate the breakdown of prey carcasses to pitcher-absorbable nitrogen forms. Using in vitro digestion experiments replicating *N. gracilis* pitcher communities, we examined the total pitcher absorbable nitrogen released from prey carcasses under varying conditions of inquiline occupancy. We investigated the positive effect of inquilines on plant nitrogen sequestration along two gradients: a gradient of prey resource abundance (different numbers of ant prey), and a gradient of prey digestibility (different species of ant prey). Along the gradient of prey resource abundance, the net benefit of inquilines on plant nitrogen sequestration decreased linearly with increasing resource levels, lending support for the linear, rather than hump-shaped, SGH. Along the gradient of prey digestibility, the net effect of inquilines on plant nitrogen sequestration was positive in prey which had low digestibility (i.e., resistant to enzyme degradation), but negative in prey which had high digestibility. This finding offers itself as a useful principle governing digestive mutualisms, a class of mutualistic interactions which may be clearly delineated through their common underlying mechanism. Our study has important implications for communities existing on modified landscapes, which are often exposed to large variations in resource fluxes that in turn greatly alter the outcomes of positive species interactions.

Paper Number: 961
Tuesday, 03 July 2018 | Petra 2
General Session 16 - Plant Ecology

Mating system and fine-scale spatial genetic structure in the aggregated, self-compatible hermaphrodite mistletoe *Dendrophthoe pentandra* (Loranthaceae) in Xishuangbanna, SW China

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Mistletoes are a special group of semi-parasitic plants that play key roles in forest ecosystems, they often exhibit aggregated distribution, depend upon animal vectors for pollination and dispersal, so outcrossing and strong local genetic structures are thought to be a general feature. However, empirical estimates of their mating system and genetic study are rather rare. We investigated the pollination biology and their avian vector flying range of a generalist mistletoe *Dendrophthoe pentandra* and used simple sequence repeat markers with 13 loci to examine outcrossing rates of four populations and the fine-scale spatial genetic structure (SGS) of 368 different age's individuals from three hosts and three sites in ML population in Xishuangbanna, southwest China. Our results showed that flowers of *Dendrophthoe pentandra* were inconspicuous, asynchronous, continuously secreted nectar and high pollen:ovule ratio and exhibited explosive flowering which the tepals of the corolla tubes require birds to open the flowers for pollination. The species was self-compatible, yet exhibited no autonomous selfing; however, pollinators may facilitate geitonogamy with varied visiting frequency among populations. As the main pollinators and seed dispersers of this mistletoe, *Dicaeum concolor* and *Zosterops japonicus*'s flying speed were 1.18 ± 0.15 m/min and 0.99 ± 0.12 m/min (mean $\pm$ se) respectively, their flying ranges were less than 100 m in diameters. Genetic analysis revealed high outcrossing rates (0.827–0.973), and a high r_p suggested that pollen-donors were infrequent. For mature plants, the mean observed and expected heterozygosities were 0.432 (H_O) and 0.462 (H_E), respectively, similar to the progeny, and the F_{ST} value (0.462) indicated that the populations were highly structured. Moreover, *D. pentandra* in ML population showed significant SGS, positive correlations were found between the distance at which maximum autocorrelation coefficient r values were reached and different hosts and sites, but not between ages. It is likely that *D. pentandra* maintained high levels of outcrossing and genetic diversity, and strong spatial genetic structure, despite its self-compatibility and clump-distribution; these may be attributed to its bird pollination, and seed dispersal, and post seed-dispersal mechanisms.

Paper Number: 250
Tuesday, 03 July 2018 | Petra 2
General Session 16 - Plant Ecology

GENERAL SESSION 17.1

Forest Ecology & Conservation

Disentangling the mechanistic and functional trait drivers of spatial aggregation in tropical forest trees

Ian McFadden

Environmental filtering and dispersal limitation can both maintain diversity in plant communities by aggregating conspecifics, but parsing the contribution of each process to community assembly has proven difficult empirically. Here we assess the contribution of filtering and dispersal limitation to the spatial aggregation patterns of 456 tree species in a hyperdiverse Amazonian forest, and find estimates of these processes are correlated with different functional traits. Spatial point process model analysis revealed that both mechanisms are important drivers of intraspecific aggregation for the majority of species. Leaf turgor loss point, a measure of drought tolerance, predicted species topographic distributions in this aseasonal rainforest, suggesting that future increases in drought severity could significantly impact community structure. In addition, seed mass was correlated with the size and density of dispersal-related aggregation, such that larger-seeded species had larger and more sparse clusters. Taken together, these results reveal how variation in environmental filtering and dispersal limitation act in concert to drive the spatial and functional structure of diverse forest communities.

Paper Number: 794
Tuesday, 03 July 2018 | Taj Mahal
General Session 17.1 - Forest Ecology & Conservation

Forest Integrity Assessment: testing a new field assessment tool for identifying and monitoring conservation set-asides

Jennifer M. Lucey, Andrew J. Suggitt, Yeong K. Loong, Anders Lindhe, Glen Reynolds, Keith Hamer, Agnes Agama, Jane K. Hill

Justification: Across the tropics, attempts are being made to identify, manage and monitor forest areas for conservation. Remaining areas of forest differ considerably in their degree of disturbance, which has impacts for the forest structure and the biodiversity and ecosystem functions that the forests support, but the available survey techniques are timing consuming, expensive and/or require a high level of expertise. Such information is required to help land managers and conservationists identify high quality forest to protect, and to prioritise restoration and management for poorer quality forest. In order to assess forest conservation value, we developed a forest integrity survey tool for lowland dipterocarp forest on Borneo in collaboration with the High Conservation Value Resource Network. The tool is designed to be used by non-expert field workers with no requirement to take any measurements or identify species.

Objective: The aim of the study was to test the effectiveness of the Forest Integrity Assessment (FIA) tool for determining the conservation value of forest areas.

Methods: The FIA survey requires the completion of a “yes-no” survey of 50 questions covering characteristics such as topography, vegetation, fauna and disturbance. 62 volunteer assessors carried out FIAs in 16 forest sites in Sabah (Malaysian Borneo) that ranged in quality from primary to severely degraded forest fragments. We compared the survey responses to independent measurements of vegetation, biodiversity and ecosystem functioning at the same sites from previous studies.

Results: We found a strong correlation between survey responses and a range of conservation value metrics, and crucially, the prior level of volunteer expertise did not affect survey responses. There was some variation among respondents which may be reduced with a small amount of training.

Conclusion & Implications: We conclude that the wealth of scientific data already available can be used to develop simple conservation tools, increasing accessibility and uptake without reducing the robustness of assessments. We are working with industry and conservation practitioners to incorporate the Forest Integrity Assessment tool into management and monitoring procedures.

Paper Number: 248
Tuesday, 03 July 2018 | Taj Mahal
General Session 17.1 - Forest Ecology & Conservation

Decline in soil moisture availability elevate the effects of disturbances in tropical dry forest

Ravi Chaturvedi

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Tropical dry forests (TDF) are subject to severe anthropogenic pressure and have experienced the third highest loss in forest cover, after boreal forests and humid tropical forests. Determining the causes of the tropical forest deforestation and degradation is a prerequisite for understanding how to manage them better. We investigated the severity of disturbances in TDF fragments in central India arrayed across a soil moisture gradient. We asked the following questions: (1) Which disturbances (harvesting, browsing, drought and fire) are important for tree mortality in a TDF and do these change with size class (juvenile, sapling, adult)? (2) How is mortality and recruitment in a TDF related to soil moisture content (SMC) and does the relationship change for different size classes? (3) Is disturbance-related mortality selective? We recorded the numbers of individuals in the three size class killed by the four disturbance types over two years. We also recorded total stem density and recruitment at the forest sites. We compared annual mortality index (AMI) and its four disturbance components (harvesting, browsing, drought, fire) and annual recruitment index (ARI), against the mean SMC of each site using simple linear regression. The impact of all disturbances and total AMI decreased as SMC increased whereas ARI increased as SMC increased. Mortality due to harvesting was substantially greater than other disturbances for adult and sapling trees whereas both harvesting and browsing were important drivers of mortality for juveniles. Tree saplings and adults in this TDF were mainly killed by harvesting, indicating that anthropogenic impacts on tree mortality are more important than non-anthropogenic impacts in the TDF, and impacts of all disturbances are more severe with increasing water stress. Thus, changes in TDF structure due to harvesting are likely to be more rapid in more arid environments.

Paper Number: 23

Tuesday, 03 July 2018 | Taj Mahal

General Session 17.1 - Forest Ecology & Conservation

Pushing the limits of plant communities resilience to human disturbance

Parra-Sanchez, E. & Banks-Leite, C.

Silwood Park, Imperial College London, UK.

Continuous forest is now one of the most scarce types of forest cover worldwide. The recurrent transformation of natural landscapes into human-modified landscapes has dramatically divided continuous into fragmented forests. Therefore, the suitability of human-modified landscapes for native species and the response of species to habitat transformation are two important ecological factors that need to be quantified for several taxa in order to develop more holistic conservation strategies. Here we investigate the extent and magnitude of edge effects on epiphyte communities at a landscape scale in the Brazilian Atlantic Forest. Our design encompasses a comprehensive gradient of habitat availability for epiphytes, ranging from old-growth forests to open matrix. We also integrated responses at a diversity, community and species-specific level, and included canopy and understory forest strata, to decompose the edge effect along the vertical as well as the horizontal gradient. Our results provide evidence that old-growth forest, away from the edge influence, represents the best and perhaps in many ways the only shelter for the majority of epiphyte species. We highlight three key findings: (i) edge impacts in different ways the vertical strata, with more detrimental effects on the understory than the canopy; (ii) the community that now persists in the forest edges and forest interior do have poor resemblance to the communities in the control forest; and (iii) the edge effect in our landscape has reached far into forest interiors (<500 m) affecting local communities and species' abundance distribution in the landscape. Our findings underline that the current forests area do not sufficiently provide resources to maintain vascular epiphytes in human-modified landscapes. Therefore, protecting large continuous old-growth forest seems to be the only strategy viable to maintain this group in highly human-modified forests.

Paper Number: 68

Tuesday, 03 July 2018 | Taj Mahal

General Session 17.1 - Forest Ecology & Conservation

Are blowdowns reducing forest carbon stocks in the Western Amazon?

John Terborgh, Harald Beck, Miles Silman,
Nigel Pitman, Nohemi Huanca Nuñez, and William Farfan

The vital role that forests play in the earth's carbon budget has stimulated investigation of many facets of forest change driven directly and indirectly by human activities. A driver of forest change that has only recently begun to attract attention is the occurrence of violent downdrafts that sometimes accompany the advance of storm fronts. The most severe of these are termed "microbursts." Microbursts were first shown to damage Amazonian forests on the scale of km² in 1994 by Bruce Nelson of INPA. A recent assessment of the capacity of microbursts to alter the carbon dynamics of the Amazon forest came to the conclusion that these events are too widely scattered in time and space to play an important role in carbon dynamics. Not evaluated in this assessment was the impact of less violent events. Strong gusts of wind that accompany advancing storm fronts are far more frequent and widespread than microbursts, but the resulting damage is inconspicuous from space, so cannot (yet) be evaluated via remote sensing. At the Cocha Cashu Biological Station in Amazonian Peru, we have experienced a number of such events since 1973. Three of these (1994, 1999 and 2010) were particularly severe and led to follow-up investigations. With each of these events, the forest around Cocha Cashu suffered an immediate biomass decrement in the form of broken and uprooted trees. The question we analyze is whether these decrements added to a long-term loss of biomass. We found that winds accompanying storm fronts selectively fell large trees in the upper 5% of the size distribution. Recruitment of new individuals into this size class quickly restores the lost biomass so that 8 long-term data sets spanning one to all three storm events show little change in the representation of big trees ≥ 70 cm dbh. Nevertheless, monitoring of mass blowdowns by a regional NGO suggests a sharp increase since 2011 in the incidence of these events in the Peruvian Amazon. At this point, we have to conclude that the jury is still out on whether increasing frequency or severity of windstorms is reducing forest biomass in the Western Amazon.

Paper Number: 480
Tuesday, 03 July 2018 | Taj Mahal
General Session 17.1 - Forest Ecology & Conservation

Resilience of a dry tropical forest in southern Mexico

Rodrigo Muñoz, Frans Bongers, Danaë MA Rozendaal, Edgar J González & Jorge A Meave

Resilience is a complex and intriguing property of tropical forests, essential for the long-term preservation of their attributes and the ecosystem services they provide. Resilience can be assessed by evaluating changes over time in forest state variables, with smaller changes indicating higher resilience. Yet, the role of underlying demographic processes on the dynamics of the state variables that characterize any forest is still poorly understood. We evaluated community-level regulation on three major community state variables of a tropical dry forest (basal area, tree density, and species richness) under the premise that such regulation implies forest resilience. We evaluated the relationship between community state variables, their rates of change, and their demographic drivers (basal area: recruitment, growth, and mortality; density: recruitment and mortality; species richness: immigration and local extinction) of 15 years of dynamics of 31 secondary- and old-growth forest plots in southern Mexico. For this period, the changes in these state variables and their demographic drivers were modeled as functions of state values of the same variables. Linear mixed-effects models were used to account for temporal autocorrelation in the data. Old-growth forest showed relatively stable dynamics over time, as expected. When secondary forest stands were included in the analysis, the relationships between rates of change in all state variables and their state values were negative, i.e., rates of change were high and positive when state variables had low values, and they were high and negative at high values of state variables. The negative slope of this relationship suggests a strong community-level regulation in this community dynamics. Also, the fact that the rates of change were near zero when community state variables were close to their mean mature forest values provides evidence for a resilient behavior, as this is precisely which allows for the existence of attraction basins. Species richness showed a strong regulation of its two underlying demographic processes. Conversely, we only observed a single well-regulated demographic process both for basal area (recruitment) and tree density (mortality). Based on our results, we conclude that the state variables analyzed for this tropical dry forest show community-level regulation, even though not every demographic process associated with them has such regulation. Our findings suggest that forest resilience can be achieved through the regulation of a single demographic process per state variable.

Paper Number: 617
Tuesday, 03 July 2018 | Taj Mahal
General Session 17.1 - Forest Ecology & Conservation

GENERAL SESSION 1.3

Bird Ecology & Conservation

Occupancy modeling for detecting potential hornbill nest trees in a secondary forest patch in the Kinabatangan Wildlife Sanctuary, Borneo, Malaysia

Ravinder Kaur

Eight species of hornbills including the critically endangered Helmeted hornbill (*Rhinoplax vigil*) and near threatened Rhinoceros hornbill (*Buceros rhinoceros*) can be found in the Kinabatangan Wildlife Sanctuary, Borneo. Hornbills are secondary cavity-nesting birds. Therefore their population is limited by the availability of naturally formed tree cavities. A study was carried out to estimate the proportion of forest that is currently occupied by potential nest trees i.e trees with cavities. Using Arcgis, a grid was laid on the 10km² study area, with each site being 250mx250m. Thirty sites were visited systematically by four trained observers that walked in a 'S' shape for greater area coverage. Detection of trees with cavities that appears suitable for hornbills based on a criteria list were recorded. Despite the efforts, cavities can go undetected by the observer, hidden behind foliage, leading to bias estimates. Hence, to address the measurement error and analyse data obtained along transects, a zero-inflated Poisson process occupancy model was applied, as it describes the detection process as a continuous point process i.e time and it assumes independence between detections. The observers detected trees with cavities in twelve out of thirty sites, hence the observed proportion of occupied sites is $\Psi_{naive} = 0.40$. Based on the Bayesian prior distribution and the data, trees with cavities occupied twenty-five sites, ($\Psi = 0.81$). Fourteen trees with cavities ($n=14$) were geotagged, to enable tree species identification and measurements to be carried out in the subsequent survey in June 2018. The results of this study show the difference between a naïve occupancy estimate and an occupancy estimation using zero inflated Poisson process. This study can also be replicated in other areas, as a quick and cost effective assessment tool, to gain insight of the state of a secondary forest, prior to the introduction of artificial nest boxes. It provides insight into an important resource of the hornbills, the proportion of sites occupied by trees with cavities in a secondary forest.

Paper Number: 845
Tuesday, 03 July 2018 | Giza
General Session 1.3 - Bird Ecology & Conservation

Habitat associations of great argus and Bornean crested fireback in three commercial forest reserves in Sabah, Malaysian Borneo

Robin Lietz

Great argus (*Argusianus argus*) and Bornean crested fireback (*Lophura ignita*) are two lowland species of pheasants, potentially serving important ecological roles as invertebrate predators and seed dispersers. Both are listed as Near Threatened due to suspected population declines. Great argus is threatened by habitat loss and hunting while the Bornean crested fireback population is believed to be threatened primarily by unsustainable logging practices. Camera traps are widely used to study terrestrial mammals, but have only recently emerged as a useful tool to study elusive ground-dwelling birds. In order to assess the habitat associations of the two species, we used data from a large-scale camera-trapping effort in three contiguous forest reserves operating under different forest management strategies from Sabah, Malaysian Borneo. One reserve, Deramakot Forest Reserve, is actively logged using Reduced Impact Logging (RIL) and certified by the Forest Stewardship Council (FSC) for its sustainable forest management. The other two forest reserves, Tangkulap-Pinangah and Northern Kuamut Forest Reserve, were conventionally selectively logged until 2002 and 2011, respectively and are now recovering. The three forest reserves are all located within the central forest block in the Heart of Borneo.

Camera-trap data were collected from 2014 - 2016. Within 12,281 trap days we recorded 451 detections of great argus and 239 detections of Bornean crested fireback. Using a single season occupancy modelling framework, we found that great argus occupancy probability was positively associated with higher canopy cover, high forest quality and percentage of secondary forest. Bornean crested fireback occupancy was positively associated with lower elevation and higher forest quality. Occupancy of both species was highest in Deramakot, the FSC certified forest reserve. Great argus occupancy was also relatively high in Kuamut, where logging ceased only recently. Future studies are needed to ensure that this not an extinction debt. Bornean crested fireback occupancy was significantly lower in both forest reserves that experienced more severe forest degradation through conventional logging. Our results highlight how well managed forests can benefit both species. Understanding habitat associations of these species, particularly within forests with varying logging activity, has important implications for their future management as the forests of Borneo continue to undergo anthropogenic change.

Paper Number: 552
Tuesday, 03 July 2018 | Giza
General Session 1.3 - Bird Ecology & Conservation

15 years of wintering waterbird survey in Hainan: so much land, so little bird...

ZHENG Xi, LI Fei, CHAN Pui Lok Bosco

As the second largest island in China, Hainan is an important stopover site for waterbirds in the East Asian-Australasian Flyway. A total of 138 waterbird species have hitherto been recorded in Hainan, including a number of large-bodied species such as pelicans, storks and cranes which are historically known from the island. In order to provide baseline data to better protect Hainan's waterbirds, we conducted annual wintering waterbird survey in Hainan from 2003 to 2017 in over 70 wetland sites, and recorded 85 waterbird species so far. Significant findings include the largest known population of Lesser Whistling-duck *Dendrocygna javanica* in China, regular wintering sites for the globally Endangered Black-faced Spoonbill *Platalea minor*, and several new provincial records. Although no obvious decline can be observed in the overall population and species richness over the past 15 years, the total number of waterbirds recorded was low compared to other significant wetland sites in the region. A number of threatened species with historical records were also missing.

While the disappearance of many species may be contributed to over-hunting throughout their migration routes in East Asia, including on Hainan Island itself, habitat loss and degradation could be the main reasons for the low density and diversity of waterbirds in Hainan in recent years. China's coastal wetlands are some of the most threatened ecosystems worldwide; rampant loss of wetlands caused by escalating urbanization and unsustainable fishery and aquaculture industries along the coastal areas of Hainan will continue to pose great pressures on its wetlands and waterbirds. Considering the strategic location of Hainan for migratory waterbirds, more conservation effort and eco-friendly land use planning is needed to bring back Hainan's once diverse avifauna.

Paper Number: 314
Tuesday, 03 July 2018 | Giza
General Session 1.3 - Bird Ecology & Conservation

Saving the last home of the Green peafowl

Wanrong Chen

The green peafowl used to be widespread throughout Southeast Asia but its population has declined so rapidly to warrant a globally endangered status. China represents its eastern most distribution range, with a historical distribution covering a large part south of the Yellow River. However, the population has declined drastically in recent decades, and little has been done to study and conserve this iconic species. In early 2017, construction of a hydropower station started at one of the peacock's last remaining homes in the Red River valley.

As a response, Wild China conducted interviews and biodiversity surveys (camera trap and line transects) to assess the population status. It is estimated that the total population of the green peafowl in China to be less than 300, and is distributed sparingly in several patches of unprotected seasonal rainforest, of which, the patch where the hydropower station was going to be constructed is the most intact forest with the largest peacock population (4 groups with 10-12 peacocks per group).

To raise public awareness in the hope of alleviating the threat, Wild China has led a joint public campaign - news and articles have been regularly disseminated through social media, lobbying activities, and public seminars at major cities (e.g. Beijing, Shenzhen, Shanghai, Guangzhou, Taipei). Over the course of one year, 30 media reports (10 million readership) have been produced and 10 seminars (>1000 audiences) have been conducted.

With all these efforts, this development project has been suspended by the end of 2017. This case study demonstrates the power of public campaign in habitat conservation, when all other means of protection failed.

Paper Number: 293
Tuesday, 03 July 2018 | Giza
General Session 1.3 - Bird Ecology & Conservation

Abundance of island avian predators in a heavily impacted tropical forest suggests that endemics face greatest risk from landscape changes

Camille Silvosa

Anthropogenic land cover change is among the largest threats to biodiversity, and island endemics and habitat specialists are especially vulnerable to these changes. We used road surveys and occupancy modeling to determine the distribution of birds of prey in the southern Philippine island of Mindanao and to assess the land cover characteristics that influence this distribution. During winter field surveys between 2014 and 2016, we observed 13 of the 27 birds of prey species present on Mindanao and we counted 1,656 individuals. Preliminary analyses suggest that the Brahminy Kite (*Haliastur indus*) and the Philippine Serpent Eagle (*Spilornis holospilus*) were the most commonly observed species. Our models suggest that on average, detection probability was 86% for all raptors combined, 50% for Brahminy Kites, and 35% for Philippine Serpent Eagles. Our models also predict that the probability of occupancy by Brahminy Kites (a purported habitat generalist with a large distribution) was positively correlated with forest disturbance while probability of occupancy by Philippine Serpent Eagles (an endemic and purported forest specialist) was highest in near-pristine forests. Further, we observed fewer island endemics and more non-endemic residents than predicted by our models. These suggest that the anthropogenic changes in central and eastern Mindanao are more consequential to endemics than expected and that endemics are more vulnerable to these changes than are more widespread species.

Paper Number: 777
Tuesday, 03 July 2018 | Giza
General Session 1.3 - Bird Ecology & Conservation

Response of insect and bird communities in tropical rainforests of Papua New Guinea to elevation and disturbance

Alfred Mani

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Introduction. Papua New Guinea is a part of the third largest block of rainforest remaining on the planet. It is also a highly diverse tropical island with high level of endemism. Unfortunately PNG forests are coming under increased pressure from logging and land conversion to agriculture. Their biodiversity remains poorly known which makes it difficult to develop land use strategies balancing economic development and biodiversity conservation. This is made even more difficult by the unique situation in PNG where virtually all the land is under customary indigenous ownership so that the tribal communities decide about land use.

Objectives. The Papua New Guinea National Forest Inventory (funded by EU and FAO) aims to explore the forest biodiversity in the country, focusing both on plant communities and focal animal taxa. The main aim of the zoological survey component, reported here, is to evaluate the importance of vegetation structure and species composition on insect and bird communities, and to assess the impact of environmental variation, including elevation, soil type, rainfall, and forest disturbance on community structure and composition on these communities.

Methods. Quantitative community data obtained from replicated samples at a network of study sites covering various forest types and environments include data sets obtained by light trapping data for geometrid moths (Lepidoptera), tuna baits and hand collecting for ants (Hymenoptera), Steiner lure traps for fruit flies (Diptera) and point counts for birds. These data are combined with detailed data from botanical plots, and their composition and diversity was analysed with respect to plant community data and environmental variation including elevation, soils, rainfall and disturbance level, using GML models, ordination and other statistical techniques.

Results. We have documented the primary impact of plant composition and elevation on the composition of the insect and bird communities in the forests of PNG. The species diversity declined with elevation for ants and fruit flies very rapidly, and for birds at a lower rate, while the geometrids showed mid-elevation maximum in species diversity. Forest disturbance caused change in animal species composition, but not necessarily decline in their species numbers.

Implications. Our results indicate that preserving primary forests along long altitudinal gradients is the key measure in ensuring comprehensive biodiversity preservation. Forest disturbance can have both positive and negative impact on species diversity, depending on the taxon studied. However, there is a marked change in species composition between primary and secondary forests in many taxa studies, indicating that large areas of disturbed forests, whilst valuable for biodiversity conservation, are not a replacement for primary forest reserves.

Paper Number: 406
Tuesday, 03 July 2018 | Giza
General Session 1.3 - Bird Ecology & Conservation

The effects of habitat fragmentation on bird song characteristics in a neotropical forest

Patrick Hart

The oscine passerines, an avian suborder that comprises almost half of all bird species worldwide, learn their song primarily through cultural transmission. As the world's forests become increasingly fragmented and the population sizes of many forest dwelling species decline, there may be increasingly restricted opportunities for the transmission of cultural information. However the effects of forest fragmentation on bird song have not been well-documented. In this paper, we examine the relationship between forest fragment size and song characteristics for two forest bird species, one an oscine passerine (orange-billed sparrow; *Arremon aurantiirostris*) that learns its song culturally, and the other a sub-oscine passerine (scale-crested pygmy tyrant; *Lophotriccus pileatus*) that does not. Recordings were taken from individuals in twelve premontane wet forest fragments ranging in size from approximately 1.4ha to 360ha in southern Costa Rica. As predicted under the "cultural erosion" hypothesis, we found that acoustic characteristics associated with song complexity such as the number of syllables per song and song duration decreased with decreasing fragment size for the oscine but not the sub-oscine species. This study supports the idea that learned cultural elements are sensitive to fragment size and that cultural diversity should be considered along with other forms of biodiversity in the conservation of social learning species.

Paper Number: 318
Tuesday, 03 July 2018 | Giza
General Session 1.3 - Bird Ecology & Conservation

GENERAL SESSION 18.1

Invertebrate Ecology & Conservation

Male contest competition increases population resilience to habitat change: sexual selection enhances the survival and persistence of Bornean dung beetles within modified forest landscapes

Jonathan Parrett

Understanding how animals adapt and persist within changing environments is of clear importance to ecologists and conservation biologists. Sexual selection is a powerful evolutionary force ubiquitous in sexually reproducing organism and has been suggested theoretically to influence both adaptation rates and extinction risk. There is growing support, largely from the laboratory, that sexual selection can increase adaptation by skewing reproductive success towards 'high quality' individuals. Despite its widespread implications very few field studies have examined whether sexual selection influence adaptation and population persistence within a novel environment. These few field studies however have found that species with strong sexual selection tend to be at increased risk of localised extinction, attributed to increasing costs of sexually selected traits. Here, I present data from communities of Bornean dung beetles (Scarabaeidae) sampled across a gradient of habitat modification found at the SAFE project (Stability of Altered Forest Ecosystem) in Sabah. Dung beetles were sampled from old growth forest, selectively logged forest, heavily logged forest and oil palm plantation. The intensity of sexual selection within each species was estimated using proxies, horn presence/absence and relative horn length, and tested for associations with population persistence and abundance across the disturbance gradient. I find that species which engage in contest competition and have high intensity of competition are more likely to persist and maintain similar abundances within the altered habitats. Over half of all horned species persist across the entire disturbance gradient. In contrast, hornless species which do not engage in male contest competition have reduced abundances in the altered forests and do not persist within oil palm plantations. These findings strongly suggest that sexual selection can increase the ability of populations to adapt to and persist within altered habitats and to my knowledge the first field study to find a positive effect of sexual selection to population persistence. These results may have wide implications in helping to identify which species are likely to be more vulnerable to changing environments and habitat modification.

Paper Number: 567
Tuesday, 03 July 2018 | Machu Pichu
General Session 18.1 - Invertebrate Ecology & Conservation

Beetles and Beta-Diversity at the SAFE Project

Adam Sharp

Borneo's biodiverse forests are immediately threatened. Half of Borneo's forest has been logged and oil palm plantations have replaced over 7.8 million hectares of forest since 1973. How does this impact the little things that run the world? We sampled beetles (order: Coleoptera) at multiple spatial scales across the land-use gradient at the Stability of Altered Forest Ecosystems (SAFE) Project in Sabah, Malaysia, over several years. Using data on 115 species of scarabaeoid beetles, a relatively charismatic and important indicator group, we detected similar richness in logged forest compared to unlogged but significant declines in the proportions of species of highest conservation value. Oil palm plantations supported few species, and those which persisted were of very low conservation value. We further examined shifts in the beta-diversity of 156 species of weevil at 10 ha, 100 ha and 1,000 ha scales. Landscape-level beta-diversity was maintained across logged and unlogged forest through high rates of spatial turnover. Turnover at smallest spatial scales in unlogged forest was highest at sites with rough topography but the reverse was true in logged forest. Plantation beta-diversity at landscape-level remained high, but in contrast to forest, was propagated by uneven abundance of beetles instead of spatial turnover. Our results suggest that weevil beta-diversity at large scales may be shaped by logging practices at small scales. We conclude that unlogged forest is irreplaceable for beetle biodiversity but shifts in the spatial arrangement of species may help conserve beetle communities in heavily-degraded landscapes.

Paper Number: 595
Tuesday, 03 July 2018 | Machu Pichu
General Session 18.1 - Invertebrate Ecology & Conservation

Dung beetles (Coleoptera: Scarabaeidae) along elevational and land use gradients on Mt. Kilimanjaro: Which factors predict species richness and abundance?

Friederike Gebert

Elevational gradients in species richness constitute some of the best depicted patterns in ecology, yet there is no consensus on the drivers of species diversity. Whereas resource availability is often cited as one of the most important factors influencing the diversity of endothermic organisms, for ectothermic organisms, temperature might play a more crucial part in adjusting physiological processes and the exploitation of resources. We investigated the importance of resource availability, climate, land use and area for the species richness and abundance of dung beetles on 66 study sites along an elevational gradient from 870 to 4550 m a.s.l. on Mt. Kilimanjaro, northern Tanzania. Since dung beetles rely on mammalian dung, we additionally documented mammals with camera traps and calculated metabolic rates as a proxy for the resources available to dung beetles. Dung beetles were recorded with baited pitfall traps.

We found that the species richness of dung beetles declined exponentially with increasing elevation in both natural and disturbed habitats. In natural habitats, dung beetle abundance declined with elevation whilst there was a hump-shaped pattern in disturbed habitats. Path analysis suggests that temperature and to a lesser degree precipitation are the most important drivers for dung beetle species richness. Neither mammal species richness nor mammal biomass appeared as important for explaining species richness of dung beetles. Dung beetle abundance was a strong predictor for dung beetle species richness and was additionally negatively influenced by land use.

Our study shows that for ectothermic organisms like dung beetles, temperature constitutes a more important driver for species diversity than resource availability. Furthermore, our study depicts that dung beetles are sensitive to anthropogenic land use changes, highlighting their utility as bioindicators. In contrast, the main determinant for mammal diversity was primary productivity, emphasizing the opposing forces shaping species richness for endothermic and ectothermic organisms along elevational gradients.

Paper Number: 143
Tuesday, 03 July 2018 | Machu Pichu
General Session 18.1 - Invertebrate Ecology & Conservation

Factors influencing the distribution of soil-transmitted helminths in a fragmented landscape in Sabah

Liesbeth Frias, Janet Nackoney, Danica Stark, Milena Salgado Lynn, Senthilvel KSS Nathan, Benoit Goossens, Tock H. Chua, Hideo Hasegawa, Munehiro Okamoto, Andrew J. J. MacIntosh

Soil-transmitted helminths (STHs) are an ever-present and often neglected component of terrestrial host communities. A wide range of biotic and abiotic factors influences their distribution: their reproduction and dispersal depends largely on the probability of successful transmission to a host, while the survival and development of infectious stages (eggs and larvae) is predominantly influenced by abiotic variables. Numerous studies have focused on the determinants of parasite infection in various taxa, but fewer studies have explored what influences the distribution of STHs at a landscape level. Here, we examined the spatial distribution of three groups of parasitic worms infecting Bornean primates inhabiting the Lower Kinabatangan floodplain in Sabah (Malaysia), an area that corresponds to one of the most primate-diverse regions in Borneo with up to 10 primate species living sympatrically. We conducted primate surveys along the river, and collected fecal samples for morphological characterization of parasites. Landscape attributes were extracted from open data sources, and delimited to the study area. Using general linear models, we provide some evidence that primate diversity and distance from forest cover loss both influence the presence and distribution of STHs: parasite prevalence was higher in areas of lower primate diversity and increased shedding intensities correlated with proximity to forest loss. These results show that habitat disturbance and biodiversity loss is associated with higher parasite prevalence. We speculate that the absence of certain host species that may down-regulate transmission can increase parasite prevalence in the remaining hosts, which may be at once more resilient to disturbance and more competent hosts for parasites. Generalist parasites, like those studied here, are also expected to pose a greater threat to species with restricted distributions or small populations, showing the effect of anthropogenic activities on native parasite communities.

Paper Number: 833
Tuesday, 03 July 2018 | Machu Pichu
General Session 18.1 - Invertebrate Ecology & Conservation

Comparative ecology of geometrid moths from tropical Uganda

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Describing fauna is an urgent task due to the current rapid decline of natural tropical ecosystems. The vast majority of tropical insects remain unexplored in terms of their taxonomy and ecology.

We carried out a three-year-long fieldwork project in Kibale National Park in Uganda, East Africa with the aim to study and collect ecological data on the regional geometrid moth fauna (Geometridae). Our broader, continuing aim is to study evolutionary-ecological patterns in temperate and tropical forest geometrid moth faunas. To employ the vast potential of phylogenetic comparative methods in aiding such questions, an original phylogeny for 355 geometrid moth taxa, mainly from tropical Uganda and temperate Estonia, was constructed.

As an example of the patterns we study, we will introduce the results of a study on larval host-plant specialisation. In particular, we asked whether tropical moths are more specialised in their host use than temperate ones. Since host relations for tropical geometrids are largely not known we applied a novel index – adult oviposition latency – to answer the following questions: a) does oviposition latency correlate with host specificity across species in a temperate region? b) does oviposition latency, and therefore host-plant specialisation, differ between temperate and tropical regions? We found a significant correlation between oviposition latency and host specificity, showing that this index can be used as a tool to estimate specialisation in regions such as the tropics, where actual host relations are not known. No differences in oviposition latency between temperate Estonia and tropical Uganda were found, hinting at no difference in specificity in larval host-plant use among the species assemblages inhabiting these two geographically distant study sites.

Paper Number: 14
Tuesday, 03 July 2018 | Machu Pichu
General Session 18.1 - Invertebrate Ecology & Conservation

GENERAL SESSION 19.1

Biodiversity Patterns

Vertical stratification influences global patterns of biodiversity

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Background - Species distributions in terrestrial ecosystems are three-dimensional, spanning both the horizontal landscape and the vertical space provided by the physical environment. Classical hypotheses suggest that communities become more vertically stratified with increasing species richness, owing to reduced competition or finer niche subdivision. However, this assertion remains untested in the context of the broader realm of biogeography.

Objective - Here, integrating traits and distribution data for amphibians globally, we show how vertical niche strategies interact with the physical and climatic environments to govern global patterns of species richness and community composition.

Methods - We created the first ever global dataset on the vertical niches of over 4,000 amphibian species and compare patterns of verticality to topography, forest complexity and bioclimatic variables such as precipitation and temperature variability.

Results - Our results reveal a marked latitudinal shift in strategies of vertical habitat use, from highly arboreal assemblages in the tropics to highly fossorial assemblages in sub-tropical and temperate regions. Arboreality is strongly associated with precipitation, vegetation structure and climatic stability, whereas fossoriality is more common in dry environments with high diurnal temperature range and low vegetation structure.

Conclusion - I will discuss how these analyses shed light on the importance of vertical stratification for species coexistence in species-rich regions. Further I will discuss how drying from climate change can drive tropical diversity from vertically stratified to “flattened”, with future communities living mostly on or beneath the ground.

Paper Number: 947
Tuesday, 03 July 2018 | Chichen Itza
General Session 19.1 - Biodiversity Patterns

The hidden diversity of trap-jaw ants along elevational gradients in Borneo

Daniela Magdalena Sorger

Elevational gradients and the divergence along them have taken an increasingly prominent role in biogeography. Climate varies rapidly and systematically along such gradients resulting in multiple ecological niches along these steep environmental clines. Typically species along elevational gradients are treated as though they are discrete entities with low and high elevation limits. However, most tropical species are described based on morphology which may conceal cryptic species and genetic structure. Here we use genetic (mtDNA and nDNA), morphological, color, and chemical (cuticular hydrocarbon profiles) tools to test the hypothesis of divergence in trap-jaw ant populations (genus *Odontomachus*) along an elevational gradient in Sarawak, Borneo with a focus on *O. rixosus*, previously regarded as a widespread species with a broad elevational range. Our results reveal two new species within the *O. rixosus* species complex along the gradient, each with a distinct geographic and elevational distribution. We discuss these results in the light of the possibility that such genetic divergence patterns may be common along tropical elevation gradients.

Paper Number: 77
Tuesday, 03 July 2018 | Chichen Itza
General Session 19.1 - Biodiversity Patterns

How many sampling events per year are required to quantify biodiversity change?

Kingsly Chuo Beng

The litter layer of tropical forests supports a significant fraction of total arthropod diversity and decomposition within it is the main pathway by which nutrients are returned to the soil and carbon dioxide to the atmosphere. Conversion of tropical forests to agriculture is the main threat to biodiversity and ecosystem services, and understanding effects on the litter layer is important for understanding and mitigating these impacts. We used high through-put DNA sequencing of the mitochondrial cytochrome c oxidase subunit I (COI) gene to assess seasonal changes in the diversity and composition of the litter fauna at five matched pairs of natural forests and monoculture rubber plantations in tropical SW China every month for a year, and measured the environmental factors expected to drive intra-annual variation. Natural forests and rubber plantations had very different arthropod assemblages throughout the year (<22% of species shared in any month), with forests more species-rich than rubber in all months except February. Very high rates of intra-annual turnover in species composition in both forests and rubber were associated with seasonality in environmental variables, with the influence of particular variables differing among taxa. Sampling at one time of the year only captured a subset (<25%) of the total litter community while sampling at least four times over the year (January, May, August and November) was necessary to capture half the total annual fauna.

Paper Number: 613
Tuesday, 03 July 2018 | Chichen Itza
General Session 19.1 - Biodiversity Patterns

Water availability shapes the functional structure of lowland tropical forest tree communities at both regional and landscape scales in New Caledonia

Gregoire Blanchard

Understanding the factors driving species distribution across spatial scales in highly diverse forests is challenging and critical for biodiversity conservation planning. Functional ecology provides powerful tools to assess the effect of environment on species assemblages and to better understand the role of niche-based processes. Here, we explored how a key environmental factor, water availability, drives species distribution at both regional and landscape scales in lowland species-rich forests in the biodiversity hotspot of New Caledonia.

We studied two landscapes located on the dry west-coast (~1000 mm.yr⁻¹) and the wet east-coast (~3000 mm.yr⁻¹) of the New Caledonian main island. Within each landscape, 20 tree communities were sampled (in 0.04-ha plots) along a topographical gradient that correlates with water availability (Topographic Wetness Index, TWI). We sampled and measured five functional traits (wood density, leaf area, leaf specific area, leaf dry matter content, and leaf thickness) involved in drought resistance and resource acquisition.

First, we examined trait covariation and identified functional trade-offs across species. Second, we assessed the functional composition of local communities using four trait-based statistics (community weighted-mean, community unweighted mean, trait range, and community weighted variance). We tested the deviation of these statistics from null models of random species distribution designed either at regional or landscape scale.

We identified two main ecological trade-offs driving trait variation across tree species: (i) one opposing high hydraulic efficiency to drought resistance and related to a wood economic spectrum and (ii) the other opposing resource acquisition to resource conservation and related to a leaf economic spectrum. At regional scale, species with drought-resistance strategies (i.e. high wood density and small leaves) were favored under low precipitation while strategies were more divergent under higher precipitation. At landscape scale, we found contrasted responses of tree communities. In the dry landscape, drought-resistant species were selected under low TWI, while in the wet landscape, low TWI increased the abundance of species with conservative strategies (i.e. low leaf specific area and high leaf thickness).

Our study showed that water availability drives the variation of tree community composition at both landscape and regional scales. In the low precipitation landscape, environmental filtering on the wood economic spectrum due to hydric constraints was the main driver of community assembly. However, in the high precipitation landscape, water stress was weaker and the selection of species across topographic heterogeneity rather rely on their resource-use strategies along the leaf economic spectrum.

Paper Number: 723
Tuesday, 03 July 2018 | Chichen Itza
General Session 19.1 - Biodiversity Patterns

Differing strengths of density dependence between arbuscular mycorrhizal and ectomycorrhizal tree species do not explain the latitudinal diversity gradient

Jonathan Myers

The latitudinal diversity gradient—an increase in the number of species from temperate to tropical latitudes—is considered Earth's most striking biodiversity gradient. Recent evidence indicates that higher species diversity in tropical versus temperate tree communities can be maintained by negative density-dependent species interactions at local scales. Classical hypotheses for negative density dependence emphasize the importance of specialized natural enemies or intraspecific competition. More recently, studies have suggested that the strength of density dependence varies systematically among tree species depending on their mutualistic associations with different types of mycorrhizal fungi (arbuscular mycorrhizae versus ectomycorrhizae). However, the extent to which differences in tree mycorrhizal type scale up to determine changes in density dependence and species diversity across temperate and tropical latitudes is unknown. We tested the contribution of tree mycorrhizal type to the strength of density dependence and tree species richness across 32 large (4–50 ha), stem-mapped forest plots (19 tropical forests, 13 temperate forests) in the Smithsonian Forest Global Earth Observatory (ForestGEO) Network. Because ectomycorrhizae (EM) associate with their tree hosts in a more species-specific manner than arbuscular mycorrhizae (AM), we predicted: (1) EM-associated tree species would have weaker negative density dependence and decreased species richness at the local neighborhood scale; and (2) forest plots dominated by EM-associated tree species would have weaker median negative density dependence and lower species richness. We found that the strength of negative density dependence was weaker for EM-associated tree species versus AM-associated tree species in the tropics, but not in the temperate zone. EM-associated tree species also had lower species richness at the local neighborhood scale (10 m radii) compared to AM-associated tree species. However, these differences between EM- and AM-associated tree species did not account for differences in density dependence and species richness at the global scale. Instead, higher species richness at tropical versus temperate latitudes was strongly associated with an indirect influence of climate (temperature) on the strength of negative density dependence. These results indicate that while tree mycorrhizal type contributes to differences in strengths of density dependence and species diversity at the local scale, they do not appear to scale up to explain differences in species diversity at the global scale. In contrast, our results suggest that the latitudinal diversity gradient may reflect temperature-associated increases in the strength of antagonistic species interactions from temperate to tropical latitudes.

Paper Number: 922

Tuesday, 03 July 2018 | Chichen Itza
General Session 19.1 - Biodiversity Patterns

GENERAL SESSION 20

Hunting & Trade

Design, monitoring and evaluation of a direct payments approach for an ecotourism strategy to reduce illegal hunting and trade of wildlife in Lao PDR

Paul Frederick Eshoo

Ecotourism as a strategy for achieving biodiversity conservation often results in limited conservation impact relative to its investment and revenue return. In cases where an ecotourism strategy has been used, projects are frequently criticized for not providing sufficient evidence on how the strategy has reduced threats or improved the status of the biodiversity it purports to protect. In Lao PDR, revenue from ecotourism has not been directly linked to or dependent on improvements in biodiversity and there is no evidence that ecotourism enterprises have contributed to conservation. In other developing countries, direct payments through explicit contracts in return for ecosystem services have been proposed as a more cost-effective means for achieving conservation, although further research is needed to evaluate the impact of this approach. To address this need, a new model was tested in the Nam Et-Phou Louey National Protected Area (NPA) in Lao PDR using a direct payments approach to create ecotourism incentives for villagers to increase wildlife populations. Over a four-year period, we monitored along a theory of change to evaluate assumptions about the linkages between intermediate results and biological outcomes. Preliminary results show a negative correlation between ecotourism benefits and hunting infractions in target villages; no increase in hunting sign in the ecotourism sector of the NPA relative to a three-fold increase in hunting sign across the NPA's non-tourism sectors; and an overall increase in wildlife sightings. This case provides key lessons on the design of a direct payments approach for an ecotourism strategy, including how to combine threat monitoring and data on wildlife sightings to evaluate strategy effectiveness, on setting rates for wildlife sightings and village fees, and the utility of the approach for protecting very rare species.

Paper Number: 429
Tuesday, 03 July 2018 | Colosseum 1
General Session 20 - Hunting & Trade

The trade dynamics of the Philippine Forest Turtle *Siebenrockiella leytensis*

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The Philippine Forest Turtle *Siebenrockiella leytensis* is the only endemic turtle known to occur in the Philippines. It has been assessed as Critically Endangered since 2000 and is considered as one of the world's top 25 most endangered turtles since 2003. The species is accorded protection nationally by the Wildlife Act of 2001 and the international trade is regulated by the CITES. However, the publication of its rediscovery in 2004 triggered unrelenting poaching and illegal trading nationally and internationally. With the aim of quantifying the extent of poaching and trade, ad hoc online survey was conducted and international trade and seizure records from 2004-2017 were analysed to provide insight on the trade dynamics. In the last 14 years, 24 seizure incidents involving 4,723 Philippine Forest Turtles were recorded. I also estimated 1,150 individuals were smuggled and illegally offered for sale in China in 2015. While at least 74 individuals were legally exported from the Philippines, I gathered compelling evidences that government-registered breeding farms are involved in wildlife laundering and exported individuals were most likely sourced illegally from the wild. The illegal wildlife trade remains the most important factor threatening the survival of this critically endangered endemic species.

Paper Number: 379
Tuesday, 03 July 2018 | Colosseum 1
General Session 20 - Hunting & Trade

Impacts of enforcement on Indigenous Peoples and Local Communities: How current enforcement strategies impact communities?

Pei Hue Koh

Environmental NGOs who concentrate in wildlife conservation may not have a holistic understanding of the indigenous peoples and local communities (IPLC). Wildlife law enforcement almost always, has a negative impact on indigenous communities on their personal safety, health, culture, privacy and family life (Bennet 2015). The strategies used in the enforcement and protection of wildlife and conservation rarely take into account IPLC rights.

Over the last 2 years, 7 local communities were charged under the WCE 1997, with a total of MYR 22,000 and 144 months of jail term. These “successful” enforcement strategies today ultimately has a great impact on the indigenous peoples relationship with land and their access to a sustainable livelihood.

Pilot projects are being conducted in various Sabahan landscapes to address this gap. Methods utilised includes Rapid Rural Appraisal (RRA) system involves a focus group discussion and household questionnaire surveys. Combination of these methods ensured a consenting and balanced information gathering.

Local consumption and trade on wildlife by IPLC reveals that 84.6% wildlife hunted is consumed by the hunter's household and 15.4% is sold at the local markets. Findings from the RRA system indicate the motivation behind the hunting activities are source of income, traditional practices, beliefs and value systems and main protein source.

Hunting patterns have changed in the last 50 years in Tropical East Asia (Corlett 2014). Hunting currently involves women and children, modern weapon, use of transportation and storage facilities and most importantly hunting for trade. In recent years the increased awareness of the judiciary has led to maximum penalty being imposed on offenders. The impact being that now, IPLC offenders are having to sell their land in order to pay the penalty. For IPLCs that are imprisoned, the impact being that the family suffers as the economic provider is unable to provide. These impacts are not being studied or addressed. So does a successful prosecution today lead to a sustainable future for wildlife tomorrow?

At this important juncture, conservationists need to step back and evaluate the impact of enforcement strategies towards local communities. If wildlife is truly considered as a resource owned by the commons, it is pertinent to involve all traditional resource users in management and planning, thus enhancing their rights to resources, improving their livelihood by considering their needs and encouraging interactive communication because they are the first line of defence in combatting wildlife crime.

Paper Number: 368
Tuesday, 03 July 2018 | Colosseum 1
General Session 20 - Hunting & Trade

Evaluating the Effectiveness of Efforts to Combat the Illegal Wildlife Trade

Hannah O'Kelly

Efforts to combat the illegal wildlife trade (IWT) typically concentrate on three points in the trade chain: anti-poaching actions to protect key wildlife populations in source countries; anti-trafficking actions in source, transit, and consumer countries; and actions to prevent illegal (or all) sales of, and reduce demand for, wildlife and wildlife parts and products in consumer countries. Assessing the effectiveness of these actions is a significant challenge and the efficacy of many interventions to date remains poorly known. Methods for reliably assessing successes and failures need to be implemented more widely and consistently or, in some cases, developed. Particularly pressing challenges include: (1) a lack of appropriate baselines (e.g. population sizes, poaching rates, or levels of demand); (2) the issue of imperfect detectability (e.g. the proportion of unrecorded animals killed by poachers or assessing the number of items for sale in markets, both physical and virtual) and how this may vary in response to the specific nature of the data collection process and other factors; (3) spatial and temporal scale problems with sampling designs (e.g. when assessing poaching rates, rates of trafficking, or changes in demand, and how these respond to multi-scale interventions); and (4) attribution problems, e.g. with many simultaneous interventions aimed at reducing demand how can causal linkages be established between specific interventions and any apparent changes in demand? To address these and other challenges, we present a unifying framework that shows: (1) which of the key problems apply at each stage in the trade chain; (2) how the problems differ in severity depending both on the stage in the chain at which they occur and other factors, especially the spatial scale; and (3) the existing (but often under-utilised) solutions to the problems as well as the remaining gaps which require further conceptual development and empirical validation.

Paper Number: 342
Tuesday, 03 July 2018 | Colosseum 1
General Session 20 - Hunting & Trade

GENERAL SESSION 9.3

Mammal Ecology & Conservation

Primate research and conservation in Penang: Introducing Langur Project Penang (LPP)

Jo Leen Yap

Dusky langurs (*Trachypithecus obscurus*) in Penang are threatened by habitat loss and fragmentation on the island. Due to deforestation that is the result of Penang's rapid development, habitat loss has driven the dusky langurs out of their natural habitats into urban and disturbed areas. As food sources become scarce, the langurs are forced to travel between forest fragments, exposing themselves to risks, such as road accidents and poachers. There is a lack of understanding on the human-primate co-existence among island residents. To bridge the gap between the community and primates in Penang, Langur Project Penang (LPP) was initiated on 1st January 2016. LPP positions itself as an outreach and research project under the umbrella of the Malaysian Primatology Society (MPS) and Universiti Sains Malaysia (USM). In collaboration with governmental bodies, educational institutions and non-governmental organizations in Malaysia, LPP serves as a platform for environmental research and education for students and the local community. LPP's approach combines 1) research, whereby we studied activity budgets and social behaviour, habitat use and diet of a wild langurs in order to better understand their relationship with disturbed environments; 2) conservation, whereby we assist in handling and coordinating Penang's primate-related issues with the authority and work with them to reconnect habitat fragments by canopy bridges for arboreal wildlife; 3) nature education, whereby we have conducted more than 40 outreach programmes for the public. LPP is now expanding into a citizen science programme whereby our local volunteers contribute their parts toward primate conservation as field assistants and educators. LPP has established itself as a crucial platform for primate research, conservation and education on the island of Penang and is dedicated to continue its work in the future by expanding to other parts of Malaysia. LPP is funded by The Rufford Foundation and Manulife Malaysia Berhad.

Paper Number: 228
Tuesday, 03 July 2018 | Petra 1
General Session 9.3 - Mammal Ecology & Conservation

An alternative approach to salvage a highly threatened ungulate population – a case study on Hainan Eld's Deer (*Rucervus eldii*)

Michelle Wong

Many ungulate species are under severe threats from poaching and habitat loss, which are most prevalent in tropical and subtropical Asia. Wild ungulates naturally live in low densities; white-tailed deer in the US averages 6-11 deer/km², sambar deer in Thailand 2-3 deer/km², Eld's deer in Myanmar 3-7 deer/km². This is because food, water and mineral sources for deer are seasonal and patchy distributed, implying that the animals need to travel over a large area. The intrinsic low-density and wide-ranging behaviour make any targeted protection effort challenging. In most cases, effective protection cannot be achieved due to difficulty in law enforcement against poaching and deforestation over vast areas.

To rescue highly threatened small populations, ex-situ conservation actions involving purpose-built enclosures, intensive husbandry and vet care, and selective breeding is often adopted. Any eventual release demands tedious rehabilitation procedures to ensure that the animals learn to cope with lives in the wild. Captive breeding, rehabilitation and release are all costly as well as risky.

The wild population of Hainan Eld's deer once dropped to below 50 animals with imminent extinction risk. The management approaches adopted was to fence off the site with the last wild population, with targeted patrol and food supplement in the lean season. This approach was proven effective to minimize poaching, while maintaining the deer's wild nature. Kadoorie Farm and Botanic Garden is collaborating with Hainan Bangxi Nature Reserve to explore ways to further improve the carrying capacity of the limited reserve area. These include habitat enhancement, rotational grazing and diversified natural food sources of the focal species. With these efforts, deer density has been increased to 70 deer/km² with minimal husbandry care.

This case study demonstrates an alternative approach as a last resort to salvage an ungulate population from immediate extinction threats, by creating an insurance colony while maintaining the ecological traits of wild populations with limited resource input.

Paper Number: 296
Tuesday, 03 July 2018 | Petra 1
General Session 9.3 - Mammal Ecology & Conservation

Spatial patterns of mammalian diversity in Borneo, identified using leech-based molecular sampling

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Recent studies have shown that DNA recovered from the guts of terrestrial leeches (and other invertebrates) can be used for sampling mammals. To date, most such studies have focused on leeches sampled opportunistically over broad geographical regions. Here we describe a study in which we applied this method to assess spatial patterns of mammalian biodiversity across a gradient of degraded forests in Sabah, Borneo. In 2016, we collected samples of the terrestrial leech *Haemadipsa picta* from lowland rainforest subjected to different levels of historic and ongoing land-use. We pooled 517 leeches into batches of approximately ten individuals for PCR targeting the 16S rRNA locus and then amplicon sequencing using Illumina MiSeq. The resulting sequences were filtered and trimmed based on quality and those sequences passing the strict filters were identified using a Bornean mammal specific reference database. 100% of the pooled leech samples contained amplifiable mammalian DNA which was matched to 12 different families, all known to be present in Sabah. Initial results show that mammal richness was higher in samples collected from the less degraded logged forest compared with the heavily degraded forest fragments. At the same time, we recorded rare taxa such as the Sunda pangolin (*Manis javanica*) across all habitat types. Our results show that highly degraded forest can hold considerable conservation value for rare mammal species. More generally, we demonstrate the utility of applying leech-based analyses for quantifying local mammal diversity at a landscape-scale.

Paper Number: 341

Tuesday, 03 July 2018 | Petra 1

General Session 9.3 - Mammal Ecology & Conservation

Mammal Diversity in the Heart of Borneo

Boyd Simpson

Sitting on the equator, Borneo is a hotspot of tropical biodiversity and is home to a host of endemic and iconic species. We have been working in numerous areas within the Heart of Borneo to assess mammal diversity in some of Sarawak's most remote and little-explored interior forests. Using camera traps over 3137 trap nights, we identified 27 species of medium and large-sized mammals from two different areas within the Production Forests of the Ulu Baram region. Endemic or elusive species such as Bornean clouded leopard, marbled cat, striped palm civet, Hose's civet and Hose's langur were photographed. We identified 21 species from heavily disturbed areas whilst 24 species were recorded in the near-intact forests of the Mt Tamu Renan mountain range. Not only did we find more species in the better-quality forests, but we found a better 'quality' of species (more endemic or elusive) here. Interesting insights into animal behaviour were obtained with video captures, as well as some significant differences in species activity patterns between the two forest types. We had no indication of the critically endangered Sumatran rhinoceros or banteng from these survey areas, although high disturbance levels and lack of appropriate habitat may have precluded these rare species. Camera trapping has shown to be an important tool in assessing biodiversity and has highlighting the high conservation value of some of Sarawak's production forests. Given the previously restricted access to this region of Sarawak, further insights into the mammal diversity of the Heart of Borneo should be exposed as further work continues.

Paper Number: 816

Tuesday, 03 July 2018 | Petra 1

General Session 9.3 - Mammal Ecology & Conservation

GENERAL SESSION 21

Key Conservaiton Issues in Malaysia

National Framework for Protected Areas (NFPA): Strengthening PA Governance to Fulfil PA Coverage Targets by 2025

Sivananthan Elagupillay

Malaysia has a long history of designating and managing protected areas (PA), terrestrial and marine, specifically for the protection and conservation of biodiversity resources and the sustainable use of such PAs. Based on the Draft Interim Master List of Protected Areas 2015 initiated by the Ministry of Natural Resources and Environment (NRE), Malaysia has designated 493 terrestrial and marine PAs through gazettlements since 1903, constituting of 12.1% of terrestrial area and 1.4% of the marine area of Malaysia.

Under the National Policy on Biological Diversity (NPBD) 2016-2025, Malaysia aims to increase these PA coverage to 20% of terrestrial area and 10% of marine area of the country. Through stakeholders' consultation undertaken at federal and state levels, NRE has developed a draft National PA Framework (NFPA) for Malaysia with technical assistance from the GEF-UNDP PA Financing Project. Stakeholders are confident these targets are achievable provided if existing challenges could be overcome, including the lack of incentives for State Governments, lengthy designation process, lack of common PA standards, sub-optimal management of existing PAs and lack of stakeholder empowerment.

To overcome these challenges, the NFPA has a detailed Strategic Action Plan (SAP), to be implemented in a phased-out manner by 2025 under six major objectives: Strengthen and Streamline PA Governance; Ensure Ecological Representativeness of the PA Sub-Systems; Ensure Effective PA Coverage; Enhancing Conservation of Biodiversity Resources & PA Management; Empowering Stakeholders; and Diversifying Funding Sources through Sustainable Financing.

Paper Number: 985
Tuesday, 03 July 2018 | Petra 2
General Session 21 - Key Conservation Issues in Malaysia

Reaching high towards a UNESCO Biosphere Reserve (BR) status: Penang Hill and its surrounds

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In late 2015, the Penang Hill Corporation, representing the Penang State, initiated a proposal to designate Penang Hill and its surrounds as a UNESCO Biosphere Reserve with the financial support and resources of The Habitat Penang Hill Park, an ecotourism enterprise located at the summit of Penang Hill. The Habitat is founded and fully funded by the Cockrell Family who are long-time residents of Penang Hill and who wanted to share their love of the Hill with everyone, hence, The Habitat Penang Hill Park and now, through evolution, the Foundation which supports conservation by supporting initiatives in Environmental Education, Conservation Research and Sustainable Tourism. Their core business is in the ecotourism industry through educating the public on the natural wonders of the 130 million year rainforest of Penang Hill. Their mission and vision are to create a circular economy where profits generated by the for-profit Park will be utilized to support the work of the not for profit Foundation. This is well aligned to the Lima Action Plan (2016 -2025) that recognises the importance of entrepreneurs and social enterprises to accelerate the sustainable function of a UNESCO Biosphere. A UNESCO BR is a site designated by UNESCO under the Man and Biosphere (MAB) program where biological resources are exploited in a sustainable manner by the communities inhabiting, thus reconciling biodiversity conservation and human development. The proposed Penang Hill UNESCO BR encompasses two major ecosystems, namely a forested area which serves as the green lung of the Penang Island, and a marine ecosystem. Within it also lies the smallest national park in the world, the Penang National Park. Riding on its unique features, immense biodiversity the proposed biosphere reserve has provided a variety of benefits that has supported the livelihoods of the communities living in the area and good economic returns for nature-based industry partners which have invested in this area. In October 2017 the Habitat hosted over a hundred local and international scientists to undertake a whole forest survey, the BioBlitz 2017, a culmination of a series of international meetings, symposia and discussions that took place over a period of two years. The results of this expedition are important supplementary data to the existing biodiversity literature, crucial information as a biodiversity hotspot towards recognition of Penang Hill and its environs as a UNESCO Biosphere Reserve. The nomination application process to UNESCO is now in its final stages.

Paper Number: 866
Tuesday, 03 July 2018 | Petra 2
General Session 21 - Key Conservation Issues in Malaysia

Conservation of Ulu Muda forest for Ecotourism and Ecosystem Services

Ngai Weng Chan

The Ulu Muda forest is a rich rainforest in northern Peninsular Malaysia that provides many natural functions such as micro-climate control, carbon sink, water catchment, ecosystem services and biodiversity reservoir. Despite such importance, the forest is threatened by logging, poaching and encroachment for quick profits as reported in the mainstream media as well as by NGOs. This paper relies on both primary and secondary data. Primary data was collected from qualitative interviews with relevant stakeholders from government officials (2), private sector (1), academics (2), NGOs (3) and the public (2). Secondary data include published reports, environmental baseline data and articles on Ulu Muda. Results showed that logging has resulted in negative environmental effects such as siltation, pollution of the Sg Muda's waters, erosion, landslides and downstream flooding. Loss of biodiversity, loss of climate control, loss of natural filtration and flood control, loss of ecosystem services and depletion of water resources were other effects. Results of the qualitative interviews showed that the best ways to protect the Ulu Muda forest is to develop it into an ecotourism destination by turning part of the forests as a national or state park. Results indicate that the forest is rich in natural attractions, rich flora and fauna, and pristine rivers. Salt licks and wildlife offer tourists good opportunities to view wildlife. Pristine hydrological features such as rivers, waterfalls and lakes also provide water recreation. Flora identification and wildlife watching also have great potentials as the area is home to rafflesia (and other endemic flora) as well as endangered wildlife such as hornbills, elephants and migrating birds. The Ulu Muda forest is also great for camping, trekking, rock climbing and other outdoor activities. The indigenous (orang asli) communities and other local communities in the area can be integrated into ecotourism activities to ensure ecotourism benefits locals. The forest also acts as a natural laboratory for research. To ensure ecotourism is prioritised and the forest protected, one of the best options is to gazette part or the entire Ulu Muda forest as a State or National Park.

Paper Number: 967
Tuesday, 03 July 2018 | Petra 2
General Session 21 - Key Conservation Issues in Malaysia

Biodiversity Conservation in Sarawak, Malaysia

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Sarawak Forestry Corporation

Malaysia is very rich in biodiversity; it also contributes significantly to the fact that it is rated as one of the 12 "megadiverse" countries of the world. Over 90% of the country's terrestrial biological species occur in natural forests. In Malaysia, states have jurisdiction over land, forests, fishery, agriculture, and water resources. State Government of Sarawak, Malaysia is committed to manage its forest sustainably. The tropical rainforest of Sarawak is well gifted with some of the world's richest forests. Its forest is not only rich in terms of numbers and uniqueness of species but also diversity of habitats and ecosystems. The natural forest includes Permanent Forest Estate, State land and Totally Protected Areas (TPAs). Of this total, 944,197.40 hectares are TPAs. TPAs are specified areas gazetted for the purpose of biodiversity conservation, preservation of natural landscape, scenic, cultural and historical value that affording opportunities for public appreciation, enjoyment, education and scientific research. Land areas were opened for development purposes, where at the same time there are significant increase in the gazettement of TPAs. In 1950s (or 1957), the total area gazetted as TPAs was 2,727 hectares and it was increased to 944,197.40 hectares in 2018. The Sarawak Government is targeting at least one million hectares (10% of the state land area) to be gazetted as TPA and also committed in forest and biodiversity conservation where effort is taken to ensure the in situ and ex situ conservation.

Paper Number: 601
Tuesday, 03 July 2018 | Petra 2
General Session 21 - Key Conservation Issues in Malaysia

GENERAL SESSION 22

Karst Ecology & Conservation

Uncovering karst endemism within Southeast Asia with an emphasis on Bornean *Cyrtodactylus*

Hayden Davis

Cyrtodactylus is among the most well-studied gekkonid genera in Southeast Asia, yet knowledge of the genus within Borneo is limited and out-of-date. Despite Borneo's large size and centralized location in Sundaland, only nine of the nearly 250 described *Cyrtodactylus* species have been recorded from the island. A high degree of genetic and morphological specialization has been recorded within the genus in comparison to other genera in the family Gekkonidae. In particular limestone-karst ecosystems have recently been shown to harbor a high degree of genetic diversity in mainland Southeast Asia, with 27 new karst-dwelling species being described in the past two years. I studied similar ecosystems within Sarawak, East Malaysian, Borneo, where karst systems are common and widespread, and focused my sampling efforts on minimally studied karst formations. Through these methods I was able to discover and describe two new species from Gunung Mulu and Serian, Sarawak, Malaysia. These species are both phylogenetically and morphologically distinct, with several distinguishing characters such as the shape of the preanal groove, coloration pattern, tuberculation, and meristic data. The phylogenies I generated place the new species within the Philippine/Borneo *Cyrtodactylus* group with stronger support than shown in previous studies. These new discoveries further demonstrate the high levels of endemism and diversity within karst ecosystems. Until now, only a single karst-dwelling *Cyrtodactylus* species was known from Borneo; however, my research suggest that additional explorations of unstudied karst systems may reveal further endemism, adding to our growing understanding of the true Bornean biodiversity. The endemism and unique life styles associated with limestone formations demonstrate the pressing need for their conservation and the necessity to conduct in-depth studies to understand the biodiversity present.

Paper Number: 796
Tuesday, 03 July 2018 | Taj Mahal
General Session 22 - Karst Ecology & Conservation

Seasonal dynamics of stem radial growth of evergreen and deciduous tree species and their responses to microclimate in an Asian tropical dry karst forest

Ze-xin Fan

Relationships between environmental factors and stem radius variation at short temporal scales can provide useful information regarding the sensitivity of tree species' productivity to climate change. In this study, we used automatic point dendrometers to continuously record day-to-day stem radius variations of two evergreen (*Alphonsea monogyna* and *Celtis philippensis* Blanco) and two deciduous (*Lagerstroemia villosa*, *Garuga floribunda* var. *gamblei*) broadleaves species growing in a tropical karst forest in Xishuangbanna, Yunnan, southwest China. Daily stem radius increments were extracted from dendrometer traces, and were correlated with environmental variables recorded from nearby standard meteorological stations. The results indicated that stem radial growth of the four species initiated from late dry season (middle April), speeded in rainy season (July to August) and slowed down after October. Daily stem radius increments of the four species correlated positively with relative humidity (RH) and rainfall (PRE), while correlated negatively with daily maximum temperatures (Tmax), vapor pressure deficit (VPD) and photosynthetic active radiation (PAR). Rainfall and moisture availability during early growth season (May–June) was important for stem radius growth of the four studied species. Stem radial growth rates of two deciduous species (*L. villosa*, *G. floribunda* var. *gamblei*) declined significantly during short-term drought events occurred during late April and late May to early June, then recovered quickly after one or more rainfall events, which indicated a more sensitive response to climatic factors as compared with evergreen species. These results provide evidences for studying and predicting tree growths and forest productivities in the tropical karst forests under future climate change.

Paper Number: 791
Tuesday, 03 July 2018 | Taj Mahal
General Session 22 - Karst Ecology & Conservation

Snails, Cement and Conservation: Bridging the science and management of limestone karst biodiversity in the most extensively quarried landscape in Peninsular Malaysia

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The future of endemic limestone karst biodiversity in Malaysia is jeopardised by human activities such as quarrying and deforestation. Nowhere is this situation more marked than in central Perak, Peninsular Malaysia, where almost 60% of Malaysia's limestone quarries are situated. Until recently, scientists found it difficult to engage with the key stakeholder in this conservation issue – the limestone quarrying industry. The watershed moment came in 2016 when a cement company began recognising the importance of limestone biodiversity at its site. In collaboration with the company, we conducted a standardised sampling of land snails on 12 limestone hills across central Perak to assess the level of endemism within the quarry site as well as the surrounding limestone hills. Our study revealed that the quarry site has high species diversity (63 species) and a high number of endemic species (6 species). We are now collaborating with the cement company to further study the ecology of land snails to better manage limestone biodiversity at their site. These data can also help further inform limestone biodiversity conservation in the region. This report highlights how targeted basic research can help the conservation of limestone karst biodiversity in Malaysia.

Paper Number: 726

Tuesday, 03 July 2018 | Taj Mahal

General Session 22 - Karst Ecology & Conservation

GENERAL SESSION 23

Fire & Tropical Rain Forests

Impacts of Wildfires on Forest Biodiversity in Indonesian Borneo

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Borneo's tropical forests are globally important for biodiversity, carbon and other ecosystem services, but are threatened by fires and haze pollution, particularly in Kalimantan's (Indonesian Borneo) peatlands. Here, decades of agricultural development, illegal logging and peat mis-management has led to widespread forest degradation and peat drainage, creating heightened fire vulnerability during dry seasons. This was highlighted in 2015, when a strong El Niño led to extensive wildfires. Large areas were burned in major remaining peat forests, including Sabangau, Mawas and Tanjung Puting.

We consider the potential impacts of these fires on biodiversity at both Kalimantan-wide and local scale. First, we use 2015 burned area maps from high-resolution Sentinel-1 satellite imagery to estimate the impacts on mammals over their Kalimantan-wide range. Second, we use Landsat images of the Sebangau peat-swamp forest to compare forest loss between non-fire (2010/2011) and fire (2015/2016) years. Finally, we analyse long-term biodiversity datasets collected in the Sebangau from 2003 to present, covering multiple major El Niño fire seasons (2006, 2009 and 2015).

Preliminary comparisons of burned forest areas in 2015 vs. mammal distributions in Kalimantan suggest high degrees of overlap across many species, thus indicating that forest loss and degradation resulting from fire is negatively impacting biodiversity across Kalimantan. Local imagery indicates 277 km² of forest was lost due to burning in Sebangau (5.2% decline), during the non-fire year; compared to 510 km² (9.6%) during the 2015 fires. Analysis of long-term biodiversity data from Sebangau reveals that, during fire/haze periods: forest leaf fall increases dramatically (non-smoke mean = 697 kg/ha/mo; smoke mean = 1,079 kg/ha/mo), total butterfly abundance declines (mean captures from 20 traps during August-October: 107.7 in 2014 vs. 39.5 in 2015), and fish catch per unit effort from 20 river traps declines (from 18.21 prior to the 2015 fires to 4.02 immediately afterwards), corresponding to an increase in river acidity (from pH 3.88 to 3.20).

These results demonstrate serious negative impacts of fire and haze pollution on biodiversity on Kalimantan at both a large and small scale, resulting from habitat loss and degradation, potential direct stresses from prolonged exposure to toxic haze and increases in river acidity. Further, they indicate additional negative impacts on important ecosystem services for local communities (fish provision). We expect that these negative impacts will persist and worsen in future, particularly if Kalimantan's mis-managed and drained peatland area continues to increase, and strict burning bans are not enforced.

Paper Number: 809

Tuesday, 03 July 2018 | Giza

General Session 23 - Fire & Tropical Rain Forests

Long-term effects of forest fires on the ranging behavior of siamangs (*Symphalangus syndactylus*) in southern Sumatra, Indonesia

Susan Lappan

During a drought associated with the 1997 El Niño-Southern Oscillation Event, anthropogenic fires damaged a 165-ha section of the Way Cangkuk Research Area in Lampung Province, Sumatra, Indonesia. After the fires, siamangs disappeared from some areas, and the size and quality of home ranges living adjacent to the burned areas were substantially lower than those of groups living in undamaged habitat. In 2000-2002, 2007-2009, and 2014-2015, we monitored the ranging behavior and composition of seven habituated siamang groups in contiguous home ranges adjacent to fire-damaged habitat to assess their long-term responses to fire damage. We predicted that if substantial habitat recovery occurred, home ranges in the affected area would increase in size, and home ranges would shift to include recovering habitat. In the 17 years post-fire, there was no change in the mean size of siamang home ranges in the area adjacent to the burned area, and the home range centroids shifted by <5 m/yr. Home range centroids did not consistently shift to include areas recovering from the fires, although the home range of one group did shift in the predicted direction. A comparison of the Hansen global forest change maps from 2000 and 2014 show that tree cover in some areas damaged in 1997 was still discernibly different from that in undamaged areas 17 years post-fire. Our observations suggest that fire damage has long-term impacts on siamang ranging behavior, despite regrowth of vegetation in the decades post-fire.

Paper Number: 631

Tuesday, 03 July 2018 | Giza

General Session 23 - Fire & Tropical Rain Forests

Future changes in Amazon's fire regimes

Paulo Brando

Background

In Southern Amazonia, extreme weather events and agricultural practices have already intensified forest fire regimes. Recent severe droughts have triggered forest fires that are larger and more frequent, spanning a wider range of dry-season months—even as deforestation rates decline. As climate and land-use change, forest fires could impact even larger forested areas.

Objective

We used a coupled fire-ecosystem model to address the question of how climate change and deforestation may affect future burned area (BA) and fire-induced C emissions across the seasonally driest portion of the Amazon (representing 61% of the Brazilian Legal Amazon), where forest fires are most common

Method

The study area comprises the meridional Brazilian Amazon, where prolonged dry seasons (3-5 months with precipitation ≤ 100 mm). The total modelled area is about 191.724.450 Mha, of which 72% is covered by native forests. The main land-use in deforested areas is cattle ranching, with mechanized agriculture covering ranking second. To address our question, we used a coupled fire- ecosystem model. Our fire model simulates monthly fire ignition and burned area (BA) at a resolution of 500 m for the Amazon region, while our ecosystem model simulates monthly forest carbon dynamics as a function of climatic variables.

Result

We find that compared to the 2000s, simulated forest fires burn larger areas, combust more fuels, release more energy, and emit more C to the atmosphere in the coming decades. In our scenarios, avoiding new deforestation reduced the simulated burned area and total fire emissions by half and prevented fire spreading into protected forests.

The implications and conclusions

The intensification of fire regimes projected for both of our climate scenarios highlights the need to lower fire probability in Amazonia. Avoiding deforestation could substantially reduce fire- induced C emissions, but not enough to offset those increases associated with climate change. Aggressive efforts to eliminate ignition sources and increase wildfire suppression in the region could further reduce emissions

Paper Number: 918
Tuesday, 03 July 2018 | Giza
General Session 23 - Fire & Tropical Rain Forests

Flaming peat: a palaeoecological perspective on burning in tropical peatlands

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Fires within degraded tropical peatlands are now commonplace; whilst fires within intact peat swamp forests are thought to be rare events. Yet little is known about the long-term natural fire regime in these landscapes. Using fossil pollen and charcoal data from three peat cores collected from Sarawak, Malaysian Borneo, we looked at the incidence and impact of local and regional fire on coastal peat swamp forests over the last 7000 years. Palaeoecological results demonstrate that burning has occurred in these wetland ecosystems throughout their history, with peaks corresponding to periods of strengthened ENSO. However, prior to the Colonial era c. 1839 when human presence in the coastal peat swamp forests was relatively minimal, neither local nor regional burning significantly impacted on the forest vegetation. After the mid-19th Century, at the onset of intensified land-use change, fire incidence elevated significantly within the peatlands. Although fire does not correlate with past vegetation changes in these ecosystems, the long-term data reveal that open vegetation, a proxy for human forest clearance, does follow a similar pattern. Our results suggest that human activity may be strongly influencing and acting synergistically with fire in the recent past, leading to the enhanced degradation of these peatland ecosystems. These findings support present-day concerns about the increase in fire incidence and combined impacts of fire, human disturbance and El Niño on peat swamp forests, with serious implications for biodiversity, human health and global climate change.

Paper Number: 304
Tuesday, 03 July 2018 | Giza
General Session 23 - Fire & Tropical Rain Forests



GENERAL SESSION 24

Ecosystem Services

The value of forest fragments in maintaining ecosystem services for subsistence farming in West - African Montane forest

Murna Tela

Forest-agricultural mosaics are common ecosystems in Nigeria and in montane habitats the forest fragments support a potentially rich diversity of bird species. While some of these species may be providing valuable ecosystem services such as pest control to agricultural crops, the future of the forest fragments forests is threatened because they are being farmed. This in turn could negatively impact crops. The aims of this study were threefold; first to assess avian diversity and species richness in both farmland and forest fragments, secondly to classify bird species into trophic functional groups and finally to identify to what extent insectivorous species control insect pests in the most common crop, Zea maize. I used the point count method across 16 farmlands and 22 forest fragments to monitor bird species and classified each species into a feeding guild. I recorded a total of 15,917 individual birds comprising 203 species from 53 families. Species diversity and richness was significantly higher in the forest fragments than in the farmlands. A non-metric multidimensional scaling ordination showed that bird species composition differed between the two habitat types and bird species clustered according to their feeding guild, with carnivores, omnivores, carrion eaters, piscivores, frugivores and nectarivores mostly occurring in forest fragments. In contrast generalists and granivores were strongly associated with farmlands. 112 of the 203 species identified were insectivores and were evenly dispersed across both the farmlands and the forest fragments, suggesting they may be providing the ecosystem service of pest control. Most importantly, 72% of these species use the forest fragments for breeding which implies that retention of forest fragments is likely to enhance pest control for Nigerian farmlands. The scale at which this operates remains to be investigated. The study, the first of its kind in this part of Nigeria shows the forest-agricultural landscape of montane areas supports a high diversity of bird species emphasising the importance of this ecosystem in conserving biodiversity.

Paper Number: 70
Tuesday, 03 July 2018 | Machu Pichu
General Session 24 – Ecosystem Services

Coffee – can sustainability schemes really address threats to biodiversity conservation?

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Sustainability schemes (hereafter 'schemes') are used across many industries from timber to tuna, but coffee is a pioneer in this space. In fact, coffee is on track to become the world's first globally sustainable crop. However, sustainability itself is a difficult concept to define—in the case of coffee—it is unclear the extent to which these schemes can really address the underlying threats to biodiversity from coffee agriculture.

In this study, we evaluate the potential of eight prominent schemes within the coffee sector. These range from voluntary certification schemes, to compulsory industry standards specifically designed to improve coffee sustainability from farm to cup. These eight schemes differ within the coffee sector in regards to their primary focus, which may be: biodiversity conservation (Rainforest Alliance and Bird Friendly), synthetic-chemical and GMO free (Organic), human rights and social justice (Fairtrade), coffee-bean quality (Nespresso AAA Sustainable Quality™ Program), or a mix of these (Starbucks' C.A.F.E. Practices, Global Coffee Platform—formally 4C Baseline Common Code, and UTZ). Here, we use programme theory evaluation (PTE) to assess how these schemes address the underlying threat processes surrounding biodiversity conservation. PTE is a commonly used tool in environmental policy analyses that evaluate whether policy goals, needs, tools and outcomes connect in a logical manner, with this study excluding 'goals' as they differ widely.

We found that no single scheme is currently capable of adequately addressing all, or even a majority, of the underlying threats to biodiversity conservation. For example, although Starbucks' C.A.F.E. Practices address habitat loss and pollution well at the local level, this scheme cannot adequately address fragmentation at a landscape or regional level. Having an accurate understanding of the gaps across existing sustainable coffee schemes is critical for their continual development and refinement. This understanding is further needed to better address the full-range of threat processes on biodiversity conservation from coffee agriculture, particularly in relation to fragmentation and connectivity at the landscape level.

Paper Number: 643
Tuesday, 03 July 2018 | Machu Pichu
General Session 24 – Ecosystem Services

The effect of temperature on insect flower visitor and its consequence to the quality and quantity of coffee fruit

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Temperature changing could affect the insect diversity. Insects flower visitor, especially pollinator has play an important role in improving the quantity and quality of fruits. The aimed of this study was to understand the effect of temperature differences on insect visitor diversity and its effect on the quantity and quality of coffee fruits. Observation was conducted at two sites which different average daily temperature. The first site was shaded and the second site almost unshaded. Observation was conducted on 1080 flowers which belongs to 48 inflorescent of *Coffea arabica*. Insects' visitor was recorded every hour and for the purpose of identification the insect was collected by sweeping net. The result showed that, the difference of temperature (23.01 oC and 24.31 oC) could affect the diversity of insect visitor. At site 1 found 7 species, however at site 2 was 11 species. Consequently, the pea berry production and the productivity of coffee fruit mass also differs. Pea berry production in site 2 was lower (4.74%) than site 1 and the fruit mass at site 2 was heavier (0.125 grams/cherry) than site 1. However, the percentage of coffee bean defects was 0.13% higher at site 2 than site 1. These results found that the more diverse of insect visitor at unshaded site, the lower peaberry production and the heavier fruit mass which could lead to the higher defect of coffee bean.

Paper Number: 382
Tuesday, 03 July 2018 | Machu Pichu
General Session 24 – Ecosystem Services

SYMPOSIUM 18.1

Making Science Matter - from conservation research to implementation

Ecosystem services in tropical agroforestry - opportunities for conservation, mainstreaming, and implementation

Bea Maas

The Aichi Biodiversity Targets define global goals to counteract the progressive loss of biodiversity and associated services and processes. But the rapidly ongoing expansion and intensification of conventional land use threaten to undermine these targets, as they are the main cause of declining biodiversity and degraded ecosystems worldwide – with particularly strong effects in species-rich and fast growing tropical countries. Field experiments, such as the experimental enclosure of birds and bats, constitute a powerful tool to study the impacts of wildlife on pests and crop yields in agricultural systems. Combined with studies on the importance of species diversity and identity, and with appropriate management measures, ecosystem services in tropical land use systems can be managed and communicated more effectively. In this talk I will present results from 32 enclosure studies from seven tropical countries, highlighting the high global potential of bird and bat mediated pest suppression services to improve conservation and land use sustainability. Further, with focus on a long-term enclosure experiment from Indonesia, I will present findings from avian pest control experiments and collaboration with local cacao farmers and stakeholders, highlighting both the importance of species identity for the provision of ecosystem services and opportunities for improving practical implementation of research findings through enhanced understanding of functional relationships and transdisciplinary communication. The results of the presented studies demonstrate the tremendous economic impact of bird and bat mediated pest suppression services (e.g., corresponding to 730 USD per hectare and year in Indonesian cacao), but also stress the importance of local management and landscape factors and how efficient ecological intensification is hampered by knowledge gaps (e.g. on multiple ecosystem services and multitrophic interactions) and research implementation gaps (e.g. knowledge transfer and communication). Through a targeted and transdisciplinary design and communication of the Indonesian study, the results were considered in the development of the Nagoya Protocol on Access and Benefit Sharing (ABS) and have contributed to a more effective and sustainable cacao management in the study area, including reduced use of pesticides and enhanced public awareness of biodiversity related ecosystem services. Based on these findings, I will conclude with an overview of opportunities to improve the transferability and communication of ecosystem service research in tropical agroforestry systems and thus enhance their impact on biodiversity conservation and more sustainable land use management.

Paper Number: 75

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.1 - Making Science Matter - from conservation research to implementation

Co-management of conservation area: Local government perspective on the management of conservation area in Banyuasin District, South Sumatra, Indonesia

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Banyuasin District, South Sumatra Province, has the most extensive conservation area in the province. Twenty six percent (26%) of its areas are designated as national park and conservation areas, where its management authority is held by the national government (The Ministry of Environment and Forestry). The areas are part of the Berbak-Sembilang National Park, Padang Sugihan Wildlife Reserve, and Bentayan Wildlife Reserve, with 282.944 hectares in total. As in other conservation areas in Indonesia, the classical problem of conservation occurs with increasing threats and pressures due to human activities and development. In Banyuasin, the typical threats are encroachment, expansion of agricultural activity and settlements, illegal logging, forest and peat fire, and other development activities.

The role of local government is problematic as the authority to control and to manage the conservation areas legally falls upon the national government i.e. the Ministry of Forestry and environment, whilst the areas itself are actually within the boundaries of the district and the livelihood of the community are in the hands of the local government. This situation creates the need for a good collaboration between the national and local government, since the local community to some extent depend their livelihood on the conservation areas.

This paper will describe Banyuasin District's perspective on the management of conservation area and exploring idea of applying co-management approach for the better management of the area. Transferring greater authority and role to local government (district) through better implementation of co-management approach will be more effective to achieve the goal of conservation management i.e. ecosystems and biodiversity protection and local development. Interest to conserve and to develop the need to be understood as complementary and not as opposite, as part of the whole landscape management. In this context, local and national government should not be opposites but complementary. Co-management approach where key stakeholders including local government, local community and private sector are inclusively participate in the management need to be developed with intensive coordination, especially between national and local government as the formal regulator in the landscape.

Paper Number: 987

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.1 - Making Science Matter - from conservation research to implementation

Promoting community-based bird monitoring in the tropics: Conservation, research, environmental education, capacity-building, and local incomes

Cagan Sekercioglu

Long-term, locally-based biodiversity monitoring programs are essential for understanding and mitigating the effects of global change on tropical biodiversity while providing capacity-building, environmental education, and public outreach. However, these programs are lacking in most tropical countries. Birds are the best-known major group of organism, comprise excellent environmental indicators, are relatively easy to monitor, and are met with enthusiasm and interest by people worldwide. Bird monitoring programs using mist nets and bird banding (ringing) are especially valuable, as these well-established techniques enable the use of capture-mark-recapture (CMR) models to measure population change and other demographic parameters. Equally important for conservation, the ability to capture and release birds makes it possible to provide hands-on ornithological training and educational activities to students, conservationists, villagers, decision-makers, journalists, and other local people. Bird banding programs provide

local jobs for research assistants, who often go on to productive careers in conservation, education, research, or ecotourism. Long-term bird banding stations also provide the nuclei, infrastructure, and staff for monitoring, education, and conservation programs focused on other taxa. As successful examples from Costa Rica and Ethiopia show, bird monitoring programs that integrate conservation, ecological research, environmental education, capacity-building, and income generation are cost-effective tools to achieve the goals of community-based biodiversity conservation and poverty reduction in the developing world. Therefore, locally-based and long-term bird monitoring programs should be encouraged, established, and funded throughout the tropics.

Paper Number: 86

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.1 - Making Science Matter - from conservation research to implementation

Role of actors and conflict in building local capacity to implement conservation decisions on the ground

Maria J Santos, Ivan Vera Concha, Mary-Ann George and Clare Barnes

Introduction: It is becoming widely recognized that conservation success is dependent on inclusion of multiple actors in the management process. In community forest management (CFM), it is expected that communities themselves will effectively overcome management dilemmas to maintain and prevent the collapse of their common resources. In many instances of CFM, external actors act as boundary institutions or capacity building institutions intervening to initiate or further develop the community level action deemed necessary for the sustainable management of community resources.

Objectives: Here we examine two types of external actor presence and their effects on natural resources, one with the presence of intentional external actors in India and one with the presence of unintentional external actors in Colombia.

Methods: We merged data from surveys, field data collection and remote sensing to assess how do external actors affect the livelihoods capitals of the local communities, with particular focus on the natural capital.

Results: We find that in the case of the intentional external actors in India (NGO and government institution), many of the livelihood capitals are maintained or enhanced by the presence of the external actor, with the exception of natural capital. On the contrary, in the case of the unintentional external actors in Colombia (paramilitary armed groups) most livelihood capitals are reduced, and natural capital may be either reduced or improved and this outcome is dependent on the level and continuity of the armed conflict.

Conclusions: These two cases illustrate how intended and unintended interventions to build local capacity to implement conservation decisions may produce unexpected outcomes, and that we need more case studies under different external actor settings to fully assess the success of such interventions.

Paper Number: 199

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.1 - Making Science Matter - from conservation research to implementation

Toward an open science platform for Asian Soundscape network

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Soundscape represents the ecological domain of acoustic signals generated from biotic and abiotic themes in the environment. Investigating spatio-temporal patterns of soundscape, we are able to eavesdrop occurrence and behaviors of vocal species, changes of the environment, anthropogenic activities, and the interactions between them. Acoustic techniques have been increasingly adopted by ecologists in understanding of phenological patterns, species diversity, ecosystem integrity, and how human impact biodiversity. Precise and accurate extraction of acoustic information from sound recordings is critical for implantation of acoustics in biodiversity monitoring. Deployment of effective analytic tools by experienced people is therefore necessary for bioacoustics research, especially for those comparing large quantity of data from different sources. This is apparently challenging for low-income regions, e.g. most Southeast Asian countries, where funding is usually limited to afford expensive commercial tools and knowledge of bioacoustics techniques is generally lack. The Asian Soundscape Network (<http://soundscape.twgrid.org/>), established by Academia Sinica and Taiwan Forestry Research Institute in 2014, aims to establish carrying capacity for and to promote bioacoustics studies in East and Southeast Asia. To date, the team has established 18 long-term acoustic monitoring sites for terrestrial audible soundscape from 4 countries in the region and set up an online open-assessed platform for data management, query, listening, and visualization for audible soundscapes. With a support from TEIN (Trans-Eurasia Information Network) and APAN (All Partners Access Network) infrastructure, our next step is to design a new web portal equipped with functions of big data workflow, extensive machine-learning analysis services, and metadata management for terrestrial audible and ultra-soundscape, and marine soundscape studies. Our ultimate goals are to provide a user-friendly platform for general users, to boot up the development of bioacoustics studies, and to form a regional research network on soundscapes in the region.

Paper Number: 173

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.1 - Making Science Matter - from conservation research to implementation

Translating Conservation Science into Conservation Action

Alice Hughes

Recent decades has seen the evolution of new methodologies which facilitate an understanding of ecology and ecosystem function which was never formerly possible. However, as these new and increasingly sophisticated techniques have evolved, there has been an increasing disconnection between researchers, and both data-producers and research users. Disciplines such as macroecology depend on the generation of largescale datasets, yet this increasing disconnection means that research outcomes risk being both too "theoretical" and too uncertain (due to mismatches in the resolutions and scale within analysis) to provide useful perspectives to better inform on the ground conservation and management. In this presentation we explore the significance of these mismatches, and lack of communications between sectors and disciplines for generating useful data for management and conservation, and discuss mechanisms to increase the relevance and applicability of research outcomes, in addition to modes of dissemination to translate conservation and macroecological science into something which is both relevant and accessible to those who can utilise it to effect conservation and management outcomes.

Paper Number: 909

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.1 - Making Science Matter - from conservation research to implementation



GENERAL SESSION 25

Climate Change

Anthropogenic climate change in Southeast Asia and its impacts on biodiversity.

Richard Corlett

Southeast Asia is a very difficult region for modeling climate: sea and land are intimately mixed, the monsoons are complicated, the Himalaya is high, and the region is strongly influenced on a variety of timescales by a range of poorly understood cycles, including ENSO, IOD, PDO, and AMO. Moreover, humans have massively changed land surface properties by deforestation, cultivation, and urbanization, and continue to add huge amounts of short-lived aerosols to the atmosphere in complex mixtures. Not surprisingly, therefore, while global climate models agree fairly well on future changes in temperature under particular emission scenarios, projections of future rainfall and other climate variables are model-dependent, and there is little or no agreement for most of the region. Impact uncertainties are added to climate model uncertainties. Species can acclimate, adapt, move, or die, but none of these processes are well understood. The paleoecological record suggests movement has been the dominant response to past climate change, but habitat fragmentation makes this difficult for most species now. Moreover, projected rates of change are higher than any currently known from the paleo record, and climates are already warmer than 90% of the Pleistocene. Despite these difficulties, it is essential that we plan now for biodiversity conservation in the face of climate change. The objective of this presentation is therefore to show what we can do with our existing knowledge. Possible approaches include minimizing climate model spread by excluding models that do not perform well for the present climate, extrapolating current climate trends instead of modeling, constraining species distribution models by relevant species traits, and improved presentation of uncertainties. Conservation planners and managers need an honest summary of the best current science, including the full range of plausible futures, not just worst-case scenarios. Overall, our current understanding of climate change in SE Asia does not support the more pessimistic predictions for the region, at least in the next few decades. We have time to make global mitigation efforts work and to improve local and regional adaptation for conservation.

Paper Number: 456
Wednesday, 04 July 2018 | Colosseum 2
General Session 25 - Climate Change

Too hot to handle? Vulnerability of the Megapodes (Megapodiidae, Aves) to Climate Change

Robert Davis

Introduction

Owing to high rates of endemism, inherent species range restrictions, and high vulnerability to stochastic and anthropogenic impacts, tropical island biota are more imperilled by climate change than other ecosystem. Aspects of species life histories may also increase their susceptibility to climate change. Owing to their exclusive reliance on environmental sources of heat for incubation, megapodes, a group of 22 mostly tropical, mound-nesting birds, may be especially vulnerable. All but two species are confined to the tropics and many to islands. Consequently, megapodes are an ideal model group for investigating the predicted broad-scale impacts of climate change on insular tropical biota.

Objectives

We investigated the susceptibility of 22 species of megapode to environmental change caused by predicted increases in temperature, fluctuations in rainfall, and sea level rise.

Methods

We used a trait-based vulnerability assessment to assess megapode exposure to projected climate variables of increasing temperatures, fluctuating rainfall, and sea level rise, and their biological sensitivity and capacity to adapt. To determine and score species sensitivity and adaptive capacity based on our criteria, we drew on published literature and relied heavily on current data made available by the IUCN. To determine exposure we used relevant climate data from the IPCC (2014) and the Commonwealth Science and Industrial Research Organization (CSIRO). We reviewed literature using Web of Science, Scopus, and Google Scholar.

Results

The Nicobar, Moluccan and Vanuatu megapodes, and Waigeo brush-turkey were ranked most vulnerable to climate change, while the orange-footed and Philippine megapodes, malleefowl and black-billed and Australian brush-turkeys were ranked least vulnerable. Sensitivity contributed to the vulnerability of seven species and the most influential exposure characteristic was temperature change, which increased for all species and scored 98.4% of available points, followed by sea level rise (43.3%) and precipitation change (29.5%). Adaptive capacity had little influence on the vulnerability ranking of megapodes. Annual mean temperature increase was the most important exposure criterion and all species except the Polynesian megapode were predicted to experience a temperature increase of $\geq 2.1^{\circ}\text{C}$. Sixteen species will be exposed to rising sea levels, eight of which will be at least moderately affected.

Conclusions

Given the innate vulnerability of megapodes to climate change, our results are concerning and suggest that birds of the tropics, especially those on islands may be at great risk from sea level rise and changes to precipitation and temperatures.

Paper Number: 193
Wednesday, 04 July 2018 | Colosseum 2
General Session 25 - Climate Change

Multi-scale modeling of anthropogenic and climatic drivers of vegetation cover change in the Uttarakhand Himalaya

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Climatic and anthropogenic factors significantly influence the spatio-temporal pattern of vegetation cover. Continuous monitoring of this dynamic response enables appropriate management responses and long-term conservation action plans. However, the cause and effect relationships operate at multiple spatial and temporal scales, and thus, information general should correspond to the scale-dependent relationships. Accordingly, we studied Normalized Difference Vegetation Index (NDVI), as a measure of vegetation cover, over the Uttarakhand Himalayan Region for two time periods (2000 and 2015) and at three different spatial scales (16 km, 4km and 1km). A combination of spatial analyses and generalized linear modeling was employed for these three scales to explore the key drivers of vegetation cover change and to identify the scale-specific climatic and anthropogenic driver. The results demonstrated that the majority of the landscape (63 %) has experienced noticeable increase in vegetation over the last 15 years. However, there are spatial variations in the vegetation cover change across different scales with sharp increases and declines observed in specific areas. The outputs of linear regression modelling showed that spatial scale played a vital role in discerning the variation of driving factors and different driving forces operated at different spatial scales. Changes in vegetation cover were driven primarily by anthropogenic effects ($p < 0.0001$) at the 16 km scale ($n = 251$), maximum temperature of the warmest month ($p < 0.0001$) at the 4 km ($n = 3478$) and minimum temperature of the coldest month ($p < 0.0001$) at the 1 km scale ($n = 53148$). Both climatic and human factors were responsible for vegetation cover changes in the Uttarakhand Himalayan region but with human generated factors more important at the larger and seasonal extremities at the smaller scales. The findings of the study reinstated that appropriate knowledge generation and management response would require multi-scale approach since ecological processes and resilience capacity of the system operate at different scales.

Paper Number: 222
Wednesday, 04 July 2018 | Colosseum 2
General Session 25 - Climate Change

Using Open top chambers (OTC) to simulate future warming scenarios in the Paramos, a tropical alpine ecosystem of the Northern Andes

Eloisa Lasso

The world is getting warmer and mountaintops are warming faster. In the mountaintops of the Northern Andean Mountains we can find paramo, an important ecosystem that has historically stored large quantities of soil carbon and is host to more than 40% of endemic species. In this study we used open top chambers (OTC) to simulate future warming scenarios and evaluate how a rise in temperature will affect several ecosystem processes related to ecosystem carbon storage. Response variables included soil respiration, decomposition rate, microbial community composition, photosynthesis, primary productivity and vegetation changes. Twenty OTC were established in 2016 in two paramo sites located in the oriental range of los Andes, 10 on each site. Environmental variables monitored inside and outside the OTC indicates that OTC are warming and drying the soil and the air, especially during the dry season. Temperature inside the OTC was on average 2oC warmer than in the control plots but on sunny days temperature could be up to 10oC warmer in the OTC compared to the control. During the dry seasons, OTCs were slightly drier and soil water potential was lower. After two years of warming, soil respiration and decomposition rates haven't been affected by warming, and turnover in microbial community composition shows greater correlation with plant cover and soil water content than with warming. Belowground productivity hasn't increased either, but aboveground productivity, measured at the species level, indicates species differential response to warming where some species grew more when warmed and other grew less. Likewise, the change in vegetation cover after two years of warming indicates differential response to warming among life forms, functional types, and species. Grasses and mosses are increasing in cover inside the OTC while other life forms have remained constant. None of the species has been negatively affected by warming so far, and only one species *Hipericum strictum* seems to be taking particular advantage of the warmer conditions by increasing their cover in the OTC. Our preliminary results after only two years of warming suggest that warming per se does not have a direct effect in any of the ecosystem processes related to carbon storage. We might expect that paramos could shift from carbon sink to sources only if longer-term changes in vegetation and microbial community composition and/or metabolism, in combination with warmer and drier conditions, leads to changes in substrate stoichiometry that contribute to increases in decomposition and soil respiration.

Paper Number: 719
Wednesday, 04 July 2018 | Colosseum 2
General Session 25 - Climate Change

Complex occurrence changes in a tropical lowland moth community following a decade of warming

Wenda Cheng

Climate change is driving many species towards higher latitudes and higher elevations. However, empirical studies documenting these changes have largely focused on presence/absence based range shifts in temperate regions, while studies controlling detection probabilities in lowland tropical ecosystems are lacking. Here by analyzing a 15 years of Geometrid moths trapping dataset along a lowland elevation gradient in Hong Kong, at the northern border of the tropics, we were able to use multiple metrics and approaches to estimate and compare the occurrence probabilities, presence/absence, and communities changes of moth species from 2000 to 2014. Over the study period we detected subtle habitat change in habitat (as measured by forest cover change) but a notable increase in maximum temperatures (~0.5 °C per decade). We found that one out of the 123 examined species exhibited increased occurrence probabilities across all elevations across a decade; all other species exhibited no change. However, when comparing presence/absence we found two species have become newly established in Hong Kong and 26 % species showed lower or upper range limit changes. At the community level, geometrids showed a noticeable upslope shift at all but one of the examined current sites. The complex patterns observed highlights the difficulties and limitations in detecting climate change impacts on diverse tropical communities. However, our results indicate possible early responses of tropical species to a relatively short time span of environmental changes and the necessity in long term monitoring of tropical species and provide insights into the management and conservation of vulnerable species.

Paper Number: 555
Wednesday, 04 July 2018 | Colosseum 2
General Session 25 - Climate Change

Extensive range contraction predicted under climate warming for a gliding mammal in north-eastern Australia

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We used MaxEnt to model the current distribution of the yellow-bellied glider (YBG) (*Petaurus australis*) and to predict the likely shift in the species' future distribution under climate warming scenarios in the Wet Tropics (WT) Bioregion in north Queensland and in the South-eastern Queensland (SEQld) Bioregion, which encompasses south-eastern Queensland and north-eastern New South Wales. Bioclimatic layers were used to generate models from 57 independent records in the WT and 428 records in SEQld. The modelled distribution of core habitat under current climate showed a good fit to the data, encompassing 91% and 88% of the records in each area, respectively. Modelling of future warming scenarios suggest large contractions in distribution could occur in both bioregions. In the WT, 98% of core habitat is predicted to be lost under low warming (1°C increase) and 100% under high warming (2-3°C increase) by 2070. In SEQld, 80% of core habitat is predicted to be lost under low warming and 90% under high warming by 2070. These results suggest that this species is highly vulnerable to climate warming and highlight the importance of focusing conservation efforts at the bioregional scale. There is also a need to identify potential thermal refuges and ensure habitat connectivity.

Paper Number: 560
Wednesday, 04 July 2018 | Colosseum 2
General Session 25 - Climate Change

SYMPOSIUM 19.1

Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

Elephant messengers: mobiles for Asian elephant conservation in urbanized settings in south India

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Human-elephant conflict mitigation often employ reactive measures such as chasing, capture and translocation, or retaliatory persecution, but these often do not resolve conflicts on a sustained basis, empower communities to implement solutions and promote human-elephant co-existence.

