ABSTRACTS BOOK

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PLENARY

The history, current status, and future of the protected areas of Madagasar

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Field Museum, Chicago, Illinois, USA
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Madagascar is infamous for its exceptional biota with high levels of endemism at different taxonomic levels. Based on a number of factors in the historical biogeography of the island, the fauna and flora has few parallels in the world associated with levels of endemism. These aspects have been the themes of research for several decades and the importance of these biological splendors continue to be documented with continuous new discoveries, as well as this information being incorporated into on-going conservation programs. One of the critical aspects is that the vast majority of the terrestrial biota is forest-dwelling. On the basis of a shifting sequence of factors, the natural vegetation of the island has been greatly reduced and a small portion of the original natural forest cover remains. In 1989, Martin Nicoll and Olivier Langrand published a review of Madagascar's protected areas, and from local and international perspectives, this was a monumental advancement. Subsequently, several important aspects have changed for the positive, including: a dramatic increase in the number of conservation sites; many conservation organizations working to protect the remaining natural areas; enormous efforts to study and document the biota; generations of national field biologists emerging and taking their rightful place in conservation related activities and research; new perspectives on the evolutionary history, systematics, and ecology of a multitude of organisms; and something approaching an exponential growth in available information. On the negative side, particularly overlaid on population growth and economic problems, rates of deforestation have not decreased, fire remains an important problem, and different forms of natural resource exploitation are on the increase. In any case, all of these aspects provide the need to revisit the synthesis of Nicoll and Langrand. In this presentation, which is based on a recent large-scale review of 98 terrestrial protected areas of Madagascar, different aspects are presented.

Tuesday, 30 July 2019 | Auditorium
Plenary 1 – The history, current status, and future of the protected areas of Madagasar

Conservation in the remote western Amazon: A natural history museum putting science into the hands of decision-makers

CORINE VRIESENDORP
Field Museum of Natural History, Chicago, Illinois, USA

The pace of change in our world and the politics of decision-making are rapid. Natural history museums harbor collections on the opposite end of the time spectrum: a record of cultural, biological and geological diversity that embodies deep knowledge about our planet throughout its history. For the last twenty years, the Field Museum of Natural History in Chicago has undertaken an experiment: can a museum provide science—cultural, biological, geological—in a way that is high quality but fast enough to inform decision-making on conservation and well-being of local people in the upper Amazon? Can interdisciplinary teams work together and create integrated information in real time? Can museum scientists work hand-in-hand with indigenous organizations, NGOs, and government agencies to design conservation landscapes that reflect the vision, traditions, and cultural beliefs of local people? Our team—together with scores of in-country scientists, diverse partners, and local communities—conducted 30 rapid inventories in the last 20 years, 23 of them in the Western Amazon. These rapid inventories bring together two teams of expert scientists: one team surveys the geology and biology at the heart of a conservation priority area, characterizing the dominant species and species that are rare and new to science, and evaluating the area's conservation value at the regional and global level. Simultaneously, another team visits communities living in and around this area and focuses on existing traditions, values and beliefs, the organizational strengths of local people and their aspirations for the area. The teams synthesize their biological, geological, and social findings, analyzing the threats, opportunities, and assets in the area, and creating a roadmap for the long-term conservation of the landscape grounded in the vision of local people. The rapid inventory results and conservation roadmap are presented locally, regionally, and nationally. Then the team works with partners to continue to arm local, regional, and national decision-makers with relevant cultural and biological science to move the top recommendations into results. Since 2000, these inventories have provided governments in Ecuador, Peru, and Bolivia with technical support for creation of 18 new conservation areas (9.6 million ha). We believe that the rapid inventory program's success in spurring conservation outcomes reflects three deliberate strategies. (1) Building a consensus vision for conservation across a wide range of stakeholders and scientists. (2) Ensuring that local residents and organizations are at the forefront of that vision. (3) Creating products that decision-makers can readily use to implement the vision as policy. While we did not know it at the time, these strategies adhere closely to the newly described field of translational ecology, "an intentional approach in which ecologists, stakeholders, and decision makers work collaboratively to develop and deliver ecological research that, ideally, results in improved environment-related decision making." Our experience suggests that natural history museums of the 21st century have a tremendous "translational" or "boundary-spanning" role to play in conservation, and in the wellbeing of local people.

Wednesday, 31 July 2019 | Auditorium
Plenary 2 – Conservation in the remote western Amazon: A natural history museum putting science into the hands of decision-makers

From food chemistry to the evolution of primate communities: Historical perspective, progresses, gaps and new approaches

JÖRG GANZHORN
University of Hamburg, Hamburg, Germany

Primatologists were among the first to test early theories on the role of plant chemistry on food selection in the seventies of the last century. The analytical approaches remained unchanged for more than 40 years. The large number of these studies spread all over the tropics, revealed very variable responses that made it difficult to come to a cohesive picture on the factors that affect food selection of primates. Recent meta-analyses on a global scale provided insights into the role of regional peculiarities that affect the seemingly variable criteria of food selection. Regional forest characteristics also have consequences for the evolution of primate and non-primate communities, such as, the low proportion of frugivorous primates and birds on Madagascar that might be a consequence of much lower protein concentrations in Malagasy fruits compared to other parts of the world. Despite these promising results, the standard approaches of comparing rather crude chemical properties of food and non-food items seem to have delivered most of what they can for descriptive, non-experimental studies. Studies on Australian folivores introduced new methods that facilitate syntheses combining behavioral observation, chemical food properties and population dynamics of species. They also allow investigating effects of climate change from the perspective of plants and animals alike and thus will contribute to the modelling of climate change effects on animal distributions. Though primates are less suitable for experimental manipulations and captive studies than marsupials, the Australian approaches could be mimicked by studies along environmental gradients. More recently, the physiological bases for food selection are supplemented by analyses of proxies for nutrients or toxic components. These proxies could be related to sensory inputs, such as vision, taste or olfaction. The integration of digestive and sensory physiology together with plant composition and plant signals will be a fascinating field for understanding the evolution of animal-plant interactions.

Wednesday, 31 July 2019 | Auditorium
Plenary 3 – From food chemistry to the evolution of primate communities: Historical perspective, progresses, gaps and new approaches

Infrastructure Armageddon and the future of tropical nature

WILLIAM LAURANCE
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We are living in the most explosive era of infrastructure expansion in human history. The most ambitious scheme is China's Belt & Road Initiative, which will involve over 7,000 planned infrastructure and extractive-industry projects that could span much of the planet. Chinese President Xi Jinping promises that the Belt & Road will be "green", "low-carbon," and "sustainable", but I argue that this is highly misleading. I will illustrate the harsh realities of the Belt & Road and other large-scale infrastructure ventures by describing the plight of wildlife and key ecosystems across the planet, and well as important social, economic, financial, and political risks of major infrastructure projects. I will then identify strategies to lessen the most urgent environmental and societal hazards of the global infrastructure tsunami. China has a combination of characteristics that make it a high-risk partner for business and finance. Inside China, bad news about the Belt & Road is blocked by China's government censors, its Great Internet Firewall, and passive censorship — meaning virtually no Chinese journalist would translate a negative story about the Belt & Road into Mandarin Chinese. The Belt & Road is officially inscribed into the Charter of the Central Communist Party, making it illegal for any Chinese citizen or media outlet to criticize it. Among Chinese scientists, there is considerable angst about the environmental consequences of the Belt & Road, but among the public there is little transparency, balance, or informed debate. When operating overseas, Chinese companies and financiers frequently use corruption to get what they want—bribing even at the highest levels of a government. According to Transparency International, "There have been no investigations or charges *ever* laid in China against its companies, citizens, or residents for foreign corrupt practices". This is alarming and remarkable. Furthermore, most Chinese corporations fail to reveal even basic financial information such as profits, expenditures, and balance sheets. Collectively, such attributes are a formula for promoting bad business practices, social abuses, environmental crimes, and predatory development. Such practices create massive risks for the 130 host nations that China wants to exploit for natural resources, food, land, and geopolitical advantage. There are also great risks for the myriad investors from around the world who are being asked to help to pay for the Belt & Road — potentially contributing trillions of dollars. Unless these investors are careful, they could lose vast sums of money and take severe hits on their reputations. Clearly, developing nations urgently need smart economic and social development. But there is a world of difference between well-conceived developments that benefits a wide cross-section of society, versus ill-advised, often predatory projects that leave host nations mired in debt. Such 'bad' projects tend to enrich a few powerful people — such as certain politicians and land developers — but the rest of the population gains little or falls behind economically. Many bad projects also create environmental crises — creating long-term social and economic problems for the host nations. Overall, the Belt & Road, and other large infrastructure ventures, present important economic opportunities but also imminent, unique dangers to the environments of developing societies. The manner in which these unprecedented ventures are managed will have profound impacts on ecosystems, biodiversity, and economies across the planet.

Thursday, 1 August 2019 | Auditorium
Plenary 4 – Infrastructure Armageddon and the future of tropical nature

Land use, climate change and tropical forest conservation

KAORU KITAJIMA
Kyoto University, Sakyo-ku, Kyoto, Japan

Conservation of tropical forests in the landscape context is central for achieving sustainable development goals. Loss and degradation of tropical forests mean loss of biodiversity and many benefits to humans. The global community is aware of the risks emerging from the interactive effects of climate change and land degradation, which can cause negative spirals of land degradation. Intergovernmental Panel on Climate Change (IPCC) is about to release a special report on this topic. Certain policy instruments for mitigation and adaptation to climate change come with serious trade-offs. Particularly contentious is the extensive use of bioenergy production and afforestation/reforestation projects as climate change mitigation measures, because of potential competition for lands and other trade-offs. For example, national REDD+ projects should not result in net conversion of natural forests to forest plantations. It is not easy to implement a set of policies that avoid degradation of remaining relatively pristine natural ecosystems, while sustainably meeting food and energy demands of people. Good governance at local, regional and national scales, and policy coordination among ministries tasked with different missions, are necessary. In the increasingly globally connected world, policies based on firm understanding of global and regional value chains and bold campaign for changes in consumer behaviors, may offer significant solutions.

Friday, 2 August 2019 | Auditorium
Plenary 5 – Land use, climate change and tropical forest conservation

Why emerging conservation leaders are our best hope for saving biodiversity

JONAH RATSIMBAZAFY
GERP, Antananarivo, Madagascar

The majority of disappearing wildlife is found in places where human populations live in poverty, ravaged by food insecurity and poor education. Many cannot read or write. The destitution of these communities living near protected areas contributes to their reliance on natural resources, which in turn makes it especially difficult for conservation actors to protect wildlife. There is an abundance of researchers that produce high-quality studies on these topics, but too often it seems that the results of their work remain within academic circles and are not properly utilized as tools to protect the species on the brink of extinction. The conditions that lead to the threats and pressures in these protected areas are well-understood. Indeed, there are many proposed sustainable solutions to alleviate them, but it seems as though only few seriously consider implementing them. The response to many of these challenges is found in the youth, women, and capable community members who unfortunately often lack political and cultural power in their social contexts, and indeed whose presence is sometimes seen as a burden to conservation. There may be some truth in the statement that the knowledge base in local populations is low due to a lack of quality education. At the same time, young people, women, and talented workers may be found practically everywhere. Because there have been few perspectives that consider how these groups can become conservation tools to prevent the loss of wildlife, most management plans ignore local knowledge in favor of top-down expertise, achieving limited results. Many development specialists who have been targeting young people have organized them into groups and provided trainings on agriculture, livestock breeding, and environmental conservation. Consequently, these activities in these areas have become highly productive because of the trainings. The same success stories hold true for women's associations that actively engage women in producing marketable goods (such as handicrafts, livestock breeding, and agriculture), health education, environmental protection, etc. Community elders with decades of experience and wisdom are also often overlooked by conservation managers, but they hold enormous potential with their knowledge and wisdom to participate in effectively safeguarding the treasures found in protected areas. Indeed, researchers must consider that all people need to be incorporated into the environmental protection efforts, but the government also bears responsibility for implementing the system and facilitating strategies that will enable everyone to actively take part. Because of the urgency to produce results in the fields of research and conservation, it is prudent to have youth trained today to lead and manage protected areas tomorrow. We call these professionals “Emerging Conservation Leaders”. Each country may have its own methodology to galvanize these groups to conserve their natural resources, but the goal remains the same. Therefore, we who attend this congress ATBC 2019 bear responsibility for the establishment of a base of Emerging Conservation Leaders in our all of our respective places around the world. We are all accountable for protecting our natural resources so that future generations may enjoy them as we have.

Saturday, 3 August 2019 | Auditorium
Plenary 6 – Why emerging conservation leaders are our best hope for saving biodiversity

SYMPOSIA

SYMPOSIUM 1.1
Seed Dispersal Ecology in Madagascar's Forest: Advance and Future Directions

The undervalued seed dispersers of Madagascar's rainforests: Birds contribute to fruit removal as much as lemurs

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[2]South Dakota State University, Brookings, SD, USA

The removal of fruits by frugivorous animals is an important step for seed dispersal, which can have important impacts on plant life cycle. In many tropical systems, primates and birds constitute the major groups of seed dispersers of many plant species. A large body of literature has contributed to our understanding that seed dispersal by Malagasy primates (lemurs) can play important role as seed dispersal agents in the island's tropical systems. However, the different steps of seed dispersal by birds are understudied. Here, we examined the contributions of an assemblage of bird frugivores to fruit removal for 18 rainforest tree species, as compared to that of frugivorous lemur assemblage; we then investigated trait similarity among the plant species dispersed by these two groups. We collected data through observations of fruiting trees, in forest edge and interior habitats in the rainforests of the Complex Torotorofotsy-Ihofa, in the east. Our results demonstrate that fruit removal rate by birds (8 species) and lemurs (8 species) were not significantly different, in both forest edge and interior habitats. However, birds removed fruits more than lemurs and visited the trees more frequently than lemurs. We also found that the plant species dispersed by the assemblage of lemurs and birds have similar traits, in terms of fruit size and fruit color. However, most of the small fruits are removed by medium-bodied birds and small-bodied lemurs. The large-sized fruits are more commonly consumed by large-bodied lemurs and birds. These results suggest that birds could be as important as lemurs in removal of fruits, also suggesting their potential importance in seed dispersal. Additionally, given that the edge habitat had higher richness of bird species than the interior, birds could play an important role in the regeneration of such disturbed habitats.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.1 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

Examining spatially explicit networks of individual plant interactions with a frugivorous lemur mutualist (*Eulemur rubriventer*)

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In diverse tropical forests, frugivores play an important role in seed dispersal; by dispersing seeds throughout their daily foraging and movement, animals determine the site of seed arrival and generate the spatial patterns over which processes determining seed germination, survival, and eventual recruitment take place. The factors which motivate frugivore foraging and movement patterns are thus hypothesized to play a role in structuring patterns of community structure, and biodiversity. However, despite substantial evidence that variation in frugivore foraging and movement has important consequences for plant communities, the complexity of these community-level interactions has made understanding the mechanisms which generate patterns challenging. While frugivores typically consume fruits of many species of co-fruiting plants, resource preferences, availability, and spatial distributions may result in variation of frugivore visitation between plant species and individual plants on a landscape. Examining the factors which influence such individual-level variation and spatial patterns of plant-frugivore interactions and dispersal can help increase our understanding of the mechanisms at play. To contribute to such an understanding, we used direct observations of lemur (*Eulemur rubriventer*) movement and foraging to generate a spatially explicit network of individual plant-frugivore interactions. Using this network, we explored the distribution of interactions between plant species and individuals, examined spatial structure of these interactions and studied the relationship between individual plant traits, fruiting neighborhood properties, and spatial structure and an individual plant's topological role within the network. Preliminary results have demonstrated substantial variation in the interactions of individual plants with their lemur mutualists and revealed the spatially modular structure of these interaction networks. By taking an individual approach to the study of plant-animal interactions, this work will contribute to our specific understanding of frugivory and dispersal, while continuing to elucidate the importance of considering individual-level variation when examining species interactions.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.1 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

Importance of wind-dispersal in the invasion success of *Pinus kesiya* in Tapia forests in Madagascar

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[2]Université de La Réunion
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Malagasy endemic biodiversity is subject to several pressures that threaten their perenniality. The endemic sclerophyllous Tapia woodland at Arivonimamo is one of those ecosystems threatened by the invasion of exotic reforestation trees, *Pinus kesiya*. In order to better preserve the Tapia woodland, the present study aims to determine the factors influencing the invasion of these species in this ecosystem to counter it. For achieving this purpose, 125 transects contained three plots of 100 m^2 each have been inventoried. In each plot, dendrometric and environmental data were recorded. The geographic coordinates of *Pinus* source trees have also been noted in this area. The analysis of the main factors of invasion was carried out with the generalized linear model. The result shows that the installation of source trees nearby and spread by wind has the greatest influence on the various stages of *Pinus* invasion in the Tapia forest. Forest landscape management is then necessary to reconcile the need of the population and the conservation of this endemic biodiversity.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.1 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

Animal-mediated spread of the invasive strawberry guava (*Psidium cattleianum*) in Madagascar

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Strawberry guava, *Psidium cattleianum* Sabine (Myrtaceae), is an aggressive invader of Madagascar's rainforests. Though *P. cattleianum* is rapidly spreading across the island, little is known about the drivers of this invasion. We addressed this gap by investigating how it spreads throughout Madagascar's rainforests, using a multifaceted approach that integrates animal surveys and population genetics. We found that lemur frugivores (namely *Eulemur rubriventer, E. rufifrons,* and *Varecia variegata editorum*) were the primary seed dispersers of *P. cattleianum* in Madagascar's rainforests. Although overall lemur-mediated seed dispersal did not impact germination rates, whereas *E. rubriventer* significantly decreased their success. Additionally, we found three inferred genetic subpopulations of *P. cattleianum* throughout Madagascar's rainforests. There was high genetic differentiation between subpopulations and high genetic variability among individuals within subpopulations. These results suggest there was likely multiple independent *P. cattleianum* introductions into Madagascar, and that long-distance animal-mediated seed dispersal could have facilitated the spread of these subpopulations between regions. Increased knowledge of the mechanisms and genetic characteristics of the *P. cattleianum* invasion will help inform invasive species management and will contribute to the urgent discourse surrounding biodiversity conservation in Madagascar.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.1 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

The effectiveness of extinct versus extant animals as seed dispersers of Malagasy baobabs

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Malagasy baobab trees (genus *Adansonia*) are hypothesized to have lost their co-evolved seed dispersers, the Malagasy megafauna including giant tortoises, giant lemurs, and elephant birds. Therefore, baobab species are considered anachronistic plants. Currently, baobab fruit consumption and seed dispersal might be assured by introduced and native mammals. We tested this hypothesis by studying the effectiveness as seed dispersal agents of extinct *versus* extant animals. We tested in an experimental manner the effects of baobab seeds (*Adansonia rubrostipa*) passage through guts in three types of animals. Indeed, we used one native species, lemurs (*Eulemur rufifrons*), one introduced animal species, zebus (*Bos taurus*), and Aldabran giant tortoises (*Aldabrachelys gigantea*) as ecological analog species of the extinct Malagasy giant tortoises (*Aldabrachelys grandidieri* and *A. abrupta*). We determined the dispersal effectiveness of different animal species, considering the quantity and quality components of seed dispersal. Seed dispersal quantity was the proportion of intact defecated seeds by each animal species. Quality was defined as the germination rates of gut-passed seeds. Results showed that giant tortoises dispersed a higher proportion of dung with intact seeds than zebus and lemurs. The germination of baobab seeds ingested by zebus was greater than uneaten seeds. Germination rates of seeds ingested by giant tortoises and by lemurs did not differ from those of uneaten seeds. Seed dispersal effectiveness for different animals showed a notable difference and we determined that lemurs are the most effective dispersers. These results indicate that, in the absence of Malagasy megafauna, lemurs might play an important role in Malagasy baobab population recruitment.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.1 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

Success of seed dispersal for Malagasy large-seeded trees: Linking to behavioral strategies of frugivorous lemurs

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In dry deciduous forests of western Madagascar, the largest seed disperser, Brown Lemurs (*Eulemur fulvus*), reduce activities during dry season due to less fruit diversity and low water availability, and our previous studies demonstrated that Brown Lemurs disperse seeds shorter distances during the dry season (median: 75 m) than the rainy season (170 m). In this presentation, I will estimate seed shadows produced by fruiting trees based on seed removal and dispersal distance by Brown Lemurs focusing on two large-seeded tree species, one that fruits during the dry season - *Astrotrichilia asterotricha* (Meliaceae) and the other during the rainy season - *Abrahamia deflexa* (Anacardiaceae). Then, I will discuss success of seed dispersal linking to behavioral strategies of Brown Lemurs. I observed this species activities in nine *Astrotrichilia* and seven *Abrahamia* fruiting trees (total observation time was 640 h from June 2015 to February 2016). Number of seeds removed per visit by a lemur group was estimated as 144 seeds in *Astrotrichilia* and 62 seeds in *Abrahamia*. I installed seed traps under crowns for estimating the amount of fallen seeds. I also recorded presence of lemur feces in the traps to evaluate frequency of visits. Visitation by lemur groups occurred 12 times in *Astrotrichilia* and six times in *Abrahamia* on average. According to seed shadows by fruiting trees, 50% of produced seeds fell under mother trees, 50% were carried out of mother trees, and 21% were dispersed over 100 m from mother trees in *Astrotrichilia*. In *Abrahamia*, these percentages were 79%, 21%, and 16%, respectively. During the rainy season, although Brown Lemurs disperse swallowed seeds far away through their active traveling, produced seeds mostly fell under mother trees. During dry season, lemurs repeatedly visit large fruiting patches to reduce activities for minimizing expenditure of energy and water. This behavioral strategy can lead large trees of *Astrotrichilia* to succeed in dispersing more produced seeds further from mother trees.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.2 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

Frugivore declines and the vulnerability of seed dispersal services across Madagascar

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Rice University, Houston, TEXAS

Global patterns of biodiversity decline have raised concerns about the concurrent loss of functional diversity within ecosystems. In Madagascar, past and ongoing political instability, humanitarian crises, and foreign exploitation have resulted in a depletion of natural resources and an extinction crisis that threatens forest ecosystems island-wide. While the direct threat to biodiversity is clear, how this may be linked to deterioration of ecological processes and functioning is less clear. We studied distributions of frugivore richness, functional diversity, and extinction threat across the island to determine hotspots of seed dispersal vulnerability across Madagascar. The highly asymmetric seed dispersal network in Madagascar combined with the intensity and non-random pattern of species endangerment in regards to functional traits related to dispersal, suggests that impending biodiversity loss may have dramatic effects on a major ecological process supporting one of the most biodiverse regions of the world. Results have important implications for prioritizing conservation actions and management decisions in a region undergoing a conservation crisis.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.2 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

Smallest nocturnal primates assist in maintaining plant species diversity in Malagasy rainforests

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Fruit-eating animals often play important roles as seed dispersal agents in many ecosystems, particularly in tropical regions. Yet, the extent to which seed dispersal by omnivorous nocturnal animals may facilitate the germination and recruitment of plant communities is poorly investigated. Characterizing their roles in seed dispersal could provide a more complete picture of how animal-mediated seed dispersal ecology influences tropical forest ecosystems functioning. Here, we investigated the roles and impacts of two species of omnivorous nocturnal lemur species (*Microcebus rufus* and *M. jollyae*) dispersal service in Madagascar's southeastern rainforests. We collected data on dispersal events by sampling seeds from fecal materials of live-trapped individuals, and conducted germination trials with defecated seeds compared to manually extracted seeds from fresh fruits (control). Data show that the two species can have significant contributions as seed dispersers as they defecated a large proportion of seeds from 22 plant species from various forest strata, and 83.3% of the defecated plant species germinated and produced viable seedlings. In addition, defecated seeds germinated faster than control seeds with a significantly high germination rate and seedling length. Although the two lemur species dispersed both native and non-native plant species, non-native species represent only a small proportion (17.2%) of the defecated seeds. These results suggest that omnivorous animals can acts as important seed dispersers, which may have critical implications for forest regeneration and diversity maintenance. These findings add also to the limited information on the ecological contribution of omnivorous nocturnal animals in the functioning of tropical rainforests. Finally, this work could provide important insights to promote mouse lemur conservation as well as taxa associated with them.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.2 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

Dispersal of an invasive plant species by a native seed predator

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Frugivorous species are embedded in a complex plant–animal network that strongly influences the composition and structure of plant communities, especially in tropical rainforest environments. In Madagascar, unlike in most other tropical systems, frugivorous bird and bat seed dispersers are not common, and a large proportion of rainforest plant species are dispersed by lemurs. This study aims to dissect the association between morphological characteristics of seeds and lemurs, and the dispersal of seeds by all diurnal frugivorous lemurs found in Ranomafana National Park (RNP). Seeds were extracted, taxonomically identified, and measured from 171 lemur faecal samples collected during March and April of 2017. The geometric mean diameters of seeds were calculated and then regressed against lemur age-class and body mass, and residuals from a pGLS of lemur masseter muscle mass and body mass (gleaned from the literature) were regressed against number of seeds in the faeces. The average size of seeds deposited in faeces was found to increase with an increase in lemur body size, and the mean number of seeds per faecal sample significantly decreased as lemur residual masseter-muscle mass increased. Surprisingly, 73% of faecal samples of Milne-Edwards sifaka, *Propithecus edwardsi*, typically considered to be a seed predator, contained whole, undamaged seeds of *Psidium cattleianum*, the invasive strawberry guava plant, in the most highly-disturbed area of the forest. While *P. cattleianum* does typically fruit during the months that data were collected, *Propithecus edwardsi* is not known from the literature to perform seed dispersal for any plant species. This suggests that the small, hard seeds of this highly invasive species of guava can be dispersed by both lemur seed dispersers and lemur seed predators in the rainforest. This may increase successful recruitment of invasive guava, aiding it to out compete endemic rainforest species.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.2 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

Impact of collecting seeds from Black-and-white Ruffed Lemurs feces on natural regeneration at Kianjavato forest fragments, SE Madagascar

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Seeds germination success contained in the feces of an animal disperser as well as the chance of seedlings to survive are already reported by previous studies. Since 2009, seed extraction from *Varecia variegata* (Black-and-white Ruffed Lemur) feces has been conducted in Kianjavato forest (KF), southeastern Madagascar, to supply tree nursery. However, no information is available on the impacts of these extraction series on the natural regeneration rate (RR) of tree species. This study provides information of the impact of such collection activities on the RR of five tree species: *Canarium planifolium*, *Cryptocarya myristicoides*, *Noronhia urceolata*, *Uapaca ferruginea*, and *U. thouarsii*. We carried out study between four forest fragments (FF), including two control fragments characterized by absence of seeds extraction and two collecting fragments where Black-and-white Ruffed Lemur feces are extracted. RR of the five target tree species in the two types of FF has been compared based on seedling with basal diameter lower than 2.5 cm within a distance of 10 m around the parent trees. RR is higher in all FF where seed extraction was performed (Mean of RR = 66%; min = 50%; max = 80%) compared to those from control fragments (Mean RR = 46%; min = 30%; max = 65%) and this for all five target tree species. Results demonstrate that seed extraction activities improve seedling survival and encourage noncompetitive growth. Collection of seeds contained in feces of this species does not have a significant negative impact on the natural regeneration rate of the five target species in KF. Though limited by a short study period, results suggest that *V. variegata* play important roles in the ongoing reforestation and forest restoration efforts in KF by providing seeds with high rate of germination success. Loss of large-bodied seed dispersers may have far-reaching ecological consequences including impacts on forest structure and dynamics.

Wednesday, 31 July 2019 | Auditorium
Symposium 1.2 – Seed dispersal ecology in Madagascar's forest: Advance and future directions

SYMPOSIUM 2
Broad-Scale Determinants of Tropical Diversification and Community Assembly

A macroevolutionary process model to investigate hotspots of tropical biodiversity

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Biodiversity reaches remarkably high levels in parts of the tropics, and explanations based on primary productivity, on topography, and on the age and biogeographic origin of major radiations have each added to understanding of the spatial distribution of tropical biodiversity. Current diversity is also the result of a long dynamic history of species ranges shifting and fragmenting and niches evolving in response to changing environments. Macro-ecological process models are showing great potential to increase understanding of the ways in which interacting processes of climate, geography and evolution have shaped the spatial distribution of biodiversity. Recently, it has been shown how a relatively simple set of parameters can shed light on the complex dynamics which generate and sustain biodiversity. The work presented here extends macro-ecological modelling approaches, to focus on the phylogeographic scale, where new species arise through repeated processes of divergence and reintegration, isolation and secondary contact. By simulating spatially explicit gene flow, niche evolution, and range shifts on real and simulated landscapes, this approach aims to understand how different landforms generate and sustain diversity and produce areas of endemism. Varying just three parameters: dispersal speed, rate of local niche evolution, and the rate at which genomic divergence leads to reproductive isolation, this model elicits emergent properties observed in nature (but not coded into the model). These include range limitation due to gene flow along environmental gradients preventing local adaptation; and dominance of rare genomic variants on fronts of range expansion. The new approach presented here will add to knowledge of the role of landscape dynamics in generating macro-scale patterns of phylo-diversity and endemism. It provides a spatially explicit framework to investigate the contribution of dynamics within species, to broad scale patterns of tropical diversity.

Thursday, 1 August 2019 | Grenat
Symposium 2 –Broad-scale determinants of tropical diversification and community assembly

Biogeographic contingencies shape the savanna biome

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The savanna biome occupies approximately 20% of the global land mass, but the dynamics and limits of savannas are changing rapidly in ways that are difficult to predict. Numerous analyses of savanna vegetation based on productivity are unable explain why the dynamics or limits of this biome differ among regions (e.g., Australia, South America, Asia, and Africa), implying a significant biogeographic factor, both in terms of its dynamics but also for predicting regional responses to global change. The woody flora of each savanna region evolved in situ from forest ancestors and as such woody floras across these savanna regions can be characterised as provincial. In contrast, emerging evidence of grass community composition across these vast areas shows that lineages of grasses are globally widespread, with a number of ecologically important grass species having ranges that span the Old and New world, along with evidence that these widespread species achieved these expansive ranges sizes in the last half million years. Combined this suggests: 1) differences in generation times between trees and grasses mean that regional woody floras have had to adapt to the novel ecological conditions presented by grasses, namely fire and grazing; 2) regional differences in the dynamics of savannas are a likely a product of functional differences in the ecology of tree species of each region that determines patterns of growth and mortality. Thereby, biogeographic contingencies are more likely to be shaped by the trees rather than the grasses that characterise savannas of Australia, Africa, South America, and Asia.

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Symposium 2 – Broad-scale determinants of tropical diversification and community assembly

The origin and evolution of the Amazonian biota

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The Amazon represents one of the most iconic biodiversity hotspot on Earth. Despite that, the exact factors that have shaped the Amazonian biota still remain to be understood. This study aims to characterize the spatial distribution of selected lineages of Amazonian taxa (e.g., plants, birds, butterflies, and primates), as well as their phylogenetic and biogeographic histories. We used phylogenomics and biogeographical approaches to reconstruct the time of origin and past history in Amazonia. Our results show that elements of the modern Amazonian biota have very old roots going back to the Paleogene or even the Cretaceous. However, living vertebrate lineages originated mostly during the Plio-Pleistocene. While several living plant lineages also originated in the Plio-Pleistocene, others date back to the Miocene. Our findings suggest that the origin and evolution of the Amazonian biota may be related to the establishment of the river drainage and Terra Firme formation. Despite that, a full understanding of the assembly of the Amazonian biota depends on more comparable data across taxa including increased phylogenetic sampling, and a deeper understanding of the past history of the incredibly dynamic vegetation and river drainage formation.

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Symposium 2 – Broad-scale determinants of tropical diversification and community assembly

Linking present day ecology with micro- and macro-evolution across Neotropical biomes

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Numerous studies demonstrate that Neotropical plant phylogenies are ecologically rather than geographically structured, and that phylogenetic biome conservatism has played a significant role in shaping evolution. This suggests a key role for ecology in the evolutionary process. To demonstrate the value of linking present-day ecology with micro- and macroevolution across Neotropical biomes. We use phylogenies densely sampled at species and population level based upon Sanger and next-generation hybrid capture DNA sequencing for several genera characteristic of rainforest, seasonally dry tropical forest (SDTF) and savanna biomes. At the macro-evolutionary level, we address the relative permeability of different major biomes to lineages. At the micro-evolutionary level, we address whether dispersal may be the critical initiation process in the speciation of Neotropical plants. Finally, we examine the influence of ecology on the nature of species in different biomes. We suggest that the adaptive barrier to enter SDTF may be higher than that to enter savanna or rain forest, perhaps reflecting the ease of adaptation to fire (savanna) compared to the difficulty of adapting to erratic drought on shallow soils (SDTF). We show that rain forest tree communities are dispersal assembled but that in some cases SDTF communities are built by in-situ speciation. We suggest a peripatric speciation model, driven by dispersal, may be common for Neotropical trees. We show that species from different biomes are resolved differently in phylogenetic trees – often monophyletic, with old (> 1 Ma) stem ages in SDTF, and often non-monophyletic and more recent (< 1 Ma) in rainforest. Different evolutionary and biogeographic patterns characteristic of different major Neotropical biomes suggest that a biogeographic model emphasizing dispersal and the influence of ecology operating over evolutionary timescales may be more fruitful than more traditional approaches that emphasize singular geological and climatic events.

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Symposium 2 – Broad-scale determinants of tropical diversification and community assembly

Improving biodiversity prediction in the Brazilian Atlantic rainforest: Mapping diversity and its environmental correlates

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Little consensus exists over what environmental variables constitute good predictors of biodiversity, particularly in the tropics. Species richness appears to be highly correlated to environmental variation, although the specific contribution of different factors appears idiosyncratic when contrasting multiple taxa. Similarly, observed patterns of phylogenetic diversity and phylogenetic endemism may be related to environmental variation. Determining those correlates will help predict diversity patterns and changes, particularly in the face of global warming. Here, we studied these relationships in one of the world's most biodiverse and threatened places, the Brazilian Atlantic Rainforest hotspot. We targeted nine groups with distinct dispersal abilities and natural histories, including five groups of plants and four groups of animals, providing a comprehensive view of relationships between environment and diversity. We used species richness, phylogenetic diversity and phylogenetic endemism maps built from locality data and phylogenetic information, combined with spatially-explicit environmental descriptions (e.g. temperature, precipitation, climatic stability over time, topography), to determine model predictive power and correlates of diversity through machine learning models. Our results suggest environmental variables are very good predictors of species richness, phylogenetic diversity and their mismatch. In the case of phylogenetic endemism results are more heterogeneous with generally less predictive power. However, we found consistently good predictive power for at least four of the studied groups. The individual importance of environmental variables in the models varies with the predicted diversity measure. Climate variables, and precipitation in particular result in higher contributions for explaining species richness and phylogenetic diversity with a slightly higher contribution of climate stability in time in explaining phylogenetic diversity. Phylogenetic endemism shows a more distributed contribution of all considered variables including topographic variables that were not important for the other measures. Within each diversity measure, the contributions of variables vary between taxonomic groups which could be associated to their different life-histories.

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Symposium 2 – Broad-scale determinants of tropical diversification and community assembly

Chemical defenses and the commonness and rarity of *Protium* (Burseraceae) trees in Amazonia

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Plant-herbivore interactions often have been implicated in the origin and maintenance of tropical tree diversity. At the local scale, theoretical studies show that plant species with successful chemical defense strategies could overcome herbivore pressure and become locally abundant. However, little is known about how plant herbivore interactions and consequently, plant chemical diversity could influence community assembly at regional scales. Tree species with a high chemical defense diversity could be more likely to colonize new sites due to a higher chance of fending off novel herbivores as they expand their geographic range. Alternatively, chemically diverse species might also be more likely to develop local chemical adaptations due to the higher number of already active metabolic pathways. Here, we use a combination of large field herbivore surveys, metabolomic approaches, and data from large-scale surveys to assess whether plant secondary chemical diversity is associated with the relative abundance of *Protium* species across the Amazon basin. *Protium* (Burseraceae) is one of several species-rich genera in the Neotropics that accounts for a disproportionate share of the total local diversity at any given site, including both extremely common "hyperdominant" species as well as dozens of extremely rare taxa. We found significant associations between the local *Protium* chemical diversity, local herbivore diversity, and regional species abundances. We believe that these findings are the result of a highly effective and very diverse chemical arsenal in common Protium species, rather than the outcome of local chemical adaptations. Despite large geographic distances, we found a very high consistency in species secondary chemical composition across two distant Amazonian sites. In concert, our results suggest that plant chemistry, as well as plant-enemy interactions play an important role in the regional distribution and community assembly of tropical trees.

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SYMPOSIUM 3
Role Entomological Surveys and Systematics for Conservation Action in the Southwest Indian Ocean

Uncovering the endemic biodiversity of assassin bugs of Madagascar (Hemiptera: Reduviidae)

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Reduviidae, the assassin bugs, are a species-rich (~7,000 described) and morphologically and ecologically diverse group of true bugs that comprises the medically important vectors of Chagas disease and predatory groups that include beneficial insects, but also potentially harmful pollinator predators. As in other groups of insects that are speciose in the tropics, Madagascar has a rich and largely endemic assassin bug fauna that continues to be described and documented. More than 340 species are currently known from the island, with more than 27% described during the past two decades. Based on examination and digitization of >2,500 specimens many collected during the California Academy of Sciences' Terrestrial Arthropod Inventory of Madagascar Project, we here outline current progress with assassin bug discovery and documentation in Madagascar, with emphasis on species distribution ranges, areas of endemism, abundances, and insights on the biogeographic history of selected groups.

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Symposium 3 – Role Entomological Surveys and Systematics for Conservation Action in the Southwest Indian Ocean

Impact of degradation and restoration of native forest on endemic crickets and bush crickets: Use of surveys, taxonomy, and acoustic monitoring

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On many tropical islands, anthropogenic factors such as habitat degradation/loss and introduction of invasive alien species has caused species extinctions and threatened remaining taxa. Native habitat restoration schemes are now conducted on many oceanic islands, and these mostly target plant species and vertebrates. When assessing habitat degradation as well as evaluation of restoration schemes, arthropods are often neglected. However, these may represent the largest proportion of extant native terrestrial animals surviving habitat degradation. The combination of surveys, taxonomy and passive acoustic monitoring of crickets and bush crickets has allowed the assessment of the impact of habitat degradation and to evaluate the success of distinct restoration schemes conducted in Mascarene Islands (Rodrigues, Mauritius, and La Réunion). A similar approach is now implemented in Madagascar. The similarities and the surprising differences between our results and those obtained for plants and vertebrates may help to improve conservation action in southwestern Indian Ocean Islands.

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Lepidopteran fauna on Réunion Island: Link with the quality of habitats and its evolution for 30 years

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Though most of its remaining native habitats are protected by a national park that comprise 40% of Réunion Island, biological invasions and climate changes still are important and challenging threats to preserve its unique biodiversity. Arthropods represents worldwide the largest part of the biodiversity, with 31% of the Réunion arthropod species endemic to the island (40% of the Mascarenes). With 650 known species, Lepidoptera is a well-known group that has been monitored for more than 30 years on the island. Data from 700 light trap sessions across Réunion were analysed to examine relations of habitats, level of habitat conservation, past and ongoing disturbances, changes in abundance through time, and possible elevation shifts. The proportion of endemic species is good indicator of the level of habitat conservation, as most habitats which can be used to define priority conservation areas or to measure the effectiveness of ecological restoration operations. Based on 308 moth species, between 1983 and 2013, the probability of species occurrences were divided by two to four on average. The native species from the lowlands were the most impacted whereas the Réunion endemics were less affected; the exotic species became more frequent, especially at low and mid altitude. The decline of low altitude species is likely due to habitat transformation or at least disturbance. When an altitude shift was detected in one species, this was due to the disappearance of populations at low altitudes and not to a translation of all populations to the highest altitudes. Such an altitude shift, a possible consequence of global warming, has only been observed for a few species, which are common endemic species. This last result must be confirmed for the future use of these species of moths as bio-indicators of climate change on Réunion.

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Overlooking the obvious - Understanding the diversity and impact of minute parasitic wasps

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The superfamily Chalcidoidea are highly diverse but comprised of very minute wasps that are often overlooked in surveys and conservation efforts. Most species are undescribed, but have a tremendous impact in controlling other insects and also for the pollination of fig trees. Because they attack and kill other insects, they have been successfully used in many different biological control programs of insect pests. Over 23,000 species have been described worldwide, but conservative numbers suggest more than 500,000 estimated species. The Eucharitidae are one group of these wasps that are parasitoids of the immature stages of ants. Understanding their diversity and complex life history is used to highlight the general diversity and biogeographic history of chalcidoid wasps in Madagascar.

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The globally outstanding biodiversity in the UNESCO world heritage site Rainforests of Atsinanana: Discovering three new branches of the diving beetle tree of life

JOHANNES BERGSTEN
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Rainforests of the Atsinanana was inscribed on the UNESCO World Heritage List in 2007 and comprise a serial property of six components, all formally protected as National Parks (Marojejy, Masoala, Zahamena, Ranomafana, Andringitra, and Andohahela). The property was inscribed based on its outstanding endemic biodiversity values, represents a selection of the most important habitats of the unique rainforest biota of Madagascar and are critically important for maintaining ongoing ecological processes necessary for the survival of Madagascar's unique biodiversity. Since 2010, Atsinanana is inscribed on the List of World Heritage in Danger, following a surge in illegal logging and hunting threatening its Outstanding Universal Values. In 2018, we carried out an expedition to explore the aquatic beetle fauna in the three northern components of Atsinanana (Marojejy, Masoala, and Zahamena). In particular, our focus was diving beetles (Dytiscidae), a globally distributed family with about 4500 species. Three endemic genera were known from Madagascar. From sea-level to central highlands we collected two new genera of Dytiscidae, and a possible third later came to our attention, potentially doubling the number of endemic higher taxa of Dytiscidae on Madagascar. All three belong to subfamily Hydroporinae and tribe Bidessini. This is extraordinary in light of the global average description rate of new genera of Dytiscidae (1.5/year) and highlights the absolutely stunning but yet largely unknown insect biodiversity of Atsinanana. A recent IUCN assessment of freshwater biodiversity in Madagascar found that almost half of the species are threatened with extinction. The largest threats come from habitat loss and degradation caused by unsustainable agricultural practices, such as the slash-and-burn approach and drainage of wetlands. For much-needed multidisciplinary conservation work of freshwater sites, entomological surveys are a first necessary step to identify, understand, and fully appreciate the scale of Outstanding Universal Biodiversity Values on Madagascar.

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Why are entomologists sitting on the conservation sidelines? Insects and People (IPSIO.org): Efforts to end the silence on habitat loss in Madagascar

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Insects are everywhere, yet invisible in most conservation efforts. Since terrestrial ecosystems make no sense except in light of insects, this is short-sighted and unfortunate. The time is now for entomologists to end their silence on the loss of insect habitats. After all, how much tropical forest will be left in 50 years? Madagascar, a locus of biodiversity research, is a prime example. Since 2001, we have inventoried over 350 localities across the island, visiting all major habitats, soil types and bioclimates, processing millions of specimens, training students, and collaborating with 180 taxonomists. Despite the scale of this effort, knowing the name of any insect, its habits, its distribution, whether it is endangered, or whether it is invasive remains difficult. Given the breakneck speed of habitat destruction, should not we try to apply our knowledge to protect habitats, monitor ecosystems, and link the health of humans to that of the natural world. Large-scale insect biodiversity inventories have failed to save a single forest in Madagascar. The current entomological effort could be characterized as haphazard and opportunistic and does not focus on concrete conservation advances. Instead, taxonomic advances are driven by individual interests and not on collective need. The Insects and People of the Southwest Indian Ocean (IPSIO) network aims to help entomologists focus their efforts on local outcomes. IPSIO provides the organizational infrastructure to translate taxonomic research into conservation improvements, providing vetted data for conservation assessments, forest restoration, and invasive species monitoring. Other efforts include using insects as food and insects in tourism.

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Symposium 3 – Role Entomological Surveys and Systematics for Conservation Action in the Southwest Indian Ocean

SYMPOSIUM 4
Functional Responses to Changing Environments

Traits shape the drought survival and tree species distribution along a rainfall gradient in Ghana

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A mechanistic understanding of how traits influence species drought survival and distribution along rainfall gradients is important for understanding current species distribution patterns and for predicting how species will respond to climate change. We tested the hypothesis that similar traits will predict drought survival and species position on Ghana's rainfall gradient. We studied 24 Ghanaian tree species with different distributions along the rainfall gradient in a greenhouse experiment where seedlings were exposed to two light treatments (5% and 20% of full sunlight) and two watering treatments (watered daily and a dry-down experiment in which water was withheld for nine weeks). We measured 16 morphological and physiological traits, seedling growth and survival. In a separate analysis, we quantified the position of species on the rainfall gradient using climatic variables and inventory data of 2505 1-ha plots distributed in the forests of Ghana. We used multi model inference to identify the traits with the greatest relative importance for drought survival and the minimum rainfall at which species occur. Species drought survival in the dry-down experiment increased with biomass allocation traits that enhance water uptake (high biomass fraction in roots) and reduce water loss (low biomass fraction in leaves) and tough leaf- stem- and root tissues that enable physiological drought tolerance. Specific leaf area (leaf area per unit leaf mass) was the best predictor of the minimum rainfall at which species occurred; species with high SLA occurred at low rainfall. Similar traits predicted drought survival and minimum rainfall at which species occur. However, the most important traits that predicted drought survival and species position on the rainfall gradient were not the same, indicating that other factors than drought tolerance co-shape species distribution. Our results suggest drought tolerance act in concert with other biotic and abiotic factors to determine species distribution along rainfall gradients.

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Symposium 4 – Functional Responses to Changing Environments

Effects of topography on tropical forest structure depend on climate context

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Topography affects abiotic conditions which can influence the structure, function, and dynamics of ecological communities. Some studies have demonstrated biological consequences of fine-scale topographic heterogeneity but we have a limited understanding of how these effects depend on the climate context. To determine how effects of topography on tropical forest structure depend on climate context. We merged high-resolution (1 m^2) lidar data on topography and canopy height derived with data from 15 forest plots in Puerto Rico spanning a precipitation gradient from ca. 800 to 3,500 mm yr^{-1}. Plot data included species composition, estimated above-ground biomass (AGB), and two key functional traits (wood density and leaf mass per area, LMA) that reflect resource-use and hydraulic strategies. We evaluated how topography and climate interactions are related to forest structure (i.e., canopy height and AGB), as well as taxonomic and functional diversity. Fine-scale topography significantly affected forest structure and the strength (and in some cases direction) of these effects varied across the precipitation gradient. In all plots, canopy height was higher in topographically wetter microsites but the effect was stronger in dry compared to wet forests. In dry forest plots, topographically wetter microsites had relatively high levels of AGB but in wet forest plots, topographically drier microsites had higher AGB. Fine-scale topography influenced functional but not taxonomic composition and diversity. The effects of fine-scale topographic heterogeneity on tropical forest structure and composition depend on the climate context. Our study demonstrates how a stronger integration of topographic heterogeneity across precipitation gradients could improve estimates of forest structure and biomass, and may provide insight to the ways that topography might mediate species responses to drought events and climate change.

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Symposium 4 – Functional Responses to Changing Environments

Ontogeny, light, and topography shape leaf functional trait values of individuals in Neotropical tree species complexes

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Theories on the maintenance of biodiversity have mainly considered questions pertaining to the species coexistence level. This approach, however, has some limitations as there is no unanimity about how to define a species, and individuals within species present variation in performance, phenotypes, and genes. A growing body of research has suggested that intraspecific trait variability is likely to shape community assembly. To gain insights into the structure of intraspecific trait variation in tropical tree species complexes, we examined leaf functional trait variation along ontogeny and across the environment in a highly diverse tropical forest of the Guiana Shield. We collected leaf functional traits from 766 adult trees belonging to five species and two genera in permanent plots encompassing a diversity of micro-habitats, i.e. topographical levels. We tested the role of ontogeny and abiotic environment on leaf functional trait variation with a hierarchical Bayesian model. Diameter at breast height, representing indissociable effects of ontogeny and access to light, was positively correlated with leaf thickness and leaf mass per area and negatively with leaf area. The changes towards more conservative trait values for bigger trees in more luminous environment, previously observed between seedling/sapling and adults, persist in later life changes. Moreover, higher topographic position resulted in a shift from acquisitive to conservative strategies, both across and within species. Our results suggest that intraspecific trait variability could increase species tolerance to environmental filtering and contribute to species coexistence. This highlights the interest of a structured and thoughtful sampling effort within species and individuals for trait-based studies of community assemblage.

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Symposium 4 – Functional Responses to Changing Environments

Horizontal and vertical light gradients shape demographic strategies of tree species in a moist tropical forest

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Light is a key resource in tropical rainforests and demographic strategies of tree species have evolved to cope with light limitation. The well-known growth–survival tradeoff (fast–slow continuum) distinguishes fast species that grow and die fast and require canopy gaps to maintain populations from slow species that grow slow but survive well in the shade. Recently, a second demographic tradeoff has been identified – the 'stature–recruitment' tradeoff – which is orthogonal to the fast–slow continuum. It distinguishes tall-statured long-lived pioneers that grow fast and live long but suffer low recruitment from short-statured short-lived breeders that grow and survive poorly but produce many recruits. However, it is unclear whether this second demographic tradeoff is also related to gradients in light availability. To address this question, we quantified horizontal and vertical variation in light availability in a 50-ha plot in the moist tropical forest on Barro Colorado Island, Panama, and determined community-weighted means and demographic diversity with respect to the two demographic tradeoffs. Horizontally, we quantified light availability at 2 m height in 5 x 5 m subplots. Vertically, we grouped species into seven size classes. Along the horizontal light gradient, local communities were less demographically diverse than expected (environmental filtering) with respect to the fast–slow continuum (but not the stature–recruitment tradeoff), with local communities being 'faster' in high-light sites and 'slower' in low-light sites. Along the vertical light/size gradient, size classes were less demographically diverse than expected with respect to the stature–recruitment tradeoff (but not the fast–slow continuum), with big trees being skewed towards long-lived pioneers and small trees being skewed towards short-lived breeders. Our results suggest that the two demographic tradeoffs emerged as adaptations to the two spatial gradients in light availability.

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Symposium 4 – Functional Responses to Changing Environments

A continuum of assembly rules shapes trait diversity in lowland Amazonian forests

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Trait-based approaches provide valuable insight into the role of different community assembly processes, yet it remains unclear which general laws govern community assembly across biomes and regions. Here we test for the existence of a general backbone shaping tropical tree communities despite local environmental idiosyncrasies. We analyze a network of 74 plots in French Guiana and Peru, two opposite ends of the Amazon basin that differ in species composition, substrate age and climate seasonality. The network in each of these regions also encompasses the three main habitats of lowland Amazonia (terra firme, seasonally-flooded and white-sand forests) that represent gradients of soil fertility and water availability. We combine species abundance with data for 14 functional traits describing leaves, stems and roots to calculate the mean, variance, skewness, kurtosis and range for each community. Specifically, we advance beyond summary indices used in most previous functional analyses and use the skewness-kurtosis relationship (SKR) of each trait distribution to disentangle trait convergence/divergence and evaluate non-random commonalities between communities. We find that some trait distributions are highly peaked, suggesting strong environmental filtering towards a single trait value. In contrast, other trait distributions are relatively flat, suggesting a maximization of local functional diversity and an important role for limiting similarity. Importantly, while each of the 14 trait distributions responds to specific community assembly mechanisms, taken together they define a single continuum of assembly rules. Despite strong environmental gradients and high species turnover across lowland Amazonia, our findings suggest common deterministic laws of community assembly in these tropical forests, wherein biophysical constraints of trees may shape the SKR signature of individual traits. Our study allows a nuanced evaluation of the signatures of both abiotic and biotic factors in shaping trait distributions, which has the potential to improve predictive models of the future of communities and ecosystems.

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Symposium 4 – Functional Responses to Changing Environments

SYMPOSIUM 5
Restoration of Tropical Forests: Lessons From Madagascar and Beyond

Forest cover in Madagascar: Past, present and future

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Madagascar is recognized for its exceptional biodiversity both in terms of number of species and endemism. This biodiversity is concentrated in the tropical forests of the island and is highly threatened by deforestation. Here, we (i) present the historical changes in Madagascar natural forest cover (1953-2017), (ii) characterize present natural forests (2017), and (iii) forecast future forest cover (2050 and 2100). First, we analyzed the forest cover change (1953-2017) combining historical national forest cover maps (1953-2000) with a recent global annual tree cover loss dataset (2001-2017). Second, using a new spatial deforestation model, we identified the areas with higher risk of deforestation. The model takes into account the regional variability of the deforestation process and the effect of various socio-economical and environmental landscape factors. We show that deforestation has dramatically increased recently, reaching 1.9%/yr in 2015-2017. We produced new forest cover maps at 30 m resolution for the year 2017. We show that Madagascar has lost 49% of its natural forest in the period 1953-2017 and that residual forest in 2017 (8.4 Mha) is highly fragmented. Half of the forest is now located at less than 100 m from a forest edge. Using the deforestation model, we show that protected areas will effectively reduce deforestation outside biodiversity hotspots only in the short term. Assuming an annual deforestation of 100,000 ha, only 5.1 Mha of natural forest will remain in 2050 in Madagascar. Remaining forest will be concentrated in less accessible remote areas at higher elevation (e.g. around the Masoala Peninsula). Forecasts indicate that if no action is taken quickly to stop deforestation, a major part of the natural forests of the island and associated biodiversity will disappear during this century.

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Symposium 5 – Restoration of Tropical Forests: Lessons From Madagascar and Beyond

Tropical rainforest assembly: Evolution, ecology, and biogeography

ROBERT KOOYMAN
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The factors influencing rainforest assembly in natural environments are the same as those we need to understand to restore rainforest in degraded landscape settings. However, degraded landscapes often require the development of specific strategies to compensate for extreme conditions, the loss of species and species interactions, and the failure of fundamental ecological processes. As examples, the distribution and establishment of canopy tree species may be disrupted by the loss of specific seed dispersers, while species of the mature forest may be disadvantaged by the 'hostile' or exposed habitat, establishment, and growth conditions of human-modified landscapes. Understanding how species establish, survive, and make a living, and which species they co-occur and/or compete with under different environmental conditions, is a key objective for community ecology, and restoration. Using examples from Madagascar, Australia, and Southeast Asia, this talk examines restoration objectives and end points, from restoring the 'original' forest, to promoting natural regeneration. We use a range of methods to explore rainforest community assembly. We highlight how having knowledge of the ancestry and origins of lineages in a local flora can provide insights into species distributions, functional ecology, and the traits that shape plant strategies. In addition, genomic (genetic) measures can show how within and between species genetic diversity is structured across landscapes, and environmental gradients. In combination, such information can provide insights into the resilience, plasticity, and distribution of local species, and how they might differ relative to biogeographic history, and in their responses to the extremes of contemporary conditions, and future climate change. Even in the face of major inhibiting factors, understanding the factors shaping the 'original' forest and natural disturbance responses can help conservation planning and promote development of resilient climate-ready forest communities, and facilitate the development of socially and ecologically acceptable forest restorations.

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Mining companies as potential leaders in Malagasy forest restoration

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Between 1950 and 2000, 40% of remaining Malagasy forest was destroyed and forest loss continues today at a similar pace. Much of the remaining forest is degraded and fragmented and successful long term conservation of forest' biodiversity will require restoration to improve integrity and connectivity. Our objective in this study was to describe the current status of native forest restoration in Madagascar and to identify opportunities to promote the successful implementation of this activity here. A comprehensive list of projects that planted native trees on degraded land in 2017 and 2018 were identified, and the manager of each was interviewed to establish the vision, protocols and results of the work as well as perceptions of challenges and opportunities. This information was analysed to provide an overview of such work in Madagascar. This showed that most projects are of small scale (< 10 ha planted annually) and while they have a vision this is rarely supported by a convincing plan. While there is some experimentation with protocols, the methods used are generally similar to those used to establish plantations of alien species. Apart from counting the number of plants planted, most projects do not monitor progress towards achieving their vision, and most projects do not know the identity of all the plants used in their endeavours. Among projects that monitor the survival and growth of seedlings, mortality is high and growth slow compared to the values reported from other tropical countries. However, some mining companies demonstrated a clearer vision to forest restoration, underpinned their work with a restoration plan, sought to establish best practice, invested in monitoring progress, and could demonstrate their outcomes. Although such companies have many advantages over conservation organisations, their restoration work, if shared, could inspire and inform others.

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Linking science to applied restoration: The Ambatovy project as an example

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Ecological restoration is one of Ambatovy's main environmental commitments. Environmental studies demonstrated high biodiversity and endemism in the area of the mine. To protect and preserve the fauna and flora species during and beyond the life of the mine, requires scientific approaches involving national and international experts**.** The Ambatovy mine restoration seeks to restore 1500 ha of multi-use forest in 35 years. The restored forest will be coherent with the surrounding vegetation, suitable as habitat for local rainforest species, and contribute to local community livelihoods. Rehabilitation trials were conducted at various sites within the mine using native species identified and inventoried during baseline studies before mining commenced. Restored areas were monitored to assess plant growth, mortality, and natural regeneration. Soil microbiological and chemical sampling and analyses were conducted. Planting trials were monitored for eight years and showed canopy coverage of 20% compared to the > 70% of rainforest reference sites. The high light environment allowed weeds and invasive grass species to colonize some test plots. The early planting trials showed that planting densities of 5000/ha were not sufficient to achieve the objective of vigorously growing forest with a high diversity and density of tree species to facilitate rapid canopy coverage. The trials failed to achieve the high leaf litter accumulation and improved soil microbiology and mycorrhiza activity sought. However, the low planting density did favour weed and grass development, and increased the potential risk of fire. Our response has been to increase the planting density (10,000-12,500/ha) and diversity, and include the broadcasting of pioneer forest tree seeds between planted trees to offset the loss of fresh topsoil. As part of the adaptive management response this new approach is currently being implemented and monitored intensively to improve the restoration methods.

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Tree survival after wildfire in a rainforest restoration project in NE Madagascar

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As fire becomes more common in rainforests due to climate change, understanding tolerance of rainforest tree species to fire becomes increasingly important. Madagascar's northeast coast is particularly vulnerable to fire given the spread of the fern, *Dicranopteris linearis*, which is extremely flammable and promotes its own dominance in this region. The objective of the study was to investigate which Malagasy tree species were better able to survive a wildfire disturbance and what site conditions or species characteristics were associated with survival. We planted 4,000 trees of 11 different Malagasy tree species in 160 small monoculture islands consisting of 25 trees each. Several months after planting a wildfire burned the project. Prior to wildfire, we had recorded litter depth (=fuel depth), slope, sapling height, and position within the tree island. After the wildfire, we scored the intensity and severity of the fire at each sapling. Several months later, we returned and recorded tree survival. Selection of species was the most important factor affecting survival. Our fire survivors were *Neotina* spp., *Harungana madagascariensis*, *Trema orientalis*, *Intsia bijuga*, *Hymenaea verrucosa*, and *Terminalia mantaly*. A number of life history traits emerged that were associated with survival. We categorized these into three categories: retardance, resistance, resilience. Retardant species cool the fire as it passes. Resistant species suffer lower damage for a given level of fire intensity. Resilient species have high rates of resprouting after suffering strong levels of damage from the fire. Location within the tree island was also an important factor for sapling survival after wildfire. Interior trees had higher survival suggesting that planting designs with low perimeter: area ratios reduce fire impacts. For restoration-practitioners who work amidst highly flammable fuels, our results suggest that careful planning for the possibility of subsequent fire disturbances can greatly increase the chance that trees reach maturity.

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The tricky art of selecting reference ecosystems to guide restoration of a uranium mine in a World Heritage Area

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Ecosystem restoration of an open-cut mining operation is complicated. Firstly, ecosystems that overlay the mineral ore are rarely well studied and therefore poorly understood. Secondly, soils cleared to access the ore are generally misplaced, or severely degraded, during the mining process, thus losing organic material and native seeds that are critical for effective restoration. Thirdly, there are no exact guidelines on how to select a reference ecosystem to guide restoration of a post-mining landform and substrate that has no local analogues. Ranger uranium mine, surrounded by the World Heritage Kakadu National Park, in northern Australia, is currently marching towards closure and all of these issues have come into sharp focus. Soil types and vegetation communities were mapped prior to mining, but after filling the mine pits the new land surface will be composed of crushed waste rock, as none of the original topsoil is available. This final growth substrate is nutrient deficient, has a low water holding capacity and has a higher albedo than the original soils. All of these factors mean that the establishment of a vegetation cover and meeting a legislative requirement "to be similar to surrounds" will be a difficult task. This talk will demonstrate the selection process we used to select relevant reference ecosystems utilising existing vegetation mapping products, land units, fire history and species descriptions. It will also highlight the potential pitfalls that may arise during the ecosystem restoration phase and the research required for native species propagation beyond key woody framework species.

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SYMPOSIUM 6.1 & 6.2 Monitoring the Forest Cover: Tools for Managing Natural Resources

Remote sensing in support of conservation monitoring and planning

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Protected areas are a key approach to conservation biodiversity. Madagascar has some 110 terrestrial sites covering some 8% of land surface. Here we present a study from the Makira Protected Area in the northeast, which consists of different usage zones. We report on the land use change within the Controlled Occupied Zones and Controlled Used Zones and those with Community Management areas. We use georeferenced aerial photography for the whole Makira Protected Area coupled with Google earth tools to estimate deforestation and identify the roof tops of houses, as a proxy for anthropogenic pressure. The goal is to evaluate the deforestation in the protected area, and the change in type of houses and in number of houses within a period before and after the establishment of the Makira National Park in 2009. A deforestation map from 2005 until 2017 shows changes in forest cover with a forest loss of about 3,230 ha (0.90%) for the entire protected area and 2,700 ha (0.83%) for the core zone only. Results of these analyses were used by the park management to inform the patrolling teams about their itineraries and increase conservation and monitoring efforts and planning. We use also the result of the deforestation analysis to better guide community awareness actions for the local communities. We concentrate our community sensitization effort to where the rate of deforestation increased and encourage to continue their implication in conservation for those community where the deforestation rate is low.

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Symposium 6.1 – Monitoring the Forest Cover: Tools for Managing Natural Resources

GLAD, an opportunity to refine Madagascar National Park's current strategy to combat illegal deforestation in remote protected areas

GUY RAMANGASON, OLLIER ANDRIANAMBININA
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The endemic biodiversity of Madagascar relies heavily on forest ecosystems, which is more and more, found in protected areas of the island. For any manager of Madagascar's parks and reserves, the main concern is to avoid forest loss. Detecting land clearance and loss of natural forest cover is therefore a constant challenge. In the western dry forests, the delay between slashing and burning is short, sometimes few days only. In the eastern humid forests, burning is carried out five to six months after clearing. The main challenge is to detect in real—or near-real—time the changes in forest cover, stop or slow down it, and prevent fires. Madagascar National Parks (MNP) has a modernized system of fire alerts and active system to combat fires; the system has proven to detect and stop fires with local partners. The Global Land Analysis & Discovery – GLAD — is a new efficient and effective tool to alert in near-real time about land clearing, i.e., before the forest is put on fire. MNP has started testing the new GLAD alerts in the Mantadia National Park. The preliminary results show how MNP can optimize its field device designed to fight against fires, to integrate GLAD alerts to combat deforestation and allow action before the forest is put on fire. Monitoring forest cover is a national concern that can build on new tools; it needs to be analyzed and implemented at the regional level and has to tackle the roots on the ground.

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Innovation and ground work needed to save the central Menabe, the threatened hotspot of western Madagascar

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Menabe Antimena Protected Area (210,312 ha), a very popular tourist destination in western Madagascar, is home to over 19 globally threatened animal species including the Giant Jumping Rat (*Hypogeomys antimena*) and Madame Berthe's Mouse Lemur (*Microcebus berthae*), with various rare endemic trees such as *Hazomalania voyronii*, *Dalbergia greveana*, *Diospyros perrieri*, and *Adansonia grandidieri*. However, despite conservation efforts, Menabe Antimena has lost approximately 30% of its dry forest during the last 10 years due to continual slash and burn agriculture for illegal maize and peanuts plantation, and is still facing increasing anthropogenic pressure. Since 2004, we have been implementing participatory ecological monitoring by engaging 72 volunteers who carry out biodiversity and threats patrols within strict conservation zones on a weekly base. Topping up our pen and paper based basic methods with innovative technology SMART, MODIS fire, and GLAD alerts using tablets, substantially helped improving the effectiveness of the local patrols in terms of informing decision-making and enforcing environmental laws. This recent innovative citizen science approach gives some hope as it builds valuable data and speeds up communication of information to better control illegal activities and improve the management of the protected area.

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Symposium 6.1 – Monitoring the Forest Cover: Tools for Managing Natural Resources

Comparing global and national approaches to estimating deforestation rates in REDD+ countries

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Article 5 of the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) encourages all Parties to make full use of forests for climate change mitigation, and explicitly calls for Parties to move forward with REDD+ implementation. How Madagascar and other developing countries measure and report emissions reductions from avoided deforestation is critical for the success of REDD+. National forest monitoring systems must be widely perceived as credible by both domestic and international stakeholders to enable the flow of results-based payments. However, with advances in satellite technology for deforestation monitoring, different data are being produced by different groups for different purposes, using different methods and time periods, and leading to divergent results. The goal of this session is to clarify how much, where, and why results differ between deforestation estimates reported by the Government of Madagascar in its FREL submission to the UNFCCC and the Global Forest Change (GFC) tree cover loss data of Hansen et al. By doing so, we hope to reduce confusion and controversy surrounding differing estimates, which will ultimately help to engender the needed trust in REDD+ and, more broadly, in the use of forests for climate change mitigation.

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Symposium 6.1 – Monitoring the Forest Cover: Tools for Managing Natural Resources

Adapting the percentage of canopy cover to best reflect the diversity of forests in Madagascar

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Madagascar has a network of 123 terrestrial and marine parks and reserves in 2019 to protect the island biodiversity in various land- and seascapes. The terrestrial protected areas cover an area of almost 7 million hectares that have specific management plans falling under one of the 6 IUCN conservation categories. They are scattered within different types of vegetation from humid forests to dry forest and dry spiny forest-thickets, and other open vegetation types. Even though the forests of Madagascar host some 80% or more of the endemic biodiversity, the deforestation puts high pressure on these ecosystems, both outside and inside the protected areas. Because of the various types of vegetation spread across the different region of Madagascar, this study will focus on adapting the percentage of canopy cover to capture the diversity of forests. The most recent protected areas data and shape files were used in combination with the vegetation layer from Moat and Smith, and both tree cover density and tree loss from Hansen/UMD/Google/USGS/NASA to look at the deforestation from 2001 until 2018. Preprocessing was conducted by cleaning the data sets, repairing the geometry, and re-projecting each data sets. The different data were merged to obtain the annual deforestation rates from 2011 to 2018 for each type of vegetation. We look at the best estimate to evaluate the forest cover and forest loss through the different variation of the percentage of tree cover density, by considering the different types of vegetation within the protected areas. Preliminary analysis suggested the importance of varying the tree cover density depending on the type of vegetation, with more than 90% for humid forest, 50% of tree cover density for the Madagascar Western dry forest, and just above 10% for dry spiny forest to avoid over- or underestimation of the forests cover.

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Using near-real-time satellite alerts to support journalists reporting on forests

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As the availability of near real-time data in about forest change expands, there exists a growing number for opportunities for journalists to leverage this data in their reporting on forest issues. In collaboration with Global Forest Watch (GFW), Mongabay is catalyzing its global network of reporters with deforestation alerts by using this data as a starting point for place-based news articles featuring on-the-ground interviews, photos, video and satellite imagery that contextualize recent forest losses within their broader pattern of change. This reporting process draws upon near-real-time satellite data, automated algorithms and field intelligence to identify new areas of interest on a monthly basis. Once locations are identified, Mongabay (one of the world's most read conservation and environmental science news sources) initiates further investigation by commissioning reporting assignments and publishing news articles that are easily understood by both mainstream and more sophisticated audiences. These articles are added to GFW's "Places to Watch" map layer and included in a monthly newsletter to better inform responses to recent forest change.

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Symposium 6.1 – Monitoring the Forest Cover: Tools for Managing Natural Resources

Climate variability effect on the plant phenology and tree mortality in unique dry spiny forest of southwestern Madagascar

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In tropical forests, plant phenology shows complex links to environmental factors such as precipitation, temperature and day's length. Southwestern Madagascar is the driest part of the island, characterized by spiny forest ecosystems and known for high temporal and spatial variability in intra- and inter-annual precipitation. The goal was to document the change in the phenological characteristics of different plant species in the dry spiny forest of southwestern Madagascar in the long-term aspect. I will present detailed data on several temporal and spatial scales to come to a better understanding of the relationships especially between rainfall and plant phenology. The seasonal rainfall showed large inter-annual variability with significant change over the 2007–2019 period. Several decades of data on precipitation indicated a shift in rainfall patterns during the last decade. The deciduous plant species did not react in the same way to change in environmental factors. The irregular rainfall pattern should make it difficult for plants to trigger their phenophases on the photoperiod. Thus, it is expected that plants that trigger flowering on photoperiod should be disadvantaged. To this end, the phenology of different vegetation types within the spiny forest ecosystem has been monitored in bi-weekly intervals for more than 10 years (2008-2018). The different phenophases (flowering, fruiting, leaf production) will be related to precipitation patterns and day-length. Tree mortality is analyzed on the species level, physiological properties and in relation to precipitation. Spatial variability of phenological patterns has been documented along an environmental gradient for selected tree species over the course of one year. Since information on small-scale weather conditions is lacking, stable nitrogen isotope signatures in leaves from this tree species are used as indicators for local water stress and phenological characteristics will be related to these fine scaled measurements.

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Symposium 6.2 – Monitoring the Forest Cover: Tools for Managing Natural Resources

Developing strategies for forest restoration integrating seed dispersal by lemurs and socio-economic interests of the local community

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In Madagascar, historic and on-going deforestation has led to fragmented and degraded habitats, while global warming and water scarcity add further pressures to biodiversity. The large proportion of species at risk of extinction is alarming. In 2017, the government launched a strategy to reforest 4 million ha by 2030. However, it is expected that this will mainly be achieved by plantations of fast-growing alien species that are popular for timber and charcoal production rather than restoration using slower growing and less popular native trees. Nevertheless, native forests provide more diverse and more abundant ecosystem goods and services, including being attractive to tourists, and they harbor a greater biodiversity. The dry forests of Oronjia, a new protected area in northern Madagascar, is highly degraded but still of great conservation importance. Based on the analysis of different steps of natural regeneration of the forest, we aim to develop cost-effective restoration strategies. To contribute to these strategies, we have considered the possible role in the regeneration of Oronjia of the frugivorous and seed-dispersing lemur, *Eulemur coronatus*. By behavioral observations we described the species' ranging and feeding patterns to determine which plants are dispersed where. With germination experiments we assessed the influence of the lemur's gastrointestinal passage on seed viability, germination time and rate. Via rodent surveys and seed removal experiments we considered the impact of secondary seed dispersal and/or predation. In vegetation plots we measure actual regeneration of plants in differently degraded parts of the forest, with different disturbance levels. Our results show that despite Oronjia is now subject to a conservation program, the forest's regeneration is compromised for various reasons. Although *E. coronatus* plays an important role for the regeneration of the Oronjia Forest, we also found limitations to this.

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Forest Watcher App implementation to design protected area patrolling system in Beampingaratsy Forest corridor, SE Madagascar

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Nitidae, Antananarivo, Analamanga, Madagascar

Located in southeastern Madagascar, the Beampingaratsy Forest was gazetted as a provisional protected area in late 2018. In respect of the Protected Area Law (COAP), the protected area promoter (Association Nitidæ) must establish efficient patrolling system to detect and monitor anthropogenic pressures on habitats and biodiversity. This system is necessary to document offences for further law enforcement operations with regional Environment & Forest Direction authorities. The Forest Watcher application is a smartphone-based solution to receive and monitor fires and vegetation loss alerts. A six-month preliminary assessment was conducted to identify main constraints/opportunities to improve the tool's operationalization in the management system, especially to design patrolling and reporting plans. Different aspects were assessed using information clouded on the Forest Watcher desktop software: (i) GLAD/VIIRS alerts confidence based on detailed reports, (ii) alerts transmission to smartphone delays after alert publications, (iii) quality of information collected by forest agents on the Forest Watcher questionnaire, (iv) patrolling effort: monthly area covered by agents based on alerts verification, and (v) practicability and ease of use and acceptance based on stakeholders and agents surveys Comparative analysis was performed according to different implementation contexts and forest agents' basic know-how: remoteness (network, power access), habitat types, local communities situation (forest management transfers areas, project presence history). Main constraints (network access, smartphone use, accounts management, navigation to alerts location) and opportunities (communities' participation, rapid information access, detailed reports, photographs) were identified to improve further system deployment. Following tool development were planned to connect Global Forest Watch alert and Forest Watcher application systems to conservation actors, including (i) regular formal monthly reports addressed to all stakeholders for information (local associations, elders, mayors), (ii) detailed reports for enforcement actions to regional administration (coordinates, photographs, areas), and (iii) explained case studies for outreach and education actions.

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Symposium 6.2 – Monitoring the Forest Cover: Tools for Managing Natural Resources

When monitoring isn't an option – rationales for uplisting Malagasy precious woods to CITES Appendix I

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[6]Missouri Botanical Garden

Deforestation in tropical forests continues unabated despite international conventions such as the New York Declaration on Forests, or the Bonn Challenge, aimed at reversing this trend. The illegal timber trade is a global issue also concerning precious woods such as rosewoods, which are highly prized and mainly sourced from Africa and Madagascar. In Madagascar, deforestation has reached unprecedented heights since the early 2010s, when corruption started increasing substantially, placing Madagascar amongst the worst tier. The political instability is recurrent since the 1990s; forest regulations that have been in place for the past 15 years have facilitated illegal logging of rosewood. Sustainable use of precious woods is not possible in the current context, which precludes any form of exploitation that is not detrimental to the natural stand of these species. The Malagasy government, supported by some international donors, nevertheless encourages the sale of large stocks of precious wood that have been confiscated. The sale of these stocks risks spurring new illegal harvest. As it currently stands, no suitable tools are available to identify, control or monitor standing trees or logs of these trees such as the Traffic Wood identifier (which only allows the identification of ebony and rosewood), radio frequency identification technology, or DNA bar-coding. There are also substantial gaps in our knowledge regarding the taxonomy and species limits of the rosewood and ebony species, population sizes, as well as species distribution and abundance. Given the prevailing taxonomic confusion and weak governance, all precious woods of Madagascar should be uplifted from Appendix II to Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

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Using bioacoustics to strengthen corporate conservation commitments

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[2]Mongabay (Primary Presenter)
[3]The Nature Conservancy

Corporate conservation commitments, such as various certification schemes and zero deforestation pledges have become a popular and widely publicized conservation strategy. Whether or not deforestation has occurred within the concessions of companies that are certified or committed to zero deforestation can be verified through satellite imagery. However, the conservation benefit of such commitments is determined not just by forest loss but also by the level of degradation in those forests left standing: even forests that appear as intact on satellite imagery may have low biodiversity conservation value due to over-hunting, habitat destruction, invasive species, etc. These forms of degradation are difficult to monitor remotely, so there is a common but unreasonable assumption that conserving forest cover is equivalent to conserving biodiversity. Bioacoustics, and specifically the recording and analysis of entire soundscapes, could be a suitable tool for monitoring animal biodiversity in the conservation areas of various industries, either by following change of a soundscape through time, or by comparing to a regional soundscape baseline. We will explain how using bioacoustics to monitor the success, or lack thereof, in certified forestry or forests spared through zero deforestation commitments, might be an advantageous solution for all stakeholders involved. We describe the results of a pilot experiment characterizing a timeseries of soundscapes of Bornean tropical lowland forest in a certified logging concession and in a spared conservation zone of an oil palm company committed to zero deforestation. We conclude that soundscape time series can provide a relatively cheap, objective, sensitive, and transparent tool to track industry conservation commitments.

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Symposium 6.2 – Monitoring the Forest Cover: Tools for Managing Natural Resources

Urban Forests – the role they can play in an increasingly urbanised world

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Urban green infrastructure is important for human welfare and for the quality of life in cities; urban greenery can reduce exposure to pollution, counteract urban heat, absorb rainwater, and attenuate flow across the impervious cities surfaces. Urban greenery is the nature that city-dwellers see and live with and it formats their relationship with biodiversity and ecological processes. This paper presents the results of tree plantings by a single group undertaken in Antananarivo over the past 18 years. Promoting the planting of native tree species, trees were planted for a range of different clients –civic and private, on a range of sites including both private and public land, and for a diversity of reasons, including increasing biodiversity, shade and reduction of urban heat. Monitoring of urban green infrastructure may be carried out by technicians and volunteers using tailored computer data-collection programmes or by visual assessments and measuring. Information sought from monitoring of urban green infrastructure usually concerns the provision of ecosystem services, including biodiversity, CO_2 sequestration, impacts on urban temperatures, and water flow. Here we present an overview of technical monitoring programmes such as i-Tree Eco, which, when calibrated for the site, is suitable for mapping and monitoring urban trees. The programme has not been calibrated for Antananarivo, so our data has been collected through visual assessments and measurements, and is confined to species, size gain, and tree health, coupled with 'tree cost data' including root damage, leaf litter or insect pest waste. Such limited data remains valuable and has been used to leverage a change in attitudes and to increase tree planting in the city. It has formed the basis of promotional communications seeking to expand urban green infrastructure. Exposing city-dwellers to rich, native biodiversity is one way of building support for species conservation.

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SYMPOSIUM 7
Restoring 100 Million Hectares in Africa by 2030: Goals, Lessons and Challenges

AFR100: An introduction to the commitment to restore 100 million hectares in Africa by 2030

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AUDA-NEPAD Agency, Midrand

Degraded land has a cost both to local people and national economies, contributing to the escalation of natural disasters such as flooding and erosion and exacerbating social conflict as people seek better access to food and water. Restoration of productive landscapes in Africa can help lift people out of poverty, stabilize food production, protect biodiversity, help African economies grow, and contribute to adapting to and mitigating climate change. The African Forest Landscape Restoration (AFR100) Initiative is a country-led effort to restore 100 million hectares of deforested and degraded landscapes across Africa by 2030. The initiative seeks to build on field support, capacity building and policy advice to restore forests and landscapes on the ground, promote large-scale FLR, leverage additional resources for FLR, share FLR experiences and monitor FLR results. It does so by connecting participating African nations with technical and financial support to achieve large-scale forest landscape restoration (FLR). Since its launch in 2015, AFR100 has successfully catalyzed political will for restoration, with half of the African continent now committed to the initiative. A network of 27 technical and 12 financial partners supports this effort. Impact investors have earmarked USD 481 million in private finance for restoration and USD 1 billion in development finance has been committed. As AFR100 nears its goal, strategic and streamlined implementation is the path forward. This talk will provide an overview of the Initiative with special focus on outlining the FLR principles that guide the work and approaches of AFR100, the multiple ways in which individuals and their institutions can engage in the initiative, and the areas requiring urgent attention. A few examples will be provided to illustrate how, FLR, when supported by national policies, contributes significantly to improve livelihoods and boost economies in Africa.

Friday, 2 August 2019 | Rubis
Symposium 7 – Restoring 100 Million Hectares in Africa by 2030: Goals, Lessons and Challenges

Identifying restoration hotspots in Africa's wet tropics

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Almost half of the African continent is affected by land degradation, emphasizing the urgent need to restore forests, ecosystems, and landscapes to benefit people and the environment. Identifying *restoration hotspots*—areas that combine high potential for socio-environmental benefits with high restoration feasibility—can be an essential tool for achieving ambitious restoration commitments, such as AFR100. Toward this objective, we identified restoration opportunities in lowland tropical rainforest landscapes by overlaying seven peer-reviewed spatial datasets as proxies for the socio-environmental benefits and feasibility of restoration. For restoration benefits, we include four variables: biodiversity conservation, climate change mitigation, climate change adaptation, and human water security. For restoration feasibility, we include three variables: land opportunity costs, landscape variation in forest restoration success, and likelihood of restoration persistence. We designated landscapes within the top 10% of the restoration opportunity score (ROS) globally as *restoration hotspots*. We found areas with high potential benefits and feasibility across the humid tropics, but six African countries showed the highest spatial average ROS: Rwanda, Uganda, Burundi, Togo, South Sudan, and Madagascar. Four of the top 15 ecoregions with the largest area of restoration hotspots were also found in the African tropics. We further examined the distribution of restoration hotspots in relation to biodiversity conservation hotspots. Globally, two of the three conservation hotspots with the highest mean ROS were Madagascar and the Indian Ocean Islands and Eastern Afromontane. The Guinean Forests Hotspot of West Africa had the third greatest restoration hotspot area. Our analysis provides a critical step forward in identifying areas within the moist tropics of Africa where forest and landscape restoration is likely to provide multiple benefits and will be the most feasible to implement. We encourage a deeper analysis within countries to assess how and where effective restoration interventions can be implemented with the engagement of local stakeholders.

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Measuring the contribution of trees-on-farms to forest landscape restoration

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Land degradation is a critical driver of environmental and social ills in Africa, and forces poor farmers to engage in activities, such as charcoal production, land clearing and bushmeat hunting, that conflict with conservation goals and carbon emission reduction targets. Hence, enhancing agricultural sustainability is recognised as a cross-cutting issue under international agreements (e.g. Aichi Target 7, SDG 15) and will be crucial to achieving the ambitious restoration targets under AFR100. Agroforestry is being promoted as an important intervention, including under Forest Landscape Restoration (FLR), because of the environmental and social benefits of Trees on Farms (TonF). TonF provide essential resources for smallholder farmers and enhance rural livelihoods through the ecosystem services they underpin. TonF also lock up carbon and can contribute to biodiversity conservation. However, these benefits are highly dependent on the species composition, abundance and spatial configuration of tree features in the landscape. Hence, trade-offs between the social and environmental benefits of TonF may arise depending on the choice of tree species and their distribution. So, it is essential that we can measure and monitor the social and environmental benefits of TonF, and their contribution to agricultural sustainability, to make informed decisions. Here, we present protocols for assessing TonF that have been road-tested in Zambia and Uganda. The protocols focus on linking both plot (e.g. species, biomass) and landscape scale (e.g. fragment size and distance effects) tree characteristics to remote sensing, enabling wide-scale assessment and cost-efficient monitoring. Bird surveys provide a means to link TonF information to conversation values and optional protocols enable practitioners to add components of local interest, such as pollinators, natural enemies and terrestrial mammals. We anticipate these tools could be used in planning, including scenario testing, and for monitoring and reporting on agricultural sustainability at both landscape and national levels.

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Enhancing socio-economic benefits through FLR via the Sustainable Fuelwood Management (SFM) project in Cross River State, Nigeria

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Forestry Commission, Cross River State, Calabar, Nigeria

Fuelwood is central to the livelihoods of the African people. Over 70% of the Nigerian population still rely on fuelwood for meeting their cooking and heating energy needs. The unsustainable cutting down of forest trees to meet fuelwood needs, however, is one of the major drivers of deforestation and forest degradation in the tropics. The SFM project seeks to promote the sustainable utilization of fuelwood with its attendant environmental, social, and economic benefits. Building on the premise that restoring degraded ecosystems is not sufficient without catering for the overall well-being of humans especially those whose livelihood is largely dependent on the forest. By aiming to restore over 6000 hectares of degraded forest and marginal lands in urban and rural areas of the country, the SFM project directly contributes to the AFR100 initiative, a continental effort to restore 100 million ha of degraded lands by 2030. So far, the 16 month-old project is piloted in three states in Nigeria. The success story of SFM in Cross River State under afforestation include: raising of a 15-hectare fuelwood plantation with fast growing indigenous (*Khaya ivorensis* and *Pterocarpus soyioxii*) and exotic (*Tectonia grandis* and *Gmelina aboreae*). Plantations are established across degraded swampy coastlines, mined fields, and depleted community forests and marginal lands. Restoration of degraded marginal land enables fulfilment of three objectives: 1. restoring the capacity of degraded ecosystems to provide ecosystem services, specifically habitat for biodiversity, erosion control, carbon sequestration, watershed protection, climate change mitigation, and adaptation; 2. provide ecosystem goods, primarily fuelwood thereby reducing deforestation, and further degradation of natural forests; and 3. boosting livelihoods, especially those of forest-dependent communities, through value chain addition in related businesses, e.g., fuelwood and energy-efficient cook stoves supply.

Capacity development for forest restoration in Africa

ROSIE TREVELYAN
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The role that restoration can play in mitigating climate change, enhancing ecosystem services and human well-being is increasingly recognised. For example, the UN has designated 2021-2030 the UN Decade on Ecosystem Restoration. Nevertheless, restoring ecosystems requires skills and capacity coupled with political and institutional support. My talk will explore how capacity development could enhance forest restoration through building the broad skills-set that managers need as well as through creating closer links between inter-government initiatives such as AFR100 and conservation managers and practitioners on the ground. Restoring forests requires a set of skills that encompass long-term planning, understanding and engaging with stakeholders, communication, and advocacy. Restoration ecologists and managers need to be able to articulate the outcomes and impacts they expect from restoration projects long term – in spite of the constraints that are often imposed by short-term or stop-start funding. Capacity development thus ideally needs to incorporate all these issues, yet training is often compartmentalised into different subjects and is itself subject to funding constraints. I will use case studies from the Tropical Biology Association that have incorporated these wider, multi-disciplinary, skills into collaborative capacity development initiatives for African restoration managers and ecologists. For example, the TBA has incorporated theory of change training and measuring and communicating impacts into restoration courses. I will present current methods for measuring impact of capacity building – relevant to forest restoration – and what time frames are most appropriate. Capacity development can also play an important role in building awareness around international and regional issues. However, managers on the ground are often unaware of or disconnected from, high-level policy initiatives. I will report on what levels of awareness exist on AFR100 among the African conservation managers we have trained and explore whether capacity development represents an effective means to bridge this awareness and knowledge gap.

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The use of online and blended (online and field-based training) to build capacity for FLR in Africa

KARIN BUCHT
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The Bonn Challenge and AFR100 represent an incredible opportunity to prioritize and scale up the restoration of degraded land and ecosystems in Africa through forest landscape restoration (FLR). To achieve successful restoration, however, it is imperative for the people who manage and influence tropical landscapes to have access to the latest science and applied experience to make more sustainable land use decisions. Achieving successful FLR at scale will demand individuals with in-depth knowledge on diverse topics such as ecology, socio-political factors, and economic factors, in addition to strong collaboration between sectors and stakeholders. Capacity development offers a pathway to develop individuals with strong networks and interdisciplinary knowledge, capable of putting ideas into action. The Yale Environmental Leadership & Training Initiative (ELTI) is a capacity development initiative with over 12 years of experience training and supporting leaders from around the world to restore and conserve tropical forest landscapes. Recent advances in technology and increasing expansion of internet access around the world presents a unique opportunity to facilitate the exchange of information and build collaboration on a global level through web-based tools. Over the last six years, ELTI has developed and delivered online courses, training over 500 individuals throughout the tropics. This presentation will highlight the experiences of ELTI's online training program, including lessons, benefits, and challenges in using online tools for capacity development. In particular, this presentation will also explore ELTI's "blended training" model, which combines online, classroom-based and field components, in the context of developing capacity for FLR planning and implementation in Africa.

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SYMPOSIUM 8
Tropical Biome Responses to Global Change: Integrating Empirical Data and Models

The impacts of Ozone (O3) on tropical vegetation

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Tropospheric ozone (O_3) reduces plant productivity by entering leaves, generating reactive oxygen species, causing oxidative stress and thereby reducing biomass accumulation and the terrestrial carbon sink. On average, tropospheric O_3, a secondary air pollutant, has doubled since 1850 due to emissions from vehicles, industrial processes, and the burning of forests, and is now considered responsible for substantive losses in agronomic productivity around the globe. Due to rapid land clearing and land use change, coupled to environmental conditions conducive to O_3 uptake the tropics faces an unprecedented threat from O_3 pollution. However, although suspected little is known about how changing air quality in the tropics impacts both natural and agricultural landscapes or how this may impact land-atmosphere feedbacks. Our research group (TropOz) brings together researchers from around the globe to examine the effects of predicted O_3 concentrations across the tropics and its implications on global land system models. Coupling empirical work conducted in Australia with O_3 observations in Brazil, Panama, Indonesia and Australia we are seeking to elucidate not only the sensitivity to O_3 of tropical trees within a functional trait context but the integration of this understanding with next generation community land surface models (e.g. JULES). The development of fully coupled land-atmosphere models which account for the implications of O_3 and its feedback on reduced biomass productivity will be required to accurately predict the fate of tropical forests and agricultural systems in a changing world. Here we present some earlier work on the effects of O_3 on tropical plants, and show-case our new empirical experiment at James Cook University, Cairns, Australia.

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Stomatal optimisation based on xylem hydraulics (SOX) predicts global leaf and ecosystem responses to climate

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University of Exeter, Exeter, United Kingdom

Most land surface models (LSM) use empirical drought factors to represent vegetation responses to soil moisture decline. These approaches neglect recent advances in plant hydraulics and stomatal optimality theory. In this talk, I will present a novel approach to simulate vegetation responses to drought in LSM using a stomatal optimization model based on xylem hydraulics (SOX). SOX assumes that plant stomata were selected through plant evolution to balance carbon assimilation with the instantaneous risks of xylem embolism. We coupled this new model to the Joint UK Land Environment Simulator (JULES) LSM and conducted a global evaluation of SOX. We have found that SOX produces realistic patterns of leaf stomatal conductance responses to climate for a wide range of Plant Functional Types (PFT), reaching a mean Nash-Sutcliffe model efficiency index of 0.5 (SE±0.02) and a mean root means squared error of 0.125 (SE±0.03) mol m^{-2} s^{-1}. SOX decreased JULES gross primary productivity (GPP) sensitivity to soil drought, which improved JULES's capacity to represent seasonal eddy-flux observations at over 70 sites. SOX was also able to simulate the seasonal sap flux patterns of a tropical forest exposed to long-term through fall exclusion. The more gradual stomatal closure in response to soil drought predicted by SOX results in a greater depletion of soil moisture compared to default JULES, with important consequences for vegetation dynamics and ecosystem resilience. Our results demonstrate that SOX can provide a parsimonious way to incorporate plant hydraulics and stomatal optimality theory into LSM. However, SOX parametrization for global simulations requires a comprehensive characterization of the global plant hydraulic diversity, which highlights the urgent need for more plant hydraulic data, as well as techniques to scale tissue-level hydraulic parameters to whole-tree and ecosystem-scales.

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Bringing together modelers and field ecologists in the development of the Tropical Responses to Altered Climate Experiment (TRACE)

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The Tropical Responses to Altered Climate Experiment (TRACE) is a field-scale forest warming experiment based in the Luquillo Experimental Forest in Puerto Rico. TRACE is the first experiment of its kind in a tropical forest. Throughout early development of TRACE, our team held a set of workshops designed to bring together modelers and field ecologists to evaluate and compare predictions of tropical forest responses to warming. Here, I will discuss the goals and outcomes of this effort, and where we plan to direct our energies moving forward. Our initial goals for the modeler-ecologist working group included: (1) to model the responses of different tropical forest sites to increased temperature using a selection of models specializing in different scales and processes, (2) to highlight current gaps in understanding and future research needs by collating existing datasets relevant to model parameterization, and (3) to use results of modeling and data gathering exercises to generate testable hypotheses regarding the responses of tropical forests to experimental warming. Overall, these workshops enabled the incorporation of modeling into TRACE from the project's beginning. While our goals were ambitious and the challenges of launching a large-scale warming experiment in a tropical forest shifted some of our initial priorities, we succeeded in many of our aims. Members of our working group produced two modeling studies: one based on a forest canopy processes model, and one exploration of an ecosystem demography model. Additional products include an idea paper about the incorporation of phosphorus into global modelling efforts, and a field data benchmarking paper for tropical forest carbon balance. Finally, we used a meta-analytic approach to help close the gap in our understanding of tropical tree photosynthetic temperature sensitivity. Ultimately, we aim to continue this effort to improve communication and understanding between research disciplines leading to productive future collaborations.

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Plant salt-tolerance regulates vegetation-groundwater interactions in tidal wetlands

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Over the past century, about 25-50% of the World's coastal wetlands have been lost to climate change and different sources of anthropogenic forcing. Such a trend is expected to continue into the next decades as a consequence of sea level rise and the subsequent salt-water incursions into coastal areas. Although tidal ecosystems can oppose the adverse effects of inundations through sediment accretion, the impact of salinization on the two-way interaction between vegetation and water table dynamics remains uncertain and mostly unexplored. Salinity is known to affect plant capability to uptake water, hence, impacting soil water balance and water table fluctuations to an extent significantly varying with vegetation salt-tolerance. The response of wetlands to the projected water level increase and salinization will thus depend on vegetation-groundwater interactions as modulated by salinity and plants salt-resilience. Here, we propose a minimalistic approach linking observations with a stochastic model of water table dynamics accounting for vegetation response to salt stress. The model has been used to interpret water table observations from three saline wetlands in the Florida Everglades subjected to similar hydro-climatic forcing but different salinity levels and vegetation species. From our analyses, it emerges that salinity and species-specific salt-tolerance are the dominant drivers determining water table position. The resilience of coastal wetlands to sea level rise relies on ecosystem shifts and species turnover (i.e., transition to more salt-tolerant vegetation). By maintaining a deep water table through effective saline water uptake, salt-tolerant plants enhance salinization and create a niche for their ecological success. However, given their low productivity, a stable regime shift could impair the capability of tidal wetlands to store carbon and mitigate climate change.

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Representing tropical forest diversity in vegetation models: Conceptual challenges and demographic opportunities

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Capturing the structure and dynamics of tropical forests is critical to predicting the future of atmospheric carbon using vegetation models. Currently, however, models treat the great diversity of tropical tree species in very simplistic ways. The need to better aggregate the tens of thousands of tropical tree species into meaningful groups is now appreciated. We set out to find collections of species that could both reflect important ecological and evolutionary functions of species while addressing the needs of vegetation models. Using demographic data from millions of individual stems from large plots in Asia, Africa, and the Neotropics, we fit demographic models to tree growth and survival. Parameters from these models include ontogenetic changes in rates and responsiveness to resources. Cluster analysis on PCAs from key life-history parameters showed shared demographic strategies that can inform vegetation models. We call these Demographic Functional Types (DFTs). Importantly, we found that all sites contain all DFTs, but do so in different proportions. Further, the assemblages of DFTs are not structured in straightforward ways. Climate, soil fertility, disturbance regime, and other factors influence DFT composition. Simulations from DFT demographic rates show critical ways in which carbon fluxes change according to the composition of the community. Improving understanding of collective demographic strategies and the ways in which these strategies might benefit or penalize species in forests that experience new climatic and disturbance conditions may be essential for improving predictions of the future of tropical forests in vegetation models.

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SYMPOSIUM 9
Telecoupled Land Use Change in Madagascar – Implications for Conservation and Sustainable Development

Telecoupled land use changes in northeastern Madagascar: Co-producing knowledge for sustainable development

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Landscapes on forest frontiers in the humid tropics provide powerful examples of the challenge to reconcile different global demands e.g. for biodiversity conservation, climate change mitigation, or commercial agricultural production, with local demands for social-economic development. Distant influences on such landscapes (e.g. through flows of money, information, or technology) are not only triggering rapid land use change processes, but also unchaining spill-overs to and feedback effects from different stakeholders connected to these landscapes. Land system and sustainability scientists have conceptualized this phenomenon under the term of "telecoupling". The northeastern escarpment of Madagascar illustrates such a telecoupled situation with its protected areas of Masoala and Makira, funded through international sources, and the simultaneous expansion of clove and vanilla plantations fuelled by global consumers' demand for these highly valuable cash crops. At the same time, deforestation through small-scale farmers is continuing due to their strong dependence on land to fulfil various wellbeing needs. In this presentation, I will discuss how we approach this complex sustainable development issue through an ongoing six-year transdisciplinary research project. Using participatory mapping, social network analysis, and qualitative wellbeing interviews, we generated "systems knowledge" on the current sustainability challenges in two case study landscapes in the Maroantsetra district in northeastern Madagascar. Through multi-stakeholder processes across administrative levels, we then created visions of sustainable land use and land governance in the future i.e. "target knowledge". And based on the "systems knowledge" we co-produced ideas for transformative actions towards the stakeholders' visions (i.e. "transformation knowledge"), which we are currently implementing. Through a critical reflection about our achievements and failures, I hope to inspire more conservation researchers to engage in transdisciplinary research.

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Symposium 9 – Telecoupled Land Use Change in Madagascar – Implications for Conservation and Sustainable Development

Telecoupled land use change in northeastern Madagascar under conservation interventions and cash crops booms: Impacts on human well-being and forest dynamics

JORGE LLOPIS
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Land use change is increasingly driven by distant processes, leading to telecoupled situations, where external factors come to outpace local determinants of land use dynamics. Implementation of biodiversity conservation schemes managed by international conservation NGOs or increasing flows of international trade on land-based commodities are two such dynamics. Understanding how these processes affect forest cover, and how in turn this influence local well-being is key to devising sound conservation and sustainable development interventions. We conducted both land use change and well-being assessments in two forest-frontier landscapes of northeast Madagascar. The region is a global biodiversity hotspot, which has led in last decades to implementation of several externally-funded protected areas to curb on-going deforestation processes. Furthermore, the region is also a hub for production of vanilla and clove in Madagascar, cash crops traded in the international market, and currently under a price spike. We developed a participatory mapping approach drawing on very high-resolution satellite imagery, mapping workshops and intensive field walks, yielding annual land use change maps for the past three decades. For the well-being assessment, we conducted eight focus group discussions and 100 household-level interviews, which were analysed through the capability approach. Our results show that implementation of protected areas, on a first stage, encouraged on-going deforestation processes, while in a second stage, they, together with transfer of management rights for their buffer zone to local communities, managed to halt forest loss. Regarding the on-going cash crops boom, while it is encouraging farmers to intensify their land uses, it is also putting pressure on forests, as shown by the increasing conversion of forest to cash crop fields. Implications for local well-being are contradictory, as these dynamics lead to trade-offs between capabilities, which also present a bundle character, where changes in one capability trigger changes in a whole set of them.

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Symposium 9 – Telecoupled Land Use Change in Madagascar – Implications for Conservation and Sustainable Development

On the importance of biophysical and socio-economic factors on driving land-use change in northeastern Madagascar: Insights from two case studies

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[3]Ecole Supérieure des Sciences Agronomiques

Northeastern Madagascar receives a lot of attention due to its extraordinary biodiversity and due to land-use change causing decrease of ecosystem services. On the one hand, deforestation for shifting cultivation predominates in forest. It has been found that shifting cultivation has intensified because of farmers' subsistence needs. On the other hand, the introduction of cash crops during the colonial times in Madagascar has played an important role in deforestation, as their development has mainly taken place in the most fertile or accessible areas. It is, however, not well understood how and why farmers manage their land as they do, and ultimately, what is the relative importance of drivers of land use change decision making. In order to formulate more sustainable land management strategies, it is essential to understand land-use change underlying decision-making mechanisms. This contribution addresses the key question of how strongly biophysical and socio-economic factors influence land-use change in the forest frontier context of northeastern Madagascar. This is illustrated through two case studies nearby to the Makira and Masoala protected areas. To this end, we applied a Bayesian network-based land-use decision modelling approach, which allows to represent causalities between factors. Additionally, we take into account local decision-makers' knowledge. Results show that farmers' intention, water availability, and slope are the most important driving factors at plot level. We observed that the presence of protected areas influence farmers to intensify shifting cultivation and even convert forest into mixed-agroforestry system. Insights from understanding drivers of land use changes in forest frontiers could serve as a basis for policies which should then consider spatial boundary conditions, as they modify the rate of land use changes.

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Symposium 9 – Telecoupled Land Use Change in Madagascar – Implications for Conservation and Sustainable Development

Socio-economic and land use changes driven by large-scale agricultural investment: Contrasted case studies in Madagascar

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On Madagascar, during the 2005-2010 period, seemingly under developed large land tracts have attracted many foreign investors for the production of various crops (jatropha, maize). 10 years later, most of the large investment projects collapsed but the government and the agricultural policy still promote agribusiness and large scale agricultural investment. The objective of this presentation is, based on two case studies, to qualify and quantify what are the direct impacts of large-scale agricultural investment on the local communities. In order to address the trade-offs between the three dimensions of sustainable development, and to qualify winners and losers, the presentation analyses changes in terms of land use change, labor creation, local agricultural and cattle breeding activities, and local governance. The research is based on qualitative and quantitative data. After a qualitative assessment based on in-depth interviews with the company team members, households and local authorities (75 and 40 per case study, respectively), a total of 420 households (300 and 120, respectively) were randomly selected and interviewed in impacted areas (buffer zones around the large farming enterprises) and in counterfactual zones (Ihorombe and Itasy regions). Results show that in both cases, the large farm development triggered land losses for local communities (pastures and crop land). The overall job creation in the two sites is significant at local level although very different according production model, but not higher than family farming when calculated per cultivated hectares. Depending of the setting, the jobs benefit the migrants or the youth and women, but in both cases, the jobs rarely benefit the households who lose land. Conflicts and tensions are present at both sites, but are less important where the company respects land rights and authority of local people. All these results help to inform decision-makers on the models of agriculture and the type of land arrangements to be promoted.

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Symposium 9 – Telecoupled Land Use Change in Madagascar – Implications for Conservation and Sustainable Development

Local perception of priority ecosystem services in the tropical forest of eastern Madagascar: The case of the Ambatovy mine area

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Ecosystem services are the benefits provided by nature to humans. Ecosystems must therefore be managed in a way that they can provide important ecosystem services for the local population, while assuring their sustainability in the long run. In order to identify priority ecosystem services to communities bordering the forests of eastern Madagascar, we assessed local perceptions of populations living nearby the forests surrounding the Ambatovy mine area in Moramanga. In order to make the ecosystem services concept understandable to local communities, our participatory and informative approach drew on the use of photos representing ecosystem services during the surveys we conducted in this study with rural communities. According to the results of our survey involving 190 households, the priority ecosystem services to local communities in the study area are, in order of importance: agricultural production, timber, water, livestock production, and fuelwood. The analysis suggests that the choice of priority ecosystem services is closely linked to the livelihood activities of rural communities, and reinforces the idea of their dependence on natural resources for their livelihoods. A revision of the ecosystem management plan is therefore necessary, so that it can provide these priority ecosystem services in a constant and sustainable manner. Hence, activities and techniques for exploiting natural resources by rural communities need to be reformulated to align with these ecosystem management goals.

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SYMPOSIUM 10
The Challenge of Connectivity in a Fragmented World – Insights from Malagasy Forests

Corridor effects on the genetic diversity of mouse lemurs in a fragmented landscape

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Corridors rank top among the recommendations to counteract the effects of habitat modification because as a conservation tool they (1) are expected to enable the movement of individuals among patches of habitat that would otherwise be isolated, (2) work as an extension of the available habitat and (3) promote intra -and interspecies interactions. In doing so, vulnerability of small populations to environmental variation and stochastic processes, such as genetic drift, is reduced. However, research aiming at evaluating the effectiveness of corridors face multiple challenges, one being the limited number of case studies for which longitudinal data is available. In contrast to snapshot studies, data from long-term monitoring is likely to be more robust to confounding factors such as the time-lag associated to the response of the target species to corridors. Here, we compare the patterns of neutral (microsatellites) and adaptive (MHC II DRB gene) genetic diversity of *Microcebus ganzhorni* before and after the establishment of corridors in the littoral forests of Mandena, southwestern Madagascar. While we find similar patterns of neutral and adaptive individual diversity (estimates of heterozygosity and allelic richness) in both sampling periods, we provide evidence that after the establishment of corridors a larger number of shared alleles are found at microsatellite loci. Furthermore, our results confirm the role of selection as a main driver of MHC II diversity in *M. ganzhorni*. We argue that corridors, even for animals that appear to be robust to fragmentation, might play an important role in population dynamics. Our study highlights the relevance of long-term genetic monitoring whereby providing insight into the evolutionary history and patterns of gene flow of whereby providing insight into the evolutionary history and patterns of gene flow of wild populations and the possibility to tease apart the effects of drift from selection maintaining MHC adaptive variability.

Thursday, 1 August 2019 | Saphir
Symposium 10 –The Challenge of Connectivity in a Fragmented World – Insights from Malagasy Forests

Factors affecting connectivity and diversity of mouse lemur populations in northwestern Madagascar

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Habitat loss and fragmentation are major ecological forces threatening animal communities across the globe. This is especially true in Madagascar, where forest loss has been rapid and widespread leading to fragmented landscapes across the island. Generally, habitat loss and fragmentation leads to decreased genetic diversity within populations and reduced connectivity between subpopulations. As a result, organisms may have an increased risk of extinction via stochastic events. However, species-specific and landscape features may mitigate the effects of habitat loss and fragmentation on persistence in fragmented landscapes. We examined the response of two sympatric mouse lemurs (*Microcebus murinus* and *M. ravelobensis*) to forest fragmentation in a dry forest landscape containing continuous forest and discrete fragments of habitat in northwestern Madagascar. We captured 717 individuals during two six-month periods in 2017 and 2018. A RADseq dataset was generated for a subset of these individuals (*M. murinus*: 58, *M. ravelobensis*: 33) for landscape genetic analyses. First, we examined the effect of fragment isolation, size, and distance to continuous forest on genetic diversity. We additionally used Mantel tests to assess the resistance of landscape features such as savannas, bushes of varying quality, and rivers on gene flow. Our preliminary results indicate that *M. murinus* and *M. ravelobensis* populations in small fragmented patches of forest still show connectivity amongst fragments and with the continuous forest, although there are species-specific differences. We suggest that these differences are due to differing dispersal abilities of the two species, with *M. murinus* having a greater ability to disperse between fragmented sites than *M. ravelobensis*.

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Covariation of genetic diversity in forest dwelling taxa facing habitat loss and fragmentation on Madagascar

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Human-driven habitat loss and fragmentation are driving a major and unprecedented biodiversity crisis. This crisis is particularly striking in biodiversity hotspots such as Madagascar. However, deforestation is not occurring at the same pace in all regions. In particular, the Loky-Manambato region (Daraina, northern Madagascar) presents a low historical deforestation rate in contrast to most other regions. In addition, in the Loky-Manambato region, the relative impact of past climate change and of humans since their recent early Holocene colonization of the island is still debated. To assess the relative effect of human activities and climate on forest-dwelling organisms, we investigated genetic dynamics of forest-dwelling species using restriction associated sequencing data (RADseq) for lemurs (*Microcebus* and *Lepilemur*) and Malagasy olive trees (*Noronhia*) across the Loky-Manambato region. Our analyses first allowed identifying the major landscape features limiting or promoting gene flow among forests and highlighted a particularly striking genetic co-variation in the coexisting taxa. Inferring and comparing their demographic history during the Quaternary will shed light on the processes that drove forest fragmentation in Northern Madagascar. Ultimately, this study may also help decision-making in projects of conservation of the Loky-Manambato forests.

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Genetic consequences of habitat loss and fragmentation: Insights using spatio-temporal simulations

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Past natural climate change has affected ecosystems worldwide, also by influencing connectivity among populations. More recently, anthropogenic activities have strongly intensified such changes, leading to habitat loss and fragmentation (HL&F) at a fast rate. There is a need for understanding the genetic consequences of HL&F, including the rate at which populations lose genetic diversity and accumulate differences when connectivity is limited. Most species worldwide have a geographically restricted dispersal, which genetically translates into a positive relationship between genetic and geographic distances, known as "isolation-by-distance". However, relatively few studies have assessed the consequences of HL&F in space and time, in part because a general population genetic theory of spatio-temporal processes is still missing. In the present study, we used a spatially explicit individual-based model to assess 1) the time required for detecting genetic differences in spatially structured populations after HL&F; and 2) the distribution of genetic diversity within habitat fragments. Moreover, we tested 3) whether a recently developed statistic, which quantifies edge effects on the basis of habitat information, would be a good predictor of edge-determined changes in genetic diversity. Using spatial simulations, several landscape topologies and varying population sizes and migration rates, we found that this statistic can predict up to 90% of the genetic variability affected by edges. However, these results require still a thorough validation and application to real data.

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Testing dispersal abilities of large-bodied lemurs: Long-term monitoring of a relocated population of Collared Brown Lemurs in littoral forest fragments

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Medium and long-term species persistence in forest fragments depends on the ability of dispersing individuals to move across the matrix between suitable patches of habitat. The observation of brown lemurs, *Eulemur* sp, in forest patches that are not large enough for it to live in suggests a tendency of these lemurs to move across non-forested habitats. However, little is known on the dispersal abilities of this genus. The Endangered Collared Brown Lemur, *E. collaris*, is the largest species occurring in the littoral forest fragments of southeastern Madagascar. Two decades ago, a small population of this species was relocated from an area under anthropic pressure to a recently protected forest fragment, the Mandena Conservation Area. Here the resident population of this species was previously reduced to zero as a result of hunting. Since we know the initial genetic structure of the relocated population, this represents an excellent opportunity to investigate the genetic evolution of a small population of large-sized lemur and its connection with the other populations in the region via the surrounding matrix. We generated multi-annual data of the mitochondrial hypervariable region and genotyped eight nuclear microsatellite loci from a total of 47 individuals. The results show the introgression of mitochondrial and nuclear alleles in 2008 and 2011 and an increase of diversity over the last years. The comparison with the nearby forest fragments showed that five of the seven novel alleles were found in the neighbouring populations. The recorded gene flow is discussed in light of the possible routes of dispersal across the savannah, exotic plantations, and roads that today surround the area. These findings, in addition to the recently observed re-colonisation of a forest patch by a group of Collared Brown Lemurs in the region, offer encouraging clues for the conservation management of brown lemurs.

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A biogeographic model of minimum protected area requirements for primates in eastern Madagascar

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We used species-area models to investigate the idealized size of protected areas for lemurs in eastern Madagascar. We sought specifically to answer the following questions: what is the minimum area requirement for a protected area to preserve primate diversity and how do current reserves compare to the minimum area estimate in the eastern humid forests of Madagascar? We constructed historical and current species-area models for 21 lemur taxa that range into eastern humid forests. Historical range maps were sampled through six plots each in four size categories (1,000 ha; 10,000 ha; 50,000 ha; and 100,000 ha). A current species-area relationship was estimated using existing data on lemur diversity in 15 protected areas in eastern Madagascar. The generation of species-area curves was accomplished by using least squares regression to fit a power model. We estimate that a minimum area of 26,583 ha (range of 11,739-105,050 ha) is required for protected areas to maintain their complement of lemur taxa in eastern Madagascar. Only 16 protected areas are larger than the minimal size of 11,739 ha in eastern Madagascar, indicating that 27% of protected areas in this region may experience future lemur extirpations irrespective of conservation efforts.

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SYMPOSIUM 11
Large-scale ecosystem manipulation experiments as a way forward to tropical vegetation ecology

An overview of modeling and experimental results from the AmazonFACE research program

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The existence, magnitude, and duration of a supposed CO_2 fertilization effect in tropical forests remains largely undetermined, despite being suggested for nearly 20 years as a key knowledge gap for understanding the future resilience of Amazonian forests and its impact on the future global carbon cycle. Reducing this uncertainty is therefore critical for assessing the future of the Amazon region as well as its vulnerability to climate change. The AmazonFACE (Free-Air CO_2 Enrichment) research program is located in an old-growth Amazon forest near Manaus, Brazil (www.inpa.gov.br/amazonface) that aims at reducing such uncertainty. Here we focus on the results obtained in the experiment's first phase, in which a comprehensive multi-year baseline characterization of the AmazonFACE experimental forest has been made. We will also show the preliminary results from an elevated-CO_2 Open-Top Chamber (OTC) experiment aimed at the forest understory, as well as the results of a dynamic global vegetation model (DGVM) intercomparison simulating the AmazonFACE experiment (+200ppm of CO_2). Among the findings from the experiment's phase 1 are that the relation between carbon assimilation and leaf age is asymmetric along the forest light availability gradient, and that fine root productivity is 40% higher than previous estimates, with important impacts for regional estimates of NPP partitioning. Preliminary results from the OTC experiment show that understory saplings under eCO_2 increase carbon assimilation in 17%, as long as sufficient light is provided. Longer-term exposition of understory saplings will enlighten whether these plants can acclimate to eCO_2, and how systematic changes in light, soil water and nutrient availability can enhance plant responses to eCO_2. The DGVM intercomparison revealed that soil phosphorus availability reduces the projected CO_2-induced biomass carbon growth by about 50% compared to estimates from carbon-only and carbon-nitrogen models, suggesting that forest resilience to climate change may be weaker than previously assumed.

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The Amazon Fertilisation Experiment: Ecosystem scale nutrient manipulation in Amazonia

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Soils influence forest productivity and carbon cycling in many ways. Throughout soil evolution, nitrogen (N) accumulates due to deposition and biological nitrogen fixation, whereas rock-derived nutrients, such as phosphorus (P) and cations (Ca, Mg, K), decrease due to losses from leaching and weathering processes. Many tropical soils are geologically old, and phosphorus is hypothesized to limit forest productivity and ecosystem processes. Large-scale, long-term experiments are helpful tools to disentangle the effect of confounding factors, such as species composition, soil type, and climate, from the effects of soil nutrients on forest carbon cycling. We test the P-limitation hypothesis in a large-scale nutrient manipulation experiment in a Central Amazonian mature forest in Manaus, Brazil (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 additions. Within one year, phosphorus addition affected forest productivity significantly. Canopy productivity increased significantly with P addition. Belowground processes also changed, with soil respiration increasing in P treatments, and major changes observed in the strategy roots were adopting for acquiring phosphorus. Phosphatase activity decreased and mycorrhizal colonization increased in P treatments suggesting a change from mining to foraging strategies. However, while N additions had little impact on key processes, cation additions also had major effects on the forest, increasing root productivity substantially and apparently promoting investment in reproduction. Our results demonstrate that the availability of rock-derived elements plays a key role in controlling the function of central Amazon forests, and that even slow growing trees can respond rapidly to changes in the availability of phosphorus and cations.

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Long-term impacts of drought on tropical forest

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The impacts of climate extremes and long-term climate change are challenging to examine as we need to understand and predict their effects over timescales that are relatively short (seasons-years-decades) in comparison to natural cycles in vegetation of response and resilience. This is particularly true for forests, and least well understood for tropical forests, despite their ecological and societal importance. Direct environmental manipulation studies provide unique insight into this question and are ideally implemented at large scale to enable study of different ecosystem components. We use data derived from the world's only long-term (>10 yrs) ecosystem drought experiment in tropical rain forest to address this question. We have imposed soil drought on an eastern Amazon rainforest for more than 17 years, and observed signficant changes in growth, litterfall, reproductive behaviour and tree mortality. We consider how specific physiological processes and integrating growth signals have changed in response to increased moisture stress, and examine how they can inform our understanding of the impacts of drought elsewhere and at large scale under a likely future, drier and hotter climate. We present new data and insight on the use and acquisition of water and carbon by tropical rainforest trees during drought, its variation among species, how this provides new understanding of rainforest tree ecological strategies, and how well simplifying modelling assumptions can help us predict future functioning of tropical forests.

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Pushing forests over the edge with drought and fire: Results from two large-scale ecological experiments in Amazonia

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Droughts are an important mechanism in reducing forest carbon uptake and stocks by elevating tree mortality, increasing autotrophic respiration, and promoting wildfires. With continued climate change, the intensity and frequency of droughts will likely increase, with land-use change intensifying their effects. It is unclear at what point the impacts of severe, repeated disturbances by drought and fire could exceed the resilience of tropical forests. Here, we present results from two large-scale field experiments in Amazonia. The first was comprised of three 50-ha plots burned annually, triennially, or not at all from 2004-2010, while the second was comprised of one 1-ha plot experiencing reduced throughfall during five rainy seasons. In both experiments, woody vegetation in our experimental plots showed strong resistance either to fire or drought. However, extreme drought conditions drove abrupt increases in drought- and fire-induced tree mortality, with aboveground declining up to 40% and 80% in the throughfall and fire experiments, respectively. Focused field observations, experiments, and improved numerical models are critical for a significantly improved understanding of tropical forest responses to future perturbations related to changing climate and drought and fire frequency and intensity.

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SYMPOSIUM 12
Conservation in Madagascar: Threats and opportunities

Village by village: Rebuilding inshore fisheries with coastal communities in Madagascar

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Since the establishment of Madagascar's first locally managed marine area (LMMA) in 2006, over 100 such areas have been declared, now collectively covering over 17.7% of the island's inshore seabed. Most of these initiatives evolved through local efforts to improve the productivity of high-value small-scale fisheries through periodic fisheries closures, enacted using local customary laws. This approach has strengthened local participation in marine and fisheries management, and improved local catches in some cases. Some communities have gone further − establishing permanent reserves, introducing rules to regulate destructive fishing, and securing the legal mandate to manage their waters, restricting industrial uses, including trawling. A learning network established in 2012 to share experiences between LMMAs has evolved into an active movement advocating for the rights of small-scale fishers in Madagascar. High level political commitments reflect growing governmental support to safeguard traditional fisheries livelihoods, including through LMMAs. Despite these policy commitments, reform has been slow, and Madagascar still lacks effective legal mechanisms to secure coastal community rights in the face of outside threats. Hundreds of thousands of Madagascar's small-scale fishers face severe poverty, remaining disenfranchised from decision-making, and marginalised by a lack of access to equitable markets for catches.

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Symposium 12 – Conservation in Madagascar: Threats and opportunities

Combat climate change, protect watersheds and biodiversity, and improve human well-being starting in the city center of Antananarivo

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Cities4Forests is an initiative valuing the role of trees among urban dwellers from the center of cities to the watershed scale through the urban peripheries. Antananarivo is one of the 45 founding cities of Cities4Forests and one of the four founding cities of Africa. The city-hall has been developing urban agriculture for years and is pursuing urban agroforestry, while trying to combat erosion, pollution, the effects of cyclones and other cataclysms linked to climate change. A dendrological inventory is jointly conducted with experts from two international NGOs–Missouri Botanical Garden and The Royal Botanic Gardens of Kew—the University of Antananarivo and the national herbarium TAN of the Zoological and Botanical Park of Tsimbazaza. The species are identified by experts, the collected data compiled and analyzed, and information gathered from the citizens. Meteorological and population census data are also compiled in the database. A comprehensive inventory of tree nurseries–to produce the need seedlings for plantations—with endemic or at least autochthonous tree species has been completed. The preliminary results of the dendrological inventory are presented. Among the 92 public primary schools of the Urban Commune of Antananarivo and the basic health centers, the city-hall representatives identified those who had enough space for tree planting. A map shows the distribution of trees found in the city as well as public spaces that could be planted with trees. Trees improve the well-being of citizens of all ages and social classes. It is assumed that Antananarivo citizens' knowledge of their city's trees is fragmentary but will improve with the planting of new autochthonous trees followed by awareness and information campaigns. A web portal under construction, tagging trees with chips and a specific application tana4forests will bring the townspeople closer to nature.

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Covering conservation in Madagascar

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International media pay scant attention to Madagascar beyond presidential elections and natural disasters. Yet Madagascar's remarkable and highly threatened biodiversity and its citizens' efforts to build their country against many challenges are inherently newsworthy. They have also drawn an unusual degree of attention and investment from the international conservation community, making the country a testing ground for conservation methodologies in extremis. Here, globally important biodiversity, ambitious conservation goals and a stream of international funding collide with entrenched poverty, a growing human population, political instability, weak rule of law, and ambitious economic and human development goals. This session will cover some of the key takeaways from recent news coverage of Madagascar's conservation sector by the environmental news website Mongabay.com. Notable themes include the threats local conservationists face from business interests, authorities and even local people; the effects of poor governance and law enforcement on conservation projects; the successes that can emerge when conservation interests partner with local communities to address human and environmental needs in tandem; what happens when international conservation groups and funders pull back on commitments; the phenomenon of mass farming and mining rushes into protected areas; and how international economic drivers, legal and illegal, pressure local landscapes.

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Symposium 12 – Conservation in Madagascar: Threats and opportunities

How should conservationists deal with corruption and security threats?

ROWAN MOORE GERETY
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Corruption and political instability are associated with negative environmental outcomes in Madagascar and around the world. These influences are felt both directly and indirectly. Corrupt government action (or inaction) allows poaching and illicit industrial activity to flourish, while threats to "rule of law'' weaken deterrence, reduce benefits from legal and sustainable livelihoods, and increase the risks of pro-social behaviors like respecting regulations, reporting corruption, or denouncing illegal activity. Conservationists often refrain from addressing "rule of law" directly in their projects. Questions of governance and security are seen as implicating the highest levels of political power in a given country, and introducing operational risks better met by other actors. As such, reforms targeting the ministry of finance, say, or the national police force, though they may be of critical importance to stated conservation goals, are seen as "beyond the scope" or "above the pay grade" of environmental projects. Building on Mongabay's prior reporting on links between conservation and security from Ranomafana, Bongolava, and northeastern Madagascar. This discussion will address potential solutions in policy & project design as well as areas for further research and reporting. In Madagascar, conservationists' failure to fully grasp the salience of security and governance issues for their longterm goals has left the sector particularly vulnerable to fallout from recent political crises, and severed an important stream of foreign aid—biodiversity conservation funding—from the realities of the country. It has also discouraged creative approaches to the problem by reinforcing silos in western countries' treatment of trade and foreign policy, on the one hand, and land and wildlife conservation on the other (For example, see USAID's practice of including "critical assumptions" on security and governance issues as a disclaimer in environmental project documents).

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Symposium 12 – Conservation in Madagascar: Threats and opportunities

Disease and conservation: A tale of vectors, spill-over, and invasive species

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Environmentally-mediated and zoonotic pathogens represent an increasing burden on the health and well-being of humans, domesticated animals, and wildlife within the tropics. To determine how and why anthropogenic change to tropical forests place people and wildlife in such systems at increased risk of pathogen exchange. For the past decade, we have employed an integrated one health approach to examine how key human behaviors, wildlife behaviors, ecological conditions, and landscape features affect the risk of interspecific disease transmission in and around Ranomafana National Park, Madagascar. Key findings of our work stress that 1) direct contact between species is not necessary for interspecific disease transmission; 2) some forms of human overlap with wildlife present far lower risk of transmission than others; 3) invasive rodents and domesticated animals represent a chronic source of infection for local people; and 4) forest cover provides a protective affect against some vector-borne pathogens for human communities.These results have the potential to inform and improve targeted control and prevention policies for select pathogens and conservation management strategies for threatened species.

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SYMPOSIUM 13
Biodiversity management and development: Challenges, opportunities and new directions

From biodiversity offsets to target-based compensation

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The mitigation hierarchy claims to achieve at least ‘no net loss’ of biodiversity, while still allowing for unavoidable impacts, and this approach is an increasingly important mechanism for reconciling development and biodiversity conservation. Nevertheless, the biodiversity outcome from offsets is often unclear, especially as 'no net loss' of biodiversity can be interpreted in many different ways. In addition, there has also been relatively little focus on how to align offsets, or other forms of ecological compensation associated with development projects, with the achievement of broader (e.g. national) targets for biodiversity conservation. We will present an approach for better aligning compensatory actions at the project level with jurisdiction-level biodiversity conservation goals or targets. Being explicit about the desired outcome for biodiversity at the jurisdictional level can help to clarify the type of compensatory approach that would be most appropriate at the project level, in response to residual biodiversity losses. The framework helps clarify the role that different types of ecological compensation can play in contributing to jurisdictional-level targets, and helps resolve ambiguity around the concept of 'no net loss'. Linking project-level ecological compensation to jurisdiction-level targets represents an opportunity to ensure such actions contribute to, rather than detract from, the achievement of broader biodiversity conservation goals.

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Symposium 13 – Biodiversity management and development: Challenges, opportunities and new directions

Promoting best practice across the tropics: Lessons learned from Africa, South America and Indochina

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Across the globe, corporations, financial institutions, and governments increasingly refer to ‘no net loss’ or ‘net gains’ (NNL/NG) as a framework for managing development impacts on biodiversity. On the ground, actual commitments and actions remain highly variable and difficult to track. There is an increasing willingness for companies to discuss publicly their successes and challenges and an important development has been mutually reinforcing learning across organizations at a global level, thanks to BBOP and other forums. The BBOP Standard has proven a very useful tool for planning, implementation, and evaluation, but sustaining gains beyond the life of a project will only occur by taking social aspects into account and embedding offsets into a broader conservation and sustainable land-use framework, including enforceable legislation. We present experiences by Biotope, Wildlife Conservation Society, and Forests Trends mainstreaming best practice in mitigation and offsetting. This includes the COMBO project in Guinea, Madagascar, Mozambique, and Uganda, work with governments and industry in central Africa (Cameroon, Republic of Congo, Gabon), Asia (Laos, Papua New Guinea), South America (Bolivia, Colombia, Peru), etc. A key challenge has been the alignment of lender standards and national regulations. Key Issues include the long-term engagement that developing national NNL/NG systems entails, to fill capacity, and governance gaps. In this regard, it is important to build on existing systems (e.g. permitting) and to focus on continuous improvement. The BBOP roadmap highlights the key building blocks that must not be overlooked.

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Symposium 13 – Biodiversity management and development: Challenges, opportunities and new directions

Biodiversity data management for mitigating and offsetting development impacts on biodiversity: Lessons learned from Madagascar

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Madagascar is data rich, but data access is poor. And this is a problem for adequate mitigation and offsetting of development impacts. Biodiversity data are integral to the establishment and management (monitoring) of protected area and conservation programmes, but only if data are available, sufficiently accurate, and provided in a manner that accounts for Madagascar's high rate of species discovery and taxonomic change. REBIOMA (http://data.rebioma.net/) offers a solution to this challenge. It is an online biodiversity data network that facilitates the publication of biodiversity occurrence data and species distribution models for Madagascar. Setting up such a data portal in Madagascar promotes data accuracy through an automated and expert-mediated review process. We show how this improved biodiversity data management can contribute to considering biodiversity features, threats and management options in systematic conservation planning, including areas that could be prioritized for avoidance and offsetting as part of the mitigation hierarchy applied to investment decisions (at the programme and project level). For instance, data can be fed into tools such as MaxEnt, Marxan, and Zonation for identifying potential areas for terrestrial and marine biodiversity conservation, and this in turn could help decision-makers promote better outcomes for both people and nature. Through the COMBO project (http://combo-africa.org/), WCS and its partners are raising awareness on why and how data from REBIOMA can be used to make better decisions on managing biodiversity in the context of development projects.

Thursday, 1 August 2019 | Rubis
Symposium 13 – Biodiversity management and development: Challenges, opportunities and new directions

Net Gain: Seeking better outcomes for people when mitigating biodiversity losses from development

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Economic development projects are increasingly required to apply the mitigation hierarchy to biodiversity impacts and achieve No Net Loss, or even a Net Gain, of biodiversity (hereafter Net Gain). This can affect people's well-being because people value biodiversity and its associated ecosystem services; however, local values for biodiversity currently receive little consideration in biodiversity mitigation. We argue that there are ethical, practical, and regulatory reasons why development projects applying the mitigation hierarchy should address these values, and we provide examples illustrating how this might be done. The most controversial part of the mitigation hierarchy (biodiversity offsets) can pose particular risks to wellbeing where local wellbeing depends on ecosystem services, and conservation management required to generate biodiversity benefits in the offset restricts local access. We illustrate this with the case of a mine in Madagascar. Finally, we present a framework which identifies challenges associated with biodiversity Net Gain, alongside potential approaches to improving outcomes for people as well as biodiversity. Incorporating the ways in which local people value and use biodiversity into Net Gain designs, and better coordination between social and biodiversity mitigation experts, will ensure that efforts to reduce the negative impacts of development on biodiversity contribute to, rather than detract from, local people's well-being.

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Symposium 13 – Biodiversity management and development: Challenges, opportunities and new directions

Evaluation of three governance approaches to offsetting residual impacts of QMM's mining activities in SE Madagascar

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Mining companies seek financial benefits for their investors. When operating in countries with good governance, their activities can also promote economic development as a secondary outcome. As a business they are relatively risk adverse and endeavour, as far as possible, to operate in a stable and favourable socio-economic environment. One of the risks that mining companies face is public backlash due the inevitable negative impact of the mine on biodiversity. This risk is particularly important in a biodiversity hotspot such as Madagascar. The main approach to reduce this risk is to apply a mitigation hierarchy. After the negative impacts of the mine have been first avoided, then minimized, including on-site restoration, the final step in this hierarchy is to offset the residual impacts of the mine. In this study, we describe how QMM-Rio Tinto endeavours to offset the residual negative biodiversity impacts of its ilmenite mine in SE Madagascar using three different governance approaches and consider how well each approach respond to the diverse desired conservation outcomes of the different stakeholders including the mining company itself, the conservation organisations, and the Malagasy government. These include approaches include the financial governance model through the partnership with the Conservation Trust Fund: Fondation pour les Aires protégées et la biodiversité de Madagascar (FAPBM). A SWOT analysis of QMM's offset approaches is presented from the perspective of each of these different stakeholders.

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Linking livelihood program with conservation efforts: Lessons learned from Ambatovy's experiences

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Ambatovy Mining company is committed to applying the mitigation hierarchy to its environmental management efforts, and includes a commitment to achieve a "no net loss" of biodiversity and ecosystem services. To achieve this, Ambatovy have established a comprehensive Offsets program encompassing four Offset sites. One of the Offset sites, the conservation zone (CZ), is located adjacent to the mine footprint. The CZ is surrounded by 93 villages, which are heavily dependent on natural resources. The objective of the conservation activities is to maintain the habitat quality and biodiversity. Results and lessons learned from linking livelihood programs with conservation actions are discussed in detail. Methods used to collect data from regular patrolling activities and income generating activities (IGAs) were analyzed to assess the changes and trends in current threats, primarily from forest clearing and illegal logging in and around the conservation zone. Prior to 2012, offset management consisted primarily of activities focused on reducing anthropogenic threats. Since 2012, an increase in both logging and forest clearing has been observed. To mitigate this increase, livelihood activities were introduced to Community Based Associations (COBAs) in order to maintain the populations' standard of living and dietary needs (particularly in rice consumption). Selected livelihood programs implemented were based on the needs of locally affected people. Since implementation of the IGAs, there has been a reduction in forest clearing. However, illegal logging has increased which may be the result of restricted land access. Implications: The decrease in forest clearing demonstrates short-term success for conservation. But this could potentially present other risks for the future status of the conservation zone, if the other threats are not appropriately managed. Ambatovy's offsetting program has been revised to include consideration of ecosystem services and the livelihood needs of the population.

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Symposium 14
Ecosystem conservation through biocultural conservation approaches

Biocultural conservation through the sacred forests of India, Ghana, and Sierra Leone

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Sacred groves occur worldwide and are community managed forests that are protected due to cultural traditions. These groves harbor natural resources, including diverse flora and fauna, as well as springs. Some of the sacred groves are considered home to local gods. A multi-year, multi-site research program on sacred natural sites is underway. Results will be presented from research in Ghana in 2006, India in 2009-2010, and Sierra Leone in 2012. A qualitative, ethnographic research methodology was used, including semi-structured interviews. A similar questionnaire was used at all three research locations to interview residents in about natural resource use, rules, and belief systems regarding local sacred groves. Results indicate that management approach and level of community involvement are linked to effectiveness of site protection and community attitudes. Societal traditions are key to the continued protection of the groves. In some cases, changing religious traditions and high demands for natural resources have resulted in the reduction or loss of groves. However, culturally protected sacred sites can still play a role as key biodiversity conservation areas if community conservation traditions are supported. The groves' cultural significance and local management help ensure conservation of these forested areas.

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Symposium 14 – Ecosystem conservation through biocultural conservation approaches

Cocoon-silk enterprise: Farming, collecting, and transformation of endemic silk to generate income and support local biodiversity

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Conservation and land management approaches have traditionally been determined by the needs of plants and animals to function in healthy ecosystems. Historically, indigenous populations, who lived as a part of these ecosystems, helped maintain them, which benefited the people as well as the ecosystem. With globalization, political and economic actions distant from the conservation sites now affect and often try to direct management of local conservation. *Conservation through Poverty Alleviation International* (*www.CPALI.org*) was organized in 2003 and, in 2009, partnered with the *Community-based Silk Producer Association Madagascar* (www.sepalim.org) to design and implement a new type of conservation program focused on endemic resource farming and product transformation for sales to developed markets. SEPALIM farmers profit from farming or sustainably collecting cocoons spun by endemic species of silkworms. Other members of the farming families earn money by transforming the cocoons into nonwoven, cocoon-silk textiles. CPALI builds market links and sells the products that SEPALIM produces and returns all revenues to the SEPALIM program. Challenging aspects of our approach to supporting local species diversity through enterprise include lack of infrastructure in Madagascar (electricity, internet, and transportation systems), as well as fluctuating market prices and the need of poor farmers to respond to whatever opportunity offers the greatest return. To maintain enough cocoon production to build a market, SEPALI has had to establish the program in three different geographic areas and make use of five species of silk moths as well as introduce the weaving and dyeing of raffia, to supplement the earnings of the participants. This project highlights the difficulty of marketing products that sustain both the ecology and economics of non-industrialized countries to industrialized countries where buyers are reluctant to pay higher prices to support biodiversity at distant locations with which they are unfamiliar.

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Attitudes of homestay operators near Bardia National Park, Nepal

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Homestay programs, where guests stay in the house of a host and share meals and common space with the hosts, are a way to improve well-being in many naturally and culturally rich rural communities. Homestay programs may be promoted in conjunction with a community-based tourism approach, which provides an opportunity for residents to offer locally based tourism resources to visitors. Although homestay programs as part of community-based tourism are not a novel concept, it is important to understand challenges and opportunities to programs both for sustainable livelihoods and for conservation effectiveness. This study examined a homestay program in the vicinity of Bardia National Park (BNP), Nepal. Since its establishment in 2010, this homestay program has addressed human-wildlife conflict and supported conservation efforts, as well as women's empowerment and community well-being. There are 22 owners involved in providing homestay services to visitors. In this study, homestay owners were interviewed to understand their perception of the homestay program. Our research findings suggest that the homestay program supports socio-cultural and environmental values in the community. For example, the homestay has promoted awareness of sanitation issues, addressed the park-people relationship through positive involvement in conservation, increased a sense of cultural pride, and supported gender equality. Of the homestay income, 10% is contributed towards general community development funds. The homestay challenges include program visibility, site access, support from the government and BNP, and cultural sensitivity. We conclude that to run a successful homestay program near BNP in the long-run, the community will need support from the government and non-governmental organizations for additional publicity, increased membership access, and other initiatives to fulfill the vision of the homestay owners.

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Use, conservation, and harvesting techniques of medicinal plants by the Ogiek of East Mau Forest, Nakuru District, Kenya

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Many communities in the world use plants as medicine. Plants are one of the most important sources of medicine dating back to the prehistoric period. The Ogiek are a community of forest dwellers in the Rift Valley in Kenya who have survived without modern medications for disease treatment, because they have little access to primary health care. It is therefore important to research the ethnomedicine of this community, in order to document this vital information, in view of the rapid deforestation that is taking place in many Kenyan forests, including East Mau. The justification and objective of this work is that the medicinal plants are very important, yet they are disappearing before they are documented. A survey of medicinal plants was carried out and questionnaires were used to interview 427 adults in East Mau Forest. Plant specimens were collected and identified at the East African Herbarium in Nairobi. The number and type of medicinal plant species and the harvesting methods were investigated in 100 quadrats. The data were analysed statistically and 119 species of medicinal plants were documented. Of the people surveyed, 98% indicated that they use medicinal plants. Most of these plants were still abundant and their harvesting was non-destructive. Roots, leaves, and stem bark were the plant parts most commonly used. The most important ailments mentioned that are treated by medicinal plants were: stomach problems, malaria, and colds. The main implications of this study are that much can be learned from this community on how to utilise traditional knowledge for conservation of nature. In conclusion, it is worth investigating whether the success of the Ogiek in the use and conservation of medicinal plants may be duplicated elsewhere in the management of ecosystems.

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SYMPOSIUM 15
Regeneration of Malagasy forests: A synthesis

Low resilience of xerophytic thickets following human disturbances: Implications for dry forest conservation and management

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The natural vegetation of the driest part of southwest Madagascar is the xerophytic thicket (XT). It is characterised by a high fauna and flora endemism rate (up to 90% for the flora). XT is subject to deforestation and forest degradation (annual loss > 1%). Slash-and-burn cultivation (SBC), wood charcoal (WC) production, and goat grazing are the main human disturbances. In order to assess XT resilience on the basis of these three types of disturbance, the results of research carried out by the authors of this paper and their respective teams on the XT ecosystem in southwestern Madagascar are summarised and analysed. Goat grazing, with a stocking rate of one head per hectare, did not affect XT floristic composition, diversity (species richness and evenness index), leaf biomass production (< 3 cm diameter) and regeneration of XT. Wood charcoal production has significantly reduced XT above ground biomass and is unsustainable: it may lead to the disappearance of WC species individuals in a few decades. Finally, post-SBC recovery of XT came essentially from remaining tree sprouts, and the role of seed germination in XT secondary succession is negligible. SBC and WC production seem to be the activities most detrimental to the XT ecosystem. However, goat grazing did not engender a significant footprint in this ecosystem, and it may be considered as a suitable activity to favour conservation. Furthermore, goat breeding may be a viable alternative to SBC and WC production. Goat breeding is in fact the main source of income of people living in and around XT, and its development may reduce pressure on XT vegetation.

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Regeneration and fragmentation of dry deciduous forest of Madagascar

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Deforestation of dry deciduous forest has been documented (1999-2015) in the Analamisampy Commune, southwestern Madagascar. There was rapid deforestation before 2000, slowed deforestation after the foundation in 2007 of the Mikea National Park, and very rapid deforestation since 2014. Whatever the period, the mechanism is fragmentation. Monitoring the patterns of change in the forest cover and understanding the dynamics of its fragmentation are key features for implementing sustainable forest management and conservation. The distribution of forest fragments into three size classes (<50 ha, 10-50 ha, <10 ha) is described at 7 SPOT image dates. Forest structure, diversity, and regeneration have been studied to determine the impact of fragment size on the biodiversity. Nine small fragments (<10 ha) and nine medium-sized fragments (10-50 ha) were localized in SPOT images, respectively in 2014 and 2015. Nine, 20 x 50 m^2 plots for each forest fragment were sampled. 79 species belonging to 30 families were inventoried in small fragments versus 75 species (27 families) in medium-sized fragments. Mean species richness did not vary significantly between the two fragment sizes ($p = 0.691$). However, mean evenness index and structure parameters (basal area, tree abundance, and above ground biomass) of small fragments were significantly lower than those of medium-sized fragments ($p < 0.01$). In both fragment size classes, there is on average one individual regeneration per mature individual. Fragment size affected floristic composition: species in medium-sized fragments are essentially tall trees (>10 m), such as *Adansonia za* and *Givotia madagascariensis* and in small fragments shrubby species (<10 m), such as *Diporidium ciliatum* and *Strychnos madagascariensis*. Forest fragmentation reduces wood biomass, comparatively to continuous dry forest. Native forest species are to be planted between residual fragments to increase their area, protect them from fire and ultimately restore forest connectivity. This presentation advocates for specific fragmentation analysis, linking ecology to remote sensing, as a basis for planning the restoration strategy.

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Comparative review of regeneration of rain forests and dry forests in Madagascar

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In Madagascar, most research focuses on natural ecosystems with little disturbance. However, if one seeks to reflect on the conditions for maintaining biodiversity in Madagascar, it is necessary to understand the biodiversity dynamics in extensive areas of disturbed and secondary forests. The quality of conservation in protected areas is also dependent on the ecological quality (structure and composition) of secondary forests. A survey of knowledge of the factors (agricultural practices and their interrelation with soil and climate conditions, landscape configuration, seed sources, and seed dispersal agents) influencing forest regeneration after cultivation, will be proposed, contrasting humid forest and dry forest. Systematic reviews were carried out with three key words, humid forest, dry forest, and xerophytic thicket, using Web of Science, Science Direct, and GoogleScholar. Papers found were filtred down to 35 humid forest articles; we added to the database 25 more papers related to dry forest and xerophytic thicket. These papers were subjected to full qualitative and quantitative analysis. Principal factors influencing secondary succession were: 1) type and intensity of agricultural practices, tillage, cropping regimes, and the length and the number of crop-fallow cycles; and 2) landscape configuration, particularly regarding seed sources and the diversity and abundance of seed dispersal agents. The comparison between dry and rain forest showed differences (apart from climate conditions and soils) mainly between agricultural practices, the origin of plant species regeneration, the increase in species diversity, and the rate of biomass accumulation in forest regrowths. However, few documents address the potential factors that affect soil seed-bank and rain-seed in dry and rain forest. Little is known about the effect of annual rainfall variability on seedling abundance in dry forest, on seed dispersal, and plant species diversity. In conclusion, the knowledge gaps that provide the basis for future research have been identified.

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Seed bank and seed rain relative contribution to secondary forest regeneration after cultivation: The case of rainforests of eastern Madagascar

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Secondary forest succession studies in tropical areas generally examine the structure and the diversity of the different stages of forest regeneration. Early forest regeneration after cultivation may be generated by post-disturbance seed rain, seed banks, and/or by remaining tree sprouts. The aim of the present experiment is to assess the relative importance of seed-bank and seed-rain in early and late succession stages in the rainforests of eastern Madagascar. Two formerly cultivated regrowths (2-3 and 5-6 years old) and a secondary forest were compared. Four treatments were considered in each forest regrowth type. Each treatment consists of a (1 x 1) m² plot replicated six times. Remaining stumps were removed before each treatment. In the seed-bank treatment (SB), seed-rain arrival was obstructed by transparent nylon nets (0.5 x 0.5 mm² pores). Seedlings in this treatment came from the seed-bank. In the seed-rain treatment (SR), soil from the (1 x 1) m² plot, 10 cm deep, was sterilized and then put back in place. Seedlings in this treatment came from the seed-rain. In the seed-bank and seed-rain treatments, the 1x1m² plots were exposed to the seed-rain and their soils were not sterilized. Seedlings in this treatment came from both seed-rain and seed-bank. Control treatment is a combination of SB and SR treatments (soil sterilization and seed-rain obstruction by nylon net). This treatment tests the effectiveness of seed-rain obstruction and seed-bank sterilization. Seedling counting, and species identification were performed in each treatment every 1-2 months for 12 months (seven observations). Repeated measures ANOVA were used to compare variations of seedling abundance and species richness between the four treatments and by vegetation type. Seedling species number and abundance did not vary significantly with vegetation type. SB treatment contributed the most to seedling abundance and to the species richness during the first 12 months for the three vegetation types.

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Dry forests and rainforests, thickets, regrowths: What transitions for forest resource conservation in Madagascar?

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Dry forests and xerophytic thickets are vegetal formations adapted to dry conditions, which coexist in the southwest and south of Madagascar, according to the annual rainfall, the duration of dry season and the type of soil, sandy or calcareous, which determines soil humidity. However, discrepancies between the terms used in practice by conservation actors and the ecological and biogeographical typology have to be resolved, in order to achieve a consensus on the definition of forests, thickets, fallows, vegetation regrowths, savannas, and their transitions. The difference of geographical localization and botanical composition between dry forest and xerophytic thicket suggests that there is no transition between these two formations. The dominance of the Didieraceae and Euphorbiaceae families is an indicator of xerophytic thicket formation. Modeling the land use dynamics after deforestation, by slash-and-burn cropping and bush burning for pasture renewal, clearly separates the regeneration mechanisms after dry forest and after xerophytic thickets. Comparing the dry forest and the rainforest in the past, paleoclimate studies indicate drier conditions in the past, which could explain the possible transformation from dry forest to rain forest. In this case, the regeneration model should be the same, but the rate of regeneration is lower in dry forest and rainforest is more resilient. Future research is expected on *Dalbergia* spp., of which the species may be common to both dry forests and rainforests. This knowledge should be explained and made available to the actors of forest conservation.

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Symposium 15 – Regeneration of Malagasy forests: A synthesis

The effectiveness of the community-based forest management system in reducing deforestation in eastern Madagascar

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The Contractual Forest Management (CFM) policy (Gestion Contractualisée des Forêts or GCF) adopted by the Malagasy government since 1990 has given local communities the responsibility for managing the forest resources. Despite a few published studies on potential links between CFM and deforestation dynamics in Madagascar, the effectiveness of CFM in reducing deforestation remains unclear. The aim of this study is to assess the effectiveness of community-based forest management since 2000 in reducing deforestation in less than 10% of the rainforest of the Ranomafana-Est district. Landsat images (1990, 1998, 2008, and 2018) were used to analyse forest spatial dynamics. The forest surface area and the annual rate of forest cover change were estimated and compared between the managed and unmanaged area. The forest cover in 2018 was 3559.5 ha. An overall decrease of forest loss was observed during CFM implementation: an annual loss of 3.28% during the 1990-1998 period and 2.82% during the 1998-2018 period. However, during the first eight years of CFM implementation, an annual forest gain of 1.67% due to the natural regeneration process was observed within the managed area, but only 0.74% outside the area. During the last years of CFM (2008-2018), an annual loss of 7.92% within the managed area was observed, but only 4.84% outside the area. This study showed that community management is partially effective in reducing deforestation in this region. However, this effectiveness is probably conditioned by socio-political context: political instability since 2009 may explain the high deforestation rate during the 2008-2018 period.

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SYMPOSIUM 16
Mangroves: A highly valuable ecosystem for the sustainable development of coastal areas in Madagascar

Community based Mangrove management in the western part of Madagascar

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The mangrove ecosystem in the Manambolo-Tsiribihina landscape, in western Madagascar, has been subjected to different forms of pressure, be it natural or human activities. In addition, 19% of mangroves in this landscape were rated highly vulnerable in 2011 to climate change. Initiatives have been launched by WWF and its partners since 2005 to maintain the area covered by intact mangroves and to restore degraded areas while taking into account the integration of the climate change aspect in its management. Two major approaches have been adopted to guarantee the conservation of the ecological integrity of this ecosystem to ensure the sustainability of the economic and social benefits that the people of this area can derive from it. The approaches consist of (i) mobilizing and strengthening the capacity of regional actors, be it STDs or CTDs as well as the various organizations at regional level on the importance of sustainable management of mangroves, (ii) voluntary empowerment of local communities in the management of these resources following the sustainable way by supporting them in terms of capacity building in collaboration with actors mobilized in the first approach. As a result, 39,000 ha of mangroves in the western part of Madagascar are currently under management contract. After the 10 years of implementation, 1,500 ha of degraded mangroves are currently passively and actively restored with a plantation of at least 2,500,000 sprouts since 2011. Communicating to communities their right, responsibility and obligations towards the resources constitute a key step in the success of community-based mangrove management actions. And this should always be reinforced by the commitments of stakeholders who will support them so that they can truly enjoy their rights, responsibilities, and obligations.

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Symposium 16 – Mangroves: A highly valuable ecosystem for the sustainable development of coastal areas in Madagascar

Community-led mangrove carbon project, an incentivized approach for sustainable mangrove management

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The coastal communities are highly dependent on mangrove forests for a variety of goods and services. Mangroves are essential natural barriers against storm, source of fuelwood and construction material, and provide nursery habitat for fish, shrimp, crab, and other species that are harvested for food and sale. Despite their value, mangroves are being threatened by degradation and deforestation. Sustainable solutions are crucial to secure these vital forests. The Tahiry Honko project is the first carbon sequestration project in Madagascar focused on a mangrove ecosystem. It is designed to earn carbon credits through the conservation and restoration of over 1,230 ha of mangrove surrounding the Bay of Assassins, southern part of the Locally Managed Marine Area Velondriake, southwest Madagascar. The project is based on a 20-year crediting period. Project activities include prevention of ecosystem conversion, improved land use management and ecosystem restoration. The project engages all people, including marginalized groups such as women and young people through a participatory approach. Local residents have participated in multiple consultations to draft local regulations and a mangrove management plan. They are committed to replanting the deforested areas, improving land management by establishing terrestrial tree species plantations will provide an alternative source of fuelwood and building material. Total carbon sequestered from these activities is estimated to be 1,350 tons of CO2 per year throughout the crediting period. Benefits from the sale of carbon credits will accrue to villages, with a total population of approximately 4,000 residents. These communities have prioritized a list of needed infrastructure projects to invest these funds including schools, wells, health clinics, and subsidize school fees for children in the project area. Livelihood alternatives supported by the project, including sea cucumber farming, seaweed cultivation and training in apiculture techniques, will offer local residents opportunities to increase and diversify the sources of income.

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Enhancing mangrove governance through carbon financing: A case study of Mikoko Pamoja project

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KMFRI, MOMBASA, Kenya

Mangroves are one of the most threatened natural ecosystem on earth. In the Western Indian Ocean (WIO) region mangroves are threatened by over-harvesting of resources, conversion pressure and pollution. Climate change on the other hand is taking a toll on the remaining mangroves in WIO, particularly through sea-level rise, increased aridity and flooding. Pressure on mangrove ecosystems is likely to grow tremendously in WIO. This could significantly affect resource governance, the rights of local communities, and their livelihoods. Poor governance of mangroves in Kenya has been associated with illegal harvesting of wood products and encroachment of mangrove land. Interventions that strengthen resource tenure and community rights can help improve the management of mangrove resources. At Gazi pilot area in Kenya, the local community is engaged in an innovative project to restore and protect mangroves through sales of carbon credits. The scheme is verified by Plan Vivo systems and standards to sell ca.3000 tCO2-eq/yr for a crediting period of 20 years (since 2013). Revenue generated is used to support community development projects in water and sanitation, education, and environmental conservation. Mikoko Pamoja has a triple win to – climate, community and biodiversity.

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Towards the establishment of an integrated management strategy to address a complex multifunctional Mangrove resource governance

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Mangroves are one of the most effective multifunction/nal ecosystems, ensuring together production, protection and regulatory roles. Madagascar's mangroves are governed by various regulatory frameworks, considered both as (1) "forest" managed by the forest administration, (2) nursery area for marine resources and therefore managed by the Ministry in charge of Fisheries, (3) "sensitive area" and therefore managed by the National Environmental Office; and finally, classified as Public Domain so their use is assigned by the Ministry of Land Use Planning. In addition, the state of mangrove resources is highly influenced by other sector activities such as Energy sector where mangrove timber is used to compensate for the energy needs (charcoal and firewood) of the surrounding villages or cities. As a result, mangrove degradation is becoming more and more alarming. The objective of this initiative is to support the elaboration process of Madagascar national strategy for the integrated mangrove management, taking into account its multifunctional and multi-actor characters, its multisectoral uses and considering the coordination needs between all government actors. In this regard, the main approaches are (1) revitalizing the existing National Commission for the Integrated Management of Mangroves (CNGIM), jointly led by the Ministry in charge of forest and in charge of Fisheries, and involving relevant other Ministries, marine conservation NGOs, private sector, research institutions, and representatives of local communities and operators; and (2) to elaborate roadmap of activities which will be developed through the organization of a National Workshop aiming to share the latest knowledge on the mangrove ecosystem and management best practices; and to formulate recommendations to ensure rational and sustainable mangrove management on technical, institutional and political aspects. The final outcome will be to produce a participatory strategy document that will be applicable for all actors at all levels to ensure sustainable management of the mangrove of Madagascar.

Wednesday, 31 July 2019 | Zircon
Symposium 16 – Mangroves: A highly valuable ecosystem for the sustainable development of coastal areas in Madagascar

SYMPOSIUM 17.1
Synthesizing camera trapping data for tropical ecology and conservation

Synthesizing camera trapping data for tropical ecology and conservation & Symposium introductory talk

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Tropical mammals are among the most charismatic and threatened taxa globally, and an essential component of tropical forest ecosystems. Systematic monitoring data from camera traps provide an unprecedented opportunity for understanding population and community ecology, and improving their conservation. We will introduce the symposium theme by presenting examples of large scale, standardized camera trap efforts, with focus on the Tropical Ecology, Assessment and Monitoring (TEAM) network, and the newly launched, global Wildlife Insights (WI) platform. Camera traps have taken millions of photos around the world, yet most of these data are not effectively shared or analysed, leaving their potential largely unused. WI aims to amplify the impact of existing data on conservation by providing a centralized venue and analytical tools for use by scientists around the world. The second part of the talk will present an example of study that used TEAM data to assess how the structure of mammal communities varies across the tropics. We asked if the convergence in functional traits among assemblages - recognized at coarse scales (110-200 km resolution) - holds at fine scales, where local processes and biotic interactions act. We assessed trophic guild and body mass of 16 communities, and how these traits change with habitat and anthropogenic factors. We found that despite their taxonomic differences, communities have a consistent composition, and respond similarly to these factors, with insectivores being the most vulnerable guild. Local scale trait convergence indicates that species and communities follow similar trophic strategies and exhibit similar responses. These similarities provide a foundation for sharing conservation measures. The study exemplifies how camera trap data can fill the gap in field-based validations of coarse-scale patterns, and demonstrates the value of large scale and standardized camera trap data to address a range of fundamental and applied questions in ecology and conservation.

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Symposium 17.1 – Synthesizing camera trapping data for tropical ecology and conservation

Community composition of tropical forest mammals in relation to management regimes

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Numerous protected areas (PAs) have been created worldwide to safeguard wildlife and other natural resources from anthropogenic threats such as habitat destruction and bushmeat hunting. However, conservation efforts in many tropical PAs are still inadequate, revealing deficiencies in management effectiveness. It is therefore important to quantify how different protection regimes impact wildlife within PAs. We investigated the differences between forest mammal communities in two ecologically comparable PAs in the Udzungwa Mountains (Tanzania) with contrasting management regimes. One is a well-protected national park with efficient law enforcement; the other has suffered decades of inadequate protection, mainly resulting in high levels of illegal hunting. Using camera-trapping data, we assessed the target communities in terms of species richness, functional composition (i.e., proportions of trophic guilds) and species-specific occurrences, all while accounting for imperfect detection. We found striking differences between the two mammal communities: lower species richness, alteration in the trophic structure, and reduced occurrence probabilities for most species in the forest with high disturbance. The difference in occurrence probability between the two PAs tended to be higher for larger-bodied species. Our results show that strictly-enforced legal protection is required to maintain diverse mammal communities in tropical forests under ever-increasing anthropogenic threats. While PAs are the cornerstone of efforts to conserve tropical biodiversity, the future of biodiversity within them is closely tied to the effectiveness of enforcement.

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National Park, Madagascar: Monitoring environmental and climatic change through camera trapping

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Ranomafana National Park (RNP) has been well known worldwide to be among the most diversified rainforests of Madagascar. With its high level of endemism and following the 1986 discovery of the Golden Bamboo Lemur, birds and carnivoran communities represent notably unique and diverse species. However, environmental deterioration through human pressures, such as illegal intrusion and mining, forest exploitation, and damage via natural catastrophes (cyclones and erosion), have been impacting RNP wildlife. Consequences of the conflicts are felt especially by the terrestrial vertebrates, such as birds and carnivorans. These anthropogenic activities, habitat loss, and climatic change have caused drastic negative impacts to the forest habitat conditions. The studies aim to examine changes over time in distribution patterns of bird and carnivoran species within RNP. From 2010 to 2014, large-scale camera trap monitoring of terrestrial vertebrates was conducted within three forest arrays of RNP, as part of the "Tropical Ecology Assessment and Monitoring" (TEAM) network, which seeks a better understanding on responses of forests and wildlife to changes at local, regional, and global scales. Bird and carnivoran species distribution have greatly impacted by human induced habitat and environmental climatic changes. The most vulnerable are rare and cryptic species, as they tend to shy away from human induced habitat disturbance by moving towards more pristine habitats. Habitat human frequentation level, presence of invasive species, and variation of temperature are the most determinant for their distribution and movements. However, diversity or abundance of species was not directly affected. Camera trap monitoring may contribute to the reduction of human-wildlife conflict threats related to RNP bird and carnivoran species through an early warning system. Conservation management policy of this UNESCO World Heritage rainforest can also be influenced by the outcomes from camera trapping research, especially studies of most threatened endemic and cryptic species.

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Occupancy and habitat use of terrestrial vertebrates in the Virunga Massif, Rwanda-Uganda

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Occupancy studies are fundamental to our understanding of wildlife populations, species diversity and conservation status. To estimate species occupancy and habitat use, we placed camera traps in 60 locations stratified in a grid throughout the Virunga Massif, in Rwanda and Uganda. Cameras operate for a minimum of 30 days at each location each year. We identified 25 non-human species from 255,000 photographs recorded over four consecutive years (2014-2017). We ran occupancy models using three covariates: elevation, distance from park edge, and major vegetation types (mixed forest, bamboo, *Hagenia-Hypericum*, herbaceous, and subalpine zones. Only four commonly detected species (i.e., Black-fronted Duiker *Cephalophus nigrifrons*, Bushbuck *Tragelaphus scriptus*, Buffalo *Syncerus caffer*, and Golden monkey *Cercopithecus mitis-kandti*) had enough data (more than 50 detection-histories per season) to run plausible multiple season occupancy models with elevation and distance as covariates. However, for assessing habitat preferences, we ran single season occupancy models on 10-species. Duikers were found to occupy high elevation zones and the interior of the forest conversely to Bushbucks which were found to occupy mostly low elevation areas. Buffalos and Golden Monkeys tended to occupy low elevation zones at the forest edge. In terms of habitat use, both duikers and Bushbucks are well distributed across all vegetation zones whilst Francolins *Francolinus nobilis*, Jackals *Canis adustus*, Buffalos and Golden Monkeys mostly occur in bamboo and mixed forest. Genet *Genetta servalina* and African Golden Cat *Caracal aurata* were found in mixed forest, but Mountain Gorilla *Gorilla beringei beringei* occupy mostly herbaceous zones. The Serval Cat *Leptairulus serval* was mostly found to occupy *Hagenia-Hypericum* and subalpine zones. This study documented the activity patterns and overlap of species. Our findings suggest that elevation, distance-from-edge, and vegetation type influence species occurrence and distribution within the Virunga Massif and has implications in human wildlife conflicts around the park.

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SYMPOSIUM 17.2
Synthesizing camera trapping data for tropical ecology and conservation

Food web structure of tropical forest mammals varies among continents

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The structure of food webs can affect the maintenance of diversity and ecosystem function in ecological communities. The extent to which the structure of communities in similar environmental conditions but in different parts of the world converges is a longstanding question in ecology and evolution. Anthropogenic disturbances, however, may complicate the opportunity to make robust community comparisons. We investigated the food web structure of ground-dwelling mammal communities in 14 protected forests in the Neo-, Afro-, and Asian tropics to test for 1) effects of anthropogenic disturbance and 2) convergence in food web network structure. Mammal communities were identified from TEAM network camera traps, forest fragmentation was calculated from remotely sensed forest cover data, hunting information was obtained from local managers, and predator-prey interaction data were collected from published literature. We found that mammal food web structure did not vary significantly with anthropogenic disturbance, but did vary significantly between continents. Continental differences in mammal food web structure were not significantly associated with forest fragmentation (measured as the percent forested and forest edge density per community) or hunting (measured as the percent of populations hunted per community). However, mammal communities in the Neotropics had significantly higher directed connectance (mean = 0.15, SD = 0.02) than mammal communities in Africa (mean = 0.06, SD = 0.02) or southeast Asia (mean = 0.07, SD = 0.01). The fraction of isolated nodes was highest in the Afrotropics (mean=0.19, SD = 0.13), lowest in the Neotropics (mean = 0.01, SD = 0.02), and differed significantly between all continents. These results suggest that tropical forest protected areas are an important conservation tool for conserving biodiversity and ecosystem function. Furthermore, continental-level variation in mammalian food web structure may be the product of ecological and evolutionary forces.

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An assessment of the terrestrial mammal diversity in a sustainably logged forest in east Gabon: Impact of camera trap placement strategy on the detected species

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Camera traps are widely used for assessing terrestrial vertebrate diversity across tropical forests. Non-random placement strategy is traditionally adopted, with camera traps oriented towards specific features such as game trails. However, this could artificially bias the capture rates of certain species. Here, we first assessed the terrestrial mammal diversity of sustainably logged forests in east Gabon. Then, we investigated the impact of placement strategy on the detected diversity by comparing game-trail based and systematically oriented camera traps. We followed a grid design replicated consecutively in four areas, composed of 15-17 sampling points placed every 2 km², and left for one month on the field. Each sampling point was composed of two cameras: the 'random camera' was placed close to the theoretical point and oriented towards a naturally cleared area, while the 'game-trail oriented camera' was located within a 20 m radius of the systematic camera. A total of 31 mammal species were identified, including gorillas, chimps, elephants, and leopards. Game-trail placement provided greater relative abundance for most species and the deviation to this pattern only concerned extremely infrequent species (sitatunga, golden cat). Multivariate analyses did not distinguish different species composition between the two strategies at the site scale (grid), although local differences did appear between pairs at the camera scale. When examining species occupancy, game-trail strategy does not seem to bias inventories compared to the random placement, and data from both strategies can be used in multi-site analyses, but this does not hold true for relative abundance. However, it is almost impossible to set up a strict random sampling and both strategies need a subjective decision when installing camera traps. We recommend maintaining game-trail orientation for large-scale camera trapping inventories conducted at species or community level.

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Environmental determinants of mammal abundance across the Neotropics

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We assemble and integrate a large intercontinental scale data set based on 730 camera-trapping studies—yielding over 1.2 million camera-trapping days of sampling effort across 12 countries—to investigate the broad scale environmental determinants of terrestrial mammal abundance and biomass across the New World tropics. We examined the role of a number of geographic, climatic, primary productivity, habitat structure, and socioeconomic variables, which were standardized across the entire study region, as potential drivers of mammal abundance. Coarse measures of habitat structure across all sites within 10 major Neotropical biomes were decisive drivers of overall mammal abundance, although assemblage-wide differences in abundance were further affected by the history of disturbance and wider landscape context of different sites. We further disaggregate the analysis at the level of major trophic guilds to understand their overall responses to environmental drivers. Finally, we consider patterns of population abundance for a number of threatened mammal taxa in light of both historical and future habitat loss projected into the next several decades.

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High mammal functional diversity and functional redundancy over time in a tropical forest protected area

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Tropical rainforests are some of the most functionally diverse and functionally rich ecosystems on the planet, but are facing global increases in degradation from human impacts. Protected areas have been shown to benefit species diversity, but their effectiveness at retaining functional diversity is less well known, despite the fact that functional diversity may provide a better metric of ecosystem health than taxonomic diversity. More broadly, it is unknown whether species extinctions in the future could cause large decreases in functional diversity within tropical forest protected areas as a result of low functional redundancy. Using eight years of camera trap data from the TEAM Network, we quantified functional diversity and redundancy over time for the large mammal community in the Volcán Barva protected area in Costa Rica. We also modeled environmental and anthropogenic factors that best predicted functional diversity over time. We found significantly higher functional diversity than expected compared to a null model with randomly associated species functional dissimilarities and abundances. We also found high functional redundancy, with significant declines in functional diversity only occurring once ~71% of species had been lost from the community. Emergence of new canopy gaps within Volcán Barva was the best predictor of functional diversity over time. High functional diversity and redundancy indicate that the protected area is maintaining the functionality of its large mammal community. Our analyses suggest that internal ecological processes rather than direct human influences may be associated with change in functional community composition during the study period.

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SYMPOSIUM 18.1
Bridging the divide: Understanding tropical grassy biomes across Africa

Manisa bozaka: Counting the grasses of Madagascar

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Is *bozaka* is all the same, zebu food and African weeds? Why should we look at grasses in detail? The discipline of agrostology is a separate field of botany because of the specialist technical expertise required to distinguish and understand grasses (family Poaceae including bamboos). Grass spikelets are often less than 1 mm long and require microscopy. This presentation will demonstrate how understanding grasses opens up a new dimension of multidisciplinary enquiry into Madagascar's diversity, evolution, and landscape history. Grasses are a young family and the Miocene expansion of grasslands took place between 3-8 Ma creating African savannas, the cradle of mankind. Of the estimated 500-600 species in Madagascar around 40% are endemic. The southern biome and montane habitats are particularly rich in unique Poaceae such as *Decaryella* and *Lecomtella* but endemics are not limited to these habitats: the recently described *Andropogon itremoensis* is a grazing lawn species restricted to the highlands. Grasses dispersed to Madagascar 69 times, and 44 of these dispersal events were C4 grasses that colonised largely open canopy habitats. It is possible to trace the arrival of non-endemic grasses through the genomes of Malagasy populations: *Themeda triandra* seems to have arrived directly from Asia around 1.4 Ma. The Malagasy *Loudetia simplex* is clearly distinct from the African populations. Many grasses are natural pioneers even when they are narrow endemics and it is not possible to assign species as native or alien without further genetic and archival research. Grassy ecosystems are separate worlds driven by the functional traits of the dominant grasses. The dynamic nature of these ecosystems can make it difficult to distinguish ancient savannas from anthropogenic habitats. We are working on unifying the descriptive character dataset in *GrassBase* with functional traits relevant to ecology, as well as forage value measurements necessary to improve animal production.

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Symposium 18.1 – Bridging the divide: Understanding tropical grassy biomes across Africa and Madagascar

The assembly of the African grass flora and how this relates to grass invasions, including "invasions" of other biomes

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Africa is synonymous with savannas. Perhaps less appreciated is that the region extending from southern into east Africa and Madagascar is one of the most species-rich areas of the world for grasses, particularly C4 grasses in the subfamily Panicoideae. In this talk I will present evidence that the unique grass flora of Africa and Madagascar contributes to a number of macro-ecological patterns: Firstly, African grasses are well over-represented among grass invasive species elsewhere in the world and I will explore reasons for why this may be the case. Secondly, the interaction of Africa grasses and fire is particularly strong, and evidence suggests that this explains the widespread existence of savannas across much of Africa. However, less is known about the interaction of grasses, particularly C4 species, and shrubby biomes in Africa. Arguably grasses and fire may suppress shrubby plants, much as they do savanna trees. However, suppression of shrubs may be outright and lead to vegetation shifts from shrub-dominated vegetation to grasslands. I will discuss how this relates to the distribution and diversity of shrubby biomes in South Africa, including the fynbos and Nama karoo. These patterns may have important consequences for conservation and invasive species management, particularly with regards to climate change, which I will also discuss.

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GBIF Poaceae data mobilisation and the Madagascar grass atlas

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Grassy ecosystems cover 65% of Madagascar. The island is home to at least 522 endemic, native, and alien species of Poaceae. This is a growing area of interest because of their significance for the national economy, as well as land management and conservation. The lack of species occurrence data became a limiting factor for our research and understanding, and we decided to compile and mobilize all Madagascar grass occurrence data, with support from the Biodiversity Information for Development (BID) initiative funded by the Global Biodiversity Information Facility (GBIF) and the European Union. The majority of herbarium specimens are held at the Muséum national d'Histoire naturelle, Paris (P herbarium) and are not accessible in Madagascar due to poor internet connections which often make it impossible to view or download specimen images. Transcription and georeferencing of these specimens was carried out and combined with specimen data from Parc Botanique et Zoologique de Tsimbazaza (TAN herbarium) and Maria Vorontsova's ongoing research. Data were assembled on 14,670 collection events and published on the GBIF portal in conjunction with the Madagascar Poaceae checklist. Our research and bibliographic compilation suggest that 51% of the species are endemic, 36% native, and 13% alien, although the taxonomy is incomplete, and the data available on alien introductions may not be reliable. These occurrence data were used to produce the *Madagascar Grass Atlas*. 577 distribution maps were produced for every species, every infraspecific taxon, and every group of incompletely identified specimens. We hope it will be useful for both researchers and the public in spite of its preliminary nature. We hope these data and maps will be used by Malagasy policy makers to establish the national strategy on the knowledge and sustainable management of alien and invasive grass species in Madagascar.

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Poaceae checklist of the Isalo National Park

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Our knowledge of the grass (Poaceae) diversity across Madagascar remains incomplete: For many years, research focused on forests, while grasses were considered to be unworthy of botanical study. International woody plant plot networks fail to recognise the diversity of these plants that form the structural bulk of the world's open canopy ecosystems. A Central Highland Poaceae inventory was conducted in the Itremo Protected Area, where 100 species were recorded: 18% of the estimated 541 species in Madagascar. This MSc project was conducted in the second grass survey on the island, working in a possible ancient savanna site of the Isalo National Park. Two field trips were carried out to collect as many different grasses as possible; their habitats were recorded. All specimens were identified using herbarium collections. Older collections and bibliographic records were incorporated into the analysis. A total of 563 occurrence records have been assigned to 112 species of Poaceae, in 58 genera. The Isalo grass flora includes seven of the 13 Poaceae subfamilies and, like Itremo, it is especially rich in the subfamily Panicoideae, which make up 65% of the species. 22% of the species are endemic to Madagascar and 4% are known only from Isalo, including the unusual charismatic ground cover species *Tristachya humbertii* and *Tristachya (Isalus isalensis)*. Forests harbour the highest grass species diversity, closely followed by the open savannas. Open savanna and tapia have the most similar grass floras, while swampy environments have the most distinct species composition. Unlike the Itremo grass checklist, this study did not include any cultivated areas or fallow fields, and nevertheless recorded the highest grass diversity known in a single area of Madagascar. Our results resemble Poaceae checklists from Tanzanian protected areas, which have 120-240 recorded species. This study builds diversity baseline data to enable an informed approach to ecological and conservation work.

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National Herbarium in Pretoria and the Poaceae collections for the Flora of Southern Africa

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The National Herbarium, Pretoria (PRE) is the largest herbarium in southern Africa, holding the highest number (about 1.5 million) specimens in its collection. Curation holds a central importance in managing the collections, and this includes physical curation to preserve the specimens in the longer term as well scientific curation for accurate and up to date identification. Users of the herbarium specimens and associated data include researchers, staff of other herbaria, conservation professionals, ecologists, experts carrying out environmental impact assessments, students, and farmers. Grass identification is carried out using dichotomous identification keys, distribution maps, taxonomic literature, comparison of new specimens to the herbarium collection, and a *Quick Guide*. The practice of regularly performing herbarium curation duties helps staff to gain knowledge of grasses and to identify knowledge gaps. The herbarium, with its number of specimens per genus or species, helps improve the taxonomy, and could indicate a unrecorded species or even a totally unknown species. The multidisciplinary need for up-to-date baseline data on the grasses for the *Flora of Southern Africa* (covering South Africa, Botswana, Namibia, Swaziland, and Lesotho), with keys, generic and species descriptions, distribution maps and illustrations led to the "*Identification guide to southern African grasses*" book published in 2015. We would like to share our experiences of grass herbarium management, identification, and taxonomy work in South Africa and hope it will be useful to building the knowledge of Madagascar grasses for future generations.

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Origins and diversification of Cyperaceae in Madagascar

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With c. 320 species, sedges (Cyperaceae) are among the top 10 most species rich angiosperm families in Madagascar. When compared with other countries, Madagascar has the second highest endemism level (37%), after the Cape Provinces. A third of the endemic sedge flora of Madagascar occurs in forests. We aim to estimate the number, age, and origins of endemic sedge lineages in Madagascar, and to compare the diversification of C3 and C4 taxa. A large dataset of two nuclear (ETS, ITS) and seven chloroplasts (*matK*, *ndhF*, rbcL, *rpl32-trnL*, *rps16*, *trnH-psbA*, and *trnL-F*) markers, which includes a large proportion of Madagascar's known sedge flora, is used to estimated time-calibrated molecular phylogenies. Information on distribution, photosynthesis type and habitat preference has been assembled from literature. Diversification analyses and ancestral area reconstruction are performed to investigate the history of Cyperaceae in Madagascar, and to compare the patterns of lineage accumulation between endemic C3 and C4 sedges. The results show that the sedge flora assembly in Madagascar has involved multiple overseas dispersals, predominantly from Africa, coupled with Neogene radiation in upland humid forests and open wetland habitats.

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SYMPOSIUM 18.2
Bridging the divide: Understanding tropical grassy biomes across Africa

The distribution of savanna in Madagascar

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Savanna ecosystems cover 20% of dry land worldwide, and 40% of the African continent. They are broadly represented across Madagascar, covering an estimated 70% of the island. Multiple factors define the distribution of savannas. We use eco-floristic zones and phytogeographical units to describe and classify Malagasy savannas. Our classification is (1) ecological: based on temperature, rainfall, and soil; (2) physiognomic, describing vegetation appearance and composition; and also (3) dynamic: encompassing different kinds of degradation. A broad range of studies have focused on the Malagasy savannas. Some authors worked at the local or regional level, while others considered the whole of Madagascar. The compilation of these studies and datasets allowed us to define and describe the main types of Malagasy savannas according to their occurrence in different eco-floristic zones. We show that each eco-floristic zone includes at least one type of savanna. 72% of savannas are in the western region and 20% in the eastern region. At high elevations (>1800 m), savannas are rare (0.5%). The vast majority (68%) are between 0-800 m (low elevations) and about one-third (31.3%) of savannas are located between 800-1800 m. In conclusion, Malagasy savannas are mainly in the west and at low elevations. As trade winds cross the central region of the island, they gradually lose water and form foehn winds on the western side, driving the drier vegetation of the west dominated by dry savanna.

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Composition and functional diversity of fire and grazing grasslands of Madagascar's Central Highlands

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Madagascar Central Highland vegetation is dominated by an extensive area of grassland and woodland. These ecosystems support the livelihood of millions of Malagasy people and they are currently shaped by fire and cattle grazing. Here, we use grass species composition and functional traits to distinguish fire and grazer-maintained grassland communities. Grass function is considered in relation to the environment, to inform our understanding of the vegetation structure and dynamics. We sampled grass community composition at 71 burned or grazed sites across the central ecoregion. We selected 10 functional traits with direct functional roles in response to fire and grazing, and measured them for the 67 grass species found there. We carried out species correlation analysis using a generalized latent variable model, species functional group richness, and a fourth corner model, to differentiate grass communities shaped by different disturbances. We found a divergence in grass community composition between burned and grazed sites. Fire-driven communities are less diverse and mainly within the Andropogoneae tribe, harbouring fire adaptation traits. The grasses are primarily tall, caespitose with erect culms, high shoot biomass and low bulk density, persisting in the frequently burnt environment. In contrast, grazed sites are composed of a distinct suite of species, which exhibit contrasting traits. Most species are short, mat-forming, with horizontal growing culms, wide leaves and high bulk density. These differences are supported by significant correlations between environment and traits, with fire and grazing shaping grass functional traits in different ways. Trait variation mostly explained grass responses to alluvial and lake deposits, geology, precipitation, and distance to roads. We conclude that the grassy landscape is composed of two different communities whose structure and dynamics depend on the feedbacks between them, and on the disturbances occurring at a community level.

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Symposium 18.2 – Bridging the divide: Understanding tropical grassy biomes across Africa and Madagascar

A unified framework for plant life history strategies shaped by fire and herbivory

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Grass-dominated ecosystems currently account for 40% of global land area, covering environmental conditions ranging from extreme cold, to extreme drought. In tropical grasslands both fire and herbivory are frequent disturbances, and although they both remove above-ground biomass, they seem to select for very different plant growth forms and life histories. Fire and herbivore functional traits are generally considered separately but there are advances made in understanding fire which relate to herbivory, and vice versa. Here we discuss how flammability and fire tolerance, palatability and grazing tolerance traits organise themselves in ecosystems exposed to these consumers, and how these traits might have evolved with reference to other strong selective processes like aridity. Our framework can be used to predict both the diversity of life history strategies and plant species diversity under different consumer regimes. Grasslands are important for the livelihoods and economies of many developing countries, and we show here that integrating taxonomic, phylogenetic, and ecological insights can improve grassland management and our ability to predict the complex interactions between drought, grazing, and fire

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Palatability-flammability trade-offs promote alternate grassland states

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Within grasses, a family of over 11,000 species, there are numerous life history strategies – yet two strategies stand out for their remarkable ability to drive the 'consumer regime' in a landscape towards a fire- or grazer-dominated state. Fire and mammal grazers consume grasses, and feedbacks between grass species, their functional traits and consumers have profound effects on grassland structure, such that grasslands characterised by fire or grazing can be considered alternate states. On the one hand, there are grasses with trait combinations that make them highly flammable but which also increase their dominance under frequent burning; these 'fire grasses' are important to maintaining the savanna-forest boundary. On the other hand, 'grazing lawn' grasses are highly palatable and thus sought after by grazers, but the proliferation of these grasses is promoted by regular grazing. These positive feedbacks make it possible for shifts in grass community composition to profoundly affect the ecosystem at large: the amount of fire and grazers has implications for soil carbon, nutrient cycling, plant community composition, biodiversity, and habitat structure – among innumerable other cascading effects. There are many parallels between the ecological dynamics that give rise to grazer-vs-fire grass and savanna-vs-forest alternate states. Forest and fire grass states dominate higher up the productivity gradient (here represented by rainfall), and being taller, are better light competitors than the savanna and grazing lawn states respectively. On the other hand, savanna and grazing lawn states both require a positive feedback with a consumer – i.e. fire and grazers respectively – for them to be maintained and potentially expand up the productivity gradient.

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Symposium 18.2 – Bridging the divide: Understanding tropical grassy biomes across Africa and Madagascar

History of the savanna Malagasy olive tree (*Noronhia lowryi*)

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The debated origin of savannas long opposed the role of humans and climate. In Madagascar, there has been a recent accumulating of evidence for a natural expansion of savannas since the Miocene, as well as the role of pastoralism and economic activities on recent forest loss. Yet, understanding the origins of the island's savannas remains essential to identifying the processes that led to mosaics of habitats of the Central Highlands. To tackle this question, we examine the evolution of the only savanna species of the large radiative Oleaceae genus *Noronhia* (at least 84 species in Madagascar). *Noronhia lowryi* is a small shrub species patchily occurring in the Central Highlands of the island. It is further suspected to use a geophyte strategy to resprout after fire or grazing. 77 *N. lowryi* individuals were sampled at three sites and genotyped at 14 nuclear and 24 chloroplastic microsatellites markers. Clonal growth was evidenced on only two genets, indicating this reproductive strategy plays a limited role in the long survival of *N. lowryi* in savanna. We further found a highly contrasted nuclear and plastid genetic structure suggesting that pollen-mediated gene flow (by moth or wind) allows panmixia, while seed-based dispersal (probably by small mammals) is very limited and rarely exceed tens of meters. From full plastid genomes of 12 *Noronhia* accessions, including the three *N. lowryi* maternal lineages, we dated the surprisingly old crown age of the species back to ~6.2 Mya, co-occurring with the documented global expansion of savannas. In contrast, recent demographic history of *N. lowryi* inferred from nuclear data, shows a clear bottleneck signature ca. 350 generations ago, possibly reflecting the impact of early human colonization on the Central Highlands.