Our long-term studies (since 2002) in two critical landscapes of Valparai plateau and Hassan–Kodagu region in southern India, enabled us to understand elephant movements, their conflicts with people and identify and implement targeted conflict mitigation efforts. The major conflict concerns in both landscapes were the safety of human life besides property and crop damages due to elephants. The Valparai plateau is a 220 km² landscape matrix of tea, coffee, eucalyptus plantations and rainforest fragments, supporting 70,000 people and around 120 elephants that move across plantations into surrounding PAs. Whereas, the Hassan landscape is a 210 km² of coffee-acacia-eucalyptus with paddy grown in the fallow regions among plantations, supporting 45,000 people and around 35 elephants. Our investigation of 44 incidents of human deaths due to elephants in Valparai region (1994–2017) and 36 cases in Hassan (2010–2017) revealed that around 65% of fatal incidents occurred on roads. Temporally, in the Valparai region, 65% of cases occurred during a three month-period between December and February, denoting peak conflict period in a year but no such pattern observed in the Hassan region. Time of the day had no influence on the occurrence of fatalities in the Valparai region. Whereas in Hassan region, 67% of human deaths occurred between 6–10 AM and 4–8 PM, indicating sensitive time periods during the day. In both landscapes, a majority of incidents occurred due to people were unaware of elephant presence and their movements and lack of safety facilities at work place and at home, suggesting a need for early intimation systems. We have implemented simple and locally-appropriate early-warning systems involving stakeholders (TV crawl, bulk SMS, mobile-operated alert beacons, and digital display boards) to alert people in advance about elephant presence. As a result, in the Valparai region, average number of fatal incidents reduced from three persons/year (1994–2002) to one person/year (2003–2017). We have extended these technological interventions to Hassan-Kodagu region where we believe that these may help minimize human-elephant conflict. Our studies suggest that a shift from conventional reactive strategies of problem animal approach to pro-active problem location approach with sustained participation by stakeholders could pave way for coexistence in modified landscapes.

Paper Number: 335

Wednesday, 04 July 2018 | Petra 1

Symposium 19.1 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

Movement responses of translocated elephants in Peninsular Malaysia

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Translocating elephants is a common practice in an attempt to resolve the human-elephant conflict. Currently there are few studies that have monitored the response of elephants to translocation. Elephant translocation programs require large amounts of resources and time, and elephant mortality is common. Despite these drawbacks, most countries continue to translocate elephants without post-release monitoring, so effectiveness is usually unknown. Here our aim was to analyse the movement responses of Asian elephants to translocation in Peninsular Malaysia. Specifically, we investigated how elephants respond to translocation by: (1) categorically describing the type of response to translocation; (2) examining changes in daily movements and directional behaviour over time; and (3) quantifying movement behaviour using a net-squared displacement modelling framework that includes classifications of migration, nomadism, residency and dispersal. We used GPS telemetry to study the movements of 30 translocated and 14 non-translocated Asian elephants (*Elephas maximus*) throughout Peninsular Malaysia. In 31 translocations, eight elephants returned home, 14 elephants remained at the release site, and nine elephants left the release site but did not return home. All non-translocated elephants remained at the release site, which was within their home range. Translocated elephants had greater variation in daily movements than non-translocated elephants across the entire study period. Exploratory behaviour of translocated elephants was consistently present in the first seven months following release. No exploratory behaviour was evident for both translocated and non-translocated elephants after 12 months following release. Our preliminary results from the net-squared displacement modelling indicate translocated elephant movements best fitted dispersal and nomadic models while non-translocated elephants were showing resident behaviour. The results from this study reveal critical patterns of response by Asian elephants to translocation programs. Translocated elephants varied in their responses, with a high proportion of elephants returning home to the original human-conflict area. Given a high mortality rate during the translocation process (such as unanticipated responses to drugs and stress), the high amount of resources required, and the varied response by elephants to translocation, the appropriateness of translocation programs as a human-conflict mitigation method needs to be considered.

Paper Number: 851

Wednesday, 04 July 2018 | Petra 1

Symposium 19.1 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

Behavioural responses of Asian elephants to human disturbance in relatively undisturbed habitat

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During Anthropocene epoch, understanding animals' response towards humans is not just necessary and fascinating, but has become an integral part of several welfare and conservation projects. For instance, human-elephant conflict (HEC) is one of the major concerns for policy-makers and conservationists in elephant-ranging countries. For a species like elephants, which plays a vital role in maintaining the functional health of an ecosystem, any negative interactions with humans could influence their survival and fitness. Though the reasons for these interactions could be multiple, we attempted to understand this issue by assessing the behavioral responses of free-ranging Asian elephants. One primitive aspect of HEC is to evaluate how elephant responds to the presence of humans. This study, hence, highlights how elephants respond (both vocally and immediate responses) to human activities when they are in the core area and at the periphery (road-crossing behavior) of the protected habitats. To address these objectives, we conducted the study in the Mudumalai National Park, where elephants experienced relatively lesser human-disturbances in the core areas and face the vehicular traffics at the periphery. To understand how elephants respond to human activity in the core areas, along with their acoustic and immediate behavioral responses, the time they spent for being vigilant, distance they moved away from the source of disturbance were also recorded and analyzed. To assess elephants' responses at the periphery of the forests where they encountered vehicles, their collective behaviors during road-crossing events were assessed. We found that, in the core areas, free-ranging elephants spent more time in vigilance in response to humans on foot and moved further away as compared to vehicular sound. The immediate vocal responses were mainly trumpets, chirps and rumbles. However, 'rumbles' showed high frequency modulations compared to other calls. While at the periphery of forests, when elephants experienced vehicular disturbances, they spent more time before crossing the roads and they were relatively 'quick' while on the road. Types of roads, age-structure, group-size and order of progression influenced the road-crossing behavior. All these findings suggest that elephants actively respond towards the human-activities when they are in less disturbed habitats and could be avoiding such exposures. This information could be extrapolated to understand the behaviors of elephants when they are in highly disturbed habitats or in conflict zones. Furthermore, such insights could be a valuable knowledge to formulate more practical site-specific conservation strategies, emphasizing the behavioral aspects of elephants.

Paper Number: 386

Wednesday, 04 July 2018 | Petra 1

Symposium 19.1 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

Do new developments in insurance schemes represent a promising new way to facilitate human-elephant co-existence?

Simon Hedges

There is a growing interest in using insurance to mitigate human-wildlife conflict (HWC), partly as a response to the failure of many other methods of mitigating HWC, especially for species such as elephants. Compensation for crop depredations by elephants is generally regarded as an ineffective, even counter-productive, approach to human-elephant conflict (HEC) mitigation. Insurance schemes are related to compensation schemes but by making payments (either in cash or kind, such as rice) contingent on payment of a premium (and potentially also contingent on guarding of crops and on crop type) one of the most serious problems affecting compensation schemes is reduced, i.e. the potentially reduced incentive to guard crops. Nevertheless, work by the Wildlife Conservation Society and Greenomics in Indonesia found that commercial insurance against crop depredations by elephants was impracticable because (1) the premiums proposed by insurance companies were high relative to the cost of the damage done by elephants and (2) the difficulties of meeting commercially acceptable risk management standards for reinsurance. However, insurance schemes arguably lend themselves to small-scale micro-finance or village-credit schemes that do not have the administrative burden typical of state- or province-level compensation schemes. Most promisingly, new approaches to dealing with the problems inherent in insuring large numbers of very poor, small-scale farmers that have been developed recently in response to climate change and the increased frequency of extreme weather events also lend themselves to insuring such farmers against HEC and other forms of HWC. The promise and potential pitfalls of using insurance to mitigate the impact of HEC will be discussed and possible ways of avoiding perverse outcomes such as agricultural expansion and encroachment into wildlife habitat, especially protected areas, proposed.

Paper Number: 466

Wednesday, 04 July 2018 | Petra 1

Symposium 19.1 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

Breaking through “Us versus them”: how cognitive psychology and hormones help to bridge the divide between humans and elephants

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After 145 years, the Ringling Brothers ended their circus performances and sent their elephants to a sanctuary, citing that the business model for circus was no longer sustainable. In 2017, TripAdvisor adopted a “no touching of wildlife policy” and banned ticket sales for elephant rides and tiger petting amongst others. More and more, the public are accepting that animals are sentient beings and people are concerned about animal welfare. The power of consumers and how they spend their dollars are influencing changes in the way captive animals are managed. However, to convince local communities who are experiencing human-elephant conflict (HEC) and have strong fear for their safety, the animal welfare argument may not be enough. Field conservationists face the challenges of having to gain community trust; helping the community to overcome their fear of elephants and avoiding the risk of being labelled as an outsider who “cares more about wildlife than the fate of the local community and their customs”. Here, I review important theories influencing wildlife behaviour and case studies from cognitive psychology and neuroendocrinology, including Hamilton’s “Selfish Herd Theory”, Frans de Waal’s “Evolution of Fairness” and the “Cambridge Declaration on Consciousness”. More importantly, I will propose a possible communication strategy to help break down the barriers between stakeholder distrusts and gain their support for the conservation of wild Asian elephants. Besides simplifying wildlife behaviour findings for community outreach and education awareness, there is a lot more we can do to sway stakeholders’ sentiment to support conservation of wild elephants. For example, cognitive psychology has shown that by priming participants unconsciously with certain words linked to their identity, it can influence participant performances in cognitive tests. Meanwhile, the study of brain and hormones showed negative emotions such as fear, can have strong influence on our behaviour; and how by activating the prefrontal cortex (logical rationalisation) can help in overcoming these biases. Last but not least, we must not underestimate the power of a carefully crafted story that captures the imagination of its audience, evoke compassion for the ‘enemy’, encourage personal reflection and influence a shift in culture. By using knowledge gained from cognitive psychology and neuroendocrinology, we can gain a lot of insight on both wildlife and human behaviour to help advance conservation efforts.

Paper Number: 932

Wednesday, 04 July 2018 | Petra 1

Symposium 19.1 - Moving towards coexistence – reconciling Asian elephant’s behaviour and humans’ social dimension

Principles of human dimensions in HEC mitigation processes

Alexandra Zimmermann

Assam in northeast India is one of the last strongholds for the Asian Elephant, but also one of the worst hotspots of human-elephant conflict in the world. An extensive community-based initiative called the Assam Haathi Project, was successful in mitigating the conflict in over 80 villages to the extent that crop-raiding and property damage reduced by up to 75% and no people nor elephants were killed around the project villages. Various interventions were used, but the reasons for their success had more to do with the human dimensions, than with the technical design of the fences or the variety of chillies used in repellents. Instead, the success of these interventions stems from the social process by which they were devised and implemented. In our experience, electric fences worked well because the affected communities not only participated, but took full ownership and responsibility of these methods. Decisions around the exact locations of fences, which materials to use, and its actual construction, were made by the communities themselves after discussions and assistance from project staff. The communities figured out their own maintenance rota and even established their own funds for repairs, deciding how to distribute the burden of cost and effort. Thus they owned not only the fence, but also the entire process. The result was a shift in decision-making and perception of agency and responsibility. This talk describes how this process was achieved in northeast India and concludes that the key to HEC management lies not solely in the efficacy of the damage control methods, but in investing considerable effort into understanding the cultural and socio-political aspects of the given situation, making the communities feel heard, addressing their concerns, and ensuring their ownership not only of the activities but of the entire process of conflict management.

Paper Number: 778

Wednesday, 04 July 2018 | Petra 1

Symposium 19.1 - Moving towards coexistence – reconciling Asian elephant’s behaviour and humans’ social dimension

SYMPOSIUM 20

Novel techniques and emerging findings in tropical bat ecology and conservation

Regional scale analysis of bat-virus associations in Tropical Asia to support One Health surveillance

Heather Davies

BACKGROUND: Bats are natural reservoirs of emerging infectious diseases (EIDs) in South and East Asia. Significant zoonotic spillover events (e.g., Nipah virus infection and Severe Acute Respiratory Syndrome) were traced back to bat exposure in this region. Viral surveillance activities focused in these areas, along with the recent availability of metagenomic sequencing technology, has resulted in voluminous data related to the virome of bats. **OBJECTIVE:** To utilize published surveillance data within South and East Asia, to enable regional-scale spatial analysis of bat-borne viruses to support One Health research. **METHODS:** A systematic literature review was completed of bat-virus associations in the target region within four viral families (Coronaviridae, Filoviridae, Paramyxoviridae, and Rhabdoviridae). Bat range and habitat data published by the International Union for the Conservation of Nature (IUCN) were processed to match range extent with species elevation sensitivity. Challenges of divergent diagnostic methods, taxa, and range descriptions were resolved to the extent possible for analysis to enable a more granular, regional scale of data exploration. **RESULTS:** Over 1,200 abstracts were reviewed, and 117 papers met inclusion criteria for quantitative data extraction and meta-analysis of key findings and associations. Between the years 1997 and 2017, bat virome surveillance has collected data on nearly 200 chiropteran species in 40 genera across 22 countries within the target region. Spatial analysis based on data aggregated and curated from this review reveal the diversity and distribution of bat species that, to date, have demonstrated capacity to host viruses of concern. Meta-analysis of associations regarding viral prevalence, seasonality, life cycle, and sampling media were used to refine country-, species-specific EID risk profiles. **IMPORTANCE:** Conservation medicine and One Health approaches seek to integrate research on human, animal, and ecosystem health, through transdisciplinary collaboration, and to build a foundation for pursuit of blended outcomes to conserve biodiversity and local socio-economic vitality, while minimizing potential threats to regional and global health security. Zoonotic risk mapping at a regionally-relevant scale can enhance prevention and education related to agriculture, extraction, recreational and religious cave use, and conservation activities, as well as future surveillance planning in an area of the world considered a high-risk hotspot for novel disease emergence.

Paper Number: 149

Wednesday, 04 July 2018 | Petra 2

Symposium 20 - Novel techniques and emerging findings in tropical bat ecology and conservation

Acoustic Diversity and Activity Pattern of Insectivorous Bats in a Riverine Forest of Gunung Mulu National Park, Malaysian Borneo

Ellen Mc Arthur

Background

Rivers and water bodies are known to be important foraging habitats for insect-eating bats in temperate and dry regions of the world. However, few studies have investigated the use of riverine habitats by foraging bats in the tropical forests of Southeast Asia. Acoustic monitoring with ultrasonic detectors has emerged, in recent years, as an essential tool to quantify activity of echolocating bats and identify key habitats used by them for commuting and foraging.

Objective

We conducted full night passive acoustic sampling to investigate the species composition and foraging activity of insectivorous bats in a 3.5 sq. km. area of lowland riverine forest, between extensive karst outcrops and the boundary of Gunung Mulu National Park.

Methods

Between May and November 2016, a full spectrum ultrasonic detector was used to record bat activity during 105 nights, at 35 points along three rivers of different width and also adjacent trails and forest interior 50 metres from trails and rivers. Recorded calls were analysed by spectrogram viewer software and compared manually to a collection of reference calls recorded from 502 individuals representing 30 species of insectivorous bats, previously captured within the same area. Discriminate function analysis was performed on reference calls to determine which species could be accurately identified from their calls.

Results

A total of 273.02 gigabytes of files containing an estimated 104,834 bat passes were recorded. Overall, 93% of passes were recorded at rivers, while 5% were recorded on trails and 2% in forest interior. Based on results from discriminant function analysis, five species of cave roosting Rhinolophidae, seven Hipposideridae, Chaerephon plicatus and Miniopterus australis could be identified and represented 62% of total recorded passes. A further 36% of passes were identified to a Myotis species call group and at least four call types from unknown species were detected. Accurate identification of low intensity, high frequency calls from members of the forest roosting Vespertilionidae subfamilies Kerivoulinae and Muriniinae proved to be problematic, however this group of species only represented 1% of recorded calls.

Conclusions

Acoustic sampling, although challenging to conduct in megadiverse and threatened tropical environments, is proving to be very effective in providing information about the foraging ecology of cave roosting insectivorous bats that could not be easily obtained by any other sampling method.

Paper Number: 531

Wednesday, 04 July 2018 | Petra 2

Symposium 20 - Novel techniques and emerging findings in tropical bat ecology and conservation

DNA barcoding allows novel insights into the diet of insectivorous bats in Sabah's logged and primary forest

David Hemprich-bennett

Much of the rainforest of Southeast Asia has been selectively logged, frequently reducing the diversity of the taxonomic community in the affected areas. Despite these trends, communities of insectivorous bats captured in logged forest remain little-affected, indicating potentially high value of such habitat to the resilience of these communities to habitat change. To assess their ability to adapt to such disturbance it is necessary to assess their ecology, particularly their use of available resources in response to disturbance events.

In this study we sought to assess the utility of logged forest areas for the conservation of insectivorous bats by characterising changes in their diet between selectively logged and primary forest. In particular we assessed the diet of bats within fragments of a logged forest site (The SAFE project) both before and after salvage logging took place around them.

We collected over 900 guano samples from individual bats in the forests of Sabah, Malaysia between 2015 and 2017. Through high-throughput sequencing of the COI barcoding region of prey DNA in the bats' guano, we assessed the taxonomic makeup of the arthropods fed on by bats at each sampling site and event.

We used these data to construct predator-prey interaction networks and observed little difference in the overall network structure between the logged forest and primary forest sites, with the exception of the network measured in the logged forest immediately following the salvage logging. During this period niche overlap between bat species was temporarily reduced despite a simultaneous decline in number of prey nodes in the network, potentially indicating a sudden scarcity of prey causing bats to feed more opportunistically. The taxonomic composition of diet in the most common bat species did not change dramatically between sites. We observed that many species were found to rely on termites and cockroaches to a greater extent than previously expected.

The logged forests of Borneo retain a high diversity of insectivorous bats whose feeding ecology has been little understood. Our data suggest that the ecology of bats in selectively logged and primary forest are similar but does change in response to salvage logging of these forests. Their ability to withstand some forest modification means that these areas of selectively logged forest remain important to the conservation of Borneo's bats. It is therefore important to prioritise preservation of these forest areas.

Paper Number: 894
Wednesday, 04 July 2018 | Petra 2

Symposium 20 - Novel techniques and emerging findings in tropical bat ecology and conservation

Into the light: Atypical diurnal foraging activity of Blyth's horseshoe bat, *Rhinolophus lepidus* on Tioman Island, Malaysia

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Diurnal flight and foraging activity in insectivorous bats are atypical behaviours that have been recorded from islands with few avian predators, and from locations with extended daylight hours. We present the first known observations of diurnal activity of *Rhinolophus lepidus* in forest on Tioman Island, Malaysia recorded using visual surveys and acoustic monitoring. The bats were flying during the day and at night, and feeding buzzes detected suggest that they were actively foraging during the day. This appears to be a regular phenomenon on Tioman Island. The absence of resident diurnal avian predators that hunt below the forest canopy may account for the diurnal activity of *R. lepidus* in forests there.

Paper Number: 216
Wednesday, 04 July 2018 | Petra 2

Symposium 20 - Novel techniques and emerging findings in tropical bat ecology and conservation

Home range and space use by the yellow-winged bat (*Lavia frons*) in a tropical desert

Irene Conenna

Movement ecology analysis and the study of how animals use space has attracted much interest. The continuous development of GPS technology is allowing to explore the movement ecology of species that were to-date beyond the minimum size requirements for these tracking devices, allowing to collect data with reduced operator bias. In this study we used a new generation of lightweight GPS technology to study the use of habitat by an insectivorous bat with low mobility, the yellow-winged bat (*Lavia frons*), in a tropical desert in Northern Kenya. Bats were monitored for an average of 5.8 nights over both rainy (April-May 2017, $n=13$) and dry (January-February 2018, $n=11$) season in order to explore effects of water availability and reproduction. Bats expressed high fidelity to roosting site, and field observations revealed the use of alternative roosting trees within the same vegetation clutter. Home ranges were small, with an average ranging from 0.27 ha of the 95% kernel to 0.57 ha of the Minimum Convex Polygon, and showed a seasonal trend, although not significant, with larger home ranges during the dry season. Additionally, home ranges during the rainy season showed a significantly smaller variance, possibility linked with territorial behaviour associated with reproduction and the need to increase foraging effort during the dry season due to lower insect abundance. Given the short range of movements displayed and the absence of superficial water sources during the dry season, our results suggest that yellow-winged bats are likely independent of open water sources.

Paper Number: 823

Wednesday, 04 July 2018 | Petra 2

Symposium 20 - Novel techniques and emerging findings in tropical bat ecology and conservation

Optimising acoustic survey protocols for bat research in species-rich tropical forests

Adrià López-Baucells, Ricardo Rocha, Paulo E. D. Bobrowiec, Jorge Palmeirim, Christoph F. J. Meyer

Owing to major recent technological advances, bioacoustics has become a burgeoning field in ecological research and conservation science worldwide. Autonomous passive acoustic recorders are becoming widely used to monitor bats and automatic classifiers have emerged to aid researchers in the daunting task of analysing the resulting massive acoustic datasets. However, the lack of reference calls and the elevated equipment costs still hamper their application in highly diverse tropical assemblages. Furthermore, choosing the proper sampling protocol is often a challenging question for researchers due to time-cost commitment constraints. Capitalizing on a unique acoustic dataset of more than 650,000 bat call sequences collected over a 3-year period in the Amazon we (a) assessed how pre-identified bat recordings could be used to train automatic classifiers, b) evaluated the combination of automatic classification with visual post-validation, and c) optimised field sampling protocols (with manual and automatic detectors) under different recording schemes (time-windows at hour, replica, year and season basis).

Amongst all tested algorithms, random forest had the greatest predictive power. We confirmed the reliability of using free-flying bats calls to train a custom-built automatic classifier. To achieve a general classification accuracy of ~85%, it had to be trained with at least 500 pulses per species. Adopting a desired accuracy probability threshold of 95% for the classifier, the percentage of recordings required for manual post-validation could be reduced by up to 75%. For short-term projects, the most efficient method was using hand-held detectors across transects, while for long-term studies, it was better with autonomous static detectors. If lowering cost- effort became a necessity, we recommend, in terms of priority, reducing the replicas, the sampling hours per night, the years of surveys and finally the seasons. The minimum time-window to record a decent amount of bat species includes the first four hours after sunset. However, depending on the homogeneity of the landscape, the required sampling effort greatly varies.

Combining automatic classification with manual ID through fully customizable classifiers help to overcome the acknowledged risks associated with the sole reliance on automatic classification, and highly optimized sampling protocols improve the economic viability of several projects when funding is limited, especially for diverse tropical bat assemblages.

Paper Number: 831

Wednesday, 04 July 2018 | Petra 2

Symposium 20 - Novel techniques and emerging findings in tropical bat ecology and conservation

SYMPOSIUM 21

Seeding resilient forest landscape restoration and its contribution to sustainable development goals

Developing protocols for locating seed trees by drone

Stephen Elliott^{1*} & Krishna Bahadur Rai²

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Demand for native forest tree seed is surging, to supply the vast quantities of planting stock needed to achieve ambitious global reforestation targets. Current seed-collection methods are time-consuming, labor-intensive and inefficient, relying on collectors using binoculars to search for seed trees, along forest paths, where both visibility and coverage are limited. Such uncertain and arduous work encourages seed collection from the few trees that are nearest home base and from the same trees each year. This narrows the genetic base of the planting stock thus reducing resilience of restored forests. Locating target seed tree species from above, has been attempted with satellite images and aerial photos, using gross crown morphology or expensive hyperspectral imagery and lidar. As drones with high-resolution digital cameras, have become more affordable, the development of finer, cost-effective tree-crown identification systems have become possible. Consequently, we are using an off-the-shelf drone (DJI Phantom 4 Pro), an automated flight planner (Litchi) and open-source, image-processing software (ImageJ) to develop keys to tree crown species based on i) crown morphology, (shape, texture etc.) from flights above 100 m, ii) leaf characteristics (shape, arrangement etc.) and iii) image filtering (hue, saturation, brightest). Initial results indicate that leaf type, shape and arrangement can be distinguished easily at lower altitudes (30-50 m) and are distinctive for some species. Although flying drones, at such low altitudes over tall forest, increases the risk of collision, the proximity sensors of the Phantom 4 Pro have so far proved effective at preventing mishaps. Whilst image filtering can clearly distinguish some individual species within the forest canopy, its reliability is highly variable among species and over time. A species that is highly distinctive when flushing new leaves, for example, becomes indistinguishable from the rest of the canopy just a few weeks later. We, therefore conclude that drones be used to record the GPS co-ordinates of potential seed trees, when the trees are most distinguishable, returning to the located trees at regular intervals thereafter, at lower altitudes, to record fruit set and ripeness. Since drone usage is becoming common in ecological studies, it is suggested that tree identification handbooks should, from now on, include photos of trees crowns from above as well as crown and leaf characteristics that are distinguishable from drone imagery and the filter settings that distinguish species during their most distinctive phenophases.

Paper Number: 461

Wednesday, 04 July 2018 | Taj Mahal

Symposium 21 - Seeding resilient forest landscape restoration and its contribution to sustainable development goals

Private-public partnerships to support conservation and restoration within Malaysia's Central Forest Spine Initiative

Dzaeman Dzulkifli

Working together with state government agencies and local stakeholders, Tropical Rainforest Conservation and Research Centre (TRCRC) has co-developed projects aimed at the rescue of threatened tropical climax species (dipterocarps) and forest-landscape restoration in alignment within the national Central Forest Spine (CFS) initiative in Perak, Terengganu and Kelantan - through spatial-planning and developing effective partnerships to support conservation. After identifying relevant stakeholders in each state, project development involved data gathering through regular stakeholder consultations, land-use mapping, and ground-truthing to identify forest-landscape restoration opportunities. At the end of the processes, conservation management plans were produced for the target states to provide recommendations for seed-collection work (to rescue threatened plant species), the co-development of conservation nurseries, and site-specific restoration opportunities within the CFS-landscapes of target states.

The first output is a statewide plan to rescue threatened plant species from forest fragments (especially at high risk of conversion), which will be germinated and grown conservation nurseries, and then planted in living collections or future restoration projects. The second output is the identification and of restoration opportunities within key landscapes identified in the CFS Master Plan to improve forest connectivity and prevent further degradation. The output highlights key areas that require action, and a recommendation framework to address degradation issues.

The three states vary in terms of commitments towards restoration and conservation commitments towards CFS, and various case studies will be presented to showcase significant lessons. In Perak, most of the opportunities were identified within forest reserves in Hulu Perak – with existing commitments from various stakeholders to improve forest connectivity and support better conservation. In Terengganu, the amount of degraded areas were relatively low – but the CFS plan would benefit from better forest monitoring and improving connectivity through modified landscapes (e.g. plantations). In Kelantan, where forest loss is at the recorded highest, efforts towards improving connectivity was limited to an isolated site, while opportunities for landscape wide intervention are yet to be developed.

Paper Number: 892

Wednesday, 04 July 2018 | Taj Mahal

Symposium 21 - Seeding resilient forest landscape restoration and its contribution to sustainable development goals

Diversity for restoration: Scaling up to fail or deliver sustainable development

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² Diversity for restoration: Scaling up to fail or deliver sustainable development.

Degraded lands across the tropics are urgently in need of restoration. Restoring these degraded lands offers opportunities to conserve soil, improve water quality and availability, mitigate climate change and support biodiversity conservation. Consequently, countries around the world have pledged to bring 350 million hectares of degraded land under forest landscape restoration (FLR) by 2030, under the Bonn Challenge. It is estimated this restoration will accrue approximately USD 84 billion per year in net benefits. There is also rapidly growing interest from the finance investment and private sector, which sees potentially viable sustainable investment opportunities through FLR. The need to speed up and scale up FLR across the tropic faces a significant challenge – to provide the diversity of seeds and planting material in sufficient volume and quality to deliver on sustainable development goals (SDGs). I will present a summary of recent results from my research group highlighting why we cannot rely on natural seed dispersal and regeneration if we want diverse and resilient restoration outcomes. I will also present a novel decision support tool (Diversity4Restoration) to help restoration practitioners to make informed decisions on how to select and source the most appropriate planting material for their restoration projects. Finally, using an example of a currently developing project in Sarawak, I will discuss the importance of linking income generation and livelihood of local communities to sustainable use of forest genetic resources to scale up seed systems and explore how community nursery projects and novel technologies can support SDGs and resilient restoration.

Paper Number: 830

Wednesday, 04 July 2018 | Taj Mahal

Symposium 21 - Seeding resilient forest landscape restoration and its contribution to sustainable development goals

Capacity-building to promote coal mine site rehabilitation in Kalimantan (Indonesian Borneo)

Arbainsyah I

Although it has received relatively little attention compared to other industries, coal mining is a major driver of environmental degradation in Kalimantan. Millions of hectares of land have been granted as mining concessions leading to wide-scale deforestation and the loss of biodiversity and ecosystem services. Although Indonesian government regulations require mine companies to progressively rehabilitate mined areas as a way to mitigate the industry's social and environmental impacts, the results to date have remained largely inadequate. In some cases, mining companies—particularly small-scale mines approved at the district level—simply abandon formerly mined land due to lax government monitoring and enforcement. In many other cases, mining companies try to fulfill their regulatory responsibilities, but have very limited technical knowledge about how to achieve successful mine site rehabilitation. This situation is exacerbated by the fact that government staff at the local level, who are responsible for providing technical guidance and/or evaluating the quality of the rehabilitation efforts, often have less expertise than the companies themselves. To begin addressing this problem, Yale University's Environmental Leadership & Training Initiative (ELTI) and Tropenbos Indonesia (TBI) have been working very closely with the Indonesian Ministry of Environment & Forestry (MOEF) to implement a training program for mine company staff and relevant government representatives. MOEF's Research & Development Institute for Natural Resources Conservation Technology (BALITEK-KSDA) in Samboja has been particularly supportive of this training initiative by conducting mine rehabilitation-related research, developing publications to support the training program, and establishing a series of demonstration sites at the PT Singlurus Pratama mine site near Balikpapan. MOEF's Center for Education & Training (PUSDIKLAT) and the related regional training center in Samarinda have also started collaborating on training programs. To date, a total of six trainings have been held since 2012. This presentation will provide a more detailed overview of the opportunities and challenges to building local capacity in mine site rehabilitation, as well as discuss some of the rehabilitation approaches being used. It will also spell out some ideas for moving forward, including the development of an online training program, the involvement of other PUSDIKLAT-related regional training centers in addressing the rehabilitation of other forms of mining, and the establishment of a professional competency standard for mine site rehabilitation.

Paper Number: 300

Wednesday, 04 July 2018 | Taj Mahal

Symposium 21 - Seeding resilient forest landscape restoration and its contribution to sustainable development goals

Gender Matters in Forest Landscape Restoration: A Framework for Design and Evaluation

Bimbika Sijapati Basnett, Marlène Elias, Markus Ihalainen, Ana Maria Paez-Valencia

Forest Landscape Restoration (FLR) is commonly understood as “a planned process that aims to regain ecological integrity and enhance wellbeing in deforested and degraded landscapes” (Dudley et al. 2005). Unlocking the potential of FLR to achieve both social and environmental outcomes rests critically on the support, contributions and cooperation of a wide range of stakeholders at all levels. Studies have shown that encouraging and incentivizing women’s and men’s participation can enhance the effectiveness and sustainability of forest management. Equitable participation in restoration initiatives — in terms of decision making and influence, and the distribution of (labor) costs and benefits — generates broader local buy-in and enhanced capacities, thereby improving prospects for human and socioeconomic development and positive environmental outcomes. Yet, despite potential synergies between restoration and gender equality outcomes, gender remains poorly addressed in restoration research and practice. In this presentation, we propose a framework and set of recommendations for enhancing gender equality and women’s rights in and through FLR initiatives. The essence of gender-responsive FLR is ensuring that there are safeguards to protect women and men’s rights over land and other resources, that women and men can participate at all levels have equal voice and influence in strategic decisions related to FLR, and that this contributes to substantive equality in outcomes (costs and benefits) for women and men. Key considerations for gender-responsive FLR draw on lessons from the wider gender and natural resource management literature, ongoing and past restoration, and relevant initiatives to alter local land uses for global conservation and development goals.

Paper Number: 978

Wednesday, 04 July 2018 | Taj Mahal

Symposium 21 - Seeding resilient forest landscape restoration and its contribution to sustainable development goals

Community mapping, forest restoration and sustainable development

Sophie Schwer

Policy makers and forestry practitioners now broadly recognize the need to restore degraded tropical forests and landscapes for environmental and societal benefits. Yet, two crucial resources for successful restoration are rapidly dwindling: genetically diverse seed sources for native tree species, and the traditional ecological knowledge about these sources and the species that is held by forest-dwelling communities.

Community mapping is a useful tool for communities to document their knowledge along with the distribution of native tree species on their land. Furthermore, the maps prove their connection to their ancestral lands and can support their often contested land claims.

However, the forest and the traditional knowledge are being threatened by deforestation and resulting loss of traditional livelihoods. Development of sustainable forest-based income opportunities can support self-directed development and choices for maintaining aspects of traditional ways of life.

After carefully mapping their territories, the Penan of the Selungo are now experimenting with community-based approaches for tree seed sourcing to improve their livelihoods and foster the conservation of the remaining primary rainforest.

Paper Number: 977

Wednesday, 04 July 2018 | Taj Mahal

Symposium 21 - Seeding resilient forest landscape restoration and its contribution to sustainable development goals

GENERAL SESSION 17.2

Forest Ecology & Conservation

Is regeneration in tropical Afromontane forests declining? An assessment of seed rain and seedling composition and diversity in a Nigerian Montane forest

Iveren Abiem, Ian Dickie and Hazel M. Chapman

Afromontane forests are among the most threatened ecosystems in world because of intense anthropogenic pressure including agriculture, cattle grazing and hunting which has led to a significant decline in the frugivore population. There is therefore a need to understand how these forests might respond in terms of forest regeneration. In this study, we estimated the species composition of seed, recruiting seedlings and established seedling, and compared this to the species composition of large, adult trees in Ngel-Nyaki Forest of Mambilla Plateau, Nigeria.

Using a long-term forest census plot at the study area, we inventoried seed rain for one year from 106 seed traps; recruited seedlings from 318 seedling plots measured on three sides of each seed trap and established seedlings from 8112 seedling plots distributed throughout the plot. Seedling plots measured 1 m² and all seedlings with a diameter at breast height (DBH) <1 cm were recorded. We related the composition and abundance of seeds to recruited seedlings and the abundance of established seedlings to adult abundance.

We recorded a total of 3600 undamaged seeds representing 31 species in 49 weeks, 1515 recruited seedling representing 51 species and 11,918 established seedlings representing 84 species. Seeds and seedlings comprised of tree, shrub and liana species. Of the 107-species previously recorded from the census of trees with DBH ≥ 1 cm, 28 were represented in the seed census, 39 in the recruited seedling census and 65 in the established seedling census. The other species recorded from the seed rain and seedling samples were mostly lianas. Diversity indices were lower for the regenerating layer. Number of recruit seedlings and established seedlings significantly increased with higher seed input and adult abundance respectively.

Our study explains that seed input and seedling composition in the forest are subgroups of the adults in the forest and species abundance in the regenerating layer is a function of adult abundance. The low species diversity in the seedling layer suggests dispersal and/or recruitment limitation. Overall, our study suggests a decline in species composition and diversity in the regeneration layer of the forest, we recommend studies to investigate factors and /or mechanisms that shape species distributions in this Afromontane forest.

Paper Number: 260
Wednesday, 04 July 2018 | Giza
General Session 17.2 - Forest Ecology & Conservation

Shift in community level traits across forest types in tropical Ghana, result of climate changes, phenology changes or both?

Jesús Aguirre Gutiérrez^{1,2}, Imma Oliveras¹, Sami Rifai¹, Shopie Fausset³, Simon L. Lewis³, Ted R. Feldpausch³, Michael D. Swaine³ and Yadvinder Malhi¹

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Introduction:

Tropical rain forests contain the highest biodiversity around the world and carry out irreplaceable ecosystem functions as water acquisition and CO₂ assimilation. These forests are experiencing high levels of degradation given deforestation and climate change impacts. One way to halt this has been the creation of protected areas. However, protected areas cannot safe wards biodiversity from climate change effects and species rely on their traits to face this challenge. Most research about trait distribution patterns and responses to climate changes has been limited by lack of relevant trait and past vegetation census data across forest types.

Objectives:

Here we investigate if community level traits are changing given changes in environmental conditions across different forest types.

Methods:

We make use of 16 vegetation census 1 ha plots from Ghana ranging from wet to semi-dry forest. We calculated community weighted trait mean values across two time periods (~1980 and ~2010) and analyzed their changes as a function of their climatic water deficit.

Results:

We show how community level trait distributions of leaf and wood economics spectrum and hydraulics across a latitudinal environmental gradient have responded to the near past changes in climatic conditions based on census data between 1980 and the present. We show that community level traits have shifted during last decades and that not all forest types, given their climatic water deficit, responded in the same way to changes in the environment. We show that drier forests are becoming more deciduous, that these changes directly impact the distribution of other traits and that wetter forests do not present a strong response to such changes in climatic conditions.

Main conclusion:

Forests across Ghana have changed and this may have direct implications for their functioning and services provision. In particular we show that drier forests changes to more deciduous species are driving changes in other community level mean trait conditions, deciduousness increase being a stronger predictor of such changes than the climatic water deficit. In the other hand, wetter forests are shown to be more resilient to such changes on average showing no significant community level mean trait shifts. Our results render insights into the way how different forests types may respond to changes in climatic conditions and may be useful when investigating future impacts of climatic changes on forest ecosystems.

Paper Number: 82

Wednesday, 04 July 2018 | Giza

General Session 17.2 - Forest Ecology & Conservation

Ecology and conservation of *Entandrophragma excelsum*, Africa's tallest tree species on Kilimanjaro

Andreas Hemp

While world records of tree heights were set by American, Australian and Asian tree species, Africa seemed to play no role here. We measured biomass and height and monitored growth rates of trees using laser dendro-relascopes and high resolution dendrometry on 65 plots on Kilimanjaro. On our submontane forest plots in a remote valley we discovered giant trees of the species *Entandrophragma excelsum* (Meliaceae) with over 80 tons of woody biomass and over 80 m, which have to be included in the list of the world's superlative trees. Estimating tree age from growth rates in combination with C14 dating of tree cores indicates that the tallest individuals may reach more than 850 years of age. A unique combination of anatomical peculiarities and favorable site conditions might explain their enormous size. The late date of this discovery of Africa's tallest trees may be due to the comparably low study efforts at Kilimanjaro compared with other biodiversity hotspots. Since only a few square kilometers of this habitat of *Entandrophragma* are left, Kilimanjaro (and Africa) is about to lose not only a unique biogeographical archive with highly diverse vegetation, but also its tallest trees. The inclusion of these valleys into the immediately neighboring Kilimanjaro National Park would be an excellent and urgent possibility of protection.

Paper Number: 166

Wednesday, 04 July 2018 | Giza

General Session 17.2 - Forest Ecology & Conservation

Use of the spectral reflectance to study the diversity and ecological processes of plant tropical communities

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Tropical forests are being increasingly affected by human activities worldwide. Therefore, it is urgent to develop rapid techniques to study their diversity and community assembly. Hyperspectral techniques have been used in tropical forest to characterize plant functional traits as well as different vegetation types. However, hyperspectral data could also be useful to infer ecological processes and the different dimensions of plant diversity. The main goal of this study was to the use of hyperspectral data in the study of the diversity (i.e. relationships among spectral, specific, phylogenetic and functional diversity) and community assembly of tropical vegetation. First, we analyzed the leaf-level spectral reflectance and functional traits of 3732 woody individuals of 279 species, in a tropical forest of western Mexico. These individuals were distributed in eight 50*20 m plots representing conserved and disturbed forests. Second, we built a phylogenetic tree with the species encountered. Third, we evaluated, at the plot level, the relationships among the different dimensions of diversity through generalized linear models, in which the spectral diversity was the response variable while the specific, functional and phylogenetic diversity were the explicative variables. Finally, we analyzed the distribution of the values correspondent to functional and spectral data, to detect the occurrence of niche processes in the assembly of our communities (plots). We found that the spectral diversity was significantly explained by the functional and phylogenetic diversity in several assemblages. We also found that the distribution of spectral values resembled the distribution of certain functional trait values (i.e. specific leaf area, relative chlorophyll content). Moreover, we found a more constrained distribution of functional and spectral data in disturbed forests than in conserved forests, which suggests that the community assembly of secondary forests is being modulated by environmental filters. In general, these findings indicate that spectral diversity is related to other dimensions of diversity and could potentially be used as a proxy of functional and phylogenetic diversity in tropical plant communities. The spectral data could also be useful to detect the occurrence of niche processes affecting the distribution of functional trait values in these communities. This study constitutes a scientific basis to apply the hyperspectral remote sensing in the study of ecological processes in tropical forests at the landscape level. The knowledge produced would allow us to know how the diversity and ecological processes of these endangered ecosystems are affected by the anthropogenic disturbance.

Paper Number: 323
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General Session 17.2 - Forest Ecology & Conservation

Tropical forests are hyper-diverse because of enemies

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Tropical forests can contain over 1000 sympatric tree species, posing a major challenge to ecological theory. Early attempts to explain tropical diversity were rooted in the idea of niche assembly based on functional differences between species. However, models based on niche diversification and minimum similarity have failed to explain observed levels of diversity. Hubbell's neutral theory of biodiversity offered an alternative based on the assumption that individuals of all species have the same probabilities of birth and death independent of species identity. Each species undergoes a random walk, either to extinction or monodominance, which is counteracted by dispersal from a metacommunity, but the mechanism giving rise to a diverse metacommunity is not clear. A third approach is offered by the Janzen-Connell (J-C) mechanism, in which host-specific natural enemies restrict the recruitment of juveniles near conspecific adults. J-C is strongly supported empirically, and recent work has demonstrated that global plant diversity is associated with increased conspecific negative density dependence in local tree neighborhoods, but existing theory predicts that Janzen-Connell negative density dependence is unlikely to allow the coexistence of more than a few species. Here we use high-performance computing and analytical models to demonstrate that distance-responsive natural enemies lead to dramatically reduced extinction rates, so that observed levels of tropical forest diversity can be maintained nearly indefinitely in a prolonged state of transient dynamics. Diversity maintenance does not require dispersal from a metacommunity, speciation, or niche partitioning, only a small zone around conspecific adults in which saplings fail to recruit. Further, we show that Janzen-Connell effects lead to community regulation of diversity by imposing a diversity-dependent cost to commonness and benefit to rarity. We conclude that the empirically supported Janzen-Connell mechanism explains the maintenance of diverse tropical tree communities.

Paper Number: 36
Wednesday, 04 July 2018 | Giza
General Session 17.2 - Forest Ecology & Conservation

GENERAL SESSION 26

Impacts of Logging on Tropical Forests

Trade-offs between carbon stocks and timber recovery in tropical forests are mediated by logging intensity

Anand Roopsind

Forest degradation accounts for ~ 70% of total carbon losses from tropical forests. Substantial emissions are from selective logging, a land-use activity that decreases forest carbon density. To maintain carbon values in selectively logged forests, climate change mitigation policies and government agencies promote the adoption of reduced-impact logging (RIL) practices. However, whether RIL will maintain both carbon and timber values in managed tropical forests over time remains uncertain. In this study, we quantify the recovery of timber stocks and aboveground carbon at an experimental site where forests were subjected to different intensities of RIL (4 trees ha⁻¹, 8 trees ha⁻¹, and 16 trees ha⁻¹). Our census data spans 20 years post-logging and 17 years after the liberation of future crop trees from competition in a tropical forest on the Guiana Shield, a globally important forest carbon reservoir. We model recovery of timber and carbon with a breakpoint regression that allowed us to capture elevated tree mortality immediately after logging. Recovery rates of timber and carbon were governed by the presence of residual trees (i.e., trees that persisted through the first harvest). The liberation treatment stimulated faster recovery of timber albeit at a carbon cost. Model results suggest a threshold logging intensity beyond which forests managed for timber and carbon derive few benefits from RIL, with recruitment and residual growth not sufficient to offset losses. Inclusion of the breakpoint at which carbon and timber gains outpaced post-logging mortality led to high predictive accuracy, including out-of-sample R^2 values >90%, and enabled inference on demographic changes post-logging. Our modeling framework is broadly applicable to studies that aim to quantify impacts of logging on forest recovery. Overall, we demonstrate that initial mortality drives variation in recovery rates, that the second harvest depends on old growth wood, and that timber intensification lowers carbon stock

Paper Number: 252

Wednesday, 04 July 2018 | Machu Pichu

General Session 26 -Impacts of Logging on Tropical Forests

How does restoring logged tropical forests affect biodiversity?

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Selective logging is the most prevalent land-use change in the tropics. Despite the resulting degradation of forest structure, selectively logged forests harbour much biodiversity leading to suggestions that their protection is the next best alternative to conserving primary, old-growth forests. Restoring carbon stocks under Reducing Emissions from Deforestation and Forest Degradation (REDD+) schemes is a potential method for obtaining funding to protect logged forests, via enrichment planting and liberation cutting of climbing vines and bamboo. A key question is how such restoration affects biodiversity? Here, we investigate the impacts of restoring logged forests in Borneo on avian phylogenetic diversity—the evolutionary history shared across all species within a community—and on functional diversity—the patterns of functional trait distribution in communities. Combined, these metrics have important implications for the protection of evolutionarily unique species and the provision of many ecosystem services. Avifaunal communities were studied using point count and mist-netting surveys in Danum Valley, Malaysian Borneo. Restoration caused a significant loss in phylogenetic diversity leaving a bird community of less total evolutionary history and more closely related species compared to unlogged forests. The avian community also experienced a significant loss of functional strategies and species with more specialized traits in restored forests compared to unlogged forests, which led to functional clustering in the community and fewer niches occupied in the understorey bird community compared to unlogged forests. Our study suggests that while there are additional benefits of restoration for forest regeneration, carbon sequestration, future timber harvests, and potentially reduced threat of forest conversion, this must be weighed against the apparent loss of avian phylogenetic and functional diversity, making the biodiversity-friendliness of carbon sequestration schemes questionable under future REDD+ agreements. To reduce perverse biodiversity outcomes, it is important to focus restoration only on the most degraded areas or at reduced intensity where breaks between regimes are incorporated.

Paper Number: 81

Wednesday, 04 July 2018 | Machu Pichu

General Session 26 -Impacts of Logging on Tropical Forests

The effect of selective logging and topography on canopy tree stoichiometry

Tom Swinfield

Selective logging is pervasive across the lowland tropics, affecting millions of hectares of forest, yet its influences on nutrient cycling remain poorly understood. One hypothesis is that selective logging has a strong influence on phosphorus cycling, because this already scarce nutrient is removed in extracted timber and eroded soil, leading to shifts in ecosystem functioning and community composition. However, testing this hypothesis is challenging given strong underlying variation in nutrient cycling associated with fine-scale variation in geology, topography and climate. Here we use airborne LiDAR-guided hyperspectral imagery to map foliar nutrient concentrations over 400 km² of northeastern Borneo, including a disturbance gradient spanning from old-growth to repeatedly logged forests. The maps reveal that leaf phosphorus and nitrogen concentrations decrease with elevation, consistent with nutrient availability measurements based on chemical analyses. Specific leaf area also decreased with elevation, consistent with physiological adaptation to low resource availability. After controlling for topography, foliar nutrient concentrations were found to be elevated in heavily logged forest when compared to old-growth areas, reflecting a shift in composition to pioneer species with acquisitive traits. However, lightly logged forests were indistinguishable from old-growth forests, suggesting that forest recovery is not limited by phosphorus availability. This analysis represents the first landscape scale assessment of how functional leaf traits change in response to anthropogenic disturbance and highlights the ability of logged forests to recover old-growth functioning rapidly after disturbance.

Paper Number: 706

Wednesday, 04 July 2018 | Machu Pichu

General Session 26 -Impacts of Logging on Tropical Forests

Using airborne LiDAR to map the structural impacts of logging and land use change on forest canopies across a gradient of degradation in Sabah, Malaysian Borneo

David Milodowski

Many of Borneo's tropical forests are under intense pressure from degradation and fragmentation as a result of logging and conversion to alternative land uses, in particular relating to the expansion of oil palm plantations. Quantifying the impact of this degradation on canopy structure is essential for understanding how these pressures impact on a host of fundamental ecosystem functions, yet characterising the effects of degradation, in particular, on forests remains challenging. We use high resolution airborne Light Detection And Ranging (LiDAR) data to constrain spatial variations in the vertical distribution of vegetation within forest canopies across the SAFE landscape fragmentation experiment in Sabah, Malaysian Borneo. This landscape has been subject to a gradient of degradation intensity, encompassing near-pristine old-growth forests that tower over 70 m in height, heavily disturbed forest fragments that have been subject to multiple rounds of logging, and oil palm plantations. We demonstrate that degradation is associated with major changes in canopy structure. Plant Area Index (PAI, a close proxy for LAI) declines from ~8-9 in old growth forests to ~3-4 in heavily logged forest fragments, following a linear relationship with stand basal area. These trends are driven by the long-lived and near-complete removal of the upper canopy layers from the vertical canopy profiles of logged forests, associated with the removal of large trees during selective logging rounds. In contrast, we observe expansion of vegetation density in the understory, as regenerating trees exploit the increase in light availability beneath the fragmented canopy. The contrasts in canopy structure are even starker in areas that have been cleared for conversion to oil palm plantations. Our results demonstrate the utility of LiDAR for mapping the structural effects of degradation and deforestation in structurally complex tropical forests, and highlight the structural impact of these processes on Borneo's unique forests, with clear implications for forest biogeochemical cycles, habitat provision and microclimate in affected areas.

Paper Number: 880

Wednesday, 04 July 2018 | Machu Pichu

General Session 26 -Impacts of Logging on Tropical Forests

Why are large trees vulnerable to drought, and can management help? The interactive roles of tree size, crown exposure, and logging in drought-induced tree mortality

Alexander Shenkin

Large trees in the tropics are reportedly more vulnerable to droughts than their smaller neighbors. This pattern is of interest due to what it portends for forest structure, timber production, carbon sequestration, and multiple other values given that droughts are expected to increase in frequency and intensity as climate change progresses. What is unclear, however, is what it is about large trees that renders them vulnerable to drought-induced mortality, and how this vulnerability changes with forest degradation. Using a large-scale, long-term silvicultural experiment in a transitional Amazonian forest in Bolivia, we disentangle the effects of stem diameter, tree height, crown exposure, and logging-induced degradation on trees' risks of drought-induced mortality. In unlogged plots, tree height is positively associated with drought risk whereas neither stem diameter nor crown exposure affect drought-induced mortality. In logged plots, large stem diameter buffered trees against drought. Overall, while tree mortality in response to drought increased in both logged and unlogged plots, logging reduced drought-induced mortality of large remnant trees. Our results suggest that while tall trees in undisturbed tropical forests may experience especially elevated mortality rates during droughts, tree size may be less of a burden and perhaps even a buffer if forests are either selectively logged or degrade as a result of climate change-induced droughts. Thinning might be considered as a short-term intervention to buffer large tropical trees against drought, especially where droughts are predicted to increase most strongly.

Paper Number: 737

Wednesday, 04 July 2018 | Machu Pichu

General Session 26 -Impacts of Logging on Tropical Forests

Pan-tropical comparisons of selective logging emissions and potential emission reductions from reduced-impact logging

Francis Putz

Selective logging accounts for at least half of the emissions from anthropogenic forest degradation. Climate-effective reduced-impact logging (RIL-C), is proposed as a way to maintain timber production while reducing damage to the forest, thereby mitigating carbon emissions and contributing to international climate change commitments. Here we analyse patterns across coordinated field-based surveys of logging impacts in sixty-one forest management units of seven countries to calculate baseline carbon emissions from tropical selective logging throughout diverse geographies. We analyze differences in logging impacts by source (skidding, felling, and hauling), harvest intensity, geography, and environmental and social contexts. We further estimate the potential leakage-free mitigation from application of RIL-C practices at regional and pan-tropical scales. Results indicate that RIL-C could reduce logging impacts by up to 50% and deliver a majority of many tropical countries' contributions to the Paris Climate Agreement.

Paper Number: 395

Wednesday, 04 July 2018 | Machu Pichu

General Session 26 -Impacts of Logging on Tropical Forests

SYMPOSIUM 22

Plant-soil-microbial interactions in the tropics

Fungal community structure along a tropical ultramafic altitudinal transect in Malaysia

Francis Brearley

Soil fungi are key regulators of many ecosystem processes and whilst our understanding of the role of factors influencing soil micro-organisms is improving, we have little data from the tropics where the diversity of soil fungi is high. This study aimed to examine the role of ultramafic soil chemistry (having naturally high in metals such as Mg and Ni) and elevation on influencing soil fungi. Using Illumina HiSeq next generation sequencing of 20 surface soil samples from Mount Tambuyukon in Malaysia from 800 m altitude to the summit at 2579 m, we ascertained determinants of fungal community structure and diversity. We generated over 2 million DNA sequences per sample and found nearly 10000 unique OTUs, 280 of which were ectomycorrhizal fungi. There appeared to be a mid-elevation peak in fungal diversity corresponding with the cloud forest ecotone; this ecotone also influenced the fungal community structure as assessed via an NMDS ordination. Among ectomycorrhizal fungi, we noted the decline of certain genera (e.g. *Russula*) with elevation or with increasing concentrations of soil metals. Of particular interest was the positive correlation between the abundance of *Cortinarius* and soil Cr, Fe and Ni concurring with the high abundance of this genus in other tropical ultramafic localities such as New Caledonia. This study shows how multiple factors can interact to determine the structure of tropical fungal communities on ultramafic soils and how microbial communities are influenced by altitudinal variation in climatic factors.

Paper Number: 832

Wednesday, 04 July 2018 | Chichen Itza

Symposium 22 - Plant-soil-microbial interactions in the tropics

Plant-soil feedbacks and the dominance of conifers in a tropical montane forest in Borneo

Masayuki Ushio & Kanehiro Kitayama

Introduction:

Feedbacks between plants, soils and microbes influence a wide range of ecosystem processes such as community dynamic and nutrient cycling in a forest ecosystem. However, whether and how such feedbacks influence community dynamics in tropical forest ecosystems have just begun to be understood.

Objectives:

Our objectives were to investigate consequences of plant-soil feedbacks (PSFs) in a tropical montane forest on Mt. Kinabalu in Borneo by measurements of light and soil conditions, ecophysiological analyses of tree seedlings, a long-term adult and seedling census and a simple simulation model. Specifically, we investigated whether and how PSFs contribute to the dominance of conifer tree species in the tropical montane forest.

Methods, Results and Discussion:

The study plot (2.74 ha) is in a mixed conifer-broadleaf forest and the relative basal area of conifers (Podocarpaceae) is ca. 24%. First, we investigated soil conditions beneath two dominant species, a conifer *Dacrydium gracilis* (Podocarpaceae) and a broadleaf *Lithocarpus clementianus* (Fagaceae). The concentrations of inorganic nitrogen and labile phosphorus, and the nitrogen mineralization rates were lower beneath the conifer species than beneath the broadleaf species, suggesting that soils beneath the conifer were more nutrient-limited. In addition, molecular analyses of root-associated mycorrhizal fungal communities and stable isotopic evidence supported the hypothesis that *Dacrydium* seedlings are more efficient in inorganic nitrogen acquisition than *Lithocarpus* seedlings. These results predicted that the conifer seedlings would out-compete broadleaf seedlings and have a greater advantage beneath the conifer canopy. To test the possible advantage of conifer seedlings in growth and survival, we estimated growth and mortality rates using the seedling census data during 2006 – 2012. We found that conifer seedlings performed better than broadleaf seedlings beneath *Dacrydium* canopy. On the other hand, broadleaf seedlings better performed than conifer seedlings beneath *Lithocarpus* canopy. The consequences of the PSFs for the tree community composition were investigated by developing a simple simulation model, and were compared with the results of a model without PSFs. After a 10,000-year simulation, the relative abundance of conifers with PSFs converged to 22%, which was consistent with the actual abundance; the model without effects of PSFs predicted a relative abundance of only ca. 10%.

Conclusions:

The results suggested that soil mineralization processes, saprotrophic microbes, root-fungal associations, tree functional traits and their interactions can be important determinants of PSFs, which consequently contribute to the maintenance of the conifer dominance in the tropical montane forest.

Paper Number: 99

Wednesday, 04 July 2018 | Chichen Itza

Symposium 22 - Plant-soil-microbial interactions in the tropics

Fungal and bacterial assembly across soil types and horizons at Lambir Hills, Malaysia

Krista McGuire

In diverse tropical forests, soil edaphic variation has been posited as a major factor structuring tropical tree communities. However, the extent to which soil microbes track these patterns or contribute to tree edaphic specialization is not fully understood. Here, we examine fungal and bacterial composition across a soil edaphic gradient in Borneo (Lambir Hills), which is one of the most diverse lowland tropical forests ever documented. The soils in this region are divided into two major formations (shale-derived vs. sandstone-derived) and six minor divisions. Numerous tree species display edaphic specialization across these soil divisions, but few studies to date have examined microbial communities. We aimed to address the following questions: 1) How are bacterial and fungal communities structured across a soil edaphic gradient? and 2) How are soil microbial communities structured vertically within and among soil types? We collected soil cores from four of the minor soil divisions and separated them into four sampling depths: litter (forest floor), 0-2cm, 2-10cm, and 10-20cm. Fungi and bacteria were then sequenced using the Illumina MiSeq platform. Both fungal and bacterial communities were significantly clustered across soil types ($P < 0.01$), but were also strongly structured across sampling depths ($P < 0.001$). Within the bacterial communities, Proteobacteria were more abundant on the sandstone-derived soils and in the upper soil horizons, while Actinobacteria, Verrucomicrobia, and Firmicutes were more abundant on the shale-derived soils. Ectomycorrhizal fungi, which associate with the dominant Dipterocarpaceae trees in this region, were also compositionally distinct in each soil type and showed increasing abundance with soil depth, with nearly 50% of the detected taxa occurring in the deepest sampling depth (10-20 cm). ECM fungal abundance was also negatively correlated with total soil nutrients and individual genera responded differently to soil N and P, indicating that resource specialization may contribute to the observed patterns of community clustering across soils and horizons. Together, these results indicate that soil microbial communities are structured across soil edaphic gradients both horizontally and vertically, but that there is a continuum of soil specialist and generalist taxa, as has been observed for trees in this system. The mechanisms related to plant-microbial feedbacks remain to be identified, but likely play a significant role in structuring these communities.

Paper Number: 878

Wednesday, 04 July 2018 | Chichen Itza

Symposium 22 - Plant-soil-microbial interactions in the tropics

Stoichiometric niche shift at a biogeographic juncture: a comprehension of the Sulawesi edaphic mosaic

Liam Trethowan

Southeast Asian species distribution patterns have been a source of conjecture for decades. Attempts have been made to delineate biogeographic regions based upon the distribution of taxa and latterly with the integration of phylogenetic data. Consideration from an abiotic perspective is infrequent. Sulawesi, often apportioned to both Asian or Australian biota, is emblematic of the discrepancy in biogeographical conclusions. We present data across ten 0.25 ha permanent forest plots spanning the edaphic mosaic in Sulawesi. We examine this system within the context of ecological stoichiometry. Specifically, we reveal edaphic effects upon tree communities in regard to the position of individuals within multivariate stoichiometric space i.e. their stoichiometric niche. The soil driven stoichiometric shift is irrespective of phylogenetic dissimilarity between plots. The observed lineage turnover is determined by spatial distance which may prove proxy for the impact of Sulawesi's remarkable and recent ontogeny. Four plots within our series are on heavy metal rich, phytonutrient poor ultramafic soil. Ultramafic geology outcrops to such an extent throughout the Southeast Asian archipelago that lineages that traverse the region will likely face exposure to the physiological challenge posed by these soils. We identify intra-island, ultramafic, stoichiometric impact, which posits questions regarding the macroecological influence of these soils across the Southeast Asian archipelago.

Paper Number: 69

Wednesday, 04 July 2018 | Chichen Itza

Symposium 22 - Plant-soil-microbial interactions in the tropics

Influence of soil characteristics on a Bornean heath forest (kerangas) structure, species composition and growth

Giacomo Sellan

Tropical heath forests have a characteristic physiognomy and sustain a high number of endemic species. Nevertheless the ecological forces causing the peculiar species assemblage and low productivity of these stands is still under debate, with the most accredited being low soil nitrogen and/or highly acidic soil pH.

Here we tested whether and how soil characteristics and topography influenced tree species distribution and growth in a Bornean tropical heath forest.

To this aim, we have been performing a 2 year lime (CaCO_3 ; c. 5500 kg ha yr⁻¹) and N (50 kg ha yr⁻¹ as urea) addition experiment in 16 small forest plots in the Kabil-Sepilok Forest Reserve (KSFR) heath forest (Sabah, Malaysia). Prior to the treatments, we tested the relationship among α -, β - diversity, stem density and basal area as well as species distribution with soil nutrients and topography. Species distribution in the KSFR heath forest is mainly driven by soil available Al and soil depth, nonetheless trees 5-10 cm DBH appear to be distributed according to total P and CEC too. Basal area and stem density generally increase with total and available P as well, especially for trees 5-10 cm DBH. Alpha diversity was greater in high total and available P plots, whereas Beta diversity was linked to soil H/Al ratio and soil depth (although both alpha and beta diversity depended, to some degree, on tree DBH).

After the first year of lime and N addition we observed an increased relative growth only in the N treatment plots, in particular for trees 2-10cm DBH.

Species distribution in our heath forest seems to be driven by the combined effect of soil acidity (in the form of available Al) and soil depth; phosphorus turned out to be important for forest structure (basal area and stem density). On the other side, the nutrient addition experiment showed a fast response of tree growth to nitrogen addition instead of increased pH. Our results therefore indicate that there is an interplay between various edaphic factors influencing different aspects of forest tree distributions, structure and growth in this Bornean heath forest.

Paper Number: 92

Wednesday, 04 July 2018 | Chichen Itza

Symposium 22 - Plant-soil-microbial interactions in the tropics

Assembly and consequences of root-fungal associations across a soil fertility gradient in a Bornean rainforest.

R. Max Segnitz, Sabrina Russo, Kabir Peay

Ecology increasingly recognizes critical impacts of microbial communities on plant growth and plant community dynamics. This is of particular interest in the tropics, where plant richness peaks and plays an outsize role in shaping global diversity patterns; yet microbial diversity in the tropics remains understudied. While molecular tools have greatly expanded the ability to characterize patterns of microbial diversity, a majority of studies thus far remain observational, making it difficult to resolve questions about biological and edaphic controls on microbial community assembly. As these microscopic communities may constitute inputs on macro species composition and turnover, they are critical to understanding how tropical forests may change in response to myriad anthropogenic pressures.

Working in Sarawak, Malaysia, we used a bioassay experiment to assess the role that soil type (geological origin), soil fertility, and plant phylogenetic neighborhood effects play in structuring root-associated fungal communities of eight tree species in a mixed Dipterocarp forest. We grew ectomycorrhizal and arbuscular mycorrhizal seedlings for 1.5 years in field-collected soils from two parent geological formations and collected from beneath a variety of adult tree species. Using next-generation sequencing of fungal ITS via the Illumina Myseq platform, we characterized root associated fungi following a destructive harvest of experiment seedlings.

We found a dominant role of geological soil origin in structuring root fungal composition, suggesting that edaphic properties may exert stronger controls on assembly of root fungal communities than do local plant-available soil nutrients. Consistent with previous work in this system, we found weak effects of host species on root fungal communities, reflecting a lack of strong host-specificity and a stronger influence of neighborhood effects on fungi. The independent assortment of plants and fungal partners across this soil ecotone reflects the need for a better understanding of how plant interactions with fungal mutualists and antagonists inform plant distributions within this system.

Paper Number: 672

Wednesday, 04 July 2018 | Chichen Itza

Symposium 22 - Plant-soil-microbial interactions in the tropics

GENERAL SESSION 27.1

Miscellaneous Conservation

Seasonal waterholes support globally threatened species in the Deciduous Dipterocarp Forests of the Eastern Plains Landscape of Cambodia

Chanratana Pin

Deciduous dipterocarp forests (DDFs) throughout Asia provide crucial habitat for several globally-threatened species. DDFs are also highly seasonal habitats experiencing 5-6 months of drought per year. During the dry season, the landscape's water availability in these forests is primarily limited to perennial rivers and seasonal waterholes. These water sources form an essential part of these dry forests and are used by a variety of wildlife, including large mammals and large-bodied birds. During the dry season between December 2015-June 2016, I conducted a camera-trap study to investigate utilization of seasonal waterholes by six globally threatened dry forest specialists: Banteng *Bos javanicus* (Endangered), Eld's deer *Rucervus eldii* (Endangered), Giant ibis *Thaumatibis gigantea* (Critically Endangered), Green peafowl *Pavo muticus* (Endangered), Lesser adjutant *Leptoptilos javanicus* (Vulnerable) and Asian Woolly-necked stork *Ciconia episcopus* (Vulnerable). I camera trapped at 54 waterholes across the core zone of Srepok Wildlife Sanctuary in the Eastern Plains Landscape of Cambodia. I collected nine environmental and anthropogenic factors including waterhole and landscape characteristics, and indicators of human disturbance. Camera traps recorded over 29 species including 15 critically endangered, endangered and vulnerable species. The results suggested that waterhole depth and maximum area were the main environmental factors influencing waterhole use. Additionally, waterholes further from villages were more likely to be used than those nearer. Our study reaffirmed the importance of seasonal waterholes in supporting globally threatened species, especially large grazers which are critical for maintaining these dry forest ecosystems. We suggested that artificially enlarging and deepening of selected seasonal waterholes, particularly those further from human disturbance, could enhance available habitat for a range of species, especially large grazers. However, this would need to be conducted in coordination with law enforcement and patrolling activities to ensure waterholes are not targets for illegal hunting which continues to be a problem in the region.

Paper Number: 280

Wednesday, 04 July 2018 | Eiffel 1

General Session 27.1 - Miscellaneous Conservation

Creating Wildlife-Friendly Water Retention Systems in Dry Forest Ecosystems

Joanne Li & Hil Padilla

Kadoorie Conservation China, Kadoorie Farm and Botanic Garden, Hong Kong, China

Water availability highly affects the carrying capacity for many species in dry forest ecosystems. The rapid conversion of forests to croplands and pastures in biodiverse dry ecosystems further worsen the situation for wildlife as it reduces water availability. Water retention systems can provide crucial water sources and habitats for those remaining endangered species. Most often, they are constructed without a holistic view, limiting their conservation potentials. Kadoorie Conservation China had helped create waterholes in a nature reserve for the globally threatened Eld's Deer (*Rucervus eldii*) in Hainan, China and reservoirs totaling over 70 hectares in an Economic Land Concession (ELC), in Kratie Province, Cambodia. Both sites have pronounced wet and dry seasons and relatively low annual precipitation. In the Hainan reserve, the annual rainfall is 1,000mm (2 months wet, 10 months dry) and 1,700mm (6 months wet, 6 months dry) in the ELC. Lessons learned in site selections, designs, construction methods and water-proofing techniques while considering the needs of wildlife are shared in these case studies.

In the Eld's Deer reserve we helped create 8 waterholes and wallowing ponds. Gently sloping edges were shaped to create habitats with different water depths. We waterproofed them by shaking muddy water with a machine digger and one was lined with thin ferro-cement. Despite high evapotranspiration rate, all are able to provide additional seasonal water sources for 2-4 months after the rains. Three were able to retain water year-round and 2 of which had no concrete at all. Sites with larger watersheds and being a natural drainage proved to be critical considerations. Camera traps and Eld's Deer footprints show the frequency of usage of the waterholes. The proximity of the waterholes also allow the deer to minimize their energy budget to obtain water. Male deer are provided with more wallows which are essential for their reproduction. In the ELC, instead of the damming the river to irrigate the 3,500 hectares of plantation crops using solar pumps, the farm followed our recommendations to create 4 multi-function reservoirs in different locations instead of one huge centralized artificial lake. No concrete was used except for the sluice gate valve. The 2 reservoirs already created, 70 hectares in total, have attracted waterbirds while meeting irrigation needs. The lessons learned could serve to inspire farms and conservationists on the feasibility of harvesting the manna from heaven in properly designed water retention system even in dry forest ecosystems.

Paper Number: 274

Wednesday, 04 July 2018 | Eiffel 1

General Session 27.1 - Miscellaneous Conservation

Free-ranging livestock in forests encroach the habitat of threatened wildlife

Binbin Li

Livestock grazing has become a serious problem in the forest ecosystem, causing forest degradation, competition, human-wildlife conflicts and other conservation issues. China has implemented forest policies and expanded protected areas to halt deforestation and protect giant panda habitats. These policies simultaneously encouraged local communities to raise livestock that then freely range in forests. This grazing had unintended consequences. As an alternative livelihood, it has become the most prevalent human disturbance across the panda's range. How do free-ranging livestock impact giant panda habitats and what are the implications for future conservation and policy on a larger scale? We use Wanglang National Nature Reserve as a case study. It has seen a nine-fold livestock increase during past 15 years. We combined bamboo survey plots, GPS collar tracking, long-term monitoring, and species distribution modelling incorporating species interaction to understand the impacts across spatial and temporal scales. Our results showed that livestock, especially horses, lead to a significant reduction of bamboo biomass and regeneration. The most intensively used areas by livestock are in the valleys, which are also the areas that pandas prefer. Adding livestock presence to predictive models of the giant panda's distribution yielded a higher accuracy and suggested livestock reduce panda habitat by 34%. Pandas were driven out of the areas intensively used by livestock. We recommend the nature reserve carefully implement a livestock ban and prioritise removing horses because they cause the greater harm. To give up livestock, local communities prefer long-term subsidies or jobs to a one-time payment. Thus, we recommend the government provide payments for ecosystem services that create jobs in forest stewardship or tourism while reducing the number of domestic animals.

Paper Number: 62

Wednesday, 04 July 2018 | Eiffel 1

General Session 27.1 - Miscellaneous Conservation

Sustaining rainforest bird communities in a deforested and heterogeneous landscape

Guohualing Huang

Rainforest fragmentation is an important consequence of human caused habitat loss. When mature rainforest is cleared and converted for agriculture and grazing, many species that depend on old-growth habitat declines or disappear. Some may persist even in small habitat fragments, and benefit from habitat restoration. While the effects of forest fragmentation have been widely studied, the responses of species to the full range of fragmentation intensity and habitat recovery have rarely been quantified. We assessed the effects of both rainforest fragmentation and regeneration on bird communities in the Big Scrub region, of subtropical Australia, where 99% of rainforest was cleared for agriculture in the 1800s, of which about 25% has regenerated into camphor laurel regrowth forest since the mid-1990s. In each of 42 sites, we conducted quantitative observational bird surveys. These sites were spread across about 75,000 km² and represented seven stages of habitat conversion: 1) continuous rainforest (150 ha), 2) small fragments (5-21 ha), 3) very small fragments (1-3 ha), 4) regrowth forest patches (2-20 ha), 5) isolated native *Ficus* trees, 6) isolated camphor laurel trees, and 7) pasture (each with 6 sites). Of 93 bird species recorded, 62 occurred at >3 sites. Converting mature rainforest to pasture was associated with reduced abundance of all birds and of many individual species, with lower richness, and altered species composition; while a small number of species were most abundant in pasture. Habitat fragments had generally similar abundance, richness, and species composition to mature forest, although 1-3 ha fragments tended to show most divergence. However, isolated trees were more similar to pasture, whether they were native *Ficus* or the non-native invasive camphor laurel. The camphor regrowth patches had recovered a bird community that was most similar to that of the smallest fragments. Only one species (a large fruit pigeon) was restricted to continuous forest, and most species in pasture and isolated trees were insectivores or seedeaters. We concluded that maximizing the total rainforest habitat area in the landscape (including fragments and regenerating forest) will be critical to conserving most species in the region's bird community.

Paper Number: 814

Wednesday, 04 July 2018 | Eiffel 1

General Session 27.1 - Miscellaneous Conservation

Conservation benefits of tropical multifunctional land-uses in and around a forest protected area of Bangladesh

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Competing interests in land for agriculture and commodity production in tropical human-dominated landscapes make forests and biodiversity conservation particularly challenging. Establishment of protected areas in this regard is not functioning as expected due to exclusive ecological focus and poor recognition of local people's traditional forest use and dependence. In recent years, multifunctional land-use systems such as agroforestry have widely been promoted as an efficient land-use in such circumstances, although their conservation effectiveness remains poorly investigated. We undertake a rapid biodiversity survey to understand the conservation value of four contrasting forms of local land-use, namely: betel leaf (*Piper betle*) agroforestry; lemon (*Citrus limon*) agroforestry; pineapple (*Ananas comosus*) agroforestry; and, shifting cultivation-fallow managed largely by the indigenous communities in and around a highly diverse forest protected area of Bangladesh. We measure the alpha and beta diversity of plants, birds, and mammals in these multifunctional land-uses, as well as in the old-growth secondary forest in the area. Our study finds local land-use critical in conserving biodiversity in the area, with comparable biodiversity benefits as those of the old-growth secondary forest. In Bangladesh, where population pressure and rural people's dependence on forests are common, multifunctional land-uses in areas of high conservation priority could potentially be used to bridge the gap between conservation and commodity production, ensuring that the ecological integrity of such landscapes will be altered as little as possible.

Paper Number: 963

Wednesday, 04 July 2018 | Eiffel 1

General Session 27.1 - Miscellaneous Conservation

AKECOP: Partnership between ASEAN and Korea towards a sustainable tropical forest ecosystem management

Ho Sang Kang

The main goal of the ASEAN-Korea Environmental Cooperation Project (AKECOP) is to enhance the capacity of ASEAN Member States (AMS) in managing their degraded terrestrial and mangrove forest ecosystems in a sustainable manner and to conserve biodiversity. This has been achieved through collaborative research partnership, capacity building, and scientific and technical information exchange. AKECOP has organized and implemented a range of regional researches, graduate courses, short-term training courses, training workshops and conferences for local researchers in the AMS. The training programs have focused on sharing of technology and information among AMS as well as between AMS and Korea. The programs have enhanced the capacity of researchers and institutions in managing AMS's degraded terrestrial and mangrove forest ecosystems. Some programs such as agroforestry practice have focused on sustainable income and food security in collaboration between the trained local researchers and local community. Based upon the successful experience of AKECOP, further projects for improving livelihood of local people in Asian countries are expected to be developed. The project will continue utilizing various forms of training activities in order to enhance human resource developments and will adopt strategies such as: 1) Cross-sectorial, multi-disciplinary and holistic approach on key issues of sustainable forest management; and 2) Enhancement of national capacity in AMS by dealing with existing and emerging issues on sustainable tropical forest ecosystem management.

Paper Number: 900

Wednesday, 04 July 2018 | Eiffel 1

General Session 27.1 - Miscellaneous Conservation

Strict protected areas are crucial for the conservation of threatened and larger mammal species in the Brazilian Cerrado

Guilherme Braga Ferreira, Marcell Soares Pinheiro, Marcelo Rabelo Oliveira, Fernando Ferreira de Pinho, Tim Newbold, Chris Carbone, Marcus Rowcliffe and Ben Collen

Although protected area (PA) cover has sharply increased during the last few decades, it remains unclear to which extent PAs deliver positive benefits to biodiversity. Most PAs performance evaluations conducted so far have focused on remote sensing data to estimate conversion of natural vegetation, with only a few assessments focusing on local biodiversity. However, because biodiversity loss can still happen without a significant change in vegetation cover, reliable measures of conservation outcomes based on local biodiversity metrics are crucial to assess PA effectiveness and performance. To this end we surveyed the large mammal community in areas with contrasting levels of protection in the Brazilian Cerrado to investigate the effect of stricter forms of habitat protection on local biodiversity. We collected species-level detection/non-detection data in 517 camera trap sites covering approximately 1,100 km² distributed across nine survey areas in northern Minas Gerais state. We used occupancy modelling to estimate species occupancy in strict (IUCN categories II and IV) and multiple-use PAs (IUCN category V), while accounting for the following variables that may influence both PA location and mammal occupancy: distance from roads, towns and rivers, as well as broad ecosystem type. Camera trap model and the location of camera trap in relation to trails were used as detection variables. We built 128 models for 16 species considering all possible additive combination of variables and ranked them according to AIC. We found occupancy to be significantly higher in strict PAs than in multiple-use PAs for six species (37.5%), whereas none of the species investigated had significantly higher occupancy in multiple-use PAs. Species with greater occupancy in strict PAs tend to be threatened and/or large, as they included three of the four globally threatened species recorded and five of the six largest species investigated. This is one of the few systematic attempts to investigate the effect of PAs on local biodiversity in Brazil and agrees with another assessment showing that strict PAs are more effective in avoiding Cerrado conversion than category V PAs. Our findings give further support to the call for expanding strict PA coverage in the Cerrado (currently at only 3%), particularly if we are to safeguard more sensitive species. Furthermore, they highlight the relevance of strict PAs for biodiversity conservation in Brazil and should be used as an argument against the ongoing events of PA downgrading, downsizing and degazettement happening in the country.

Paper Number: 402

Wednesday, 04 July 2018 | Eiffel 1

General Session 27.1 - Miscellaneous Conservation

SYMPOSIUM 18.2

Making Science Matter - from conservation research to implementation

How Just and Just How? Incorporating Social Equity Considerations into Conservation Research and Decision-Making

Rachel Friedman, Elizabeth Law, Nathan Bennett, Christopher D. Ives, Jessica Thorn, Kerrie A. Wilson

Background

Conservation decisions not only impact wildlife, habitat, and environmental health, but also human wellbeing and social justice. Environmental decisions have been fraught with ethical implications, often dealing with issues of the common good, timescales that involve intergenerational interests, and values of non-human entities. As such, the inclusion of safeguards and equity considerations in the field of conservation has increasingly garnered attention in international policy processes and among conservation practitioners. Yet, what constitutes an “equitable” solution can take many forms - depending on the people involved, their values, the context of the system, and the underlying study motivations. At present, this plurality of social equity remains insufficiently captured in conservation.

Methods

This presentation is based on a systematic review, which identified and analysed studies examining social equity in relation to conservation actions, to understand how the concept of equity is developed and applied within conservation research. The authors developed a coding framework through iterative consultation to guide the review process, focusing on the current state of, definitions used for, and methods of assessing social equity in conservation research. Information on the dimensions of equity studies cover (i.e. distribution, participation, recognition, and context), types of variables measured, and the impacts of conservation actions on equity was extracted from each of the 138 studies reviewed.

Results and Implications

The results demonstrate the current limitations of research on social equity in conservation, and raise important questions about the impacts of conservation actions as well as bias in the research itself. While social equity and conservation were often framed as mutually beneficial, little data for environmental outcomes was presented, and most studies suggested mixed or negative impacts on equity from conservation actions. There was also a focus on countries in the Global South, though institutions outside this geography seem to drive the research. Overall, research in this space would benefit from clear definitions of equity within a study, greater transparency of the motivation for considering it, and further assessment of trade-offs between equity dimensions and conservation objectives and beneficiaries. Given the growing impetus to capture and understand the complex realities of conservation in socio-ecological systems, there is a need for the field to engage more deeply with different notions of equity when studying, planning, and implementing conservation actions.

Paper Number: 21

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.2 - Making Science Matter - from conservation research to implementation

Social media as a novel platform for direct and indirect conservation

Akiva Topper

Participation of the general public in data collection is increasingly used for research (“Citizen science”) and for engaging the public in conservation. Social media presents novel opportunities for citizen science and conservation due to its accessibility and global popularity, yet its vast potential in these fields remains largely overlooked. While dedicated online platforms for recording wildlife observations exist, their international scope and predominant use of English are predicted to attract mainly professionals and deter the general public. Our goal is to promote effective leverage of social media for citizen science and conservation through the founding of regional, taxon-targeted, social media platforms, administrated by local experts, and in which users are encouraged to accompany their photographs with observations submitted through dedicated online forms. Such platforms are advantageous due to the focus on local wildlife and use of local languages that increase attractiveness and accessibility respectively, resulting in involvement of the general public and younger audiences alongside professionals. Additional benefits include immediate positive feedback for data sharing, and direct, real-time interaction with experts that can stimulate educational, conservation, and enforcement efforts; and dissemination of accessible scientific knowledge to interested audiences.

As a case study we present data from a Facebook group that focuses on local herpetofauna: following nine months of activity the group comprises 2150 members; 340 observations concerning 71 species were registered (far surpassing observation report rates in other popular international online platforms); five articles about local herpetofauna were published in the native language; ties with local conservation organizations have developed; and many fruitful discussions serving to educate the general public about local herpetofauna and its conservation have taken place.

We believe that our approach can connect numerous audiences to the subject of conservation and thus contribute directly and indirectly to protection of biodiversity.

Paper Number: 960

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.2 - Making Science Matter - from conservation research to implementation

Making Science Matter - from conservation research to implementation: integrating citizen science in income generation and site management at Veun Sai-Siem Pang National Park, Cambodia

Naven Hon¹

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Veun Sai-Siem Pang National Park is comprised of 57, 000 ha of evergreen and semi-green forests. The area is rich in biodiversity, with at least 130 bird, 60 mammal, and 60 reptile species are found. Most are classified as either endangered or critically endangered on the ICUN Red List. However, the area is under threat, with logging, deforestation, poaching and poverty being major concerns. Since 2009, Conservation International has conducted a series of biodiversity and socio-economic surveys. These activities led to the identification of a new gibbon species (*Nomascus annamensis*) and formed the basis for a programme that integrates scientific data with livelihood, biodiversity and law enforcement interventions in a uniquely innovative, self- supporting process. Premised on strengthened community level institutions and landscape level planning, the project uses evidence from socio-economic and ecological research derived from cutting edge technology such as UAVs and sentinel sites, as well as community led engagement practices, to inform programming decisions, product development, and site management. In concert with the Ministry of Environment, the programme has established a benefit sharing mechanism that builds value and ownership into the interventions, creating a set of transparently managed nested institutions. Binding this structure, is an eco-tourism project that integrates citizen science, through tourist led camera trapping and data collection activities, into commercial tour packages that feed income back to both community development funds and the Ministry of Environment for law enforcement. This mutually reinforcing process provides a win-win for the government and communities creating sustainable incentives and resources for conservation. Critically, the project increases scientific understanding amongst locals and tourists, deepens involvement of a range of stakeholders in site management, and has led to a series of capacity development inputs for rangers and communities alike that were previously not possible. As a direct result of these activities, over 20 rangers have been trained in a range of law enforcement techniques that couple technology with traditional field skills; there has been a year on year increase in tourists; and community members have been trained on a range of skills including data collection, service provision, and business development. Finally, several sustainable harvesting groups of non-timber forest products have been established.

Paper Number: 549

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.2 - Making Science Matter - from conservation research to implementation

Bridging the gap of science and policy: a look on community-based forest conservation approach in the Philippines “Last Ecological Frontier”

Rizza Karen Veridiano

In a country where participatory involvement of different stakeholders is the norm, we have come to learn how to translate numbers and data into a language that communities and policy makers alike would understand. Much has been done since the inception of REDD+ in the Philippines as part of a larger framework for its implementation. Case in point is the Victoria-Anepahan REDD+ demonstration site located in Palawan province. This study highlights the importance of ensuring that communities of indigenous peoples (IP) play an integral part in every component of REDD+ implementation. Through a series of training workshops, forest inventory and biodiversity assessments (conducted from 2013-2015), we were able to train and develop capacities of 97 participants (76% of which are IPs), of whom eventually gained a step-wise understanding of various REDD+ concepts as well as an appreciation of the results of biodiversity and carbon assessments. Together with the partner IP communities and as a result of the community-based conservation approach, we're able to estimate that the sub-national REDD+ site currently harbours 11.20 ± 1.37 Mt CO₂eq/yr. This estimate is still the most recent that we have for the country at the sub-national REDD+ scale. The mean biomass estimate (254.99 t/ha) generated from the study conforms to the default values at the national (227.40 t/ha) and sub-national (297.51 t/ha) scales. Yet, the story does not end with them having understood these concepts. Equipped with this new knowledge, local IPs together with policy makers from the provincial government initiated the establishment of a community-managed watershed reserve, ratified through a local ordinance and demarcated on the ground. Such actions and initiatives further demonstrate the indigenous peoples communities' capacity to act upon science-based assessments and translate them into conservation policies that promote better management and conservation of the remaining forests of Palawan, Philippines. Lastly, this approach also provides a concrete example on how participatory conservation approach has the capacity to influence policies and can be a good example for upscaling at the national or even at the regional (Asia-Pacific) level.

Paper Number: 759

Wednesday, 04 July 2018 | Colosseum 1

Symposium 18.2 - Making Science Matter - from conservation research to implementation

GENERAL SESSION 28

Impacts of Land Use Change

Thinking beyond advancing low-carbon pathways to achieving multiple benefits from land-use through REDD+ in developing countries, the Nigeria experience.

Edu Effiom

The overall objective of REDD+ (reducing emission from deforestation and forest degradation, the plus signifies multiple benefits from land use best practices) is to ensure viable sustainable forest management (SFM) practices that enhance the capacity of tropical forest to act as carbon sink and at the same time provide socio economic benefits to humans especially the forest dependent community. This has become urgently needful due to ongoing conflicts between humans and externally established Wildlife conservation institutions over access to and use of forest resources especially in developing nations. It therefore means that climate mitigation via forest land use policy that do not adequately include measures that enhance accessibility to forest resources for the livelihood of rural community is likely not going to be sustainable.

We combined socio-economic and ecological data from government agencies managing land resources and from 4 villages in and around the Cross River National Park in Cross River State, Nigeria to study 1. Rural households livelihood dependence on forest resources and non-forest resources by comparing the consumption pattern of bushmeat and farm animals. 2. Since key drivers of deforestation is a given for developing countries, We ask which indirect driver of deforestation poses the greatest risk to the implementation of REDD+ relevant policies and measures (PAMs) implementation by participatory analyses of these PAMs. We found a significant difference between the consumption of bushmeat and farm animals among the villages. Three out of the four villages studied showed high preference for bushmeat despite the proximity of two of these villages to major roads which gives them access to other options. We also found out that inadequate participation of forest dependent communities in the design and implementation of REDD+ relevant PAMs was the greatest risk compared to institutional/capacity or financial inadequacies.

Our results emphasize the need for a multiple land use design that span advances toward low carbon pathways to advances towards human livelihood sustainability as the panacea to not just climate change mitigation but also poverty alleviation and conflict resolution between the rural communities and the conservation of biodiversity.

Paper Number: 64
Wednesday, 04 July 2018 | Colosseum 2
General Session 28 - Impacts of Land Use Change

Biodiversity loss and carbon emissions from forest conversion to rubber in Asia: can carbon finance help, and what can rubber agroforestry offer?

Eleanor Warren-thomas

Plantations of monocultural rubber are replacing forests in South and Southeast Asia, meeting continued demand for natural rubber used in the manufacture of vehicle and aeroplane tyres. Using data from Cambodia, where thousands of hectares of forest have been cleared to make way for rubber, we asked whether carbon finance schemes that provide payments for forest carbon could offer an attractive economic alternative to forest conversion to rubber. Using extensive forest data, we show that conversion of both open dry forest ecosystems and dense evergreen forest systems to rubber results in net carbon emissions. With an opportunity cost approach, we also found that carbon prices need to be 6 – 10 times greater than those currently being offered through carbon markets or REDD+ negotiations, if they are to offset forgone profits from logging and rubber plantations. Conversion of forest to monocultural rubber also results in biodiversity losses: monocultures are usually intensively managed via the application of pesticide and herbicides, and removal of understorey vegetation, leading to loss of species richness and changes in community composition of plants, birds, beetles and bats. Agroforestry, where a wider diversity of crops are planted within rubber plantations, could offer a more biodiversity-friendly mode of production. In some areas of Asia, low-intensity “jungle rubber” supports a large proportion of forest-dependent species, but yields in these systems are low, increasing the footprint of rubber cultivation and limiting farmer incomes. In Southern Thailand, higher intensity agroforestry systems show promise for supporting farmer livelihoods, by maintaining rubber yields while diversifying income sources. We compared the biodiversity value of high-intensity rubber agroforests with that of monocultures using 64 rubber farms in Thailand, and investigated the importance of both within-farm habitat structure, and landscape composition. We found modest benefits for butterfly richness in agroforests (mean of six species per plot, compared to three species in monocultural plots), and increased bird species richness where understorey plants were allowed to flourish under rubber trees (14.8 bird species where herb height was 98cm, compared to 11.8 species at 37cm). These findings offer a way forward for increasing the biodiversity value of rubber plantations, but also show the fundamental importance of conserving forest, as no forest-dependent species were found in either rubber cultivation system.

Paper Number: 407
Wednesday, 04 July 2018 | Colosseum 2
General Session 28 - Impacts of Land Use Change

Taking the temperature of human-modified tropical forest landscapes from a mile up using airborne laser scanning

Tommaso Jucker, Stephen R. Hardwick, Sabine Both, Dafydd M.O. Elias, Robert M. Ewers, Yadvinder Malhi, David T. Milodowski, Terhi Riutta, Tom Swinfield and David A. Coomes

Introduction

Local-scale microclimatic conditions in forest understoreys play a key role in shaping the composition, diversity and function of these ecosystems. Consequently, understanding what drives variation in forest microclimate is critical to forecasting ecosystem responses to global change, particularly in the tropics where many species already operate close to their thermal limits and rapid land-use intensification is profoundly altering local environments. Yet our ability to characterise forest microclimate at ecologically-meaningful scales remains inherently limited, as tree cover precludes any direct measurement of understorey conditions from beyond the canopy.

Objectives

To address this challenge, we explore the potential of airborne laser scanning (ALS) – a remote sensing technology that allows the 3D structure of ecosystems to be captured in exquisite detail – as a way to indirectly characterise fine-scale variation in microclimate across human-modified tropical forest landscapes.

Methods

We established a network of microclimate sensors across one of the world's largest forest degradation experiments in Borneo that spans from 80-m tall old-growth forests to oil palm plantations. We then used structural equation modelling to combine these observations with high-resolution ALS data to characterise how topography and canopy structure shape variation in microclimate both locally and across the entire landscape.

Results

We found that topography and vegetation structure were strong predictors of local microclimate, with elevation and terrain curvature primarily influencing daily mean temperatures and vapour pressure deficit (VPD), whereas canopy height had a clear dampening effect on microclimate extremes. This buffering effect was particularly pronounced on wind-exposed slopes but tended to saturate in strength once canopy height exceeded 20 m – suggesting that despite intensive logging, secondary forests remain largely thermally buffered. Nonetheless, at a landscape-scale microclimate was highly heterogeneous, with daily maximum temperatures ranging between 24.2–37.2°C and VPD varying more than a hundredfold.

Implication for tropical forest conservation

Based on this, we estimate that 15% of the landscape is currently sub-optimal for forest regeneration, a figure that we project could rise to 34% by 2100 due to regional warming alone. Together, our results emphasise how emerging remote sensing technologies such as ALS can redefine how we model habitat suitability and ecosystem functioning at scales relevant for tropical forest conservation.

Paper Number: 582

Wednesday, 04 July 2018 | Colosseum 2

General Session 28 - Impacts of Land Use Change

Land-use change interacts with climate to determine elevational species redistribution

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Background: Climate change is driving global species redistribution across latitude, elevation, and depth with profound social and economic impacts. However, small-scale species movement along elevational gradients could be largely constrained by local habitat availability and connectivity, of which the interaction effects with climate remain largely unknown. **Methods:** Here we examine published data on 2798 elevational range shifts from 43 study sites to assess the confounding effect of land-use change on climate-driven species redistribution. Making use of high-resolution forest and climate datasets, we performed our analyses at both site and species levels through ordinary least-square (OLS) regressions and linear mixed effect models (LMMs). **Results:** We show that baseline forest cover and recent forest cover change are critical predictors in determining the magnitude of elevational range shifts. Forest loss positively interacts with baseline temperature conditions at the site level, such that forest loss in warmer regions tends to accelerate species' upslope movement. **Conclusion:** Consequently, not only climate but also habitat loss stressors and, importantly, their synergistic effects matter in forecasting species elevational redistribution. Conservation planning and management should therefore consider such interactions especially in the tropics, where both warm temperature conditions and contemporary deforestation will increase the risk of net lowland biotic attrition.

Paper Number: 381

Wednesday, 04 July 2018 | Colosseum 2

General Session 28 - Impacts of Land Use Change

SYMPOSIUM 19.2

Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

Tool use by elephants - “implication for HEC mitigation” in Udawalawe National Park Sri Lanka

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Human Elephant Conflict (HEC) is the primary threat to the survival of Asian elephants. Electric fences are the most widely used HEC mitigation measure used around the world. However Asian elephants are increasingly challenging HEC mitigation measures with their insightful behavioural adaptations. We report the first evidence of the use of trees as tools in breaking electric fences, by free ranging Asian elephants. The study was conducted at the Udawalawe National Park Sri Lanka. The data was collected opportunistically during 50 field days from January 2016 to November 2017. A total of a 3 km stretch of the park electric fence was monitored. Night vision camera traps and indirect signs (mainly elephant foot prints) were used to confirm that the damages were caused by elephants. Information including tree species, diameter and length of the toppled trees, and success of the attempt were recorded. Perpendicular distance between the fence and toppled trees were measured and their characteristics compared with standing trees closest to the electric fence. A total of 27 attempts of fence breaking were recorded of which 85% were by using trees and 15% by using branches. Teak trees (*Tectona grandis*) were primarily used (52%) in fence breaking. Out of the 23 occasions of tree usage, the toppled trees fell on the fence on 82% of occasions breaking the fence. There was a positive correlation between tree length and distance to fence. Out of the 150 standing trees, 69% were not tall enough to break the fence if toppled. Therefore the 95 % confidence interval for the success percentage of avoiding the shorter trees was 60% - 76%. Our results show that the elephants selected suitable trees as tools in breaking the electric fence.

Paper Number: 440

Wednesday, 04 July 2018 | Petra 1

Symposium 19.2 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

Translocating “Problem” Elephants – What can we learn from their movement behaviour?

John McEvoy, Smithsonian Conservation Biology Institute, USA

Introduction

The natural landscapes of Southeast and South Asia are undergoing unprecedented transformation driven by expanding human populations and rapidly developing economies. Anthropogenic disturbance has a major effect on the movement, habitat use and ultimately the survival of many species. Asian elephants live in the most densely human-populated areas on earth. Yet, in comparison to their more populous African cousins, we know little about how they move through these landscapes and how they survive in such rapidly changing ecosystems. Satellite tracking has become an important tool in monitoring these effects and better understanding elephant movements. Translocation of persistent ‘problem’ elephants that engage in repeated crop-raiding or other conflict behaviours is a common practice in many elephant range countries.

Methods

This study utilizes data from GPS tracked translocated elephants drawn from long term tracking studies in different countries including Sri Lanka, Myanmar. Home ranges were analyzed using recently developed auto-correlated kernel density estimates providing statistics such as home range crossing time and confidence estimates for estimated home range that allow for comparison across studies. Using behavioural change point analysis we determine how long it takes a translocated elephant to establish normal home-ranging behavior similar to elephants that have never been forcibly moved.

Results

We reveal a range of behavioural responses to this mitigation strategy. Our findings suggest that before translocation is undertaken as mitigation strategy for human-elephant conflict, it should be considered carefully in the context of elephant movement behavior and social dynamics.

Paper Number: 574

Wednesday, 04 July 2018 | Petra 1

Symposium 19.2 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

Expanding the Scope of Conservation: Response to Asian Elephants in Large, Private Landholdings

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In light of the pervasive influence of anthropogenic pressures on wildlife habitat, effective conservation of wide-ranging large mammals necessarily needs to consider lands outside protected areas (PAs) to meet space and resource requirements for target species. The use of lands outside PAs by large mammals can however elicit negative responses from people, and even lead to human–wildlife conflict. Thus, conservation in such lands necessitates a participatory model of engagement that facilitates human–wildlife coexistence. Central to such a goal is the need to understand risks and challenges associated with the presence of large mammals in private lands, as perceived by people resident on such lands. We take the example of the endangered Asian elephant, a species that often has competing and conflicting resources needs with people, to ask the question: what are the perceptions of people towards the occasional presence of elephants in their backyard? Our study site was in Assam, Northeast India where tea estates present a large, private landholding that has the potential to play a subsidiary conservation role in meeting the habitat and movement needs of the Asian elephant. We interviewed 2289 people from 18 tea estates in the Kaziranga–Karbi Anglong landscape of Assam, including 1242 male and 1047 female respondents from both estate management and on-ground staff. People were largely positive in their response to elephants, although they overwhelmingly considered conflict with elephants as a major challenge that they needed help with managing. On closer inspection, we found that 96% of respondents were happy with elephant presence in the tea estates provided human safety concerns are addressed. We show how this is a challenge that can be readily overcome, thus enabling tea estates to play a vital conservation role in supporting the habitat needs of the Asian elephant. Our findings, by way of an example, highlight great opportunity to expand the scope of conservation to large, private landholdings—a critical conservation need for wide-ranging large mammal species that are striving to find space and resources in an increasingly fragmented and human-dominated world.

Paper Number: 916

Wednesday, 04 July 2018 | Petra 1

Symposium 19.2 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

Finding joint solutions for Human-Elephant Conflict in an intensifying plantation landscape in Sabah, Malaysian Borneo

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Landuse plans in Asian elephant range often fail to factor in the large land area elephants need to survive, and therefore result in obstructions to their free movement and access to habitat. In addition to habitat loss for elephants, such situations lead to crop damages, risks to elephant and human life and other forms of human-elephant conflict (HEC). In a forested landscape being developed for tree and oil palm plantation in Kalabakan in southeastern Sabah, Malaysian Borneo, the Borneo elephants are being exposed to such a situation.

As the plantations are being developed, HEC reduction methods are also established to protect crops and livelihoods. These methods include constructing electric fences, forming crop protection units and translocating problematic elephants. Often, the effectiveness of these methods do not adequately consider the habitats and movement requirements of elephants. Knowledge on elephant movements across different landuse types and cooperation of all land owners and managers are essential for integrating both these objectives - HEC reduction and elephant persistence.

A strategy was developed by WWF over the past five years to reduce HEC by developing joint solutions with stakeholders. This includes two components: 1) forming a working group comprising representatives of plantation companies that are experiencing HEC, forest concession holders, the state forest and wildlife departments and 2) identifying elephant habitat needs by studying their movements using satellite-collars. Six groups of elephants were fitted with satellite-collars and their movements have been studied over the past four years.

The working group has now become functional and begun to identify site-specific management options for HEC. These include re-alignment of electric fences and joint electric fencing options between neighboring plantations as well as setting aside parts of the land in plantations to enable movement of elephants. In June 2017, as part of a joint solution of the working group, the neighboring plantations of Sabah Softwoods Berhad and Golden Borneo Palm Sdn. Bhd. agreed to install joint electric fences. This move enabled both companies to reduce the operational costs of maintaining the electric fences while ensuring the movement of elephants were not hampered.

These cooperative efforts are expected to help reduce the frequency of HEC and increase the long-term survival of elephants in this landscape. This strategy of including evidence-based identification of solutions, collective decision-making and cooperative implementation among land managers, presents a new model of conservation practice for HEC reduction in Asian elephant landscapes.

Paper Number: 338

Wednesday, 04 July 2018 | Petra 1

Symposium 19.2 - Moving towards coexistence – reconciling Asian elephant's behaviour and humans' social dimension

SYMPOSIUM 23

Bat ecology and conservation: A pantropical perspective

Scanning the underworld –the global distribution and conservation of cave-dwelling bats

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More than 30% (or approximately 356 species) of global bats are dependent or occur on caves for different life-history processes with a large proportion are endemic and restricted to this ecosystem. Bats are considered as cave “keystone species” for their crucial role in delivering organic material and energy. Thus, protecting cave-dwelling-bats provides a holistic indicator of the whole cave ecosystem. Understanding of diversity patterns and their conservation status requires a concrete baseline, which is central to establish appropriate priorities for regional and global biological conservation targets. In this study, we attempt to address this gap to inform and develop strategic ideas to effectively protect bats and cave ecosystems. Here, we built a database based on the literature and public records with currently 4000± multiple datasets from over 1500 cave records from all over the globe. The majority of cave sites were reported from Southeastern Europe (n=313, 10%), where there is a strong consortium of European nations (e.g., Eurobats) towards bats and their habitats particularly caves. This is followed by South America (n=265), China (n=250), and Southeast Asia (n=213), the regions with highest known endemism patterns observed from due to recent increase on explorations and elucidation of cryptic and complexes in the region. In addition to intrusive industries such as tourism and mining, large and hyper-abundant caves species (e.g., frugivorous *Rousettus* spp.) are largely hunted for bushmeat across the paleotropics. White-nose syndrome poses a large threat to many temperate species in North America, no similar pandemics are recorded elsewhere. These threats may have reflected non-existence or real implementation of cave protection policies in the past or in the present in many regions. It is undeniable that caves are important ecosystems and are vulnerable to many forms of disturbance. Therefore, it is imperative that conservation priorities should be properly aligned and equally allocated to prevent future losses and to certainly maintain these ecosystems and its provisions.

Paper Number: 702

Wednesday, 04 July 2018 | Petra 2

Symposium 23 - Bat ecology and conservation: A pantropical perspective

Effects of agricultural activities on bat community in Madre de Dios, Peru

Farah Carrasco - Rueda

We examined how two different agricultural landuse practices affect bat species occurrence, abundance, assemblages and functional diversity in different habitats (forest edge, forest interior, and agricultural land) in a human-modified landscape in Madre de Dios, Peru. For this, we selected two agricultural land uses, cattle pastures and papaya plantations, in a forest-dominated landscape in Peru. We sampled bat assemblages at 12 sites (six per land use). We examined differences in richness and abundance for phyllostomid bats and aerial insectivores in varied habitats using mist-nets and acoustic surveys and analyzed similarity in assemblage composition. For phyllostomid bats, habitats in papaya plantations sites show higher species richness and capture rate when compared to habitats in cattle pasture sites. Gleaning insectivores trophic guild was lost in cattle pasture. We found habitats influence bat species composition. Forest and edges habitats showed similar assemblage composition independently from the agricultural land present in the site. Bat composition tends to differ between cattle pasture and papaya plantation. Results show how agricultural practices can impact bat diversity in adjacent forest and edges, and thus inform management decisions to target desired ecological services.