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SYMPOSIUM 19
The interplay of infectious disease and biodiversity conservation

Effects of land use, habitat characteristics, and small mammal diversity on Leptospira prevalence in lowland northeastern Madagascar

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Anthropogenic habitat degradation can increase or decrease exposure to zoonotic diseases. The outcome depends in part on how those activities affect the composition and abundance of disease reservoirs living in the environment. Understanding the effects of human land use on mechanisms of parasite transmission between wildlife and people is important for designing interventions. One example is pathogenic *Leptospira*, a bacterium mainly maintained by mammal reservoirs. In humans, leptospirosis results in a range of symptoms, including high fever, jaundice and multi-organ failure. Transmission most frequently occurs through contact with an environment contaminated by the urine of infected hosts, such as drinking water. This study investigated the links between land use and a zoonotic parasite in small mammals around Marojejy National Park, northeastern Madagascar. We tested the hypothesis that small mammal diversity and *Leptospira* infection differs across an anthropogenic gradient of habitat types. We sampled 125 tenrecs, 46 shrews, and 358 rodents (eight native and 350 introduced) in intact and fragmented forests, agricultural fields, including dry and flooded rice fields, and human settlements. We found that the prevalence of *Leptospira* was highest in flooded rice fields (up to 50%), and was positively related to small mammal species richness, which was highest (seven species) in rice fields compared to other habitats. The probability of infection with *Leptospira* was highest in flooded rice fields in the wet season, and was higher in the introduced mouse (*Mus*) compared to other species. Infection was less likely in forested habitats and during the dry season. These results highlight the prominent indirect water-borne transmission mode of the parasite and point to management of introduced species as an intervention that could benefit public health.

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Symposium 19 – The interplay of infectious disease and biodiversity conservation

The synergistic effect of parasitic infestation and socio-ecological factors on the body condition of *Microcebus rufus*

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Ecological theory predicts that body condition and parasite loads are linked. To date, little is known about the effects of parasitism on the health of lemurs, a critical gap given the threats to their conservation. In this study, we tested the synergistic effects of parasitic infection and socio-ecological factors on the body condition of *Microcebus rufus* in habitats with varying levels of human disturbance. Flotation and direct observation techniques were used to examine endoparasites and ectoparasites, respectively. In addition, we quantified body condition using two measurements: the Volume Index, and the Scaled Mass Index. Multiple collinear measures were condensed using principal component analysis. we tested the relationships between parasite infection measurements and body condition indices using Generalized Linear Mixed Model, with the identity of individuals used as a random factor. Among the 204 *Microcebus* captured, 185 responded positively to the presence of parasites. Five species of helminths, one species of protozoan, and one species of louse were identified. There was a negative relationship between parasite species richness and body size. Individuals in better condition secreted more parasite eggs or oocysts in their fecal matter. The results show that an individual's body condition constitutes an indicator of risk of parasite infection and transmission.

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Symposium 19 – The interplay of infectious disease and biodiversity conservation

Who let the dogs out?: Invasive carnivores, zoonotic pathogens, and wildlife conservation

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Madagascar is characterized as a biodiversity hotspot; and all of the island's endemic wildlife, including lemurs, are threatened due to human activities. In addition, free-roaming invasive carnivorans associated with humans (namely dogs and cats) have been found to negatively interact with lemurs. The impact of free-roaming invasive carnivorans on native biodiversity through pathogen transmission has been largely unexplored, although the presence of dogs in fragile environments may further threaten endemic species through zoonotic spillover events. Eastern rain forest mouse lemurs (*Microcebus rufus*) are commonly found in degraded habitats where free-roaming dogs most frequently occur. Here, we hypothesize that canine pathogens will be detected in mouse lemurs in degraded habitats. Through camera trapping of dogs and minimally invasive sampling of *M. rufus* blood during processing, we provide the first molecular detection of canine heartworm (*Dirofilaria immitis*), a mosquito-borne pathogen, in a wild non-human primate (*M. rufus*). We also identify other zoonotic pathogens in free-roaming dog populations, such as *D. repens*, that have potential to spill over into overlapping lemur communities. With human encroachment and associated increases in free-roaming dog populations in Madagascar, these pathogens may represent a conservation concern for lemurs. Further, we established a comprehensive global database of published literature (N=562) on pathogen infection in free-roaming cats and dogs from 47 countries for 123 pathogens. These results suggest that cats have significantly greater ($p=0.005$) incidence of zoonotic pathogens than non-zoonotic pathogens. Together, these local and global findings suggest the importance of including free-roaming carnivore pathogen dynamics into wildlife conservation mitigation strategies.

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Symposium 19 – The interplay of infectious disease and biodiversity conservation

Specific human behaviors and animal associations affect the risk of diarrheal disease at the zoonotic interface of a biodiverse tropical forest ecosystem

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Diarrheal disease (DD) is a leading cause of morbidity and mortality in the tropics caused by fecal contamination of water or food. Although many of the pathogens responsible for DD have zoonotic potential (i.e., animal contact / overlap constitutes a viable infection route), the relative importance of animal sources of infection remains poorly characterized. Furthermore, variability in human behaviors in biodiverse ecosystems may play a role in determining DD outcomes. We combined behavioral, demographic, and socio-economic data with pathogen and ecological contact data to identify the primary factors influencing the probability of experiencing DD for individuals within the biodiverse, tropical forest-dominated greater Ranomafana ecosystem of Madagascar. From May to September, 2017**,** we surveyed 979 people within 219 households within 5 km of the boundary of Ranomafana National Park regarding household information; socio-economic indicators; water and sanitation; activities within the national park; and interaction with wildlife, domesticated animals, and peridomestic rodents. Fecal samples were also collected from participants, their domesticated animals, associated peridomestic rodents to screen for DD-causing pathogens. Eight percent of households had at least one member currently experiencing DD, while 80% of households tested positive for at least one DD-causing pathogen. DD and pathogen prevalence were positively associated with evidence of rats in the household, healthcare expenditures, contact with lemurs, off-farm employment, and manure use. These results demonstrate that specific human behaviors and forms of animal interaction affect the risk of experiencing DD and highlight the need for further research on zoonotic sources of infection for communities associated with biodiverse, tropical ecosystems.

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Behavioral responses, infectious disease, and parasites: Implications for biodiversity conservation

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Behavioral responses are an animal's first line of defense in negative interactions with competitors, predators, and parasites. Feedbacks occur between host behaviors and parasite transmission. Many animal behaviors are influenced by parasite avoidance, and behavior can also drive parasite transmission. Relationships between social behaviors and parasite transmission and avoidance are complicated, and may result in an arms race between host and parasite. Infectious diseases may drive threatened species to the brink of extinction. In addition, some animal responses to infection – such as sickness behaviors – can alter disease transmission. While infectious diseases would appear to operate at the individual and population level, behavioral responses have effects that scale up to higher levels of community assembly. We will examine the effects of behavioral responses including sociality, interspecies interactions and social behavior on both parasites and diseases. Finally, we will model ways that global change exacerbated by anthropogenic and climate factors may influence or modify parasite and disease transmission and impact.

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SYMPOSIUM 20
Sustainable tropical agroforestry: Balancing biodiversity and crop yield through ecosystem services

Biodiversity assessment of vanilla agroforests in the SAVA Region of Madagascar: The impact of plantation management on the diversity of plants and vertebrate fauna, including lemurs

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Conversion of land for agriculture can have catastrophic impacts on tropical ecosystems and biodiversity. However, different crop cultivation methods have different effects on biodiversity. Vanilla plantations in Madagascar's northeastern SAVA Region are one example of a valuable cash-crop. Vanilla is produced in SAVA using a variety of cultivation methods, ranging from small-scale plantations grown in and around existing forests, to large intensively-farmed plantations. However, the impact of vanilla production on Malagasy biodiversity is unknown. We undertook a series of rapid biodiversity assessments of these vanilla plantations to assess how the different plantation management practices impact on biodiversity. We also surveyed nearby natural forest fragments, to act as uncultivated controls. We observed over 500 plant and 200 vertebrate taxa. Species richness tended to be lower in plantations compared to natural forests, suggesting that conversion of forest to plantation was detrimental to biodiversity. However, plantation location and management regime had significant impacts on resident flora and fauna. Species richness was significantly higher in traditionally maintained vanilla plantations grown in or adjacent to natural forest fragments, compared to more intensively farmed, anthropogenic sites. Vanilla plantations also harboured numerous threatened animal species, suggesting that they are valuable habitats for these taxa. The most surprising result was the observation that five different species of lemurs inhabited vanilla plantations, including the newly described dwarf lemur *Cheirogaleus shethi*. Lemurs were significantly more likely to be found in traditionally maintained plantations compared to intensively farmed sites. While vanilla plantations may not be ecological substitutes for natural forests, we show that they harbour significant levels of biodiversity, particularly when maintained with ecologically sympathetic management techniques. Appropriately managed vanilla plantations may provide a sustainable way for local people to use and potentially expand existing forests, rather than the traditional slash and burn removal of forest for other agriculture or grazing.

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Symposium 20 – The interplay of infectious disease and biodiversity conservation

Bird communities in Afrotropical cocoa farms are diverse but lack specialised forest insectivores

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About 70% of the World's cacao is grown in sub-Saharan Africa, providing farmers with a major source of economic revenue. When cultivated intensively, cacao agriculture causes deforestation of large areas of rainforest. Cacao can also be grown in low intensity agroforestry systems, yet little is known about the ability of cacao agroforests to support biodiversity in Africa. Using three decades of bird mist-net captures from primary forest (n=5361) and cacao plantations (n=3916) across Cameroon, we investigate the shift in avian communities between forest and cacao agricultural systems. Additionally, we investigate the effect of cacao management intensity on bird communities, using MODIS satellite imagery to estimate shade tree canopy density. Although species richness is similar between habitats, bird community composition in cacao plantations is very different from that in primary forest. Specifically, cacao plantations support smaller and less diverse populations of insectivorous birds than the forest, whilst the opposite trend occurs in frugivorous birds. The abundance and species richness of insectivorous birds increases with decreasing management intensity in cacao; highly forested cacao plantations have an abundance and richness of insectivores on par with mature forest. Birds from specialised forest feeding guilds, such as ant-followers and mixed-species flocks, show the starkest contrast in abundance between forest and cacao plantations. Cacao agroforestry systems support less than half the abundance of forest specialists encountered in mature forest. Additionally, forest specialist abundance and richness increase with decreasing management intensity of cacao agroforests. Our results suggest that conversion of forested land to cacao agroforestry systems results in the steep decline in abundance and richness of certain bird groups. However, we show evidence that low-intensity African cacao agroforestry systems can provide suitable habitat for birds, including those forest species most sensitive to disturbance.

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The birds, the bats, and the chocolate trees: Achieving sustainable agriculture in the Afrotropics through DNA metabarcoding

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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 sub-Saharan Africa on smallholder farms. Fortunately, cacao is typically not as destructive as other crops as it can be grown under a canopy of rainforest trees. However, 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 insectivorous predators. We were able to recover arthropod DNA barcodes from nearly 80% of these samples, and to recover plant DNA from nearly 80% as well. This DNA recovery allowed us to reconstruct large portions of a tri-tropic food web including detailed connections among thousands of organisms. We unexpectedly found that 83% of bats consumed Anopheles mosquitos - the genus that is the main vector of human malaria. We are currently optimizing lab protocols and building reference barcode libraries for cocoa pests and Anopheles mosquitos. By understanding the cacao food web as mapped by the framework we outline here, we can make meaningful management recommendations to farmers that will a result in a biodiverse community that provides ecosystem services that reduce both cocoa pests and disease carrying mosquitos.

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Economics of cocoa pollination: Towards a high-yielding, biodiversity-friendly, and climate-adapted production system in Ivory Coast, Ghana, and Indonesia

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Production of the third largest trade commodity, cocoa, has seen sharp and climate-related yield declines, forcing farmers to expand production in often forested habitats and putting high pressure on the environment. The future goal for cocoa production combines the high yields of input-intensive monocultures with climate-adapted and biodiversity-friendly agroforestry systems into a 'high-yielding agroforestry system'. Here we use data of more than 150,000 cocoa farms to show that manually enhancing cocoa pollination ('artificial pollination') could augment farm yields and farmers' annual profit in Ivory Coast, Ghana, and Indonesia, which together account for 66.8% of the global cocoa bean production. Taking price elasticities into account, an increasing global cocoa production through artificial pollination could lead to positive supply changes of up to 12.5%. Following short term income benefits to farmers before market adjustment to higher cocoa bean supplies, the global cocoa price may decrease by 29.3% to 1.61 USD/kg on the long-term. This could force 24.6% of cocoa farmers into alternative income sources and encroach pristine areas. These results highlight a large potential to increase farm yields in high-yielding agroforestry system through pollination, where low yields in sustainable agroforestry systems may be enhanced, and shade trees in monocultures could be planted in lieu of old trees without compromising yields. In the long-term, effective land-use policies, new cocoa varieties, and enhanced natural pollination need to gradually replace artificial pollination. This may reduce efficiency of global supply increases, ease the pressure on the global cocoa price, and allow maintaining high-yielding agroforestry system. In addition, natural pollination likely depends on the sustainable management of agroforestry systems, reduces the operational costs and ultimately benefits farmers. We highlight future research avenues for high-yielding, biodiversity-friendly, and climate smart cocoa production systems.

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ORAL PRESENTATIONS

GS01
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Effect of physical habitat features at multiple scales in the occupation area of an endangered salamander: *Ambystoma ordinarium* (Caudata: Ambystomatidae)

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The Michoacan Stream Salamander (*Ambystoma ordinarium*) is highly associated with aquatic ecosystems along the Trans Mexican Volcanic Belt (TMVB), one of the most ecologically degraded areas in Mexico. Urbanization and agriculture have been recognized as the main causes of salamander´s habitat loss. The objective of this study is to determine the current and potential distribution of *A. ordinarium*, as well as the environmental factors influencing them. At a local and a landscape scales, we evaluated the effect of elevation, temperature, dissolved O_2, conductivity, tree cover and stream depth in the occupation of *A. ordinarium*. We surveyed 60 streams along TMVB six times during 2018. Using occupation models, we determined that detection and occupancy probabilities of *A. ordinarium* respond to different environmental variables between seasons. In the dry season, detection probability was associated to temperature and stream depth; whereas, occupation probability was better explained by elevation and the extent of agricultural areas. In the rainy season, detection probabilities were not explained by the environmental physical variables considered; whereas occupancy was explained by stream´s dissolved O_2 and conductivity. The estimated proportion area occupied by *A. ordinarium* showed a more restricted distribution than current projections. Therefore, the implementation of conservation actions is urgent including. Species inhabiting the TVB appear as highly vulnerable to climate change, as evidenced by a relatively large projected loss of *A. ordinarium* distribution area.

Wednesday, 31 July 2019 | Grenat
GS01 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Mammal distribution implications of nocturnal and diurnal thermoregulation

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Diel activity patterns are an important factor in determining species distributions but are often overlooked in spatial patterns of diversity and distributions. In this study we predicted species distributions for several small mammals based on metabolic scope integrated with daily minimum and maximum temperatures and compared them with the species' known distributions from IUCN. We found that the predicted distributions based on simple thermoregulatory traits were significantly more accurate when daily minimum temperatures were used to predict the ranges of nocturnal species and daily maximum temperatures for diurnal species. As climate change is increasing nighttime temperatures at a faster rate than daytime temperatures, our results show that diel activity patterns will be an important factor in managing mammal responses to climate change.

Wednesday, 31 July 2019 | Grenat
GS01 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Community dynamics in stochastic environments and implications for biodiversity conservation

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Understanding and mitigating biodiversity loss is a fundamental goal in conservation biology. The primary culprits for species losses are anthropogenic habitat destruction, overkill, introduced species, extinction cascades, and climate change. For small populations, demographic stochasticity can also increase extinction risks. An additional type of stochasticity, environmental stochasticity, is inconspicuous, yet ubiquitous, and can increase the risk of biodiversity loss. In this talk, I will use mathematical models to show how environmental stochasticity can be the principal driver of two ecological patterns: (i) increase in the abundance of generalist species and decline of specialist species due to habitat loss can be driven by stochastic process and not by habitat fragmentation *per se*, (ii) increases in the strength of density dependence that stabilizes a deterministic system can have an opposite, destabilizing effect on a stochastic system. These results underscore the potential importance and unexpected effect of environmental stochasticity on community composition, persistence, and stability. Although, these results have been motivated by empirical patterns in temperate regions, the underlying mechanisms are equally applicable to tropical systems. Overall, environmental stochasticity should not be overlooked as a possible driver of biodiversity loss.

Wednesday, 31 July 2019 | Grenat
GS01 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Spatial distribution of different vegetation types of Andohahela National Park, southeastern Madagascar

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[3]UMR SYSTEM, CIRAD

Andohahela National Park (ANP) is known for the great variability of its vegetation types from wet to dry vegetation and transition to dry vegetation and its exceptional richness in both faunal and floristic species. It is also the only rainforest on the island south of the Tropic of Capricorn. The objective of this study is to verify the spatial distribution of trees in these different types of vegetation types, considered as animal habitat, using Ripley's K function. The spatial organization of trees with a dhp ≥ 2.5 cm and a height ≥ 3 m was studied. Twelve 2,700 m² (3 x 900 m²) quadrats were installed, eight in the xerophytic bush, two in the rainforest, and two in the transition forest, and three of 1,000 m² each were in the gallery forests. In the field, 5,793 individuals belonging to 170 species, 138 genera, and 54 families were inventoried. Tree densities range from 380.5 to 2,537.0 ind/ha and basal area from 26.9 m²/ha (in the xerophytic bush) to 110.4 m²/ha (in the rainforest). The spatial distribution of individuals varies according to the type of vegetation. A mixture between the three types of distribution was observed in the xerophytic forest (Mangatsiaka, Ambatoabo, and Ankoba) and the humid forest (Mahamavo). Vegetation distribution is aggregated (i) at short distances (r<7 m) and then tends towards random (ii) (r ≥ 7 m). A regular distribution (iii) is visible in the gallery forest (Tsimelahy), the transition forest (Tsimelahy), and the xerophytic bush of Ihazofotsy and Mangatsiaka with a high r value. This regularity can be considered as a sign of anthropogenic activity of the studied plant formation.

Wednesday, 31 July 2019 | Grenat
GS01 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Radial and vertical variation of *Ravenala madagascariensis* wood density, effect of the botanical variety and geographical provenance

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Ravenala madagascariensis or "traveler's tree" is a non-ligneous, emblematic, and endemic species of Madagascar. This species is very abundant in degraded forests and is widely used by the local population especially in the eastern part of the island. The majority of traditional Malagasy houses in this eastern part is made from this species. There is a lack of knowledge concerning the technological properties of its wood. This study aims to analyze the variability of wood density of *R. madagascariensis*. For that aim, 120 trees of *R. madagascariensis* from four geographical provenances (Soanierana Ivongo, Beforona, Brickaville, and Vavatenina) were harvested. Samples from three parts were sampled for each tree (trunk, leaf sheath, petiole). Density value was estimated using a portable NIR spectrometer with a spectral range varying from 950 to 1650 nm. Estimation models were based on PLS regression, by using several spectra pre-processing methods and wavelength selections. The best prediction model was obtained with "Standard Normal Variate+Detrending" spectra pre-processing method, with a R^2 of 0.70 and a RPD (Ratio of Performance to Deviation) of 2.17 using test set validation. Results show that the density of *R. madagascariensis* is variable from the center to the bark. The peripheral zone is 46% denser than central zone with high significant difference at α=5%. The geographical provenance and the botanical variety of *R. madagascariensis* affect significantly the density values. Density varies significantly according the compartment. In decreasing order, the trunk has the highest density, followed by the leaf sheath then petioles have the lowest density. These results are very useful for the rational use of this species since its performance in the various uses depends on its technological properties. Density values can also be used for the estimation of aboveground biomass storage of this species.

Wednesday, 31 July 2019 | Grenat
GS01 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

On the origin of species in a Neotropical savanna: Divergence times and evolutionary patterns of extant biodiversity in the Brazilian Cerrado

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Understanding the tempo and mode of evolution has been one of the main objectives of biogeographers and evolutionists since the neo-Darwinian paradigm was established. Despite centuries of investigation, the origins of current Neotropical biodiversity and its temporal patterns are still under constant scientific enquiry. While Biodiversity levels in the Cerrado (Brazilian savanna) are higher than in any other tropical savanna, most research on temporal biogeographic patterns in the region have only been published in the last decade. These divergence times, estimated using molecular clocks, are crucial to understand the evolutionary processes that generate biodiversity. Neotropical temporal diversification patterns are mainly based on rainforest studies, biasing our understanding of regional evolutionary patterns. To fill this knowledge gap, we compiled published information on divergence times in the Cerrado, and analysed them in light of described Cerrado Quaternary and Neogene geological events. Following the methodology of Rull, we exhaustively searched for papers that estimated divergence times of monophyletic lineages inhabiting the Cerrado. We compiled divergence times, number and type of loci, and if the existence of cryptic species was reported. We correlated divergence times with published data on Quaternary climate change and Neogene neotectonics. Data was available for Amphibia, Arthropoda, Aves, Mammalia, Plants, and Reptilia. The overall patterns show that most lineages diversified during the Neogene, but a clear trend or rapid diversification also happened in the Quaternary. Surprisingly, all papers used multilocus data to estimate divergence times. No cryptic lineages were reported for Aves or Plants, and Reptiles had the highest number of cryptic lineages. Our results contrast with the current patterns reported for Neotropical biota diversification timing based on rainforest studies. Origin of biodiversity in the Cerrado appears to be mainly linked to the uplift of the central Brazilian plateau in the Neogene, and to climatic fluctuations in the Quaternary.

Wednesday, 31 July 2019 | Grenat
GS01 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Unraveling diversity patterns and endemism in Malagasy ants: A phylogenomic approach

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The first step in preserving biodiversity and its associated ecosystem functions is assessing and quantifying measurable units of this diversity. Two key elements of measuring biodiversity across space and time are species diversity and endemism. In the past, most survey efforts have been focused on using taxonomic species as the units of diversity and endemism, but over the last decade it has become more common practice to assess phylogenetic (or lineage) diversity alongside taxonomic species richness. Measuring arthropod diversity based on either of these units is challenging, given that surveys are often too limited in geographic scope to capture the magnitude and breadth of arthropod species distributions and diversity, and timely identification of collected samples is difficult. Arthropods are thus often excluded from conservation planning decisions. Here we outline the goals of our project MAMI (Malagasy ant microendemism), which aims at a synthesis of survey efforts for ants in Madagascar spanning two decades. We use a phylogenomic approach to investigate regional patterns of phylogenetic diversity, endemism, and community structure across ants in Madagascar based on ~2,200 loci of ultraconserved elements. We present first results from our project using a data set of 32 species of Malagasy acrobat ants (genus *Crematogaster*), for which we compiled distribution data from approximately 2,400 collection records across 168 well-sampled communities. We analyzed phylogenetic patterns of community structure, diversity and endemism of these ants in Madagascar across 11 different habitat types and along climatic and primary productivity gradients. Our island-wide community analyses will uncover general patterns of species richness, lineage diversity and endemism across ant communities in Madagascar, allowing us to draw broad, widely applicable conclusions about the importance of these patterns for conservation planning.

Wednesday, 31 July 2019 | Grenat
GS01 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS02
ECOSYSTEM FUNCTIONS and SERVICES

Restoring ecosystem function and services in the Panama Canal watershed

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One of the biggest development challenges faced in the 21st century is access to abundant fresh water while arguably the biggest environmental challenge faced is Climate Change. Recent evidence from Panama has shown that forests can regulate the hydrological cycle by enhancing dry season and mitigating peak stream flows. Policy makers and practitioners call for reforestation in order to restore this and other ecosystem functions.The Agua Salud Project was established in the moist steepland forests of the Panama Canal Watershed in 2008 to study the ecosystem services provided by seasonal tropical forests and how they change with land use and climate change. Nine watersheds that include mature forest, pasture, and different active and passive reforestation treatments have been monitored since 2008 to both test forests ability to regulate the hydrological cycle and how these different land management techniques can restore this and other ecosystem functions. All reforestation treatments were initiated in 2008 and have been monitored for tree growth and mortality. In this presentation we will present data verifying the sponge effect at our site. We will present stream flow data from reforestation treatments and discuss saturated hydraulic conductivity (Ks, an index of infiltration) recovery. Finally we will discuss tradeoffs between forest and plantation stand development, carbon accumulation, Ks, and streamflow across land uses. Different aspects of ecosystem function can recover surprisingly rapidly with results of restoration visible within a matter of years.

Wednesday, 31 July 2019 | Cristall
GS02 – ECOSYSTEM FUNCTIONS and SERVICES

Forest cover and temporal resource availability driving avian-cross habitat spillover into Brazilian sun coffee farms

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The cross-habitat spillover process refers to biological fluxes between different habitat types. These movements occur very often from native habitats into agricultural lands, and when this happen, this process as an important mediator of ecosystem services provisioning. We aimed to respond how landscape structure and the temporal pulse of resource within agricultural matrix modulated avian-cross habitat spillover into sun coffee farms. Data were collected in nine independent landscapes ranging from 5-50% of native forest cover remaining in southeastern Brazil. We used automated telemetry to access bird movement into coffee farms across two temporal seasons (out of outbreak, Jan-Mar 2019; coffee borer beetle CBB outbreak, Jun-Jul 2019). Automated receptors were allocated at forest edges and at three distances from edges: 30 m, 70 m, 110 m. A grid with 16 receptors (~25 m of reachable radii) were established - 4 at each distance gradient 50 m apart (covering an area around 4 ha). We focus in tagging six small insectivorous bird species (range 12-20 gr): two forest-generalist, and four forest-dependent species across. Automated Receptors were established during 10 consecutive days in each landscape. Preliminary results from the first season (out of CBB outbreak) encompass 58 individuals and 8,136 detections. Most spillover performed by forest-dependent species occurred at edges and until ~50 m from edges. For another hand, forest-generalist spillover reached further distances, being more often detected around 70-110 m. Moreover, the spillover was intensified at landscapes with intermediate amounts of forest cover (25-40%). Our preliminary results show that forest-dependent species spillover occurs overwhelming at closer distances from the forest and at at intermediated amounts of forest cover with important implications in terms of landscape management. Once data collection ends next season, we expect to have indicators that resource pulse is also an important driver of spillover into coffee farm with implications in terms of CCB control.

Wednesday, 31 July 2019 | Cristall
GS02 – ECOSYSTEM FUNCTIONS and SERVICES

Ecosystem natural capital accounting in the new protected area (PA) of the complex Mahavavy-Kinkony (CMK) - Boeny Region: Carbon of mangrove account

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Mangroves are well-known for their capacity to sequester carbon and associated socio-economic services for local people. However, apart from anthropic impacts, there is also climate change influences on this ecosystem state. The carbon of mangrove account performed in PA CMK had permitted to determine the state and the variation of mangrove ecosystem carbon between 2013 and 2018 for data collecting allowed to establish biophysical accounts for natural capital, to ensure a good management and to be consider the value of natural resources in the national economy. In fact, the ecological survey method has been used to characterize the vegetation; land cover maps and land cover account from 2013 and 2018 were used for studying the spatiotemporal dynamic; MODIS images were used to evaluate the potentiality for carbon sequestration. To complete the data outcome from those studies, ethnobotanical and socio-economic countable data were used for the establishment of carbon ecosystem accounting and to identify the change which had happened during these last five years. For the carbon account, a series of four tables is used including carbon baseline, available resource account, use of carbon account and the table for indication of use intensity and ecosystem health. The results of the accounts show that the regression of mangrove forest induces a decrease of the carbon stock. The use index is 0.5 (<1); The carbon resources risk to be drain because of its high intensity of use. The index of the ecosystem carbon health is 2 (>1); this shows the possibility for renewal of settlement. The ecosystem intern value is 1, 25 (>1), so the improvement of the ecosystem carbon health still possible. Ecosystem carbon account is essential to ensure the sustainability of resources. It can also reflect the values of ecosystem and its contribution to national economy.

Wednesday, 31 July 2019 | Cristall
GS02 – ECOSYSTEM FUNCTIONS and SERVICES

Climate changes, threats to the Ecosystem Service provision and their relationships to socio-environmental vulnerability: A study in contrasting landscapes of Brazil

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Brazil is one of the largest agricultural commodities exporters, for instance, the ethanol from sugarcane belt in São Paulo state, which constitutes a fragmented landscape, but with relevant economic power. Furthermore, the country is also a global powerhouse of biodiversity and Ecosystem Services (ESs) as the Amazon Rainforest. Conversely, the changes in Earth' climate implies the hypothesis Brazilian Amazon "Forest-dieback", whose prediction is that a warmer temperature and drier conditions will convert the Amazon biome into savanna landscapes, that in turn can impact the functional diversity, (ESs) and hence human well-being. This research aims to relate the ESs provision affected by climate changes and local community vulnerability in distinct landscape gradients. This research already started in Sao Paulo, where we gathered secondary data and conducted surveys with rural people. The research's second phase will replicate that methodology in Amazon context and will include biophysical approach, through the Carbon and Ecosystem Functional-Trait Evaluation model (CAETÊ) to model the vegetation functional diversity and its relationship to current and forthcoming supplying of ESs in the Amazon. Our first outcomes pointed out the Sao Paulo's respondents (80%) recognized a higher priority of the ESs related direct or indirect to climate such as air, water and local climate regulation. These ESs revealed to be indispensable for local farming and when there were reduction of water availability and raise temperature, in drought of the year 2013/2014, the farmer's incomes were severely affected due to lack of strategies to re-build their activities (i.e. Low adaptive capacity). The results either of Sao Paulo or of Amazonia allow determining the quali-quantitative proxies over socioenvironmental vulnerability in different economic and environmental contexts. Thus, strategies for natural resource management and social adaptation actions are being drawn and anticipated by considering the funds in institutional and policy agendas (National or International ones).

Wednesday, 31 July 2019 | Cristall
GS02 – ECOSYSTEM FUNCTIONS and SERVICES

Challenges in quantifying carbon stock in above ground and below ground biomass and in soil sediments of mangroves in NW Madagascar

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Mangrove ecosystems store and sequester a large quantities of carbon considering that carbon is the central driver in climate change mitigation. However, Madagascar's mangroves are being lost due to increased charcoal and timber harvests, expansion of agriculture, and aquaculture. In particular, Tsimipaika and Ambaro Bays (TAB), in northwestern Madagascar, more than 25,000 ha of mangrove, approximately 20% of the forest have been lost from 1990 to 2010, driven primarily by over-harvesting of charcoal production. Therefore, this study attempts to quantify the leftover of carbon stock in above and below ground biomass and in the soil for TAB mangroves. To assess carbon stocks, a mapping analysis and a satellite image processing for stratification and classification of the area, followed by tree measurement and soil sampling were carried out. In addition, allometric equations were used for the quantification of carbon in the biomass (above and belowground) while soil organic carbon (SOC) was determined in the laboratory by loss on ignition (LOI) method. As results, four classes of mangroves were defined in TAB and 117 plots were inventoried. For both soil and tree biomass, the class 4 had the highest average carbon value of 744.38 Mg/ha compared to other classes of mangrove forest. The class 3 and the class 2 had an average carbon value of 695.87 Mg/ha and 622.05 Mg/ha, respectively. Finally, the class 1 had the lowest average carbon value of 306.32 Mg/ha. This study is absolutely indispensable to implement an efficient blue carbon project in Madagascar by providing accurate information on mangrove carbon accounting. Besides, the results are necessary for the efforts of piloting a verified carbon standard (VCS) certification in TAB and getting carbon credits to help maintain and diversify local livelihoods for more sustainable management of mangrove ecosystems with the local communities.

Wednesday, 31 July 2019 | Cristall
GS02 – ECOSYSTEM FUNCTIONS and SERVICES

Photosynthetic responses to large-scale nutrient additions in Central Amazonia

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Tropical forests are globally important for regulating carbon and water cycles and biodiversity. Despite high productivity, tropical forests are often found on ancient, highly weathered soils with low concentrations of phosphorus and other rock-derived nutrients, such as cations, relative to nitrogen. Therefore, tropical forests are hypothesized to be phosphorus limited. In this study, we test nutrient limitation of photosynthesis of canopy trees from key hyperdominant taxa in a large-scale fertilisation experiment in Central Amazonia (AFEX). We hypothesized that if nutrients determine leaf physiological responses, photosynthetic rates will increase and dark respiration will decrease with the addition of limiting nutrients. We measured leaf gas exchange on canopy leaves of 8 trees per plot for all 32 plots of the fully factorial nutrient addition (N*P*Cations) experiment 18 months after initiating annual fertilisation treatments. Despite significant increases in nutrient content of senesced leaves and leaf turnover rates, area-based leaf gas exchange parameters (A_{max},A_{sat}) did not significantly differ across treatments. However, both $A_{max}$and A_{sat} were highest in the P+Cations treatment (16.32 ± 1.39 and 5.24 ± 0.6 (mmol $CO_2m^{-2}s^{-1}$), respectively). In contrast, $A_{max}$was lowest in the N+Cation treatment (13.42 ± 1.74 mmol $CO_2m^{-2}s^{-1}$), whereas A_{sat} was lowest in the control plots (4.14 ± 0.34 mmol $CO_2m^{-2}s^{-1}$). Dark respiration ranged from 1.32 ± 0.09 to 1.67 ± 0.13 (mmol $CO_2m^{-2}s^{-1}$) in the N+P+Cations and N+Cations treatments, respectively. Together, these results suggest that P+Cations may be increasing carbon assimilation, whereas N+Cations may be decreasing carbon gains and increasing carbon losses. Specific leaf area and foliar nutrient content will give further insights on leaf-level responses to nutrient additions and whether leaf economic strategies of trees adapted to low nutrient soils are capable of physiological shifts with nutrient manipulations.

Wednesday, 31 July 2019 | Cristall
GS02 – ECOSYSTEM FUNCTIONS and SERVICES

Taxonomic, functional, and phylogenetic beta diversity of conifers in Mexican mountain ranges

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Mexico has an unusually high beta diversity of tree species, particularly in its mountain ranges, due to their sharp environmental gradients and fragmented forests. The high diversity of conifer species distribution is determined locally by environmental filtering, but also regionally by climatic and geological history. We investigated the species, functional, and phylogenetic beta diversity of Mexican conifers across and between eight mountain ranges in Mexico, using species richness, functional traits, and a phylogenetic approach in order to assess the importance of geographic and environmental distance in conifer diversity. We ask the following questions: 1) which beta diversity pattern (turnover or nestedness) is dominant among conifers in the Mexican mountain ranges?; 2) how are patterns of species, functional, and phylogenetic beta diversity affected by geographic distance, altitude, and the environment. We used georeferenced data on Mexican conifer distributions 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. A total of 6,963 plots, each 0.4 ha in size, distributed in eight montane areas were assessed and a grid of 0.1 degree cells was overlaid in order to calculate the taxonomic, functional, and phylogenetic beta diversity. Our results show that taxonomic and phylogenetic diversity increase with geographic distance, likely due to dispersal limitation. We also observed an increase in all forms of beta diversity, particularly functional diversity, with environmental distance due to trait selection. For taxonomic and phylogenetic diversity, turnover dominates over geographic distance, and nestedness with altitude within mountain ranges. Functional diversity, in contrast, showed turnover with environment due to trait selection. Mountain ranges contained distinct species compositions but consistent trait relationships with the environment.

Wednesday, 31 July 2019 | Cristall
GS02 – ECOSYSTEM FUNCTIONS and SERVICES

GS03
THREATS, PRESSURES, AND SUSTAINABLE DEVELOPMENT

Improving data quality for better biodiversity management

RIVOLALA R ANDRIAMPARANY, JAMES LOVA RAKOTOVAO, HAINGOVOLA ANDRIANJAFIMAHERY, TSILAVINA RANDRIANALY, JOSIA RAZAFINDRAMANANA

Ambatovy Joint Venture

Madagascar is renowned for its mega-biodiversity with an endemicity rate can reach up to 82%. However, in the eastern region, the loss of the forest and natural habitat threaten the biodiversity; including the protected area of Ambohidray. The socio-economic activities of the population are the main causes of these losses. The poverty and the demographic growth are also a factors that accelerate the degradation of the natural resources. For these reasons, this study was conducted to set a sustainable conservation of the biodiversity of this protected area and to ensure its protection. An ethnobotanical and socio-economic methods were conducted by using interviews of local villagers on the resources exploited in the forest and on their income-generating activities and finally direct field observations of the actual damage caused by their activities. This later method takes into account the extent of degraded surfaces, the types and importance of the impacts. Four types of pressure were collected and observed: charcoal making, traditional gold mining, agriculture, and the introduction of exotic species into the natural forest. The evaluation of these pressures and the threats suggest that charcoal production is the most important pressure in this protected area. Thus, two solutions are proposed: i) increase the extent of tree plantation and ii) introduce a new technology to improve charcoal production. It is also important that the creation of income-generating activities and environmental education remain the most important actions to insure the sustainable management of Malagasy biodiversity. The results of this study are among the main challenges in conservation of biodiversity in the tropical countries.

Wednesday, 31 July 2019 | Auditorium
GS03 – ECOSYSTEM FUNCTIONS and SERVICES

Pressures and threats for the eastern forests of Madagascar: Case of the new protected area of Ambohidray

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Madagascar is renowned for its mega-biodiversity with an endemicity rate can reach up to 82%. However, in the eastern region, the loss of the forest and natural habitat threaten the biodiversity; including the protected area of Ambohidray. The socio-economic activities of the population are the main causes of these losses. The poverty and the demographic growth are also a factors that accelerate the degradation of the natural resources. For these reasons, this study was conducted to set a sustainable conservation of the biodiversity of this protected area and to ensure its protection. An ethnobotanical and socio-economic methods were conducted by using interviews of local villagers on the resources exploited in the forest and on their income-generating activities and finally direct field observations of the actual damage caused by their activities. This later method takes into account the extent of degraded surfaces, the types and importance of the impacts. Four types of pressure were collected and observed: charcoal making, traditional gold mining, agriculture, and the introduction of exotic species into the natural forest. The evaluation of these pressures and the threats suggest that charcoal production is the most important pressure in this protected area. Thus, two solutions are proposed: i) increase the extent of tree plantation and ii) introduce a new technology to improve charcoal production. It is also important that the creation of income-generating activities and environmental education remain the most important actions to insure the sustainable management of Malagasy biodiversity. The results of this study are among the main challenges in conservation of biodiversity in the tropical countries.

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GS03 – ECOSYSTEM FUNCTIONS and SERVICES

Determinants of deforestation and prediction of future forest loss in remote and rural northeastern Madagascar

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The global biodiversity hotspot of Madagascar has already lost much of its natural vegetation and land cover change is mainly driven by deforestation, although forest loss shows large spatial variability. We analyzed satellite images between 1990 and 2018 from northeastern Madagascar to evaluate the contribution of 10 potential variables (e.g., topographic, demographic, forest protection) to explain recent and predict future deforestation probabilities of the remaining forests under four different scenarios. The study region has lost 14% of its forest cover since 1990 and the once continuous north-south rain forest belt has become disrupted at four different locations. Status of forest protection, altitude, proximity to the forest edge, coast, villages, and the valley bottom were determined as significant predictors. At least 20% of the 3,136 villages in the area were only established since 1990 and this housing sprawl is directly related to deforestation. Furthermore, high to very high deforestation probabilities are predicted for up to 43.1% of the remaining forests and further habitat loss is anticipated. Recent deforestation appears to be fueled by negative incentives bringing benefits to local land users for destroying forests, since this is the traditional pathway of land acquisition. Changes in livelihood strategies are most likely a result of reactive behaviors, but may also be triggered in a proactive manner before remaining forests are fully depleted. This study suggests that the maintenance of current landscape connectivity will require the establishment of newly protected areas and strategic planning of forest corridors that should be based on extensive agroforestry systems. However, this process will involve pull factors that are most likely to be initiated by external stakeholders (e.g., NGOs). We therefore highly recommend them to participate in future land use planning in north-eastern Madagascar.

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GS03 – ECOSYSTEM FUNCTIONS and SERVICES

Community based conservation of threatened wild yams in Madagascar

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A significant part of Madagascar's rural population, and even some urban areas, rely on wild yams for food, especially during the hungry season. The over 40 described species of Malagasy yams are largely endemic (ca 88%) with edible tubers (85%). At least 13 species are threatened by habitat loss and overexploitation. Within two projects funded by the Darwin Initiative and one by the April Trust we are aiming to conserve wild endemic yams through working with communities in Antsiranana, Menabe, and Fianarantsoa areas, while maintaining a sustainable food supply and enhancing nutrition. This is being supplemented by ex-situ conservation, with yams brought into community and regional cultivation and national and international seed banking. Working with 92 communities covering 4478 households, the project provided extensive training and cultivated yam planting materials, which were planted with wild yams in household plots. This changed behaviours because people reduced wild yam tuber collection in the forest and has overall increased income and improved nutrition. Each project community has a demonstration plot used as field school for household beneficiaries. Seven threatened species are currently represented in the living collections (community, regional, and national). Twenty-three species have been banked as seed with 2 to 10+ accessions. Wild yam population surveys have been performed by communities and the information provided will be used to enhance IUCN red list assessments (29 IUCN assessment provided by the project), by local decision makers, and to develop species management plans for forest conservation. Increased production is being addressed by development of marketing platforms with the aim of further improving incomes and making conservation financially sustainable.

Wednesday, 31 July 2019 | Auditorium
GS03 – ECOSYSTEM FUNCTIONS and SERVICES

"Green List" assessment of freshwater turtles reveals priorities for community-based pan-Amazonian conservation success

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The conservation of biological and cultural diversity along Amazonian waterways is a global priority. Freshwater turtles are a diverse and imperiled group of aquatic reptiles that are an important food source for many residents of Amazonian regions and are therefore a flagship reflecting the success or failure of broader efforts to conserve aquatic ecosystems. Our objective is to identify spatially explicit priorities and obtain achievable targets for the continental scale conservation success of Amazonian freshwater turtles. A Green List assessment was conducted for 13 species of freshwater turtles from the Amazon, Orinoco, and Magdalena river basins. Across 59 river sub-basins spanning 9 M km^2 we calculated for each species four conservation metrics that demonstrate i) impacts of action; ii) identify conservation dependence; iii) quantify expected gains; and iv) specify requirements to achieve population recovery over the long term. Three scenarios were then used to identify demographic target values necessary for the plausible, aspirational and complete recovery of species. Widespread and ubiquitous threats (e.g., overexploitation and land use change) indicate that freshwater turtle species are likely to experience severe (≥ 50%) and rapid (< 50 years) future losses across much of their range in the absence of effective conservation actions. Community-based management could catalyze a rapid continental scale recovery for at least four Amazonian freshwater turtle species within a few decades. If community-based management is implemented together with the existing protected area network, there could be up to a threefold continental scale population increase within 50 years for overexploited species such as *Podocnemis* spp. Our findings demonstrate clear conservation targets and spatial priorities for the conservation of biological diversity along Amazonian waterways. Additionally, the ability of community-based management to extend and accelerate species recovery strongly supports the need to prioritize the conservation of cultural diversity along Amazonian waterways.

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GS03 – ECOSYSTEM FUNCTIONS and SERVICES

Does the use of modern agricultural inputs by smallholder farmers reduce deforestation? A case study for Zambia

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Increasing food production to meet growing demand while reducing tropical deforestation is one of the greatest sustainability challenges the world faces. Agricultural expansion is the main driver of deforestation in the tropics. Forests and woodlands play a crucial role for biodiversity conservation and provide a suite of products and ecosystem services for humanity. Reducing emissions from deforestation and increasing terrestrial carbon sinks are also pillars of the global mitigation strategy to stabilize our climate system. Limiting agricultural expansion into forested lands is therefore crucial. This issue is especially important in sub-Saharan Africa (SSA), which faces critical problems with food security and increasing deforestation. In SSA, patterns of forest cover loss are associated with agricultural expansion by smallholder farmers, who may respond more to increase in productivity by reducing forest conversion than large-scale producers. The objective of this research is to test empirically the effects of modern input use on forest cover loss in order to orient policies that could address the dual challenges of increasing global food security and reducing deforestation. Using Zambia as a case study, we use an innovative approach to analyze the impacts of modern input use by smallholders on forest cover loss at a national scale. We make use of detailed nationally representative panel agricultural survey data on smallholder farm households. Using small area estimation techniques, we predict inorganic fertilizer and improved seed use for the country. We then test the effects of using these inputs on forest cover loss with mixed effect models, controlling for spatial and temporal characteristics. We find that the use of inorganic fertilizer and improve seeds have opposite effects on forest cover loss. These results call for re-visiting assumptions on how agricultural intensification can spare forestland for conservation and to adopt policies that are consistent with empirical findings.

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GS03 – ECOSYSTEM FUNCTIONS and SERVICES

A dynamic tool to balance environmental and economic demands for native vegetation compensation in Brazil

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Offsetting schemes are usually important to avoid biodiversity loss in environmental policy implementation on private lands. However, the practical definition of ecological equivalence may be a challenging and conflicting target. Particularly, offsetting may increase biodiversity gains, but also restrict the available areas for trade, raising the compensation costs. We developed a dynamic tool to balance environmental and economic demands for native vegetation compensation and applied this approach for the implementation of the Brazilian Native Vegetation Protection Law in the São Paulo State. The tool is based on two compensation strategies: like for like (trade for similar areas according to abiotic variables) and trading up (trade for areas with high biodiversity value). We measured ecological similarity considering 14 variables including soil, terrain, and climate characteristics. Areas for trading up were defined based on regional conservation plans. The dynamic tool allows the comparison between ecological similarity gain and land offer according to the degree of ecological similarity required, i.e., the feasibility of compensation implementing according to a balance between demand and supply. For this purpose, the tool automatically plots the tradeoff in selecting the appropriate number of groups: minimizing the heterogeneity of the abiotic characteristics or facilitating the balance between native vegetation surpluses and deficits in the same group. The tool also allows the inclusion of alternatives for compensation: inclusion of areas for trading up or restoration of pasturelands with low agricultural suitability. Both strategies increase the supply for compensation, improving land balance. Decision makers can use the dynamic tool to define the level of ecological equivalence required in order to allow a good balance between native vegetation deficits and surplus in a same ecologically similar region. The proposed approach is flexible and can evaluate different strategies of compensation. It can also be easily adopted as negotiation framework for different compensation schemes.

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GS03 – ECOSYSTEM FUNCTIONS and SERVICES

GS04
ECOSYSTEM FUNCTIONS and SERVICES

Dynamics of treefall gaps in an Upper Amazonian floodplain forest

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We took advantage of two natural experiments to investigate processes that regulate tree recruitment in gaps. In the first, we examined the recruitment of small and large saplings and trees into 31 gaps resulting from treefalls occurring between 1984 and 2015 in a 2.25 ha core area of a 4 ha tree plot at Cocha Cashu in Perú. In the second, we documented the tallest saplings recruiting into 69 gaps created simultaneously during a violent windstorm in 2000. In the established tree plot, we compared the composition of saplings in the disturbance zones of gaps prior to, during the period of gap formation and subsequently. A surprisingly high proportion (≥60%) of established saplings survived gap formation. Light demanding species, as proxied by mortality rates, recruited under all conditions, but preferentially during periods of gap formation, a pattern that was especially strong among gap pioneers. Similar results were noted for small and large saplings and trees recruiting at ≥10 cm dbh. 100% of /previously untagged trees recruiting into gaps in the first post-disturbance census were gap pioneers, suggesting rapid development. This conclusion was strongly supported in a survey of the 69 gaps that had been simultaneously created in a wind storm. After 19 months, 10 species of "gap pioneers" had attained heights of 6 – 10 m. After 3 years, more than 30% of surviving stems had attained tree status. The 10 gap pioneers are dispersed, variously, by primates, bats, birds and wind and reached maximum frequency in different-sized gaps (range <100 m^2 to >1,000 m^2). How microenvironments and dispersal interact in regulating differential recruitment in relation to gap size remains an open topic for study.

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GS04 – ECOSYSTEM FUNCTIONS and SERVICES

How does defaunation influence gene flow and spatial genetic structure in a hyper abundant animal-dispersed Neotropical palm?

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Demographic and evolutionary dynamics in plants are largely determined by the dispersal of pollen and seeds. In tropical forests, most tree species rely on frugivores for seed dispersal services. Consequently, defaunation could alter seed-mediated gene flow and damage the genetic diversity and evolutionary potential of tree populations in tropical forests. However, we know little about the genetic consequences of defaunation on animal-dispersed plant populations. To address this knowledge gap, we collected genetic and spatial data from 3 populations of the most abundant palm species in the Amazon Basin, *Euterpe precatoria*, along a well-studied defaunation gradient in Peru. Using 8 microsatellite markers, we assessed how defaunation relates to (1) genetic diversity and inbreeding; (2) dispersal distances; (3) number of effective maternal trees, and (4) fine-scale spatial genetic structure in seedlings. Results have important implications for how defaunation influences the maintenance and spatial distribution of genetic variation for tree populations. This study contributes an informative component towards our mechanistic understanding of how vertebrates influence evolutionary processes and the maintenance of genetic diversity in tropical tree communities.

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GS04 – ECOSYSTEM FUNCTIONS and SERVICES

Same frugivore, different seed fate: The case of howler monkeys and large-seeded trees

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Most tropical tree species depend on frugivores animals to disperse their seeds. Primates are important seed dispersers, especially for those large seeded tree species (> 1 cm length). In fact, for some tree species the dispersal services provided by primates could not be carried out by other frugivores. In the Montes Azules Biosphere Reserve, southern Mexico, we investigated the effect of Howler Monkey (*Alouatta pigra*) gut passage on the germination rate and maximum germination (%) of seven large-seeded tree species considered as top food species in the diets of this primate: *Ampelocera hottlei*, *Castilla elastica*, *Dialium guianense*, *Garcinia intermedia*, *Pourouma bicolor*, *Spondia bombin*, and *Trophis racemosa*. Maximum germination was defined as the cumulative percentage of seeds germinated after 60 days since sowing date, whereas germination rate refers to the proportion of seeds germinating per day. Three groups of howler monkeys were followed and feces were collected soon after defecation and seeds removed. Seeds from three individuals of each species were collected from mature fruits underneath the parent trees and used as experimental controls. Seeds were placed in germination trays and the number of germinated seeds was counted daily. Except for *Garcinia*, ingested seeds showed significantly greater germination rates than non-ingested seeds. In fact, in non-ingested seeds of *Dialium*, germination was negligible. Regarding maximum germination, ingested seeds showed three different responses; while *Dialium*, *Pouruma*, *Spondias* and *Trophis* showed significantly greater germination percentage, *Garcinia* showed significantly lower germination percentage and no effect of seed ingestion was observed on *Ampelocera* and *Castilla*. In general, seed ingestion by howler monkeys confers greater germination rates than non-ingested seeds. Greater germination rates reduce predation probabilities and increases seedling establishment. Dispersal services by Howler Monkeys may contribute to germination heterogeneity within tree populations of old-growth forest species.

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GS04 – ECOSYSTEM FUNCTIONS and SERVICES

Functional diversity of bird and bat communities are similarly related to abiotic and biotic drivers on Mount Kilimanjaro

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Birds and bats are key components of ecosystems and provide essential ecosystem functions, such as pollination, seed dispersal, and insect pest control. Both groups show special functional adaptations that determine their contributions to these functions, in particular in terms of body size, wing shape, and beak or rostrum shape. The diversity of these functional traits in bird and bat communities can be directly influenced by abiotic factors, such as climate and land use, and indirectly via biotic factors, such as vegetation structure and resource availability. To test the importance of direct and indirect effects of abiotic and biotic factors, we investigated the functional diversity (FD) of bird and bat communities in relation to biotic and abiotic factors along the elevational gradient of the world's highest free-standing mountain, Mount Kilimanjaro. We counted birds on 63 plots and recorded bat sonotypes on 58 plots distributed in disturbed and undisturbed habitat from 700 to 4600 m.a.s.l. For the recorded taxa, we additionally compiled movement and foraging traits and body size from museum specimens and databases. Further, we recorded mean annual temperature, precipitation, vegetation heterogeneity and fruits, flowers, and insect biomass (as measures of available food resources) on each plot. Using path analyses, we found similar responses of bird and bat FD to the variation in abiotic and biotic drivers along the mountain slope. For both groups, direct temperature effects were most important, but additional indirect effects of temperature, precipitation and land use were mediated by both vegetation heterogeneity and resource availability. Biotic factors were particularly important to explain the variation in FD components related to movement traits and body size. Our findings indicate that similar abiotic and biotic drivers determine the FD of bird and bat communities and that these drivers jointly modulate variation in FD of flying vertebrates along large environmental gradients.

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GS04 – ECOSYSTEM FUNCTIONS and SERVICES

Fig seeds dispersal by the fruit-eating cyprinid fishes in tropical freshwater: Evidence from feeding experiments

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Riparian fig trees (*Ficus*) produced fruits or figs year-round as a keystone species and there are important resources for different frugivorous fishes during the filling or flood. The important role of fish in seed dispersal is increasingly recognised, however, many species which are not clearly act as either seed predators or seed dispersers. To assess the potential role of both seed and fish traits in ichthyochory, we employed seed feeding trials to quantify species differences in disperser quality within two cyprinid species: *Mystacoleucus chilopterus* (Ray-finned Fish) and *Barbodes schwanenfeldi* (Tinfoil Barb), using seeds of three riparian fig species (*F. ischnopoda*, *F. montana*, and *F. racemosa*). The experimental study divided into a series as follows: seed uptake, seed retention time, seed survival, germination probability, and germination rate after gut passage. Feeding experiments showed that seed survival and germination varied among seed sizes, seeds of *F. racemosa* responded to disperse by *B. schwanenfeldi* in positive way. Approximately 18–24 h to pass through the digestive tract, seeds were still viable and significantly increased accelerated seed germination than seeds that had been left in the fig exposed to air or floated in water, while *M. chilopterus* was granivory (seed predator) in case of the seeds damaged by chew and not viable. This evidence allows us to conclude that seed traits such as size and hardness appeared crucial for the survival, whereas body size and the correlated bite force is an important fish trait in ichthyochory. Although seeds in riparian forests also can be carried by water and by a variety of nonaquatic vertebrates, we argue that fishes should be important seed dispersers when seeds are non-buoyant or when there are few nonaquatic dispersers.

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GS04 – ECOSYSTEM FUNCTIONS and SERVICES

Intra-individual variability in xylem water isotopic signature causes incorrect assessment of root water uptake depth

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Using plant xylem water isotopic signatures to decipher the vertical location of root water uptake (RWU) has gained popularity within the ecohydrological community. Among other assumptions, this technique presumes a uniform xylem isotopic signature within lignified plant. However, this crucial assumption is poorly corroborated. Here, we hypothesize that major intra-individual alterations in the xylem water isotopic signatures is in fact rather likely since RWU depths and sap flow velocity which both experience diurnal fluctuations as a result of the dynamic evaporative demand and the heterogeneous soil water potential distribution. We developed a mechanistic plant hydraulic model coupled with a standard multi-source mixing model, which enables studying the impact of sapflow velocity and water potential gradients in the soil-plant-atmosphere continuum on the xylem water isotopic signatures along the stem. Our model (SWIFT) predicts that variation in xylem water isotopic signatures rapidly arises because of diurnal spatiotemporal RWU fluctuations and persists along the length of the plants' conductive tissues. Field data of xylem water isotopic signatures (δ^2H and $\delta^{18}O$) along the length of six tropical lianas and six tropical canopy trees sampled in Laussat, French Guiana, corroborated our model results. Observed intra-individual variability was as large as 20‰ in δ^2H and 4‰ in $\delta^{18}O$, vastly exceeding acceptable error ranges but in agreement with the model predictions for such a case study. We here highlight that one of the fundamental assumptions of the technique is not valid. Our work points at important possible interpretation and calculation errors in literature, and illustrates the importance of including sapflow measurements in future RWU assessments. Finally, based on our model, we present a new theoretical approach enabling spatiotemporal RWU assessment for individual plants by simultaneous monitoring of sapflow, xylem and soil water isotopic signatures, as well as soil water potentials.

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GS04 – ECOSYSTEM FUNCTIONS and SERVICES

Functional diversity at tropical forests and savannas

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Tropical forests and savannas account for most of Earth's primary productivity. Therefore, understanding how such ecosystems are functioning, but also how they might be responding to global changes, is of great interest. Currently, there is a large effort in applying descriptors of plant functional traits in modelling the dynamics of vegetation communities and ecosystem functioning. In order to link biodiversity and ecosystem function, a better understanding of how functional diversity varies among vegetations is necessary. Here we present an analysis of how functional diversity varies within and among savannas and forest sites (26 of each) evaluated in South America (Brazil and Bolivia), Africa (Ghana, Burkina-Faso, Mali, and Cameroon), and Australia. We determined community averaged means of the following leaf traits related to carbon acquisition: leaf mass to area ratio (LMA), leaf content of nitrogen (N_{area}) and phosphorus (P_{area}) and maximum carboxylation capacity (V_{cmax} – derived from A-Ci curves). Multi-trait functional diversity indexes were calculated with the freely available software *FDiversity*. In this study we found no significant differences between forest and savanna vegetation regarding Functional Richness (p = 0.41), Evenness (p = 0.99), Divergence (p = 0.88), Dispersion (p = 0.56) or Speciation (p = 0.21). In addition, no distinction between forest and savanna was observed for Functional Attribute diversity (FAD) (p = 0.25), Standardized FAD (p = 0.51) or Modified FAD (p = 0.34). Such results suggest that although community weighted means of specific traits might vary considerably, savannas and forests do not differ in the dispersion of species within the trait space. We conclude that although tropical forests and savannas present distinct carbon stocks and fluxes, the community functional diversity controlling such ecosystem processes is rather similar.

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GS04 – ECOSYSTEM FUNCTIONS and SERVICES

GS05
OTHER

Environmental influences on geographic variations in body size in Greater Gliders (*Petauroides volans*)

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Greater Gliders (*Petauroides volans*) north of the Tropic of Capricorn are half the size of those to the south. Similar latitudinal clines in body mass, described by the ecogeographic trend known as Bergmann's Rule, are common. However, the mechanism behind this trend is highly controversial. The prevailing theory is heat conservation, due to a decreased surface area to mass ratio in larger animals. Alternative mechanisms have been suggested, as reptiles show a similar body size variation across latitude but do not thermal regulate through metabolic heat production. This study tests the primary productivity hypothesis by assessing the relationship between body mass and the quantity of food and water resources between four populations of Greater Gliders at the corners of their geographical range across eastern Australia. *P. volans* are obligate folivores dependent on this highly specialized diet for food and water. Leaves were sampled from each study site and analysed for total nitrogen, available nitrogen, and water content. Our results concluded that while there was a significant variation in body mass between northern and southern populations there was no significant difference between water content and available Nitrogen in leaf samples between study sites. Therefore, it is highly unlikely that primary productivity is the underlying mechanism responsible for body size variation in this species. Advancements in the identification of ecogeographical rules and the mechanisms that drive them will allow for increasingly accurate modelling and subsequently assist in identifying species and populations with the greatest need of intervention and management.

Wednesday, 31 July 2019 | Opale
GS05 – OTHER

Inaturalist: Rescuing Madagascan plants with new technology

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Madagascar has over 12,000 plant species, with around 80% endemism amongst the known taxa. Fungi are almost completely unknown. Most of the known taxa were collected and described during the colonial period, during the compilation of the *Flore de Madagascar*. Most of the type specimens and plants collections from Madagascar are held at Paris herbarium (P). They are not accessible for botanists undertaking extinction risk assessments. Until 2015 less than 300 plants species figured on the IUCN Red List. At this rate it would take decades for the flora of Madagascar to be published on the IUCN Red List, whereas most natural vegetation is being cleared throughout the island. In 2014 Kew Madagascar Conservation Centre (KMCC) and Royal Botanic Gardens Kew (RBG Kew) got funding from the JRS Biodiversity Foundation to support a project to investigate the mobilisation of plant data using new smart phone technology and a citizen science platform. The objective of our project is to increase the data on plants of Madagascar available for IUCN Red List threat assessments. To meet this objective, we have enhanced the way we gather data in the field by utilising smartphones. Inaturalist platform utilises advances in technologies, especially in smartphone applications and computing, it is available as an application for both Android and iOS systems. The program allows specialists and non-specialists, to view, comment and name photographed taxa, uploaded by a member of the platform, with a certain number of criteria. Furthermore, ZavamaniryGasy (iNatZavgasy https://www.inaturalist.org/projects/zavamaniry-gasy-plants-of-madagascar), a subproject of Inaturalist, designed especially for plants observed in Madagascar, has 279 members, 21507 observations and covers 3223 species. Promoting the use of this platform has the Red List of Madagascar plants species to guide conservation action and help the government to meet global targets (GSPC, Aichi 2020).

Wednesday, 31 July 2019 | Opale
GS05 – OTHER

Study of transport efficiency of an Indian ant in the natural terrain

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Ants occupy nests with varying degree of complexity from ephemeral cavities in fallen twigs to elaborate underground structures with a multitude of interconnected chambers. Nevertheless, ant species across all biomes show nest relocation - a process by which adults, immature young and resources have to be moved from one location to another. Our study examined natural relocation of eight colonies of an Indian tropical ant (*Diacamma indicum*) that exhibits direct recruitment. Transport characteristics involving speed, path efficiency, and heading orientation of 987 uniquely labelled ants were analysed through real-time observation and video records. Generalised linear mixed-effects model were used to understand the effect of parameters like patch heterogeneity and transport type on the speed and path efficiency of these ants. Computation of sinuosity of transporting ants reveal a high degree of path efficiency (85.23 ± 9.72%). Transporters reoriented towards the target nest soon after exiting their old nest and tandem running in this species is so well tuned that 97% of 1000 transports reached their target nest without facing any interruption. Coupled adult-brood transport observed in this species is indeed more economical than individual transports across homogenous as well as heterogeneous terrain. Transporters face varying degrees of impedance in the natural habitat due to terrain heterogeneity leading to decreased speed in grassy patches. This modulation in speed would be one of the costs paid by these ants for maintenance of a high degree of path efficiency and sustained leader-follower cohesion across heterogeneous patches while relocating in their natural habitat. While the impact of various factors like temperature, rain and increased stress can be examined through studies in individual species, a more holistic picture of the challenges that transporting ants face and how they overcome them calls for similar studies contrasting different modes of recruitment across different species in their natural habitat.

Wednesday, 31 July 2019 | Opale
GS05 – OTHER

Direct interactions between mammalian and insect herbivores: Mechanisms and implications

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Mammalian herbivores alter the distribution and the physical and chemical characteristics of the plants they feed on. Consequently, plant-dwelling invertebrates, predominantly insect herbivores that depend on those plants and the predators and parasitoids that are associated with them may be critically affected. These plant-mediated indirect interactions between mammals and invertebrates have been extensively studied. However, mammalian herbivores may also directly affect insect herbivores by incidentally ingesting them or force them to move while feeding. The ubiquity and small size of insects render them highly susceptible to incidental ingestion, but as common as this interaction may intuitively seem, very little is known about its prevalence and ecological consequences. Nevertheless, cases of incidental ingestion of insect herbivores (especially of the less mobile species) and the associated adaptations for avoiding it that have been accumulated in recent years. It allows us to carefully extrapolate and conclude that it should be common and important especially in grasslands (e.g. in east African tropical savannas). Ingestion (incidental or not) of insects by mammalian herbivores may be fatal to the formers, but it may also affect the latter and the shared plants.

Wednesday, 31 July 2019 | Opale
GS05 – OTHER

Why can we see lianas from space?

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Lianas are found in almost all tropical forests and have a disproportionate influence on forest dynamics, structure and functioning. Increasingly, ecologists are applying remote sensing techniques to study lianas, and previous work has successfully and accurately detected lianas even from satellite images. However, this work relies on automated blackbox classifiers and there has been no advancement in understanding why lianas have a distinct spectral signal. Without such an understanding important limitations and caveats cannot be understood. In this talk I tackle the question of why we can see lianas from space. I identify the distinct spectral signal of lianas in the solar spectrum at the leaf, canopy and stand scales and use mechanistic leaf and radiative transfer models to theoretically determine which biochemical or biophysical processes are responsible for the liana signal. I then corroborate these theoretical findings with newly collected field data. Finally, I show the limitations and dangers when applying automated classifiers to detect lianas from remotely sensed images at the leaf to stand scales.

Wednesday, 31 July 2019 | Opale
GS05 – OTHER

Successional pathways and vegetation recovery dynamics on charcoal kiln sites

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Traditional charcoal production in the tropics is often associated with deforestation and forest degradation. Charcoal production also leaves a legacy of patches of scarred and exposed surfaces where kilns were located, and on which soils were induced to temperatures of up to 60°C. As increasingly more tropical forests are incorporated into formal management regimes in which charcoal production is permitted, there is urgent need to understand kiln site recovery dynamics, and, identifying recovery pathways patterns and the conditions conducive to rapid recovery. In this vein, we studied the vegetation recovery patterns of 124 kiln sites aged one month to 40 years in four charcoal production sites located in the western Mexican highlands. Our objectives were to identify successional pathways typical of the recovery process, to test the effect of kiln size and surrounding vegetation on recovery, and the effect of land use (particularly grazing) on recovery rates. Control sites were chosen nearby as reference for how the site would have been had it not been used for charcoal making. Soil characterization was conducted up to 1 m depth on kiln sites and controls. Preliminary analysis indicates that charcoal making significantly alters soil properties of kiln sites. Highly predictable successional pathways were identified with a similar pattern of kiln site recolonization across all four study sites. In terms of species composition, the resultant vegetation is highly distinct from that of control sites. Even after 40+ years kiln sites do not resemble the surrounding vegetation, although in the absence of grazing, > 15-year sites eventually become colonized by tree species. Given the long-term and seemingly irreversible impact that kilns cause, minimizing the number and size of sites that charcoal production creates should be a key management objective.

Wednesday, 31 July 2019 | Opale
GS05 – OTHER

The influence of inter-annual climatic variability on abandoned field successional dynamics in a wet tropical forest

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Dynamical trajectories of secondary forest succession in the tropics often exhibit high levels of stochasticity. Effects of inter-annual climate variability on successional dynamics may account for part of such stochasticity, but is poorly understood. Here, we employed a long-term study (20002018) to explore the role of inter-annual rainfall variation on secondary forest successional dynamics in a tropical rainforest region in southern Mexico. We assessed the influence of climate temporal variability relative to other factors (e.g., land use history, amount of forest habitat around successional fields). In 2000, we established a chronosequence of abandoned cornfields with fallow ages ranged from 1 to 17 years. At each site, trees with 1.5 m height or taller were tagged and monitored for survival, growth, and recruitment (trees reaching 1.5 m height) over 18 consecutive years. Annual rates of recruitment, mortality, and community growth rate were calculated. Over the study period the mean annual precipitation was 2,700 mm, range: 1,741 to 3,482 mm/yr. This interannual variation was 10 fold when considered rainfall in the dry season (range January to May: 58,689 mm). Overall, rates of recruitment and mortality, as well as community growth rate, decreased with successional time. Mortality increased with decreasing rainfall in the dry season. ENSO related drought events occurred between 2001 and 2002, producing the highest mortality rate over the study years. Also recruitment rate and community growth rate, reduced with decreasing rainfall in the dry season. However, variation in community rates across sites and years explained by rainfall variation was below 20%. Also, high heterogeneity existed among secondary forests of similar age in their response to rainfall variation. We discuss how the interaction between rainfall temporal variation and factors such as land use history, biotic interactions, and landscape structure result in important levels of stochasticity in the dynamics of second growth tropical forests.

Wednesday, 31 July 2019 | Opale
GS05 – OTHER

GS06
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

The first comprehensive study of insect body size for a complete elevational gradient in the tropics reveals a striking pattern

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The body size of an animal may well be its most important functional trait. For arthropods, geographical patterns and environmental drivers of body size variation are still poorly documented and poorly understood, especially in the tropics. Along a complete tropical elevational gradient in Costa Rica, we studied two species-rich, phylogenetically independent moth taxa (794 species of Geometridae, 308 species of Arctiinae; 19,214 individuals, total) to assess the following hypotheses: 1) body size increases with decreasing ambient temperature (a Bergmann pattern), as predicted by the temperature–size rule (temperature-dependent discordance between growth and reproductive maturation rates); 2) body size increases with increasing rainfall and primary productivity, as predicted from considerations of starvation resistance; and 3) body size scales allometrically with wing area, as elevation increases, such that wing loading (the ratio of body size to wing area) decreases with increasing elevation to compensate for decreasing air density. We analyzed mean forewing length (a proven proxy for body mass) along the elevational gradient within species, among species means, and for assemblage means. Body size consistently increased with elevation in both taxa—for individuals within species, species means, and assemblage means. Temperature was the best predictor for these patterns, whereas body size was poorly correlated with rainfall and enhanced vegetation index. Wing loading increased with elevation, counter to hypothesis. Our results support the temperature–size rule as an important mechanism for body size variation in arthropods along largely a seasonal tropical elevational gradients, whereas starvation resistance and optimization of flight mechanics seem to be of minor importance.

Wednesday, 31 July 2019 | Rubis
GS06 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Unveiling the origins of the endemic avifauna of the Caatinga Dry Forest

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Until quite recently, the Caatinga (the largest nucleus of Seasonally Dry Tropical Forest in the Neotropics) was considered a region with relatively low biodiversity, low levels of endemism, with few species adapted to dry environments, and without a clear biogeographic affinity. Today, we know that the Caatinga represents the most diverse tropical forest in the Neotropics, with high levels of endemism, and a highly adapted fauna. Here, we evaluate whether the current endemic avifauna of the Caatinga likely originated from nearby mesic environments, as has been historically suggested for mammals, or whether they represent lineages well adapted to dry environments and a long history of adaptation. To reach this goal, we compiled a list of Caatinga endemic avian taxa (33 species and 18 subspecies) and used phylogenies to perform ancestral area reconstructions to evaluate potential mesic or xeric origins of each avian endemic. We divided South America in seven different biomes and included each endemic taxon and its closest relatives in our analyses. We found that most taxa (34) likely represent lineages from dry environments, and only a third of them represent arrivals from more humid environments. We found that many of the arrivals in the Caatinga predate the Pleistocene and represent old lineages. We elaborate on the timing of these historic arrivals and compare the timing between mesic and xeric lineages. These results represent the first historic look at the avifauna of the Caatinga, and add to the growing body of knowledge suggesting that Neotropical Dry Forests represent important cradles of diversity and key component to better understand the origins of the Neotropical avifauna.

Wednesday, 31 July 2019 | Rubis
GS06 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Prioritizing area using genomic approach for a long term conservation of black lemurs population

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Most threats on lemurs are connected to an increasing degree of habitat loss and fragmentation. Alarmingly, one in four lemur species is currently listed as either *Endangered* or *Critically Endangered* by the Red list. Madagascar is a large country and prioritizing conservation zones remains challenging both logistically and with regard to limited budgets. To approach this question, we have combined state-of-the-art lab-based and applied methods from the fields of conservation genetics and conservation biology. We have conducted a project in the Sambirano Region, northwestern Madagascar, and have identified lemur populations of high conservation value by next generation sequencing techniques on black lemurs or *Eulemur macaco*. The genetic tools provided sound estimates of the remaining genetic diversity, uniqueness, and populations' connectivity. Theoretical models predict long-term population viability given a high genetic diversity, which in turn has helped defining part of its overall conservation value. Four populations of *E. macaco* around the Sambirano Region have been sampled and used for this genomic study. The results show the importance of Ampasindava Peninsula populations. Therefore, this area has been prioritized as a hotspot to develop a highly-focused community-based conservation strategy for sustainable use of natural resources, starting from an environmental education programme in public primary school. For the first phase, we have used locally-based information center to train teachers how to use a particularly scholar kit designed for Ampasindava called *Ma Jôby*. This tool aims to raise awareness on black lemur's conservation and their natural habitat. Impact of the program was measured by analysing pupil's perspectives before and after using the kit for few months.

Wednesday, 31 July 2019 | Rubis
GS06 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Plant diversity and structure of Analandramanavy remaining forest of Soavinandriana District, Itasy Region, Madagascar

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Analandramanavy Forest is the one of the last humid forests remaining in the Soavinandriana District, Itasy Region, central Madagascar. Confronted to different anthropogenic pressures, the forest area decreases continuously. Thus, conservation of this important forest is necessary. A better knowledge of the flora composition, the vegetation and its functioning is therefore essential for sustainable management of this forest--hence, the interest of this study. Using a rapid biological assessment method, we identified 64 plant species from 44 different genera and 35 families. Plant population density is high, 150 to 300 individuals per hectare, as well as basal area and biovolume showing the high wood potential of Analandramanavy Forest. Population structure is stable and has a very high regeneration rate. Nevertheless, the forest is exposed to illegal logging, clearing for the extension of agricultural areas and producing erosion risks. Forest conservation, protection, and restoration activities should be carried out in collaboration with the local population since 2013, within a legal community based structure designed to protect this forest remaining.

Wednesday, 31 July 2019 | Rubis
GS06 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Structure and diversity of a terrestrial vertebrate community in terra firme forests in the Colombian Amazon

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The Amazon is the largest tropical forest in the world, representing a bioregion of high relevance not only because of its biodiversity, but also by the ecosystem services that it provides. Simultaneously, this forest is highly threatened by anthropogenic disturbances mainly related to deforestation. Unfortunately, our knowledge about the diversity and its attributes in the Amazon basin is still limited, with wide gaps in relation to the structure and ecology of biological communities. In this research, the structure and species and functional diversity of a terrestrial vertebrate community associated to terra firme forests in the southernmost part of the Colombian amazon is assessed. Between August 2015 and February 2019, I sampled the terrestrial vertebrate community following a camera trapping design in a 12-km^2 grid. Based on over 6,000 images, approximately 30 terrestrial vertebrate species were detected. Most of the observed species were omnivorous, herbivorous, and carnivorous, dominated by mammals, followed by ground birds, marsupials, and reptiles. Body size of species ranged from small reptiles with a weight of less than 25 g, to large herbivores (i.e., Tapir), with more than 200 kg. Estimated occupancy ranged from 0.02-0.3, with approximately half of the species falling below 0.1. I then explored associations between these attributes and habitat and anthropogenic variables. In general, habitat complexity and heterogeneity promoted higher species and functional diversity. Disturbed sites (e.g., closer to human settlements) had lower species richness, species diversity, functional diversity and abundance, with large body-sized species virtually absent from these sites. Despite the relatively good conservation condition of this forest, my study highlights the strong effect of past and current human disturbance in the integrity of terrestrial community diversity and structure. Implications of these findings, as well as the relevance of long-term studies to achieve more realistic conservation and management goals, are further discussed.

Wednesday, 31 July 2019 | Rubis
GS06 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Tropical forest leaf reflectance can detect Mayan pyramids across the Yucatan Peninsula, Mexico

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Ancient Mayan civilization developed in and eventually returned to tropical forest, meaning their settlements and infrastructure are often obscured by jungle. Traditional ground survey in the Mayan lowlands is hindered by the profuse vegetation and the amount of funding and effort required. Thus, key questions concerning the extent, structure and functioning of Mayan society are still debated. Remote sensing can help answer many of these questions. Light detection and ranging (LiDAR) has revealed thousands of new Mayan structures. Yet their architectural legacy was merely one way in which the Mayans transformed their environment. They also modified local vegetation and soils, affecting the composition and functioning of tropical forests, which is still visible today. Here, we explore the novel archaeological information that plant material growing on Mayan ruins may contain. Vegetation may reveal the presence of Mayan sites by exhibiting slightly different characteristics to the surrounding forest. Vegetation chemistry may indicate areas of nutrient-enriched soil, suggesting the presence of ancient activities such as farming, feasting or waste disposal. We collected 848 leaves from three Mayan archeological sites across the Yucatan Peninsula: Calakmul, Kaxil Kiuic, and Dzibilchaltún. The leaves were collected from trees growing on Mayan structures and from the surrounding forest. Hyperspectral reflectance measurements (400-2500nm) were taken for each leaf. Leaves were then measured for thickness, leaf mass per area and water content. We found that leaves growing on Mayan structures were thicker, denser and drier than those growing in the surrounding landscape. Applying Random Forest classification to the hyperspectral measurements, we were able to distinguish leaves growing on Mayan ruins with 75% accuracy. This methodology has interesting applications for airborne hyperspectral sensors and the new raft of planned hyperspectral satellites: (1) for identifying previously undiscovered Mayan ruins and (2) for quantifying the extent of ancient Mayan environmental impacts (the “Mayacene”) across the landscape.

Wednesday, 31 July 2019 | Rubis
GS06 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Effect of riverine characteristics in structuring the small carnivore communities in the Great Himalayan National Park, India

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Riverine system serves a gradient of habitat quality and plays a crucial role in determining the species demography and long-term survival. Small carnivores have lesser home range sizes and it is likely that any small scale changes in habitat composition may affect their communities at early stage. Therefore, it is important to understand the key features that require attention toward implementing conservation measures. We assessed patterns of distribution of Red Fox, Leopard Cat, and Yellow-throated Marten focusing on the ecological correlates linked to riverine features. We discerned the species-habitat association of these species across space and time. The study was focused on elevation gradient of 1500 m to 4000 m in the Tirthan Valley of the Great Himalayan National Park, Himachal Pradesh. Systematic camera trapping (500 m to 1 km distance) was carried out in occupancy framework across five different blocks in summer and winter during 2017 and 2018, respectively. Relative abundances were estimated based on 1) the proportion of detection sites and 2) the detection rate per 100 trap night. Mann-Whitney U test was performed at α=0.05 to detect statistical significance. Total trap nights of 5280 over vertical gradient reflected site fidelity. Proportion of detection sites of Red Fox was highest between 1500 to 2000 m from river and detection rate was higher towards higher elevation (p-value=0.012). For both Leopard Cat and Yellow-throated Marten, the proportion of detection was maximum between 500 to 1000 m from river. The detection rate for Leopard Cat peaked at middle elevation (p-value=0.028) and Yellow-throated Marten always showed higher detection rates at lower elevation (p value=0.030). All three species showed variation in the intensity of habitat use with preference for specific sites. There is a pattern of community structure in both vertical and horizontal gradients with riverine areas, which can be defined with improved sampling intensity.

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GS06 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS07
TROPICAL DIVERSITY, SOCIOECONMIC, and CULTURAL DIMENSIONS

Conservation efforts surrounding tropical agriculture cause unanticipated land-use changes

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Commercial agriculture is the main driver of global forest and biodiversity loss. While research and policies focus on implementing sustainable, cost-efficient agricultural practices to reduce deforestation rates whilst meeting rising global food demands, they often overlook market responses and indirect impacts on land-use change. As forest loss for agriculture is primarily market-driven, not accounting for these market responses could lead to grossly underestimating the extent of forest and biodiversity impacts. We assessed the potential risk of our conservation efforts being undermined by economic feedbacks and indirect land-use changes. Focusing on palm oil production — the most widely traded vegetable oil and biofuel — in Indonesia — the global epicentre of oil palm expansion — we investigated how perverse market outcomes arise from common conservation interventions and policies through integrating economic theories with land-use models. We developed a novel crop-expansion model that explicitly relates oil palm expansion to prices, production costs and profitability via a land-rent framework. Using this model, we identified areas vulnerable to further oil palm expansion across Indonesia, and showed how palm oil supply and demand change under different land-management and conservation scenarios, and how they impact land use, forests and biodiversity. Furthermore, we showed that although in-situ agricultural intensification can increase palm oil production to meet growing demands, it also increases vulnerability of the spared land to land conversion due to profitability, thus incentivizing further crop expansion into forests. This unintended feedback increases both supply and demand for palm oil, resulting in greater forest and biodiversity loss. Without stringent land-use regulations, sparing land for nature could instead backfire and accelerate further forest loss. It is therefore imperative we account for market-driven responses to our conservation efforts to develop more effective policy interventions.

Wednesday, 31 July 2019 | Saphir
GS07 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Perceptions of wildlife

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The human population is increasing globally which is leading to more frequent incidences of human-wildlife conflict. Human wildlife conflict contributes to declining biodiversity levels both directly, through retaliatory killings, and indirectly, through habitat degradation. Attitudes towards wildlife can predict negative behaviors that threaten biodiversity conservation such as habitat degradation or poaching. Attitudes can be shaped by direct costs, direct benefits, indirect costs, indirect benefits, and/or socio-demographics. For this study, I analyzed the key factors driving attitudes toward local wildlife outside Sabie Game Park in southwestern Mozambique. I developed a logit model to predict either positive or negative perceptions of wildlife based on 15 different variables. The variables included demographics and measurements of direct costs/benefits. The final model had five independent variables (gender, household location, agreement with park rules, restricted access to natural resources, and wildlife benefits) and correctly predicted 71.4% of the cases. Surprisingly, direct costs such as livestock loss, crop damage, and human injury were not significant predictors of attitudes. Households closer to the protected area were much more likely to have negative attitudes towards local wildlife than households farther away. Knowledge of the significant predictors of wildlife attitudes can guide local conservation initiatives and ultimately improve biodiversity conservation within the area. For example, increasing benefits from wildlife may be more beneficial that decreasing livestock/crop loss. Also, establishing a buffer zone around the park may minimize negative encounters and improve the relationship between the communities and the wildlife.

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GS07 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Using local actors' perceptions to evaluate a conservation tool: The case of the Mexican compensation scheme for depredation in Calakmul

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Biodiversity conflicts arise because people have different points of view on how to manage biodiversity. The nature of biodiversity conflicts is therefore social. As a corollary, conservation tools such as compensation schemes, developed to counteract losses of crops or livestock by wildlife of conservation concern, should be assessed from a social perspective. Here, we assess a compensation scheme implemented to support jaguar conservation in Mexico, focusing on the perceptions of local actors as the main determinant of their acceptance and attitudes towards it. We carried out 165 semi-structured interviews to obtain livestock breeders' perceptions of both depredation and the scheme. We developed criteria to cover every aspect of the scheme (accessibility, relationships, efficiency, transparency), which we measured through 5-point Likert items. Among those individuals who had yet to claim compensation, responses regarding the reputation of the scheme were mixed, where their experience of depredation was negatively associated with their evaluation. More individuals who had used the scheme rated it positively, and those who felt more trust in the scheme's staff rated the scheme more positively. Last, ranchers were more likely to be satisfied with the application process if they found it easier to contact the scheme's staff, while their satisfaction with the results was related to their trust in the staff. A deeper understanding of local actors' perceptions allowed us to uncover criteria that they used to shape their evaluations that cannot be found in biological or economic assessments. Our assessment, based on social data, points out to relationships between actors involved in a biodiversity conflict as key determinants of how users see the compensation scheme. Such an assessment has the capability of delivering answers on how to improve compensation tools.

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GS07 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Strategic plan for tourism development, a tool for biodiversity conservation

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In an underdeveloped country like Madagascar, the regulations exist but not respected. There is no rule of law on every level, the top down phenomenon impact the management of natural resources; burned or killed. The objective of the research is to promote the sustainable tourism as a tool for biodiversity conservation through strategic plan for tourism development. One of the way to reach this goal is to implement a regional and then local strategic plan for tourism development by organizing a survey for the 4 Districts in the Alaotra Mangoro Region. Results of the surveys and local interviews have shown the natural and socio economic characteristics have a link to environment protection. It is essential to analyse how the culture, the migration history, the main activity around the area impact the use of natural resources. Tourism brings economic growth. For example, in the National Park of Andasibe there are more than 35000 visitors per year; one tourist provides at least 4 local jobs. The question is to know if the current system management in tourism impact the local community. The access also limits tourism development. We have started creating a land reserve for tourism with the community in Antsirika and Zahamena Park and the changes are perceptible. The process starts with community consultation and explanation on the advantages of a protected area, like water supply and the energy regulatory, and the community based tourism. All the stakeholders must be aware of environmental accountability and responsibility. Identifying the barriers and reach the minority or marginalized group especially training women are hugely important. The role of the State by creating investment opportunity and arranging the opportunity for every actor is lacking in every level. In sum, the sustainable and new way to address environmental issues is promoting community based tourism activities and the establishment of the strategic plan for tourism development.

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GS07 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

A novel experimental game reveals the importance of performance-based payments and social equity in conservation conflict interventions

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As conservation conflicts become increasingly complex and multifaceted, predicting the effects of different mitigation strategies is critical. We developed a novel experimental game around farmer land use decisions in Gabon to examine behavioural responses to three elephant conflict mitigation options: support for deterrents, flat rate subsidy, and agglomeration payments. We found that all three policies significantly reduced participants' inclinations to engage in lethal control; however, the support for deterrent and agglomeration payments were more likely to succeed where levels of social equity were higher. Only the two economic incentives increased farmers' predisposition to provide habitats for elephants, suggesting that performance-based payments were conducive to pro-conservation behaviour. Unexpectedly, different subsidy levels did not affect responses. Likewise, neither participants' socio-economic characteristics nor their real-life experiences of crop damage by elephants affected game decisions. Killing behaviour was 64% lower in villages influenced by protected areas than in villages surrounded by logging concessions, highlighting the need to address conservation conflicts beyond protected areas. Our study shows the importance of addressing underlying social conflicts, specifically equity attitudes, prior to, or alongside addressing material losses.

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GS07 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Illegal wildlife trade assisted by overseas tourism in Southeast Asia

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Global illegal wildlife trade with a focus on ivory, rhino horn, and pangolin poses great threats to tropical biodiversity. After China's domestic ivory ban, prosperous tourism in Southeast Asia fulfills partial demand. This study aims to fill the information gap of wildlife trade assisted by tourism in Southeast Asia and provide policy suggestions to mitigate illegal trade. Pilot market investigations were conducted in five tourism hotspot cities in China, Myanmar, and Laos in June and August 2018. Methods of information collection in this study included investigative observations, semi-structured interviews with multiple stakeholders (tourism agencies, tour guides, tourists/buyers, delivery companies' owners, and employees, illegal dealers, customs officials, and NGOs), and direct participation in a tourist group. The preliminary results showed that most supply chains start from African countries through Vietnam harbor, then transit to Myanmar and Laos to Chinese tourists. The daily trade volume from tourists varied, however, about 80% lower than daily online sales on average. Even though some customers did not buy any products in the physical markets, they initiated the purchases online when they returned to China. Three distinct levels of ivory prices were identified from different types of outlets and dealers, varying from 2 to 15 US dollars per gram. Tourists led by tour guides were charged higher than individual travelers, and they purchased wildlife products for gifts, self-use, and medicinal use. Commissions for tour guides were up to 50% of the purchases, while tourism companies usually were unaware of the deals of their guides. Tourists were able to bring illegal wildlife products back to China due to the lack of effective customs inspections. Both local and Chinese package delivery companies facilitated transboundary transportation in serving of online orders. Policy suggestions stress responsibilities of tourism companies, customs, delivery companies, and tourists to mitigate illegal trade.

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GS07 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Contribution of trees on farms to bird conservation in Peru

FERNANDO ANGULO

CORBIDI

Trees on farms is a common practice in agriculture in Peru. They are arranged in lines and are used basically to separate agricultural plots. Also, some areas are covered with original remnant vegetation. There is currently no calculations on the percentage of trees that are part of agricultural land in the country. Trees on farms provide a wide range of valuable products and/or services to local farmers, such as delimitation of properties, fruits, and seeds both for people and livestock, fire wood, timber for construction and fences, food for livestock, shade for people and livestock, and many more. Besides the benefits to people, trees on farms contribute to the biodiversity, both conserving the existing and maintaining connectivity between otherwise isolated sites. Birds are a very good element to study, and to prove such benefits to biodiversity, since they are easy to detect, identify, and relatively well known. Trees on farms provide habitat, food, nesting site, roosting, and other "services" for several species. Also, they serve as corridors between forest (or other habitats) patches. I will analyze the particular case of the contribution of trees on farms in the conservation of avifauna in Peru and discuss how this contribution can be improved.

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GS07 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

GS08
TROPICAL BIODIVERSITY and GLOBAL CHANGES

Increase in functional diversity in drier climate conditions can buffer reduction in Amazon forest carbon stock

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The uncertainties on the effects of climate change on functional diversity and its consequences for ecosystem processes (e.g. carbon stock) are especially important in hyperdiverse ecosystems such as Amazon forest. This study aimed to understand how a decrease of 50% in precipitation affects the functional diversity of Amazon forest and how it influences its capacity to store carbon. For this, we have used two versions of the same trait-based model (CAETÊ – Carbon and Ecosystem Functional Trait Evaluation model). The low diversity version (LD) characterized the vegetation through 5 plant functional types with values for functional traits fix in space and time. The high diversity version (HD) allows the values for functional traits to be variant and simulates thousands of different ecological life strategies that differ in terms of the values for functional traits. Six functional traits were used: allocation and residence time of carbon in three plant compartments (leaves, aboveground woody tissues and fine roots). The HD version avoided a loss of 1.6 Pg of carbon when compared to the LD version. This was possible because HD allows a change in community composition: we observed a decrease in dominance what enable new combinations of traits to compose the community, leading to an increase in functional diversity both when analyzing traits separately and in a multi-trait analysis. These new strategies presented more carbon allocation and increased residence time in fine roots resulting in a biomass increase in this compartment which allowed a higher absorption of water. This study shows the importance of incorporating the diversity of trait values in vegetation models when researching for the effects of climate change in terrestrial ecosystems. It also suggests that drier conditions can change functional diversity in Amazon forest that can act as a buffer to the effects of climate change.

Wednesday, 31 July 2019 | Zircon
GS08 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Wild edible plants in Vohibe Forest, Ambalabe community, Madagascar

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Madagascar is widely recognized for its tremendous richness of biodiversity with high levels of endemism. It is considered as a cradle of marvelous nature due to its different bioclimatic zones and substrates which have allowed the development of diverse plant species. Generally rural Malagasy communities are isolated from markets and economic opportunities, making them depending on natural resources for their daily subsistence needs. Unfortunately, the close correlation of increased population pressures and high poverty rate intensify natural resources degradation. In that scope, the objective of our research project was to inventory wild edible plants at the Vohibe Forest in order to establish sustainable uses and ensure conservation of each useful species. Prior to our study, ethnobotanical surveys were conducted among villagers living nearby Vohibe Forest to gather information on the use of plant species and the associated potential threats of their utilization. 34 edible species, grouped into 23 families and 27 genera, were recorded during the study. Also it was found that 70% of the species recorded are used because of their edible fruits. Another significant finding of the same study was the excessive uses of one palm and one *Dioscorea* species rendering their existence in the area threatened. Thus, as part of this research project we plan to establish a sustainable practice and management plan for plant uses at this site to avoid irreversible fate for any useful species, and also to further develop an alternative source of income for the local population.

Wednesday, 31 July 2019 | Zircon
GS08 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Are tropical montane forests at risk of drought? Quantifying the vulnerability and resilience of tree species to changing water availability in the face of climate change

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Tropical montane cloud forests make up only 1.4% of the world's tropical forests, yet they contribute substantially to global biodiversity with large numbers of endemic species. These critically threatened forests benefit many people in developing countries via important ecosystem functions, including cloud-water interception which reduces downstream erosion and flooding, and augmenting the supply of drinking water. Climate change is predicted to cause a rise in the elevation of cloud formation over tropical forests, which has negative implications for the hydrology of cloud forests. These clouds and associated nutrient-rich water are essential to the growth and survival of cloud forest species. As such, it is critical to understand the vulnerability of cloud forest trees to shifting water availability in order to predict how these forests might respond to a changing climate**.** Plant sensitivity to water deficit manifests as a tradeoff between water conservation and growth. For each species, this tradeoff defines its hydraulic strategy. Here we investigated the hydraulic strategies of congeneric pairs of tree species that occupied forests habitually immersed in the clouds versus forests below the cloud base in Monteverde, Costa Rica, by quantifying vulnerability to embolism and stomatal regulation in response to water loss. These measurements allowed us to quantify a hydraulic "safety margin" to evaluate susceptibility to drought. Our results suggest that a diversity of hydraulic strategies leads to a range of safety margins and therefore a range of drought vulnerabilities between congeneric species pairs that occupy divergent habitats. These data will ultimately aid in predicting and managing the fate of these tropical forests in the face of climate change-type droughts.

Wednesday, 31 July 2019 | Zircon
GS08 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Effects of ENSO and tropical cyclones on the flower and seed production in a subtropical rain forest

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Both El Niño–Southern Oscillation (ENSO) and tropical cyclones have great impacts on forest ecosystems. In particular, plant reproduction is highly sensitive to these two external forcings. However, it is unclear how these two external forcings simultaneously shape plant reproduction. Since ENSO may change the intensity and frequency of tropical cyclones as climate changes, it is critical for us to know their joint effects on plant reproduction. We have monitored flower and seed production in a subtropical rain forest, Fushan, Taiwan, since 2002. The weather in Fushan is strongly influenced by tropical cyclones and ENSO. Using wavelet analysis with the 16-yr phenological records (2002–2018) from Fushan, we quantify the effects of ENSO and tropical cyclones on the flower and seed production. We show that the effects of ENSO on plant reproduction depended on the effects of tropical cyclones in Fushan. During the El Niño events, temperature and irradiance increased and, thus, enhanced flower and seed production without intense tropical cyclones influence. In years with intense passing tropical cyclones, their strong negative effects on plant reproduction would cancel the positive effects of ENSO. Our findings reveal the complex influences of external forcings on plant reproduction, and highlight the importance of long-term ecological studies.

Wednesday, 31 July 2019 | Zircon
GS08 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Climate and soil drive tree demographic rates in the tropical rainforests of Australia – A combined approach at the crossroads of population and functional ecology

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Plant functional traits (FT) allow understanding how tree communities change along environmental gradients, a topical matter in a context of rapid climate change. FTs–environment interactions have mostly been studied through averaged traits weighted by community composition (CWM). Although having yielded key advances in plant ecology, CWM used alone have recently raised concerns, notably as the adaptive nature of traits is rarely empirically tested on the components of fitness, that is, demographic rates (growth, survival, recruitment). The study aims to determine how the interplay of climate, soil, and functional traits impacts tree growth along an elevation/temperature gradient in tropical rainforests. The study encompasses 22 plots of tropical wet forests inventoried for over 40 years and distributed along a broad elevation gradient, in Queensland (Australia). Individual growth rates, key physiological, chemical, and morphological FTs of 81 tree species, and climate, soil, and topography variables were combined to model tree growth as a function of the interaction between the FTs and the environment. The results highlighted that the adaptive value of traits for tree growth was conditional on environmental conditions. For instance, trees with high water use efficiency grow better at higher vapour pressure deficit values. Species with thick leaves and low SLA grow better in drier conditions, while high SLA and thinner leaves yield a better growth in moister environments. In addition, some traits commonly considered as functional showed no effect on growth in the broad range of environmental conditions considered. These results highlight that the adaptive value of different traits directly depends on different environmental conditions. They also illustrate the necessity to explicitly consider the components of fitness together with functional traits along environmental gradients to better understand the way tropical tree communities assemble as well as to achieve better predictions of their response in the face of climate change.

Wednesday, 31 July 2019 | Zircon
GS08 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

The potential effects of climate change and forest loss on the wild yams of Madagascar

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There are 40 native species of yams known from Madagascar and they are all endemic and most are edible. Between harvests of staple crops, yams form a significant part of rural diets in areas with remaining forests. At least a third of yam species are now threatened with extinction and even widespread species are vulnerable from unsustainable harvesting. The Royal Botanic Gardens Kew, working with local partners such as the NGO NyTanintsika and funding from the UK Darwin Initiative, has taught communities in several areas how to cultivate 20 species to improve livelihoods and food security and to take pressure off wild populations. This research has assessed the impact of continuing forest loss and climate change under various scenarios on extinction risk and rural livelihoods. Bayesian species distribution models (SDMs) were built using standard climate datasets and locality records based on verified herbarium specimens and sight observations from the iNaturalist platform, which was used to map populations. Both forest loss and climate under various scenarios were found to have potential impact on the extinction risk of yams and on rural diets and livelihoods. Selecting appropriate species for cultivation may mitigate some of the risk caused by climate change; but our work shows that rural communities can help to protect food security themselves by working with authorities to conserve and restore forests.

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Drier tropical forests may become more functionally, taxonomically, and phylogenetically homogenous than wetter forests after a long term drought

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Tropical forests are experiencing exceptional changes in biodiversity levels and reshuffling of their species composition at local and global scales, with climatic changes being hypothesized as a main driver of such changes. Along a climatic gradient in western Africa it has been shown that a drying trend in the region may have caused changes in forest traits and species composition and leaf phenology. This makes it especially interesting to disentangle if and how such forest is shifting their functional, taxonomic and phylogenetic facets. Here, we aim at disentangling if and to what extent different tropical forests along a climatic and soil gradient and over the last three decades have responded to a changing environment by means of shifts in their functional, taxonomic and phylogenetic diversity. We make use of 21 vegetation census plots from Ghana distributed from wet to semi-dry forest. We calculated their changes in functional taxonomic and phylogenetic diversity across two time periods (~1980 and ~2013) and analyzed such changes as a function of their climatic water deficit and soil characteristics. Functional diversity has slightly increased across time, most likely associated to shifts in the hydraulic, leaf, and phenological traits spectrum, and increased towards wetter forests along the climatic gradient. Taxonomic diversity showed a slight increase across time but with decreases in drier locations and increases towards wetter areas. The phylogenetic diversity showed large average decreases across time and along the climatic gradient. We show that forests at the wettest end of the climatic water deficit gradient tended to increase in the three diversity facets, or at least showed the smallest decreases. Drier forests communities that have experienced stronger decreases in water availability over the past decades have gone through a functional, taxonomic and phylogenetic homogenization which may lead to changes in the ecosystem functioning.

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GS09
THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Adaptation to aridity may buffer Endangered zebra from parasite exposure risk in new habitat

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The endangered Grevy's Zebra (*Equus grevyi*) has shifted its distribution dramatically over the past few decades from arid and semi-arid habitat to wetter savannah and savannah-woodland. This has brought Grevy's Zebras into greater range overlap with a more mesic-adapted cousin, the Plains Zebra (also known as the Common Zebra, *Equus quagga burchellii*), and raises concerns over habitat suitability and increased disease transmission. One potential threat is greater exposure to gastrointestinal nematodes, parasites that can cause reduced fitness and death in equids and that spread easily in wet areas with high dung density. We established that transmission can occur between plains and Grevy's Zebras using DNA metabarcoding techniques on >500 dung samples, determining that they harbour the same nematode species. Next, we investigated how exposure may contribute to transmission dynamics by comparing exposure risk between Grevy's Zebras in mesic and semi-arid sites and between Plains and Grevy's Zebras. We quantified nematode egg shedding using the McMaster technique on our dung samples, compared dung density at 132 grazing sites, ran 17 long-range dung transects to determine dung distribution, and conducted regular censuses over several years to track zebra movement. Grevy's Zebras neither grazed in areas with higher dung density nor shed more eggs in mesic habitats than within their native range. Compared to plains zebras, they were less likely to be super shedders, possibly because they are arid-adapted and roamed and grazed farther from water, where there was lower dung density and lower exposure risk. These ranging differences between the zebra species appeared to generate some segregation of their grazing sites. Our results suggest that spatial niche differentiation mediated by differences in water dependence between the two zebras may buffer the Grevy's Zebra from higher parasite exposure risk in wetter habitats even in the presence of abundant plains zebra populations.

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Spatial and temporal dynamics of a parasite and hyperparasite interaction on coffee

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Coffee leaf rust caused by *Hemileia vastatrix* is one of the major challenges for coffee production all over the world. In some areas the rust can be attacked by a hyperparasite *Lecanicillium lecanii* that grow on top of the rust and kills it. Both the rust and the hyperparasite occur in southwestern Ethiopia where coffee originates but knowledge is lacking regarding the dynamics and potential antagonistic effect of the hyperparasite. Here, we studied the spatial and temporal dynamics of the rust and the hyperparasite at 60 sites selected along a gradient of coffee management in southwestern Ethiopia that range from unmanaged coffee growing under dense natural forest canopies to intensively managed coffee in plantations. The rust was found in all sites but was more severe at low altitudes and in the dry season. The hyperparasite on the other hand displayed the opposite pattern with a higher proportion of the rust infected leafs having the hyperparasite at high altitudes and during the wet season. Two possible explanations are: 1) that the two species have different abiotic requirements for growth or 2) that the hyperparasite is capable of reducing the rust infections during wetter parts of the seasons and in wetter climatic conditions. Our findings suggest that it could be worth to manipulate the management of coffee systems in ways that enhance the hyperparasite prevalence.

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Patterns and drivers of a fungal disease community on Arabica coffee: From native forest to intensively managed plantations

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Arabica coffee originated in the Ethiopian highlands, and currently provides a livelihood for millions of poor smallholder farmers. Both globally and regionally, Arabica coffee is threatened by many plant diseases. However, most studies of plant diseases focus on single diseases in either a natural or an agricultural system, and we lack insights into the dynamics and environmental drivers of multiple diseases co-occurring on a single host plant, and how management affects these dynamics. The gradient we studied ranged from largely unmanaged coffee under natural forest canopies to intensively managed coffee in plantations in the area of origin of Arabica coffee in southwestern Ethiopia. We found that the environmental and management factors related to disease incidence and severity differed strongly among the four fungal diseases. Coffee leaf rust (*Hemileia vastatrix*) and *Armillaria* root rot were more common in highly managed sites, whereas the opposite was true for coffee berry disease (*Colletotrichum kahawae*) and coffee wilt disease (*Gibberella xylarioides*). Coffee leaf rust was more common and severe at low altitude sites, while the other three diseases were more common at high altitudes, due to differential responses to climate. At site level, incidence and severity of the four fungal diseases poorly correlated with each other. Within sites, however, shrubs that were heavily attacked by coffee leaf rust had high levels of coffee berry disease infection. Based on these findings, we provide insights in the management of multiple diseases in complex agro-ecological systems.

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Babesial infection in the Malagasy flying fox, *Pteropus rufus* E. Geoffroy, 1803

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Babesiae are erythrocytic protozoans, which infect the red blood cells of vertebrate hosts to cause disease. Previous studies have described potentially pathogenic infections of *Babesia vesperuginis* in insectivorous bats in Europe, the Americas and Asia. To date, no babesial infections have been documented in the bats of Madagascar, or in any frugivorous bat species worldwide. We used standard microscopy and conventional PCR to identify babesiae in blood from the endemic Malagasy flying fox (*Pteropus rufus*). Out of 203 *P. rufus* individuals captured between November 2013 and January 2016 and screened for erythrocytic parasites, nine adult males (4.43%) were infected with babesiae. Phylogenetic analysis of sequences obtained from positive samples indicates that they cluster in the *Babesia microti* clade, which typically infect felids, rodents, primates, and canids, but are distinct from *B. vesperuginis* previously described in bats. Statistical analysis of ecological trends in the data suggests that infections were most commonly observed in the rainy season and in older-age individuals. No pathological effects of infection on the host were documented; age-prevalence patterns indicated susceptible-infectious (SI) transmission dynamics characteristic of a non-immunizing persistent infection. To our knowledge, this study is the first report of any erythrocytic protozoan infecting Malagasy fruit bats and the first record of a babesial infection in a pteropodid fruit bat globally. Given the extent to which fruit bats have been implicated as reservoirs for emerging human pathogens, any new record of their parasite repertoire and transmission dynamics offers notable insights into our understanding of the ecology of emerging pathogens.

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Distribution of stem gall disease in *Rhizophora mangle* as determined by citizen science efforts in Tampa Bay, Florida

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The Red Mangrove (*Rhizophora mangle*) is susceptible to infection by several agents that cause galls in woody tissues. In Florida, such abnormal growth in this species has been attributed to the presence of the endophytic fungus *Cylindrocarpon didymium*. Although present in Florida for at least five decades, the disease is apparently limited to the southern portion of the state (Tampa Bay and Mosquito Lagoon the northern limits on the west and east coasts, respectively) with low temperature suggested as the limiting factor for further northern expansion. Within the Tampa Bay estuary, some mangrove forested areas are entirely free of galls while others are completely riddled with the disease; a cursory survey revealed that the occurrence of the disease does not follow a simple latitudinal gradient within this system. In order to gain greater insight into the factors that affect the distribution of stem galls in the mangroves of Tampa Bay, we employed the assistance of citizen scientists using the Epicollect 5 application on their cell phones to document the location and density of gall infected mangroves by means of geolocated photographs and guided data entry forms. Low intensity sampling was applied to establish the system-wide distribution, while intensive effort was exerted to identify patterns within subordinate embayments within Tampa Bay. Analysis of historical aerial photographs, historical vegetation surveys, forestry measures, digital elevation models, and water quality data indicate that forest age, elevation, tree density, and anthropogenic disturbance may play a role in the spread of mangrove stem galls in Tampa Bay.

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What are the environmental factors on seedling distribution and survival at Mo Singto Forest Dynamics Plot, Thailand?

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The Mo Singto Forest Dynamics Plot, Khao Yai National Park, Thailand, has been established in 1996. The 4th tree census was completed in 2017. The data analysis of tree size distribution showed that some species have a deficit of young trees and some species are increasing on the number of population. The survival of young seedlings is critical for creating and maintaining species diversity. We tried to find out what are the environmental factors on seedling distribution and survival with the objectives; (1) identify the environmental variables that best predict the distribution of seedlings of all common tree species; (2) measure photosynthetically active radiation (PAR) within Mo Singto FDP; and (3) identify variables that influence or limit seedling survival, by carrying out transplant and enclosure experiments on the plot. The analysis with some environmental factors showed that only elevation of the plot had correlation with seedling abundance ($p < 0.05$) in many species and some species correlated with slope. Light transmittance as another variable was measured with a new software and application on a mobile phone. Most of percent light transmittance was below 6% except in gap area of primary forest. To test seedling survival, 15 species were selected for transplant experiments. Three individuals of each species were transplanted in each cage which was set up in 18 random quadrats. The seedling survival decreased gradually within two months in all habitats. Also, each species showed the different survival, which some species might be sensitive for some environmental factors such as seedling predators, soil moisture, etc. Later multivariate analysis should be used for these dataset including other biological factors.

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GS09 – THREATS, PRESSUES, and SUSTAINABLE DEVELOPMENT

Impact of habitat fragmentation on plant-frugivore interactions in lowland tropical forests of northeast India

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Most tropical forests globally face deleterious effects of forest fragmentation. However, fragments might still hold a great potential to preserve native biodiversity. In the past century, habitat conversion to tea plantations and agriculture, logging and oil extraction have resulted in the fragmentation of the last remaining lowland tropical forests in northeast India. There is paucity of information from Asia on how seed dispersal by frugivores is affected by fragmentation. In this ongoing study (to be completed in June 2019), we investigate the changes in plant-seed disperser networks due to habitat fragmentation. We are documenting plant-frugivore interactions using a network of trails in four fragments varying in size from 2-24 km^2 and comparing them with two contiguous forest sites. Spot censuses consisting of instantaneous and focal scans of frugivores are being carried out to record interactions on fruiting trees, shrubs, and climbers. We aim to use weighted bipartite networks to compare network properties across fragmented and contiguous forests and use the linear modelling framework to understand the influence of fragmentation, fruit crop size, and fruit and seed size on seed disperser diversity. Preliminary analysis indicates higher diversity of interactions in contiguous forests compared to fragments. Initial trends show *Ficus* spp. have a disproportionate contribution to the interactions recorded in the fragments, while *Rubus* contributed to the greatest number of interactions in the contiguous forests. Trees with short fruiting periods made significant contribution to the total interactions during their fruiting tenure. Barbets and bulbuls constituted most interactions in all sites. *Ficus* spp. constitute an important resource during lean fruiting season in the contiguous area, while they may be important year-round in the fragments, due to scarcity of other fruiting trees. Generalist frugivores, like barbets and bulbuls, play an important role in maintaining functional diversity in a fragmented landscape.

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GS10
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

The importance of searching for lost plant species for biodiversity conservation in Madagascar

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According to Global Wildlife Conservation, lost plant species are plants that have gone unrecorded for years or decades and may be considered as lost. Lost species may therefore be considered as presumably extinct species. New records of their existence in the field will allow to change their status. There can be many causes to the lack of records: 1) the species natural habitat has been degraded or has been completely transformed; 2) the habitat is intact but the species is reduced in size and has not been collected again during posterior collects; 3) there has not been any inventory conducted after the last collection. In this study, we inventoried the species that have not been collected since 1967, taking into consideration rare species that are only known from the type specimen or from one locality since these species are the most threatened with extinction. We mapped their distribution using the Tropicos Madagascar Vascular Plants Catalogue database. By overlaying the distribution map with those of the Madagascar protected areas system and the Madagascar vegetation atlas, we were able to assess the possible status with regards to extinction of the targeted species. The species that occur inside protected areas or in undisturbed area outside protected areas might be rediscovered. By using the maps of the history of deforestation between 2003 and 2016, we were able to identify the species that have possibly gone extinct when their distribution matched with degraded ecosystems or even cultivation fields. We censused 1740 SPE of which 413 are rare. This study allowed us to identify the sites to be investigated in priority for the future inventories.

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GS10 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Habitat disturbance affects gut microbiota communities differently in wild arboreal and ground-feeding tropical primates

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Human exploitation and destruction of natural ecosystems cause extinction of wild animal species on a global scale, and loss of gut 'micro-biodiversity' (bacterial and fungal communities) essential for individual nutrition and health is not excluded. While previous investigations have revealed lower gut bacterial diversity in populations living in fragmented compared to intact habitats, no data are available about the other relevant gut component: the fungi (mycobiota). Given their phylogenetic affinity to humans, their conservation status and importance to tropical ecosystems, wild non-human primates make excellent models to investigate the effect of human disturbance on this micro-biodiversity. Thus, to establish whether gut bacterial and fungal communities interact and are affected by diet and/or human disturbance we measured the diversity and composition of gut bacterial and fungal communities in two wild primate species with diverse diets living in human-modified habitats compared to pristine forests within the Udzungwa Mountains of Tanzania. We analysed non-invasively collected samples of 12 groups of *Procolobus gordonorum* (N = 89), the Udzungwa Red Colobus, endemic and endangered arboreal primates (mainly folivorous), and five groups of *Papio cynocephalus* (N = 69), the Yellow Baboon of least concern (omnivorous and ground-feeding), using metataxonomic sequencing of the partial 16S rRNA gene and ITS1-ITS2. Despite large intraspecific variability, this study revealed gut bacterial diversities are associated with habitat in both Yellow Baboons and Udzungwa Red Colobus, supporting their usage as sensitive biomarkers of habitat integrity. The details of these associations depend on host physiology and dietary habits. Moreover, gut mycobiota show distinctive traits across hosts and habitat type, resembling patterns found in gut bacterial communities and highlighting the importance of investigating this relatively unexplored gut component.

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GS10 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Ecology and conservation of the Bengal Slow Loris (*Nycticebus bengalensis*) and other nocturnal mammals in an agroforestry-forest mosaic in northeastern Bangladesh

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Tropical forests are disappearing rapidly throughout the world due to anthropogenic factors. Most forests in South Asia are already highly fragmented posing major threats to biodiversity. Tropical forests harbor complex communities that are linked through biotic relationships. In Asian forests in particular, loss of apex predators due to habitat loss could result in mesopredator release. We studied a small forest patch in northeastern Bangladesh, Satchari National Park, to determine density and diversity of nocturnal mammals and evaluate their relationships. Transects were walked from February 2015 to July 2016 and density was estimated using distance sampling methods. Several species of nocturnal mammals were recorded with relatively high density estimates for some species. Nine species of mammals (five arboreal and four ground-dwelling) were encountered. Densities of the Bengal slow loris, *Nycticebus bengalensis*, and common palm civets, *Paradoxurus hermaphrodites*, were the highest (18.01 ± 0.99 SE and 20.13 ± 1.55 SE individuals/km2). Density of small Indian civets, large Indian civets and Indian mongoose were lower (2.67 - 11.95 individuals/km2). Slow loris and masked palm civets, *Paguma larvata*, were significantly associated suggesting biotic interactions. We suggest that higher densities of some species indicate mesopredator release, although further studies covering more forested areas are needed to better understand this process. Conservation in Bangladesh remains a challenge due to high human population density. Unexpectedly, a wide range of nocturnal mammals co-existed in this forest patch, in spite of fragmentation and severe disturbance. Thus, strict conservation measures are needed to permit the long-term survival of these species.

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GS10 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

The effect of landscape variables and human disturbance on the recovery of tiger prey in western Thailand

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Tigers are facing extinction partly due to prey depletion. Monitoring the status of tiger prey and understanding their habitat requirements are thus important for tiger conservation. We used camera traps to monitor four main ungulate prey species of tigers (muntjac, wild pig, sambar, and guar) in two National Parks in Thailand, from 2012 to 2016. Our study examined the effects of four ecological features (distance to stream, distance to saltlick, normalized difference vegetation index (NDVI), and elevation), and human disturbance (distance to village) on occupancy and population trends (colonization of new sites) of these ungulates using multi-season occupancy models.Our results, show that ungulate occupancy was associated with distance to saltlick (muntjac), distance to stream (muntjac), low NDVI (sambar), and distance to village (wild pig and sambar). Gaur occupancy was related to saltlicks and disturbance. Muntjac and wild pig occupancy increased 8.1 and 26.4%, respectively, between 2012 and 2016. Muntjac increase was related to proximity to streams. Pig increase was not associated with any variables: pigs colonized new sites without respect to ecological features of the landscape or distance to humans. Occupancy rates of sambar and gaur were low in year one (0.215, 0.174) and remained so through time, with no apparent trend. The main variables influencing the spatial distribution and recovery of four tiger prey species were saltlicks, presence of grasslands (low NDVI), availability of streams, and distance to villages. Therefore, three major approaches recommended for securing and supporting prey population and their habitat are: 1) create artificial saltlicks throughout the area, 2) create grasslands to increase food supply for ungulatesand 3) monitor the effects of human activities on wildlife populations and habitats. Moreover, increasing anti-poaching efforts together with community engagement are also significant steps to ensure the long term on conserving tiger and their prey.

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GS10 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Ants from Caatinga dry forest: Biogeography, ecology, and conservation

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Despite the outstanding diversity and ecological relevance of ants in most terrestrial ecosystems, current knowledge of ants from Caatinga – a Neotropical seasonally dry tropical forest – is still incipient. This presentation offers an overview covering diversity, taxonomy, biogeography, and functional composition of the Caatinga ant fauna, and a synthesis on ant response to chronic anthropogenic disturbance and increased aridity, the most supported prediction of climate change for Caatinga region. We compiled a database consisting of 572 presence-absence ant records and 276 ant species from 37 localities in the Caatinga region. As expected, most of Caatinga region has not been intensively sampled for ants, with the intensive sampling conducted revealing high rates of species turnover across localities. Most ant species recorded in Caatinga are widely distributed in other biomes, especially in Cerrado savanna, and few species can be considered as endemic to Caatinga. Thus, the Caatinga ant fauna appears to represent an impoverished subset of the Cerrado's fauna. Such a reduced endemism and the occurrence of a highly depauperate ant fauna at regional level contrast to the diversity patterns exhibited by the Caatinga flora and other faunal groups. Significant changes in ant taxonomic and functional composition in response to human disturbance are observed, with a predictable winner-loser replacement. Disturbance winners consist of generalist species exhibiting wide environmental tolerances and those inhabiting open habitats (opportunists and dominant Dolichoderinae). Highly specialised species are disturbance losers (specialist predators). Aridity also affects both species occurrence and functional-group composition of local assemblages. Like disturbance, increasing aridity is likely to favor generalists over specialists. Since several ant species and functional-groups are sensitive to increasing disturbance and aridity, ant-mediated ecological services are already threatened in the Caatinga biota.

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GS10 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Hill fire impacts on ant abundance and implications for Chinese Pangolin habitat suitability

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The Critically Endangered Chinese Pangolin, rare and elusive throughout its distribution, have habitat requirements that remain poorly understood. Previous observations have proposed that there is a possible increased presence of pangolins at sites of recent burns. While this might be due to positive impacts of fire on ant abundance and food resources for pangolins, the impact of fire on ant communities globally are complex and inconsistent. Within sites of potential Chinese Pangolin habitat, we studied seven paired burned and unburned transects across Hong Kong and used pit fall traps to estimate ant abundance and the effects of hill fire. We found that ant abundance was higher (by ~10 ants per pitfall trap) in unburned transects. Our findings suggest that hill fire in Hong Kong does not increase the surface activity of ants and implies that increased nutritional access may not cause increased preference for burned sites (if there is indeed a preference). Further studies into the habitat links and trophic dependencies upon which Chinese Pangolin rely will be key for successful on-the-ground conservation interventions.

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GS10 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Conservation status of the genus *Aloe* in Madagascar

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Madagascar currently has 163 taxa of *Aloe*, all endemic, and 132 species with only one that is not endemic: *A. massawana* from Tanzania. The Malagasy aloes represent almost a quarter of the total aloes in the world. However, apart from a dozen species, the balance of species have very limited distribution, including some with a distributional area of less than 4 km^2 - *A. descoingsii*, *A. rauhii*, *A. castillionae* and *A. guillaumetii*. Because of its rarity and its beauty, Malagasy aloes are very prized by horticulturists. In Madagascar aloes represent 5% of the total exportation of ornamental succulent plants. As a result, species are threatened by illicit collecting of living plants in their natural habitat. Currently, only two species are in the Red List of threatened species (*Aloe helenae* and *A. suzannae*) yet study of preliminary conservation status of the Malagasy aloes revealed that three species are Extinct in the Wild, 39% are Threatened, 49.6% are Data Deficient, and only 4.3% are Least Concern. In 2018, a full conservation assessment of the aloes of Madagascar was done. Data from different herbaria and electronic sources were gathered and compiled into Brahms for the analysis for this study. Visits of many herbaria (K, PRE, TAN) were completed to update identification information. As a result, 73% of *Aloe* species are Threatened, 2% are Near Threatened, 18% are Least Concern, and only 7% are Data Deficient.

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GS10 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS11
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Genetic structuring of aphyllous *Vanilla* species from the southwest Indian Ocean region

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Aphyllous *Vanilla* species (Orchidaceae) are adapted to xeric ecological conditions. They have appeared independently at least three times during the evolution of the genus in Africa, Asia, and America. There are 19 aphyllous species in the world, seven of which are indigenous to the southwest Indian Ocean (SWIO) region, but their morphological recognition is very delicate as these seven species belong to a recent monophyletic group. In order to assess the degree of their differentiation, we determined the genetic structuring of these SWIO species using seven microsatellites loci which are highly variable markers. We conducted Bayesian clustering analyses without a priori taxonomic affiliations on a large number of accessions. The results indicate that the SWIO species are divided into two major genetic groups, corresponding to species with white flowers and others with yellow flowers. In the white flowers species group, five genetic subgroups are revealed. Four of the genetic subgroups are determined in Madagascar (for three described species) apparently correlated with geographical distribution and ecological conditions. The presence of hybrid individuals between different genetic groups is also suspected in some parts of Madagascar. The two species described as endemic to Seychelles and the coastal region of southeast Africa form the remaining genetic subgroup. Four genetic subgroups are shown for aphyllous species with yellow flowers, in agreement with the geographical distribution of the concerned islands (Mayotte, Grande Comore, Anjouan/Mohéli, Madagascar) whereas only two species have been described (Madagascar, Comoros). These results confirm the taxonomic complexity of this clade of SWIO aphyllous species, which can be considered as a species complex. To further resolve this taxonomic puzzle, an ecological and molecular integrated approach is now being pursued, combining an increased systematic sampling of the whole SWIO (particularly in Madagascar), with a fine identification of the morphological distinctions between genetic groups.

Thursday, 1 August 2019 | Opale
GS11 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Evolution of digestive symbiotic systems in termites in the light of termite transcriptome phylogeny

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Termites have enormous impact on tropical terrestrial ecosystems across the globe, where they are the most important macroscopic decomposers of organic matter. All termites are associated with bacteria, archaea, and lignocellulolytic protists that participate to wood digestion. Higher termites (Termitidae) are one exception, as they lost their gut protists, and include two lineages that evolved new associations with external symbionts: the Macrotermitinae, which cultivate fungal combs, and the Sphaerotermitinae, which build bacterial combs. These changes in digestive symbiotic communities allowed Termitidae to diversify their diet, with species feeding on microepiphytes, humus and soil, and to become the most diverse group of modern termites, comprising over 2,000 species or 70% of described termite diversity. To understand the key evolutionary transitions that shaped modern termites, including their coevolution with digestive symbionts, we reconstructed robust phylogenetic trees using genomes and transcriptomes of 68 termite species and seven dictyopteran outgroups representing the main termite lineages and ecological niches. Our timetree estimated the age of modern termites at 149.3 million years ago, and the age of crown Termitidae at 52.6 million years ago. The branching of our trees largely agrees with previous phylogenies inferred from mitochondrial sequences, with one notable exception for the sister relationships between the comb-building Sphaerotermitinae and Macrotermitinae. This key finding indicates that comb building is a derived trait within Termitidae, and that the creation of an 'external rumen' involving bacteria or fungi may not have driven the loss of protozoa from ancestral termitids, as previously hypothesized. Instead, the colonization of termite guts by novel prokaryotic symbionts, combined with dietary shifts from wood to other plant-based substrates, may have played a more important role in this symbiotic transition. Our phylogenetic tree provides a foundation for uncovering how termites raised to the position of ecological engineers through coevolution with microbial symbionts.

Thursday, 1 August 2019 | Opale
GS11 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Catch me if you can: Species interactions and moon illumination effects on mammals of tropical forest of Manas National Park, India

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Species interaction plays a vital role in structuring communities by stimulating behavioral responses in temporal niche, thereby affecting the sympatric associations and prey-predator relationships. We determined encounter rates (ER) and activity periods of each species to understand temporal overlaps between sympatric species and moonlight influence on nocturnal activity on mammals through camera-traps in tropical forest of Manas National Park, in the state of Assam, India. Camera traps (n = 241) in a 1 × 1 grid were deployed from April 2017 to May 2018. The species-wise ER was calculated as the summed-up detections from all camera-traps, divided by the total number of trap nights and then multiplied by 100. Activity periods were classified as diurnal, nocturnal, crepuscular, and cathemeral. Activity patterns and temporal overlaps were determined using kernel density estimation. Moon phases were classified as new, waxing, full & waning. A total of 35 species were photo-captured with 16,214 independent records. We obtained 657 photographs of five large & medium sized carnivores and 764 photographs of 12 small carnivores. Small carnivores were either strictly nocturnal (*Prionailurus bengalensis* & Viverridae spp.) or diurnal (*Martes flavigula* and Herpestidae spp.). Large carnivores (*Panthera tigris*, *P. pardus*, and *Ursus thibetanus*) were cathemeral. We found a high degree of temporal overlap (>60%) among most of the sympatric species, with specific activity peaks. A non-differential activity pattern throughout all moon phases was observed for the large carnivores ($r = 0.014$, $p = 0.838$) and small felids ($r = -0.098$, $p = 0.154$), while viverrids activities were preferentially oriented to darker phases ($r = -0.220$, $p < 0.01$). Data on viverrids indicated that they might change their activity based on the lunar cycle either as an anti-predator strategy or to increase their foraging efficiency. The study demonstrated that forest-dependent mammals dominant species activities were not affected by lunar cycle, while sub-dominant species maintained lunarphobic activity.

Thursday, 1 August 2019 | Opale
GS11 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Demographic inference and model choice using the IICR (inverse instantaneous coalescence rate) as a summary of genomic diversity

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An increasing number of inferential methods allow to reconstruct the demographic history of species using genomic data. Many of these methods assume a panmictic population and quantify and date population size changes. However, it has been increasingly shown that population structure can generate spurious signals of population size change. Mazet et al (2016) introduced the IICR (inverse instantaneous coalescence rate), a time-and sample-dependent parameter, which is equivalent to a population size in panmictic models. However, they also showed that the IICR should not be interpreted as a population size when structure is present, as this interpretation may be significantly misleading. The IICR suggests population size changes even when the total population size was constant. The IICR is also dependent on the sampling scheme. Thus, changing the sampling scheme may change the inferred demographic history. Here we (i) introduce the IICR, (ii) show how the IICR is influenced by population structure and the sampling scheme, (iii) argue that IICR plots can be seen as summaries of genomic information that can be used for demographic inference and model choice, (iv) argue that the IICR can be estimated with real data using the PSMC (pairwise sequentially Markovian coalescent) method. We finally apply these concepts to lemurs and orang-utans, and show that population structure can explain the PSMC plots that have been obtained on these species. This suggests that these species may have been influenced by changes in connectivity in the past in relation to ancient climate change events. This means that PSMC plots should be interpreted with care for species living in habitats that have been fragmented in different periods of climatic change.

Thursday, 1 August 2019 | Opale

Functional metagenomics sheds light on the gut microbiome evolution of 37 species of genus *Microcerotermes*

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Termites are amongst the most abundant terrestrial animals on the planet largely due to their ability to digest lignocellulose, the most abundant organic molecule on Earth. In the higher termites, lignocellulose is broken down in the gut with the help of symbiotic bacteria. Studies have shown that most termite gut microbes are found nowhere else than in termite guts, and that they are acquired by vertical transfer from parent to offspring, and horizontal transfer between colonies. Up to now, most studies have used 16S rRNA marker to determine the bacterial community composition, preventing any functional analyses. Additionally, most studies focused on distantly related species, preventing any attempt to quantify the contribution of vertical and horizontal transmission to gut microbial communities. To address these questions, I sequenced gut metagenomes of 60 samples, belonging to 37 species of *Microcerotermes* collected across four continents. In this talk, I will describe how bacterial communities varies within species, and between closely related species. I will attempt to quantify the proportion of termite gut bacterial communities shaped by vertical and horizontal transmission, and how this affects the functional composition of the gut bacterial communities.

Thursday, 1 August 2019 | Opale
GS11 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Social canid in a metapopulation network: Dhole genetics in Eastern Vidarbha landscape, Maharashtra, India

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Asiatic wild dog or dhole is a highly elusive, monophyletic, forest dwelling social canid ranging across South and South East Asia. With a global population of about 949-2215 mature individuals, this species is considered Endangered by IUCN. The Indian subcontinent currently retains the majority of the remaining dhole populations, where they face severe conservation challenges from anthropogenic interventions in the form of habitat loss, prey depletion, and human persecution. However, their cryptic nature, habitat preferences, and absence of individual-specific patterns make it difficult to generate information at population and demography levels. We used non-invasive genetic tools to individually identify dholes and conducted analyses of population parameters across the five protected areas (MTR, PTR, NNTR, TATR, UKWLS) in the state of Maharashtra, India, having varying degree of habitat connectivity. We extensively surveyed the entire study area to collect 419 fresh canid feces and used, species and sex-specific molecular assays to identify dhole scats. Further, we standardized a panel of 12 polymorphic microsatellite loci for dhole individual identification. Unique dhole individuals from different parts of the study area were used to determine population structure and signatures of demographic decline across the landscape. We ascertained a total of 370 genetically confirmed dhole scats, and identified a total of 176 unique dhole individuals using the standardized microsatellite panel. The cumulative PID sibs and PID unbiased values were 1.5 x 10 -4 and 4.7 x 10 -10, respectively, indicating a statistically strong result. The population structure analyses indicated no genetic sharing between MTR and PTR, while NNTR shares genetic similarity with both MTR and PTR. TATR forms a separate cluster with sharing of signatures with UKWLS and PTR. Two independent demography analyses indicated varying signals of population decline in the populations. This study will help in understanding the population dynamics of dhole at local and landscape level.

Thursday, 1 August 2019 | Opale
GS11 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Assessing the effectiveness of protected areas for conserving endemic forest species on Borneo

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Rainforests on Borneo support exceptional concentrations of endemic insect biodiversity, but many of these forest-dependent species are threatened by land-use change. Totally protected areas (TPAs) of forest are key for conserving biodiversity, and we examined the effectiveness of the current TPA network for conserving endemic and range-restricted butterflies in Sabah (Malaysian Borneo). We compiled butterfly distribution data since the 1950s from museum specimens and published papers. Our study focused on 77 species that are restricted to Sundaland, including 15 species that are endemic to Borneo. We found that mean diurnal temperature range and precipitation of the wettest quarter of the year were the most important predictors of butterfly distributions, and that species richness increased with elevation and aboveground forest carbon. On average across all species, TPAs were effective at conserving ~43% of species' ranges, but encompassed only ~40% of areas with high species richness (i.e., containing at least 50% of our study species). The TPA network also included only 33-40% of areas identified as high priority for conserving range-restricted species, as determined by a systematic conservation prioritization analysis. We conclude that the current TPA network is reasonably effective at conserving range-restricted butterflies, and hence will presumably be effective for conserving other taxa with similar patterns of distribution. However, we find that considerable areas of high species richness and high conservation priority are not currently protected, and these areas are high priority for protection. Sabah's remaining forests, and the endemic species they support, are under continued threat from agricultural expansion and urban development, and our study highlights important areas of rainforest necessary for enhanced protection.

Thursday, 1 August 2019 | Opale
GS11 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS12
TROPICAL BIODIVERSITY and GLOBAL CHANGES

The food web is not collapsing in the Luquillo Experimental Forest, Puerto Rico

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Multiple studies have recently documented declines in insect populations that have been attributed to habitat loss, pesticides, biological factors, or climate change. A 2018 study in Puerto Rico described large reductions in abundance of insects and lizards between two samples collected 35 years apart and attributed these reductions to increases in mean maximum temperature associated with climate change. Using public data from the Luquillo Long Term Ecological Research (LTER) Program, the 2018 study also concluded that populations of canopy arthropods, walking sticks, frogs, and birds declined during a period of ~15 years, causing the collapse of the food web in lower montane rain forest. These conclusions were reported widely in the media. In contrast, our re-analysis of the LTER data does not corroborate the original results or conclusions of the 2018 study. We found no evidence that increasing mean maximum temperature is driving long-term trends in abundance in these taxa. Moreover, temperature actually declined based on meteorological data from the forest in which faunal studies were executed. The contradiction in results arises because of the use of inaccurate temperature data in the 2018 study, questionable manipulations of some of the abundance data, and a failure to adjust estimates of abundance for variable sampling effort. Finally, the 2018 study did not consider the effects of disturbance or secondary succession on animal abundance in this hurricane-prone system. Specifically, all the analyzed populations were responding during the temporal domain of the studies to the effects of Hurricanes Hugo and Georges, in addition to empirical variation in temperature and rainfall. Thus, we contend that the role of warming and the suggestion of food web collapse are oversimplified or unfounded for this tropical forest ecosystem.

Thursday, 1 August 2019 | Emeraude
GS12 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Do protected areas prevent deforestation in a global deforestation hotspot?

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Deforestation is a high priority issue. Protected areas are important investments in combating deforestation threats, and it is important to know how effective they are at achieving this purpose. We evaluated strictly protected areas in Queensland, Australia, with doubly robust evaluation methods to study their effectiveness. To do this, we used statistical matching combined with regression adjustment to assess what would have if forested protected areas in nine of Queensland's bioregions would have been deforested in the absence of protection. We found that, on average, the bioregions had an avoided loss measure of -0.05. This means that 718,000 hectares of Queensland's 14,000,000 hectares would have been deforested without protection. We strongly encourage evaluation measures for future acquisitions to combat rapid deforestation occurring across the State.

Thursday, 1 August 2019 | Emeraude
GS12 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Live fast, die younger, longevity reduction of tropical trees under warm and dry climate

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The role of the biosphere in the global carbon cycle largely depends on the trade-off between longevity and growth rate of trees as they assimilate carbon during growth and store it throughout lifetime. The oldest and slowest growing trees are found in temperature (cold) and water-limited sites from extratropics, where warming may increase growth rate at the expense of longevity. The “live fast, die young” side of this global trade-off is likely represented by trees from the already warm tropics, where global warming may not have the same impact on tree longevity and growth rate. Here we present the first pantropical analysis of tree longevity and growth rate using tree-ring data of 17,000 trees from 287 species, aiming to understand how climate is limiting tree longevity and growth in tropical lowlands. A comparison across the globe shows a continuum of increasing growth rates and decreasing longevity from extratropical to tropical biomes. Trees inhabiting the driest biomes are found at both ends of this trade-off, supporting and challenging the current believe that the oldest trees are found in the driest sites. This is true for extratropical trees inhabiting cold- and water-limited conditions that constraining growth, but it is not for trees inhabiting water-limited conditions in the warm tropical lowlands. Longevity is in average 34% lower in the driest tropical biomes, but growth rate remains similarly high. According to our model, longevity of tropical trees is negatively associated with moisture availability. Longevity also decreases above a threshold of mean annual temperature of 25˚C, regardless of the moisture availability. These patterns are consistent with reported hydraulic limitations leading to increased mortality risks for trees growing under drier and warmer coditions. Our results indicate longevity may reduce under wamer and drier conditions, probably with no effect on growth rate, affecting forest dynamics and biomass.

Thursday, 1 August 2019 | Emeraude
GS12 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Anticipating future wildfire risk in southern Amazonia: A social-ecological systems analysis

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Wildfires in the southern rim of Amazonia are likely to become more frequent as a result of positive feedbacks between rapid deforestation, increased fire use and extended dry seasons. We conducted a social-ecological systems analysis to study wildfire in this region and ways to anticipate future wildfire risk under different climatic and developmental conditions. For the analysis we adopted a multi-scalar approach and integrated different scientific disciplines (i.e. ecosystem, social, and geospatial sciences) and multiple forms of knowledge and understandings offire (i.e. from policy, business, and civil society perspectives). Methods included modelling, geospatial analysis, ecological surveys, focus group discussions, and semi-structured interviews. Our approach combined ground-based studies in two specific sites looking at fine-grained social and ecological dynamics of wildfire with remote sensing assessing coarse-grained spatial dynamics driving fire risk at the regional level. Findings are discussed in terms of ecological, social, and landscape governance aspects that are important to consider for future wildfire risk management. The ecological aspect looks at biomass loss and the response of forests to recurrent fires through a shift in tree species composition with already-present fire-tolerant species becoming more dominant. The social aspect emphasizes how wildfire risk strategies in the region are in tension between two conflicting narratives and understandings of fire, and proposes a deliberation process to integrate opposing views. Findings related to landscape governance focus on future scenarios of fire risk considering interactions between climate change and different land policies and development trajectories. The interdisciplinary approach to study wildfire as a social-ecological system is discussed in terms of its usefulness to build capacity to anticipate and adapt to future climate and wildfire risks and its potential to inform more resilient and inclusive land management strategies in tropical forest landscapes.

Thursday, 1 August 2019 | Emeraude
GS12 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Spatio-temporal dynamics of Ampamanta mangroves, areas of usage right in the biocultural site of Antrema, northwestern Madagascar

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The economic interest of mangroves concerns their large production of wood, the abundance of fauna, the food chain associated with it as well as its role in relation to the coastal protection against marine erosion. Mangroves are often degraded or destroyed because of anthropogenic pressures. This study conducted in Ampamanta, in the protected area of Antrema, and includes a diachronic analysis based on satellite imagery over a period of 45 years (1972-2017) and was undertaken to determine the evolution of the propagation of the mangroves over time and space. The results consist of a land-use map of the study area following five different periods: 1972, 1992, 2010, 2001 and 2017. The NDVI (Normalization Difference Vegetation Index) were extracted from each image and then used to distinguish mangrove vegetation. According to the dynamism of the mangrove forest between these dates, deforestation rates increased by 46% between 1972-2001. From 2001-2010, the deforestation rate was only 11.2 ha and the surface of the mangrove has extended to 291.1 ha between 2010 and 2017 due to an intensive restoration and environmental education program. The use of the different spectral bands in the Landsat images allowed us to highlight the limit of the mangroves, as well as its structure based on the dominance of species and stages of degradation. This study opens new research perspectives and its impacts, as well as environmental and socio-economic aspects.

Thursday, 1 August 2019 | Emeraude
GS12 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Primates' inherent susceptibility to tropical cyclones: A trait-based approach

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Substantial progress is being made in assessing impacts of long-term changes in climatic means on animal species. However, less attention has been given to the assessment of extreme weather events. Focusing on the world's primates and impacts of tropical cyclones, we developed a framework for assessing sensitivities and adaptive capacities associated with intrinsic biological traits — referred collectively as “intrinsic susceptibility". Based on ecological and extinction risk theory, we conducted a literature review to identify the traits that are likely to influence primates’ inherent susceptibility to cyclones which resulted in nine traits (body mass, day journey length, home range, litters per year, group size, primary diet, diet breadth, habitat breadth, and terrestriality). Using the guidelines for assessing vulnerabiliy to climate change impacts of the IUCN-SSC Climate Change Specialist Group, we scored these traits and also assigned a confidence level to each trait. The taxa with the lowest 25% of susceptibility scores (≤ 4.5) were assumed to be “non-significantly susceptible” to short-term and long-term impacts of tropical cyclones whereas those with a score > 4.5 were assessed as “significantly susceptible”. We identified that 499 primate taxa were significantly susceptible to cyclone impacts. In abscence of any robust predictive framework for risk to species from extreme climatic and weather events, the assessment of inherent suspcetibiity as presented here is a practical baseline to develop more robust risk evaluations as these phenomena are becoming increasingly frequent and intense.

Thursday, 1 August 2019 | Emeraude
GS12 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Integrating dynamic energy budgets and population viability analyses to assess the effects of habitat degradation

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Developing effective conservation strategies for endangered species requires quantifying extinction risk. By treating the birth and death of individual organisms as a stochastic process, population viability analyses (PVA) characterize the likelihood that a population will go extinct in a certain number of years. However, evaluating how specific anthropogenic perturbations alter a population's vital rates requires incorporating greater biological realism into these analyses. For instance, if habitat destruction reduces a consumer's resource, then how such resource depletion reduces fecundity and increases starvation risk need to be incorporated into the analysis. Here we incorporate dynamic energy budget modeling into PVA. Dynamic energy budget theory formalizes how key life-history traits (feeding, growth, development, mortality and reproduction) are linked. We link dynamic energy budget models and PVA through an individual-based modeling framework, thereby connecting extinction risk to the effects of antropogenic perturbations on individual organisms. We apply this approach to a critically endangered subspecies of the common caiman, *Caiman crocodilus apaporiensis*. We examine how three processes associated with habitat degredation - declines in adult food resources (larger fish, tetrapods), declines in juvenile food resources (smaller fish and invertebrates), and increased juvenile mortality due to declines in nest site quality - affect extinction risk. Our model predicts extinction risk to be highly sensitive to reduced nest site quality, while the effects of declines in adult resources are most apparent when such reductions are severe. Reduced juvenile resources elevate extinction risk by lengthening the amount of time individuals spend in a relatively vulnerable size class, rather than through starvation induced mortality. Using *C. crocodilus* apaporiensis as a case study, we show how incorporating dynamic energy budgeting into population viability analysis can provide a mechanistic link between the effects of anthropogenic perturbations on individual organisms and population-level extinction risks.

Thursday, 1 August 2019 | Emeraude
GS12 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

GS13
TROPICAL BIODIVERSITY and GLOBAL CHANGES

Functional shifts in human-modified Amazonian forests as a consequence of an extreme drought and consequent wildfires

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The combination of extreme climatic events with on-the-ground human-driven disturbances is one of the greatest threat to Amazonian forests. High levels of tree mortality and subsequent carbon loss due to either extreme droughts or the effects of selective logging and understory fires have been widely reported, but their interactions, and especially their impacts on functional diversity, have not been evaluated. Here, we examined how human-modified Amazonian forests responded to the 2015-16 El Niño, which led to one of the most severe droughts the region has ever experienced and unprecedented wildfires. We specifically ask whether large-scale tree mortality, as a consequence of drought and wildfires, lead to a shift in community trait composition. We continuously monitored the fate of 6,117 stems over a 36-month period, from October 2015 until October 2018, along a gradient of undisturbed and human-modified forests. Sampling was conducted quarterly to evaluate whether a stem was either dead or alive. We combine this dataset with traits data collected in the region, including wood density, bark thickness, specific leaf area, leaf thickness, and leaf nitrogen and phosphorus content. We found that both drought and fire killed 38% of stems, with mortality being significantly higher in burned forests. Both drought and fire-affected forests became gradually dominated by high wood density species and those with high leaf nitrogen content. Results were similar both in undisturbed and human-modified forests. However, this trend might change as mortality rates are still significantly higher than baseline levels. The increased frequency of extreme drought events and the consequent increase in large-scale wildfires may lead to significant shifts in functional composition across Amazonian forests. The impacts of these changes in biogeochemical cycles remain unclear.

Thursday, 1 August 2019 | Auditorium
GS13 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Lianas in silico: The impact of forest structure on the abundance of woody vines

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Lianas are an important component of tropical forests, constituting up to 40% of the woody stems and about 35% of the woody species. Tropical forests have been experiencing large-scale structural changes, including an increase in liana abundance and biomass. This may eventually reduce the projected carbon sink of tropical forests. The mechanisms explaining this liana proliferation are still debated and a number of potential drivers have been proposed. Despite their importance, the modelling community has only started to include their impact when simulating forest dynamic. A new framework for simulating lianas was developed within the Formind model. The new liana PFT was tested against a multitude of different datasets including size distributions, predicted biomass, liana clustering and climbing success rates. An extensive comparison between model output and empirical data is provided to benchmark the model. The agreement between simulated and observed patterns suggests that the model is a robust tool to forecast the liana dynamic in tropical forests. To investigate what mechanisms are responsible for liana proliferation, we analyzed forest properties like disturbance level, age, PFT composition, mortality rates and modes and assessed their impact on liana abundance and biomass

Thursday, 1 August 2019 | Auditorium
GS13 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Response of dry forests to rainfall variability and human land use over the last 2000 years, western Madagascar

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Environmental change is experienced worldwide, and the island of Madagascar is not exempt from such events. Over the past 2000 years, a history of extinctions and landscape changes have been recorded across the island and debate remains as to whether the main cause of these changes was climate or humans. This research uses dendroclimatological and palaeoecological approaches to reconstruct respectively rainfall, vegetation, and human land use of the last millennium in the semi-arid southwest Madagascar. The questions are when and how rainfall and humans have influenced the dry forest ecosystem. Rainfall records of the past millennium show continuous decreasing rainfall across the region and changes in human land use from massive pastoralism towards extensive agriculture in the northern site at Kirindy National Park, whereas the southern site Mikea National Park reveals low increases in agriculture. Our results suggest different responses of vegetation to climate and human land use across the region. The northern site showed response to human land-use over time associated to the increase of agricultural practices in the region. The southern site, however, showed response to the decreasing rainfall trend over time despite increases in seasonal agricultural practices by its occupants. Such results are important in planning sustainable biodiversity conservation relative to these factors and evaluate human adaptability to drying climate.

Thursday, 1 August 2019 | Auditorium
GS13 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Knowledge integration in conservation under the light of a methodology of partial overlaps

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The importance of traditional knowledge for understanding and managing local environments is widely acknowledged, leading to proposals for integrating scientific knowledge and traditional knowledge in conservation, and to debates about “co-creation”, “co-management”, “transdisciplinarity”. However, to integrate different knowledge systems, which embed different ways of knowing and validating knowledge, as well as different ontologies and value systems, is no free lunch. Here, we tackle a key philosophical issue for integration proposals, namely the need to be attentive to both success and failure in knowledge integration, advocating that we should theorize on these possible outcomes of integrating efforts. To develop a methodology for addressing both epistemic productivity and failure in efforts to integrate scientific and traditional knowledge in conservation and sustainable management. We developed a framework for addressing questions of integration through four core domains of philosophy - epistemology, ontology, value theory, and political theory - using in each dimension a methodology of partial overlaps that results in models acknowledging both substantial similarities and differences between knowledge systems. We exemplify these models with field results from ethnobiological studies in fishing villages in Brazil, and discuss what partial overlaps entail in conservation and educational efforts in traditional communities. Partially overlapping ontologies are exemplified through results from ethnobiological studies on *Buteogallus aequinoctialis* (a near-threatened species locally known as Gacici), showing the epistemic productivity of integrating properties ascribed to this convergent item in scientific taxonomy and ethnotaxonomy. The partiality of overlaps is shown through relationships between local ethnotaxonomic species and scientific species of sandpipers, where the convergence is not so simple, as fishermen are lumpers regarding these birds. Yet, epistemic productivity can also be shown in this case. We will also discuss partial overlaps in epistemology and value systems, stressing implications for current integration efforts in the construction of ICDP plans.

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GS13 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Deep-time defaunation: The botanical consequences of the dinosaur extinctions

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Mega-herbivores (>1000 kg) have shaped terrestrial vegetation since the Jurassic. With the KT extinction of the dinosaurs, terrestrial ecosystems faced a 25 Myr 'mega-herbivore gap' before the rise of large-bodied mammals from c. 40 Ma onwards. The botanical consequences of this mega-herbivore gap remain puzzling. Here, we hypothesize that plant functional groups that were adapted/exapted to mega-herbivores, such as open-habitat grasses due to grazing, plants with megafaunal fruits for seed dispersal, and spines for defence, show diversification rate shifts during the mega-herbivore gap (65-40 Ma). Additionally, we expect these functional groups to show increased functional turnover during this time, evolving shade-tolerance, small fruits and spineless growth forms, respectively. We use a comparative framework to fit time-dependent diversification models to fossil-calibrated phylogenies of grasses (Poales) and palms (Arecaceae) – clades with spectacular species and functional diversity that currently dominate grassland and rainforest biomes globally. We found that mega-herbivores (i.e. dinosaurs and/or large-bodied mammals) facilitated fast diversification rates of open-habitat grasses and palms with spines, as compared to closed-habitat grasses and palms without spines, respectively. Furthermore, during the mega-herbivore gap, we detected fast functional and taxonomic turnover of lineages, regardless of their traits. Our results suggest that the KT 'defaunation' event influenced plants globally, but that functional responses are less predictable and possibly obscured by simultaneously rising global temperatures.

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GS13 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Double mutualisms: A global tropical island phenomenon

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A double mutualism (DM) occurs when two interacting species benefit each other in two different functions, e.g. when an animal species acts both as pollinator and seed disperser of the same plant. Besides the double benefit, a DM also imposes a larger risk to both functions if the performance of one partner declines. We conducted the first global review of DMs involving pollinators and seed dispersers, aiming to: (1) assess their prevalence across ecosystems and biogeographical regions; (2) identify the main plant and animal taxa, and their traits, implicated in DMs; and (3) evaluate the conservation status of double mutualist species. We compiled published and unpublished DM records using specific search terms, noting the species involved, their conservation status, and geographic location, as well as the type of study (species vs community-level) in which the DM was detected. We identified 302 DM cases involving 207 plant and 92 animal species from 16 mainland and 17 island areas. Most records come from tropical regions and islands. Animals included birds (62%), mammals (22%), and reptiles (16%), mostly opportunist species; only 18% were nectarivores. Plants were mainly fleshy-fruited shrub or tree species (59%) with actinomorphic flowers that were visited by several or many pollinator species (87%). Most (56%) DMs were detected in community-level studies. DMs are mostly prevalent in ecosystems with limited food resources and mutualist partners, and with high generalization levels. Nearly 30% of the species involved in DMs are threatened according to IUCN criteria, 68% of which are found on islands. The high prevalence of DM on tropical islands paired with the threat status of island species suggest that the loss of a double mutualist and its cascading consequences may have a severe impact on community composition and functioning of these fragile island ecosystems.

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GS13 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Local representation of the forest in the rural commune of Ranomafana-Est, eastern Madagascar: From resources use to conservation

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Madagascar has an exceptional wealth of biodiversity. The eastern part of Madagascar contains humid forests faced with threats and pressures such as deforestation due to anthropogenic activities. In the rural commune of Ranomafana-Est, the local population has strong links with forest resources but it seems that forest local management modalities would not ensure the sustainability of the ecosystem. On the basis of this hypothesis, the present research aims to determine whether the local population's representations of the forest prevent or promote its conservation. This study was conducted with 300 individuals from seven different communities (fokontany). The results for socio-economic aspects based on a questionnaire and interview surveys, that for 55% of the respondents that the forest is perceived as a farmland reserve by 55% and as a source of food, medicinal plants, and energy for another 30%. Finally, 15% were of the view that it is a source of income and provides 60% of the local population's incoming revenue. All this information confirms how much the forest is of concern to a large majority of residents because of its socio-economic importance on one hand, and because of its progressive degradation on the other. Faced with these results, these local communities are aware of the issues and challenges related to the sustainable preservation of the forest ecosystem. In this way, the local population's involvement in the regular control of forest habitat, as well as their effective participation in restoration work, should enable a progressive strategy of conservation and sustainable management of the forest.

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GS13 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS14
TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Citizen science for the tropics

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Citizen science is a widespread practice in the field of ecology and conservation, loosely defined as the engagement of volunteers or the public in scientific investigations. Since the start of the 21st century, citizen science as a concept and practice has gained remarkable momentum in many public and professional spheres. For example, governments in the U.S., European Union, and Australia have invested in citizen science programs to address societal problems or facilitate research and innovation. In the past decade, three professional societies for citizen science have been launched, and several journals have dedicated special issues to the topic of citizen science. Additionally, thousands of citizen science efforts have gained visibility or become increasingly more networked in nature through collaborative Internet portals. However, a review of these efforts reveals a glaring absence: studies and information about citizen science projects in tropical regions. Given the paucity of information in the published literature, one might assume that citizen science is rare in tropical regions. Here, we argue that citizen science is happening in the tropics, and that it is essential for modern tropical ecology and conservation. We present results from (i) a review of the published literature on citizen science in tropical regions and (ii) a survey of conservation practitioners. We highlight selected citizen science efforts in the tropics that have taken place at global, regional, and local scales. We also share insights from an ongoing project, Citizen Science for the Amazon, which aims to understand the potential linkages between environmental conditions and freshwater fish migrations at a basin scale through a citizen science approach. Finally, we discuss challenges and opportunities and present a preliminary set of principles for citizen science for the tropics.

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GS14 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

The effects of human disturbance on the integrity of sacred church forests in northern Ethiopia

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Land-use change can have profound effects on tree and seedling communities in forests, compromising their ability to regenerate and their long-term persistence on the landscape. Forest fragmentation decreases forest size, increases edge effects, and forest isolation, all of which negatively impact forest health. We examined the extent of human disturbance and its influence on the ecological status of sacred church forests in northern Ethiopia, the last remaining forests in the region. These sacred forests are alive with human activity, as they are local gathering areas for meeting, worship, and education. In 44 sacred church forests across South Gondar, Ethiopia, we measured the effect of disturbance (e.g. human structures, planted taxa) on sacred church forest integrity. We measured their potential for regeneration and the impacts of forest size, elevation, distance to population center, and the presence of an exterior wall on species richness, abundance (ha-1), and biomass (ha-1) of standing live trees, as well as the richness and abundance of tree seedlings. We found that disturbance was high across all forests (56%) and negatively influenced all measured parameters. Contrary to expectation, forests < 15.5 ha exhibited no difference in disturbance level with distance from population center, which may reflect differential forest use by local rural and urban communities; and that the presence of exterior walls had a minimal effect on forest integrity. We recommend conservation strategies that not only protect large forests, but also the small and highly used forests which are critical to the needs of local people, including preserving large trees for seed sources, removing exotic and weedy species from forests, and reducing clearings and trails within forests.

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GS14 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Culture inextricably entwined with nature: Linking biocultural values and human well-being in the Eastern Cape, South Africa

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Qualitative research in the Eastern Cape of South Africa has revealed that rural and peri-urban Xhosa-speaking people display a profound appreciation for specific natural vegetation and plant species, and that there appears to be a close link between traditional cultural practices, a sense of Xhosa identity, and access to spaces and resources from natural and semi-natural vegetation (especially subtropical thicket). Many people accessing thicket or forest experience solace, calm, and a sense of well-being. We hypothesized that engaging in traditional nature-culture based practices and accessing nature for personal or cultural reasons would contribute to a person's well-being via a sense of identity, belonging and 'rootedness', and also via the sensory and spiritual experience of being in nature. We conducted a questionnaire survey of 700 respondents in five locations spanning a rural-urban gradient to (a) generalize our qualitative data across a large sample, and (b) to model the interrelationships between wellbeing, nature access, cultural beliefs, nature and culture knowledge among others, to see whether nature/culture experience and practices affect wellbeing. Our key findings were that accessing nature, using natural resources, nature and culture knowledge, and Xhosa cultural beliefs and practices remain closely interrelated and that cultural beliefs and practices are still extremely widespread even in urban areas. People who hold and practice nature-culture beliefs placed a higher importance on accessing nature for traditional purposes for their wellbeing. Most people expressed positive feelings about nature and disagreed with statements indicating that accessing nature was no longer necessary. Our findings highlight that cultural identity, heritage, and spiritual meanings of nature are key components of local communities' sense of well-being and should contribute to conservation and stewardship.

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GS14 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Challenges in determining the status of the Yellow-spotted River Turtle (*Podocnemis unifilis*) in Manu National Park, Peru

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The world's estimated 335 species of turtles play important roles in riverine ecology, the economy and sociology of many human cultures. Historically, turtles have been used by indigenous people as food, medicine, and cultural resources. However, international commercial demand has led to intensive harvest, drastically reducing the populations and range of approximately 40% of turtle species. This study focus on *Podocnemis unifilis*, a river turtle included in the IUCN Red List as Vulnerable, in the Manu National Park, Peru. Using established protocols, the first turtle population size was determined after 20 years. After the first survey in the 1990's, the population was expected to increase following the implementation of two park checkpoints and an expected reduction in poaching. The population size appears similar. The 8.6 individuals/km found may suggest a 'healthy' state, however, with only two time points surveyed 20 years apart, we cannot determine population trend or variation. We also found several cases of 'cooked' eggs in nests and desiccated hatchlings on the beaches. Tracking this mortality response to heat waves is important to modeling the response of P. unfilis to climate change. All these highlights the importance of long term monitoring. Strategies to reverse these negative trends require understanding the species besides sustainable monitoring programs, the joint participation of the local population, researchers, civil organizations and the state, within a landscape approach. Matziguenka people, researchers, and the Peruvian Government, participated in this study as part of a broader landscape project. We are gaining understanding by comparing populations in neighboring rivers in Peru. Yet we could achieve greater insights by comparing the life and evolutionary histories of closely related taxa, such as *Erymmochelys madagascariensis*, a Madagascar species under similar anthropogenic pressures and already listed as in critical status.

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GS14 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Agents of change under telecoupling: Aiming for sustainable land governance in northeastern Madagascar

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Telecoupled land governance in forest frontier landscapes shapes local land uses. These distant interactions are assumed to have unsustainable consequences such as land competition and displacement. Among the countries showing this phenomenon is Madagascar, where local land use is increasingly influenced by distant actors. In northeastern Madagascar, small-scale farmers are subject to double incentives from actors from environmental and economic domains, leading to the expansion of their agricultural land into the remaining protected forests and to the loss of biodiversity and reduced carbon storage. Actions towards reaching sustainable development goals (SDGs) are strongly required in Madagascar and elsewhere. However, empirical studies on transformation pathways towards adaptive governance are still scarce. Very few studies have addressed the identification of those actors through whom these transformational activities could be achieved i.e. agents of change. To address this gap, we combined agency analysis and social network analysis to disentangle attributes and transformation potential of different actors involved in land governance in northeastern Madagascar. Our findings show that the actors' likelihood to be agents of change depends on their meanings, means, and centrality in the land governance network. Different types of actors exist regarding these three analytical components. Moreover, different combinations of actors are present. An actor could have a clear strategy related to land and sufficient resources, but could be missing the social network to implement the strategy. Alternatively, an actor could be very central in the land governance network but lacking a clear strategy regarding sustainable land use. Therefore, a pathway towards transformation should contribute to empowering central actors and connecting them to those actors with clear meanings and significant resources.

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GS14 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Small-scale spatial variation in malaria prevalence and deforestation among human communities near priority areas in Madagascar

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Improving the well-being of the human communities living near conservation priority areas is often critical to, or an explicit aim of, conservation and development efforts. However, such communities are often vulnerable and face increased risks of poor health outcomes. In Madagascar, in particular, deforestation rates around threatened biodiversity hotspots have been alarmingly high. For malaria, a consequence of deforestation can be to increase the local malaria transmission potential by increasing the density of habitats suitable for its mosquito vectors. We sought to characterize the burden of malaria infection at the individual, household, and village level in rural communities in Madagascar that were within or adjacent to remaining tracts of forest. We also aimed to better characeterize the larval ecology of malaria mosquito vectors near these communities to better understand the linkage between deforestation and malaria risk in Madagascar. Malaria prevalence surveys were newly performed as a part of multiple, large epidemiological field studies between 2013-2017. To allow cross-regional comparison, sampling was performed at 31 sites distributed across the distinct eco-regions of Madagascar: the tropical rainforest east coast, the dry deciduous west coast, and the semi-arid spiny forests of the southwest. In total, we sampled more than 1100 households and 7000 individuals were sampled. Malaria prevalence varied greatly between nearby sites (from 0 to 45%) but was much higher than reported regional averages in many of the rural communities we studied, especially in the west coast deciduous forest region. We note that in areas of active conservation and development programming, malaria burden at the household level was often high, with an excess of infected individuals in a subset of houses. Due to a lack of prior adequate data from these regions, these data give new insight into the burden of malaria among communities crucial to Madagascar's conservation goals. We highlight communities in the Mikea Forest area especially for their exceptionally high malaria burden.

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GS14 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Bridging the gap through community local conservation

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16% of Madagascar's surface area is covered by native forests and these remaining forests are highly fragmented. The anthropogenic deforestation is one of the threats to the survival of species and the maintenance of essential ecological services. With the aim of reversing the current rate of deforestation, it is imperative that effective measures be implemented. According to the Rio Conventions in 1992, local communities have a vital role in environmental management. Their integrative approach involving the inclusive participation of local communities in conservation was among the appropriate method for achieving this goal. One of the community approach is the forest restoration at the level of their areas of conservation responding to the 5th Aichi biodiversity Target. The present study evaluated the effectiveness of a project sample and analyzed success story related to environmental, ecological, social, cultural, and economic aspects. The case study is the community forest restoration held at the Alaotra-Mangoro Region. The forest restoration going on with invasive species eradication started in 2015 with a success rate of 80% in a former logged 30 ha forest contiguous to the Analamazaotra Protected Area, eastern humid forest. In five years, the results show an average growth of 20 m for fast-growing species, 5 m for medium growing species, and 50 cm for slow-growing species. At this stage, *Propithecus diadema* groups moving towards the community forest areas are increasing in number. This positive results on habitat recovery leading to ecotourism promotion are shared and replicated within communities. The decrease of the threats upon the forest conservation is mainly based on the prioritization of community benefits. Being closed to the natural resources, valuing community efforts in the management of their natural resources is important in accordance with conservation and sustainability of ecosystem and natural species for future generations.

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GS14 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

GS15
THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Plant succession in the forest fragment of Ankorabe, eastern Madagascar

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Madagascar has a high rate of endemism and high species richness but the annual rate of deforestation, caused by slash and burn agricultural practice, is increasing in time. This study, conducted in the Ankorabe Forest fragment in the eastern part of the island, aims to determine the dynamics of plant succession. The hypothesis of this study concerns floristic homogeneity for each age class of abandoned fallow plots. The method consists of collecting floristic and ecological data on the different fallow ages and the forest fragment that is still intact, to study its demographic structures, to identify the characteristic species in each succession of vegetation and to analyze the data. After 1 to 3 years after being fallow, there is an increase in the number of herbaceous species. During the succession of plants (between 0 to 10 years), there is always the presence of pioneer species that settle permanently. The structure of the vegetation reveals a young and dynamic population with strong regeneration. Nine species characterize the degraded area of the forest fragment of Ankorabe and 20 species characterize the forest fragment. Species richness decreases in old fallows, especially greater than 10 years. The index is high in fallow areas less than one-year-old due to the presence of pioneer species. Regularity index values vary from 0.65 to 0.77 show that species are statistically homogeneous. According to a co-inertia analysis, a trajectory of the ecosystem tends towards an herbaceous formation after forest cutting.

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GS15 – THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Natural tree regeneration and planted tree survival after suppression of the fern, Dicranopteris linearis, with mechanical removal, fire, and cover crops

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Agricultural practices and wildfire have contributed to the spread of the fern, *Dicranopteris linearis*, along Madagascar's northeast coast. This fern creates dense monodominant patches with a thick mat of fern litter. This mat can range from 1-5 m in depth. *Dicranopteris* thickets appear to suppress natural regeneration, make tree planting challenging and overall pose significant challenges to forest restoration efforts. The objective of the study was to investigate a range of approaches for suppression of the fern and reestablishment of tree cover. We compared natural regeneration and growth and survival of trees planted under three fern treatments: mechanical removal (cut), burning, and burning and planting a cover crop of pineapple and manioc. Natural regeneration was highest in burn + cover crop and lowest in cut alone. We posit that this is due to difficulty of seeds reaching the ground and growing up through the thick fern mat. Planted trees suffered high mortality rates in burn only plots likely due to high surface soil and air temperatures. Burning plus cover cropping provide shade and promoted survival of planted trees. It also provided food for the landowners implementing restoration. For surviving trees, planted tree growth was similar across treatments for most species. *Intsia bijuga* and *Hymenaea verrucosa* grew taller on burned compared to cut plots. In contrast, *Draceana* grew more on cut plots compared to either burned plot. Overall our results suggest different approaches can be effective for forest restoration depending on project goals and resources available.

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GS15 – THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Identification and priorisation of zones for forest landscape restoration areas in the Antrema protected area, northwestern Madagascar

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Undertaking ecological restoration is urgent on Madagascar due to the degradation and the threats of its biodiversity. However, it is difficult to describe a flexible and affordable framework for quickly identifying potential Forest Landscape Restoration (FLR), as well as analyzing and identifying these areas. This study is inspired by Restoration Opportunities Assessment Methodology (ROAM); it is based on the Geographic Information System (GIS), which is used for the identification and mapping of the priority areas for the restoration. Four assessment parameters were taken into account: the slope, elevation, the percentage of the gap opening at the vegetation canopy, and the presence or absence of fire in the site. The superposition of these four parameters allows to produce a stratified map; this latter permits the establishment of priority classes and the restoration types in the Antrema protected area. The treatments result in a priority map representing the location and the area of each defined priority class. According to the results, Priority 1 has the smallest area with 111.9 ha, Priority 2 with 714.5 ha, and Priority 3 with 1292 ha. Among the known three types of restoration, mosaic restoration, small-scale restoration, and large-scale restoration, only the large-scale restoration is encountered in the Antrema protected area. The vegetation units included in Priority 1 are the most threatened because these consist of degraded and open vegetation more extensive class; they are also those with the smallest surface in terms of cover area. Priority 2 is also important for restoration, while Priority 3 is the least threatened of the three classes. These priorities classes are ranked according to the level of degradation but managers can decide the adequate priority class according to their time and their budget.

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GS15 – THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Sumatran peatlands and their forests: Can peat restoration improve biodiversity and rainforest connectivity?

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Tropical peat swamp forest ecosystems store huge below-ground carbon stocks, and support unique flora and fauna. In Indonesia, peat drainage and forest clearance for oil palm and *Acacia* resulted in a fire and haze crisis in 2015 that caused major health and economic damage, as well as massive carbon emissions. Widespread forest loss also means that increasingly isolated patches of remaining forest are some of the last refugia for forest-dependent species. Peat management is therefore crucial for climate change mitigation, biodiversity conservation and human wellbeing. The Indonesian government has committed to peat restoration by conserving remaining forest, raising water tables in drained areas and revegetating degraded peatlands. Key questions around peat restoration in Indonesia are: whether current and planned restoration efforts will benefit biodiversity, whether rewetting will impact peatland agricultural yields, and whether forest restoration can improve forest connectivity. We focus on Sumatra, where 81% of peatlands have been deforested, and where there were substantial peat fires in 2015. We quantify changes in avian species richness and community composition between peat swamp forest and neighbouring smallholder oil palm farms, showing substantial shifts in community composition. We also assess the impact of peatland water tables on oil palm yields, and show how peat restoration could affect biodiversity-yield trade-offs on smallholder farms. Finally, we use connectivity models (Condatis) to quantify declines in forest area and habitat connectivity between 1990 and 2015, and highlight "bottlenecks" where targeted peat forest restoration would be most effective at enhancing connectivity. Our findings reveal potential biodiversity and forest connectivity benefits from peat restoration, and provide information for policy makers to target their restoration most efficiently.

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GS15 – THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Creating the world's largest protected areas: Optimizing a partial closure of the high seas

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Pelagic ecosystems have relatively low rates of protection relative to coastal waters or terrestrial biomes, in part because a large majority of their extent occurs in the high seas, outside of any nation's exclusive economic zone. A partial closure of the high seas (i.e. defacto creation of an enormous system of marine protected areas) through an amendment to the Law of the Sea could instantly rectify this disparity. Here we explore 10%, 25%, and 40% closure scenarios, examining how much of the total productivity of the high seas could be protected if net primary productivity (NPP) or chlorophyll-a concentrations are used as optimization criteria. Using NPP estimates from 2003-2015 and chlorophyll-a estimates from 2009-2013, we find that a 10% closure could protect more than 22% of total high seas NPP and nearly 30% of its chlorophyll-a, due to the strongly right-skewed distribution of both variables. What's more, in both cases, these areas tend to form coherent blocks spread across tropical and temperate latitudes. These regions overlap only slightly more than randomly with the most fished areas of the high seas (as determined by automatic identification system transponder data from Global Fishing Watch). These findings suggest that the game-theoretic difficulties inherent in international environmental negotiations would be relatively minor and that the path toward the creation of the world's largest protected areas is viable.

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GS15 – THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Restoring forests in the Eastern Himalaya: The importance of monitoring and maintenance

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High rates of forest loss and habitat degradation due to anthropogenic activities in the Asian tropics makes ecological restoration an important strategy for recovery of native forests. Restoration through planting native species can play an important role in mitigating forest loss and habitat fragmentation enabling better landscape connectivity. In 2014, we established a nursery to grow native tropical tree species to restore degraded forests inside and outside Pakke Tiger Reserve in northeast India. The site is located in the Eastern Himalaya Biodiversity Hotspot and the surrounding areas have experienced high deforestation in the last two decades. To evaluate the efficacy of our restoration efforts, we compared overall sapling survival across sites that were frequently de-weeded (bi-monthly) and occasionally de-weeded (up to three times in a year). We also compared annual survival and growth rates of representative plant species (nine species) that include abiotically and biotically dispersed species. Restoration planting was done between 2016 and 2018. In this period, 8310 saplings of 63 species were planted across five sites, in areas ranging from 0.23 to 2.58 ha. Higher mortality of the regularly monitored saplings was noted in the dry season. Sapling survival ranged between 37.5 to 73.1% over a period of 1.5 years across three different sites. Survival was lower in the occasionally de-weeded sites compared to the frequently de-weeded sites. There was inter and intra-species variation in survival across the sites. Data for growth rates for the different sapling species is still being collected and will be presented. This study highlights the importance of monitoring and site maintenance in ensuring higher sapling survival. Our data on sapling survival and species growth rates can play a crucial role in informing and facilitating faster restoration of degraded forest patches.

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GS15 – THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

First signals of small-scale molecular edge effects in a non-human primate

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Habitat edges lead to major ecological interactions of abiotic and biotic variables due to high ecological contrast. These processes are known to result in variable responses of plants and animals, although little is known about how animals respond to edge effects in tropical dry forests. In this context, interactions between edge effects and animal movement patterns are a critical yet largely unexplored area of ecological research. The aim of this study is to use population genetics tools to infer molecular edge effects in *Microcebus ravelobensis*, a small, nocturnal, arboreal, endangered lemur species, endemic to the dry deciduous forests of northwestern Madagascar. *Microcebus ravelobensis* was sampled in one edge and two interior habitats in close proximity to each other (500-1,400 m) in a continuous forest bordering abruptly on a savannah. A total of 41 individual mouse lemurs were genotyped with a suite of nuclear microsatellites to determine genetic diversity, genetic differentiation, and movements between the sites. Furthermore, the mitochondrial D-loop was sequenced to determine maternal lineages. The overall genetic diversity was lower in the edge habitat compared to the two interior sites, and all subpopulations showed relatively low genetic exchange and significant genetic differentiation, despite the short geographical distances that lie within the possible dispersal distance of single individuals. These findings support a local preference model and can be interpreted as the first signals of molecular edge effects, while suggesting the potential for local adaptation. Such an effect should have important conservation implications, since an additional molecular subdivision of already small populations inhabiting fragmented landscapes should further increase their vulnerability to stochastic demographic changes and collapse.

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GS15 – THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

GS16
TROPICAL BIODIVERSITY and GLOBAL CHANGES

Biodiversity and coffee management in Ethiopia

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To understand biodiversity of southwestern Ethiopia one needs to recognize the ecology and management of coffee *Coffea arabica*. In one end of the gradient of management types, coffee is planted in rows under a sparse and species poor canopy, while in the other end coffee is growing wild under an intact canopy of moist evergreen forests. In a study of deforestation across one district of 1500 km^2 we found that when the altitude becomes too high for coffee (>2000 masl) the deforestation had been higher. From interviews with farmers we understood that that the reason was that the balance between ecosystem services and disservices changes in favour of clearing the forest when coffee cannot be grown under the canopy. We also investigated 60 sites with coffee along a management gradient in the same area. The species composition of trees varies along the management gradient with few forest specialists in sites with much management. A similar pattern was found for associated understory and epiphytic plant biodiversity, showing a strong gradient in species composition including increased richness from heavily managed sites to less managed sites. The species composition of seedlings was also related to the surrounding landscape, with more forest specialist species germinating at closer distances to larger intact forests. However, interestingly coffee density was not related to any of the biodiversity measures, suggesting that there is an urgent need to get data on yield and revenue from the different management systems in order to evaluate how strong the trade-off is between biodiversity and production. From our studies it is apparent that coffee management both buffers the deforestation pattern (by protecting forests) and reinforce the degradation of forests (by simplification of the canopy). Thus, these opposing effects of coffee management need to be understood to preserve the rich biodiversity in this landscape.

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GS16 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Disentangling the effects of functional diversity, land-use change and environmental conditions on biogeochemical cycling in human-modified tropical forest in northern Borneo

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Land-use change in the lowland tropics is irrevocably altering biodiversity, and transforming ecosystem structure and function in the tropics. Here we report the results of a large-scale research programme investigating the interactive effects of functional diversity and land-use change on ecosystem structure and function in Borneo. Major cover types included old-growth forest, moderately logged forest (logged once or twice), heavily logged forest (logged twice or more) and oil palm. Carbon dynamics were quantified at multiple spatial and temporal scales using RAINFOR-GEM carbon plots, soil flux and isotope measurements, remote sensing, process-based modelling and data assimilation. The functional diversity of plant, microbial and invertebrate communities across different land-uses was determined using taxonomic surveys, substrate utilisation experiments, molecular and lipid biomarker analysis, and quantification of eco-physiological traits. Targeted plot-level manipulations were also implemented to test the role of key functional groups in modulating biogeochemical cycles. Key ecosystem processes, such as net primary productivity, were comparable among different land-uses. Other processes (e.g. decomposition, respiration) or system properties (e.g. canopy structure, foliar nitrogen and phosphorus) varied depending on the effects of land-use history, biotic functional traits, or underlying site conditions (e.g. topography, soil nutrient status, microclimate). Use of the CARDAMOM data assimilation scheme was effective in simulating temporal trends in carbon dynamics, with limits imposed by litterfall and leaf area index data. Evidence for both top-down and bottom-up regulation of ecosystem processes was observed. For example, the functional composition of the plant community appeared to regulate the structure and function of soil microbial communities; removal of ectomycorrhizal Dipterocarpaceae due to selective logging led to significant reductions in mycorrhizae and a concomitant rise in saprotrophic fungi. In contrast, invertebrates appeared to exert a bottom-up control on ecosystem structure and function. For example, termites mitigated the effects of drought on soil moisture, decomposition and seedling survival.

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GS16 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Resurrection of Amazonian forests: Re-sprouting as a post-disturbance strategy in human-modified Amazonian forests

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Given the likelihood of stronger droughts and the expected increase in rates of human-driven disturbances for the Amazon region understanding how resilient are the human-modified Amazonian forests to future droughts and fires is critically important to combat climate change impacts and achieve key conservation strategies. One of the main recovery mechanisms of trees to disturbances is resprouting, but this has not been studied for Amazonian forests. In this study we analyse resprouting strategies in Amazon human-modified forests affected by drought and wildfires, with the aim of establishing the effect of El Nino droughts and fires over resprouting ability. Data was sampled in 2014 and 2016, approximately two years before and 11 months after the 2015-16 El Niño droughts and associated wildfires. We used a dataset comprising 9,025 stems belonging to 780 species measured in 36 permanent forests plots in the eastern Brazilian Amazon These forests are distributed along a pre-El Niño disturbance gradient encompassing undisturbed forests, logged forests, logged-and-burned forests and secondary forests. All plots were affected by the El Niño drought, while some of them were affected by understorey fires (n=16). Amazonian forests showed to have a remarkable number of resprouter species (248 out of 780 species). In 2014, secondary forests had the highest percentage of resprouting species, but after El Niño, logged forests presented the highest percentage of resprouting species. Undisturbed forests showed the smallest intensity of changes and therefore had the highest resilience to both El Niño droughts and fire. Drought-only affected forests presented significantly less resprouting than naturally in 2014, while fire-affected forests presented a significantly more resprouting in 2016. There results render new knowledge of the recovery ability of human-modified Amazonian forests, and on possible future trajectories on succession with increased droughts and fires.

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Land-use effects on climbers and herbs' regeneration in Amazonian secondary forests

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In human-modified landscapes, different sources of disturbance shapes heterogeneous mosaics of successional communities. Increased past-land use intensity leads to reduced regrowth rates and different composition of tree species, but little is known on how it affects the regeneration of other life forms. Here we evaluated the roles of management intensity (number of previous slash-and-burn cycles), landscape configuration (distance to the old-growth forest) and soil properties on the structure, diversity and species composition of climbers, palms and herbs, in a shifting cultivation landscape in the Brazilian Amazon. The abundance of climbers and graminoid herbs (e.g. Poaceae and Cyperaceae) increased with management intensity. Climber's diversity decreased with distance to the forest, but no effect was identified in herb's community. A combination of management, landscape and soil characteristics affected the species composition of lianas and herbs. We found that 10 out of 21 dominating climber species (that occurred in > 10 plots) had their abundance determined mainly by management intensity, three species mainly by landscape configuration and one species (*Davilla kunthi*) determined by soil nutrient content (TEB). For the other six species there was no significant model. Differently, the abundance of dominating herb species (seven species occurring in > 10 plots) showed a unimodal distribution with an increase in intermediate levels of management intensity. Our results show that past land-use do not affect climbers and herbs' communities in the same way. The response of climbers' communities to land use is more similar to trees' response than herb's communities. While it is possible to identify an overall trend for climbers' community, the response of herbs to land-use intensity is species-specific. The wide variety of herb's survival and dispersal strategies probably explain these patterns. The variation in responses of different life forms to land-use intensity may contribute to the low predictability of tropical secondary succession.

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Intra-annual variation in tree growth rate and biomass across Amazon forests differing in land-use history

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The Amazon forest represents over half of the planet´s remaining rainforests, and it has a key role in the carbon and water cycles, climate and biodiversity conservation. However, changes in land use can negatively intensify the effects of climate change on forest dynamics such as tree growth and biomass accumulation. Aiming better understand the variation on diametric tree growth and biomass increment across forests with different land use, nearly 2000 dendrometer bands were installed and monitored bi-monthly for a period of approximately three years. We evaluated tree growth and biomass increment in a terra-firme forest in Central Amazonia containing mainly three different forest landscapes: 30 years old secondary forests, 10 ha forest fragments and pristine continuous forests. We correlated intra/inter annual variations on tree growth rates (TGR) between the communities with climatic variables (rainfall, temperature, humidity, etc). TGR were higher in the secondary forests, followed respectively by 10 ha forest fragments and pristine forests, while biomass accumulation had the opposite pattern. Canopy opening was equally important for TGR in the three landscapes, however distinct floristic composition and structure seems to be the main cause of differences in tree growth patterns between forests. Fragments and pristine forests had species with denser wood and higher proportion of large trees than secondary forest. These trees, despite the lower TGR, are able to accumulate more biomass than earlier successional and fast growing trees typical of secondary forests. In addition, secondary forests presented greater intra-annual variation in TGR with greater decrease in periods of drought. We conclude that, despite the increase of naturally regrown forests across the tropics, this may not necessarily indicate a proportional increase in biomass storage. Furthermore, secondary forests may be more susceptible to climate changes. This study highlights the importance of mature forests in the maintenance of carbon stocks of tropical ecosystems.

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Forest fragments enhance the potential of secondary forests to restore and preserve biodiversity in human-modified landscapes

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Tropical forests account for over 90% of global tree diversity, but are rapidly lost due to conversion for agricultural land-use. Secondary forest succession on abandoned fields is increasingly considered a low-cost strategy to restore large areas of forests and contribute to the conservation of tree diversity in tropical agricultural landscapes. This potential, however, is contingent on the presence of older forest fragments that provide seed sources and habitat and connectivity for seed dispersers. In this study, we examined the effects of forest fragments and dispersal limitation on the tree diversity in secondary forests and how these effects change over the course of succession. We present results from a large landscape-scale study on secondary forest succession, with 45, 0-39 year old secondary forest sites. In each site, two 0.1 ha plots were established, one adjacent to an older forest fragment and the other at 20-120 m from that fragment. Annual census data of seedlings and trees ≥ 1 cm DBH was collected from 2009 until 2017, and combined with locally collected seed mass data. Our result show that older forest fragments play an important role in the assembly of successional plant communities over the first several decades of secondary forest succession. Specifically, we found clear evidence that dispersal limitation was stronger when further from such fragments. Closer to forest fragments, (1) alpha and beta diversity of seedlings, saplings, and trees was higher; (2) species arrived earlier; (3) species were more frequent across the landscape; (4) the effect of spatial distance on community composition was stronger; and (5) community-weighted seed mass was higher. Differences in (1) and (2) increased during succession. Forest fragments are essential to the potential of secondary forest to restore and maintain tree diversity in tropical agricultural landscapes.