Paper Number: 514

Wednesday, 04 July 2018 | Petra 2

Symposium 23 - Bat ecology and conservation: A pantropical perspective

How Rainforest Transformation to Rubber and Oil Palm affects Chiropteran Diversity at Multiple Dimensions: Insights from Sumatra, Indonesia and Palawan, Philippines

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Drastic land-use transformations have occurred in the tropical forests of Southeast Asia, being logged and converted to rubber and oil palm plantations driven by strong global demand. While the overall impacts of these changes in land use on biodiversity are negative, relatively little research on this subject has been carried out particularly its impact on the different dimensions of bat diversity. We assessed the impacts of lowland rainforest transformation to rubber and oil palm on the taxonomic, functional and phylogenetic diversity of bats in Sumatra, Indonesia and Palawan, Philippines, regions known as hotspots for biodiversity but have already undergone extensive land transformation. Bat surveys were carried out across different transformation systems with lowland rainforests as reference sites, rubber agroforest and intensive rubber and oil palm plantations. Taxonomic diversity was quantified by species richness, evenness, dominance, and effective number of species. Morphological and ecological traits were used to estimate functional diversity and a chiropteran supertree was used as the basis for estimating phylogenetic diversity. Species diversity was highest in forest sites and significantly decreased towards rubber and oil palm plantations. Conversion to rubber and oil palm monoculture led to a marked reduction in functional diversity and a decline in phylogenetic diversity. Our study suggests that land transformation to rubber and oil palm plantation have a negative impact on bat diversity. Furthermore, agroforestry systems showed a much greater conservation potential in conserving bat diversity yet, protection of the remaining forest fragments is still critical for the conservation of intact bat assemblages in agricultural landscapes.

Paper Number: 688

Wednesday, 04 July 2018 | Petra 2

Symposium 23 - Bat ecology and conservation: A pantropical perspective

SYMPOSIUM 24

Tropical plant-pathogen interactions in a changing world

Fungal pathogens and insect herbivores mediate seedling dynamics and diversity patterns along a tropical forest humidity gradient.

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One persistent explanation for plant species coexistence in tropical forests, the Janzen-Connell mechanism, postulates that density-dependent mortality mediated by natural plant enemies, such as fungal pathogens and insect herbivores, puts locally rare plant species at an advantage, preventing any one species from dominating. Evidence from vegetation plots suggests that this form of density-dependence plays a key role in the maintenance of plant diversity in the tropics.

Still, most theories explaining species coexistence emphasize on local processes, while one of the clearest and best-documented patterns in plant diversity is the strong correlation between diversity and humidity at regional to global scales. While differential plant drought sensitivity is an important determinant of changes in plant species composition along humidity gradients, alternative mechanisms are needed to explain positive diversity-humidity correlations.

To investigate how Janzen-Connell effects vary with humidity, we monitored seed arrival and seedling recruitment for 18 months at eight forest sites spanning a steep natural precipitation gradient across the Isthmus of Panama (1756 – 3203mm). In each of the 1ha forest plots, seeds were collected from fifty 1m² seed traps every fortnight, and seventy-five 1m² seedling plots that were treated with either a fungicide, an insecticide or used as a control (sprayed with equal amounts of water). All seeds and seedlings were identified by experts to the lowest taxonomical level, and seedling dynamics were monitored using four consecutive seedling censuses, every six months.

Results show that seedling recruitment was negatively density-dependent in control plots and that the strength of the negative density dependent effect increased along the precipitation gradient. This density-dependence was greatly reduced in the pesticide-treated plots. The insecticide treatment also largely eliminated the increase in diversity observed in control plots when comparing seedlings to seeds. The positive effects of insect herbivory on plant diversity increased significantly with rainfall.

Our results suggest a mechanistic explanation for the well-documented positive relationships between humidity and (i) the strength of negative density dependence and (ii) overall tropical forest plant diversity, where fungal pathogens, and especially insect herbivores operate as important mediators.

Paper Number: 827

Wednesday, 04 July 2018 | Taj Mahal

Symposium 24 - Tropical plant-pathogen interactions in a changing world

Understanding endophyte diversity using metagenomics: initial findings from a neotropical rainforest canopy

Julian Donald

Endophytes, organisms inhabiting plant tissues, are ubiquitous, abundant and diverse in tropical rainforests. Certain endophytes have been shown to influence plant defences against abiotic stress, herbivores and pathogens, likely through the production of secondary metabolites, whilst others are thought to be pathogens themselves. It is not well understood how communities of endophytes inhabiting plant tissues are assembled, in spite of their likely role in determining host tree fitness.

To understand how fungal endophyte communities are structured in rainforest canopies, 430 leaves from the upper crown of 45 trees were sampled using the Canopy Operating Permanent Access System (COPAS) at the Nouragues Field Station in French Guiana. Leaves were sterilized and dried before being transported to EDB, Toulouse, where they were processed using a NucleoSpin Plant II Kit. Metabarcoding of fungal endophytes was used to determine the diversity of canopy leaf communities, with extracted DNA amplified by PCR with primers specific to the ITS region. Products were sent to Genotoul (INRA, Toulouse) for high-throughput sequencing using the Illumina MiSeq platform. Produced data was computed and quality-filtered before taxa were assigned.

Across all trees, endophytes represented a striking level of abundance and species diversity, with some 65% of defined OTUs (operational taxonomic units) currently absent from databases reflecting high levels of undocumented fungal endophyte diversity. PERMANOVA analysis revealed the significant effect of host tree species in determining endophyte community composition, but also of the sampled tree, branch and leaf. High levels of unaccounted variation also point to potential neutral mechanisms in determining community composition.

These findings demonstrate the high levels of endophyte diversity in tropical canopies, and the relative roles of niche-based and random colonization in structuring communities. In addition, these results demonstrate how metagenomic methods can increase our understanding of microbial diversity in rainforests.

Paper Number: 676

Wednesday, 04 July 2018 | Taj Mahal

Symposium 24 - Tropical plant-pathogen interactions in a changing world

How might altered plant-pathogen interactions reduce plant diversity in disturbed forests?

Robert Bagchi

There is growing consensus that fungal phytopathogens help maintain species diversity of tropical trees, raising questions about how environmental change might alter these interactions and hence affect tree coexistence. Decreasing precipitation and forest fragmentation might erode plant biodiversity by altering disease prevalence and pathogen host-specificity. Analysis of SIR models suggests that increased disease could increase density dependent control of plant populations but also increase apparent competition among plants. Models also suggest that increasing host specificity might facilitate host coexistence, but also destabilize pathogen populations, reducing diversity in the long-term. Drier conditions, projected for many tropical regions due to climate change and forest fragmentation, could disrupt plant-pathogen interactions. Because many pathogens are good dispersers and often have wider environmental tolerances than their hosts, disease incidence could actually increase with climate change and in forest fragments. Slightly increased disease incidence in drier forests in Panama supports this prediction. Host specificity is likely to decline in fragmented landscapes, because theoretical and empirical approaches suggest that specialized consumers are disadvantaged in small, isolated habitat patches. By escaping their natural enemies, certain tree species may become dominant in small forest fragments, a prediction that is supported for some tree species in the Western Ghats system. While reduced specificity in forest fragments may disrupt plant-pathogen interactions so as to reduce plant coexistence, the effects of climate change are hard to determine on the basis of current data.

Paper Number: 713

Wednesday, 04 July 2018 | Taj Mahal

Symposium 24 - Tropical plant-pathogen interactions in a changing world

Tropical rainforest fragmentation and plant susceptibility to pathogen attack

Julieta Benitez-Malvido

In forest fragments, little is known about how edge effects influence the interaction between seedlings and their natural enemies over time. In central Amazonia, we recorded damage by insect herbivores and leaf-fungal pathogens of *Chrysophyllum pomiferum* (Sapotaceae) seedlings that were exposed to different numbers of edges and to different distances from the forest edge. Young seedlings were transplanted into one-square-meter plots within 1-ha blocks located in the centre (no edge), the edge (one edge) and the corner (two edges), and at different distances from the edge towards the interior (i.e. 20, 40, 60, 80, and 100 m) of two rectangular fragments (10- and 100-ha in size). Results showed that herbivory and fungal damage varied over time with the presence of nearby edges and with the distance from the edge. Herbivory was greater at the fragments' centres and decreased with edge proximity over time, while leaf-fungal damage was greater at the corners than in the edges and increased significantly over time. Biotic damage was correlated with seedling size. Small seedlings were more susceptible to fungal attack while larger seedlings were to herbivores. This study demonstrated that despite stochastic environmental factors biotic damage by herbivores and fungal pathogens varied with the level of edge exposure and proximity, which may threaten forest regeneration in the long term.

Paper Number: 520

Wednesday, 04 July 2018 | Taj Mahal

Symposium 24 - Tropical plant-pathogen interactions in a changing world

GENERAL SESSION 29.1

Human Influence in Tropical Ecosystems

Amazonian forest oligarchies are derived from Pre-Columbian unnatural selection

David Campbell

Recent discoveries in archaeology and pedology have revealed that pre-Columbian lowland Amazonia supported high density human settlements, extensive agriculture, and sophisticated polities with skewed trophic dependency ratios. Because of this, we hypothesize that the vegetation of vast areas of Amazonia had become anthropogenic by 1492, resulting in lowland Amazonian terra firme forests converging on pervasive oligarchies of low beta diversity - a phytosociology the opposite of those forest's overall patterns of high beta diversity. Un-natural selection by humans, intended to enhance the density of economically valuable species, may have created these disparate patterns, a process that has been obfuscated by holocaust and linguicide. To test this hypothesis, we used inventories of terra firme forests in Pará and Acre States (Brazil) to demonstrate that the species compositions of oligarchies (as measured by relative dominance) were conserved over large geographical ranges, whereas the beta diversity of the forests in which those oligarchies were embedded remained high.

Paper Number: 775

Wednesday, 04 July 2018 | Giza

General Session 29.1 - Human Influence in Tropical Ecosystems

Fire, forests, and farms: linking pre-Columbian Amazonian legacies to modern forests

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Introduction: Soils and forests of Amazonia potentially had some degree of pre-Columbian human impact and past fire that left a lasting imprint on forests across the region. The soils are highly weathered and nutrient poor, with Amazonian Dark Earths (ADEs) an exception formed by historical long-term agriculture and fire that enriched the soils in pyrogenic carbon (PyC, macro and microscopic charcoal). **Objectives:** We address the question of how past fires modified soils across Amazonia and whether the persistent effect of landscape use in ADEs resulted in long-term legacies in forest vegetation. **Methods:** In plots spanning southern and eastern Amazonia, we examined drivers of variation in PyC and at focal sites whether floristic composition, diversity, and biomass varied at ADEs and non-ADEs forests. **Results:** In intact forests with no known history of recent fire, the higher than predicted stocks of soil PyC was mainly influenced by soil texture and rainfall. Soil PyC was associated with higher soil fertility. There was a marked difference in forest composition and biomass between ADE and non-ADE forests. In southern Amazonia, ADE forests showed, on average, higher biomass than other forests of the region, while in central Amazonia, their biomass was similar to that of non-ADE forests. The species richness of both forest types was within the range from regional studies. Differences in composition between trees of large and small diameter may indicate long-term recovery from past land-use. There was a greater number of known useful tree species at non-ADE sites in both regions, suggesting that ADEs may still be recovering from historical land-use dominated by annual food crops rather than tree species. **Conclusions:** Regional soil PyC indicates fire was potentially pervasive and PyC associated with soil physicochemical properties and precipitation. Improved understanding of drivers of variation in PyC and the time required for recovery from historical land-use will help to manage and conserve forests in a region increasingly dominated by fire.

Paper Number: 915

Wednesday, 04 July 2018 | Giza

General Session 29.1 - Human Influence in Tropical Ecosystems

Examination of human influence on island biogeography in the Sunda Islands

Elsbeth N. Wilman, Ding Li Yong, Timothy C. Bonebrake, Luke Gibson

The Sunda Islands of Indonesia and Malaysia provide a natural laboratory for testing Island Biogeographic Theory (IBT), as they were fragmented from continental Southeast Asia around 11,000 years ago when sea levels rose and now encompass a wide range of sizes and isolation distances. A previous study (Okie & Brown, PNAS 2009) compared the Pleistocene mammal fauna from fossil records on 14 of the Sunda Islands with historical, pre-European colonisation fauna, finding that the extirpation of mammals after isolation of the islands followed the pattern predicted by IBT, i.e., that larger islands retained more species. We extended this analysis by comparing the historical data with current species records compiled from the IUCN Red List and expert knowledge, expecting that the effects of human presence and activity, such as forest loss and overhunting, would cause a change in the species-area relationship (SAR). Surprisingly, the SAR did not change, but other interesting patterns emerged. Overall, there were 76 island extirpations and 99 island introductions. Nine alien species were introduced to the islands, and introductions and extirpations had no relationship with island area. However, the four species that went entirely extinct from the islands had historically been found only on the four largest islands, contrary to expectations. The differences between expectation and reality in the Sunda Islands may provide valuable insights into the impact of human disturbance on natural island extinction processes in the Anthropocene.

Paper Number: 540

Wednesday, 04 July 2018 | Giza

General Session 29.1 - Human Influence in Tropical Ecosystems

Human impacts on forest-savanna bimodality at continental scales in tropical Africa

Krishnapriya Tamma

Introduction

Recent analyses of vegetation patterns in tropical Africa demonstrated a bimodal distribution of tree-cover for intermediate ranges of rainfall (1300-2000 mm of rainfall). This led to the inference of bistability in the system, corresponding to forests and savanna states, which can undergo abrupt transitions. Bimodality is often taken as a proxy to infer bistability in such ecosystems, as bistability is difficult to demonstrate. However, human activities such as deforestation, agriculture and changes to fire regimes can also introduce bimodality in tree-cover. Differentiating bimodality stemming from intrinsic dynamics and human-impacts is important for managing ecosystems, as the thresholds at which the system is likely to tip into the alternative state could differ.

Objective(s)

1. To compare the extent of bimodality in tree-cover in 'natural' and 'human-dominated' regions.
2. To examine what variables are associated with observed differences in bimodality between natural and human-impacted regions

Method(s)

We used data from the Human footprint map to delimit sub-saharan Africa into 'human-impacted' (with high human footprint index scores) and 'natural' (low human footprint index scores) regions. We obtained a combined environmental predictor (CEP) that includes data for mean annual rainfall, rainfall seasonality and soil variables. Enhanced Vegetation Index (EVI) was used as proxy for vegetation cover. To determine the extent of bimodality in each region, we plotted EVI as a function of the CEP. The range of CEP values for which bimodality was observed was determined. Using spatial datasets, we evaluated if the human-impacted and the natural regions show differences in fire regimes, deforestation and domestic herbivore densities, that may be leading to differences in bimodality.

Result(s)

We found that the extent of bimodality (or the range of environmental driver for which bimodality is observed) for the human-impacted was larger than that for natural regions, by about 200 mm of rainfall at each threshold. Fire frequency, fire regimes, domestic herbivore densities and land-use patterns differ between the natural and the human-impacted regions, contributing to the observed differences in the extent of bimodality.

Conclusions

Our results demonstrate that the extent of bimodality in environmental space is smaller in the natural regions, suggesting that human activities have had considerable impact on the tree cover distributions in tropical Africa, and potentially interfere with the natural dynamics of tropical forest-savanna systems.

Paper Number: 332

Wednesday, 04 July 2018 | Giza

General Session 29.1 - Human Influence in Tropical Ecosystems

SYMPOSIUM 25

Exploring the consequences of anthropogenic change for symbiotic species in tropical ecosystems

Ant-trophobiont interactions inside nests in tropical trees: opening the black box

Petr Klimeš

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Background. Trophobiotic interactions between ants and honeydew-providing hemipterans are widespread and are one of the key mechanisms that maintain ant super-abundance in tropical forests. Many of them occur inside ant nests. However, previous studies had typically focused only on certain myrmecophytic plants and one habitat. It is thus poorly understood, how those cryptic associations change with plant hosts and forest disturbance.

Methods. In my talk, I will focus on datasets of trophobionts gathered from destructive host plant dissection in two following systems: (i) myrmecophytic *Macaranga* plants that are associated with *Crematogaster* ants in SE Asia. (ii) complete tree-dwelling ant communities and their trophobionts from forest plots in Papua New Guinea.

Results. In *Macaranga*, the ants and plants are associated with a relatively limited range of homopterans inside stems from a single scale insect family Coccidae (Sternorrhyncha: Coccoidea). The interactions are rather generalised at the species level, although some *Macaranga* hosts can differ in the symbiont preferences and thus in their community composition.

When the complete vegetation in New Guinean primary forests is considered, most of the cryptic interactions are also with scale insects but from multiple families, while ant-planthopper associations are rare (6% of all interactions). In particular, scale insects are diverse in the lowland primary forest (16 species in four families per 0.5 ha) and most of them (70% cases) are kept inside nests and tree structures. Those native interactions are dominated by the family Coccidae and are associated with many ant genera. In contrast, secondary forest assemblage hosts more of mealybugs (Pseudococcidae) and interactions outside nests are more common there. However, a similar symbiotic diversity and network specialisation occurs in both forest types.

Association with hoppers (Auchenorrhyncha) seems to be unique for primary forests and one ant genus (*Pseudolasius*) and one related group of symbionts (Flatidae). Comparison across the Auchenorrhyncha phylogeny revealed that such obligate associations are scarce and over-dispersed across the group, with only about ten cases reported so far.

Conclusions. The interactions among symbiotic scale insects and ants inside nests are very common in the both myrmecophytic plants and common canopy trees. However, they are less frequent in disturbed forests, where the invasive scale insects species feeding externally on the plants persist. The relationships with Auchenorrhyncha inside nests are more partner-specific, but rare. Further research is needed to answer, how these symbioses inside ant nests are maintained and influenced by human disturbances.

Paper Number: 144

Wednesday, 04 July 2018 | Machu Pichu

Symposium 25 - Exploring the consequences of anthropogenic change for symbiotic species in tropical ecosystems

Mutualistic ant partners go on 'Leave' in Borneo oil palm plantations

Mickal Houadria

One of the most diverse mutualistic interactions occurring in SE Asia is between *Macaranga* trees and *Crematogaster* ants. These early succession trees, often comprising the majority of individuals in disturbed habitats, are ecologically important because they potentially provide shade for late-succession trees. However, little is known about how plant fitness is affected by the identity of their ant mutualists and how this varies across anthropogenically modified landscapes. *Macaranga pearsonii* is a frequently encountered species in both oil palm plantations and logged forest, which could potentially play an important role in the future restoration of these sites. This role might be altered by changes in the mutualistic relationship between ants and plants during habitat degradation. Here we analyse the relationship between ant occupation and herbivory damage of these plants, and compare a degraded habitat where severe logging has occurred but where *Macaranga pearsonii* density is very high with oil palm plantation, where densities are lower. Over 40 trees (0.5m to over 6.5m) were collected and dissected in each habitat. We quantified ant and scale insect abundance in each branch as well as leaf biomass. We controlled for environmental factors including soil phosphate, nitrate, pH, soil density and canopy cover that may also influence plant fitness. Additionally we considered specific aspects of the mutualism relating to plant fitness such as ant patrolling and herbivory damage. We demonstrate that depending on the habitat the relation between ant abundance and herbivory is not always positively correlated. Other factors such as ant species identity, the number of colonising queens and how many different species simultaneously occupy the same tree influence the herbivory damage of plants, which may differ in relation to the habitat.

Paper Number: 391

Wednesday, 04 July 2018 | Machu Pichu

Symposium 25 - Exploring the consequences of anthropogenic change for symbiotic species in tropical ecosystems

Ant mosaics in tropical lowland forests: Finding drivers of spatial structure

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Background. The ant mosaic theory was established to describe the patchy structure of arboreal ant communities in forest systems and it is built upon the concept of behavioral hierarchies of ant species and the existence of negative and positive associations among them. Existence of ant mosaic was confirmed in degraded habitats (secondary forest, plantation) but its presence in primary forest is still relatively uncertain with researchers failing to find same conclusion. In addition, very few studies try to explain driver of these spatial structures. These structures could have two relatively unexplored causes: behavioral competition (i.e. competition) and/or resource limitation (habitat filtering).

Methods. We sampled dominant arboreal ants from a 9 ha primary forest plot in Papua New Guinea, randomly selecting 25 canopy trees from each hectare (225 trees in total) and used a slingshot to install ropes with tuna-honey baits in the tree crowns. We used simple behavioral tests (living specimen of same species from neighboring trees into ziplock) to determine boundaries of individual canopy colonies (ranging from 1 tree to almost 1 ha).

Results. We found 57 ant species (20 genera) on 1127 baits in different strata (0–35 m). Spatial structure of arboreal ant community was confirmed using Checkerboard score (observed values were significantly higher than randomized). Using multivariable analysis, we confirmed that community composition is not affected by size of sampled tree, species composition of the forest or canopy connectivity. However, after adjusting the results for spatial auto-correlation, differences in the elevation of sampled trees had a small but significant effect, suggesting a small influence of habitat filtering. We also performed novel statistical method (Colony Area Null Modelling Algorithm, CANMA) to disentangle the spatial structure of ant community between trees, comparing overlap of territories to randomization, showing marginally not significant result for whole canopy community but strong effect of spatially dominant species. In addition, we did a series of aggression tests between species in custom arenas to search for measure of aggression of spatially dominant species. Our Aggression Index for focal species was correlated with their spatial segregation from CANMA.

Conclusions. These results confirm the existence of ant mosaics in tropical primary forest and suggest that changes in microhabitats (differences in elevation) and behavioral dominance drive spatial distribution, suggesting the importance of individual species behavior on the spatial distribution of canopy ants.

Paper Number: 231

Wednesday, 04 July 2018 | Machu Pichu

Symposium 25 - Exploring the consequences of anthropogenic change for symbiotic species in tropical ecosystems

Diversity and network structure of *Crematogaster*-*Macaranga* interactions in different habitats

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Our natural environment is rapidly being severely altered through continuous deforestation and large-scale conversion of landscapes. This is affecting the way that species interact with each other. We conducted a study on the pioneer plant genus *Macaranga* and its *Crematogaster* ant partners in order to understand the way that the network of interactions between these species is affected by logging of rainforest, fragmentation and conversion to oil palm plantation. This study was conducted in the Stability of Altered Forest Ecosystems (SAFE) Project, Kalabakan, the largest ever tropical forest fragmentation experiment, located in the Malaysian state of Sabah. A total of 264 *Macaranga* trees were sampled by manual collection across four habitats: continuous logged forest, logged forest adjacent to rivers (riparian forest), experimentally fragmented forest, and oil palm plantation. *M. pearsonii* was most abundant in logged, riparian and fragmented forest, while *M. winkleri* was most abundant in oil palm plantation. Multiple *Crematogaster* species were found in the forested habitats, while only one *Crematogaster* species was found in oil palm plantation. Overall, 67.8% of *Macaranga* trees were found to be inhabited by ants and the riparian forest had the highest diversity of *Macaranga* species ($D_s=0.98$). *M. pearsonii* was the most common species found across all habitats, with ant colonisation rates for this species not varying between habitats (ANOVA, $F(3,24) = 2.19$, $p = 0.124$). For the most common ant species, *C. borneensis*, there was a significant difference in colonisation rates between host plants (ANOVA, $F(3,42) = 222.47$, $p = 8.47E-26$). Understanding network responses for this mutualism is important, since *Macaranga* are an abundant early succession group, and are likely to be critical to any efforts to regeneration heavily logged forests in SE Asia.

Paper Number: 202

Wednesday, 04 July 2018 | Machu Pichu

Symposium 25 - Exploring the consequences of anthropogenic change for symbiotic species in tropical ecosystems

GENERAL SESSION 30

Plant-Soil-Microbial Interactions

Soil Nematode Community Shifted to Bacterial-Based Food Web in Response to the Tropical Agricultural Plants

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Soil nematodes have significantly contributed to decomposition process of organic matter, and provide a valuable indicator of soil food web responsible for nutrient cycling. However, published data on nematode community dynamics due to plant changes in tropics are lacking even though plant species or plant type changes is a common practice in agriculture. This research examined nematode community response to plant changes, from forest tree to agricultural plants. We established microcosms of forest soil (*Agathis dammara*) and planted with *Oryza sativa*, *Amaranthus* sp, *Solanum lycopersicum*, *Arachis hypogaea*, and *Citrus reticulata* (105 pots). To further follow soil food web dynamics, we sampled the soil after 6, 15, and 23 weeks of plant growth for nematode enumeration. Ecological indices, food web indices, and canonical correspondence analysis (6900 data points) were used to measure the community. After six weeks of plant replacement, nematode abundance decreased to 40-86%, except for soil with *A. hypogaea* (2% increase). It required 15 weeks for nematode community to reach its original abundance in the soil of *C. reticulata* and all plants, 23 weeks for soil with *S. lycopersicon*. Although the ecological indices revealed similar values for nematode community across the selected plants (H' : 2.69-3.07, E : 0.46-0.68, Berger-Parker: 0.15-0.24), food web indices showed different patterns. The soil community changed from nematodes assembling fungal decomposition channel in the forest soil (CI: 73) to the community supporting the bacterial decomposition channel (BI: 43-78) when the plants altered. The community separated into three major nematode compositions according to the plants, i.e., the community of *S. lycopersicon*, the community of *Amaranthus* sp-*O. sativa*-*C. reticulata*, and the community of *A. hypogaea* (RAX-1: 0.97, RAX-2: 0.79, CV: 87%). Temporal changes of nematode genera diversity appeared not to affect their functional diversity but driving the community toward bacterivorous dominance with three separate compositions.

Paper Number: 669

Wednesday, 04 July 2018 | Chichen Itza

General Session 30 - Plant-Soil-Microbial Interactions

Soil nutrients account for significant variation in species composition of secondary forests on a local, but not landscape scale

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Background: Niche assembly processes are thought to play an important role in succession. Light partitioning, in particular, is a cornerstone of forest succession models. The role of soil resources is much less clear. Soil resources have been found to account for significant variation in species composition in old-growth forests, but similar studies are lacking in secondary forests. Here we test if stronger differences in soil resources lead to higher species dissimilarities within (local-scale) or among (landscape-scale) early successional forests.

Methods: Data was collected in 104 plots in 52 secondary forest patches across a human-modified landscape in central Panama. Soils are Oxisols and Inceptisols with little variation in texture and nutrient concentrations. We used a simple general linear model to test if within-site dissimilarities in species composition and soil nutrients were related, and if this relationship became stronger over the course of succession. We applied a distance-based redundancy analysis to test for a similar association across sites. To examine the response of individual species to soil fertility, we modelled species abundances in a joint species distribution model as a function of soil nutrient composition, stand basal area and the interaction between both.

Results: Heterogeneity in soil nutrients accounted for ~35% of the within-site variation in species composition, but this effect did not change with forest age. Forest age, distance and dissimilarity in soil nutrients explained only very small (but significant) proportions of the variation in species composition across the landscape (respectively 7%, 2.5% and 0.4%). The soil main effect was significant for 40% of the species in the joint distribution model. Effect sizes were not related to indicators of the successional status of species.

Conclusions: Our results provide evidence for a significant role of soil resource partitioning in driving species distributions and local species diversity in young secondary forests, even when variation in soils properties is very limited. Effects of soil resources seemed to be unrelated to successional age or the successional niche of species. Our results also suggest that stochastic processes and dispersal limitation may overwhelm effects of habitat differentiation at increasing spatial scale. Overall, our findings provide new insights into the maintenance of biodiversity in tropical human-modified landscapes through the process of forest succession.

Paper Number: 865

Wednesday, 04 July 2018 | Chichen Itza

General Session 30 - Plant-Soil-Microbial Interactions

Decomposition in surface soil in human-modified landscapes of tropical Singapore

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Decomposition of organic matter is an important process driving ecological functions such as nutrient and carbon cycling in terrestrial ecosystems. Factors known to influence rates of decomposition include vegetation type, climate and litter quality, all of which have been intensively studied in natural ecosystems. However, much less is known about decomposition in human-modified landscapes in the tropics, which are often highly disturbed or degraded. In the tropical city of Singapore, for example, more than 99% of the original forests have been cleared through rapid urbanisation. As of 2011, 56% of Singapore is covered with actively managed vegetation (27%) and spontaneous vegetation (29%). Our study - the first systematic landscape-scale study in Singapore - was designed to investigate the effects of vegetation type and soil physico-chemical properties upon litter decomposition. We compared rates of decomposition in five structural types of vegetation (grass, shrubs, trees, trees with shrubs and secondary forests) using an adaptation of the tea-bag index method of Keuskamp et al. (2013). Using a stratified random design, two tea bags - one of Lipton green tea and one of Lipton rooibos tea - were buried for 60 days at each of 120 sites located in eight quadrats (500 m x 500 m). Soil samples were collected from the sites (n=480) for analyses of soil particle size distribution, nutrients (available nitrogen, phosphorus, potassium), organic carbon content and pH. The percentage cover of leaf litter was also recorded. The dry mass loss for each type of tea was measured and modelled as a function of the soil properties and vegetation types using generalised linear regression models. The decomposition rates of green tea ($p < 0.001$) and rooibos tea ($p < 0.001$) varied significantly between structural vegetation types. The lowest rates of mass loss were in grass sites, while the highest rates were in secondary forests, where they were associated with high invertebrate activity in the litter. Decomposition rates in soils with tiered planting (trees with shrubs below) were higher than other forms of managed greenery. With an increasing rate of deforestation due to land use changes, it is important to retain forested areas for their ecological functions and services. In addition, an understanding of the relationships between decomposition rate, soil properties and vegetation types may allow rehabilitation of degraded soil in human-modified landscapes for ecological functions, through better informed planning and management.

Paper Number: 500

Wednesday, 04 July 2018 | Chichen Itza

General Session 30 - Plant-Soil-Microbial Interactions

Soil phosphorus partitioning and species coexistence among arbuscular and ectomycorrhizal trees in tropical and subtropical forests

Xubing Liu

Species coexistence is commonly hypothesized to result from trade-offs that promote specialization on different limiting resources. A recent hypothesis proposes that resource partitioning of soil phosphorus (P) pools may be one of the main contributors to plant diversity in tropical and subtropical forests, but experimental support is currently lacking. Here, we provided different chemical forms of P to seedlings of 15 tree species with contrasting root symbiotic relationships in shade-house experiments, to investigate P acquisition among common species at both tropical lowland rainforest and subtropical evergreen forests. We found that both ectomycorrhizal (ECM) and arbuscular mycorrhizal (AM) trees responded positively to addition of inorganic P, but strikingly, ECM tree species had similar or even higher biomass in response to phytic acid, indicating that ECM trees can also acquire P from complex organic forms. Six out of the nine ECM tree species and all AM tree species also showed some capacity to take up simple organic P (monophosphate). Root colonization by mycorrhizal fungi was negatively correlated with soil extractable P concentration, and all host species had the highest colonization level in the organic P solution or control (water only) treatment, suggesting that levels of mycorrhizal colonization determines P acquisition among tree species. Our results support the hypothesis that ECM and AM plant species partition soil P sources, which may play an ecologically important role in promoting the coexistence of tree species in tropical and subtropical forests.

Paper Number: 128

Wednesday, 04 July 2018 | Chichen Itza

General Session 30 - Plant-Soil-Microbial Interactions

GENERAL SESSION 31

Making Science Matter

Decision making in the face of post-project impacts: the case of the Amur Falcon in Nagaland, India

Neha Sinha

Background: Many countries that are signatories to Convention on Biological Diversity and the Convention on Migratory Species have a ban on domestic hunting of wildlife species. However, bans on hunting have not been always been implemented, despite well-developed law and policy, particularly in the context of developing countries. Nagaland is a remote state in India's North-east and is well known for its culture of hunting, despite this being illegal as per the Wildlife (Protection) Act of 1974 and several state-led policies. In 2012, a video of mass hunting of migratory Amur Falcons (*Falco amurensis*) in Doyang Important Bird Area was shared on social media. It was revealed that approximately 10,000 Amur Falcons were killed every day for at least 10 days, after the falcons started congregating on a reservoir created because of a dam.

Objectives: to examine the policy framework for post-project impacts of projects, and tackling impacts like illegal hunting.

Methods: A study was done on the framework for understanding post project impacts. A review of existing law and policy was done. As the current dam project has had impacts on local communities and has negatively impacted wildlife conservation, an effort was made to understand under which circumstances laws would be followed. For this, semi-structured interviews of eco club teachers and villagers who had ceased Amur falcon hunting was undertaken.

Results:

1. It is found that while India has a means of measuring environmental decision making impacts through environmental impact assessments, this process is barely followed. Further, if there are impacts on wildlife or migratory birds, there is no follow up. EIAs tend not to take migratory species into account.
2. Semi-structured interviews were conducted with adult members of villages around Doyang IBA who have ceased hunting and are involved in eco-clubs. They were questioned on why they gave up hunting and took up community engagement, and most said this was because of the honour involved in conserving a protected species rather than any other driver. This indicates two broad aspects. Firstly, the existence of law and policy, particularly in complex contexts intertwined with tradition or physical remoteness does not entail following of the law. There is a need to have contextual and appropriate support from local communities in order to uphold law and policy.
3. Coercive threats to uphold law may not work in several contexts, and thus law and policy can be enforced in a 'soft', non-threatening way. Secondly, law and policy should not exist in a vacuum from post-project impacts. The creation of Doyang dam had an impact on bird congregation, community activity and ultimately on wildlife conservation.

Implications and conclusions

The creation of Doyang dam had an impact on bird congregation, community activity and ultimately on wildlife conservation. Large projects like dams can have negative impacts on conservation and Multilateral Environmental Agreements. The mass scale congregation and hunting of Amur Falcons due to the creation of a dam reservoir can be considered a project impact. The project needs to have a monitoring system to examine such impacts on migratory species, and related social impacts such as opportunistic, illegal hunting.

While post-project impacts in environmental decision-making do not appear evident, there is a need to make this part of the project execution and clearance. Finally, the economic decision of making a dam has social and environmental costs and impacts, and in order to uphold law, convention and obligations, application of law has to be culturally appropriate. Environmental-decision making safeguards and policy have to go hand in hand have to beyond hard punitive action. They must go beyond hard law, and take a 'soft' approach when necessary.

Paper Number: 986
Wednesday, 04 July 2018 | Colosseum 1
General Session 31 - Making Science Matter

National Biodiversity Hotspot Identification – Importance of Unpublished Data

Naruemon Tantipisanuh

High priority areas for conservation are typically identified based on ad hoc methods without supporting data due to a lack of scientific resources and staff. The objective of this study was to show how unpublished data can be useful for identifying biodiversity hotspot areas using Thailand as an example. Species records were aggregated from various sources both published (records permanently archived or temporarily available on the internet) and unpublished data (derived from interviews). Data from 2001 to 2016 were used to identify hotspot areas. In total, 15% of the data were obtained from personal interviews. Most Thai hotspot areas were already inside government protected areas. Amphibians and reptiles were the taxa that unpublished data had the greatest influence on hotspot identification, while this influence was least for birds. Spatial coverage of species records showed a bias toward particular regions and areas, probably due to a number of factors including their international reputation and previous species records. Results from this project reveal the importance of unpublished records as a source for identifying hotspot locations especially for less studied species groups and indicates the continued need for encouraging scientists as well as amateur naturalists to report their observations to archived websites and/or publish in peer-reviewed journals.

Paper Number: 74
Wednesday, 04 July 2018 | Colosseum 1
General Session 31 - Making Science Matter

Evidence-based approaches for for proactive protection of tropical wildlife in Southeast Asia

Jonathan Hunter

Around the tropics, wildlife is devastated by unsustainable harvest and illegal trade. Lessons from other enforcement fields can help scientists and government agencies address the threats facing wildlife in tropical forests. Many wildlife crimes are witnessed by community members, for example forest workers, or market sellers. With the rise of social media and smartphones, it is easier than ever for concerned citizens to report wildlife crime. But how do we collect and process the data to give meaningful protection to wildlife? In this session Jonathan presents a selection of tools designed for a conservation context. Field teams can report incidents of wildlife crime using an online reporting form. An experimental plugin for the SMART monitoring tool designed to track interactions between entities, handles these reports. For higher level applications, IBM's i2 software searches for connections between large volumes of data and can present the results in crime-network diagrams. Effective deployment of these tools in the context of a dedicated analytical team will provide wildlife enforcement and threat monitoring teams with a much greater understanding of what they face in any given project site.

Paper Number: 367
Wednesday, 04 July 2018 | Colosseum 1
General Session 31 - Making Science Matter

So where do we begin? Analysing conservation priorities for the Asia Pacific

Tasya Sarira

The Asia Pacific region is known for its dynamism in agriculture, forestry and fishery production, with most people depending on natural resources for their livelihoods. Extensive and rapid transformations however, have consequently impacted terrestrial, freshwater and marine ecosystems, threatening the lifeblood of the region ecologically and economically. Recent advancements in geospatial information and technologies have well documented the region's natural capital. Nevertheless, at 65 million km², where do we begin to invest in conservation efforts? Through a priority framework based on the United Nations' Sustainable Development Goals (SDGs), we aim to develop a spatially explicit priority model that identifies key natural and biodiverse areas that are vital to support human livelihoods and well-being. Preliminary results show that of the top 25 % of terrestrial species rich areas, only 34.9 % of the area is protected. Similarly, of the top 25 % of marine species rich areas, only 6.07 % of the area is protected; signifying further potential for biodiversity protection. This priority model thus hope to provide an overview of the region's conservation priorities with aim to assist practitioners to make conservation decisions and optimise finite resources towards effective ecological and economic outcomes.

Paper Number: 620
Wednesday, 04 July 2018 | Colosseum 1
General Session 31 - Making Science Matter

Harmonizing conservation and development: a tale from Cambodia

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Relationships between conservationists and developers are usually adversarial; while developers always want to develop more, conservationists always want to conserve more. Under most circumstances, conservationists are on the losing end since the majority of public are partial to economic advancement. Therefore, more and more conservationists are seeking for ways to reconcile conservation and economic development. However, empirical case studies for successful integration of conservation with development projects are few and far between. Since 2016, at the invitation of an Economic Land Concessions (ELC) owner in Cambodia, we have the opportunity to infuse biodiversity conservation into agriculture development. The ELC, located east of lower Mekong River, is about 13,000 ha in size with over 70% of its total land are still covered by Dry Deciduous Forest and Semi-evergreen Forest. The ELC owner want us to identify high conservation value forest (HCVF) within the ELC and co-develop a master plan to balance agricultural development and conservation, with an aim to minimize biodiversity loss and integrate sustainability into their agroindustry development. Our preliminary biodiversity survey in the ELC in the past two years yielded some exciting results; documenting 23 butterfly, one gecko and two bird species new for Cambodia, and confirming the existence of 12 globally threatened species including Yellow-breasted Bunting, Green Peafowl, Banteng, Indochinese Silver Langur and Black-shanked Douc; some of these endangered species are found to be quite widespread and common at this site. The results reveal that the remaining unlogged forest within the ELC still harbor a high biodiversity and have great conservation value on par with some famous protected areas in the region. The ELC developer is also impressed by the significant biodiversity value and potential for eco-tourism of the site, and is willing to make further concession to protect more forest. A consensual joint-effort is now underway to safeguard the remaining biodiversity through a number of conservation strategies: 1) eco-friendly land use planning, 2) strengthen forest patrol, 3) regular biodiversity monitoring, 4) establish eco-corridors and riparian belt in cleared land, 5) develop sustainable incomes, and 6) awareness raising in local communities. Our experience demonstrate the utmost importance of opening up dialogues with developers, and to invest time to negotiate, and more importantly, to compromise with them to reach a win-win situation. Bold, creative attempts are called for in seeking opportunities to influence development planning and management; or else conservationists stand to lose the battle in preserving biodiversity on a landscape level.

Paper Number: 211
Wednesday, 04 July 2018 | Colosseum 1
General Session 31 - Making Science Matter

The Legacy of the Organization for Tropical Studies in Enhancing Conservation Policy in the Tropics

Sandy Andelman

A recent report from the U.S. National Academy of Sciences on Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century acknowledged the important role field stations can play, not only in research and education, but also in supporting innovative policy decisions. The report found that most information on the societal impact of field stations is lacking or anecdotal. It suggested that such impact could be measured by assessing the number of laws, regulations, policy decisions or global assessments informed by field station research and data. In this context, I synthesized information on key contributions of the Organization for Tropical Studies (OTS) and its four field stations in Costa Rica and South Africa to policy and conservation in the tropics and sub-tropics. I gathered information through review of literature and reports and through informal surveys of current and former OTS board members, representatives of member institutions, course alumni and government agencies. The results of this synthesis provide an overview of the innovative policy impacts OTS has had, as measured by all four of the metrics proposed by the National Academy. The synthesis revealed policy impacts that are both important and wide ranging, including designating national parks and World Heritage Sites, establishing global standards for sustainable tourism, enactment of new laws, amending the constitution of Costa Rica and helping catalyze the United Nations to create the International Day of the Tropics and contributing to the State of the Tropics assessment. Although the contributions of OTS and other field stations to science and education are well known, the number and magnitude of their impacts on conservation and policy have seldom been documented or recognized. There has never been a more important time for field stations to demonstrate their value to both science and society. This analysis demonstrates the feasibility for field stations to measure societal impact using the metrics proposed by the U.S. National Academy of Sciences panel. It also shows the utility of maintaining and reporting on policy impacts as a way to demonstrate the full range and magnitude of field station impacts.

Paper Number: 578
Wednesday, 04 July 2018 | Colosseum 1
General Session 31 - Making Science Matter

Endau-Rompin Johor National Park – Challenges and Lesson Learnt

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¹Johor National Parks Corporation and ²UNDP PA Financing Project

Endau-Rompin is one of the few remaining expanses of lowland rain forest left in peninsular Malaysia especially in the South. Spanning an area of 48,905ha, Endau-Rompin Johor National Park (ERJNP) holds an exceedingly diverse spectrum of ecosystems, plants and animals and high in endemism. The Park is located within the Riau Pocket and it is an important breeding ground for many protected, rare and endangered species of plants and animals. Endau-Rompin has been recognized as an Important Bird Area (IBA) and nominated as ASEAN Heritage Park in 2018. It is managed by the Johor National Parks Corporation (JNPC), the leading agencies in managing protected areas in Johor.

Johor Sustainability Policy 2017-2021 and JNPC strategic plan have highlighted the importance of conserving Johor natural heritage especially in species conservation and habitat protection. ERJNP, being the first National Parks in Johor and its prestigious biodiversity status, has always been the focus for many conservation initiatives and efforts in Johor. Issues such as poaching, land disputes with local communities, diminishing of the key species, lack of capacity and personnel's and funding are ongoing challenges that need to be addressed by the Park in stages. Various conservation programme such as working with various stakeholders under the Johor Wildlife Conservation Programme (JWCP), MOU with various universities, research institution and NGOs including UTHM and WCS, environment education with public and students are ongoing efforts to protect wildlife and natural wonders in ERJNP and Johor. Capacity building programme such as SMART Patrolling, interpretation course, trail building and rehabilitation, technical visits were organized to strengthen the institutional capacity of JNPC. To enhance effective management of the Park, Management Effectiveness Tracking Tool (METT) has been adopted and conducted every two years to monitor and improve the effectiveness of the Park management. METT score of ERJNP has indicated positive changes and management improvement on site over the years.

Apart from that, JNPC has developed a Management and Business Plan of ERJNP and working closely with local communities to enhance the management of the Park and Endau-Rompin landscape in collaboration with GEF/UNDP-PA Financing Project and IC-CFS Project. It is a paradigm shift in the protected areas management in Johor and has shown significant changes in building better working relationship amongst government agencies and local communities. Best practises such as multi-agencies collaboration, targeted capacity building, stakeholder and community engagement, development of management and business plan, adopting METT has resulted positive changes on site and help to enhance the biodiversity conservation in Johor especially in ERJNP and it should be replicated in other protected areas.

Paper Number: 912
Wednesday, 04 July 2018 | Colosseum 1
General Session 31 - Making Science Matter

SYMPOSIUM 26

Role of Local Community in the Conservation of Tomorrow's Biodiversity

Linking life history to the conservation of Amazon River turtles: The effectiveness of conventional and community-based management approaches to turtle conservation at the

Lou Martini

Effective conservation of threatened species requires detailed knowledge of their life history. This includes an understanding of their rates of growth, survival and reproduction. Amazon river turtles are under significant threat from over harvesting and the loss of nesting habitat. Since the 1960's the Brazilian Government has established a number of Biological Reserves for protection of their nesting sites. The conventional method of managing river turtles within these reserves relies on the efforts of a few Government rangers patrolling the main nesting sandbanks with minimal involvement from the local community. This method has been used at the Rio Trombetas Biological Reserve (ReBio-Trombetas), in Pará State, Brazil, since the early 1980's, to protect the Giant South American River Turtle (*Podocnemis expansa*). More recently, a community-based approach to conservation has been trialled at Lake Erepecu in the ReBio-Trombetas to protect two other species of riverine turtles (*Podocnemis unifilis* and *P. sextuberculata*). This approach involves active participation of the local community in the protection of turtle nesting beaches, as well as the transfer of nests to protected beaches. Our study tested the effectiveness of these two approaches to Amazon river turtle conservation, based on the number of hatchlings produced each season. Our results suggest that a detailed understanding of the linkage between the life-history traits of species and their conservation is fundamental to determining effective management measures. The effectiveness of the approaches ("fines and fences" or community engagement, under the Trombetas scenario) was highly related to the turtle nesting behaviour. *Podocnemis unifilis* and *P. sextuberculata* conservation is more effective under a community engagement program. In contrast, our model indicates "fines and fences" as the most appropriate approach for *P. expansa*, which is socially gregarious during the nesting season. However, the number of Giant South American River Turtle (*Podocnemis expansa*) hatchlings at the Reserve has declined by 94% from 1981 to 2016. The life history traits exhibited by *Podocnemididae* river turtles (late sexual maturity, longevity and low recruitment) place significant constraints on their ability to respond to over harvesting outside the reserve. The early success of the management approach trialled at Lake Erepecu suggests that conservation programs which engage the community, and recognise the importance of protecting all life stages, have a greater chance of success. Furthermore, it is likely that the community engagement program at Lake Erepecu may have indirectly positively affected the *P. expansa* beach protection program upstream of the ReBio-Trombetas.

Paper Number: 837

Wednesday, 04 July 2018 | Colosseum 2

Symposium 26 - Role of Local Community in the Conservation of Tomorrow's Biodiversity

Community Forest Management for Biodiversity Conservation and Sustainable Community Development

Tapan Kumar Nath

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In the event of state failure to conserve the forest biodiversity in early 1980s, many countries observed the emergence of community forest management (CFM). For the last four decades the CFM has been advocated in many developing countries with the aim of biodiversity conservation and socio-economic development of the local communities. In this study, drawing on two case studies in Bangladesh and peninsular Malaysia, we examined the impact of CFM on biodiversity conservation and sustainable community development. Following participatory rural appraisal method, and by using semi-structured household survey, focus group discussions and field visits data were collected related to background on peoples' participation in CFM, institutional support, forest conservation status and socio-economic improvement. In Bangladesh case, this was a pioneer CFM project where landless local farmers were involved in the rehabilitation of degraded forest land. Each participating farmers were given 1.62 ha of degraded forest and khas land for plantations and dwelling. The forest department (FD) provided seedlings, technical and other material support. The degraded forests have now been converted into plantations and agroforestry where we identified 35 tree species with a density of 1164 trees/ha. With the income from plantations and agroforestry farmers diversified their livelihood means. Once they lived from hand to mouth, now 90% of them are food sufficient. In peninsular Malaysia, this was also a pioneer CFM project where local people were involved in the rehabilitation and conservation of peat swamp forests (PSF). Although local people are not benefited directly from PSF, they enjoy a number of ecosystems services. In turn they collaborate with the FD and NGO for the restoration and protection of PSF. The CFM in Bangladesh has strong institutional support in respect to policy and rules, and as such the participants enjoy a fair autonomy in taking forest management related decisions. In peninsular Malaysia CFM is relatively a recent intervention, having no comprehensive policy and rules to support local peoples' participation. The NGO-Global Environment Centre- has been working as a medium to connect between local people and the FD. However, in order to sustain peoples' participation in PSF management it is necessary to institutionalise the CFM in Malaysia.

Paper Number: 376

Wednesday, 04 July 2018 | Colosseum 2

Symposium 26 - Role of Local Community in the Conservation of Tomorrow's Biodiversity

Our shared heritage, our shared responsibility: putting policy into practice – enabling community participation in the care and protection of vital natural areas

Justine Vaz

Our shared heritage, our shared responsibility: putting policy into practice – enabling community participation in the care and protection of protected areas and vital natural habitats.

-Justine Vaz, The Habitat Foundation

Malaysia's National Policy on Biodiversity 2016-2025 is a document that appears to embrace the language and direction of the UN Strategic Plan on Biodiversity 2010-2020. The Strategic Plan, or sometimes referred to as the Aichi Targets, was devised to give urgent new direction and impetus to global efforts to reverse the loss of biodiversity, strengthen ecosystem resilience, and enhance its benefits for people. Both plans voice concern about the steady decline of biodiversity worldwide and call for wider participation in efforts to stem these losses. With Malaysia's policy, the phrase "our shared heritage, our shared responsibility", powerfully acknowledges that government alone cannot fulfill the objective of biodiversity conservation. It makes a concerted call for the participation of local communities, organizations, and the private sector. For those that have long been advocating for greater receptivity to community-based approaches in conservation, this is a significant policy shift. It seems to herald a more inclusive stance on natural resource management which has yielded significant conservation benefits where it has been implemented elsewhere in the world. By drawing upon contemporary examples and conversations with practitioners both in Peninsular Malaysia and Malaysian Borneo, this paper evaluates whether the intentions of the Policy are being translated into meaningful change on the ground.

Drawing on examples from Malaysia, the paper showcases case studies of instances where empowering local people to play a role in the protection and management of natural areas has led to successful conservation and management outcomes. The paper samples from diverse settings from villages in the mountainous interior of Sabah to those along riverine forests along the Kinabatangan River. In the Peninsular, examples are drawn from areas bordering Taman Negara National Park and the urban forests of Greater Kuala Lumpur. Some of these examples are mature case studies of 10 - 15 years, while others are examples of scenarios where collaborative initiatives with local communities and protected area managers can invigorate local participation and help tackle conservation problem while providing a good foundation for access and benefit sharing. In Penang, The Habitat Penang Hill provides an example of private-public partnership which is contributing to gains for biodiversity while benefiting the state economically. The paper will conclude with observations on the factors that contribute to successful partnerships on the ground and provides some of the potential steps that can be taken to institutionalize and properly mainstream the more transformative potential contained within the national policy.

Paper Number: 498

Wednesday, 04 July 2018 | Colosseum 2

Symposium 26 - Role of Local Community in the Conservation of Tomorrow's Biodiversity

Monitoring Poverty in Social Forestry Areas

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Perhutanan Sosial (PS, Social Forestry) is the sustainable forest management system within the government-designated state or customary forest areas. Between 2015 and 2019 the Indonesian Government will allocate 12.7 million hectares of forests to PS. Social Forestry aims to increase the wellbeing of people whilst sustaining environmental balance and enhancing social-cultural dynamics. There is a need for a coordinated large scale monitoring mechanism in order to evaluate whether the overall PS programme is effective at improving human wellbeing. We compare two approaches used to assess poverty and wellbeing levels in PS villages over time. We compare the government Potensi Desa (PODES) village census data with a field-based method targeting households Nested Spheres of Poverty (NESP) in West Kalimantan province, Indonesia. PODES and NESP methods reveal similar patterns for basic, infrastructural (services), social and environmental wellbeing. The two methods use different indicators for economic wellbeing so results are inconsistent. Agreement is 73% with economic indicators excluded. The local context, including the type of forest, and support for the community, are key to the successes of recently established social forestry schemes. It is important to note that it will take time for the benefits for social forestry to be felt.

Paper Number: 891

Wednesday, 04 July 2018 | Colosseum 2

Symposium 26 - Role of Local Community in the Conservation of Tomorrow's Biodiversity

GENERAL SESSION 32

Asian Elephant Ecology & Conservation

Using fecal DNA to estimate Asian elephant population abundance in the Cardamom Mountain Landscape, Cambodia

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The Cardamom Mountain Landscape in southwestern Cambodia is a globally important Asian elephant recovery landscape, and the only identified 'core' elephant population in Indochina occupying a landscape large enough for long-term viability. As part of our efforts to conserve the Asian elephant in the Cardamom Mountains, we have established a long-term population monitoring program. In 2016-2017 we estimated the abundance of the core population of elephants in the southern Cardamom Mountain Landscape using fecal DNA to inform a capture-mark-recapture analysis. In the 100,000 ha sampling area we estimated 45 elephants (95% CI: 38-54). This constitutes the main population in the Cardamom Mountains, although there are a few partially to fully isolated sub-populations. Additional analyses showed that this population has extremely low genetic diversity, possibly a result of going through a bottleneck from hunting. There has been no poaching in over a decade in the Cardamom Mountains, yet this population has shown almost no recovery since the last population estimate conducted in 2007. Despite the low numbers, this still represents a globally important Asian elephant population who only lives in a fraction of the available habitat. Conservation measures need to ensure that habitat connectivity and encroachment is stopped in order to ensure that this population can re-populate available habitat as it recovers in the long-term.

Paper Number: 317

Wednesday, 04 July 2018 | Petra 1

General Session 32 -Asian Elephant Ecology & Conservation

Conservation genetics of Asian elephants (*Elephas maximus*) in peninsula India

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We assessed the population genetic structure and genetic variation in the endangered Asian elephant (*Elephas maximus*) using non-invasive sampling of DNA from the surface epithelial layer of fresh elephant dung. The study was carried out in four populations, three in the Western Ghats and one in Odisha in northern section of the Eastern Ghats. We collected over 1000 samples from field, from which we have so far identified 300+ individuals using 10 microsatellite markers. The Nilgiri Biosphere Reserve (NBR) in the Western Ghats which has the largest elephant population in the wild (6000 elephants), had higher levels of heterozygosity (mean observed heterozygosity=0.7003), than the Anamalai-Palni range, south of the Palghat Gap, and the southernmost population in the Agasthyamalai range. The population in northeastern Odisha was from the Similipal-Kuldiha protected areas in Odisha. The populations had high levels of genetic structuring, and gene flow within the NBR and between the other three populations in the Western Ghats. Conservation of elephant populations in peninsula India requires protection of the elephant habitat and ensuring gene flow by provision of corridors between habitats to enable dispersal and migration.

Paper Number: 366

Wednesday, 04 July 2018 | Petra 1

General Session 32 -Asian Elephant Ecology & Conservation

Dietary and Herbivory Impacts of Asian Elephants on Forest Structure in Peninsular Malaysia

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Megaherbivores exert important top-down impacts on vegetation. Little is known, however, about the foraging impacts of Asian elephants (*Elephas maximus*) in tropical rain forests. In a previous study, we compared Malaysian forests with and without elephants and found lower tree sapling and adult palm densities in the forest with elephants. Unexpectedly, we also found that tree break scars (considered a sign of herbivory impacts) occurred at lower heights in the forest with elephants. These patterns required further understanding of the way Asian elephants handle and impact the different plants they consume.

Here we report direct observations on the foraging of Asian elephants in the Krau Wildlife Reserve of Peninsular Malaysia. We recorded 40 feeding-bouts (one feeding-bout = 30-min of continuous observation of a single elephant) of five captive elephants and documented the plant composition of foraged patches. We recorded feeding as (a) trunkfuls of different plant types (e.g. bamboo, ginger, grass, palm, liana and tree) and (b) the behaviour employed (i.e. leaf stripping, branch breaking, stem breaking, uprooting, debarking, or pushing down of tree trunks).

The mean ingestion rate was 28.9 ± 1.6 trunkfuls per 30-min (n=40). Elephants most frequently selected palms (22.7 ± 5.0 % of trunkfuls were palms above 1m-high and 10.8 ± 2.2% were palms below 1m) followed by tree saplings (17.2 ± 2.9% of trunkfuls were large saplings, 6.5 ± 1.4% small saplings; n=17). Elephants consumed tree saplings by breaking the main stem (27.7%) or uprooting them (22.8%); for palms, 32.3% were uprooted and 11.8% were consumed by breaking the main stem. Elephants broke tree saplings at an average diameter of 1.7 ± 1.1 cm and at heights ranging from 0.05 to 2.8 m (mean 1.1 ± 0.5 m). This finding may explain the observation of frequent breaks below 1m height in our previous study, with added effects from other animals such as wild boars (*Sus scrofa*) and tapirs (*Tapirus indicus*). Elephants displayed a pronounced selectivity for palms, consuming 41.4 ± 10.5% of palms in foraged plots but only 25.1 ± 4.0% of dicot saplings. The observation is in accord with our earlier finding that relatively few palms were present in a forest supporting a high density of elephants. Elephant foraging thus appears to alter a forest's structure and composition, but further research will be required to fully understand the impacts of megafauna in tropical forests.

Paper Number: 780

Wednesday, 04 July 2018 | Petra 1

General Session 32 -Asian Elephant Ecology & Conservation

Modelling the combined effects of climate change and anthropogenic impact on the future distribution of the Asian Elephant (*Elephas maximus*) in South Asia

Jean-Philippe Puyravaud

In South Asia alteration of the monsoon cycle due to global warming could pose additional risk for endangered species in human-dominated landscapes. South Asia hosts the largest numbers of Asian elephants (*Elephas maximus*) in the wild, which are increasingly threatened by habitat loss and fragmentation. Climate change could pose a further threat in monsoonal climates with a dry season prone to drought. The objective of this study was to use an information-theoretic approach to assess the relative contributions of different factors associated with habitat suitability for Asian elephants (e.g., climatic factors, human-induced threats, vegetation, and topography), and to predict changes in rainfall seasonality and human induced disturbance on its future distribution. With a comprehensive database on geographical coordinates of elephant presence in various regions in South Asia, we used MAXENT modelling to predict changes in habitat which would affect elephant distributions. The best performing model that also showed less severe overfitting was selected from the combination of the climate and the disturbance hypotheses and its explanatory variables were used in the ensemble approach. Our results indicate that changes in the distribution of Asian elephants in India and Nepal is driven predominantly by changes in climatic water balance (60%), temperature (20%) and proxies of human-induced disturbance (20%). We predicted a potential range shift with elephants seeking refuge areas in high altitude Himalayan mountains along the water availability gradient (low altitude mountain valleys). More than half of the 128 673 km² available suitable habitat is projected to be lost (51.7%) when considering the joint effects of climate change dynamics and human pressures. If only climate change were considered, the projection is for a loss of 38.5% of suitable habitat by the end of Century. However, loss of habitat could be less drastic if connectivity between core habitat areas can be established through corridors that permit elephant dispersal. This has significant implications for the long term management of elephant populations in South Asia, where habitat loss, seasonal drought and anthropogenic disturbance are serious threats to species.

Paper Number: 572
Wednesday, 04 July 2018 | Petra 1
General Session 32 -Asian Elephant Ecology & Conservation

Genetic Diversity of Sumatran Elephant Population in Bukit Barisan Selatan National Park, Sumatra

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Understanding the genetic structure of the remaining elephant populations in Sumatra, Indonesia is critical to develop a more effective conservation and management plan. This elephant subspecies, *Elephas maximus sumatranus*, experiences a continued population decline across its geographic ranges in Sumatra due to poaching, habitat loss and isolation, and retaliatory killings from conflicts with human. This study provides the first estimates of genetic variability and phylogenetic relationship among different elephant groups in Bukit Barisan Selatan National Park (BBSNP) in Lampung, Indonesia. DNA was obtained non-invasively from fecal samples to be sequenced for the left hypervariable region of D-loop of mitochondrial DNA. Mitochondrial diversity (H_d , π) was calculated from 41 samples out of 179 samples collected for this study. Alignment with Asian elephant mitochondrial genome was conducted to determine the polymorphic sites. Phylogenetic tree was constructed along with the calculation of haplotype and nucleotide diversity. We found 6 polymorphic sites that defined 2 haplotypes within BBSNP elephant population and identified them as BT and BS haplotypes from clade β of Asian elephant's haplogroup. Thus, the haplotype (H_d) and the nucleotide (π) diversity calculated was 0.180 and 0.00031, respectively. Evidently, the genetic diversity of the elephant population in BBSNP is low. However, compared to Way Kambas National Park, another habitat fragment in Southern Sumatra, we observed one extra haplotype which suggests that BBSNP might still be connected to other larger Sumatran elephant subpopulation in the north. Nevertheless, without strong protection and targeted conservation action in reducing the risk of population decline, the threat of extinction is imminent.

Paper Number: 486
Wednesday, 04 July 2018 | Petra 1
General Session 32 -Asian Elephant Ecology & Conservation

GENERAL SESSION 33

Bat Ecology & Conservation

Neotropical bats in a recovering fragmented landscape: effects of matrix regeneration on specialist and generalist species

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Tropical deforestation keeps apace and rates of forest loss and fragmentation are due to increase in coming decades. Understanding how matrix dynamics, especially secondary forest regrowth, can lessen fragmentation impacts is key to understanding species persistence in modified landscapes. Here, we use a whole-ecosystem fragmentation experiment at the Biological Dynamics of Forest Fragments Project, Central Amazon, Brazil, to investigate how bat assemblages are influenced by the regeneration of the secondary forest matrix. We surveyed bat assemblages in continuous forest ($n = 6$), forest fragments ($n = 6$) and secondary forest matrix habitats ($n = 7$), ~15 and ~30 years after forest clearance. We captured 4,028 bats in the first period (35, 33 and 22 species in continuous forest, forest fragments and secondary forest respectively; 20 species shared between the three habitats) and 2,081 bats in the second period (33, 34 and 35 species in continuous forest, forest fragments and secondary forest respectively; 26 species shared between the three habitats). Species were classified according to their habitat affinity into old-growth specialists (27 species) and habitat generalists (23 species). For both groups, we used a joint species distribution modelling framework to investigate temporal changes in species occupancy and abundance across the landscape. We observed that the regeneration of the second growth matrix between ~1996 and ~2011 had overall positive effects on the occupancy and abundance of specialist bats across all sampled habitats. Conversely, effects on generalist species were negligible for forest fragments and negative for secondary forest. Species responses were idiosyncratic and although specialist species generally benefited from forest regeneration, evidence was limited for increasing assemblage similarity between continuous and modified habitats (fragments and secondary forest) with regeneration time. Our results, although contingent on the existence of source populations, show that the conservation potential of secondary forests for reverting faunal declines in fragmented tropical landscapes increases with secondary forest age and that old-growth specialists, which are often of most conservation concern, are the greatest beneficiaries of secondary forest maturation. This suggests that matrix management, and specifically the management of regenerating (secondary) forest can majorly dictate the future of biodiversity in human-modified landscapes, including that remaining in fragments of natural vegetation. Additionally, our findings emphasize that the transposition of patterns of biodiversity persistence in island ecosystems to fragmented terrestrial settings can be hampered by the dynamic nature of human-dominated landscapes.

Paper Number: 855

Wednesday, 04 July 2018 | Petra 2

General Session 33 - Bat Ecology & Conservation

Seasonal variation in bat species composition and activity in different habitat types at a humid forest of northeastern Taiwan

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Many factors may affect where and when bats are active, e.g. temperature, rainfall, food, predators, physical limitations of bat species, including ultrasonic characteristics, and habitat types. Most studies on bat activity and species composition have primarily been conducted within limited temporal and spatial scales. In our study, we used acoustic recording and trapping to monitor seasonal changes in bat species composition and activity between 2010-2014 in four types of habitats, i.e. within dense forest, along forest trails, along forest edges, and in open areas at Fushan Experimental Forest, a humid natural broadleaf forest located in northeastern Taiwan. During the study period, the average temperature was 17.5 °C and the average monthly rainfall was 307 mm. We divided the seasons of a year into the warm season (May–October) with average monthly temperature above 17.5 °C and the cold season (November–April). A total of 15 bat species was recorded at the study sites. We recorded 26,160 ultrasound calls of at least 10 species of bats and caught 11 species (173 individuals) in the warm season. However, only 1 call was recorded and 3 bat species (28 individuals) were caught in the cold season, indicating higher species diversity in the warm season, as expected. In the dense forest, only *Murina puta* and *M. recondita* were recorded. These two species are also active along forest trail and forest edge. *Rhinolophus formosae*, *R. monoceros*, *Hipposideros armiger terasensis*, *Eptesicus serotinus horikawai*, *Pipistrellus* sp. *Myotis* sp., and *Miniopterus fuliginosus* were recorded in all types of habitat except within the dense forest. All three *Murina* species recorded, i.e. *M. puta*, *M. recondita*, and *Harpiola isodon* were never caught in open areas whereas *Nyctalus plancyi velutinus*, and *Tadarida insignis* were only active along forest edge and open area. In the cold seasons, only *R. formosae*, *M. puta* and *M. recondita* were recorded, and the dominant species captured was *M. puta* (26/28 by individual) which showed a switch in habitat use from dense forest in the warm seasons to forest edge in the cold seasons.

Paper Number: 968

Wednesday, 04 July 2018 | Petra 2

General Session 33 - Bat Ecology & Conservation

Drivers potentially influencing host-bat fly interactions in anthropogenic Neotropical landscapes at different spatial scales

Luis Daniel Avila Cabadilla

The anthropogenic modification of natural landscapes, and the consequent changes on the environmental conditions and resources availability at multiple spatial scales, can affect complex species interactions involving key-stone species such as bat-streblid interactions. On one hand, bats provide important ecological services such as pollination, seed dispersal, control of animal populations, recycling and translocation of nutrient and the promotion of forest regeneration. On the other hand, bat flies can affect host fitness and population dynamics and could also be reservoirs or vectors of bat-borne infectious diseases. In this study, we aimed to identify the drivers potentially influencing bats and bat flies (streblids) assemblages attributes, as well as the way in which both groups of species interact in an endangered tropical forest. For this purpose, we mist-netted phyllostomid and moormopid bats and collected the streblids parasitizing them in 10 sites representing secondary and old growth forest (8 sampling sessions per site). Then, we evaluated the association among the variation in bat and streblid communities' attributes (species composition, richness and diversity), and in the attributes of their interaction networks, with the habitat attributes at multiple spatial scales, using a set of metrics characterizing host abundance and body condition, the vegetation structural complexity, the amount of habitat and its connectivity at landscape scale. The overall sampling effort (89,760.0 mh-1) resulted in the capture of 836 bats representing 15 species and 526 streblids representing 16 species. In general, we observed that changes on landscape composition, landscape configuration and vegetation structural complexity were associated to: 1) an increase in the degree of parasites prevalence and intensity of infestation, 2) a lower level of specialization on bat-fly interaction networks, and 3) the occurrence of novel host-bat fly interactions in anthropogenic landscapes. This could be due to the loss of bat roosting, which potentially increases the likelihood of intraspecific and interspecific parasites transmission among bats. Additionally, we found that variations in the composition of bat communities could determine the degree of streblid prevalence and infestation intensity in a given species (*A. jamaicensis*). This would be explained by the ability of some streblids to infest multiple host species and by the influence of the interactions among bat species (i.e. competition) on the host-parasite interaction. Understanding the multiscale effect of anthropogenic disturbance on host bat-parasites interaction, will provide an invaluable tool for the preservation of bats, the key ecological processes and services they sustain, and the human health.

Paper Number: 58

Wednesday, 04 July 2018 | Petra 2

General Session 33 - Bat Ecology & Conservation

The impact of the Mauritian flying fox (*Pteropus niger*) on commercial fruit plantations through high resolution GPS tracking and orchard assessment

Ryszard Oleksy

Introduction / Background / Justification

The Mauritius flying fox (*Pteropus niger*) is a threatened species endemic to Mauritius. It is perceived to be a major pest in commercial fruit farms and is claimed to cause up to 100% loss of litchi and mango fruits. As a result the government announced a national cull of the species between 2015 and 2016 which officially killed over 30,000 bats.

Objective(s)

The study aimed to quantify the impact bats and other animals have on commercial fruits and to assess how widely the bats ranged in search of food and roosts.

Method(s) used

Between 2015 and 2016 11 bats were tagged with GPS/GSM devices to track their movement. To assess the damage bat cause to the fruit farms, four orchards were monitored during the 2015/2016 fruiting season.

Result(s) observed

The results indicated that bulbuls and monkeys as well as bats fed on commercial fruits. However, bats are able to cause major fruit losses. The movement study indicated that bats travel long distances at night and move across the whole island feeding on native forest resources.

The implications and conclusions based upon the results

Commercial orchards in Mauritius must implement non-lethal fruit protection, such as netting, to decrease the damage bats cause to the fruits. It is equally important to restore forest ecosystems in Mauritius to increase native food supply for the bats.

Paper Number: 573
Wednesday, 04 July 2018 | Petra 2
General Session 33 - Bat Ecology & Conservation

Small islands pose big problems for the world's largest bats

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Three quarters (143/196) of the world's flying foxes (megabats; Old World fruit bats; Pteropodidae) are found on islands, where they are ecological keystones as seed dispersers and pollinators. Although nearly half of the species are considered threatened, the conservation status of most pteropodids remains largely unknown because of the lack of research on remote islands. While all island flying foxes are expected to be suffering from the conflicting overlap with anthropogenic use of their forested habitats, species differ in their sensitivity to the disturbance. As a result, changes in species composition among these communities of pollinators and seed dispersers may be effecting a shift in the ecological function of threatened island ecosystems. Among fruit bats, ecological specialists in particular are of concern, because their diet and use of forest habitat is tied more closely to native ecosystems. Specialists are disappearing globally relative to generalists across a wide range of taxa. Large data sets that show positive correlation between species' ecological specialization and extinction risk, but protected area managers on the ground need finer detail on how specialisation increases sensitivity to disturbance. To test this specialisation-disturbance hypothesis and support endangered species conservation, I studied the population-level responses of two coexisting fruit bats in the Philippines to their main threats: habitat loss and roost site disturbance. My results suggest the specialist is much more sensitive to disturbance than the generalist. Population abundance correlates closely with native forest cover for both species ($R^2 > 0.92$). However, the specialist is uniquely dependent on forest, with a 3-dimensional ecological niche that lies only in forest and is entirely included within the larger niche of the generalist. The specialist populations are 20 times less abundant and require >5.6 times more forest than generalists. The specialist is also >6.2 times more sensitive to disturbance at and around the roost than the generalist. Hence, lower tolerance to disturbance is putting the specialist at a competitive disadvantage and fuelling a negative population growth feedback loop. The ecological implications of declining specialist population sizes is a diminished ecological role in the species' forest habitat. To maintain persisting populations of the specialist species and the ecosystem they maintain, managers need to address colony compositions that are heavily skewed toward the generalist and strictly protect roost sites and surrounding forest from disturbance.

Paper Number: 930
Wednesday, 04 July 2018 | Petra 2
General Session 33 - Bat Ecology & Conservation

Mass-culling of a threatened island flying fox species fails to increase fruit-growers' profits and worsens conservation issues

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Human-wildlife conflicts (HWC) pose a widespread and growing threat to biodiversity worldwide, prompting intensifying research efforts for solutions. Solutions, however, can be as sound as the understanding of the HWC itself, therefore requiring carefully examinations of local situations to inform mitigation strategies. In this context, Mauritius recently provided a rare example of severely impacting conflict when it mass-culled a threatened flying fox (*Pteropus niger*) in 2015 and 2016, purportedly to increase profits of fruit-growers. Here we aim to understand what enabled the mass-culling so that recurrences locally and elsewhere might be recognised early enough to be mitigated and lessons be drawn. We analysed the literature and data available to critically appraise the setting and timeline of events and the reasoning used to investigate how these led to the culling. We also investigated its outcomes on fruit production and on the threat status of the flying fox. We found that the idea to cull *P. niger* was a decade old and that the mass-culls started after Mauritius' biodiversity protection law was finally weakened in 2015. Appeals, supported by best scientific evidence from local and international organisations and conservationists, that culls would not increase fruit-producers' profits, and make the species more threatened, were ignored. Pro-cull proponents used exaggerated figures and incorrect ecological reasoning. The decision to cull in 2015 was taken before the law was passed, making it illegal. It was also consistent with exceeding set quota (e.g. targeting more animals than planned and carried out using rifles during the breeding season). The decision to cull in 2016 was legal but not evidenced-based. Although culling halved the flying fox population, worsening its threat status, fruit production dropped greatly after the culls. The events are consistent with the authorities pursuing perception of taking action in favour of fruit-producers, over implementing solutions to the conflict. Fruit-producers have increased hidden costs of their activities and externalisation of their business risks. Also, resources devoted to conservation were used to set-back conservation progress when the National Parks and Conservation Services supported the culling. To forestall future similar events here and elsewhere, it matters to understand why the mass-culls could not be stopped. It is an opportunity to analyse and question the strategy that was used by conservationists and to propose alternative strategies that bring tangible positive results instead. The situation also exemplifies the eroding commitment of Mauritius towards biodiversity conservation, facilitated by withdrawal from evidence-based policy.

Paper Number: 946
Wednesday, 04 July 2018 | Petra 2
General Session 33 - Bat Ecology & Conservation

SYMPOSIUM 27

Socio-ecological dimensions of forest transitions and second growth forests in tropical landscapes

Neotropical reforestation hotspots: Biophysical and socioeconomic typologies of contemporary forest expansion

Ana Sofia Nanni

Tropical reforestation is a significant component of global environmental change that is far less understood than tropical deforestation, despite having increased widely in scale during recent decades. The regional biophysical and socioeconomic contexts defining such reforestation have not been well described. They are likely to differ significantly from those outlined by site-specific observations that predominate in the literature. In response, this study determines the scale and contexts of apparently spontaneous reforestation. It delineates regional 'hotspots' of significant net reforestation across Latin America and the Caribbean and defines a typology of these hotspots with reference to the biophysical and socioeconomic characteristics that unite and distinguish amongst them. Fifteen regional hotspots were identified on the basis of spatial criteria pertaining to the area, distribution, and rate of reforestation 2001-2014, observed using a custom continental MODIS satellite land-cover classification. Collectively, these hotspots cover 11% of Latin America and the Caribbean and they include 167,667.7 km² of new forests. Comparisons with other remotely sensed estimates of reforestation indicate that these hotspots contain a significantly disproportionate share of tropical reforestation, continentally and pantropically. The extent of reforestation as a proportion of its hotspot was relatively invariable (3-14%) given large disparities in hotspot areas and contexts. An ordination analysis defined a typology of five clusters, distinguished largely by their topographical roughness and related aspects of agro-ecological marginality, climate, population trends, and degree of urbanization: 'Urban lowlands', 'Mountainous populated areas', 'Rural highlands', 'Rural humid lands' and 'Rural dry lands'. The typology highlights that a range of distinct, oppositional biophysical, demographic, and agricultural contexts have equally given rise to significant, regional net reforestation.

Paper Number: 169

Wednesday, 04 July 2018 | Taj Mahal

Symposium 27 - Socio-ecological dimensions of forest transitions and second growth forests in tropical landscapes

Spatial models to link landowner decision-making with tree cover dynamics in Southwestern Panama

Trevor Caughlin

Tropical forest restoration can increase biodiversity and sequester carbon on degraded land. These benefits have helped inspire plans to restore forest to millions of hectares across the tropics. The large spatial extent of these plans will require careful decision-making about when and where to allocate limited resources for maximum restoration effect. However, high variability in rates of observed rates of forest succession hinders our ability to forecast the outcomes of ecological restoration at landscape scales. Remotely sensed data could provide a solution by increasing spatial coverage of secondary forest dynamics, including landscape-scale drivers of ecological variability that are difficult to replicate in field studies. Numerous studies have demonstrated ongoing forest cover increases in tropical countries, including much of Latin America. Nevertheless, a significant gap remains between pixel-level estimates of tree cover derived from satellite reflectance and ecologically-meaningful measurements of forest structure.

We bridge this gap by using Landsat-LiDAR fusion to provide continuous measurements of tree cover at a regional scale over a 15-year period. Previous studies have suggested that our study site, the Azuero Peninsula of Southwestern Panama, is undergoing a forest transition with widespread increases in forest cover. Our time series data of tree cover trajectories at a 30-m scale revealed a more complicated narrative. Tree cover dynamics were highly spatially-heterogeneous, with tree cover increases limited to a small number of landowner parcels in the region. Even in areas with increased tree cover, increases in tree cover were non-linear and transient decreases in estimated tree cover were frequent. Finally, even areas that had apparently undergone reforestation and reached canopy closure did not approach the levels of tree height or photosynthetic fraction found in older forests in the landscape.

Overall, our results demonstrate the importance of quantifying tree cover change in ways that can be related to individual trees and individual landowners. Our data fusion approach, combining the publicly-available Landsat record, with a global extent and a 30-year history, and finer-resolution LiDAR data could be applied to many other tropical landscapes. This research highlights the potential for novel analyses to further our understanding of the ecological details that lead to varying successional trajectories over large spatial extents.

Paper Number: 413

Wednesday, 04 July 2018 | Taj Mahal

Symposium 27 - Socio-ecological dimensions of forest transitions and second growth forests in tropical landscapes

Reversals of reforestation in Latin America and the Caribbean between 2001 and 2014

Naomi Schwartz, T. Mitchell Aide, Jordan Graesser, H. Ricardo Grau, Maria Uriarte

Carbon sequestration through reforestation is relatively inexpensive and bears low environmental risks. Natural forest regeneration in the tropics could make a substantial contribution to carbon sequestration, biodiversity conservation, and livelihoods. However, relying excessively on reforestation is risky, because forests can be cleared and increases in forest cover can be reversed fairly abruptly. Though recent increases in forest cover in some tropical regions are encouraging, the extent to which short-term (5-10 year) increases in forest cover persist over longer time scales, a pre-requisite for carbon sequestration and effective biodiversity conservation, remains uncertain. To address this uncertainty, we use annual remote sensing data covering all of Latin America and the Caribbean to describe trends in forest cover, with a particular focus on cases where reforestation has reversed. We identify geographic, social, and ecological factors associated with different trajectories of forest cover change. We then explore the implications of reversals of reforestation for carbon sequestration.

We identified reforestation reversals in 13% of forested grid cells in Latin America and the Caribbean. Though locations where reforestation reversed still typically experienced net forest gain over the study period, about 75% of the forest cover gained was lost by the end of the study period. The prevalence of reforestation reversals differed across countries, with these events particularly common in Colombia and Venezuela, where recent economic and political changes may explain some of the shift from reforestation to deforestation. Because reversals of reforestation are common, many second growth forests will lack the long-term permanence necessary for substantial carbon sequestration. We argue that without strong policies and institutions that protect new forests, optimism about the role of second-growth forests for climate change mitigation should be tempered. Studies like this one can be useful for identifying target areas for policies and practices aimed at improving permanence.

Paper Number: 208

Wednesday, 04 July 2018 | Taj Mahal

Symposium 27 - Socio-ecological dimensions of forest transitions and second growth forests in tropical landscapes

Assessing the evidence base for nature's contributions to people through forest restoration and reforestation in the tropics

Robin Chazdon

Introduction: Transforming extensive areas of degraded and deforested lands into restored ecosystems and landscapes is a global imperative. Yet, we lack a clear understanding of how different modes of reforestation improve ecosystem and landscape functions and how these improvements benefit different stakeholders. Changes in ecosystem properties during reforestation depend on the environmental context and the approach used. Reforestation approaches include commercial tree plantations, spontaneous and assisted natural regeneration, restoration plantings of native species, and agroforestry.

Objective: Based on a broad socio-ecological approach based on a Nature's Contributions to People (NCP) framework of the IPBES, we disaggregate the benefits that emerge from these five different reforestation approaches, assessing their implications for different stakeholders and the value tradeoffs among them that can potentially lead to social conflict and inequity. These conflicts can jeopardize short- and long-term outcomes of restoration.

Methods: We conducted a rigorous literature search to synthesize published information on the quantity and quality of nine NCPs across different restoration approaches, encompassing direct and indirect material and non-material contributions. We then surveyed literature on perceived and realized benefits and costs across NCPs that vary widely across stakeholder groups at different scales.

Results: Different modes of restoration provide NCPs at different levels and rates, leading to tradeoffs among types of benefits flows. The evidence base for NCPs from reforestation, however, is sparse and inadequate. Value tradeoffs can potentially create social conflict, inequality and restricted benefits to stakeholder groups involved in co-production of NCPs. Moreover, as benefits for stakeholders change over time, they are strongly affected by discounting rates and future societal expectations as well as how planning, management and governance of restoration is carried out. Our literature review reflects an emphasis of studies on carbon storage during reforestation and restoration, but few robust comparisons among different approaches. Even less information is available on temporal trajectories of NCP, which are needed to evaluate tradeoffs, to validate process models, and to develop realistic scenarios for planning restoration. Further, few studies have addressed how these NCPs impact different stakeholders at local and regional scales.

Conclusions: We conclude by presenting a framework for assessing the benefits and burdens of NCP during forest restoration in the global tropics.

Paper Number: 320

Wednesday, 04 July 2018 | Taj Mahal

Symposium 27 - Socio-ecological dimensions of forest transitions and second growth forests in tropical landscapes

Dynamics and meanings of tropical reforestation for rural livelihoods in Mexico

Lazos, Elena, Universidad Nacional Autónoma de México, Luis García
Barrios, Ecosur-Chiapas, Marcela Jiménez

In changing agrarian settings worldwide, rural livelihoods display a diverse array of activities, farming and foresting being only two of many, differentiated across and within households. In this presentation, in order to understand the social, economic and ecological dynamics of tropical reforestation and regeneration, we will analyze three scenarios in Mexico: a) the community forests in Oaxaca; b) the reforestation/deforestation tension associated with substituting rust-susceptible with rust-resistant coffee varieties at the forest frontier in a MAB reserve in Chiapas; and c) the cattle-raisers' forest proposals in Veracruz. These three cases underline the most important characteristics at the household level (availability of labor force, migration, access to land) as well as at the regional/national level (markets, environmental and agricultural policies) to identify why certain type of reforestation is possible, but they also allow us to apprehend the cultural and social meanings for the households involved. The results will be framed in an understanding of broader causes of impoverishment, disempowerment, and inequity, but also of opportunities and enterprise, and with this, the institutional and political processes that influence the diverse outcomes.

Paper Number: 536

Wednesday, 04 July 2018 | Taj Mahal

Symposium 27 - Socio-ecological dimensions of forest transitions and second growth forests in tropical landscapes

Effectiveness of community forest enterprises in conserving biodiversity in Papua New Guinea

Micah Scudder

There has been an increased global interest in transitioning forest management to Indigenous communities to reduce the loss of biodiversity caused by deforestation and forest degradation. The underlying assumption is that community based forestry (CBF) will result in forest management practices that are more conducive to biodiversity conservation and community livelihoods seeing greater improvements than would occur with industrial forest management. The commercialization of community-based forest products is one CBF management strategy being implemented. In Papua New Guinea (PNG), beginning in the 1990s, there was an undertaking by multiple non-governmental organizations (NGOs) to initiate and support community forest enterprises (CFEs) that produced sustainably certified sawn lumber for commercial use using selective logging techniques and portable sawmills. The objective of our research was to determine the effectiveness of this CBF management model in conserving biodiversity and improving the livelihoods of these Indigenous forest communities. We selected an NGO located in the Madang Province of PNG that had facilitated CBF management and sawn lumber production with five separate communities. Data was collected from articles/reports authored by employees of the NGO, forest management plans produced by the NGO for the five communities, an external evaluation of the NGO and interviews with existing and former NGO employees. From the data collected, we conducted a thematic analysis to identify central themes of the specific management activities employed by the NGO and the CFEs, and the outcomes of those activities. We found this CBF management model ultimately failed at conserving biodiversity and improving the livelihoods of the Indigenous forest communities. We determined that the human, social and financial capacities of the CFEs and the NGO were not at a sufficient level required for commercial activities. Furthermore, we found that the timber harvests were primarily comprised of only one tree species with high commercial value rather than an even mix of all merchantable species, as was proposed in the forest management plans. The key conclusions that can be drawn from this analysis are that prior to CFE implementation, assessments should be made of; 1) the capacities of the Indigenous communities and supporting organizations; and 2) market demand for the CBF products being proposed for commercialization and the expected impact market factors will have on CFE activities.

Paper Number: 421

Wednesday, 04 July 2018 | Taj Mahal

Symposium 27 - Socio-ecological dimensions of forest transitions and second growth forests in tropical landscapes

Ephemeral forests: rapid re-clearing of secondary tropical forests in southern Costa Rica

Leighton Reid

Secondary forests are increasingly recognized for conserving biodiversity and mitigating global climate change, but these and other desired outcomes can only be achieved after decades of regeneration, and secondary forests are frequently re-cleared before they recover to pre-disturbance conditions. We used a time series of aerial photographs (1947-2014) to evaluate multi-decadal longevity of secondary forests across a 320 km² landscape in southern Costa Rica. Secondary forests had relatively short lifespans, with 50% re-cleared within 20 years and 85% re-cleared within 54 years of when they were first observed. Forests near rivers had a lower hazard of re-clearance, but forest persistence did not differ among patch sizes or over time indicating that regional forest regeneration may be generally ephemeral. Costa Rica has made an international commitment to reforest 1 million ha of degraded land by 2020. Depending on how this is achieved, only half that target may remain forested by 2040.

Paper Number: 209

Wednesday, 04 July 2018 | Taj Mahal

Symposium 27 - Socio-ecological dimensions of forest transitions and second growth forests in tropical landscapes

GENERAL SESSION 34

Mangroves and Coral Ecology & Conservation

Characterizing changes in spatial metrics in expanding mangrove forests

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Mangrove expansion has been observed in many regions in the world. However, previous studies on mangrove expansion have rarely investigated changes in the spatial characteristics (complexity, connectivity, and configuration). Using satellite images and Fragstats the change in spatial metrics (1940 versus 2014) was investigated across mangrove forests in the Auckland Region, New Zealand. The study showed that the increase in total mangrove area in the region is driven by an increase in patch size as patch size increased significantly (75%) while the number of mangrove patches remained stable. The study also found that tall mangrove patches became more fragmented as indicated by a decrease (35%) in Mean Proximity Index and the shape of tall mangrove patches becoming more irregular (Mean Shape Index in 2014 = 1.9, an increase of 24%). Characteristics of spatial metrics of mangroves varied widely among estuary size depending on the hydrodynamic conditions within estuaries and mangrove stature. The variability in patch complexity was mainly explained (up to 71%) by catchment related factors (e.g., sedimentation rate). In contrast, patch connectivity and configuration were more sensitive to oceanic (e.g., wave height, nitrogen concentration, and tide amplitude) and climatic (e.g. temperature) factors. Our findings showed that spatial metrics is a helpful approach to assess the underlying process of mangrove expansion. These findings can be used to facilitate decision-making concerning the sustainable management of mangroves expansion.

Paper Number: 158

Wednesday, 04 July 2018 | Giza

General Session 34 - Mangroves and Coral Ecology & Conservation

Benthic microalgae in Indonesian mangrove sediments: their nature to adapt unique environment

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Introduction and objectives: Mangrove swamps are known to be highly productive areas, and one-third of those productions have been attributed to the mangrove litterfall. While origins of the remaining production are as yet known, photosynthetic microalgae on the sediments are plausible to play roles. In this study, bio- diversity of the microalgae at the Indonesian mangrove swamps was investigated, as well as culture experiments to reveal their physiological characteristics.

Methods: Samplings were conducted from September to October 2016, during low tide period at three different mangrove sites along the East Java coast. Physio-chemical conditions of lying water on the sediment were recorded within five points at each site. One-centimeter surface of the mud was scrapped off and further examined for the benthic microalgae. By using culture strains isolated from the sites, temperature was increased from 25 to 36°C, and their photosynthetic performance (Fv/Fm; maximum yield of light utilization) was monitored by a pulse-amplitude-modulation fluorometer. Also, their growth rates were measured in the salinity range from 10 PSU to 30. Light experiments were done by exposing to different light regimes sequentially (40, 800, 40 $\mu\text{mol photon m}^{-2} \text{s}^{-1}$) and tracing their photosynthetic responses.

Results: Total 27 microalgae species were recorded, and they were occupied by diatom species. Diatoms were abundantly found in Situbondo (conserved mangrove site), whereas the lowest biomass was in Banyuwangi (affected by shrimp pond wastewater). Total biomass, based on the cell-volume measurement of the occurring species, was also highest at Situbondo, attained 210,171 $\mu\text{m}^3 \text{cm}^{-3}$. Among them, a large diatom species *Surirella fastuosa* dominated, assumingly to be a good indicator of fertility. In the culture experiments, two common diatoms, *Gyrosigma balticum* and *Thalassiosira oestrupii*, maintained functional photosynthesis (Fv/Fm > 0.4) even at 36°C, the temperature did not support planktonic diatoms. Daily cell division rate of *G. balticum* was highest under the lowest salinity, 10 PSU. These results highlighted unique natures of these diatoms that tolerated high temperature and low salinity, typical environments of mangrove swamp. Light experiment revealed that, under strong light exposure, these two diatoms were not capable to release excess light energy as heat, a typical response of plants, indicating they were not tolerate strong light and may explain their nature in mangrove swamps where covered by tree shade.

Implications and conclusions: We firstly found diverse diatoms inhabit in or within the mangrove sediments, and also revealed their unique characteristics facing the harsh conditions of mangroves.

Paper Number: 327

Wednesday, 04 July 2018 | Giza

General Session 34 - Mangroves and Coral Ecology & Conservation

Cold tolerance in the black mangrove, *Bruguiera gymnorhiza*

Aidan William Short

Introduction: As annual minimum temperatures continue to increase tropical species are shifting polewards into the subtropics, where they will encounter more frequent and more intense low temperature conditions that can exceed their current acclimation capacity. In order to determine how these species have and will adapt to conditions in the subtropics it is crucial to identify candidate genes that may be the target(s) of adaption to more frequent and/or intense cold stress. The molecular pathway of cold acclimation in tropical plant species however is not well understood. Mangroves are a useful system for studying the cold tolerance of tropical plants because they are found throughout the world in tropical and subtropical regions, and have recently displayed poleward range expansion across the world.

Objective(s): In this study, we measured the physiological and molecular response of the mangrove, *Bruguiera gymnorhiza* to a cold stress temperature (5°C) for 72 hours to determine the cold sensitivity and changes in gene expression induced by cold stress in this species.

Method(s): To measure the physiological response to cold we used the effective quantum yield of photosystem II (Fv/Fm) to determine the extent of cold induced photoinhibition. To measure the molecular response to cold we used transcriptomic sequencing to compare gene expression before, during and after exposure to 5°C.

Result(s): Pre-cold treatment at 28°C the average Fv/Fm of *B. gymnorhiza* was above 0.75, indicating no photoinhibition previous to cold exposure. At 5°C the average Fv/Fm of *B. gymnorhiza* was 0.29, indicating strong photoinhibition in response to cold exposure. Post-cold treatment at 28°C the average Fv/Fm was 0.50, indicating recovery but not yet to pre-treatment levels. Suggesting that the damage induced by cold stress is reversible, but that more time is needed for full recovery. At the molecular level, exposure to 5°C resulted in the up regulation of 3267 genes including 10 cold responsive genes, and the down regulation of 3672 genes including 8 cold responsive genes.

Conclusion: The results of this study provide candidate genes that can be used as a basis for the determination of how tropical species have adapted to conditions within the subtropics, and how species may adapt to future changes in environmental conditions.

Paper Number: 687

Wednesday, 04 July 2018 | Giza

General Session 34 - Mangroves and Coral Ecology & Conservation

Variation in structure, species composition and ecosystem carbon stocks in a deltaic versus estuarine mangrove forest

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Effective conservation of mangrove forests requires a nuanced understanding of the complex interactions between mangrove vegetation and hydrogeomorphology. Using two sites of equivalent latitude but differing hydrogeomorphological setting within peninsular Thailand, we investigate both within- and across-site variation in mangrove ecosystem structure and function. More specifically, we quantify and compare species composition, forest structure and carbon stocks of the two sites. The first site is located at the mouth of the Krabi River Estuary whereas the second is within the highly depositional delta of the Cha-Uat river in Pak Panang. In the summer of 2015, we conducted a field sampling campaign comprising of standardized methods for sampling forest structure, composition and carbon stocks in mangroves. Following the field sampling campaign, we estimate the ecosystem carbon density of the Krabi River Estuary (961 Mg ha⁻¹) to be approximately twice that of the Pak Panang mangrove forest (407 Mg ha⁻¹). Species composition between the two sites was relatively similar, with a total of 12 mangrove tree species found in Krabi, and 9 species found within Pak Panang. The results show that although species composition and forest structure were relatively similar, soil organic carbon (SOC) density differed significantly between the two sites. Within the estuarine site, SOC was both significantly higher (870 ± 137 Mg ha⁻¹) and highly variable, with no pattern in density identified within-site. Conversely, in the deltaic site, SOC was lower (251 ± 8 Mg ha⁻¹), less variable, and exhibited a statistically significant linear increase in density with distance from the shoreline. Core specific estimates of SOC density in the Krabi River Estuary ranged from 397 – 1,371 Mg ha⁻¹, whereas SOC core specific estimates ranged from 196 – 322 Mg ha⁻¹. More specifically, both bulk density and percent organic carbon were found to be highly variable within the estuarine forest. Although the sites exist as individual case studies and broader trends cannot be inferred, the results corroborate with recent hypotheses that mangrove forests experiencing high sediment deposition are characterized by low SOC density. The finding has important implications for management of mangroves for ecosystem services, as sediment deposition related benefits such as shoreline stabilization may not go hand in hand with high SOC densities.

Paper Number: 765

Wednesday, 04 July 2018 | Giza

General Session 34 - Mangroves and Coral Ecology & Conservation

Dwarfing phenomenon and biomass estimation of a mangrove in the Philippines

Rempei Suwa

Introduction: For estimating the mangrove biomass using allometric models, biometric parameters, such as stem diameter at breast height D , tree height H and wood density ρ , are necessary. H is often not measured in the field because field measurement of H is laborious. However, mangrove tends to show drastic change in the D – H relationship along a tidal gradient, namely dwarfing phenomenon (eg, Suwa et al. 2008 in Aquatic Bot), which suggests that biomass estimation based on D without H , may involve systematic error along a tidal gradient.

Objective: We aimed to evaluate the importance of dwarfing phenomenon on biomass estimation along a tidal gradient.

Methods: Four transects (125 m in length) were set at different tidal positions in a mangrove located in the northern regions of Panay island, Philippine. We recorded species name and tree size, and compared individual aboveground biomass AGB based on different assumptions that D – H relationship is constant or vice versa. AGB was estimated with a generic allometric model with D , H and ρ as explanatory variables (Chave et al. 2005 in Oecologia).

Results: In total, 392 individuals involving 20 species were recorded except for palm species. The maximum D and H were 129 cm of a *A. officinalis* tree and 23.8 m of a *A. rumphiana* tree, respectively. The D – H relationship showed an upward convex trend where H increased sharply with D and the slope became mild as D increased. The D – H relationship was modelled with a hyperbolic equation on an assumption that the D – H relationship is constant among transects (hereinafter called D – H constant model). Individual AGB was calculated with the D – H constant model. Compared to AGB estimated with original dataset, the D – H constant model showed average relative errors with a range from ca. -10 to 40% because of the variation of D – H relationship under different tidal conditions. In particular, significant overestimations of AGB were found at transects near both of seaward and landward boundaries between mangrove and adjacent areas, i.e. H specific to D was lower near the boundaries than in the interior mangrove.

Conclusions: Even within a mangrove area, D – H relationship changed drastically along a tidal gradient. Our analysis suggested that significant errors in AGB estimation can be generated without consideration to the variation in the D – H relationship.

Paper Number: 789

Wednesday, 04 July 2018 | Giza

General Session 34 - Mangroves and Coral Ecology & Conservation

Exploring Coral Restoration at Dapeng Bay at Southeast China at the Northern Tip of the Coral Triangle

Yan Zhou

Shenzhen is a metropolis (with 12 million human population) by the estuary of the Pearl River, coastal China. Its coastal waters is at the northern tip of the Coral Triangle. However, years of uncontrolled anthropogenic damages means the coral reefs are in a highly degraded state. According to a study in 2015, the coral area around Shenzhen's Dapeng Bay was 1.34 km²; the average coral coverage was 36.63%, with 21 genera in 8 families of hermatypic coral identified. Due to human-related threats like unsustainable fishing practices, land reclamation and pollution, the coral communities has been deteriorating. Since 2015, Dive for Love started exploring the effectiveness of coral restoration using coral nursery frames and artificial reefs at Dapeng Bay.

To assess and compare the effectiveness of the two restoration approaches, 3 coral nursery frames and 25 artificial concrete reef nurseries were set up underwater, and 5,600 coral transplants of the species *Acropora pruinosa*, *Pavona decussate*, and *Turbinaria peltata* were attached. The distances of the nurseries to human activities were measured, and periodic inspections on the coral communities were conducted by volunteer scuba divers.

Overall, the loss of transplants was 43.34% and in situ mortality of transplants was 27.39%, and these are mainly due to ghost nets and trawling. Even though artificial concrete reef is more hardy and long-lasting, our results indicated that nursery frame outperformed artificial concrete reef, because 1) it is easier to set up and requires less maintenance, and 2) coral survival rate is higher due to better water flow and less algal growth. There is also a positive correlation between coral loss and the level of human activities. After coral restoration, biodiversity improved with more coral fish (e.g. the demoiselle *Neopomacentrus bankieri*, Blenniidae etc.) as well as arthropods and mollusks compared with other areas of the bay.

To enhance the effectiveness of coral conservation and restoration at this vulnerable site, we recommend 1) using nursery frames instead of artificial concrete reef, 2) setting up coral conservation zones to ban fishing and control other human activities near the coral reefs, 3) actively removing ghost nets and garbage near the shore, 4) erecting warning signs and floating anchors to avoid damage from fishing and traffic, 5) promoting coral conservation through publicity and education at local communities, and 6) most important of all, determined efforts from the government and citizens of the surrounding area to control water pollution and sediment accumulation.

Paper Number: 758

Wednesday, 04 July 2018 | Giza

General Session 34 - Mangroves and Coral Ecology & Conservation

Zooxanthella expelled from giant clams (*Tridacna crocea*): possible symbiont source of coral reef ecosystem

Shin-ya Morishima

Introduction and objective

Giant clams inhabit in tropical waters and are important fishery resources. Similar to corals, they harbor symbiotic microalgae (zooxanthellae) in their tissues and rely their nutrition on the symbionts' photosynthetic products. Recently, coral bleaching, in which corals appear their skeletal white due to loss of zooxanthellae, has become worldwide problem. Giant clams are also suffered from bleaching, though, the research for this phenomenon is limited comparing to the corals' case. We found numerous zooxanthellae were expelled from giant clams, and the algae were packed in fecal pellets and seemed to be intact. We report here the details (morphology, photosynthetic activity, genetic clades) of the expelled zooxanthellae in the fecal pellets and discuss their possible contributions as the symbiont sources in coral ecosystems.

Methods

Each six individuals of *Tridacna crocea* was separately incubated in a 1.8L glass jar under 28 °C and 500

$\mu\text{mol m}^{-2} \text{s}^{-1}$ for light intensity. After 5 h, fecal pellets were retrieved by a pipette. The pellets consisted of two types; one (Type A) contained dense zooxanthellae which emitted bright chlorophyll autofluorescence, and another (Type B) contained lesser zooxanthellae with pale fluorescence. These fecal pellets were subjected to the followings: Photosynthetic activity measurement (Fv/Fm; maximum-quantum-yield of Photosystem II) by a microscopy-type PAM fluorometer, ultrastructure observation by a transmission- electron-microscopy (TEM) and genetic clade analysis by a qPCR. These results were compared with the zooxanthellae retained in the tissues.

Result and Discussion

The mean Fv/Fm value of the zooxanthellae in the Type A was 0.47 ± 0.04 , which was similar to those retained in the tissue (0.48 ± 0.03), insisting that the cells in the Type A were photosynthetically competent. In contrast, Fv/Fm of the Type B were unmeasurable because of their weak chlorophyll fluorescence. In the TEM observation, while zooxanthellae in the Type B showed extensive shrinkage of the cytoplasm, those in the Type A possessed intact organelles, occasionally with flagella and eyespot components, implying the cells underwent morphogenesis into the swimming stage. The genetic clade compositions of the zooxanthellae in the Type A were similar to those in the tissues, while the minor clade in the tissue dominantly occurred in the Type B. We therefore concluded that the zooxanthellae in the Type B were expelled through selective digestion whereas the cells in the Type A were spillover of the competent populations in the tissue, which might be symbiont sources for zooxanthella-bearing animals in coral reefs.

Paper Number: 328

Wednesday, 04 July 2018 | Giza

General Session 34 - Mangroves and Coral Ecology & Conservation

GENERAL SESSION 35

Spatial Patterns of Tropical Biodiversity

Tree species and functional distribution in response to a rainfall gradient in Panama.

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Introduction:

A central goal in ecology is to determine the mechanisms driving species distributions along environmental gradients. Tropical forests occur across a wide range of precipitation regimes that strongly influence species distributions. Functional traits determine species responses to the environment and shed light on the drivers of species composition across these gradients. For example, based on variation in water availability only, dry sites would be characterized by species with traits conferring drought tolerance while wet sites would have species with drought tolerant and intolerant traits, resulting in a nested pattern of species and functional composition across the gradient. However, light and nutrients typically co-vary along precipitation gradients and may exert opposite pressures on traits and species, leading to a complete turnover of species and functions instead of a nested pattern.

Objective:

We combined information on tree inventories including 550 species and functional traits linked to drought and shade tolerance (leaf mass per area (LMA) and wood density (WD)) to examine (1) how functional composition changes along the moisture gradient in Panama and (2) whether functional trends mirror the pattern found for taxonomic composition.

Methods:

For LMA and WD, we calculated community weighted means (CWM) and standardized functional richness (SES-FRic) for 72 tree communities. We then tested for a correlation between a site-level moisture index and CWM and SES-FRic, and examined whether values showed a nested or turnover pattern across the gradient. We also examined whether species distributions showed a nested or turnover pattern by evaluating the taxonomic replacements across the meta-community.

Results:

For WD, neither metric was significantly correlated with the moisture index. For LMA, CWM (but not SES-FRic) increased along the gradient and the relationship was triangular, with higher variation in CWM-values for dry than for wet sites, indicating a nested pattern. In contrast, species distributions along the gradient showed a pattern consistent with turnover.

Discussion:

Changes in functional composition along gradients reveal complex responses to multiple climatic factors and do not necessarily match patterns for taxonomic composition. Our results for LMA suggest that, together with water-limitation, light-limitation is an additional key factor that drives functional composition along the gradient. Further, the species turnover pattern reflects a response to factors that are not totally captured by changes in LMA and WD, such as soil-nutrients and natural enemies. Integrating multiple functional dimensions is a critical step to disentangle mechanisms driving species distributions along environmental gradients.