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Verreaux's sifaka (*Propithecus verreauxi*) group size, group composition, and dispersal patterns are influenced by climate: The case study of a lemur inhabiting a tropical dry forest

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Conservation strategies for Madagascar's biodiversity must be based on an understanding of how species respond to local consequences of climate change. However, little is known about species-specific responses. We examined the effect of temporal variation in green vegetation on lemur demography in Kirindy Mitea National Park. Monthly censuses of five social groups of Verreaux's sifaka (*Propithecus verreauxi*) inhabiting the 1 km^2 Ankoatsifaka Research Station study area were conducted from 2007 to 2013. We created a monthly time series of an index of green vegetation, the Enhanced Vegetation Index (EVI), over the time period for the 1 km^2 forest block. Maximum value composite images were computed by recording the highest EVI value for each of 36 pixels for each month. We assessed the temporal variability within each year using the coefficient of variation (CV) of mean monthly EVIs for the 12 months. Median group size was six individuals and not influenced by the CV of EVI. However, CV of EVI predicted range in group size ($p = 0.007$): groups were more stable when green vegetation was more variable across the year. This demographic response was primarily driven by changes in male membership. The CV of EVI predicted the median number of adult males in groups ($p = 0.005$), with more resident adult males in more variable years. Our study suggests that sifaka will respond to droughts with smaller, stable groups comprised of fewer adult males and wetter rainy seasons with larger groups comprised of a greater number of adult males who migrate among groups more frequently. Long-term conservation strategies must account for these demographic responses to a changing climate.

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GS17
ECOSYSTEM FUNCTIONS and SERVICES

Total above and below ground carbon stock portioning in eastern Cameroonian tropical rainforest

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Tropical forests contribute to climate change mitigation by absorbing carbon from the atmosphere and storing this in biomass and soil organic matter. However, there is still considerable uncertainty about the above and below ground quantity and distribution of carbon stocks, especially in African tropical forests. Here, we evaluate total carbon stocks (above ground biomass, above ground dead biomass, soil organic carbon, and root biomass) and assess how each carbon pool contributes to variation in total carbon in tropical forests in the Congo Basin. We evaluated data of detailed extensive inventories within 30, 1-ha plots spanning the semi-deciduous terra firme forest in east Cameroon, and tested hypotheses using variation partitioning, linear regressions and correlation tests. We found that semi-deciduous forests of east Cameroon store on average 274.97 ± 50.18 Mg ha^{-1}. The variation partitioning analysis showed that above ground biomass pool, with an average carbon stock of 177.66 ± 32.97 Mg ha^{-1}, mostly explained variation in total carbon stocks (R^2 = 87.7; p <0.001). From above ground biomass, carbon in adult trees was most strongly correlated with total carbon stocks. The second most important carbon pool was below ground carbon (on average 80.79 ± 12.41 Mg ha^{-1}; with R^2 = 82.2, p < 0.001), mainly explained by root (coarse + fine) biomass. Carbon in dead biomass had only a small contribution to total carbon stocks (R^2 = 29.5; p < 0.05). Hence, we show that most carbon is stored by above ground in adult trees, indicating that variation among forests in above ground biomass is a good predictor for variation in total carbon storage.

Thursday, 1 August 2019 | Cristall
GS17 – ECOSYSTEM FUNCTIONS and SERVICES

Influence of plant functional traits on leaf litter arthropod communities: An experimental community restoration approach in lowland wet forest in Hawaii

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In restoration ecology, it is often assumed that “if you build it, they will come.” Thus, the main focus has been on manipulating the plant community, with the assumption that animals will follow. It is not known how the plant species chosen for restoration affect animal presence and abundance. We use an on-going restoration project in a lowland Hawaiian wet forest in which plant communities were planted with the same species richness but differing functional diversity. In the first stage of the project, we have focused on the individual plant species that were outplanted, both native and non-native, because species vary greatly in their leaf traits such as thickness, size, and nutrient concentrations. The outplants in the experiment are diverging in ecosystem-level indices of litterfall and decomposition, which provide a template to investigate the litter arthropod community. At 3.5 years after outplanting, we sampled 0.25 m^2 litter samples from underneath 11 outplanted species and identified oribatid mites to the morphospecies level. In these samples, we identified at least 13 morphospecies and found their abundance to vary among litter types. Collembola, Araneae, and Diplopoda were also common in these samples. We resampled litter from all 20 species five years after outplanting, and although the number of species may be low (as expected for an isolated island system), the most important result is that community composition still appeared to vary by litter type, providing support that different plant species mixtures will foster food webs that differ in structure and composition. The project will delve into the development of an ecosystem services framework for restoration that incorporates animal communities. These invaded forests are living experiments in novel ecosystem community assembly, with environmental conditions ideal for examining multi-trophic interactions due to low species richness and fast rates of nutrient cycling and biomass accrual.

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Preserving Orangutan biodiversity through reversing deforestation with human health care: The work of non-profit Health In Harmony in Indonesian Borneo

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Devastating deforestation is occurring across Indonesian Borneo, leaving wildlife with less and less habitat, including an estimated 2,500 orangutans in Gunung Palung National Park – a significant percentage of the remaining Bornean orangutans. Since 2007, Health In Harmony has been working in 44 villages bordering Gunung Palung to understand the root causes of this deforestation. They spent over 400 hours speaking with these communities, and learned that the health of the rainforest was intricately linked with the health of the locals, which ultimately impacted the health of the wildlife population. Much of the deforestation was caused by illegal logging by locals who had no other way to pay for the nearly inaccessible and unaffordable healthcare. The communities told Health In Harmony they could stop logging illegally if they could access quality, affordable healthcare and receive training in organic farming as a new way to make a living. Health In Harmony supported these communities to make their community-designed solutions a reality, creating regional and mobile health care clinics that today serve 120,000 people in Borneo. Over the past 10 years, their work has helped deliver not only a 90% drop in the number of illegal logging households but also a 67% drop in infant mortality, according to data analyzed by Stanford University. They have not only greatly reduced the destruction of the orangutan's habitat, they have also focused on reforestation to begin to build it back up, including reforesting a wildlife corridor that connects two separated parts of the park. This is important because sub-groups of the orangutan population would otherwise be separated and not able to inter-breed and maintain necessary genetic diversity. Their work has greatly impacted both the region's standard of living and biodiversity. Now, they look to implement this strategy in other areas of the world.

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GS17 – ECOSYSTEM FUNCTIONS and SERVICES

Small roots of Parashorea chinensis decompose slower than twigs

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Plants produce above- and below-ground biomass. However, our understanding of both production and decomposition of below-ground biomass is poor, largely because of the difficulties of accessing roots. Below-ground organic matter decomposition studies are scanty and especially rare in the tropics. In this study, we used a litter bag experiment to quantify the mass loss and nutrients dynamics of decomposing twigs and small roots from an arbuscular mycorrhizal fungal associated tree, *Parashorea chinensis*, in a tropical rain forest in southwest China. Overall, twig litter decomposed 1.9 times faster than fine roots (decay rate (k) twig=0.255, root=0.134). The difference in decomposition rates can be explained by a difference in phosphorus (P) concentration, availability, and use by decomposers or carbon quality. Twigs and small roots showed an increase in nitrogen concentration, with final concentrations still higher than initial levels. This suggests nitrogen transfer from surrounding environment into decomposing twigs and fine roots. Both carbon and nitrogen dynamics were significantly predicted by mass loss and showed a negative and positive relationship, respectively. Our study results imply that small roots carbon and nitrogen increase the resident time in the soil. Therefore, better understanding of carbon cycle requires better understanding of mechanisms governing below-ground biomass decomposition.

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Leaf-stem segmentation of drought-induced vulnerability to embolism across

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The vulnerability segmentation (VS) hypothesis predicts that leaves should be more vulnerable to drought-induced xylem embolism than stems. Even if the VS hypothesis has been intensively investigated in the past ten years, there is presently no data for Neotropical trees. Moreover, the current state of knowledge suggests a lack of VS for trees of other tropical areas. Finally, the sacrifice of leaves for the preserving of the hydraulic integrity of stems in the frame of the VS should theoretically limit residual losses of water during water stress, as these losses would be rather driven by the bark. But the real gain (or not) of time for survival to desiccation due to VS is unknown. Here, we assess if the VS exists across Neotropical tree species. If so, we address the advantage of VS in terms of gain of desiccation time to branch mortality (DTBM, days). We investigated VS as the difference in xylem vulnerability to embolism between stems (centrifuge method) and leaves (optical method), across 15 Neotropical canopy tree species. The DTBM was determined as being the time from stomatal closure, to loss of leaf conductivity if VS occurred, to complete loss of stem conductivity. Knowing the total amount of water available in branch-level leaf and stem tissues, leaf, and bark epidermal conductances determine the time to deplete this amount of water. A large diversity of VS degree was spanned, with some species showing large VS whereas some species were not segmented. Segmented species exhibited larger DTBM than under the hypothetical absence of VS for these species. VS does exist for a substantial part of Amazonian canopy tree species. It is an efficient mechanism of drought resistance since DTBM is enhanced. Thus, VS could be relevant for future predictions concerning the functioning and fate of the Amazon forest.

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Using remote sensing techniques to monitor forest degradation and forest regeneration in Madagascar's tropical eastern rainforest

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Large-scale and high resolution quantification of forest dynamics is essential to improve natural resource's management. In Madagascar, recent studies have shown the importance of deforestation, primarily related to subsistence agriculture. However, very few studies attempted to quantify forest degradation and regeneration processes. Our aim was to quantify forest degradation and forest regeneration processes in the eastern Madagascar's tropical rainforest (217,636 km2). We developed a methodology based on above-ground biomass density mapping and change detection between 2000 and 2015. We carried out and collected a forest inventory of 614 plots covering more than 180 ha of intact and secondary forests. A model was then developed by combining inventory data with potentially relevant factors, including satellite imagery, climatic and topographic spatial dataset. The model was applied on 2015 and 2010 spatial dataset and a 2000-2015 carbon change maps was calculated. To account for uncertainty and non-significant changes we calculated a Minimum Difference Detection threshold index based on uncertainty maps in order to derive the final carbon change map. Results shows that show satisfactory quality indexes with R2 greater than 0.8 and a root mean square error of 32 MgC.ha-1. We estimated an average loss of 25 MgC.ha-1 on 2000 intact forest areas (excluding deforestation areas) and a gain 12 MgC.ha-1 for non-forest area converted into forest. We demonstrate that forest degradation and regeneration's extent in the humid region of Madagascar is the same order of magnitude compared to deforestation. This study brings new insight on forest dynamics in Madagascar.

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GS17 – ECOSYSTEM FUNCTIONS and SERVICES

How do environmental and socioeconomic drivers govern biodiversity recovery in natural regeneration of tropical forests?

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There is currently a simplistic understanding of how environmental drivers affect natural regeneration and its outcomes. Moreover, socioeconomic drivers of natural regeneration and the complex feedbacks among environmental and socioeconomic drivers have been overlooked. Understanding how different drivers and their interdependence affect natural forest regeneration and its outcomes at multiple scales is critical for enhancing the delivery of socio-environmental benefits in a cost-effective manner. Here we propose a theoretical conceptual model accounting not only for the direct effects of environmental and socioeconomic drivers governing natural regeneration and its outcomes, but also its indirect effects. We then conducted a global meta-analysis and a systems thinking approach to test our theoretical conceptual model of the pathways through which environmental and socioeconomic drivers affects biodiversity benefits arising from natural regeneration. We revealed that only socioeconomic drivers had direct and indirect effects. The direct drivers are the amount of urban areas and population migration. The indirect driver is HDI, which affects indirectly the benefit from natural regeneration (biodiversity recovery) through urban areas. Although biodiversity recovery is only one aspect of the "Forest Landscape Restoration" approach, the re-colonization of restored forests by old-growth species may help recover other key ecological functions, such as carbon sequestration, other ecosystem services, and improved crop production in neighboring agricultural areas through enhanced pollination and pest control.

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OTHER

Secondary forests dynamics: What are the key societal drivers at local to global scales?

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Secondary forests are becoming the dominating land cover type in tropical landscape yet little emphasis has been put on what are the key societal drivers that regulate such dynamics. Here we analyze two study cases, a tropical dry (TDF) and a tropical rain forests (TRF) in Mexico, that were both colonized after 1970, and assess: 1) the contrasting landscape dynamics in the past 60 years, 2) the biophysical and societal drivers associated to the management decisions of individual tropical forest plots that underpin these landscape dynamics, 3) the state, national and global societal drivers that underpin these landscape dynamics. We used multiple data sources: analysis of remote sensed images, qualitative synthesis of 30 years social-ecological of research, analysis of governmental sources on relevant sources and statistics (demographics, agricultural production). We found that in both areas old-growth forests coexist with secondary forests as pastures are abandoned; in the dry forests agriculture is replaced soon by pastures; in the dry forests abandonment has led to highly degraded systems (e.g. dominated by ferns). The rate of change in land use was highest in both areas after 1990. At the local level, droughts (in TDF), degradation (in TRF), lack of labor and lack of financial resources drive abandonment in tropical forests. At the landscape/regional level, agriculture expansion is promoted by markets, increasing population density, and increased infrastructure. At the national level, policies fostering agricultural development clash with those aimed at biodiversity conservation. At the global scale, demand for products from the tropical forests (e.g. oil palm for TRF) is driving a rapid change in agricultural and pastoral lands. We discuss how these different drivers operating at different scales are interacting and leading to complex dynamics in these contrasting regions.

Thursday, 1 August 2019 | Zircon
GS18 – OTHER

The Queen of Sheba's chickpeas: Trade routes for diversification of domesticated chickpea inferred from landrace genomics

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The geographical spread of crops from centres of origin is often clouded in mysteries, with linguistics and archeology providing incomplete evidence of movement in times before written history. Chickpea, a pulse crop that occurs early in archeological records of the Fertile Crescent, but disappears for a 2000 year period, is currently most widely grown and consumed in subtropical South Asia, and is also an important crop in the East African highlands. Biblical tales of the Queen of Sheba suggest the Ethiopian genepool may be of Middle Eastern origin, as appears to be the case with wheat, although the dark seeded phenotype of Ethiopian landraces suggests a South Asian origin. We aim to shed light on the subtropical transition of chickpea with genomic data. We have developed new approaches for genomic data based on reticulate gene trees analyzed with TREEMIX. We have tested this data with a set of 500 chickpea landraces from the Vavilov Institute for Research in Russia, and that were collected before the green revolution, and a subset of chickpea landraces from the Ethiopian Biodiversity Institute collected in the late 20th century. We find that Ethiopian chickpea landraces bear considerable affinity to South Asian landraces, suggesting that the biblically suggested Middle Eastern source for chickpeas is not likely. We find limited change in genetic diversity of Ethiopian landraces before and after the green revolution. We also find no evidence of replacement of Turkish chickpea landraces from South or Central Asia, which has also been hypothesized. Advances in analyses of genomic datasets provides insights into the historical movement of crop species, and the needs for conservation of declining landraces. Historical collections such as those in the Vavilov Institute for Research that pre-date the green revolution are of particular conservation concern.

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GS18 – OTHER

Tree growth and conservation in semi-arid southern Madagascar

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The threat to the forests of Madagascar is acknowledged to be at a crisis level, nowhere more so than in the semi-arid south, but tree growth characteristics in this region are poorly known. Without a proper knowledge of growth, any reforestation effort could fail or, even worse, damage an already fragile ecosystem. Our work aims to provide a basis for forest restoration through a study of growth and regeneration in the shrinking forest of Berenty, a private reserve in southern Madagascar. A three-year planting program of endemic species was initiated in 2016. Four pilot plots were established in degraded openings with varying microclimates and soil conditions: on the riverside, mid-forest, and in a sunlit area. We planted 2335 seedlings and measured their height, canopy breadth, and stem diameters annually over the period. Our study aims to reveal which common native trees thrive best, where, and under what conditions. It is intended that the selected species will form a nucleus for the repopulation of the forest with ecological processes and functions matching those of the existing canopy areas. The project's long-term goal is to reduce forest decline and restore biodiversity levels to those typical of the remaining forest fragments thus conserving key resources for the endangered lemurs and other endemic fauna. Additionally, we have been collecting, preparing, and cataloguing tree specimens to go in an herbarium in a new research centre which will also include a veterinary clinic and a meeting hall, with visual displays and educational material for school children, local people, and tourists. The centre's aim is to demonstrate the very special nature of this environment, while also acting as a locus for reference material for the fauna and flora of the whole southern biome.

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GS18 – OTHER

Use of camera traps to study the predation of the Puerto Rican Racer (*Borikenophis portoricensis*) in the Cambalache State Forest, Arecibo, Puerto Rico

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Through the development of visual censuses in the Cambalache State Forest, it was found that a large number of *Borikenophis portoricensis* showed scars of possible predators. The research on this type of behavior is complicated due to the secret behavior of snakes. Camera traps have been used in recent years in the study of wildlife with emphasis on the analysis of behaviors, population censuses, occupation, and abundance, among others. Our objective in this research was to analyze the operation of the camera trap "Bushnell Trophy Cam 20MP", using snake models to identify potential predators of the *B. portoricensis* in the Cambalache State Forest. Cameras were positioned in areas in which snakes were observed most frequently. These were programmed to take sequences of photos and videos when a movement was sensed. The models used were covered with plasticine to detect any evidence of attacks that the cameras failed to capture. The data were evaluated according to the number of sightings of predation attempts. In the initial phase of the study, we were able to determine that the combination of two plasticine type was the best result due to the tropical climate of Puerto Rico. Most publications that use this type of method to test predation comes from tempered environments. The models successfully became a part of the environment as both predators and prey showed expected behaviors towards them. It should be noted that the best performance obtained from them was in the activation of the high Censor PIR mode. The main predators observed in these cameras were invasive species such as domestic cats and rats. Most of the reported attacks were in the head and tail, highly sensitive areas, of snakes. The combination of cameras traps and models were useful to identify predation of *B. portoricensis.*

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GS18 – OTHER

Opening the black box: An editor's perspective on scientific publishing

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From the outside, publication in high-impact general-science journals can seem like a mysterious process. A general understanding of the procedures and practices at Science can help unravel the mystery a bit, and contribute to an understanding of what makes a great paper a high-impact-journal paper. In particular, while many researchers strive to publish in these journals because of their high impacts, they are fundamentally general-science journals, and understanding this can help authors assess which aspects of their own work will be most successful in such outlets. I will discuss some of the inner workings of Science and provide insight for helping authors prepare and assess their own work for consideration in high-impact general-science publications.

Thursday, 1 August 2019 | Zircon
GS18 - OTHER

Termite diversity is robust to land-use change along forest-cocoa intensification gradient

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Cocoa is an important crop to Ghana's economy contributing 25% GDP. The crop, however, is mainly cultivated on forest soils and is a major cause of land-use change. Termites are an important biological component of tropical ecosystems providing numerous ecosystem services. Previous studies have indicated termites are sensitive to disturbance and decrease in richness and abundance across land-use intensification gradients, with consequences for the essential services they provide. Native shade trees are often used to improve cocoa cultivation and may reduce the detrimental effects of land-use change on biodiversity. The aim of this study was therefore to explore how termites respond to cocoa cultivation along a shade-tree gradient. We sampled termites along a forest-cocoa gradient at plots varying from 80 to 27% shade cover in the Kakum National Park and surrounding cocoa farms. In the study we predicted that termite richness and abundance would decrease as shade cover decreased. Using a standardized transect method approach termites were sampled at nine plots along the shade gradient. 29 species from 23 genera were collected, with *Ancistrotermes* and *Microcerotermes* found in all the plots. Species richness and abundance showed no particular trends across the land-use gradient, and composition did not alter significantly indicating that despite a change in the dominant vegetation type, termite communities were robust to the disturbance. In contrast to our prediction termite richness and abundance did not change along the shade gradient.

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GS18 – OTHER

Testing the environmental prediction hypothesis for general flowering using flowering phenology data monitored at the Pasoh Forest Reserve in Malaysia

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Ultimate factors of general flowering, one of spectacular masting events observed only in tropical rain forests in southeast Asia, have been argued in the context of predator satiation, pollination efficiency, and environmental prediction hypotheses. The environmental prediction hypothesis for general flowering have the potential to bridge the proximal and ultimate explanations of general flowering because which environmental cues are used for flowering has a significant impact on seedling recruitment. In this study, we tested the environmental prediction hypothesis of general flowering using high temporal resolution data of flowering phenology and climatic factors monitored at the Pasoh Forest Reserve in Malaysia. We first detected causal relationship between flowering phenology and potential environmental trigger of flowering to identify potential environmental cues for flowering. Secondly, we addressed whether the environmental trigger of general flowering causally influences improved water availability during the period of seed germination and seedling growth. If environmental prediction hypothesis is true, causal relationship between proximate cue of flowering and improved water availability during seedling growth should be detected. Our analyses showed that there is a clear causal relationship between proximate cue of flowering and improved water availability during seedling recruitment. This is the first report testing the environmental prediction hypothesis in tropical rain forests.

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GS18 – OTHER

GS19
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Comparitive breadth of niche between sympatric *Macaca leonina* and *M. mulatta* in a fragmented tropical forest, southwest China

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The coexistence of species is a basic question in ecology and one of the most interesting issues for primate researchers. As the core of classical coexistence theory, the niche differentiation is considered as a stable mechanism to reduce competition and promote coexistence. The *Macaca leonina* and *M. mulatta* are dominant macaque species in Naban River Watershed National Nature Reserve (NRW-NNR), a fragmented tropical forest in southwestern China. Based on the camera trapping data obtained from 2012 to 2016, their potential distribution was modeled by Maximum entropy model (MaxEnt) respectively. *Macaca leonina* was predominantly at higher elevation and *M. mulatta* at lower elevation. The broad-leaved evergreen forest was suitable for both of them, while the rubber forest was unsuitable and restricted the spread of macaque. The niche indices were analyzed in three dimensions of elevation, habitat and activity pattern. The two macaques coexisted with a highly spatio-temporal niche overlap. Their niche was tended to be mainly differed in habitat, including elevation and vegetation dimensions. Driven by space limitation in the overlapping area, the significant differentiation of activity pattern was started up. The niche differentiation occured in at least one dimension for their stable sympatry. *Macaca leonina* exhibited a flexible niche breadth, which was wider in general, but narrowed in overlapping area and varied more obviously in seasons, compared with *M. mulatta*. More comparative studies between these two macaques in other dimensions are needed in the future.

Friday, 2 August 2019 | Opale
GS19 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Context dependency in plant interactions: Meta-analysis of facilitation and competition in coastal dunes

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Plants established next to other plants may have their performance positively or negatively affected by neighbors, which characterizes interactions of facilitation and competition, respectively. However, facilitation and competition may occur simultaneously and understanding which one predominates in pairwise interactions under different ecological contexts is important to comprehend the structure and dynamics of plant communities. According to the stress-gradient hypothesis (SGH), facilitation would prevail in more severe environments, but the outcome of interactions may change depending on features of interacting individuals, such as life form and ontogenetic stages. As harsh conditions and high diversity of plant life-forms are characteristic of coastal dunes, the amount of studies about plant interactions has been rapidly increasing in these ecosystems, with apparent divergent conclusions. We conducted a meta-analysis to investigate how environmental stress and the simultaneous influence of plant life form and ontogenetic stage affect the outcome of facilitation and competition in coastal dunes around the world. We used four performance metrics to estimate the outcome: abundance, survival, growth, and reproduction. Contrary to predictions of SGH, we found that negative impacts of neighbors on plant reproduction increase towards more arid conditions, but this effect was not observed for other performance metrics. Our results also indicate woody neighbors facilitate the survival of woody seedlings and the reproduction of herbs, while herbaceous neighbors facilitate the growth of other herbaceous plants. Overall, the outcome of plant interactions in coastal dunes depends on the measured performance variable and on both environmental conditions and plant features, indicating an interaction between these factors. Benefits of woody neighbors to the survival of woody seedlings corroborate the concept of successional feedbacks in the beach-inland physiognomic gradient, and reinforce the use of nurse plants in coastal dunes as a valuable tool to restoration of these endangered ecosystems.

Friday, 2 August 2019 | Opale
GS19 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Competition for nest cavities among introduced parrots in Singapore

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Over the past half century, populations of the heavily traded Critically Endangered Yellow-crested Cockatoo (*Cacatua sulphurea*) have been established in two wildlife trade centres: Hong Kong and Singapore. In Hong Kong, the ex-situ population has grown slowly but steadily over time, while the Singapore population has remained small. Introduced urban populations may play an important role in the long term conservation of this species, therefore it is important to understand what factors contribute to these different trajectories. One major factor may be competition for nest-holes, a rare resource in heavily urbanized areas. In Singapore, several species of medium- and large-bodied cavity-nesting birds compete for nest holes, while in Hong Kong, cavity nesting species are rare in urban areas. To test whether population declines of Yellow-crested Cockatoos in Singapore may be attributed to nest-hole competition, we recorded antagonistic interactions between birds around nesting sites in Singapore during 270+ focal watch hours during the 2019 breeding season. We observed 316+ interactions involving 30+ species. Top aggressors include Goffin's Cockatoos (*Cacatua Goffiana*), Javan Mynas (*Acridotheres javanicus*) and Red-breasted Parakeets (*Psittacula alexandri*), all introduced species in Singapore. Resident Oriental Pied Hornbills (*Anthracoceros albirostris*) were also aggressive around nest sites, and have significantly increased in number over the last few years. Similar work being carried out in Hong Kong suggests that competition over this resource is minimal, suggesting that differences in competition between the two cities may at least partially explain the different patterns of population growth. In Singapore, we also observed mixed species flocks, hybrid fledglings and staggered nesting cycles, indicating complex ecological interactions in urban areas. Monitoring inter-specific interactions and quantifying levels of competition for finite breeding resources will provide important information to the broader conservation and management strategy for *C. sulphurea* and other urban adapters, and help to develop solutions.

Friday, 2 August 2019 | Opale
GS19 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Nematode - scarab beetle interactions in the Indian Ocean with a focus on Réunion Island

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The nematode *Pristionchus pacificus* has been established as a satellite model organism to the already well-studied nematode organism *Caenorhabditis elegans* for comparative studies in developmental biology, ecology, and population genetics. Like *C. elegans*, *P. pacificus* is a self-fertilizing hermaphrodite with a small percentage of male offspring, which can mate with hermaphrodites and thus allow genetic experimentation and facilitate recombination between different lineages. Extensive world-wide sampling revealed that *Pristionchus* worms are soil nematodes, which are reliably found in an association with scarab beetles, providing a framework for the integration of lab-based studies with field work. Rather than being symbiotic or parasitic, *Pristionchus* nematodes have a necromenic association with these beetles. This means that they sit in a growth-arrested stage on the beetle and only resume development to become adult after the death of the beetle while feeding on microorganisms that grow on the beetle's carcass. Wanting to understand island biology, invasion and distribution of nematodes, we started to explore La Réunion in 2008 and have been in the region at least once a year since then. Together with endemic and introduced beetles we could isolate hundreds of strains of *P. pacificus* and other *Pristionchus* species on La Réunion. Molecular tools allow us to identify the origin of introductions and to show dispersal and divergence on the island. La Réunion got colonized several times independently, from different parts of the world, both with species of *Pristionchus*, which surprisingly all were hermaphroditic while only 15% of all *Pristionchus* species are hermaphroditic, and strains of *P. pacificus*. The introduction of *P. pacificus* strains happened multiple times from different, sometimes unknown areas. Other islands in the Indian Ocean were used for comparison with very mixed results.

Friday, 2 August 2019 | Opale
GS19 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Reproductive ecology, pollination, and floral visitors of Malagasy plants

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Madagascar, the island continent, boasts a unique flora of over 12,000 plant species of which over 80% are believed to be endemic. Unfortunately, it is a highly threatened biodiversity. Malagasy endemic plants are poorly known with regards in reproductive ecology, floral visitors, and pollination. We present an overview in these fields based on published papers and field observation for over 10 years. Studies were undertaken for 22 species, included in 14 families: Annonaceae, Apocynaceae, Araceae, Commelinaceae, Euphorbiaceae, Gentianaceae, Lamiaceae, Leguminosae, Malvaceae, Orchidaceae, Melastomataceae, Passifloraceae, Pedaliaceae, and Winteraceae. Plant reproductive mechanisms include selfing, overnight sex changing, pollination by deceit, foraging reward, and shelter. Identified floral visitors were beetles, moths, bees, wasps, birds, and lemurs. Further works remain to be done in this area in order to insure conservation of Malagasy biodiversity.

Friday, 2 August 2019 | Opale
GS19 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Variation in social dominance in six mouse lemurs across an ecological gradient in northwestern of Madagascar

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Social dominance and rank have been shown to influence the social relationships formed by individuals of many species and may regulate the access to limited resources in times of low resource availability. It remains a controversial subject in how far dominance patterns vary between closely related species and in how far they are influenced by ecological and biological factors, such as forest type and reproductive activity. We investigate some sources of variation in social dominance developing in male-male and male-female dyads in a nocturnal primate radiation, the Malagasy mouse lemurs (*Microcebus* spp.). We explored the patterns of inter-(male-female) and intra-sexual (male-male) interactions among six closely related mouse lemur species, at six sites in northwestern Madagascar using a standardized social encounter paradigm. Six intra- and six intersexual pairs were being observed per species, each for 3h at the beginning of their activity period, over six consecutive days (18h in total). Direct observations were conducted with all agonistic behaviors of both pair partners being recorded whenever they occurred. Dominance was determined by comparing the number of decided conflicts between the dyad partners. Male-female dyads of the six species differed significantly in the frequency of agonistic behaviors. Results suggest that mouse lemur females have higher aggression rates and more agonistic conflicts with males when females in the population are reproducing, at least in resource-rich humid forests. Variations in aggression rates between male-male dyads could be influenced by differences in forest type and/orin reproductive state. Only one (*M. mamiratra*) out of five species showed signals of unambiguous female dominance in all male-female dyads. The study confirms a higher degree of social plasticity between species than previously expected in these small solitary foragers and its requires further scientific attention.

Friday, 2 August 2019 | Opale
GS19 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Determinants of native fish species turnover in the Western Ghats, India

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Rivers in South Asia are amongst the most threatened ecosystems, which poses major challenges for both conservation and livelihoods. Response of species assemblages to habitat heterogeneity across spatial and environmental gradients has been poorly investigated in South Asian Rivers. I adopted a hierarchical nested design. Two sub-basins namely Bhadra and Tunga were selected, which were similar in their elevation range and habitat types in the central Western Ghats, India. Fishes were sampled by using castnet with different mesh sizes in every segment over wet seasons from 2013 to 2014. Various stream habitat characteristics were also measured. Bray-Curtis dissimilarity index was used to quantify the species compositional change in native freshwater fishes at sub-basin and a local (segment) scale. To understand the spatial structure of fish communities in each sub-basin I used mantel's correlogram. In total, I recorded 46 species with 6209 individuals in two sub-basins. Bhadra was more impoverish sub-basin (21 species) than Tunga (45 species). The Mantel's correlogram indicated a sine-hole pattern suggesting a high turnover at small spatial scale in both sub-basin. In Bhadra, it was significantly associated with stream order (Mantel r= 0.17), rocks (r = 0.14), and canopy cover (r =0.12), while negatively correlated with depth-width (r= -0.01), water temperature (r = -0.03) etc. In Tunga, it was positively and significantly associated with gravels (r = 0.27), rocks (0.26), and boulders (r = 0.16). The species composition did not vary across three habitat types suggesting habitat connectivity and fish mobility in the wet season. This study showed the spatial turnover at smaller spatial scale indicating a dispersal limitation. Additionally, environmental variables (niche based processes) such as stream characteristics influenced the fish species turnover. Future studies should focus on covering multiple season covering different stream habitat types to understand the fish species turnover at larger scale.

Friday, 2 August 2019 | Opale
GS19 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS20
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Ecological characterization of dry forest of Antrema for ecological monitoring

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Dry forests cover 7.7 % of the territory of Madagascar, they contain unique biodiversity and constitute one of the economic assets of primary importance. However, faced with heavy constraints on them, their area continues to deteriorate. Thus, the present study was conducted with the objective of establishing an ecological monitoring system in the Antrema Protected Area to reinforce the strategy of conservation of natural resources. Permanent Monitoring Plot and Braun Blanquet's Plot methods were used to collect floristic and structural data. The results obtained show that the overall floristic richness is high with a rate of endemism of 76%. Microphanerophyts are the most abundant. Woody individuals are dominated by trees and shrubs 10 to 15 cm in diameter. The different formations have low wood potential, with a biovolume of less than 27 m^3/ha. However, the natural regeneration analysis showed that these formations are still in good health and the dominance of the regenerated individuals insures the vegetal repopulation of these formations, and the exploitable wood resources of the useful species for the local population are still available in each formation. The knowledge on the current state of the vegetation helps the manager of this protected area to make decisions for the development of each formation. Thus, the work of regular ecological monitoring of the delimited parcels and the enlargement of permanent plots in other forest formations are recommended.

Friday, 2 August 2019 | Grenat
GS20 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Malagasy inselbergs: Neglected but floristically diverse and in need of conservation

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Globally, inselbergs which are isolated mountain rock outcrops, mostly of granitic or gneissic origin, constitute old terrestrial habitat islands and are widespread throughout the tropics. They form prominent landscape features, mainly in the central highland regions and have clearly been neglected by the botanical and conservation communities in Madagascar. It was demonstrated that this specific habitat provides important ecosystem services such as source of mineral water. Besides, only few Inselbergs are currently encompassed within the Madagascar System of Protected Areas. The selection of inselbergs took into account parameters such as accessibility, relative intactness and sites known to be under-collected. General plant collecting method used by Missouri Botanical Garden was applied. Furthermore, local vernacular names for the plants provided by local informants were recorded, as well as their local uses. Extensive fieldwork has been conducted in more than 40 Malagasy inselbergs. More than 800 species of vascular plants have been recorded on Malagasy inselbergs, which represents a high species richness for these ecosystems, particularly amongst some groups such as succulents, terrestrial orchids, resurrection, and carnivorous plants. This habitat is home to many desiccation-tolerant plants that survive in a dry state for at least several months. Direct observations in the field indicated that Malagasy inselbergs are currently threatened by habitat degradation due to human pressures. Many of the species encountered on inselbergs are highly endangered and classified as threatened. From 177 species assessed for their risk of extinction, four are classified as Critically Endangered, 37 as Endangered, and 35 as Vulnerable. Inselbergs are under-represented within the Protected Area network of Madagascar. Conservation of this unique ecosystem is urgently needed at regional, national as well as international levels.

Friday, 2 August 2019 | Grenat
GS20 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Wood anatomy analysis for identification of some Malagasy *Dalbergia* species

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Wood anatomy has a major role in law enforcement to help protecting endangered tree species from illegal logging and to support CITES, which restricts international trade in endangered species. Madagascar is home to commercially important precious woods: rosewood and palisander belonging to the genus *Dalbergia*, recently listed in Appendix II of the CITES treaty. Identification is the basic element for CITES enforcement and legislation which requires identification to the species level. Controlling the international trade in timber from Madagascar is currently not feasible because species identification and provenance assignment are not possible from logs where morphological traits used in species identification such as flowers, bark, and fruits are not available and reliable tools for species and provenance identification remain to be improved and validated. The aim of this project is to contribute to control of precious wood trading by proper identification. Wood samples were collected in different bio-geographical regions of Madagascar. Standard macroscopic and microscopic methods for wood anatomy study were applied on 14 commercially valuable Malagasy *Dalbergia* species and a key mainly focused on wood identification was developed, based on origin and porosity. All species from western areas have distinct dry season growth rings and these species are categorized according to the type and the arrangement of parenchyma cells. In contrast, eastern species show aliform and banded parenchyma. However, some western species have aliform and sometimes marginal parenchyma. For some other species, which fall in the same category, microscopic features such as type and width of ray and number of storied structure can be used to separate them at the species level. This study answers the expectations of the Madagascar action plan for *Dalbergia* spp. about the establishment identification system for CITES-listed species.

Friday, 2 August 2019 | Grenat
GS20 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Detecting economically important palms using UAV imagery in intact, moist tropical forest

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Palm trees are important resources in the moist tropical forest due to the provisioning ecosystem services that they supply, especially for fruit production. Some of these fruits are considered as “super foods” due to their rich nutritional values, and they are an important food for both local communities and fauna. A common constraint to expanding sustainable management of palms in intact forest has been the difficulty of mapping their abundance and distribution at large scales. Typical ground-based surveys sample small areas, while management decisions require precise information at larger scales. In recent years, small Unmanned Aerial Vehicles (UAVs) have become an important tool for mapping forest areas as they are cheap and easy to transport, and they provide high spatial resolution imagery of remote and difficult-to-access areas. This study combined field data and RGB UAV imagery to identify and delineate palm tree crowns in intact forest in the Peruvian Amazon. Eight permanent RAINFOR plots with 1,472 reference palm trees were flown with a Phantom 4Pro UAV from October to December 2017 in the Loreto Region, Peru. The results indicate that the textural information obtained from the RGB imagery combined with the canopy height model can identify important palm species like *Mauritia flexuosa*, *Euterpe precatoria*, and *Oenocarpus bataua* with an overall accuracy of 84% using a support vector machine radial algorithm. However, since the UAV camera only takes pictures of the canopy, on average, only 73% of the referenced palm trees were identified, and understorey palms were often missed. The integration of field and UAV data has the potential of providing precise estimates of resource availability at scales relevant to forest management, especially where cloud cover limits the use of satellite imagery, and the large areas and accessibility restrict ground-based surveys.

Friday, 2 August 2019 | Grenat
GS20 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Genome wide association study approach for tropical timber species to enhance productivity through planting activities

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Tree species belonging to Dipterocarpaceae are distributed in tropical forests in Southeast Asia and occupy the large portion of canopy in the area. These species provide not only various ecological services but also main timber production from the area. This timber, known as lauan, has been produced from mainly natural stocks in the area using selective logging protocol. However, stocks are largely declined, and recovery rate is slower than expected, therefore, it is necessary to promote enrichment planting and develop effective technologies to improve production of timber species. To improve growth and productivity of planted dipterocarp timber species, we applied genome wide association study (GWAS) to identify genetic markers which are closely linked genes involved in focal phenotypes. Progeny trials for two dipterocarp timber species, *Shorea leprosula* and *S. platyclados*, located in Sari Bumi Kusuma forest concession at central Kalimantan are used. Double digestion restriction site associated sequencing (dd-RAD seq) represented 1,442 SNP loci among 344 individuals in the progeny trial of *S. platyclados*. Decay of LD was very rapid like other outcrossing tree species with large population size (r^2 = 0.2 at 1,059 bp). General Linear Model (GLM) explaining population structure showed that three SNP loci were significantly associated with height of trees and a SNP locus was significantly associated with branch angle after Bonferroni correction. Analysis of GWAS for *S. leprosula* is now ongoing. We found some significantly associated loci with the focal phenotypes which are important to improve productivity of enrichment planting. We will perform marker assisted selection (MAS) from the existing genetic resources in natural forest to select plus trees. These plus trees should increase productivity of enrichment planting, which contributes not only timber production but also other ecological services, such as mitigation of climate change through enhancing stock of carbon.

Friday, 2 August 2019 | Grenat
GS20 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Evaluating diversification mechanisms in biodiversity hotspots

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Rapid developments in high-throughput sequencing technologies have increased the documentation of biodiversity in far greater detail than previously possible. The widespread generation of genome-wide SNP (single nucleotide polymorphism) datasets and adoption of High Performance Computing and bioinformatics enable a wide variety of ecological and evolutionary questions to be addressed for both model and non-model organisms. I focus on identifying and quantifying the historical and contemporary diversification mechanisms that have shaped extant biodiversity across multiple taxa. For many Afrotropical vertebrates, isolated forest refugia are thought to have played an important role in the diversification of intraspecific populations throughout Quaternary climate oscillations. However, this hypothesis has not been tested against alternatives due to a lack of appropriate high-resolution data. By explicitly testing forest refuge against alternative models (landscape barriers/ecotones/anthropogenic effects) in a demographic model-testing framework (∂a∂i) with genome-wide SNP (RAD-seq and exome) data, I quantitatively evaluate diversification hypotheses with novel datasets of amphibians (East Africa) and primates (West/Central Africa). Genomic data are supplemented by divergence dating, ecological niche models and connectivity modelling through time. Though multiple taxa show congruent biodiversity patterns (e.g population structure), the mechanisms shaping these patterns across species can vary considerably, and the forest refuge hypothesis is only partly applicable, with rivers in particular playing an extremely important role in most population divergences. Using an integrated framework which captures mechanisms of isolation, migration, secondary contact and population size changes allows powerful inference about population histories to be made, and enables a clearer mechanistic view of how biodiversity accumulates. With this we can improve our understanding of the processes that shape biodiversity patterns in tropical biodiversity hotspots, with multiple taxa and at varying scales, providing useful data for future conservation prioritisation.

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GS20 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Lemurs and birds as frugivores and potential seed dispersers of mistletoe in a southeastern rainforest of Madagascar

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The epiphytic hemiparasitic mistletoe, *Bakerella* spp. (Loranthaceae) is considered a keystone species in Madagascar's tropical rainforests because it produces high-lipid fruits year-round, providing food resources for many frugivores. Yet, we know relatively little about the nature and extent of its interactions with frugivores, which may rely on its fruits during periods of food scarcity. Here, we aim to measure the dispersal of *Bakerella* spp. by two taxonomic groups of frugivores in the southeastern rainforest of Madagascar. We collected four months of data through direct observations of 24 trees with fruiting *Bakerella* spp., at different times throughout the day, to record the visitation and fruit removal by frugivores. We also performed germination experiments, directly on host trees and in Petri dishes, using lemur-defecated seeds and manually depulped seeds from unripe and ripe fruits. We observed 57 visitations of *Bakerella* from 15 frugivorous bird species and 66 visitations from four lemur species. The total number of seeds consumed by lemur visitors was almost double that of bird visitors. While lemurs consumed about the same proportion of ripe and unripe fruits, birds consumed twice as many unripe fruits than ripe ones. Seeds from lemur feces had significantly higher germination rates (78.3%) than the manually depulped seeds (0%) in both lab and field conditions. We were unable to obtain seeds from bird scats for a comparison. Bird consumption of more unripe fruits indicates that they may provide a lower quantity dispersal of *Bakerella*. However, more work is needed to examine deposition sites of seeds by the different frugivore groups onto the branches and trunks of host trees, a necessary step for mistletoe recruitment. Our study is an important first step for understanding of the role of lemur and bird frugivores in seed dispersal of an important and potentially keystone resource in a biodiversity hotspot.

Friday, 2 August 2019 | Grenat
GS20 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS21
ECOSYSTEM FUNCTIONS and SERVICES

Associations between stream fish assemblage and riparian vegetation in Amazonian streams of southern Colombia

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Recent evidence shows that aquatic and terrestrial systems are connected by physical, chemical, and biological interactions. In the Amazon bioregion, these ecosystems are annually interconnected during several months as a result of the flood pulse. This is the case of blackwater streams, which represent a dominant Amazonian ecosystem that despite being an oligotrophic system, sustain high diversity of fishes mainly because of the resources coming from the riparian forest. However, little information is available on this interaction for the region. In this research, we evaluated the contribution of riparian vegetation to the fish assemblages in three Amazonian streams in Leticia City, southern Colombia, during high and low water periods (May and October 2018, respectively). Fish sampling was conducted using trawling and gill nets along nine transects (250 m) across a gradient of vegetation structure. At 27 points we quantified physicochemical parameters, surveyed riparian vegetation structure within quadrats, and collected allochthonous inputs (e.g., seeds, fruits and arthropods) falling into the stream using pan traps. These streams are acid [mean (SD); pH: 6.6 ± 0.6] and oligotrophic (Secchi transparency 0.64 ± 0.39 m, conductivity: 42.56 ± 21.09 µS / cm, dissolved oxygen 8.8±16.5 $mg.l^{-1}$). 115 species of fishes were found, mostly Characiformes (56.25%) and Siluriformes (18.75%). Highest fish diversity was associated with forested riparian zones. Eight trophic guilds grouped most of the local ichthyofauna. Allochthonous food items were dominant resources found in stomach contains in fishes during low water (39,1% of total). Streams with riparian forest in the surroundings showed a higher input rate of arthropods compared to those with herbaceous vegetation (0.88 $ind.m\text{-}^{2}.d\text{-}^{1}$ vs. 0.23 $ind.m^{-2}.d^{-1}$, respectively), with fishes using more allochthonous resources in the former. Our findings suggest that highly dynamic terrestrial-aquatic trophic linkages can help explain the high diversity of fish assemblages in Amazonian blackwater streams.

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GS21 – ECOSYSTEM FUNCTIONS and SERVICES

Generality of Demographic Trade-offs in Undisturbed and Hurricane Disturbed Tropical Forests

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All organisms face resource allocation trade-offs that underlie demographic processes (growth, survival and reproduction), which restrict the range of viable life-history strategies. For tropical tree communities, two major strategy axes have been identified: 1) a trade-off between growth and survival, corresponding to a fast–slow lifestyle continuum; and 2) a trade-off between fast growth and high survival, versus high recruitment rates, corresponding to a stature–recruitment axis. However, it is unclear if tropical forests differing in climate and disturbance regimes are structured along these two axes. Using Bayesian models and weighted Principal Component Analysis, we quantified demographic trade-offs across 10 large tropical forest plots from the ForestGeo network. Our results show that forests that are relatively undisturbed are generally structured by the growth-survival and stature-recruitment trade-offs, albeit with differing intensities. For disturbed plots after major hurricane events, we observe a decoupling of growth and survival rates, and the emergence of two novel strategy axes: a survival–recruitment, and growth–recruitment trade-offs. The length of the dry season, and the number of coexisting species, did not appear to be related to the observed demographic trade-offs. Our findings reveal how environmental constraints alter the demographic structure of tropical tree communities, and allow us to predict forest dynamics and carbon storage under changing conditions, such as the predicted increase in hurricane frequency.

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GS21 – ECOSYSTEM FUNCTIONS and SERVICES

Exploring the drivers and agents of decomposition in South African savannas

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Grass and dung represent over a third of the total carbon stock of savannas in South Africa. The process of decomposition transfers this carbon back to the soil, other organisms or the atmosphere. The main agents of decomposition are fungi, bacteria, and soil/litter invertebrates such as termites. The rate of decomposition by these biological agents is thought to be principally mediated by rainfall and temperature. The first aim of our study was to compare the rate of grass and dung decomposition between a medium (650 mm/annum; Wits Rural Facility) and low rainfall savanna site (300 mm/annum, Nwanedi Nature Reserve) in South Africa. We expected that decomposition rates would be greater at our higher rainfall site, as both termite and microbial activity increase with rainfall. Our second aim was to quantify the different biological agents that contribute to decomposition. To achieve this, we conducted a novel large-scale manipulative field experiment to suppress termite activity in our medium rainfall site. This allowed us to make the first quantification of the relative contribution of termites and microbes to grass and dung decomposition. The termite standing biomass in African savannas has been estimated to be between 70 and 110 kg ha^{-1}, comparable to that of both ungulates and megaherbivores. Given their dominance in savanna landscapes, we expected that in the absence of termites there will be significantly lower rates of both grass and dung decomposition. A better understanding of the drivers and agents of decomposition will help improve the accuracy of modelling savannas and global carbon budgets in the face of a changing climate.

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GS21 – ECOSYSTEM FUNCTIONS and SERVICES

Drivers of biomass dominance structure in Neotropical secondary forests

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Community composition and structure change in space and time along environmental and successional gradients. These changes in community structure translate to changes in ecosystem functions. Surprisingly, few studies have formally analyzed how community structure changes across environmental and successional gradients over broad biogeographic scales, thus limiting our understanding of patterns and causes of such changes and subsequently of ecosystem function drivers. We analyzed changes in biomass, a key driver of ecosystem function, across a wide range of successional plots and environmental gradients in the Neotropics to understand how biomass distributes among species in the community and how do temporal (i.e. successional) gradients and gradients in water availability and soil fertility influence the biomass structure of communities. To this end we used chronosequence data from over 40 sites and 1000 plots and hierarchical models to analyze the effects of plot and site factors jointly. Preliminary results show that with succession, fast-growing early-successional species give way to a more diverse group of slow-growing late successional species, leading to a decrease in biomass dominance and an increase in biomass evenness. A weak pattern of lower dominance and higher evenness with increasing rainfall was found likely as a result of an increase in functional diversity with rainfall. A weak pattern of higher dominance and lower evenness with increases in soil fertility was also found; this could relate to competitive species capitalizing on high resource availability. Our results show that temporal changes and environmental variation significantly and directionally affect forest biomass distribution across species. Species biomass is closely related to species contribution to ecosystem functioning. From a practical perspective, successional, precipitation and soil fertility effects on the distribution of biomass among species in a community should be accounted for in projects of conservation and restoration of biomass driven ecosystem functions.

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Fertilization of soil nitrogen by symbiotic nitrogen-fixing trees – a case of "altruism" in tropical forests?

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Symbiotic nitrogen-fixing trees, which have the capacity of accessing atmospheric dinitrogen gas via nodule-dwelling nitrogen-fixing bacteria, play a key role in facilitating tropical forest regeneration. Their strategy of fertilizing soil with nitrogen-rich leaf litter and facilitating growth of other species that rely on soil nitrogen represents perhaps a unique case of "altruism" in tropical forests. Plants conserve leaf nitrogen by breaking down chlorophyll and re-absorbing leaf nitrogen during leaf senescence. Symbiotic nitrogen-fixing trees, which typically have high leaf nitrogen content, have been shown to re-translocate less leaf nitrogen compared to other species. Nitrogen-limited environment should in theory provide symbiotic nitrogen-fixing trees a competitive advantage, whereas fertilized nitrogen-rich soil would help non-fixing neighbors to grow. Why, then, did nitrogen-rich symbiotic nitrogen-fixing trees develop low leaf nitrogen resorption rate, instead of keeping the nitrogen advantage to themselves? Understanding this question offers theoretical insights in the evolution of plant nutrient conservation strategies and practical guidance on management of tropical biogeochemical cycles. We here developed a theoretical model to investigate the relationship between nutrient conservation strategy (i.e. leaf nitrogen resorption rate, R) and nitrogen fixation rate. We specifically modeled the physiological processes underlying photosynthesis and leaf senescence, and analyzed trees' fitness under competition for light and nutrient. Using adaptive dynamics, we calculated the evolutionarily stable strategy of R given different fixation rate. We found that, in monoculture, as fixation rate increases, R increases. This result is driven by the intricate balance of how fixation and resorption together affect the equilibrium soil nitrogen availability, and leaf layer construction using nitrogen from soil nitrogen uptake and fixation. High leaf nitrogen loss rate of symbiotic nitrogen-fixing trees might have evolved in monoculture, which then resulted in interesting forest successional dynamics when interacting with other non-fixing individuals.

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Large frugivores matter: Insights from network and seed dispersal effectiveness approaches

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While large avian frugivores are known to be key dispersers for large-seeded tree species, their role in community-wide plant-disperser networks are still poorly known. Large avian frugivores are also among the most threatened due to anthropogenic impacts. We evaluated the role of large avian frugivores in a plant-disperser community by a) determining whether the plant-disperser community was modular, with a distinct community of large frugivores, b) determining relative qualitative and quantitative roles played by large-bodied frugivores vis-à-vis other frugivores, and c) determining impacts of large-bodied frugivore loss on the plant-disperser community. The study was conducted at a tropical forests of northeast India which are part of the Eastern Himalaya Biodiversity Hotspot. We collected tree watch data (2055 h) from 46 tree species, which represented 85% of tree species that are predominantly bird-dispersed in the area. We found that the plant-disperser community was modular, with a distinct module of large-seeded tree species and large frugivores. Intermediate-sized frugivores such as barbets and bulbuls were the most connected, while large-sized frugivores, such as hornbills and imperial-pigeons were moderately well-connected. Qualitative and quantitative roles played by different dispersers varied across the gradient of frugivore body size. Hornbills, the largest avian frugivores, consumed significantly greater number of fruits and swallowed larger proportions of fruits as compared to other avian groups. In comparison to similar-sized frugivores, imperial-pigeons fed on larger-sized fruits, highlighting their importance for dispersal of large-seeded plants. Under simulated extinction scenarios, extinctions of frugivores with high species strengths (including hornbills and imperial-pigeons) resulted in larger extinction cascades. Integrating information from networks and seed dispersal effectiveness approaches enabled a better understanding of large frugivore role in a plant-disperser community. While large-bodied frugivores may not play a central role in plant-disperser communities, they are crucial as seed dispersers for large-seeded plants.

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GS21 – ECOSYSTEM FUNCTIONS and SERVICES

3D modeling of tropical dry forest using UAV imagery and Structure from Motion

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Tropical dry forests (TDF) are highly threatened. Despite their importance as vital resources for wildlife, people, and livestock, TDF in southern Madagascar remain relatively little studied and only coarsely mapped in country-wide forest mapping efforts that have largely focused on rain forests. TDF types exhibit significant variation in both vertical and horizontal structural elements. By exploiting this variability, we hypothesize that we can resolve differences in TDF types and create vastly improved forest maps. Unfortunately, data used to model 3D forest structure, such as LIDAR, are not readily available. Here we present an alternative means of constructing 3D models of TDF. Using a consumer-level unmanned aerial vehicle (UAV), we collected high-resolution imagery and then created digital surface models of TDF. Data were collected at Bezà Mahafaly Special Reserve in southern Madagascar where TDF types are aligned along a gradient of deciduousness. Forest here is also representative of TDF found throughout the region. Flight paths throughout the reserve were created using Map Pilot. The UAV was flown in grid transects with 90% overlap; orthomosaics and 3D forest models were computed with Pix4D using Structure from Motion (SfM) photogrammetry (a method of extracting 3D structure from overlapping photographs). Dry season was the ideal sampling period for TDF mapping because differences in forest canopy structure are more distinctive at this time. 3D maps reveal significant differences in forest structure and canopy height between forest types. Maps of smaller areas were less accurate than larger ones (2-5 ha) owing to greater edge density where transect overlap was reduced; however, flights over larger areas required significantly more batteries. 3D models derived from UAV imagery show great promise for improving forest classification maps of Madagascar's TDF. And given forest structure is correlated with biomass, primary productivity, and biodiversity, these low-cost 3D models could open up new avenues of research.

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GS21 – ECOSYSTEM FUNCTIONS and SERVICES

GS22
THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Are plant populations demographically better off in a diverse community?

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Understanding the threat to and measuring the consequence of biological diversity in terms of ecosystem services is a central goal of conservation biology. The general assumption is that increasing biological diversity has positive effects at the population, community and ecosystem levels. However, our mechanistic understanding of if and how species diversity affects plant population demography and dynamics is limited. We studied the consequence of biological diversity on the demography and dynamics of African mahogany (*Khaya senegalensis*), an important tree species in West Africa which is pruned by Fulani for their livelihoods. We asked if African mahogany was better off in a diverse community than in species-poor plant communities while accounting for the confounding effect of anthropogenic disturbance. To understand why diverse communities can be beneficial for a given plant species we investigated the effects of species diversity on positive (facultative mutualism) and negative (gall parasitism) ecological interactions in African mahogany communities. Weaver ants protect African mahogany trees against shoot borers (herbivore) and in return, the trees provide foliar shelter and honeydew from scale insects. In addition, African mahogany leaves are attacked by galls both in natural populations and in plantations. We show that pruning by the Fulani led to the disruption of mutualism between weaver ants and mahogany trees, forcing weaver ants to use a greater number of alternative plant host species than expected by chance in disturbed populations. The number of these weaver host plant species increased with total site species diversity. Contrary to the theory of biotic resistance, species richness did not significantly affect leaf galls prevalence. Similarly, gall prevalence was not significantly affected by pruning. Our study highlights the conflicting impact of biological diversity on ecological interactions that may explain the potential weak influence of diversity on population dynamics.

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GS22 – THREATS, PRESSURES, AND SUSTAINABLE DEVELOPMENT

Transforming human-wildlife interactions by integrating mitigation, compensation, and technology

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Addressing human-wildlife interactions is a global conservation challenge. The role of mitigation investments and compensation payments in resolving human-wildlife conflict are widely debated. I examined procedures, types and payments made for incidents reported in India's 29 states from 2010-2015. Across India, 81,100 total incidents were reported (73% crop loss and property damage, 21% livestock predation, 6% human injury, and < 0.4% human death). Payments totaled US$ 5.3 million (average expenditures per incident were US $46 for crop and property damage, $68 for livestock, $103 for human injury, and $3,188 for human death). Mitigation efforts by > 5000 households living around 11 parks were also evaluated. A household's conflict history, proximity to parks, and crops grown/livestock owned were associated with higher mitigation use. Finally, insights from Wild Seve- a live mobile based conflict monitoring and compensation reporting program will be shared. This program has assisted > 13,000 compensation claims with families receiving > $240,000 in payments. Despite a government mandate supporting compensation payments, there exist inconsistencies in eligibility, application, implementation, and payment procedures. For mitigation and compensation to actually assist people and conserve wildlife standardisation of processes and increasing transparency is required with policy and technology solutions having impact if they are sensitive to local ecological and social dynamics.

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GS22 – THREATS, PRESSURES, AND SUSTAINABLE DEVELOPMENT

Species conservation in the Alandraza-Agnalavelo Protected Area, Madagascar: Case of *Euphorbia mandravioky*

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During botanical collection realized in the Alandraza-Agnalavelo Protected Area in 2012, we collected *Euphorbia mandravioky* in this sacred forest. This euphorb species was first discovered from the deciduous and semi-deciduous forests of northern Madagascar and classified as endangered. During the 2012s work, we noticed that *E. mandravioky* is among the threatened species associated with honey collection and wanted to increase scientific knowledge on the plant within this protected area. We undertook an ecological study of this species at the site with four plots of 900 m2 (30 x 30 m) each. We did in situ conservation through enhancing local community capacity of forest management and increasing their knowledge about the species. We carried out also ex-situ conservation in the existing village nursery. There are four sub-population of the *E. mandravioky* in the sacred forest. Each sub-population is composed by 8 to 32 individuals with mean height at 11 m and mean DBH at 42 cm, although some individuals can reach a DBH of 1.35 m. Fruits maturation is during rainy period from January to March. Natural regeneration of *E. mandravioky* is possible but its regeneration rate is very low. This project enriches the local nursery with 150 seedlings of *E. mandravioky*, which can be grown in the dry forest surrounding the village or used for the active restoration of the forest. It provided the means to train ca 65 villagers about beekeeping activities. After a series of awareness raising activities, ca 1200 people including 800 adults and 400 children, are now aware of the importance of the target species. The results will be used to update IUCN status of this species.

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GS22 – THREATS, PRESSURES, AND SUSTAINABLE DEVELOPMENT

Rhizospheric soil property of *Millettia* (Fabaceae) in Madagascar with two endemic species and one introduced

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The genus *Milletia* includes several species well known for their potentialities (environmental, energetic, and medicinal). In Madagascar, the presence of eight endemic species and one exotic species (*M. pinnata*) has been reported but little is known about their ecology and distribution given the degradation of forest ecosystems in Madagascar. In this study, we propose to describe the conditions which may influence the regeneration of these species based on the description of chemical and microbiological parameters that characterize the rhizospheric soils in their natural habitat. So, the rhizospheric soil of three species of which *M. capuronii*, *M. hitsika*, and *M. pinatta* were taken respectively from Sainte Marie, Analalava, and Antalaha. The amount of mineral element such as carbon, nitrogen, potassium, and phosphorus, the soil pH, the total microbial activity, the phosphatase activity, and the cultivable flora density of the soil were analyzed in laboratory. The results showed that the soils under the three species have a high amount of carbon (0.77-4.42 %) and nitrogen (0.13-0.35%). The amount of potassium is low (0.06-0.17 méq/100g). The amount of phosphorus is different for the three species, it is medium (6.1 ppm) for *M. capuronii*, low for *M. hitsika* and low to high (0.4-30.4 ppm) for *M. pinnata*. The soil pH is acidic for all species. The soils of these species presented also low soil cultivable flora density and total microbial activity compared to the forest soil (without *Millettia*). Moreover, the soil under *M. hitsika* presented a phosphatase activity as forest soil, whereas the soil under *M. capuronii* is very low compared to forest soil. These soil characteristics are associated with the development conditions of these species of *Millettia* in its natural habitat that deserves to be exploited for their regeneration in order to improve their conservation.

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GS22 – THREATS, PRESSURES, AND SUSTAINABLE DEVELOPMENT

Effects of habitat fragmentation on seedling establishment of epiphytic orchids: A case study in tropical China

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The seasonal tropical limestone forests in Xishuangbanna, China, have high considerable epiphytic and lithophytic orchid diversity. Today most limestone forests have been reduced to fragments surrounded by cultivated rubber tree plantations. The orchid populations are threatened both by over-collecting and by changes to the growing environment: forest fragmentation potentially alters microclimate, reducing humidity and raising temperatures, thereby increasing environmental stress for epiphytic plants. We sought to understand the effects of habitat fragmentation on seedling establishment after reintroduction of two threatened epiphytic orchids in southwestern China, *Rhynchostylis retusa* and *Cymbidium mannii*. We reintroduced seedlings of the two orchid species of different sizes (large and small), during different times of the year (start of rainy season, end of rainy season), and in fragmented patches and continuous forests. Survival rate depended on seedling size, planting date, and forest fragmentation. The overall survival rate of *C. mannii* reintroduced in May 2013 was 64.6%, higher than 19.2% that of reintroduced in September 2012. Survival rate of seedlings introduced before the rainy season (May and June) was higher than those introduced at the end of the rainy season seedling stage (in September). Large seedlings of both species had greater survival rates than small seedlings. The survival rate of *R. retusa* seedlings in QYZ of fragmented tropical limestone forest was lower than in GLF of continuous forest. The air humidity and temperature of the research sites are significantly reduced at the end of the rainy season (October). Plant size and timing of reintroduction may both be critical for the success of epiphytic orchid re-establishment in seasonal forests. Forest fragmentation appears to reduce success rates, suggesting that larger forest fragments are necessary to ensure suitable conditions for native orchid species.

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Use of Near InfraRed Spectroscopy for an easy determination of taxonomic identity of some *Dalbergia* and *Diospyros* species of Madagascar

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Dalbergia and *Diospyros* species are appreciated for the quality of their wood. They are illegally logged and traded due mainly to the difficulty of their identification. Current used identification technics can not reach species level for the case of some *Dalbergia* and *Diospyros* species. Thus, the aim of this study is to assess the potentiality of a portable Near InfraRed (NIR) spectrometer to discriminate some precious woods of Madagascar. NIR Spectroscopy, compared to others identification methods, is more suitable for field use because it does not need any specific scientific knowledge from users, it needs no sample preparation and it is low cost. Absorbance spectrum were acquired from 72 corewood samples belonging to the two genera (*Dalbergia* and *Diospyros*), and four *Dalbergia* species (*D. chlorocarpa, D. abrahamii, D. greveana,* and *D. pseudobaronii*). Several spectra preprocessing methods were tested and the best methods were used. Discrimination models were established using Partial Least Square Discriminant Analysis (PLSDA) method. Models were established to discriminate the two genera and to discriminate *Dalbergia* species. There are also models to discriminate species based on spectra from heartwood and that from sapwood. Results show that better discrimination can be obtained from spectra of heartwood. With a test set validation, the best models give a high classification rate of 93% for the discrimination of the two genera, and a high classification rate of 80% for the discrimination of *Dalbergia* species. This work highlighted the ability of the MicroNIR Spectrometer to be an efficient helpful tool to monitor timber trade. Deeper study should be carried out to consider more samples for each species from several origins and to use a wider spectral range to help for a legal and sustainable trade of these species.

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Fire risk in selectively logged Amazonian forests

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Selective logging is one of the most widespread patterns of disturbance in tropical forests and even though it is less detrimental to forest structure than wildfires and clear-cuts it has been identified as a facilitator of fire. However, the extent to which forest edges induced by selective logging affects the forest thermal environment, and their interaction with fire risk, have not been explored. We investigated the *i)* impacts of commercial selective logging on the forest thermal environment in the Brazilian Amazon in and around logging gaps; *ii)* how such impacts relate to forest flammability; and *iii)* how long is required for the forest to recover its baseline thermal environmental conditions. We found that centre of logging gaps are always hotter and drier than the surrounding forest, and that the thermal environment around larger gaps is more affected than that around smaller gaps. Heated conditions in the gap centre cause a sharper rate of leaf litter moisture content loss than that of the surroundings. However, this pattern did not directly translate into Ignitability (how well fuel ignites) and Sustainability of fire (maintenance of burning over time), which means that the whole forest, including unlogged areas within the logging concession, is under the same risk of catching fire if exposed to an ignition source, and of maintaining that fire across the landscape. Moreover, although commercial selective logging can severely damage tropical forest structure, the forest can rapidly regain its thermal environment. Selectively logged tropical forests can be vital for long-term maintenance of global biodiversity, but they are at a higher risk of burning because of the increased exposure to ignitions sources, especially under contemporary scenarios of climate change. Thus, post-logging forest management should carefully focus on preventing fire incursions focusing on controlling ignition sources, with special attention to those 3-5 years post-harvest.

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TROPICAL BIODIVERSITY and GLOBAL CHANGES

Potential effect of climate change on annual reptile species: Case of the Malagasy chameleon with the shortest lifespan *Furcifer labordi* (Reptilia, Chamaeleonidae)

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Published studies on reptile shifts in natural history parameters associated with climate change are few. However, as different aspects of these parameters are directly related to climatic variation, they are among the vulnerable groups. Also, this study attempted to understand the possible effect of climate change on the life-history traits of annual reptiles. The biological model chosen was *Furcifer labordi*, a chameleon species restricted to western and southwestern Madagascar. Its life history is annual and unique with the population mostly represented in the egg stage during austral winter. The eggs hatch synchronously at the onset of the rainy season and this species has the shortest lifespan (6-9 months) among tetrapods. Temperature and precipitation data were gathered from 2012 to 2018 and chameleons were sampled in 2013, 2015, and 2017 in Kirindy Forest (CNFEREF), western Madagascar. This forest is characterized by a seasonal and unpredictable climate. The results showed significant temperature and precipitation variation across years. The first rains usually fall in September but was delayed by two months in 2016 and 2017. Moreover, the first hatchlings were observed less than one month after the first rains and a two-month hatching delay was observed in 2017. Furthermore, growth in this species was positively correlated with temperature. Hence, climatic variation influences the life cycle of *F. labordi* with a quick phenological response expressed by a shift in hatching time. However, a shorter/longer embryonic diapause period may affect the hatching rate. Survivors are subject to natural selection and have to adapt to the year-to-year climatic conditions variation. Thus, as an annual species, a complete population could be lost if a single cohort cannot cope with climatic shifts, demonstrating the vulnerability of annual reptiles to climate change. Nevertheless, further studies are required to assess the long-term effect of climate change on their life-history traits.

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Tracking the effects of global change on central Africa's tropical forest using a unique herbarium record

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Terrestrial ecosystems globally are increasingly subjected to changing environmental conditions; i.e. increases in temperature, atmospheric CO2, and reactive nitrogen, triggering physiological responses in plant ecosystems. As forests are both biodiversity hotspots and a major actor in the global carbon cycle, predicting their future response to global change is vital. This holds especially for tropical forests, since they represent about 40–50% of the total carbon that is stored in terrestrial vegetation, with the Amazon Basin and the Congo Basin being the largest two contiguous blocks. However, our current understanding of such responses is limited, due to the complexity of forest ecosystems and the slow dynamics that inherently form these systems. Luckily, herbaria can help us to track the species-specific responses of trees during the last decennia, thereby exceeding experimental time lines. In this study we use herbarium samples from one central location in the D.R. Congo from the last century, to disentangle effects of important global change drivers on central African rainforest. Contrary to herbarium studies from other parts of the tropics, the leaf $d^{18}O$ and $d^{13}C$ isotopic signatures indicate a photosynthesis-related decreasing water use efficiency in central Africa. Such a strong and clear trend could be alarming, but further research is needed to validate these findings in other parts of sub-Saharan Africa and to see the impact on the regional carbon balance.

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Anthropogenic impacts on watersheds: Conservation and management of the hippopotamus through spatial ecology research

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In sub-Saharan Africa, watersheds are experiencing anthropogenically accelerated ecological and biophysical change from increased water abstraction and climate change. The consequences of these changes are profound because they alter the ecological role of an important semi-aquatic ecosystem engineer – the common hippopotamus, *Hippopotamus amphibius*. Recent studies show that hippopotamus dung inputs interact with river hydrology to alter the biogeochemistry and aquatic biodiversity of entire rivers. However, to date, there is a lack of information about the potential effects of climate change on the spatial requirements and habitat use of the hippopotamus, which in turn, drives the river-scale changes in biodiversity. As such, managers seeking to sustainably manage this important species have no rigorous data to rely upon to adapt current management protocols into tools that are effective in a changing environment. To address this issue, we present GPS tracking data collected from hippopotamus in a historically perennial river in central Tanzania that, as a result of human modification, dries down seasonally into a series of isolated pools to answer three key questions: 1) How much space do hippopotamus need to survive? 2) What habitats are beneficial and/or deleterious to hippopotamus populations? and 3) How is hippopotamus habitat and space use influenced by changes in river hydrology? We found that hippopotamus space usage and foraging is highly constrained by aquatic refugia and that river hydrology is a key driver of hippopotamus dispersal behavior. As such, this work provides important information for the conservation and management of an at-risk species. It also calls attention to the consequences of altering regional hydrology on wildlife health and generates essential management recommendations for sustaining hippopotamus populations in the face of watershed degradation and climate-change induced shifts in regional hydrology.

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Thermoregulatory consequences of activity time in mammals

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In mammals, species have shifted from being nocturnal to diurnal and vice versa over both short ecological and long evolutionary time scales. However, the thermal and energetic consequences of variable activity patterns across species and space remain largely unexplored. This study used theoretical thermoregulatory polygons bounded by estimates of basal metabolic rates (BMR), maximum metabolic rates (MMR), and thermal conductance (C) in small mammals to explore the metabolic consequences of being active and exposed to global scale day-time and night-time temperatures. Model results were then compared to published estimates of body mass, thermal conductance, and nocturnality in rodents and mammals. The model predicted higher metabolic scope for activity for nocturnal species at low latitudes and found that reduced C and larger body size increased the geographic range in which nocturnality was advantageous. Consistent with predictions, within rodents, nocturnality predominates at low latitudes and nocturnal species have a lower C than diurnal species. However, nocturnal mammals are also significantly smaller than diurnal species likely reflecting the importance of additional factors driving body size. Taken together these findings demonstrate the broad importance of energetic considerations in diel activity patterns for endotherms. How nocturnal and diurnal species differentially experience and adapt to thermal variation will determine how they respond to environmental change – addressing this question will lead to important evolutionary and conservation insights, crucial for managing global change impacts in a rapidly warming world.

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A novel atlas representing Madagascar's biodiversity and potential refuges driven by deforestation and climate change

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Madagascar is known for its exceptional biodiversity which is threatened by both land-use and climate change. These two drivers are expected to induce shifts in species distribution. Our objectives are (i) to produce an atlas of species distribution forecast in the future according to different climate and land-use change scenarios and (ii) identify refuges for biodiversity. We used high quality occurrence data for 4969 species which were compiled into the largest national biodiversity database to date. Occurrences data were combined with expert selected explanatory variables to produce 1 km species distribution maps. We used an ensemble forecasting approach with five different statistical algorithms (GLM, GAM, Random Forests, ANN, and Maxent) and three global climate models (CCSM4, GISS-E2-R, and HadGEM2-ES). Species distribution projections were made for the years 2050 and 2080 for different emissions (RCP 4.5 and 8.5) and land-use change (with/without deforestation) scenarios. To perform these tasks, we developed a specific R package (named "speciasatlas") which simplifies the process of modelling current and future species distribution. We then aggregated these results at the community level. We obtained synthetic maps for each species assessing their vulnerability to climate and land-use change. From these results we were able to identify biodiversity refuges and assess the risk of deforestation upon these areas. These results are expected to improve conservation strategies in Madagascar by identifying high priority areas for biodiversity in the context of both climate change and deforestation. The "speciesatlas" R package enables anyone to easily replicate this approach in other countries.

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GS23 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Assessing exposure to extreme climatic events for the world's primates

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Primates are an essential component of tropical biodiversity, contributing to forest regeneration and ecosystem health. However, over 60% of the world's primate species are threatened with extinction largely as a result of habitat loss, fragmentation, and overexploitation. Along with these stressors, changes in the distribution and intensity of extreme climatic events, as a component of human-induced climate change, have been observed as an emergent and accelerating threat to primate survival. To quantify the threat from two extreme climatic events – cyclones and droughts, we examined exposure of the world's 607 primate taxa (primate species and subspecies) to both events in the past 45 years. Exposure of each taxon was quantified as an average percentage overlap between cyclone/drought distributions and the taxon's range within the time of one generation length of the taxon. Globally, 122 primate taxa (~20%) were assessed as moderately (48 taxa), highly (42 taxa), and extremely high exposed (32 taxa) to cyclone impacts, respectively, which are largely concentrated in forests along the coast of Madagascar. 156 primate taxa (26%) were assessed as moderately (88 taxa), highly (59 taxa), and extremely high exposed (9 taxa) to droughts, respectively, which are distributed mainly in tropical forests of southeast Asia, moist forests of Guinea, Sierra Leone, Liberia, Central Africa, and Madagascar's coastal areas. Our study identified the primate taxa exposed to cyclones and droughts of moderate to high severity and highlighted the hotspots where these exposed taxa are concentrated. As the frequency and/or intensity of extreme climatic events have been projected to increase, pinpointing primate taxa recently exposed is expected to help target the ones with biological traits that make them highly vulnerable to such events, and to facilitate the prioritization of sites for effective risk mitigation.

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Vegetation structure of mangroves in an ecotone along a latitudinal gradient, Florida

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Tropical mangrove forests are expected to replace temperate salt marshes in the coming decades due to a reduction in extreme winter temperatures. Evidence for this comes from both climate-vegetation models, and empirical research along the salt marsh-mangrove ecotone. In Florida, USA data from the Atlantic coast suggests the dispersion and establishment of mangroves, particularly the Black Mangrove (*Avicennia germinans*), is documented, but data are lacking from the coast along the Gulf of Mexico. In this study, mangrove vegetative growth, reproduction, seedling establishment and the change in salt marsh cover is documented for sites along the ecotone of the Gulf coast. Results suggest there is a difference in structure of mangroves along a latitudinal gradient. Several hypotheses concerning black mangrove as a more cold- and freeze-tolerant species are examined in light of the data for this study.

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THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Hydropower expansion and the decline of top predators: Contrasting current and future scenarios for jaguars and tigers

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The rapid expansion of hydropower across tropical landscapes has caused extensive destruction and fragmentation of important habitats, triggering biodiversity loss and possibly the decline of threatened animal populations. We quantified the effects of habitat loss following inundation of hydropower reservoirs on two apex predators, jaguars and tigers, by matching published values of species density with reservoir area. We found 165 and 280 dams intersecting current jaguar and tiger distribution, accounting for the loss of 20.7–22.6% and 0.56% of the total population size of tigers (3,200 to 3,500 individuals) and jaguars (~173,000 individuals), respectively. Despite the lower proportional impact, reservoirs in the Neotropics caused a greater absolute population loss (~915 jaguars vs. ~724 tigers), resulting from the overall larger area of Neotropical reservoirs (mean = 1475 ± 3860 km^2; max = 4437 km^2) compared to those in Asia (913 ± 2112 km^2; max = 1198 km^2). Unfortunately, this situation will only get worse; hydropower development will nearly triple the number of dams within the range of jaguars in the decades ahead (n = 429). Although there are relatively few dams planned across tiger distribution (n = 39), many will intersect priority conservation areas, threatening key population strongholds for this species. We also examined the trade-off between energy production and jaguar population decline within Brazil; currently, each 100 MW of hydroelectricity generation causes a median loss of 0.54 jaguars. This ratio will nearly double (median= 0.97 individuals 100 MW^{-1}) for planned dams, which will generally occupy larger areas per unit energy. To mitigate these conspicuous impacts from hydropower development, we urge the expansion and enhancement of protected areas surrounding existing reservoirs and the selection of alternative dam construction sites outside the distribution of these iconic, threatened species.

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New framework to develop High Conservation Value concept for plant species: The Gabonese endemics as a case study

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High Conservation Value (HCV) concept was developed as a framework to sustainable forest management by the Forest Stewardship Council. It is nowadays employed worldwide for certification of diverse industrial activities, such as forestry and agriculture. Many logging and palm companies have already adopted the HCV concept. Nevertheless, HCV1 criterion, which deals with endemic, and rare, threatened or endangered species, is rarely used in the certification, mainly because of incomplete list of threatened species, especially for plant, and time-consuming assessment process. Using Gabonese endemic species as a case study, we propose an automated procedure to rapidly identify HCV1 plant species using the categories and criteria of the IUCN Red List. Our interpretation is that HCV1 correspond to CR, EN or VU species. Based on 3341 occurrence records (verified and georeferenced herbarium specimens), we used land-cover, roads, logging and mining activities layers and ConR, a R package, to identify threatened species using an approach that mimic criteria A, B and D of the red list. On 398 taxa identified as endemic of Gabon, 88% are preliminary identified as threatened (91 CR, 182 EN and 77 VU). They are equally represented within herb, shrub, tree, and liana habitus but mainly belong to Rubiaceae and Fabaceae families (25.4% and 18.5% respectively). Only 30.6% of the threatened endemics are represented by at least one specimen in a National Park but 62% are found in logging concessions. Over 90% of our preliminary assessments was congruent with recent status published on the Red List or found in literature. Differences concerned species whose habitats were not threatened, such as roads corridors. Our results show that our methodology can be used to easily and quickly identify which plant species can be considered as HCV1, but also highlight the necessity to verify species by species the automated preliminary assessment.

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Intact but empty forests? Patterns of hunting-induced mammal defaunation in the tropics

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Tropical forests are increasingly degraded by industrial logging, urbanization, agriculture, and infrastructure, with only 20% of the remaining area considered intact. However, this figure does not include other, more cryptic but pervasive forms of degradation, such as overhunting. Here, we quantified and mapped the spatial patterns of mammal defaunation in the tropics using a database of 3,281 mammal abundance declines from local hunting studies. We simultaneously accounted for population abundance declines and the probability of local extirpation of a population as a function of several predictors related to human accessibility to remote areas and species' vulnerability to hunting. We estimated an average abundance decline of 13% across all tropical mammal species, with medium-sized species being reduced by > 27% and large mammals by > 40%. Mammal populations are predicted to be partially defaunated (i.e. declines of 10-100%) in ca. 50% of the pantropical forest area (14 million km^2), with large declines (> 70%) in West Africa. According to our projections, 52% of the intact forests and 62% of the wilderness areas are partially devoid of large mammals, and hunting may affect mammal populations in 20% of protected areas in the tropics, particularly in West and Central Africa and SE Asia. The pervasive effects of overhunting on tropical mammal populations may have profound ramifications for ecosystem functioning and the livelihoods of wild-meat-dependent communities, and underscore that forest coverage alone is not necessarily indicative of ecosystem intactness. We call for a systematic consideration of hunting effects in (large-scale) biodiversity assessments for more representative estimates of human-induced biodiversity loss.

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Decline of the wild Ploughshare Tortoise caused by poaching for illegal trade

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The Ploughshare Tortoise, *Astrochelys yniphora*, is endemic to an area of 160 km² in the Baly Bay National Park, northwestern Madagascar, and is known as the rarest tortoise on earth. Wild Ploughshare Tortoises are victims of regular fires and poaching to supply the international pet trade. This study was done to investigate the decline of wild Ploughshare Tortoise with the objective of identifying any conservation action to fight against poaching, and evaluate the impact of undertaken conservation actions. To understand the impact of poaching on the wild populations of this species, we conducted population surveys from 2006 until 2015 using distance sampling. The first set of surveys was done from 2006 until 2008, then another for 2012 to 2013, and the last for 2014 and 2015. Additionally, we have recorded all reported seizures inside Madagascar and internationally during the same period in order to see the impact of the international trafficking of wild populations of this species. Results show that population size of wild Ploughshare Tortoise has decreased from around 1100 to 500 from 2006 to 2015, which is more than 50% in nine years. Number of seized animals has increased since 2009 and had peaks in 2011 and 2015. Permanent markings by shell engraving were done in Madagascar to reduce the value of individuals of this species, but that did not affect the poaching and trafficking. Few seized Ploughshare Tortoises and photos seen on selling websites or social media have shown marked animals, which is indicative of individuals taken from wild and released populations. Conservation actions at the site include permanent patrols, sometimes armed, law enforcement and lobbying in different levels in order to stop poaching from the wild but trafficking still continues and the species is getting rarer.

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Rapid increase in deforestation after peace agreement in Colombia: A time-series analysis

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Past November 2016, the Colombian government and strongest local armed group, the Revolutionary Forces of Colombia – Peoples Army (FARC-EP), signed a peace agreement that has changed the political environment in many rural and remote areas, unleashing extractive forces and land grabbing. We analysed tree-cover loss in Colombia using fine-scale resolution maps together with environmental and socio-political data. The chosen period encompasses 17 years of the conflictive situation in Colombia since 2000. Our results from a time series analysis using autoregressive linear mixed models show that armed conflict has had an effect in preventing higher rates of deforestation at a national scale, however, demographic and topographic variables were better predictors of deforestation. Lowland municipalities, with less rural population density, are suffering major losses of tree cover compared to the municipalities in the Andean mountain range. The deforestation frontier is mainly expanding from the Andes foothills into the heart of the Amazon and in the Magdalena plains towards the Darien gap. Urgent efforts in territorial planning for a post-conflict era in Colombia are needed to prevent major destruction of natural landscapes. Establishment of new protected areas and expansion of the existing ones are essential measures to take, as well as the reinforcement of environmental agencies and control in these power vacuum areas.

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Assessing the impacts of forest degradation on *Varecia rubra* (Red Ruffed Lemur)

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Varecia rubra, is a critically endangered lemur species restricted to the forests of the Masoala Peninsula, which has suffered from illegal logging of precious woods. Deforestation and forest disturbance mapping between 2008 and 2011 indicated that forest change rate in Masoala was 1.3%, higher than the annual deforestation rate for Madagascar on average. Cyclone disturbances aggravate forest degradation. Previous research on the impact of the cyclone Hudah showed that this species is very sensitive to habitat disturbance and population recovery is very low. The aim of this study is to assess the current state of the population of *Varecia rubra* following disturbances from successive cyclones and intensive logging. Data on demography were collected in 2000, 2001, 2004, and 2018 in the same census transects situated in the northeastern portion of the peninsula, during the same season (wet season) and performed the same methodology to determine the effects of the forest degradation on the demographic parameters (density, abundance, group number, group size, and reproduction rate). Vegetation parameters (vertical profiles, tree densities, food availability of flowers and fruits) were collected from plots along with the lemur census transects. Data analysis compared demographic parameters of the four periods. Correlation analysis between demographic and habitat structure using PCA (Principal Component Analysis) was conducted to determine the interdependence between vegetation and demographic parameters. Results show that the abundance of *V. rubra* at the study site is increasing, however, the group number is decreasing. The significant vegetation parameters affectng the presence of *V. rubra* are the number of species, percent canopy cover, number of trees, number of trees in flower, and average DBH. Altitude affects also the structures of both vegetation and species presence. This species is able to adaptat strategies to habitat disturbance and this information helps to improve site management.

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Biogenic Volatile Organic Compound (BVOC) emission patterns of two hyperdominant tree species distributed in an environmental gradient in central Amazonia

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Tropical forests are the dominant source of BVOCs to the global atmosphere. But modeled emissions from tropical vegetation carry high uncertainty due to the challenge of scaling relatively few observations across the great diversity of species and environments, and due to a poor understanding of the biological and environmental controls on emissions. BVOC compositions are conserved within plant species, but emission quantities may vary significantly with photosynthetic capacity, carbon and nutrient investment tradeoffs, and the environment. Here, we measured net photosynthetic rate, stomatal conductance, and leaf flux and within leaf content of BVOCs, and plant functional traits of two hyperdominant tree species from central Amazonia—*Protium apiculatum* and *Eschweilera bracteosa*—distributed along a topographic and edaphic environmental gradient at the Amazon Tall Tower Observatory (ATTO) site. Our objective was to quantify the partitioning of BVOC plasticity among plant traits, environment, and their co-dependencies. Measurements were carried out for five individuals of each tree species and at each environment—plateau, white-sand forest, and valley— from October 2018 to February 2019. Previous studies have shown that *Protium apiculatum* does not store isoprenoids - the biggest group of BVOCs. However, our results showed that it emits isoprene, which is a not stored compound and the largest emitted to the atmosphere, and monoterpenes. *E. bracteosa* presented isoprene emissions and stored monoterpenes and sesquiterpenes. The three environments of this study provide different microclimates and resources to plants, which had implications on plant functional strategies to produce and emit BVOCs. In this light, we will present results on how the potential different plant strategies for each environment, in terms of functional traits, may structure and affect BVOC emissions. This research is a new approach that has empirical foundation for scaling up BVOC emissions in different environmental landscapes of tropical vegetation.

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GS25
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

First density and survival estimates of the Malagasy striped civet *Fossa fossana* in Madagascar's largest protected area

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Determining population abundance and survival rates is key to basic wildlife conservation and management decisions. Madagascar, though home to numerous endemic and threatened species, is lacking in basic population trend data for many of its wildlife. We took a six-year camera trap dataset collected over eight years to estimate encounter and movement rates, population density, and survival of the Malagasy striped civet (*Fossa fossana*; Near Threatened) at an intermediately degraded rainforest site in the Masoala-Makira protected area complex in northeastern Madagascar. We detected 45 unique individuals a total of 375 times over the six years. Baseline encounter rate averaged at 1.87 +/- SE 0.67 and was positively related to bird relative abundance (beta = 0.23 +/- SE 0.09) and negatively related to human relative abundance (beta = -0.27 +/- SE 0.09). Survival remained relatively constant over the years at 0.75 +/- SE 0.06, although there was evidence of a large turnover of individuals between the 2012 and 2013 surveys. Movement rates averaged 174.7 +/- SE 24.0 m and movement of individual home range centers between years averaged 155.3 +/- SE 23.7 m. Density averaged out at 1.28 +/- SE 0.33 individuals/km^2, which is similar to an estimate from Ranomafana National Park's selectively-logged forests. However, density varied throughout the years and was at its lowest in 2013 at 0.47 +/- SE 0.17 individuals/km^2. We emphasize the importance of basic ecological studies to fundamental conservation and management actions.

Friday, 2 August 2019 | Saphir
GS25 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Rapid loss of flight in extant and extinct populations of the evolutionarily unique Aldabra White-throated Rail *Dryolimnas* [*cuvieri*] *aldabranus*

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Flightlessness has evolved independently in multiple lineages of island birds worldwide due to predator release on islands, and this is particularly common among the rails (Rallidae). Appropriate conservation management of flightless birds is vital, since they are vulnerable to declines and extinction following the establishment of human populations and the introduction of non-native predators. The Aldabra White-throated Rail (*Dryolimnas* [*cuvieri*] *aldabranus*) is the only living flightless subspecies within the otherwise volant species *D. cuvieri*, and the last surviving flightless bird in the western Indian Ocean. We assessed the evolutionary uniqueness of the Aldabra White-throated Rail using molecular and morphological data and investigated the divergence times among extant and extinct populations of *D. cuvieri*. Thirty-eight samples (museum toe-pads and fresh blood samples), representing all *Dryolimnas* subspecies, were sequenced at three mitochodrial gene regions and a dated phylogeny was constructed. Additionally, morphological measurements (wing and tail length, tarsus length, bill length, bill width, and weight) were taken from all live birds and museum specimens and compared among subspecies. Using genetic and morphological evidence from both living and extinct subspecies, our data placed *D.* [*c.*] *aldabranus* among the most rapid documented avian flight loss cases (~70,000–130,000 years). However, the unusual intraspecific variability in flight capacity within *D. cuvieri* is best explained by levels of genetic divergence, which to our knowledge exceed those documented between other volant versus flightless close relatives, all of which have full species status. Contrary to the current situation, our results support consideration of *D.* [*cuvieri*] *aldabranus* as sufficiently evolutionary distinct from *D. c. cuvieri* to warrant management as an evolutionary significant unit, that should at least be classified as a Vulnerable subspecies based on IUCN criteria.

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GS25 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Madagascar bamboos: Ecology, systematics, and benefits

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In Madagascar, bamboos have many domestic and agricultural uses, ranging from musical instruments to construction and agricultural structures for irrigation. This subfamily of Bambusoideae is a poorly understood group due to identification difficulties, rarity of flowering material, and lengthy generation times. The endemic bamboos of Madagascar are a significant knowledge gap in spite of their common occurrence, widespread use, and close evolutionary relationship to economically significant bamboos. Recent research suggests that Malagasy bamboos are nested within Asian clades. There are an estimated 35 species, the majority are endemic and within the genera *Cathariostachys*, *Decaryochloa*, *Hickelia*, *Hitchcockella*, *Nastus*, *Oldeania*, *Perrieribambus*, *Sirochloa*, *Sokinochloa*, and *Valiha*. Although bamboos began to be described from Madagascar in 1828, there was a long hiatus during the latter half of the 19th-century. Limited collection during the early 20th-century permitted the description of a total of 27 species up to 1960. New collections made between 1987 and 1996 permitted recent revisions of *Hickelia* and *Decaryochloa*, with descriptions of three new genera, *Valiha*, *Cathariostachys*, and *Sirochloa*. It is likely that additional revisions and some new species descriptions may be produced in the future. Actually, Madagascar has 35 species of endemic woody bamboos and is therefore strikingly richer in species than continental Africa.

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GS25 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

The Rubiaceae of Gabon

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Gabon is situated on the Atlantic coast of Central Africa, and covers around 267,000 km². More than 80% of its territory consists of equatorial rainforest, the rest being mostly savanna. It is thus the most forested country in tropical Africa. It has a very rich flora with around 5175 species of vascular plants recorded to date, nearly 10% of which are considered endemic; however, the botanical exploration of the country is not yet complete, and these numbers are still increasing. Rubiaceae are the fourth largest largest plant family worldwide and the most important one in Gabon, with an estimated 640 species in 81 genera; the most diverse of these are *Psychotria* (106 species), *Sabicea* (47 species), *Pavetta* (c. 30 species), *Pauridiantha* (26 species), *Tricalysia* (23 species), *Chassalia* (22 species), and *Eumachia* (22 species). Many species are still undescribed and new discoveries are regularly made. The talk will present an overview of the diversity of Gabonese Rubiaceae, with a particular focus on recent discoveries and ongoing taxonomic revisions. Around one third of the genera have been treated in volumes 12 and 17 of the *Flore du Gabon*, while for the rest, no recent national treatment is available. The Meise Botanic Garden is currently planning to finalize the *Flore du Gabon* series.

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GS25 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Towards passive acoustic monitoring of lemurs: A field test of an affordable autonomous recording unit to monitor *Phaner pallescens*

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Passive Acoustic Monitoring (PAM) has a long history in monitoring aquatic biodiversity but has recently been shown to be a valuable approach for terrestrial taxa as well, including bats, birds, elephants, and primates. As over 90% of the >100 lemur species known today are threatened by extinction, evaluating the potential of PAM for lemurs is of particular importance. The objective of this study was therefore to test the performance of a low-cost (< 200 €) open source autonomous recording unit (ARU) for monitoring one of the most vocal but least studied lemur taxa, the Pale Fork-marked Lemur, *Phaner pallescens*. ARUs were set to record continuously for approximately 55 hours at a total of 27 locations across two months in the dry deciduous forest of Kirindy, western Madagascar. We conducted playback experiments to infer detection distances of *Phaner* "kiu" calls and compared manually annotated recordings with an automatic detection algorithm implemented in the R-package monitoR. Overall, the recorders could be easily deployed and operated reliably during the study period leading to > 1500 hours of continuous recordings. Only one out of four ARUs failed a single time during the study period due to a hardware problem. The maximum detection distances of *Phaner* playbacks was estimated at 160 m. The height of the playback stimulus had a significant effect on detection probability, whereas vegetation structure did not. The efficiency of the automated detection algorithm for detecting True Positive "kiu" calls was estimated to be on average around 75%. An abundance estimate calculated from calling activity closely resembles previously published abundance estimates of *Phaner* in Kirindy Forest. Our results indicate that PAM has excellent potential for monitoring vocally active lemurs. We discuss practical and technical limitations and possible future applications of PAM in (lemur) ecology and conservation.

Friday, 2 August 2019 | Saphir
GS25 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Using the U-net convolutional network to identify indicators of forest disturbance in a Neotropical forest with very high resolution multispectral images

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Mapping tree species at landscape scale to provide information for ecologists and forest managers is a new challenge for the remote sensing community. Here, we tested the potential of a recent deep learning algorithm to identify and segment tree species associated with forest disturbance, such as *Cecropia hololeuca* and *Tibouchina pulchra*, in very high-resolution multispectral images (0.3 m) from WorldView-3 satellite. The study was conducted in a region of the critically endangered Brazilian Atlantic Rainforest, which is a global priority for biodiversity conservation due to its abundance of species of flora and fauna occurring across an extremely fragmented and degraded landscape. The convolutional network generated in this study for identifying trees from different species was trained with about 1500 high-resolution true colour synthetic optical images and their labelled masks for each species. Additionally, we created a new framework for measuring disturbance levels within forest fragments based on the spatial distribution of individual disturbance-related trees. Our deep learning network segmented tree species with overall accuracies of above 95% and Dice coefficients of above 0.85. Then, the segmentation of tree species was produced over a region >1000 km² using WorldView-3 Red, Green and Blue bands pan-sharpened at 0.3 m. We found that the crowns of disturbance-related species covered between 1 and 5 % of the natural forest canopies. Our results based on the trees distribution shown that disturbance tends to increase with fragment size and revealed information that were not accessible from classical landscape fragmentation analysis, which is mainly based on size and connection of the forest fragments. We are still far from recognizing all the species, however, our algorithm can detect species that are indicator of disturbance and of early successional stage. It can provide new information that can be used to understand the recent forest history and its recover.

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GS25 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

A countryside carnivore: Aspects of leopard ecology at Jawai, Rajasthan

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Proliferating human population and habitat fragmentation has impacted the large carnivore population across India. Leopard among pantherine is more tolerant of human disturbances and co-occur with humans in the wide variety of habitats and also one of the most reported problematic animals with humans. The present study aims to understand the factors of leopard's survival in a human-dominated landscape. The study was conducted in the semi-arid landscape of Jawai, Rajasthan, India. Leopard density was estimated in 217 km^2 area, using systematic camera traps (98 days with 26 paired cameras). Camera trap data was analyzed using spatially explicit capture-recapture framework (SECR). Dietary composition of the leopard was examined through scat analysis. In total, 78 interviews across 16 villages have been conducted to understand local people's perception towards the leopard. Density of leopards was estimated to be 6.38/100km^2. Total 11 prey species were found in diet of leopards through scat analysis. Consumption of domestic prey (52.3%) was comparatively higher than wild prey (48.3%). Villagers have similar tolerance and religious views towards leopard. Villagers have higher economic losses (livestock loss by leopards), however, tolerance is maintained due to benefits (tourism activities) generated by hotel lobbies. Villagers have minimal loss of human life and injuries by leopards. Leopards exist in this area in fairly high human density (236 human/km^2) due to its connectivity with Kumbhalgarh Wildlife Sanctuary, complex terrain, availability of livestock, their carcasses, and tolerance of local people. Thus, co-occurrence of leopard with human in Jawai is a complex interaction of resource availability, people's belief, and socio-economic influences of hoteliers.

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GS25 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS26
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Assessing the effects of elephant foraging on the structure and diversity of an Afrotropical forest

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African forest elephants (*Loxodonta cyclotis*) are ecosystem engineers that browse and damage vast quantities of vegetation during their foraging and movement. Though elephant trail networks and clearings are conspicuous features of many African forests, the consequences of elephant foraging for the forest understory are poorly documented. In this study, conducted in northeastern Gabon, we compare stem size, stem density, proportional damage, species diversity, and species relative abundance of seedlings and saplings in the vicinity of seven tree species that produce elephant-preferred fruits ("elephant trees") relative to control trees that do not. Across 34 survey trees, with a combined census area of 2.04 ha, we recorded data on more than 30,000 woody stems in three sizes classes. A significantly greater proportion of seedlings and a marginally greater proportion of saplings were damaged by elephants around elephant trees than control trees, with 82% and 42% greater odds of damage, respectively. Neither stem density nor species diversity differed significantly around elephant trees versus control trees. The relative abundance of seedlings of elephant tree species was significantly higher around elephant trees than control trees (representing 2.14% versus 1.75% of seedlings), though the relative abundance of saplings was not. Using quadrat location as an indicator of elephant foraging intensity, we found that increasing distance from focal elephant trees was associated with significantly reduced sapling stem damage, significantly increased sapling stem density, and significantly increased sapling species diversity. Considered in sum, our results suggest that elephants can affect the structure and diversity of Afrotropical forests through their foraging activities, with some variation based on plant size class. Developing a more complete understanding of elephants' ecological effects will require continued research, ideally with manipulative experiments.

Saturday, 3 August 2019 | Grenat
GS26 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Home range size in the Blue-eyed Black Lemur (*Eulemur flavifrons*): A comparison between dry and wet seasons

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The distribution of the Blue-eyed Black Lemur (*Eulemur flavifrons*) is restricted to a small area of forest in northwestern Madagascar, and the Sahamalaza-Iles Radama National Park is the main habitat of this species. Western Madagascar is subjected to a long dry winter season, which coincides with food scarcity. We investigated the effect of this seasonal variation in food availability on the home ranges of this species within the Sahamalaza-Iles Radama National Park. We aimed to understand the ranging patterns of this species, as this is crucial to quantify their spatial and ecological needs for conservation and management of small populations that inhabit fragmented forests. The study was conducted from September 2006 to March 2008 with five groups of lemur. Animals located by direct observation and geographical locations were recorded to determine the daily path length and the home range sizes of the study groups in the respective seasons. Daily path length and home range size varied significantly between seasons. Daily path length was significantly greater in the dry season (673.4 ± 539.2 m) than in the wet season (423.6 ± 183.2 m). Home ranges overlapped between groups in both seasons, but were significantly larger during the dry season (7.5 ± 6.6 ha) than in the wet season (3.0 ± 1.6 ha). There was no clear relationship between home range size and group size in either the dry or the wet season. Seasonal changes in home range area are likely to be a consequence of reduced food availability in the dry season. Compared to other primates, including some lemur species, the home range size of the Blue-eyed Black Lemur is relatively small.

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GS26 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Resource partitioning in Neotropical frugivorous understory birds

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Belonging to the most important seed dispersers of fleshy-fruited understory plants, birds impact forest structure and ecosystem functioning via seed dispersal service. Despite the ecological importance of this animal-plant interaction, our knowledge on the feeding ecology and specificity of frugivorous understory bird assemblages is still very limited. Employing faecal sampling, this study provides an observer unbiased insight into frugivore-plant interactions taking place in the undergrowth of a tropical lowland rainforest. The study was conducted from November 2017 to February 2018 in the Piedras Blancas NP, an avian biodiversity hotspot in Costa Rica. 15 mist-netting sites, equally distributed between creek, slope, and ridge forest sites, were selected for trapping understory birds and obtaining faecal samples. Mist-netting took place for a total of 69 days, during which bird droppings were obtained from 71% of the 942 mist-netted birds belonging to 59 species. Using a reference seed collection, which was created during this study, 87% of more than 27,000 seeds found in 263 samples from 15 avian species could be identified to species level. The majority of fruits utilised by frugivorous birds were attributed to the family Melastomataceae (60%) and Rubiaceae (17%), two highly abundant plant families in the understory at our study area. The occurrence frequencies of plant species in the faecal samples was used to quantify and test the similarity of fruit consumption between habitats and the eight most abundant frugivorous bird species. This revealed significant interspecific variation in the diet of birds and highlighted the effect of forest type on the composition of consumed fruits. Our results suggest, that while feeding preferences exist between understory frugivores, fruit consumption might also reflect fruit availability within the undergrowth. Impending trait-based analyses will allow for a more refined picture of the potential causes for resource partitioning within this frugivorous bird assemblage.

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GS26 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Seed dispersal strategy as drivers to the evolution of flowering phenology

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Polycarpic plants exhibit various flowering phenology patterns, which could be characterized by flowering frequency, from continuous to supra-annual, and by regularity, from periodic to irregular pulses. These different flowering patterns often coexist in the same plant community. Many hypotheses have been proposed to explain irregular and supra-annual flowering phenology (masting), such as pollination efficiency, predator satiation, resource optimization and phylogenetic constraints. However, less attention has been paid to the evolution of plants that flower frequently and regularly. We propose that animal-dispersed species may evolve regular reproductive phenologies to sustain populations of seed dispersers by providing constant food supplies (fruits). Regular bouts of reproduction could avoid satiation of seed dispersers, which could select for the evolution of non-masting phenology. Here, we used a long-term dataset of weekly flower production from a lowland tropical rainforest in Malaysia to test two hypotheses. We hypothesize that 1) wind and other mechanically dispersed species should reproduce synchronously and irregularly to minimize seed predation, while 2) animal-dispersed species should reproduce at frequent and regular intervals to minimize satiation of seed dispersers. Additionally, phylogenetic constraints may interplay with the above forces and influence phenology pattern. We characterize flowering phenology for 239 species using 17-years of weekly flower production data. We also categorize dispersal mode into zoochorous and nonzoochorous based on previous knowledge of fruit morphology. We then analyze the correlation between phenology and dispersal mode. We also explore relationships between phenology and phylogeny. We show that 88% of mechanistically dispersed species and 74% of biotically dispersed species are characterized by masting.

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GS26 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Phylogenetic preferences in herbivorous beetle diet on trees in KwaZulu-Natal, South Africa

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Recent studies have shown that many specialist herbivores are not strictly monophagous but feed on several closely related plant species. We studied patterns of species richness and abundance in beetles on South African trees, considering phylogenetic preferences in the beetles' diet. We conducted our research in the Palmiet Nature Reserve in Durban, South Africa. We collected beetle species from 12 distantly related tree species. We conducted the study from mid-November until mid-December, the peak in beetle abundance for the study area. We collected 194 beetle morphospecies, belonging to 27 families; 143 of the species were herbivores and 85 of these were putative specialists, i.e. they occurred on only one of the studied tree species. Beetle species richness differed significantly between tree species, with higher values on leguminous trees. Ordination analyses on beetle assemblage structure, as well as a test linking ordination results to plant phylogenetic distances, partly support a phylogenetic component to the set of factors structuring beetle assemblages.

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GS26 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Use of SENTINEL1 radar images for the characterization of plant formations: The case of two savannah species *Acridocarpus excelsus* and *Terminalia* aff. *mantaly* in the Antrema Protected Area site (Madagascar).

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The mapping of plant formations is a real challenge for monitoring and conservation in protected areas where the impact of human activities can quickly lead to the disappearance of certain formations or species. The availability of satellite image data sets for the community in both visible and radar wavelengths provides an opportunity to better characterize plant formations. The use of Sentinel1 radar images made it possible to test the responses of two species that are well represented in the savannah in the Majunga region, more precisely in the Antrema Protected area, western Madagascar. Two species are observed at different densities depending on the mechanisms of regeneration and dynamics of the savannahs according to the frequency of fires. These two species are distinguished by different morphological differences. *Acridocarpus excelsus* A. Juss. (Malpighiaceae) has upright or orthotropic axes that curve slightly, while *Terminalia* aff. *mantaly* (Combretaceae) has a typical architecture of this family (Fagerlind model) with branches arranged horizontally (plagiotropic) across different vertical levels. The use of Sentinel1 images, dual polarization VV and VH, has made it possible to highlight these two species in the *Bismarckia nobilis* Hild. & Wendl. (Areacae) plant formations in the Antrema Protected Area. Plagiotropic species have a better signature in VH polarizations. The development of *Teminalia* aff. *mantaly* coincides with the change in natural environment management practices and the reduction of savannah fires in some areas. *Terminalia* aff. *mantaly* being much less resistant to savannah fires than *Acridocarpus excelsus*.

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GS26 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS27
THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

IUCN status assessment and management plan of *Neobeguea mahafaliensis*, *Alluaudia montagnacii* and *Alantsilodendron alluaudianum*, the most commonly used woody species in the spiny thicket of SW Madagascar

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The southwestern part of Madagascar, despite its richness in endemic species, is poorly regarded in terms of studies on conservation. Most of the plant species of the spiny thicket are not yet evaluate, for example, at the site of Lavavolo, and are subject to increasing anthropogenic pressures. Woody plants compose 100% of human construction needs in this area. The objectives of this study are to assess the IUCN status and to propose a management plan of *Neobeguea mahafaliensis*, *Alluaudia montagnacii*, and *Alantsilodendron alluaudianum*, endemic species of the southwest, and among the plants used by the population for their wood. Ecological surveys of the vegetation were conducted to obtain demographic data, the use of GeoCat to geographical distribution, the Maxent analysis for the study of the potential distribution and reduction, and ethnobotanical study to characterize the uses of target species. The results show that *Alluaudia montagnacii* is the one with a restricted distribution, but in the case of *Neobeguea mahafaliensis*, it is one of the mosly widely used plants at Lavavolo. In contrast, *Alantsilodendron alluaudianum* is found in high density at Lavavolo, but is rarely used by people. Based on the degradation of their habitat, all three species could show linear decline. An Endangered status is proposed for *Alluaudia montagnacii* and Vulnerable status for *N. mahafaliensis* and *Alantsilodendron alluaudianum*. In conjunction with the proposed status, a management plan is focused on ex-situ and in-situ conservation, integrating the needs of the locals. After the identification of the degraded area, restoration is one of the primary actions to adopt. Even if a species does not currently need critical conservation in terms of their threats, their future decline and reduction can irreversibly influence on the ecosystem. Excessive use of these species could influence the population of *Lepilemur sp.*, which feeds frequently the leaves of these three species.

Saturday, 3 August 2019 | Cristall
GS27 – THREATS, PRESSURES, and DEVELOPMENT

Oil palm plantation use by terrestrial mammals in Colombia: Species-specific responses to an expanding monoculture

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While the conservation role of remaining natural habitats in anthropogenic landscapes is clear, the degree to which agricultural matrices impose limitations to animal use is not well understood, but vital to assess species´ resilience to land use change. Using an occupancy framework, we evaluated how oil palm plantations affect the occurrence and habitat use of terrestrial mammals in the Colombian Llanos. Further, we evaluated the effect of undergrowth vegetation and proximity to forest on habitat use within plantations. Most species exhibited restricted distributions across the study area, especially in oil palm plantations. Habitat type strongly influenced habitat use of four of the 12 more widely distributed species with oil palm negatively affecting species such as capybara and naked tailed armadillo. The remaining species showed no apparent effect of habitat type, but oil palm and forest use probabilities varied among species. Overall, generalist mesocarnivores, white-tailed deer, and giant anteater were more likely to use oil palm plantations, while the remaining species, including ocelot and lesser anteater, showed a preference for forest. Distance to nearest forest had mixed effects on species habitat use, while understory vegetation facilitated the presence of species using oil palms. Our findings suggest that allowing undergrowth vegetation inside plantations and maintaining nearby riparian corridors would increase the likelihood of terrestrial mammals´ occurrence within oil palm landscapes.

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GS27 – THREATS, PRESSURES, and DEVELOPMENT

Temporal changes in tropical urban bird and butterfly communities in Singapore

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The provision of urban greenery is one way to achieve ecologically sustainable urban development but for this to enhance urban biodiversity conservation, it is important to understand how species respond to changes in the urban landscape. Most ecological research projects of urban landscapes are observational, cross-sectional studies that identify correlations between species responses and landscape variables. These correlations may be confounded by spatial patterns, hence, our understanding of the underlying ecological processes would be strengthened if they are corroborated by the results from longitudinal studies. We compared the changes in bird and butterfly communities and species abundances against changes in urban landscape and greenery variables in two residential towns in Singapore between 2010–2016. There was a temporal turnover in bird communities and a significant increase in alpha-diversity. Bird community composition was associated with the amount of lawn cover and cultivated shrub-richness. Cultivated-shrub cover was positively correlated with rare bird abundance, but this effect diminishes with increasing road-lane density. Butterfly communities became more similar over time although alpha-diversity increased. Built-area density was associated with butterfly community composition and negatively correlated with alpha-diversity. Butterfly communities appeared to have homogenised over time but the changes were not associated with the urban greenery variables examined. Congruent with expectations from cross-sectional studies, we demonstrated the negative impacts of increasing urbanisation on bird and butterfly communities. However, the expected positive relationship between cultivated trees and bird and butterfly communities found in previous cross-sectional studies was not found in this longitudinal study. On the other hand, cultivated shrubs may be important for urban birds and a diverse mix of shrubs planted further from roads will be more favourable for urban bird diversity. Hence, we encourage the use of complementary longitudinal studies to better assess and predict the impacts of changing urban landscape on urban biodiversity.

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GS27 – THREATS, PRESSURES, and DEVELOPMENT

Physiographic unit mosaic in the floodable savannas from the Colombian Orinoco

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The biological distinctiveness of the Orinoco Basin has a global importance. At the same time, it is considered the last agricultural frontier in Colombia according to the national agenda; there big land use changes are expected in the next years. The lowlands of the Orinoco Basin, in Colombia, have been divided in four major biogeographic systems: Piedmont, Floodable Savannas, Aeolian Savannas, and High Savannas. The Floodable Savannas are characterized by a micro concave-convex relief and the occurrence of an annual flood pulse as result of the strong seasonality (rainy season: April-November and dry season: December-March), originating different physiographic units. We hypothesized that C3 and C4 photosynthesis pathways are more predominant in lower and higher physiographic units, respectively. The identification of physiographic units was done from photo interpretation of aerial photographs. Their level variation was assessed using a clinometer every 25, on a transect of 4.050 m along them. Vegetation was evaluated with quadrants on the same transect. The combination of micro relief and flood pulse shapes a delicate mosaic of physiographic units, which level differences are in centimeters. C4 is the most common photosynthesis pathway. The advance of the agricultural frontier can imply a threat for such a delicate system. Crops as rice and oil palm tree are growing every year bringing associated irrigation and draining systems. It is expected these systems have an impact on the occurrence, level and duration of the natural flood pulse and therefore on the physiographic units and their vegetation.

Saturday, 3 August 2019 | Cristall
GS27 – THREATS, PRESSURES, and DEVELOPMENT

Understanding anthropogenic pressures around the Ankerana Forest offset, Madagascar

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Ambatovy applies the mitigation hierarchy concept to managing the impact of their mining activities. Conservation programs are now being implemented in each of the offset sites in order to achieve no net loss in biodiversity and ecosystem services. One of the four offset sites is the Ankerana Forest. This study examines the dynamic changes and analyzes anthropogenic pressures around Ankerana Forest from 2006 to 2015, including areas deforested, before and during the establishment and operation of the offset. The methods consist of combining satellite image analysis with detailed understanding of landscape ecology, and livelihood, patrol, environmental education, and awareness activities. Various landscape fragmentations patterns were observed in the Ankerana Forest. Total number of forest patches increased by 33% from 2006 to 2015. An annual average deforestation rate of 2.04 % was recorded from 2006 to 2011. The eastern and northern parts of Ankerana Forest suffer from higher levels of threat. Since 2011, the conservation program showed a significant decrease in threats. The annual deforestation rate reduced to 0.55%. However, it was observed that the threats have moved away and scattered to the nearby forest patches around the Ankerana Forests and another local protected area. The results of correlation analysis between the decrease in deforestation, leakage phenomena, offsetting activities, and habitat quality will be discussed in order to improve the biodiversity management system within Ambatovy.

Saturday, 3 August 2019 | Cristall
GS27 – THREATS, PRESSURES, and DEVELOPMENT

Towards sustainable use and management of frankincense

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Frankincense, the famous resin collected from five *Boswellia* trees and shrubs, is traded for millennia, mainly from the Arabian Peninsula and the Horn of Africa. Currently the dry woodlands in which *Boswellia* thrives are under serious threat: conversion to agricultural land, cattle grazing, fire, and intensive exploitation for wood, fodder, and frankincense. We evaluate sustainable use and management of the five main species, and detail the situation for one species, *B. papyrifera*, as an example. We analysed wild populations of this species in 23 sites in Ethiopia, Eritrea, and Sudan, and found that regeneration is practically absent, that adult trees have high mortality rates and that populations are declining fast. Frankincense yield halves in 15-20 years at current population decline rates. Production management strategies are diverse and depend on the region and the alternatives for lively-hoods. Increasingly trees are managed on short term arrangements leading to more intense use with devastating effects. Recent developments show expanding efforts towards cultivation, but this faces serious challenges. Also, further product diversification demands selection and specialization. These developments will be compared to developments in other frankincense species. Under the current socio-economic and environmental conditions wild frankincense populations decline fast for most species. Concerted action including application of guidelines for sustainable management and use of populations, area protection, woodland enrichment, cultivation and selection is needed to keep frankincense production into the future. Enabling socio-economic factors, both local and (inter)national, will be highlighted.

Saturday, 3 August 2019 | Cristall
GS27 – THREATS, PRESSURES, and DEVELOPMENT

Meeting the need of Endangered species and people in and around Giant Panda reserves

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Meeting human needs while sustaining ecosystems and the benefits they provide is a global challenge. Conventional conservation planning usually benefit one or few targeting species but ignores the complex interactions between human and natural systems. Such inadequate consideration may compromise the effectiveness of conservation planning in the long run. Here we collected information on human and natural systems using interdisciplinary techniques (e.g. camera trapping, remote sensing, and household interview) in and outside Giant Panda nature reserves, southwest China. We followed an integrative systems approach, telecoupling, to evaluate the risks and benefits for human and natural systems at local and broader scales. For the coupled human and natural system in Giant Panda nature reserves at a local scale, we found Giant Panda and the neighboring human communities shared the need for upgraded protection effort and improved forest coverage and quality. However, grazing and farming were either less likely to benefit human livelihood, or negative to Giant Panda habitat suitability. For the telecoupling (interactions across distant systems) between panda reserves and other systems at regional scale, we found the environmental investiments and working opportunities provided by distant cities could benefit both human and natural systems, while the development of tourism had mixed effects and unforeseen future risks. The telecoupling framework provided an integrative tool for future conservation planning by evaluating the needs of both Giant Pandas and human. We believe that the framework has strong implications beyond Giant Panda, where there are sustainable goals to benefit both human and natural systems.

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GS27 – THREATS, PRESSURES, and DEVELOPMENT

GS28
TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Optimising biodiversity and yield in Ghanaian smallholder oil palm plantations

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Oil palm is a highly controversial crop, not least because of concerns over its environmental impacts. Yet palm oil is globally the most widely consumed edible oil, and is increasingly targeted by governments in western Africa and elsewhere as a key sector for agricultural growth and to address rural poverty. Moreover, while most attention to date has focused on large industrial plantations, most oil palm growers are smallholder farmers who rely on cultivation for both income and household consumption. For instance, in Ghana, ~90% of the land cultivated for oil-palm comprises smallholdings. Ghana also supports rich biodiversity, much of which is threatened by forest loss, making it vital to provide smallholders with tools and guidance to help them develop sustainable agricultural practices that optimise economic returns, reduce biodiversity losses and environmental threats, and ensure the protection of high conservation value rainforest. Here we present new evidence examining how the intensity of crop management by smallholders and their use of different management practices affect both fruit crop yields and biodiversity, focusing on birds, butterflies and ants. Our results not only indicate high levels of biodiversity in Ghanaian smallholdings compared to industrial plantations elsewhere but also highlight the potential for farmers to increase their fruit yields by adoption of sustainable practices that also support biodiversity and ecosystem services.

Saturday, 3 August 2019 | Opale
GS28 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Profile and competency needs of terrestrial protected areas professionals in Madagascar

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Since 2003, the number of protected areas in Madagascar has increased from 47 to 123, of which 90% are terrestrial. This great quantitative leap has led to the extension of institutions and individuals managing these sites. But there is very little information available about the personnel of these terrestrial protected areas. As part of the establishment of a national *Forum of Terrestrial Protected Areas Professionals of Madagascar*, a study was conducted to better know the individuals who these professionals are: their profiles and skills, and thus align the Forum's interventions with their needs. We have used the Madagascar's Standard of Competence and the World Register of Competences for Protected Area Practitioners to develop a competency need assessment questionnaire which was administered during workshops or by email. Of the 139 people from 46 terrestrial protected areas consulted, 49% are technicians, 31% are site managers and 16% are field agents and 4% are protected area network administrators. The sector is largely dominated by men (73%), and 49% have less than five years experience in protected area management. Proportion of staff with a conservation-related educational background (natural sciences, forestry, environment) increases along with hierarchy, ranging from 22% for field agents to 83% for administrators. However, the top two of senior managers'working areas are Strategy and Project Management, and Communication and Public Relations, which both require managerial competencies. These results show a need to better address capacity development for protected areas staff, to adequately fulfill their tasks according to the established standards of competences. This study also sheds a light on an often overlooked aspect of conservation in Madagascar: career management and staff working conditions.

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GS28 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Intention of preserving forest remnants among landowners in the Atlantic Forest hotspot: The role of the ecological context and experiences with nature

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Unravelling the psychological processes determining landowners' support towards forest conservation is key, particularly in developing countries, where most forest remnants are within private lands. As human-nature connections are known to shape pro-environmental behaviors, the intention of preserving forest remnants should ultimately be determined by the ecological context people live in. Here, we investigate the pathways through which the ecological context (forest cover), via experiences with nature (direct contact, received ecosystem services, and disservices), influences the psychological antecedents of conservation behavior (beliefs, attitude, and intention towards preserving forest remnants). We conceptualized a model based on the Reasoned Action Approach from Social Psychology, using the ecological context and experiences with nature as background factors, and tested the model using Piecewise Structural Equation Modelling. Data was collected through an interview-based protocol applied to 106 landowners across 13 landscapes varying in forest cover in a region of the Brazilian Atlantic Forest. Our results indicate that: (i) ecosystem services are more important than disservices for shaping intention of preserving forests, particularly those related to non-provisioning benefits; (ii) contact with forest has an indirect effect on intention, by positively influencing the use of ecosystem services; (iii) people living in more forested ecological contexts have more experiences with nature, and ultimately stronger intention of preserving forests. Hence, our study suggests a dangerous positive feedback loop between deforestation and the extinction of human-nature connections. Local demands across the full range of ecosystem services, the balance between services and disservices, and the ecological context people live in should be considered when developing conservation initiatives in rural areas.

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GS28 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Human dimension of conservation planning: The case of Madagascar

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Recommendations from multiple conservation planning efforts have resulted in the current locations of reserves in Madagascar, based exclusively on species habitat and important conservation sites. However, taking account of human costs of the reserve network has received little to no attention to date. I used a systematic conservation planning framework to identify a cost-effective reserve network design for Madagascar. I considered habitat for 327 species of plants and animals and seven important conservation sites as biodiversity surrogates, and threat and vulnerability of species habitat to alternative land uses as costs to systematic conservation planning. I developed cost-layer maps from current rice field cultivation, fire occurrences, and deforestation. I also considered suitable land for rice field cultivation under scenarios of future climate change to assess the likely persistence of the selected reserve network. My results show that while inclusion of costs in systematic conservation planning did not drastically change the design of the current reserve network at the national level, multiple changes are found to be more pronounced at the regional scale. Similarly, with regards to taking into account shifting costs due to future climate change, I observed reduction and expansion of conservation sites more at regional level. This study concludes by giving recommendations regarding new reserve areas and priority for setting up additional conservation sites.

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GS28 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Combining citizen science, social media and scientific research for ecological and conservation assessments: Wild canids in India as a case study

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Wild canids are among the most under-represented large mammal groups in terms of research and conservation focus in India. We undertook a nationwide survey aimed at making ecological and conservation assessments of wild canids. The study focused on eight species and sub-species of wild canids: Dhole *Cuon alpinus*, Golden Jackal *Canis aureus*, Indian Wolf *C. lupus pallipes*, Tibetan Wolf *C. l. chanco*, Indian Fox *Vulpes bengalensis*, Red Fox *V. vulpes*, Desert Fox *V. v. pusilla*, and Tibetan Fox *V. ferrilata*. We also included the Striped Hyena *Hyaena hyaena* in our assessment because of its ecological similarities with wild canids. We combined citizen-science, information from social media, published scientific literature, remotely sensed data and surveys of field experts to create the largest database of wild canids and hyenas (>5000 records) in the country. Using a suite of spatial modeling methods, we (1) created reliable distribution maps for the focal species, (2) quantified threats to their persistence, and (3) identified critical and vulnerable landscapes to be prioritized for conservation. To maximize engagement with citizens, we also created a web-based platform for continuous sharing of the assessment process, results and insights with the public. Dhole, Desert Fox, and Tibetan Wolf showed restricted distribution patterns, while Golden Jackal, Indian Wolf, Indian Fox, and Striped Hyena showed more widespread occurrence. Nonetheless, all species appeared to face human-induced threats that could hamper their persistence in the long-term. Our results provide the foundation for building a holistic conservation strategy to conserve a wide range of habitats that the focal species represent. Based on our findings, we discuss the potential for expanding our efforts to setup a protocol for combining technology, citizen science and outreach initiatives for long-term, nationwide monitoring of wild canids and hyenas in India.

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GS28 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Deforestation and rice: A multi-temporal study projecting patterns of forest change in eastern Madagascar

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In the species rich tropics, forest conservation is often eclipsed by anthropogenic disturbance, resulting in a heightened need for an accurate assessment of biomass and an understanding of the drivers of deforestation before threatened ecosystems disappear. The combination of multi-temporal remote sensing data, field data and forest growth modeling to quantify carbon stocks and flux is therefore of great importance. In this study, we utilize these methods to (1) improve forest biomass and carbon flux estimates for the study region in eastern Madagascar, and (2) initialize an individual-based growth model that incorporates the anthropogenic factors causing deforestation to project ecosystem response to future environmental change. Recent studies have shown that there is a direct correlation between the international rice market and rates of deforestation in tropical countries such as Madagascar. Further, although law protects the remaining forest areas, the political climate and lack of funding has led to poor or non-existent enforcement of protected areas over the past 33 years. Using multi-temporal remote sensing analysis, we measured rates of change of deforestation with respect to politics and the price of rice using by classifying and comparing biomass using 30 m Landsat during six political regime time periods (1985-1992, 1993-1996, 1997-2001, 2002-2008, 2009-2013, 2014-2018). Forest biomass estimations were calibrated using forest inventory data collected over three growing seasons over the study region (130 small circular plots in primary forest). Our findings showed a significant positive correlation (cc = 0.901) between increasing deforestation rates and higher local rice prices due to political regime and international market factors. The rate of loss of primary forest the study region has accelerated from prior to (0.021 GtC) and following (0.026 GtC/yr) the political coup of 2009.

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GS28 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

Conservation clubs: Community participation and biodiversity conservation

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For successful biodiversity conservation in Madagascar involving rural communities is key. Community participation was developed in villages surrounding Ranomafana National Park by Centre ValBio Research Station in order to teach local residents to value and understand nature as well as to improve their livelihoods. There are 34 villages involved with over 2000 participants including a women weavers group, 13 conservation clubs for youth, environmental arts groups, and a traditional healers' society. Led by trained technicians from Centre ValBio, farmers are informed about the importance of rainforest, engaged in reforestation activities, and are trained to use more sustainable ways of living. Income generating activities focused on sustainable livelihood as more efficient rice production, chicken farming, fish farming, and environmental arts. Conservation clubs plant 5000 native trees a year, as well as farm vegetable gardens using compost and sustainable methods. For the last three years, scientists and professionals worked together for trainings in health care and hygiene, agriculture methods, responding to natural disaster risks, and reforestation with both endemic and fruit trees. Using media such as radio and cell phone applications are new techniques used to educate people with digital stories concerning wildlife and people. Empowering villagers may have a broader and more lasting impact to convince residents to preserve tropical nature.

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GS28 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, and CULTURAL DIMENSIONS

GS29
TROPICAL BIODIVERSITY and GLOBAL CHANGES

Invasive vs. native ant diversity across a land use gradient in vanilla landscapes of the Sava Region, northeastern Madagascar

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Conversion of natural habitat to agriculture has been recognized as drivers of native biodiversity loss and promoter of invasive species dispersion. However, the variety of habitats within the agricultural landscape differentially affects biodiversity. In this study, we investigated the diversity of native vs. invasive ants across a land use gradient in the Sava Region, northeastern Madagascar. Ants were sampled using sardine and sugar baits at 70 plots: ten replicates each of forest fragment, forest-derived vanilla plantation, woody fallow, herbaceous fallow, and rice paddy, and 20 replicates for fallow-derived vanilla plantation. Ants were identified to species level and categorized as native or invasive. Kruskal-Wallis ANOVA was used to test the differences in the species richness of ants among land use types studied. Ant diversity of each land use types was evaluated with Shannon-Weiner diversity index. In total, we collected 48 native and 10 invasive ant species. The six land use types showed significant differences in the number of both native (p-value = 0.0001) and invasive (p-value < 0.001) ant species. Forest-derived vanilla plantations had greater native ant diversity and richness but also lower invasive ant diversity and richness compared with the other land use types. Rice paddies and herbaceous fallows had the highest value for species richness of invasive ant. Fallow-derived vanilla plantations were characterized by an intermediate native ant diversity and richness. This study highlights the value of agricultural landscape for native ant conservation. Forest-derived vanilla plantations have the ability to preserve the highest proportion of native ant species within the agroecosystem in the Sava Region of Madagascar. Besides, our findings also provide useful information which might help to develop a control strategy of invasive ants.

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GS29 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Sub-lethal effects of invasive predators: The impact of free-ranging dogs on temporal activity of Atlantic forest mammals

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Invasive predators impact native species in various ways. Beyond the well-known effects of predation, predator-prey interactions may lead to sub-lethal effects, altering the behavior or physiology of native species. Free-ranging dogs are considered one of the most harmful invasive species worldwide, and their highly vocal behavior suggest sub-lethal effects are a key mechanism underlying their impacts. Based on an extensive camera-trap dataset (96 forest sites across 300,000-ha Atlantic forest region), we investigated the effects of free-ranging dogs on temporal activity of two diurnal (tayra, coati) and two nocturnal (crab-eating fox, opossum) native mammals. We hypothesized that changes in activity patterns are stronger (1) in diurnal compared to nocturnal species, as dogs are mainly diurnal, and (2) where dog abundance is higher. We selected 12 landscapes and set eight camera-traps in forest sites in each of them for 42 days. Using N-mixture models, we estimated dog abundance (intensity of invasion) in each site. We then fitted data on time recorded in camera-trap photos to flexible circular continuous distribution to estimate for each species: (1) shifts in temporal activity between sites with low and high invasion, and (2) overlap in temporal activity with dogs in each site. The only species showing shifts in temporal activity was a diurnal species - the coati: activity shifted to nocturnal hours in patches with high invasion, and the grater the abundance of dogs, the smaller the observed temporal overlap with dog activity. Results highlight the potential for sub-lethal effects of dog invasion on diurnal species through shifts in temporal activity to suboptimal conditions. However, they suggest this type of response to invasive predators is not ubiquitous among diurnal species. This in turn reveals the importance of considering the potential for higher predation or negative effects of stress on these species.

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GS29 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Female mate selection and courtship under elevated background predation risk in an invasive tropical aquatic species

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Despite non-random female mate choice acting as a major driver of male secondary sexual traits in a variety of living organisms, few studies have examined behavioural trade-offs associated with mate selection and courtship under chemically-mediated predator-rich environments. Prey inhabiting aquatic systems rely upon publicly available threat-sensitive chemical cues in order to detect and respond to potential predators. As animals engaging in courtship and mating are prone to predation, natural selection should strongly favour early predator detection, as well as threat-sensitive modification of reproductive behaviours in females. It is hypothesized that females reared under elevated background predation risk will select males displaying muted secondary sexual characteristics, as well as reduce decision-making time, in order to minimize the risk of being predated upon. In the current experiment female Trinidadian guppies (*Poecilia reticulata*), an invasive Neotropical fish species introduced throughout the world as a means of mosquito control, are reared under simulated visual and chemical predation risk and given a choice between two potential mates of either muted or bright coloration. Females from the elevated background predation risk group are expected to spend more time close to mute coloured males, make faster decisions between males, and spend less time moving between choices than those reared in a low background predation environment. As human-induced rapid environmental change drives changing predator-prey dynamics, this research will garner insight into potential impacts of novel selective pressures on reproductive decision-making behaviours in an invasive tropical species.

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GS29 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Managing a stinking problem: Understanding threats and improving weed control options for *Passiflora foetida* in Australia

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Stinking Passionflower (*Passiflora foetida*) is a vine from South and Central America that has been widely introduced into many tropical regions of the world. Across the drier parts of tropical northern Australia, it is considered to be one of the most significant weed problems in landscapes of high biodiversity, cultural, and economic value. Current manual control options are costly, labour intensive, and have minimal impact on long-term control. A major impediment for developing effective control strategies for this species is that very little is known about its biology. Here we document our findings to this point in order to underpin a biological control solution for the weed. We detail impacts on high value landscapes in regard to threats for native flora and fauna, quantify climatic growth limitations, and recruitment and establishment drivers, establish genetic insights into variation between native and introduced populations globally, and outline the early stages of our search for biocontrol agents. Our findings reinforce the idea that this passionflower has traits and impacts that make it a significant weed threat, that there are multiple likely introductions into Australia from different source regions, and that there are a number of native range pathogens worth exploring in the agent refinement process. These insights will help improve the efficiency and effectiveness not only of a biological control program for Australia, but for other control approaches and other countries in which stinking passionflower is an invasion threat.

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GS29 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Adaptation strategy and use analysis of the urban environment of Antananarivo by Common Mynas (*Acridotheres tristis*)

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The Common Myna (*Acridotheres tristis*) is among the 100 worst invasive species in the world and showing recent dramatic increases in its global distribution range. It has been introduced to Madagascar. For that, the spread of this species could have an impact on Madagascar's biodiversity. However, the Common Myna has been well studied in its native country but few studies have focused on this species in Madagascar, where it is spreading fast across the island. The objective is to understand the species' adaptive strategies based on the breeding ecology, population evolution, the areas uses, and its interaction with bird species. Three sample sites (Tsarasaotra, Tsimbazaza, and Tanjombato) were studied from September 2015 to September 2017 and choose by presence of the roost of the species. Scan sampling method were used for breeding ecology and bird interaction, and transect and point count for assessing its population. The Common Myna breeds twice a year in Antananarivo (October to December and January to March). Abundance was estimated to 7.9 ind/ha and a roosting site were about 6196 individuals and it is increasing twice by year. Each study site is used as a foraging area during the day and as a roosting site at night. Five bird species are interacted frequently with the Common Myna near its nest and three other species in the roost. Cohabitation between the species is generally observed, but competition was sometimes observed for access to nesting and roosting sites. No predators were found during the study. Consequently, the Common Myna adapts and has thus easily colonized Antananarivo because the associated ecological characteristics are completed and even that the species is continuously increasing today.

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GS29 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

The Red Devil Cichlid (*Amphilophus labiatus*, Günther 1864) and its relationship to environmental and biodiversity factors in Lake Sentani Papua, Indonesia

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Lake Sentani is located in Jayapura, Papua, Indonesia, and one out of 15 priority lakes in Indonesia. The lake is facing high pressure of habitat alteration and introduction of exotic species. *Amphilophus labiatus* (Günther 1864) is the most dominant and invasive introduced species in the lake whose impact on endemic and native species was not previously known. This study aimed to document the impact of habitat quality on the species and its relationship to native/endemic fish species in the lake. Fish were sampled at six locations in Lake Sentani using gill nets during February and March 2018. Water samples of Lake Sentani were measured in Environmental Laboratory of Health Department, Papua Province. All statistical analyses for relationship of water quality and fish, also endemic/native fish and red devil cichlid were conducted in R statistic version 2.8.1. NMDS analysis for 54 water data sets were using to test whether water parameter in Lake Sentani has any influenced on fish especially *A. labiatus*. Nitrate (NO_2-N) significantly influenced fish in Lake Sentani at $\rho < 0.001$. Site 1 in Asei had highest NO_2-N level and Snakehead gudgeon (*Giuris margaritaceus*) was the most tolerant species to NO_2-N while *A. labiatus* was one of the most non-tolerant fish to NO_2-N. Pearson correlation analysis of 18 data sets of fish showed 12 positive significant correlations among five native and introduced species. *Amphilophus labiatus* had no positive or negative correlation to other fish. Other survey recorded *A. labiatus* dominated the community and had serious impacts on endemic and native species in Lake Sentani. Future study in food preference and reproduction of the cichlid will be applied to know other contributor factor, which could be impacted endemic and native fish species.

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GS29 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

Invasion dynamics of an amphibian with frequent human-mediated translocations on the Andaman Archipelago

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Tropical island communities can be highly susceptible to invasions, but also provide unique opportunities to manage invasions. Post species introduction to islands, human-mediated translocations (HMT) can alter the course of invasions by accelerating invasive spread. Therefore, modelling of invading organisms requires accounting for HMT along with complexities in species demography, spatial context, and natural dispersal. We aim to disentangle these invasion dynamics for the Indian bullfrog (*Hoplobatrachus tigerinus*) on the Andaman Archipelago, a global biodiversity hotspot, to assess i) the effect of HMT on colonization rates, and ii) the efficacy of two potential management interventions in limiting invasive spread. We combined an age-structured demographic model allowing stage-based dispersal with a gravity model of human influence, in a spatially explicit modelling context. We parametrized the model using life-history and dispersal variables from *H. tigerinus* (or similar species), and remote-sensed variables describing spatial heterogeneity. The modelled invasion dynamics of *H. tigerinus* shows human influence can increase spread rates by a factor of three, as compared to invasion without human influence on spread. Such exacerbation of spread rates is driven by facilitation of both between and within island movements of *H. tigerinus* by humans. The model also predicted an overriding effect of HMTs on the origin of invasion. Of the two simulated management interventions, only constraining movement of *H. tigerinus* between islands was effective in limiting spread, but success was dependent on time elapsed since introduction. Based on model predictions, we find merit in recommending screening at points of entry (e.g. ports) for the hitherto uncolonized Baratang and Long Islands. Although the model provided insights into the human influence on invasive spread in an archipelago context, it did not perform optimally in estimating demographic dynamics and natural dispersal. We demonstrate the suitability of this modelling approach in understanding invasions with persisting human influence, especially in island systems.

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GS29 – TROPICAL BIODIVERSITY and GLOBAL CHANGES

GS30
ECOSYSTEM FUNCTIONS and SERVICES

Captured sunshine: How much photosynthetic energy ends up consumed by vertebrates in intact and logged tropical forests?

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All ecosystems are powered by the capture of sunshine by photosynthesis and its transfer through the many trophic levels of the ecosystems. There are few studies that try to quantify and describe this flow, mainly because such studies require quantification of both primary productivity and information on the biomass, abundance and diet of key taxa. Here we present an analysis of this "captured sunshine" energy flow from through vegetation to mammals and birds in old growth and logged forests and oil palm plantations in Sabah, Malaysian Borneo. We ask the question: what fraction of this captured energy ends up being consumed by vertebrates, and how and why does this fraction vary between intact and human-modified ecosystems? We collected data on gross and net primary productivity using the Global Ecosystems Network protocol, measuring the major components of biomass production and consumption. We collected data on mammal and bird abundances using surveys and camera traps. The animal data was converted into consumption rates using a metabolic approach based on body mass and diet content. We show that the fraction of energy conversion into vertebrate biomass doubles in a logged forest. This appears to be because the canopy opening favours more ground-level herbaceous growth that is accessible to large herbivores, and is also relatively palatable and less chemically defended. In the oil palm plantation is there a large decrease in resources available to animal consumption. We demonstrate that our trophic approach provides a useful approach to quantify resource flow through ecosystems and how they are affected by local and global change. We also compare the tropical analysis with a European woodland (Wytham Woods, UK), to explore how and why trophic flow differs between temperate and tropical forests.

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Invitation to forest canopy ecology: Global scale collaboration opportunities

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The canopy is the defining components of any forest ecosystem and is known to harbour a large proportion of global biodiversity. The canopy community is vitally important for the essential roles in ecosystem functioning and services. Over the last several decades there have been significant advances in canopy science, and extensive education programs have been successful in disseminating information about the importance of forests and their canopies in promoting human well-being. There remain many challenges in understanding canopy systems in order to make predictions about the consequences of global-scale human disturbances and their impact on forest biodiversity and ecosystem functioning. Much further research is needed to understand fully forests and their canopy ecosystems. Moreover, canopy science is undergoing an exciting, radical change of approach from descriptive studies to experimental manipulation. Here we examine recent progress in canopy science, and invite you to join global canopy networks which can be incorporated into multilateral, collaborative efforts to further develop our understanding of canopy ecosystems.

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The consequences of land use on subsurface water storage and vegetative water source in a tropical dry forest

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Tropical dry forests (TDFs) are considered one of the most heavily utilized and disturbed ecosystems in the world, yet studies of hydrological processes in TDFs make up less than 1% of published forest hydrology literature. In Bahía de Caráquez, Ecuador, over 98% of the total extent of native TDF has been deforested, and the remaining TDF is highly fragmented. In TDF's we do not know the relationship between land use (either deforestation or reforestation) and hydrologic properties such as the movement and retention of subsurface water. In collaboration with the Ecuadorian non-profit Corredores de Conservacion de la Bioregion and with the cooperation of the Cordillera del Bálsamo, we tested the hypothesis that the deforestation and degradation of native TDF has resulted in decreased shallow subsurface water storage and plant available water. Over the course of this study we conducted snapshot measurements of the extreme seasonal changes in water availability to predict changes in subsurface water storage and water use across varying land use types by (1) constructing site specific moisture release curves, (2) tracking seasonal changes in predawn and midday leaf water potentials, and (3) tracking seasonal changes in the isotope composition of vegetative source water. Our preliminary results show that (1) land conversion is responsible for a longer and more severe dry season, accompanied by a significant decline in plant available water, (2) tree water potentials track seasonal changes in soil water availability, and (3) the source waters of trees in the primary forest is constant year round, but drought tolerant secondary forest species shift their water source to more reliable sources over the dry out. The data produced in this thesis will help explain seasonally dependent hydrologic processes across varying levels of forest disturbance, and we hope will stimulate conservation efforts in coastal Ecuador and other TDF's.

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Land-use history and shade management influence the conservation value of vanilla agroforestry in the biodiversity hotspot of northeastern Madagascar

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Cash crops farmed in agroforestry systems are often considered to be a biodiversity-friendly yet economically attractive land-use option for smallholder farmers in the tropics. Whether such win-win situations can be realised is however, highly context-dependent. Here, we study the impacts of vanilla agroforestry in northeastern Madagascar; a biodiversity hotspot which loses forest cover at high rates to agriculture. This transformation is mainly attributed to subsistence slash-and-burn agriculture, but the current vanilla boom driven by prices of up to 600€ per kilo may also lead to the encroachment of vanilla plantations into remaining forests. Alternatively, vanilla plantations can be derived from open fallow land currently under slash-and-burn agriculture, leading to a potentially more biodiversity-friendly land-use. We compared vanilla yields, canopy closure, and bird diversity of forest-derived plantations (n=10) with fallow-derived plantations (n=20) to investigate (i) how vanilla yields vary between plantation types and under different canopy closure regimes, and (ii) how land-use history interacts with shade management practices affecting canopy closure and endemic bird diversity. Interestingly, vanilla yields were not correlated to canopy closure. Older forest-derived plantations had lower canopy closure than more recently established plantations. Given that endemic birds were more likely to occur in tree-rich plantations, this ongoing loss of trees may impede the conservation value of forest-derived vanilla plantations in the long run. On fallow-derived vanilla plantations, endemic bird richness was uncorrelated with tree metrics suggesting a limited potential for bird conservation, even if trees would regenerate post-conversion. Our results indicate that the cultivation of the same cash crop might have very different outcomes for biodiversity depending on land-use history and management practices. The missing association between vanilla yields and canopy closure further implies the possibility of win-win situations combining high yields with a high biodiversity value in vanilla agroforestry.

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Herbaceous plant communities across land-use types within vanilla production landscapes in northeastern Madagascar

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Madagascar, rich in terms of biodiversity, is considered as priority for conservation; but high rates of deforestation are threatening remaining forest areas. Agricultural practices are often pointed out as the most important driver of deforestation in Madagascar. However, agroforestry systems, such as vanilla farming, can provide new opportunities for biodiversity conservation outside protected areas. This research aims to find out the importances of vanilla production landscapes in northeastern Madagascar for biodiversity conservation focusing on herbaceous plants. We particularly want to know (1) how vanilla plantations differ from other prevalent land-use types including primary forest in terms of herbaceous plant diversity (alpha and beta diversity), (2) how is the proportion of endemic and indigenous species between different land-use types within vanilla landscapes, and (3) If canopy closure and land use history (forest derived vs. fallow derived) influence herbaceous plant community (plant cover, plant life forms, and species diversity). We conducted the assessment of herbaceous plants on 80 plots across the SAVA Region in northeastern Madagascar: 30 vanilla plantations (differing in land use history and canopy closure), 40 plots of other prevalent land-use types (forest fragments, woody fallows, herbaceous fallows, and rice paddies), as well as 10 primary forest plots as baseline. We found that (a) vanilla plantations can home similiar or even higher herbaceous plant diversity compared to forest fragments, (b) vanilla plantations have higher endemic species richness compared to fallows and rice paddies, (c) land history and canopy closure influence herbaceous plant community. Our research contributes to the knowledge of Malagasy plant biodiversity as well as revealing new opportunities for herbaceous plant conservation in the vanilla landscapes of northeastern Madagascar.

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Human disturbances and the decline of aboveground biomass in the Caatinga dry forest

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Human disturbances have biologically reorganized tropical forests from population to ecosystem level as natural landscapes are converted into human-modified landscapes. Particularly in seasonally dry tropical forests, a combination of slash-and-burn agriculture, exploitation of forest products and extensive cattle raising can drastically affect patterns of forest regeneration, biomass accumulation and persistence at multiple spatial scales. Here we investigate the drivers of aboveground biomass in a human-modified landscape of the Caatinga dry forest, northeast Brazil. Forest aboveground biomass was estimated via an allometric model through 35 permanent plots, which covered a wide range of habitats, including regeneration and old-growth forest stands (a total of 8,911 stems from 144 woody plant species). Caatinga flora was dominated by species exhibiting moderate-heavy wood, with few dominating species and narrow stems responding for most of the aboveground biomass. Biomass averaged 28.48 ± 23.32 Mg ha^{-1} with a high cross-stand variation as it resulted from a complex interaction of age of forest stand, rainfall and plant species richness. It worth mention that old-growth forest stands supported twice as much biomass (38.81 ± 25.08 Mg ha^{-1}) than successional stands (14.68 ± 10.52 Mg ha^{-1}). Drivers of plot-level biomass also affected biomass at species level as well as the abundance of the species which contributed most for forest biomass. Our results suggest that Caatinga supports reduced aboveground biomass as compared to other dry forests. Moreover, slash-and-burn agriculture results into forest biomass mosaics at landscape level. In addition to forest successional stage, biomass responds positively to precipitation level and woody plant species richness. It implies that biomass accumulation/persistence in human-modified landscapes is a complex and a multi-driving process. Biomass accumulation/persistence and related ecosystem services require not only long fallow periods, but also the protection of species-rich forest assemblages, what is challenging by considering the current trend of land use intensification.

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Recovery of functional diversity during secondary forest succession

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Community assembly is determined by environmental filtering, biotic interactions (e.g. competition, pathogens), and dispersal. Tropical forest succession after land abandonment may initially be mainly determined by environmental filtering because of stressful conditions (e.g. high temperature) in more open forests. During later succession, however, biotic interactions may become more important. Evaluating changes in the functional trait composition and diversity within the community can provide a better understanding of the mechanisms underlying community assembly. For example, if the strength of biotic interactions increases during succession, then the newly establishing species should be more dissimilar in trait values and, hence, the community would increase in functional trait diversity. However, if environmental filtering increases, we would expect a decrease in functional diversity. We evaluate how functional trait diversity indices change during tropical forest succession. We evaluate these changes across 534 chronosequence plots in 25 Neotropical secondary forest sites. This chronosequence approach enables us to evaluate long-term community assembly and underlying mechanisms. We find that functional richness increases with succession, but that this increase is similar when traits are randomly assigned to species. Hence, the increase in functional richness during succession is fully driven by increases in species richness, which, by chance, can add species with more extreme trait values to the community. These results suggest that dispersal differences among species may be a stronger mechanism of community assembly than biotic interactions or habitat filtering.

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GS31
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Distribution of the Amber Mountain Fork-marked Lemur (*Phaner electromontis*) throughout northern Madagascar

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The geographic distribution of a species can provide insights into its ecology, evolution, and how it responds to environmental change. Furthermore, knowing and understanding the distributions of threatened species is crucial for their conservation, such is the case for tropical primates. However, there is little data available for many recently-described yet understudied primate taxa, making the study and conservation of these highly-threatened species difficult. Here, we investigated the distribution of the Amber Mountain Fork-marked Lemur (*Phaner electromontis*), an Endangered, nocturnal primate that is endemic to northern Madagascar. Fork-marked lemurs are highly vocal, so we used an acoustic surveying method to assess this species' presence/absence and relative population density within 66 different survey sites in forests throughout the Diana and Sava Regions of northern Madagascar. Further, we compared our data among five forest habitat types (dry, dry-transitional, humid, humid-transitional, littoral), and we investigated the relationship between *P. electromontis* population density and climate. We were able to confirm the presence of *P. electromontis* within 22 of our 66 study sites, of which many populations were not previously known, and we observed higher *P. electromontis* presence-rates and relative population densities within dry-transitional forests in comparison to the other forest types. Additionally, we confirmed significant relationships between *P. electromontis* population density and temperature and precipitation, suggesting a niche preference in this species. Our results suggest that a major river geographically separates two distinct populations of this species, one of which may in fact be a new species. Further genetic, acoustic, and ecological research of *P. electromontis* is needed to answer the questions of its taxonomy and natural history, something that is required for its conservation.

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GS31 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Beta diversity of woody plants in east Asian tropics and temperate insular biotas: The roles of geohistorical and ecological processes throughout the Philippines, Taiwan, and Japan

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Species diversity patterns are shaped by local deterministic processes and regional historical events occurring at larger spatial and time scales. Understanding the effects of the latter on contemporary biodiversity patterns is a major challenge for ecological and biogeographical studies. In this view, exploring phylogenetic diversity provides clues about the geohistorical filter effects on present-day community assemblages. This study addresses the relative roles of geohistorical and current environmental factors in shaping the beta diversity of woody plants in East Asian insular biotas (the Philippines, Taiwan, and Japan) and also examines the contribution of recent diversification in this region. Large-scale occurrence data of woody plant species were compiled in the three archipelagos. First, we investigated the relationships among geographical (straits, distance, and area) and ecological (topographical heterogeneity, minimum temperature, and annual precipitation) variables and taxonomic and phylogenetic dissimilarities using regression models. Second, geographical patterns of phylogenetic beta diversity were compared with those of taxonomic beta diversity using ordination and randomization tests. These analyses were applied to the woody plants overall and to their functional groups defined by life-form (coniferous, deciduous broad-leaved, and evergreen broad-leaved groups). The results of these analyses revealed the contributions of environmental drivers to taxonomic/phylogenetic beta diversity for the woody plants overall and their functional groups. They also shed light on how the combination of geographical isolation and environmental filtering in response to geohistorical perturbations and environmental gradients shaped the beta diversity patterns of woody plants in east Asian insular biotas, and how their insular environments function as a refugia for relict taxa and as hotspots for endemics.

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GS31 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Application of the point-transect distance sampling method to estimate gibbon density in dry evergreen forest, western Thailand

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In Thailand, gibbons (*Hylobates* spp. and *Symphalangus*), only occur in well-protected forests. Most gibbon surveys in Thai forests have been done using traditional auditory methods that fail to take into account the decline in audibility with distance and, hence, may overestimate the effective listening area. Such methods may underestimate gibbon populations and adversely affect conservation priorities. Our aim in this study was to develop an improved method to estimate the population of White-handed Gibbons (*Hylobates lar*) in the well protected Huai Kha Khaeng Wildlife Sanctuary in western Thailand. This survey combined traditional and novel approaches by using arrays of listening posts placed around randomly selected sample points. After mapping the locations of the groups by triangulation, we then used point-transect distance sampling to estimate group density. We selected 35 arrays that contained 140 listening posts around the 35 sample points in the western and eastern parts of the sanctuary. The survey area was located only in dry evergreen forest as this is the most suitable habitat for gibbons. We detected (triangulated on) 423 gibbon groups in 10 months of survey across 2017–2018. The estimated gibbon density was 4.35 groups/km^2 (95% CI: 3.53–5.35). The hazard rate function provided the best fit to the detection function, and detectability remained high up to about 600 m from the sample point. Average group size was 3.4 individuals (range: 2–7; N = 61). The density of groups found in this large wildlife sanctuary is among the highest ever found for any gibbon species in Southeast Asia, and we recommend that this method, which is relatively labor-intensive, be used as a baseline to test other newer survey methods.

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Passive auditory monitoring as a promising method for occupancy modeling of spider monkey populations

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Shared habitats between human and non-human primates have become a major conservation challenge in the 21st century, demanding solutions for a successful co-existence. Accurate determination of species distributions and monitoring of populations are important requirements for successful conservation research. Passive auditory monitoring has been developed as a monitoring tool which requires a lot less survey effort and less survey area than traditional sampling methods. Passive auditory monitoring consists of using autonomous recording devices to capture animal sounds. The acoustic information can then be analyzed for various purposes, such as the detection of animals, density estimations of a species and biodiversity monitoring. Passive auditory monitoring has been successfully applied to birds, amphibians, bats, cetaceans, elephants, and recently to primates. We tested the feasibility of using autonomous recording devices to detect vocalizations of Geoffroy's Spider Monkeys (*Ateles geoffroyi*) for passive auditory monitoring. The study was carried out in the inland area of the Riviera Maya, which is a growing tourist hotspot and priority conservation area in Mexico. We compared data obtained from passive auditory monitoring to those obtained from a ground survey using traditional point-count sampling in areas known for the presence of spider monkeys. We found that passive auditory monitoring estimates spider monkey occupancy more accurately than point-count sampling. We conclude that passive auditory monitoring is a promising new approach for conservation research on spider monkeys in challenging environments because of its effectiveness, its economic use of space and its low degree of invasiveness.

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GS31 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Mixing floodplain avifaunas with the confluence of major rivers in northwestern Brazilian Amazonia

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River “color” or water type is an important determinant of biodiversity in Amazonian floodplain forests. Yet, the relevance to the distribution of non-aquatic floodplain fauna of mixing distinct water types downstream from rivers joining has been largely overlooked. We investigated how the entrance of a major white-water tributary affects the floodplain forest avifauna along the world’s largest black-water river in northwestern Brazilian Amazonia. We sampled bird species composition and analyzed satellite image-based estimates of floodplain attributes at 42 sites (along nine river sections), distributed on both banks and islands of the Rio Negro, above and below its confluence with the Rio Branco. A total of 270 bird species were encountered, and species composition downstream from the confluence was significantly different and richer than that upstream. Compositional changes were significantly correlated with estimates of sediment load in the water and with floodplain location (islands or riverbanks). More than 30 species that upstream are found predominantly in white-water tributaries (including four exclusive to the Rio Branco) occurred downstream on the islands or along the north (left) bank of the lower Rio Negro; there, species predominantly found in black-water tributaries were significantly less frequent. A group of typically white-water species, however, also occurred above the confluence. The input of sediments from the Rio Branco, and likely from other white-water tributaries, into the Rio Negro promotes the co-occurrence (at landscape scale) of species that typically do not occur together, thus enhancing species richness. Rather than being simply the classic black-water river and a potential barrier between white-water systems, the Rio Negro is a mosaic of floodplain forests, bridging and holding important populations of range-restricted floodplain specialists. This mixing phenomenon expresses the multiple roles of confluences of major rivers in the distribution and evolution of Amazonian floodplain biodiversity.

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The pitfalls of biodiversity proxies: Differences in richness estimates from DNA metabarcoding, tree inventories, and bird surveys across Amazonia

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Most knowledge on tropical biodiversity derives from the study of charismatic macro-organisms, such as vertebrates and flowering plants. However, these groups constitute only a minor fraction of the total biodiversity of ecosystems. The diversity of micro-organisms, despite constituting the majority of all life forms on Earth, remains poorly studied and mapped. Here we address a question of fundamental importance in ecology and conservation: Do the same richness patterns emerge for macro and micro-organisms? To tackle this question, we barcoded community samples of soil, litter, and insects from four localities on a west-to-east transect across Brazilian Amazonia. We quantify the diversity in those samples using three molecular markers: 16S, 18S, and COI to target prokaryotes, eukaryotes, and metazoans and related groups, respectively. We compare diversity estimates from these markers, quantified as Operational Taxonomic Units (OTUs) richness, with taxonomic richness estimated from taxonomic inventories of two groups of well-studied organisms in Amazonia: trees and birds. We found that OTU richness at the site level is decoupled from taxonomic richness of birds and trees. Within our sites, richness estimates for trees and birds are also uncorrelated. OTU richness, in contrast, show a west-to-east declining diversity gradient that reflects previously documented patterns for birds and trees at larger (Amazon-wide) spatial scales. These results suggest that all, or at least most, taxonomic groups may respond to the same overall diversity gradient across Amazonia, which relate to differences in precipitation, nutrient levels, and evolutionary history, among others. In spite of that, our results also suggest that the idiosyncrasy of each taxonomic group and peculiarities of the local environment frequently override large-scale diversity gradients. We highlight the benefits of combining different sources of data and the importance of including multiple organisms to better understandIn

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GS31 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Jaguar moths: A model for large-scale conservation

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The Neotropical genus *Gaujonia* (Noctuidae: Pantheinae) belongs to a poorly studied group called "Jaguar moths" that are endemic to the Americas. *Gaujonia* was considered to contain only four described species that are restricted at high elevations in the Andes Mountains. However, a preliminary extensive study of its evolutionary history and behavior showed that this genus is not monophyletic, but a generic complex comprised of five genera (*Cicadomorphus*, *Gaujonia*, *Gaujoptera*, *Millerana*, and *Oculicattus*) with several new endemic species. We also found that some of these species secrete unique defensive chemicals, are specialists on at-risk plants, and are restricted to small areas, making them good targets for conservation efforts. Therefore, we decided to use Species Distribution Models (SDM) and Vulnerability Indices (VI) in 22 species of the *Gaujonia* complex in order to establish large-scale conservation priorities, using data from museums and private collections. We incorporated information on endemism, habitat specialization, and geographical rarity as criteria for estimating vulnerability. Also, potential distribution along with three alternative vulnerability indices were employed to assess potential Biodiversity Conservation Concern index (BCCI) and potential Biodiversity Conservation Weight (BCWI) to determine probabilities of species occurrence. Results showed that seven species were classified as vulnerable using the three criteria. Colombia and Ecuador were the regions with the highest estimated values of potential species richness, with nine and 15 species respectively. BCCI and BCWI showed that the Andean region is vulnerable, especially in Ecuador, Peru, and Colombia. In conclusion, we demonstrate that the *Gaujonia* complex is a good model for large scale conservation, especially in the Andean Hotspot, which is severely threatened by logging, mining, agriculture, and other practices that increase the probability of micro-extinctions. Thus, we believe these moths and other Andean fauna must be considered a priority for conservation.

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GS32
ISLAND BIODIVERSITY, MARINE, and COASTAL

Does forest fragment size mediate the impacts of introduced rodent predators? Foraging behavior and impact of Hawaiian birds on their arthropod resources

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On oceanic islands worldwide, native species increasingly contend with the interacting stressors of habitat fragmentation and invasive predators, yet their joint effects have rarely been examined. Here we isolated the independent and interactive effects of invasive omnivorous black rats (*Rattus rattus*) and forest fragment size on the interactions between forest birds and their arthropod resources. A system of volcanically isolated forests (kīpuka) on Hawaii Island provided a 100-fold range in fragment size (0.1 to 12 ha). We experimentally removed rats at the kīpuka-level (16 removal, 18 control), excluded birds with netting in the forest canopies in each kīpuka, monitored bird foraging behavior and nesting success, and tracked arthropod abundance and composition. We predicted that the reduced edge effects and greater structural complexity and canopy height of larger fragments would limit the total and proportional habitat space frequented by rats and thus limit their impact on both arthropod biomass and birds' foraging behavior. Rat removal was associated with shifts in the vertical distribution of arthropod biomass, irrespective of fragment size. Bird foraging behavior mirrored this shift, and the impact of rat removal was greater for birds that primarily eat fruit and insects compared with those that consume nectar. Functionally, birds played a greater role in larger fragments in limiting canopy arthropod abundance in the presence of rats, but this pattern disappeared when rats were removed. Evidence from this island study system indicates that invasive rats indirectly alter the feeding behavior of native birds, with consequences for multiple trophic levels.

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Low fruit production in a dry forest tree: Resource or pollination limited?

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Plants of seasonally dry tropical forests frequently experience unfavorable periods, where insufficient rainfall limits nutrient uptake by roots. This not only negatively affects photosynthesis in these plants, but also their capacity to produce flowers and fruit. With a limited resource budget, selection may favor a reduction in the quality or quantity of resources allocated to attract pollinators. In turn, this may reduce pollinator visitation rates and ultimately limit fruit production. The dry forest tree, *Plumeria alba* produces no pollinator rewards and thereby deceives insects into providing pollinator services, apparently for free. In this field study, I conduct a pollination experiment with the intention of determining if *P. alba* is pollination or resource limited. Previous studies conducted in 1998 and 1999 with this same population of *P. alba* trees, resulted in zero fruit set. Unfortunately, no fruit production calls into question if hand pollinations were unsuccessful due to technique or if plants simply lacked the resources to produce fruit. Inflorescences on 11 *P. alba* trees were bagged with nylon mesh bags to better control pollinations by hand and another 11 trees were tagged as control trees, open to pollen transfer by animals. Of the total fruit that matured, two were from control and 1.5 fruit were produced on hand pollinated inflorescences. A series of photographs taken every two weeks, provided a data record of development from flower to fruit during this study. Resources and not a limited number of pollinators appear to account for low fruit production in this long-lived tree.

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New genus and tribe (Rubiaceae) from the Seychelles sister to a tropical African lineage and a sole representative of a critically endangered lineage

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The Seychelles Archipelago, situated about 1100 km northeast of Madagascar and 1600 km east of Africa, is formed by both granitic and coralline islands. The granitic Seychelles are Gondwanan fragments that were joined with Madagascar and India to form the Indigascar landmass in the Late Cretaceous. The biota of the Seychelles reflects the geological and biogeographical histories of its islands, and includes cases of dispersal-mediated divergence and vicariance from African or Malagasy or Indian taxa. One Sechellois plant, *Psathura sechellarum* Baker (Rubiaceae), has been postulated to be a relict species descending from an ancient widespread Gondwanan-flora, which became extinct in the continental mainlands but survived on the granitic islands of Mahé and Silhouette. On the other hand, the Seychellois *Psychotria* spp. and the Mascarenes *Psathura* (= *Psychotria*) spp. have been shown to be the result of independent long-distance dispersal events from Madagascar that took place in the Miocene-Pliocene. *Psathura sechellarum* has not previously included in any molecular and biogeographic study of Rubiaceae and molecular data needed to test these conflicting biogeographic hypotheses are presently lacking. We conducted molecular phylogenetic and dating analyses of the subfamily Rubioideae. *Psathura sechellarum* was resolved with high support as sister to a species-poor, tropical African lineage that is distantly related to *Psychotria*. We conclude that this Seychellois plant represents a relict and Critically Endangered species, which is a sole representative of its lineage and thus carries unique genetic information. The resulting phylogeny was linked with the morphological and geographical distinctness of *P. sechellarum* for supporting the description of a new genus (and tribe) to accommodate this species.

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Endemic fish species diagnostic in Lake Itasy catchment area - towards a conservation strategy

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In December 2018, we surveyed the fish fauna of the Lac Itasy basin, 120 km to the west of Antananarivo. To learn more about the ecology and the actual distribution of the endemic species (*Ptychochromoides itasy*, *Paratilapia* sp., and *Ratsirakia* sp.), four rivers and six lakes spread over the Lac Itasy basin were inventoried. Water quality and aquatic invertebrates were investigated; fish species were inventoried. The water was warm (27.4 ± 1.8°C), moderately alkaline (pH = 7.5 ± 0.5), lightly mineralised (electrical conductivity = 105.2 ± 20.5 µS cm^{-1}), soft (GH < 1-2°dH; KH: 1-3°dH), and well oxygenated (7.5 ± 2.4 mg l^{-1}). The concentrations of nitrogen, phosphate, and iron were relatively low. Of the 36 families of macroinvertebrate assessed, pond snails (Lymnaeidae) were dominant. A total of 13 fish species was found, six native and seven introduced. The introduced species occurred at 100% of the sampling sites where they are the most abundant species. Formerly widespread in the region, *Ptychochromoides itasy* (CE) is now restricted to the Mahajilo River while *Paratilaripa* sp. was found in Ilempo and Andranomena Lakes. *Ratsirakia* sp. is more widespread. The main threats are the habitat loss, the exotic species introductions and the overfishing. A locally based conservation strategy is urgent.

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Linking social and ecological data to understand how Pacific Island fishers navigate changing coral reefs

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Coral reefs are transforming due to global and local stressors, and millions of coastal people who depend on reefs for their well-being will be compelled to adapt their resource use strategies. However, links between ecological state of the reef and human activities such as fishing remain poorly understood. One opportunity for exploring the reciprocal feedbacks between small-scale fishers and fishing reefs arises when an abrupt and dramatic change in ecological state occurs. The responses of local resource users in such cases are critical, as the targeted species in the fishery may sustain ecosystem resilience or amplify the shifts. Here we combine underwater ecological censuses, catch data, and household surveys to evaluate how reef fish and fishers in Moorea, French Polynesia, responded to landscape-scale loss of coral resulting from a destructive cyclone followed by an outbreak of crown of thorns sea stars. We identified and sized fish in the catch and on the reef during a nine-year period that spanned the disturbances. We found that the overall biomass of fishable resources changed little over time, but that there were substantial changes in the taxonomic composition of the catch, many of which reflected taxonomic shifts in abundances of fishes on the reef. Although there was evidence for high taxonomic selectivity in fishing, few households indicated that they changed their fishing practices in response to the disturbances. Despite the observed changes in the catch, fishers continued to heavily target herbivorous fishes, a practice that can contribute to loss of resilience in coral reef ecosystems. Our findings have broad implications for implementing effective local-level comanagement where resource users, scientists, and conservation practitioners may have different interpretations of what constitutes change, as well as resource harvesting strategies that promote resilience, in these highly dynamic systems.

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Humpback whale calves' vocal repertoire in the Sainte Marie channel breeding ground

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Humpback whales use vocalizations during diverse social interactions or to organise activity such as foraging or mating. Unlike songs, which are confined to males, social calls are involved in social interactions, and have been reported to be produced by all types of individuals, adult males and females, juveniles, and calves. Recent studies have described these social calls in different geographic areas; however, the context and biological functions of these social calls remain unknown. This study aims to investigate the vocal repertoire of humpback whale calves during interactions with their mothers. We recorded mother-calf vocal activity during the breeding season in Madagascar by using Acousondes tags attached to mother-calf pairs (either mother or calf or both). Based on a previous description of the vocal repertoire of social sounds in the study area, we were able to identify nine types of calls by calves, varying from low to mid-frequency, including one call presenting amplitude modulation. Two of the calves' vocalizations reported in this study were similar to calves' vocalizations described in the literature of other geographic areas, and four call types appeared to be group-specific. Though humpback whale calves' vocalizations are in general relatively simple in structure, we found that calves are also able to produce combined calls, composite calls and sequenced calls. Such diversity in call production may be part of the vocal ontogeny of humpback whales, and could lead to a more stable and complex vocal repertoire at adulthood.

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Could restoring normal water column mixing improve outcomes for shallow corals during mass bleaching events? – The Reef Havens Research Project

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Reefs worldwide are experiencing mass bleaching events and severe coral mortality as a result of rapid climate change, and the Great Barrier Reef (GBR) is no exception. In addition to its inherent ecological and World Heritage value, the GBR currently sustains a $6 billion pa tourism industry and 60,000 jobs, yet we have limited knowledge of science-based tools and methods that could be used to actively manage for persistence and/or better enable adaptation of complex coral communities to climate change, even at the very small scale of a reef tourism site (~350 m^2). We used a range of publicly-available datasets to investigate how local weather conditions (wind) affected the temperature of the water column during bleaching and non-bleaching years on GBR reefs in the vicinity of Cairns, Australia. While the GBR lagoon is generally well-mixed in terms of temperature due to wind acting on the water's surface, this mixing process begins to fail during periods of low (doldrum) winds. When a series of doldrum days occurs during summer the water column begins to stratify, with as much as 2°C difference in temperature observed between the surface and 12–14 m, and as much as 3°C difference in temperature between the surface and deeper waters (~40 m). Could restoring normal mixing processes (ie, destratification) at small scales improve outcomes for shallow corals during bleaching events? The Australian Government-funded Reef Havens Research Project is ongoing and has established an in-situ research platform at Moore Reef near Cairns that is being used to increase mechanistic understanding of patterns in local-scale coral bleaching and recovery, and evaluate the feasibility of possible interventions with scientific rigour. A variety of instruments have delivered ~200 million data points to date, including fine-scale temperature and flow, and these will shortly be made publicly available.

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Evaluation of the effect of climate change in vegetation phenology using long-term NDVI, case of Menabe, Madagascar

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In Madagascar, deforestation has been studied thoroughly, with almost a countrywide analysis every five (5) years but there has been little analysis in forest degradation due to technical difficulty in measuring a gradual change in the forest. In this study, forest degradation was evaluated by computing long term change in phenology parameters using Normalized Difference Vegetation Index (NDVI) available through MODIS satellite platform from 2002 to 2017. Objectives of this study are to evaluate the impact of climate in the vegetation phenology and productivity in Menabe and understand the relationship between rainfall, forest degradation, and wildfires occurrences. Phenological parameters such as start of season (SOS), end of season (EOS) and peak of season (POS), would inform on the shift in vegetative cycle but also the possible degradation of the forest. Moreover, these parameters provide information on the vegetation response to climate change. The phenology cycle is also compared to rainfall pattern to explain if there is a relationship between the change in phenological cycle and the climate. The results show a slow but steady decrease in vegetation activity as the mean NDVI trends is decreasing. This decrease in NDVI is a proxy to degradation in the forest as the productivity of the vegetation decreases along with the stand and biomass. Also, SOS comes later, and EOS comes earlier meaning that the active vegetative season is shortening. Preliminary comparison to rainfall shows the same shortening in rainy season. The study shows that climate change is affecting the vegetation cycle. The shortening of the rainy season induces a decrease in productivity. Also, the longer dry season may result in increased wildfires and slashing and burn cultivation. We hope that the information provided will inform policies in coping with climate change, fight wildfires and deal with deforestation.

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Roadkills in northern Peninsular Malaysia

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As Malaysia's economy continues to grow, an ever-expanding road network is being built to support the new developments. Whilst roads increase accessibility to Malaysia's resource rich rural areas, they also bring with them a host of environmental and conservation problems such as habitat fragmentation and destruction, poaching, pollution and roadkills. Of these, roadkills are the most direct and visible impact of building roads, yet few dedicated studies have been conducted on the extent of roadkills and how to minimise them in Malaysia. In this study, we examine the richness and abundance of vertebrate roadkills along 8 one-km stretches (2 in each environment) of highways in Terengganu and Pahang across four environments: rainforest, commercial oil palm plantation, subsistence agricultural land and village. Each stretch of highway was surveyed by walking six times between May to November 2017 and March to September 2018. A total of 436 roadkilled animals were recorded, and consisted of at least 29 species. Six of these are under some protection status by Malaysian law. The most common roadkilled animals were bats and frogs. For every roadkill we also recorded the location's specific habitat and landscape characteristics. We found that the most number of roadkills were found close to vegetation cover and in particular, fruit trees. We suggest that making a few changes to the structure and composition of roadside vegetation could significantly reduce the number of roadkills.

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Demystifying deforestation in Madagascar, case study at Moramanga

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Accurate account of forest cover and deforestation rates are important factor in protecting nature. There is however a great discrepancy in reported forest cover and deforestation rates in Madagascar. Depending on images used, method and/or forest definition, there are differences in figures. We are trying to harmonize the reported forest cover and deforestation by establishing a standard, comparing likes to likes and report what exactly is the loss rate of each category of forest/tree cover. The study area is limited to a deforestation hotspot in Moramanga, next to the Corridor Ankeniheny Zahamena (CAZ) protected area due to limitation in accessible high-resolution images. Results from WRI's Global forest watch is compared to an analysis using Landsat 8 Images with 30 m resolution and Sentinel 2 images with 10 m resolution, and, for a more accurate and higher resolution images, 5 m RapidEye images are used. In addition, GoogleEarth images are used in lieu of higher resolution images (assumed 1.5 m resolution for GoogleEarth). For the area being studied and, within the year 2015 – 2017, Global Forest Watch reported 26% of 'tree cover loss' while a traditional image analysis using Landsat 8 reported 6% 'forest loss'. The 26% tree cover loss of GFW is then decomposed based on a class of tree cover of 0-30%, 30-50%, 50-70%, and 70% or more in an attempt to identify which is deforestation. It is finally then possible to compare deforestation in a like for like manner and determine true deforestation value. We hope that the precise data provided at the end of studies will help the policymakers in the forests management, reforestation, and to tackle deforestation issue. It is also possible to undertake the same analysis for a larger scale for a more comprehensive understanding of regional variation, necessary for targeting critical areas needing immediate actions

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Projecting body size limits for mammals under current hunting practices

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Globally, the harvest of terrestrial vertebrates is one of the leading threats to tropical and subtropical biodiversity and ecosystem function. Yet the social dimensions of hunting activity at broad scales has remained largely undescribed. Regional studies have highlighted several hypotheses for factors that promote hunting, such as food or protein insecurity and market pressure. By synthesizing 100 studies across subtropical and tropical sites, we illustrate that metrics of protein access and market demand are strongly associated with hunting activity. Moreover, we consider whether exploiting a wide range of species, both in terms of speciosity and traits, may drive hunting-down-the-web outcomes. We perform statistical and deterministic modeling using social data on hunting in tropical systems. We find that for mammals, hunters exploit many species and large spectrum of body masses that typically spans three orders of magnitude. Speciose harvesting systems are particularly concerning because effort may not decline as high-value and vulnerable populations collapse. We demonstrate how predictions of hunting activity and species life history can be combined to estimate the maximum body size among exploited mammalian communities. Our results highlight that current hunting practices pose imminent threats to the persistence of megafauna globally.

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Activity budget of Indochinese Grey Langur (*Trachypithecus crepusculus*) in Namkan National Protected Area, Bokeo Province, Lao PDR

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Indochinese Grey Langur, *Trachypithecus crepusculus*, is considered as an endangered species, it is believed to have undergone a decline of more than 50% over the last three generations, due to a combination of habitat loss and hunting. In Laos, this species is classified under a list of prohibited species. Previous research on Indochinese Grey Langur in Laos mostly involved distribution and habitat used, while behavior ecology was not undertaken, thus the research focused on the daily activity budgets of *T. crepusculus* was conducted in Namkan National Protected Area, Bokeo Province, Laos. The major objectives of the study were to describe the general behavior of this langur. Scan sampling method at 15-minute intervals was used to record a variety of behaviors, only adult males and adult females were observed during six months from August 2013 to January 2014. Behavioral observation of 24 individuals was conducted for 8 hours per day, from 6:00 h to 18:00 h, on average. 1,769 data points was obtained, feeding was the most common behavior (30.1%, n=532), followed by locomotion (25.8%, n=453), resting was 15.8% (n=280), others behavior was (12.1%, n=215), grooming (8.2%, n=145) and lowest was vigilance (8.1%, n=144). Seasonal shifts resulted in changes to feeding, vigilance, locomotion, and other behaviors, but found not to resting and grooming. However, further behavioral ecology studies of this species are needed from other habitat sites and with different pressures to enable proper comparison with our results. This study is important to understand clearly the daily activity budgets of Indochinese Grey Langurs in the study area, which can lead to their effective management and conservation in the future.

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Age-based insights into population trends and infection dynamics for Malagasy fruit bats

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Madagascar is home to three endemic species of Old World fruit bats, which are important pollinators and seed dispersers. We aimed to quantitatively assess population trajectories for the two largest of these species, the IUCN-listed Vulnerable *Eidolon dupreanum* and *Pteropus rufus*. To this end, we conducted a longitudinal field study, in which we live-captured *E. dupreanum* and *P. rufus*, estimated species-specific fecundity rates, and generated age-frequency data via histological analysis of cementum annuli layering in tooth samples extracted from a subset of individuals. We fit exponential models to resulting data to estimate annual survival probabilities for adult bats (Sa = 0.794 for *E. dupreanum*; Sa = 0.511 for *P. rufus*), then applied Lefkovitch modeling techniques to infer the minimum required juvenile survival rate needed to permit longterm population persistence. Given estimated adult survival, population persistence was only possible for *E. dupreanum* when field-based fecundity estimates were replaced by higher values reported in the literature for related species. For *P. rufus*, tooth-derived estimates of adult survival were so low that even assumptions of perfect (100%) juvenile annual survival would not permit stable population trajectories. Age-based survival analyses were further supported by longitudinal exit counts conducted at *P. rufus* roost sites between 2013-2018, which demonstrated a statistically significant, faintly negative time trend, indicative of subtle regional population declines. These results suggest that Malagasy fruit bat species face significant threats to population viability, with *P. rufus* particularly imperiled. Our study highlights the value of age data for evaluating conservation status; more briefly, we also emphasize how such information can be leveraged with complementary infection studies to elucidate transmission dynamics for henipa- and filovirus spp. seropositive fruit bats in this same system. Immediate conservation interventions, including habitat restoration and cessation of legally sanctioned hunting, will be needed to protect Madagascar's fruit bats into the future.

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Does community development assisted by ICDP contribute to better conservation goals in the long run?

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Direct payment for ecosystem services and indirect approaches such as Integrated Conservation and Development Projects (ICDP) have been applied widely to combat biodiversity loss. However, with the increasing failures especially from ICDPs, the link between poverty alleviation and conservation becomes highly skeptical. In the Panda habitat, both payments for ecosystem services such as Grain for Green Program (GFGP) and ICDP have been implemented to protect forests. Thus, we tested how these two policies could contribute to the increasing free-ranging livestock, an emerging threat to Panda habitat. We collected data from the township near Wanglang National Nature Reserve in Sichuan and used Zero-inflated Negative Binomial Model to address the excessive zeros and overdispersion problems in the count data. Our results showed that ICDP had a significant positive correlation with both the traditional livestock type cattle, as well the new type horses for tourism, and meat production. The participation in ICDP increased the number of cattle by 95.0% and increase the number of horses by 173.7%. GFGP had a significant negative correlation with only cattle. Engagement with tourism and off-farm jobs contributed to reduced reliance on livestock. With the ban on logging and reduced cropland areas, assistance from ICDP to develop alternative income, the participants accumulated wealth much quicker than the others. With stochastic events such as earthquakes and dam relocation that blocked the income from tourism, and with lack of long-term guidance and monitoring from ICDP, the financial capacity facilitated the participants to raise livestock. Our study suggested the immediate success in community development of the short-duration projects could fail the conservation goal in the end. Thus, we urge the future indirect conservation projects either to establish long-term mechanisms such as conditionality for incentives or to create self-interests in conservation amongst the communists to cope with unexpected threats in the future.

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Primary school conservation education: Critical thinking and participatory science in Madagascar

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Threats to Madagascar's biodiversity are not confined to deliberate attacks on wildlife, but extend to include the attitudes of children and rural communities around the rainforests, coupled with the vulnerabilities that can drive their actions. An antidote to this is education, which can serve as the bedrock to inspire and empower children to care about nature and conservation. To instill in young people, the desire to be conservation partners, the *My Rainforest, My World* program has developed a curriculum focused on inquiry-based learning, lemur radio shows, hand-on activities, and a variety of games. This innovate approach is meant to encourage more children to be part of conservation action. *My Rainforest, My World* is a Centre ValBio's afterschool science program serving 3rd and 4th grade students in 20 remote villages east of Ranomafana. Teaching is led by trained intern teachers, with a Centre ValBio education team monitoring and evaluating the program. Over the last three years, 862 students, 40 intern teachers, and 40 local teachers have participated. Pre- and post-lesson knowledge retention and comprehension evaluation tests of participating students revealed a significant increase. This demonstrable increase in retention is a tool to encourage sustainability, as schools become eager to adopt the curriculum and its methods. Additionally, students engage in both a sustainable vegetable gardening program that produced 825 kg of vegetables in 2018, and a collaborative school-community reforestation program that planted 2,965 trees. Parents and community leaders also participate in the program by attending student project presentations, participating in preparing school lunches, and assisting with school repairs. By engaging with all ages of people, and clearly linking the message of the program with the needs of the whole village, we aim to create a self-sustaining culture of engagement with the rainforest.