Paper Number: 311

Wednesday, 04 July 2018 | Machu Pichu

General Session 35 - Spatial Patterns of Tropical Biodiversity

Using joint species distribution modelling to understand the factors that influence the distribution of a key ecological indicator group

Elizabeth Raine, Nicholas Deere, Matt Struebig, Oliver Wearn, Eleanor Slade

Dung beetles are highly abundant, species rich, easy to collect, and sensitive to habitat change. To this end, dung beetles are frequently used as a bioindicator for habitat change as surrogates for other species. As detritivores thought to show generalist feeding preferences, their reliance on dung suggests that mammal species composition is an important factor influencing dung beetle species occurrence. Yet the association between dung beetles and mammals is still poorly understood, and mammal data is rarely included in studies of dung beetle distribution.

We used a joint species distribution model to identify the importance of mammal composition, habitat, and abiotic conditions for dung beetle species occurrence. Forty-six dung beetle species collected over old growth forest, secondary forest, and oil palm plantation in Borneo were modelled as a response to both biotic (mammal species composition and forest biomass), and abiotic (soil moisture and temperature) variables. Dung beetle traits (body size, feeding guild and diel activity) and phylogeny were included in the model to relate community level responses to environmental variation. Dung beetle response to mammal composition was then predicted whilst holding other factors constant to identify the effects of mammal species composition on dung beetle communities in different habitat types.

The observed species-specific responses confirmed previous anecdotal associations between dung beetles and environmental variables. Abiotic factors explained 35% of the variation in dung beetle species occurrence, biotic factors explained 41% and the final 24% of variation was explained by spatial factors. The association between explanatory variables and dung beetle species traits was strongly correlated with phylogeny. However less than 1% of the variation in species occurrence in the model was accounted for by dung beetle species traits. This is evidence for niche conservatism within dung beetles and suggests that there are traits influencing dung beetle species distribution that were not accounted for in the model.

In secondary forest, dung beetle species richness and community similarity to old growth forest were positively associated with mammal species related to undisturbed forest. The dung beetle community in oil palm showed low species richness and community similarity with reference to old growth forest, irrespective of how the mammal composition varied. These results are evidence that mammal species composition plays an important role in influencing dung beetle species distribution. This study highlights that biotic factors are equally as important as abiotic and environmental conditions in determining how species are distributed and respond to changing environments.

Paper Number: 307
Wednesday, 04 July 2018 | Machu Pichu
General Session 35 - Spatial Patterns of Tropical Biodiversity

Species–area relationships and biodiversity loss in fragmented landscapes

Ryan Chisholm

To estimate species loss from habitat destruction, ecologists typically use species–area relationships, but this approach neglects the spatial pattern of habitat fragmentation. I will present new, easily applied, analytical methods that place upper and lower bounds on immediate species loss at any spatial scale and for any spatial pattern of habitat loss. The new formulas are expressed in terms of what I name the ‘Preston function’, which describes triphasic species–area relationships for contiguous regions. I apply the new method to case studies of deforestation and tropical tree species loss at three different scales: a 50 ha forest plot in Panama, the tropical city-state of Singapore and the Brazilian Amazon. Results show that immediate species loss is somewhat insensitive to fragmentation pattern at small scales but highly sensitive at larger scales: predicted species loss in the Amazon varies by a factor of 16 across different spatial structures of habitat loss.

Paper Number: 980
Wednesday, 04 July 2018 | Machu Pichu
General Session 35 - Spatial Patterns of Tropical Biodiversity

Scale-dependent interaction between niche and neutral processes gives rise to plant diversity gradients in tropical forest landscapes.

Boris Bongalov

Tropical forest diversity is believed to arise as a result of an interaction between deterministic niche filtering and neutral processes, however, their relative contribution remains unknown. While changes in the abiotic environment between biogeographic regions gives rise to global biodiversity gradients, axes of niche separation are increasingly difficult to define as abiotic conditions approach homogeneity with reduction in scale and competitive interactions become increasingly neutral. Models based on Neutral Theory have been successful in reproducing multiple biodiversity patterns observed in forest plot surveys, but they have been unable to model beta diversity and species-area relationships simultaneously, probably because they ignore the contribution of niche structuring. Our ability to separate the contribution of niche and neutral processes in driving patterns of beta diversity is currently limited by the size of forest inventory plots, which are small, non-randomly located and difficult to establish and survey. To address this problem in a new light, we used airborne laser scanning and imaging spectroscopy to develop landscape-level maps of spatial turnover in species composition, as well as the niche-structure of the underlying environment over a soil fertility gradient. The Kabili-Sepilok Forest Reserve in Northeastern Borneo harbours three distinct soil community associations in discrete geographic space: nutrient-rich alluvial soils transition via intermediate sandstones to impoverished heath soils. We found that beta-diversity increases across this gradient of nutrient availability where the three soil types act as filters to give rise to distinct communities. While the spatial patterns within soil types is also influenced by environmental gradients, a relatively constant proportion can only be explained by limited seed dispersal. We found that the environmental gradients that structure diversity extend up to 2km, which explains why they are difficult to measure with forest inventory plots. Environmental structure can be incorporated into the dispersal parameters of neutral models, matching the observed beta diversity patterns, so that local communities may appear neutral. We used our landscape predictions of species turnover and environmental change to assess the contribution of environmental gradients to beta diversity and found that approximately 10% of the dissimilarity is spatially structured but not due to the underlying environment, which is the space where neutral processes may play a role. A coalescent neutral model was then used to simulate the soil communities over the island of Borneo and test if this residual spatial pattern can be explained by dispersal limitation. To our knowledge, this is the first time the relative role of niche and neutral processes has been quantified on such a scale and resolution. Our work confirms the previously theorised weakening of niche structuring with decreases in spatial scale and the emergence of neutral processes in structuring diversity turnover. Our results have implications for understating the relationship between biodiversity and ecosystem functioning.

Paper Number: 774

Wednesday, 04 July 2018 | Machu Pichu

General Session 35 - Spatial Patterns of Tropical Biodiversity

Ecological drivers of species distribution in *Syzygium* (Myrtaceae), a hyperdiverse genus of trees in New Guinean forests

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Introduction. Genus *Syzygium* in the family Myrtaceae is rated 16th most species rich tree genus globally. In Papua New Guinea it is also known as one of the most species rich tree genera with more than 200 species. Uniquely, it is distributed widely from the lowlands at the sea level to the highlands up to 3000 m above sea level and in a variety of forest types and soils. Several species in the genus are commercially important, and the genus is known to support diverse food webs including herbivores, pollinators and frugivores.

Objectives. The genus *Syzygium* represents an ideal model taxon for the study of species coexistence mechanisms for hyper-diverse taxa of woody plants in tropical forest. We will examine the distribution of *Syzygium* species and their segregation along abiotic and biotic gradients, and also identify potential mechanisms of coexistence of multiple species in the same forest.

Methods. We have used two data sets, one comprising 4,000 records in the National Herbarium in Lae (PNG), the largest herbarium for New Guinea flora. This data set included 158 *Syzygium* species. A complementary data set includes new quantitative surveys in 32 study sites, within plot (25 m radius) in the PNG National Forest Inventory.

Results. The Herbarium records show that 15% of the species observed were distributed widely from the lowlands (low altitude) at sea level up to 3000 m highlands (high altitude) forest, 19% were widely distributed in the lowland forests and 12% in the montane (high altitude) forests. The remaining 54% species were each restricted to a narrow range of elevations. From the NFI plots, presence of *Syzygium* was also observed in both the lowlands (low altitude) and the highlands (high altitude) plots. The analysis of vegetation plots indicated slight decrease in species diversity with altitude, as well as significant turnover of species with altitude as the Jaccard coefficient of similarity for *Syzygium* species between the lowlands and highlands plots was only 21% on average. Further we analyze coexistence of *Syzygium* species and identify the vegetation communities characteristic for each species.

Conclusions. The primary segregation mechanism for *Syzygium* species is elevation, but this still leaves numerous species coexisting in each forest, but each associated with a different suite of other woody plant species.

Paper Number: 412

Wednesday, 04 July 2018 | Machu Pichu

General Session 35 - Spatial Patterns of Tropical Biodiversity

Species differences or stochasticity: What drives successional trajectories in local and landscape scale diversities?

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Introduction: Several longitudinal studies have shown large variability in successional trajectories of tropical secondary forests across time (within sites) and space (across sites in a landscape). Uncertainties in successional dynamics are often attributed to dispersal limitation and the stochastic nature of species recruitment across sites. This contrasts with the classical model of succession as a process driven by differences in species' recruitment and mortality rates in response to predictable changes in environmental conditions. The current view is that succession is shaped by both deterministic and stochastic processes. In this talk, we explore how different degrees to which recruitment varies stochastically across species and sites can affect successional shifts in diversity across secondary forest.

Methods: We developed a computational model that simulates successional patterns within (alpha diversity) and across (beta diversity) a number of independent locations. Each location is defined by a local species pool that is a random subset of the regional species pool, and species are recruited from this local species pool in one sample plot per location. Model input parameters are informed by data from a large long-term secondary forest dynamics study in a tropical forest of central Panama. In our simulations, we varied the degree to which species differed in their recruitment probabilities as a function of successional age and the degree to which these probabilities varied stochastically across sites for each species. We assessed the effects of spatial-temporal variation on species diversity on local and landscape scales and compared simulation outputs with field observations.

Results and implications: The degree to which recruitment probabilities varied stochastically across species and sites strongly affected successional patterns in diversity and its variation across plots. Even so, some combinations of model settings led to qualitatively similar diversity patterns, which underlines that patterns alone tell us little about the underlying processes. To get across-site variation in alpha diversity and levels of beta diversity similar to levels observed in the field, we included a strong degree of stochasticity in species' recruitment probabilities, with a strongly skewed probability distribution for each species. The latter reflect the field observation that generally even the most common species that occur have few individuals in most plots, and a very high abundance in a few sites only. Our results suggest important roles for stochasticity and dispersal limitation, implying that we need a stronger focus on landscape-scale processes to advance our understanding of tropical forest succession in human-modified landscapes.

Paper Number: 638

Wednesday, 04 July 2018 | Machu Pichu

General Session 35 - Spatial Patterns of Tropical Biodiversity

GENERAL SESSION 36

Arboreal Mammals Ecology & Conservation

Borneo's Arboreal Mammals: Diversity and Vulnerability to Habitat Change

Jessica Haysom

Borneo's rainforests hold remarkably high mammal diversity, with at least 120 non-flying species recorded. Of these, more than 70 are arboreal or semi-arboreal – using the canopy space exclusively or regularly. Arboreal mammals are by their nature difficult to sample due to the heights at which they live and the complex layers of vegetation between ground and canopy. In addition, many are small-bodied, cryptically-coloured and nocturnal. Consequently, Borneo's arboreal mammals are poorly known and critically understudied.

Mammals play important roles in key ecosystem processes such as seed dispersal and predator-prey dynamics. Given the diversity of arboreal mammals, it is likely that as a group they exert a strong influence on rainforest functioning. It is therefore crucial to obtain rigorous data on arboreal communities if we are to effectively understand and conserve the rainforest ecosystem as a whole.

We are optimising arboreal sampling methods in order to document arboreal taxa and evaluate their responses to habitat disturbance. Camera traps, widely used in ground-based mammal surveys, are being tested at canopy height. In addition, fur traps target small-bodied species and comprise a baited funnel, lined with an adhesive which retains strands of fur when a mammal enters. Species are later identified using next-generation sequencing.

We set traps at 25 locations in an ex-logging concession in Sabah, Malaysian Borneo. At each locality, a camera- and fur-trap set at ground level were paired with an equivalent array in the canopy (11-26m height, average 19m). In total, 3946 camera trap nights recorded 34 mammal species. Of these, 20 were exclusively photographed on the ground and 10 exclusively in the canopy, with only four species documented at both heights. This demonstrates a distinct lack of overlap between arboreal and terrestrial species and suggests that studies using only ground-based sampling will fail to capture almost a third of rainforest mammalian fauna.

Fur traps also showed high success rates, with 30% containing fur after one month and both canopy and terrestrial traps contributing equally to fur capture. However, success after 3 months dropped to 8% and while this still compares favourably to success rates from traditional cage trapping methods (average 6%), the reason for this decrease is not yet clear. Further research will repeat the study in unlogged and fragmented forest in order to determine the effects of habitat disturbance on the arboreal mammal fauna.

Paper Number: 566

Wednesday, 04 July 2018 | Chichen Itza

General Session 36 - Arboreal Mammals Ecology & Conservation

Current diversity and status of tree squirrels and flying squirrels in Yunnan Gaoligongshan, China: a mega-hotspot for sciurid diversity

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The family Sciuridae comprises a large group of small to medium-size rodents with a worldwide distribution, being native to all continents except Australasia and Antarctica. Because of their diversity and abundance, they are a key component of natural ecosystems. Tree squirrels and flying squirrels are widely distributed in forested landscapes, with the highest diversity in Asian tropics. However, relatively little research has been done to update their taxonomy, distribution and conservation status. China has a rich sciurid fauna with 17 species of tree squirrels and 20 species of flying squirrels hitherto recorded, but most of the species are in a poor state of knowledge, especially in the tropical regions. China's Gaoligongshan is located in southwestern Yunnan bordering Myanmar's Kachin State, the 600 km-long massif spans across the Tibetan Plateau to northern Indochina and is considered to be the southern offshoot of the Eastern Himalayas. It is a biogeographical melting pot with elements of Himalayan, Indo-Malayan and Southwest China species, making it one of the world's mega-biodiversity hotspots. To improve our knowledge on arboreal sciurids of the area, we conducted field survey, including day- and night-time transects, from 2014 to 2017 at the southern portion of Gaoligongshan between 24°26' - 25°51'N, with a total area of roughly 10,000 km². Habitats covered included lowland dipterocarp rainforest to sub-alpine bamboo-rhododendron forest between an elevation ranges of 250 to 3,400 m. A total of 15 identifiable Sciuridae species have been recorded so far, including nine species of tree squirrels and six species of flying squirrels; two species are globally Near Threatened and three species represented new records for the study area. Our results indicate that the southern portion of Gaoligongshan supports a surprisingly rich squirrel diversity; the regions' geographic location as the division of the Salween and Irrawaddy rivers, the diverse habitat types and elevation ranges are possible reasons for the species richness. Our survey only covered the southern portion of Gaoligongshan, and survey methods was limited to field observation which may underestimate the true diversity. More survey is needed covering a larger area with more comprehensive survey methodology, and the taxonomy and distribution of sciurids be systematically updated.

Paper Number: 887

Wednesday, 04 July 2018 | Chichen Itza

General Session 36 - Arboreal Mammals Ecology & Conservation

Into the canopy: camera traps as an efficient tool for arboreal mammals monitoring and conservation

Mariane Kaizer

Half of the world's biodiversity is in the canopies of tropical forests, including a great richness of mammals and a large proportion of primates. Considering the extent of threats to mammal species' survival, there is an increasing need for effective approaches to animal monitoring. Recent technological advances have allowed conservationists the use of new methods and tools, which have great potential to assess accurately arboreal animal populations in remote areas, where the use of traditional methods is not logistically feasible. Although camera trap has been widely applied for wildlife monitoring, the technique has rarely been used for arboreal species. Here, we present data on a year-long study of monitoring wild mammals in the Atlantic Forest of Brazil. At a potential aerial route (i.e., tree branches) through the canopy, were placed Bushnell 119774C cameras in 17 sampling locations at a mean height of 11m. After six months of data collection were obtained over 32,000 records including photos and 30-second videos. Three of the five primate species that occur in the study area were recorded, including the critically endangered Northern Muriqui (*Brachyteles hypoxanthus*). Other seven species of mammals and five bird species were recorded. The data indicate that arboreal camera trapping is an efficient method for survey and monitor arboreal mammals in dense rainforest. Also, the data show the animals do not change their activity patterns to avoid the cameras, suggesting that canopy cameras are relatively non-invasive research method and may improve the studies and its applicability for the arboreal mammals' conservation.

Paper Number: 344

Wednesday, 04 July 2018 | Chichen Itza

General Session 36 - Arboreal Mammals Ecology & Conservation

Getting off the ground: Can drone-based surveys effectively estimate arboreal mammal populations? A case study for the Koala on Kangaroo Island.

Molly Ellis Hennekam, Lian Pin Koh

Effective conservation management strategies are often dependent on accurate population estimates. However the survey methods required for many arboreal species can be lengthy, expensive and physically demanding. Since its introduction to Kangaroo Island the population of Koalas (*Phascolarctos cinereus*) has seen immense growth, particularly within Blue Gum (*Eucalyptus globulus*) plantations. Current ground-based methods are subject to a number of constraints which have limited the regularity of surveys and scope of area monitored while recent drone-based surveys offer an opportunity to reduce these constraints. We trialled the effectiveness of drone-based surveys with thermal sensors against current ground-based surveying techniques to estimate Koala populations across three plantations on Kangaroo Island. We found that drone-based surveys were highly effective in identifying Koalas in tree canopies and this approach generally resulted in higher population density estimates than conventional methods (significantly higher at one of three study sites). The findings from this initial study show the implementation of this technology is a highly promising new approach for population surveys of Koalas, and potentially other arboreal mammals. The application of this technique for future surveys of such populations could significantly improve the effectiveness of future management strategies and thus the future of the species more broadly.

Paper Number: 824

Wednesday, 04 July 2018 | Chichen Itza

General Session 36 - Arboreal Mammals Ecology & Conservation

Glide performance and tree usage in the Sunda colugo (*Galeopterus variegatus*): implications for habitat connectivity

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Arboreal gliders are often impacted by habitat fragmentation because they rarely descend to the ground level and require highly-connected canopy for locomotion. One such glider in Southeast Asia is the Sunda colugo (*Galeopterus variegatus*) and the species inhabits tropical forests with closed canopies. While the colugo is a glider with the most extensive patagium and can glide up to 136 m, there are limits to its gliding abilities and fragmented forests may present gaps that are impassable given their glide thresholds. However, information on the glide performance of the species is limited, and that hinders a holistic and data-driven assessment on the impacts of fragmentation on their habitat connectivity. Additionally, even though mitigation measures like rope bridges and gliding posts may benefit arboreal species, there is a need to design such structures with characteristics that will facilitate usage by the target species. In Singapore, the Mandai Lake Road bisects a colugo-inhabited forest and is slated for widening in the next few years. This increase in gap distance and the removal of currently-used gliding trees may reduce habitat connectivity across Mandai Lake Road. Thus, this study investigated the characteristics of tree used during gliding and the glide performance of Sunda colugos, before finally quantifying the reduction in habitat connectivity due to the road widening. We recorded 44 glides and found that the longer glides had a glide ratio (horizontal distance : vertical drop in height) of approximately 3.0. Using regression tree on six parameters of tree used during a glide, the first and second most important predictors were tree height of >14.1 m and height of first branch at >3.25 m, respectively. The findings of this study contribute towards the scant knowledge of gliding behaviours of the Sunda colugo. Perhaps more importantly, the information will aid conservation workers in improving their habitat connectivity in highly urbanised Singapore, such as through the design and location of gliding poles as informed by the tree usage data and identification of sites with greatest reduction in crossing sites due to the road widening.

Paper Number: 561
Wednesday, 04 July 2018 | Chichen Itza
General Session 36 - Arboreal Mammals Ecology & Conservation

Distribution and population densities of nocturnal arboreal mammals in Penang Island, Peninsular Malaysia

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Data of the distribution and abundance of nocturnal mammals are lacking in Peninsular Malaysia. We studied the distribution of the Sunda slow loris (*Nycticebus coucang*), the Sunda colugo (*Galeopterus variegatus*), the Horsfield's flying squirrel (*Iomys horsfieldii*) and the red giant flying squirrel (*Petaurista petaurista*) on Penang Island, Malaysia and conducted interviews with communities to better understand the local knowledge and perceptions about these species.

We conducted transect surveys following set paths to assess animal presence/absence and population density. We surveyed 15 areas comprising between 15-20 transects of 500 m each, in virgin rain forests and rural areas. We used a red head torch and a Flir thermal device to detect animals. Thermal imaging is an efficient tool to study nocturnal animals and we spotted a total of 22 different species during our transect walks. Our results indicate that the Sunda colugo (*Galeopterus variegatus*) was the most abundant species (11.14 ind/km²) of nocturnal, arboreal mammal on the island, and Sunda slow lorises (*Nycticebus coucang*; 1.52 ind/km²) were least abundant. We sampled most species, and most individuals per species close to areas with anthropogenic disturbance. Diversity indexes across all sites ranged from 0.29 and 1.65 (Shannon Wiener H', N=20) with Hmax=2.08. The sites with most diversity were the anthropogenically disturbed environment and not the natural ones.

In order to gain a better understanding about the local knowledge of communities living nearby our sampling sites, we interviewed 200 people about our study species. We found that most people are not aware that our species of interest occur on the island and that farmers have misconceptions about some species, which they consider as crop pest and which they might even kill.

Our survey provides important baseline data that can contribute to conservation efforts of nocturnal mammals in Peninsular Malaysia to mitigate impacts of agricultural and urban development on these species.

Paper Number: 535
Wednesday, 04 July 2018 | Chichen Itza
General Session 36 - Arboreal Mammals Ecology & Conservation

First results on the status of the elusive Palawan binturong

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The binturong *Arctictis binturong* is a threatened carnivore living in the tropical forests of South-east Asia; it is mainly frugivorous and is a potential seed disperser. Despite that its habitat is fast disappearing, very little is known on this arboreal species. In particular, the Palawan binturong has been described in 1910 as a separate subspecies, *Arctictis binturong whitei*, but its systematic status, distribution, habitat preferences, and threats are unknown. The subspecies is known only by around 10 museum specimens, collected before 1937. The objectives of our study was to determine the systematic status of the Palawan binturong, and try to detect this species in the field, in order to initiate a field study to establish its conservation status and threats. For this purpose, two mitochondrial and one nuclear genes were analysed for a hundred individuals. These analyses confirmed the low polymorphism within the binturong, and the split of the species into two major haplogroups, one for the north of the isthmus of Kra (Indochinese region) and one for the Sundaic region in the south of the range (Indonesia, Malaysia, the Philippines) with a mean divergence between the two of ca. 3% for Cytb. The latter group includes the Palawan population, which forms a monophyletic group, suggesting a single event for the colonization of the island, from Borneo. The divergence of the Palawan binturong to the other Indonesian and Malaysian populations was quite low (0.6% Cytb divergence). However, the Palawan population is crucial to preserve due to the extreme high level of deforestation in the rest of the binturong range. On the island of Palawan, 12 camera traps were deployed in trees at a high of 5 to 20 m, in the primary forest of Langogan Barangay (90- 200 m asl). The Palawan binturong was detected by camera trapping for the first time, with a detection rate of 0.32% (for 1252 trap nights). In the other regions, the detection rate with camera trapping was between 0.005 and 0.393% (average 0.085%), suggesting a good level of detection in our study site in Palawan. Further field studies will be conducted to determine the home range, population status and threats of the understudied Palawan binturong.

Paper Number: 463

Wednesday, 04 July 2018 | Chichen Itza

General Session 36 - Arboreal Mammals Ecology & Conservation

SYMPOSIUM 28.1

Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

Restoring seed dispersal to an empty forest: a case study from the island of Guam

Haldre S. Rogers, Evan Fricke, Elizabeth Wandrag, Evan Rehm, Henry Pollock, Hugo Thierry, Ann Marie Gawel, Ryszard Oleksy, Tammy Mildenstein, Josh Tewksbury, and Julie Savidge

Recent declines, extinctions, and range contractions of vertebrates have affected important ecological functions such as seed dispersal. In one of the world's most extreme examples of vertebrate loss, the invasive brown treesnake has extirpated all native vertebrate seed dispersers on the Pacific island of Guam. We compared the importance of seed dispersal for forest composition and structure on Guam to nearby islands with vertebrate seed dispersers, using island comparisons, manipulative experiments, and a forest model. We demonstrate that Guam's forests will become less diverse and less able to recover from disturbance without vertebrate seed dispersers. Following this finding, we developed a strategy to restore seed dispersal to the Guam's forests. We identified the seed dispersal effectiveness of native avian seed dispersers (one of which is present in a snake controlled area on Guam and all of which are present on nearby islands), and non-native mammal species currently present on Guam - the feral pig (*Sus scrofa*) and black rat (*Rattus rattus*). The native avian seed dispersers varied in their effectiveness as dispersers. Two species that demonstrated a broad diet, positive impact on germination, and wide movement across habitat types were selected as preferred candidates for reintroduction. While the non-native pig effectively dispersed seeds, the non-native rat did not. We propose to expand the range of the bird species that is present in an area under snake control on Guam, and to reintroduce another species found on nearby islands. Birds would be protected from snake predation using a combination of nest boxes, fencing, and toxicants. The non-native pig may be useful as a temporary measure. Restoration of seed dispersal in the presence of the brown treesnake may be an achievable goal and could serve as a guide for rewilding efforts in other places that are under threat.

Paper Number: 926

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.1 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

Mutualistic networks in the Galápagos Islands and how alien species modify their structure

Anna Traveset

Mediterranean Institute of Advanced Studies (IMEDEA, CSIC-UIB)

Islands harbor much of the world's threatened biodiversity, most of which is endangered by habitat degradation, over-exploitation and the introduction of alien invasive species. Increasing evidence confirms that it is not the decline of species diversity per se that scientists, conservationists, and restoration managers should be most concerned about, but rather the extinction of the interactions between organisms that ultimately breathe life into ecosystems. Consequently, research on species interactions patterns has increased dramatically in recent years, mostly thanks to the implementation of network theory which facilitates the representation and interpretation of such complex interaction networks. In this talk, I will present our findings on the dynamic structure of mutualistic (pollination and seed dispersal) networks in the Galapagos archipelago, and the mechanisms underlying the observed patterns. I will also deep into the mechanisms whereby alien species infiltrate the mutualistic networks, and discuss the potential cascading effects of invasive alien species on the native ones and their interactions.

Paper Number: 83

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.1 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

Slowed regeneration of native montane forests on Hawai'i: ecological thresholds and alternative stable states

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Background

Abandoned tropical pastures offer excellent opportunities to restore native forest communities but multiple barriers to restoration often need to be overcome to re-establish native forests. In Hakalau Forest National Wildlife Refuge on Hawai'i island, managers have planted over 400,000 native *Acacia koa* (*koa*) trees in abandoned pastures to facilitate forest regeneration. Their goal was to restore canopy trees to promote native understory recruitment by increasing bird-mediated seed rain while decreasing competition from invasive grasses. However, natural recruitment of native understory has not occurred after nearly 30 years. By contrast, recruitment of native understory species does appear to occur under remnant canopy trees of a different native species, 'ōhi'a (*Metrosideros polymorpha*).

Objectives

We assessed potential barriers to native plant regeneration in these restoration forests by experimentally manipulating thresholds of (1) seed rain and (2) grass competition and evaluating how they interact to influence woody plant establishment.

Methods

Under individual *koa* and 'ōhi'a trees we implemented a factorial experiment that varied grass biomass (100, 50 or 0% removal) and seed addition (0, 10, 20, 50, 100, or 200 seeds/m²) for each of two common native understory species (*Pilo* - *Coprosma* spp, 'Ōlapa - *Cheirodendron trigynum*). Seedling establishment was monitored every two weeks and survival tracked through time.

Results

Pilo recruitment was higher under 'ōhi'a than under *koa* ($p < 0.01$) suggesting that canopy trees can significantly alter recruitment of the understory. In addition, there was an interaction between grass removal and seed addition on seedling recruitment ($p = 0.053$). Recruitment was elevated in the 50 and 100% grass removal treatments relative to 0% grass removal indicating that grasses can suppress native seedling recruitment. However, we observed seedling establishment in the high seed density plots even when grass was not removed, indicating that seed dispersal may also limit native seedling recruitment and grass competition can be overcome perhaps by high seed rain.

For 'Ōlapa, germination through the first six months of the experiment has been negligible. It is unclear if seeds are exhibiting dormancy or if additional factors are preventing recruitment in the restoration forests (e.g. altered microclimate or missing mycorrhizal associations).

Conclusions

These findings suggest that thresholds to natural understory regeneration exist that are holding restoration forests with invasive grass understory in a relatively stable state, making restoration difficult. With no grass removal, seedling establishment occurs only at high levels of seed addition; levels which are an order of magnitude greater than current bird mediated seed rain. Removing just half of the grass cover can increase seedling establishment, at least in the short term.

Paper Number: 163

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.1 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

Functional restoration attempts in Island forests: Why redundancy wins in the short term

Susan Cordell

Choosing species for forest restoration is a complex task. Typically, native species are chosen to accelerate natural regeneration of forest ecosystems and encourage biodiversity recovery. When these traditional approaches fail, adaptive management is a means to move forward. Our work attempting to restore a Hawaiian lowland rainforest provides a unique opportunity to explore some of these alternative techniques. In Hawai'i, invasive species put such great pressure on native biodiversity that restoration must focus on invasion resistance to succeed. Our assumption, based on community assembly theory, is that restoration using species mixtures that have complementary traits and functions would be more successful at invasion resistance than species mixtures with redundant traits. To test this idea we established a restoration effort in a lowland wet forest in Hawai'i, employing both native and exotic (non-native but non-invasive) species with varying functional trait expression in experimental treatments. Sixteen plots with similar vegetation structure, light levels, and soil nutrients were cleared of all invasive species, while four additional ones were left uncleared as reference plots. The treatments consisted of different sets of ten planted species. The experimental restoration plots have been monitored for the last four years with a suite of parameters measured in order to evaluate the success of these hybrid communities. The components used to evaluate restoration success are productivity, invasion resistance, and reproduction. Much to our surprise the redundant (R) treatments show significantly higher rates in most of the productivity measures relative to the complementary (C) treatments. For example, survival is 12 percent higher, growth rates are faster, height and basal area larger (4m height and 7.2 m² ha⁻¹ basal area for R vs 2.5m height and 2.1 m² ha⁻¹ basal area for C), litter production greater (16 g m⁻² per month for R vs 9.8 g m⁻² per month for C), and canopy cover greater (88% for R vs 81% for C). Further, invasion resistance, measured as the amount of maintenance effort to remove invasive species, is significantly reduced in the redundant treatments. Interestingly, reproductive output (flowering and fruiting) is considerably higher in the complementary treatment. Our results indicate that species with similar strategies (redundant) may promote a faster path to canopy closure and invasion resistance in the short-term. Growth-reproductive tradeoffs associated with our complementary treatment imply that species with different resource-use strategies may confer long-term success once resources become more limited in the system.

Paper Number: 164

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.1 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

Extinction-Driven Changes in Frugivore Communities on Oceanic Islands

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Global change and human expansion have resulted in many species extinctions worldwide, but the geographic variation and determinants of extinction risk in particular guilds still remain little explored. Here, we quantified insular extinctions of frugivorous vertebrates (including birds, mammals and reptiles) across 74 tropical and subtropical oceanic islands within 20 archipelagos worldwide and investigated extinction in relation to island characteristics (island area, isolation, elevation and climate) and species' functional traits (body mass, diet and ability to fly). Out of 74 islands, 33 islands have records of frugivore extinctions, with one third of the pre-extinction frugivore community being lost. Geographic areas with more than 50% loss of pre-extinction species richness include islands in the Pacific and the Indian Ocean. The proportion of species richness lost from original pre-extinction communities is highest on small and isolated islands, increases with island elevation, but is unrelated to temperature or precipitation. Large and flightless species had higher extinction probability than small or volant species. Across islands with extinction events, a pronounced downsizing of the frugivore community is observed, with a strong extinction-driven reduction of mean body mass and maximum body mass. The results document a substantial trophic downgrading of frugivore communities on oceanic islands worldwide, with a non-random pattern in relation to geography, island characteristics and species' functional traits. This implies severe consequences for ecosystem processes that depend on mutualistic plant-animal interactions, including ecosystem dynamics that result from the dispersal of large-seeded plants by large-bodied frugivores.

Paper Number: 45

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.1 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

The Small-Island Effect Revisited: Patterns and Drivers of Species Richness on Small Islands in a Tropical Archipelago

Julian Schrader, Christian König, Gunnar Keppel, Soetjipto Moeliono, Meelis Pärtel, Holger Kreft

The rate at which species richness on islands increases with area is expressed by the species-area relationship. One of the few exceptions to the generality of the species- area relationship is the small-island effect (SIE), which states that on very small islands, species richness displays high variation independently of island area, or increases at a lesser rate than on larger islands.

We analysed a new empirical plant dataset of trees on 60 islands in the Raja Ampat Archipelago of Indonesia. We tested whether tree species on small islands have specific area requirements and whether the SIE originated already from the species pool. Simulations showed that most tree species had significantly different area requirements compared to random colonisation based on which we calculated probabilistic island-specific species pools. Exploring how species pools and richness response to area, we found strong support for the SIE being shaped by local limiting processes which have no impact on the species pool but control how much of the pool is realized on an island.

Our findings are also relevant for understanding ecological processes in small fragmented and isolated habitats and with high relevance for nature conservation as any species have area requirements larger than remaining habitat fragments.

Paper Number: 140

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.1 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

SYMPOSIUM 29

Spatial analysis to support conservation and restoration planning for tropical tree species

Filling the knowledge gaps for conservation of priority tree species: Introduction to the session

Riina Jalonen*, Hannes Gaisberger, Christopher Kettle, Barbara Vinceti
Biodiversity International

Thousands of ecologically and socio-economically important tree species across the tropics are threatened, yet very little information is available on their historical and current distribution, patterns of genetic diversity, intensity of threats across their distribution ranges, or availability of seed sources to support restoration. Effective conservation and restoration strategies for these species and their genetic resources cannot be identified without improving the knowledge on the species' distributions and the threats they are facing. This presentation provides an introduction to the session, the objectives of which are to: (1) Share information of spatial analysis methods and tools for conservation research and practice, (2) Identify main gaps in the availability of and accessibility to spatial data on tree species, (3) Discuss safeguards needed to avoid misuse of spatial data, (4) Identify action points for supporting the availability of spatial data for research and conservation.

Species distribution modeling has become well-established as a method for predicting the distributions of species based on their known occurrences and data on environmental variables. Research suggests that the models could also indicate adaptive variation within species, with areas of high predicted habitat suitability also having higher regeneration and genetic diversity than areas with lower predicted suitability. Nevertheless, the models need to be validated through expert knowledge, which has often proven to be very helpful for refining the distribution ranges. Methods for mapping threats to species' populations are less advanced and currently rely largely on aggregated datasets and expert knowledge, which, however, yields much more variable results than when used for validating distribution models.

Global information systems such as the Global Biodiversity Information Facility (GBIF, www.gbif.org) include hundreds of millions of records of species occurrences. However, data is generally scarce for tropical tree species in key biodiversity regions. Less than 20% of the occurrence records for 50 socio-economically important tree species in tropical Asia in the database were both accurate enough for species distribution modeling (at least 4 decimal points), and at least relatively recent (from the past 30 years).

Biodiversity International and the Asia Pacific Forest Genetic Resources Programme (APFORGEN) are implementing a regional project to develop up-to-date distribution and threat maps for 50 regionally important pilot species, genetic conservation guidelines based on the results, and improved methods and capacities for applying these to the thousands of other, valuable yet little documented tree species in the region. Session participants are invited to participate in this regional collaboration.

Paper Number: 619

Thursday, 05 July 2018 | Colosseum 2

Symposium 29 - Spatial analysis to support conservation and restoration planning for tropical tree species

Predicting Dipterocarp Distribution for Prioritizing Conservation Areas in Sabah

Yew Leung Lee

As part of Malaysia's commitments under Target 12 of the Aichi Biodiversity Targets, Sabah needs to implement measures to prevent the extinction of threatened species. However, as the threat status of most plants of Sabah is largely unknown, it is difficult to gauge which species and areas should be targeted. This study focuses on the Dipterocarpaceae, the dominant trees in forests of Sabah, and uses a combination of regional Red List assessments and species distribution models (SDM) to determine which species are most at risk and to predict their distribution across the state. To achieve this, we extracted the locality data for Sabah's 182 Dipterocarp species from herbarium records and expedition inventories. This yielded approximately 15,000 data points covering the period 1938 to 2016. Points without GPSed localities were georeferenced according to GBIF's standard protocols. A reduction analysis was conducted using GeoCAT to assess the species Red List status. SDM were generated with MaxENT using soil association, altitude and four bioclim layers (Bio1, Bio12, Bio13, Bio 14). The models that passed the criteria for inclusion (test AUC > 0.7) were selected to make presence-absence maps based on the Maximum Training Sensitivity and Specificity threshold. We combined the SDM outputs to produce a heat map showing dipterocarp diversity patterns across the state, as well as the occurrence of threatened dipterocarp. Of the 49 species that have undergone a regional Red List assessment,

55.1% are considered to be threatened, of which 25.9% are Critically Endangered (CR). Species distribution models have been generated for 37 species to date, with the AUCs for these models averaging 0.7741. Soil association was the environmental layer that contributes the most to these models. Our preliminary heat maps indicate two areas in the state of high dipterocarp diversity. The first was the lowland coastal hill areas in the west of the state, and secondly an east coast region centre around the Deramakot and Segaliud Lokan Forest Reserves. While some of these areas fall within protected areas, most are either gazetted as Production Forest Reserve or State Land. These heat maps can be overlaid with recently developed forest quality maps to identify new areas to be set aside for conservation by the Sabah Forestry Department.

Paper Number: 944

Thursday, 05 July 2018 | Colosseum 2

Symposium 29 - Spatial analysis to support conservation and restoration planning for tropical tree species

Plant material transfer guidelines of important tropical tree species and its application for forest rehabilitation

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Plant material transfer zone or seed transfer zone, represents an area in which natural genetic exchange occurs for a particular plant species, whereby transfer of plant materials within the designated zone should have no inherent risk. Plant material transfer guidelines are strategies used to restrict movement of plant materials to ensure that the plants will be adapted to the site of interest. At Forest Research Institute Malaysia (FRIM), genetic information generated through years of comprehensive genetic studies on five important tropical tree species, namely *Neobalanocarpus heimii* (Chengal), *Gonystylus bancanus* (Ramin melawis), *Shorea platyclados* (Meranti bukit), *Koompassia malaccensis* (Kempas) and *Aquilaria malaccensis* (Karas), has enabled the establishment of the first plant material transfer guidelines in Malaysia. The plant material transfer zones of each species were delineated based on the respective genetic structure inferred from chloroplast DNA and microsatellite analyses. With the availability of the guidelines, the risk of introducing maladapted genotypes can be minimized to prevent poor seedling establishment during enrichment or rehabilitation programmes, which is a common practice in Malaysia to improve the stocking density for future yield and quality of the forest.

Paper Number: 152

Thursday, 05 July 2018 | Colosseum 2

Symposium 29 - Spatial analysis to support conservation and restoration planning for tropical tree species

Life history approach to develop genetic conservation guidelines of forest tree species in the tropics

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Tropical forests are rich in plant species diversity, as such obtaining adequate knowledge to set genetic conservation guidelines for the majority of these species is almost impossible. Thus, we propose that for the conservation of tree species, the species can be grouped according to their life history traits. The information generated for a particular species can then be adopted to species that share similar life history traits. Accordingly, in order to conserve forest tree resources in Malaysia, to date, we have generated genetic information for 11 important tree species (*Shorea lumutensis*, *S. leprosula*, *S. parvifolia*, *S. platyclados*, *Hopea bilitonensis*, *H. subalata*, *Neobalanocarpus heimii*, *Koompassia malaccensis*, *Intsia palembanica*, *Gonystylus bancanus* and *Aquilaria malaccensis*) with various life history traits. The genetic information generated was translated into in situ and ex situ conservation guidelines, plant material transfer guidelines and germplasm collection guidelines. For the in situ conservation guideline, there are two major factors to be considered during site selection, i.e., the geographical location and the size of identified conservation areas or minimum population size. The life history approach will allow the prediction of minimum population size for effective conservation of tropical forest tree species.

Paper Number: 181

Thursday, 05 July 2018 | Colosseum 2

Symposium 29 - Spatial analysis to support conservation and restoration planning for tropical tree species

Genetic diversity assessment of *Intsia palembanica* and its implications for conservation

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Intsia palembanica is a high-value widespread timber species in Malaysia. It belongs to the family Leguminosae. This heavy hardwood is in demand for hardwood flooring and also used for furniture and musical instruments such as drum frames and the necks of guitars. High demand of this species has driven to over-exploitation and the threat of illegal logging further jeopardises its sustainability. Hence, a comprehensive population genetic study has been conducted with the aim of safeguarding and sustainable utilisation of its genetic resources. A total of 39 populations of *I. palembanica* across its major distribution ranges in Peninsular Malaysia were investigated at 14 polymorphic microsatellite loci (181 observed alleles) and four chloroplast DNA regions (six haplotypes identified). The *I. palembanica* populations showed a moderate high genetic diversity (microsatellite gene diversity, mean $HE = 0.5971$; chloroplast haplotype diversity, $hT = 0.741$) and low genetic differentiation ($F_{st} = 0.0263$). Simulation test on optimum population size showed that 630 individuals were required to maintain 95% of its genetic diversity. STRUCTURE analysis divided the *I. palembanica* populations from Peninsular Malaysia into northern and southern genetic clusters. These two major groups will be considered as two unique clusters for conservation purposes. Based on the genetic information, we proposed three conservation guidelines for sustainable management of this species: 1) in situ conservation, 2) ex situ conservation and 3) plant material transfer.

Paper Number: 151

Thursday, 05 July 2018 | Colosseum 2

Symposium 29 - Spatial analysis to support conservation and restoration planning for tropical tree species

SYMPOSIUM 30.1

Trophic interactions in human-modified tropical landscapes

Functional diversity is a poor representation of ecosystem functioning changes caused by habitat disturbance

Cristina Banks-leite

It is generally expected that landscape changes, such as habitat loss and fragmentation, should negatively affect functional diversity metrics, which in turn impact ecosystem functioning. But how much evidence is there to support the use of functional diversity metrics in tropical regions? We searched for studies conducted in the tropics in the last 10 years to understand how different aspects of landscape change affect functional diversity metrics and how the latter are associated to ecosystem functioning. In total, we found 24 papers that assessed the effects of landscape metrics on functional diversity, evenness, divergence and composition, and although there was a general trend for functional diversity metrics to improve with habitat cover, we found a wide range of responses. Most surprisingly, however, we only found five studies from the tropics assessing the extent to which functional diversity metrics were correlated to measures of ecosystem functioning, and in general, very weak support was found. In conclusion, our results show that it is crucial to first investigate the level to which functional diversity metrics truly represent or may lead to changes in ecosystem functioning, and this is particularly important for animal communities in the tropics. We highlight cases where the functions of e.g. pest control, as measured by traits in predators, do not correlate with actual changes in prey abundances, because although while one predatory taxa may be impacted by habitat loss, another may be benefited. Without such confirmation, there is little reason to pursue further work to reach a consensus regarding how landscape modification affects functional diversity metrics.

Paper Number: 459

Thursday, 05 July 2018 | Petra 1

Symposium 30.1 - Trophic interactions in human-modified tropical landscapes

Dung Beetle and Mammal Interaction Networks Across a Multi-Use Landscape in Sabah

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Habitat degradation and modification of tropical forests reduces species richness and diversity. However, the cascading functional consequences of these anthropogenic changes remain poorly understood despite many studies on their impact. An overlooked component of biodiversity loss is the extinction of ecological interactions. These extinctions are important as they often accompany or precede species loss. This may stimulate local extinction of dependent and associated taxa with disruption to ecosystem functioning. Loss of large-bodied mammals, through hunting, habitat degradation and fragmentation is one of the most significant anthropogenic impacts on the environment. We investigated the cascading effects of these extinctions across a habitat gradient, focusing on the highly important interaction networks among mammals and dung beetles. Networks were constructed across a habitat gradient from protected forest, through secondary and recently logged forests to agroforestry, mosaic plantation and oil palm in the UNDP-GEF multi-use project area in south-eastern Sabah. Networks were constructed for nine mammal dung types commonly found within the area: herbivores (1) bali cattle, (2) elephant, (3) sambar deer; omnivores (1) human, (2) sun bear, (3) civet, (4) pig, (5) orang utan; carnivores (1) cat. We assessed how dung beetle – mammal interaction networks changed across the land-use gradient. Twelve transects were established across the land use gradient with pitfall traps baited with the different dung types. Only few studies show the first quantitative mammal-dung beetle networks for South-East Asia. Although most dung beetle species were found to be fairly generalist across the different dung types, we found reductions in diversity and changes in the composition and abundance of dung beetles across the habitat gradient. There were corresponding changes in network structure across the gradient with a concurrent reduction in the diversity of interactions. This resulted in simplified networks in perturbed systems. This study highlights the importance of species change and their ecological interactions when ecosystems are modified.

Paper Number: 257

Thursday, 05 July 2018 | Petra 1

Symposium 30.1 - Trophic interactions in human-modified tropical landscapes

Tree and bird communities show parallel responses to loss of forest cover in a human-modified landscape in central Panama

Daisy Dent

Tropical landscapes are rapidly shifting from continuous tracts of undisturbed forest to complex landscape mosaics of primary forest fragments, degraded forest, regenerating forest and agricultural land. Human-modified landscapes cover increasingly large areas across the tropics and yet less than 10% of the tropical forest biome is strictly protected. Therefore, the long-term conservation of tropical forest biodiversity is dependent on human-modified landscapes to maintain viable populations of tropical forest species. To quantify the conservation potential of human-modified landscapes, we conducted forest inventories and bird point counts across an agricultural landscape in central Panama. We surveyed key components of these landscapes including living fences, remnant forest and regenerating forest patches. Specifically we investigate 1) how species composition compares with that of neighbouring continuous forest within protected areas, 2) whether species characteristics or life-history traits can explain abundance across the landscape, and 3) if habitat fragmentation and disturbance have similar impacts on tree and bird communities.

A total of 454 tree species were found across the landscape, including 244 (or 81%) of the species that were present in neighbouring primary forest. Species overlap with primary forest was greatest in remnant forest (72%) and lowest in living fences (47%). The most abundant species across the landscape (i.e. those present in the greatest number of sites) tended to have low shade-tolerance and/or human-uses (e.g., fruit trees, or trees suitable for animal fodder or fencing). In contrast, species present in old-growth forest but absent from the agricultural landscape tended to have large, animal dispersed seeds. For birds, 260 species were recorded in the landscape. Although species richness did not vary greatly between habitat types, there habitats differed significantly in community composition. Species overlap with continuous forest was highest in remnant forest fragments (76%) and lowest in living-fences and isolated trees (41%). The number of bird species present in forest fragments decreased with increasing distance from continuous forest. Some functional guilds were disproportionately affected by landscape disturbance including understory insectivores and large-bodied frugivores. Our data indicate that while human-modified landscapes may provide suitable habitat for many forest species, the loss of certain bird guilds may inhibit key ecosystem processes such as seed dispersal, with knock-on effects for plant communities that have not yet been fully realised. Detailed studies are needed to determine the mechanisms that maintain species populations across these complex landscapes.

Paper Number: 493

Thursday, 05 July 2018 | Petra 1

Symposium 30.1 - Trophic interactions in human-modified tropical landscapes

Effect of tropical forest disturbance on the competitive interactions within a diverse ant community

Ross Gray

Understanding how anthropogenic disturbance influences patterns of community composition and the reinforcing interactive processes that structure communities is important to mitigate threats to biodiversity. Competition is considered a primary reinforcing process, yet little is known concerning disturbance effects on competitive interaction networks. We examined how differences in ant community composition between undisturbed and disturbed Bornean rainforest, is potentially reflected by changes in competitive interactions over a food resource. Comparing 10 primary forest sites to 10 in selectively-logged forest, we found higher genus richness and diversity in the primary forest, with 18.5% and 13.0% of genera endemic to primary and logged respectively. From 180 hours of filming bait cards, we assessed ant-ant interactions, finding that despite considered aggression over food sources, the majority of ant interactions were neutral. Proportion of competitive interactions at bait cards did not differ between forest type, however, the rate and per capita number of competitive interactions was significantly lower in logged forest. Furthermore, the majority of genera showed large changes in aggression-score with often inverse relationships to their occupancy rank. This provides evidence of a shuffled competitive network, and these unexpected changes in aggressive relationships could be considered a type of competitive network re-wiring after disturbance.

Paper Number: 378

Thursday, 05 July 2018 | Petra 1

Symposium 30.1 - Trophic interactions in human-modified tropical landscapes

Diet shift of mobile predators in response to habitat disturbance

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Loss and degradation of pristine forest in the tropics has led to a pressing need to understand the conservation value of degraded forest. Studies conducted over the last decade suggest that forests in the late stage of recovery, and with high percentage of native cover, can support levels of species richness close to that of intact forests. In contrast to the large number of studies that have examined impacts of forest degradation on taxonomic composition and species richness, the extent to which ecosystem functioning is impaired by such habitat modification has received much less attention. To examine how forest degradation influences trophic structure and associated ecosystem functions, we focused on the dietary response of an important guild of apex predators, insectivorous bats. We applied stable isotope analyses to estimate the trophic position and dietary niches of multiple predator species across a landscape-scale, and assessed how these metrics are influenced by forest degradation. By summarising complex dietary information, stable isotope analyses allowed us to move beyond taxonomic responses and gain insights into energy pathways. We calculated population-level dietary metrics from 300 bat individuals sampled across 12 locations, which differ in previous logging intensity. Feeding niches contracted significantly with reduced forest quality and quantity, and this reduction was more pronounced for degradation at the landscape scale. Dietary niche contracted by 78% as forest cover over the 1 Km extent declined from 100% to 70%. This relationship was independent of species, implying a general responses across different guilds of mobile predators. Our results reveal the negative consequence of relatively minimal forest degradation for trophic interactions, and suggest that functionally-important shifts in trophic pathways may be uncoupled from changes in species composition and identity. This is particularly important in tropical forests which provision countless ecosystem services and products, signposted by their high priority focus in the context of the CBD 2020 targets for Biodiversity.

Paper Number: 346

Thursday, 05 July 2018 | Petra 1

Symposium 30.1 - Trophic interactions in human-modified tropical landscapes

SYMPOSIUM 31

Advances in the understanding of tropical bats as pollinators and seed dispersers

Role of specialized and facultative nectar-feeding bats in the pollination network in the agricultural system

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Recent advances in the study of pollination networks have improved our ability to describe species interactions at the community level. In this study, we compared the abundance and network strength of facultative and obligate nectar-feeding bats to determine their roles in pollinating mixed fruit orchards. We were particularly interested in the effect of distance from forests and caves on the foraging activity of these two bat groups. For this study, we examined 10 pairs of orchards; each pair consisted of one orchard near to (< 1 km) and one orchard far from (> 7 km) the forest edge. We estimated the abundance of each bat group (nectarivorous vs. frugineectarivorous) using video observations to determine floral visitation rates. A pollination network was then created for each of the 20 study orchards and network strength was calculated for each bat group at each orchard. We found that nectarivorous bats showed higher abundance and network strength than frugi-nectarivorous bats. Both bat abundance and network strength were negatively correlated with distance to the nearest cave, however, only network strength was affected by distance to the forest. These results corroborate the importance of nectarivorous bats in pollinating crops within southern Thailand's mixed fruit orchards. Higher network strength of bats near forests and caves emphasizes the role of natural habitats as pollinator sources.

Paper Number: 176

Thursday, 05 July 2018 | Petra 2

Symposium 31 - Advances in the understanding of tropical bats as pollinators and seed dispersers

Flying foxes, plants, and people: conserving an uncharismatic animal of ecological and economic importance

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Pteropodid bats perform important ecosystem services through pollination and seed dispersal. Yet it is predicted that many in Southeast Asia will become globally extinct by the end of this century, with flying foxes (Pteropodidae: Pteropus spp.) being of particular concern due to hunting. And, although interactions between flying foxes and plants provide us with many benefits, it can also cause conflict with humans. There is now a widespread consensus that flying fox conservation and monitoring must be prioritised within the region. The urgency of this situation is particularly exemplified by Malaysia, where a combination of relentless hunting pressure, agricultural expansion, and lack of conservation attention has drastically reduced the numbers of its two flying fox species. This may have negative implications for the country's ecosystems, especially on islands. In order to support conservation action, there is an urgent need to identify and understand the ecological roles of these threatened bats. Effective mitigation of human-bat conflict is also needed. Project Pteropus was initiated by Rimba to meet these needs. Data on the island flying fox *Pteropus hypomelanus* on Tioman Island were collected to support flying fox conservation. A questionnaire survey showed that local people have low awareness of bat ecosystem services, and negative attitudes towards *P. hypomelanus* are due to concerns over noise, hygiene, and fruit raiding in orchards and gardens. Next-Generation Sequencing of *P. hypomelanus* droppings suggests that the diet of this species is actually dominated by wild figs. Lastly, camera-trapping revealed the role of flying foxes as pollinators of the durian tree *Durio zibethinus*, which produces commercially important fruit. This project thus helps us to better understand the situation of flying foxes in Malaysia, and to argue for the conservation of bats and forests. It also shows that it is imperative to protect flying foxes and their habitats, conduct education and outreach activities on flying foxes, and initiate efforts to mitigate conflict between flying foxes and humans.

Paper Number: 102

Thursday, 05 July 2018 | Petra 2

Symposium 31 - Advances in the understanding of tropical bats as pollinators and seed dispersers

Big roles from big bats!

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Flying foxes (genus *Pteropus* and *Acerodon*) play a critical role in stable ecosystems as seed dispersers and pollinators. These services are indispensable for the propagation of ecologically important native species and production of economically important cash crops. However, flying foxes are threatened by intense hunting and habitat loss in many parts of their distribution making them one of the most threatened bat taxa, particularly in Indonesia. Scientific data on flying fox ecosystem services are lacking, yet these data can be a crucial component to government prioritization of flying fox conservation. This study aims to investigate 1) flying fox pollination services for durian using a pollination exclusion experiment and camera trapping, and 2) seed dispersal and pollination services for native plants by identifying pollen samples collected from fur. We conducted our study in Sulawesi for eight months (May to December 2017) and confirmed that bats were the primary pollinators of durian. Based on camera trap data, another pteropodid, *Eonycteris spelaea*, had the highest mean duration of visit (116.87 sec/visit) compared to *Pteropus alecto* (11.07 sec/visit) and *Acerodon celebensis* (11.60 s/visit). However, the average level of durian fruit set was higher in flowers that were visited by both other pteropodids and flying foxes, compared to flowers that were only visited by other pteropodids. This result suggests that flying foxes are presumably more effective than pollinators because they can deposit larger loads of pollen and move them over longer distances. Additionally, we collected pollen samples from 52 individuals of *Pteropus griseus* and 33 individuals of *A. celebensis*. Pollen usually acts as a proxy for pollination services, and simultaneous flowering and fruiting of tropical plants means that pollen may also indicate fruits eaten and potential seed dispersal services by the flying foxes. We found that *P. griseus* used flower resources more compared to *A. celebensis*, which mainly consumed fruits. This suggested that *P. griseus* were pollinators whereas *A. celebensis* were seed dispersers. We identified ~16 plant species used by both flying fox species, several of which were economically valuable to local livelihoods and ecologically essential to the Sulawesi rainforest. These findings link the health of flying fox populations to both the health of the local economy and ecosystem. Conservation of flying foxes in Sulawesi should be promoted to prevent the loss of productivity of plant species that rely on them.

Paper Number: 145

Thursday, 05 July 2018 | Petra 2

Symposium 31 - Advances in the understanding of tropical bats as pollinators and seed dispersers

Utilisation of DNA Barcoding in Assessing the Diversity of Bats and Their Phytophagous Diet in Peninsular Malaysia

Voon Ching Lim

The bat diversity of Peninsular Malaysia was previously assessed through morphological identification of captured bats while the diet of plant-visiting bats of the region were examined through morphological identification of seeds and pollen grains collected from bats. Yet morphological identification is often of limited service when applied to identification of morphologically similar bat and plant species. The objective of this research is to use a molecular approach, DNA barcoding to examine the diversity of bats and their plant-based diet in Peninsular Malaysia. Through literature review and Neighbour-Joining analyses of DNA barcodes available from bats sampled in Peninsular Malaysia, at least 110 bat species have been documented in the region and eighteen of them are species complex which deserve further investigation. The diet of frugivorous bat, *Cynopterus brachyotis* at secondary forest, oil palm plantation and urban area were compared by identifying pulps and seeds found in bats' faeces using DNA barcoding which utilises Sanger sequencing. Native and introduced plants were detected from bat faeces at all sampling sites, suggesting the dual role of *C. brachyotis* in dispersing (i) native plants which aid in forest regeneration, and (ii) introduced plants which potentially facilitate their invasion. The diet of nectarivorous bat, *Eonycteris spelaea* at urban area was examined by identifying plant material present in bat faeces using DNA metabarcoding which utilises next-generation sequencing. Many plant species which were detected from the bat faeces have not been reported in previous dietary studies of *E. spelaea* including ferns and figs, consequently suggesting that *E. spelaea* may not be specialized nectarivore. Therefore, the use of DNA barcoding has highlighted the taxonomic uncertainties in bats and provided new insights into diet of plant-visiting bats.

Paper Number: 628

Thursday, 05 July 2018 | Petra 2

Symposium 31 - Advances in the understanding of tropical bats as pollinators and seed dispersers

Reproductive biology of a critically endangered mangrove, *Sonneratia griffithii* Kurz 1871, in Satun province, Thailand

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Sonneratia griffithii is a true mangrove species that grows up to 25 m and towers above the other *Sonneratia* species in Satun Province, Thailand. It is rare, locally extinct in some areas of its original range, and was previously observed to have low seed viability. Hence, is it classified by the IUCN Redlist as Critically Endangered. This study focuses on the species' reproductive biology. Floral biology traits, including morphology, anthesis, nectar production, and pollen-ovule ratio, were determined from two small populations in Satun Province, Thailand. Flowers were used in a pollination experiment with five treatments (open pollination, insect pollination, hand-cross pollination, and hand-self pollination). Results show that *S. griffithii* blooms seasonally during the rainy season, displays xenogamous characteristics (herkogamy and protogyny), and has a pollen- ovule ratio indicating facultative xenogamy. Results from the pollination experiment showed that *S. griffithii* is partially self-compatible (30% of hand-self pollinated flowers transitioned to fruits). However, probably because of the small sample sizes, no significant differences were identified among the treatments. Instead, fruit set was influenced by location, rather than treatment. *Macroglossus minimus* and *Eonycteris spelaea* are presumably the most common pollinators of *S. griffithii*, as they were the only bat species netted near the flowers. Further research is needed on this critically endangered species, particularly regarding its pollinators and ecology, which may help explain why fruit set varied by location.

Paper Number: 905

Thursday, 05 July 2018 | Petra 2

Symposium 31 - Advances in the understanding of tropical bats as pollinators and seed dispersers

Knowledge, Attitude and Perception among Durian Growers toward Bats Visiting Their Durian Orchards in Kuala Nerus, Terengganu, Malaysia

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Bats play a major role in pollination of durian. However, not many people are aware on the importance of bats in the ecosystem. Bats are always misunderstood as pests, especially among durian growers, thus may threat their survival. This human-bat conflict should be understood in order to avoid continuous population decline. Face-to-face surveys were conducted among 60 durian growers in Kuala Nerus, Terengganu in order (1) to determine the level of knowledge, attitude and perception among the durian growers and (2) to investigate the relationship between socio-demographic and the attitude of these durian growers towards bats visiting their durian orchards. Respondents were asked about their demographic profiles such as age, gender, level of education and occupation. Majority (82%) of the respondents were above 50 years old, with only 37% of them received education at least until secondary school level, while majority (48%) only until primary school level. 57% of the total respondents were males and 43% were females. 68% of the total respondents was with good level of general knowledge (score of 70-100%) on the ecosystem services provided by bats. However, this result does not reflect their attitudes towards bats. 67% of the respondents agreed that bats are dirty and 72% of the respondents showed negative attitudes towards bats by supporting to kill them and agreed that they should not be conserved or protected. There was significant difference between gender among durian growers in level of knowledge as determined by t-test ($p < 0.027$). However, there were no significant difference between gender with attitude and perceptions. There were also no significant difference between age, occupation and educational level of durian growers with level of knowledge, attitude and perceptions. Our results indicate the need for more conservation and education awareness programs in Malaysia, particularly for the durian growers. Our findings can be used as basis to tackle the conflict between humans and bats by providing information and mitigation strategies to support bats conservation efforts in Malaysia.

Paper Number: 120

Thursday, 05 July 2018 | Petra 2

Symposium 31 - Advances in the understanding of tropical bats as pollinators and seed dispersers

SYMPOSIUM 32.1

Frontiers in demographic modeling for tropical forest ecology and conservation

Are there synergistic effects of drought and fragmentation on the demography of tropical understory plants?

Emilio Bruna

Forest fragmentation and drought are major threats to biodiversity, particularly in tropical forests. It has therefore been hypothesized that they could act synergistically to further reduce population viability in fragmented landscapes. This is thought to be particularly true for tropical plant species, for which many of the observed local extinctions from fragments are attributed to changes in abiotic conditions. To date, however, this hypothesis remains untested for three primary reasons. First, most studies elucidating how tropical plants respond to fragmentation have studied either juvenile (i.e., seed, seedling) or larger, reproductive plants. Second, there is a growing literature on how tropical plants respond to severe droughts, but few studies have compared the responses of plants in continuous forest with those in fragments. Finally, the long-term data needed to test population-level hypotheses about climate change-fragmentation synergies are scant, especially for tropical systems. However, without multi-decadal sampling one cannot capture enough droughts to quantify their ecological impact, nor the variation in vital rates needed to parameterize demographic models of long-lived species in changing climates. Long-term data are also needed because while some demographic effects of fragmentation or drought on can be detected immediately, others may take years to manifest.

Since 1997 we have been conducting annual demographic censuses of populations of the understory herb *Heliconia acuminata* in an experimentally fragmented landscape in the central Amazon. We use this dataset, coupled with the results of prior experiments and climatic data, to test of the hypothesis that plant population viability in fragmented landscapes decreases with increased drought frequency and intensity. We addressed three questions: (1) Do drought events decrease post-seedling plant growth and survivorship, how is this influenced by plant size and demographic history, and are these effects exacerbated in fragments relative to continuous forest? (2) How do forest fragmentation and drought interact to influence plant reproduction, seedling establishment, and seedling survivorship? (3) Do the observed changes in vital rates interact to increase the probability of extinction in fragments relative to that in continuous forest? Our results to date suggest that the effects of drought on growth are exacerbated in fragments, and that they have far greater impacts on population growth rates than the low and persistent recruitment of seedlings in fragments.

Paper Number: 920

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.1 - Frontiers in demographic modeling for tropical forest ecology and conservation

Relating demography and primary productivity among tree species and across forests

Takashi Kohyama

Whether large biomass stocks and fast turnover promote the coexistence of many tree species in tropical rain forests remains a challenge. The data from repeated tree census in forest plots is often independently used to describe various forest properties; e.g., (i) interspecific variation in recruitment, growth and mortality (species demography), (ii) stand-level tree demography of all stems, and (iii) forest biomass turnover rates (wood production and loss). Forest-level estimates of recruitment, mortality, biomass production and loss are all influenced by interspecific variation, and we need to use a generic, and unbiased procedure for estimating these rates jointly for tree species and forests. Using this procedure, we can relate forest biomass, productivity and interspecific demographic differentiation, and examine the linkage between ecosystem and population processes. If a tree population shows stable stem size distribution (while population size can either be increasing or decreasing), the net relative growth rate of biomass (RB, i.e., relative production rate minus relative loss rate) is the same as the net relative growth rate of tree number (RN, i.e., per-capita recruitment rate minus mortality). In contrast, if a species population is in a transient state, RB is not equal to RN, such that $RN < 0$ and $RB > 0$ in an interim stage of regeneration. Comparison of tree species in Southeast Asian rain forest shows that species properties in a forest are variable in the combination of RB and RN with their positive correlation. It also shows that species-level relative production rate and per-capita recruitment rate decrease with species biomass (but not with stem density of species). These conditions partly support the theoretical prediction of foliage partitioning for stable coexistence. Cross-forest comparison suggests that stand-level relative production rate increases with stand biomass. High biomass and high per-biomass productivity in tropical rain forests would jointly facilitate species coexistence.

Paper Number: 272

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.1 - Frontiers in demographic modeling for tropical forest ecology and conservation

Using Integral Projection Models to study the effects of forest fragmentation on the population dynamics of a late-successional tropical tree

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The investigation of fragmented tropical landscapes has severely increased in recent years, with many studies documenting decreased biodiversity and species persistence due to habitat fragmentation. But to date, we still lack a basic understanding of the demographic mechanisms behind the declines of fragmented plant populations, especially for long-lived tree species. Most of our understanding comes from matrix demographic approaches that have some limitations when dealing with life cycles that are best described as a continuous variable. Integral projection models (IPM) have recently emerged as a valuable alternative, as they allow for the modeling of population dynamics based on both continuous and discrete state variables.

In this study, we examined the demographic effects of forest fragmentation by comparing the population dynamics of the late-successional tree *Poulsenia armata* (Moraceae) at Los Tuxtlas forest, southern Mexico, between a continuous forest and several forest fragments using IPMs. As a distinctive tree species with a broad geographic range, occurring in forests from Mexico to Bolivia, *P. armata* can act as an indicator of long-term viability of remaining forest fragments.

Though forest fragmentation did not consistently reduce population density, and it even resulted in higher population growth rates, the dynamics of fragmented populations of *P. armata* differed considerably when compared to the continuous populations. Fragmented populations shifted towards smaller sizes and experienced a significant decrease in juvenile survival and growth compared to populations in the continuous forest. Moreover, we found low damping ratios, suggesting a slow recovery for *P. armata* after disturbances, potentially jeopardizing the persistence of fragmented populations of this tree species.

The lack of regeneration of tropical late-successional species is of critical concern for the long-term persistence of biodiversity in fragmented landscapes. Los Tuxtlas area is characterized by a recent history of intense anthropogenic activities altering demographic parameters of *P. armata*, threatening the capacity of this tree species to withstand foreseeable changes in the environment. In summary, our results demonstrate the importance of developing a quantitative understanding of how forest fragmentation affects population dynamics of dominant species for predicting the conservation status and fate of forest ecosystems.

Paper Number: 559

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.1 - Frontiers in demographic modeling for tropical forest ecology and conservation

Variation in germination and survival of early life history stages affects the population growth of palms across their elevational ranges.

Rachel Hillyer

Understanding species responses to climate change is fundamentally a question of species performance and distribution across environmental gradients. In the face of climate change, one option species have is to shift their geographic ranges to respond to changing temperatures, precipitation, and other climatic variables. Montane forest species are expected to shift ranges upslope. Early life history stages will form the leading edges of any movement in species ranges, and will likely exhibit differential abilities to germinate and survive outside of their ranges. However, these differences may or may not translate into meaningful changes in population sizes.

Seeds from five species of Neotropical arborescent palms were transplanted along an elevational gradient (600 m to 2000 m) in the Peruvian Andes within and outside of their elevational ranges. This transplant experiment was used to quantify seed survival, germination, germinant survival, and the transition from germinant to seedling along an elevational gradient, and to study the effect of environmental factors (elevation, percent canopy openness) and species characteristics (seed volume, range) on the occurrence probability of early life history events. A life table response experiment was used to test if the population growth of species can respond to changes in survival and germination across species elevational ranges. The survival of early life history stages and transition rates between stages varied with elevation but not in predictable ways, with high variability even among closely related species. Species ranges did not always coincide with increasing or decreasing germination, survival, and population growth; some species had higher germination and survival rates beyond the upper limit of their elevational range. These findings suggest that, if they are not limited by dispersal, there is the potential for some species to shift their ranges upslope.

Paper Number: 924

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.1 - Frontiers in demographic modeling for tropical forest ecology and conservation

Low reproductive values confer resilience of mangrove species to harvest

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The ecology of harvesting timber products has been widely investigated to inform management strategies of forests. However, these studies rely strongly on two major assumptions: i) more seedlings predispose for positive population dynamics, and ii) more adult trees is a guarantee for a strong reproductive capability of the population. These assumptions are applied without accounting for the life history of the harvested species. Here, we revisit these assumptions in light of the life history theory, which predicts different responses of short- and long-lived species to perturbation. We predict that harvesting late life stage of long-lived species, rather than reducing seedling density, would have greater impact on their population dynamics. We tested our prediction on three mangrove species in South Africa. First, we reconstructed the projection matrices for three mangrove species in the Mngazana Estuary of Eastern Cape, South Africa (*Bruguiera gymnorrhiza*, *Rhizophora mucronata*, *Avicennia marina*). Next, we simulated various harvest intensities of different life stages and explored how different harvest intensities influence the population dynamics of each species. Finally, we examined the age-specific mortality trajectories for all three species. We found that the populations of all three mangrove species were closer to their stable stage distribution. Contrary to popular belief, we also found that reducing or increasing density of seedling will have minimal effects on the dynamics of the three mangrove species, a finding that matches the prediction of the life history theory. However, contrary to expectation, increasing mortality of large individual life stages through harvesting had minimal effect on population dynamics. This is due to low residual reproductive value for these late stages. Our analysis of age-specific mortality trajectories further provided evidence for positive senescence particularly for *Avicennia* which was the least resilient to harvest. Our findings cast doubt on the traditional forest management strategies that rely strongly on seedling density as a metric of sustainability and forbid unquestionably harvesting old or large individuals. We call for caution while generalizing forest management strategies irrespective of the life history of the species at hand.

Paper Number: 37

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.1 - Frontiers in demographic modeling for tropical forest ecology and conservation

Beyond density-dependence alone: How density-dependent and independent mechanisms together determine species abundance in a common tree species.

Marco Visser

Stable coexistence requires that tree species have positive population growth rates at low density, and negative rates at high density. Yet few studies empirically quantify such population-level density-dependence, and none have evaluated the relative importance of all underlying demographic processes. We used high resolution aerial pictures to quantify landscape-scale variation in adult density on Barro Colorado Island, in Panama. We used this to select ten nearby locations varying 20-fold in population density of a common tropical palm species *Attalea butyracea*. Subsequently, we established 10 4-ha field plots and followed the fate of seeds, seedlings and adult palms from 2007 to 2012. We measured all vital rates (growth, survival and reproduction) and quantified density dependence in these rates, and then applied density-dependent Integral Projection Models to integrate vital rate functions across the life cycle. Estimated population growth rates were positive at low density and negative at high density, mainly due to negative density dependence of seedling establishment. Invasion growth rates and projected equilibrium density, however, were mostly determined by transition rates of density-independent life stages that reflect light limitation. Our results show that the combined effects of (density-dependent) regulating and (density-independent) limiting factors drive abundance and demography in these populations.

Paper Number: 457

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.1 - Frontiers in demographic modeling for tropical forest ecology and conservation

SYMPOSIUM 33

Lianas and their impact on ecosystem processes

Pervasive decline in lianas in Congo basin contrasts with global patterns

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Lianas, woody climbing plants, are increasing in many tropical forests, with cascading effects such as decreased forest productivity, carbon sequestration, and resilience. Possible drivers are increasing forest fragmentation, CO₂ fertilization, and drought. Determining the primary changing species and their underlying vital rates help explain the main issues. We monitored 17,000 liana stems for 13 years in 20 ha of old-growth forest in the Congo Basin and evaluated changes and vital rates for the 78 most abundant species. The total abundance of these species declined from 13,131 lianas in 1994 to 8,736 in 2007. Over one third (36%) of these species have significantly declining populations. Declining species had higher mortality and lower recruitment rates but similar growth rates compared to other species. Species change was independent of lifetime light requirements, climbing-, and dispersal mechanism. The main drivers underlying global liana increase do not hold here. We suggest the warfare to have decimated the elephant population, leading to forest closure and declining liana numbers. In this tropical forest, local stand dynamics override more global drivers of liana change resulting in liana decline which sharply contrasts with the increasing lianas worldwide.

Paper Number: 161

Thursday, 05 July 2018 | Giza

Symposium 33 - Lianas and their impact on ecosystem processes

Linking landscape-scale liana infestation to carbon storage using airborne hyperspectral imagery

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Increasing biomass and abundance of lianas relative to trees may lead to reduced forest carbon storage. Yet, the impact of lianas on carbon sequestration and storage is understudied in large-scale tropical forests, especially in the Palaeotropics. Remote sensing techniques provide potential tools to map lianas at large spatial scales, which is key to understanding the mechanisms that drive their distribution and quantifying their effects on forest carbon storage. Here, we therefore combine high-resolution airborne hyperspectral imagery with a ground-based tree canopy census to map the distribution of liana infestation in tree canopies based on the difference in spectral response of trees and lianas in Danum Valley, Malaysia. Using image segmentation combined with a neural network model, our preliminary results show that we achieved an accuracy of 64% (F-score: 0.37) for the prediction of liana infestation into three classes (0-40%, 41-69%, 70-100%). Considering the spectral response of lianas and trees are less pronounced in wet tropical forests, this approach shows promising results to map lianas at the landscape scale. Additional extensive ground sampling is required to increase sample size, especially for trees with heavy liana infestation, and provide validation to the liana infestation map. An accurate map of liana canopy cover provides a highly effective method to relate landscape-scale interactions between liana infestation and forest dynamics including carbon storage and forest structure. Using high resolution LiDAR imagery we formed a carbon storage map across the primary forest of Danum Valley. Relating these spatial patterns will help determine the impact lianas have on the role of tropical forests in the global carbon cycle.

Paper Number: 258

Thursday, 05 July 2018 | Giza

Symposium 33 - Lianas and their impact on ecosystem processes

Branch development helps explaining the greater success of lianas over trees in dry compared to wet forest.

Frank Sterck

Lianas, as structural parasites, use the structural investment and wide arrange of morphological features of trees for support and to reach the canopy to capitalize on light interception. This has negative consequences for the ecosystem given that lianas have negative impacts on tree growth, reproduction, and survival. By using two canopy cranes, we followed the development of ~260 branches from 16 lianas and 16 tree species in a tropical dry and wet forest in Panama for a period of 17 months to expand our understanding of the liana strategy at the canopy level. As expected, lianas also developed less axillary shoots and concentrated most of its growth into primary extension, suggesting that lianas have a more active forage strategy for good canopy conditions compared to trees. In addition, liana branches allocated more resources into branch elongation and leaf production than trees, and this was particularly the case in the dry forest. Tropical forests canopies are highly diverse environments determined by the complex distribution of branches and foliage. We conclude that the ability of lianas to invest most of the resources into photosynthetic biomass and allocate it in a more efficient display may favour lianas over trees, particularly in dry forests.

Paper Number: 658

Thursday, 05 July 2018 | Giza

Symposium 33 - Lianas and their impact on ecosystem processes

Lianas Decrease Biomass Accumulation in Early Successional Tropical Forests

Sergio Estrada-Villegas, Michiel van Breugel, Jefferson Hall, Stefan A. Schnitzer

Introduction. Succession is a fundamental process by which ecosystems gain species and biomass as they recover from disturbance. Understanding tropical forest succession today is crucial because old-growth forests are being replaced by secondary forests at an alarming rate, and these secondary forests are expected to mitigate climate change via rapid accumulation of atmospheric carbon. However, the abundance and biomass of lianas (woody vines) has been increasing in Neotropical forests in the past decades, an increase that may alter the speed at which secondary forests accumulate carbon. Lianas recruit rapidly in young tropical forests and may stall tree regeneration due to fierce competition for light and water, thus limiting tree carbon accumulation.

Hypotheses. Lianas may have the strongest effect on trees in the youngest forests if liana proliferation stalls tree growth and regeneration. As the forest matures, trees may shed lianas, thus reducing the negative effects of lianas. Alternatively, lianas may have the strongest effect on trees in older successional forests if the effect of lianas is commensurate with their density, which increases dramatically in the first 30 years of forest regeneration.

Objectives. We tested between these two alternative hypotheses using a multi-forest liana removal experiment in 30 forest stands that ranged from 10-35 years old in the Republic of Panama. We standardized our measurements by tree size so that we had an unbiased comparison of the effects of lianas on both small and large trees across forests of different ages.

Results. We found that liana removal initially increased light availability, and by year four, trees compensated the foliage that was occupied by lianas. Lianas had a relative small effect on small trees. For large trees, however, lianas significantly decreased tree biomass accumulation in early secondary forests. The effect of liana removal for large trees decreased with forest age, supporting the hypothesis that lianas have the strongest effect on trees in very young successional forests. Large trees accumulated more biomass in the absence of lianas in younger forests (compared to controls) even after accounting for the effect of tree crown health and crown illumination.

Conclusions. Our results have important implications: large trees accumulate disproportionate more biomass in tropical forests and continue to be major carbon dioxide sinks as forests age. Therefore, high liana densities at the onset of forest succession, which now appear to be common, reduce biomass accumulation and decrease the capacity of young secondary forests to mitigate climate change.

Paper Number: 593

Thursday, 05 July 2018 | Giza

Symposium 33 - Lianas and their impact on ecosystem processes

Forest resilience to global liana proliferation

Marshall, Platts, Chazdon, Pfeifer

Abrupt change can have catastrophic consequences for ecosystem resilience. Considerable evidence now shows that rapid growth of parasitic lianas (woody vines) after heavy forest disturbance is harming trees on a massive scale and threatening the global carbon sink. Liana research is therefore essential for understanding global forest dynamics and is increasing exponentially, now offering potential to test the mechanism and scale of their impacts. Here we review the liana and resilience literature to introduce a “Liana Threshold Hypothesis”, proposing that lianas act as a major negative feedback to productivity and succession in degraded forests. However, liana vigour declines with environmental drivers (e.g. cold, shaded areas) and hence their influence is not ubiquitous. Furthermore, while many lianas are “parasitoids”, armed with several adaptations to compete with trees, many also act as “bandages”, enhancing forest ecosystem function and protecting from external stresses. We discuss and conceptualise measurement and modelling of the presence and position of a liana threshold, including the drivers, disturbance triggers and biological response indicators. Experimental manipulation and chronosequence studies across multiple regions, combined with change-point detection and dynamic modelling, will likely provide the best opportunities to achieve orthogonality and adequate controls. Our review is intended to set a framework for this vital research that will make fundamental contributions to global ecology, environmental change and forest management.

Paper Number: 959

Thursday, 05 July 2018 | Giza

Symposium 33 - Lianas and their impact on ecosystem processes

Assessing the impact of lianas on tree growth in tropical forests

Elizabeth Kearsley, Geertje van der Heijden, Stefan Schnitzer, Kris Verheyen, Hans Verbeeck

Lianas (woody climbers) are structural parasites and an important component of tropical forests. Due to their strong competition with trees for above and belowground resources, lianas can have a large effect on tree diversity, recruitment, growth and survival, which can further impact tree community composition, carbon storage and carbon, nutrient and water fluxes. Moreover, recent research from the Neotropics has indicated that lianas are proliferating in abundance and biomass related to climate change. Although the drivers behind this liana increase are currently not fully understood, liana proliferation itself can endanger the future of the tropical carbon sink as lianas reduce carbon sequestration and storage in these forests. As tropical forests play an important role in the global carbon cycle, this in turn may lead to increased atmospheric CO₂ concentrations, which may have serious implications for climate change.

In this study, we use a large-scale liana removal experiment conducted in the Barro Colorado National Monument in the Republic of Panama to investigate the impact of lianas on individual tree growth. The impact of varying severities of liana infestation in the crown on tree growth is assessed, while controlling for growth environment (light, neighboring competition) and species identity using structural equation modeling. The impact of lianas is validated with plots that are liana-free. We show that lianas reduce tree annual diameter increment by ~45.4-68.1% dependent on the amount of liana crown infestation. Approximately 18% of this reduction is attributed to belowground competition, while the majority of the impact is caused by aboveground competition.

Paper Number: 436

Thursday, 05 July 2018 | Giza

Symposium 33 - Lianas and their impact on ecosystem processes

Lianas and trees: insect folivory and leaf traits in an Australian subtropical rainforest

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Introduction and objective

Lianas are the second largest primary producer in rainforests and in some forests contribute up to 40% of the leafy biomass. This substantial contribution indicates a likely functional importance of lianas, particularly for herbivores. Much of our understanding of insect herbivory in rainforests comes from the study of large canopy trees and saplings. However, difference in leaf traits between lianas and trees, including, structural chemical, and phenological properties, suggest inferences and conclusions about herbivory gathered from data on trees may not apply to lianas. Information which quantifies the contribution of each functional group, and the roles they play in supporting herbivory is scarce. In this study we aim narrow this knowledge gap. Understanding the roles and relative importance of lianas in rainforests may be of wider significance as liana biomass and abundances increase in response to global warming.

Methods

In May of 2016 and 2017, leaves were collected from 36 liana individuals and 57 individual trees (29 of which hosted the sampled lianas) in a subtropical rainforest in Queensland, Australia. Leaf damage was quantified from 14,746 leaves using the software package ImageJ, and leaf traits such as leaf toughness, total phenols, and elemental concentrations, were determined.

Results

Trait analyses suggest distinct ecophysiological variation in leaf chemistry, leaf structure and herbivory between trees and lianas; and between trees with and without lianas. Liana leaves had greater concentrations of nitrogen and lower quantities of phenols and a significantly lower tensile strength than tree leaves. Leaves from trees associated with lianas had significantly greater foliar nitrogen concentrations and marginally more phosphorus than leaves on trees without lianas. We also found a lack of consistency among the variables influencing herbivory on trees and lianas and variation in the response of herbivory to leaf traits on the different plant types. We also found evidence to suggest lianas mitigate herbivory on their host trees, particularly during times of environmental stress.

Implications and conclusions

We conclude that inferences and conclusions about herbivory developed from data on trees cannot simply be extended to lianas. As lianas are important components of forests and the second largest contributor of primary production in these systems, studies specifically investigating the dynamics of herbivory on lianas (and the impacts this has on their hosts and overall ecosystem functioning), are needed to develop a holistic understanding of herbivory in forests.

Paper Number: 134

Thursday, 05 July 2018 | Giza

Symposium 33 - Lianas and their impact on ecosystem processes

GENERAL SESSION 29.2

Human Influence in Tropical Ecosystems

The most marketable wild edible mushrooms in the northern lowland of Papua, Indonesia

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Mushrooms are one kind of non-timber forest products that play an important role as food and income source for local people nearby. In Papua lowland forest, there are several wild edible mushrooms that have been consumed by local communities. However there is still lack of data on the wild edible mushrooms sold in the market in Papua. Therefore this study was done to collect the information on the most marketable wild edible mushrooms in the market in lowland of north Papua and to assess their antioxidant activity. Survey was conducted in 5 established markets, 4 mobile markets and 6 daily local markets of Jayapura city, Jayapura regency and Keerom regency in Papua province. Wild edible mushrooms were bought, dried and extracted to analyze their antioxidant activity using DPPH method. The results showed that *Pleurotus sajor-caju* and *Volvariella* sp were the most common wild edible mushrooms sold in the market in those areas. Wild edible mushrooms trade was mostly took place in the mobile market and daily local market. The price of fresh *Pleurotus sajor-caju* were IDR 10,000-IDR 20,000 (0.72 USD-1.43 USD) per heap and *Volvariella* sp were IDR 10,000-IDR 30,000 (0.72 USD-2.15 USD) per heap. The mushrooms were gathered from the tropical forest and sago or palm oil plantation nearby the markets and their availability depended on the rainfall. Based on qualitative analysis, both mushrooms showed potential antioxidant activity, but *Pleurotus sajor-caju* has higher activity than *Volvariella* sp. *Pleurotus sajor-caju* contained 15.74% of protein, 2.59 % fat, and 50.17 % carbohydrates, while *Volvariella* sp (sago mushroom) had 1.01 g fat, 1.30 g protein, 0.18 g carbohydrates per 100 g of fresh weight. Both mushrooms show economical and nutritional value which is important to local community. However, infrastructure development altered the mushrooms habitat in the area. Therefore, to maintain the productivity of wild edible mushroom, the conservation of their habitat is a must. Furthermore, study on the wild edible mushrooms cultivation from those area also need to be done.

Paper Number: 292

Thursday, 05 July 2018 | Machu Pichu

General Session 29.2 -Human Influence in Tropical Ecosystems

Linking RSPO Compensation to Village Forest.

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Palm oil is the biggest contributor for Indonesia foreign exchange in 2017 and the major driver for deforestation. RSPO, as a leading organization in certifying Sustainable Palm Oil, has developed a schema (RaCP) to remediate and compensate any deforestation caused by the palm oil company. One of the high priority areas to channel RaCP is village forest (Hutan Desa). This study objective is to assess the feasibility of RaCP in community forests against the RaCP principles of long-lasting, knowledge-based, additional and equitable. Our findings show that channeling RaCP to community forests might provide greater impact on biodiversity conservation, livelihood improvement, and climate change mitigation if it has fulfilled the social, environmental, and institutional safeguards or pass international standard (i.e. Plan Vivo). Our case study shows an increase in community livelihood, forests protection, and carbon sequestration due to better management of forest in Laman Satong Village. With a long support from the RaCP schema, we believe this model can be replicated in another village forests that have complied with international requirements.

Paper Number: 884

Thursday, 05 July 2018 | Machu Pichu

General Session 29.2 -Human Influence in Tropical Ecosystems

The legal basis for Forest Management Units as Conservation practitioners in Aceh Province, Indonesia

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Qanun are provincial regulations which can be used to regulate forest use and management in Aceh. In 2016, Aceh enacted Qanun No.7/2016, replacing Qanun No.14/2002 with the purpose of promoting sustainable forest management. Forest Management Units (FMUs) are part of the Aceh government and were formed based on governor regulation No. 20/2013. FMUs were identified as the institutions able to achieve this goal. There are six FMUs in Aceh divided based on natural watershed boundaries and one based on terrestrial ecosystems (TAHURA Pocut Meurah Intan). These categories are made to ensure optimal management in line with ecological, social and economic principles. In addition, Aceh applied Qanun No.20/2002 which regulates the conservation of natural resources. Thus, there are three policies which regulate forest management and conservation of natural resources. This study aims to find out FMU performance to conserve natural resources as a relatively new decentralised forest manager at the site level. Management Effectiveness Tracking Tool (METT) is used to measure those performances. The survey was conducted in August - October 2017 in three FMUs (FMU I, II, PMI) of Aceh. The results of this study resulted in a score of 60%, 55% and 57% from FMU I, II and PMI respectively. Based on the Laveringthorn effectiveness category, the scores fall below the "less effective" category. The main factors contributing to these scores are: (a) the lack of funding allocations to support FMU operations, (b) the lack of engagement with local stakeholders that do not fully understand the role and responsibility of FMUs on the ground, (c) human resource capacity in FMU, especially at the level of Sub-FMU and RPH (resort level). Despite these challenges, there are data to show that deforestation rates in Aceh have dropped significantly and that this is in part due to FMU establishment and operations and part to better coordination among stakeholders (HAKA data). This study recommends that the Government of Aceh further encourage and support FMU operations to improve their efficacy; budget allocations for FMUs should be ring-fenced and capacity building in FMUs must be improved. The maintenance of forest ecosystems in Aceh through conservation effort can only be carried out through the work of FMUs, and the quality of FMU work will ultimately depend on the commitment and support of the Aceh provincial government.

Paper Number: 844

Thursday, 05 July 2018 | Machu Pichu

General Session 29.2 -Human Influence in Tropical Ecosystems

The cultural significance and conservation of *Dipterocarpus hasseltii* Blume in sacred groves in Bali, Indonesia

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The conservation and appreciation of nature has been an important component of cultures worldwide. One of the most notable traditions in this regard is the communal protection of forest fragments with religious significance, known as sacred groves. Sacred groves are common in Bali (Indonesia), where traditionally the harmonious relationship between human and nature is revered as one of the three causes of well-being. Here, we present the first academic account of sacred groves comprising of *Dipterocarpus hasseltii* Blume (*Dipterocarpaceae*) stands. *Dipterocarpus hasseltii* is listed as an endangered species on the IUCN Red List, mostly due to habitat loss and overexploitation as a source of timber. Therefore, the sacred groves of *D. hasseltii* in Bali play a crucial role in the conservation of this species. However, little is known about the *D. hasseltii* stands in the sacred groves and the effect of different management regimes on its conservation. This study aims to make an inventory of *D. hasseltii* stands within and beyond the sacred groves on the island, document the management regime, and assess the cultural and conservation significance of these stands. We located a total of six *D. hasseltii* stands, one in the West Bali National Park, one in an unprotected forest and four others in sacred groves. In four of the six stands, we conducted a population demography survey and interviewed the community regarding the management and cultural utility of the stand. The highest population density and population size of *D. hasseltii*, regardless of the age classes, was found in Sangeh, a sacred grove collaboratively managed by the Nature Conservation Agency of Indonesia and the local community. However, the stand was relatively homogenous and plant species diversity was low. Regardless, this management regime presented the best conservation outcome and cultural significance when compared to stands managed solely by either the Ministry of Environment and Forestry of Indonesia or the local community. This study highlights the importance of decentralization and local tradition in ensuring effective conservation.

Paper Number: 675

Thursday, 05 July 2018 | Machu Pichu

General Session 29.2 -Human Influence in Tropical Ecosystems

Conservation of sacred groves of the Western Ghats: contrast in perception among rural and urban neighborhood communities

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Introduction/Background

Sacred groves of the Western Ghats are the Hindu community-managed and protected forests. The strong cultural belief was the major driving force of conservation of sacred groves in India. This is the reason why over 1,00,000 sacred groves of different sizes (<1 ha to > 100 ha) were once existed in different parts including the heavily populated urban parts. Since they have been protected for many centuries, most of the sacred groves are the relics of primary forests and maintain the genetic pool of many endangered and endemic species of the Western Ghats. However, due to the cultural disbeliefs among young generation the forest part of many sacred groves have shrunk their size, degraded, or often vanished.

Objective

To study the perception and attitudes of the local communities on the neighborhood sacred groves in the Western Ghats

Method

Following a detailed questionnaire method, we have analyzed the attitudes of the local communities in the neighborhood of 70 sacred groves in the Western Ghats – 50 sacred groves in rural forest-dominated landscape in Kodagu and 20 sacred groves in urban human populated landscape in Kasargod – to understand their current involvement and perception on continued conservation of sacred groves.

Results/Conclusions

There were significant differences on attitudes of local communities on conservation of sacred groves in their neighborhood. The rural communities (35%) use the forests of the grove for many purposes, but the urban communities not (3%). 95% and 73% of urban and rural communities, respectively believe that the sacred groves have important roles in maintaining ecosystem functions and services. 35% of the urban community believe that the sacred grove might be a source of the wildlife including insect pests, which leads to increasing human-wildlife conflict in cropland. Marginally significantly high proportion of rural communities (58% vs. 35%; $p=0.025$) believe that sacred groves are the sources of mosquito problem and mosquito-related diseases. Both the communities disagree that neither them nor they do allow outsiders to use the forest as a waste-disposal place ($p=0.56$). The people in the urban area are more vigilant about peoples' use and abuse of the forest (96% vs. 87%, $p=0.002$). However, 100% and about 99% of the respondents of the urban and rural areas are in agreement that the forests in the sacred groves should be protected either by the local community (urban respondent 99%) or by the forest department (rural environment 59%).

Paper Number: 276

Thursday, 05 July 2018 | Machu Pichu

General Session 29.2 -Human Influence in Tropical Ecosystems

Are perceptions of biodiversity and ecosystem service provision linked with attitudes towards conservation? Evidence from eastern Amazon, Brazil

Sergio Milheiras

The way relationships between people and nature are perceived has changed through time. One recent development is that society is now more aware of the services ecosystems provide to people. Conservationists expect that a better perception of these services will contribute to strengthen the support for the conservation of those same ecosystems. However, the empirical evidence confirming this claim is surprisingly scarce. Here we aim to assess if people perceive the links between biodiversity and ecosystem services (BES) that are supported in the scientific literature. We also analyse which factors influence that perception and finally if that perception has in turn an influence on attitudes towards conservation. We applied a total of 403 questionnaires to communities in the Eastern Amazon region, within the Jari and Cajari river basins and in the capital of Amapá state, Brazil. Generalised linear mixed models and multi-model inference were used to analyse the data. We find that respondents that are aware of more BES links are more likely to have a positive attitude towards nature conservation. BES perceptions in this study are positively influenced by income level and Brazil nut extraction. In general respondents recognised biodiversity plays a role on ecosystem service provision, especially in the provisioning and cultural categories. Our findings corroborate the use of the ecosystem services framework in conservation outreach and suggest that measures improving awareness of the role biodiversity plays in the provision of several vital services to people might be an effective way to gain support for nature conservation amongst the public, including local communities living in areas of high conservation interest.

Paper Number: 326

Thursday, 05 July 2018 | Machu Pichu

General Session 29.2 -Human Influence in Tropical Ecosystems

A Family Resilience Conceptual Model for Exploring the Sustainability of Forest Adjacent Communities in Africa

Ian E. Munanura, Jeffrey D. Kline, and Chad Kooistra

Studies on the sustainability of forest adjacent communities in Africa have explored links between poverty and human induced threats to wildlife. These studies have led to livelihoods based solutions, aimed to improve the wellbeing of forest adjacent communities in Africa. However, the livelihoods based solutions have been driven by material aspects of wellbeing, and their conservation impact has been challenged empirically. The human wellbeing is a multidimensional construct, which involves material, relational and emotional wellbeing dimensions. Improving the material wellbeing of forest adjacent communities could partially address the human wellbeing constraints with potential to influence the human induced threats to wildlife. In addition, human wellbeing constraints are conceptually part of the household functioning process, where positive or negative household functioning outcomes could emerge, with varied implications for the sustainability of forest adjacent communities. The family resilience theory for example suggests that a household's potential to overcome a stressful livelihood event is dependent on the nature of the stressful event, household capabilities, and stress coping strength. Together, these three dimensions encompass the household functioning process. Using examples from case studies in East Africa, we demonstrate that these dimensions of a household functioning process interact to shape outcomes, which emerge in form of vulnerable, durable, secure and resilient household functioning. These types of the household functioning outcomes could have varied implications for the sustainability of forest adjacent communities and wildlife conservation in Africa. The household functioning conceptual model proposed, synthesizes the human wellbeing framework and family resilience theory to outline a model for family functioning. The utility of the proposed household functioning model for understanding the sustainability of forest adjacent communities in Africa is presented.

Paper Number: 20

Thursday, 05 July 2018 | Machu Pichu

General Session 29.2 -Human Influence in Tropical Ecosystems

GENERAL SESSION 18.2

Invertebrate Ecology & Conservation

Morphological and behavioral specialization of tropical butterflies permits persistence in marginal environments

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Species are adapted to the environments where they are distributed and tropical species inhabiting stable thermal environments are therefore likely to have low tolerance to cold. This observation was popularized by Dan Janzen's famous "mountain passes are higher in the tropics" theory. Such intolerance of cold is often conserved among species of tropical origin despite distributions that extend into cooler areas, such as subtropical boundaries. In this case, whether other adaptive mechanisms such as behavior and morphology can compensate for lower physiological tolerance to cold is unknown and may provide important insights into climate change impacts. Here, we examined behaviors and body temperatures of butterflies across elevational gradients at multiple sites in China. We tested whether coexisting tropical and widespread butterfly species differ in their thermoregulation ability to respond to cold air temperatures. Based on a validated biophysical model, we used the amount of heat gain from basking as an indicator and incorporated body temperatures, behaviors, and thermoregulatory morphological traits of butterflies sampled in the field. We found that tropical species are more constrained in their activity at low air temperatures. Relative to temperate/widespread species, tropical species also have larger thorax sizes and are more likely to bask at cooler air temperatures. This study highlights the importance of behavior and morphological adaptations in thermoregulation for tropical butterflies in temperate and subtropical environments. These thermoregulatory mechanisms allow tropical species to persist in cooler environments but may limit their expansion into higher latitudes and also likely suggests that higher seasonal variability under climate change may render these species particularly vulnerable to cold weather extremes.

Paper Number: 603

Thursday, 05 July 2018 | Chichen Itza

General Session 18.2 - Invertebrate Ecology & Conservation

Species and trait diversity of an insular tropical Lepidoptera assemblage across space and time

Catherine Hulshof

Introduction

Variation in functional traits form the foundation for studying natural selection. In addition, traits regulate species distributions via their effects on dispersal and demography, arguably shaping broad gradients in species richness. Traits such as body size and color influence species dispersal and distributions and determine how species respond to environmental change. With increasing elevation, for example, body size is expected to decrease and melanism is expected to increase resulting in trait clines and likely reduced species richness at high elevations. Furthermore, global warming is expected to shift species ranges upward, creating more fragmented populations. Thus, predicting how species respond to environmental change provides an important analog for predicting how species respond to climate change.

Objectives and Methods

Lepidoptera are particularly diverse in morphology, especially in color and size. As ectotherms, they are sensitive to temperature and are model organisms for understanding the causes and consequences of trait variation in structuring communities both across environmental gradients in geographical space and in response to environmental changes in time. In this study we examined patterns in wing size and coloration in lepidopteran communities across Puerto Rico to

1) test whether wing size and coloration predict distributions or changes in distributions under future climate scenarios and 2) examine large-scale variation in species richness under current and future scenarios of climate change. Towards this end we used thousands of museum specimens to generate species distribution models for present and future climate scenarios.

Results and Conclusions

Based on weighted model averages, the highest species richness occurred at low elevations. Further, high elevation regions were predicted to experience the greatest declines in species richness under all projected climate change scenarios. Spatial variation of traits was evident. Wing size declined non-linearly with elevation. The geographic distribution of wing coloration was more nuanced across the island's complex topography. However, in general, species at low elevations tended to be brighter, more intense and saturated in color whereas high elevation species tended to be darker and duller in coloration. Models predicted an upward expansion of low elevation species and concomitant changes in trait distributions. We use these results to identify hotspots for conservation and species most vulnerable to climate change.

Paper Number: 846

Thursday, 05 July 2018 | Chichen Itza

General Session 18.2 - Invertebrate Ecology & Conservation

Inter-annual Monitoring Improves Capture of Regional Tropical Butterfly Assemblages

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Monitoring programs for diverse tropical butterfly assemblages are scarce and such diversity patterns in these assemblages are poorly understood. Temporal patterns of diversity at multiple scales are particularly under-studied despite the importance of frequency and timing in determining monitoring schemes. We adopted an approach with additive partitioning of diversity to determine how temporal butterfly species richness was structured at the levels of days, months, and years in five tropical/subtropical sites across three continents covering up to nine years of monitoring. We found that observed butterfly richness was not uniformly distributed across temporal levels, and in particular, observed species richness was higher than expected at the level of years. Butterfly species composition also differed across months and years, potentially accounting for the fact that temporal butterfly species richness among months (18.8 to 40.2%) and among years (24.8 to 67.5%) contributed a high proportion of total species richness. We further examined how species richness of common (>0.5 of total abundance) and uncommon species (<0.5 of total abundance) were structured across temporal levels. The results showed that relative contribution of species richness at lower temporal levels to total species richness was higher for the common species pool. In contrast, uncommon species showed the opposite, greater contributions at higher temporal levels. This may imply that lower temporal level sampling (e.g. daily or weekly) may be more useful in examining common species demography while higher level sampling (e.g. years) will be more effective in capturing uncommon or rare species. We therefore encourage careful consideration of temporal replication at different levels in developing butterfly monitoring schemes. As uncommon and rare species dominated the butterfly assemblages in terms of species richness (56 to 90%) across sites, yearly sampling is essential for improvement in the resolution of species estimation and diversity patterns for tropical ecosystems.

Paper Number: 849

Thursday, 05 July 2018 | Chichen Itza

General Session 18.2 - Invertebrate Ecology & Conservation

Treading the Wallacean shortfall for an endangered, iconic and in-demand tropical butterfly (*Teinopalpus aureus*)

Shuang Xing, Au Tsun Fung, Wenda Cheng, Pauline Dufour, Felix Landry Yuan, Fenghai Jia, Lien V Vu, Min Wang, Timothy C Bonebrake

The insufficiency in geographical distribution information for species, described as the Wallacean shortfall, has been considered a primary issue in conservation biogeography. Such problems are notably common among invertebrates and could be critical for rare species under multiple threats. Due to its rarity and striking appearance, the Golden Kaiser-i-Hind (*Teinopalpus aureus*), a tropical butterfly species, is popular in the trade but its conservation status remains unclear, largely due to a lack of integrated population and distribution information. In this study, by collecting distribution information from different sources for *T. aureus*, we applied species distribution models to estimate its current and future distribution range with climate change. We further evaluated the vulnerability of the species under multiple threats including climate change, habitat loss as well as wildlife trade and compared the conservation efforts across countries in protecting the species. As a high elevation species, we found that *T. aureus* is predicted to lose 56% of its suitable climatic habitat and the mean suitable elevation would shift about 274 m up with climate change in the future. In addition, most suitable habitats for *T. aureus* are outside protected areas for all countries within its distribution and suitable habitats within protected areas will continue to shrink with climate change effects. Conservation efforts in protecting *T. aureus* vary across countries, with the highest proportion of suitable habitats protected in Laos and the strictest policy against poaching and trade of the species in China. Our findings not only provide the most updated distribution for *T. aureus*, but also evaluate its current conservation status and vulnerability to multiple threats. Our work highlights the importance of data collection for rare invertebrate species and emphasizes the challenges in cross-border conservation for in-demand species under global change impacts in the tropics.

Paper Number: 539

Thursday, 05 July 2018 | Chichen Itza

General Session 18.2 - Invertebrate Ecology & Conservation

Altitudinal filtering of Planthopper (Insecta Hemiptera Auchenorrhyncha) on Mont Wilhelm (Papua New Guinea)

Eric Guilbert

Tropical mountains are critical spots for biodiversity conservation due to their specific species assemblages. Since environmental conditions vary along slopes, they are also key models for global change issues.

Understanding altitudinal assemblages of species depends on biotic, abiotic and historical factors. Defining the historical frame may be the first step as ecological processes structuring communities depends first on historical constraints.

We analyze Planthoppers (Insecta: Hemiptera: Auchenorrhyncha) community along an elevational gradient made on Mount Wilhelm in Papua-New Guinea (200-3700m) using Malaise traps placed in eight spots in October-November 2012. The altitudinal gradient is made of four zonation differing in terms of vegetation composition : <1000m tropical forest dominated by Dipterocarpaceae, 1000-2500m: Lauraceae and Fagaceae dominating, 2500-3000m : Podocarpaceae dominating, and >3000m, sub-alpine vegetation dominated by Cyatheaceae.