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A common pool resource role-playing game for increased stakeholder engagement

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Common pool resource management remains one of the biggest global challenges for conservation. In Lake Alaotra, the rice breadbasket of Madagascar, the destruction of marshes for agricultural production is a key issue, both shrinking the habitat of endangered species such as *Hapalemur alaotrensis* and negatively affecting local communities due to reduced ecosystem services. At the same time, a steadily growing human population is in need of more food, water, and energy. Breaking free of this vicious circle of continuous environmental degradation requires the involvement of many different stakeholders. Our objective was to increase local resource users' knowledge and understanding of the crucial role the Alaotra marshlands play in providing ecosystem services. Based on the Companion Modeling approach, the Wetland Education Game (WEdu) is a simplified model of the Lake Alaotra socio-ecological system, where eight players discuss and learn about the interlinkages of the system by establishing and exploring different management rules. Results of 152 questionnaires administered during 19 game workshops suggest that the WEdu increased players' understanding of the role of marshes for fish reproduction and water availability within the system. For fishery management, local resource users suggested respecting the fishing closure, taking into consideration fish size (no extraction of small fish, ban of small mesh sizes), construction of fish breeding pools, and the enforcement of fishing licenses. For the management of the marshes, players mainly discussed the prohibition of marsh fire, the distinction between exploitable and protected marsh, and restoration activities. Overall, study participants cited many conservation rules already in place with some acknowledging that the reasons and purpose of these existing conservation rules only became clear to them after having played the game. In conclusion, the WEdu promotes increased understanding of conservation rules, and has potential for strengthening the adaptive management capacity of communities.

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Thermal infrared imaging from drones offers a major advance for spider monkey surveys

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Accurate and precise population estimates form the base of conservation action but are lacking for many arboreal species due to the high costs and difficulty of surveying these species. Recently researchers have started to use drones to obtain data on animal distribution and density. In this study we compared ground and drone counts for spider monkeys (*Ateles geoffroyi*) at their sleeping sites in Los Arboles Tulum, Mexico, using a custom-built drone fitted with a thermal infrared camera. We demonstrated that a drone with a thermal infrared camera can be successfully employed to determine the presence and count the number of spider monkeys in a closed-canopy forest. Using a concordance analysis, we found that agreement between ground and drone counts was high for small monkey subgroups (<10 individuals), indicating that the methods do not differ when surveying small subgroups. However, we found no agreement between the methods for larger subgroups (>10 individuals); 10/12 drone counts were higher than corresponding ground counts. We could identify additional individuals from thermal infrared drone footage due to a greater area covered compared to ground surveys. In this study we are unable to confirm whether either ground or drone counts provide the true number of monkeys in an area, but given that drone surveys can cover a larger area and allow counts to be performed at a more leisurely pace post-flight while replaying the footage to identify monkeys in different areas, we suggest that drone surveys provide counts that are closer to the true number of animals inhabiting the area. We therefore recommend using thermal infrared drones for spider monkey surveys and encourage its application to surveys of other arboreal mammals.

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GS34 – THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Assessing the conservation value and quality of forest remnants in oil palm landscapes on Borneo

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One strategy for improving biodiversity in oil palm landscapes is to identify and conserve forest patches that are considered High Conservation Value (HCV). Our empirical studies reveal that very small forest fragments may be unable to support forest-dependent species, making it important to determine the conservation value of these set-asides. Roundtable on Sustainable Palm Oil (RSPO) voluntary certification standards require that areas of forest deemed HCV are conserved, and we examine the extent, above-ground carbon and biodiversity value of these set-asides. We mapped the extent of 2016 forest cover, as well as forest fragment size and quantity, within RSPO-certified and uncertified plantations across Sabah, Borneo. We also assessed forest quality and bird species richness by collecting new field data from HCV areas and uncertified forest fragments in Eastern Sabah. We surveyed 25 sites across continuous forest (n=4 primary and n=5 logged sites) and oil palm plantations (n=12 HCV areas and n=4 uncertified fragments). Forested areas within RSPO-certified and uncertified plantations varied in both size and above-ground carbon. Our field data suggest that HCV areas were of higher quality than forest fragments in uncertified plantations, but there was a high degree of variation across sites. Both HCV areas and forested areas in uncertified plantations provided some biodiversity benefits (i.e., they contained forest-dependent and endemic bird species). However, these benefits were dependent on the amount of surrounding forest cover in the landscape, and the size and quality of the set-aside. Our study quantifies the ecological benefits of HCV areas, and hence the impact of the RSPO's environmental sustainability standards for maintaining biodiversity in plantation landscapes. We assessed the robustness of the HCV process and provide recommendations to the RSPO for managing HCV areas in order to promote biodiversity in oil palm landscapes.

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Population genetics data of tropical African trees suggest that species richness is largely underestimated due to cryptic species and taxonomic over-lumping

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Tropical forests host a remarkable diversity but the estimation of their species richness depends on how species are delimited. Hence, species richness can be underestimated by the occurrence of cryptic species or overestimated by taxonomical oversplitting. DNA sequencing is increasingly used to guide species delimitation. However, reciprocal monophyly in phylogenetic trees requires that the number of generations since speciation largely exceeds the effective population sizes of the sister species, making it a very conservative criterion in long-living organisms, such as trees. Alternatively, population genetics methods allow assessing reproductive isolation to test the biological species concept (BSC). Using the BSC, we evaluate species delimitation in 25 African tree taxa. For each taxon, samples covering the whole distribution ranges were genotyped using nuclear microsatellite markers to identify genetic cluster using STRUCTURE software. We considered that distinct species can be recognized when well differentiated genetic clusters occur in sympatry. Chloroplast genes were also sequenced. (i) We found no case of oversplitting: even when phenotypically very similar, species distinguished by taxonomists formed distinct genetic clusters, although hybridization was occasionally detected. (ii) By contrast, in nearly half of the taxonomical species investigated, we found several sympatric genetic clusters, indicating that cryptic species are not uncommon. (iii) A re-examination of morphological traits associated to each genetic cluster often revealed diagnostic characters but some exceptions suggest that truly cryptic species might also occur. (iv) Finally, markers from the chloroplast genome were not always reliable to distinguish closely related species, limiting the usefulness of plastid-based DNA barcodes. According to our results the number of African tropical tree species might in reality be underestimated by a twofold factor due to (near) cryptic species. This could have important consequences for conservation that still need to be assessed.

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GS34 – THREATS, PRESSURES, and SUSTAINABLE DEVELOPMENT

Reconstructing the demographic history of a nocturnal primate, *Microcebus arnholdi*, during the late Quaternary

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Marked climatic oscillations during the Pleistocene had consequences for vegetation and animal population dynamics worldwide. Mouse lemurs (*Microcebus* spp.) are forest-dwelling primates that are endemic to Madagascar for which Pleistocene climatic and vegetation changes have been postulated and patchily shown. *Microcebus arnholdi* is a mouse lemur species restricted to Montagne d'Ambre National Park in northern Madagascar. This study aims to evaluate the demographic dynamics of two populations of *M. arnholdi* during the late Quaternary. Two populations were sampled (2 x 33 individuals) in a continuous montane humid forest at 1,073 m a.s.l., and in a discontinuous evergreen forest interspersed with savannah situated at 848 m a.s.l. Whereas we hypothesize that the higher elevation areas of Montagne d'Ambre constituted a Pleistocene refugium with continuous forest cover, we still predict a population bottleneck as a result of vegetation contraction during the Last Glacial Maximum (LGM), which should be stronger for the population sampled in the discontinuous forest at lower altitude than for the population sampled in the mid-elevation continuous forest. Clustering methods were initially used to assess genetic structure and revealed that our samples belong to geographically distinct genetic clusters. Demographic fluctuations were then reconstructed by three complementary methods. First, two approaches assuming panmixia were used to infer demographic trajectories over recent (Stairway Plots) and more ancient times (PSMC), by using RADseq and full genome data, respectively. Additionally, a simulation based approach (fastsimcoal2) was used to test the fit of a suite of more complex demographic models to the observed data, including genetic structure. Preliminary results point towards the occurrence of an ancient bottleneck during the LGM (25 kya), followed by a population expansion until the mid-Holocene (8 kya), and a subsequent population decline in both populations.

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Amphibian and reptile diversity along a land-use gradient in NE Madagascar

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Land-use change is a major driver of biodiversity decline globally. In the tropics, large expanses of rainforest have been converted into smallholder-dominated agricultural mosaics. Agricultural mosaics may provide essential ecosystem services and livelihoods for rural people. In Madagascar, 80% of the population are farmers and 85% of forest cover was lost. Northeastern Madagascar is the region with the highest percentage of remaining forest cover and a hotspot for amphibian and reptile diversity. Besides its importance for biodiversity conservation, the region is also the global center of vanilla production, and the recent boom of vanilla prices motivated people to cultivate more vanilla. However, amphibian and reptile diversity associated with the smallholder agricultural mosaics remains largely unknown. Here we evaluate how agricultural mosaics can contribute to amphibian and reptile conservation. We have conducted 6 time-standardized transects across different land-use types such vanilla plantations (forest-derived vanilla and fallow-derived vanilla), forest fragment, herbaceous fallow, woody fallow, rice paddy, and vegetation along streams in 10 villages and primary forest (PF) inside Marojejy National Park (8-10 replicates; total n = 96 plots). We found that primary forest had the highest species richness but species abundance was low. Rice paddy in contrast had the lowest species richness but high abundance. Forest-derived vanilla plantations showed similar species numbers compared to forest fragments while fallow-derived vanilla plantations had fewer species and a species composition more similar to fallow land. The species richness along streams inside and outside of PF did not differ significantly. Overall, our findings suggest that small-scale vanilla plantations represent a refuge for certain amphibian and reptile species, particularly if the plantation results from direct forest conversion. However, the marked differences between PF and all land-use types highlight the importance of primary forest conservation. Our future research will assess how microhabitat parameters influence species richness and abundance.

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GS35
ECOSYSTEM FUNCTIONS and SERVICES

Nutrient demand and use efficiency explain differences in savanna and forest formations

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Net primary productivity (NPP), together with carbon and nutrient cycling are important ecosystem processes primarily limited by nutrient availability, which may be the main factor controlling carbon balance and sequestration in forests. Therefore, there is a major interest in the relationship between nutrient and carbon, especially in tropical ecosystems that are the most productive on Earth. Here, we describe different nutrient use and allocation strategies in savanna (Cerrãdo) and forest (Cerradão) species, report leaf nutrient resorption and calculate ecosystem-level nutrient use efficiency. For the first time, we couple NPP estimates with nutrient stoichiometry to quantify nutrient demand for different components of the biomass and understand the ability of landscapes to form forests and savannas. We found no difference between the two vegetation types for leaf nutrient concentration and nutrient resorption efficiency. However, Cerradão showed higher NPP for canopy and wood components, but Cerrãdo showed higher fine roots NPP. In agreement with our expectations, nutrient demand was generally higher for Cerradão species for all nutrients except for phosphorus demand for the wood component, which was 3-folds higher in the Cerrãdo site. Nutrient requirement in the two vegetation was predominantly allocated to canopy, with canopy resorption contribution generally higher than 50% of the total canopy demand, while less than 25% of the N, P, K, Ca, and Mg were allocated to the wood or fine roots. Our findings show that nutrient demand generally increases from savannas to forest formations, while nutrient use efficiency retains very similar between the two vegetation types. Tree species composition is likely the major factor regulating nutrient use, limiting vegetation transitions, and influencing nutrient demand at landscape scales.

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Performance of laser-based electronic devices for structural analysis of Amazonian terra-firme forests

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Tropical vegetation biomass represents a key component of the carbon stored in global forest ecosystems. Estimates of above-ground biomass (AGB) commonly rely on measurements of tree size (diameter, height) and then indirectly relate, via allometric relationships and wood density, to biomass sampled from a relatively small number of harvested and weighed trees. Recently, novel *in-situ* remote sensing techniques have shown to provide alternative approaches to destructive methods based on tree felling. Nonetheless, we still lack knowledge of measurement uncertainty, as both calibration and validation of estimates using different techniques and instruments would require a consistent assessment of the underlying errors. We quantify total and systematic errors among measurements obtained from terrestrial light detection and ranging, hypsometer-based trigonometry and traditional forest inventory. We report respective error metrics for measurements of tree diameter and tree height and discuss consequences for estimated AGB. We show that relative uncertainties vary among respective methodology applied and vegetation parameters used for parameterization of allometric relationships estimating AGB. Our analysis suggests that compared to traditional methods laser-based estimates of AGB exhibited low measurement uncertainty (10.6–15.0%), whereas AGB estimates varied widely among commonly applied allometric equations (39.7–66.4%). Hence, we conclude that laser-based electronic devices could complement conventional methods when analyzing tropical vegetation parameters, thus providing reliable estimates of tropical vegetation biomass.

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Fine root production increases with soil fertility and plant species diversity along a successional gradient in Upper Andean tropical forests

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Large areas of the northern Andes have been transformed for agriculture and currently, secondary forests are common on the landscape. Many of these forests are growing on degraded soils. Yet, we have a poor understanding of belowground productivity in these ecosystems and how it relates to edaphic and biotic factors. Our goal was to determine if fine root production (FRP) was related to soil fertility and plant species diversity along a broad successional gradient in Upper Andean forests. We hypothesized that 1) FRP will be lower in secondary than in mature forests due to lower soil fertility in the former and that 2) FRP will increase with plant species diversity due to higher complementarity in the exploitation of belowground resources. 14 permanent plots (20 x 20 m) encompassing early and late successional forests, were established near Bogota, Colombia, at altitudes that varied between 2600 and 3000 m. Nine root-in-growth *cores* (30 cm deep) were established in each plot (n = 126). Fine roots (< 2 mm diameter) were harvested at the beginning of the experiment and every six months for a year. Soil nutrients fluxes were quantified using PRS® Probes. Aboveground net primary production (NPP) was obtained from previous studies. FRP was lower in secondary than in mature forests, while the proportion of NPP allocated to FRP was higher in secondary than in mature forests. FRP increased with increasing soil nitrogen but decreased with increasing Al flux. FRP increased with species diversity (cf. Hill numbers), but diversity was unrelated to successional status. Lower FRP in secondary forests can be attributed to low N and high Al flux, but secondary forests also compensated for low fertility by increasing resource allocation to FRP. The increase in FRP with diversity suggests the presence of niche complementarity that favors higher belowground productivity.

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Logging intensity drives variability in carbon stocks in lowland forests in Vietnam

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Forest degradation accounts for significant carbon losses from tropical forests. In Asia, logging is the main driver of forest degradation. For the implementation of REDD+ projects in logged forests in Vietnam, the impacts of logging on forest carbon stocks need to be assessed. Here, we research the impacts of logging intensity, soil characteristics and topography on carbon stocks in logged lowland forests in central Vietnam. Landsat analyses and community interviews were used to identify the density of historical disturbances and logging in the area to estimate past logging intensities. 24, 0.25 ha plots were established in sites that vary in logging intensity and data on carbon stocks in above ground biomass, dead wood and soil, recent logging, soil parameters, elevation and slope were collected. Above ground carbon (AGC) varied with logging intensity and was lower in medium and heavily logged forests, mainly due to the reduction of large trees. Large trees stored a large fraction of AGC in lightly logged sites. Combining logging intensities with soil and topographic data showed that logging intensity was the main factor explaining the variability in AGC. Carbon stocks in AGC of small trees and dead wood comprised only small fractions of total carbon stocks and did not differ with logging intensity. Soil organic carbon (SOC) made a substantial contribution to total carbon stocks and did not differ with logging intensity. Our research shows the reduction in AGC stocks in medium and heavily logged sites and highlights the importance of conserving big trees to maintain high forest carbon stocks. Further, it shows the importance of accounting for SOC in total carbon stock estimates.

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In the eye of the storm: The effects of hurricane disturbance on forest recovery in a warmer world

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In 2017, Puerto Rico was devastated by two major hurricanes. At the same time, models project that temperatures in the tropics will increase by 3-5 C within the next 20 years. The combined effects of hurricane disturbance and warmer temperatures could fundamentally alter the trajectory and duration of forest recovery following disturbance, resulting in altered ecosystem states that are difficult to predict from historical data alone. We capitalize on a once in a century opportunity to investigate key carbon cycling responses to experimental warming in the wake of two major Hurricanes within the Luquillo Experimental Forest in Puerto Rico. We conducted 12 months of field-level understory warming using infrared heaters arranged in six 4-m diameter plots (three +4 °C heated, three control) as part of the Tropical Responses to Altered Climate Experiment (TRACE). We investigated effects of warming on decomposition, soil and root specific respiration, and photosynthesis as well as changes in understory community composition. After one year of warming, Hurricanes Irma and Maria struck the island and followed forest recovery for 1-year. After 6-8 months of warming, warmed plants showed increasing signs of stress, where optimum photosynthetic rates and root specific respiration were significantly reduced. At the same time, soil respiration rates were significantly higher in warmed plots. Following hurricane disturbance, root production was initially reduced in warmed relative to control plots. Interestingly, root specific respiration patterns reversed, with high root specific respiration in warmed relative to control plots. Overall, results could indicate a shift towards a net negative carbon balance in tropical forested ecosystems as global temperatures increase. Slower recovery responses of the warmed plots could be a consequence of reduced carbon cycling in warmed plots prior to disturbance.

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Overcoming obstacles to rainy season fires in tropical savanna-forest mosaics

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Land-use policies intended to prevent forest fires threaten the conservation of tropical savannas and pastoral livelihoods. The challenge of reconciling savanna fires with forest fire prevention is particularly acute across the seasonally dry tropics, where fire-dependent savannas form mosaics with fire-sensitive forests. I propose that a shift to rainy season burns (the historical fire season) could maintain savannas, protect forests, and improve livestock production. Currently, intensive cattle grazing, which dramatically reduces savanna flammability, causes land managers either not to burn, or to choose to burn in the dry season, when fires are more likely to spread into forests. To assess the effects of grazing on savanna flammability, I established nine pairs of grazed and ungrazed (exclosure) plots in lowland Bolivia. To demonstrate the benefits of rainy season prescribed fires for livestock, I am tracking the weight gain of cattle in burned and unburned savannas. After two years, mean fine fuel loads in grazed savannas were 50% lower compared to ungrazed plots (4.0 versus 7.9 Mg/ha). Grazing also reduced mean grass cover, from 91% to 71%, and grass height, from 36 to 14 cm. Where grazing was most intensive, fuel was reduced to 1.1 Mg/ha, grass cover was reduced to 49%, and grass height was 3 cm. Three months after a rainy season burn, cattle gained 80% more weight than animals in unburned savanna (mean 19.1 versus 10.5 kg/animal/month). Cattle can reduce savanna flammability to such an extent that rainy season burns are impossible. Although a return to rainy season burns would require the cessation of grazing for at least one year, to allow fuels to accumulate, the near-term cost of such fallow periods could be offset by improved cattle weight gain after prescribed fires.

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FRED - degrees of Freedom, Emergence and Dimensions

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Tropical rainforests exhibit a high degree off complexity. This complexity includes aspects of biodiversity, forest structure and turnover dynamics. Assessing this complexity is important in the context of international conventions (e.g. ICB), but also in terms of Carbon cycling and forest use for human well-being. Measurement based methods exit but are costly in terms of time and work force. Here we will present a set of different methods to assess complexity based on terrestrial ecosystem modelling and concepts borrowed from physics and higher mathematics. Specifically, we will use a biogeochemistry model calibrated and validated for the Western Congolian rainforest and savannah ecosystems to produce long time series of outputs to reconstruct attractors of Carbon cycle dynamics, analyze these attractors with methods from Dynamic Systems Theory. Results indicate that (i) attractor characteristics allow the estimation of Carbon turnover times, (ii) that we can define the complexity and information content of the respective ecosystem system and (iii) that we assess differences among the two ecosystem types. Based on simple example from everyday life we will demonstrate the significance of the novel methodology, present its possible implications for future research and will assess still missing methodological gaps.

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GS36 – ECOSYSTEM FUNCTIONS and SERVICES

The ability to resprout as a mechanism to face the environmental stress in tropical dry forest

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Based on biomass differential allocation hypothesis, in tropical dry forests it is suggested the existence of a trade-off between biomass differential allocation either to vegetative growth or to reproduction (asexual reproduction/sexual reproduction) in adults, resulting from a trade-off between drought tolerance of species at early successional stages and shade tolerance at later stages. In this study, the occurrence of this trade-off was evaluated across a 50-yr chronosequence of Tropical Dry Forest (TDF) on a protected area in the Colombian Caribbean. It is hypothesized that if the structural complexity of forest increases along with the increase of water and nutrients availability and the decrease of understory light availability, then the ratio of resprouter species (asexual reproduction) declines and the ratio of non-resprouter species rises (a trade-off between asexual and sexual reproduction). The ability of species to resprout was measured in 25 plots of 500 m^2 distributed among four successional stages of TDF. This trait was related to different features of plant communities measured in these plots, such as species diversity, species composition and vegetation structure, as well as to the environmental variables soil water content, canopy closure and physic-chemical soil characteristics. A decreasing tendency in the dominance of resprouter species (asexual reproduction) was found as successional process advanced. This tendency was negatively related to the decrease of plant diversity and positively to the increase of plant height. It was also correlated with the reducing number of resprouter species through succession. Along this gradient, bulk density, sand content and aluminum concentration increased while soil water content declined. These results support evidence of a trade-off between sexual and asexual reproduction along succession (resprouter vs non-resprouter species) related to the species composition, forest structure and diversity, aligned with the hypothesis of this work.

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Deterministic and stochastic factors influence the seed-to-seedling transition in tropical wet forest restoration

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A suite of deterministic and stochastic processes influence tropical forest succession and have been well documented in minimally disturbed forests. We investigated factors influencing the seed-to-seedling transition (STS) using a large-scale tropical forest restoration experiment in Costa Rica. We asked: (1) how do restoration treatments, canopy cover, and life-history traits influence STS; (2) what are effects of stochastic and/or deterministic processes on seed and establishment limitation; and (3) does availability of animal-dispersed seeds impact seed limitation across treatments? We used a 3.5-yr record of seed rain and seedling recruitment to examine limitations on STS across natural regeneration and two active restoration treatments (applied nucleation; plantation) at five sites after a decade of recovery. For 43 focal tree species, we modeled STS as the rate of seedlings recruiting per number of seeds arriving, and determined how restoration treatments and species' traits affected STS. We used a randomization procedure to determine whether deterministic and stochastic processes influenced seed and establishment limitation, and how seed availability influenced those processes. Deterministic factors influence STS by driving differences in establishment limitation. In contrast, we found that stochastic factors likely drive seed dispersal limitation within restoration treatments as none of the focal species had seed limitation values that differed from the null. STS was more likely to occur in restored treatments than in adjacent reference forests, but there were no differences in STS among restoration treatments. Consistent with previous studies, we found that species with animal-dispersed seeds, and those with larger seeds (>5 mm), were more likely to make STS. Seed limitation in all treatments appeared to be influenced primarily by source. Results reflect previous findings from minimally disturbed forests demonstrating that deterministic processes largely influence STS, however, we show that stochastic factors have a greater influence on seed dispersal limitation in this context than in less disturbed forests.

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Spatial and temporal variation in microclimatic conditions across secondary succession in two seasonally dry tropical forests

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Microclimatic conditions such as soil moisture and temperature are commonly considered strong environmental filters that help determine where plant species and their functional traits occur. A cornerstone of contemporary models of tropical succession in seasonally dry tropical forests assume that microclimatic conditions in early successional land uses are harsh, and this selects for species with conservative values of functional traits. As succession proceeds, the growing plant canopy presumably ameliorates the harsh microclimate, favoring species with acquisitive trait syndromes. However, this assumption has only been tested in a handful of sites. We measured soil moisture, temperature, leaf area index, and basal area in replicated land uses representing different successional stages in tropical dry forest in Costa Rica and Puerto Rico over the course of a growing season. We complemented these measurements with simulation modeling of energy budgets and microclimates. Contrary to our expectations, soil moisture was not consistently lower in the early successional plots. In Costa Rica, mean soil moisture was marginally higher than open, shrubby or plantation land uses. In Puerto Rico, soil moisture declined as follows: plantations > open > forest. We did find that early successional land uses showed more dynamic behavior: soil moisture both increased and then declined faster compared to forested sites, suggesting that the forest canopy buffers against rapid changes in microclimatic variables. These results suggest that microclimatic dynamics should not be extrapolated from one site to another, as there is a lot of geographic variation. Morever, biogeophysical processes such as greater evaporation in sites with higher forest cover may draw down soil moisture. These results have implications for understanding seedling regeneration in secondary forest gradients.

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Modelling the reconciliation of forest conservation, climate change research, and environmental education: Two Biosphere Reserves in the Congo Basin

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Forest disturbance regimes have changed profoundly in many forest ecosystems, with climate being an important driver of disturbance change. Understanding how such change affects large forest ecosystems such as the Congo Basin Forest, is critical to managing forests for sustained benefits, as a persistent carbon sink, rich in biodiversity and an important provider of ecosystem services. The UNESCO Man and the Biosphere (MAB) Reserves of Yangambi (235,000 ha) and Luki (33,000 ha) are situated within the Democratic Republic of Congo (DRC) and the Congo Basin rainforest. The PilotMAB-project will develop activities of research, training, and education in these MAB Reserves, focussing on carbon budgets and forest resilience, through analysis of tree recruitment, growth and mortality, and tree trait analysis. Training programs will contribute to capacity building of African researchers and local management policies. An educational program will translate research and model function of the Biosphere Reserves to schools. The PilotMAB-project started in July 2019 and will run until July 2023, supporting the model function of the UNESCO MAB Luki and Yangambi Reserves (DRC). PilotMAB is coordinated by the Royal Museum for Central Africa, working with local executive partners R&SD, VVOB-DRC, and ERAIFT. As a significant new activity for forest research, development, and capacity building in the Congo Basin, we are interested to inform and engage with stakeholders at the ATBC 2019 meeting to strengthen our network and improve our chances of success.

Saturday, 3 August 2019 | Grenat
GS36 – ECOSYSTEM FUNCTIONS and SERVICES

Impacts of lianas on secondary forest recovery in the Neotropics

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Regenerating secondary forests rapidly recover aboveground biomass (AGB) and species richness. Recent analyses from >45 secondary forest sites spanning the Neotropics suggest that secondary forests take up carbon at 11 times the rate of primary forests. However, AGB recovery varied significantly among sites - at 20 years AGB ranged from 20 to 225 Mg ha^{-1} - and much of this variation is unexplained by water and nutrient availability. Biotic factors, such as liana density or pathogen pressure, interact with climate and soil properties to determine successional trajectories. Elevated liana densities and biomass can reduce tree biomass and suppress successional development in tropical forests. Integrating liana density with tree census data may be key to understanding variation in successional change among sites. We present liana and tree census data from Neotropical secondary forest sites that range in annual rainfall from <800 mm to >2600 mm. Liana stem density decreased with increasing rainfall; the wettest site had as few as 150 stems ha^{-1} and the driest site >1500 stems ha^{-1}. Importantly, our analyses suggest that liana proliferation slows successional recovery in secondary forests and prevents accumulation of AGB. This is the first multisite study to assess impacts of lianas on secondary forest recovery and suggests that liana proliferation could undermine the value of regenerating forests in the long-term.

Saturday, 3 August 2019 | Grenat
GS36 – ECOSYSTEM FUNCTIONS and SERVICES

The fate of tropical forests: High resolution global maps of deforestation risk and future forest cover

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Tropical deforestation is one of the major causes of biodiversity loss at the global scale. Forecasting deforestation is useful to alert stakeholders to the likely fate of tropical forests and anticipate the potential biodiversity loss. Here, we present a new statistical approach and new informatic tools to model the risk of deforestation spatially and produce high resolution global maps of the future forest cover. The deforestation spatial model takes into account the regional variability of the deforestation process and the effect of various socio-economical and environmental factors. Models were fitted for every tropical country independently and results were combined at the global scale. We computed the spatial probability of deforestation at 30 m for the year 2018. Following a business-as-usual scenario based on historical deforestation rates (2000-2018), we derived future forest cover maps for the years 2050 and 2100 at the global scale. For each country, we were able to identify areas with higher risks of deforestation. Under a business-as-usual scenario, several countries in South America, sub-Saharan Africa, and Southeast Asia should experience a complete loss of their humid tropical forest in the next decades. Big forest blocks, such as in the Congo Basin, should be highly fragmented in the future. At the global scale, our results underline the strong risk of tropical forest and biodiversity loss if no serious action is taken quickly to stop deforestation. At the national scale, result maps can be used by politics and stakeholders to identify priority areas for biodiversity conservation.

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GS36 – ECOSYSTEM FUNCTIONS and SERVICES

GS37
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Structure, composition, and functional diversity of a tropical dry gallery forest in Madagascar

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Berenty Reserve, located in the south of Madagascar, preserves some of the few remaining fragments of dry forest in the island, one of the most threatened forest types worldwide. Due to their apparent differences in plant composition, three different forest areas named Ankoba, Malaza, and Anaramalangy, have been distinguished at Berenty. Our study was motivated by the question of whether these forest sites differ enough to be considered three distinct forest types in terms of plant species composition (identity and diversity), structure, and functional trait diversity. Due to the lack of knowledge and baseline information about these forests and of the drivers shaping their plant communities, answering this question could help to better guide and prioritize restoration sites in the reserve. To do so, a plant inventory was conducted in 31 20 x 50 m plots. Individuals >10 cm at 1.3 height were measured and identified. Forest structure, plant species richness, diversity, and importance values, were compared among the forest sites. Community-weighted means (CWM) of leaf area index, specific leaf area, and leaf dry matter content were assessed and functional diversity indices were calculated. A total of 1719 individuals were identified, representing 45 species and morphospecies. Only basal area, functional richness, and functional dispersion as well as CWM of specific leaf area and leaf area index differed significantly between Ankoba and the other two forest sites. Overall, the results found in this study do not support the hypothesis that the three forest types differ significantly from one another. This study provided important baseline data that was required in Berenty in order to establish solid conservation and restoration programs, to monitor forest dynamics and recovery from past and future disturbances, and to evaluate future reforestation efforts that will serve as a reference for similar restoration projects in the tropical dry forests.

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GS37 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Global increases in beta-diversity accompany three decades of deforestation

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Habitat loss and degradation is the greatest current threat to our planet's biodiversity. Forest ecosystems in particular are at ongoing risk of conversion for agriculture and timber extraction, and have decreased in area by over 1.3 million km^2 since 1990. Such extensive land-use modification is likely to have negative impacts on biodiversity and countless studies have documented declines in alpha diversity (diversity at a single point) associated with reduced forest cover. Other studies have reported increased beta diversity (diversity between points) linked to disturbance, but only at small spatial scales. We expand on these findings by estimating temporal global shifts in forest alpha and beta diversity in multiple vertebrate, invertebrate and plant taxa between the periods 1984-2000 and 2001-2017. Using data freely available through the Global Biodiversity Information Facility, we developed Stan Bayesian inference models to quantify patterns at "landscape" scale (10,000 ha), "region" scale (1 million ha) and "realm" scale (100 million ha). We found significant deforestation-driven declines in global forest alpha diversity in recent decades, but increases in forest beta diversity, presumably as species become more sparsely distributed. Forest-specialist taxa were most strongly affected, while many non-forest taxa showed the opposite trend; responses were greatest at landscape scale but were evident at even the largest spatial scale. Our results suggest that increased beta diversity confers at least some resilience to widespread land-use change, and there exists huge potential for biodiversity conservation. However, we stress that we found no evidence to indicate that any elevated shifts in beta diversity will remain given escalating deforestation rates.

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GS37 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Climate and forest gradient changes from dry tropical forest to Afro-montane forest in Kenya and restoration of natural forests

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Kenya is located astride the equator and has various climatic gradients. Forest patches remain in the savanna as forest islands. Here especially the climate and inland forest gradient are discussed. Inland forests of Kenya are classified into Afro-montane forest and dry tropical forest. These forests are unique to the savanna in Kenya. Especially moisture affects the elevational distribution of forests. The climate gradient and human impacts make it difficult to identify boundaries in this forest zonation. The Great Rift Valley divides Kenya into eastern and western parts. Mt. Kenya is located in the eastern part and, as an old volcano that reaches 5400 m above sea level and accumulates moisture from the ocean. Lauraceae (*Ocotea*) forests occur from the foot to mid-elevations. On the south, the upper part of the Ngong Hills has *Albizia gummifera* forests, as secondary forest after *Ocotea* forest. Similar types are described on Mt. Kenya. On the other hand, *Ocotea* forests occur only in a particular valley on the west side of the Great Rift Valley, which is drier than the east side because it is farther from the sea and sits in a rain shadow, except around Lake Victoria. Especially the Kakamega Forest area keeps moisture as lowland basin. It has a mixture of dry and Afro-montane forest. The Great Rift Valley affects dryness to western part of Kenya. Mt. Elgon (4222 m) is located on the western edge of Kenya and extends into Uganda. Forest zonation in eastern Kenya includes dry montane forest.

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GS37 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Biogeography and conservation status of *Meineckia* Baill. (Phyllanthaceae) in Madagascar

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With 32 species, *Meineckia* Baill. is one of the largest genera in Phyllanthaceae Martynov, tribe Poranthereae Grüning. It occurs in South and Central America, Africa, Madagascar, Socotra, the Arabian Peninsula, Sri Lanka, and India. Madagascar is considered as a centre of endemism of *Meineckia* as it is home to 14 species (43% of the genera), and all of these are endemic. The objective of this study was to compile data on the *Meineckia* of Madagascar to understand its ecology, biodiversity, and extinction risk for the IUCN Red List and to inform conservation strategies. Our studies were based on herbarium materials from Paris, Kew, and the national herbaria in Madagascar (TAN and TEF). The conservation status of each species was assessed by using the Geospatial Conservation Assessment Tool (GeoCAT) developed by the Royal Botanic Gardens Kew (http://geocat.kew.org). Our results showed that (i) Malagasy *Meineckia* occupy a wide range of habitats ranging from dry spiny, dry forest to rainforest and are grouped in three sets according to their ecological preference and distribution, (ii) all *Meineckia* of Madagascar are threatened, either Critically Endangered (CR) or Endangered (EN). They are mostly found outside of protected areas and are threatened by habitat degradation due to human activities such as annual fires, forest logging, grazing, and mining.

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GS37 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Extinction risk assessment of the orchids of Madagascar

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Orchids are a high-profile group in Madagascar, with near 1000 species of which over 90% are endemic. Most of the Madagascar orchids are threatened even if many species occur in protected areas and threats persist. The Global Strategy for Plant Conservation (GSPC) Target 2 calls for an assessment of conservation status of all known plant species by 2020. Madagascar is still far for reaching this goal. Only 186 orchid species are currently listed in the IUCN website. Kew Madagascar Conservation Centre and the Royal Botanic Gardens Kew are aiming to inverse this situation by achieving all the assessment of the 970 accepted orchid taxa by 2020 for the IUCN Redlist and to updating data on their distribution and threats. The baseline of IUCN Red List assessments for plants is in addition an important tool for identifying species at risk of extinction using IUCN categories and criteria. The assessment is based on analysing data collection from herbaria on the GeoCAT tool developed by RBG Kew (www.geocat.kew.org), review of literature and field survey. So far, our results indicate that more than 72% are threatened as Critically Endangered, Endangered, and Vulnerable. We hope that the information the results of our work will be useful for both researchers, Malagasy decision makers and park managers to establish the species conservation strategies and prioritize the conservation actions for the threatened orchids species in Madagascar.

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GS37 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

"Singing" in the rain and on the moon: The responses of Amazonian aerial insectivorous bat activity to weather conditions and moonlight

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The effect of extrinsic factors on animal activity can be assessed at hourly, monthly, and moon-cycle time scales. Aerial insectivorous bats foraging behavior is strongly associated with weather conditions and moonlight. Influence of environmental cues on activity has been investigated for many temperate aerial-insectivorous bat species, but rarely in tropical species. Furthermore, most studies in the tropics evaluate one environmental factor or removed periods with unfavorable conditions, such as rainy nights. The objectives of the study were to evaluate the temporal activity of tropical aerial-insectivorous bats in response to temperature, rainfall, and moonlight intensity among nights and if the rainfall affect the duration and the hour of bat activity within a night. We sampled 20 plots within the grid of Ducke Reserve (Central Amazonia) in Brazil during the 2013 rainy season. To estimate bat activity of seven species, we used automatic recording detectors that registered bat calls during 18h to 6h. The weather data are from the meteorological station of the reserve and moonlight percentage is from Moontool software. Temperature positively affected activity of two species (*Cormura brevirostris* and *Saccopteryx bilineata*). *Myotis riparius* activity was reduced by moonlight and *Pteronotus rubiginosus* and *S. bilineata* activity increased by the moonlight. Rainfall can promote an irregular peak in hourly activity compared to nights without rainfall, but only *S. leptura* was found to be active for more time after rainfall. The higher activity of some species during warmer and bright nights may be an indirect response to prey availability, some tropical insect orders have higher activity in these nights. Foraging activity was not interrupted during light rain, but bats can modify the activity peak to compensate for the energetically costly flights during rainfall. Our findings indicate that moonlight and temperature are the variables with the highest impact on the bat activity and the light rain can influence hour of activity peak of some bat species.

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GS37 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Effects of habitat fragmentation on ectoparasite communities in mouse lemurs (*Microcebus* spp.) and small mammals in northwestern Madagascar

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Habitat loss and fragmentation are reasons for a worldwide depletion of biodiversity. Malagasy ecosystems as biodiversity hotspots are particularly vulnerable. Although they may have profound effects on host and ecosystem integrity, fragmentation effects in parasites are largely understudied. This study aims to investigate if and how habitat fragmentation affects the composition of ectoparasite communities on small mammalian hosts in networks of tropical dry forest in Madagascar. Forest fragments differing in host density, size, shape, connectivity, and sites in the neighbouring continuous forest were studied in the Ankarafantsika National Park and the Mahamavo region in northwestern Madagascar. 923 individuals of two mouse lemur species, *Microcebus murinus* (n = 199) and *M. ravelobensis* (n = 426), and two rodent species, *Eliurus myoxinus* (n = 114) and *Rattus rattus* (n = 184), were captured for ectoparasite sampling. Ectoparasite prevalence and species richness were statistically related to 14 ecological variables by generalized linear modelling. The investigated host species harboured ticks (*Haemaphysalis* sp.), mites (Laelaptidae, Trombiculidae, *Listrophoroides* spp.), and sucking lice (*Lemurpediculus* spp., *Polyplax spinulosa*, *Hoplopleura* sp.). In mouse lemurs, ectoparasite prevalence and species richness were higher in continuous forest areas compared to fragments. Proximity to the forest edge led to a lower prevalence and host population density had a positive effect on the prevalence of temporary ectoparasites (ticks, Trombiculidae, Laelaptidae) of all investigated hosts. The results strongly suggest that habitat fragmentation and especially edge effects impact ectoparasite communities, in particular by affecting temporary parasite species. The results are best explained by an interplay of parasite-specific life cycles, different responses to abiotic factors, and a differential reaction of different host species to habitat fragmentation and edge effects. Due to a very basic knowledge on the role of parasites in biocenoses, consequences can hardly be assessed. Additional research is necessary for the conservation of stable ecosystems.

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GS37 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

GS38
TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, AND CULTURAL DIMENSIONS

The socioecological role of restored traditional homegardens in "La Montaña" in Guerrero, Mexico

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Restoration of traditional agroforestry systems, is gaining in importance since it provides viable and lasting solutions to the global socio-ecological crisis, especially in poor rural areas. This study evaluated the motivations and benefits obtained through of participatory traditional homegarden (TH) restoration project, promoted by the Indigenous non-governmental organization (NGO) Xuajin Me´Phaa in "La Montaña" of Guerrero State, Mexico. This study also characterized the structure and composition of TH and explored their ecological potential as promoters of landscape connection through the study of the bird and vegetation community. The main motivation in TH restoration was food safety. Banana, mango, and pineapple were the most important species in terms of the relative importance value index. More than half of the species were native (57%) and arboreal (52%), and 90% of tree species were zoogamic and 92% zoocoric. A total of 36 species of birds belonging to 13 trophic guilds used the TH as places of passage or rest, to nest and as a source of food; and all the vegetation layers present in the TH had a significant number of visits. In addition, it was found that most of the birds left the backyard in a direction opposite to the one they entered and preferred to do so in the direction of the forest fragments closest to the village. Therefore, TH promoted food security and favored the conservation of bird diversity and landscape connectivity.

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GS38 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, AND CULTURAL DIMENSIONS

Ethnobotanical and biological inventories of *Tacca* species (Dioscoreaceae) in the Menabe and Sofia Regions, western Madagascar

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Tacca (Dioscoreaceae) is a small genus comprising of approximatly six species in Madagascar, of which five are endemic. Yet very little information is available on the ethnobotany characteristics of this genus. The present study was conducted to inventory the species of *Tacca* in the Menabe and Sofia Regions and to characterize the ethnobotany of these species. To do this, the approach in methodology is based on the ethnobotanical interviews and floristic inventories. Three species were inventoried, two species (*T. heterofoliolata* - endemic and *T. leontopetaloides* - introduced) in Menabe and one new species (*Tacca* sp.) in Sofia. This study is among the first to have been conducted on the genus in the western part of Madagascar. Thus our studies contributed in part to the knowledge of the *Tacca* species of Menabe and Sofia.The ethnobotanic study shows that these species constitute a source of food for the local population during the lean period. Furthermore, they have a medicinal value and represent a real cultural value for the populations.

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GS38 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, AND CULTURAL DIMENSIONS

Local knowledge of medicinal plants - The case of Ambohimahavelona, Madagascar

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The village of Ambohimahavelona is characterized by thorny thickets, forest gallery, and mangroves. The local population depends mainly on natural resources for their subsistence and also for their health. In order to understand local ecological knowledge related to medicinal plants and thus the dependence of people toward natural resources to take care of themselves, ethnopharmacological study were done. We aim at identifying the differences related to age, gender, and socio-economic activities on medicinal plants knowledge. The data collection methods used were interviews and direct observations of the villagers' activities. The number of people interviewed was 162 including 80 women and 82 men. The results of the analysis attest that men are more familiar with plants used to treat wounds, while women have more knowledge about plants used in pediatrics and maternity. 56 medicinal species distributed in 46 genera and 26 families were identified. The most common diseases cited were digestive (with 18 species) and respiratory (six species for treatment). The population also uses a large number of species (14 species) to heal wounds. *Cedrelopsis grevei* is the most used species (frequency 72.8%, use index: 1.27, saliency index: 0.785). The villagers use *C. grevei* to treat various illness. Bark concoction of *C. grevei* is also drunk by villagers as an energezing beverage. The most used part is the stem (48%). All of these species play also ecological functions inside the ecosystem. Thus, it is important to take the needs and knowledge of people and the ecology of these plant species into account in order to work out species management measures and conservation plans.

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GS38 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, AND CULTURAL DIMENSIONS

Genome sequence of *Cavitermes tuberosus* and its associated *Wolbachia* symbiont

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Termites are ecologically dominant and play the key role of decomposer in tropical ecosystems. Like other insects, termites are often infected by *Wolbachia*, some of which appears to be beneficial to their termite host. This is the case in *Cavitermes tuberosus*, a soil-feeding termite housing a bacteriome-like organ that is primarily filled with a new strain of Wolbachia. This strain bears close resemblance (99% identity) to the strain of *Wolbachia* associated with the parthenogenetic bed bugs, *Cimex lecticularis*, which carried vitamin B2 and B7 genes of *Rickettsia* origin. While the role of *Wolbachia* in inducing parthenogenesis in *C. tuberosus* is unclear, the presence of this strain in a bacteriome-like structure suggests nutritional mutualism. To determine the exact role of *Wolbachia* in *C. tuberosus* we sequenced the genomes of both the termite and the symbiont, using Illumina HiSeq paired-end read libraries constructed with inserts of different sizes. In addition, we used long reads generated by MinION and PremethION. Here, we will describe the genomes *Wolbachia* and *C. tuberosus*, and how they provide a better understanding of the complex life cycle of *C. tuberosus*.

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GS38 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, AND CULTURAL DIMENSIONS

Valuing existing data and information for lemur conservation

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Despite awareness within conservation and research circles of the growing threats experience by lemur species, efforts to date have failed to reverse negative trends in lemur conservation status. A contributing factor to this failure is related to weak biodiversity information and access to knowledge on the part of stakeholders involved in conservation activities. The lemur portal (http://www.lemursportal.org) tool was established to overcome difficulties in communicating the existing data, addressing gaps, and facilitating exchanges between stakeholders in lemur conservation. Based on the needs of the users, the lemur portal includes an *online forum* to promote real-time exchanges between different users, a comprehensive *species database*, a *ready-made and tailored visualizations*, and a *mobile application* integrating iNaturalist for citizen science. Achievements to date show the availability of comprehensive information on 110 lemur species in the Lemur Portal, more than 13,000 occurrences of lemur data, 190 users, 300 trained technicians, and 30 experts for forum moderation and data validation. Over 15 institutions have agreed to officially partner with the lemur portal project, providing inputs from their specialties and localities. This initiative enhances the importance of biodiversity data and community involvement for knowledge sharing and conservation decision. Yet, the direct impact of the lemur portal on decision making processes cannot be measured quantitatively; but steps were already taken to catalyze reflections on this challenge. One key feature of this tool is the potential use in species distribution model, produced from species occurrences data uploaded into the portal. The result could be interpreted as a prediction of habitat suitability.

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GS38 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, AND CULTURAL DIMENSIONS

Net primary productivity and its allocation in tropical old growth and logged-over forests in Ghana

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There is paucity of information on how net primary productivity (NPP), and the allocation of photosynthetic products to different plant components change in tropical forests after several decades of logging. In this study, we quantified the components of NPP in an old-growth forest and a 54-year-old logged-over forest between August 2013 and June 2015 to estimate total net primary productivity, and to determine the allocation of NPP between canopy (leaves, flowers and fruit), wood and fine roots in both forests. Total NPP was 8% higher in the old-growth forest than in the logged-over forest. In both forests, the fraction of NPP allocated to canopy was similar. However, greater NPP was allocated to fine roots in the old-growth forest, whereas in the logged-over forest greater NPP was allocated to wood. A shift in the allocation of NPP between wood and fine roots is consistent with recent theory, which suggests that a tradeoff between wood and fine roots dominates allocation patterns in forest ecosystems. The study highlights the need to consider successional stage, and the trade-offs that exist between different plant parts when modelling allocation in forests.

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GS38 – TROPICAL BIODIVERSITY, SOCIO-ECONOMIC, AND CULTURAL DIMENSIONS

Effectiveness of collaborative management of protected areas: Some case studies from Lao PDR

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Protected area category according to the IUCN Protected Areas' System designed in various objectives dependent on a site outstanding and to be managed in various approaches toward the conservation objectives but for a national park or managed category recently requires the ownership of local people. Local conflicts with government over use of forest resources have been reported worldwide and increased the number of wildlife killed intentionally. It has been called for changes from fencing a protected area to a collaborative manner. In this regard and fortunately, the Lao PDR has principally designed its protected area system with including local people. Although this the term of collaborative management has been known for long the appropriate practical approach is still underway of testing to obtain best practice. The objective of this paper to communicate some possible long-term success in protected areas with local communities' participation through reviews with hand on experience. The results shown that effectiveness and sustainability for protected area management needs to have local people to play a key role with clear mandates, responsibilities, mechanisms, and appropriate alternative livelihood support in place with regular monitoring to ensure the conservation objective is met. Give the rights to the local communities for building their ownership from making them understandable their issues for lives from lack of conservation through situation analysis of the conditions and contexts to find ways to address the issues together as for from designing to planning, implementing and monitoring in a practical and semi-standard. Strong community leaders/harmonization and benefit sharing are important to succeed. It needs to build to meet the high participation level at co-learning and collective action. Of course, ensuring government commitment, ensure local voices and transparency. Therefore, the protected areas management requires a collaborative approach but it needs to do right way from understanding the conditions

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GS39
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Ploidy & genome size of desiccation tolerant plants from tropical inselbergs

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Whole-genome duplications are supposed to be common in the evolutionary history of higher plants. The existence of additional gene-copies within a genome can facilitate the formation of new traits, which is particularly important for species in challenging environments. Our objectives were the investigation of the ploidy level and genome size of a variety of desiccation-tolerant plants (Cyperaceae and Poaceae) from tropical inselbergs. Determination of ploidy-level and genome size by flow cytometry and evaluation of the data by flowing software. The data indicate a heterogenous ploidy-level among analyzed specimen.

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GS39 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Distribution status and habitat use of two otter species on the southern Andaman coast of Thailand

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Information regarding several globally threatened small mammal carnivoran species in Thailand comes from surveys of terrestrial forests, leaving knowledge gaps in other important ecosystems. This project aimed to evaluate the distribution status and habitat use of two otter species (Asian Small-clawed Otter [AScO] and Smooth-coated Otter [ScO]) in mangrove forests of southern Thailand. From July 2016 to December 2018, surveys were conducted in four provinces (Ranong, Phang-nga, Krabi, and Trang), covering 4,275 km^2. In total, 748 line-transects were surveyed along rivers and canals (1,193 km), 750 locations were camera-trapped (15,446 trap-days), and 187 local people were interviewed. From camera-trap data analysis, occupancy probabilities of both otter species were positively related to the amount of aquaculture and mangrove forest. AScO occupied 45% of the surveyed area, while ScO occupied 66%. If otters were present, the chance of detecting AScO by camera-trap was approximately 10% per survey day, while for ScO it was 25%. Comparing provinces, occupancy probability of AScO in Ranong Province was significantly lower than in other provinces, while for ScO the probability was highest in Krabi and Trang Provinces. More than half of the local fishermen interviewed believed that currently otter populations were declining compared with the past 20-30 years (1987-1997) mainly due to anthropogenic activities, prey depletion and habitat conversion. The findings from this study show that both otter species can still be found in all provinces along the Andaman coast of southern Thailand, although the numbers vary. However, due to several anthropogenic threats, their populations have been declining and this trend continues. To prevent their extinction, conservation management specifically suitable for this region where the majority of the land is dominated by people is needed.

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GS39 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Endemicity in tropical sky islands: Environmental specificity or isolation?

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Páramos are Neotropical alpine ecosystems characterized by a particularly high diversity and species endemicity. Because the treeline is relatively high (~ 3000-3500 m) in the Colombian Andes, these ecosystems consist of highly fragmented “sky-islands” scattered throughout the three mountain ranges of the Colombian landscape. Past climatic variations have influenced the páramo extent with successive glacial and interglacial periods corresponding to alternating cycles of ecosystem expansion and contraction. Two main hypotheses are proposed to explain these endemicity patterns: (i) the environmental and climatic specificity and (ii) the isolation of its different patches. We assembled a floristic database from large herbarium collection aggregators (e.g., GBIF, Tropicos, COL) and community-oriented phytosociological (Vegparamo) and systematic plot data (from Instituto Alexander von Humboldt). We overlapped these data with a list of 734 endemic species in order to measure endemicity rates in each patch of páramo. We calculated environmental specificity of the páramo by means of multivariate dispersion of a PCA based on bioclimatic data issued from the Worldclim database and topographic variables from a Colombian digital elevation model. Additionally, we used spatial graphs to estimate the current patch spatial isolation. Finally, we compared the relative importance of environmental specificity and isolation in models predicting the endemicity rates. Our results suggest that both factors interact to determine the endemicity, with isolation playing a slightly more important role. Understanding the role of both processes may help us prioritize conservation areas that present high levels of environmental specificity and isolation in these highly endangered ecosystems in the context of global climate change.

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GS39 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Flora and vegetation of Ngazidja Island in the Comoros Archipelago

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The island of Ngazidja (Grande Comore) in the Comoros Archipelago does not have a complete record of its updated vegetation map, which is the purpose of this project. As an updated floristic list of the island was also lacking, exhaustive inventories of all plant formations were made. The phytogeographical nomenclature used is that proposed at the Yangambi AETFAT Congress (1956) for the definition of vegetation types in tropical Africa. All the characteristics of the vegetal formations, such as the physiognomy, the phytosociology, the structures, the dendrometric analysis, the surface and the modifications undergone by the plant formations of the island, following the pressures and threats, natural or anthropic, are all treated in the 12 plant formations of the island of which six are described here for the first time. This notice also highlights the places that are called "refuges" and/or "centers of endemism" because of the ecological particularity of their habitat as well as their richness in endemic species. The floristic inventories identified 1304 species, represented by 208 families, of which 919 are indigenous and 385 exotics, and 184 are endemic. 19 new species were found. Three species are identified as widely distributed, one in dry and subhumid formations (*Eucleia racemosa*) and two in wet and subhumid formations (*Weinmannia comorensis* and *Nuxia pseudodentata*). The most invasive exotic plants in wet formations occur above 600 m and are *Psidium cattleianum*, *Clidemia hirta*, *Syzygium jambos*, and *Hedychium flavescens*. Below 600 m altitude the most invasive are *Lantana camara* and *Eucalyptus robusta*. Nine species are probably extinct and eight very rare on the island; their integration into the IUCN Red List is urgent. Eight refuges are observed, four of climatic origins, three of volcanic origins, and one of climatic and volcanic origin.

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GS39 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Comparing the patterns of population connectivity between a specialist and generalist rodent species in a coffee agroecosystem

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Agricultural production is the dominant land-use in the world today. The associated loss and fragmentation of natural habitat is considered the main driver of population declines and loss of biodiversity. Understanding the effect of agricultural matrix composition on population connectivity is essential for the development of successful conservation plans. Our study uses genetic information to measure population connectivity in a landscape fragmented by coffee production. We evaluate the genetic structure of two common rodent species in southern Mexico; *Heteromys desmarestianus goldmani*, a forest habitat specialist species and *Peromyscus gymnotis*, a habitat generalist species. Species were sampled in forest fragments and the surrounding coffee agricultural matrix. We used RADseq to generate a SNP marker library for each species and determine the level of genetic connectivity among *H. d. goldmani* and *P. gymnotis* individuals. Preliminary results show limits in population connectivity for *H. d. goldmani* and high connectivity for *P. gymnotis* individuals. These results support a previous study on *H.d. goldmani* with microsatellite markers that detected five different genetic clusters in the study region. Additionally, we found that Euclidean distance only explains a small amount of the structure detected for *H. d. goldmani*. These results suggest that agricultural landscape variables are most likely limiting the connectivity of the forest specialist species, *H. d. goldmani*, but have no effect on the connectivity of *P. gymnotis*.

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GS39 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Butterfly diversity in the vanilla landscapes of northeastern Madagascar - opportunities for sustainable land use?

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Deforestation spurred by agricultural expansion is one of the biggest threats to biodiversity conservation in tropical developing countries. In contrast to global trends, smallholder subsistence farming continues to play a major role in Madagascar's forest-agriculture frontiers. Here, knowledge on sustainable land use management to aid biodiversity conservation is urgently needed. Objective: We address this research gap by assessing the value of small-scale vanilla production for biodiversity conservation in Northeastern Madagascar. Using butterflies as focus taxa, we compared alpha diversity of 30 *Vanilla planifolia* plantations differing in land-conversion history (fallow derived vs. forest derived) to other prevalent land use types (rice paddies, herbaceous fallow, woody fallow, forest fragments) with primary forest sampling as a baseline. Butterflies (Papilionoidea) were sampled using fruit baited traps in combination with time-standardized netting. Canopy closure as plot-based parameter as well as forest cover as landscape-scale parameter were used to explain patterns of local biodiversity. Using general linear regression model in R we compared species richness between land use types and conversion history. We found that disturbance adapted butterfly species increased in abundance with loss of canopy closure. Furthermore, forest-derived vanilla as well as forest fragments and primary forest showed a higher diversity within the species rich genus *Heteropsis*, whereas fallow-derived vanilla was characterized by fewer species within this indicator group. Additionally, species richness of *Heteropsis* was positively correlated with forest cover. Supporting preceding studies, especially the on Madagascar largely endemic genus *Heteropsis* (family Nymphalidae), mirrors the habitat change along our sampled land use gradient by its changes in species richness and abundance. Our results underpin the importance of northeastern Madagascar's vanishing primary forests for species conservation as well as identifying so far unknown opportunities in vanilla agroforestry aligning land-use and conservation.

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GS39 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Long-term responses of tropical palms (Arecaceae) to hurricane disturbance

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It is generally assumed that palms (Arecaceae) have the ability to withstand physical damage, particularly species growing in regions with frequent cyclones. We studied palms in the Bladen Nature Reserve (BNR), Belize, over a 21-yr period (1999-2019) that included the passage of category 4 hurricane Iris in 2001. The first impression after the hurricane was that survival of *Astrocaryum mexicanum*, the <7 m tall dominant understory palm and *Attalea cohune*, the <25 m tall dominant overstory palm was almost 100%. However, the long-term fates of these two species have been very different. All mature *Astrocaryum* individuals survived the hurricane. Due to a substantial increase of canopy openness (from <5% to 32%), the mean fruit production increased from 45.4/tree/yr to 135.2/tree/yr during the first two years after the hurricane. In the following years, the fruit production fluctuated dramatically and has stabilized at approximately 60% of the pre-hurricane level. Preceding the hurricane, mature *Astrocaryum* had approximately the same mean density (433/ha on the average) as its seedlings in the BNR, which indicates dramatic seedling mortality. However, the 2002-2003 cohort may contribute to the rather bizarre age structure of this species that is apparently caused by frequent hurricane events. Initially, it seemed that >90% of *Attalea* overstory individuals survived. However, about 65% of mature individuals died within eight years after the hurricane. This observation solved one of the mysteries of this forest: while on average there are about 30 mature *Attalea* individuals/ha, the density of saplings, which only rarely die, is an order of magnitude larger. With the average frequency of one hurricane every 18 years, the density of mature *Attalea* palms is kept relatively low. It seems that periodic hurricane disturbances are, at least partly, responsible for relatively high species richness of the BNR forests (102-114 tree species ≥5cm dbh/ha).

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GS40
CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Do masquerading of snail poop enhance the protective value of sawfly caterpillars?

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Anti-predatory mechanisms, such as crypsis, mimicry and aposematism, have evolved to assist prey species to enhance protective efficacy against predation. Masquerade is a type of mimicry where organisms resemble inedible objects so that their potential predators misidentify their prey. Though masquerade is a well-known antipredator mechanism, its efficacy is often not verified or explicitly quantified. Sawfly caterpillars (Hymenoptera: Symphyta) commonly found in monsoonal tropical forests of Xishuangbanna region, southwest China, are solitary and black, and present curled posture when resting, resembling snail excrement. We investigate the protective value of masquerading by these sawfly caterpillars by comparing the predation rates on artificial caterpillars of different colors and shapes. We used green, white and black oil-based, non-toxic clay to make dummy caterpillars in two shapes: straight and curled. We established a total eight plots (8 m*10 m) in a rainforest and limestone forest at Xishuangbanna Tropical Botanical Garden (XTBG) from 14 to 20 November 2018. At each plot, we deployed 320 caterpillars in different colors and shapes, and recorded presence of predation marks left of the clay caterpillars after 48 hours (a total of 5120 caterpillar-days). Total daily predation rate was slightly higher in the rainforest (13.5%) than limestone forest (12.7%). Among the predation marks left by different groups of predators, insect predation (primarily by ants) was the most common. Predation rate was lower for black and green than white caterpillars, but shapes had no influence. The results of our study suggest that black and green colors are effective in reducing predation but curled postures may have different purposes other than masquerading. Anti-predatory mechanisms are often assumed based on field observation, but our study suggests that such mechanisms should be elucidated.

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GS40 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Attempt of partial pedigree reconstruction in a wild non-habituated chimpanzee community using faecal samples

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We used genetic markers to identify parent-offspring relationships in a non-habituated chimpanzee (*Pan troglodytes schweinfurthii*) community inhabiting Kahuzi-Biega National Park, Democratic Republic of Congo. This study shows the ability to confirm parent–offspring matches and offspring–parent matches, using microsatellite loci in combination with mtDNA information as an additional advantage to the parentage analysis. We extracted DNA from chimpanzee dung, which allowed to get genetic data, including a) individual identification, b) sex determination, and c) paternal and maternal lineage (11 Y-STR loci and 455-base pair segment of the mitochondrial control region) on which the pedigree is based. The mtDNA haplotype analysis was used in this study to confirm parentage genetic analysis results suggesting that maternal linkage may be a complementary tool for parentage analysis in the attempt to describe pedigree of the wild chimpanzee community. The study shows that combination of dung size providing information on ape's age and parentage analysis using genetic data, allows the determination of a pedigree relationship in a dyadic pair of individuals, specifically adult and infants individuals, but not so for juveniles and adolescents. These results may suggest that non-invasive genetic sampling may provide useful information regarding inbreeding avoidance mechanisms in a wild non-habituated chimpanzee community and may therefore offer opportunity to compare the findings with that from other chimpanzee populations across Africa.

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GS40 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Cathemeral activities in *Varecia variegata* in Kianjavato, southeastern Madagascar: Revisited

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Cathemerality (active in both day and night) is an activity pattern is seen in a variety of organisms. While uncommon in the Primate order, cathemerality is pervasive in Lemuridae, being present in most species in four of five genera (*Eulemur*, *Hapalemur*, *Prolemur*, and *Lemur*). The remaining genus, *Varecia*, had been considered diurnal until recently when captive studies and anecdotal evidence from the wild suggested they exhibited some activity at night. Our aim was to determine if a wild population of Black-and-white Ruffed Lemur, *Varecia variegata*, exhibited a cathemeral activity pattern. We collected data from June 2016 to January 2018 using instantaneous focal animal sampling at Kianjavato, southeastern Madagascar. Data were collected from two forest fragments, with daytime data collected from 7am-4pm (2-hour follows = 150) and nighttime data collected either from partial-night (4 pm – 12 am, n = 38) or all-night follows (4 pm – 6 am, n = 4). Diurnal: nocturnal activity ratios were calculated for each individual (n = 15) and compared to those of other cathemeral and diurnal lemurs. Our results show that 66.7% of individuals fell within the range exhibited by cathemeral species, with ratios ranging from 1.38:1 to 4.72:1. However, the majority of activity at night was self-grooming (58.6%). The definition of cathemerality states that significant feeding and travelling must be undertaken. Therefore, when self-grooming was categorised as inactive, fewer individuals (33.3%) were considered to exhibit a cathemeral activity pattern. These results give insight into the flexibility of activity patterns in *V. variegata* and suggest this species falls on the day-active end of the cathemerality spectrum within the lemurids.

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GS40 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

The pattern of scent and over-marking in Diademed Sifaka (*Propithecus diadema*)

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Sexual selection led to elaboration of secondary sexual display in many animals in service to choosy females. Some primate species rely on specialized scent glands where their secretions are associated with scent marking; such behavior is usually sexually dimorphic. Studying the related cues influencing scents pattern may provide informative figure on the evolutionary function of this behavior, and *Propithecus diadema* can be a good model for investigating this aspect. This study aims to determine the influence of life history variables on scent and overmarking. We followed 4 groups in Maromizaha Forest and collected all scent and overmarking deposited by 21 individuals. Using General Liner Mixed effect Model (GLMMs), we assessed the influence of sex, social / reproductive status and season on scent and overmarking occurrence. The result showed that gender, reproductive status, and seasons highly affected scent and over-marking pattern and both reproductive male and female scent mark reached their highest level in premating and mating periods. Also, male over-marked at higher rate than female throughout the seasons; however, we did not observe female over-marking during mating season. Furthermore, dominant and reproductive male's overmarking targeted majority of dominant female scent marks than same-sex conspecifics. Our results suggest that scent marking may be a form of intra-sexual competition in male but as mate attraction in female, while overmarking can be a mate guarding in males and remains unclear in females. These traits can be useful for studying intergroup interactions and highlight the species' conservation status.

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GS40 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Influence of environmental parameters on the breeding of an endemic Malagasy fruit bat, *Rousettus madagascariensis* (Pteropodidae)

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Few details are available on the reproductive ecology of Malagasy bats, the majority being unique to the island. The aim of the present study is to examine annual periodicity in the breeding cycle of an endemic cave-roosting bat, *Rousettus madagascariensis*, in northern Madagascar, a region with notably seasonal climatic patterns. The birth period was assessed from video recordings made between 2017 and 2018 of observed mating behavior and presence of neonates. Based on animals trapped between 2014 and 2018, we also estimated the stage of female pregnancy and the age of neonates. An analysis of video recordings indicates that mating was mainly in September, July, and January. Proportionately, this behavior took place largely during the dry season, was negatively correlated with temperature and rainfall, and was positively correlation with cave relative humidity. Using an estimated gestation period, mating taking place between July and September resulted in young being born during the wet season, the period of highest fruit abundance. In contrast, for January mating, the young were born during the dry season, a time of general low fruit availability. Parturition periods did not show significant annual variation and seemed mainly regulated by broad-scale patterns of rainfall and temperature. So, the reproduction of *Rousettus madagascariensis* follows a seasonal pattern, regulated by climatic parameters and presumably food availability.

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GS40 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Breeding biology and diet of the Madagascar Pond Heron, *Ardeola idae*, in monospecific colony at Sofia Lake in Bealanana, northern Madagascar

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The biology and ecology of the endangered Madagascar Pond Heron, *Ardeola idae*, a migratory waterbird and endemic breeder of Madagascar, are still poorly known. The present study constitutes the first record of a single-species colony of *A. idae* and aims to provide new informations on breeding biology and diet of this species in Madagascar. The colony, located at Sofia Lake, was surveyed from November 2017 to March 2018. We documented 75 nests in order to study diverse parameters of reproduction. The diet was studied by analyzing 51 pellets collected at the same colony during the breeding season. *Ardeola idae* started nest building and egg laying from the middle of November. Hatching started by the beginning of December. Egg laying and hatching continued throughout January and February, possibly due to second broods. This species took 7.14 ± 1.28 days on average to complete a nest. All the nests were constructed inside the clusters of *Cyperus madagascariens*. The height of nests above water level varied from 0.45 to 1.8 m with an average of 1.02 ± 0.35 m (n = 75). Mean clutch size was 2.81 ± 0.65 eggs (range 2-4 eggs, n = 75). The incubation period averaged 21.2 ± 0.9 days (range 20-23 days, n = 75). Of the 211 eggs laid in 75 nests, 178 (84.4%) hatched, and 158 (74.9%) of those hatchlings fledged. Thus, overall productivity was 2.37 young per nest, while the breeding success rate reached 74.9%. Based on 813 identified prey items in the 51 analyzed pellets, the diet of *A. idae* was composed of invertebrates such as insects (85.7%), arachnids (3.1%), mollusks (2.2%), crustaceans (0.6%), and vertebrates, such as frogs (4.4%), fishes (2.6%), and small lizards (1.4%). These results are very useful for the conservation of this threatened species.

Saturday, 3 August 2019 | Rubis
GS40 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

Current status of Rufous-necked Hornbill from Arunachal Pradesh, India

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Aceros nipalensis – a large bodied hornbill is with a Vulnerable conservation statute because of anthropogenic pressures, including habitat loss and hunting. It is found in tall broadleaved evergreen forests of Indian subcontinent and southeast Asia. In Arunachal Pradesh, India, the species was recorded from protected and non-protected areas. The study aims to study the current occurrence of the species in Upper Siang district of Arunachal Pradesh. The area is thinly populated by the Adi tribal community. It is a hilly tract located in the Eastern Himalayan region of India (94°-95° N and 28°-29° E), and separated by the Siang River, with moderate to steep slopes covered by thick forests. The forest area is legally classified as unclassed state forest (USF), where tribal people exercise their customary rights. The occupancy-based framework was used for the hornbill survey. The study site was gridded into 90 grids of size 25 km2. Knowledge of occupancy for presence of species was obtained by semi structure interviews with the hunters of the village, which also included detections for last three decades. Spatially-replicated trail walks combined with site-specific and sample-specific covariates (such as number of snares and traps, number of gunshots, etc) were done in each grid to get the detection probability. Based on the interview surveys, 60 out of 90 grids evidence of *A. nipalensis* was found. Field surveys were completed at 20 sites during Feb 2018 till March 2019. The species was encounter only at single site documenting its rarity in the area. Despite of 0.5 occupancy the detection was less than 0.1%. This species is facing high anthropogenic pressure (hunting) and in need of urgent conservation effort. Hornbills are very important in the local traditional cultures and combining this aspect and protection, will help to formulate a critical conservation programme.

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GS40 – CHARACTERIZATION of TROPICAL BIODIVERSITY (species, genetics, and landscape)

SPEED PRESENTATIONS

Analysis of conflict between piscivorous birds and shrimp farming in Ecuador

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Shrimp farming is an important commercial activity in tropical regions that represents the second source of income by exports for Ecuador. The presence of piscivorous birds at shrimp farms often ignites conflicts over fish resources managed by humans, as a result of this, a number of deterring systems have been implemented, often causing damages and death of many birds. Despite the impact of this activity, few studies have been carried out in tropical regions about deterring systems. The objective of this study is to quantify the number of birds killed by owners and shrimp depredation caused by birds. To do so, we conducted our study on three shrimp farms in the Ecuadorian coast during one year. We recorded all birds killed by owners weekly. Also, we carried out diurnal bird census once a week to identify more conflictive species and quantify shrimp depredation. The most conflictive species is the Neotropical Cormorant (*Phalacrocorax brasilianus*). We estimated that this bird causes between 12% and 8% production lost in dry and rainy season, respectively. We estimated 96 Neotropical Cormorant/year/farm killed by owners. Based on our research, thousands of birds are killed all over the country every year, because this birds cause less profits to owners. Therefore, it is necessary bird management strategies to reduce the problems associated with piscivorous birds at aquaculture sites in tropical regions while improving bird conservation.

Friday, 2 August 2019 | Grenat
Presentation Order:1

The rise of commercial poaching in Namibia: A socio-economic perspective

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The escalation in poaching across Africa over the past decade threatens the long-term persistence of rhinoceros populations. Much research has been conducted on the demand for rhinoceros horn, including market assessments and end-user studies, but significantly less research has been conducted on the motivations for involvement in the supply of wildlife products. We diagram the tiers of commercial poaching syndicates to better understand their structure and recruitment mechanisms. We explore both the societal drivers and the personal motivations for individuals to become involved in poaching syndicates in Namibia to provide more problem-oriented context to rhinoceros conservation practitioners. Between May and August 2017, we conducted key informant interviews and group interviews with 79 informants including former poachers, local farmers and herders, conservancy members, NGOs, government representatives, rangers, park management, and tourism representatives. Using Q-methodology, we separated informants into distinct populations and performed cluster analysis to test weather informants in the same population returned similar response sets. A series of chi-square tests identified associations between informant populations and responses. We produced a visual representation of the multi-tiered commercial poaching syndicates operating in Namibia. We discuss socio-economic stressors, including unemployment rates, alcohol abuse, dissatisfaction with conservancy benefit distribution, and the cultural importance of wealth and social status. We show how informants in different populations have significantly differing perspectives on the societal drivers and personal motivations of involvement in poaching syndicates. Since informants in each population have different perspectives on the drivers of poaching, we conclude that many conservation practitioners are not adequately addressing the root causes of involvement in syndicates. We identify mitigation strategies for this disconnect between community-level informants and conservation practitioners. We provide recommendations for improved efficiency in local engagement strategies for increasing pro-rhinoceros behavior and decreasing involvement in syndicated wildlife crime.

Friday, 2 August 2019 | Grenat
Presentation Order: 2

To build or not to build: Potential of narrow logging roads for climate change mitigation

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Clearing of forests to construct logging access roads is a considerable source of greenhouse gas emissions (~25% of total emissions). However, landscape level planning and improvements in road construction, have the potential to minimize these effects, and to be an effective mechanism of climate change mitigation by forests. In this study, we aim to determine the emissions due to construction of primary logging roads in selected timber concessions in the Indonesian provinces of Papua and West Papua. We then aim to estimate the emissions reduction potential of improving road construction practices, focusing on narrower roads, built to facilitate drainage and trafficability. We employ a novel combination of methods spanning the use of field-based measurements of location and width, satellite imagery analysis and statistical analysis (employing machine learning) to determine the total area cleared for roads within each logging concession in the study area. This will involve mapping road networks using a predictive learning framework, such as the Random Forest classifier. Lastly, we will combine the area calculated with field and remotely sensed carbon stocks of surrounding forests to calculate associated emissions. Modeling of the total emissions reduction potential anticipates potential road width reductions by investigating the range of field measured widths and available road construction technology. Of all improved practices recommended, improvements in primary road construction have the highest potential to reduce emissions due to deforestation. This study will provide improved remotely sensed estimates of the potential to reduce emissions through improved road construction in the Indonesian provinces of Papua and West Papua.

Friday, 2 August 2019 | Grenat
Presentation Order: 3

Microhabitat preferences for affiliative behavior in two Endangered sifaka species

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In obligatorily social animal species, strong, enduring social relationships have a variety of fitness benefits, including increased longevity, mating success, and increased infant survival. In Endangered species, such relationships may also be important in the continued survival of fragmented populations facing anthropogenic pressures. Previous work has suggested that affiliative social behavior can be affected by both abiotic and biotic factors, such as fluctuations in temperature and rainfall, predation risk, and characteristics of the trees used. Thus, understanding the connection between microhabitat characteristics and social relationships may be crucial in evaluating the suitability of proposed protected areas and in predicting how threatened species will fare with increasing habitat change. To that end, we investigated the extent to which two Endangered sifaka species (*Propithecus diadema* and *P. verreauxi*) cluster their affiliative behavior around specific microhabitat contexts. Using over 450 combined hours of focal sample data on affiliative behavior combined with botanical data on over 200 specific trees used during grooming and play, we found that both *P. diadema* and *P. verreauxi* showed hotspots within their home ranges that were preferred for social behavior (clustering of social behavior, Ripley's K Function, $p < 0.001$). In *P. diadema*, such hotspots generally consisted of large trees of a variety of species. In *P. verreauxi*, however, affiliative behavior was clustered around several key tree species, and tree revisits were relatively frequent. These results suggest that sifaka are sensitive at least to botanical contexts when engaging in social behavior. Conserving their entire behavioral diversity thus should take into account such microhabitat preferences in order to sustain populations beyond just their nutritional requirements.

Friday, 2 August 2019 | Grenat
Presentation Order: 4

Dry season duration, soil type and period of active land use are the most important hindrances for secondary forest growth rates across Brazilian Amazon

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The Secondary Forests (SFs) play an important role of being a conservation stronghold for biodiversity and a carbon pool in the near future. However, SFs recovery rates are not equal across Amazon due to the different climatic and edaphic conditions, as well as to their historical use, therefore, reducing the accuracy of carbon uptaking estimates. We made a comprehensive meta-analysis of SF biomass recovering rates in the Brazilian Amazon analyzing 452 SFs plots ranging from 0.1-590 $Mg.ha^{-1}$ and aging up to 70 years published on the literature to evaluate the most importance hindrances on biomass and carbon accumulation. The models were adjusted by Nonlinear Mixed Effects Models (NLME) and its growth rates were obtained by differentiating. Considering that organic C is the half of the fresh above ground biomass (AGB), the mean annual increment (MAI) of C had 77% of coefficient of variation from the average MAI = 4.05 ± 3.1 $Mg.C.ha^{-1}.yr^{-1}$. The most important bioclimatic variables were dry season duration (DSD), soil type, and total precipitation; the period of active land-use (PALU), frequency of clear cuts, and the use of fire, respectively, were the most important abiotic variables in the model. The results showed that, on average, the MAI is almost 30% higher for DSD ≤ 2 months, 1.3 times higher in areas of PALU < two years, and between 1.45-2.2 times higher in alfisols and anthrosols than in oxisols, spodosols, and ultisols. With the current technologies for extract remote sensing time-series data, there is a urgent need to process and track the age and the past-use of SFs, as well as to provide information of bioclimatic and edaphic condition on large scale to improve estimates of annual carbon uptaking on these very dynamic areas.

Friday, 2 August 2019 | Grenat
Presentation Order: 5

Effects of human-induced forest fires on the abundance of Jolly's Mouse Lemur in southeastern Madagascar

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Slash-and-burn agriculture and burning for pasture land have been the principal drivers of habitat loss in Madagascar for the past 150 years. These fire-induced changes in the forest can reduce food supply or shelter availability for arboreal animals such as lemurs, leaving them at risk of population declines and extirpation. However, forest fires can also result in an increase of insects that infest injured trees, thus providing more resources for omnivorous species that consume insects. We evaluated the effects of forest fires on the encounter rates (ER) of an omnivore, Jolly's Mouse Lemur (*Microcebus jollyae*), in two forest fragments near Kianjavato, southeastern Madagascar. We conducted surveys before and after two forest fragments were partially burned in late 2015. We repeatedly walked 16 line-transects (500 m), with a total sampling effort of 100 km. To compare pre- and post-fire ER for this species, we performed a two-step analysis. First, we examined the ER from both burned and unburned transects in the partially-burned forest fragments. Next, we analyzed the change in ER on only the burned transects. Since *M. jollyae* is an omnivorous species, we expected an increase in ER in burned areas. We did not find a significant change in the ER of *M. jollyae* when all the transects were considered (GLMM: z = -0.28; p = 0.78), but we did find a significant decrease in ER when only the burned transects were included (z = -2.01; p = 0.04). This could suggest that *M. jollyae* left the burned areas due to lack of food resources and shelter but did not leave the forest fragments entirely. Although *Microcebus* is usually recognized as a disturbance-tolerant genus because of its small body size, omnivorous diet, and generalized locomotion, markedly reduced food supply and the loss of habitat connectivity could explain the decrease in ER in burned areas in the Kianjavato region.

Friday, 2 August 2019 | Grenat
Presentation Order: 6

Conservation of the world's rarest duck, the Madagascar Pochard, *Aythya innotata*, and the state of Central High Plateau wetlands

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The Madagascar pochard, *Aythya innotata*, was rediscovered in 2006 in a remote area of northern Madagascar after disappearing from its previous range, particularly the Lake Alaotra wetlands. It is one of the rarest birds in the world (less than 100 in the wild) and classified as Critically Endangered. Our objectives were to assess 1) the viability of the last remaining population of *A. innotata* and 2) the suitability of central high plateau wetlands for the species. We conducted daily and monthly monitoring to study fledging success, activity budgets and population trends at Lake Matsaborimena by scan sampling methods. Invertebrates were recorded using grab samples to identify the abundance of available food. We assessed 32 wetlands across the Central High Plateau using human pressures, marsh loss, exotic fishes, invertebrates, and water birds as indicators of wetland quality. Our results show a very low breeding success rate for *A. innotata*. This seems to be due to various factors: predation, lack of food, and lack of suitable habitats. However, the population has slightly increased over period of monitoring (16.50 ± 3.23 in 2012 and 52.75 ± 8.20 in 2018). The fledging success increase from 3.2% in 2011 to 11.0% in 2018. Invertebrate richness in the lake is high but abundance is very low. Assessment of wetlands has shown that they have low species richness and abundance of invertebrates and endemic water birds. The level of human disturbance is rapidly increasing with many wetlands partially or completely transformed into rice fields and with proliferating exotic species. There has been a population increase at Lake Matsaborimena but the site is tiny and it is the only one. A reintroduction program is required to save this species.

Friday, 2 August 2019 | Grenat
Presentation Order: 7

Linking biodiversity conservation and education: An exploratory research of education programmes implemented in protected areas of Madagascar

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Education is being used as a tool to foster supportive behaviours for conservation, particularly amongst local communities living around protected areas. Yet, despite a shared narrative that education programmes benefit conservation there is a lack of strong scientific evidence of their effectiveness, and particularly of their long-term impacts. This research explores the ways in which education can harmonize conservation and local communities. Concretely, it examines the status quo of conservation education in schooling and in diverse programmes implemented by NGOs around four different protected areas in Madagascar. This study uses a qualitative approach based on key informant semi-structured interviews with key actors in conservation education in Madagascar. The study aims at appraising long-running programmes, providing new insights in the conservation context, while scoping needs and opportunities for change. We found that, in the context of primary education, conservation education is marginally integrated in the school curriculum, which is fixed at the national level and does not reflect the local biocultural context. As a result, NGOs are the main actors conducting conservation education. The majority target children, and conduct their activities within the school settings with few visits inside protected areas. Current evaluation methods focus on quantifying short-term changes in knowledge and attitudes, rather than assessing behaviour outcomes, or their final impacts on conservation. These findings, while preliminary, are relevant beyond this context, and raise intriguing questions regarding the influence of education in conservation success. Many conservation strategies are based on the simplified assumption that knowledge modifies attitudes, which in turn motivates changes in behaviour. In addition, there is still a disconnection between local communities, education and conservation. Further research and discussion remains open to understand how – from a decolonizing approach – education can be a participatory and inclusive tool that bridges the gap between conservation and human well-being goals.

Friday, 2 August 2019 | Grenat
Presentation Order: 8

Isolation and characterization of lactic acid bacteria from the gut of grasscutters (*Thryonomys swinderianus*) in Ghana

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[2]Kyoto Prefectural University
[3]Chubu University
[4]Kyoto University

Grasscutter (*Thryonomys swinderianus*) is a wild hystricomorph rodent that is heavily hunted because it is an important protein resource in western and central Africa. The species has been under domestication over the last several decades to forestall the negative practices associated with its hunting. The aim of this study was to isolate and characterise lactic acid bacteria in the gut of the Grasscutter in Ghana and to explore their potential use as probiotic. 57 bacterial isolates were picked from 26 fresh faecal samples collected from Grasscutters comprising nine domesticated grasscutters kept on farms in Accra and 17 wild grasscutters from Mankessim in the Central Region of Ghana. DNA was extracted from bacterial colonies and sequenced at the 16S rRNA gene to identify the bacteria at the species level using Basic Local Alignment Search Tool (BLAST) of GenBank. Five genera comprising 15 species of lactic acid bacteria were identified at ≥ 99% similarity with registered sequences. These included *Lactobacillus fermentum, L. salivarius, L. ingluviei, L. plantarum, L. reuteri, L. formosensis, L. taiwanensis, L. rhamnosus, Pediococcus pentosaceus, Enterococcus gallinarum, E. hirae, E. faecium*, *Staphylococcus homini*, *Weissella cibaria*, and *W. paramesenteroides*. Of these, *L. ingluviei, L. taiwanensis, L. formosensis,* and *L. fermentum* were found exclusively in the wild Grasscutters. The isolation of *L. ingluviei* is of interest since this species was originally isolated from birds and was previously reported to be associated with weight gain in mice. A preliminary trial involving *L. ingluviei* inoculation of weaned Grasscutters ($n = 8$) for 12 weeks indicated an improved feed intake ($W = 50$, $p < 0.05$) compared to a control ($n = 7$). The results of this study suggest that *L. ingluviei* could be used to improve the nutrition of domesticated Grasscutters.

Friday, 2 August 2019 | Grenat
Presentation Order: 9

Population structure and gene flow of *Triops granarius* using MiSeq technology

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The tadpole shrimp *Triops granarius* is the largest natural freshwater invertebrate in Qatar, where it dwells in short-lived pools in desert environment. This iconic status makes *T. granarius* a fitting subject for studying species diversity and habitat preservation in Qatar. Previous studies have examined mitochondrial markers to evaluate the species status for this extensively distributed species in the genus. This study focuses on intra- as well as inter-population divergence using microsatellite markers. To identify microsatellite loci and develop primers, the whole genome of a single individual from a northern population was sequenced using paired-end MiSeq technology. Currently 52 markers with tri- or tetra-nucleotide repeats have been identified and primers of similar melting temperatures have been designed. Variable microsatellite loci were identified by analyzing a panel of individuals from different collection sites. We used these variable loci to examine population structure and gene flow across the five study sites, all located 2-30 km apart between northeastern and northwestern populations. Our results shed light on population dynamics of this species, where dispersal as adults is virtually impossible due to habitat constraints but wind-assisted movements may allow earlier life stages to disperse over long distances. This could be the basis for why the animal is found in various parts of the world regardless of climate and habitat.

Friday, 2 August 2019 | Grenat
Presentation Order: 10

New records of polymorphic phenotypes in the Neotropical mammal fauna: Insights for evolutionary ecology and conservation

LUCAS GONÇALVES DA SILVA, MARTIN ALEJANDRO MONTES
Federal Rural University of Pernambuco, Recife, Brazil

Biodiversity conservation includes preserving variations potentially relevant for evolutionary ecology of species, especially to environmental adaptation. Polymorphic phenotypes are common in many groups of mammals worldwide, and may play adaptive roles in varying habitats and certain ecological conditions. Cases of polymorphic phenoptypes genetically controlled such as melanism, leucism, and albinism had not been well mapped in natural populations, but they are recurrent in Neotropical mammals, especially carnivores, xenarthrans, ungulates, and primates. Here we investigated the spatial distribution of polymorphic phenotypes in many Neotropical mammal species aiming to identify its presence in distinct biomes, current representation in protected areas, and biological aspects related to natural selection under different environments. We obtained more than 10.000 records of Neotropical mammals from field surveys, which evidenced the presence of coloration polymorphisms in more than 15 species: Melanism in Jaguar (*Panthera onca*), Geoffroy's Cat (*Leopardus geoffroyi*), Pampas Cat (*L. colocola*), Southern Tiger Cat (*L. guttulus*), Kodkod (*L. guigna*), Jaguarundi (*Puma yagouaroundi*), Maned Wolf (*Chrysocyon brachyurus*), Crab-eating Fox (*Cerdocyon thous*), Southern Tamandua (*Tamandua tetradactyla*), and Lowland Tapir (*Tapirus terrestris*); leucism in Puma (*Puma concolor*), Ocelot (*Leopardus pardalis*), Tayra (*Eira barbara*), Crab-eatin Fox, Southern Tamandua, Black-penciled Marmoset (*Callithrix penicillata*), and Commom Marmoset (*C. jacchus*); and albinism in Tapirs (*T. terrestris*). These records were collected in specific biomes and landscape features, indicating that the presence of polymorphic phenotypes is directly influenced by the natural selection under color patterns genetically controlled. Classical hypothesis such as the Gloger's rule is applied for polymorphic phenotypes in the Neotropical region. Also, most of the records were obtained in protected areas, highlighting the relevance of these sites to safeguard remaining populations and these rare colors in nature. This is the first biogeographic map of polymorphic phenotypes in these mammals, and our results represent important tools for iconic morphs conservation.

Friday, 2 August 2019 | Grenat
Presentation Order: 11

Mutualism disruption by an invasive species: Measuring ant-elephant induced shifts in savanna tree cover

BRANDON R HAYS, TODD PALMER, JACOB GOHEEN, CORINNA RIGINOS
University of Wyoming

In the Laikipia Highlands of central Kenya, the whistling-thorn tree, *Acacia drepanolobium*, accounts for >99% of all trees across vast swathes (>100 km^2) of land. This myrmecophyte (ant-plant) provides food and shelter for native *Crematogaster* ants in exchange for protection against elephants (*Loxodonta africana*). Across entire landscapes, this ant-plant mutualism stabilizes tree populations that would otherwise succumb to lethal browsing by elephants, thereby preventing the savanna from transforming into a treeless grassland. Recent invasion by a non-native ant, the big-headed ant (*Pheidole megacephala*), has disrupted the native ant–acacia mutualism. Since *P. megacephala* kill all native ants they encounter but do not provide protection against herbivory, the invasion renders trees vulnerable to browsing by elephants. This mutualism disruption may therefore lead to a reduction in cover by whistling-thorn trees. My main goal was to identify differences in tree cover between areas invaded by *P. megacephala* and uninvaded controls. I carried out drone surveys to collect very high (<0.5 cm) resolution remotely sensed imagery and recorded individual tree locations with a GPS. Using supervised classifications in GIS software and validating with known tree locations, I isolated trees and measured differences in tree cover. Overall, I found that tree cover was significantly lower in areas invaded by *P. megacephala*. Quantifying shifts in tree cover triggered by the ongoing invasion of big-headed ants will allow me to predict further changes in tree cover as the invasion progresses. This will be crucial for land managers in mitigating the negative consequences of mutualism disruption; whistling-thorn trees are both a critical food for several endangered large herbivores and a key driver of ecosystem function. More broadly, quantifying the consequences of mutualism disruption will enhance our mechanistic understanding of the current and future impacts of invasive species globally.

Friday, 2 August 2019 | Grenat
Presentation Order: 12

WORKSHOPS

How to get your paper published: skills for writing papers and the journey to publication

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[1]Tropical Biology Association, Cambridge, United Kingdom
[2]Forestry Commission, Cross River State, Nigeria, Calabar, Nigeria
[3]South Dakota State University, Brookings, South Dakota, USA

The workshop aims to give early career scientists – including graduate students – insights, knowledge, and skills in how to publish a scientific paper. Practical exercises will cover scientific writing skills and how to structure a paper. Participants will also learn how the publishing process works, including advice on choosing journals, and how to avoid common pitfalls. It is important that conservation research is published so that useful information is made available to the scientific community- to guide future research and conservation actions. Publishing not only raises the profile of conservation scientists, it raises their credibility because peer reviewed publications are seen as high quality and reliable. Publication thus boosts scientists' careers and can increase authors' chances of attracting funding and collaborators. Nevertheless, students often feel they lack the confidence, support or skills to publish their work. This workshop is aimed at early career scientists who have completed some work but have not yet published widely. It will provide interactive, practical training in how they can publish their research, highlighting common pitfalls and how to overcome them. The workshop will explore how to structure a paper and participants will put this into practice for their own papers including a plan of the paragraphs to be included. Practical exercises on writing style will help participants refine their own writing as will a session on how to present research data. There will be some time for specific advice and peer review and people will make connections that can be continued beyond the workshop.