We made a phylogenetic analysis of Planthoppers families Cixiidae, Derbidae and Achilidae including 168 terminals representing 65 taxa, described by 3 molecular markers (CO1, 18S and H3) using Bayesian inference. We analyzed the phylogenetic structure of the community using abundance of species in the eight plots by performing a spatial analysis with permutation test such as Partial Mantel test on pairwise statistics to determinate clustering or overdispersion of species. We verify also through these tests whether the filtering was due to altitude and not to distances between plots.

The phylogenetic tree obtained separates the terminals in two major clades, one including the Cixiidae and another one grouping Achilidae + Derbidae. The tests show a global altitudinal filtering for the whole phylogeny but show also that it is due to a strong altitudinal clustering of Cixiidae and a random distribution of Achilidae+ Derbidae though altitudes.

Mid-elevation range may be the ancestral state for Cixidae, Derbidae and Achilidae. Achilidae + Derbidae may have dispersed to the other vegetation profiles, while Cixidae may have switched to low elevations and high elevations in several clades independently.

Achilidae+Derbidae overdispersion may be interpreted as a better adaptation to altitudinal or environmental changes, while Cixiidae niche conservatism may be interpreted as a low capability of adaptation to environmental changes. Consequences of global warming may not be the same for these two groups.

Paper Number: 691
Thursday, 05 July 2018 | Chichen Itza
General Session 18.2 - Invertebrate Ecology & Conservation

Diversity of the *Onchocerca* genus and emergence of zoonotic infections

Coralie Martin

Leaf-cutting ants (LCA) are dominant herbivores in Neotropical rainforests, and their colony densities increase in disturbed habitats such as forest edges. On one hand, LCA prefer softer leaves, on the other hand, they prefer disturbed habitats. We studied LCA foraging in the edge and interior of an Atlantic forest fragment to elucidate the forces regulating foraging in human-modified landscapes. We applied phylogenetic signal analysis to investigate LCA diet across plant lineages and performed phylogenetic generalized linear models to analyse the diet in both habitats. We found a phylogenetic signal in LCA diet and in leaf toughness which means that LCA prefer closely related plants with softer leaves. We also found that irrespective of phylogeny, LCA prefer softer leaves, both in edge and interior. However, LCA prefer more abundant plants only in edges. High abundance of optimal diet makes LCA foraging easier in edges and supports why LCA colony densities increase in disturbed habitats. It is also worth to mention that phylogenetic signal in diet might result in LCA vulnerability in the case of their preferred clades are reduced in abundance or even locally extinct due to LCA herbivory or other changes in the habitat.

Paper Number: 962
Thursday, 05 July 2018 | Chichen Itza
General Session 18.2 - Invertebrate Ecology & Conservation

GENERAL SESSION 9.4

Mammal Ecology & Conservation

A nuanced insight into the impacts of tropical forest degradation on medium-large mammals

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Habitat degradation impacts 500 million hectares of tropical forest globally, compromising the provision of ecosystem services and the persistence of biodiversity. Selective logging is a major cause of forest degradation in the tropics, reducing structural complexity through biomass extraction and collateral damage to residual vegetation. The structural properties of vegetation govern the distribution, diversity and ecology of animal species through their influence on niche availability, microclimatic conditions and predator-prey interactions. However, due to difficulties associated with quantifying degradation, how species respond and adapt to the structural alterations associated with selective logging, remains poorly understood, but is imperative to biodiversity management in human-modified systems. Here, we assess mammalian responses to structural degradation in Sabah, Malaysian Borneo, where 55.6% of the remaining forest estate is classified as degraded due to repeated timber extraction. Mammals were considered the optimal study system as they are sensitive to anthropogenic habitat disturbance and occupy key trophic positions in forest ecosystems. To provide a nuanced insight into forest degradation, airborne Light Detection and Ranging (LiDAR) methods were employed to develop 3-dimensional metrics of forest structure, which we compared across a disturbance gradient of varying logging intensities. Data collected from 125 camera-traps, distributed across 75 sites, between 2016 and 2017 were used to characterise the mammal community. We applied Bayesian hierarchical multi-species models, to assess relationships between LiDAR-derived structural indicators of forest degradation and mammalian occupancy. Our results identified a distinct structural signature across the disturbance gradient. Heavily degraded forests were characterized by a lower, more variable height profile, increased gap fraction, higher plant area density within lower height strata and reduced niche availability. Across 5,950 camera-trap nights we recorded 33 medium-large mammal species. Dietary specialisation and conservation status were key determinants of species responses to structural metrics. Contrasting responses between species, trophic guilds and functional effects groups emphasize the challenges of a one-size-fits-all approach to mammal conservation in tropical forests. Our findings dissect the architectural consequences of forest degradation while providing valuable insights into mammal ecology in human-modified landscapes. This can be used to inform biodiversity conservation and support management practices such as reduced-impact logging that seek to attenuate the pernicious environmental impacts of timber extraction in the tropics. From a policy perspective, we demonstrate the value of LiDAR-derived structural metrics to monitor forest degradation, which represents an explicit consideration of the United Nations Reducing Emissions from Deforestation and Forest Degradation (REDD+) programme.

Paper Number: 591

Thursday, 05 July 2018 | Eiffel 1

General Session 9.4 - Mammal Ecology & Conservation

Surviving in a degraded forest environment: foraging strategies and space use of northern pigtailed macaques (*Macaca leonina*) in Sakaerat Biosphere reserve, Northeastern Thailand

Eva Gazagne

Space-use patterns and foraging strategy in degraded habitat are crucial to understand the ecology, adaptation, and conservation of primates. However, detailed ranging and behavioral data are scarce for many species, especially from Southeast Asia.

We aimed to determine the northern pigtailed macaques (*Macaca leonina*) dietary, ranging, and habitat use patterns in the Sakaerat Biosphere reserve in Northeastern Thailand, a degraded habitat with ancient plantations and sub-optimal resources availability. We studied these patterns for eleven months in regard of fruit availability in a wild troop of these macaques. We used Characteristic Hull Polygons (CHP) combined with spatial statistics to estimate home ranges and core areas. We ran a monthly phenology survey to measure fruit availability over the study period. We predicted that macaques would increase their ranging during low fruit abundance to gather enough food (i.e. energy-maximizing strategy) and would use more intensively plantation and edge areas. We found a total home range of 535.5 ha and an average core area of 219.3 ha, with an average daily path length of 2,226 m. During high fruit abundance, macaques spent more time around fruit-tree species in the dry evergreen forest. During low fruit abundance, they extended their home range to plantations forest and edge areas. Fruit consumption was positively correlated to fruit abundance and there was a clear shift from flesh and pulp to dry fruit during low fruit abundance season. While the portion of home range used decreased in period of high fruit availability, daily path length and core area size did not change. Overall, as predicted, our preliminary data shows that the study troop used an energy-maximizing strategy and was able to expand the range of resources consumed in fruit scarcity period.

Conversely, a study done using the same method on the same species in the nearby pristine Khao Yai National park found an energy-minimizing strategy, that is, decreased ranging area in periods of food scarcity. In conclusion, as in previous studies, our results show indeed that northern pigtailed macaques adapt their diet, monthly range and habitat use according to food abundance. However, they indicate they adapt it in an opposite way. In a degraded forest environment, the northern pigtailed macaques seem to change their survival strategy by increasing their range in periods of food scarcity to seek additional resources. These findings pose the question of substantial modification of ecological strategies by species constrained by human alteration of their habitat.

Paper Number: 448

Thursday, 05 July 2018 | Eiffel 1

General Session 9.4 - Mammal Ecology & Conservation

Passive acoustic monitoring unveil howler monkeys' vocal repertoire and call functions

Leandro Do Nascimento

Introduction

Our understanding of the functions of howler monkey calls is hampered by our inability to collect acoustic and behavioral data across their entire period of activity. It is not surprising that most studies with wild populations were restricted to the daylight period despite knowledge that this genus is also active at night. As a result, we lack even basic information about their call structure and repertoire, not to mention their specific functions. One form of remote sensing that has received great attention lately and seems ideal to unveil patterns of howler monkeys calls is passive acoustic monitoring (PAM). These devices can monitor 24 hour activity cycles across many sites, allowing simultaneous acoustic data collection of neighbor troops and their nocturnal interactions.

Objective

Our goal was to investigate if nocturnal loud calls differ from diurnal loud calls in howler monkeys to aid in understanding their functions.

Methods

We used PAM devices to simultaneously collect acoustic data of three neighbor troops of howler monkeys in the Viruá National Park, Brazil. 6408 hours of recordings were obtained from February to May 2018. Ninety randomly selected nocturnal and diurnal calls were analyzed in detail and their length in seconds annotated. We ran a two sample t-test between nocturnal and diurnal calls duration to test if the means differs significantly. Field observations helped elucidated the social context which the recorded calls were given.

Results

There is a significant difference between the duration of nocturnal and diurnal calls ($t = 3.29$, $p = 0.001$). Nocturnal calls were shorter than diurnal calls (mean duration = 257s and 319s, respectively). Shorter and aggressive calls (less than 200s) were given right after a potential intruder vocalized nearby the troop being recorded and these calls were almost exclusively observed during the night.

Conclusions

Different patterns of vocalizations between the nocturnal and diurnal periods suggest that the loud calls here analyzed may have different functions in howler monkeys societies. For example, long diurnal calls may serve as a cue for inter-grouping spacing between neighbor troops while short nocturnal calls, especially the most aggressive variation may be used to defend important food resources, females, and vulnerable offspring from intruders. PAM revealed to be a very useful tool to aid in understanding animal behavior such as temporal and spatial patterns of vocalizations and intra-specific communication dynamics.

Paper Number: 288

Thursday, 05 July 2018 | Eiffel 1

General Session 9.4 - Mammal Ecology & Conservation

A Test of Species Delimitation and Biogeography Hypothesis Using Southeast Asian Round-Leaf Bats (Genus *Hipposideros*)

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The Round-leaf bats, genus *Hipposideros* are an exemplar lineage, being understudied, broadly distributed throughout the biodiversity hotspots of Southeast Asia, and cryptic genetic diversity has previously been identified through mitochondrial sequence analysis. The taxonomic description of biodiversity is essential for conservation decisions, yet this description invariably relies on the acceptance of divergence thresholds, which are strengthened by corroboration from different forms of biological data. To provide a robust dataset for informed biodiversity assignment we used a combination of echolocation data, mitochondrial cytochrome-b and NADH dehydrogenase subunit-2 sequence data, nuclear AFLPs, and a combination of phylogenetic and biogeographic tools. Together these data were used to characterize *Hipposideros* biodiversity and to explore the utility of coalescent stochastic modeling in identifying “species level lineages” as compared to those identified following proposed mammalian percent divergence thresholds. The nuclear DNA phylogeny identified a total of 27 lineages out of the 34 lineages with > 5% divergence in mtDNA. Echolocation data supported mitochondrial clades for which maternal and nuclear phylogenies were discordant; these phylogenetic contrasts describe recent gene flow among islands during the last glacial maximum. Biogeographic reconstructions of *Hipposideros* suggest the Southeast Asian lineage studied here originated on the Sunda Shelf ~19.2 mya and subsequently diversified into adjacent regions. Species identification using coalescent stochastic modeling and the proposed mammalian percent divergence threshold of > 5% were concordant. The combined information from these decision-making criteria and data types employed indicates the number of unrecognized species in Southeast Asian *Hipposideros* is about half of that currently described.

Paper Number: 897

Thursday, 05 July 2018 | Eiffel 1

General Session 9.4 - Mammal Ecology & Conservation

A Preliminary Observation on Activity Patterns of Two Porcupine Species using Camera Traps in Sarawak, Malaysia

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Porcupines are mostly an agricultural pest and widely killed for their meats. The rodents are elusive as they reside in underground burrows, hampering detection in their natural habitats. The use of camera traps mitigates the issue by increasing the chance of observing cryptic or rare species when field visits fail to directly see them. This study was carried out to examine activity patterns of the porcupines in their natural habitats by using the camera-trapping method. There were 508 camera trap-day conducted in five localities selected around Kampung Wawasan Jaya Bintulu, Sarawak. The sampling effort managed to capture the presences of two porcupine species namely, the protected and endemic Bornean Porcupine *Hystrix crassispinis* and the totally protected and endangered long-tailed porcupine *Trichys fasciculata*. Their activity patterns were then assessed based on 107 photos captured. The Bornean porcupine was found to be active between 20:00 and 23:00 hours and 4:00 to 5:00 hours. The long-tailed porcupine did not indicate any peak activity time during the observation period, but like the Borneo porcupine, the long-tailed porcupine was also active in the evening, from 18:00 to 6:00 hours. There were also no photos recorded during daytime at any location where camera traps were installed. Such behavior confirms the known fact that they are nocturnal. Specifically, the Bornean porcupine and the long-tailed porcupine exhibited three broad behavior categories, namely solitary juvenile (where there was only one juvenile porcupine detected), solitary adult (only one adult porcupine detected) and in groups (more than one porcupine detected). They both used specific trails in their foraging activities. Although both porcupine species shows in group activity, Bornean porcupine are found to be using a prime location as a gathering place before commencing its activities. This documentation increases our understanding of both ecologically protected rodents that are otherwise overlooked due to the threats they pose to agricultural farms.

Paper Number: 752

Thursday, 05 July 2018 | Eiffel 1

General Session 9.4 - Mammal Ecology & Conservation

Modelling spatial distribution of northern swamp deer subspecies *Rucervus duvaucelii duvaucelii* across upper Gangetic plains, India using survey and molecular data

Shrutarshi Paul

Swamp deer (*Rucervus duvaucelii*) or Barasingha is an endemic, grassland-dwelling cervid of India and Nepal. With a global population of <5000 wild individuals belonging to three subspecies, it is classified as “Vulnerable” by IUCN. Information about distribution of northern subspecies (*Rucervus duvaucelii duvaucelii*) which represents ~80% of the global population is scanty in the upper Gangetic plains of India except a few protected areas. To assess fine scale swamp deer distribution and threats in this landscape we surveyed an area of ~6000km² in the landscape, covering two major swamp deer habitat blocks: The Ganges and tributary complex between Jhilmil Jheel Conservation Reserve, Uttarakhand and Bijnor Barrage area of Hastinapur Wildlife Sanctuary, Uttar Pradesh and river Sharda and its tributaries in Uttar Pradesh. We considered direct sighting as well as antlers, hoof marks and genetically identified pellets as evidences of swamp deer presence. The survey revealed much fine-scale swamp deer presence within non-protected wetlands along Ganges and a previously unreported population in Uttar Pradesh. Major threats were habitat conversion, livestock grazing, poaching, conflict and other types of anthropogenic disturbances. Subsequently, we used maximum entropy modelling to predict potential swamp deer distribution in the entire upper Gangetic plains. We combined information of 377 presence points from direct and indirect evidences, environmental variables, elevation, Normalized difference vegetation index (NDVI), distance to water and nightlight for modelling. Annual mean temperature, NDVI and distance to river emerged as important drivers of swamp deer distribution. Our confirmatory surveys along a 100km stretch of Ganga downstream of Bijnor Barrage showed that the model predicted swamp deer distribution with 86% accuracy. Swamp deer evidence was found in wetlands along Ganga in multiple areas like Muzaffarnagar Forest Division, Meerut Forest Division, and Hapur Forest Division. These results provide detailed information on swamp deer distribution, whose conservation as an umbrella species should be prioritized to protect this species and other endangered fauna inhabiting these grassland/wetland habitats.

Paper Number: 125
Thursday, 05 July 2018 | Eiffel 1
General Session 9.4 - Mammal Ecology & Conservation

Fragmented forests: overlooked avenues for tropical small carnivore conservation?

Wyatt Petersen

Small carnivores are increasingly faced with living in human-dominated landscapes, yet research in the tropics is biased towards large protected areas containing charismatic species. This is problematic as studies have already demonstrated that species densities, distributions, and behaviors vary between fragmented and intact habitats. To better understand the role these fragmented areas play in small carnivore conservation we used camera-trap data for 5 species within a seasonally dry tropical forest fragment (148 km²) in northeastern Thailand. Historical and current lists (from camera-trap and spotlight surveys) of small carnivore species remaining at our study site were also compared to explore the effects of forest fragmentation on small carnivore diversity. We assessed species occupancy models including microhabitat and resource variables across periods of high and low resource availability (fruit abundance and rodent biomass). Models including microhabitat variables performed well for all species suggesting that Asiatic jackals (*Canis aureus*), small Asian mongooses (*Herpestes javanicus*), and small Indian civets (*Viverricula indica*) were all open-forest specialists. Common palm civets (*Paradoxurus hermaphroditus*) and leopard cats (*Prionailurus bengalensis*), although more generalist, strongly associated with closed-forest conditions. Resource variables were relevant for three species, but only during periods of low availability. These resource variables were fruit abundance for common palm civets and rodent biomass for both leopard cats and small Indian civets. Our comparison of historical and current species records imply that species persistence reflects the availability of remaining suitable habitat. Specialist species such as frugivores which are reliant upon primary forest (e.g., binturong *Arctictis binturong*, masked palm civet *Paguma larvata*) and mixed deciduous forest habitat specialists (e.g., large spotted civet *Viverra zibetha*) are now mostly or completely extirpated from our site—likely due to past deforestation and subsequent reforestation by exotic, rather than native, tree species. Seasonal restrictions in resource availability were also shown to limit the distribution of more resource-dependent species and, with regards to fruit availability specifically, this restriction may be exacerbated in previously logged sites which lack primary forest. Our results highlight the importance of habitat diversity and quality (i.e., the ability to provide sufficient resources) for small carnivore species diversity within fragmented areas. It is also important to consider that not all of our study area's 148 km² of protected forest is suitable for each species. Asiatic jackal, small Asian mongoose, and small Indian civet, for example, were mostly confined to open-forests which are only 16 km² (~11%) of our study site.

Paper Number: 330
Thursday, 05 July 2018 | Eiffel 1
General Session 9.4 - Mammal Ecology & Conservation

SYMPOSIUM 28.2

Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

When effective conservation of oceanic island plant species depends on systematic understanding of natural history: Case of Mauritius endemic *Roussea simplex* (Rousseaceae)

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Many oceanic island plants are highly threatened with extinction and Mauritius holds its fair share with one of the most threatened biota worldwide and indeed the rarest species too. Although some conservation efforts on Mauritian plants are resulting in successful in-situ recovery, many endemic species, including some well-studied ones, continue to decline towards extinction for unclear reasons. This situation is exemplified by *Roussea simplex*, a mono-specific scrambler once abundant and now down to about 250 individuals. After characterising the temporal decline over the island using the literature, herbarium specimens and surveys, we examined the ecological interactions at each life history stage of the plant at several localities including the last two strongholds, to document and quantify their strengths and implications on the survival, growth and reproduction of *R. simplex* individuals. We used a mix of primarily in-situ observational and manipulative experiments focusing to study aspects from pollination to mortality of adult plants. Endemic vertebrates pollinate flowers but seed set per fruit is reduced due to pollinators' rarity or local extinction, while disruption of pollination mutualism by invasive ants plays a minor role. However, seed set per plant is reduced by > 90 % by florivory or plucking by alien rats and macaques. Rats are also nectar robbers. Many immature fruits are destroyed further reducing seed production. Consumption of ripe fruits is rare indicating limited seed dissemination; indeed no wild seedlings are known. Germination microsites occur primarily on trunks of a native tree fern itself rare due to past flower-pot harvesting and still declining in face of invasion by alien plants, which also reduce survival and growth of *Roussea* modules and individuals. The decline of *R. simplex* is thus driven by many direct and indirect impacts of alien plants and animals and these vary in severity depending on place and time. Impacts affecting seed production are typically sequential and additive or more rarely antagonistic. The lack of natural regeneration is partly compensated for by clonal reproduction but survival of clones is typically very low. These findings radically change the prospects for effective conservation management of the species whose decline was until recently attributed mostly to limited pollination and impacts of invasive ants. The systematic study of the species' natural history has revealed a much more complex situation with a wider range of interacting threats which need to be addressed in a specific sequence in a well-coordinated and time sensitive manner.

Paper Number: 183

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.2 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

Divergence in carotenoid pigments and resultant island endemism of flameback woodpeckers in a tropical island

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The divergence in color patterns seen in island populations as a result of reproductive isolation, selection and/or drift usually contribute towards island endemism, which is a key determinant of tropical biodiversity. Therefore the study of coloration in island birds provides insights into the selection pressures associated with divergence and reproductive isolation in islands. To understand the role of pigment expression in generating endemism of an insular population, we studied the expression of key pigments, the carotenoids in an Asian woodpecker genus *Dinopium* in the island of Sri Lanka. The island has two *Dinopium* species, red color *D. psarodes* (Lesser Sri Lanka Flameback), which is endemic to Sri Lanka, and yellow color *D. benghalense* (Black-rumped Flameback). The two species hybridize in a narrow hybrid zone and the resulting hybrids are orange in color. We measured the reflectance spectra of the main feather tracts in 18 live flamebacks and 58 study skins using a reflectance spectrometer and a light source of 375–700nm wavelength. The pigments from mantle feathers of these specimens were extracted into a gradient of polar solvents and were analyzed by using absorption spectroscopy, TLC chromatography and HPLC chromatography. A subset of feathers underwent ATR-FTIR spectrometry as well. Yellow and red feathers showed reflectance peaks at ~510nm and ~575nm wavelengths respectively and orange hybrids showed intermediate reflectance peaks. TLC and HPLC chromatograms and ATR-FTIR spectrograms showed two sets of peaks in red feathers, however yellow feathers had a single set of peaks corresponding yellow color. A combination of ketocarotenoids and hydroxycarotenoids contributed towards the red-color expression in Sri Lankan endemic *D. psarodes*. Ketocarotenoids were absent in yellow feathers of *D. benghalense*. The orange coloration in genetic hybrids was characterized by a reduced concentration of both keto- and hydroxy-carotenoids. The humid wet evergreen habitat in the wet zone of Sri Lanka might favor dark birds, while the dry deciduous environment in the dry zone of Sri Lanka and adjacent mainland (India) might favor light colored birds. Consequently, we have shown evidence for divergence of carotenoid pigments that can absorb yellow color and express red color as a response to the dark wet zone forests, triggering a speciation event that adds an endemic species to the island of Sri Lanka. Therefore this study provides unique insights into the divergence in pigment expression that may have led to the divergence of an insular population of woodpeckers in a continental island.

Paper Number: 715

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.2 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

Introduction of Barn Owls in a Tropical Island in the South China Sea for the Control of Rodent Pest Population and for Ecology Studies

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Pulau Rawa is an isolated tropical island off the coast of Johor, Malaysia, with a commercial resort operating on the island. Southeast Asian barn owls, *Tyto alba javanica*, were introduced on the island to control the rat population on the island as an alternative to rodenticide use and to study the possible interactions between owl and non-target species on the island. In 2017, a total of nine radio-tagged barn owls with differing backgrounds were introduced on the island in pairs throughout a year. A pair of adult wild owls, a pair of wild fledglings, a pair of captive owls and three hand-raised owls were introduced on Pulau Rawa. The owls were radio-tracked following their releases and at the end of the project, the signal of three owls were still active, a definite confirmation that the owls were established on the island. To monitor the impact of introduced owls on the local fauna of the island; rat, bird and bat populations on the island were monitored throughout the year. The rat island population was estimated using Capture-Mark-Recapture technique, line transect distance sampling was used to monitor the bird population and day roost counts were done to estimate the island bat population. After one year, the bird and bat population remained unaffected by owl releases, indicating that owl introductions had no significant impact on them. Meanwhile, the island rat population had significantly reduced from an estimated size of 501.21 before the owl releases to 104.50 at the end of the year. Analysis of recovered regurgitated barn owl pellets show rat and insect remains. This study shows that barn owls can significantly lower rat populations. Our study also further strengthens the impact of barn owls in rodent population control; a sustainable solution that also eliminates the need for harmful rodenticide use. Further study period is needed for long-term monitoring of the impact of introduced barn owls on non-target species, especially birds, on the island.

Paper Number: 35

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.2 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

Major positive benefits of mechanical control of invasive alien plants on the woody plant community of an oceanic island

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Islands are instrumental in understanding many basic biological patterns and processes, including human impacts on native biodiversity. Several oceanic islands, though reached by humans relatively recently, are among the places having sustained the highest levels of habitat destruction and fragmentation, extinctions and endangerment, alien species invasion and extreme human population densities. Mauritius, in the Mascarenes (Indian Ocean), is a good example as it ranks among the top countries in all the above-named issues. The surviving native habitat remnants are highly invaded, mostly by the small tree strawberry guava (*Psidium cattleianum*, Myrtaceae), a problematic invader in many other tropical ecosystems. We aimed to characterise the medium-term effects of controlling alien plants as a conservation measure on the native plant community of a well preserved and protected wet forest. We measured and tagged all native flowering plants reaching 1.3 m high in permanent plots of 4 x 25 m in forest areas invaded by alien plants for comparison with similar data from adjacent areas weeded of all alien plants seven years previously. Plots were monitored twice over the following 15 years. Recruitment of native woody plants was negligible within the invaded forests, and major (added nearly 50% more plants) in the weeded forests within 20 years after weed control. The species with the highest number of recruits was a woody liana of small stem diameter, which was virtually absent within invaded forests. Mortality rate of understorey trees was higher and affected more species within invaded forests, compared to the weeded areas, where fewer plants were lost per species, apart from the short lived liana. Weeding alien plants is a powerful conservation measure allowing species that were virtually vanishing from invaded forests to recover rapidly. This is mostly because native species regeneration in invaded forest is virtually nil, with rates of mortality, especially of understorey trees, being higher in weeds' presence, a pattern also recently found in large trees during multi-decadal monitoring. To conserve native ecosystems that are highly invaded, like those in Mauritius, removal of alien plants is essential and serves as the necessary precursor to a number of other conservation management like re-introduction of seed-dispersers or control of alien predators of seeds. This study also serves to show that planting in areas undergoing restoration, like often done, is largely redundant except for a few select species, because removal of alien weeds alone improves regeneration of most native plant species.

Paper Number: 945

Thursday, 05 July 2018 | Colosseum 1

Symposium 28.2 - Biodiversity loss on islands. Causes, consequences, and approaches for restoring diversity and ecosystem function

SYMPOSIUM 34

Integrating perspectives to address social-ecological challenges in conservation

Evaluating the social and ecological factors behind the 2015 extreme fire event in Sumatra, Indonesia

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Introduction

Annual burning events in Indonesia release massive amounts of carbon, averaging 49 TgCyr⁻¹ in Sumatra and are exacerbated during El Niño events. The recent 2015 fires were greatly aggravated by an extended drought period associated with a strong El Niño, resulting in an extreme haze event with higher carbon emissions than the record breaking 1997 fires, as well as enormous social and environmental damages.

Objectives

This study aims to empirically evaluate the socio-ecological causes of fire occurrences within fire-prone regions in Indonesia (specifically Riau, Jambi and South Sumatra), by integrating geospatial and social analyses techniques. Specifically, we are interested to know what were the major contributing socio-ecological factors to fire activity in the eastern provinces of Sumatra in 2015 at two spatial scales (i) a regency administrative scale and (ii) a pixel (1 km) scale.

Methods

We built upon past conceptual frameworks on how mega-fires are the consequence of predisposing conditions in the landscape, which define the vulnerability of the landscape to fires, and fire ignitions, which are largely from anthropogenic sources. We developed indicators for plausible social and ecological drivers of fire activity which could contribute to mega-fires as a predisposing condition or as a source of fire ignitions. We used generalized linear mixed models (GLMM) and boosted regression trees to model fire activity as a result of our list of social and ecological factors at the regency- and pixel-level respectively.

Results

Our regency- and pixel-scale analysis identified three common factors which are important for predicting fires - rainfall, slope and population density. Under our regency-scale analysis, economic land use such as different sizes of plantations, wood fiber concessions and the practice of burning at a village level were included as important drivers of fire activity. However, at a higher spatial resolution (1 km pixel scale), the only other factor included was road density. We did not find any evidence for land conflict as a driver of fires in 2015.

Implications

Due to the spatially explicit nature of our pixel-scale analysis, we expect it to be more reliable than our regency- scale analysis. We will present comparisons of our results with published studies on drivers of fire activity in Indonesia and provide suggestions on future fire management and prevention strategies for a more resilient socio-ecological landscape in Sumatra.

Paper Number: 530

Thursday, 05 July 2018 | Colosseum 2

Symposium 34 - Integrating perspectives to address social-ecological challenges in conservation

Taking a multi-dimensional approach to human-wellbeing - impacts of community forest management in Indonesian Borneo

Truly Santika, Kerrie A. Wilson, Sugeng Budiharta, Ahmad Kusworo, Freya A.V. St. John, Erik Meijaard, Elizabeth A. Law, Rachel Friedman, Joseph A. Hutabarat, Tito P. Indrawan, & Matthew Struebig

Institution

Community forest management seeks to not only avoid forest loss, but also improve social welfare and land rights of rural communities. However, little is known about the impacts of community forestry on aspects of human-wellbeing, other than income-oriented outcomes. We assessed change in five dimensions of human-wellbeing as a result of Indonesia's community forestry scheme - Hutan Desa (Village Forest) - using matched villages with and without Hutan Desa. We found that overall, the Village Forest designation successfully improves human-wellbeing; yet these benefits are heterogeneously distributed across land-use zones, reflecting baseline community livelihood characteristics. Communities benefit the most in watershed protection zones and typically rely on subsistence farming. In limited production zones, where communities depend largely on logging, basic wellbeing is reduced due to restrictions on timber harvest. In permanent or convertible production zones, where large monoculture plantations dominate, Hutan Desa has negative impacts on basic and environmental wellbeing, presumably related to land scarcity and the associated pressure to intensify agriculture production. Understanding the human-wellbeing consequences of Village Forests and how this varies spatially can help identify ways to address the heterogeneous needs and constraints of communities, and to inform future policy design.

Paper Number: 324

Thursday, 05 July 2018 | Colosseum 2

Symposium 34 - Integrating perspectives to address social-ecological challenges in conservation

Intention to kill: Tolerance and illegal persecution of Sumatran tigers and sympatric species

Freya St John

Rapid land-use change in tropical developing countries means that natural habitats are being lost and many remaining areas are degraded and fragmented. However, there is still enormous richness and biodiversity left to protect, and significant initiatives towards forest rehabilitation and restoration are starting. Climate change is already affecting tropical species, and there is particular concern about whether they will be able to shift from areas that become too hot or dry, across fragmented landscapes, to reach refuges in montane regions. If land-use change and forest degradation continue too intensively in these countries, species and ecosystem functions will be lost, leading to detrimental impacts on the livelihoods of local people dependent on these lands.

We have developed a model called Condatis, based on ecological understanding of range shifts, which quantifies how different elements of a habitat network contribute to long-distance connectivity. We will explain how Condatis can identify both the best habitat to preserve, and the best locations to target for restoration. It does this by simulating the iterative removal of habitat, which tests how the costs of removal can spread far and wide across the network. We will also show how Condatis can make good use of a limited amount of data, for example land cover data and small-scale studies of biodiversity in different land cover types. We are using Condatis with partners in Malaysia to help protect functional routes between protected areas that will be needed under climate change. Contrastingly, we are using it with partners in Ghana to prioritise the restoration of agroforestry, to facilitate the coexistence of wildlife with local communities.

Condatis complements the more established tools of systematic conservation planning. Its particular advantages are its relevance to conservation under climate change, and its ability to prioritise the process of range shifting rather than the pattern of where species are currently found. We also argue it is particularly useful for developing countries because it does not need excessive amounts of data and it is accessible as a web application. Thus, it enables large-scale sustainable land-use planning for tropical developing countries under climate change.

Paper Number: 213

Thursday, 05 July 2018 | Colosseum 2

Symposium 34 - Integrating perspectives to address social-ecological challenges in conservation

Surveys for Exotic and Rare Native Pigs in Baluran National Park and Adjacent Areas, East Java

Betty Millyanawati, Hariyawan A. Wahyudi, Dendi Sutiadi, Carl Traeholt

The Javan warty pig (*Sus verrucosus*) is endemic to Java and it is found in very low numbers at several patches and human dominated forest of East Java. Based on the biodiversity database managed by the park management, it is believed to be extinct from Baluran National Park, Indonesia. The purpose of this study is to assess: (1) presence of warty pigs (*S. verrucosus*) in Baluran NP; and (2) presence of warty pigs in adjacent areas. We used camera traps and interviews of local communities, to gather information about the presence of pig species and its distribution in the study areas. There is only one pig species recorded from camera trap survey: wild pig (*S. scrofa*), either inside or outside Baluran National Park. Our survey toward local communities, indicating there are still some population of wild warty pig in several areas in East Java, such as in Probolinggo, Bojonegoro, Mojokerto, Gresik and Tuban. This review will provide the necessary information to adjust the future strategy and action plan to conserve this species.

Paper Number: 501

Thursday, 05 July 2018 | Colosseum 2

Symposium 34 - Integrating perspectives to address social-ecological challenges in conservation

SYMPOSIUM 30.2

Trophic interactions in human-modified tropical landscapes

Freshwater fish suffer large reductions in species and functional richness while maintaining provisioning ecosystem service across a land use gradient in Borneo

Clare Wilkinson, Darren C. J. Yeo, Heok Hui Tan, Robert Ewers

The majority of the world's freshwater fish diversity is contained within tropical regions, but increasing anthropogenic pressure in tropical forests from fishing, deforestation, land degradation and conversion to agricultural plantations is altering the diversity and abundance of freshwater fish. At the same time, freshwater fish are also a vital provisioning ecosystem service for local communities across the rural tropics. Despite this importance for human well-being, the impact of land use change on freshwater fish remains largely understudied and poorly understood.

The Stability of Altered Forest Ecosystems (SAFE) project in Sabah, Malaysian Borneo provides a unique combination of environments in which to determine the effects of deforestation and land use change on freshwater ecosystems using freshwater fish as a focal taxon. We used exhaustive sampling (multi-pass electrofishing, cast netting and tray netting) of 23 streams, to determine fish community change across the land use gradient; and cast net data of 16 streams, obtained over three sampling seasons, to assess the availability of freshwater fish for local communities, known to subsist on freshwater fish, across this land use gradient.

There was a significant reduction in species richness and functional richness of fish communities in all disturbed land use types (i.e. logged forest and oil palm plantation streams with and without riparian reserves) from protected forest streams. However, contrary to expectations, biomass remained unchanged, while no impact of land use on total fish availability to local communities was detected across the land use gradient. There was variation in the mean length and availability of five locally important food species, but we attribute these small differences to associated variation in their specific habitats that co-vary with land use change.

Freshwater fish in small headwater streams therefore appear to represent a sustainable provisioning ecosystem service for villages established in oil palm plantations. The reduction in species in all land uses compared to protected forests, however, suggests it is essential to continue protecting primary forested areas to maintain freshwater diversity; and that it is crucial to also explore strategies to protect freshwater ecosystems through land use change during logging, deforestation, and conversion to plantation monocultures that are expected to continue across Southeast Asia.

Paper Number: 489

Thursday, 05 July 2018 | Petra 1

Symposium 30.2 - Trophic interactions in human-modified tropical landscapes

Ant assemblage composition explains high predation pressure on artificial caterpillars during early night

Zhenghong Wang

Predator-prey interactions, especially of those involving herbivory insects, are of great importance to the maintenance of biodiversity. Predation pressure is known to present temporal variability in response to availability and activities of prey. Little is known, however, about the patterns and drivers of fluctuations in predation pressure at a fine temporal scale.

We used artificial caterpillars (placed on plant leaves at breast height) to assess changes in predation rate across four temporal intervals per day in a monsoonal tropical rainforest of southeast China. We examined how primary drivers of predation pressure, arboreal ants, changed their assemblage composition across the same time intervals. We evaluated the potential linkages between biotic (arboreal ants) and abiotic factors (temperature and light intensity) and predation rate.

We found that predation rate on caterpillars during early night (19:00 pm ~ 1:00 am) was higher than other three time intervals (morning, afternoon, and late night) significantly. Most importantly, the results provided robust evidence that ant assemblage composition, rather than ant species richness or total abundance per se, best explained the variations in predation rate on artificial caterpillars.

Our results help strengthen the understanding of trophic interactions along diel time scale by demonstrating that predation pressure fluctuates at finer time scales than previously thought and tested, and that particular set of ant species may play major roles in predation on caterpillars.

Paper Number: 101

Thursday, 05 July 2018 | Petra 1

Symposium 30.2 - Trophic interactions in human-modified tropical landscapes

Freshwater food webs in the tropics: drivers of structure and responses to anthropogenic habitat modification

Liew JH* & Yeo DCJ

Unprecedented biodiversity losses in the Anthropocene necessitates the adoption of pragmatic approaches to conservation, including an emphasis on the preservation of ecosystem functions. Food webs, networks comprising all trophic interactions, are important aspects of ecosystem functioning yet many gaps remain in our understanding of the mechanisms influencing their ecology. This is especially pressing in tropical fresh waters where ecological studies are only starting to emerge in recent years. In this talk, we highlight studies addressing two fundamental knowledge gaps in food web ecology. First, we assessed the relative roles of environmental and biological factors in governing the structure of five empirical food webs associated with tropical reservoirs which were derived using gut content and stable isotope analyses. Second, we characterized changes in the food webs of tropical lotic communities as a consequence of anthropogenic flow-modification (i.e., impoundment and canalization) with fish assemblage data from approximately four decades apart (~1966 and ~2010). Our data suggest that food web structure was influenced primarily by environmental factors in a bottom-up direction. Specifically, food webs of greater complexity were associated with higher nutrient levels. We did not observe significant changes in food web complexity but maximum trophic levels were lower in canalized rivers while the opposite was true in impounded rivers. Both studies are indicative of the pervasive influence of habitat modification on freshwater communities. Our findings further our understanding of food web ecology and may serve as a basis to predictively model changes in trophic interactions; a potentially important tool for mitigating ecosystem function loss with rapidly accruing anthropogenic pressure.

Paper Number: 365

Thursday, 05 July 2018 | Petra 1

Symposium 30.2 - Trophic interactions in human-modified tropical landscapes

Mini-cascade: ants exert top-down control on hemipteran herbivores and predators

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The rapid expansion of oil palm and other exotic tree plantations has contributed to the loss of forest throughout Southeast Asia. As intact forests become increasingly fragmented and disturbed, we have yet to understand the full consequences these disturbances, which could alter food web dynamics and reorganize interspecific relationships. Previous studies of ants - a diverse animal group that play important roles in key ecosystem processes show a shift in species composition with disturbance. Top-down control by ants may cascade through multiple trophic levels in a given ecosystem, however, little quantitative field data are available, particularly in tropical systems. Hemiptera are a mega-diverse order, abundant in tropical rainforests and ecologically important, including both herbivorous and predatory groups. In order to understand the roles of ants in exerting top-down control on both herbivores and other predators in tropical rainforests, we established a large-scale ecosystem manipulation experiment in Maliau Basin Conservation Area in Malaysian Borneo, suppressing the activity of ants on 4, 1ha plots over a two-year period. We collected leaf litter samples in July 2015 and September 2016, during a drought and a non-drought period, and recorded numbers of hemipterans in the plots. A total of 244 individuals belonging to 42 species were identified. While herbivorous hemipteran species richness did not vary across the ant-suppression and control plots, predatory hemipteran species richness increased in ant-suppression plots. Species composition of predators varied significantly in treated plots vs non-treated plots, while species composition of herbivores only showed variation in the second year of sampling. These results show that ants exert top down control over predators. A shift in ant diversity with disturbance could therefore result in trophic cascades within tropical rainforests, and an increase in non-ant predators such as predatory hemipterans, with potential knock-on ecosystem-level effects.

Paper Number: 836

Thursday, 05 July 2018 | Petra 1

Symposium 30.2 - Trophic interactions in human-modified tropical landscapes

GENERAL SESSION 37

Oil Palm & Sustainability

Alley-cropping System Can Boost Arthropod Biodiversity in Oil Palm Production Landscapes

Mohamad Ashraf Abdul Mutalib

Oil palm (*Elaeis guineensis*) is among the fastest expanding crops, due to high global demand for vegetable oils. Large areas of forest are converted into oil palm plantation to meet the market demand in producing countries which causes rapid decline in tropical biodiversity, including arthropods. The alley-cropping system has the potential to promote faunal biodiversity, related ecosystem services and food security in agricultural landscapes. In alley-cropping, a main crop is intercropped with a secondary crop (often a food crop), secondary crops are cultivated in the alleys in between the main crop. We compared arthropod contribution and arthropod order composition between five alley-cropping treatments (pineapple, bamboo, black pepper, cacao, bactris), where oil palm is intercropped with another species. In addition, we sampled two control treatments: monoculture oil palm, aged seven and 15 years old. A total of 50,155 arthropod individuals were recorded using pitfall trap sampling, representing 19 orders and 28 families. Fourteen orders belonging to sub-phylum Insecta, three orders from Arachnida (Araneae; Acarinae; Scorpiones) and two orders from Myriapoda (Chordeumatida; Geophilomorpha). We detected an increase in beta-diversity of oil palm production landscape. Specifically, we found that four orders (i.e. Hymenoptera, Orthoptera, Coleoptera and Araneae) represented 92 % of the arthropod composition in the alley-cropping system and the other 15 orders constituted 8 %. We also found a significant difference between arthropod composition in all the treatments. Our findings suggest that the alley-cropping system can become a key management strategy to provide additional source of revenue as well as making the plantation more hospitable to biodiversity, potentially improving yields of both crops.

Paper Number: 136
Thursday, 05 July 2018 | Petra 2
General Session 37 - Oil Palm & Sustainability

Fish Fauna From Conservation Area In Oil Palm Plantation On Peat

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Peat swamps are known to be important habitats for fish that have narrow niches and restricted range. As peatland is being utilised for agriculture, biodiversity conservation has an essential role as one of the criteria for sustainable agriculture. In an oil palm production landscape which is located at Tinbarap Estate in Miri, Sarawak, a total of 210.63 ha of peat swamp forest was set aside for conservation by Sarawak Oil Palms Berhad (SOPB), known as Tinbarap Conservation Area (TCA). This study documents the ichthyofauna of Sungai Kulak which flows through the conservation area. Samplings were conducted in April 2016 and November 2016 whereby a total of 106 fish representing 13 species and 7 families of were recorded. In terms of the number of family caught, 78.30% were from family Cyprinidae, 8.49% were from family Siluridae, 4.72% were from family Channidae, 3.77% were from family Osphronemidae, 1.89% were from family Anabantidae, 1.89% were from family Bagridae and 0.94% were from family Helostomatidae. The dominant species was *Desmopuntius johorensis* which accounts for 47.17% of the total fish recorded. The dominance of Cyprinidae in TCA was similar as in other peat swamp habitats. The result of our present study would provide useful information on the diversity of fish at Sungai Kulak which later could be valuable in conservation planning of the aquatic environment in the TCA of Tinbarap Estate.

Paper Number: 686
Thursday, 05 July 2018 | Petra 2
General Session 37 - Oil Palm & Sustainability

The value of riparian buffers for conservation in oil palm plantations

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Oil palm agriculture has expanded rapidly in Southeast Asia in recent decades, as global population and rates of consumption have increased. This has led to widespread conversion of forest habitat to plantation, and consequent losses of habitat complexity, reduced biodiversity, and changes in ecosystem functions and services. With demand for palm oil continuing to increase, there is a need to develop conservation strategies to try to balance the competing demands of production and ecosystem protection.

Riparian buffers are strips of non-cultivated land left beside waterways in agricultural areas, and have been suggested as a possible conservation strategy in oil palm plantations. Through a review of existing literature, and studies in the field based at the Stability of Altered Forest Ecosystems (SAFE) Project in Sabah, Malaysian Borneo, we assess a range of benefits of riparian buffers and how buffer design and management affect benefits. We also consider how best to restore riparian buffers via a large scale, long term experiment called the Riparian Ecosystem Restoration in Tropical Agriculture (RERTA) Project, based in Sumatra, Indonesia.

We found that riparian buffers have substantial potential to provide benefits for hydrology, water quality, biodiversity, and carbon storage, with little evidence of disservices for surrounding agriculture. Buffers are generally more successful if they are wider, and have higher quality of natural habitat, but requirements vary for different suites of benefits. Restoration has the potential to increase buffer width, habitat quality, and also to put buffers back into landscapes where they have been lost.

Paper Number: 861
Thursday, 05 July 2018 | Petra 2
General Session 37 - Oil Palm & Sustainability

Effects of leaf litter quality and riparian buffer structure on community dynamics of bacterial decomposers in oil palm plantations

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Southeast Asia is undergoing extensive conversion of tropical forests into exotic monoculture plantations, particularly oil palm (*Elaeis guineensis*) (OP). This undoubtedly alters aquatic bacterial decomposer communities with possible alterations to energy and nutrient provisions for aquatic food webs. We investigated bacterial community succession on decomposing leaf litter of two contrasting litter qualities, *Macaranga* and oil palm leaves in streams across a gradient of riparian disturbance in oil palm plantations using 16S rRNA gene sequencing. Our study sites follow a gradient of riparian disturbance: (i) forested reference sites (NF); (ii) OP with ~20m buffer of native vegetation along both banks (OPF); (iii) OP planted to stream edge with no chemical application within ~20m of stream edge on both banks (OPOP); (iv) OP planted to stream edge with chemical application (OPNB). We found that overall, bacterial community composition was more heavily influenced by leaf litter quality than changes in stream environmental conditions due to the differing riparian buffer qualities. Nonetheless, bacterial colonization on *Macaranga* litter was susceptible to increased nutrients and higher stream temperatures in oil palm streams, whereas, oil palm litter was more impacted by significant alterations in bacterial community composition possibly due to long term agricultural disturbances. These results paralleled impacts on litter decomposition rates. Retention of riparian buffers in oil palm streams mitigated impacts on bacterial diversity and richness between native forested streams and oil palm streams with no buffer. Oil palm streams with a forested buffer had most similar bacterial assemblages to pristine streams followed by oil palm streams with untreated buffer (i.e. no chemical inputs). Regardless of riparian disturbance, both *Macaranga* and oil palm litter were dominated by Proteobacteria and Bacteroidetes. Additionally, we identified several taxa capable of degradation of lignocellulose compounds (e.g. Chitinophaga, Caulobacteraceae, Actinomycetales), which confirms the role of bacteria in litter decomposition. In conclusion, we found that changing riparian biodiversity and quality can alter bacterial assemblages and the ecosystem processes they mediate. However, retaining riparian vegetation with high tree diversity mitigates impacts on the formation of litter bacterial assemblages in oil palm plantation streams.

Paper Number: 502
Thursday, 05 July 2018 | Petra 2
General Session 37 - Oil Palm & Sustainability

SYMPOSIUM 32.2

Frontiers in demographic modeling for tropical forest ecology and conservation

When seed dispersal matters: extracting information of diversity maintenance mechanisms and demography from spatial-point patterns and seed dispersal networks

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In tropical forest, seed dispersal is a critical period of tropical tree demography. It is also a key mechanism of diversity maintenance. Tracking a seed fate is usually conducted to understand how seed dispersal contributes to the whole life stage of a species. However, this is a time-consuming and labor-intensive task and limited mostly in an early life stage. Because approximately 70-80% of tropical trees is dispersed by animal, each tree species may share many seed dispersers forming into a complex mutualistic network. Consequently, this makes difficulty to study a role of these animals contributing into the demography of tropical trees. Theoretical studies show that information of ecological or demographic processes embedded in a spatial point pattern is able to be extracted using an appropriate spatial statistics. Here we present an example using the analysis, namely the “individual species–area relationship”, with the dataset of Mo Singto plot (30 ha), one of the ForestGEO plot in Thailand. We tested whether the local species richness of small (dbh <10 cm) and large (dbh ≥10 cm) trees in the neighbourhood of large trees of focal species was larger or smaller than expected by an appropriate null model. Focal species was classified into three groups: (1) accumulator (2) repeller and (3) no-effect. The underlying assumption is that the large-small pattern represent a consequence of seed dispersal. After, we used the results to conduct a new analysis with the binary data (+ or 0) on the seed dispersal network, and then tested the hypothesis that the major primate frugivores, rather than other arboreal frugivores, generated patterns of locally increased species richness around their preferred diet species in sapling (small) and adult trees. Our results suggest that primates are major drivers of contagious seed dispersal which generate species-rich seed rain around their preferred food-tree species, which results in significantly larger local species richness of saplings. Nevertheless, these patterns detected remain had a few theoretical supports. Methodology in tree demography has been advanced such as spatial explicit individual-based models. Thus, incorporating these models may help to advance on testing capacity of spatial statistics to detect the ecological and demographic processes.

Paper Number: 496

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.2 - Frontiers in demographic modeling for tropical forest ecology and conservation

Individual heterogeneity drives population growth and induces functional equivalence in Malaysian rainforest trees

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Background. Differences in the performance of individuals within a population – ‘individual heterogeneity’ – can fundamentally change the dynamics of populations and communities. This may have implications for the viability of threatened species, the management of exploited species and the spread of invasive species. These differences between individuals may also have important implications for competition and coexistence of species in communities. This may be of particular interest in highly diverse communities such as tropical forests.

Objectives. We aimed to (1) quantify the degree to which fast-growing individuals drive population growth of Malaysian rainforest tree species, (2) quantify the degree to which individual differences lead to overlap between tree species, and (3) relate this demographic overlap to similarity in functional traits.

Methods. We obtained rates of growth, survival and recruitment of 277 tree species collected during 1990-2005 in the 50-ha forest monitoring plot at Pasoh, Malaysia. The forest at Pasoh Reserve is very diverse, with >800 of trees (> 1 cm stem diameter) occurring within 50 ha. We used these rates to evaluate the degree of growth autocorrelation and to construct population models (Integral Projection Models) in which effects of individual variation on population growth can be simulated.

Results. We found that individual heterogeneity was mainly generated by stochastic processes, and that it caused fast and slow growth trajectories to differ strongly. The contribution to population growth (elasticity) of fast-growth trajectories was twice as high compared to that of slow-growth trajectories. Thus, fast growers are substantially more important than slow growers. At community-level, we found that individual heterogeneity caused substantial overlap in elasticity between species pairs. This overlap was as much as 32% between any two of our study species. The large demographic overlap was only weakly related to similarity in four functional traits (wood density, leaf mass area, maximum size and maximum growth).

Implications and conclusions. Large demographic overlap among species is an indication for substantial functional equivalence among rainforest tree species. This is the first study providing empirical evidence of functional equivalence, one of the pillars of neutral theory. Yet, as demographic overlap is not complete and is weakly related to differences in functional traits, there is (at least some) room for species differences to modify the degree of functional equivalence.

Paper Number: 247

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.2 - Frontiers in demographic modeling for tropical forest ecology and conservation

Demography of Javanese Edelweiss (*Anaphalis javanica* (DC.) Sch.Bip.) on Selo Hiking Track, Semuncar Resort, Merbabu Mountain National Park: A Baseline Measurement for Population Management

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Javanese Edelweiss, (*Anaphalis javanica* (DC.) Sch.Bip.), is facing threats due to extensive camping activity around the Selo hiking track. Although it is a dominant species in the sub-alpine zone of Merbabu Mountain National Park there is a lack of information about its density and population size. This has increased the vulnerability of the species. The number of Javanese Edelweiss along the hiking track may be decreasing but there remains hope through population management. As the actual 'demography' of the species remains unknown, research of the baseline measures was conducted to determine the density and population size.

To estimate the density and population size a quadrat method used 29 square plots of 5m x 5m. The plots were evenly distributed at various altitudes, ranging from 2400 masl to 3142 masl. The number of individual plants and the height and diameters of each were recorded for every plot. Additionally, temperature, moisture, and light intensity were measured and a site description was taken.

The density of Javanese Edelweiss was described by the mean number of individuals per sample plot, variance, coefficient variance, and confidence interval. The population size was then classified using cluster analysis. The distribution pattern was measured using the Poisson Index of Dispersion.

The density of Javanese Edelweiss is 15.572 individuals per hectare. The population structure is highly stratified and dominated by the height class of III to VI and the diameter class of I to III. The spatial pattern is identified as clumped dispersion. The average number of the individuals per plot is very varied and the number of seedlings is low and clustered in groups. Accordingly, the natural regeneration may be limited. Therefore, population management specifically for the hiking track should be established. Limiting the number of visitors and moving the camping zone away from the habitat would be beneficial. Finally, the population of Javanese Edelweiss could be increased by means of active management.

Paper Number: 504

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.2 - Frontiers in demographic modeling for tropical forest ecology and conservation

Density-Dependent Mortality of Dipterocarp Seedlings within the Degraded Forest of Sungai Tiagau Forest Reserve

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Tropical rainforests are diverse and complex ecosystems supporting the co-existence of many similar species. Numerous theories seek to explain this co-existence. One of the most influential is the Janzen-Connell hypothesis, which suggests that seedling mortality increases with increasing conspecific density, also referred to as negative density dependence. We investigated if negative density dependence were generally occurring among species in the Sungai Tiagau Forest Reserve over a 2 years period. We established eight 16 ha plots with all trees greater than 25 cm DBH enumerated. Within each 16 ha plot, 36 circular seedling plots of 2 m radius were established, and we checked seedlings mortality over the study period. Generalized linear mixed effects model were used to investigate the relationship between seedling mortality and densities of conspecific and heterospecific mother trees and seedlings. A total of 6,023 Dipterocarp wildlings from 28 species were enumerated. However, only 5 species, *Dryobalanops lanceolata*, *Dryobalanops keithii*, *Shorea fallax*, *Parashorea smythiesii*, and *Parashorea tomentella* occurred in high enough densities for further analysis. Seedling mortality ranged from 28% to 46%. Two of the species, *Parashorea smythiesii* and *Dryobalanops keithii* showed evidence of negative density dependence. For these species, we found increased seedling mortality in areas with high densities of conspecific adults. In contrast, *Shorea fallax*, *Dryobalanops lanceolata*, and *Parashorea tomentella* showed no evidence of negative density dependence. The results show negative density-dependence effect were not a general mechanism of co-existence across communities in Sungai Tiagau Forest Reserve.

Paper Number: 642

Thursday, 05 July 2018 | Taj Mahal

Symposium 32.2 - Frontiers in demographic modeling for tropical forest ecology and conservation

GENERAL SESSION 38

Pollination & Ecosystem Services

Frequent hybridization and obligate pollination may facilitate species diversification of *Ficus* plants

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The species diversification is among one of the fundamental questions in evolutionary biology. Obligate pollinator pollinated plants often harbor rather high species diversity comparing to generalist pollinated plants. Interspecies hybridization mediated with pollinator mistaking visitation may be one important factor in generating species diversity, while empirical studies supporting this hypothesis are still lacking. In this study, we take highly species diverse *Ficus* plants and their obligate pollinating fig wasps as the researching system. Firstly, we investigate the frequency of temporal hybridization and pollinator sharing with genetic markers in population level of five close related species, and test pollinators' responds to the floral volatiles of each fig species. Second, we detect the frequency of ancient hybridization of *Ficus* plants in subgenus level and sympatric species level within sub-clade of two subgenus by means of phylogenetic network analysis and cyto-nuclear phylogenetic conflict comparison based on reduced genomic sequencing data (SLAFseq) of 49 fig species. Third, we investigate the plasticity of pollinator host preference after artificial host shifting treatment, to test potential quick pollinator isolation capability of hybrid groups. Our results show: 1) Hybrid individuals and pollinator sharing events were detected in all five species studied. Floral volatiles of each fig species were proved attracting at least two pollinator species. Pollinator sharing and hybridization can predominantly exist. 2) The web-alike, instead of tree-alike structure of *Ficus* evolutionary relationship were selected at both subgenus and species levels for the phylogenetic network analysis. Ancient hybridization events were detected in three of the six main clades (subgenus) in subgenus level, and at least five and three hybridization events were also detected in species level at two sub-clades of subgenus *Sycomorus* and *Urostigma*, respectively. 3) Pollinating fig wasp show higher preference to new host figs after artificial host shifting treatment, which supporting the capability of potential pollinator isolation establishing of new fig group. Considering all above evidences, this study thus suggest, the frequent hybridization alone *Ficus* evolution and ability of quick pollinator isolation of hybrid groups, co-support the species diversification of this obligate pollination *Ficus* plants. Whether this diversification model also predominantly exists in other obligate pollination plants, requests further investigation.

Paper Number: 148

Thursday, 05 July 2018 | Glza

General Session 38 - Pollination & Ecosystem Services

The relative importance of herkogamy and reciprocity in determining disassortative pollen transfer and fruit set in a stigma height dimorphic species

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Background

The separation between the stigma and anther within a flower (herkogamy), and the relative position of stigmata and anthers in complementary morphs (reciprocity) is crucial in determining disassortative pollen transfer and fruit set in style-length polymorphic plants. Understanding the relative importance of herkogamy and reciprocity becomes particularly important in stigma height dimorphism, where stigmata are present at the two different heights, but anthers at the same height in complementary morphs. This leads to imperfect reciprocity and a reduction in disassortative pollen transfer. Consequently, stigma height dimorphism is considered to be a rare and transient intermediate state in the evolution of reciprocal heterostyly.

Objectives and Methods

Here we examine the relative importance of herkogamy and reciprocity in determining disassortative pollen transfer and fitness in *Jasminum malabaricum*, a self-compatible stigma-height dimorphic species. We quantify and compare the relationship of herkogamy and reciprocity with stigma pollen load, disassortative pollen load and fruit set in naturally occurring populations from the Northern Western Ghats of Peninsular India.

Results

We observed no relationship between herkogamy and total stigma load, but as expected we saw a positive relationship with disassortative pollen load, and consequently fruit set in the long-styled morph. Although reciprocity was positively related to total pollen load, contrary to expectations, we found that it was negatively related to disassortative pollen load in the long-styled morph, and fruit set in the short-styled morph. We found no relationship between total pollen load or disassortative pollen load with fruit set, suggesting no pollen limitation in this population. Finally, we observed a negative relationship between herkogamy and reciprocity in these plants.

Conclusion

These results suggest that herkogamy is more important than reciprocity in determining disassortative pollination and fruit set in this population. Increased separation between the anther and stigma within a flower was related to reduced reciprocity between sex organs of complementary morphs in these plants. This likely explains the negative relationship observed between reciprocity and disassortative pollen load and fruit set. These results suggest that herkogamy can play a significant role in encouraging disassortative pollen flow and stabilising such polymorphic intermediates, allowing reciprocity between complementary organs to arise latter in the evolutionary pathways towards perfectly reciprocal heterostyly.

Paper Number: 739

Thursday, 05 July 2018 | Glza

General Session 38 - Pollination & Ecosystem Services

Seed and pollen dispersal of African timber tree species - implications for sustainable forest exploitation

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Seed and pollen dispersal are important components of natural forest regeneration. Logging activities can potentially interfere with these processes, for example if the reduced density of reproductive trees after exploitation causes pollen limitation leading to reduced seed set and/or higher self-pollination, or limits the chance that seeds reach suitable micro-habitats due to dispersal limitation. To evaluate these risks, baseline data on seed and pollen dispersal distances are needed.

Our objective here is to summarize the outputs of studies conducted on Central African timber species to estimate selfing rates as well as seed and pollen dispersal distances.

We rely mostly on parentage analyses conducted within plots of several km² situated in forests managed under selective logging. Microsatellite markers allowed to identify the parents of seeds and seedlings and estimate parameters such as selfing rate, rates of pollen and seed immigration, seed and pollen dispersal distances, and selective gradients.

Most tree species are predominantly outbreeding with one exception, *Pericopsis elata*, which relies predominantly on self-pollination. Species showing moderate levels of self-pollination (e.g. 5 to 25%) typically display signs of strong inbreeding depression. Pollen dispersal distances vary widely among species and increase substantially when adult density decreases. Preliminary data suggest that larger and more specialized pollinators could result in longer dispersal distances (median distances >1000m) than smaller and more generalist pollinators. Seed dispersal also vary widely among species, with median distances varying from c. 50m to >1000m in wind dispersed species.

For most tree species, selective logging as typically performed in FSC certified concession is not expected to interfere substantially with seed and pollen dispersal. Nevertheless, there are some concerns in a few species displaying (i) low natural density combined with high rates of self-pollination, or (ii) a minimum diameter of effective reproduction close to the minimum diameter of exploitation.

Paper Number: 769
Thursday, 05 July 2018 | Glza
General Session 38 - Pollination & Ecosystem Services

The birds, the bats, the bees and the chocolate trees: Achieving sustainable agriculture in the Afrotropics through DNA metabarcoding and network analysis

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Humans destroy huge swaths of tropical rainforest every year—mostly driven by agricultural expansion. Cacao, which fuels the multi-billion dollar chocolate market, is grown primarily in west and central Africa on small, family owned farms. Fortunately, cacao is typically not as destructive as other crops as it can be grown under a canopy of rainforest trees. Unfortunately, very little is known about sustainable management of African cacao farms—either for the benefit of agricultural production or biodiversity. Here we use a novel genetics technique (DNA metabarcoding) to sequence arthropod and plant DNA from bird and bat fecal samples collected in cacao farms. The objectives of our barcoding/network analysis effort are to understand: 1) The shade tree species that maximize biodiversity (“keystone species”); and 2) The birds, bats and shade trees that maximize cacao productivity through reduction of pest insects (“ecosystem service species”)

We captured birds and bats in 16 central African cacao farms over two seasons, conducting DNA metabarcoding on 220 fecal samples from strictly insectivorous predators. We were able to recover arthropod DNA barcodes from nearly 80% of these samples, and, equally importantly, were able to recover plant DNA from nearly 80% as well, meaning that DNA barcodes remained in tact after passing through the guts of both predators and plant-consuming arthropods. This DNA recovery allowed us to reconstruct large portions of a tri-tropic food web including detailed connections among thousands of organisms. *Ficus* and *Ceiba* trees had especially large numbers of connections in the network, indicating their potential as keystone trees. Several insect-gleaning bird and bat species consumed cacao pests, suggesting that they save farmers a considerable sums through ecosystem services. Increasing demand for cacao from the chocolate industry has pushed farmers further and further into tropical rainforests, and increasingly towards species-poor, full-sun agricultural systems. Full sun cocoa is more productive in the short term, but sun-grown trees quickly become unproductive and require far more agricultural input (fertilizer, pesticides) relative to shade grown cacao, which is more sustainable over the long term. By understanding the cacao food web as mapped by the framework we outline here, we can make meaningful management recommendations to farmers (i.e., which shade trees to plant) that will result in a biodiverse system rich in ecosystem service providing animals.

Paper Number: 474
Thursday, 05 July 2018 | Glza
General Session 38 - Pollination & Ecosystem Services

GENERAL SESSION 39

Reptile Ecology & Conservation

Habitat use by king cobras in a palm oil plantation in southern Borneo

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Snake species in the family Elapidae are important to Asian tropical forest ecosystems, functioning as both predators and prey. The presence of a variety of elapid species, all of which are venomous, in monocultural landscapes, such as palm oil plantations, is important from both a human-safety and biodiversity conservation perspective. Here, we report on a study of the home range, movement patterns, diet and behavior of King Cobras (*Ophiophagus hannah*) in a palm oil plantation (United Plantations/PT SSS Estate) in Central Kalimantan Province, Borneo, Indonesia. The estate was designed according to protocols established by the RSPO, which calls for the integration of riparian zones, wetlands and other areas with high conservation value areas in conjunction with planted areas. Since March 2015, we captured 11 king cobras and implanted radio-transmitter into each of them. Tracking data reveal that the mean home range (95% FK) size of king cobra ($n = 11$) was 1 km² ($n = 2174$ locations, $SD \pm 0.69$, range 0.34 – 2.06 km²), with monthly movement averages 2173 meter. Snakes were the main prey of King Cobras, including Sumatran Spitting Cobras. King Cobras used palm oil most of the time, but also periodically used adjacent riverine riparian forests. Our data on habitat use indicates the importance of maintaining intact native habitat as an integrated part of the palm oil plantation. Our future goal is to use intensive radio telemetry to guide us in determining the size and configuration of protected areas needed to sustain reptile diversity in areas where the demand for agricultural lands is high.

Paper Number: 581

Thursday, 05 July 2018 | Machu Itza

General Session 39 - Reptile Ecology & Conservation

Varanus Salvator Population Dynamics and Parasite Diversity: A Fast Food Effect in a Fragmented Landscape

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Varanus salvator, one of the biggest predators in South East Asia's wetlands, is also an efficient scavenger well adapted to the highly fragmented landscape across its distribution range. As a generalist species, monitor lizard populations seem highly abundant in fragmented anthropogenic landscapes thanks to the abundant food source. Nevertheless, little is known about the effects of their ecological adaptation. In this study, we looked at how habitat fragmentation influences on the monitor lizard's parasite diversity as part of the trade-off that apparently benefits the species. Population size was assessed by capture-mark-recapture methods in six different sites within the Lower Kinabatangan Wildlife Sanctuary and the surrounding oil palm plantations in the area in Sabah, Malaysia. Feces were collected from trapped individuals and processed by concentration methods to identify parasite eggs. Additionally, eggs per gram of feces were quantified by McMaster method. Diet diversity was assessed by recording the preys found in the vomit of trapped individuals. After 3231 trapping days, 420 individuals were caught and 92 fecal samples were collected. As expected, POPAN model showed higher population sizes in plantations (OPP; 159.3 $\pm$ 31.26) than in forested areas (96.22 $\pm$ 14.33SD). Nevertheless, the survival and growing rates seem to be higher in the forest than in OPPs ($\Phi = 0.55 / 0.27$; $\lambda = 1.041 / 0.466$). Diet diversity as well as parasite diversity were also higher in the forest than in OPPs ($H'_{\text{diet}} = 0.883 / 0.36$; $H'_{\text{parasites}} = 0.941 / 0.83$). We identified 13 taxonomic groups of parasites and one unidentified morphotype. Generalized Linear Models showed that a combination of factors such as host abundance, diet and parasite diversity have strong association with the prevalence of some parasites such as oxyuroids and spirurids, while egg's shedding rate was more associated to host abundance, prevalence and parasite diversity. We were not able to confirm whether parasite eggs came from parasitic worms infecting lizards, or if they are incidental events associated with food behavior. Nevertheless, it is clear that the so called positive consequences of habitat fragmentation for such a generalist are also the drivers for parasites prevalence and spreading, which could also represent a risk for other carnivores even more susceptible. We suggest to perform full health population assessment in order to get a better idea of how habitat fragmentation impact on this and other generalist species.

Paper Number: 835

Thursday, 05 July 2018 | Machu Itza

General Session 39 - Reptile Ecology & Conservation

Habitat-specific warming responses in an Afrotropical skink

Felix Landry Yuan

Distributional shifts, range contractions and extinction in ectotherms are amongst the most severe consequences recorded due to climate change. Yet, vulnerability to such impacts is not equal, and often dependent on a combination of biotic and abiotic elements. An important underlying factor tends to be the climatic nature of a habitat occupied, where species or populations from environments lower in thermal variability could be at a higher risk. The habitat transition from forest to gallery forest-savanna mosaic (ecotone) in Cameroon presents an ideal gradient to explore this concept. Here, *Trachylepis affinis* is a broad ranging lizard species showing morphological and genetic divergence across this ecological gradient. Although a common method to investigate climate change vulnerability is to estimate habitat suitability using correlative species distribution models, I additionally took an integrative approach by first quantifying the thermal performance of *T. affinis* across habitats. With these data as a foundation, I then applied a mechanistic niche model (NicheMapR) to project changes in potential activity time throughout Cameroon for both ecotone and forest lizards in response to future warming. For the mechanistic projections, the resulting habitat-specific difference was distinct; potential activity time of forest lizards dropped sharply in forests, while ecotone lizards would benefit from warming in those same regions. On the other hand, the correlative models depicted a less clear picture, with habitat suitability increasing in some forest areas yet decreasing in others for the forest lizards, and the ecotone lizards facing slight decreases in certain ecotone regions. These results showcase the importance of implementing thermal physiology in climate change impact predictions, since mechanistic models can reveal consequences undetectable using correlative models alone. From this perspective, my work demonstrates how physiological variation across habitats translates to contrasting responses to climate change within a species.

Paper Number: 278

Thursday, 05 July 2018 | Machu Itza

General Session 39 - Reptile Ecology & Conservation

Movement ecology and natural history predict human-snake conflict patterns

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As the unprecedented scale of human encroachment on natural systems expands, it is increasingly important to understand the drivers of human-wildlife conflict, in order to mitigate these encounters. Snakebite envenomation is an important instance, as a neglected tropical disease that affects up to 5.5 million people annually. Mapping and forecasting snakebite incidence requires models that integrate ecological and environmental drivers of human-snake interactions, but these are limited by paucity of data on snake life history, and by open questions about how life history patterns translate into encounter rates. We combined surveillance data on 280 human-snake conflict events, with fine-grained relocation data from 17 white-lipped pit vipers in Hong Kong over two years (*Trimeresurus albolabris*, the main conflict species in the region; 13 female, 4 male), hypothesizing that movement and breeding phenology, plays a key role in shaping seasonal patterns of human-snake conflict. The snake tracking data included geographic location, height above ground and perch type every 2-4 days. Male home ranges were on average 2.5 times larger than female home ranges. The difference in home range size was explained by larger horizontal movements made by males during September and October, corresponding with distinct segments of their trajectories that displayed characteristics of mate-searching movements. Females tended to perch on branches lower to the ground (i.e. closer to the range of human height) in the month of October. These trends overlapped temporally with physiological changes related to reproduction, and the putative mating season for this species. Females displayed no gestational or overwintering migration, and were as likely to hibernate in artificial microhabitat as in natural underground crevices. Seasonal peaks in conflict encounter rates with humans were better explained by natural history and movements of *T. albolabris* than by climatic variables alone. Our results show that human-viper interactions may be reduced by seasonally clearing both artificial and natural perch substrates around homes, and removing potential artificial hibernation sites such as building rubble and trash piles. Lowering encounter rates has beneficial implications for both snake conservation and human health by reducing rates of translocation or euthanasia of snakes, and decreasing snakebite morbidity in humans.

Paper Number: 767

Thursday, 05 July 2018 | Machu Itza

General Session 39 - Reptile Ecology & Conservation

GENERAL SESSION 40

Altered Ecosystems Ecology & Conservation

The home range and movement behaviours of a pack of free-roaming dogs in Singapore

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Movement is a fundamental characteristic of life, and it determines the fate of an individual organism and its potential impact within an ecosystem. Understanding an organism's capacity to move is particularly important when controlling the spread of a non-native predator across landscapes and managing their supposed impacts on lower trophic prey organisms. Dogs are the most abundant carnivores in the world and this is likely the result of being a well-liked domestic animal where they can be the intentional recipients of different types of supplementary resources (e.g., food, protection) from humans (i.e., their caregiver). At present, the scientific literature on dog ecology is lacking, and their movement patterns and impacts on wildlife remains relatively undocumented, especially in the biodiversity-rich landscapes of South-east Asia. This study examined the influence of a caregiver and the temporal variations in home range size and activity levels of a free-roaming pack inhabiting an offshore island of Singapore. We predicted that the dogs will have larger home range sizes and greater movement (1) in the absence of their caregiver and (2) during crepuscular hours. Home range sizes were estimated using three home range estimators (minimum convex polygon, kernel density estimation, and time local convex hull) on GPS data collected from tracking collars. In addition, movement behaviours were predicted from tri-axial accelerometry measurements with the use of Random Forest Machine Learning Algorithms that were trained with proxy data collected from domestic dogs. The activity levels of the free-roaming dogs were then examined through an activity budget constructed with eight different predicted movement behaviours. We found that the movement of the pack was centred around the caregiver's residence with frequent forays extending along the coastal shores. Home range sizes and activity levels were similar throughout the day which suggests that these dogs were not crepuscular animals. However, home range sizes were comparatively smaller (95% and 50% isopleth) in the caregiver's presence even though activity levels in the absence and presence of the caregiver were similar, indicating that these dogs were less likely to roam farther for foraging opportunities when the caregiver is around, probably due to the likely provision of supplementary resources. These results will also be used as a framework for the future examination of the dogs' impacts and roles within a tropical ecosystem.

Paper Number: 722

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General Session 40 - Altered Ecosystems Ecology & Conservation

Species composition of native mammals in urban forest patches in Selangor, Malaysia

Sze Ling Tee

Introduction

Rapid urbanisation has caused major deforestation and habitat fragmentation in the tropics. Yet, the mammal species composition has not been investigated in urban forest landscapes particularly those that are heavily surrounded by anthropogenic activities.

Objective

This study attempts to determine the species composition of medium- and large-sized mammal species in three forest patches and a contiguous forest in Peninsular Malaysia.

Method

The study was conducted from September 2016 to October 2017 by using camera trapping method.

Results

A total number of 19 mammal species comprising 11 omnivores, 4 herbivores and 4 carnivores from 120 sampling points were recorded. Only three conservation priority species were recorded, namely the Sunda Pangolin in AHFR and BFR, the Asian Tapir in BCFR and SLFR, and the White-handed Gibbon in SLFR. Top predators such as Tigers and Leopards were absent from the forest patches. The high abundance of wild boars reflects this. Mammal species composition was analysed using SIMPER which showed the mammal community is primarily represented by omnivores in all study sites.

Implications and Conclusions

Conservation stakeholders are recommended to take intervention measures such as improving the connectivity between forest patches and contiguous forest and reintroducing species and restocking the wild populations of selected species in the urban forest patches.

Paper Number: 115

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General Session 40 - Altered Ecosystems Ecology & Conservation

Resilience of heronry birds to urbanization

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Urbanization is an inevitable ecosystem process affecting biodiversity in developing countries including India. Some species are resilient to the urban ecosystems and heronry birds are the latest example. Heronry is a communal nesting of multiple waterbirds, predominantly the herons, egrets and cormorants. Their original roosting and breeding sites were mangrove islets. But, some avenue trees in urban areas give alternate substrate for their nesting. Hence, we first investigated the nesting tree species characteristics. Also, increasing use of urban habitats for breeding has been suggested as a depredation skill. We, therefore hypothesized that the heronries in urban landscapes experience relatively less predation. Census on nesting trees was done in 3 major microhabitats of the urban ecosystem (roads, non-residential, and residential areas) apart from the mangrove islets during the peak breeding season. Number of nests per tree was used as a measure of nest tree occupancy and as the response variable in the analyses to study the effect of urban habitat type and nesting tree species on heronries. We used generalized linear mixed effect model (GLMM) with Poisson error as the distribution to compare the effects of microhabitat and the road type on the heronries. We quantified diversity, abundance, and frequency of avian predator and predatory attempts in heronries of wild (mangrove forest) and urban habitats during a breeding season to test the hypothesis. We studied the effect of habitat type on total number of predators, total number of predation attempts, and total number of successful predation using GLMM. The study found that 174 trees of 22 species hosted 1,928 heronry bird nests in the urban habitats; mangrove forests, although plentiful in the study area, hosted only about 20% of the total nests encountered in the study. The differences in the observed frequencies of nesting trees in 3 microhabitats and in 3 types of roads (national highways>state highways>small pocket road) were significant. Canopy spread, girth size, and quality of the trees predicted the tree selection of the heronry birds in urban environments. House crow (*Corvus splendens*), Brahminy kite (*Haliastur indus*), and Black kite (*Milvus migrans*) were the major predators of heronry nests of both mangrove forest and urban ecosystem. But, their abundance and frequency of successful predation of eggs and chicks of heronry nests were significantly low in urban heronries. Thus, heronry birds prefer urban sites due to low predation pressure and availability of suitability of nesting trees.

Paper Number: 340

Thursday, 05 July 2018 | Chichen Itza

General Session 40 - Altered Ecosystems Ecology & Conservation

Temporal changes and compositional organization of ant communities along vegetation succession in Hong Kong

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Deforestation has severely impacted tropical and subtropical ecosystems and is a major cause of biodiversity loss. Following forest clearance, areas considered with low economic values are leftover and gradually replaced by secondary forests. The increasing importance of these habitats for conservation in Southeast Asia underlies the necessity to understand species recolonization patterns and processes along secondary forest succession. Nevertheless, most studies are based on short-term comparisons which hinder the understanding of long-term recovery processes. Following centuries of complete deforestation, Hong Kong forests have progressively returned over the past 70 years and now provide unique opportunities to study faunal recovery processes and serve as a precursor case in Asia. Here we predicted that effects of abiotic factors will act as primary factors on species recolonization in early successional stages but will then decrease to be progressively complemented by biotic interactions, such as competition, along forest succession. Using a baseline survey realized in the early 90's and a recent survey we investigate 1) the turnover patterns in ant species richness and composition; and 2) disentangle the relative importance of abiotic and biotic processes on ant recolonization using a functional trait based approach along forest succession. Species collected with pitfall traps and baiting at 58 sites were identified and morphological traits measured to compute taxonomic and functional diversity indices. Our results show that in open habitat such as grasslands, in which disturbance is frequent, ant community composition present a higher species turnover between sites, while within more mature/closed habitats ant community composition tend to more similar than expected by chance. However, our results based on functional diversity present a more contrasted pattern. In grasslands, functional diversity become more homogenized which suggest important environmental filtering processes on trait selection over time. In forested habitats, ant communities switched from processes controlled by stochastic factors to a more clustered pattern governed by environmental factors along a 20 years period; in contradiction to our initial expectation and previous studies. The causes of such mechanistic transition deserve further works, but it could be hypothesized that apart from natural processes, disturbance from historical deforestation and on-going urbanization exerted alternate selection pressures on the recovery of ant communities. A joint consideration of space and time will allow a better understanding and prediction of species recolonization patterns under the Anthropocene.

Paper Number: 674

Thursday, 05 July 2018 | Chichen Itza

General Session 40 - Altered Ecosystems Ecology & Conservation

GENERAL SESSION 41

Plant Phenological Patterns

Assessment of plant phenological responses in the tropics based on gene expression analyses and mathematical modeling

Akiko Satake

Synchronized flowering in tropical rain forests, called general flowering, is considered one of the most mysterious and large-scale events in ecosystems. With irregular intervals of several years, nearly all tree species of the Dipterocarpaceae family come heavily into flower. The genetic description of flowering pathways has been well established, with rapid progress in genetic and molecular analyses in model plants such as *Arabidopsis thaliana*. Molecular genetic tools have been increasingly used in the field of flowering phenology only recently, demonstrating the usefulness of the molecular phenology approach to unravel molecular mechanisms of plant response to naturally fluctuating environments in diverse plant species. To investigate the proximate factors for floral initiation of mast flowering trees in the tropics, we monitored the expression dynamics of two key flowering genes, meteorological conditions and endogenous resources over two flowering events of *Shorea curtisii* and *Shorea leprosula* in the Malay Peninsula. Comparisons of expression dynamics of genes studied indicated functional conservation of FLOWERING LOCUS T (FT) and LEAFY (LFY) in *Shorea*. The genes were highly expressed at least 1 month before anthesis for both species. Gene expression data were used to parameterize a mathematical model that predicts flowering dynamics in tropical rain forests in Southeast Asia. The model that considered the synergistic effect of chilling and drought was successful to explain the observed gene expression dynamics in two *Shorea* species. Nonlinear time series analyses of meteorological data revealed that using chilling and drought as a flowering cue is adaptive to synchronize the timing of seedling growth with the period when sufficient moisture is available. Our study emphasizes the usefulness of modeling approach for comprehensive understanding of both proximate and ultimate mechanisms underlying synchronous flowering in tropics.

Paper Number: 281
Thursday, 05 July 2018 | Eiffel 1
General Session 41 - Plant Phenological Patterns

Toward establishing detailed baseline tree phenology responses to climate drivers for the central Congo Basin

Koen Hufkens

Introduction:

The African rainforest, is the second largest on Earth, stores up to 66 Pg of carbon and is presently a persistent carbon sink (0.34Pg C yr⁻¹). Recent studies have shown that these forests are being subjected to a long-term drying trend. These drought events can substantially alter forest structure and tree functioning, providing large feedbacks to the climate system, raising fears over the drought resilience of tropical tree species through acclimation and the persistence of this important terrestrial carbon sink.

Our understanding of plant and by extension forest responses to climate change rely heavily on consistent long-term observations. However, measuring traits of tropical plant species is particularly demanding, and established long-term observation programmes are rare. Despite these challenges some long-term (historical) records of phenology observations, important plant traits and indicators of climate change and growing season variability, do exist.

Methods:

The historical archives of the Institut National d'Etudes Agronomique du Congo Belge (INEAC) span approximately five decades (~1910 – 1960) of observations across the Congo Basin and hold vast amounts of data including forestry, climatological, ecological and biodiversity data with great potential and relevance for basic and applied forestry research. We combine past and ongoing transcription efforts of historical INEAC data in a concise analysis representative of the central Congo Basin. In particular we use historical INEAC phenological and climatological data recovered during the Jungle Rhythms citizen science project (<http://junglerhythms.org>) and the ongoing "Congo basin eco-climatological data recovery and valorisation (COBECORE)" project respectively (<http://cobecore.org>).

Results:

We summarize initial findings covering >500 species, 2492 individuals and a total of >25K observation years. In particular we discuss the seasonality and synchronicity across all observed dominant canopy tree species in a central Congo Basin, as well as their sensitivity to the local climate, shedding light on their drought resistance and plasticity.

Paper Number: 585
Thursday, 05 July 2018 | Eiffel 1
General Session 41 - Plant Phenological Patterns

Quantitative indices of leafing phenology in woody tree species from a seasonally dry tropical forest

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Broad-leaved evergreen and deciduous species is an important and dominant plant functional type in dry tropical forests. These leaf phenology categories represent different water use and conservation strategies observed in these regions. However, species within these categories exhibit wide variation in leaf phenology. For example, different deciduous species can range in leafless duration from a week to greater than six months. Similarly, in evergreen species, maximum canopy loss can range from zero to >75% of the total canopy.

In this study we monitored leaf phenology in 76 woody species from seasonally dry forests in the Northern Western Ghats of peninsular India. We calculated three indices to represent continuous quantitative estimates of deciduousness (hereafter indices of deciduousness): 1) Average annual canopy loss; 2) Minimum canopy observed; and, 3) Duration of leafless period. We examined relationships between indices, and calculated a composite index represented by the principal component axis of these measures. To understand the functional consequences of these indices we examined the relationship between the deciduousness indices and flushing and senescence timing in the study species.

We observed wide variation between species in the deciduousness indices calculated. Minimum canopy varied from negligible loss of canopy in very evergreen species to 100% of the canopy in deciduous species. The duration of deciduousness ranged from zero in the evergreen, to almost 4 months in the most deciduous species. Average annual canopy, an integrated measure of the canopy maintained through the year, ranged from 0 to 47%. These continuous quantitative measures of leafing behaviour were related to the timing of peak leaf flush, but not to peak leaf senescence in these species.

These results show that these quantitative measures of deciduousness provide valuable information about leafing behaviour. These measures were continuous rather than bimodal indicating that continuous quantitative estimates may be more appropriate, rather than discrete categories. Importantly, we found that these quantitative measures of deciduousness were functionally relevant and were related to the timing of leaf flushing in these species. Species that were more evergreen had lower deciduous index scores and flushed leaves earlier in the year close to or before the spring equinox. In contrast, more deciduous species with higher deciduous index scores flushed leaves closer to the onset of the rains, likely indicating a greater reliance on water availability.

Paper Number: 729
Thursday, 05 July 2018 | Eiffel 1
General Session 41 - Plant Phenological Patterns

SYMPOSIUM 35

Connectivity in Tropical Landscapes

How do we decide which wildlife corridors to conserve? Prioritizing connections to maximize regional biodiversity persistence

Jedediah Brodie

Landscape connectivity is critical to prevent the loss of biodiversity in isolated protected areas. Recent advances have been made in determining the optimal locations for habitat corridors that can link parks or forest patches. But of all the possible corridors that we could protect, how do we decide which are the most important? Here we develop a new analysis approach that links landscape ecology to metapopulation theory, allowing the quantitative prioritization of connectivity areas for conservation based on their contribution to long-term, regional biodiversity persistence. Using a “cameras to corridors” sequence of analyses, we show how field data on animal occurrence across Sarawak and Sabah were used to estimate habitat selection and dispersal and, in turn, the importance of different forested areas for the regional population viability of terrestrial mammals. Our analysis seeks to maximize dispersal among the existing national parks of Malaysia and Indonesia and also the maintenance of populations within parks and the corridors themselves. We find that linkages between Kayan Metarang, Hose Mountains, and Betung Kerihun National Parks are particularly critical to maintain. Corridors in this area would add less than 1% to the total protected area coverage on Borneo but reduce extinction risk of threatened mammals by an average of 10% across species. Ongoing engagement with government agencies in Sarawak and Sabah is leading towards the formal protection of several of these corridor sites.

Paper Number: 659
Thursday, 05 July 2018 | Colosseum 1
Symposium 35 - Connectivity in Tropical Landscapes

Growing a corridor: incorporating simulated animal movement and location weighting into iterative connectivity optimization

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Habitat loss and degradation has led to the isolation of wildlife populations by decreasing landscape connectivity, which limits the movements of individuals and groups of animals between remnant patches of high quality habitat. In Sabah, Malaysia, over 1.8 million hectares of land are currently protected, and a large portion are configured as large protected areas (PAs) that can support wildlife populations. Government agencies in Sabah have committed to protecting additional land and are identifying areas for new protection within Sabah. Including areas that provide corridors for animal movements between existing and new PAs is critical to maintain regional biodiversity. Our aim was to identify and prioritize currently unprotected areas of forested habitat that may serve as these corridors. We used a novel approach that integrates simulated animal movement, location weighting, and iteration-based solutions to conservation problems to dynamically optimize the selection of discrete landscape units to ‘grow’ corridors between existing large PAs. Our analysis prioritized corridors between existing PAs in southern and western Sabah and led to connections to Kayan Mentarang National Park in North Kalimantan. Our results highlight that corridors providing connectivity do not always follow strictly linear pathways, and have shape irregularities that allow for biological and ecological realities of animal movement and habitat quality. Corridors we identified will be incorporated with a variety of other ecological inputs to prioritize future landscape protections that conserve vertebrate, invertebrate, and plant species ranges, as well as connectivity that is critical for population- and community-level ecological processes.

Paper Number: 792
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Symposium 35 - Connectivity in Tropical Landscapes

Decision support for restoring ecological networks in tropical developing countries using Condatis

Jenny Hodgson

Rapid land-use change in tropical developing countries means that natural habitats are being lost and many remaining areas are degraded and fragmented. However, there is still enormous richness and biodiversity left to protect, and significant initiatives towards forest rehabilitation and restoration are starting. Climate change is already affecting tropical species, and there is particular concern about whether they will be able to shift from areas that become too hot or dry, across fragmented landscapes, to reach refuges in montane regions. If land-use change and forest degradation continue too intensively in these countries, species and ecosystem functions will be lost, leading to detrimental impacts on the livelihoods of local people dependent on these lands.

We have developed a model called Condatis, based on ecological understanding of range shifts, which quantifies how different elements of a habitat network contribute to long-distance connectivity. We will explain how Condatis can identify both the best habitat to preserve, and the best locations to target for restoration. It does this by simulating the iterative removal of habitat, which tests how the costs of removal can spread far and wide across the network. We will also show how Condatis can make good use of a limited amount of data, for example land cover data and small-scale studies of biodiversity in different land cover types. We are using Condatis with partners in Malaysia to help protect functional routes between protected areas that will be needed under climate change. Contrastingly, we are using it with partners in Ghana to prioritise the restoration of agroforestry, to facilitate the coexistence of wildlife with local communities.

Condatis complements the more established tools of systematic conservation planning. Its particular advantages are its relevance to conservation under climate change, and its ability to prioritise the process of range shifting rather than the pattern of where species are currently found. We also argue it is particularly useful for developing countries because it does not need excessive amounts of data and it is accessible as a web application. Thus, it enables large-scale sustainable land-use planning for tropical developing countries under climate change.

Paper Number: 214
Thursday, 05 July 2018 | Colosseum 1
Symposium 35 - Connectivity in Tropical Landscapes

Species traits predict variation in environmental thresholds

Simon Mitchell

In terrestrial ecosystems, the leading causes of species extinction and ecosystem collapse are direct anthropogenic modification of vegetation, (including through logging, habitat conversion and fragmentation). Whilst links between species assemblages and land use change, forest degradation and habitat configuration are well established, the nature of such relationships is often less well understood. Non-linear responses at both community and species levels mean that beyond certain thresholds the impact of anthropogenic changes may increase or decrease, but this requires high resolution community and vegetation data to assess. We used an occupancy modelling approach to assess the responses of tropical birds to vegetation changes associated with both logging in continuous forests and the configuration of riparian corridors in oil palm landscapes. In the two different contexts, we quantify the breakpoints of multiple relationships between species and environmental variables and use this to inform broader trends between different species trait-groups and anthropogenic landscape alteration. We demonstrate that for several metrics, including forest canopy height and forest connectivity, multiple species have non-linear responses. Furthermore, we show that the breakpoints of such responses differ according to species trait-groups.

Paper Number: 657
Thursday, 05 July 2018 | Colosseum 1
Symposium 35 - Connectivity in Tropical Landscapes

Human behaviour as a spatio-temporally varying barrier to species connectivity

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With ubiquitous habitat fragmentation, connectivity is today a concern for conservation programs worldwide. Studies show that a loss of connectivity has negative impacts for species, hence emphasizing the importance of this issue. The tropics, with high human population density and extensive agricultural lands, are particularly vulnerable to a loss of connectivity. In these regions, dispersing animals inevitably encounter humans; these encounters may be negative, resulting in human–wildlife conflict. Here, we discuss the role of conflict, or negative interactions between people and dispersing animals, in shaping species connectivity. We use the example of the Asian elephant in human-dominated landscapes. First, reviewing studies on human–elephant conflict in India and Asia, we show that conflict and conflict mitigation measures have the potential to impede elephant connectivity across their range. We distinguish conflict (and associated mitigation measures) that serve as a spatial barrier, with what varies across both space and time. We discuss potential ramifications of each of these on connectivity patterns in fragmented landscapes. We then take the case study of a landscape in Northeast India to show the juxtaposition of conflict and connectivity. We use data from ecological surveys and questionnaire surveys, as well as insights from stakeholder interactions, to demonstrate the issue of human behaviour as a spatio-temporally varying barrier to animal movement. We demonstrate that elephants modify their behaviour on encountering negative interactions from people in the landscape. We discuss conservation interventions that can aid in mitigating this barrier impact on the Asian elephant and other wildlife. We conclude by discussing how the added dimension of time can be incorporated into ecological studies, movement models, and conservation programs to effectively implement connectivity conservation for conflict-prone species in human-dominated landscapes.

Paper Number: 852

Thursday, 05 July 2018 | Colosseum 1

Symposium 35 - Connectivity in Tropical Landscapes

Cultural and biological connectivity in a massive conservation corridor in the Putumayo watershed in South America

Corine Vriesendorp

Intact forests are considered an “exceptional value” for conservation, and forest corridors are increasingly lauded as critical for achieving global conservation goals and sustaining traditional livelihoods. However, there is a shortage of blueprints for ensuring that intact forests remain standing and healthy. One model is consolidating a conservation corridor, which hinges on bringing together diverse actors, integrating management across a land-use mosaic (including protected areas and indigenous territories), and ensuring a coordinated and consistent response in the face of threats. We report on the experience of an effort to build a conservation corridor in South America in the Putumayo watershed, a basin shared by Peru, Colombia, Ecuador, and Brazil. The Putumayo boasts vast expanses of intact forest with 4.8 million ha of indigenous territories (39% of the watershed), 2.5 million ha in existing conservation areas (19%) and 1.7 million ha of proposed conservation areas in Peru (15%). The remaining 28% of the basin falls within other land-use categories, including forestry concessions, petroleum blocks, and public lands. In the last 16 years, a mere 1% of the basin has been deforested, almost entirely in the Colombian and Ecuadorean foothills of the Andes. Numerous indigenous groups live in the watershed—Murui Muina, Murui, Bora, Miraña, Ocaina, Kichwa, Yagua, Tikuna, Maijuna, Secoya, Cofan, Cocama and Resigaró—and at least four (Cofan, Bora, Huitoto-Murui, and Tikuna) of the groups live on both sides of an international border. In the last 10 years, The Field Museum and partners have conducted six rapid social and biological inventories in the Peruvian Putumayo (Güepí, Ere-Campuya-Algodón, Medio Putumayo-Algodón, Maijuna, Ampiyacu-Apayacu, and Yaguas). Those inventories have resulted in an assessment of the basin’s biodiversity, increased visibility for local indigenous federations and recognition of their priorities, and supported the creation of six new conservation areas, including two national parks, two communal reserves, and two regional conservation areas. In 2017, we brought together indigenous people, protected areas staff, NGOs, and government actors from either side of the border to see how together we could best consolidate this cultural and biological corridor. In parallel, we are exploring a suite of mechanisms to mitigate threats to the basin based on a binational agenda in Peru and Colombia for conservation and management that includes scaling indigenous life plans, pursuing permanent river protection, and coordinating management of natural resources.

Paper Number: 548

Thursday, 05 July 2018 | Colosseum 1

Symposium 35 - Connectivity in Tropical Landscapes

GENERAL SESSION 42

Disturbance, Succession & Restoration

Global map on the ecological uncertainty of forest landscape restoration success

Renato Crouzeilles, Pedro Brancalion, Felipe S. Barros, Paulo Molin, David B. Lindenmayer, Mariana S. Ferreira, Andre B. Jumnequeira, B. B. N. Strassburg

Several international commitments have emerged to boost forest and landscape restoration worldwide supported by estimated US\$ 18 billion. Yet the restoration cost and the uncertainty of the success of ecological restoration may constrain the flow of financial capital to restoration initiatives due to its high risk associated. Here we conduct a global meta-analysis over 135 study landscapes to map the global ecological uncertainty of forest landscapes where restoration success for biodiversity. We identify for the first time landscapes where restoration approaches are most likely to foster biodiversity recovery to similar levels found in old-growth or less-disturbed forests. Our global pattern of exponentially decreasing the ecological uncertainty of forest restoration success as the amount of forest cover increases is strongest within a buffer of 5 km radius around a landscape. Despite the largely amount of deforested lands worldwide, most of the forested biomes still keep a low ecological uncertainty of landscape restoration success. This key message provides a strong rational for continued investment in forest landscape restoration initiatives. Staring the implementation of large-scale forest restoration in landscapes with lower ecological uncertainty can be a key strategy to unlock the flow of financial investments to the ambitious restoration commitments.

Paper Number: 283
Thursday, 05 July 2018 | Colosseum 1
General Session 42 - Disturbance, Succession & Restoration

Evaluating Tropical Dry Forest Responses to Landscape Degradation and Forest Succession Based On Sounds Of Nature

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Bioacoustic monitoring has become a popular and handy tool to provide data in biodiversity monitoring projects through the quantitative assessment of communities of vocalizing animals, and thereby has been shown to be a potential proxy of the overall state of landscapes. Here we show evidence of its versatility in tropical dry forests (TDF) of Colombia, one of the most threatened ecosystems worldwide. In Colombia, only 8% of the potential extension of TDF area remains, and less than 1% is under protection. Given its precarious situation, it is critical to enhance our understanding on the ecology and functioning of this ecosystem in order to provide salient information for decision-makers to develop conservation and management strategies. The Alexander von Humboldt Research Institute (IAvH; Colombia) has focused its efforts in characterizing the relevant ecological attributes and indicators that provide insights into the conservation level of this ecosystem across the country. Our goal is to evaluate changes in biodiversity along gradients of landscape transformation and succession. To do so, we have established monitoring platforms on three watersheds across the Caribbean region. For each watershed we selected nine sites, following an experimental design that combined three levels of successional state (early, intermediate and mature) nested within three levels of landscape transformation (low, intermediate and high). To assess the importance of these factors (landscape transformation and successional state), we characterized the soundscape for each site within each watershed. A total of 15,840 audio recordings were quantitatively characterized and were plotted in a low dimensional space. Then, we calculated spectral features for each recording. The spectral features revealed conspicuous differences among sites depending upon its transformation level. Our analyses showed that each of the treatments of the experimental design had a unique acoustic signature, and this finding was consistent across watersheds. Overall, we demonstrate that TDF have specific acoustic community structures depending upon the transformation level of the surrounding landscape. Deepening our understanding in acoustic ecology will allow us to develop soundscape indicators related to the successional state and conservation status of this endangered ecosystem.

Paper Number: 785
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General Session 42 - Disturbance, Succession & Restoration

Comparing the recovery trajectories in taxonomic and functional composition between young secondary and old-growth forests after an extensive tree fall event

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Young and old-growth forests may recover differently from new disturbances. Longitudinal studies of ecological communities and the representation of community assemblages in terms of functional trait rather than taxonomic composition are valuable approaches for a mechanistic understanding of processes driving community assembly. However, it can be difficult to make sense of the resulting data, especially in species-rich tropical communities. Principal Response Curves (PRC) is an approach originally meant to summarize multivariate responses to treatment(s) against a reference group. The partial redundancy analyses underlying the PRC approach antialias temporal trends, thereby extracting the differences in species responses between treatment(s) and reference communities as “species coefficients”. PRCs present the community compositions in terms of these species coefficients over time. We used PRC to analyse a five-year annual survey of a set of vegetation plots set up in a mosaic of areas affected and unaffected by a massive wind-generated tree fall event, in young secondary and old-growth forests, in Singapore. Taxonomic composition showed divergence between young and old secondary forest sapling communities during succession; surprisingly, there was no statistical evidence of such divergence in functional composition represented by community-weighted mean specific leaf area, leaf dry matter content, leaf thickness, wood density, maximum height, and seed dry mass. A plot of the species coefficients along the first two PRC axes revealed different suites of species that were colonizers of young secondary versus old-growth forests. The PRC approach therefore shows promise in summarizing temporal trajectories of community compositions in longitudinal studies of succession. Our results also show that the taxonomic compositional changes during succession are much more obvious than functional composition changes represented by community-weighted means of the main plant functional traits.

Paper Number: 430

Thursday, 05 July 2018 | Colosseum 1

General Session 42 - Disturbance, Succession & Restoration

Ecological recovery of soil quality through intercropping of rubber plantation

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This study was undertaken to examine various intercropping patterns that could enhance overall soil quality of rubber cultivated forest and enhance nutrient acquisition in agroforestry. Against rubber-based intercropping, an experimental evaluation of rubber monoculture is needed. Rubber trees in selected forest plot were intercropped with five vegetation species commonly cultivated in this area: Tea (RT), Cacao (RC), Bauhinia (RB), Tea-orange (RTO), and Flemingia (RF). The ordination test indicated that all intercropping types had different soil quality to rubber monoculture (R). Degree of cluster was highest at axis 1 (37%) when compared to axis 2 (5%). The effect of intercropping on bulk density was not statistically significant ($p > 0.05$) at rubber-based plantations in comparison to rubber monoculture (R), except in RT ($p = 0.008$) and RB ($p = 0.036$). Available nitrogen (AN) was increased by intercropping rubber ($p < 0.05$) with other plants except for tea (RT). The overall soil quality assessment showed significant changes which varied between the rubber monoculture (R) and other rubber-based agroforestry systems and identified Bauhinia as better intercrop for rubber-based agroforestry in China.

Paper Number: 93

Thursday, 05 July 2018 | Colosseum 1

General Session 42 - Disturbance, Succession & Restoration

Rainforest regeneration and restoration investigated using DNA barcoding in the Lower Kinabatangan Floodplain, Sabah, Malaysian Borneo.

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Rainforest destruction continues to accelerate with significant losses of biodiversity and its associated ecosystem services. As primary forest has been lost, secondary forests are now assuming greater importance for biodiversity. There is an urgent need for increased understanding of natural regeneration within these forests and robust protocols for restoration. DNA barcoding allows rapid identification for biodiversity assessment, monitoring and conservation planning.

The Lower Kinabatangan Floodplain in Sabah, Malaysian Borneo, contains a partially fragmented rainforest corridor, varying in width on either side of the Kinabatangan River. It contains a range of secondary forest habitats and supports an extremely high level of biodiversity. Extensive oil palm plantations surround the forest. In some areas native trees have been replanted in order to create a continuous rainforest canopy.

We are interested in the resilience of the forest to reductions in size, increased fragmentation and changes in the composition of animals involved in pollination and dispersal. A DNA barcode library of adult trees is being created and used to identify saplings in order to investigate forest regeneration and to optimize protocols for rainforest restoration.

We have surveyed 15 permanent plots (each 50 m²) within established forest and two plots within replanted restoration sites. Adult trees and saplings have been DNA barcoded with *rbcL*, *matK*, *trnL* and *ITS2*.

The plots established within secondary forest contained between 8 to 41 taxa of adult trees with Simpson's diversity ranging from 0.15 to 0.94. The number of sapling taxa within plots ranged from 8 to 33 with 20% to 62% of these saplings also recorded as adults within the plots. Frequently occurring trees included *Dillenia excelsa*, *Colona serratifolia*, *Kleinhovia hospita*, *Mallotus muticus*, *Antidesma thwaitesianum*, *Vitex pinnata* and *Pterospermum* spp. The two restoration plots were created 5 and 10 years ago, using a small number of locally collected native trees, that could create canopy cover quickly. The older plot contained 43 and the younger plot 15 tree taxa with Simpson's diversity of 0.93 and 0.90. These saplings had arisen through natural regeneration and were characteristic of the surrounding forest tree community.

DNA barcoding provides an effective method for identifying saplings that are difficult or impossible to identify using morphological approaches. This has allowed us to characterize the tree communities within secondary forest and show that natural regeneration within replanted sites is comparable in terms of diversity and composition to established forest.

Paper Number: 509

Thursday, 05 July 2018 | Colosseum 1

General Session 42 - Disturbance, Succession & Restoration

Tropical secondary forest enrichment using giant stakes of keystone figs

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Developing rapid, cost-effective, methods to facilitate forest recovery in degraded tropical habitats is a key goal in restoration. In this study, we evaluated the efficacy of establishing large vegetative cuttings or stakes in the genus *Ficus* (Moraceae), which are well-known to play essential roles in ecological food webs and are often classified as keystone species. We evaluated vegetative plantings in three separate studies in southern Costa Rica: (1) a common garden field trial of 6 species (4 m tall stakes); (2) a multi-site trial of four species at 11 sites (4 m); and (3) a resurvey of an earlier study utilizing *Ficus americana* (2 m) planted in 2004. A total of eight species were evaluated, all of which have broad geographic distributions in the Neotropics. Sprouting and survival ranged from 0-100% among all species. Six species in the subgenus *Urostigma* sprouted at much higher rates (80-100% of individual stakes) than the two species in the subgenus *Pharmacosycea* (0-18%). Contrary to our expectation, sprouting did not vary among species with different wood specific gravity. The species that showed greatest promise (highest percent sprouting and long-term survival) included *F. colubrinae*, *F. costaricana*, and *F. hartwegii*. Mean canopy area for species that established well in the two recent field trials ranged between 1.1-1.4 m² after 2 yr; diameter growth at this stage was negligible. One species (*F. costaricana*) developed fruit (~12% of individuals) at 2 yr. In the older resurvey, surviving stakes with an initial mean DBH of 3.8 ± 0.9 cm had grown to a mean DBH of 19.0 ± 7.9 cm with a canopy height of 10.7 ± 2.7 m after 12 yr; 75% of these individuals were fruiting at the peak of the dry season when they were surveyed. Additionally, there was no mortality in the 10 yr time lapse since they were last surveyed. Results indicate that the methodology shows promise, at least for some species of *Ficus*, and the approach could be used to establish enrichment plantings in degraded habitats as a means to increase fruit production and availability, thereby facilitating recovery.

Paper Number: 96

Thursday, 05 July 2018 | Colosseum 1

General Session 42 - Disturbance, Succession & Restoration

Rethinking the tropical sustainable-use protected area paradigm

Tropical forest degradation is one of the most imperative concerns of this millennium, due to tragic losses of biodiversity, ecosystem services and livelihoods. Protected areas (PAs) have been used as the main tool to achieve conservation outcomes. However, if PAs are conceived only as biodiversity islands, battling against external factors, the socioecological asymmetry between areas inside and outside can generate a negative feedback loop, where conflicts between users will increasingly become unavoidable. We conducted a comprehensive evaluation of ecological and social indicators both within and outside a network of sustainable-use protected areas (PAs) in Brazilian Amazonia, through systematic multi-taxa surveys along ~2,000 km of the Juruá River. We recorded the population status of high-value fish species (*Arapaima gigas* and *siluriformes*), freshwater turtles (*Podocnemis expansa* and *P. unifilis*), caimans (*Melanosuchus niger*) and migratory birds (*Rynchops niger* and *Phaetusa simplex*) in a paired design that compares unprotected and no-take areas ensured by a Community-Based Management (CBM) arrangement. We also performed 420 interviews, covering more than 100 rural communities, quantifying social benefits at different levels, including community infrastructure, empowerment, social capital and wellbeing. We found a strong positive effect of CBM on all sampled taxa. No-take areas explained 70-85% of the variation in abundance, even controlling for important environmental variables. In addition, we show a clear improvement in welfare conditions at a range of different scales. At a community scale, communities under a CBM structure and inside PAs had better access to health care, education opportunities, electricity, basic sanitation and communication infrastructure. At a household level, we found that living inside PAs, followed by governmental subsidies and number of people per household were the strongest predictors of household wealth. Collective benefits also impacted individual perceptions; only 5% of adult residents inside PAs aspired to move away, compared to 58% of adults in unprotected areas. A similar pattern was observed for young informants (<17 years); 31% wished to move out of PAs into an urban center, compared to 59% in unprotected areas. Our results reinforce the imperative to including local people in conservation programs, especially in tropical countries with limited financial and human resources. We advocate that sustainable-use PAs should be conceived under a socioecological framework, whereby CBM initiatives are developed, strengthened and expanded to include neighbouring unprotected areas, decentralizing the conservation paradigm beyond PAs.

Paper Number: 741

Thursday, 05 July 2018 | Colosseum 2

General Session 27.2 - Miscellaneous Conservation

GENERAL SESSION 27.2

Miscellaneous Conservation

Multinational collaborations in ecology and environmental science within Asia: current status and pathways forward.

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Publications in the fields of ecology and environmental science have greatly increased in Asia over the past decades, often as part of multinational collaborations. Yet a pattern in these collaborations is that they are often a partnership of one Asian country and its international partners. For example, in a dataset of papers published in 2015, 22% contain authors from at least one Asian country, but only 2% had authors from more than one Asian country. We argue there is an opportunity to increase collaborations between Asian countries, as (a) most countries in Asia share a large percentage of their biodiversity, at least at the generic and familial levels; (b) Asian countries also share a range of threats that are especially extreme in the region. To illustrate the later point, we focus on a set of toxicological substances, as well as the rate of urbanization in Asia. Concentrating on the two largest Asian countries, China and India, we discuss the cultural and political barriers that can make collaboration difficult, as well as successful ventures that have bridged these gaps. Ultimately, collaborations between Asian countries can result in more widely sampled datasets that are more generalizable, different perspectives that can arise from different cultures and experiences, and the realization that many countries share the same environmental challenges.

Paper Number: 673

Thursday, 05 July 2018 | Colosseum 2

General Session 27.2 - Miscellaneous Conservation

Dynamic biodiversity management at range edges

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The distribution ranges of many tropical species are expanding latitudinally and altitudinally in response to increasing global temperatures. This could lead to profound biotic changes at the range edges of species, in terms of community assembly, functional diversity and even ecosystems. Nature reserves have played a crucial role in preserving biodiversity and habitats. However, most nature reserves have not incorporated the dynamics of communities and ecosystems at the landscape level in their management policy, let alone responding to the changes in species distribution range in a way that maximizes conservation outcome. Also, as nature reserves are, in essence, geographically-defined, legally-protected areas, they lack the flexibility to “move” along with the species or ecosystem they are designated to preserve. In this study, I first review the challenges a dynamic landscape place on nature reserves, using one case study each for latitudinal and altitudinal range shifts (the National Special Natural Monument area in Kiire, Japan, and the Kinabalu Park in Sabah, Malaysia, respectively). Then, I present a framework for dynamic biodiversity management at the range edges of species that are both practical and scalable. In summary, latitudinal and altitudinal range shifts present starkly different challenges to biodiversity management—the presence of more suitable habitats beyond the nature reserve in the former, and the changes in community assembly and potential influx of species from neighbouring areas in the latter. To accommodate latitudinal range shifts, nature reserves should look into setting up satellite sites that include newly colonized habitat of protected species. On the other hand, nature reserves at tropical montane region should adapt their visitor policies to minimize tourism pressure and establish habitat connectivity with neighbouring areas to facilitate altitudinal range shifts. I advocate for a necessary paradigm shift towards dynamic biodiversity management that account for changes in distribution range, in order to achieve the long-term goals of biodiversity conservation.

Paper Number: 772

Thursday, 05 July 2018 | Colosseum 2

General Session 27.2 - Miscellaneous Conservation

Training Indigenous Scientists to Build a Base for Conservation in the Baram River Basin, Malaysian Borneo

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With over 80% of forests heavily impacted by logging in Malaysian Borneo, time is running out to protect the last remaining fragments of forest. Community-led conservation is increasingly acknowledged as a promising way to protect ecosystems.

Studies that work together with local people to collect data for wide-reaching surveys are currently being explored in the Baram region of Sarawak, a forested area inhabited by indigenous Penan, Kenyah, Kelabit, and Saban communities. In the Amazon, this research method has been used to train indigenous communities to gather ecological, land use, and socio-economic data. This method has not only proven to be an effective and accurate method for scientific use, it also builds engagement in communities, re-connects individuals to biocultural knowledge, and enables them to make appropriate planning decisions for their communities and forests.

From October and November of 2018 several researchers accompanied local and international non-profits to the Baram River Basin of Sarawak to explore implementing this method. The team presented information about research conducted in the Amazon in seven different villages to gauge local interest in participating in a similar study, reaching representatives from around twenty indigenous villages from around the Baram River Basin. The overall result was overwhelmingly positive, and generated support and interest from 90% of villages contacted. Given the positive response, researchers and organizations are now moving forward to find funding and approval for a larger scale project. The study hopes to generate long-term buy in of indigenous communities in conservation efforts by empowering communities with data about their territories, reconnecting them to their land, and enabling government and civil-society organizations to propose appropriate livelihood and development projects based on accurate and abundant data.

Paper Number: 714

Thursday, 05 July 2018 | Colosseum 2

General Session 27.2 - Miscellaneous Conservation

Tambora Muda: Enhancing the capacity building and networking among young conservationists to aid biodiversity conservation in Indonesia

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Indonesia is one of the world's biodiversity hotspots, yet current conservation effort to preserve this biodiverse region is still inadequate. Knowledgeable and skillful professionals in biodiversity conservation are urgently needed to achieve desired conservation goals; however, there are still gaps in access to professional skills and knowledge advancement, especially for the younger generation of conservationists. Therefore, in 2015 we established a networking group for Indonesian young conservationists, Tambora Muda, to address this gap. The aims of our organization are to enhance the professional capacity of Indonesian young conservationists and facilitate collaboration in conservation. Our main activities are (1) hosting workshops, public lectures, and seminars which are run independently or in collaboration with local and international scientists; (2) disseminating conservation-related information, such as job vacancies, scholarships, and postgraduate study opportunities through social media platforms and newsletters; and (3) providing writing assistance, such as for scientific papers, abstracts, and CVs. By March 2018, we had 451 members, including 57 people in the steering committee. As a part of our capacity building programs, in January 2018, we conducted a 12-day training camp, called "Conservation Camp," in Sulawesi for undergraduate students and early-career professionals in conservation. The training included diverse topics, such as basic research skills, ecological surveys, sociological studies for conservation, and science communication. Fourteen participants from across major islands in Indonesia—Sumatra, Java, Borneo, Sulawesi, and Papua—attended the camp. We conducted pre- and post-camp surveys using a Likert scale to assess their skill improvement. Of eight skills assessed, we found significant improvement in six conservation-related skills. We encountered some challenges in running Tambora Muda, primarily related to limited human resources and funding. All committee members work voluntarily to run Tambora Muda in addition to their own studies or jobs, and we do not have a dedicated funding source or endowment. With limited resources, however, we have been successful in achieving our objectives of initiating multidisciplinary collaboration for conservation and capacity building. We call for more commitment from conservation organization to allocate resources to capacity building of early-career conservationists in developing countries. Guidance from more senior conservationists and regional collaboration would improve the performance of Tambora Muda, and hence, support today's young generation to safeguard the future of Indonesian biodiversity.

Paper Number: 546

Thursday, 05 July 2018 | Colosseum 2

General Session 27.2 - Miscellaneous Conservation

Status and Distribution of Forest Partridge in the Thai Peninsula: a worrying situation

Tiwa Ong-in, Tommaso Savini

Forest partridges are threatened by habitat degradation and habitat loss due to deforestation, forest fragmentation as well as unregulated hunting. Efforts to develop appropriate conservation and management action plans are hampered by a general lack of quantitative information on the status and distribution of forest partridge and poor understanding of their ecology. This project aimed to assess the conservation status of Sundaic partridges and other Galliformes in the forests of the Thai Peninsula. Line transect surveys were used to estimate the density of all Galliformes, with particular focus on Sundaic partridge namely the vulnerable Chestnut-necklaced Partridge (*Arborophila charltonii*), as well as the near threatened Ferruginous Partridge (*Caloperdix oculeus*), Long-billed Partridge (*Rhizothera longirostris*), Crested Partridge (*Rollulus rouloul*), and the least concern Malaysian Partridge (*Arborophila campbelli*). Between July 2016 and May 2017, 29 line transects were surveyed along nature trails and paved roads in Kaeng Krachan National Park, Kuiburi National Park and Khlong Saeng Wildlife Sanctuary, where focal partridges were formerly detected. In Kaeng Krachan, only one target species was found (Ferruginous Partridge), but only 14 detections too low to estimate density reliably (<1 bird/km²), while other Galliformes occurred at notably lower densities (e.g., Green-legged Partridge 10.2 birds/km², Grey peacock-pheasant, 7.2 birds/km²) compared to relatively undisturbed habitat surveyed elsewhere. In Kuiburi, eight Ferruginous and two Green-legged Partridge were detected, too few to estimate density. In Khlong Saeng Wildlife Sanctuary, where the lowland habitat was flooded after dam construction, no partridge species were found out of four species previously recorded. The only Galliformes recorded was Great Argus (*Argusianus argus*) with a density of 4.6 calling males/km² which increased in abundance with increasing distance from the reservoir edge. The apparent absence of partridge, with the exclusion of two species found in very low density, could be either due to the low quality of the habitats due to degradation, at least in part of the area, or more alarming, due to a general decline due to additional high hunting pressure. More areas need to be surveyed to determine their status in the remaining forest patches in the rest of the Sundaic forest range of southern peninsular Thailand, although the sites we surveyed so far represent the largest remaining patches of forest in the peninsula.

Paper Number: 750

Thursday, 05 July 2018 | Colosseum 2

General Session 27.2 - Miscellaneous Conservation

GENERAL SESSION 43

Ecology & Conservation in Tropical Tree Plantations

The short lived haven of plantation forests for *N. bengalensis*

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In fast disappearing tropical ecosystems the conservation importance of small patches of degraded forest and plantation are often overlooked despite being relatively abundant in most tropical regions. Determining how animals' use and survive in these areas has now become critical. Due to their arboreal tendencies, forest disturbance has made primates one of the most threatened taxonomic orders in the world as their survival in disturbed forests is determined by a complex of habitat features. For the cryptic nocturnal arboreal primates, these ecological features are little known and particularly difficult to investigate. The Bengal slow loris (*Nycticebus bengalensis*), similarly to the other primate species, suffers from habitat loss and hunting. However, unlike many other primates, some loroid species have been found to exploit more disturbed environments such as plantation forest that can offer dense vegetation vital for movement and predation avoidance. This research aimed to explore the connections between disturbance and loris habitat use by assessing the impact of macro and microhabitat features on *N. bengalensis* in a degraded fragment of dry evergreen forest and old plantation (*Acacia* sp.) of north-east Thailand (Sakaerat Biosphere Reserve). Distance sampling estimates revealed high density in old plantation (27.05 loris/km²) followed by dry evergreen forest (16.99 loris/km²). Old plantation revealed the highest productivity of sap, fruit, and flower, all found to have a positive association with loris abundance. Logistic regression analysis identified a positive association between loris presence with canopy height, canopy connections, canopy density and tree trunk vegetation cover. These microhabitat preferences indicate the species utilises denser vegetation, often associated with more disturbed habitats (old plantation). Though the importance of plantation for *N. bengalensis* is highlighted by its high food productivity and dense vegetation, we found that loris show a certain preference to microhabitat variables rather than habitat type itself. Therefore, the conservation importance of plantation forest may vary dramatically depending on the selected tree species for planting and the forests maturity. Certainly, previous studies have demonstrated younger plantation offer considerably less food and lack vegetative complexity, supporting fewer loris. In turn, the importance of a mature plantation forest may swiftly deteriorate as short-lived exotic tree species die back all around the same time. Based on this knowledge, the plantation forest may only be a temporary alternative to natural forest and further research should investigate the varying importance of this habitat for *Nycticebus* species.

Paper Number: 287

Thursday, 05 July 2018 | Petra 2

General Session 43 - Ecology & Conservation in Tropical Tree Plantations

Bearded pig (*Sus barbatus*) utilisation of a fragmented forest–oil palm landscape in Sabah, Malaysian Borneo

David Kurz

Oil palm plantations have become a dominant landscape in Southeast Asia, yet we still understand relatively little about the ways wildlife are adapting to fragmented forest–oil palm mosaics. The bearded pig is of great ecological, social, and conservation importance in Borneo and is declining in many parts of its range due to deforestation, habitat fragmentation, and overhunting. We assessed how the bearded pig is adapting to oil palm expansion by investigating habitat utilisation, activity patterns, body condition and minimum group size in a landscape composed of forest fragments and surrounding oil palm plantations. We conducted our study in Sabah, Malaysian Borneo, in and around the Lower Kinabatangan Wildlife Sanctuary, a protected area consisting of secondary forest fragments situated within an extensive oil palm matrix. We modelled bearded pig habitat use in forest fragments and oil palm plantations using survey data from line transects. Camera traps placed in forest fragments were used to assess pig activity patterns, body condition, and minimum group size. All forest transects and 80% of plantation transects showed pig presence, but mean pig signs per transect were much more prevalent in forest (70.00 ± 13.00 s.e.) than in plantations (0.91 ± 0.42 s.e.). Pig tracks had a positive relationship with leaf cover and a negative relationship with grass cover; pig rooting sites had a positive relationship with wet and moderate soils compared with drier soils. Ninety-five percent of pigs displayed 'good' or 'very good' body condition in forests across the study area. Pigs also aggregated in small groups (mean = 2.7 ± 0.1 s.e. individuals), and showed largely diurnal activity patterns with peak activity taking place at dawn and dusk. Our findings suggest that bearded pigs in our study area regularly utilise oil palm as habitat, as indicated by their signs in most oil palm sites surveyed. The apparently good body condition displayed by the vast majority of pigs in our study likely results from year-round cross-border fruit subsidies from surrounding oil palm plantations. Consistent bearded pig presence and good body condition are potentially indications of successful adaptation to agricultural expansion in the study area. However, bearded pigs use forest fragments more frequently and for a wider range of behaviors (e.g. nesting, wallowing) than adjacent oil palm plantations. These degraded forests remain the most important habitat for the bearded pig in the Lower Kinabatangan region, and their protection is a high conservation priority for this species.

Paper Number: 857

Thursday, 05 July 2018 | Petra 2

General Session 43 - Ecology & Conservation in Tropical Tree Plantations

Biodiversity Conservation Value of Forest Fragments for Birds in Swidden vs. Oil Palm Plantations in West Kalimantan, Indonesia

Iin T. Simamora and S. Dewo and Y. Laumonier

The conversion of natural forest to oil palm plantation is a well-documented threat to the biodiversity conservation in South East Asia. The effectiveness of “wildlife-friendly” practices in agricultural landscapes to maintain biodiversity is still a matter of debate. This study examines how oil palm and land conversion affect avian diversity in the last forest frontier of West Kalimantan province, the “conservation district” of Kapuas Hulu. The area is still largely forested and agriculture land is still dominated by swidden traditional practices while oil palm plantations are expanding.

Birds were sampled at three sites representing different intensities of forest fragmentation at various distances from the contiguous forest. We searched for swidden landscapes featuring natural forest, old and young fallows, mixed gardens, smallholder rubber plantations (Batang Lupar and Mentebah) and forest remnant in oil palm concession (Semitau). We used mist nets and timed point-counts at each site.

In the forest fragments of the oil palm concession, 634 individuals of 91 species were recorded. In the swidden landscapes, 1059 individuals of 136 species were found in Batang Lupar and

1580 individuals of 133 species in Mentebah. These two sites were separated by c. 100 km, but the similarity of natural forest species between these two sites was significantly high. Bird species richness and evenness were significantly higher in natural forest of Batang Lupar site. Out of all the species captured in natural forest of the Batang Lupar site, strikingly, only 5% were presence in Mentebah and the oil palm concession site. The notoriously missing species from these two sites were terrestrial birds, habitat specialists, insectivores and frugivores. Low species evenness and feeding guild imbalance in both Mentebah (young fallows and mixed rubber gardens) and the oil palm concession was noteworthy. Forest fragments in swidden landscape significantly harbored more diverse species composition than oil palm concession fragments and were even comparable in term of species richness with natural forests.

The simplification of the habitat has a tremendous impact on bird diversity. Oil palm plantation patches of vegetation are poor habitats for birds compared to forest fallows, and species that live in oil palm plantations have low conservation value. This study confirms that the conservation of forest bird species requires the preservation of large reserves of intact forest.

Paper Number: 868

Thursday, 05 July 2018 | Petra 2

General Session 43 - Ecology & Conservation in Tropical Tree Plantations

Rubber plantations replace forest ant species with habitat generalists with larger geographic distributions: a case study in Xishuangbanna, China, and a global meta-analysis

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Rubber plantation has now become one of the most dominant human-modified landscape feature in northern Southeast Asia. Despite the large number of studies documenting the impacts of rubber plantations, most focus on changes in diversity per se and little attention has been paid to other ecological aspects like community assembly. We compared the species richness, composition and range breadth of ants in rainforest, limestone forest and rubber plantation in Xishuangbanna, monsoonal tropical region of southwest China. Additionally, we conducted meta-analysis of 24 other papers and used an online database (<http://antmaps.org/>) to compare distribution range of ants in forests (primary and secondary) and rubber plantations. We hypothesized that species richness is lower in rubber plantations compared with forests and that assemblages in rubber plantations are characterized by habitat generalists with broader distribution range. Our results showed that rubber plantations had lower alpha and gamma diversity, and a unique assemblage whose members have larger distribution ranges, compared with rainforest and limestone forest in Xishuangbanna. The same pattern was also observed from the global scale meta-analysis, with rubber plantations species occupying wider distribution ranges than primary forest ants, while secondary forest ants had intermediate range breadths. The results suggest that forest conversion to monoculture plantations not only alters species diversity, but also replaces specialist species with generalists with broader geographic distribution. This replacement by generalist ants may be linked to homogenization of ants in disturbed habitats, which may alter ecosystem functions and service provision.

Paper Number: 701

Thursday, 05 July 2018 | Petra 2

General Session 43 - Ecology & Conservation in Tropical Tree Plantations

Do ecosystem services benefit from intercropping in oil palm smallholdings?

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Oil palm (OP) plantations are producing vegetable oil in a very efficient way. However, OP plantations are generally scoring a lot lower in the provisioning of other ecosystem services like biodiversity conservation and carbon sequestration. Mixing OP plantations with other crops and plants (intercropping or polycultures) may counterbalance this and is thought to generate more ecosystem services compared to monoculture oil palm plantations. This may however come at the cost of reduced production of palm oil.

In this study we investigated whether intercropping in OP smallholdings had an effect on the provisioning of the three selected ecosystem services: (1) crop-production, (2) natural pest control, and (3) carbon sequestration. We sampled ecosystem services in 25 monoculture and 25 polyculture oil palm smallholder plantations in the Tanjung Karang area, Malaysia, by doing interviews (crop-production), herbivory measurements at palm leaves (as indicator of pest-control) and measurement on woody vegetation (carbon).

- (1) Although density of oil palms (88 vs 115 /ha) and production (13 vs 14.4 ton/ha/yr) of fresh fruit bunches (FFB) varied between polyculture and monoculture OP plantations respectively, we did not find any significant difference in crop-production between monoculture and polyculture OP plantations (Mann-Whitney U-test, $p > 0.05$). Polyculture OP plantations do provide however several (14) by-products which are either sold on the local market or used directly by the smallholders. This effect however was not quantified.
- (2) We found no significant difference (Mann-Whitney U-test, $p > 0.05$) in herbivory levels between poly- and monoculture OP plantations (3.6% in polyculture, 4.2% in monoculture), suggesting that natural pest control was not affected by intercropping. Regression analysis showed that there was a weak positive (but non-significant, $p < 0.05$) effect of the density of oil palms on the percentage herbivory.
- (3) The total aboveground carbon stock in monoculture OP plantations was found to be 29.5 tC/ha, versus $29.0 \pm 1.5 = 30.5$ tC/ha in polyculture OP plantations (palms and intercrops). Once again this difference was not statically different (Mann-Whitney U-test, $p > 0.05$).

Our conclusion is that mixing OP with other trees and crops did not significantly affect the provisioning of the selected three ecosystem services in the selected smallholding OP plantations. The large variation in density of OP in both mono- and polyculture plantation may have hampered our study. Also the large number of intercrops (19) which were used in different compositions has limited the power of our analysis. Further studies are underway to verify our assumptions.

Paper Number: 817

Thursday, 05 July 2018 | Petra 2

General Session 43 - Ecology & Conservation in Tropical Tree Plantations

Effect Of Biochar Application To Nitrous Oxide Emission From Oil Palm Cultivation

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The use of biochar as soil amendment is increasingly popular as an effort to mitigate greenhouse gas fluxes, yet the mechanism is not yet understood. Excess and inefficient management of nitrogen fertilizer can increase nitrous oxide (N₂O) emissions from soil. Laboratory incubation studies have been performed to investigate the effect of biochar application on N₂O emissions but very few studies have been conducted in the field, especially on peat soils. To address this knowledge gap, a field study was conducted to investigate the effects of biochar amendment on N₂O fluxes in an oil palm plantation cultivated on tropical peat upon nitrogen (urea) fertilizer application. Different rates of biochar application (4.3, 8.6 and 17.1 t ha⁻¹) were used to determine if different levels of biochar addition reduced N₂O emissions from soil. Fluxes were quantified regularly over seven months after fertilizer application to explore the impacts of fertilizer application on N₂O fluxes over time from soils with or without biochar amendments. From this study, we found the differences in fluxes from treatments compared to the control were not statistically significant. We also found the effectiveness of biochar in reducing N₂O fluxes decreased after the eleventh month of biochar application. From the results obtained, we conclude that biochar application did not appear to work well in these peat soils because of ageing of the biochar and the effectiveness of biochar amendment on soils was soil specific.

Paper Number: 760

Thursday, 05 July 2018 | Petra 2

General Session 43 - Ecology & Conservation in Tropical Tree Plantations

GENERAL SESSION 17.3

Forest Ecology & Conservation

Biodiversity of ecological communities in

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Descriptive studies with check lists of plants of isolated hills distributed along moist monsoonal ecotone belt of Sri Lanka have been carried out since a century ago. They have shown that these hills are 'mesic islands' rising above the surrounding plains harboring a number of localized endemics and threatened plant species. However, these isolated hill forests, which have the potential to serve as excellent indicators of biotic change in response to climate change over time, have not been subjected to any quantitative ecological analyses, with a few exceptions.

We examined the species richness, diversity and community ecology of vascular plants of three isolated hills (Moneragala, Doluwakanda and Kokagala) in the ecotone between aseasonal rain forest- and seasonally dry monsoon forest regions of Sri Lanka using gradient-directed plot sampling and the data were analyzed using univariate/multivariate techniques.

A total of 727 vascular plant species representing 17% of Sri Lankan angiosperm-, 11% of herpteridophyte- and 15% of her endemic angiosperm flora was recorded. Among them, 52 species were globally threatened while 92 were nationally threatened. Sixteen tree/liana communities (five each in Doluwakanda and Kokagala and six in Moneragala) varying along their respective altitudinal gradients were identified in the three study sites based on cluster analyses and NMS ordination using PRIMER version 6 statistical software. These communities were then subjected to another cluster analysis to examine community relationships among the hills. Relatively undisturbed communities in each forest site separated into distinct clusters; however, the disturbed communities and grasslands separated as outliers.

All three hill forests showed evidence of heterogeneous communities with localization of species in their species-area curves and log-normal or log-series species rank-abundance patterns. In contrast, their grasslands showed a geometric-series pattern. Fisher's alpha diversity varied from 1.4 - 28.3 for the tree/liana flora, 5.72 - 25.1 for the understory tree/shrub flora and 2.26 - 9.38 for the herbaceous ground flora.

The three isolated hills studied rich in biodiversity, represent small, yet distinct refugial communities or local hotspots within the moist monsoonal floristic region. Based on results of the current study, it is strongly recommended that these three isolated hills be included in Sri Lanka's protected area network to ensure the conservation of their biodiversity, currently threatened by the rapidly changing land-use patterns along with likely influences on their local climate.

Paper Number: 428

Thursday, 05 July 2018 | Taj Mahal

General Session 17.3 - Forest Ecology & Conservation

Seedling Diversity and Dynamics across Multiple Land Uses in South Central Sabah

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Multiple-use Forest Management (MFM) has been envisioned as a promising, more balanced alternative to timber-dominated strategies. The UNDP-GEF Project in south-central Sabah is aiming to institutionalise a MFM management model that brings the management of critical protected areas and connecting landscapes under a common management umbrella. However, one of the major challenges is to assess the impacts of different forest management practices on the mechanisms maintaining biodiversity and associated ecosystem functions. We focus on seedlings as they are more abundant than other life stages, their short-term dynamics are easily studied and because of their influence on population dynamics. We used a stratified random sampling design to compare seedling diversity and dynamics among primary forests, secondary forests, recently logged forests and agroforestry areas that include both rubber and oil palm plantations across a 261,264-ha project area in south-central Sabah. Seedling density differed significantly among these forest types (means of 31505, 19428, 13095, and 42863 seedlings per ha for primary, secondary, logged and agro-forests respectively). Seedling diversity also differed among forest types (Shannon's Diversity Index values of 4.21, 3.30, 3.97, and 1.05 for primary, secondary, logged and agro-forests respectively) and was positively correlated with estimates of above-ground carbon density determined from an airborne LiDAR survey resolved to (60 x 60 m). Seedling mortality over 8 months did not differ between forest types, whilst recruitment was negligible. We conclude that degradation and conversion to various land uses impacts the structure and diversity of woody plant seedling communities, but longer-term data are required to understand the demographic mechanisms that determine these patterns.

Paper Number: 646

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General Session 17.3 - Forest Ecology & Conservation

Can variation in seed removal patterns of Neotropical pioneer tree species be explained by local ant community composition?

Selina A. Ruzi and Andrew V. Suarez

Ants are important seed dispersers in many ecosystems. Ants may also bring seeds into their colonies providing them with suitable microsites for germination or to become incorporated into the topsoil. A majority of ant-mediated seed dispersal research has focused on myrmecochorous plants that invoke seed dispersal by providing a food body called an elaiosome on their seeds. Our previous work on Barro Colorado Island, Panama, demonstrated that seeds of some Neotropical pioneer tree species are attractive to ants despite lacking a food reward. However, observed removal patterns of these seeds varied both among sites and location in the soil seed bank (above-ground and below-ground removal). We therefore tested if heterogeneity in ant community composition among sites, and between above- and below-ground foraging guilds, predicted the observed variation in seed dispersal rates. We sampled ants by placing a total of 315 pitfall traps and 160 belowground traps across five sites where seed removal rates were estimated. Ants were identified to species and communities assessed using non-metric multidimensional scaling (NMDS) and multiple response permutation procedure (MRPP) to determine if above- and below-ground communities differed within plots. A distance based regression model was used to determine if ant communities were predictive of seed removal rates. Our results suggest that ant assemblages vary greatly even over small spatial scales (assemblages at the same site differ at different locations within the soil seed bank), and that ant assemblages among sites may experience functional redundancy when it comes to seed removal.

Paper Number: 205
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General Session 17.3 - Forest Ecology & Conservation

Functional traits moderate plant recruitment in a wind-disturbed tropical lowland rainforest in Singapore

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A key step to understanding how environmental filtering drives species abundance and distribution during community assembly is to identify the functional traits that moderate the responses of species towards abiotic conditions. The fourth-corner approach has been proposed to find trait–environment associations from three common ecological matrices: species abundance across sites, environmental data across sites, and trait values across species. Using 28 100-m² plots in a wind-disturbed tropical lowland rainforest in Singapore, we applied the fourth-corner approach to examine how recruitment of 54 woody plant species over five years of secondary succession reflected functional strategies and trade-offs predicted by trait-based ecology. Species recruitment along the light availability gradient was moderated by the wood economic spectrum: recruitment of low wood-density species increased with elevated light conditions possibly by being more responsive in vertical height growth. Seed mass indicated a tolerance–fecundity trade-off, in that large-seeded species with a greater energy reserve recruited more with thicker leaf litter depths. Adult stature (maximum height) suggests a juvenile–adult performance trade-off by allowing short-statured species to exploit elevated soil phosphorus to maximise their juvenile performance and hence recruitment. Adult stature also revealed the possibility of historical contingency during post-disturbance succession, in that tall-statured species recruited more in tall-canopy forest sites. Leaf economic traits (specific leaf area, leaf dry-matter content, and lamina thickness) did not seem to moderate recruitment responses to environmental changes, possibly because of trait plasticity or their weaker role during earlier life stages. We have therefore identified wood density, seed mass, and adult stature as the main functional traits that moderate sapling recruitment in the wind-generated forest gaps. This study highlights a few generalisable trait–environment associations for secondary succession in tropical forest gaps.

Paper Number: 268
Thursday, 05 July 2018 | Taj Mahal
General Session 17.3 - Forest Ecology & Conservation

A proposed correction formula for litterfall production measurements in a tropical lowland forest

Sara Fern Leitman

Litterfall is an important nutrient return component in the tight nutrient cycling in tropical forests. Estimations of nutrient return via litterfall depend on measurements of litter material nutrient content and mass of litterfall production. While collecting samples from litterfall traps to measure production, I noticed evidence of loss of accumulated litterfall material due to decomposition and fragmentation during our 4-5 week collection intervals. I hypothesized significant loss of litter material, with loss rate dependent on environmental conditions and length of collection interval. To determine what portion of cumulative litterfall inputs remain in traps after three commonly used collection intervals (1, 4, and 5 weeks) I designed an in-situ litterfall trap experiment on Barro Colorado Island in Panama. Daily litterfall inputs were weighed, accumulated in 0.58 m² 1.3mm window screen mesh and PVC traps at 20 sites in one forest-type, and all material remaining was collected from traps at the end of each collection period. The natural log of the ratio of cumulative input to material in the trap after the accumulation period was modeled as the response variable. To test my hypotheses, mean daily rainfall in mm (measure of environmental conditions) and length of collection interval in days were tested as explanatory variables: the interaction term was highly significant ($p < 0.0001$), however the additional inclusion of the individual terms did not significantly improve the model ($p = 0.06$). Mixed effects models were used to account for significant random effect of site ($\Delta AIC = 5.4$). At mean dry season rainfall levels (1.4mm per day), model results are 5% (95% CI 4-7%) mass loss during 1-week collections, 9% (CI 8-11%) during 4-week collections, and 11% (CI 9-12%) during 5-week collections; at mean wet season rainfall levels (9.9mm per day), 12% (CI 10-13%) mass loss during 1-week collections, 33% (CI 27-38%) for 4-week collections, and 38% (CI 32-44%) for 5-week collections. My results show that current methods significantly under-estimate litterfall production in the tropics, and that the magnitude of this underestimation is dependent on rainfall and length of collection interval. I propose a correction formula to correct for the realities of litterfall studies in a lowland tropical forest in Panama; improving estimations of litterfall nutrient inputs in this highly studied area will contribute to a better understanding of nutrient cycling in tropical forests.

Paper Number: 927
Thursday, 05 July 2018 | Taj Mahal
General Session 17.3 - Forest Ecology & Conservation

Stand structural components and species richness across four land-use systems in Sumatra

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Land-use change from forests to agricultural systems is currently the strongest driver for species loss and ecological change in the tropics. The conversion of tropical forest comes along with a reduction of plant species richness and changes in stand structural components. Both stand structure and plant species richness are mutually dependent and affect the species richness of other groups of organisms. These relationships can be complex and remain poorly understood. Here we use extensive structural measurements and detailed inventories of various taxa of the EFForTS project across four tree-dominated land-use systems in Sumatra (Indonesia): lowland rainforest, jungle rubber agroforests, rubber plantations, and oil palm plantations. We investigated the relationship between 30 different stand structure measures and the species richness of 11 taxa ranging from bacteria to birds. All structure measures differed significantly among the four land-use systems and the relative influence of structural components on species richness differed among taxa. Most taxa showed significantly higher species numbers in complex forests than in homogenous monocultures and responded clearly to structural measures. Interestingly, bird and bat species richness did not vary in relation to the different land-use systems or structure measures, indicating that for some taxa, species composition might be more meaningful than total species richness.

Our data have important implications for conservation and sustainable management approaches by showing, which structural variables have to be considered for the protection of specific taxa.

Paper Number: 242
Thursday, 05 July 2018 | Taj Mahal
General Session 17.3 - Forest Ecology & Conservation

GENERAL SESSION 44

Gibbon Ecology & Conservation

Population census and conservation status of the Skywalker hoolock gibbon (Hoolock tianxing) in China

Lu Yan

Hoolock tianxing is formerly considered as the eastern hoolock gibbon (*H. leuconedys*). This recently described gibbon species is found in a restricted area in southwestern Yunnan province in China and eastern Myanmar, between the Salween River and the Mali Hka tributary of the Irrawaddy. A field survey conducted in 2008-2009 suggested that there were <200 individuals in 40-43 groups remained in China. Illegal hunting and habitat degradation and fragmentation are known to be the key threats of the gibbons. After the species has been elevated to a full species in 2017, a new census had been conducted in China, using interview survey with local villagers, and field surveys based on observations and acoustic evidence. The results showed that the current population of Hoolock tianxing is <150 individuals, comprising of 37 family groups and 12 solitary individuals.

The results indicate that the species is currently under severe and imminent threats, and that long-term intensive population monitoring and habitat analysis should be implemented immediately.

Based on these suggestions, Gaoligongshan National Nature Reserve, where the species live, launched a gibbon monitoring scheme which allocated 36 of its staff to monitor each of the 18 gibbon group for at least five days per month. In addition, 9 of the 18 gibbon groups in Yingjiang County are monitored by wardens and local villagers from a current project funding. For those groups living outside protected area, we are collaborating with the local governments to establish several community conservation areas. The preliminary result of habitat analysis is being used to devise habitat restoration plan. And to make sure all the conservation efforts are effective and cohesive within and outside the nature reserve, a species conservation action plan has been developed. The update of the species' taxonomy created an important opportunity for the conservation of Hoolock tianxing.

Paper Number: 401

Thursday, 05 July 2018 | Giza

General Session 44 - Gibbon Ecology & Conservation

Habitat assessment and population viability analysis for the Cao-vit gibbon (*Nomascus nasutus*) in Trung Khanh Forest, Northern Vietnam

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When a population becomes small, isolated, and localized, the risk of extinction due to chance events increases. In these cases, population viability analysis is a valuable tool to explore potential management scenarios.

The Cao-vit gibbon (*Nomascus nasutus*), once widespread in South China and North-East Vietnam, persists in only one population of less than 150 individuals in the border region between Vietnam and China. To inform viability management of the population, I assessed habitat quality and estimated carrying capacity, explored population sensitivity to inbreeding depression, and predicted the result of increasing habitat carrying capacity on the population dynamics, and explored number of gibbons and time intervals for translocation.

To these ends, I analysed tree cover data to assess habitat quality from Hansen's Global Forest Change dataset and estimated carrying capacity by extrapolating current population to all suitable areas. I applied Vortex 10.0 to simulate population dynamics of the gibbon and to compare the impacts of inbreeding depression, habitat carrying capacity and gibbon harvest for translocation. To parameterize the models, I used gibbon data from surveys conducted since 2002 and an extensive literature review.

I found (i) suitable habitats for gibbons outside their current area of occupancy and protected area; thus, future growth of the Cao-vit gibbon population could result in an increase from 192 to 248 animals; (ii) inbreeding depression appears to be not influential to the population dynamics despite of high lethal equivalents of 31.4, (iii) possibility to take up to 2, 3 and 5 pairs/couples of sub-adult gibbons for translocation in the time intervals of 2, 4, and 5 years respectively. Based on my model results, I recommend protected area extension, strict protection of gibbons from hunting and further feasibility studies and research to prepare for capture and reintroduction. In addition, more research was also recommended to make the genetic models stronger.

Paper Number: 223

Thursday, 05 July 2018 | Giza

General Session 44 - Gibbon Ecology & Conservation

Home range use by Javan Gibbons (*Hylobates moloch*) in Submontane Tropical Forest, Indonesia

Rahayu Oktaviani

Knowledge of a species' home-range size is vital for understanding its behavioral ecology and habitat requirements. In this study we examined changes in range-use characteristics in three well habituated groups of Javan gibbons (*Hylobates moloch*) from 2014 to 2017 at Citalahab, Gunung Halimun Salak National Park, Indonesia. We observed the behavior of Javan gibbons by followed study groups on a rotating basis, marked the activities and locations at 15 minutes interval and used the data to be analyzed using Geographic Information System through minimum convex polygon (MCP) by connecting the outer-most mapped locations to calculated the home range of each group. The mean home range size for three groups of Javan gibbons in our research area was 34.9 ± 8.2 ha where mean home range of Group A was 25.4 ± 2.8 ha, Group B 43.7 ± 2.9 ha and Group S was 35.6 ± 2.4 ha, respectively. Despite inter-annual changes in core area use we found that home range location was stable across years. Our results provided a baseline data that essential for conservation and management initiatives for Javan gibbons and its habitat on the last remaining submontane tropical forest in Java.

Paper Number: 117
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General Session 44 - Gibbon Ecology & Conservation

Assessment of Community-based Initiatives in conservation project for the World's Most Critically Endangered Primate

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Community-based Initiatives (CBI) as economic incentives is often invested by conservation organisations in an attempt to improve villagers' livelihood, thus alleviating their need to extract forest resources. Yet there is little empirical research to evaluate the effectiveness of such approach. This study analysed the impacts of CBI on a conservation project for the Hainan Gibbon (*Nomascus hainanus*) launched at the closest community to the gibbon habitat in Hainan Bawangling National Nature Reserve - the last home to the world's most critically endangered primate. This remote community consists of two ethnic minority groups which rely heavily on agriculture and extractive forest resource use. A series of CBI were implemented to mitigate villagers' impact on natural environment and engage them in our conservation work since 2010, such as alternative livelihood and market creation. The objectives of this study were to: 1) document how CBI improve local livelihood; 2) assess the effectiveness of CBI in changing villagers' perception in conservation issues; 3) evaluate effectiveness of CBI in protecting the gibbons. Information for this study was derived from both primary and secondary data sources. Stratified sampling was employed to ensure an equal number of interviewees from 3 designated groups, one with heavy involvement in CBI, participated in more than one initiatives; another group with moderate involvement, participated in one initiative; and the rest of them were non-CBI participants. All respondents had lived in the area for more than 10 years. Semi-structured interview was conducted with 39 villagers from the 5 villages in the community during the period of Jan-Mar 2018, both the sampled CBI and non-CBI participants were randomly selected. Primary data as qualitative and quantitative information was collected. Questions covered attitudes toward CBI was used by quantitative method; while open-ended questions were used by the qualitative method. Two officials from the Reserve were also interviewed about their views on the effectiveness of CBI. The findings indicated that our CBI improved villagers' livelihood. CBI beneficiaries gained more knowledge of the Hainan Gibbon and expressed greater concern over conservation issues. Of the 39 interviewees, 65% of interviewees have positive perceptual change towards the Hainan Gibbon. Implications of these findings were discussed, CBI should be conducted in a larger scale in order to raise villagers' awareness. Conservation education and governmental collaboration is also suggested.

Paper Number: 472
Thursday, 05 July 2018 | Giza
General Session 44 - Gibbon Ecology & Conservation

Immatures grow too fast? Age difference in activity budget, feeding and ranging behavior of wild Javan gibbons (*Hylobates moloch*) is not obvious

Ahyun Choi

Changes in body size, foraging and motor skill, physiological status, and social relationship by developmental stage may result in different behavioral patterns in animal. However, behavioral development of wild Javan gibbons (*Hylobates moloch*), which is endangered species, has been rarely studied. This study aimed to investigate age differences in activity budget, feeding and ranging behaviors of wild Javan gibbons. We followed groups of wild Javan gibbons in Gunung Halimun-Salak National Park, West Java, Indonesia, from November 2016 to August 2017. Using scan sampling method with 15-min interval, we compared behavior patterns of adults, adolescents (5-7 years old), and juveniles (2-4 years old).

Javan gibbons spent most of their time in resting (51.8%), followed by feeding (33.3%), travelling (11.3%), and social behavior (3.2%). There was no age difference in resting, feeding, and travelling. Using Kruskal-Wallis analysis, we found significant age differences in grooming ($p=0.001$) and playing ($p<0.001$) despite they spent relatively less time in social behavior. Main food source of Javan gibbon was fruits (65.7%) with young leaves (25.7%), flower (2.6%) and insect (6.0%). They fed on fig and non-fig fruits similarly, and fig species *Ficus villosa* was consumed the most for all individuals. We found no age difference on food species and plant part consumed. We also compared daily home range use of each individual to examine spatial peripheralization of adolescents. We calculated proportion of overlapping area between adult and immature individuals. Overlapping area occupied 88% of individual daily home range on average, and we could not find age difference.

These results showed that behavioral patterns of juvenile and adolescent Javan gibbons are not very different from those of adults except that immature played more and adults spent more time grooming. We suggest that wild Javan gibbons may develop their behavior early in their life stage. Also, there might be methodological problems such as small sample size and long interval of scan samples. More systematic and longitudinal research is necessary to understand development of Javan gibbons better.

Paper Number: 958
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General Session 44 - Gibbon Ecology & Conservation

Do seasons and reproductive status affect foraging time and diet composition in wild Javan gibbon (*Hylobates moloch*)?

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Foraging can be challenging for species in highly seasonal habitats due to fluctuations in food availability. Besides, females face additional challenges because of higher energetic and nutritional requirements to reproduce. For instance, gibbons inhabit tropical rain forests, characterized by seasonal variations, and are under high ecological pressure to develop foraging strategies accommodating seven months of gestation and two years of breastfeeding.

In this study, we examined changes in the feeding behavior of Javan gibbons (*Hylobates moloch*) according to season and reproductive stages in Gunung Halimun-Salak National Park, in West Java, Indonesia. The study area was a primary forest, exhibiting high seasonality based on rainfall: dry, wet and very wet season. Data were collected from three habituated adult pairs of gibbons for four years (2014-2017) by using scan sampling method with every 15 minutes.

On average, individuals spent 32.4% of their activity time for feeding. They mostly ate fruits (71% of feeding time) divided into fig (34%) and non-fig (37%); and followed by leaves (21%), flowers (4%) and insects (4%). There was a significant seasonal variation in the time spent foraging for fruit. Gibbons showed seasonality different foraging patterns: they ate more fruits in the wet and very wet seasons, in comparison to the dry season. There was no difference in foraging time between sexes. Females consumed significantly different diets depending on reproductive stages, the time spent feeding on fruits peaked during the late pregnancy and early lactation. They also consumed more figs during late pregnancy and more non-fig fruits during early lactation. Our study demonstrated the absence of difference in foraging time between sexes, probably due to low sexual dimorphism.

Our results also indicate that gibbons are likely to fulfill their energetic requirements in accordance with seasonal changes and reproductive stages. Females are likely to eat more fruits to acquire energy and provide nutrients for their infants. In summary, gibbons developed various foraging strategies in answer to seasonal environments and reproductive requirements. Since there are almost no studies about gibbons exist, our results can help understanding overall feeding behavior related to seasonality and reproductive stages.

Paper Number: 882
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General Session 44 - Gibbon Ecology & Conservation

GENERAL SESSION 19.2

Biodiversity Patterns

How we measure diversity matters: assessing variation in biodiversity indicators across a gradient of human disturbance in tropical forest.

Laura Allen

There are an overwhelming number of biodiversity indices and indicators available for ecologists and conservationists to use when seeking to understand how biodiversity responds to human disturbance. In choosing between measures there is often an underlying assumption that if a measure works well for one group it will be equally applicable to another. In this study, we use multiple taxa to explore the performance of a wide range of alpha and beta diversity measures for studying biodiversity responses to human disturbance in tropical forest. We sampled 18 sites along a gradient of human disturbance from primary tropical forest to banana monocultures in Peru. We chose three groups suggested to be useful indicators for studying biodiversity responses to disturbance: orchid bees ($n=1783$), dung beetles ($n=3787$) and butterflies ($n=2506$). This allowed us to identify how these groups responded to disturbance, which diversity measures were most sensitive for detecting those changes and whether the same measures were suitable for all groups. We used Hill's numbers to measure alpha diversity and explored beta diversity by looking at changes in community composition and two new measures of beta diversity: redundancy and representativeness. To see how the diversity patterns changed when taxonomic similarity was considered, we used a recently developed family of similarity-sensitive diversity measures and compared the results of these against more traditional measures. We found that the diversity indices that were best for detecting disturbance patterns varied widely between taxonomic groups. For dung beetles, species richness and community composition were the most effective measures, whereas these performed poorly for orchid bees. Abundance and redundancy were more sensitive for detecting a response to disturbance in orchid bees. Using the butterfly dataset, we show that the inclusion of species similarity completely changed the diversity patterns found across the disturbance gradient. The similarity of species present in a community is likely to be important for the preservation of evolutionary adaptability and the provision of ecosystem functions and we therefore suggest that diversity measures based on similarity will be a useful additional tool for conservation and impact assessments. Our results also demonstrate the importance of choosing your diversity index carefully to suit the taxa being studied to avoid missing important ecological responses. We recommend that, where possible, multiple diversity indices and taxonomic groups should be used to reduce this risk and provide a comprehensive understanding of ecosystem patterns in response to environmental change.

Paper Number: 313
Thursday, 05 July 2018 | Machu Pichu
General Session 19.2 - Biodiversity Patterns

Scaling up latitude beta-diversity relationships using ForestGEO plots

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Introduction

Current theory predicts that variation in species composition (beta-diversity) increases with pooled species richness (gamma-diversity), which strongly influences latitudinal beta-diversity patterns. Therefore, metrics that correct for gamma-dependent effects have received abundant scientific attention and stimulated considerable discussion.

Objectives

- a) To determine the sensitivity of classical and multivariate beta-diversity metrics to gamma-diversity.
- b) To determine the influence of spatial scale on latitudinal beta-diversity patterns

Methods

We used tree data from 15 ForestGEO plots along a latitudinal gradient from northern China to Papua New Guinea to determine latitudinal beta-diversity patterns at multiple spatial scales (grain size = 0.01 ha to 1 ha) using classical (Whittaker's) beta diversity and multivariate (mean pairwise Sørensen) beta-diversity metrics.

Results

In contrast to the accepted paradigm based on analyses at small spatial scales (grain size ≤ 0.1 ha), we show that both classical and multivariate metrics of beta-diversity were not influenced by gamma-diversity while sampling at large spatial scales (≥ 0.25 ha), and, specifically, we show that observed beta-diversity does not change with increasing latitude.

Conclusions

Our results have important implications for community ecology and demonstrate that the general β -diversity patterns and the processes structuring communities are still open for discussion. Specifically, our results suggest that ecological mechanisms, not gamma-diversity, explain global scale patterns of beta-diversity, and future studies need not correct for variation in gamma-diversity when sampling at large spatial scales.

Paper Number: 364
Thursday, 05 July 2018 | Machu Pichu
General Session 19.2 - Biodiversity Patterns

Discovering the shape of biodiversity of dominant tree family Dipterocarpaceae from the edge to the core of the distribution

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Forests hold more than 75 percent of the world's terrestrial biodiversity, providing vital products and services for socioeconomic development of millions of people. Tropical forests in South-East Asia are the most important repository of biodiversity, and a thorough understanding and assessment of their ecology and evolution is essential for their conservation and sustainable use.

Dipterocarpaceae (holding more than 550 species) are the economically most important native tree family for wood production in tropical Asia, with a key ecological role. Dipterocarpaceae are spread over the tropical belt of Asia, Africa and South America, with their center of diversity in the Peninsular Malaysia, Sumatra and Borneo (over 270 species, 160 endemics).

Widening of the tropical belt will affect species occurring in subtropics, by modifying their abundances, their distributions and the rate of their extinction.

Little is known about the genomic diversity in Dipterocarpaceae. To obtain molecular data able to resolve the elusive evolutionary relationships in Dipterocarpaceae, we used a genome skimming approach, i.e. bioinformatic sorting of highly repetitive sequences, combined with both de novo and reference-guided assembly, to reconstruct both complete chloroplasts and nuclear ribosomal cistrons (NRC) for nine Dipterocarpaceae species occurring on the edge of the family's distribution, and two additional species of Dipterocarpaceae. We compared the genomic diversity at intergeneric and intrageneric taxonomic levels, together with a set of taxa spread throughout Malvales. Dipterocarpaceae species occurring in China are from five different genera, and thus showed different level of variation in repeat sequences found in chloroplasts genomes, but similar in SSRs and other characteristics investigated during comparative chloroplast genomic analyzes.

In addition, we used the MIG-seg technology to generate data to perform evolutionary and ecological analyses, based on our reconstructed phylogeny, to analyze the pattern of divergences and adaptations in > 100 Asian Dipterocarpaceae species. We also included in our study Dipterocarpaceae species from Africa and South America to resolve their evolutionary relationships with Indo-Malayan Dipterocarpaceae species, and test the hypothetical Gondwanan origin of the family.

Our results provide both insights to the biogeographic history of the family and resources for future studies on edge-species distribution responses to a changing environment in terms of abundance, range of distribution and extinction. Finally, this study is valuable to our efforts to assess and conserve plant genetic diversity in tropical timber trees, and to predict the deleterious effects of habitat- and climate-changes on populations and species dynamics.

Paper Number: 734
Thursday, 05 July 2018 | Machu Pichu
General Session 19.2 - Biodiversity Patterns

How much of the global spatiotemporal variation in tropical woody net primary productivity is attributable to meteorological conditions?

Sami Rifai

Introduction / Background / Justification

The woody net primary production (NPP) of tropical forests is an important long-lived carbon sink. Climate is a major regulator upon total tropical forest net primary productivity, but identifying Panropical patterns of how short-term meteorological variation relates to specific components of tropical forest NPP has been challenging. The recent 2015-2016 El Niño event represented an opportunity to examine how meteorological extremes influence tropical woody NPP across the Panotropics.

Objective(s)

We primarily ask the question, how much seasonal and interannual variation in tropical woody NPP can be explained with purely meteorological predictors? By addressing this question, we can estimate the global impact of the 2015-2016 El Niño event upon tropical forest woody NPP.

Method(s) used

The Global Ecosystem Monitoring network has collected an extensive dataset of dendrometer band measurements on adult tree growth (>10 cm DBH) from more than 30 forest plots across twelve tropical forest sites. These sites span a range of 1200-3000+ mm of mean annual precipitation and have been measured every three months for between 1-10+ years. We scaled these tree-level growth measurements to estimate the forest stand level monthly accumulation of carbon in woody stems. We fit hierarchical models to to statistically quantify the limits of the explanatory power of meteorological variables over woody NPP. This model was then scaled across the Panotropics to estimate the impact of the 2015-2016 El Niño event tropical forest woody NPP.

Result(s) observed

Meteorological predictors can explain more than one quarter of the variation in monthly woody NPP accumulation. This predictive power is highest over strongly seasonal forests and declines over forests with more aseasonal climates. The impacts of instantaneous and accumulated soil water deficit are complex and are conditional upon a forest's mean annual precipitation and precipitation seasonality, whereas the negative impact of atmospheric drought (vapor pressure deficit) upon woody NPP are largely consistent across the tropics.

The implications and conclusions based upon the results

Our results highlight the generalizable reduction in woody NPP due to high vapor pressure deficit, but also the different responses of highly seasonal tropical forests and aseasonal ever-wet forests to soil water deficit. When scaled across the Panotropics, woody NPP reductions attributable to the El Niño were widespread but the strongest reductions were focused over central-eastern Amazonian forests with typically high precipitation seasonality but that were afflicted by a strongly positive VPD anomaly from the El Niño event.

Paper Number: 408
Thursday, 05 July 2018 | Machu Pichu
General Session 19.2 - Biodiversity Patterns

Spatial patterns in the vegetation of a tropical montane cloud forest in Horton Plains, Sri Lanka in relation to disturbance

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Horton Plains National Park (HPNP) is a tropical montane cloud forest in the central highlands of Sri Lanka. Significant tree dieback has been reported in the recent past that is believed to alter the floristic composition and structure of the forest. This study examines the spatial variations in species composition and abundance of the vegetation. Thirty 20 x 15 m² experimental plots were randomly established in selected locations over the forested area. Standing trees (both live and dead) were tagged and recorded for individuals greater than 3 cm dbh. Among the total stem density, 5% comprised dead standing trees belonging mostly to the tree families Rubiaceae, Lauraceae, Myrtaceae, Clusiaceae and Symplocaceae. There were 3786 living trees representing 58 species, 25 plant families, and 40 genera. The dominant species (based on Important Value) comprised *Syzygium revolutum* (22.9%), *Neolitsea fuscata* (22.48%), and *Glochidion pycnocarpum* (17.2%). The dominant plant families were Rubiaceae (23.96%), Lauraceae (18.81%), Myrtaceae (16.01%) and Symplocaceae (15.08%). Other families were comprise less than 5% abundance. *Calophyllum walkeri* (Clusiaceae) comprises the tree species most susceptible to dieback. Detrended Correspondence Analysis (DCA) of the vegetation data revealed that the vegetation plots are scattered and do not cluster together indicating particular plant communities or associations (Total eigen value = 0.2695). Some experimental plots comprised *Calophyllum walkeri*, *Cinnamomum ovalifolium* and *Syzygium* spp. together suggesting the typical montane tree community for this forest type but, in others, the former two species were either absent, or present in very low densities. The spatial heterogeneity of the vegetation could be attributed to both natural spatial patterns in the vegetation as well as to disturbances because of die-back.

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Paper Number: 667

Thursday, 05 July 2018 | Machu Pichu
General Session 19.2 - Biodiversity Patterns

Taxonomic diversity pattern of tropical woody plant species across the globe

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Biodiversity estimation of tropical forests across the continents is critical to understand the mechanisms of historical diversification among tropical biomes. Global-scale data of species occurrences is a promising asset for a comprehensive description of distribution patterns of tropical plants over taxonomic clades, and informs us important plant areas for biodiversity conservation of tropical forests. In this view, we created species list of woody plants by collecting a variety of botanical information and compiled a global-scale occurrence data of tree species. Based on these datasets, we attempted to explore the clade specific diversity patterns of tropical tree species along environmental gradients. We firstly investigated incident-based sampling curves and illustrated rarefaction and extrapolation of tree species richness across the regions or latitudinal ranges. In this analysis, we found that spatial coverage of species' incident data is imperfect because of undersampling associated with logistic difficulties in tropical regions, and also revealed major biodiversity patterns of tropical forests such as diversity anomalies between the continents. This study provides a fundamental step to understand relative importance of adaptive radiations, ex-situ evolutions and dispersal processes in shaping plant biodiversity patterns at geographic and taxonomic spaces.

Paper Number: 727

Thursday, 05 July 2018 | Machu Pichu
General Session 19.2 - Biodiversity Patterns



GENERAL SESSION 45

Forest Fragmentation

Effects of forest fragmentation on gene flow in two dipterocarp tree species in tropical rain forests in Sarawak, Malaysia

Satoshi Nanami

Background: Forest fragmentation is thought to induce the genetic degradation of tree populations by increased inbreeding, including selfing. Inbreeding often has harmful effects on tree regeneration because it increases the homozygosity of deleterious recessive alleles. The frequency of inbreeding is partially dependent on the population density or fine-scale spatial genetic structure of focal tree populations.

Objectives: This study evaluated the influence of forest fragmentation on the gene flow in dipterocarp tree populations, which are dominant in tropical forests in Southeast Asia. We (i) investigated the selfing rates, pollination distances, and kinship relationships of parents of produced seeds in both preserved and fragmented forests; (ii) compared the results for tree species with different population densities and spatial genetic structures; and (iii) explored the relationships between tree population structure and influences of the forest fragmentation on reproduction of tree species.

Methods: This study was conducted in plots established in a preserved tropical forest in Lambir Hills National Park and in a fragmented forest in Sarawak, Malaysia. The focal species were the dipterocarp tree species *Shorea laxa* (Dipterocarpaceae) and *S. ovata*. For both species, all adult trees in the plots were genotyped by SSR analysis, and their spatial genetic structures were analyzed. We collected seeds from 3–15 adults, and the paternity of each seed was determined by comparing the genotypes of adults and seeds.

Results and Discussion: The population densities of *S. laxa* differed between the preserved (2.7 trees/ha) and fragmented (0.5 trees/ha) forests. The population density of *S. ovata* in both forests was low (0.4–0.8 trees/ha). The selfing rate of *S. laxa* was significantly higher in the preserved forest than in the fragmented forest, whereas the selfing rate of *S. ovata* did not differ between the forests. In both forests, short-distance pollination was dominant in both species, and the kinship between the parents of outcrossed seeds was significantly greater than expected from random pollination, perhaps due to the genetic similarity of nearby adults. However, no significant spatial genetic structure was observed for *S. laxa* in the fragmented forest. Therefore, kinship between the seed parents did not differ significantly from random pollination despite the short-distance pollination between nearby adults. The effects of forest fragmentation on the gene flow of trees should be assessed in consideration of population density and the spatial genetic structure of tree populations.

Paper Number: 270
Thursday, 05 July 2018 | Chichen Itza
General Session 45 - Forest Fragmentation

The conservation value of small forest fragments within monoculture rubber plantations in Xishuangbanna, China.

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Rapid expansion of monoculture rubber plantations in Southeast Asia have resulted in both deforestation and fragmentation at the landscape level. This process often generates a proportionally large number of small forest fragments, less than 100 ha in size, compared to a few large forest patches. However, the value of these small forest fragments for the conservation of biodiversity is still not fully understood. We sampled 14 small forest fragments and 18 monoculture rubber plantations in Xishuangbanna, tropical China, and measured aspects of the bird community (richness, diversity, density, biomass, habitat specificity, composition, evenness and feeding guilds). We recorded all bird detections (visual and aural) within 50 m radius from the plot using 10-minute variable point counts. We used general linear models to determine the effect of habitat type (rubber vs. fragment) on nine response variables: species richness, density and biomass of three classes of birds (all birds, frugivores only and insectivores only), NMDS to determine the effects of habitat type on bird community composition in rubber. Forty-two species occurred in small fragments and 29 species in monoculture rubber but 20 species were only observed in small fragments whereas seven species were only observed in rubber. Overall bird species richness, density and biomass were ~1.5x higher in small fragments compared to monoculture rubber. Insectivore richness and density were higher in small fragments, but biomass was similar between the two habitat types. Our results indicate that small forest fragments can harbor significant amounts of bird diversity within landscapes dominated by rubber plantations, although further monitoring is needed to measure avian fitness in fragments. Long-term conservation of these small forest fragments is also important to facilitate the inter-patch movements of the birds and create effective corridors for biodiversity.

Paper Number: 375
Thursday, 05 July 2018 | Chichen Itza
General Session 45 - Forest Fragmentation

Fern and tree communities in the fragmented tropical forest of China

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Fragmentation is one of the most important factors for habitat degradation and species loss, and tropical Southeast Asia has the highest deforestation rate among other tropical regions. How biotic and abiotic factors shape the plant species diversity over a tropical fragmented landscape is a major research activity in conservation biology. Tropical forest in south of Yunnan (China) is a rich ecosystem with a recent conversion of vast areas in agricultural fields. The complexity of the area has created difficulties in the complete understanding on the importance of forest fragment size versus the biotic and abiotic factors in relation with plant and animal community. In this study we consider fern and tree community over the fragmented landscape, asking the following questions: is forest fragment size more relevant than other biotic and abiotic factors in shaping the tree and fern community richness, composition and frequency? Do we observe a species nestedness among the species community? We assessed the fern and tree communities in 42 forest fragments, with a total of 75 transects, in Xishuangbanna prefecture, in tropical southwest China. Fern species were assessed by on the presence absence and cover index, whereas trees by presence absence and stem density. For each transect abiotic factors included were area, elevation, aspect, canopy openness and slope, whereas biotic factor included DBH (>10cm) for all tree within the transect and soil factors. Soil encloses water availability pH, carbon, nitrogen, magnesium, phosphorous potassium and concentration of sand silt and clay. We found that plant species richness decreased from large forest fragments to smaller fragments. Moreover, the effect of fragment size was only weakly significant for plant richness and abundance, and not significant for species composition. Soil factors and slope had the largest effects on plant species richness, composition and abundance. Furthermore, plant species were not nested for most of the factors considered in this study, with the exclusion of soil. In Conclusion, small fragments have fewer species; at the same time factors that shape species composition, richness and abundance, in a fragmented and dynamic ecosystem, are principally biotic and abiotic factors rather than the size of forest fragment.

Paper Number: 562

Thursday, 05 July 2018 | Chichen Itza
General Session 45 - Forest Fragmentation

Genome-wide data reveal patterns of small scale connectivity across fragmented landscape in six songbird species

Emilie Cros

Fragmentation is a major threat to biodiversity. Despite the high rate of deforestation observed in tropical region, studies of its impact on species connectivity and survival remain scarce. In this study we compared patterns of connectivity among six songbird species across the highly fragmented Southeast Asian island nation of Singapore. Using 13,000 – 25,000 single-nucleotide polymorphisms we investigated population structure and connectivity of six species with various ecological specificities: *Pellorneum malaccense*, *Cyanoderma erythropterum*, *Napothera abbotti*, *Mixornis gularis*, *Pycnonotus plumosus* and *Pycnonotus simplex*. We found that edge species as well as forest specific species from the canopy show high resilience to habitat fragmentation. In contrary, forest-dependent understorey insectivorous species are strongly affected by habitat fragmentation. Genetic diversity was found to be up to three times higher for populations from continuous forest compared to populations in highly fragmented landscapes. We showed that even in flying vertebrates, small forest discontinuities can act as barriers to gene flow and lead to isolation over a short time period.

Paper Number: 694

Thursday, 05 July 2018 | Chichen Itza
General Session 45 - Forest Fragmentation

Regional context drives the spatial scale that best predicts seed rain responses to landscape structure in fragmented rainforests

Miriam San-José · Víctor Arroyo-Rodríguez · Pedro Jordano · Jorge A. Meave · Miguel Martínez-Ramos

Introduction. Landscape structure shapes ecological patterns, but its effects on ecological processes remain poorly understood. Seed dispersal may depend on landscape structure. However, the spatial scale at which such dependence is maximized (i.e. scale of landscape effect, SE) is unknown, thus limiting our understanding of how this key ecological process is driven by landscape patterns.

Objective. We assessed the patterns and predictors of SE on the seed rain in two fragmented Mexican tropical regions: the relatively well-preserved Lacandona rainforest (LAC), and the strongly deforested and defaunated Los Tuxtlas rainforest (LTX).

Methods. We recorded the seed rain (1-yr period) in 40 forest sites (20 per region) and quantified the abundance and diversity of tree seeds (length >3 mm), separately assessing local (dropping from neighboring trees) and dispersed (immigrant) seeds. We measured five landscape metrics (forest cover, fragmentation, edge density, inter-patch isolation, and matrix openness) in 11 concentric landscapes (50 to 1,000 ha) surrounding each site and tested for differences in SE among regions, landscape metrics, response variables, and seed origin.

Results. We collected 67,322 seeds from 179 species. SE was significantly higher in LTX than in LAC. Only in LAC, forest cover tended to have smaller SE than other landscape metrics. In LTX, the abundance of seeds showed smaller SE than species diversity, and wind-dispersed seeds tended to show larger SE than local seeds.

Conclusions. Forest loss can lead to source limitation, making the seed-dispersal process in more deforested regions more reliant on landscape patterns measured across larger spatial scales.

Paper Number: 354
Thursday, 05 July 2018 | Chichen Itza
General Session 45 - Forest Fragmentation

POSTER PRESENTATION

Poster Board No	Paper Number	Paper Title	Presenting Author Names
1	13	Impact Of Surrounding Land Use On Water Quality In Northern Ethiopian Streams	Taylor Garner
2	44	The perception of the african manatee (<i>Trichechus senegalensis</i>) among the coastal peoples of N'Dogo Lagoon (Gabon).	Christy Achtone NKOLLO AGANGA
3	46	Extinction-driven Changes in Frugivore Communities on Oceanic Islands	Julia H. Heinen
4	48	Chemical differentiation of Bolivian <i>Cedrela</i> species as a tool to trace illegal timber trade	Kathelyn Paredes-Villanueva
5	88	Characterizing the optimal conditions for the production of Darutoside in <i>Sigesbeckia orientalis</i>	Rindra Harilanto Nantenaina
6	114	Differential Pest Damage of Maize, Teff, and Horse Beans by Surrounding Afromontane Forest Cover in the Amhara Region of Ethiopia	Patrick Mckenzie
7	124	The Assessment of patterns of Phyllogenetic Diversity of subtropical rain forest of the Great Sandy Region, Australia, using DNA Barcoding, indicate long term climatic refugia.	Marion Howard
8	191	Home Range, Daily Travel Distance and Cohesion in Colombian Woolly Monkeys in Cueva de Los Guácharos National Park Colombia: Comparing Spatial Data from GPS-collars and Direct Focal Follows.	Nancy Flechas
9	232	Conservation of Spoon-billed sandpiper (<i>Calidris pygmeus</i>) in Leizhou, China	Chengyi Liu
10	240	The biodiversity benefit of a diversity of managed forests	Xiaoyang Wang
11	241	How climate change impacts on beetle diversity in a natural reserve area in Southernwest China?	Yunyu Wang
12	256	Using metabarcoding to assess the ecological impacts of climate-induced tree diebacks in Yunnan Pine forests	Cai Wang
13	275	Survey Of Wildlife Meat And Parts At The Local Markets (Tamu) In Sabah	Julia Ng
14	301	Will the Bonobo Survive? -Focus on Local Perceptions Towards Bonobos in Bongando Ethnic Group, DR Congo-	Aya YOKOTSUKA
15	316	How have rubber trees (<i>Hevea brasiliensis</i>) adapted to variation in drought across the Amazon basin?	Peter Hietz
16	321	Relation between Leaf Quality, Soil Fertility and Biomass of Ateiid Primates in Colombia	Nancy Flechas
17	325	Alien vs predator: shading by weeds can modify nest temperatures in the freshwater crocodile	Ruchira Somaweera
18	329	Drones count wildlife more accurately and precisely than humans	Jarrod Hodgson
19	347	The IUCN Vulnerable Bornean Ironwood faces double whammy of dispersal limitation and seedling herbivory	Lan Qie
20	348	Phenotypic variation of montane and coastal populations of the Puerto Rican monarch butterfly	Mariangelí Echevarría
21	351	First a drought, then a hurricane: the uncertain future of the specialist frog <i>Eleutherodactylus portoricensis</i> in Puerto Rico.	Coralys Vicéns-López
22	360	Pollination guilds of aroids (Araceae) at Mulu National Park	Shong Kian Chai
23	363	Biofabricated silver nanoparticles as nano-warrior against phytopathogens	Sandhya Mishra
24	373	Pollination: A missing link to sustainable oil palm agroecology?	Kevin Li
25	383	A Rapid Assessment of Online Wildlife Trade in Sabah using Facebook	Dairysia Anthony Yukin
26	405	Conservation mapping of butterfly distributions for increased reserve protection in Sabah	Sarah Scriven
27	424	Growing Pains: Expanding Eucalyptus Plantations and Native Afromontane Forest Cover in Ethiopia's Northern Highlands	David Ferguson
28	425	Herbivory And Diversity Of Follicolous Lichens On Five Species Of Commonly Planted Dipterocarps In Inikea Rehabilitation Forest Project Area	Mohammad Shahrul Shahpuan
29	426	Floral Biology of Two <i>Tacca</i> spp. (Taccaceae) in West Sarawak	Kek Shen Chua
30	431	The effect of mimicry frequency on natural predation in a Batesian mimicry system	Ruchuan He
31	432	Impacts of habitat fragmentation on plant-frugivores mutualistic networks	Nancia Raoelijnanakolona
32	433	Crop cover, field margins, and crop heterogeneity influence the biodiversity of herbaceous plants in a tropical agricultural landscape of southern China	Wenjing Zhou
33	444	Population Dynamics of Selected Mammalian Species in Calauit Safari Park, Busuanga, Palawan	Arlene Talaña
34	449	Pollinator conservation and pollination services for promoting cocoa yields	Manuel Toledo-Hernández
35	460	Trait response of six dung beetle (Scarabaeidae: Scarabaeinae) species to the local extinctions of megafauna	Thary Gazi Goh
36	462	Quality Of Wildlife Trails And Camera-Trapping Assessment Of Ground-Dwelling Mammals And Birds In Inikea Forest Rehabilitation Project	Lauretta Andrew Laneng

Poster Board No	Paper Number	Paper Title	Presenting Author Names
37	464	Functional Ecology Of Amphibian Species At Sg. Moyog Water Actchment Area, Penampang	Yuta Inaguma
38	468	Modeling Habitat Preferences of Crestless Fireback (<i>Lophura erythrophthalma</i>) in Riau Ecosystem Restoration (RER) Kampar Peninsula, using Maximum Entropy Modeling	Ady Kristanto
39	470	Community phylogeny and niche divergence of a tropical rain forest in Borneo	Seiya Okuno
40	471	Epiphytes and their hosts: predictors in Wallacea	Robin Hayward
41	479	Phylogeny and ecological traits of dioecious trees in a tropical rain forest in Borneo	Itsuki Ohya
42	482	Altitudinal shifts of amphibian species over 80 years on Mount Kinabalu, Borneo	Catharina Karlsson
43	488	Effects of environmental factors on the growth of planted dipterocarp trees in a tropical rainforest restoration site in Sabah, Malaysia	Keiko Ioki
44	507	Habitat Selection and Activity Pattern of GPS Collared Sumatran Tigers	Dolly Priatna
45	525	Odonata fauna of Yunnan Province, China	Zhang Haomiao
46	542	Connectivity of peat swamp forests in Jambi province, Sumatra, Indonesia	Eleanor Warren-Thomas
47	551	Disentangling the drivers shaping the distribution of weed species in north-western Australia	Tommaso Jucker
48	558	The Functional role of leaf venation of Atlantic Forest, Brazil	Marcos PM Aïdar
49	564	Presence of <i>Batrachochytrium dendrobatidis</i> (Bd) in Amphibian Pet Trade in Puerto Rico	Adolfo Rodríguez-Velázquez
50	580	Including women in the conservation conversation: Environmental degradation disproportionately impacts women's livelihoods in the Amhara region of northern Ethiopia	Katie Brown
51	598	Birds of the Daweishan National Nature Reserve, Yunnan province, China	LuMing LIU
52	599	Survival of Planted Trees in Response to Environmental Gradients in Tropical Rainforest Rehabilitation Site	Shazrul Azwan Johari
53	600	Sex Ratio And Genetic Diversity Patterns Of <i>Elephas Maximus</i> From Selected Plots In Taman Negara National Parks, Peninsular Malaysia	Kayal Vizi Karuppannan
54	605	<i>Viburnum oliganthum</i> Batalin (Caprifoliaceae): a new record for the flora of Vietnam	Jong-won Lee
55	606	<i>Actinidia cylindrica</i> C.F. Liang (Actinidiaceae): a new record for the flora of Vietnam	Junho Choe
56	609	Biomass and carbon stocks of non-arboreal components in a Neotropical Hotspot	Yvonne Bakker
57	612	Population structure and diet of the Black-bellied Leaf Turtle (<i>Cyclemys oldhamii</i>) at Sakaerat Biosphere Reserve, Nakhon Ratchasima Province, Thailand	Sengvilay Seateun
58	614	Impact of the implementation of forest management projects on the conservation of forest resources: Case of the Forest Resources Restoration Project in northern Benin.	Oméga Lydia Clarisse GBEDAHI
59	621	Study on the invasive species of three large plateau lake in Yunnan province	Weiwei LI
60	632	Leaf nitrate reductase is an important trait for a better characterization of plant functional strategies	Nidia Mara Marchiori
61	633	The rule of pigtailed macaques (<i>Macaca nemestrina</i>) as seed disperser for forest regeneration in West-Malaysia	Giovanni Villa
62	639	Exploring the role of stochasticity in forest succession: A web application as a research and pedagogical tool	Kristoforus Odang
63	645	Assessment of the population size and distribution of a new species of <i>Magnolia</i> : A Community-Based Conservation effort in Northern Andes, Colombia	Melisa Ayala Joya
64	647	Wood Anatomical Traits Across A Land-Use Gradient In The Tropical Rainforests Of Sabah, Malaysia	Palasiah Jotan
65	660	Adaptive Genomics: relevance for tropical biology conservation	Agostinho Antunes
66	668	Mangrove recovery in southern Mexico: emerging patterns from an informal chronosequence	Daniel Chavez
67	670	Changes of Above-ground Biomass of Tropical Montane Forest in Ulu Padas, Sabah.	Jim Jun Fei Liew
68	677	Amphibian and reptile species composition in peat swamp forest of Kampar Peninsula, Riau, Indonesia	Andri Irawan Suhandi Martamenggala
69	685	Fern fronds dissection within a riparian zone of small streams in Sarawak, Malaysia.	Daniele Cicuzza
70	695	Diversity and Ecology of Araceae in Gunung Tujuh, Kerinci Seblat National Park, Jambi	Immanuela Putri Dame Ria
71	700	Rat feeding behavior of pig-tailed macaques (<i>Macaca nemestrina</i>) in oil palm plantations – implications for conservation	Anna Holzner
72	703	The Biological and Ecological Diversity of Aquatic Macroinvertebrates Assemblages of Selected Streams in Kota Marudu, Sabah, Malaysia.	Vi Vian Chaw
73	718	Evaluating the current status of <i>Lepanthes eltoroensis</i> at El Yunque National Forest: A Proposal	Rayza Hernández-Muñiz

Poster Board No	Paper Number	Paper Title	Presenting Author Names
74	731	Silicon release from leaf litter of six tropical tree species during decomposition	Ryosuke Nakamura
75	735	Clinging to survival: identifying priority areas for endemic species in Central Vietnam	Thanh Nguyen
76	743	Arthropod activity in tropical anthropogenic forests	Kong Wah Sing
77	746	Measuring habitat preferences of African elephants in Kibale National Park, Uganda	Moe Yanagi
78	751	Estimation of above-ground carbon stock in Tropical Peat Swamp Forest	Elisa Rumpang
79	754	Predicting Peat Depth from Forest Inventory Data and Landsat-8 Operational Land Imager Sensor Measurement in Tropical Peat Swamp Forest Areas, Kampar Peninsula Landscape, Riau Province, Indonesia.	Mahendra Primajati
80	764	Assessing the impact of corporate palm oil sustainability certification on deforestation	Charlotte Smith
81	770	Using DNA metabarcoding and prey size correction factors to describe dietary preferences of African leopards	Rasmus Worsoe Havmoeller
82	771	Are arboreal frugivores creating food patches for ground-dwelling fruit-eaters?	Linnea Havmoeller
83	787	Plant Water Dynamics of Páramos's Hypericum system: a multiscale analysis	Alejandra Ayarza-Páez
84	790	Using environmental DNA to monitor and manage freshwater fish resources: a case study from salmon monitoring in Alaska	Chunyan Yang
85	797	Getting a handle on Sabah's Plant Diversity: Spatial occurrence of the Hyper-Endemics	Colin Maycock
86	799	Grassroots Conservation Initiative for Endangered Gibbon in Mentawai and Java	Arif Setiawan
87	804	Shifts in avian community composition and species movement across a tropical landscape	Jessica N. Hightower
88	805	Boat operators of Klias and Weston River Cruise, Beaufort - Profiles, Business Practices And Perception Towards Tourists.	Siti Rozziana
89	807	Developing genetic techniques to understand impacts of poaching on populations of critically endangered Helmeted Hornbills	Chloe Webster
90	810	The Origin of a Common Urban Species: Natural Colonization or Human Introduction?	Yu Yan Leung
91	812	From genes to global climate change: Monitoring the diversity of a foundation tree species for resilient tropical forest restoration	Mohd Zulfazli Moktar
92	819	Awareness and attitudes of urban and rural Malaysians on issues relating to wildlife and human-wildlife conflict	Vivek Thuppil
93	820	Land use change on arthropods communities at swamp forest of East Jambi – Sumatra Island, Indonesia	Tati Suryati Syamsudin
94	821	herb layer diversity of savanna physiognomy in Yunnan, China	Mengqi Zhang
95	839	MtDNA and MHC diversity of captive tiger (Panthera tigris) in Thailand: A case study for captive breeding improvement	Worata Klinsawat
96	840	Spatial Distribution of Sabah's Endemic Trees and Shrubs	Sandy Tze Lui Tsen
97	841	Transitions to Sustainable Livelihoods to Reduce Threats to Biodiversity in North Sulawesi, Indonesia: Lessons From the Behaviour Change and Sustainable Transition Research Traditions	Ance Tatinggulu
98	842	Experimental rain forest fragmentation and an extreme climatic event drive reductions in canopy ant abundance and species richness	Kalsum Yusah
99	847	High Carbon Stock Forest in an Oil Palm Landscape in East Kalimantan: Provide Benefits for Biodiversity Richness	Prasetya Prio Utama
100	856	A Comparison of Tree Diversity across a Multiple-Land-Use Gradient in GoM-UNDP-GEF Project Area, Luasong, Sabah	Pui Kiat Hoo
101	863	The spatial distribution and conservation status of the endemic Orchids of Sabah.	Suzika Juiling
102	869	Promoting the application of conservation science among undergraduate students: a case study from Sri Lanka	Enoka Kudavidanage
103	873	Temporal Changes in Forest Structure and Tree Species Composition Due to Hydropower Plant Construction in Hulu Terengganu, Malaysia	Faeiza Razak
104	874	Tree diversity and composition recovery after selective logging in Bornean lowland forest	Martin Svátek
105	876	Population Genetic Structure Of Malayan Tapir (Tapirus Indicus) In Peninsular Malaysia	Qi Luan Lim
106	877	Linking RSPO Compensation to Village Forest. Case Study: Laman Satong Village Forests	Rahmawati Rahmawati
107	881	Linking Conservation and Local Tradition in Sub-District Gunung Raya, Kerinci to Enhance Public Awareness to Conserve Nepenthes	Hernawati

Poster Board No	Paper Number	Paper Title	Presenting Author Names
108	883	An Investigation on Water Deficit in Forest of Peninsular Malaysia from 1950-2016	Zan Hui Lee
109	895	Songbirds and visitor pressure: Implications for conserving two songbirds threatened by the pet trade in an offshore island.	Fathima Rafi
110	908	Effect of <i>Acacia auriculiformis</i> and <i>Eucalyptus globulus</i> leaf litter on the life-history traits of <i>Microhyla ornata</i> tadpoles and zooplanktons	Shomen Mukherjee
111	911	Ecological selectivity of extinction risk in terrestrial vertebrates	Maya Munstermann
112	936	Developing an underdominance gene drive system in the southern house mosquito	Jared Nishimoto
113	938	Introducing a Large Scale Ecosystem Restoration in Lowland Degraded Tropical Forest within Industrial Forest Plantation in Indonesia	Dolly Priatna
114	939	Impacts of fire to the population dynamics of the <i>Pinus merkusii</i> Tapanuli ecotype	Diny Hartiningtias
115	940	Large mammals relative to human settlements at Lanjak Entimau Wildlife Sanctuary	Olivia Cosby
116	941	Evolution of ethnovarieties definition along a food tree species (<i>Dacryodes edulis</i>) value chain in Cameroon	Jerome Duminil
117	942	The ARBOPOLIS project: Strengthening African livelihoods, food and nutrition security using indigenous fruit tree species	Jerome Duminil
118	953	Understanding tree architecture, form and function in the tropics	Alexander Shenkin
119	954	For God and For Country: Religious, Economic, and Institutional Incentives for Church Forest Conservation	Kelsey Johnson
120	970	Insect Diversity In Enhancing Forest Conservation – A Case Study Of Tambulanan Forest Reserve In Sabah	Yaw Chyang, Arthur Chung

Impact Of Surrounding Land Use On Water Quality In Northern Ethiopian Streams

Taylor Garner

Scattered across the Amhara Region in northern Ethiopia are some 19,000 church forests, the last few remaining fragments of indigenous Afromontane forests in Ethiopia. Within and around these forests are streams, used by local communities to obtain water for cooking, cleaning, drinking, etc. Streams may be polluted due to soil erosion and fecal waste. Our study examines whether streams in northern Ethiopia are more polluted from erosion when surrounded by agriculture, grazing, and urbanization as opposed to streams surrounded by church forests.

Our collaborators in Ethiopia have collected Total Suspended Solid water samples onto pre-ashed and weighed filters. Upon receiving these filters in the lab, our team weighed and calculated TSS. Once the filters were dry we placed them in a desiccator with hydrochloric acid (HCL) for 24 hours to remove inorganic carbon for subsequent analyses.

Field sampling results were then paired with Geographic Information Systems (GIS) analysis to relate to TSS data and determine if the landscape cover impacts the amount of sediment pollution in nearby streams.

Findings suggest that the forest vegetation is filtering out the solid particles before entering the stream. We are continuing data in Ethiopia along with isotopic data once filters arrive. Processed filters have been sent to a Marine Biological Lab for stable isotope analysis for carbon and nitrogen to characterize sources, such as fecal waste or fertilizer.

Paper Number: 13
Poster Board: 1

The perception of the african manatee (*Trichechus senegalensis*) among the coastal peoples of N'Dogo Lagoon (Gabon)

Christy Achtone NKOLLO AGANGA

The African manatee of its common name manga in the indigenous communities of the N'Dogo Lagoon, is a mammal very present in the aquatic environment, but whose evocation makes it possible to perceive a phantasmagorical veil.

The purpose of this work was to highlight the perception that local populations of the N 'Dogu lagoon have on the manatee. The method used was interviews with socio-historical questionnaires and free interviews with the traditional leaders of the villages present at the Lagoon for 6 months.

The results showed that the manatee occupies an important place in the traditional rites and beliefs of some Bantu tribes that they consider as Mami Wata or Mami Water a water genius that often takes the human form of a woman to make good or torment men. In addition, through interviews, traditional leaders explained with limits not to break the insiders' secret, hunting technique using the invocation of fetishes and plant mixes from the equatorial forest.

Through interviews with regular fishermen and some inhabitants of the Ndougou lagoon, this work examine the attitudes of the populations towards the manatee, whom they consider as a genius of water and give it mystical properties. Also, this work addresses human-manatee conflicts while evoking the phenomenon of bycatch in the N'Dogo Lagoon.

In addition, with the scarcity of fisheries resources and the increase in fishing gear, human-manatee conflict is beginning to be felt in the N 'Dogu lagoon and the emergence of the bycatch phenomenon, which is perceived as manna divine for the fishermen.

The cultural importance of the African manatee may be beneficial for its conservation but also negative because it is highly valued for its mystical attributes. At present, its protection is essential to safeguard this emblematic species but also to preserve the collective memory of the coastal tribes of Gabon which tends to erode and to extinguish itself.

Paper Number: 44
Poster Board: 2

Extinction-driven changes in frugivore communities on oceanic islands

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Global change and human expansion have resulted in many species extinctions worldwide, but the geographic variation and determinants of extinction risk in particular guilds still remain little explored. Here, we quantified insular extinctions of frugivorous vertebrates (including birds, mammals and reptiles) across 74 tropical and subtropical oceanic islands within 20 archipelagos worldwide and investigated extinction in relation to island characteristics (island area, isolation, elevation and climate) and species' functional traits (body mass, diet and ability to fly). Out of 74 islands, 33 islands have records of frugivore extinctions, with one third of the pre-extinction frugivore community being lost. Geographic areas with more than 50% loss of pre-extinction species richness include islands in the Pacific and the Indian Ocean. The proportion of species richness lost from original pre-extinction communities is highest on small and isolated islands, increases with island elevation, but is unrelated to temperature or precipitation. Large and flightless species had higher extinction probability than small or volant species. Across islands with extinction events, a pronounced downsizing of the frugivore community is observed, with a strong extinction-driven reduction of mean body mass and maximum body mass. The results document a substantial trophic downgrading of frugivore communities on oceanic islands worldwide, with a non-random pattern in relation to geography, island characteristics and species' functional traits. This implies severe consequences for ecosystem processes that depend on mutualistic plant-animal interactions, including ecosystem dynamics that result from the dispersal of large-seeded plants by large-bodied frugivores.

Paper Number: 46

Poster Board: 3

Chemical differentiation of Bolivian *Cedrela* species as a tool to trace illegal timber trade

Kathelyn Paredes-Villanueva, Edgard Espinoza, Jente Ottenburghs, Mark G. Sterken, Frans Bongers and Pieter A. Zuidema

Combating illegal trade of tropical timber requires the ability to identify species and verify geographic origin of timber. Forensic techniques that independently verify the declared species and geographic origin are needed, as current legality procedures are based on certificates and documents that can be falsified. Timber from the genus *Cedrela* is among the most economically valued tropical timbers worldwide. Three *Cedrela* species are included in the Appendix III of CITES: *C. fissilis*, *C. odorata* and *C. angustifolia* (listed as *C. lilloi*). There are indications that *Cedrela* timber is currently traded with false origin declarations and under a different species name, but tools to verify this are lacking. We used Direct Analysis in Real Time Time-of-Flight Mass Spectrometry (DART-TOFMS) to chemically identify *Cedrela* species and sites of origin. Heartwood samples from six species of *Cedrela* (the three CITES-listed species plus *C. balansae*, *C. montana* and *C. saltensis*) were collected at 11 sites throughout Bolivia. Mass spectra detected by DART-TOFMS comprised 1062 compounds; their relative concentrations were analyzed using Principal Component Analyses (PCA), Kernel Discriminant Analysis (KDA), and Random Forest analyses to check discrimination potential among species and sites. Species were identified with a discrimination error of 15-19%, with substantial variation in discrimination accuracy among species. The lowest error was observed in *C. fissilis* (Mean=4.4%). Site discrimination error was considerably higher: 43-54% for *C. fissilis* and 42-48% for *C. odorata*. These results provide good prospects to differentiate *C. fissilis* from other species, but at present there is no scope to do so for other tested species. This indicates that discrimination is highly species specific, which limits extrapolating these results to other species. Our findings for tests of geographic origin suggest no potential for the scale and species included in this study. Finally, we find that KDA and Random Forest analyses produced similar classifications and are complementary: KDA classifies based on all chemical compounds, whereas Random Forests identifies those components that can differentiate one species from another. Errors in identification can be reduced by comparing the probabilities of timber being assigned to other species and sites. Comparing and cross-checking results from different methods (KDA and Random Forest) reduced discrimination errors. In all, DART-TOFMS technique allows independent verification of claimed identity of *Cedrela* species in timber trade.

Paper Number: 48

Poster Board: 4

Characterizing the optimal conditions for the production of Darutoside in *Sigesbeckia orientalis*

Rindra Harilanto Nantenaina

Sigesbeckia orientalis (Asteraceae), a medicinal plant known for its wound-healing property. This species become highly demanded in cosmetic industries because of the presence of “Darutoside”, an important active compound. This study aims in determining what factors influence the production of Darutoside in *S. orientalis* in the tropical ecosystems of Madagascar. To do that, we extracted this compound from three different organs (leaves, seeds and whole plants) collected at different time periods during the rainy season (at the beginning, in the highest peak and at the end) and dried using three different methods (sun-, shade- and freeze-drying). We also analyzed how the chemical composition of the soil in the field where *S. orientalis* naturally found, influence the production of Darutoside. We found that *Sigesbeckia* leaves, collected at the end of the rainy season and dried in the shade, have the highest content of Darutoside. This content is enhanced for individuals found on a strongly acid soil, with a very sandy silt texture, rich in Carbon, Nitrogen, Potassium and Phosphorus, and for those in close proximity to a river. This research highlights the importance of taking into account both environmental conditions and biological factors in the harvest of *Sigesbeckia orientalis* for an optimal production of Darutoside. However, given that the production of active compound in medicinal plants may vary sporadically, periodic monitoring is necessary for a better understanding of the production of this important active compound.

Paper Number: 88
Poster Board: 5

Differential Pest Damage of Maize, Teff, and Horse Beans by Surrounding Afromontane Forest Cover in the Amhara Region of Ethiopia

Patrick Mckenzie

From 1971 to 2000, per capita domestic food production in Ethiopia declined as the country struggled to keep up with growing food demands. Today, 32% of the Ethiopian population is undernourished. Insect pest damage to crops has been an important contributor to this food insecurity, and fragmented forests within an agricultural landscape often provide pest regulation services. However, conversion of forests to agricultural lands has been expansive in Ethiopia, and since the early 1900s forested area has decreased from 40% to only 4.2% of total land area. The objective of this research was to examine the relationship between agricultural pest damage and nearby Afromontane forest cover in the Amhara region of Ethiopia. Annual post-planting and post-harvest pest damage for maize, teff, and horse beans were analyzed from World Bank's 2015 Ethiopian Rural Socioeconomic Survey for 4,954 farm households in the Amhara region. These data were combined with Landsat satellite imagery to examine how survey results relate to the percentage of surrounding forest cover based on Normalized Difference Vegetation Indices (NDVI). Logistic regressions revealed that forest cover was significantly positively associated with insect damage post-planting ($p=0.022$) and post-harvest ($p=0.005$) for maize. However, forest cover was significantly negatively associated with insect damage post-planting for both teff ($p=0.013$) and horse beans ($p=0.035$) but had no significant difference post-harvest. These findings suggest differential impacts of Afromontane forest cover on pest damage by crop type and season. These results indicate that it may be possible to increase food production in the Amhara region by planting different crops based on proximity of cropland to forest fragments. Further, by increasing food production of existing cropland, it may also be possible to slow the deforestation of the remaining Afromontane forest.

Paper Number: 114
Poster Board: 6

The Assessment of patterns of Phylogenetic Diversity of subtropical rain forest of the Great Sandy Region, Australia, using DNA Barcoding, indicate long term climatic

Marion Howard

Introduction: Biodiversity conservation is important for adaptation to change for species and ecosystems. Australian rainforests contain a high proportion of the continents terrestrial biodiversity. Previous studies indicated that the community assemblages of the highly fragmented subtropical rainforests of South East Queensland (SEQ) contain areas of high endemism indicative of climatic refugia, vital for the recolonisation of surrounding areas impacted by disturbance. One area found to contain significant levels of endemism, with patches of rainforest growing on white sand, is the Great Sandy Region which includes World Heritage listed Fraser Island and Coolool National Park. This was in contrast with the results of studies of rainforest on white sand in Peru. **Objectives:** This study aimed to improve our understanding and assessment of Australian environmental biodiversity heritage, its importance for global rainforest biodiversity conservation and to determine distribution of diversity by expanding and updating the DNA barcode library of the South East Queensland rainforest flora. **Methods Used:** Collection of Herbarium and DNA voucher specimens was focused on rainforest sites within the Great Sandy and surrounding areas in SEQ, Australia. DNA barcoding was performed for three standard markers for each species collected and sequences added to the DNA barcode library of SEQ rainforest plants. A dated phylogenetic tree composed of 95% of the SEQ rainforest flora was constructed and species composition of rainforest in fixed area plots from 100 sites were sampled. Phylogenetic diversity (PD) measures were calculated and together with species richness (SR) for each rainforest community and site variables such as geology, patterns and relatedness were evaluated. DNA sequences and metadata generated for 143 species from 62 families were uploaded to the BOLD (Barcode of Life Database) and GenBank databases. **Results Observed:** We found that 40% of sites in the Great Sandy Region exhibited significant phylogenetic evenness of more distantly related taxa than expected which correlates with centres of endemism and climatic refugia. Sites from adjacent areas were either not significant or significantly more related than random. Communities from northern sites near central Queensland were found to have the highest phylogenetic diversity (PD) and species richness (SR) in the study area however only 16% of these sites were found to be **phylogenetically distinctive, indicative of recolonisation and expansion.** **Conclusions:** This research emphasises the importance of the Great Sandy Region for the conservation of phylogenetic variability necessary for the recolonisation of surrounding landscapes in the event of disturbance, especially as the result of future climate change.

Paper Number: 124
Poster Board: 7

Home Range, Daily Travel Distance and Cohesion in Colombian Woolly Monkeys in Cueva de Los Guácharos National Park Colombia: Comparing Spatial Data from GPS-collars and Direct Focal Follows

Carolina García, Andrés Link, Johana Páez and Pablo R. Stevenson

Abstract Space requirements are important to assess population viability, especially for endangered species. The goal of this study was to estimate the home range size, daily travel distances and cohesion of two woolly monkey groups in a sub-Andean forest (Huila, Colombia), using two different sampling methods: Direct observations of focal animals and through GPS-collars located on few individuals. Our research questions were 1. Are there differences in the estimates of home range area and daily travel distances between methods? 2. In case of differences, are topography and trail locations associated with sampling bias? 3. Are DTR affected by fruit production and sub-group size? 4. How far apart individuals of the same group can be and is cohesion associated with fruit production? Results demonstrated that direct observations of focal animals using hand-held GPS devices had limitations because this method underestimated woolly monkeys' home range and travel distance. This is because there are topographic limitations to follow focal animals and follows are infrequent away from the trail system. Woolly monkeys of the same group were usually hundreds of meters apart, showing fission-fusion dynamics. Closer distances were observed when large fruits produced. DTR was higher for larger subgroups, consistent with the hypothesis of strong intra-group competition. The use of GPS-collars was costly, but useful to obtain data on space use since it was possible to track both study groups continuously with high quality, precision, and covering broad geographic areas.

Paper Number: 191
Poster Board: 8

Conservation of Spoon-billed sandpiper (*Calidris pygmeus*) in Leizhou, China

Chengyi Liu

Leizhou is the largest wintering ground for the critically endangered Spoon-billed sandpiper (*Calidris pygmeus*) in China (43 individuals recorded in 2016, representing about 10% of the global population). To successfully conserve this population, it is important to quantify their local habitats, identify their local threats, and raise local awareness of this conservation issue.

In this study, we carried out field population survey, benthonic animal survey, social survey as well as environmental education activity together to stress above mentioned issues for Spoonbilled sandpipers in Leizhou during 2017 - 2018.

Through population survey, we recorded 29 Spoon-billed sandpipers in December, 2017 and 12 in January, 2018; and we collected more than 10 groups of benthonic animals samples from Spoonbilled sandpiper's feeding patches. Social surveys found illegal hunting, one of most threats from local people, has decreased during years. However, local people have comparatively few knowledge of local wild birds and the threatened status of the Spoon-billed sandpiper. Based on the social survey results, we carried out education at local primary and middle schools.

On one hand, our study brought both biological and sociological information on this threatened species in Leizhou. So, our survey may can bring valuable data for coming researchers and conservationists. On the other hand, though our education activities are quite limited, we hope this attempt could be set as a model for local conservation NGO for future conservation programs.

Paper Number: 232
Poster Board: 9

The biodiversity benefit of a diversity of managed forests

Xiaoyang Wang

China's Grain-for-Green Program (GFGP) is the largest reforestation program in the world and has been operating since 1999. As the Program going on, large scale forest covered farmland, and brought benefits on basic ecosystem service like soil and water maintaining. In our previous study, we showed that GFGP monocultures supported lower bird species diversity relative to native, natural forest and farmland. However, we also found that 'mixed' GFGP forests made of 2-5 neighboring monoculture stands planted in checkboard fashion could support nearly the same bird species diversity as native, natural forest and farmland. Here we use metabarcoding to investigate whether the same mixed GFGP stands are also supporting higher species diversities of arthropods (collected with pan traps), both to generalize the above finding and to test a potential explanation for higher bird species richness. We report here that GFGP mixed forest does support higher arthropod species richness than do monospecies Japanese cedar, Eucalyptus, and bamboo forests. We also report that mixed GFGP forest arthropod communities appear to be composed of subsets of the individual monocultures and also native forest. However, overall beta diversity is dominated by turnover, not nestedness, which indicates that each of the monocultures supports its own arthropod communities. Thus, alongside the original policy recommendation to maintain and expand native forest, our results suggest that among the GFGP forests, a combination of both large monocultures and mixed checkboard monocultures will maintain the highest overall arthropod diversities in this landscape.

Paper Number: 240
Poster Board: 10

How climate change impacts on beetle diversity in a natural reserve area in Southernwest China?

Yunyu Wang

Beetle is the most diverse animal group on Earth with more than 400,000 species been described by scientist. The vast diversity of beetles play important roles in ecosystem such as decomposition and pollination. Many studies reported that beetles has expanded its range in recent years due to changing climate. However, there is lack of empirical data on ong-range dispersion beetles respond to climate change in natural reserve areas in China. In this study, we collected beetles using Malaised traps in Gaoligong Moutain, Southernwest China. Combined with environmental data, we used phylogenetic comparison, community phylogenetics and computational modeling methods combined with to analyzed time series samples with an aim to understand how climate change mediates the risk of biodiversity loss in the natural reserve. In specific, we asked: 1) are the beetle diversity in southern and northern mountain different? 2) are beetle diversity lower elevation significantly different with higher elevation? 3) which group of beetles are risk to extinct from extreme climate events? 4) can functional traits of beetle to be use in predicting ability of species in cold adaptation?

Paper Number: 241

Poster Board: 11

Using metabarcoding to assess the ecological impacts of climate-induced tree diebacks in Yunnan Pine forests

Cai Wang

Tree diebacks induced by climate change has been reported in recent decades. This situation also poses challenges for forest management. However how forest diebacks affect changes in biodiversity remains poorly known. Metabarcoding has been shown to be much faster and yet still as reliable as standard biodiversity datasets assembled with traditional labour-intensive methods. Thus, using metabarcoding to assess the impact of forest dieback on invertebrate biodiversity can boost biodiversity monitoring schemes and forest management. Applying this technique for ecological assessment, we compared the invertebrate community among several degrees of dieback forests assessing by forest management record.

The result shows that the no-dieback forests are different from dieback forests on invertebrate biodiversity, but it is blurred distinction between different categories of dieback forest. For forest management on dieback forest, it illustrates that is inadequate to indicate forest management by the old variables. We should also consider the ecological importance of invertebrate biodiversity. It's useful for a better integration of biodiversity stakes in forest management. There are more reasonable to advise such as salvage logging and change of tree species composition focused on forest dieback adaptation and dead wood forest under clime change. Moreover, metabarcoding now reduces the taxonomic impediment, which refers to the difficulty of identifying species accurately. It shows us an operational toolbox for fast invertebrate biodiversity monitoring and this is much closer to ecological changes for assessing the degree of dieback forest.

Paper Number: 256

Poster Board: 12

Survey Of Wildlife Meat And Parts At The Local Markets (Tamu) In Sabah

Julia Ng

Background / Justification

Sabah has an area of about 7.3 million ha and about 50% of the state is still forested with many local communities depending on the forest for food and other resources. The culture of hunting is deeply ingrained in many of the ethnic groups and the hunted meat and products are sold in weekly or monthly local markets (tamu) all around Sabah. Baseline data with regards to the extent of wildlife hunting and trade remains obscure in Sabah. Although there have been specified species like pangolin and sun bear trade surveys conducted in Sabah, surveying the tamu were never conducted in a systematic way before.

Objective(s)

This study is a step towards fulfilling this data gap by investigating the most popular species traded in the tamu grounds and how many are from the IUCN Red List of Threatened Species and protected by law in Sabah. This article reports of findings of the tamu surveys undertaken in 2015 and 2017. The utility of this information is crucial in developing strategies to curb illegal hunting and trade of threatened species in Sabah.

Method(s) used

The surveys were conducted in Sabah between January to April 2015 and March to June 2017. The number of tamu visits made was 156 visits in 2015 and 176 visits in 2017. The surveyors were Sabahans, who can speak the local dialect (Kadazan/Dusun/Murut) and Malay. The results were recorded as "observations" with an observation defined as the presence of a species found per stall at the tamu.

Result(s) observed

A total of 310 observations were made on wildlife being sold in Sabah's tamu for 2015 and 223 observations for 2017. Mammals were observed to be sold the most for both years (195 observations in 2015 and 151 observations in 2017). This was followed by birds and reptiles, totaling 105 and 82 observations respectively. Wildlife species classified as Totally Protected under the Sabah's Wildlife Conservation Enactment 1997 and listed in the IUCN Red List of Threatened Species were also found.

The implications and conclusions based upon the results

More research need to be conducted to make informed decisions on the management of the hunting and trade of the Bearded Pig, Sambar Deer and songbirds, and enforcement to stop the trade of illegal wildlife at tamu have to be stepped up.

Paper Number: 275
Poster Board: 13

Will the Bonobo Survive? -Focus on Local Perceptions Towards Bonobos in Bongando Ethnic Group, DR Congo-

Aya YOKOTSUKA

Bushmeat hunting is one of the biggest threats to the great apes in Central Africa. The Bongando ethnic group in Democratic Republic of Congo traditionally has a taboo against eating bonobos (*Pan paniscus*). The reason why Bongando avoid eating bonobo is because they believe bonobos are from same ancestors with Bongando. Also bonobos have a no tail, so bonobos are not animals but humans in Bongando's animal taxonomy.

However, researching other villages, the situation revolving around bonobos is dramatically different. This study aims to examine how local perceptions towards bonobos become diversified within and beyond the reserve.

I conducted a survey questionnaire to 832 Bongando people living in 7 villages to inquire their human-bonobo interactions. Two of the villages surveyed are from the reserve and five are from the non-protected areas. Results show that the perception towards the bonobos differed between the people from the reserve and the non-protected areas. In the reserve, bonobo research has been continued over 40 years.

People from the reserve tend to avoid eating bonobo due to their traditional beliefs and benefit from the bonobo research. The support from the bonobo research encourages the preservation of the bonobos in the reserve. Conversely, people from the non-protected areas are inclined to eat bonobo. This can be seen especially in the age group between 20 and 40. Furthermore, the availability of bonobo meat in these areas tends to be high in the villages from the non-protected areas.

According to my interviews, villagers hunt bonobos not for only sale.

This mean is villagers who hunt bonobos, and also consume bonobo meat by themself.

It is assumed that cultural interchanges have been accelerated after civil wars. Plantations around villages were collapsed, so people go to cities to get work.

The traditional taboo of bonobo is disappearing rapidly and the situation is critical in the non-protected areas.

How Local Perceptions of Bonobos Become Diversified among Bongando ethnic group in DR Congo

Bushmeat hunting is one of the biggest threats to the great apes in Central Africa. The Bongando ethnic group in Democratic Republic of Congo traditionally has a taboo against eating bonobos (*Pan paniscus*). The reason why Bongando avoid eating bonobo is because they believe bonobos are from same ancestors with Bongando. Also bonobos have a no tail, so bonobos are not animals but humans in Bongando's animal taxonomy. I have studied local perceptions towards bonobos in Bongando territory since 2014. I confirm that the situation revolving around bonobos is dramatically different in the reserve and non-protected areas. I conducted a survey questionnaire to 832 Bongando people to inquire their human-bonobo interactions. Two of the villages are from the reserve and five are from the non-protected areas.

In the reserve, bonobo research has been continued over 40 years.

People from the reserve tend to avoid eating bonobo due to their traditional beliefs and the support from the bonobo research. Conversely, people from the non-protected areas are inclined to eat bonobo. This can be seen especially in the age group between 20 and 40. According to my interviews, villagers hunt bonobos not for only sale.

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The traditional taboo of bonobo is disappearing rap.

Paper Number: 301
Poster Board: 14

How have rubber trees (*Hevea brasiliensis*) adapted to variation in drought across the Amazon basin?

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Background: Knowing the ways organisms adapt to a changing climate through genotypic or phenotypic variation is essential to project the effect of climate change, but also to understand the composition of extant communities. Many tropical forests are expected to experience increased drought, but there is very little information on intraspecific variation of drought tolerance.

Objectives: Understanding the genetic adaptation to the local environment across the natural range of a commercially important tropical tree. Is there intra-specific variation in drought adaptations in rainforest trees?

Methods: We used a provenance trial of 153 rubber (*Hevea brasiliensis*) tree clones originating from 15 locations in the Amazon basin that were planted in northern Thailand. We controlled for tree size, calculated phylogenetic signals, and tested which wood and leaf traits correlated with the climate at the location of origin.

Results: While tree size contributed little and therefore does not bias other correlations, genotype explained 30 – 70% of the variation in traits, and traits differed in how much of this variation was controlled by location or the relatedness among clones. There was little or no correlation with mean temperature (which does not vary much at the place of origin) or total annual rainfall (ranging from 1550 – 2250 mm). However, rainfall in the driest quarter (19 – 199 mm) was strongly related to leaf traits ($r^2 = 0.58, 0.70$ and 0.48 for correlations with leaf mass per area, carbon isotopic composition and area-based nitrogen content, respectively) and weaker to wood traits (vessel density and vessel lumen fraction). Trees from locations with a stronger dry season also had slightly higher growth rates in Thailand. All traits correlating with climate showed a significant phylogenetic signal. Surprisingly, none of the traits evidenced increased drought tolerance in trees from the drier locations. However, leaf carbon isotopes and growth indicate reduced drought stress in trees from drier locations when planted in a common garden.

Conclusions: This suggests that in rubber trees the genotypes adapted to drier conditions have evolved strategies of drought avoidance rather than drought tolerance. We conclude that to understand adaptations to climate requires looking at the trait spectrum and caution against the interpretation of individual traits. Common garden experiments are suitable tools to identify genetic variation and adaptations.

Paper Number: 316
Poster Board: 15

Relation between Leaf Quality, Soil Fertility and Biomass of Atelid Primates in Colombia

Nancy Flechas & Pablo R. Stevenson

Knowing the factors determining population abundance is necessary for conservation plans, which are urgently needed for large primates inhabiting tropical forests. In the case of folivorous primates, it has been proposed that leaf protein to fiber ratio is a good proxy of resource quality and appears to be a useful predictor of folivorous primate biomass. It is also known that large atelid monkeys base their diets on leaves during fruit scarcity periods. Accordingly, this project assess the relation between leaf quality (based on protein, fiber and tannin contents) and atelid primate biomass (*Alouatta*, *Ateles* and *Lagothrix*). We selected the species with highest basal area to evaluate its leaf quality in different forest types (terra firme, varzea and igapo) in four localities in Colombia. The chemical composition of leaves and its variation in different forests is poorly known, therefore, we evaluated a possible relation between leaf quality and soil fertility, given that soils with higher fertility are expected to contribute to a higher productivity, leaf quality, and primate biomass. We found that there is a positive relation between the protein to fiber ratio and the atelid biomass ($R^2=0.481$; $p\text{-value}=0.07$). Although there was not a strong relation between fertility and leaf quality, there are significant differences in leaf quality between forest types, where várzea had the highest leaf quality followed by terra firme and finally igapo. The latter had the species with the highest tannin leaf content. Our results suggest that the protein to fiber ratio partly explains atelid biomass and that differences in leaf quality between forest types may be due to floristic composition, more than soil fertility. In addition, this study highlights varzea's forests high quality resources and hence as a conservation goal.

Paper Number: 321
Poster Board: 16

Alien vs predator: shading by weeds can modify nest temperatures in the freshwater crocodile

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The microclimates of nest sites can influence the lifetime fitness of individuals, as well as population demographics, in reptiles with temperature-dependent sex determination. Vegetation that overtops nest sites has the potential to change incubation conditions and impact offspring viability. In north-western Australia, the introduced weed stinking passionflower (*Passiflora foetida*) frequently smothers the nesting habitat of the Australian freshwater crocodile (*Crocodylus johnstoni*), rapidly overgrowing nests during the approximately three month incubation period. For freshwater crocodiles, the temperature range for embryonic survival (T_{crit}) is 28–36 °C, and sex ratios are primarily governed by nest temperatures during a thermosensitivity period (TSP) that falls between days 20–57 of incubation at 30 °C.

To quantify the impact of weed overtopping on nest temperatures, we buried temperature loggers below ground at egg deposition level (c. 30 cm below ground) in sites used for nesting by crocodiles, both in bare ground patches and under adjacent *Passiflora* patches, in two very different substrates: river sand at Geikie Gorge National Park and ridge top shale at Lake Argyle (a man-made lake). Hourly substrate temperatures were recorded over 75 days that spanned the typical incubation period. We averaged substrate temperatures (T_s) at 20 and 40 cm below ground to explore how *Passiflora* cover might influence two key temperature-driven demographic parameters: hatching success and primary sex ratios.

At Geikie Gorge, *Passiflora* had a cooling effect on T_s ; it did not push T_s below T_{crit} at any site, but had a large enough effect to potentially alter nest sex ratios. Soil temperatures differed by 2–3 °C between treatments during the TSP, which exceeds the 'transitional range of temperatures' across which both sexes are produced. In contrast, at Lake Argyle we found no substantial effect of *Passiflora* on T_s at any substrate depths; hence T_s was not significantly different between treatments during the TSP.

Understanding indirect interactions among species are a critical component for predicting the resilience of biodiversity to global environmental change, but indirect interactions are rarely studied and there are few examples of how these interactions can be manipulated to achieve conservation benefits. Our broader aim in this three-year project is to quantify the novel indirect interactions between an apex predator and a threatening weed, which could have utility for predicting downstream effects on food webs and the population dynamics of threatened species.

Paper Number: 325

Poster Board: 17

Drones count wildlife more accurately and precisely than humans

Jarrod Hodgson

Knowing how many individuals are in a wildlife population allows informed management decisions to be made. Ecologists are increasingly using technologies, such as remotely piloted aircraft (RPA; commonly known as "drones," unmanned aerial systems or unmanned aerial vehicles), for wildlife monitoring applications. Although RPA are widely touted as a cost-effective way to collect highquality wildlife population data, the validity of these claims is unclear. Using lifesized, replica seabird colonies containing a known number of fake birds, we assessed the accuracy of RPAfacilitated wildlife population monitoring compared to the traditional groundbased counting method. The task for both approaches was to count the number of fake birds in each of 10 replica seabird colonies. We show that RPA-derived data are, on average, between 43% and 96% more accurate than the traditional ground-based data collection method. We also demonstrate that counts from this remotely sensed imagery can be semi-automated with a high degree of accuracy. The increased accuracy and increased precision of RPA-derived wildlife monitoring data provides greater statistical power to detect fine-scale population fluctuations allowing for more informed and proactive ecological management.

Paper Number: 329

Poster Board: 18

The IUCN Vulnerable Bornean Ironwood faces double whammy of dispersal limitation and seedling herbivory

Lan Qie, Imperial College London

The Bornean Ironwood (*Eusideroxylon zwageri*) is a highly valuable timber species distributed mainly in Borneo and Sumatra, renowned for its strength, durability and rot resistance. Due to over-exploitation and slow natural regeneration the species has been categorized as “vulnerable” by the IUCN. With no confirmed extant animal seed disperser, the Bornean Ironwood is a typical example of keystone tropical tree species facing reproduction challenges due to the loss of megafauna. We conducted spatial survey of the species across all life stages from seedlings to trees in 4-ha of old-growth forest at Maliau Basin Conservation Area, and tested the hypothesis that seedlings survival has negative density dependency. The local population showed marked shrinkage in the abundance of younger age classes and established saplings were extremely rare. Among seedlings, we observed high herbivory rate and this was found to decrease strongly with the conspecific seedling density. Evidence from this study points to a two-fold reproduction challenge faced by the Bornean Ironwood from dispersal limitation and high seedling herbivory, threatening the population viability of the species.

Paper Number: 347
Poster Board: 19

Phenotypic variation of montane and coastal populations of the Puerto Rican monarch butterfly

Mariangeli Echevarría

Introduction

Organisms must respond to unprecedented rates of climate change occurring across the world or face extinction. This response can be behavioral and include migration to track suitable habitat or it can take phenotypic forms. For species that do not migrate, phenotypic variation may play an important role in predicting organismal responses to climate change. In this study, we determined the possible effects of climate change based on phenotypic variation of montane and coastal populations of the nonmigratory monarch in Puerto Rico (*Lepidoptera: Nymphalidae Danaus plexippus portoricensis*).

Methods

Based on thermal regulation of ectothermic organisms, we expected montane populations to have larger wing area and darker wing pigmentation relative to coastal populations, reflecting the need to increase thermoregulation in cooler, darker montane habitats. We tested this hypothesis using museum collections for individuals collected in contrasting areas throughout Puerto Rico. We first digitized each specimen and processed each digital image to measure wing area and the total amount of orange and black pigmentation. The length of hindwings and forewings was also measured for each butterfly.

Results and conclusion

We found that differences in size and coloration between montane and coastal populations differed between males and females. Females did not differ in size or color across the contrasting habitat types. In contrast, males were systematically larger in coastal areas relative to females. Male wing size declined in montane habitat types making males and females similar sized, suggesting a convergence of wing size and color in cooler, darker habitats. Similar changes were observed in coloration patterns, suggesting that wing size and color are linked in thermoregulation. We discuss these results in light of possible energetic differences between males and females and differential susceptibility of male and female individuals to predicted climate change and emphasize the importance of museum collections for predicting organismal responses to ongoing and future climate change.

Paper Number: 348
Poster Board: 20

First a drought, then a hurricane: the uncertain future of the specialist frog *Eleutherodactylus portoricensis* in Puerto Rico

Coralys Vicéns-López

Climatic disturbances are major forces regulating the population dynamics of terrestrial fauna, particularly amphibians. In Puerto Rico (PR), a severe drought occurred between 2015 and 2016, which would have profound consequences for our amphibians. The Puerto Rican Mountain Coquí, *Eleutherodactylus portoricensis* (28-37mm SVL), is an anuran classified Endangered by the IUCN. It is adapted to conditions of low temperature and high humidity, conditions typical of tropical mountain-forests. We monitored the abundance of this species monthly using visual and acoustic surveys in four 4x30m transects (480m) for a 4-year period (2014 to present) in the Sierra de Cayey, PR. The main objective of this study is to examine the influence of this drought on the species' population dynamics. We conducted a literature review and contrasted the number of days with less than the minimum rainfall required to avoid hydric stress for this species of frog. We collected data on rainfall from our study site from June 2014 to present, which covered the period of this drought, and contrasted the deficit in rainfall compared to the historic deficit in rainfall (50-years of data for the region). We used the mean abundance of adults and recently-hatched/small-sized juveniles (<10mm SVL) to examine their relationship with rainfall at our study site. Under laboratory conditions, hatchlings reach adulthood in 22 months, and we use this estimate to examine the influence of this drought on recruitment.

Similar to other *Eleutherodactylus*, the abundance of adults and juveniles increases during months with more rainfall and higher temperature, and decreases during months with lower temperature and less rainfall. Compared to historic deficits, 13 months exceeded the total number of days resulting in hydric stress at our study site. Specifically, between 2014-2015 (425 days of drought), 91.5% of the time consisted of days with rainfall below the threshold to avoid hydric stress in this species. The abundance of juveniles decreased with increases in rainfall deficit ($r=-0.5527$, $p<0.0004$, $n=37$), and correlated with a decrease in the abundance of adults 22 months later ($r=0.5555$, $p<0.0073$, $n=22$). Currently, the population fluctuation remains within after-drought values, which suggest that decreases in the abundance of this species have been halted, presumably indicative of short-term resilience. Unfortunately, Hurricane María stroke PR in September 2017, devastated our study-site, and generated microclimate conditions typical of lowland areas. We continue the monitoring of this population to find the consequences of these sequential climatic-disturbances on the persistence of this species.

Paper Number: 351
Poster Board: 21

Pollination guilds of aroids (Araceae) at Mulu National Park

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The aroid flora of Borneo is one of the richest on the planet, comprising at least 800 species with many highly localized endemics. Not surprisingly, most of our knowledge of these taxa is limited to naming taxonomic novelties but beyond this, our knowledge remains poor. Therefore, data for the pollination biology of Bornean aroids are still very meager. Previous pollination research on aroid taxa on Borneo, revealed four pollination guilds: Coleoptera: Chrysomelidae, Nitidulidae, Staphylinidae, and Diptera: Drosophilidae. Floral morphologies, such as the presence of floral chamber, occurrence of 'sacrificial' sterile flowers and flower parts, timing of floral activity, control access of insect visitors to various aroids. This study was conducted at Gunung Mulu National Park which harbours at least 90 aroid taxa. This study aimed to determine efficient pollinators of 20 selected aroids belonging to Schismatoglottideae (four genera: Schismatoglottis, Bucephalandra, Burtianthus, and Gamogyne), Alocasia, Amorphophallus, Anadendrum, Homalomena, Lasia, and Pothos. Extensive field observations on floral biology including time lapse images of floral development stages, flowering mechanism, floral traits and rewards, insect visitors and their behaviour(s) were carried out. The outcomes of this study are: (1) Drosophilidae flies are the most possible pollinators for Schismatoglottideae, Alocasia, Aglaonema and Pothos; (2) Nitidulidae beetles are secondary pollinators for Schismatoglottideae; (3) Paratasia beetles are the pollinators of Homalomena; (4) thrips (Thripidae) are the pollinators of Anadendrum; (5) Staphylinidae beetles are the pollinators of Anadendrum, Amorphophallus and Lasia. Anthetic period of Schismatoglottideae, Homalomena, Alocasia and Aglaonema was completed within two days while Anadendrum completed anthesis within 3 days. Lasia spinosa and Pothos insignis had longer anthetic period, 8 days and 10 days respectively. All investigated aroids emitted floral odour during female anthesis (some species extended odour production until male anthesis), produced stigma secretion, and provided mating sites for pollinators. Post-mating isolating barriers among syntopically co-flowering Schismatoglottideae and Homalomena exist as some taxa share the same visiting insects.

Paper Number: 360
Poster Board: 22

Biofabricated silver nanoparticles as nano-warrior against phytopathogens

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Stenotrophomonas sp. is emerging as a popular microbe of global concern with various potential ecological roles. Biosynthesis of gold and silver nanoparticles (AgNPs) using this bacterial strain has shown promising applications in life sciences. However, there is no report on efficient agricultural applications of biosynthesized AgNPs using *Stenotrophomonas* sp. In this regard, successful biosynthesis of AgNPs using *Stenotrophomonas* sp. BHU-S7 (MTCC 5978) was monitored by Uv-visible spectrum showing surface plasmon resonance (SPR) peak at 440 nm. The biosynthesized AgNPs were spherical with an average mean size of ~12 nm. The antifungal efficacy of biosynthesized AgNPs was observed against foliar and soil-borne phytopathogens such as *Alternaria*, *Curvularia* and *Bipolaris* sp.. The inhibitory impact of AgNPs (2, 4, 10 µg/ml) on conidial germination was recorded under in vitro conditions. Interestingly, sclerotia of *Sclerotium rolfsii* exposed to AgNPs failed to germinate on PDA medium and in soil system. Moreover, AgNPs treatment successfully managed collar rot of chickpea caused by *S. rolfsii* under greenhouse conditions. The reduced sclerotia germination, phenolic acids induction, altered lignification and H₂O₂ production was observed to be the probable mechanisms providing protection to chickpea against *S. rolfsii*. Our data revealed that AgNPs treated plants are better equipped to cope with pathogen challenge pointing towards their robust applications in plant disease management.

Paper Number: 363
Poster Board: 23

Pollination: A missing link to sustainable oil palm agroecology?

Kevin Li*, Barbara Saintes, Ingo Grass, Teja Tschardtke

Oil palm (*Elaeis guineensis*) is an economically important oil crop with potentially devastating impacts on biodiversity and conservation in the tropics. Expansion of areas under oil palm cultivation in Southeast Asia is a major factor in deforestation and biodiversity loss. Despite the significance of this crop, the ecology of its pollinators is not well understood, though such information could help mitigate deforestation through improving yield gaps and identifying important pollination services that depend on natural habitats. In order to identify knowledge gaps, we conducted a review of original literature in the Web of Science using search terms ('oil palm' OR *Elaeis*) AND (pollinat* OR *Elaidobious*). Here, we present a summary of the published knowledge collected from our review and suggest potential subsequent directions for research. We find that the topic has had relatively few publications since the initial discovery in the late 1970s that weevils (*Elaidobious* sp.) play a role in oil palm pollination. Though yield has improved since the species *Elaidobious kamerunicus* was introduced in oil palm plantations outside of Africa, reliance on this species as the only pollinator in introduced regions may eventually be problematic, as *E. kamerunicus* populations have fluctuated unpredictably in some areas. Understanding the genetic diversity of introduced weevil populations and optimizing palm sex ratio and spatial arrangement are potential, yet under-explored, avenues of research that could help address this issue. In addition, though pollinator complementarity exists in Africa due to multiple pollinating species, whether this can be achieved outside the palm's native range, through introducing additional weevil species or promoting pollination by local species, is also an area that warrants further research. In particular, very little work has been done in identifying or quantifying the contributions of locally native pollinators of oil palm. Ultimately, a stronger understanding of how pollinators affect the productivity and stability of oil palm yield contributes to the development of a more sustainable model of palm oil agriculture, one that values ecosystem services gained from biodiversity conservation while also improving a source of livelihood for smallholder farmers.

Paper Number: 373
Poster Board: 24

A Rapid Assessment of Online Wildlife Trade in Sabah using Facebook

Dairysia Anthony Yukin

Wildlife trade in Sabah has gone from conventional way which local market trade to social media platform called as online trade because of the advancement of the technology. Undeniable, this platform can reach wide user which have same interest on wildlife from WeChat, WhatsApp, Instagram as well as Facebook. In Wildlife Conservation Enactment 1997, it is illegal to sell wildlife without permit from Sabah Wildlife Department which listed in three schedules. However, there is no explanation on proper procedure to sell the wildlife but selling in local market is legal if there is a permit and license from both agencies which Sabah Wildlife Department and District Council. Therefore, there is a need to review the Wildlife Conservation Enactment 1997 because of the grey area on online wildlife trade to make it clear for the authorised officer, seller and buyer. Thus, an evaluability assessment is done to examine the prevalence of the advertisement on offering wildlife in the popular social media site, Facebook. The assessment divides the wildlife according to class of the animals; mammals, reptiles, and birds to indicate species listed in Wildlife Conservation Enactment 1997, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and IUCN Red List of Threatened Species. Using online trade monitoring between July 2017 and December 2017, the result of the analysis assessment founds the majority of the advertisements offered live bird as pets which is songbird species and mostly listed in Wildlife Conservation Enactment 1997. The collated finding is used to make decision by related agencies especially Sabah Wildlife Department to clarify the enactment and collaborate with Facebook or Malaysian Communications and Multimedia Commission to figure out on solving the issues on online wildlife trade that has become rampant.

Paper Number: 383
Poster Board: 25

Conservation mapping of butterfly distributions for increased reserve protection in Sabah

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Introduction: The rainforests of Sabah are among the most biologically diverse in the tropics and support exceptional concentrations of species richness and endemism, including many IUCN critically endangered species. The Sabah Government has pledged to increase the extent of protected areas from the current 23% of land area to 30%, safeguarding nearly one million acres of rainforest. To implement this initiative, we are providing information on optimal locations to place new protected areas, integrating information on biodiversity, land use and rainforest connectivity. In order to do this, we are currently mapping endemic butterflies.

Objective: To collate existing distribution data and map endemic butterflies in Sabah.

Methods: Using data from museum collections and published records, we obtained records for butterflies on Borneo post 1950. We used species distribution modelling of 77 endemic and Sundaland-restricted butterfly species (Papilionidae, Pieridae, Nymphalidae) across Borneo (2278 locality records; 289 different sampling localities), to predict the potential distributions of these species based on five Worldclim environmental variables (related to temperature and precipitation). We used an ensemble modelling approach (R; biomod2 package) and combined projections from three different algorithms (Maximum Entropy Modelling (MAXENT), Generalized Linear Modelling (GLM) and a Random Forest model (RF)) to create the final species maps, and we determined the most important environmental variables to affect model predictions.

Results: We produced useful models (AUC > 0.7) for all our study species, and found that rainfall variables were the most important predictors of distributions. We overlaid distributions of the 77 species to create a richness map reflecting conservation priority areas for endemic and restricted-range butterflies. We highlighted areas of high richness that do not currently fall within protected areas, and this information will be used to inform our recommendations of new areas to protect.

Conclusions & Implications: We will incorporate our results into reserve design software (R; Priorizr package), along with data from other taxonomic groups (mammals, birds, amphibians and plants) in order to prioritize remaining areas of rainforest for increased protection. Sabah's remaining forests are under threat from continued timber extraction and oil palm expansion, and our study will help identify important areas of rainforest to conserve, and ensure that biodiversity losses are minimized in future.

Paper Number: 405
Poster Board: 26

Growing Pains: Expanding Eucalyptus Plantations and Native Afromontane Forest Cover in Ethiopia's Northern Highlands

David Ferguson

Background: In the Northern Highlands of Ethiopia land-use changes have consequences for locals that range from availability of food to earning potential to protection of sacred sites and native biodiversity. Across this region most of the remaining native Afromontane forest cover is found in isolated patches of forest surrounding Ethiopian Orthodox churches. These “church forests” have faced increasing pressure from land-use decisions that support the livelihoods of Ethiopia's growing population but may degrade the environment. As one example in recent decades, the planting of cash crop species including *Eucalyptus* spp. – a valuable source of fuelwood, construction materials, and income for rural households – has become common in church forest groves. The goal of our study is to understand the extent of eucalyptus planting in and directly bordering church forests in the South Gondar Administrative Zone. **Methods:** This research combines modern-day high-resolution satellite imagery (drawn from Google Earth and Bing Maps) with geo-referenced 1960s imagery (drawn from declassified Cold-War era U.S. spy plane imagery) to identify changes over time in the extent of indigenous church forest vegetation and exotic eucalyptus plantations, along with other changes in land uses within and immediately surrounding (500m) current church forest boundaries. These data allow us to analyze changes in the area of eucalyptus over time, as well as what land uses present-day eucalyptus plantations have displaced (i.e., native forests, previously cleared land). **Results:** We find that eucalyptus is present in 25% of the more than 5,000 church forests in the South Gondar region, with some church forests made up entirely of eucalyptus. Eucalyptus is most likely to be planted in church forests that are: 1) closer to towns, 2) have a greater share of cropland (rather than pasture or forestland) in the immediate surroundings, 3) have lower livestock density, and 4) higher rural population density. Preliminary analyses of church forest cover changes over time suggest that in almost 80% of the forests, eucalyptus plantations displaced previously cleared land (rather than replacing forest cover). **Implications:** This study compliments existing studies on eucalyptus in Ethiopia, while creating a dataset that can serve as a building block for future studies that can shed light on the factors driving expanded planting. Furthermore, future work could help inform local decision-making surrounding where further eucalyptus plantations might offer net benefits to communities, and where agricultural land and indigenous forest might warrant conservation

Paper Number: 424
Poster Board: 27

Herbivory And Diversity Of Follicolous Lichens On Five Species Of Commonly Planted Dipterocarps In Inikea Rehabilitation Forest Project Area

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Impact of herbivory on the growth and survival of dipterocarps in tropical rainforest varies markedly on competition between plant species, quality of leaf type, chemical emitted by the leaves and leaf cover. The relationship between herbivory and diversity of follicolous lichen on the leaf surface is important due to the extent of lichen colonization in tropical rainforest. In addition, follicolous lichens are also unique due to their fast colonization and ability to reduce leaves ability to absorb sunlight. Due to their possible impact on the plant growth, this study was aimed to determine the diversity of lichen, leaf cover and their chemical finger print, in five species of dipterocarps in “Species Plot” at INIKEA Luasong. The five species are *Dipterocarpus conformis* (KBK), *Dryobalanops keithii* (KPG), *Dryobalanops lanceolate* (KPJ), *Shorea fallax* (SDK) and *Shorea ovalis* (SKE). To date, a total of 28 species of follicolous lichens from 8 families and 16 genera have been identified and described from 5 species of dipterocarps. Lichen cover and leaf loss was quantified using scanner and BioLeaf software analysis. It was significantly shown that in *Dipterocarpus conformis*, *Shorea fallax*, and *Shorea ovalis*; low lichen cover correlates with low leaf loss. While in the other two species, *Dryobalanops keithii* and *Dryobalanops lanceolate*, there were no significant differences. We have analysed the leaf chemicals and the fingerprint of lichen chemicals to suggest the effects and role of leaf structure and leaf chemicals in repelling the herbivores. In addition, we are also analysing the Volatile Organic Chemicals that are emitted by these dipterocarps and their possible correlation of herbivory. This investigation has shed some light on the impact of follicolous lichens on the leaf chemistry and leaf herbivory in five species of dipterocarps at “Species Plot”, INIKEA, Luasong.

Paper Number: 425
Poster Board: 28

Floral Biology of Two *Tacca* spp. (Taccaceae) in West Sarawak

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Tacca, a genus of 25 accepted species, has a pantropical distribution with most of the species native to tropical Asia. Despite the peculiar appearance of its inflorescence, only a few detailed floral studies were carried out. *Tacca* species were reported to attract flies (Order: Diptera) with its dark-coloured, extravagant floral display for cross pollination. This study focused on investigating the functions of floral structures, pollination strategies and pollinator activities of *Tacca* spp. in Kuching, West Sarawak. Two species, namely *Tacca laevis* Roxb. and *T. reducta* P.C.Boyce & S.Julia were included in this study. Populations of *Tacca laevis* and *T. reducta* located at Kampung Segong, Bau and Ranchan Recreational Park, Serian respectively were studied. Preliminary observations such as flowering duration, anthetic period, floral odour, and presence of insect visitors were recorded. The functions of bracts and bracteoles on attracting insects were examined through field manipulation experiments by comparing differences in fruiting with/without of these floral structures. For controlled pollination experiments of *Tacca*, three treatments were applied: open pollination as control, artificial self-pollination, and artificial cross pollination in their natural habitat. From our observations, individual flower lasts for one day, and the anthetic period of the inflorescence is dependent on the number of flowers developed with *T. laevis* about 4 to 7 days, and *T. reducta* about 3 to 5 days. Individuals of gnats (Order: Diptera: Ceratopogonidae) were observed to approach the flowers of both species. Removal of bracts and bracteoles in *T. reducta* showed significant difference in seed set ($t = 2.31$, $t_{crit} = 1.99$, $\alpha = 0.05$, $p = 0.029$) but not fruit set ($t = 1.98$, $t_{crit} = 2.02$, $\alpha = 0.05$, $p = 0.055$). For *T. laevis*, all controls had 100% fruit set, but the removal of their bract and bracteoles halved the fruit set (51.1%). Seed set in this experiment also differed significantly ($t = 2.42$, $t_{crit} = 2.01$, $\alpha = 0.05$, $p = 0.039$). Thus, floral bracts and bracteoles aid in pollination of *T. laevis* and *T. reducta*. Moreover, pollen:ovule (P:O) ratios of both species are ca. 76; suggesting their ability to perform facultative autogamous fertilization. Our results concluded that *T. laevis* and *T. reducta* developed a mixed reproductive system whereby they are both self-compatible and outcross.

Paper Number: 426

Poster Board: 29

The effect of mimicry frequency on natural predation in a Batesian mimicry system

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Batesian mimicry, in which palatable species resemble unpalatable ones in order to avoid predation, is a classic example of natural selection. In Batesian mimicry systems, an increased frequency of mimics may increase the mortality of the models and mimics. However, the relationship between mimic frequencies and predation remains poorly understood. Predator psychology models predict that the prey will be attacked in proportion to the frequency of mimics in the population. This means there should be a linear relationship between mimic frequency and predation rate. However, previous studies' results are equivocal as to the nature of this relationship. Therefore, we conducted an experiment using mealworms associated with colored backgrounds with different frequencies of mimics. We were able to manipulate the prey unpalatability by injecting them with quinine sulfate (unpalatable prey) or water (palatable prey). These different prey types were mounted on different colored backgrounds, and used to conduct a large-scale field experiment in Nanning, China. We chose six sites in public green spaces in Nanning and at each site we had a different frequency of mimics (0%, 20%, 40%, 60%, 80%, and 100%). Each day for 4 consecutive days we released 200 prey, half of which were palatable and the other half model-mimics. We measured the proportion of fully consumed prey as well as those partially consumed. The relationship between predation rate and mimic frequency resembled a S-shaped curve, with predation rising dramatically between 40% and 60% mimicry. Partially consumed prey were much less frequent when mimics represented 80% and 100% of the population. Therefore, our results suggest that birds dramatically changed their attack strategy over a certain threshold of mimic frequency.

Paper Number: 431

Poster Board: 30

Impacts of habitat fragmentation on plant-frugivores mutualistic networks

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Mutualistic interactions among multiple species, such as plant-frugivore interactions, are vital for maintaining biodiversity and ecosystem stability. Unfortunately, continual increases of anthropogenic pressures, such habitat degradation, can put such interactions at a high risk of disruption, threatening the survival and persistence of both interacting species. Here, we examined how the structure of plant-frugivore networks may be affected by edge effects in fragmented habitats. We collected data on animal visiting fruiting trees, obtained from direct observations of fruiting trees of 9 species in the community coupled with data from camera traps, in forest edge and interior habitats in the rainforests of the Complex Torotorofotsy-Ihoha, in eastern part of Madagascar. Our data suggest that habitat fragmentation may affect the structure of plant-frugivore networks in this area by changing the composition of interacting species. While there are more interactions in forest edge vs interior overall, the observed patterns in the forest edge habitats were mostly driven by the interactions of plants with small-sized frugivores, such as *Microcebus* spp and bird species. Larger frugivores were only observed in the interior habitats. These network patterns could have serious impacts on the diversity and structure of plant communities in the edge habitats. Given the high frugivory network in forest edge, there is an urgent need to focus more on conservation actions toward edge habitats to ensure the continuation of the interactions.

Paper Number: 432
Poster Board: 31

Crop cover, field margins, and crop heterogeneity influence the biodiversity of herbaceous plants in a tropical agricultural landscape of southern China

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Although agricultural lands hold a small fraction of the biodiversity of natural ecosystems, their sheer size and proximity to remaining natural habitats make them an important target for biodiversity conservation. Non-crop areas, including remnant natural habitats and field margins, clearly increase biodiversity in agricultural areas, but the importance of cropland heterogeneity (particularly the number of crop types) is more controversial. Greater knowledge is also needed about agroecosystems in tropical biodiverse areas where there are more, smaller-scale farms. We laid out a network of 73 sites in an agricultural area of 50 km² near Nanning, Guangxi Province; here rice and sugarcane are the major crops, but we encountered a total of 45 less dominant kinds of crops. At each site we measured the diversity of herbaceous plants in four to six 1m² plots during two summers (2016-2017), relating the plant biodiversity, and the percentage of native and animal-dispersed species to the extent of agricultural cover, length of field margins and crop heterogeneity measured within a 100 m radius area (local scale), and another measure of agricultural cover within a 500 m-radius area (landscape scale). We found that agricultural cover at the local scale was associated with lower Shannon-Wiener diversity of herbaceous plants and a lower percentage of animal dispersed species in both years, and a lower percentage of native species in one year. The length of field margins had the opposite pattern: margins were related with increasing diversity in both years and an increasing percentage of animal-dispersed species in one year. Crop heterogeneity showed a mixed pattern: it was associated with increased diversity in one year, but in both years it was linked with a decreased percentage of animal-dispersed species and native species. Our results confirm that the protection of field margins is as important for herbaceous plant biodiversity in this tropical landscape as it is elsewhere. Crop heterogeneity in our site, however, may increase farmers' disturbance to agroecosystems, at the same time as providing more niches for herbaceous plants to persist.

Paper Number: 433
Poster Board: 32

Population Dynamics of Selected Mammalian Species in Calauit Safari Park, Busuanga, Palawan

Arlene Talaña

Population viability analysis (PVA) entails the assessment of populations' capacity for survival, making it an important aspect of wildlife management and conservation. The Philippines, despite its rich biodiversity and high propensity for biodiversity loss, is lagging behind on population dynamics studies. This called for the attempt to conduct a population viability analysis from already available data in the country. The Calauit Safari Park, a wildlife sanctuary located in the Calauit Island in northeastern Palawan, was established in 1977 to house large African mammals together with local fauna. African mammal and Calamian deer populations inhabiting this site were chosen for the study as they are closed populations monitored by the Palawan Council for Sustainable Development (PCSD) and years' worth of data on these populations can be readily obtained from their office. Data obtained from the PCSD was reinforced by interviews with the personnel of the park and PVA was done in VORTEX 10 with parameters derived from the results of the interview. Out of the eight African mammal species initially brought to the park during its establishment, only three have survived up to this date - the giraffe, zebra, and bushbuck. There are currently 22 giraffes in the island with 10 males and 12 females. Only two of the females are reproductively viable. The PVA revealed a gradual decrease in the giraffe population over the next 100 years. A drastic decrease in the Calamian deer population was also observed over the past few years. Major threats to these populations have been identified to be conflict with humans and the declining quality of park management due to financial limitations. Hunting for meat and agricultural fencing of human settlements in the island had substantial contributions to the decline in these populations and the extirpation of the other African mammals. Inbreeding depression might also contribute to the decrease in these populations; however, studies on its effects on the mammals of Calauit Safari Park have not been done yet. These data can steer the creation of management policies and revision of existing ones for a more efficient administration of the park. Regular biodiversity assessments, including extensive population monitoring with corresponding data analysis, is much needed by conservation programs especially in biodiversity hotspots such as the Philippines, in order to evaluate negative anthropogenic impacts on the environment and readily mitigate them as necessary.

Paper Number: 444
Poster Board: 33

Pollinator conservation and pollination services for promoting cocoa yields

Manuel Toledo-Hernández

Cocoa (*Theobroma cacao* L.) is a cross-pollinated plant that is dependent on insect pollination. Despite this plant-pollinator dependency and the large economic value of cocoa, there are still important knowledge gaps in the identity of flower visitors, plantation management to enhance their habitats, and overall potential of pollination services to improve cocoa yields. Building on our systematic review of cocoa pollinators, we investigated the effect of distance to natural forest, shade canopy cover, and litter management (i.e. tons/ha of soil litter) on flower visitation rate, diversity, and abundance of insects on 6450 flowers from 216 trees in Central Sulawesi, Indonesia. We also conducted a large scale hand pollination experiment on 128 cocoa trees to contrast the effect of pollination and chemical intensification on yields. Our preliminary results show that many insect groups, in particular small dipterans, parasitic wasps, and ants are potential pollinator agents, and that increased shade canopy cover, but not forest distance or soil litter thickness, enhances pollinator diversity and abundance. Further, our large hand pollination experiment indicates that pollination intensification is a major contributor to enhancing fruit set, fruits harvested, and dry cocoa weight (up to 60 %), in contrast to intensification with fertilizer and insecticide use. We conclude that management adjustments in shade canopy cover provide suitable habitats for pollinators, enhancing flower visitation, and pollination success. Thus, pollinator habitats under shade trees should be identified and promoted in ecological intensification strategies to improve yields while preserving biodiversity and mitigating the predicted climatic risk on the cocoa sector.

Paper Number: 449
Poster Board: 34

Trait response of six dung beetle (Scarabaeidae: Scarabaeinae) species to the local extinctions of megafauna

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The extinction of megafauna may lead to the trophic collapse of ecosystems that depend on the dung that they produce. While some dung beetle species can survive this change in resource availability, they may undergo phenotypic changes caused by this new environment. The pronotal width of dung beetles is a trait that can be used as a proxy measure for the amount of dung provisioned during the larval stage. Pronotal width is therefore susceptible to changes in resource availability. In this study, we compare the intraspecific difference in pronotal widths of dung beetles in forests with and without megafauna. Six species with a total sample size of 409 beetles were measured, with a minimum sample size of 55 beetles per species. Medians were compared using a Mann-Whitney test, while means were compared using bootstrapped 95% confidence intervals. There was no significant difference between intraspecific pronotal widths of four species; *Onthophagus babirusa*, *O. vulpes*, *Yvescambefortius sarawacus* and *Copris doriae*. There was a significant difference in pronotal widths of *Liatongus femoratus*, in which absence of megafauna resulted in larger widths. There was also a significant difference for pronotal widths of *Oniticellus tessellatus*, where the absence of megafauna resulted in smaller widths. We believe that higher competition may be selecting for wider pronotums in *L. femoratus* as wider pronotums have been correlated with higher tunneling performance. In *O. tessellatus* the smaller pronotums are possibly caused by the loss of breeding resources. Both these species belong to genera that are known to have a close association with large herbivorous mammals. The other species are likely to be generalist feeders that can use many types of dung or have a preference for the dung of omnivorous mammals such as wild boar or monkeys. This risk spreading behaviour allows some dung beetle species in Southeast Asia to withstand resource deprivation caused by the loss of megafauna. Dung beetles with an association to megafauna however undergo phenotypic changes to adapt to the loss of resources.

Paper Number: 460
Poster Board: 35

Quality Of Wildlife Trails And Camera-Trapping Assessment Of Ground-Dwelling Mammals And Birds In Inikea Forest Rehabilitation Project

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INIKEA Rehabilitation of Degraded Forest Project (INIKEA) situated in the southeast of Sabah in the Kalabakan Forest Reserve is aimed to rehabilitate degraded logged forest and enhance recovery of forests that was engulfed in fire due to prolonged drought caused by El-Nino event (1982-83). This investigation delves upon the effectiveness of three different enrichment planting, 1) Line, 2) Gap Cluster, and Liberation, at Phase I which was replanted in 2003. Biodiversity rebound was evaluated based on the distribution and abundance of ground-dwelling mammals and birds using camera trap data. A total of 27 camera-traps were deployed randomly in Phase I of enrichment planting in INIKEA. The total of 2 185 independent photograph of ground-dwelling mammals and birds yielded from 1 188 camera-trap nights, represented by 23 species in 12 families and five orders. This data was compared to the data obtained from Phase IV that served as a controlled site. The species that were successfully photo capture including the common species that were photo captured the most such as sambar deer, bearded pig, mousedeer, muntjac and pig-tailed macaque. The four rare and elusive species of Borneo's wild cat such as Bornean clouded leopard, marbled cat, bay cat and leopard cat were also successfully detected. Upon statistical analysis, data shows a difference in quality of wildlife trails and their inhabitants between the forest types. The results indicate that INIKEA has successfully regenerated after 15 years of rehabilitation, where most of the area were inhabited by many wildlife species from the common to the rare species. It is suggesting that the forest rehabilitation project plays a vital role in protecting the habitat to many wildlife species as well as maintaining their population.

Paper Number: 462
Poster Board: 36

Functional Ecology Of Amphibian Species At Sg. Moyog Water Actchment Area, Penampang

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Amphibians are regarded as the most extinct danger species around the world, particularly in the tropics. The causative factors are still being debated but rapid development and fast changing environmental factors seems to be some of the attributing causes. In this investigation, Sg. Moyog Water Catchment Area was chosen since there are fast growing settlements in its vicinity. In this study, three approach was used; (1) Geographical Data Regeneration using Geographic Information System (GIS), (2) Environmental Conditions Data (VEGAN, R Package), (3) Create Indicator Species Distribution Map (SDMs)(MaXent). Concentrate of human development is around river and low land and were classified to be 38%. A total of 334 individual and 21 anuran species were collected, among them 7 species were not listed in International Union for Conservation of Nature and Natural Resources (IUCN) report. The bio-community was analyzed by Non-Metric Multi-Dimensional Scaling (NMDS) and PERMANOVA were used to clarification the environmental correlation and similarity. As result, there was a significant difference in bio-community structure from 4 landscapes (R²: 48.59%). Additionally, the several same indicator types were calculated from the result of statistics (2 sites 6 indicators) and individual sampling (3 site 5 indicators) by using Indic-species package in R to confirm the current indicator species. Data shows that anurans bio-community is affected by landscape. However, the species inhabituating around forest and plantation were formed similarity community. Thus, environmental change in large scale, we concluded it has strongly reduces the fitness of amphibians and fall into species extinction due to survival competition in Sg Moyog Water Catchment Area.

Paper Number: 464
Poster Board: 37

Modeling Habitat Preferences of Crestless Fireback (*Lophura erythrophthalma*) in Riau Ecosystem Restoration (RER) Kampar Peninsula, using Maximum Entropy Modeling

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The vulnerable Crestless Fireback (*Lophura erythrophthalma*) distribution in Sumatra is limited and the habitat preference for this species is lacking. A series of surveys was conducted in Riau Ecosystem Restoration (RER) concessions (ca. 90,000 ha) in Kampar Peninsula, Riau Province to investigate the distribution of Crestless Fireback in peat swamp forest ecosystem in Sumatra. Point count, visual encountered survey (VES), and capture-recapture methods using camera trap were used in this study from April to October 2015. The maximum entropy technique (Maxent) was used to model the species habitat using environmental variables consisted of canal distance, peat depth, distance to the edge of the forest, and the bird's position to the main road.

Our findings suggest that the distance to canal and the distance to forest-edge influence preference habitat of 23.3% and 20.8% respectively with a probable number found over 0.5 at a distance of less than 3 km from the canal and also at a distance of between 1 km until 4 km from the forest-edge. we can conclude if this species tends to approach the water resource. These findings hopefully will contribute more on the peatland management plan with special needs for the habitat preferences endangered bird species.

Paper Number: 468
Poster Board: 38

Community phylogeny and niche divergence of a tropical rain forest in Borneo

Seiya Okuno

Introduction: Exploring patterns in community niche structure is an effective way to clarify the species assembly process from regional species pool to a local community. For this, we need a detailed community phylogeny and niche of each species in the local community. Here, we constructed a community phylogeny of the trees of a tropical rain forest in Borneo and investigated the patterns of phylogenetic niche structure.

Methods: The community phylogeny was estimated based on the sequence of chloroplast DNA. We evaluated three niches (life-form, demography, and habitat niches) for each species. The niche indices were calculated using 15-year demographic data of trees in a 50 ha forest dynamics plot at Lambir. The maximum diameter was used as a life-form niche. Mortality, growth, and recruitment rates were used as demographic niches. The average value of soil and topography indices of individual trees was used as a habitat niche. We analyzed the phylogenetic signal and diversification pattern of each niche by using the disparity-through-time plot. In addition, we analyzed the diversification patterns of Dipterocarpaceae and Myrtaceae, which respectively included the genera *Shorea* and *Syzygium* comprising many closely related sympatric species. Further, we compared the results with those of other families as well as the whole community.

Result & Discussion: Phylogenetic signal was the strongest in life-form niche and the weakest in habitat niche. The disparity of habitat niche was nearly constant during the evolutionary period, suggesting relatively constant and similar niche diversification in all lineages. The disparities of life-form and demographic niches decreased continuously with time. However, in contrast to life-form niche, the disparity of demographic niche increased after 10 Ma, suggesting that the demographic niche diverged in this period. This diversification might have been related to the climate change caused by a decrease in the global temperature after 10 Ma. Compared to other families, Dipterocarpaceae showed a higher demographic niche diversity. Myrtaceae did not show high demographic niche diversity, but the closely related species tended to have more different demographic niches than the phylogenetically distant species.

Conclusion: This study suggested habitat niche continuously diverged in all lineages and that demographic niche diverged relatively recently in lineages, in which many species evolved during the recent 10 Ma. These results suggest that, in addition to the habitat niche divergence, divergence of demographic niche may be especially important for the coexistence of closely related species of highly diverse genera such as *Shorea* and *Syzygium*.

Paper Number: 470
Poster Board: 39

Epiphytes and their hosts: predictors in Wallacea

Robin Hayward

Epiphytes are important components of the tropical rain forest ecosystem, providing food, shelter, and water resources for a wide range of taxa. However, we know relatively little about them in many areas due to the challenges of accessing their habitat in the canopy. While epiphytes are common throughout the tropics, much of their ecology remains poorly explored outside of the neotropics. Here, we aim to examine the relationships between vascular epiphytes and their hosts, in a palaeotropical context, to determine if the same predictors hold true as have been revealed elsewhere. To do this, 44 host trees (dbh 25-288 cm) were climbed at two sites of differing disturbance on Buton Island, Indonesia. For each, epiphyte richness and host above-ground biomass, altitude, bark texture, crown area, emergence, and exposure were recorded and explored using Gaussian generalised linear models. Models reveal that significant predictors ($P < 0.01$) of epiphyte species richness were host above-ground biomass (20.9%), crown area (19.6%), and disturbance (15.5%). This allows us to extend more confidently our knowledge of epiphyte-host relationships to inform forest management throughout tropics and recommend conservation of large, broad-crowned trees, away from continued logging efforts.

Paper Number: 471
Poster Board: 40

Phylogeny and ecological traits of dioecious trees in a tropical rain forest in Borneo

Itsuki Ohya

Background: The reproductive output of dioecious plant species may be limited by severe pollen limitation, narrow seed shadows, and low seed reproduction at the population level. Consequently, it is difficult to maintain populations. It is not clear how dioecious plants evolve and how they maintain their populations. However, few studies have examined the relationship between demographic traits and sex expression in plants.

Objectives: To determine the demographic and ecological traits of dioecious trees, we examined the phylogenetic relationship of sex expression at the genus level in 1173 tree species growing in a tropical rain forest in Lambir Hills National Park, Sarawak, Malaysia.

Methods: We analyzed the relationships between six demographic or ecological traits (maximum DBH [stem diameter at breast height], recruitment rate, growth rate, mortality rate, abundance, and number of species in a genus) and sex expression using phylogenetic linear regression.

Results and Discussion: The phylogenetic analysis indicated that dioecy independently evolved from hermaphrodites in several families, whereas dioecious plants had phylogenetic constraints. The analysis of the relationships between sex expression and ecological traits yielded four results. First, sympatric genera containing dioecious plants tended to have numerous species. This suggests a high species diversification rate for dioecious lineages. Second, we could not find significant differences in the recruitment, growth, and mortality rates of hermaphrodite and dioecious plants. Dioecious plants seemed to compensate for their reproductive disadvantages through demographic or ecological traits. Third, dioecious plant genera had smaller DBH and they were commonly shrubs. Because shrubs are precocious, it is possible that dioecism correlates with precocity rather than with the shrub life form per se. Finally, the genera of dioecious plants tended to be abundant, although no genus were extremely abundant. There were also a few genera that had low levels of abundance. Because the genera of dioecious plants were only moderately abundant, we postulated that it was difficult to increase the number of individuals. Dioecious plants may need a large number of individuals to maintain their populations, because populations with low levels of abundance were at a greater reproductive disadvantage.

Paper Number: 479
Poster Board: 41

Altitudinal shifts of amphibian species over 80 years on Mount Kinabalu, Borneo

Catharina Karlsson

Climate change is predicted to have major impacts on the distribution of species. Anurans present a specifically vulnerable group as they are ectothermic and are thus often unable to adapt to temperature change locally and instead need to migrate. Despite this, few data are available to test the extent to which anurans have shifted in recent decades. In this study, we used a historical dataset from 1929 on the distribution of anurans from a tropical mountain, Mount Kinabalu in Borneo, and compared these data to modern-day surveys. Of 19 species recorded in both datasets, 14 moved upwards and 5 moved downwards over 80 yr, with the average shift being 48 m upwards. The sub-sampling to site results indicate an even greater upwards shift of 72 meters. One outlier species, *Leptobrachella baluensis*, shifted downwards over 1000 m; without this species. Site species richness at low altitudes remained roughly constant over the period, whereas at mid latitudes it increased and at high altitudes it decreased. In addition, the drivers of diversity appear to have changed over time with mixed drivers in 1929 and turnover being the main driver in the modern years. This study is in line with previous research that indicates that around 25% of species move down instead of in the expected upwards direction on mountains. The results highlight the need for continuous long-term monitoring of amphibian communities and the need for further work on the effects of environmental change on community composition.

Paper Number: 482
Poster Board: 42

Effects of environmental factors on the growth of planted dipterocarp trees in a tropical rainforest restoration site in Sabah, Malaysia

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Forest restoration by enrichment planting is an important effort to improve degraded tropical forests. Diverse environment of restoration sites created by physical features, such as topography or canopy condition may affect the regeneration processes and site suitability. In this study, we investigated the relationship between various environmental factors and the growth responses of 8 Dipterocarpaceae species over 17 years after the enrichment planting at Sungai Tiagau Forest Reserve, Sabah, Malaysia. Twenty one 40 × 40 m² plots were randomly established to include the restoration planting lines and the relative growth rates for DBH and tree height of planted trees within plots were calculated. As environmental variables, we obtained terrain slope, slope aspect, elevation, light condition, and aboveground biomass of non-planted trees for each plot. Correlation analysis was then performed to understand the influences of these environmental variables on the growth rate of the planted trees. The results showed that the terrain slope was significantly correlated with the growth rate of 2 species, slope aspect with 3 species, elevation with 1 species, light condition with 3 species and aboveground biomass with 4 species, respectively. We concluded that environmental differences in enrichment sites could affect the growth of planted trees, and therefore, site suitability assessment for each tree species prior to planting would help achieve more effective forest restoration.

Paper Number: 488

Poster Board: 43

Habitat Selection and Activity Pattern of GPS Collared Sumatran Tigers

Dolly Priatna

Although translocation has been used in mitigating human-carnivores conflict for decades, few studies have been conducted on the behavioral ecology of released animals. Such information is necessary in the context of sustainable forest management. In this study we determine the type of land cover used as main habitat and examine the activity pattern of translocated tigers. Between 2008 and 2010 we captured six conflict tigers and translocated them 74-1,350 km from their capture sites in Sumatra. All tigers were fitted with global positioning system (GPS) collars. The collars were set to fix 24-48 location coordinates per day. All translocated tigers showed a preferences for a certain habitat type within their new home range, and tend to select the majority of natural land cover type within the landscape as their main habitat, but the availability of natural forest habitat within the landscape remains essential for their survival. The activity of male translocated tigers differed significantly between the six time intervals of 24 hours, and their most active periods were in the afternoon (between 14:00-18:00 hours) and in the evening (between 18:00 and 22:00 hours). Despite being preliminary, the findings of this study - which was the first such study conducted in Sumatra - highlight the conservation value of tiger translocation and provide valuable information for improving future management of conflict tigers.

Paper Number: 507

Poster Board: 44

Odonata fauna of Yunnan Province, China

Zhang Haomiao

Odonates (as known as dragonflies and damselflies) are important components of aquatic ecosystems. With their elegant appearance and superb flight skills, these ancient insects include some of the most important flagship species for conservation. As a biodiversity resource, the species richness of Odonata in China is remarkable. Over 900 species have so far been found in the country, making China the most species rich country for Odonata. Yunnan Province is located in the southwestern part of China, where the Yunnan-Guizhou Plateau merges with the Tibetan Plateau, the hotspots area of global biodiversity. Based on the on-going fieldwork between 2009-2017 to this widely unknown Odonata fauna, a total of 440 species have been recorded in the province, with a great number of new genera, new species and new records for the country, making this area one of the most important dragonfly habitats all over the world. Brief notes on the Odonata fauna of Yunnan, China as well as further information on selected species refer to their morphological characters, distribution and seasonality are summarized.

Paper Number: 525
Poster Board: 45

Connectivity of peat swamp forests in Jambi province, Sumatra, Indonesia

Eleanor Warren-Thomas

Introduction: Tropical peatlands develop under peat swamp forest ecosystems which store huge below-ground carbon stocks, and support unique and specialised flora and fauna. Peatland management is thus crucial both to global climate change mitigation efforts, and the conservation of tropical biodiversity. Indonesia contains around 47% of global tropical peatland, but peat forest cover has dramatically declined, driven by drainage and clearance to make way for industrial plantations of oil palm and pulp, and smallholder cultivation. In Sumatra, peat swamp forest covered only 19% of peatland area in 2015, much of which is degraded through selective logging, drainage, and fires. Remaining forest areas are increasingly important refugia for forest-dependent species, and restoration of peat swamp forest could increase the area of habitat available to forest-dependent species, and improve connectivity.

Objective: To assess changes in connectivity of peat swamp forest areas, identify “bottlenecks” of connectivity, and identify opportunities for restoration.

Methods: Focussing on Jambi province, Sumatra, we quantify declines in forest area and connectivity from 1990 – 2015, using incidence function models and electrical circuit theory approaches to assess connectivity. We also investigate the potential for restoration to improve forest connectivity. Targeted restoration of forest in areas known to be “bottlenecks” of connectivity between forest fragments could enhance connectivity with minimal increase in habitat area.

Results: Loss of peatland forest since 1990 through encroachment, land-use conversion and fire has had detrimental impacts on forest connectivity. We also identify “bottlenecks” and the relative effectiveness of different restoration scenarios. Our results highlight that restoration feasibility is constrained on multiple fronts, and that some scenarios are more effective than others. In addition, restoration may have dis-benefits for some local communities, that need to be balanced against benefits for biodiversity.

Conclusions & Implications: Peatland drainage and conversion to agriculture have resulted in huge emissions of carbon from degrading peat, and widespread fires that cause health and economic damage. Indonesia has recently made commitments to improve peatland management and combat degradation, with a presidential decree and subsequent regulations in 2016-17. These focus on the conservation of remaining peatland forest, and the restoration of peatland water tables, and our results provide information on where restoration will be most effective for improving connectivity.

Paper Number: 542
Poster Board: 46

Disentangling the drivers shaping the distribution of weed species in north-western Australia

Tommaso Jucker

Introduction: In Australia, weeds rank second only to climate change as the greatest threat to native biodiversity, and are a multi-billion dollar problem for agriculture. Yet our basic understanding of the distribution of weeds at appropriate scales for developing effective management solutions remains approximate at best. In large part this is because traditional sources of plant distribution data such as herbarium records tend to be spatially, temporally and taxonomically biased against weeds. Nowhere is this lack of basic data more striking than in the Pilbara bioregion of north-western Australia. As of 2014, only 804 weed occurrence records existed in herbariums for an area that spans twice the size of the United Kingdom.

Objectives: To address this lack of data, we set out to compile existing records detailing the distribution and abundance of weeds in the Pilbara in an effort to develop a comprehensive database and showcase the potential of using this type of spatial information as a management tool. As part of this effort we amassed over 285,000 georeferenced records from a wide range of data sources that represent 178 species and span across more than four decades of sampling effort.

Methods: We used these data to model the distribution of the 20 most common weed species in the Pilbara – which together make up for 99% of all weed records in the region – using Poisson Point Process Modelling (PPPM) that explicitly accounts for spatial biases in sampling effort. We then use these models to explore the key anthropogenic, climatic and natural disturbance drivers of the spatial distribution of weeds in the Pilbara.

Results and implication for weed management: We found that even after accounting for spatial sampling biases in the data, all 20 weed species were significantly more likely to be recorded near transport infrastructure and in the vicinity to populated centres. Similarly, we found a strong and consistent positive association between weeds and the presence of seasonal water bodies, while areas of the landscape characterised by persistent vegetative cover – an indicator of low natural and anthropogenic disturbance – were much less likely to harbour weeds. This included National Parks, which currently show significantly lower levels of weed infestations compared to the surrounding landscape. Together, our results highlight the value of having a comprehensive understanding of the spatial distribution of weed species if we are to improve how we tackle weed challenges in Australia and across the tropics more broadly.

Paper Number: 551

Poster Board: 47

The Functional role of leaf venation of Atlantic Forest, Brazil

Hamachi L, Carvalho FF, Bruno HB, Marabesi MA, Marchiori NM, Marinho DV, Joly CA & Aidar MPM.

Atlantic Forest is a Brazilian hotspot for conservation and located in the most populated area of Brazil, it is an important source of environmental services. Understanding the forest functionality is central in a scenario of climate change and human modified ecosystems. Leaf venation is important to plant performance, with key implications for the distribution and productivity of ecosystems, since it is linked to the leaf structure and it allows the water flow through the mesophyll granting stomatal opening and gas exchange. Leaf vein density, structural and physiological plant traits related to carbon and water metabolism were measured on forest dominant species (70% basal area) in 4 sites of Atlantic Forest, southeastern Brazil. Our data showed that major veins were mainly related to stem and leaf structural traits while minor veins correlated with leaf physiological traits. We conclude that there is a clear functional separation between major and minor veins and we suggest that leaf venation can be used as a surrogate of functionality of a tree community. This work was supported by ECOFOR project, BIOTA/FAPESP and NERC/UK.

Paper Number: 558

Poster Board: 48

Presence of *Batrachochytrium dendrobatidis* (Bd) in Amphibian Pet Trade in Puerto Rico

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The pet trade is the third largest illegal trade in the world, surpassed only by drugs and firearms, generating more than \$20 billion worldwide. Puerto Rico lacks research related to pet traffic due to the limited resources and importance given by government agencies to this issue. Although the introduction and the sale of any amphibian is illegal in this island they are one of the most popular in recent years. The global trade in amphibians is widespread, involves hundreds of species, and have been implicated in amphibian population declines. Amphibian species around the world are in crisis, with nearly one-fourth at risk of extinction. Although the causes of these declines vary, their most recent declines have been attributed to a deadly pathogenic chytridiomycete fungus, *Batrachochytrium dendrobatidis* (Bd), which causes the disease chytridiomycosis in amphibians. This newly emerged pathogen has been implicated in the decline of over 200 amphibian species worldwide. The global trade of amphibians for human consumption and as pets is suspected to have facilitated the emergence of Bd. The main objective of this study is to investigate the presence of Bd in the pet trade in Puerto Rico. Documenting the presence of this pathogen in commercial amphibians is critical to control further spread, prevent further devastation, and provide informed decisions on managing the trade of amphibians in the island. I visited 43 pet stores around Puerto Rico, the "Exotics Species Confinement Center" from the DRNA, online animal sales pages, attended to Exposition of Exotics Animals and joined 13 social media pages with the purpose of identifying amphibian sales and being able to sample some of the animals. I was given authorization from a research laboratory in which they worked with the species *Xenopus laevis* to sample some of their specimens. Bd was diagnosed via quantitative PCR in 42 individuals of 7 genera, and 9 species. From the total sample, 4% came from illegal confiscations, 19% from private collections, 24% from independent sellers, 16% from a research laboratory, and 20% from pet shop. Among those tested, there were 6 Bd-positive individuals (14%) in 4 specie. Despite the presence of Bd in these animals, all individuals appeared healthy and did not exhibit any of the symptoms associated with chytridiomycosis. It is my intention to continue this research with the purpose of increasing the number of samples and study in more detail the pet trade in Puerto Rico.

Paper Number: 564
Poster Board: 49

Including women in the conservation conversation: Environmental degradation disproportionately impacts women's livelihoods in the Amhara region of northern

Katie Brown

Forest cover and biodiversity loss in Ethiopia reduces the ecosystem services forests provide to communities, threatening rural livelihoods and undermining sustainable development goals. Environmental degradation disproportionately impacts rural women's livelihoods due to gender-specific labor burdens (e.g., water and fuelwood collection) and time poverty (e.g., travelling to collect water and fuelwood). Women's socially constructed relationship with natural resources gives them distinct knowledge surrounding local resource use due to labor burdens, yet limits their participation in management decisions due to time poverty.

Accounting for gender-specific time allocation of natural resources, our study uses household survey data collected by Ethiopian scholar Tizezew Shimekach Sisay to explore women's reports of distance travelled and time spent obtaining water and firewood. Forest degradation trends were analyzed using Landsat satellite imagery and Normalized Difference Vegetation Index (NDVI) as a proxy for forest cover in survey locations, while 80 in-person interviews were conducted using network sampling and random walk techniques. We found that women in rural areas allocate twice the amount of time and energy toward natural resource retrieval compared to women living in urban Ethiopian communities.

Conserving remaining indigenous forests in Ethiopia hinges upon actively including women in community based natural resource management decisions. As forest loss and riparian deforestation across northern Ethiopia threatens to increase the time women allocate to collecting water and fuelwood, conservation of the remaining 4.2% of these ancient forest groves is critical to sustainable development. Because women's livelihoods are directly tied to the ecosystem services forests provide, sustainable natural resource management of church forests lends itself to implementing effective solutions for conserving biodiversity that include women in adaptive management strategies.

Paper Number: 580
Poster Board: 50

Birds of the Daweishan National Nature Reserve, Yunnan province, China

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The Daweishan National Nature Reserve located in south-east of Yunnan province, China, is part of the Indo-Burma biodiversity hotspot and recognised as a high priority area for biodiversity. Between 2011 and 2013, we conducted 5 bird surveys by mist-netting and point counts, recording 195 species and, together with additional records from the literature and specimens of Kunming Natural History Museum of Zoology, compiled a total of 377 species for the Daweishan National Nature Reserves. The area provides important habitats for threatened species such as Grey Peacock Pheasant *Polyplectron bicalcaratum*, Red-breasted Parakeet *Psittacula alexandri*, Rusty-napped Pitta *Pitta oatesi*, Hooded Pitta *Pitta sordida*, Yellow-breasted Bunting *Emberiza aureola*, and Spotted Wren Babbler *Spelaornis formosus*. Although with high bird diversity, we found Daweishan's bird source was under the threats of overhunting lack of policy enforcement and habitat degradation especially in middle and lower elevation zones. We suggest that more conservation efforts should be concentrated in middle and lower-altitude areas in Daweishan National Nature Reserve, and call for strengthen management to illegal hunting.

Paper Number: 598
Poster Board: 51

Survival of Planted Trees in Response to Environmental Gradients in Tropical Rainforest Rehabilitation Site

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Large areas of tropical rainforest continue to degrade at an alarming rate, where only some of them are able to recover unaided. Restoration of these degraded forests embraces the regeneration process that can be accelerated through rehabilitation actions in improving tropical rainforest biodiversity. Survival of planted trees towards the environmental gradient such as topographic variables and forest structures alongside adaptation to restoration actions is not well understood. This research investigated the effect of environmental gradients on survival of planted trees in the restored forest areas. We used the compiled datasets of the line-planted trees from 21 plots, within Phase I areas (planted in 1998) of INIKEA Rehabilitation Project Site, Sabah, Malaysia. The planted trees from the datasets included 32 tree species, mainly Dipterocarps, fruit trees and other climax species. The survival rates of planted trees were evaluated at sub-plots level. The effects of topographical and forest structure characteristics variables including slope aspect, terrain slope, elevation, light condition and above-ground biomass towards the survival rates of planted trees were examined. The result showed a statistically significant inverse correlation between elevation gradient and survival of planted trees. This revealed that lower elevation regions had greater survival rates for planted trees compared to higher elevation regions. Considering the response of the survival to the elevation gradient, management parties could develop better strategies and planning for cost-effective rehabilitation actions in tropical forests.

Paper Number: 599
Poster Board: 52

Sex Ratio And Genetic Diversity Patterns Of *Elephas Maximus* From Selected Plots In Taman Negara National Parks, Peninsular Malaysia

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One of the long term goal of National Elephant Conservation Action Plan (NECAP) is getting a complete genetic assessment data of Asian elephant in Taman Negara National Parks (TNNP) Peninsular Malaysia and Department of Wildlife and National Parks (DWNP) were conducted 7 series of non-invasive sampling programmes in TNNP as one of the NECAP implementation. As primary move, we conducted an experiment on selected 44 Asian elephant faecal samples collected from 14 sub sampling plots in TNNP inferred by molecular sexing, nuclear and mitochondrial markers. Two types of sample preservation were used during field sampling which were FTA cards and stool containers filled with molecular grade absolute ethanol. Blood samples from 10 known *E.maximus* individuals from National Elephant Conservation Centre (NECC) Kuala Gandah Lanchang, Pahang were included as positive controls. We used 15 pairs of fluorescently labelled polymorphic microsatellite primers, a pair of mtDNA control region and 3 pairs of fluorescently labelled sexing markers in this study. Laboratory process were started from DNA extraction and 3 replicates of multiplex PCR for all three types of markers. PCR products from mitochondrial markers were purified and sent for Sanger sequencing, while PCR products from nuclear and sexing markers were sent for Fragment analysis. Fasta format raw data from fragment analysis were interpreted by using GeneMapper while data from mtDNA were interpreted using Geneious. Several genetic analysis programmes were used to calculate nucleotide diversity, haplogroups and number of females as well males among 54 samples. The final outcomes of this experiment provided valuable information on genotypes, haplotypes and sex ratio of wild *E.maximus* in the study area and the same analysis method will be applied for other collected samples to get a complete database on elephant population structure in Taman Negara National Parks Peninsular Malaysia.

Paper Number: 600

Poster Board: 53

Viburnum oliganthum Batalin (Caprifoliaceae): a new record for the flora of Vietnam

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We report *Viburnum oliganthum* Batalin (Caprifoliaceae), as a new record species in Vietnam. It was discovered in Phia Oac-Phia Den Nature Reserve in northern part of Vietnam during our investigation in 2017. The surveyed area is extended 700-2000m about sea level, as well as co-existed tropical and subtropical climate zones. It is expected that more than 1,000 plants could be distributed but its investigation was not fully studied. The genus *Viburnum* has about 200 species and those are mostly distributed in the temperate and subtropical area of Asia and South America. *V. oliganthum* is native and distributed south-central China. It has been known 12 species in Vietnam and six taxa were found in the genus including *V. oliganthum*, *V. coriaceum*, *V. cylindricum*, *V. erubescens*, *V. mullaha* and *V. sambucinum* in the surveyed area. *V. oliganthum* differs from its allied species *V. longipedunculatum* (P. S. Hsu) P. S. Hsu in having 1-2cm long, glabrous, green petiole and yellow-whitish anthers. While *V. oliganthum* has 5-15mm long, stellate-pubescent, purple petiole and purple reddish anthers. It was also distinguished with another morphologically similar species, *V. omeiense* P. S. Hsu in appearing flowers without leaves and hypocrateriform corolla whereas *V. oliganthum* in appearing flowers with leaves and funnellform corolla. It will be needed to investigate more for the conservation strategy of the species in this area.

Paper Number: 605

Poster Board: 54

Actinidia cylindrica C.F. Liang (Actinidiaceae): a new record for the flora of Vietnam

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Here, *Actinidia cylindrica* C.F. Liang is reported as a new addition to the flora of Vietnam. While flora investigation in Cao bang Province in northern Vietnam, located in subtropical and tropical climate zone near the Chinese border, we found this species that has not been reported in Vietnam. *A. cylindrica* is known as an endemic species in Guangxi, China. It has been known 7 taxa of the genus, *A. callosa* Lindl., *A. fortunatii* Finet & Gagnep., *A. fulvicoma* Hance, *A. indochinensis* Merr., *A. latifolia* (Gardner & Champ.) Merr., *A. petelotii* Diels and *A. rubricaulis* Dunn in Vietnam. *A. cylindrical* differs from its allied species, *A. callosa* in having inconspicuous lenticels, green petiole and, adaxially green lamina while *A. collosa* has conspicuous lenticels, purple petiole and adaxially blackish lamina. Also *A. cylindrica* is morphologically allied to *A. rubricauli*, but it differs due to the inconspicuous lenticels, lamellated pith and, green petioles while *A. rubricaluli* has conspicuous lenticel, solid pith and reddish petiole. The illustration, description and a key to the treated taxa of the genus in Vietnam are given.

Paper Number: 606

Poster Board: 55

Biomass and carbon stocks of non-arboreal components in a Neotropical Hotspot

Bakker, Y.V.; Padgurschi, M.C.G.; Joly, C.A.; Vieira, S.A.

Tropical Forests may have a key function in buffer the carbon dioxide (CO₂) anthropogenic emissions since it is a primary substrate for photosynthesis and may stimulate plant growth and biomass. This crucial role is the foothold for the economic incentives to help facilitate reductions from tropical deforestation and the way to calculate how much carbon (C) is storage is by estimating the aboveground biomass (AGB). Yet, data on biomass and C stocks as well as allometric models for the Atlantic Forest (AF) are lacking. Based on destructive harvest, we developed allometric models and determined the biomass and C stocks for two components that, despite their importance and greatest diversity in tropical regions, are usually forgotten: vascular epiphytes and bamboos. In three 1-ha permanent plots of the largest remnant of AF, the Serra do Mar State Park (São Paulo, Brazil), for bamboo model we collected 20 healthy culms (and divided them into compartments: culm itself, branches and leaves) and for vascular epiphyte all material of 44 phorophytes were sampled with different (a) tree canopy architecture and DBH and (b) epiphyte cover index (ECI) (which classifies individual trees according to the size and cover of the epiphytes). The collected materials were dried to obtain the dry weight and the C stocks were determined by multiplying the AGB by carbon concentration from literature data (45% for bamboos; 44% for vascular epiphytes). The culm diameter at breast height (DBH_c = 1.3 m) for bamboos; and the host tree DBH, height and ECI for vascular epiphytes were the predictor variables. Using Akaike Information Criterion corrected for small samples (AIC_c), the simplest model that best fit our bamboo data was: $AGB_{Bamboo} = (-3.0423) + 1.8487 \cdot DBH_{culm}$ and the model for vascular epiphytes was: $AGB_{Epiphytes} = \exp(-5.99 + 0.052 \cdot BDH_{host\ tree} + 0.051 \cdot H_{host\ tree} + 1.36 \cdot ECI)$. Based on these we estimated a total of 12.6 Mg ha⁻¹ of AGBBamboo(5.7 Mg C ha⁻¹) and 3.8 Mg ha⁻¹ of AGB_{Epiphytes}(1.7Mg C ha⁻¹). Considering the tree AGB(283.2 Mg ha⁻¹)and C stocks (126.7Mg C ha⁻¹) we obtained from the project's database, vascular epiphytes and bamboo together represent 5.5% of the total. These results contribute to better estimate C stocks and thus assist REDD processes. The understanding of such ecological processes is important for planning conservation actions and management of the Protected Areas.

Paper Number: 609

Poster Board: 56

Population structure and diet of the Black-bellied Leaf Turtle (*Cyclemys oldhamii*) at Sakaerat Biosphere Reserve, Nakhon Ratchasima Province, Thailand

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Populations of wild turtles in Asia are in severe decline from overexploitation for food, medicine, habitat destruction and the illegal pet trade. Very little is known about the ecology of turtles in Southeast Asia, including Thailand. The population ecology of the Asian leaf turtle, *Cyclemys oldhamii*, was investigated at manmade ponds at Sakaerat Silvicultural Research Station (SSRS) and natural streams at Sakaerat Environmental Research Station (SERS), Nakhon Ratchasima Province, Thailand. Mark-recapture method was used to estimate the population structure of *C. oldhamii* at SSRS and SERS between August 2014 and September 2015. A total of 52 individuals were marked at SSRS, consisting of 14 males, 13 females and 25 juveniles, and 51.9% of turtles were recaptured. A total of 55 individuals were marked at SERS, consisting of six males, 12 females, and 37 juveniles and 69.1% of marked turtles were recaptured. The ratio of males to females at SSRS was almost equal (1.08:1) but differed at SERS (1:2). Body size was measured based on carapace length and ranged at SSRS from 49.0 – 241.4 mm; carapace length at SERS ranged from 53.4 – 260 mm. Females were larger than males at both sites, indicating sexual dimorphism. Analysis of 189 fecal samples from 82 individual turtles revealed that this species is omnivorous. Diet items most frequently found in fecal samples were fruits/seeds for females and insects for males. For juveniles, insects and fruits/seeds were the most frequent items found in the diet. Fruit consumed by turtles included more than 10 plant families and the most frequent items were Moraceae (*Ficus* sp.) and Malvaceae (*Microcos* sp.).

Paper Number: 612
Poster Board: 57

Impact of the implementation of forest management projects on the conservation of forest resources: Case of the Forest Resources Restoration Project in northern Benin

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The degradation and loss of forest areas continues even though the majority of the world's forests undergo national conservation programs. This regression of forest areas is more pronounced in tropical environment. In order to guide efforts for the sustainable management of tropical forests, it is therefore important to find out the causes of the persistence of forest degradation and loss despite the implementation of forest management and planning projects. The case of the Forest Resource Restoration Project of the Commune of Bassila (PRRF) in northern Benin in West Africa has been studied in this perspective. A mapping approach based on remote sensing and GIS was used to determine, in the PRRF intervention area, the dynamics of the vegetation cover during and after the implementation of this project. Subsequently, local stakeholders were surveyed to assess the impact of the cessation of the PRRF on the development and management of the forest resources of the commune of Bassila. Over the thirty years between the start date of the PRRF and that of the study, the forest area in the PRRF intervention area has increased slightly. Nevertheless, considering the periods during project and after project separately, we notice that in fact the forests first doubled in size during the implementation of the PRRF and later disappeared by half after the end of the PRRF. In addition, the survey revealed that the cessation of the PRRF resulted in the closure of almost all development and management activities previously carried out with the support of the PRRF. This study shows that the intervention of the PRRF in the commune of Bassila in Benin favored the restoration of the forest resources but this positive impact did not persist after the project because of the cessation of the activities management and the lack of monitoring of the project achievements. Monitoring of forest management activities after the cessation of forest projects is therefore recommended for the sustainability of the achievements of these forest projects for the conservation of forest resources.

Paper Number: 614
Poster Board: 58

Study on the invasive species of three large plateau lake in Yunnan province

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Biological invasion is a far-reaching global problem, and the harm it brings is multifaceted and huge. As one of the most concentrated biodiversity areas in China, Yunnan is one of the most serious areas that have been invaded by adventive organisms. Yunnan has a large number of relatively closed plateau lake, which plays an important role in the construction of ecological civilization. But now Dianchi lake, Fuxianhu lake, Erhai lake and other plateau lakes are harassed by adventive organisms in varying degrees, which seriously affected the local ecological environment and ecosystem function, it has become a hot social problem and attracted more and more attention. This research projects to take Dianchi lake, Fuxianhu lake, Erhai lake which are the major national plateau Lakes in Yunnan as the objects, uses the method of combining the new technology of environment DNA and high-throughput barcode technology (matabarcoding), by using the DNA bar code, the second generation sequencing technology, bioinformatics and statistical methods, form a fast, reliable, cheap, comprehensive, large scale and falsifiability method for measuring the diversity of eukaryotes. It will carrying out a systematic and comprehensive study of the most harmful adventive animals in the world from a qualitative and quantitative perspective, providing basic datas for the study of the protections of plateau lakes and supports for comprehensive management and green development. In order to promote the conservation of biodiversity and the construction of ecological civilization in Yunnan.

Paper Number: 621
Poster Board: 59

Leaf nitrate reductase is an important trait for a better characterization of plant functional strategies

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The highly biodiverse Tropical Forests environments represent the largest contribution to Earth's productivity, but they are extremely threatened by human activity. Plant functional traits could represent ecological strategies and determine the response of plants to environmental factors. However, nitrogen is a major element for forest productivity but usually addressed in plant traits approaches only in the form of dry mass basis total N. We propose the inclusion of the leaf nitrate reductase activity as a functional trait to evaluate plant N uptake strategies. We compared five specific traits in two preserved sites and 14 fragments with different past use in the Brazilian Atlantic Forest, totaling 219 tree species and 526 individuals sampled. Three traits were related to structure, plant growth and water use (Leaf dry mass per unit area-LMA, Leaf Dry Matter Content-LDMC and wood density-WD), one trait was related carbon assimilation (Light saturated net photosynthetic rate, area basis-Asat) and one to nitrogen assimilation (Nitrate reductase activity-NRA). Results showed differences along functional groups, families and successional groups and correlation between almost all traits sampled. Most traits that were measured could be correlated in the Leaf Economic Spectrum (LES) dimension, NRA was significantly correlated to LMA (-0.267%), WD (-0.211%) and Asat(a) (0.241%), as was LDMC to LMA (0.389%), WD (0.505%) and Asat(a) (-0.318%). NRA was the main trait responsible for the distinction of plant functional traits at Atlantic Forest fragments compared to other traits, which had a gradient of response but not as clear as NRA based on multivariate analysis. Therefore, we propose that NRA should be added in leaf traits studies, especially because it is a soft trait, easily measured in the field and with a high potential to highlight "fast" or acquisitive species or strategies (pioneer or early successional). Supported by Biota-FAPESP/NERC-RCUK.

Paper Number: 632
Poster Board: 60

The rule of pigtailed macaques (*Macaca nemestrina*) as seed disperser for forest regeneration in West-Malaysia

Giovanni Villa

The overall objective of this study is to examine the ecological role of Pig-tailed macaques (*Macaca nemestrina*) as seed dispersers at the Segari Melintang Forest Reserve, Perak (Malaysia). In demonstrating their role in facilitating forest regeneration in the Segari region, an economic argument for conservation and protection of this threatened primate species can be presented.

In my study I will identify the range of plant seeds dispersed and I will examine the feeding ecology. I will determine how seeds are handled and the seed morphology. To characterize the pattern of dispersion I will establish the seed shadow and I will investigate post-dispersal seed fate. The goal is to estimate the significance for forest regeneration considering the macaque seed dispersal effectiveness comparing it with other seed dispersers (e.g. small mammals, birds) and to promote findings in peer-reviewed international journals, local community based efforts (e.g. together with NGOs that work towards wildlife protection) and university lectures.

In other words my idea is to prove that Pig-tailed macaques are seed dispersers and proving that would confirm the mutualism between plants and monkeys. These results could mean a lot for further activities of conservation.

My project is approved by the University Sains Malaysia and the Professor Nadine Ruppert.

Paper Number: 633
Poster Board: 61

Exploring the role of stochasticity in forest succession: A web application as a research and pedagogical tool

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Background: Models are useful tools to study secondary forest succession, specifically those processes that are difficult or unfeasible to study in the field. Existing models often focus on local deterministic processes, in which differences in species' life histories and predictable changes in environmental conditions drive a shift in species composition. However, species recruitment across sites is a highly stochastic process, with an important role of dispersal limitation. We present a web application that explicitly explore the role of recruitment stochasticity in succession, allowing the user to define how and to what degree stochasticity plays a role on local and landscape scale.

Methods: We have built a computational model that simulates successional patterns of alpha and beta diversity across multiple independent sites. Species are randomly recruited from the regional into local species pools, and from these local pools in one sample plot per location. The user can vary the degree to which recruitment probabilities are species and age-specific or vary stochastically across sites. Species-specific probabilities are informed by data from a field study in central Panama, but the user may choose to change this and run the model with his/her own list of species with accompanying probabilities based on either field data or theoretical considerations. To make the model accessible, we have packaged the model in a web application – accessible on any device – that the users may leverage for research and educational purposes.

Results and implications: Users can set a variety of parameters with which to run the model. After each run, the web application plots downloadable graphs of alpha and beta diversity. The generated data on species abundances over time can be downloaded for further analyses. Researchers and educators may use this web application as a tool to explore or demonstrate the role of various stochastic processes in forest succession, generate new hypotheses for testing in the field and to discuss implications on forest management / biodiversity conservation. We invite researchers and educators to test the web application and offer feedback for us to improve the model.

Paper Number: 639
Poster Board: 62

Assessment of the population size and distribution of a new species of *Magnolia*: A Community-Based Conservation effort in Northern Andes, Colombia

Melisa Ayala Joya

There are over 240 species of *Magnolia* in the world and Colombia has the highest diversity in the neotropics with 38 species. However, the 97% of them are threatened with extinction in the wild as consequence of habitat loss and land transformation, especially in the andean region. For this reason, designing conservation strategies based on the biology and ecology of these trees becomes a priority. The current study aimed to estimate the distribution pattern and population size of a new *Magnolia* species with great importance for local people regarding to the production of a unique piece of kitchen tool which is essential for chocolate preparation. The study site was located in the Serranía de los Yariquies, a mountain ridge in between the dry canyon of the Suarez River, and the humid valley of the Magdalena River, in Northern Colombia. To define the sampling localities, we used previous information and social cartography to synthesize local knowledge. Subsequently, we identified four study areas, which were surveyed by local people for eight (8) hours per day until the entire area was covered (a total of 32, 80, 64, 24 hours respectively). On each walk, we recorded the individual's coordinates, its diameter at breast height (DBH), total height, reproductive status, and associated tree species. The data were analyzed using R software and QGIS. The species was found in four localities, with a total distribution area of 6.7 km, along a gradient from 1336 to 1906 m.a.s.l, and with the highest density of individuals at the maximum altitudes of each area. We identified 167 individuals of which only 4.2% were juveniles; 28% of total population was located in pastures and 23% in coffee, cocoa and lulo (*Solanum quitoense* Lam.) plantations, where after transforming the original forest, local people use them as shadow trees, the remaining 45% was located in the forest. Our results suggest that this *magnolia* species might be endangered due to its small distribution area, number of individuals recorded, low recruitment, and as observed in the field, habitat fragmentation, replacement of native forest (especially for cattle pastures) and selective logging. Under this scenario and after sharing the results with the community, they suggested to implement a propagation plan for the species. This will show that local participation in research is the way to make them recognize the problems that species face in the wild and gain allies for sustainable conservation initiatives

Paper Number: 645
Poster Board: 63

Wood Anatomical Traits Across A Land-Use Gradient In The Tropical Rainforests Of Sabah, Malaysia

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Introduction: Ecological plant strategies are reflected in anatomical constraints and trade-offs, influencing the distribution of species in different environmental conditions. Wood anatomical traits serve multiple ecological functions such as structural stability, water conductance and nutrient storage. These functions can be essential for the resilience of trees when exposed to altered environmental conditions, such as selective logging procedures that are modifying vast areas of pristine forests in Borneo.

Objectives: In this study we investigate the ecological trait variation of trees in two different forest types and explore plant strategies related to wood anatomy. We studied mature trees in old-growth and selectively logged forest in Sabah, Borneo, and explored differences in trait expression between these two forest types.

Methods: A total of 345 trees were sampled, capturing 190 species. From cross sections of branches, we measured vessel size (A) and vessel diameter (VD) and we calculated vessel lumen fraction (F), vessel density (N), hydraulically weighted diameter (Dh), vessel area to number ratio (S), a vessel composition index and potential hydraulic conductivity (Kp).

Results : Our analyses show that across all species S varied 61-fold and N showed 15-fold variation. There were significant differences in A, VD and Kp between old-growth and selectively logged forest: Vessel size and diameter were significantly smaller for species in old-growth forest compared to selectively logged forest and thus contribute to the lower conductivity. This difference can be explained by the presence of pioneer species in selectively logged forest that represent fast growing species. Our study shows that they have larger vessel size and diameter and higher conductivity.

Conclusion: Logging tropical forests drives differential expression of wood anatomical traits in response to the modified environments created by the disturbance.

Paper Number: 647
Poster Board: 64

Adaptive Genomics: relevance for tropical biology conservation

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The completion of the human genome sequencing in 2003 opened a new perspective into the importance of whole genome sequencing projects, and currently thousands of species are having their genomes completely sequenced, from simple organisms, such as bacteria, to more complex taxa, such as mammals. This voluminous sequencing data generated across multiple organisms provides also the framework to better understand the genetic makeup of such species and related ones, allowing to explore the genetic changes underlining the evolution of diverse phenotypic and adaptive traits and their relevance for conservation. Here, recent results from our group retrieved from comparative evolutionary genomic analyses of varied endangered metazoan species will be considered to exemplify how gene novelty and gene enhancement by positive selection might have been determinant in the success of adaptive radiations into diverse tropical environments and lifestyles. The findings pinpoint unique molecular products of critical relevance in species evolution, diversification and conservation, but also highlight genomic novelties of importance for environmental and biomedical research.

Paper Number: 660

Poster Board: 65

Mangrove recovery in southern Mexico: emerging patterns from an informal chronosequence

Daniel CHÁVEZ and Jorge A. MEAVE

Mangrove communities are highly relevant due to the essential ecosystem services they provide. However, mangroves are also very fragile, both because their high environmental specificity and the intense human activity in tropical regions. Notwithstanding these reasons, the regeneration process of these communities has been little studied, and the recovery patterns of its attributes are not well known. To address this issue, we used a chronosequence, including a range of sites with imprecise successional age, to infer patterns of structural recovery for mangroves in the coastal region of Tabasco, southern Mexico. In total we sampled 26 plots (625 m² each). According to local inhabitants, 11 plots had been never disturbed in recent history; the remaining 15 plots were classified in four broad successional groups: < 10 yr, 10-15 yr, 25-30 yr, > 30 yr. Vegetation sampling included the recording of all stems with DBH ≥ 5 cm, and measurements of stem diameter, crown cover, and root cover for these plants. We analyzed recovery patterns for four community structural attributes: basal area (BA), density, crown cover, and root cover. These four variables showed contrasting successional patterns. BA increased continuously with successional age, with older successional stands being similar to mature mangrove (mean mature mangrove BA = 37.28 m²/ha). Crown cover also increased steadily with age, but more linearly than BA, and mature mangrove had the highest values (mean crown cover = 37,123 m²/ha). In contrast, root cover and stem density had unimodal behaviors, with the highest values being observed for the 25-30 yr category in the case of root cover (7876 m²/ha), and for the > 30 yr category in the case of stem density (1286 stems/ha). We conclude that mangroves are effectively recovering without human intervention in the study region, and more importantly, that the recovery of this forest is faster than anticipated, at least for some attributes. In the case of BA, which is strongly correlated with standing biomass, the oldest recovering forest category reached typical mature forest values. In turn, the unimodal pattern of stem density with a noticeable decrease towards mature forest is frequent in forest successions, due to self-thinning processes. Yet, the strong decrease in root cover observed for old successional and mature mangrove plots was unexpected; this pattern will have to be further investigated in the future.

Paper Number: 668

Poster Board: 66

Changes of Above-ground Biomass of Tropical Montane Forest in Ulu Padas, Sabah

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Increasing greenhouse gases emissions especially carbon dioxide in the past decades is the most important determinant of climate change. Carbon sequestration by forests has been considered as a viable option for reducing the emissions from the land use sector. This study examines the above-ground biomass changes of a tropical montane forest at Ulu Padas, Sabah. Field inventory was carried out twice in 2012 and 2018 for trees with a diameter at breast height (D) of more than 10 cm. AGB was estimated using the Chave's allometry. The changes of AGB were calculated for each tree and averaged at plot level. Overall, the AGB has an increment of 5.20 Mg/ha/year (± 4.62 Mg/ha/year) over the period of six years since the year 2012 to 2018, which potentially encourages carbon sequestration. Averagely, the annual increment of AGB for intact and degraded forest was 5.55 Mg/ha/year (± 5.04 Mg/ha/year) and 4.74 Mg/ha/year (± 4.24 Mg/ha/year) respectively, the former showing a higher rate of natural regeneration. Hence, conserving existing intact forests and preventing them from land use conversion to agriculture can be an instrumental strategy in climate change mitigation. For monitoring the AGB changes over a larger spatial scale, airborne remote sensing approaches such as airborne laser scanning and unmanned aerial system are needed to determine the role of degraded tropical forests in carbon sequestration.

Paper Number: 670

Poster Board: 67

Amphibian and reptile species composition in peat swamp forest of Kampar Peninsula, Riau, Indonesia

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Peat swamp forest is known as a unique and threatened ecosystem. To date, Sumatra has lost estimated 68% of its peat swamp forest, yet information on its biodiversity especially on amphibians and reptiles are not well documented. Kampar Peninsula is one of the remaining peat swamp forests in Sumatra, where Restorasi Ekosistem Riau (RER) holds a license on ecosystem restoration concession in this area. A series of surveys was conducted in RER between May – December 2015. A total of 32 km line transects was surveyed using visual encounter survey method to investigate amphibians and reptiles species composition in this area. Seventy five species (14 amphibians and 61 reptiles) were recorded, with 16 species were protected, listed in CITES, IUCN Redlist and/or Sumatran endemic. Species accumulation curve shows asymptote pattern on amphibian, but increasing pattern is still showed on reptile for both Pole Forest (PF) and Mixed Peat Swamp Forest (MPSF). Our results suggest that amphibian and reptile's species richness is similar, but the RAV is different in both PF and MPSF. The Collett's tree frog (*Polypedates colletti*) was the highest RAV for amphibian in MPSF but lower in PF. *Cyrtodactylus* sp. and common sun skink (*Eutropis multifasciata*) were the most dominant reptiles with *Cyrtodactylus* sp.'s RAV higher in MPSF, and *E. multifasciata*'s RAV higher in PF. Our findings suggest that in general MPSF support more individuals of frog compared to PF.

Paper Number: 677

Poster Board: 68

Fern fronds dissection within a riparian zone of small streams in Sarawak, Malaysia

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Leaves morphological traits are important to understand plant ecology, spatial distribution and physiology. Fern leaves (fronds) have a great diversity in shape, with entire fronds to several times dissection, unique in the plant kingdom.

Fern frond morphological traits were investigated to determine the variation of leaf dissection (shape factor [$4\pi \times \text{leaf area}/\text{perimeter}^2/\text{area}$], leaf elongate ratio[length/width], mucron angle [tip of the leaf] and stomata concentration (1mm^2)), compactness [$\text{perimeter}^2/\text{area}$] within the gradient of a tropical riparian zone of small streams. Eighteen plots were conducted in the riparian zone of Tama Abu mountain site, North Sarawak (Malaysia). Along the riparian zone six transects, of 160 meters each, were established, each transect was represented by three plots at river, mid distance and ridge site respectively.

The fern frond dissection, shape factor, and the compactness ratio show a similar significant trend. In both cases the ferns tend to have more dissected fronds away from the stream. The frond elongation ratio, on the other hand, has a significant trend with an increase from the river to the ridge site, in other word fronds have a rounder shape along the river whereas are more elongated away from the river. The mucron does not has a definite trend along the studied transect. Trend is possible to observe only when the analysis is conducted at the family level. Stomata concentration is significantly high along the river and tend to decrease toward the ridge site.

The contrasting results along the tropical streams riparian basin suggest that fronds morphological traits change significantly within of microclimatic condition, with wider fronds and more stomata along the river basin and narrower and dissected leaves with lesser stomata away from the river. This shows the variation of energy investment and efficiency adaptation within a tropical forest microsite.

Paper Number: 685

Poster Board: 69

Diversity and Ecology of Araceae in Gunung Tujuh, Kerinci Seblat National Park, Jambi

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A Study of Araceae diversity in the area of Gunung Tujuh, South Sumatra, have been done. The Research purpose is to acknowledge the diversity level of Araceae and the ecological factors that affect it in Gunung Tujuh, Jambi. The diversity of Araceae has been recorded by setting 0.6 ha plot, which is divided into 6 quadrants with each sized $50 \times 20 \text{ m}^2$, every two quadrants are placed in the elevation of 1.600, 1.900 and 2.100 meters above sea level. Abiotical factors data such as pH, temperature, light intensity, moisture and percentage of canopy cover are also taken. In this research 32 species which are classified into 12 genera have been recorded. The diversity level was calculated using Shannon – Wiener evenness index in each elevation gradually with the result of 2.44 and 0.86 in 1900 m above sea level, 2.17 and 0.71 in the elevation of 1600 m above sea level, also 1.51 and 0.68 in the 2100 m above sea level.

Paper Number: 695

Poster Board: 70

Rat feeding behavior of pig-tailed macaques (*Macaca nemestrina*) in oil palm plantations – implications for conservation

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Conversion of tropical forests into oil palm plantations reduces the habitat of primates, which can lead to conflicts with humans. In fragmented habitats, Southern pig-tailed macaques (*Macaca nemestrina*) divert their foraging activities into oil palm plantations where farmers generally consider them as crop raiders. Contrary to this common belief, we argue that macaques may act as biological pest control as we found macaques frequently feeding on plantation rats of the genus *Rattus*. To assess the impact of pig-tailed macaques on the populations of plantation rats, we recorded the feeding behavior of macaques in oil palm plantations and carried out a mark and recapture study in Segari Melintang Forest Reserve, Peninsular Malaysia. We used live wire-mesh cages to trap rats at eight different 0.6 ha sized plots, four within and four outside the home range of the pig-tailed macaque groups present at the study site. Preliminary analysis suggests that macaques significantly reduced the population of plantation rats. Ongoing data collection is expected to assist with more detailed statistical analyses (GLMM) to control for confounding factors affecting rat populations. Our findings, once verified, may significantly contribute to mitigating human-macaque conflicts by encouraging plantation managers to incorporate the protection of primates and their natural habitat and to establish corridors for maintaining macaque populations to serve as pest control agents. Supported by The Rufford Foundation, the DAAD and the University of Leipzig.

Paper Number: 700
Poster Board: 71

The Biological and Ecological Diversity of Aquatic Macroinvertebrates Assemblages of Selected Streams in Kota Marudu, Sabah, Malaysia

Chaw, Vi Vian & Fikri, Arman Hadi

A survey on the aquatic macroinvertebrates were conducted in selected streams in Kota Marudu, Sabah, Malaysia. Despite there is a growing interest in understanding the way in which anthropogenic disturbances modify natural hydrological regimes and how they lead to permanent changes in the ecological processes, there is still knowledge gap in understanding the land use linkages in affecting the ecosystems functioning, especially in Malaysia. The streams selected were based on the land use occurred around the stream area. The streams that selected are Sg. Lugu, Sg. Mangaris, Sg. Bingkongan, Sg. Batutai, Sg. Sorinsim and Sg. Kanarom with the objectives (i) to study the biological and ecological diversity of aquatic macroinvertebrate communities, (ii) to study the effects of different land use (forest, agricultural and human settlement area) on aquatic macroinvertebrate communities and (iii) to determine the influence of several physico-chemical water quality parameters on diversity of aquatic macroinvertebrate communities among the selected streams of Kota Marudu, Sabah, Malaysia. The sampling was carried out using surber net in July 2017 until October 2018. The study found that the forest area (Sg. Sorinsim and Sg. Kanarom) recorded the highest diversity of aquatic macroinvertebrates. Water integrity of streams at Kota Marudu could be considered as excellent with minimal pollution. Both physico-chemical parameters and biotic indices indicated that the aquatic macroinvertebrates were affected by the water quality in their surroundings. This proved the use of aquatic macroinvertebrates as bioindicator for rapid assessment of water quality.

Paper Number: 703
Poster Board: 72

Evaluating the current status of *Lepanthes eltoroensis* at El Yunque National Forest: A Proposal

Rayza Hernández-Muñiz

Lepanthes eltoroensis is an endangered, small epiphytic orchid, endemic and restricted to El Toro and Tradewinds trails at El Yunque National Forest (EYNF) cloud forest located at northeast of Puerto Rico. Both the ecosystem and the orchids, are threatened by extreme events, including but not limited to atmospheric phenomena such as hurricanes. These are very common across the Caribbean region and P.R. and its intensity and frequency are expected to increase in the region due to climate change. This work seeks to explain how climate change can affect biological processes such as phenology in *L. eltoroensis* orchids located in vulnerable ecosystems as EYNF. We ask if there is any relationship among populations with microclimatic conditions and habitat traits. We will evaluate demographic changes and recovery of the orchid population and its host after the disturbance of hurricanes Irma and Maria. This study will carry out rescue and relocation assessments, monitoring and documentation of individuals that have been intervened with, for the establishment of future protocols of populations of *L. eltoroensis* after a hurricane event. We hypothesize that microhabitat traits (including host conditions) may be correlated with orchid population success metrics. This work will provide information regarding the populations of *L. eltoroensis* which are vulnerable to minimal changes in the ecosystem, therefore being excellent bio-indicators of changes in the forest. Conservation efforts and management plans must address not only the vulnerability of the species, but also include features of the species that are targets in a changing environment.

Paper Number: 718
Poster Board: 73

Silicon release from leaf litter of six tropical tree species during decomposition

Ryosuke Nakamura

Silicon (Si) is a beneficial element for many higher plants. Plants differ greatly in Si uptake. Lowland tropical forests cycle a large amount of Si via litter to the soil. From these, further understanding of Si cycling is essential to reveal plant-Si interactions in tropical systems. In this cycling, however, it remains unclear how Si is released from litter to the soil during decomposition processes. Here, our study aimed to answer the following questions: i) how fast Si leaches from litter and ii) whether Si leaching rate from litter is correlated with its decomposition rate. We conducted a leaf-litter incubation experiment, using the six tropical tree species found commonly at Lambir Hills National Park, Malaysia: *Dillenia suffruticosa*, *Dipterocarpus globosus*, *Dryobalanops aromatica*, *Macaranga trachyphylla*, *Shorea bullata* and *Shorea ochracea*. Freshly senesced leaf litter was collected from the forest floor and decomposed in laboratory incubators at 20 and 30°C for 30 and 59 days. Litter mass loss was calculated by comparing the ash-free dry weight of decomposed litter with that of initial litter. Leaf-litter Si was determined with the blue colorimetry after a borate fusion. Litter Si loss was quantified by comparing the amount of Si remaining in the decomposed litter to that in the initial litter. The content of Si in initial litter differed greatly among species, ranging from 0.9 to 99.6 mg Si g⁻¹ dry weight. The patterns of Si releasing were also different among species. For example, the greatest percentage decline was found in *S. bullata* (7.2 mg Si g⁻¹ in initial litter), which lost 72% of Si at 59 days. On the other hand, there was almost no release of Si from litter of *D. aromatica* (0.9 mg Si g⁻¹ in initial litter). The effect of temperature on litter Si loss was significant only in *M. trachyphylla* (34.9 mg Si g⁻¹ in initial litter). Finally, percentage Si release from litter was not correlated with percentage litter mass loss. In conclusion, the high variability in Si loss percentage (almost 0 to 72%) may suggest that the Si-bearing phases in leaf differ largely among tropical tree species. The Si release from litter should not depend on its decomposition. To further understand the mechanisms behind the observed Si loss patterns from litter, the future research should examine the form and location of silica bodies in leaves that may differ among the six species and link with Si releasing rate from litter.

Paper Number: 731
Poster Board: 74

Clinging to survival: identifying priority areas for endemic species in Central Vietnam

Thanh Nguyen

The Annamite mountains are a global biodiversity hotspot harboring some of the world's most charismatic and least known mammal species. Historically, the ecoregion contained full a suite of Southeast Asian megafauna, including rhinos and large felids, as well as large number of endemics, such as saola *Pseudoryx nghetinhensis*, large-antlered Muntjac *Muntiacus vuquangensis*, and Annamite striped rabbit *Nesolagus timminsi*, and Edwards's pheasant *Lophura edwardsi*. However, the distribution and population sizes of all mammal species have been severely reduced from historic levels; many species are threatened with local extirpation or, in the case of endemics such as saola, global extinction. Tigers and the Javan rhino are now extinct in Vietnam, and other species are likely to follow in the near future. The primary threat to ground-dwelling species in the Annamites is indiscriminant hunting using snare lines. To efficiently use limited conservation resources, it is imperative that stakeholders target enforcement efforts in places where threatened species still occur. We carried out the systematic camera-trapping in two protected areas, Song Thanh Nature Reserve and Phong Dien Nature Reserve, in the Central Annamites landscape of Vietnam. Our objective was to rigorously assess the ground-dwelling mammal and bird community, with a special focus on rare, threatened, or little-known species. We set up a total of 67 camera-trap stations in Song Thanh Nature Reserve and 51 camera-trap stations in Phong Dien Nature Reserve. Stations were spaced 2.5 km apart across the study sites, thus giving a landscape-level perspective for both areas. In more than 11,118 nights of camera trapping effort we recorded 39 species, including 24 mammals and 10 ground-foraging birds. Several species—including large-antlered muntjac and Asiatic black bear *Ursus thibetanus*—had not been previously recorded in these protected areas with camera traps. The critically endangered large-antlered muntjac has only been photographed in three other protected areas in Vietnam within the past 15 years; our record is therefore of particular conservation importance for the species. Rare large mammals were only recorded at very remote stations, likely indicating that these species only persist in areas that are more difficult for hunters to access. Overall these results showed that intensive hunting over the last 20-30 years had a severe and negative impact on the ground-dwelling mammal and bird community in the Central Annamites landscape. To protect remaining populations, urgent anti-poaching activities are needed, especially in the areas where high-value conservation species still persist.

Paper Number: 735
Poster Board: 75

Arthropod activity in tropical anthropogenic forests

Kong Wah Sing

Global warming is considered a lower threat to arthropod biodiversity in the tropics than in temperate regions because species showing distinct seasonal patterns of activity are thought to be at higher risk of climate related extirpation. However, in addition to climate change, arthropod biodiversity in the tropics is increasingly impacted by rapid changes in land use. To examine changes in tropical arthropod communities, we deployed Malaise traps at three anthropogenic forests (Secondary Reserve Forest, Oil Palm Forest, and Urban Ornamental Forest), collected arthropods continuously for 12 months, and used metabarcoding protocols to characterise the diversity within weekly samples. Here we show that most of the arthropods (Diptera, Coleoptera, Hemiptera, Hymenoptera, and Lepidoptera) in the major anthropogenic forests in Peninsular Malaysia may face a double threat: at risk of biodiversity loss due to exploitation and disturbance of forests which consequently put the species at further risks related to global warming. We highlight the positive feedback mechanism of land use and global warming, which pose threats to the arthropod communities and further implicates ecosystem functioning and human well-being. Conservation and mitigation plans are urgently needed.

Paper Number: 743
Poster Board: 76

Measuring habitat preferences of African elephants in Kibale National Park, Uganda

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Human-wildlife conflict is a major problem for wildlife conservation and management all over world. For example, competition for resources between humans and elephants has huge impacts in Asia and Africa. Elephant crop-raiding can cause serious damage to community livelihoods. In Kibale National Park (KNP), Uganda, Africa, the density of elephants has increased more than 300% from 2001 to 2003 due to the migration of elephants from the Democratic Republic of Congo (DRC) into Uganda. This increase in elephant population density in KNP has led a rise in human-elephants conflicts within the region. This migration has resulted in recent genetic analyses that document the hybridization between savanna elephant (*Loxodonta Africana*) and forest elephant (*L. cyclotis*) in this area. Despite recent interest in the elephants of KNP, little is known about elephant ranging patterns and behavior. A better understanding of elephant behavior is needed to more effectively deal with human-elephant conflicts, as well as promote the elephant conservation.

This study focuses on quantifying elephant habitat preference in KNP. I conducted line transect censuses in a variety of vegetation types during both the dry and wet seasons of 2017. Distance sampling of dung counts was performed along transects, and DISTANCE software was used for analysis. Survey were also conducted along the border of the KNP to assess patterns in elephant occurrence relative to villages and vegetation types.

Totally 1034 dungs were detected during the 2017 study period. Results show that the frequency of habitat use was significantly higher in secondary forests and grasslands than in primary forests. The concentration of elephants in secondary forests and grasslands was higher in dry season than rainy season. The number of elephant occurrences near the KNP border were higher in dry season than in rainy season, and they often occurred along the edges of secondary forest.

These results suggest that secondary forests and grasslands are important habitat for elephant in KNP, and the villages near these habitats are at high risk of crop-raiding by elephants especially in the dry season. This research contributes important information that can be used to predict elephant behavior and inform management practices aimed at preventing damage to agriculture and community livelihoods in villages surrounding KNP. This study can serve as a model for other sites across Africa and Asia where humans and elephants are increasingly competing for resources and conflict is high.

Paper Number: 746
Poster Board: 77

Estimation of above-ground carbon stock in Tropical Peat Swamp Forest

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There is very limited literature and information to discuss about biomass stock in tropical peat swamp forest especially in Borneo. In this preliminary study, about 210.63 ha tropical peat swamp forest for conservation were established. Two study site were set up as TCA1 and TCA2. The aim of this study to determine a total carbon stock in tropical peat swamp forest. To estimate an accurate biomass, the changes in tree growth rate such as density, height and above-below ground was measured and analyze. Initial result showed TCA1 and TCA2 approximately 40 Mg C ha⁻¹ and 56 Mg C ha⁻¹. In depth study of carbon stock forest needed to allow us assess the amount carbon loss and sink due to land conversion.

Paper Number: 751
Poster Board: 78

Predicting Peat Depth from Forest Inventory Data and Landsat-8 Operational Land Imager Sensor Measurement in Tropical Peat Swamp Forest Areas, Kampar Peninsula Landscape, Riau Province, Indonesia

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To support sustainable development goals and low-carbon development strategies, understanding protection and responsible management of peat forests are crucial to reduce carbon emissions to the atmosphere and protect the carbon sink function of remaining peat forests. Tropical peat forests are important terrestrial carbon sinks. Widespread conversion of forests to agriculture, oil palm and industrial timber plantations and uncontrolled drainage are believed to be the major causes of peat forest degradation. Research on peat carbon retrieval using remote sensing in tropical peat swamp forest, is urgently needed for improved understanding of carbon cycling in such areas. To be able to improve management of peat swamp forest area, produce a map of peat depth distribution to a vast landscape area is important. We investigated the relationship between the forest inventory data collected from field survey and the most reliable optical satellite imageries available, Landsat-8 Operational Land Imager Sensor (OLI). The peat and forest inventory data were derived from 156 sampling-plots (0.25 ha each) in a c.92,500 ha of peat swamp forest and the optical satellite imageries were the medium resolution Landsat-8 operational land imager satellite sensor measurements. A randomForest (RF) and Stochastic Gradient Boosting (SGB) models were performed on the peat depth as a response variable against 32 predictors from forest inventory data such as tree count, DBH (Diameter Breast Height), tree height while the reflectance-bands, texture analysis, and vegetation Indices were used as predictors from OLI sensor. Both the RF and SGB models suggest that peat depth was best correlated with a combination of 8 predictors: pole-tree count C Class (5<DBH<15 cm), soil-adjusted vegetation index (SAVI), Normalized Difference Infra-Red Index (NDII), Mean Grey Level Co-occurrence Matrix (GLCM), Contrast & Mean Grey-level difference vector (GLDV), band 3 & 6 from OLI sensors. The RF model shows the highest in predicting peat depth with the best value of RMSD, pearson's, and spearman's correlation; 1.01, 0.67 and 0.69 respectively. The best formula generated from this model is peat depth (m) = 0.96(predictor) + 0.34. Overall, this study provides a formula to estimate peat depth in tropical peat swamp forest by testing various parameters obtained from the readily-available Landsat-8 OLI sensors. Thus, it can be extrapolated to the tropical peat swamp forest landscape in Kampar Peninsula and used by the landscape manager to make a good decision.

Paper Number: 754
Poster Board: 79

Assessing the impact of corporate palm oil sustainability certification on deforestation

Charlotte Smith

Introduction:

In response to rapid tropical deforestation due to commodity crop expansion, corporations have increasingly adopted environmental standards that require avoidance and/or conservation of forests within their landholdings. In the oil palm sector, many companies rely on forest conservation standards set by the Roundtable on Sustainable Palm Oil (RSPO). The "New Planting Procedure" (NPP), instituted in 2011, requires that before plantation expansion, RSPO members identify and manage High Conservation Value areas (HCVs), which contain biological, ecological and/or cultural values. While HCVs are designated with the intent to protect biodiversity and ecosystem services, it remains unclear whether HCV designation and management yields these intended outcomes. To address this knowledge gap, this research aims to answer these main questions:

Objectives:

- 1) How has HCV designation impacted deforestation inside HCVs?
- 2) How do HCV characteristics (e.g., patch size, HCV type) influence deforestation within HCVs?

Methods:

To answer these questions, we digitized HCV areas within n=118 RSPO member-held properties in Kalimantan, Sumatra, Papua, and Bangka-Belitung, Indonesia from NPP reports. We then used satellite data products to quantify forest area at the year of HCV designation, as well as to measure annual forest loss from 2001 to 2016. To test if HCV designation was effective at conserving forest, we compared forested HCV pixels to similar non-HCV forested pixels.

Results:

Initial findings suggest that on average these HCVs contain ~31% forest upon designation. HCVs lost an average of 5.5% forest per year after designation. Post-HCV designation, Kalimantan HCVs experienced the greatest rate of deforestation, losing an average of ~6% forest per year, while Papua experienced the lowest average rate of deforestation, losing ~0.3% forest per year. We analyzed the correlation between several geospatial variables and the likelihood of deforestation in HCVs, and found several strong predictors of deforestation.

Conclusions:

We discuss the implications of these results for the effectiveness of the HCV process in contributing to forest conservation efforts in Southeast Asia oil palm landscapes.

Paper Number: 764
Poster Board: 80

Using DNA metabarcoding and prey size correction factors to describe dietary preferences of African leopards

Rasmus Worsoee Havmoeller

The ability to adequately describe the dietary preference of wild carnivores from scats has been performed using methods for identifying prey species through morphological and molecular methods. The results have then traditionally been used to infer potential prey preference through average mean weights of identified prey and their proportional content of collected scats. However, the over-representation of small bodied mammals and under-representation of large mammals in scats have led to a debate in correctly estimating the preferred mean weight of prey eaten by carnivores. Potential loss of large prey through kleptoparasitism, prey availability, and optimal hunting habitat have been hypothesised to additionally influence preferred mean weight of prey. In this study 82 putative leopard scats over a diverse, but connected, array of habitat types in the Udzungwa Mountains National Park, Tanzania, where leopards were the single most abundant large carnivore, to investigate if preferred prey preference for African leopards changed between major habitat types. Through DNA metabarcoding of 16S ribosome and COI fragments we developed a method confirming predator origin for 89% of scats and 95% of prey to species level. Using a recently developed prey size correction factor derived from captive leopards, along with covariates on habitat type and mean occupancy of potential prey, we investigated if any of the afore mentioned factors explained leopard prey preference better than a random model. The results showed that leopards have a skewed distribution in consumed prey size, with a significantly higher proportion of small prey <19kg in closed forest habitats, and a significantly higher proportion of larger prey >80kg in open habitats, while the proportion of medium sized prey >19kg was identical. The prey size correction factor fitted our dataset better than a random model. Ungulate species constituted 45.7% of species identified from leopard scats, while primates accounted for 37.1%, indicating that primates are a more important prey source for leopards in closed habitats in Udzungwa. The difference in ungulate/primate ratio in scats collected in open versus closed habitats was statistically significant. Our study demonstrates a cost-efficient method for identifying predator and prey using DNA-metabarcoding, estimating prey preference using a recently developed correction factor for captive leopards on a wild population and highlights the important role leopards have as keystone species in connected but distinct habitats.

Paper Number: 770
Poster Board: 81

Are arboreal frugivores creating food patches for ground-dwelling fruit-eaters?

Linnea Havmoeller

Tropical rainforest ecosystems are enriched by a diverse set of complex interactions between plants and animals. Arboreal fruit-eating animals may play an important, and little studied role, as they create food patches for ground-dwelling animals. Arboreal frugivores regularly drop fruit from trees before they would naturally fall to ground, potentially providing sources of food for ground-dwelling species to exploit. If these food sources are important, we predict that terrestrial frugivores should eavesdrop on arboreal frugivores to maximise their feeding efficiency, and alter their movement in response to cues and signals produced by arboreal frugivores. In this study, we test if interspecific transfer of information about food resources play a role in the structure and assembly of Neotropical frugivore communities on Barro Colorado Island, Panama. During an ecologically simple time-period when only one main tree species is fruiting, a combination of acoustic play-back experiments, remote camera monitoring, and GPS tracking data is used to examine if ground-dwelling frugivores actively eavesdrop on signals and cues made by arboreal frugivores, are attracted by them, and adjust their food search in response. The preliminary results suggest that terrestrial frugivores are attracted, signifying that arboreal primates may play an important role in Neotropical rainforests. Primates are often the first species to be hunted and the loss of primates could affect food availability for ground-dwelling mammals, because primates drop partially consumed fruits, sometimes months prior to their availability on the ground when there is little else for terrestrial species to eat. The absence of primates from tropical forest communities could have a negative effect on the whole ecosystem as they function as seed dispersers and create food patches for ground-dwelling mammals.

Paper Number: 771
Poster Board: 82

Plant Water Dynamics of Páramos's Hypericum system: a multiscale analysis

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The Paramos, alpine tropical ecosystems found in the mountaintops along the Northern Andes, provide critical environmental services; one of them is water regulation, which is crucial for local water supply in major South American cities. Its water regulation ability is due to their soils and vegetation's traits. One of the most abundant genera in the paramos is *Hypericum*. Previous studies have shown that species in this genus tends to be distributed in response to soil moisture, but since those studies have not considered its physiology and ecological interactions is impossible to understand if their distribution respond to physiological limitations or ecological interactions. Here we evaluated the distribution pattern of three *Hypericum*; *H. goyanesii*, *H. juniperinum*, and *H. Mexicanum* to understand how drought vulnerability influences their distribution and to understand ecological and spatial relationships between water and vegetation. To do so, we established 10 plots (10 x 10 m each) in Matarredonda, a paramo in the oriental range of the Colombian Andes along a moisture gradient that was detected using a spatial analysis of variables that affect soil water content: slope, aspect, and water accumulation. On each plot we took soil moisture and temperature measurements within a 6x6m internal subplot every 1m. Same measurements were taken under each *Hypericum* found on the plot. Using aerial photographs, we estimated the vegetation cover on each plot and around each *Hypericum* species in the plot. We evaluate three physiological traits related to plant water relations: plant water potential, vulnerability curves, and vulnerability index. At the larger scale, we found significant differences in soil moisture between plots, as expected from the model, and no evidence that the type of vegetation cover is affecting soil moisture. At the *Hypericum* local scale, we found that *H. mexicanum* distribution was associated with bare soil cover, higher soil temperatures, and lower soil moisture. The other two species, *H. goyanesii* and *H. juniperinum* tend to be located in wetter sites. At the physiological scale, we found that *H. goyanesii* and *H. juniperinum* are very vulnerable to drought and were found on wetter sites suggesting that the presence *Hypericum* species was dictated by the soil water content and by its vulnerability to drought. Paramos have rarely been exposed to drought and our results suggest that some species are wetter specialist and could be too vulnerable to drought to resist longer drought episodes expected in a climate change scenario.

Paper Number: 787
Poster Board: 83

Using environmental DNA to monitor and manage freshwater fish resources: a case study from salmon monitoring in Alaska

Chunyan Yang

Developing fast and cost-effective assessments of fish resources is an important goal for many environmental managers and researchers. However, it is extremely difficult to count population sizes of fish species. Here we use a recently developed tool, environmental DNA (eDNA), as a rapid and efficient way to measure salmon abundance in Auck Creek, southeast Alaska, USA. A key question for using eDNA in such research is whether eDNA can consistently return reliable quantitative information from field samples. Our research takes advantage of a unique fish count dataset from the Alaska Department of Fish and Game to validate eDNA. Water samples for the eDNA study were collected from April, the beginning of the salmon migration, until the end of October, 2016. We used quantitative PCR with species specific primers to obtain the eDNA concentration for salmon. Then, a generalized linear model was constructed to estimate fish counts using the concentration of eDNA and a time auto regression following a Bayesian approach. Our results showed a strong quantitative relationship between eDNA concentration and salmon counts. eDNA is highly promising in providing reliable and efficient methods in fish resource monitoring and management. The Alaskan system is an excellent model for us to develop a robust and reliable eDNA protocol for monitoring freshwater fish resources in southeast Asia, which is a crucial area for China's "One Belt One Road" initiative.

Paper Number: 790
Poster Board: 84

Getting a handle on Sabah's Plant Diversity: Spatial occurrence of the Hyper-Endemics

Colin Maycock

Halting the decline of plant diversity is one of the greatest challenges facing the global conservation community. Nowhere is this more urgent than in the forests of Borneo, which have the greatest proportion of threatened vascular plant species in the tropics and the highest annual rates of deforestation. However, in order to address this problem, we need an understanding of what plant species occur in Borneo, where they are distributed and which ones are at greatest risk of extinction. Unfortunately, much of this information is not available. Our project aims to collate this information for Sabah, Malaysia. We have generated a working list of the higher plants of Sabah based on herbarium records and the published literature, and are in the process of compiling georeferenced datasets for these species. These datasets are being used to generate species distribution models and for conducting regional Red Lists assessments. Our preliminary results suggest that Sabah has in excess of 8000 plant taxa, of which over 1000 taxa are endemic to the State. Of the 300+ Sabah endemics that have been georeferenced to date, 89 taxa are known from a single collection locality. While most of these potentially hyper-endemics occur within Sabah's protected area network, approximately 25% are from areas with no formal protection. Of particular concern are the species that were collected from lowland areas in the north and west of the State. As the Sabah State Government is in the process of applying for jurisdictional Roundtable of Sustainable Palm Oil (RSPO) certification, any remaining natural forests in these areas needs to be considered of High Conservation Value (HCV).

Paper Number: 797
Poster Board: 85

Grassroots Conservation Initiative for Endangered Gibbon in Mentawai and Java

Arif Setiawan

Here we present recent fieldwork in Java and Mentawai Island for (*Hylobates moloch*) and (*Hylobates klossii*). Both gibbons are endangered living among human development pressure, hunting and habitat loss. We have been working with the communities to engage and building grass root initiative for sustainable conservation. A longterm initiative based on gibbon range population and distribution, selected for further conservation activities. Forest product such as coffee, palm sugars, and honey bees are entry points to involve community in conservation. In Java, since 2012 we have been mainstreaming primate conservation through shade grown coffee product from the habitat of gibbon, and to improve capacity of community member not only to promote the gibbon, but also enhance economic income. In Mentawai island, initiate community work just started with enhance knowledge of community to utilize value of nature resources to support their daily life. Here we learnt that conservation fieldwork should address economic problem to support conservation of gibbons and it's nature habitat, a product from habitat of gibbons and sustainable enterprise could be cultural identity will important to gain more attention among public and help conservation at grass root level.

Paper Number: 799
Poster Board: 86

Shifts in avian community composition and species movement across a tropical landscape

Jessica Hightower, Kalsum Mohd Yusah, Robert Fletcher

Deforestation over the last century has led to increasingly heterogeneous human-dominated landscapes, with novel habitats that often differ significantly from an organism's preferred habitat. Yet many species continue to persist in these novel habitats. However, it remains unclear what mechanisms facilitate the persistence of species outside of their preferred habitat. As part of a larger study to determine the mechanisms that allow for the persistence of species in these novel habitats, we investigated the patterns of avian species occurrence, abundance, and movement as a function of distance from the edge of a forest patch and the type of land cover surrounding the patch (i.e. the matrix). We addressed these issues at the Stability of Altered Forest Ecosystems, a large-scale experimental forest fragmentation project located in Sabah, Malaysia. We selected 8 study plots in two different matrix types: 1) forest fragments surrounded by forest that was recently logged, characterized by remnant trees, a dense secondary vegetation, and lacking a continuous canopy (n=4); and 2) forest fragments embedded within oil palm plantations (n=4). At each forest fragment we surveyed the breeding bird community using point counts and 100-m mist-net transects located in the interior of the forest fragment, at the edge of the forest fragment, 150 meters from the forest fragment edge, and 300 meters from the forest fragment edge. Our results indicated a difference between bird communities at each sampling location (interior, edge, 150 m, and 300 m) and between matrix types. Individuals were documented moving between sampling sites, with birds banded in the interior and edge found recaptured at sites located 150m from the edge. However, detection of movement into the matrix decreased in the sites located 300m from the edge. Overall, movement between edge and matrix type was only documented for a few species, primarily the Fluffy-backed Tit-babbler (*Macronus ptilosus*) and the Grey-headed Babbler (*Stachyris poliocephala*), both of which are forest birds, but who also occur in secondary habitat. Further research will help elucidate the mechanisms by which birds utilize heterogeneous landscapes. Understanding how birds continue or fail to persist in new habitats is essential to future conservation planning that may lead to improved management of human-dominated landscapes.

Paper Number: 804
Poster Board: 87

Boat operators of Klias and Weston River Cruise, Beaufort - Profiles, Business Practices And Perception Towards Tourists

Siti Rozziana binti Jeperi* Mahadimenakbar Mohamed Dawood¹ Fiffy Hanisdah Saikim²

Beaufort is well known as an agriculture and tourism district. Klias and Weston as a special ecotourism product has encouraged as an alternative income to the local community. Local community is becoming more involved and actively participating in the development of ecotourism of Klias and Weston, thereby taking the opportunity to enhance their social economic activities. The local community engagement and participation in tourism sector is crucial particularly to provide employment opportunities for local residents. Data for this study is gathered by distributing the questionnaires to 24 respondents selected from each of the river cruise operators. The purpose of this study is to evaluate the profile information of boat operators in Klias and Weston ecotourism site. Their involvement as boat operators is seen as a good way to raise living standards and thus reducing poverty among its population. The authorities should take the initiative in developing the tourism industry Klias and Weston without prejudice to the adverse effects on the economy, society and environment. The finding showed the majority of 15 people (62.5%) of boat operators started the business with RM0 to RM80, 000. The study revealed that only 6 people (26%) of boat operators earned RM1001 to RM2000 monthly income. Most of the boat operators earned Rm 500 - RM 1000 basis with at least one to three full-time boatman. According to the boat operators, the highest tourist visiting Klias and Weston is in February, June and September. For the Chinese tourist, 48.9% of respondents expressed the highest visit during Chinese New Year and July while for Korean during June, while the number for European and Japanese tourist is not consistent. This study also showed that Chinese tourist is the main visitors followed by Korean. This study indicated the concentration of tourist visiting Klias and Weston during school holidays. This study concludes that the success of international network encourages tourists to come to Beaufort and the participation of entrepreneurs to venture into business operations should be supported by strengthening their modal, as well as business management skills and leadership but the need for centralisation of ecotourism is a way of making sure the division of boatman income is above the medium income.

Paper Number: 805
Poster Board: 88

Developing genetic techniques to understand impacts of poaching on populations of critically endangered Helmeted Hornbills

Chloe Webster, Caroline Dingle

The critically endangered Helmeted Hornbill, *Rhinoplax vigil*, is at risk of being poached to extinction due to demand for the bird's solid, keratin casque, which is carved into jewellery and decorative ornaments. Most poaching is currently focused on Indonesian populations, however, recent seizures from Malaysia suggest poaching has expanded into new areas. Hong Kong is an important trading hub for Asia and is one of the main entry points for casques into China. Working with DNA extracted from seized casques in Hong Kong and elsewhere, we aim to 1) determine the geographic origin of seizures, thus helping to identify poaching hotspots and to monitor geographic changes in poaching effort and 2) estimate the sex ratio of seized birds in order to model the effects of poaching on wild populations and their ability to recover from their recent population declines. Working with the Hong Kong government, we have sampled DNA from casques across eight different seizures, and have sequenced a 450bp section of the D-Loop region of the mitochondrial genome. Our first results suggest that this gene is sufficiently variable to detect differences between geographically isolated populations of this species. We are now using this marker to develop a genetic map of variation across the range of the species. To achieve this, we are working in collaboration with local partners across the range of this species to collect and sequence samples of known origin from throughout the species' range. With this genetic database, we can match the genotypes of poached birds to geographic regions, allowing us to identify the origin of provenance of poached individuals. To determine sex ratios of poached birds, we have optimized a genetic sexing protocol to amplify a section of the CHD gene which differs in length between the W and Z sex chromosomes. Using this technique, we have identified the sex of all sampled casques. This sex ratio data can further provide understanding on how wild population demographics may be affected if poaching continue. We aim to make this genetic database available to researchers and governments all along the trade route to enhance enforcement and to better inform conservation efforts in order to protect this critically endangered species.

Paper Number: 807
Poster Board: 89

The Origin of a Common Urban Species: Natural Colonization or Human Introduction?

Leung Yu Yan, Caroline Dingle

The Red-whiskered Bulbul (*Pycnonotus jocosus*; hereafter bulbul) is a conspicuous frugivorous songbird native to tropical South and Southeastern Asia including India, South China, Indo-china region and most of the Malay-Thai Peninsula. This bulbul is also a popular cage-bird which has been introduced to and successfully established in multiple localities in the United States, Australia and islands of the Indian Ocean during the late twentieth century. In Hong Kong, the bulbul is the second most abundant breeding bird and one of the most important seed dispersing agents. However, early colonial-era surveys did not record this species in Hong Kong until 1904 when this bulbul was already described as abundant, leaving some question as to how this species came to exist in Hong Kong. While the bulbul is native to nearby regions and could have colonized Hong Kong by population expansion, the current bulbul population may alternatively be founded by individuals introduced via trade. To test our hypothesis that the birds are of introduced origin, we obtained genetic samples from 30 individuals across Hong Kong and sequenced two mitochondrial genes (COI and ND2). Comparing our results to sequences from birds of known origin archived in GenBank, we find that all of the Hong Kong samples fall into a geographically wide clade that includes South China, Indo-china region and the Malay-Thai Peninsula, not surprising given the geographical and morphological proximity. This same clade was also previously found to be the likely source of bulbuls that colonized Hawaii and Australia. However mitochondrial DNA alone does not provide sufficient resolution to separate birds from China and other potential source countries in the same clade. Our next step is to conduct genomic analysis using the more variable single nucleotide polymorphisms (SNPs) to investigate the finer genetic structure in the region and determine whether birds in Hong Kong is more closely related to that of China or other countries. Our work will clarify the contentious status of a locally abundant bird and shed light on the little known natural history of Hong Kong that shapes the contemporary avian diversity.

Paper Number: 810
Poster Board: 90

From genes to global climate change: Monitoring the diversity of a foundation tree species for resilient tropical forest restoration

Mohd Zulfazli Moktar

The 1982 to 1983 drought in Malaysia and Indonesia lead to catastrophic levels of wildfires that destroyed about 1 million hectares of forest in Sabah, Malaysia and some 4.5 million hectares of forest in Borneo (Borneo: Brunei, Indonesia (Kalimantan), Malaysia (Sabah and Sarawak). Most of the forest that were involved in wildfires had been over-logged leaving it vulnerable to burning during droughts compared to the unlogged forests. A large scale forest restoration endeavor, known as the INIKEA rehabilitation project (a collaboration between Sow-A-Seed Foundation of IKEA (Sweden) and Innoprise Corporation Sdn. Bhd.) set to restore 18,000 ha of degraded forest was implemented in 1998 to offset the negative impacts. Such restoration projects generally fail to consider genetic diversity or quality of the planting material and natural regenerating seedlings. Therefore, this study aims to evaluate the genetic diversity of planted and relic trees in the INIKEA rehabilitation site, which is one of the oldest and largest tropical forest restoration projects in South-East Asia. We present preliminary results on the evaluation of genetic diversity using nuclear Simple Sequence Repeat (nSSR) markers in one of the most important species of timber and carbon storage, *Shorea leprosula*, which is a large canopy emergent tree that is predominantly outbred from insect pollination. Samples of cambiums were collected from selected planted and relic mother trees, while young leaves were collected from their seedlings. DNA was then isolated and PCR amplification was performed at 10 nSSR loci. As the preliminary results, total of 94 DNA samples consisting of 47 planted and 47 relic mother trees were successfully amplified using all 10 microsatellite markers. These shows a positive result, which the microsatellite markers can be used as the genetic diversity indicator of this species.

Paper Number: 812
Poster Board: 91

Awareness and attitudes of urban and rural Malaysians on issues relating to wildlife and human-wildlife conflict

Vivek Thuppil

Malaysia is a middle-to-high income nation in Southeast Asia that aspires to become a developed nation within the next decade. Perhaps uniquely among nations of this stature, Malaysia also is home to many endangered megafauna, such as Asian elephants, tigers, leopards, and tapirs, among others found in Peninsular Malaysia alone. However, with rapid development and accompanying land use changes over the past few decades, all of these megafauna species have come under threat, with the Sumatran Rhinoceros having already been driven to extinction in Malaysia.

Therefore, understanding human awareness of and attitudes to wildlife issues is critically important. In this study, we assessed the awareness and attitudes of both urban and rural populations in Peninsular Malaysia (N = 731) toward large wildlife such as tapirs, elephants and tigers. Data were collected by semi-structured interviews via structured questionnaire. The urban populations were sampled in two types of locations in Kuala Lumpur and Taiping: i) in shopping malls and ii) in zoos. The rural population was sampled near the town of Gerik in the state of Perak in areas where human-elephant conflict was known to occur.

Location of interview was an independent variable with three levels: i) mall in an urban area (Taiping & KL), ii) zoo in an urban area (Taiping & KL), and iii) rural area (Gerik). Other independent variables tested in this study comprised of socio-demographic parameters such as: i) Gender, ii) Education level, and iii) Interest in nature. The dependent variables were the awareness and attitude scores of the participants. We found that awareness of wildlife issues was significantly lower among the urban population sampled at the mall compared to the urban population sampled at the zoo or the rural population. There was no significant difference in awareness between the urban population sampled at the zoo and the rural population. Pro-wildlife attitudes were significantly lower among the rural population compared to the urban populations sampled at either the mall or the zoo. There was no difference in pro-wildlife attitudes between the two urban populations. Our findings confirmed our hypotheses. While the rural population had the highest awareness of wildlife issues, likely due to their proximity to wildlife, their lower pro-wildlife attitudes were likely due to their experience with human-wildlife conflict. Both urban and rural populations exhibited a lack of awareness on several important issues and showed scope for improvement on attitudes on various wildlife issues.

Paper Number: 819
Poster Board: 92

Land use change on arthropods communities at swamp forest of East Jambi – Sumatra Island, Indonesia

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The increasing demand on agricultural product (such as palm oil plantation and areca plantation) has the impact on swamp forest ecosystem. Other than that forest fire also has significant impact especially on arthropods communities. The objectives of this research is to find out the effect of land use change on soil arthropods communities. Seventy five of pitfall trap was set at four different habitats: (secondary forest, oil palm plantation, areca garden and post forest fire). The study was conducted at the area of swamp forest at East Jambi Sumatra Island. Arthropods identification was done up to morphospecies level. The results found 1901 individuals of soil arthropods which belongs to 73 species or from 39 families. They are phytophagous (Cicadidae, Grillidae), pollinator (Diptera, Drosophilidae), predator (ground spider of Gnaphosidae), scavenger (Isopod, Philoscidae) and grazer (springtail of Neanuridae). At secondary forest arthropods community dominated by ants and predators. Considering the secondary forest as reference area, the number of individuals at palm oil plantation and areca garden was lower than the secondary forest (33.5% and 13.3%). The same tendency on the species richness that was the secondary forest was the highest (6.2) followed by oil palm plantation (5.25) and areca garden (3.8). The forest fire has significant impact on soil arthropods community, all runs out. Two month after forest fire, arthropods community colonised the area and the number of individuals is about 37% of the secondary forest.

Paper Number: 820
Poster Board: 93

Herb Layer Diversity Of Savanna Physiognomy In Yunnan, China

Mengqi Zhang

Savannas in Asia are mostly perceived as degraded forest landscapes caused by anthropogenic disturbance, even though fossil evidence, C4 grass diversity and climate suggest savannas were historically extensive in Asia. Because they are treated as secondary forests, they receive low conservation priority and necessary disturbances such as fire are suppressed, potentially leading to further degradation. A substantial component of savanna plant diversity is in the herb layer but this has been poorly documented both in Asia and worldwide. Understanding the herb layer diversity of regional savanna communities and understanding how they respond to fire are essential steps to developing appropriate management strategies for these communities and limiting further loss and degradation.

We sampled herb diversity in forty-five plots with savanna physiognomy across the whole of Yunnan Province, southwest China, and with different fire frequencies. Presently savanna communities are only officially recognized in the deep dry valleys of Yunnan. We specifically wanted to know: (i) Are there different savanna communities present in Yunnan? Do these extend beyond the dry valleys? (ii) If so, what climatic or soil drivers explain their distribution? (iii) Does fire have positive or negative effects on herb diversity within the community types?

We did data analysis with software R using cluster analysis, ordination and general linear model (GLM).

We found that (i) there are two savanna communities in Yunnan, valley savanna and montane savanna, extensively represented across Yunnan; (ii) valley savanna is found at higher temperatures, lower rainfall, and higher soil pH and extends far beyond the presently designated areas; montane savanna is found at higher elevation and rainfall slopes and ridges from northwestern to eastern Yunnan (iii) We found that fire positively affects plot-level species richness in valley savanna but negatively affects richness in montane savanna.

Our results suggest that savanna might be present outside the dry valleys in Yunnan, possibly providing a new thinking of biodiversity conservation plan and fire policy for these areas.

Paper Number: 821
Poster Board: 94

MtDNA and MHC diversity of captive tiger (*Panthera tigris*) in Thailand: A case study for captive breeding improvement

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Maintenance of genetic diversity observed in the wild is the crucial component to achieve effective captive management and conservation of threatened species. Tigers (*Panthera tigris*) in the wild have drastically declined worldwide and genetic management of their captive counterparts is one of the crucial components to ensure their recovery. In this study, we characterized genetic diversity of captive tigers in Thailand using hair samples and 4,540-bp mtDNA diversity (concatenated ND1, ND2, ND5, ND6, and cytochrome b). We also determined functional variation critical for pathogen recognition and disease resistance based on alpha-1 and alpha-2 domains of major histocompatibility complex (MHC) class I and beta-1 domain of DRB gene of MHC class II. Of the 13 individuals, nine individuals (three haplotypes) were clustered with the Indochinese tigers (*P. t. corbetti*), whereas the other four individuals (two haplotypes) were assigned to the Bengal tigers (*P. t. tigris*). Of the three *P. t. corbetti* haplotypes, two haplotypes (COR1, CORBETT11) were previously described both in the wild and captivity. The other haplotype (CORc) was newly discovered and could represent historical variants that have been lost from existing wild populations in Southeast Asia. For the captive Bengal tigers, both haplotypes were previously detected in wild tigers from northeastern India (TIG25) and central India (TIG12). Regarding adaptive MHC variation in both Indochinese and Bengal tigers, we detected high level of polymorphism from MHC class I (17 alleles) and class II (14 alleles), indicating positive selection in the peptide-binding sites. Phylogenetic analyses showed that class I and class II alleles from our samples were closely related to lineages in tigers and other felids, suggesting trans-species polymorphism. In addition, high MHC diversity also supported that captive programs were successful in maintaining founders with enhanced resistance to a diverse array of pathogens. The verified neutral and adaptive genetic diversity in captive tigers is useful to develop conservation strategies and breeding schemes that retain genetic variability of both neutral and adaptive loci in founders aimed for future reintroduction.

Paper Number: 839

Poster Board: 95

Spatial Distribution of Sabah's Endemic Trees and Shrubs

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Land conversion is a major cause of habitat loss in the tropic and continual destruction will lead to significant species loss. Endemic species are potentially at greater risk of extinction due to their limited distribution. Sabah has more than 1000 taxa of endemic plants, understanding their spatial distribution is crucial for their conservation. This study focuses on modeling the distribution of 589 taxa of trees and shrubs endemic to Sabah. Past collection records are being compiled from herbarium specimen, the published literature and recent plot surveys. The localities data is being georeferenced using the GBIF standard protocols. We used Maxent to generate species distribution models (SDMs) for species with more than 10 collection localities. Environmental layer used in this modeling were altitude, soil association and four bioclimatic variables (BIO 1, BIO 12, BIO 13 & BIO 14). Models are being converted to binary outputs using MaxSSS as the output threshold. The SDMs are being further validated through ground survey. To date, a total of 150 species have been georeferenced. The AUCs for the Receiver Operating Characteristic (ROC) curve for the test data varied from 0.767 to 0.995. Our preliminary result show that most of these species are represented within the PA network in Sabah, except for few lowland species found outside of this network. Of particular concerns are the endemics that were restricted to lowland areas in the north and west of the State. The result of this study can aid the Sabah Forestry Department in prioritizing new conservation area, so as to safeguard these species.

Paper Number: 840

Poster Board: 96

Transitions to Sustainable Livelihoods to Reduce Threats to Biodiversity in North Sulawesi, Indonesia: Lessons From the Behaviour Change and Sustainable Transition

Ance Tatinggulu

Selamatkan Yaki (SY: Indonesian for “Save the macaques”) is an education, research and conservation programme focused on protecting the Critically Endangered Sulawesi crested black macaque (*Macaca nigra*) and its native habitat of North Sulawesi, Indonesia. Due to habitat loss and hunting these endemic primates have experienced population declines of over 80% in the past 40 years. SY aims to protect macaques and the rich biodiversity of North Sulawesi through a collaborative, multi-stakeholder conservation strategy.

A multitude of approaches to the conservation objectives comprise extensive demographic, attitudinal and ecological monitoring, an education and awareness raising strategy, protected area management and ecotourism. A focus on social diffusion is applied via the “two-step approach” – empowering local role models ranging from religious leaders, youth representatives and celebrities to spread the conservation message and assist in removing barriers to effective behaviour change. Long-term cooperative efforts aim to reduce biodiversity pressures with development of a sustainable livelihood strategy. Sustainable livelihood approaches (SLAS) aim to reduce the prevalence of activities deemed to be environmentally detrimental by substituting them with lower impact livelihood practices that provide at least equivalent benefits to increase income and wellbeing of rural communities.

Proposed interventions need to talk to the specific needs, aspirations, natural resources and capacities of the target community, and fit within current policy frameworks. Communities should not feel “pushed” towards change, instead be “pulled” by the opportunity for change, diversification and economic growth. Transitions should be part of a systems approach, appreciating the complexity of both structural and individualistic factors, maintaining sensitivity to communities’ needs and continually monitoring key variables for change.

The systematic review of an early-stage case study identified pressures and varying dependence on natural resources in key villages and relatively high deforestation and hunting rates in buffer zones. Surveys also found the majority of proposed participants with low average income predominantly from agricultural practices, in favor of novel livelihood interventions. Key sample sizes for suggested trials were established, selecting four pilot villages with the highest feasibility ratings signifying hydroponics, permaculture and sugar palm tapping as trial interventions. Building on results of the systematic review, lessons from behaviour change and sustainable transition approaches are integrated into a livelihood strategy, guiding the process of trials currently underway and the means to integrate into models of sustainable livelihoods.

Paper Number: 841
Poster Board: 97

Experimental rain forest fragmentation and an extreme climatic event drive reductions in canopy ant abundance and species richness

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Logging of forest, conversion to agriculture, and subsequent fragmentation of remaining forest are major drivers of biodiversity loss in tropical ecosystems. In Malaysia, the main driver of this process is expansion of oil palm plantation. Ants are an important ecological group in these landscapes, and the species that live in the canopy are expected to be vulnerable to these changes. Here we report on results of surveys of canopy dwelling ants before and after experimental fragmentation of logged forest at the Stability of Altered Forest Ecosystems (SAFE) project, and also along an unmanipulated gradient of habitat degradation, from primary forest, to logged forest to oil palm plantation. The second sampling period also coincided with an El Nino event, with much hotter, drier weather. We found that before experimental fragmentation, canopy ant species richness decreased with increasing habitat degradation (primary forest>logged forest>oil palm plantation), while ant abundance was highest in logged forest sites. Following experimental fragmentation (and during the El Nino), species richness significantly decreased in some forest fragments, with the magnitude of the difference being greater in smaller fragment sizes. Interestingly, although species richness in unmanipulated primary and logged forest did not change, there was a significant reduction in canopy ant species richness in unmanipulated oil palm plantation. This indicates that the El Nino event had a greater impact in more degraded habitats, and also means that further post-El Nino sampling is required to tease apart impacts of climate and fragmentation on canopy ant species richness. Canopy ant abundance was reduced in forest fragments, with greater decreases in smaller fragments. There were no changes in ant abundance in any unmanipulated control habitats. Taken together our results indicate that synergistic impacts of climate change and habitat fragmentation can negatively affect canopy ant communities, and that utility of logged forest fragments for conservation of canopy ant biodiversity increases with fragment size over the range 1-100 ha. This also emphasises the need to assess forest fragment suitability for biodiversity during climatic conditions most likely to have negative impacts on communities, and also argues for ongoing monitoring of biological communities in forest fragments.

Paper Number: 842
Poster Board: 98

High Carbon Stock Forest in an Oil Palm Landscape in East Kalimantan: Provide Benefits for Biodiversity Richness

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Savannas in Asia are mostly perceived as degraded forest landscapes caused by anthropogenic disturbance, even though fossil evidence, C4 grass diversity and climate suggest savannas were historically extensive in Asia. Because they are treated as secondary forests, they receive low conservation priority and necessary disturbances such as fire are suppressed, potentially leading to further degradation. A substantial component of savanna plant diversity is in the herb layer but this has been poorly documented both in Asia and worldwide. Understanding the herb layer diversity of regional savanna communities and understanding how they respond to fire are essential steps to developing appropriate management strategies for these communities and limiting further loss and degradation.

We sampled herb diversity in forty-five plots with savanna physiognomy across the whole of Yunnan Province, southwest China, and with different fire frequencies. Presently savanna communities are only officially recognized in the deep dry valleys of Yunnan. We specifically wanted to know: (i) Are there different savanna communities present in Yunnan? Do these extend beyond the dry valleys? (ii) If so, what climatic or soil drivers explain their distribution? (iii) Does fire have positive or negative effects on herb diversity within the community types?

We did data analysis with software R using cluster analysis, ordination and general linear model (GLM).

We found that (i) there are two savanna communities in Yunnan, valley savanna and montane savanna, extensively represented across Yunnan; (ii) valley savanna is found at higher temperatures, lower rainfall, and higher soil pH and extends far beyond the presently designated areas; montane savanna is found at higher elevation and rainfall slopes and ridges from northwestern to eastern Yunnan (iii) We found that fire positively affects plot-level species richness in valley savanna but negatively affects richness in montane savanna.

Our results suggest that savanna might be present outside the dry valleys in Yunnan, possibly providing a new thinking of biodiversity conservation plan and fire policy for these areas.

Paper Number: 847

Poster Board: 99

A Comparison of Tree Diversity across a Multiple-Land-Use Gradient in GoM-UNDP-GEF Project Area, Luasong, Sabah

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Tropical forests function as a storehouse for carbon and biodiversity. However, this function is being threatened by unsustainable land-use changes. Multiple-use forest management (MFM) has been put forward as an approach to address this issue. Under MFM the forests are managed for multiple purposes, with the over aim of reconciling biodiversity conservation and the commercial exploitation of these forested landscapes. With Sabah's forest policy urging more Forest Management Unit holders to adopt a multiple-use forest management approach, understanding how biodiversity and aboveground carbon density respond to these changes is crucial. This study was carried out in GoM-UNDP-GEF project area in Luasong, Sabah. The aim of this study was to investigate 1) the impacts of land-use change on tree diversity and species composition and 2) the relationship between aboveground carbon density (ACD) and tree diversity. Twenty-two circular plots of 30 m² radius were established in protected areas (13 plots), mosaic planting areas (4 plots), and salvage-logged areas (5 plots). All trees greater than 10 cm DBH were enumerated. Estimates of ACD were obtained from a 0.1 ha resolution carbon map produced by Carnegie Airborne Observatory-3. We found that tree species diversity was significantly higher in protected areas (193 species), compared to mosaic planting areas (91 species) and salvage-logged areas (33 species). There were also observable shift in dominant tree families among the land uses. The protected areas were dominated by the Dipterocarpaceae, whereas the salvage-logged areas were dominated by the Euphorbiaceae, showing the impacts of salvage-logging in altering tree composition. Tree diversity and ACD showed a significant positive relationship ($p = 0.02$) at 0.28 ha spatial scale, suggesting that High Carbon Stock (HCS) areas contain high tree diversity and therefore, should be prioritized for protection.

Paper Number: 856

Poster Board: 100

The spatial distribution and conservation status of the endemic Orchids of Sabah

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Habitat loss, habitat degradation and over collection are the leading causes of population declines of Orchids. Under Aichi Biodiversity Target 12, COP members are required to prevent the extinction of known threatened species by the Year 2020. However, only a small portion of the world's Orchid flora has been evaluated for inclusion on the IUCN Red List. In Sabah which has more than 1300 species of Orchids, only 1.90% of the species are listed on the Red List. This study focuses on the 287 species that are endemic to the State and aims to develop species distribution models (SDMs) and assess their IUCN Red List status. This work will allow us to determine which species are threatened and where they occur. To address this, we are compiling datasets for these species based on herbarium records, published literature and inventories from recent expeditions. Collections without coordinates are being georeferenced following standard protocols. SDMs are being generated for species with more than 10 collection localities using MAXENT with soil association, altitude and four bioclimate variables (Bio1, Bio12, Bio13 & Bio14) as the environmental layers. An IUCN Red List assessment is being conducted using the standard IUCN protocols. Currently, datasets have been compiled for 73 species. Of these, 15 species have undergone a Red List assessment, with ten species categorized as Vulnerable (VU D2), 4 species as Least Concern (LC) and one species evaluated as Critically Endangered (CR A2c). Species distribution models have been produced for 19 species. The AUCs for these models varied from 0.838 to 0.998. For most species, soil association and altitude had the highest relative contribution (Average range: 33 to 42%) to the Maxent models. Our preliminary analysis suggests that the majority of these species are found within the mountainous regions of Sabah, most of which are designated as protected areas. While habitat loss does not appear to be a significant threat to most of the Orchids examined to date, some species are at risk due to illegal collecting. The distribution maps and Red List assessments generated by this study are being utilised by ongoing conservation planning exercises currently being undertaken in the State.

Paper Number: 863

Poster Board: 101

Promoting the application of conservation science among undergraduate students: a case study from Sri Lanka

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Protected Area Management (PAM) is a conservation science module taught at the Sabaragamuwa University, where undergraduates receive hands-on experience in addition to classroom lessons. Geographical location of the university provides easy access to several wildlife protected areas (PAs) where ground-level staff protect and facilitate the sustainable use of wildlife. Inadequate transfer of knowledge and limited understanding of conservation science often affects their decision making process. In an attempt to reverse this trend, the PAM module was used to bring together students and conservation practitioners of Lunugamwehera National Park (23,498 ha), which is located in the dry zone of Sri Lanka. Several scoping meetings were held to identify the expectations of the park staff and the students. Lunugamwehera, regardless of its rich biodiversity, has limited tourist visitations and a very high rate of poaching. Students conducted multiple surveys to assess requirements for tourism development. Twenty five park staff members were interviewed to identify management challenges and training needs. Almost 90% the staff identified poaching, cannabis cultivation and Human Elephant Conflict (HEC) as major issues related to the park. Wildlife crimes were profiled to identify trends and causes. Poaching accounts for 27% of all reported crimes, while cannabis cultivation and illegal fishing accounts for 37% and 15% respectively. 75 local community members were interviewed to analyze their perception of the park, nature of Human-Elephant conflict, interactions with the wildlife staff and how to maximize benefits for the communities. 96% of villagers proposed the tourism sector to be developed to facilitate their livelihoods. Another survey was conducted in the adjoining (proposed) Wetahirakanda elephant corridor to assess matters pertaining to relocation of people. Agriculture and development has resulted in fragmentation of elephant habitats and the survey of 35 families provided data on land-use issues pertaining to the release of this corridor, if declared could help minimize HEC. Through these activities, students gained experience and learned how to be proactive in their interactions with the practitioners. Activities implemented based on above surveys include engaging wildlife field staff in training events on ecological techniques and research methods, networking opportunities in academic field training events conducted within protected areas, placements within local and international research groups, facilitation of group research and publications by the field staff, provision of field equipment for research and patrolling, providing publicity through media and communicate staff requirements to authorities and external bodies.

Paper Number: 869

Poster Board: 102

Temporal Changes in Forest Structure and Tree Species Composition Due to Hydropower Plant Construction in Hulu Terengganu, Malaysia

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Knowledge on the forest structure changes is crucial to determine the forest dynamic and to project the future forest composition. Hulu Terengganu, Malaysia was subjected to hydropower plant development. After the dam construction and impoundment, three forest habitat types were identified namely lowland dipterocarp forest, secondary forest, and isolated island forest. Over one-year period, all trees including seedlings were measured and monitored in a 5 m × 5 m permanent plots within three different micro-habitats that of forest edge, ridge and islands. The seedlings were monitored in 1 m × 1 m quadrats within the permanent plots. Our initial data collected in January 2017 showed forest edge had the highest number of individuals with 134 records from 36 families, 58 genera and 72 species compared to ridge with 89 individuals (eight families, nine genera and 11 species) and islands recorded 59 individuals (nine families, 15 genera and 20 species). Forest edge also showed the highest density with 6700 ind./ha in 0.02 hectares compared to ridge (1780 ind./ha) in 0.05 hectares and islands (1395 ind./ha) in 0.04 hectares. Despite the difference in floral composition, these habitats had the same dominant species that of *Macaranga* sp. indicating that the area were in the early stage of regeneration. The tree stand structure for these three areas fall between 1.0 cm – 10.9 cm diameter class, with forest edge at 86.6%, ridge with 96.0% and islands at 100%. This initial data will be compared with our recent data in 2018 to observe the temporal changes in forest structure and tree species composition on these three habitats. We predict the changes of forest structure tree composition would differ between the three micro-habitats. The dynamics of the tree species within one year can later be concluded.

Paper Number: 873
Poster Board: 103

Tree diversity and composition recovery after selective logging in Bornean lowland forest

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Biodiversity losses from deforestation and selective logging may be partially offset by the recovery and expansion of the secondary forests in the tropics. The recovery of forests from selectively logging is of particular importance for biodiversity conservation especially in South East Asia, where relative deforestation rate is the highest among any major tropical regions and selective logging is a widespread harvest technique. In Borneo, despite the key role of selectively logged forests in human-altered landscape, information on the speed and extent of secondary forest recovery remains scarce.

Using 38 permanent plots (25 x 25 m each) within the Stability of Altered Forest Ecosystems (SAFE) Project in Sabah, Malaysian Borneo, we studied the dynamics of tree diversity and composition along the logging gradient (ranging from heavily, moderately, and lightly logged stands to old-growth forest). To capture annual demographic changes in composition and diversity both for trees in the main canopy and the lowest strata, we recorded growth, mortality and recruitment of all trees with diameter at breast height (dbh) ≥ 1 cm in each plot, yearly in 2011–2018.

While we found that beta diversity increased with the intensity of logging, and the most heavily disturbed plots exhibited the greatest interannual changes in species composition and diversity, despite the highest species turnover in the most heavily logged stands, the trajectory of species composition in these plots has not been approaching the old-growth forest. In heavily logged forests, there were no signs of recovery in terms of species composition and diversity, and pioneers still dominated in the plots whereas dipterocarps (late successional species) failed to increase both its abundance and basal area even after many years since logging. Because the majority of lowland tropical forests has been already affected by logging to some degree, our results emphasized the widespread long-lasting consequences of heavy selective logging for tree composition and diversity in these forests.

Paper Number: 874
Poster Board: 104

Population Genetic Structure Of Malayan Tapir (*Tapirus Indicus*) In Peninsular Malaysia

Qi Luan Lim

Malayan Tapir (*Tapirus indicus*) is one of the big mammal in Peninsular Malaysia. Despite being listed as an endangered fauna, little is known about its population in Peninsular Malaysia especially the population genetic structure. In this study, microsatellite markers were developed and amplified in Malayan Tapir samples from Peninsular Malaysia to infer their population structure. A total of 42 microsatellite markers were screened, 34 of which were originally isolated from three Neotropical tapir species, and eight were isolated from Random Amplified Microsatellite (RAM) genomic sequences. Twenty-three markers (54.8%) successfully produced expected peaks in capillary electrophoresis. Samples of 43 tapirs from seven putative populations (4-9 individuals per population) were provided by PERHILITAN and local zoos (sample collection in 2005-2016). Genotypes of the 43 tapirs at the 23 loci were obtained by fragment analysis, and eight polymorphic markers (frequency of common allele $\leq 95\%$) were revealed. Fisher's exact test on Hardy-Weinberg Equilibrium (HWE) showed that HWE was conformed in all eight markers and seven putative populations. Genetic indices across populations and loci: means of number of alleles, number of effective alleles, observed heterozygosity, expected heterozygosity were 2.2, 1.7, 0.35, 0.34 respectively. The F-statistics, F_{is} and F_{st} , were estimated at -0.030 and 0.13 respectively. These indices suggested low genetic diversity and low to moderate genetic differentiation between the sampled populations. However, population structure analysis through the pipeline of STRUCTURE, STRUCTURE HARVESTER and CLUMPAK revealed no structure across the sampled populations. Nevertheless, Principal Coordinate Analysis (PCoA) revealed weak clustering which seem to correspond to geographical distribution, especially between eastern and western populations. In conclusion, eight microsatellite markers were developed for Malayan Tapir. These microsatellite markers may serve as genetic tools for future conservation management and population studies of Malayan Tapir. Even though no distinctive structure was found in Malayan Tapir population in Peninsular Malaysia, the detected genetic differentiation possibly associated with geographical isolation coupled with habitat fragmentation may further increase the genetic differentiation and diminish the genetic diversity as the population size continues to decline. Development of more informative microsatellite markers and more studies would be needed to study the contemporary tapir populations.

Paper Number: 876
Poster Board: 105

Linking RSPO Compensation to Village Forest. Case Study: Laman Satong Village Forests

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Palm oil is the biggest contributor to Indonesia's foreign exchange in 2017 and the major driver of deforestation. RSPO, as a leading organization in certifying Sustainable Palm Oil, has developed a schema (RaCP) to remediate and compensate any deforestation caused by the palm oil company. One of the high priority areas to channel RaCP is village forest (Hutan Desa). The objective of this study is to assess the feasibility of RaCP in community forests against the RaCP principles of long-lasting, knowledge-based, additional and equitable. Our findings show that channeling RaCP to community forests might provide greater benefits for biodiversity conservation, livelihood improvement, and climate change mitigation if it has fulfills social, environmental, and institutional safeguards or pass international standard (i.e. Plan Vivo). Our case study shows an increase in community livelihood, forests protection, and carbon sequestration due to better management of forest in Laman Satong Village. With a long support from the RaCP schema, we believe this model can be replicated in another village forests that have complied with international requirements.

Paper Number: 877
Poster Board: 106

Linking Conservation and Local Tradition in Sub-District Gunung Raya, Kerinci to Enhance Public Awareness to Conserve Nepenthes

Hernawati

Sub-district Gunung Raya, Kerinci is located outside of Kerinci Seblat National Parks (TNKS). At least 8 study sites of *Nepenthes* exist in this sub-district with several *Nepenthes* species and some natural hybrids. In last two decades, Gunung Raya has been develop to a tourism destination, because of originality traditional culture and the beauty of nature of Gunung Raya. In addition of the richness *Nepenthes* diversity, a privileged of *Nepenthes* in Gunung Raya is utilization of *Nepenthes* in traditional custom ceremony that carried out each year. This condition will be a good opportunity to educating communities to care with their natural resources especially for *Nepenthes* that have been popular as a symbols of tradition. In context of educating peoples to conserve *Nepenthes*, traditional use of *Nepenthes* in Gunung Raya will give a good impact to create a model for conservation education. Overall goal of this research is to create a pilot project for conservation education from study sites of *Nepenthes* Team and integrate the result of the study in the field with local collaboration networking and education through socialization to ensure the success of conservation effort for the species of *Nepenthes* in sub-district Gunung Raya, Kerinci. Purposes of the project is to create an inovative education method for conservation of *Nepenthes* through creative media or another action so that the conservation messages got to the public communities. Result of the study is 1) updating population data for the existence of *Nepenthes* at sub-district Gunung Raya, 2) shared the result of the study through socialization to public community and stakeholder, 3) creating a campaign media to promote the exotism of *Nepenthes*, encourage peoples to save their traditional culture and conserved their natural resources.

Paper Number: 881
Poster Board: 107

An Investigation on Water Deficit in Forest of Peninsular Malaysia from 1950-2016

Zan Hui Lee

1. Introduction

An enhancement of rainfall seasonality in Southeast Asia from future climate projection suggests an increased risk of water stress for natural ecosystems and manmade water resources reservoirs.

2. Objectives

Therefore, this study aims to investigate the severity of water deficit in Peninsular Malaysia's over the last 67 years (1950-2016), particularly focuses on the forest catchments at Ulu Muda, Belum Temenggor, Hulu Terengganu and Hulu Langat with addition of a peat swamp forest from southeast Pahang.

3. Methods

Cumulative water deficit (CWD), an index of meteorologically-induced water stress was utilized to assess the drought condition in the forest catchments.

4. Results

This study found that the primary dry and wet seasons in these forest catchments are January/February-March and October-November-December, respectively. However, this is not the conventional season for climatological analysis in this region, whereas December-January/February is often addressed as the wet season in Peninsular Malaysia. The forest catchments with high seasonality are more susceptible to seasonal water deficits, which are shown in the northwest (Ulu Muda) and east coast (Pahang and Hulu Terengganu) forest.

Seasonal CWD with high intensity was mainly associated with long duration of drought, which can be observed during the La Nina, neutral, and El Nino phase. For case studies, the seasonal CWD with high intensity was desegregated into months for investigating maxima cumulative water deficit (MCWD). High magnitude of peak CWD or maxima cumulative water deficit (MCWD) was proven to be determinative on die-back effect in tropical rainforest and the biome boundary. In general, Ulu Muda and Hulu Terengganu, which experience drought the most, when affected by long duration of drought was observed to have MCWD values of about -250mm. As the driest study site, Ulu Muda, was recorded nearly -315mm during the strong El Nino year 1998, exceeding the defined savanna transition threshold (<-300mm).

5. Implications

Forest viability for its ecosystems and services as water catchment is a priority for adaptation plans under future climate changes. Water reservoirs in Ulu Muda forest are important for water supply to the Northern Corridor Economic Region in Peninsular Malaysia. However, logging activities was reported to be degrading the water quality. Considerable efforts to conserve the forest catchment is essential for the adaptation to climate changes, particularly to ensure the forest viability and the functional ecosystem services as a water catchment.

Paper Number: 883
Poster Board: 108

Songbirds and visitor pressure: Implications for conserving two songbirds threatened by the pet trade in an offshore island

Fathima Rafi

Pulau Ubin is an island lying between Singapore's main island and the mangrove-dominated southern coast of the Malaysian state of Johor. Ubin is the last rural remain of Singapore. Once a rubber plantation, Ubin was subsequently cleared of its mangroves for prawn farming in addition to granite quarries from which it got its name. Ubin is famous among cyclists both amateur and veteran and has mountain bike trails especially for the veterans. However, Ubin has provided safe homes to many birds around the region threatened by the songbird trade. This study aims to identify if Ubin truly provides a safe home to Straw-headed bulbul (*Pycnonotus zeylanicus*) and White-rumped shama (*Copsychus malabaricus*) by understanding its distribution and its correlation with the trails and anthropogenic noise levels. Point counts were used for aural and visual surveys followed by distance sampling of more than fifty sites from 7am-11am May-June 2017. The number of visitors and vehicles passing by were used as proxy for noise levels. Most Straw-headed bulbul records were aural while White-rumped shama was visual owing to their occupancy of canopy and ground vertical stratification layers. The results showed that there was a negative correlation between number of individual birds recorded and noise levels as well as the number of trails and the proximity to the jetty. However, mountain bike tracks had a greater impact on White-rumped shama relative to Straw-headed bulbul.

Pulau Ubin recently recorded increasing trends of Straw-headed bulbuls thus making it an oasis to birds undergoing pressures from the wild bird trapping occurring relentlessly in the rest of the Southeast Asian region. Therefore, measures should be taken to zone highly sensitive areas during breeding seasons to ensure that populations are least affected due to anthropogenic causes. Populations in Pulau Ubin have a high potential to serve as a stock in future conservation efforts and hence could be prevented from undergoing a genetic bottleneck.

Paper Number: 895
Poster Board: 109

Effect of *Acacia auriculiformis* and *Eucalyptus globulus* leaf litter on the life-history traits of *Microhyla ornata* tadpoles and zooplanktons

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Terrestrial leaf litter are an important source of organic matter in freshwater ecosystems. In smaller water bodies (e.g. temporary pools) the type and amount of leaf litter flowing into it can strongly affect the life-history traits of aquatic vertebrates and invertebrates. By conducting two outdoor mesocosm experiments, we explored how (a) different types of leaf litter (two non-native tree species - *Acacia auriculiformis* and *Eucalyptus globulus*), and (b) different amounts of leaf litter (of *E. globulus*), affected the life-history traits in tadpoles of a native burrowing frog (*Microhyla ornata*; 25th Gosner stage) and population dynamics and composition of zooplanktons (*Daphnia*, Copepods and Ostracods).

In the first study (litter type) we setup 18 mesocosms (30L plastic tubs) in blocks of three, each with either no litter, 8g *A. auriculiformis* dry leaf litter, or 8g *E. globulus* dry leaf litter. Here we did not find any effect of leaf litter type on tadpole survivorship ($P=0.36$) or proportion metamorphosis ($P=0.57$). However, leaf litter type strongly affected zooplankton relative abundance across time ($P<0.001$). In particular we found very low abundance of *Daphnia* in the *Acacia* and *Eucalyptus* treatments.

In the second study (litter amount), we setup 20 mesocosms (30L plastic tubs), in blocks of four, each with either no leaf litter (control), 8g dried *Eucalyptus* leaf litter (low), 40g dried *Eucalyptus* leaf litter (medium) or 80g of dried *Eucalyptus* leaf litter (high). Here while *Eucalyptus* litter amount did not affect tadpole survivorship ($P=0.23$) or proportion metamorphosis ($P=0.82$), it did affect tadpole weight at metamorphosis ($P<0.01$). Zooplankton abundance was significantly affected by leaf litter amount and time (Treatment*Time: $P=0.03$). To conclude, while non-native leaf litter (typical of monoculture plantations in India) largely did not affect life-history traits in tadpoles of a native frog, it did have strong effects on zooplanktons, particularly *Daphnia*. Future studies should not only test the effect of these leaf litters on other native frog species that coexist with *M. ornata* (namely *Kaloula taprobanica*, *Ramanella variegata* and *Microhyla rubra*), but also how these litters affect interspecific interactions, both with competitors and predators (via visibility).

Paper Number: 908
Poster Board: 110

Ecological selectivity of extinction risk in terrestrial vertebrates

Maya Munstermann

The current rate of extinction in terrestrial vertebrates globally exceeds background intervals in the fossil record and may rival rates of extinction during the “big five” mass extinctions. In order to better understand the ecological selectivity of extinction threat associated with the global biodiversity crisis and thereby better predict consequences for ecosystem function, we investigated the relationship between extinction threat and functional traits of terrestrial vertebrate species. Using a database of all 34,043 species of terrestrial vertebrates and conservation status for 25,653 species based on the International Union for Conservation of Nature Red List, we have thus far assigned 11,503 species to an ecological mode of life, which is defined by the combination of each species’ habitat association, motility, and feeding mode. We used a generalized linear mixed model with taxonomic class as a random effect to analyze the association of extinction threat with ecological mode along each of the three above defined niche axes. In this data set, we find that ecological modes differ significantly in the prevalence of extinction threat even after accounting for effects of phylogenetic dependence. In terms of habitat association, species that live on the ground surface or live partially below ground are significantly more likely to be threatened with extinction than species from other habitat types. In respect to motility, we find significantly greater threat levels for brachiating, jumping, slithering, and flying species and a reduced threat for species that walk, run, are parasitic, or use peristalsis. For feeding, scavenging, foraging, browsing, and grazing species are significantly more threatened than predators, deposit feeders, miners, or parasites. These results may help guide the development of improved conservation and management strategies by identifying which ecological attributes are most likely to make a species more susceptible to extinction.

Paper Number: 911
Poster Board: 111

Developing an underdominance gene drive system in the southern house mosquito

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Since its initial introduction to Hawaii, avian malaria has decimated native Hawaiian forest bird populations. The main vector for avian malaria, the southern house mosquito (*Culex quinquefasciatus*), continues to threaten the native birds and will become an even larger threat with global warming expanding the range in which both the vector and disease can develop. We are developing an underdominance gene drive system in the southern house mosquito to transform wild mosquito populations to carry an avian malaria refractory gene, in order to mitigate the decline of native Hawaiian birds. An underdominance gene drive has safety measures in that the spread of the transgene is resistant to migration and the transgene can be removed from the population if desired. Such a system has already been developed for the model organism, *Drosophila melanogaster*, and we recently showed that this system has remained stable for over 200 generations. In the current study, we aim to adapt our underdominance gene drive system for use in mosquitoes for the first time. We have successfully established lab colonies of the southern house mosquito and are in the process using microinjection techniques to integrate a synthetic construct into the southern house mosquito genome. This synthetic construct contains a self-docking site which will allow subsequent injections of additional constructs, such as a construct that engineers underdominance and an avian malaria refractory gene, to be site-specifically integrated. Currently, we have injected over 800 eggs (generation zero, G0), and have begun screening G1 offspring for expression of DsRed (the marker gene in the initial construct). Once DsRed expression is confirmed, positive individuals will be selected to establish homozygous colonies. Once the underdominance gene drive system is fully established, we will assess its capacity for driving a disease-refractory gene to fixation in lab populations. Successful integration and expression of the underdominant gene drive in the southern house mosquito will open up many different possibilities to control wild mosquito populations, whether it is to control for animal or human diseases.

Paper Number: 936
Poster Board: 112

Introducing a Large Scale Ecosystem Restoration in Lowland Degraded Tropical Forest within Industrial Forest Plantation in Indonesia

Dolly Priatna

Forest degradation is a serious problem worldwide, particularly in developing countries. Forest degradation refers to a reduction of the capacity of a forest to provide goods and services. In the management of industrial forest plantations in Indonesia, it is mandatory to set aside natural forest (in the form of protected areas) of at least 10% of the total concession area, but their condition has been partially degraded, with main drivers include illegal logging, agriculture (shifting cultivations), fires, fuel wood collection, and livestock grazing, which result in various degrees of degradation. During the last 50 years, there have been many of forest rehabilitation projects with employing various technical approaches in Indonesia, but the results of these reforestation efforts have largely been unsatisfactory. It has been identified that there are about 78,000 Ha of degraded natural forests, which comprise of lowland, peat and marine clay forests ecosystem, throughout the industrial forest plantation concessions supplying wood fiber to the Asia Pulp & Paper Group, which has been ready and will be restored within the next five years. The first step is to collect data on the structure and composition of the primary/secondary forest adjacent to the site of restoration which will be used as a reference. We establish a one hectare of (100m x 100m) permanent sampling plot at the site that will be restored, to determine the presence of tree species and number of seedlings or trees. We will determine the restoration/ enrichment interventions which will be conducted based on the results of the assessment on the permanent sampling plots.

Currently, we have been working with various parties including with the Indonesia's Ministry of Environment and Forestry's research and development center to develop the strategy and testing various ecosystem restoration approaches, in order to determine an efficient approach but scientifically acceptable.

Paper Number: 938
Poster Board: 113

Impacts of fire to the population dynamics of the *Pinus merkusii* Tapanuli ecotype

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Pinus merkusii, the only pine species in Indonesia, are threatened by land-use change. The habitat of this species is scattered in three locations, namely Aceh, Tapanuli, and Kerinci. In Tapanuli, *P. merkusii* forests are experience surface fires that change forest composition and structure overtime. This project examined the difference between forest composition and structure between burned and unburned areas in Sumatra. We measured tree condition, tree height, and diameter breast height (dbh) for every tree with dbh ≥ 10 cm, in 10 x 10 m plots. We also collected the mortality and regeneration of its species as the effect of fires. In addition, we will provide the evidence of cross-datable tree rings of *P. merkusii* and its sensitivity to climate, by using dendrochronology methods. The result shows that *P. merkusii* adapts to fires and shows more regeneration in area with frequent fires. Even though *P. merkusii* is well-known to have a grass-stage phase as adaptation to fire, *P. merkusii* tapanuly ecotype does not have this phase. *P. merkusii* tapanuly ecotype mostly lived in the mixed forest, therefore it does not have grass-stage such as population in Laos and Vietnam. In addition, *P. merkusii* has distinctive tree rings however there are many false rings and missing rings. This research will provide recent ecological status of *P. merkusii* and recommendation for park managers and other related organization.

Paper Number: 939
Poster Board: 114

Large mammals relative to human settlements at Lanjak Entimau Wildlife Sanctuary

Olivia Cosby

Understanding drivers of habitat selection at the boundaries of protected areas is critical to mitigating human wildlife conflict. In Borneo, remote communities reliant on hunting and harvesting forest products often border protected areas. Because Southeast Asian forests have irregular (3-10 years) synchronized fruiting events, forest wildlife near human settlements may benefit from increased availability of annual and continuously fruiting trees and palms typical of more disturbed secondary forests, but increase their risk of being hunted. This 3-year project examines distributions of large mammals in primary and human-impacted secondary forests within and adjacent to Lanjak Entimau Wildlife Sanctuary (LEWS), in Sarawak, Malaysia. Our goal is to evaluate wildlife shifts between primary and secondary forests relative to annual variation in fruit and seed production and human disturbance. Using 50 remote-sensing cameras and bimonthly phenology surveys, we are tracking fruit and seed production, and large mammals foraging under fruit trees, through 3 annual cycles. Our research focuses on species dependent on fruit consumption as well as predators dependent on small mammals. Here we present our first year of data, relating large mammal shift with phenological patterns observed in fruit trees from 50 vegetation plots (1260 m each). Since October 2016, we have documented 44 mammal species, many of whom are vulnerable or critically endangered, including orangutans (*Pongo pygmaeus*; 30 detections), sun bear (*Helarctos malayanus*; 111 detections), clouded leopard (*Neofelis diardi*; 9 detections), Bornean bay cat (*Catopuma badia*; 3 detections), Hose's civet (*Diplogale hosei*; 24 detections), white-fronted langur (*Presbytis frontata*; 5 detections), and pangolin (*Manis javanica*; 33 detections). Preliminary findings contribute much needed baseline data for LEWS, a global hotspot for biodiversity. This study is a collaboration of scientists from the Smithsonian Conservation Biology Institute (SCBI), researchers from the Sarawak Forestry Corporation (SFC), and communities that live around LEWS. This information will be used to develop best practices for the sustainable use of forest resources with the goal of mitigating risks to species of concern.

Paper Number: 940
Poster Board: 115

Evolution of ethnovarieties definition along a food tree species (*Dacryodes edulis*) value chain in Cameroon

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Forest and trees nourish people. Non-Timber Forest Products (NTFP) are collected by humans for food and medicine and for many other socio-cultural uses. Tree species that provide NTFP ('NTFP species' for short) are scientifically understudied. For some of these species such like *Dacryodes edulis* (African plum, Burseraceae), local people know their quality, their period of harvesting, how to use them and eventually transform them, yet such knowledge is often poorly documented. *D. edulis* is among NTFP species that have been taken from the wild and planted in human' managed systems such as in agro-forests, in home gardens and even in cities. Over centuries, humans have selected traits of interest, keeping only individuals they valued and prefer for their quality fruits, productivity, low vulnerability to pests and diseases, and so forth. This has led to the multiplication and recognition of different morphotypes that are often recognized as ethnovarieties. Scientific documentation of the domestication history and existing ethnovarieties of tropical tree species is woefully inadequate. Characterizing ethnovarieties encompasses the identification of the traits that differentiate them, and understanding how such traits have evolved in response to selection pressures exerted by human practices is required to orientate conservation and sustainable management strategies. Practices might differ according to the kind of relationships existing between people and the NTFP species. The different actors involved in a species value chain, from producers to consumers might have a different knowledge and influence on species diversity. In order to investigate such relationship, we have analyzed the recognition of different ethnovarieties through individual interviews of different people involved in species value chains (including consumers). Farmers recognize more varieties than consumers. From a farmer perspective, at the local scale, a wide range of varieties is found, defined according to a combination of selected fruit traits and tree characteristics. Varieties appearing at multiple sites are also those with the most desirable sets of characteristics. From a consumer perspective, less varieties are recognized, and their definition is based on more simplistic attributes. Research is now underway to better understand the influence of these different actors on species genetic diversity.

Paper Number: 941
Poster Board: 116

The ARBOPOLIS project: Strengthening African livelihoods, food and nutrition security using indigenous fruit tree species

Jerome Duminil

Driven by urban consumer demand, selective pressure from farmers and consumers for food-tree species is weakening their genetic bases. This affects food-tree species' adaptiveness to withstand environmental changes. More than half the world's population currently lives in urban areas, likely rising to 70% by 2050. This challenges food supply and security. Establishing resilient food systems by integrating/strengthening rural-urban linkages would benefit both smallholders and the urban poor. Fruit tree species are a key component of food systems, where exotic/indigenous fruit tree species (IFTS) are key elements of urban agriculture. Trees are important in increasing cities' resilience by boosting climate change mitigation and adaptation, yet they attract scant attention. IFTS are often critical for local livelihoods/ecosystems. However threats such as deforestation and climate change call for establishing sustainable IFTS management strategies. Cameroon had >70% urban population increase 2005 -2015 and 18% forest-cover loss 1990 - 2010. Achieving sustainable tree/forest management needs characterization and impact assessment of current management practices including aspects of species' adaptive capacity linked to their genetic diversity. IFTS contributions to diet and health, and consumer demand are also poorly understood. The ARBOPOLIS project focuses on IFTS in Central Africa. We aim at characterizing interplay between human practices, genetic diversity and sensory/nutritional aspects along a rural-urban continuum in Cameroon, focusing on an economically-important IFTS: *Dacryodes edulis* (African plum, Burseraceae). Management practices differ in different areas, where different genetic profiles prevail. We assume geographically local genetic resources are used when *D. edulis* trees are planted in rural areas against a range of genetic resources in urban areas, originating in various villages and/or brought to cities through market chains and/or from local sourcing from pre-existing forests. At each level, selection occurs and farmers' and consumers' choices strongly influence IFTS management. Species' contribution to diets also depends on people's sociocultural status and household position along the rural-urban gradient. Planters and consumers are thus key actors in shaping the genetic makeup of species. Understanding relationships between management practices, genetic diversity and consumer preferences will help to sustainably manage genetic resources, allowing adaptable/resilient food systems. In this poster, we present the global multi-disciplinary approach developed in the ARBOPOLIS project as well as preliminary results.

Paper Number: 942
Poster Board: 117

Understanding tree architecture, form and function in the tropics

Alexander Shenkin

The variation in structure and form of trees is a neglected topic in biology, but one that links physiology to performance, explains and scales fluxes of water and carbon within and among trees, and deconstructs constraints on tree growth and mortality. Measurement of tree architecture is potentially being revolutionized by the advent of new ground-based 3D laser scanning technologies in combination with new theoretical frameworks. In this proposed project we will: (1) employ terrestrial laser scanning (TLS) to create a novel global dataset on the form and branch architecture of diverse tropical trees; (2) extract measured and calculated tree structural traits necessary to group trees into discrete classes of tree form; (3) quantify the extent to which patterns of tree form consistently scale between branches and the whole tree; (4) explore the relationships between tree form, phylogeny and life strategy via comparisons of branching and canopy structural traits with physiological traits (i.e. develop a whole-tree integrated economic spectrum); and (5) evaluate the importance of deviation of tree form from idealised fractal branching on whole tree water use in a metabolic scaling framework. We develop and prototype the approach at a broadleaf woodland in the UK, and then focus on established environmental gradients across tropical forests in Peru, Ghana, Malaysia, Australia and Brazil where we have previously set-up and monitored forest research plots with contrasting plant communities and ecosystem properties. The work combines a number of novel approaches: (i) high resolution 3D data capture and automated tree architecture extraction, (ii) development and analysis of branching architecture and canopy traits to define tree form, (iii) the use of architectural and physiological leaf and wood traits to define species-specific strategies and allometries across tropical forests, and (iv) evaluation and refinement of scaling approaches related to plant architecture to understand forest community dynamics. Quantifying the relationship between tree form and other functional traits, and furthering our ability to monitor and interpret ecosystem properties related to plant growth and death at the landscape scale via a tree architecture-based scaling framework, represents a novel advance.

Paper Number: 953
Poster Board: 118

For God and For Country: Religious, Economic, and Institutional Incentives for Church Forest Conservation

Kelsey Johnson

In the Amhara region of Ethiopia are thousands of small patches of indigenous Afromontane forest that members of the Ethiopian Orthodox Tewahido Church, one of the oldest Christian churches in the world, have conserved for centuries as an important component of faith and livelihoods. As sacred natural sites, these “church forests” provide ecosystem services to the community such as springs for holy water and plants for traditional medicines. Over time, in order to protect these resources and the rich biodiversity from overuse and degradation, church communities have developed conservation strategies including rules governing church forest use and repercussions for violating these community-determined rules.

Today, however, rapid economic development, population growth, and climate change threaten the ecological integrity of church forests, as well as the effectiveness of the institutions that have long sustained them.

This project looks at the interactions between the formal institutions of the Ethiopian Orthodox Tewahido Church and the legal institutions of the Government of Ethiopia in terms of each actor's role in conserving church forests in rural Ethiopia against ecological, economic, and political volatility. This project also looks at the role of storytelling and how traditional knowledge contributes to church conservation efforts.

In order to understand church and state conservation efforts and how support for conservation have changed over time, this project used original household survey data from 2002, 2014, 2015, and 2016 where community attitudes on the rules and enforcement of the rules governing forest use across different church forest communities were studied. The variables that came from the questions were analyzed using descriptive statistics and tests of significance in Stata 13.1. A literature review on church forest conservation efforts from state and church was also conducted. The stories were collected through a literature search of Ethiopian folktales.

From my findings, I conclude that there has been a power relation shift overtime from religious to more legal institutions as effective governance, economic need is a factor of state involvement in governance of church forests, and that stories serve a vital role of passing cultural and ecological values over time.

My objective with this project is to raise an understanding of church and state efforts to conserve these historical and biodiverse ecosystems with implications for the entire Amhara region.

Paper Number: 954

Poster Board: 119

Insect Diversity In Enhancing Forest Conservation – A Case Study Of Tambulanan Forest Reserve In Sabah

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Tambulanan Forest Reserve is located south of Maliau Basin, beside Kalabakan-Sapulut Road, in the central southern part of Sabah. The forest covers an area of 3,265 ha. An insect diversity survey by the Sabah Forestry Department was carried out from 2nd to 7th of October, 2017. Nocturnal insect diversity was assessed through light-trapping while diurnal insects were documented through sweep nets and forceps. At least seven Bornean endemic species were recorded, which include butterflies, moths, beetles and a damselfly. The endemics and other insect species recorded during the survey provide salient information to enhance the conservation of Tambulanan Forest Reserve as a Class I (Protection) Forest Reserve. These pioneer data will serve as baseline information for other research work in future. The data procured will be incorporated in formulation of forest management plan and high conservation value report for forest certification. Besides insect fauna documentation, other conservation aspects and issues related to insects and forests were also looked into, such as forest fragmentation, connectivity and corridor, forest fire, encroachment and land-use changes. Any long term threats and issues would indirectly affect the insect fauna. As such, continuous monitoring and enforcement at strategic locations, especially along the Kalabakan-Sapulut road are important to minimize the threats and adverse issues. This will ensure that the forest quality would be improved in order to maintain the interesting biodiversity, including insects, as well as for conservation purposes.

Paper Number: 970

Poster Board: 120

SPEED PRESENTATION

Presentation Order	Paper Number	Paper Title	Presenting Author Names
1	583	Contrasting phylogeographical patterns in the closely related and nearly sympatric <i>Lumnitzera</i> mangroves across Indo-West Pacific revealed by chloroplast and nuclear markers	Yelin Huang
2	490	Asian elephants' appetite for rocks and springs in a Malaysian rainforest	Ning Hii
3	679	The Online and Physical Market for Live Animals in Viet Nam	Rosa A. Indenbaum
4	422	Gender inequality in leadership positions: an issue in Conservation Science too	Julia Verba
5	297	Comparative transcriptome analysis of the invasive weed <i>Mikania micrantha</i> with its native congeners provides insights into genetic basis underlying successful invasion	Wuxia Guo
6	710	The influence of legume species in the soil nitrogen content of savannas patches in the Amazon, Brazil	Adelaine Michela E Silva Figueira
7	487	Impacts of the Fake Genuineness of the Environmental Impact Assessments : A Case Study	Panchami Menon
8	497	Tree diversity and endemism pattern of trees of Makutta Wildlife Range, Western Ghats, India	Vimhaseno Neikha
9	533	How will increased drought affect herbivory-based insect communities in tropical rainforests?	Claire Gely
10	802	Bias in acoustic bat monitoring due to vertical stratification in sub-tropical Thailand	Matthew Crane
11	575	Low genetic diversity in <i>Triops granarius</i> (Crustacea, Notostraca) of vernal pools in Qatar	Ahmed Aly

Contrasting phylogeographical patterns in the closely related and nearly sympatric *Lumnitzera* mangroves across Indo-West Pacific revealed by chloroplast and nuclear markers

Yelin Huang

Mangroves are ecologically important but globally threatened forest communities in tropical and subtropical coasts, the effective conservation of which requires understanding of their phylogeographic structure and identification of management units. However, the phylogeographic patterns often vary among different species, even among ecologically similar taxa or within genera. Here, we investigated the level and pattern of genetic variation of *Lumnitzera*, a unique mangrove genus consisting of two species (*L. racemosa* and *L. littorea*) with nearly sympatric ranges across the Indo-West Pacific (IWP) region, by sequencing three chloroplast DNA (cpDNA) regions and genotyping 11 nuclear microsatellite loci. Consistent with findings in studies on other mangrove species, we found that both *L. racemosa* and *L. littorea* showed relatively high genetic variation among populations but low genetic variation within populations. The median-joining network of cpDNA haplotypes, Bayesian clustering of microsatellite loci, molecular variance distribution, and genetic barrier detection indicated two well differentiated clades in both *L. racemosa* and *L. littorea*, with different patterns of genetic structuring in the two species. In *L. racemosa*, the strong divergence between populations from the Indian Ocean (western clade) and the Pacific Ocean (eastern clade) previously revealed with nuclear genes was also detected from cpDNA data in this study, supporting the hypothesis of the land barrier effect of the Malay Peninsula on *L. racemosa*. In *L. littorea*, both cpDNA and nuclear microsatellite data suggested a more eastward genetic break, with the eastern and western clades being located in either side of the well-known biogeographic barrier, the Huxley's line. Such pattern of genetic differentiation as observed in *L. littorea* has never been reported for mangroves before. Bayesian estimation of divergence times suggested an earlier split of the *L. racemosa* clades than *L. littorea* clades in the Pleistocene, consistent with the relatively higher overall genetic diversity of *L. racemosa* than *L. littorea*. These results suggest that the *Lumnitzera* mangroves have different demographic histories despite their close genetic relationship and similar geographic distribution. Our findings not only present a new case of closely related mangrove species with different population structuring across similar geographic distributions, but also provide references for the conservation genetics of *Lumnitzera* mangroves, especially the endangered *L. littorea*.

Paper Number: 583
Presentation Order: 1

Asian elephants' appetite for rocks and springs in a Malaysian rainforest

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Mineral licks are scarce yet important resources for forest mammalian herbivores, as they provide nutrients lacking in their plant-based diets. Peninsular Malaysia hosts approximately 1,500 wild Asian elephants (*Elephas maximus*), but we have little knowledge of their autoecology and use of resources. Their behaviour is difficult and dangerous to observe directly, but remotely-triggered camera traps provide an opportunity to conduct indirect observations. The objectives of this study are 1) to quantify the frequency of elephants visits and activity pattern in mineral licks and 2) to describe their mineral consumption patterns. From October 2012 to October 2013, we set up camera traps at mineral licks in the Belum Temenggor Forest Complex, northern Peninsular Malaysia. The time of elephant detections and their mineral consumption behaviour were documented. A pilot testing of 10 soil samples were collected for mineral content analysis, which consist of soils extracted from active licks (n=5; where elephants are using), inactive licks (n=2; where elephants ceased to use and has been overgrown by vegetation), and forest soil (n=3; untouched, random spots at least 10 metres away from mineral licks). Monthly elephant visits were overlaid with precipitation data provided by the Meteorological Department. Throughout the year, elephants visited infrequently and the durations varied by individuals, groups and sex. On average, females visited the mineral licks at a frequency of 14.14 ($\pm$ 12.6 SD; range 1- 33) times per year. Lone adult male elephants only visited at a frequency of 4.6 ($\pm$ 3.03 SD; range 1-11) times per year. December 2012 and May 2013 had the highest record of visits which showed a marginal correlation ($r=0.5$, $df= 11$, p value= 0.08) with precipitation, suggesting that elephants might visit mineral licks more often during rainy periods. The pilot soil analysis suggests that active mineral licks had higher magnesium (559 vs 128.8 mg/Kg) and sodium (896.8 vs 301.6 mg/Kg) content as compared to the forest and inactive mineral soils. Out of the 210 elephant visits, female adults were observed to consume soil more than males (33% vs 9%, $X=0.002$, Chi square) which points out to their need to replenish nutrient loss during pregnancy or lactation. This study has provided insight into the relationship between forest elephants and mineral licks. Mineral licks seem to be a key resource for elephants and probably other wildlife in Malaysian rain forests. We therefore recommend stricter protection of these finite resources.

Paper Number: 490
Presentation Order: 2

The online and physical markets for live animals in Viet Nam

Rosa A. Indenbaum

The live animal trade, particularly birds and reptiles, has been previously documented in Viet Nam, in physical markets historically and in online markets more recently. However, the live animal trade is particularly dynamic as it changes to reflect demand for pets, wild meat, display animals, and other uses. This trade is also subject to a high turnover due to the difficulty of capturing, transporting and keeping live animals. Frequent market surveys are therefore useful in this regard to monitor changes in the market and identify species that may become threatened by trade levels. The objective of this research was to explore the breadth of the live animal trade in Viet Nam.

TRAFFIC conducted an online market survey and a physical market survey for live animals. The online survey was conducted from 01 September-06 October 2017 for 25 days (Monday to Friday). The survey effort was fixed at 02 hours per day. Within that time the researcher systematically surveyed 36 Vietnamese-language online platforms, including social media websites, e-commerce websites, auction sites, and online forums using 10 general Vietnamese keywords. The physical market survey was conducted for five days from 09-13 October 2017 in three cities in Viet Nam: Ha Noi, Nha Trang and Ho Chi Minh City. Researchers visited a total of 38 outlets, including pet cafes, pet shops, and bird shops.

A minimum of 4,181 live animals were found for sale in Vietnamese markets during the study, representing at least 140 different species of birds, reptiles, mammals and amphibians. Birds were most common making up 80.9% (3,421) of all individuals observed. Of the 140 species identified, 29 are listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), indicating a recognition that trade already impacts their populations. Where applicable, results from this study were shared with law enforcement officials and relevant online trading platforms.

This study confirms the ongoing trade of live animals in Viet Nam, particularly that of birds. A small number of the species observed are already subject to international and national trade regulation. Outlets and online platforms known to be offering these species for sale should be regularly monitored. Furthermore, the outlets and platforms offering those species for which trade is not regulated are important to watch as trade in those species may become a threat to their survival.

Paper Number: 679
Presentation Order: 3

Gender inequality in leadership positions: an issue in Conservation Science too

Julia T. Verba, Marina V. Fagundes, Ana Helena Bevilacqua, Carolina Freitas, Eliziane Garcia, Eugenia Cordero Schmidt, Heloisa Dantas Brum, Ludmila Damasio, Maria Clara Bezerra, Monalisa Rodrigues

Although professional differences between genders have been decreasing over the past 20 years, women still hold only 24% of senior positions. Indeed, few scientific leadership positions are reached by women. The remaining social traditional roles (e.g. women in charge of household chores and childcare), harassment or gender discrimination, lower salaries, and fewer invitation to talks, are some factors affecting the number of female leadership in the scientific career. In this study, we analysed differences between genders seeking to understand which are the major challenges faced by women to reach leadership positions in Conservation Science. Our hypothesis was that women's professional career tends to be more affected by aspects related to personal life. To test our hypothesis we selected research leaders in Conservation Science based on their high impact publications, awards, and involvement with publications and events in the area. We identified 556 research leaders, of which less than 30% were women. Through an online questionnaire, scientists were asked about aspects related to professional and personal life, and what they believed to be the major challenges to reach their current leadership positions. Additionally, we collected data about publication on Google Scholar profile to analyze the effect of personal and professional factors on it. So far, we had 63 questionnaires answered, of which 32% were from women. We found no significant differences between genders related to the number of children, marital status, and countries development. On the other hand, we found differences between genders related to the partners' activity: most of the men's partners are not researchers ($X^2=2$, $p=0.056$). When asked about the main career challenge faced, 80% of men addressed professional issues while 70% of women reported personal challenges (e.g. family, children, gender issues) ($X^2=16.78$, $p<0.001$). We also found that women tend to publish less as a first author after having children, while men continuously increase their number of publications over the years regardless having children ($df=1$, $F=20.28$, $p<0.001$). Finally, after having children, married women publish less than divorced women ($df=3$, $F=3.08$, $p<0.031$). In this preliminary assessment, our results corroborate our hypothesis, and show that aspects related to the personal life affects differentially the scientific career of women and men in Conservation Science, even when considering researchers in leadership positions. The society needs to try to end such unevenness, and this research points to important issues to be considered in that process.

Paper Number: 422
Presentation Order: 4

Comparative transcriptome analysis of the invasive weed *Mikania micrantha* with its native congeners provides insights into genetic basis underlying successful invasion

Wuxia Guo

Mikania micrantha H.B.K. (Asteraceae) is one of the world's most invasive weeds which has been rapidly expanding in tropical Asia, including China, while its close relative *M. cordata*, the only *Mikania* species native to China, shows no harm to the local ecosystems. These two species are very similar in morphology but differ remarkably in several ecological and physiological traits, representing an ideal system for comparative analysis to investigate the genetic basis underlying invasion success. In this study, we performed RNA-sequencing on the invader *M. micrantha* and its native congener *M. cordata* in China, to unravel the genetic basis underlying the strong invasiveness of *M. micrantha*. For a more robust comparison, another non-invasive congener *M. cordifolia* was also sequenced and compared. A total of 52,179, 55,835, and 52,983 unigenes were obtained for *M. micrantha*, *M. cordata*, and *M. cordifolia*, respectively. Phylogenetic analyses and divergence time dating revealed a relatively recent split between *M. micrantha* and *M. cordata*, i.e., approximately 4.81 million years ago (MYA), after their divergence with *M. cordifolia* (8.70 MYA). Gene ontology classifications, pathway assignments and differential expression analysis revealed higher representation or significant up-regulation of genes associated with photosynthesis, energy metabolism, protein modification and stress response in *M. micrantha* than in *M. cordata* or *M. cordifolia*. Analysis of accelerated evolution and positive selection also suggested the importance of these related genes and processes to the adaptability and invasiveness of *M. micrantha*. Particularly, most (77 out of 112, i.e. 68.75%) positively selected genes found in *M. micrantha* could be classified into four groups, i.e., energy acquisition and utilization (10 genes), growth and reproduction (13 genes), protection and repair (34 genes), and signal transduction and expression regulation (20 genes), which may have contributed to the high adaptability of *M. micrantha* to various new environments and the capability to occupy a wider niche, reflected in its high invasiveness.

Paper Number: 297
Presentation Order: 5

The influence of legume species in the soil nitrogen content of savannas patches in the Amazon, Brazil

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The savanna patches found in the Amazon region present low soil fertility, mainly due to factors such as soil texture (usually sandy and subject to intense leaching of nutrients) and low aerial biomass. In these systems, the high nitrogen content of legume species may represent a significant part of the nitrogen supply of these ecosystems, either by the decomposition of litter deposited by these species, or even by the release by the exudates of their roots. This work aims to evaluate the influence of legume species on the soil nitrogen (N) content in an area of savanna in the municipality of Santarém, Pará State, Brazil. Soil N concentrations (0-10cm depth) and nutritional composition of leaves (legumes and non legumes) were evaluated in sites established according with the presence and absence of legume species. The genera selected for this study were *Centrosema* sp. and *Chamaecrista* sp., both genera with recognized capacity of nodulation in their roots and occurring in abundance in the savannas of the region. The areas with absence of legumes have predominance of grass beside other species. Overall, we found higher levels of nitrogen content in soils covered with predominance of legume species. The nitrogen content of leaves were about two fold higher in legume species than non-legume ($14,8 \pm 3,8 \text{ g kg}^{-1}$ e $7,9 \pm 0,06 \text{ g kg}^{-1}$, respectively). These results indicate a significant influence of legume species on the nutritional supply of soils in the savanna patches of the Amazon. The nitrogen income to soils can be due either by biological nitrogen fixation through the association of some legume species with bacteria in the soil or the litter decomposition.

Paper Number: 710
Presentation Order: 6

Impacts of the Fake Genuineness of the Environmental Impact Assessments : A Case Study

Panchami Menon

Introduction:

Annamalai University was paid by Indian Medical Association (IMA) to generate an EIA to construct Common Bio Medical Waste Treatment Facility (CBMWTF) at a site in the Palode Ranges situated in the south of Western Ghats in Thiruvananthapuram, Kerala, India. Indian Medical Association Goes Eco friendly (IMAGE), a subwing organization of IMA claims in the EIA that the impact area under study is only of a 10km radius and is a forest area with insignificant agricultural fields with no endangered species of flora and fauna.

Objectives:

WHAT THE EIA MENTIONS:

- The 6.8 acres of site used to be a rubber industry.
- No human settlements within 5 km of the land site; R&R program are not required.
- Site land is a wasteland. Does not fall under PA, WHS or Tiger and Elephant Corridor
- No endangered species of flora or fauna

Methods:

Local bodies that live near Palode were interviewed and their perspectives regarding the construction of a CBMWTF were asked and produced opposition towards it as a socio-ecological manner. Classes were conducted by my NGO, EPRC. The locals were very understanding and supportive.

Results:

- The emission and odor from CBMWTF are two major concerns.
- Increase air pollution as CO and nitrate levels were observed to be Below Detectable Limit.
- The project location is in ecologically sensitive zone. Climatic changes like alteration of rainfall, changes in soil pattern, disturbance to the fauna habitat and elephant corridors, change in the direction of the stream flow, etc all this will lead to land fragmentation and loss of biodiversity.

Discussion:

TO PROVE THE FAKE GENUINITY OF EIA:

- These 6.8 acres of land is forest cover under Kulathupuzha Reserve Forest.
- Thannimoodu tribal settlement within 300m radius.
- This area has been designated as ecologically sensitive by the Kasthurirangan Committee report.
- It is the starting point for the Vamanapuram River.
- Nearby is The Mundanthurai Tiger Reserve in Tamil Nadu
- No evidence of a previous existence of rubber industry.
- Home to endemic *Myristica* Swamp.

Reference:

Environmental Impact Assessment report by Annamalai University for the construction of CBMWTF in the revenue village, Palode.
Interaction with the villagers, environmentalists, doctors of IMA, etc
Newspaper articles, blog articles, etc.

Acknowledgement:

I would like to acknowledge the President of Environmental Protection and Research Council (EPRC), Mr. Sanjay and wild life photographer, Mr. Sali Palode

Paper Number: 487
Presentation Order: 7

Tree diversity and endemism pattern of trees of Makutta Wildlife Range, Western Ghats, India

Vimhaseno Neikha

Mountain ecosystems are important as they are very diverse and are home to a number of plants and animals. Human population is heavily dependent on mountains and its resources and hence there has been a decline in the forest cover of the mountainous region around the world. Tree diversity and species endemism studies can help to prepare site specific conservation plans to conserve endemic species which not only play key roles in the ecosystem but are also crucial for the existence of other dependent fauna. This study was carried out in the Makutta Wildlife Range of Kodagu district of the Western Ghats, south India which is one of the biodiversity hotspots of the World. It aimed to understand the species diversity and endemism patterns of the trees along the altitudinal gradients starting from the base at 100m up to 800m. Quadrat sampling method was followed and a total of twenty four quadrats measuring 20m x 20m were laid with three replicates at each elevation 20m apart from each other covering an area of 0.96ha. A total of 604 individual trees belonging to 68 species, 55 genera and 30 families were observed. Among these, 26 tree species were endemic to the region constituting 296 individuals belonging to 14 families and 22 genera. The species composition varied continuously from the lower elevation to the higher elevation, with 400m elevation having maximum species richness with 27 tree species and 800m elevation having the minimum species richness with 17 tree species. Endemic species was maximum at 500m and 600m with 13 tree species each and a minimum of 5 endemic tree species at 800m. The Shannon-Wiener diversity index scored a maximum value with 3.02 at 400m and 800m scored a minimum value of 0.81 for Simpson's diversity index indicating high species diversity in these sampling sites. Tree diversity thus decreased and endemism increased along the gradients in the Makutta Wildlife Range. Endemic species if lost from their native habitat will be lost forever. Hence necessary measures needs to be taken so that the endemic species do not succumb to anthropogenic activities and are conserved to maintain a stable ecosystem and flow of ecosystem services.

Paper Number: 497
Presentation Order: 8

How will increased drought affect herbivory-based insect communities in tropical rainforests?

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Intense drought has severe impacts on rainforest ecosystems, resulting in widespread tree death and reduced plant growth. Climate change scenarios predict that drought events will increase in length and frequency in some tropical regions, due to reduced precipitation and increased evapotranspiration.

This study aims to examine how increased drought may affect: 1) herbivorous insects abundance as their food resources (sap, foliage) often decrease in quantity and quality with intense drought; and 2) wood boring levels as water-stressed trees might be more vulnerable to insect attack.

In Cape Tribulation, Queensland, Australia, we took advantage of a unique drought experiment set up on a 0.5 ha plot. Framed plastic sheets placed above ground between trees prevented rainfall from reaching the ground, thus creating an experimentally increased drought. Insect assemblages were collected every month for two years by beating leaves from trees located on the drought experiment site and a control site. A canopy crane facilitated insect collection from both canopy and ground levels.

Wood boring activity on the site was surveyed by thoroughly examining trees and saplings, along 36 transects (25 m long), for any signs of wood-boring: exit and entrance holes, lateral tracks, moults & exoskeleton, frass, latex, kino or resin, presence of termites.

Ants were more abundant in the canopy under increased drought conditions. Beetles however were less abundant at the ground level with increased drought. Variations in insect abundance following drought were dependant on the species of the host plant. Small trees and saplings were more attacked by wood-borers when they were experiencing severe water stress.

Overall, the response of insects to increased drought in tropical forests is complex and varies among different insect groups and host plants. Some trees, because of their size or species, are more vulnerable to insect attack during drought. Climate warming and increased frequency of extreme drought events will probably increase mortality episodes for those trees.

Paper Number: 533
Presentation Order: 9

Bias in acoustic bat monitoring due to vertical stratification in sub-tropical Thailand

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Bats are a critical element to the global environment, providing a plethora of ecosystem services. However, studying bats can be challenging as their echolocation abilities and flight prowess make them difficult to capture. Acoustic sampling allows researchers collect large data sets on bat activity patterns, community structure, and species richness with less man-hour effort than traditional trapping methods. However, understanding the potential biases in acoustic sampling is important to designing bat monitoring programs. We sought to see how vertical placement of passive acoustic recorders can create bias in different habitats. We set SM4BAT Recorders at the ground level and at the canopy level on two towers situated in different habitat types. One tower was in a dense dry evergreen characterized by high canopy and dense understory vegetation. The other tower was in an open dry dipterocarp forest area with very open understory and lower canopy height. We observed that the dense habitat showed greater variation based on the height of the SM4Bat in both activity patterns and species composition. In the dry evergreen site we recorded only 41 calls from the ground level compared to 318 from the canopy. In contrast the dry dipterocarp site had similar numbers of bat passes with 109 at the ground level and 79 from the canopy. We observed a higher number of passes and species from continuous frequency bats (from the Hipposideridae and Rhinolophidae families) at the ground level. Our results suggest that researchers should make sure to account for vertical stratification effects when conducting acoustic monitoring especially in dense habitats.

Paper Number: 802
Presentation Order: 10

Low genetic diversity of *Triops granarius* (Triopsidae) in vernal pools in Qatar

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Habitat loss is a real threat in rapidly developing countries such as Qatar where fauna and flora may not have been described before species are permanently lost. Recent discovery of *Triops granarius* in vernal pools in northern Qatar calls for such investigations. Samples were collected in winter of 2017-18 from two separate locations about 2 kilometers apart along a major north-south highway in northern Qatar. The DNA barcoding gene CO1 was used to analyze 12 samples from the northern pool and 16 samples from the southern pool respectively. Overall the sequence showed high between- and within-population uniformity in which the southern pool with polymorphism at only two nucleotide positions while the northern pool with polymorphism at only one, different position than in the individuals from the southern pool. The six total haplotypes yielded mean divergence within each pool at about 0.31% and 0.15% respectively, well lower than the suggested threshold of 3% for within-species divergence in the barcoding gene. The intra-specific phylogenetic analysis with other published sequences in GenBank suggests a closer relationship with samples collected from Mongolia and Japan while more distant compared to those from India and five northern and southern African countries. As some of the recent studies suggest new species be designated for populations previously recognized as *T. granarius*, there is a need for further investigations for this most widely distributed species within the genus. Furthermore, as these vernal pools are desirable water source for winter campers, there is an urgent need for protection of their habitat.

Paper Number: 575
Presentation Order: 11