Tuesday, July 30 | Emeraude
Order: **W/01**

E2M3: Ecological and epidemiological mini-modeling in Madagascar

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[2]University of Wisconsin-Madison, Madison, Wisconsin, USA
[3]Mahaliana Labs, Antananarivo, Madagascar

This two-hour intensive workshop, geared towards students in their third cycle or higher in biology, mathematics, medicine, or public health, aims to provide participants with an introduction to the use of dynamical and statistical models in understanding ecological and epidemiological data. The course is modeled after E2M2: Ecological and Epidemiological Modeling in Madagascar, a 10-day workshop, which the instructors teach annually in Madagascar. In E2M2, students participate in a series of interactive lectures and computer-based tutorials and learn to fine-tune model-based research questions, develop clear model frameworks and corresponding equations, and fit models to real-world data. In E2M3, students will receive a basic introduction to subjects covered in greater depth in the full length course—specifically learning to distinguish between statistical and mechanistic modeling approaches and apply each technique to appropriate questions. Because time is limited, we strongly advise students to familiarize themselves with basic programming in R prior to arrival to the course.

Tuesday, July 30 | Grenat
Order: **W/02**

National Geographic grants & grant writing workshop

CHLOE CIPOLLETTA[1], JILL SPEAR[2]
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[2]National Geographic Society, Washington, DC, USA

The National Geographic Society (NGS) provides grants for research, conservation, education, storytelling and technology in three focus area: Wildlife, Human Journey and Changing Planet. The Society aspires to create a community of change, advancing key insights about the planet and probing some of the most pressing scientific questions of our time, all while ensuring that the next generation is armed with geographic knowledge and global understanding. Its goal is measurable impact: furthering exploration and educating people around the world to inspire solutions for the greater good. The National Geographic Grants and Grant-Writing Workshop will be led by Chloe Cipolletta, NGS East Africa Program Director, and Jill Spear, NGS Early Career Program Officer. The two-hours workshop will include: presentation of the NGS grants types (Early Career, Exploration and Requests for proposals), project types (conservation, research, education, storytelling and technology) and focus area (Wildlife, Changing Planet and Human Journey); guidelines for grant writing (project planning; researching funding opportunities; understanding the granting agency; writing & submitting the proposal) and examples of previously funded projects presented by awarded grantees attending ATBC.The main aim of this workshop is to introduce the National Geographic Grant Program to the ATBC Conference attendants and to provide participants with key tools to develop competitive grant applications.

Thursday, August 01 | Emeraude
Order: **W/03**

Using aerial surveillance program and new technologies to improve natural resource management

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[1]WWF Madagascar Country Office, Antsakaviro, Madagascar
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Madagascar has a unique natural heritage respect to the rest of the world with an exceptional rate of endemism. Different factors, such as over-exploitation of natural resources, anthropogenic activities with negative ecological impacts, and climate change are generally considered being responsible for the loss of the biodiversity and for the degradation of natural ecosystems. To cope with those pressures and threats, the creation of protected areas has been considered as an adequate solution. However, implementing monitoring and surveillance activities is necessary for achieving optimal management efficiency and to avoid extinction of flagship species. Existing monitoring tools include an aerial surveillance program and terrestrial patrols using SMART (Spatial Monitoring and Reporting Tool). Since 2010, the goal of aerial surveillance has been to quickly localize and measure the evolution of annual deforestation in the island's different protected areas, but also by the implementation of patrols, to set-up a rapid and effective interventions at the sites where pressures occur and mostly related to forest clearing and fire. In addition, oblique aerial photography allows facilitating the dialogue between the practitioners of slash and burn agriculture and the actors of development and conservation to find sustainable responses to reduce deforestation while ensuring local development. The results prove that complementarity of aerial monitoring with terrestrial patrols contributes positively to reduce deforestation: for instance, in the Kirindy Mite National Park, the loss of forest was 5,224 ha in 2013 and only 770 ha in 2017, for the Amoron'Onilahy Protected Area, it was 202 ha in 2015 and 21 ha in 2018 and for Zamasy (a site managed by local communities through management transfer) 62 ha in 2012 and 487 ha in 2017.

Thursday, August 01 | Opale
Order: **W/04**

MIHARI Network: Building a civil society movement to safeguard marine resources

VATOSOA RAKOTONDRAZAFY, AUDREY DELHOMME, BENJAMIN HOBILALAINA, PRISCA RATSIMBAZAFY
MIHARI network, Antanananarivo, Madagascar

Locally managed marine areas (LMMAs) are areas of ocean managed by coastal communities to help protect fisheries and safeguard marine biodiversity, often with the help of partner NGOs. LMMA associations design and implement practical approaches to sustainable marine resource management such as marine reserves, alternative livelihood activities, mangrove restoration, and the creation of *dina*. The role of the MIHARI Network is to support and promote the LMMA concept all around the country. Since 2012, it has been sharing good practices and success stories, exploring common issues, and developing collaborative solutions, as well as building the capacity and skills of LMMA leaders. It has also became a vocal civil society movement advocating for the rights of small-scale fishers by giving them a voice that influences national policy and decisions relating to marine conservation. The LMMA approach has been instrumental in inspiring locally led resource management and the exchange of good practice between coastal communities. The MIHARI Network has been supporting and promoting this approach through trainings, workshops, forums, and advocacy, and its impact and successes are growing each year. Networking has therefore highy supported Madagascar's LMMAs and it will continue has MIHARI keeps thriving and strengtening itself.

Friday, August 02 | Grenat
Order: **W/05**

Capacity building for conservation in Africa

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[2]South Dakota State University, Brookings, South Dakota, USA
[3]Forestry Commission, Cross River State, Calabar, Nigeria

This workshop aims to explore how we can achieve more impact in conservation in Africa from capacity building. We will explore current approaches to capacity building and measuring impact. This will be a forum where we share what challenges exist to achieving impact (including what is not working), so we can learn from real-life practice and consider how to adapt our approaches, innovate and scale up. Capacity building is an important tool for conservation, and we need to know how to deliver it in the most effective way that will have long-term impacts. This requires knowledge about what the capacity gaps are and what methods work best in which situations. It is vital that we measure impact and share the results widely to help scale up our work as well as adapt our methods when they are not working. It is also important that we encourage innovation in capacity building, and recognise how best to integrate it with other conservation approaches rather than work in isolation. The workshop will discuss these issues and identify solutions and opportunities for capacity building in Africa that will have a greater impact in conservation. Specifically, we will discuss the gaps and constraints that exist in capacity building in Africa and solutions to these. In addition, participants will share expertise around capacity building methods and tools that have had a demonstrable impact, so that we can explore whether and how these can be scaled up further. Equally important, participants will share examples where capacity building has not “worked”, with possible reasons for this and how we need to adapt and innovate for better impact.

Thursday, August 01 | Perle
Order: **W/06**

Madagascar Lab&Kitchen by Cascoland - Installation/Workshop

MARIANA MARTÍNEZ BALVANERA
Cascoland group member

The Cascoland Mobile Lab&Kitchenis an itinerant installation that aims to connect scientists, farmers, creatives and chefs in site specific locations, around the theme of sustainable food production systems. The Mobile Lab&Kitchen is basically an installation made up of a number of kitchen tables, a temporary meeting place and a co-creation space where science, farming practices, culinary practices and creative practices and audiences meet, cook, eat and discuss food. Like we all do around our kitchen tables worldwide. While cooking and eating together in an informal setting a different discourse will evolve. Not a one way lecture but a dialogue between on food from the different perspectives of farmers, scientists, chef cooks and creatives.With food as the common ground the Mobile Lab&Kitchen aims to create a network and bridge multi-stakeholder communities in countryside and urban locations in need of new insights on farming, food production and forest restoration.In the setting of ATBC 2019, Cascoland proposes to create a temporary Lab&Kitchen to facilitate a trans-disciplinary exchange around a kitchen table, involving ATBC attendees, sustainable farmers, local chefs and researchers to address global challenges in food production. Locality is the most important aspect of the Mobile Lab&Kitchen. Cascoland will work with local resources: Madagascar's locally produced foods, local products, creatives and academics. The Lab&Kitchen will be a work-in progress that requires the audience active participation. The actionswill be a culinary lab where we will cook and eat together. We will work with providers of locally produced foods and forest products and the cooking willbe orchestrated by local Chefs. At the kitchen table, experts, farmers, scientists, academics, will discuss the relationship between food agriculture and climate change, food production,forest restoration and the importance of trans-disciplinary solutions to these questions.

Friday, August 02| Relais de plateaux
Order: **W/07**

How do we improve forest habitat conservation and ecological restoration in Madagascar?

JOSIA RAZAFINDRAMANANA[1], ROBERT KOOYMAN[2], SAMUEL RAFANOMEZANA[1]
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[2]Macquarie University, Sydney, Australia

In Madagascar, high rates of forest clearing and high levels of endemism converge to place hundreds of species of plants and animals at risk of extinction. Across the country, forest clearing and burning put essential ecosystem processes and services into decline. This workshop aims to identify key causal factors and quantify what can be done to slow (or stop) the decline and successfully restore forest habitats. At local scales establishing baselines for conservation and restoration includes defining the diversity of undisturbed forests (surveys and alpha taxonomy) and the contribution of natural systems and ecological processes to economic and human well-being. At larger scales, remote sensing (satellite imagery) shows local impacts in landscape context and provides the means to estimate and model forest cover by habitat and community type through time. There is no doubt we have substantially improved our capacity to monitor forest decline, but the question is: have we similarly improved our capacity to protect and restore the forest? We ask: How can we effectively link science, natural history, local people, and the economy, to save the incredible biodiversity of Madagascar? And allied to that: How can we improve what we do to be more effective in ecological restoration? The primary aim of the workshop is to promote discussion and identify what we need to know, and do, to slow (or stop) the decline and conversion of native forest, and successfully protect and restore forest habitats for all species. Potential leaders of the workshop belong to research and conservation institutions as well as companies involved with extractive industries. All have extensive experience in habitat restoration, and the building of a forest future for biodiversity in Madagascar.

Saturday, August 03| Saphir
Order: **W/08**

Funneling post-conference excitement into concrete next steps for achieving your career and research objectives

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[3]Tropical Biology Association
[4]Faculty of Science, University of Antananarivo

The benefits of attending international scientific conferences are numerous and they should be long lasting. Conferences provide you with an incredible platform to present your most recent work to international peers, they are an opportunity to learn about advances in your field, to connect to the community of scientists and practitioners in your field, to discuss and deliberate on exciting new topics and be inspired by keynote speakers and their work. It is far too easy, however, to underutilise the opportunities that conference interactions offer. All too often we return home charged by the conference experience, but in the absence of something specific, solid and attainable to concretize that excitement, it quickly fizzles, and the routine of our regular everyday work gradually takes over. This post-conference workshop is aimed at helping ATBC 2019 conference participants make the most of their attendance by immediately funnelling their excitement into very specific products and outcomes that benefit their research and career objectives. Aimed mostly at Africa and Madagascar Rufford Small Grant recipients (but open to any other ATBC attendant), the one-day workshop will help participants identify how to convert the new ideas and connections into meaningful research and writing collaborations, how to maintain collaborations across distance and over time, how to write compelling grant proposals for conservation research and communicate your findings effectively. Funded by the Rufford Foundation, this one-day training workshop will be conducted on Sunday, 4 August 2019. Up to 27 participants can attend. Accommodation for one night and meals for the extra day will be available for all participants through the generous support of the Rufford Foundation.

Sunday, August 04| Relais de plateaux
Order: **W/09**

Mentoring circle

ONJA RAZAFINDRATSIMA
South Dakota State University, Brookings, South Dakota, USA

The ATBC will be sponsoring its third Mentoring Circle program this year during its annual conference held in Antananarivo, Madagascar, in July 2019. The last two years of the program were very successful, proving to be a very helpful experience to both mentors and mentees. The ATBC Mentoring Circle program is designed to bring together groups of 8-10 mentees with two mentors with similar career interests to promote career development in tropical biology and conservation. Specifically, we aim to support early career tropical biologists (i.e. graduate students and post-docs) by providing a network of individuals that can offer advice, best practices, and tools to achieve success. Mentors and mentees will be assigned to their circles and attend a 2-hour meeting on Tuesday, 30 July before the opening ceremony of the ATBC 2019 annual meeting in Antananarivo, Madagascar. They will discuss each mentee's and mentor's objectives and desired outcomes. The mentoring circles will convene again at least once more in the course of the meeting during one pre-arranged lunch (Friday, 2 Aug). They will then meet virtually (e.g. via Skype or Zoom) once a month throughout the rest of the year to develop a strong and continuing relationship.

Tuesday, July 30 |Rubis
Order: **W/10**

ATBC Nature Art Station Madagascar 2019

PATRICIA SAMPAIO
University of Florida, Gainesville, Florida, USA

Would you like to take a quick break to let nature inspire your creativity in a different way than to write papers and grants? If you do, then come join us for some nature inspired art at ATBC's first Nature Art Station (NAS). We plan to do some Ceramic mug painting and rubber stamp carving (detailed description below). The NAS will take place daily during the ATBC annual meeting from 1 to 2 pm (last hour of the lunch break) in a room TBA (please meet up by the registration table on the first day). This activity is open to all meeting attendees (Only kids older than 10 and accompanied by an adult will be able to participate for safety reasons). If you have NOT yet registered for it, please do so at the registration table, as space is very limited. Please email Patricia D. Sampaio* (NAS instructor) pdsampaio2013@gmail.com if you have any questions. We will use simple techniques such as tracing with carbon copy, dotting on stickers, free hand drawing, stenciling, and etc. to apply nature inspired images (or others) to plain white ceramic mugs. We will use special oil based sharpies and ceramic paint that can later be 'baked' in a regular home oven to become water and scratch proof. We can get inspiration for the designs by going for a walk outside, remembering favorite images or looking for new ones on the computer, in a book or using imagination. You will be able to take home your final project(s). Carving block is traditionally a printmaking tool and is used to cut images that can be reproduced a number of times. We are going to use square pieces of soft rubber (or recycled old erasers) to carve into and produce images that can be stamped repeatedly in a variety of surfaces. You can choose to sketch your own images/motifs or copy it from any source and transferring it to the eraser/rubber base. Please note that we will use sharp tools in order to carve into the rubber surface.

* Full disclosure: The NAS instructor is not an artist, she has been doing pottery, collage, and drawing as a hobby for the last 10 years. She is rather a biologist passionate for art and its potential as a powerful tool to influence people's perceptions and actions towards nature.

Thursday, August 01| Rubis
Order: **W/11**

Journalist workshop: reporting on conservation issues in Madagascar

RHETT BUTLER, REBECCA KESSLER, WILLIE SHUBERT, MALAVIKA VYAWAHARE
Mongabay Org Corp, Redwood City, California, USA

Mongabay, a global environmental news platform, is organizing this workshop to provide background on key conservation themes of the ATBC conference and broader conservation issues in Madagascar. The workshop will include advice on identifying, framing, sourcing, and pitching environmental stories as well as an open discussion on challenges journalists face in covering the environment, the local media landscape in Madagascar, and the types of environment stories of interest to the Malagasy public. Who should attend? Journalists reporting on natural resources management, science, fisheries, forestry, and economics for local and international publications.

Wednesday, July 31 | Cristal
Order: **W/14**

POSTER SESSION

POSTER SESSION 1

Gene flow and mitochondrial D-loop diversity of Blue Duiker in the tropical forest of Moukalaba, Gabon

AKOMO-OKOUE ETIENNE FRANCOIS
Institut de Recherche en Ecologie Tropicale, Libreville, Estuaire, Gabon

Blue duiker, *Philantomba monticola*, is a small forest ungulate widely distributed in African forests and heavily hunted. Although current hunting pressures on this species are estimated to remain within a sustainable level, the information on genetic diversity is scarce and is needed for conservation purposes. To investigate gene flow and genetic diversity of Blue Duikers in Moukalaba Forest, we analysed mitochondrial DNA control region sequences (~600 bp) using 129 fresh faeces collected in 13, 2-km line transects. We found 56 haplotypes and the haplotype diversity and nucleotide diversity were 0.984 and 0.059, respectively. The results suggest high level of genetic diversity of Blue Duiker in Moukalaba Forest as compared to the Udzungwa Mountains, Tanzania (haplotype diversity = 0.905; nucleotide diversity = 0.026). Haplotype diversity among transects ranged from 0.555 to 0.954 and the geographic distance was correlated with $F_{ST}/(1- F_{ST})$ (Mantel test, $r = 0.222$, $p = 0.0027$). However, when only considering population pairs separated by the mountain, $F_{ST}/(1- F_{ST})$ and geographic distance, these were not correlated (Mantel test, $r = 0.053$, $p > 0.1$). This result suggests that Mont Doudou, which runs north to south with a maximum altitude of 900 m in Moukalaba Doudou National Park, appears to limit gene flow among Blue Duiker populations.

Wednesday, July 31 | Hall
Poster Board: 1

Flood adaptations and sustainable use of trees in Amazonian floodplains

PIA PAROLIN[1], LEANDRO FERREIRA[2], JOCHEN SCHÖNGART[3]
[1]University of Nice, Côte d`Azur, Sophia Antipolis, France
[2]Museu Paraense Emílio Goeldi
[3]Instituto Nacional de Pesquisas da Amazônia INPA

Amazonian floodplain forests are subject to a monomodal flood pulse that exceeds 10 m. Seedlings and adult trees are partially or completely submerged for periods of up to seven months per year. Trees grow vigorously most of the year, including the aquatic phase. Predictable and regular flooding induced the evolution of adaptations at structural, physiological, and phenological levels. Species-specific distributions and zonations along the flood gradient and within Amazonian systems are responsible for a high diversity despite the strongly restrictive environmental conditions. This diversity results from the fact that stressors at this extreme location have only a low level of restriction on tree life, and the disturbances may even represent an increase factor for resistance and adaptive evolution. The complexity of the system and the short but regular presence of factors, which are favourable for tree growth allowed the evolution of highly diversified survival strategies. Despite the high specialization, most tree species have very high ecological amplitudes. The ecological specialization of the trees is low enough to be able to react flexibly to changes in environmental conditions and ensure survival, but high enough to allow a great diversity and to allow the presence of different species along water and edaphic gradients. Since reliable growth data for trees have been collected in the past decades, a Growth-Oriented Logging (GOL) could be developed which helps to determine harvesting volumes and cutting cycles. Minimum logging diameters (MLDs) and cutting cycles were determined which are based on the timber stocks and lifetime growth rates. This way, the overexploitation of slow-growing timber species can be limited and fast-growing trees can be exploited in the Central Amazonian várzea.

Wednesday, July 31 | Hall
Poster Board: 2

Species diversity and distribution of wolf spiders (Lycosidae: Araneae) in western and northern Mindanao, Philippines

OLGA NUNEZA
Mindanao State University-Iligan Institute of Technology, Iligan City, Philippines

Despite being one of the most abundant spider families in the world, wolf/lycosid spiders are poorly studied in the Philippines. The species diversity and distribution of over 181 specimens of 11 lycosid species from pre-selected areas of western and northern Mindanao were determined in this study. Species accumulation curves of the observed species richness and non-parametric species estimators did not reach an asymptotic value suggesting that the true species richness of the sampling areas is much higher than the estimated values. Seven species of the collected specimens, namely, *Wadicosa venatrix*, *Wadicosa* sp., *Wadicosa* cf. *venatrix*, *Venonia* cf. *coruscans*, *Pardosa pusiola*, and *Draposa* sp., are new Philippine records and one species (*Artoria* sp.) is a new Mindanao record. Distribution results showed that fewer species are found in forested areas and sampled specimens usually clumped in agroecosystems near water bodies. Generally, Shannon-Weiner values are very low (H'= 0.35 to 1.25) according to the modified Fernando Biodiversity Scaling System but showed higher values (H'= 1.10 to 1.25) in sites with field margins that are located near streams or forest patches. Results indicate that distribution of wolf spiders is more in agroecosystems, which tend to exhibit lower diversity values.

Wednesday, July 31 | Hall
Poster Board: 3

Human disturbance mediates native-exotic carnivore interactions: Exploring spatio-temporal patterns across a gradient of rainforest degradation

ERIN WAMPOLE, ZACH FARRIS, BRIAN GERBER
University of Rhode Island, West Kingston, Rhode Island, USA

The ability to identify high-risk locations for threatened species across a landscape is vital for developing and implementing effective management plans. Identifying these high-risk locations results, in part, from our understanding of spatial and temporal interactions among species. An understanding of these interactions is particularly important as human encroachment and native-exotic wildlife interactions increase globally. Exotic carnivores present a serious threat as they negatively influence and/or interact with native wildlife via exploitative competition, interference competition, intraguild predation, and/or transmission of pathogens. Studies investigating species interactions fail to include both a spatial and temporal component which is likely to lead to improper inference. We present a widely-applicable, novel approach to investigate interactions between species by combining spatial (single-species and two-species occupancy analyses) and temporal (kernel density estimation) analyses. We do so by deriving a spatio-temporal value (STV) that is a relative measure of potential interaction in both niche dimensions for rainforest carnivore pairs in Madagascar using a six-year data set. We demonstrate that six of the eight native-exotic relationships revealed increasing STV overlap with increasing anthropogenic disturbance. Furthermore, we visualized these spatio-temporal interactions along a fragmentation gradient and demonstrate that these interactions are not static. This novel modeling approach allows us to identify more accurately the precise locations where co-occurring species are interacting (measured in spatio-temporal overlap), including where threatened species are at most risk, thus greatly improving our ability to develop targeted, effective management plans to conserve threatened species worldwide.

Wednesday, July 31 | Hall
Poster Board: 4

Interactions and pathogen transmission between sympatric carnivores in Madagascar

FIDISOA RASAMBAINARIVO[1], PATRICIA PARKER[2]
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[2]University of Missouri Saint Louis

Introduced animal species are exerting significant pressure on native animals through different mechanisms, such as predation or competition. This increase in native-exotic animal interactions also presents potential for "pathogen pollution," the introduction of a pathogen into a new geographic area. We studied the patterns of interactions and assess the risks of disease transmission between introduced and endemic animals in the Betampona Natural Reserve (BNR) ecosystem, a lowland tropical forest of eastern Madagascar. Using camera traps, I described the spatio-temporal interactions between carnivore species, and monitored land-use sharing between domestic and endemic wildlife in this unique ecosystem. Secondly, I used serological analyses to estimate the prevalence and identify risk factors for exposure to selected pathogens in introduced animal species inhabiting adjacent villages, as well as endemic terrestrial mammals within the BNR. Identifying domestic animal pathogens that have spilled over to wildlife or others that may potentially threaten endangered populations in the wild is a critical step in order to conduct targeted surveillance and better monitoring of animal diseases in the area. Thirdly, using microbial genetics, I investigated the structure of the transmission network for environmentally transmitted microbial agents to identify species or individuals that may act as "super-spreaders". Identifying "key species or individuals" associated with the transmission of these pathogens will facilitate the allocation of limited resources to assess and limit the impact of these diseases on endangered and endemic species. Collectively, the results that are presented here may help the conservation efforts of the unique Malagasy carnivores by highlighting the need for disease monitoring and mitigation at the domestic animal and wildlife interface of Madagascar.

Wednesday, July 31 | Hall
Poster Board: 5

An analysis of White-handed Gibbons' (*Hylobates lar*) song duets

THOMAS TERLEPH[1], ULRICH REICHARD[2]
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The White-handed Gibbon (*Hylobates lar*) is an endangered ape that inhabits Asian tropical forests. Mated pairs produce complex song duets that are thought to function in territorial defense and may also strengthen or advertise the pair bond. Greater understanding of the function(s) of these behaviors inform questions regarding intergroup spacing, pair bonding, and other social behaviors, and are thus valuable for conservation efforts for this and other duetting gibbons, which include species that are amongst the world's most critically endangered primates. Recent evidence suggests that, during duets, individuals can rapidly adjust the onset of their singing relative to that of their mate. If duet quality facilitates the behavior's putative function(s), we predicted that individuals might also adjust song structure to compensate for occasions when their mate fails to produce a full duet contribution. Using field recordings from a population of wild gibbons at Khao Yai National Park Thailand (n=13 mated pairs), we analyzed male responses to a mate's singing during the turn-taking portion of duets, comparing normal duets to those in which the female failed to produce a complete call sequence. Our findings suggest that, although males are able to adjust the timing of their song to that of a mate, abnormal female calls do not result in significant short-term changes to male song structure. Future work will address whether individuals make longer-term adjustments to a mate's singing, and thus whether established pairs are able to produce better-coordinated duets.

Wednesday, July 31 | Hall
Poster Board: 6

Expanding minds, changing hearts, and improving lemur conservation in Manombo Forest, southeastern Madagascar

ROTSINOMENA ANDRIAMISEDERA, JONAH RATSIMBAZAFY
GERP, Antananarivo, Madagascar

Habitat loss resulting from traditional cultural practices such as slash-and-burn agriculture and logging is consistently among the primary threats to endemic lemur populations in Madagascar. To raise awareness on the importance of biodiversity conservation, environmental education is often promoted as a strategy to enact behavior change in young people to secure future wildlife populations. An educational program combining classroom instruction with practicums was implemented around Manombo Forest in southeastern Madagascar to teach students the significance of protecting lemurs. In seven primary schools on the edge of the protected area, 295 students received comic books with a culturally relevant message about respecting the forest and wild animals. In two high schools in the nearby regional capital Farafangana, 97 students underwent a sensitization focused on the effects of pollution on the health of both humans and wildlife. Following post-evaluations, high-scoring students participated in Green Classroom field trips to apply their knowledge in practical environmental settings: 14 primary school students toured the Ranomafana National Park and 80 high school students travelled to Manombo to directly witness conservation activities, including beekeeping and reforestation. For the completed activities, we had an initial status of 392 school children not knowing anything about lemurs and by the end, a post-evaluation revealed that 200 of them were competent in conservation topics and motivated to contribute to lemur conservation. After the Green Classroom visits, positive reception through surveys indicated that the majority of participants were eager to continue receiving conservation lessons and training in hands-on techniques that can help protect wildlife. This curriculum is now being designed and implemented, including outreach to new primary schools and leadership programs at the high schools.

Wednesday, July 31 | Hall
Poster Board: 7

Past temporal and dietary overlap among introduced and extinct endemic herbivores in SW Madagascar

SEAN HIXON[1], KRISTINA DOUGLASS[2], LUCIEN RAKOTOZAFY[3], BROOKE CROWLEY[4], DOUGLAS KENNETT[5]
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[2]Pennsylvania State University
[3]Institut de Civilisation, Musée d'Art et d'Archéologie
[4]University of Cincinnati
[5]University of California at Santa Barbara

Early human colonists of Madagascar encountered a diverse endemic fauna during the Holocene that included elephant birds, pygmy hippopotamuses, giant tortoises, and giant lemurs. All species >10 kg went extinct by ca. 1000-500 years ago. Direct human predation and anthropogenic landscape transformation help explain aspects of the extinction pattern. Competition between introduced bovids and endemic herbivores may have also played a role, but its contribution is unknown due to poorly constrained times of past species introductions and limited information regarding the diets of past introduced species. We present radiocarbon and stable carbon and nitrogen isotope ($\delta^{13}C$ and $\delta^{15}N$) data from the bone collagen of introduced cows (*Bos indicus/taurus*) and sheep/goats (*Ovis/Capra* spp.), as well as endemic hippos (*Hippopotamus lemerlei*) and tortoises (*Aldabrachelys* sp.) from subfossil and archaeological sites in southwestern Madagascar. The radiocarbon data confirm that introduced and endemic herbivores overlapped chronologically in this region between at least 800 and 1000 calendar years before present. Stable carbon and nitrogen isotope data suggest that sheep/goats, tortoises, and hippos had broadly similar diets and foraged in similar habitats. However, the $\delta^{13}C$ data also suggest that past cows and sheep/goats exploited a wider range of plant types than endemic herbivores. These data thus support the potential for past exclusion competition between introduced and endemic herbivores. Further research on introduced herbivore diet and other human activities (e.g. habitat fragmentation and the introduction of predators) is needed to further disentangle potential causes of population decline and eventual extinction of hippos and tortoises.

Wednesday, July 31 | Hall
Poster Board: 8

The conservation status of Madagascar's tree species

MIHAJAMALALA ANDOTIANA ANDRIAMANOHERA, SOLOFO RAKOTOARISOA, MAMY TIANA RAJAONAH
Royal Botanic Gardens Kew, Ivandry, Madagascar

Madagascar, the fourth largest island in the world, is renowned for its high biodiversity and high degree of endemism. With 4,220 tree species, 96% of which are found nowhere else in the world. The Malagasy forest provides people daily needs (energy, fuelwood, food, materials for construction, medicines) and during the last 60 years, 44% of natural forests have disappeared due to shifting agriculture (*tavy*), charcoal production, logging for timber, and bush fire -- which affect the survival of many tree species. However, many of these tree species are not recorded in IUCN Red List of threatened species. Therefore, Kew Madagascar Conservation Centre (KMCC) in collaboration with Botanic Gardens Conservation International (BGCI), IUCN SSC Madagascar Plant Specialist Group, IUCN SSC Global Tree Specialist Group, Missouri Botanical Garden Madagascar Program, University of Antananarivo, and IUCN Global Species Program are working on the conservation status of Madagascar's trees species. This three-year project aims to assess and bring about 2000 species into IUCN Red List of threatened species. The project goes through a few steps: first collecting information collecting, species distribution, ecology and habitat, population size, threats and conservation measure. Subsequently, collected information was treated on the IUCN Species Information Service toolkits to assess each species and a meeting with the Madagascar Plant Specialist Group was conducted to validate assessments to have appropriates species conservation statutes. For the first-year result, 724 species were fully assessed, with 65.7% falling within threatened status; more than 1000 species will be assessed this year. Most of these threatened species are not subject to conservation and protection measures and it will be important for stakeholders, policy makers, and the public to pick species that require the development of a long-term conservation and protection strategies.

Wednesday, July 31 | Hall
Poster Board: 9

Vegetation thresholds for the occurrence and dispersal of *Lepilemur petteri* in southwestern Madagascar

HERINDRAINY DAVIDSON HAJANANTENAINA[1], JEAN FREDDY RANAIVOARISOA, JACQUES RAKOTONDRANARY, RAKOTOMALALA YEDIDYA RATOVONAMANA[2], JÖRG GANZHORN[3]
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[2]Plant Ecology, Hamburg, Germany
[3]University of Hamburg, Hamburg, Germany

The genus *Lepilemur* is widely distributed in Madagascar, occurring in all major forest vegetation types, ranging from spiny bush to evergreen humid forests. The genus seems to reach its physiological and ecological limits at the dry end in the spiny forest of the southwest. This study aimed to investigate the vegetation thresholds that might limit the distribution of *L. petteri* in the spiny bush ecosystem of Tsimanampesotse National Park and surrounding areas. To accomplish this, vegetation transects and lemur inventories were established at 13 sites along the western border of Tsimanampesotse National Park. Tree densities were measured using Point-Centred Quadrats. Lemurs were inventoried with transect counts, camera traps, and by searching for latrines. *Lepilemur petteri* was found to be present at seven of the 13 sites. Tree densities were higher at sites with *L. petteri* than those without, with a density threshold of about 1500 trees/ha, below which the animals did not occur. Their presence was also strongly related to the density of tree species that form food sources. Tree diameter was of subordinate importance. The characteristics illustrating possible thresholds for the occurrence of *L. petteri* are pushed towards lower suitability through forest degradation and climatic change, thus reducing the area of occurrence for this species.

Wednesday, July 31 | Hall
Poster Board: 10

Community seed-banking in Madagascar, to safeguard the country's unique and highly threatened flora

VONONA RANDRIANASOLO, FABIEN RAHAINGOSON, SOLOFO RAKOTOARISOA, LINAH RABARIVOLA
Royal Botanic Gardens Kew, Ivandry, Madagascar

In terms of biodiversity, Madagascar is one of the richest countries in the world. Paradoxically, it is also one of the countries where the rate of pressure and threat to biodiversity is very high (200 000 ha/year loss of vegetation cover). To help save plant species, the Royal Botanic Gardens Kew (RBG Kew) has developed an unprecedented ex-situ conservation project to harvest and maintain at a seed bank in Wakehurst, England, with about 25% of plant species around the world, including that of Madagascar, by the end of 2020. Thus, to achieve this goal, a conservation project aimed at involving 100 communities in Madagascar funded by the People Postcode Lottery (PPL) in Britain for the Millennium Seeds Bank Partnership (MSBP) project, which has reviously existed, and which had already worked in close collaboration with the Silo National des Graines Forestières (SNGF) since 2000. This project will provide income for some of Madagascar's poorest communities and further encourage their participation in the conservation of the new protected areas system that covers 10% of Madagascar's land surface. The seed collections are split between the MSBP and SNGF for long-term storage, testing and for eventual re-distribution to support the re-introduction of species disappearing from the wild. Each community received training on seed collecting and pre-treatment techniques. Seeds are sent or delivered directly to RBG Kew's office in Antananarivo by each community member. Since the beginning of the project, 127 communities distributed within 25 districts and seven regions of Madagascar have been involved in the project and provided seeds. Approximately 3,900 seed collections represented by 130 families, 530 genera and 800 species have been collected so far.

Wednesday, July 31 | Hall
Poster Board: 11

Bryophyte diversity and range distributions along an elevational gradient in Marojejy, Madagascar

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[1]University of Cape Town, Cape Town, South Africa
[2]UMR PVBMT
[3]Bolus Herbarium

Madagascar, because of its geological history and the evolutionary novelty of its biota, is an ideal region in which to study pattern and process in species diversification and distribution. Describing spatial variation in species richness and understanding its links to ecological mechanisms are complementary approaches for explaining geographical patterns of richness. The study of elevational gradients holds enormous potential for understanding the factors underlying global diversity. This study investigates the pattern of species richness and range-size distribution of epiphytic bryophytes along an elevational gradient in Marojejy National Park, in northeastern Madagascar. The main objectives are: (1) to describe bryophyte species composition and endemism in Marojejy National Park; (2) to describe bryophyte species distribution patterns along an elevational gradient, and (3) to evaluate environmental variables as explanatory factors for the observed elevational patterns. Bryophyte samples were collected in November 2009, following a nested design with four hierarchical levels (i.e. four spatial scales): elevational belts (stations), plots, quadrats, and microplots (substrates). Sampling yielded, 254 epiphytic bryophytes species comprising 157 liverworts and 97 mosses. Species richness has a hump-shaped pattern along the elevational gradient, peaking at mid-elevation, 1250 m. Our results suggest that the null mid-domain-effect model was the most effective in predicting species richness, but environmental variables such as mean temperature, relative humidity, vapour deficit pressure, and canopy height also play important roles in shaping richness pattern. Species richness along Marojejy elevational gradient is dominated by small-ranged size species, which are possibly more sensitive to environmental changes than larger-ranged species. Their occurrence throughout the elevational transect suggests that conservation efforts should consider the entire gradient rather than just species-rich areas.

Wednesday, July 31 | Hall
Poster Board: 12

Redfronted lemurs respond to sympatric bird calls

FINARITRA RANDIMBIARISON[1], ACHILLE RASELIMANANA[2], PETER KAPPELER[3], RODIN RASOLOARISON[4], CLAUDIA FICHTEL[4]
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[3]University of Göttingen
[4]Deutsches Primatenzentrum

Primates use several, non-exclusive anti-predator strategies. The Redfronted Lemur, *Eulemur rufifrons*, is a species that uses both vigilance and interspecific eavesdropping. Although its ability to recognize predator calls and others lemur species alarm calls have been documented, recognizing other taxa's alarm calls has never been tested for this species. The aim of this study was to investigate the capability of this lemur species to recognize alarms calls of several bird species of the Kirindy/CNFEREF Forest during the wet season. Moreover, the influence of sex, spatial location, and environment on induced vigilance were also tested. Vocalizations of common predators of Redfronted Lemur and sympatric birds were played back to them. Vocalizations of sympatric bird responses were played back to 16 Redfronted Lemurs. Observations were made to identify the triggers of this species vigilance in natural conditions. It responded to aerial predator calls (*Polyboroïdes radiatus*: 7.68 ± 3.68 s; *Buteo brachypterus*: 9.02 ± 4.43 s) by looking up. The Redfronted Lemur also recognized the Crested Drongo's (*Dicrurus forficatus*: 8.90 ± 6.56 s) alarm call by looking into many directions in response to it. This reaction suggest that this alarm call is not interpreted as an aerial predator alarm call but instead denotes a general danger. Neither sex, spatial location or environment affected the induced vigilance of Redfronted Lemurs. Sympatric birds are the most common vigilance triggers for this species after their own conspecific. Even though the bird-lemur interaction is random, a common predatory pressure is sufficient for an interspecific call recognition.

Wednesday, July 31 | Hall
Poster Board: 13

Assessing the potential for and reversibility of abrupt shifts to macroalgae on coral reefs

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Tropical reefs increasingly undergo abrupt shifts where macroalgae replace corals as major members of the community. The conservation and management implications of such shifts are profound because biodiversity and a host of other ecosystem services are altered greatly. A particular concern is when diverse and productive coral reefs become trapped in the degraded, algae-dominated state. A large body of evidence has implicated changes in the ability of herbivores to control macroalgae as a primary trigger of coral-to-algae state shifts. However, under certain conditions, just a sudden shock to the system can cause a reef community to flip from coral to macroalgae without any change in herbivory. To date, resource managers and conservation biologists lack the tools to detect the approach of a coral reef to the tipping point to macroalgae, as well as the means to assess how readily such a shift might be reversed. Here we present a set of field experiments tested on the reefs of Moorea, French Polynesia, that can reveal for a given coral reef: (1) whether the relationship between variation in herbivory and macroalgae is highly non-linear; and if so, (2) how close ambient herbivory is to the tipping point to high cover of macroalgae; and (3) whether there is a range of herbivory over which either coral or macroalgae can persist as self-replacing communities. Finally, should a flip to macroalgae occur, our experimental approach can provide insight into how much herbivory might need to be restored to trigger a shift back to a coral state. As such, our experimental framework is a powerful conservation and management tool that can provide useful insight to better strengthen resilience of coral communities and maintain the ecosystem services of coral reefs.

Wednesday, July 31 | Hall
Poster Board: 14

Structure and population dynamics of a local population of Rousettus madagascariensis

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Under the influence of biotic and abiotic factors, all animal populations undergo temporal changes in size and structure. Studying and understanding these changes are important aspects for successful management and conservation of a given species. Here we evaluate the structure and population size of *Rousettus madagascariensis* and see how they fluctuate throughout the years. Mark-recapture data of 1,801 individuals captured during nine visits in both the dry (September 2014, September 2015, September 2016, November 2016, and August/September 2017) and wet seasons (January 2015, 2016, 2018, and April 2017) were used for the modelization with the Cormack-Jolly-Seber model in the program MARK. Adjustment and homogeneity $\chi 2$ tests were used to determine whether the sex ratio deviated from equilibrium (1:1) and if the age-sex structure of the population varied between seasons. Population size ranged from 1,102 (CI: 367–3,250) to 5,773 (CI: 3,142–10,437) and was significantly higher during the wet season as compared to the dry season but with a decreasing general trend. Also, the population structure showed a seasonal variation, significantly biased in favor of male during the dry season and in favor of female during the wet season. This species adopts a sexual segregation at different stages of the life cycle and is influenced by factors other than demographic. Thus, for a long-term management of the population, all of the different colonies in Madagascar deserve attention.

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Montagne des Français protected area (Madagascar): Inventory and conservation status of plants

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For its rich endemic flora and fauna, Madagascar is placed as one of the top hotspots worldwide for biodiversity conservation. However, the island is renowned not only for its high biodiversity and high degree of endemism, but also for ongoing loss of the original primary vegetation. This is the case of Montagne des Français (MDF) protected area which is located in the north, Antsiranana Province. It has an area of 6,049 ha, dominated by dry forest on limestone outcrop, and its subjected to continue human pressures such as charcoal production, selective logging, and slash-burn practical for agriculture which affect the natural resources. Within the CEPF (Critical Effort Partnership Fund) grant our studies aimed to survey, map the flora and vegetation of Montagne des Français and provide baseline data for improving the conservation management planning. Participatory intensive plant inventories were undertaken to develop community capacity for identifying and conserving priority taxa. Plant species were recorded in Brahms and iNaturalist associated with the Zavamaniry Gasy project by using smartphone and conservation assessment of the species following the IUCN Redlist. Prior to this inventory, only 250 species were identified, 23 categorized as Endangered and about 60 unidentified species. During our studies, 384 species were identified, 62 of which are categorized as Threatened. We have found 10 new species, one of them already published in 2018. A checklist and distribution maps for the threatened species will be produced to help the MDF manager in their conservation planning.

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High density of conspecific seedlings underneath parent trees can occur naturally in different forest formations when seed dispersers and predators are absent

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High density of conspecific seedlings underneath parent trees ("seedling carpet") can occur naturally in undisturbed forests, defaunated forests, or reforested systems when seed dispersers and predators are absent. Because most biotic agents (i.e., pathogens or herbivores) are host-specific, distance-responsive, or density-responsive, conspecific seedlings commonly have high mortality rates of up to 100%, while heterospecific seedlings have much lower mortalities. This process, captured in the Janzen-Connell model, has also been proposed to promote coexistence and maintain tropical plant diversity. If, however, seedling carpets persist over several years, could eventually resource competition lead to negative density-dependence and affect seedling and saplings performance? Here we conducted a seedling removal experiment to test this notion within a reforested, but defaunated area, in northern Thailand. In 2012, we randomly selected 10 adult *Castanopsis diversifolia* (Fagaceae) trees; underneath their canopy we also selected two elliptic quadrants and totaled all conspecific seedlings (<50 cm) and saplings (>50 cm). In 2014, we took a second census and afterward removed 75% of seedlings in one randomly selected quadrant of each tree. In 2015, we conducted a final census. The initial mean seedling and sapling densities were 26.3 and 0.6 per square meter, respectively. As expected, there was no significant difference between seedling and sapling densities in 2012 and 2014. The final 2015 census indicated that the removal of 75% of the seedlings, 3,100 in total, had no effect on either sapling density or growth comparing with the control quadrants underneath each tree. Seedling recruitment in the treatment was 239% higher than that in the control quadrants. We conclude that if biotic agents and negative density-dependence only play minor roles, which is a rare phenomenon, ecological competitive species may eventually dominate by outcompeting weaker species, resulting in lower plant diversity. Our findings may be useful for forest managements and conservation.

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Effects of anthropogenic disturbance on understory bird communities in the Malagasy dry forest

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Madagascar's forest cover is continually exposed to anthropogenic threats associated with socio-economic development of local communities bordering protected areas. To evaluate the consequences of anthropogenic activities in the understory avian communities of Malagasy dry forests, three protected areas with different types of human pressures were chosen for this study: Ankarafantsika, in the northwest, fire; Kirindy CNFEREF, in the central west, extraction of wood; Tsimanampesotse, in the southwest, cattle pasture. In each protected areas, mist nets and general observations were used to collect data on bird species at two sites: (a) with relatively undisturbed forest, considered as the reference site and (b) with significant anthropogenic degradation. Thirty-four bird species were identified from the three protected areas. On the basis of our results, at Ankarafantsika and Kirindy CNFEREF, anthropogenic degraded sites have higher specific diversity, as compared to the relatively intact sites, and the majority of species tolerant of disturbance were more abundant. This pattern might be related to higher insect abundance, specifically for insectivorous species. At Tsimanampesotse, a decrease in bird species diversity was found in degraded forest, which has sparse tree and understory vegetation associated with cattle grazing and local extirpation of sensitive species. Human activities within dry forest habitat affect in different manners the composition and diversity of understory bird communities. This work highlights the importance of conservation measures to preserve understory forest bird.

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Exploring the evolutionary history of Gabonese savannas using termites

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Understanding of the evolutionary history of the forest/savannah mosaic in the Congo Basin is poorly known. This study aimed to explore the evolutionary history of Gabonese savannas using termites as a focal group. The choice of termites for this study is based on their low mobility, which gives them the role of bioindicator of ecosystem changes. Termite sampling was carried out across Gabon in the central (Lopé), southern (Mouila and Tchibanga) and eastern regions (Batéké Plateau) of Gabon in order to identify different termite communities along a forest-savannas gradient. Termites were collected across three habitat types (mature forest, long-unburned savannah, and frequently burned savannah) using standardised transect methods with 21 sampling points across Gabon. Preliminary analysis revealed 21 genera of termites. The abundance and diversity of termites was highest in the Lopé forests and lowest the burned savannahs of Lopé. Termites composition differed between forest and savanna, with long-unburned savanna communities intermediate. Termites composition of Lopé savannas and the southern regions are also strikingly different. These findings suggest that the evolutionary history of the savannas of Lope is quite different to that of the southern savannas, and savanna termite communities in Lopé are not characteristic of ancient savannas.

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Seasonal variation of vertical distribution of arthropods in the central western dry forest of Kirindy CNFEREF, Madagascar

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Arthropods are the most diverse taxonomic group in the world's ecosystems and involved in several ecological processes associated with the functioning of tropical forests. The different forest strata harbor considerable arthropod diversity and aspects of vegetation and climatic variation play an important role in determining the vertical distribution of these organisms. The high level of seasonality in the dry forests of Kirindy (CNFEREF) offer an opportunity to analyze variation in the vertical distribution of arthropods and to examine their response to changing ecological conditions associated with climatic conditions. Furthermore, few data are available for Madagascar on the vertical distribution of arthropods. The study was conducted during the dry (August-September 2017) and wet seasons (January-February 2018) using Malaise traps for surveying arthropods in the understory, midstory, and canopy, and pitfall traps for litter arthropods. Different variables from the sampling period were compared to the arthropod data (temperature, relative humidity, and vegetation cover). Arthropod specimens were identified at the level of family and assigned to a trophic guild. During the dry season, ground litter contains numerous arthropods; however, abundance and richness were highest in the understory during the wet season. Regardless of season, the canopy had fewer individuals as compared to other strata. Climate and vegetation structure were highly correlated with arthropod family richness compared to abundance. In analyzing each guild, vegetation cover showed a significant effect on the vertical habitat of phytophages, which were restricted to the understory. Humidity and temperature affect saprophages, which were mainly found in litter during the dry season and in the understory during the wet season. Generally, the results indicate a strong relationship between arthropod stratum preferences with respect to variation in environmental conditions. Further study is still needed for understanding more widely the response of arthropods to the habitat and climate changes of the dry forest.

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Conservation and taxonomy based on leaves and barks of the most exploited species of woody *Diospyros* spp. (Ebenaceae) in Madagascar: Preliminary results

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This research is part of the work packages of the "*Dalbergia* and *Diospyros* Sustainable Wood Project (G3D)", a scientific support to the implementation of the CITES Action Plan in Madagascar. Since 2013, both *Dalbergia* and *Diospyros* have been listed in CITES Appendix II. For Madagascar, an international trade embargo has been established and will be maintained until sufficient progress is made. In order to lift this embargo, it is essential to expand scientific databases necessary for decision-making, such as the exact scientific names of extracted and exported wood species, especially those with a minimum exploitable diameter (DME). Until now identification of species is based on floral morphology, which is not applicable for illegally traded woods. Thus, the development of a reliable identification tool for the species, through extensive taxonomic analyzes of leaves and bark, supplemented by ecological data should really help to improve the systematic control of exportation, while ensuring conservation and sustainable management of precious woods. Up to now, *Diospyros haplostylis*, *D. toxicaria*, and *D. tropophylla* samples are undergoing analyzes to be identified through their leaf architecture and morphometry and external bark description. Leaf architecture and outer bark structure variability, which are different or similar between species in the same taxonomic group or represent diagnosable characters. An easy to use identification key based on leaf architecture and outer bark morphology will be developed as a reference tool for the identification of Malagasy ebony species.

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Pollen feeding and transport by *Rousettus madagascariensis* (Chiroptera: Pteropodidae) in northern Madagascar

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Old World fruit bats play an important role in ecosystem functioning by transferring pollen and pollination. Although pollen is known to be ingested in the diet of these animals, little information is available on this aspect for *Rousettus madagascariensis*, the smallest endemic Malagasy fruit bat. The objective of this study was to identify the flowers visited and pollen ingested by *R. madagascariensis* in the Réserve Spéciale d'Ankarana during different seasons. Individual bats were captured before dawn during the dry (September and November 2016) and wet (April 2017) seasons, as the bats were entering the cave day-roost. Pollen collected from the rostrum of individual bats, as well as analysis of fecal samples were used to determine the plant species visited and pollen consumed, and 15 plant species were identified, eight of which are exotic (designated with *). 13 plant taxa were identified from the swabs, with the most common being *Parkia madagascariensis* (26.5%) and **Eucalyptus* spp. (16.9%). 10 plant taxa were identified from the feces, seven of which were in common with the swab samples, and pollen of *P. madagascariensis* (39.0%) and **Ceiba pentandra* (17.1%) were the most common. Hence, *P. madagascariensis* is the most commonly ingested pollen. However, some plant pollen (e.g., **Aphloia theiformis*, *Dombeya* sp., *Hibiscus* sp., and **Trema orientalis*) were identified only from the swabs, whereas the pollen of two other species (*Poupartia* sp., and an unidentified Sapindaceae) was found only in the feces. These differences probably reflect different feeding activities during the night overlaid and the period pollen remains attached to the fur and gut retention time of ingested food. Presence of pollen on the fur and in the feces of these bats suggest they ensure pollination of some visited plants.

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Relationship between food availability, female reproductive rates, and offspring survival in Verreaux's Sifaka, Kirindy Forest, western Madagascar

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Variation in food availability represents a main ecological challenge faced by species living in seasonal climates, especially for female mammals because of the high energetic costs of reproduction. Verreaux's Sifaka, *Propithecus verreauxi*, a folivorous and group living lemur endemic to Madagascar, inhabit dry forests habitats characterized by extreme seasonal variation, resulting in annual fluctuations in food availability, which can be locally exacerbated by climate change and human activities. This primate reproduces slowly, and most females give birth to a single offspring per year. In this study, we assessed the relationship between food availability, female reproductive rates and offspring survival in a population of this species inhabiting Kirindy Forest in order to contribute life history information that may assist conservation effort to save this Critically Endangered species. To this end, we collected monthly data on food availability across three years (2016-2018) to assess phenological variation. Second, we recorded the number of adult females and mothers living in eight habituated study groups to evaluate female reproductive rates. Finally, we noted the number of infants born each year and still alive until 2018 in order to estimate infant survival. We found pronounced variation in the average availability of food across the three study years. Furthermore, female reproductive rates were around 60% in 2016 and decreased to around 50% in 2017 and 2018. However, infant survival rate did not show much inter-annual variation averaging around 85% across these three years. Thus, female reproductive rates are correlated with food availability whereas infant survival may depend more on maternal care and social behavior, which are only secondarily influenced by energy intake. Hence, variation in food availability affects female reproductive rate and indirectly infant survival, and it will become important to continuously monitor these relationships in period of ongoing climate change.

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Malagasy near-shore islands biodiversity: The current state of knowledge

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Recent ecology, biology, and conservation studies on Madagascar have focused on protected areas and remote areas and near shore islands have received less attention. A compilation and synthesis of dispersed available data is needed to build a database on the biodiversity of Malagasy near shore islands and to highlight their biological diversity and specific composition in order to identify the characteristics of each island. The main method included a bibliographic review of published and unpublished studies on plants, vertebrates, and invertebrates. For the systematic of certain groups, recent reviews of land vertebrates and ants have been used to standardize species nomenclature. The assembled database is relatively extensive and will soon be uploaded to the Island Conservation TIB database portal. Overall, the present study revealed the biological importance of each islet, including the presence of 135 plant species, 181 amphibians and reptile species, 30 terrestrial mammal species, 87 bird species, and 196 invertebrate species. While most taxa are widely distributed and also found on the main island, some are locally endemic. The database will hopefully serve as a reference tool for further research and for potential conservation and ecotourism programs in these islands.

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Carbon sequestration quantity and quality in species-rich tropical forests and species-poor plantations

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Recent estimates suggest increasing forest cover in the tropics, but this conceals a critical qualitative shift, with afforestation using monoculture or species-poor tree plantations offsetting deforestation of species-rich natural forests in many regions. The implications of replacing species-rich forests with species-poor plantations for terrestrial carbon sequestration, however, remain unclear. We assessed aboveground carbon stocks in species-rich tropical forests and species-poor forest plantations in India. Further, using remote sensing, we tested the prediction of biodiversity and ecosystem function theory of greater temporal stability of carbon sequestration in species-rich than species-poor forests. A plot-based assessment of above ground carbon stocks in native forests and mature (>50 y) Teak (*Tectona grandis*) and Eucalyptus plantations in the Anamalai Tiger Reserve of the Western Ghats Biodiversity Hotspot is presently underway (11/2018-04/2019). A 2000-18 time series of the remotely-sensed Enhanced Vegetation Index (EVI) is being used to compare temporal stability of annual gross primary production (GPP; atmospheric CO_2 fixed by photosynthesis) across forests and plantations. Preliminary results suggest that average carbon stocks in Teak and Eucalyptus plantations (165 and 110 Mg ha^{-1}, respectively) are lower than in evergreen forests (292 Mg ha^{-1}) but comparable to deciduous forests (133 Mg ha^{-1}). Annual (median) EVIs of plantations were up to 18% and 8% lower during abnormal (high or low) and normal rainfall years, respectively, and nearly twice as variable across the focal period, as native forests. Our findings suggest that while species-poor plantations could constitute a significant terrestrial carbon pool, they show greater inter-annual variation in GPP and could prove less reliable for carbon sequestration than species-rich tropical forests, particularly under more variable future rainfall regimes. These findings are relevant to climate change and ecological compensation policies in India and elsewhere that are facilitating the large-scale expansion of low diversity tree plantations.

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Distribution update, habitat use, and conservation status assessment of the Grey-bellied Comet (*Taphrolesbia griseiventris*)

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The Grey-bellied Comet is a hummingbird endemic to northern Peru, considered Endangered by IUCN, Critically Endangered by the Peruvian government, and “rare” throughout its distribution. The current Grey-bellied Comet’s distribution comprises two Endemic Bird Areas recognized by BirdLife International, and at least one Important Bird Area, highlighting the importance of habitat-based conservation. While the species has been historically recorded in three regions, that with the highest record density is severely threatened due to slash-and-burn agriculture and a recent proposal to build a dam. In the other two regions the records have been scarce and it is critical to determine whether these are stable populations or if they no longer exist. To address these questions, I used Maxent to propose an updated distribution map of the species based on recent records. The map was processed in Google Earth Pro and used to identify areas with potential habitat. The selected areas were explored to assess the presence of the species. Where the species was present, a behavioral and habitat characterization was done to identify important ecological requirements and potential threats. Preliminary results show that the species prefers shrubby vegetation in lower valleys with seasonal preference for *Delostoma integrofolium* flowers in one of the regions (Cajamarca). While it seems to tolerate some degree of disturbance, how this affect the species presence needs to be further examined. These results will be an important input to re-assess its Red List Category and address appropriate conservation strategies.

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Mutualism disruption by an invasive species: Measuring ant-elephant induced shifts in savanna tree cover

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In the Laikipia Highlands of central Kenya, the whistling-thorn tree, *Acacia drepanolobium*, accounts for >99% of all trees across vast swathes (>100 km^2) of land. This myrmecophyte (ant-plant) provides food and shelter for native *Crematogaster* ants in exchange for protection against elephants (*Loxodonta africana*). Across entire landscapes, this ant-plant mutualism stabilizes tree populations that would otherwise succumb to lethal browsing by elephants, thereby preventing the savanna from transforming into a treeless grassland. Recent invasion by a non-native ant, the big-headed ant (*Pheidole megacephala*), has disrupted the native ant–acacia mutualism. Since *P. megacephala* kill all native ants they encounter but do not provide protection against herbivory, the invasion renders trees vulnerable to browsing by elephants. This mutualism disruption may therefore lead to a reduction in cover by whistling-thorn trees. Our main goal was to identify differences in tree cover between areas invaded by *P. megacephala* and uninvaded controls. We carried out drone surveys to collect very high (<0.5 cm) resolution remotely sensed imagery and recorded individual tree locations with a GPS. Using supervised classifications in GIS software and validating with known tree locations, we isolated trees and measured differences in tree cover. Preliminary results show significantly lower tree cover was found in areas invaded by *P. megacephala*. Quantifying shifts in tree cover triggered by the ongoing invasion of big-headed ants will allow us to predict further changes in tree cover as the invasion progresses. This will be crucial for land managers in mitigating the negative consequences of mutualism disruption; whistling-thorn trees are both a critical food for several endangered large herbivores and a key driver of ecosystem function. More broadly, quantifying the consequences of mutualism disruption will enhance our mechanistic understanding of the current and future impacts of invasive species globally.

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Understory dynamics in a successional tropical dry forest: Insights from an integrated community- and individual-level approach

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A thorough understanding of forest succession requires knowledge on understory dynamics in recovering communities. The patterns and processes pertaining to recently-established plants largely determine a forest's future canopy structure. Despite this relevance, understory dynamics in successional tropical forests has been seldom examined. Our aim was to describe understory dynamics in secondary tropical dry forest stands both at the community level (dynamics of community state variables) and to analyze the behavior of individual growth rates along the successional gradient. The understory of 17 plots of different successional ages (0 – 72 yr) was monitored over 15 years in a tropical dry forest of southern Mexico. Mixed-effects models were used to examine the relationship between fallow age and understory structure, as well as individual growth rates in diameter and height. Basal area and density of the understory community decreased with fallow age, asymptotically approaching zero at advanced successional stages. In turn, the growth of typical mature forest species, both in diameter and height, did not respond to fallow age. Conversely, the performance of pioneer species decreased as succession proceeded. These results suggest that the forest understory dynamics stabilizes shortly after the abandonment of agricultural fields. The decreases in basal area and density of individuals are likely due to canopy effects, as canopy trees compete strongly with small individuals. Moreover, canopy structure modifies environmental conditions in the understory community, particularly light availability, thus reducing sapling growth rate. This pattern is particularly clear for pioneer species, while mature forest species are considerably less sensitive, likely due to a more efficient use of resources. This study revealed a continuous feedback loop between forest understory and canopy, which highlights the need for a deeper understanding of the dynamics of these two forest compartments in order to gain a holistic view of forest regeneration.

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Warmer temperature affects the capacity of fine-root production to recover after a hurricane event in a tropical rain forest of Puerto Rico

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Increasing temperatures can affect fine-root production and turnover through multiple direct and indirect effects on carbon, water, and nutrient cycling processes. Temperature-induced changes to fine roots have numerous implications for ecosystem and global function, yet, we have little information regarding fine-root responses to increased temperature in tropical forests. To address this critical knowledge gap, we evaluated fine-root responses to the first warming experiment in the tropics: TRACE (Tropical Responses to Altered Climate Experiment) in Puerto Rico. To measure fine-root production we installed two minirhizotron tubes in three 12 m^2 warming plots and three control plots. The warming treatment was initiated in September 2016 with infrared heaters above the forest understory, and, a year later, the treatments were unexpectedly suspended by two Hurricanes. We took images of fine roots along the tubes with a minirhizotron camera every two weeks from February 2017 until the hurricane events. These events created a unique opportunity to study fine-root recovery and to explore previous warming effect on fine-root recovery. Root observations were restarted three weeks after Maria. After seven months of the warming treatment prior the hurricanes, we found that fine-root production and mortality did not vary between treatments or among soil depths. Production After Hurricanes Irma and Maria, even though the heaters were off, differences in production between previously warmed and control plots were pronounced. Fine-root production was 1.9 times higher in the control plots compared to the warmed plots. Fine-root differences between warmed and control plots have persisted up to seven months after the hurricane. Our findings are the first of their kind, especially for the tropics, and show that warmer temperatures can affect fine-root recovery after an extreme disturbance event such a hurricane and highlight the potential for legacy effects of warming.

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Degradation of Amazon forests affects energy, water, and carbon cycles: Insights from an integrated remote-sensing and modeling analysis

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The impact of expanding agricultural frontiers in the tropics is not limited to deforestation. Degradation from selective logging, forest fires, forest fragmentation, and defaunation has a direct impact on structure and composition and may affect an area comparable to deforestation. However, few studies evaluate the effects of degradation on ecosystem functioning, such as changes in productivity and evapotranspiration, at regional scale. Here, we integrate field observations, high-resolution remote sensing, and the Ecosystem Demography Model (ED–2.2) to investigate the impact of forest degradation on ecosystem functioning in the Amazon. We developed an algorithm to retrieve demographic tree distribution from airborne lidar to provide initial conditions to ED–2.2. The algorithm was trained and successfully cross-validated with 817 forest inventory plots (0.25-ha) across precipitation and degradation gradients in the Amazon. We also evaluated the ED-2.2 model against eddy covariance towers and found that water and gross primary productivity are well represented by the model at most sites. Results from regional simulation in Eastern Amazonia indicated that the magnitude and seasonality of fluxes are modulated by degradation-driven changes in forest structure. Severely degraded forests experienced water-stress decline in evapotranspiration (20–35%) and higher daily mean ground temperatures (up to 5°C) than intact forests during the dry season and under moderate droughts. In contrast, comparisons during the wet season and extreme droughts showed less differences between degraded and intact forests. Preliminary analyses using ground temperature and evapotranspiration estimates obtained from the ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) also identified significant local differences between intact and degraded forest. Our results so far indicated that disturbance-mediated changes in forest structure are fundamental to understand tropical forest responses to drought and fire, especially during non-extreme events.

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Micromammal and lemur biodiversity assessments in vanilla agroforests in the SAVA Region, northeastern Madagascar

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Large parts of Madagascar's original forests have been modified for agriculture. Yet, the degree to which anthropogenically-altered ecosystems can sustain biodiversity is poorly known. In the SAVA Region of northeastern Madagascar, vanilla cultivation is transforming not only landscapes, but also the economics and social relations of the local communities. To understand the dynamics between micromammal and lemur biodiversity and vanilla-cultivated land, we conducted surveys in 10 villages in the SAVA Region. We selected three plots per village based on land use: One forest fragment, one forest-derived vanilla agroforest, and one fallow-derived vanilla agroforest. To assess micromammals, we set pitfall and standard live traps at each plot for two nights. To assess lemurs, we conducted one diurnal and two nocturnal transect walks per plot. Data were collected between September and December 2018. We captured four introduced micromammal species (*Rattus rattus, Mus musculus, Suncus murinus, S. etruscus*) and one endemic micromammal species (*Microgale brevicaudata*). Although *R. rattus* captures were higher in forest-derived than in fallow-derived vanilla agroforests (Wilcoxon, $p = 0.02$), no further differences, in species numbers or captures, were found across plots. Furthermore, we observed four nocturnal lemur species (*Cheirogaleus crossleyi, C.* cf. *medius, Microcebus mittermeieri, Avahi laniger*). Lemur sightings were significantly higher in forest-derived vanilla agroforests (Wilcoxon, $p = 0.03$), and in plots around northern villages (towards Vohemar, Wilcoxon, $p = 0.003$). Overall, our results indicate that species numbers and/or abundance do not significantly differ between vanilla agroforests vs. forest fragments, but they do between fallow-derived vs. forest-derived vanilla agroforests. Surprisingly, more "specialist" dwarf lemurs (*Cheirogaleus*) than "generalist" mouse lemurs (*Microcebus*) were consistently observed in surveyed plots. Our results show that vanilla-agroforests can sustain micromammal diversity, especially for introduced species, as well as lemur diversity, primarily small-bodied species. Furthermore, we report that land use history (fallow vs. forest-derived) has important implications for local biodiversity.

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Madagascar's carnivore problem: Understanding cultural and ecological carrying capacities for rare species

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Human-wildlife conflict is a pervasive global challenge that has serious implications for people's welfare and for protecting biodiversity. Unfortunately, this issue has lacked attention in many developing nations, such as Madagascar. Our research focuses on the Eupleridae, an endemic family of Malagasy carnivorans, which are in decline due to habitat loss and human hunting. Euplerids are primarily hunted in reaction to the widespread belief that they predate on nutritionally and economically important livestock, such as chickens. To better understand and mitigate the reality of livestock loss, we aim to quantify the conflict risk between carnivores and communities surrounding Andasibe-Mantadia National Park (AMNP). We will conduct interviews and install wildlife camera-traps across villages within the AMNP buffer zone. The interviews will address animal husbandry practices and issues participants face in raising livestock. When predation is identified as a threat, participants will identify the species through photographs of both native and non-native carnivores. Non-native carnivores, such as dogs, cats, and the invasive Indian civet, appear to pose a higher threat to livestock as native predators have low to no occurrence in degraded habitats outside of forested areas. To document actual depredation risk, we will use 40 camera traps to survey livestock coops 24 hours a day. Using historical and current field studies, we will jointly evaluate data in a hierarchical modeling framework to distinguish among predictor variables: prey availability, abundance and distribution of native and non-native carnivores, habitat structure, and livestock husbandry. Ultimately, by considering both ecological and societal factors, our study will lead to a better understanding of how animals and humans affect one another in a complicated feedback system. Our results will be communicated with both communities and conservationists in the hope of simultaneously protecting rare and threatened carnivores and increase the welfare of people.

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Effects of forest structure on nocturnal lemur occurrence and microhabitat preference in the dry forest of southern Menabe, Morondava, Madagascar

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Habitat loss caused by anthropogenic activities affects the distribution of primates. However, the response of primates to habitat alteration varies with species. Our survey, in the dry deciduous forest of southern Menabe, took place from 4 November to 18 December 2014. The study was carried out in two different sites: Ankoatsifaka (relatively intact forest) and Antsiridrano (secondary forest). Our study aimed to determine the influence of forest structure on microhabitats choices for nocturnal lemur species: *Lepilemur ruficaudatus*, *Microcebus murinus*, and *Phaner pallescens*. Transect walks allowed us to determine the abundance of each nocturnal lemur. In addition, we collected botanical data (tree characteristics: liana densities, tree diameter at breast height [DBH], crowns and heights of trees) to characterize their microhabitats. Only the abundance of *L. ruficaudatus* significantly differed between the relatively intact forest (0.7 ± 0.4 individuals/km) and secondary forest (1.8 ± 0.4 individuals/km). The high density of vegetation inside the relatively intact forest may reduce the visibility and the probability to observe the nocturnal lemur. *L. ruficaudatus* and *P. pallescens* selected similar microhabitats characterized by tall and large trees (DBH ≥ 10 cm) both in primary and secondary forest. In contrast, *M. murinus* preferred microhabitats characterized by small trees in relatively intact forest (DBH = 5 – 9.9 cm). But in the secondary forest, *M. murinus* used mainly all microhabitats available. Compared to *L. ruficaudatus* and *P. pallescens*, *M. murinus* may have higher tolerance to the alteration of their microhabitats. Therefore, conservation plan should take into account the differences in lemur ecological and behavioral plasticity in order to prior their protection and to attempt a long-term conservation.

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The invasive strawberry guava (*Psidium cattleianum*) reshapes rainforest community structure in Madagascar

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Strawberry guava, *Psidium cattleianum* Sabine (Myrtaceae), is an aggressive invader of tropical areas, and has been rapidly spreading throughout the eastern rainforests of Madagascar, a hotspot of plant and animal biodiversity and home to many unique endemic and endangered taxa. However, the consequences of *P. cattleianum* invasion on the native flora and fauna remain largely unknown. Here, we collected data at multiple sites throughout Madagascar's eastern rainforests to examine how *P. cattleianum* may alter the composition and structure of invaded forests. *Psidium cattleianum* invasion had significant impacts on tree/ shrub size. Further, *P. cattleianum* invasion had a negative effect on taxonomic richness and taxonomic diversity, suggesting that *P. cattleianum* may be spreading at the expense of native taxa. Additionally, *P. cattleianum* invasion was associated with an increase in frugivore species richness, likely due to the species' prolific fruiting. Increased understanding of the impacts of this species on the floral and faunal communities will help frame a better approach to invasive species management and conservation in Madagascar's tropical rainforests and beyond.

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Increased vulnerability to drought in logged Bornean forest

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Selective logging modifies forest structure and species composition, but the impacts of these changes on the post-logging dynamics of tropical forests are little understood. By yearly remeasurements of trees with stem diameter ≥ 1 cm, we have been monitoring tree growth, composition and diversity across logging gradient in the SAFE Project in Malaysian Borneo since 2011. The results show that increasing intensity of logging increases the magnitude of the compositional changes, raises the proportion of pioneer species and decreases the percentage of late-successional species such as dipterocarps. During the study period (2011–2018) despite significant genus turnover, the logged forest showed almost no recovery in terms of genus composition and diversity, and the relative abundance of dipterocarps remained low especially in heavily logged forests. Although the pioneer species grew initially faster than dipterocarps, thus causing faster regrowth of heavily logged plots, their growth rate dropped significantly during El Niño drought in 2015–2016 and was similar or lower than growth rates of dipterocarps since then (i.e., did not recover). This indicates that the compositional changes caused by logging make the forest more vulnerable to future drought events under climate change.

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Ecological drivers of spatial plant communities across different forest types, Southwest China

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It is widely accepted that deterministic and neutral dispersal processes are two of the principal mechanisms driving community assembly. However, the relative importance of these processes across distinct life stages and vegetation types remains poorly understood. This study aimed to test the role of the long-lasting competing hypotheses of deterministic and dispersal processes on tree assemblage across distinct vegetation types. We used different point process models to estimate the effect of stochastic, dispersal and/or environmental processes at different life stages of trees in tropical, subtropical and subalpine forests. We used species area relationship (SAR) at community level and pair correlation function at species level to estimate the relative importance of those ecological processes. We found that dispersal limitation was found to be the dominant SAR structuring ecological process for majority of the life history stages of trees in all forest types. Environmental heterogeneity was also found to shape the communities of the small life stages of trees in the tropical Xishuangbanna FDP. At the species level, dispersal process also primarily appeared to structure species conspecific aggregation in all forest types. In general, the ontogenetic shifts of trees did not reflect significant variation on the relative importance of assembling forces for the spatial placement of species. Using different summary statistics at both community and species levels helps to discern the different spatial structure of species and ultimately to generate the general patterns and processes responsible for community assembly

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Seasonal ecology of ectoparasites from two cave-roosting fruit bats (Pteropodidae) in Madagascar: Diversity, parasitism index, and influence of ecological factors

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The specificity of arthropod ectoparasites of bats to their hosts has been demonstrated across many different fields of research, including both conservation and epidemiology. Arthropod ectoparasites may affect the fitness and/or population dynamics of their hosts, in addition to the diversity of the pathogen agents with which they are infected. To date, ectoparasite research has been particularly limited for Old World fruit bats of the family Pteropodidae. Here, we studied ecology of the ectoparasites of two species of Madagascar cave roosting fruit bats, *Eidolon dupreanum* and *Rousettus madagascariensis*, to understand their relation with their host. Bats were captured monthly from 2013 to 2019 at roosting sites in the District of Moramanga; all visible ectoparasites were removed and classified and counted by species. Three parasitism indexes were calculated (prevalence, abundance, and parasitism rate) for each species of ectoparasite recovered from each species of bats. We used a generalized linear mixed model to evaluate the effects of season and several host-specific variables (species, body size, sex, age, etc.) on the diversity and abundance of ectoparasite infestation. In total, nine species of ectoparasite belonging to four groups (fly, flea, tick, mite) were identified. Two species of bat flies (Diptera, *Eucampsipoda madagascariensis* [Nycteribiidae], *Megasterbla wenzeli* [Streblidae]), one species of flea, one species of tick, and one species of mite were collected from *R. madagascariensis.* One species of bat fly (*Cyclopodia dubia* [Diptera: Nycteribidae]) and one species of flea (*Thaumapsylla* sp.), mite, and tick were collected from *E. dupreanum*. We observed fluctuations in the abundance of each ectoparasite across the season, with the highest parasitism rates recovered during the wet season, coincident with the fruit bat reproduction period. This study provides information on the ecology of the ectoparasites of cave-roosting fruits bats in Madagascar to further inform additional studies on the dynamic of bacterial pathogens.

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Listen to a changing landscape: On site vegetation structure determines acoustic diversity in the biodiversity hotspot of NE Madagascar

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Given that Madagascar has lost 44% of its forest cover in the last six decades, rapid biodiversity assessment and monitoring methods become increasingly important. By linking ecosystem health to its acoustic diversity, acoustic surveys have been proposed as a possible approach for estimating biodiversity, especially in tropical remote areas. Here, we study variations in acoustic diversity between different land-use types within the biodiversity hotspot of north-eastern Madagascar. Land-use change in Madagascar is mainly driven by small-scale agriculture, leading to a landscape mosaic of rice fields, agroforestry systems, and forest fragments with each land-use type being characterized by a very different vegetational structure. To test whether acoustic diversity represent observed diversity, we calculated the Acoustic Diversity Index for continuous audio recordings from the predominant land-use types of the region (rice paddy, herbaceous and woody fallows, vanilla plantations, forest fragments) and primary forest. In a second step, we used multiple linear regression analysis and study site parameters to investigate variables explaining differences in acoustic diversity between study sites. Changing variable importance could be tracked during daytime using multiple models. We found acoustic diversity to be highest in primary forest and forest fragments and lowest in rice paddies. Furthermore, we found no systematic difference in acoustic diversity for structurally similar land-use types. In contrast to previous studies, differences in acoustic diversity between land-use types were greater during afternoon hours than at dawn chorus. On site parameters like vegetation density and basal area showed a positive relationship with and were the most important predictors of acoustic diversity, highlighting the urgent need to maintain forested habitats in north-eastern Madagascar. However, for realizing the full potential of ecoacoustic surveys as a rapid biodiversity assessment method, more sensitive analysis approaches like machine learning will be needed for detecting the slight differences in acoustic diversity.

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Spatial distance and climate determine modularity in a cross-biomes plant–hummingbird interaction network in Brazil

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[15]Universidade Federal de Sergipe
[16]Universidade Federal de Minas Gerais
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Knowledge about how biotic interactions are distributed within and between communities is crucial for understanding both species interdependence and community dynamics. We examined the effects of space, climate, phylogeny, and species traits on module composition in a cross-biomes plant–hummingbird network in Brazil. We compiled 31 local binary plant–hummingbird networks, combining them into one cross-biomes metanetwork. We conducted a modularity analysis and tested the relationship between species' module membership with traits, geographical location, climatic conditions, and range sizes, employing random forest models. We fitted reduced models containing groups of related variables (climatic, spatial, phylogenetic, traits) and combinations of groups to partition the variance explained by these sets into unique and shared components. The Brazilian cross-biomes network was composed of 479 plant and 42 hummingbird species and showed significant modularity. The resulting six modules conformed well to vegetation domains. Only plant traits differed between modules, notably plants' growth form, corolla length, flower shape, and color. Widespread hummingbirds were the most connected, both within and between modules, whereas widespread plants were the most connected between modules. Among traits, only nectar concentration had a weak effect on among-module connectivity. Climate and spatial filters were the main determinants of module composition for hummingbirds and plants. This probably relates to resource seasonality, especially for hummingbirds. Historical dispersal-linked contingency or environmental variations not accounted for by the explanatory factors here evaluated, could also contribute to the spatial component. Phylogeny and morphological traits had no unique effects on the assignment of species to modules. Widespread species showed higher within- and/or among-module connectivity, indicating their key role in connecting biomes, and, in the case of hummingbirds, communities within biomes. Our results indicate that climate and space are the main determinants of modularity in the cross-biomes plant-hummingbird network in Brazil.

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Five new species of the genus *Pyrostria* (Rubiaceae, Vanguerieae) from Madagascar

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The genus *Pyrostria* of the tribe Vanguerieae (Rubiaceae) contains over 70 species, which are distributed in the paleotropical regions, especially in tropical Africa, Madagascar, and nearby archipelagos, as well as southeastern Asia. A broad circumscription of the genus has been proposed to include all *Canthium* from the western Indian Ocean. Madagascar is the center of the species diversity with at least 44 endemic species. This group of plants is monophyletic, and can be easily recognized by its axillary and umbel or solitary inflorescences each subtended by a pair of persistent bracts, completely envelops each young inflorescence, and its protandrous and involucral flowers. The Malagasy *Pyrostria* has not previously been revised and the specific diversity of the genus on the island remains poorly known. The main objectives of our study are to improve the taxonomic framework of *Pyrostria* of Madagascar and propose a new species key allowing the identification of all Malagasy species. This taxonomic revision is based on 960 herbarium specimens from the MO, P, S, TEF, TAN & UPS herbaria. Our study reveal that there are at least 30 undescribed species. This poster illustrates five (*P. ambrensis*, *P. coriacea*, *P. ambohitantelensis*, *P. longicorollata*, *P. betsomangensis*) of these new taxa. Their distribution and conservation status are also presented.

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Bat diversity in a gradient of forest loss and fragmentation

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Habitat loss and fragmentation have affected biodiversity worldwide. Neotropical bats represent a useful group to study such effects as they form taxonomically and ecologically different assemblages in response to environmental changes. Here we address how different dimensions of the bat diversity – taxonomic, functional, and phylogenetic – respond to a gradient of forest loss and fragmentation in a karstic region of the Brazilian Cerrado. In satellite images, we graded the entire region (18,000 km2) into 5,000 ha units and selected 17 units 5 to 150 km apart from each other representing a gradient from 0 to 100% of forest cover. We then mistnetted bats in the 17 sites during two dry (2015 and 2016) and two wet (2016 and 2017) seasons, and measured landscape variables – forest cover, number of forest fragments, forest border length, and distance to the Serra da Bodoquena National Park's pristine forest (77,000 ha) – in satellite images, in three buffers (300, 1000, and 2500 m radius) centred on the places of the bat surveys. The responses of the three studied dimensions of diversity to landscape metrics depended on the geographical scale considered. Taxonomic, functional, and phylogenetic diversities were not affected by the landscape variables at our small scale (300 m buffer zone), but they negatively responded to the distance to the national park. At our intermediate scale (1000 m buffer zone) the length of forest borders additively affected the three diversity dimensions negatively, and area of forest cover was the third explanatory variable at our large scale (2500 m buffer zone). The results indicate that forest loss and fragmentation reduce the studied dimensions of bat diversity, and that protection of large areas with continuous habitat, such as the Serra da Bodoquena National Park, is important to increase biodiversity of neighbouring modified landscapes.

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Ethno-ecology of New Guinea singing dog population in Puncak Jaya, Papua Province, Indonesia

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New Guinea Singing Dog (NGSD) (*Canis hallstromi* Troughton, 1957) is an erratic dog and considered a native species to the highlands of New Guinea, including the mountainous areas of Papua, Indonesia. Little is known about this dog in their natural habitat. This research was conducted to study interaction betwen humans and NGSD population. The survey focused on the population of NGSD in the Grasberg area, Puncak Jaya (4,000 m asl) to understand their persistence in the mountainous areas. Particularly we undertook semi-structured interviews with the tribal members living close to the NGSD's habitat and workers of a local mining company. We encountered a healthy population of NGSD in Grasberg area consisting of three distinct groups and a number of solitary individuals. They appeared to inhabit high-altitude, high-precipitation, and rugged terrain, because of sufficient food and no potential competitors in that area. Detection of several NGSD individuals around mining field offices indicates that part of its population have been habituated to the presence of humans within their home range. This might be due to the availability of food from the workers. Local people of Moni, Amungme, and Dani tribes living in the highland areas believe that the NGSD are their ancestors, therefore the dogs are appreciated in their communities accordingly. They also believe the NGSD protects the mountains and area tribes from those who have evil intentions. Interaction between the tribes, the NGSD's, and the environment demonstrate a remarkably prudent stewardship of the natural resources that should be studied, documented, shared, and preserved.

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Parasite load fluctuation in *Varecia variegata*

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Because parasite loads can impact primate demography, behavior, and even host evolution, it is critical to investigate. Combating parasite infection intensity additionally is one of the key conservation strategies recommended for critically endangered species, such as Black-and-white Ruffed Lemurs, *Varecia variegata*. Lemurs may be vulnerable to parasitic infection due to several factors, including their ecology, health condition, social organization, and behavior. Here, we assess the relationships between gastrointestinal parasite load and changes in group size, diet, and climatic seasonality (rain fall, temperature) across a community of seven subgroups (n=36 individuals) of *V. variegata*) at Mangevo, a primary rainforest site in Ranomafana National Park, Madagascar. We examine monthly fecal samples to assess the intensity of gastrointestinal helminth (*Callistoura* sp. and *Lemuricola* sp.) infection. We then use GLMMs investigate the relative influence of average monthly subgroup size, dietary variation (via Shannon Weiner diversity indices), average monthly rainfall, and maximum monthly temperature on individual monthly endoparasite load. We predict that parasitic load will increase with increasing group size and individual dietary diversity. We also expect parasite reproductive cycle and development, and thus host susceptibility, to fluctuate with climatic seasonality.

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Cultural ecosystem services and human well-being in Madagascar under climate change

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Anthropogenic climate change, together with other global change drivers are predicted to have an unprecedented impact on human well-being. Interdisciplinary knowledge on the interplay between environmental protection, nature conservation, and public health is urgently required in order to improve the current governance systems. In this study, we aim to unravel synergies and trade-offs between climate change impacts related to cultural ecosystem services and to 'ecological grief' in Madagascar, one of the poorest countries in the world, but hosting a significant proportion of the world's biodiversity. Specifically, we carry out a survey (1) to identify climate change main associated impacts across central and east Madagascar, and (2) to identify importance of cultural ecosystem services across different local communities and sub-groups and their relationship to human well-being. Our approach allows collating spatially informed data on cultural ecosystem services, human well-being, and climate change impacts. The expected outcome of the study includes an evidence-based information for local policy makers, conservation practitioners, and climate change agencies to improve government efforts towards a sustainable development.

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Lemur diversity in the Tsimembo Manambolomaty Protected Area, Melaky Region, Madagascar

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The Complex Tsimembo Manambolomaty Protected Area (PA) is located in the western part of Madagascar, Melaky Region. This PA is classified as "Ramsar site" in 1998. It has a large remain dry deciduous forest which hosts the rarest fauna and flora in the world. Despite of the conservation effort, habitat types are still under threats due to human activities. This situation may reduce lemur population size year by year. This study which was conducted in October 2015 aims to assess diversity, abundance and density of lemur species within the PA. We surveyed lemur species in the morning from 6 a.m to 9 a.m and in the evening from 8 p.m to 10 p.m in both intact and disturbed forest areas along five permanent transects of 2 km of length each. We encountered eight different species of lemurs. Three of them are diurnal species *Propithecus deckenii*, *Eulemur rufus*, and *Hapalemur griseus* and five nocturnal species *Cheirogaleus medius*, *Mirza coquereli*, *Phaner pallescens*, *Microcebus* sp. and *Lepilemur* sp. The PA has a high density of *Propithecus deckenii* (between 66 and 261 ind/km^2) and *Phaner pallescens* (between 153 and 1,384 ind/km^2). However, the lemur populations are always threatened by hunting using traditional traps and slingshot, and habitat destruction due to slash and burn agriculture practice. Face to this situation, the PA manager already created 13 environmental clubs for kids using lemurs as key species and organizes every year a festival of lemurs in local level. We suggest the ecotourism development is a way to conserve biodiversity such as lemur species and to improve the income of local people.

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Urgent needs for lemurs and other wildlife conservation with and by the local communities

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The GERP (Groupe d'Etude et de Recherche sur les Primates de Madagascar) and the expert guides from AGA (Association des Guides d'Andasibe) firmly believe that working with and sharing knowledge with the people of local communities presents the only chance to save lemurs and the forests. This is especially true in remote areas with weak government control. The objectives of this project were: (i) to promote training of local guides and ecotourism in the area, and (ii) to delimit the forest boundaries managed by the local community. The training and the forest delimitation were conducted by the AGA under the supervision of GERP since 2015. Four modules were taught by AGA during 10 days in each site, including: a series of modules 1) understanding tourism; 2) communicating with tourists; 3) techniques of guiding/concept of biodiversity/ecology and tourism without tracks; and 4) safety and security of tourists. Since 2015, 20,197 hectares of forest managed by the local community were delimited and converted to a new protected area. The local communities can now manage the forest by themselves. Furthermore, 200 local community guides from 10 sites around Madagascar received training from the expert guides from Andasibe. We plan to continue this for the next two years.

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Impact of charcoal production and inefficient stoves on forest conservation

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Charcoal production and the fuelwood harvesting are among of the main deforestation causes in Madagascar. In Itremo Massif Protected Area (IMPA), deforestation is more accelerated inside the fragmented humid forest and tapia vegetation. This study focused on the household fuelwood and charcoal making around IMPA to get information to improve the management of the protected area, insuring resources sustainable use for the community livelihood. Data was collecting by Kew Madagascar Conservation Centre using structured questionnaire to interview 100 households and 20 charcoal makers. Our findings reveal that these two local activities were different in plant species used, in work place, and in wood quantity. The households surveyed confirmed that tapia (*Uapaca bojeri*), the autochthone and endemic species, was the most combustible in cooking. However, the charcoal makers are familiarized with *Eucalyptus robusta*, the introduced and quick growth plant, that was the best for their clients mostly represented by urban people. In general, fuelwood harvesting happened in safety areas near the village, whereas, the charcoal making site was chosen in the forests a little further, to be able to work more quietly without any control. Concerning the local community fuelwood collecting, households are interested in dead twigs in general for their daily use. Trees cutting was practiced by the charcoal makers depending to the client's demand and it was almost outside the IMPA. So, fuelwood harvesting and charcoal making cannot be ignored as a major source of forest degradation in fragmented forest in IMPA. Thus, these activities need regular control and alternative replacement to ensure the sustainable management of the IMPA and the long-term conservation of its useful plants.

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Morphological study and distribution of the genus *Bazzania* Gray (Lepidoziaceae) in Madagascar using Xper software

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Madagascar is a hotspot of biodiversity with an endemism rate of 85%. The forest of Madagascar is among the highest priority areas in the world for biodiversity conservation because many forests are threatened or degraded. Taxonomic studies on the flora of Madagascar are mainly oriented on vascular plants rather than non-vascular plants such as bryophytes. Bryophytes (mosses, liverworts, and hornworts) are small chlorophyllous plants that do not have true roots. They maintain effective mechanism for regulating uptake and loss of water (poikilohydry). They have very important roles in the ecosystem as bio indicators of pollutants and environmental changes. Malagasy bryophytes are poorly studied; their studies are often associated with neighboring islands and sub-Saharan African region. This study focuses on the *Bazzania* Gray of Madagascar, liverworts belonging to the family Lepidoziaceae. The objectives are to create a data base and identification key for the genus using Xper software, to provide a checklist of *Bazzania* in Madagascar; to describe each species and map their distribution in Madagascar. The study is based on bibliographic reviews and consultations of herbarium specimens. Species distribution map are created using QGIS software. To date, this is one of the first bryological taxonomy to use the Xper software. In total, 51 morphological descriptors or characters were used to describe *Bazzania*'s species and to build the identification key. Our results reported fourteen species of *Bazzania* for Madagascar including three endemic *B. curvidens* Steph, B. *orbanii* Pócs, *B. konratiana* Gyarmati. Supporting the status of the island as biodiversity rich. *Bazzania* has a wide distribution in Madagascar. It is more abundant in the humid dense forests (for instance the Andasibe, Marojejy, Vohimana) more than 100 specimens were collected in those areas.

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Diversity and conservation action of Madagascar's Central Highland flora

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Demonstrating the role of biodiversity inventory on sustainable management is a priority research gap and of high interest according to practitioners and researchers. Even though the Central Domain of Madagascar covers 40% of the island's land surface, only 0.7% of this area has protected area status. Its vegetation types are dominated by grasslands with a few proportion of forests, tapia woodlands, swamps, and rock outcrops. Using the RBG Kew and the IUCN Red List databases, we assessed the diversity and conservation action of plants in the Central Highlands with: (1) occurrence of threatened plants species classified as Vulnerable, Endangered, and Critically Endangered; and (2) location of protected area. Despite limitations in these databases, the results highlight how protected area play a pivotal role in conservation of plants and how we can lead action plan for threatened species according to the inventory database while remaining aware of broad threats from human activities.

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Zero deforestation cocoa: GHG mitigation in the Ghana cocoa - forest landscape

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Worldwide demand for cocoa continues to outstrip supply. Ghana is the world's second largest cocoa producer, contributing about 20% of total production, and in 2018 it experienced a 60% increase in primary rainforest loss rate, the highest in the world. Smallholder cocoa agricultural expansion is a major driver of deforestation in Ghana, resulting in high greenhouse gas emissions rates and losses of biodiversity and ecosystem services. The Government of Ghana, chocolate companies, cocoa traders, and USAID and the broader development community recognize the challenge to increase cocoa productivity and livelihood benefits while reducing deforestation and GHG emissions. USAID piloted and is the process of scaling up a Sustainable Landscapes activity to achieve the dual goals of increased production and reduced deforestation and emissions in the Ghana cocoa - forest landscape. Specifically, we are testing the combination of three interventions in Asankrangwa Stool, Western Region: 1) land tenure documentation for customary "sharecropping" farmers who otherwise would not feel empowered to rehabilitate their unproductive cocoa farms; 2) a commercially viable farm rehabilitation model to increase cocoa productivity and shade tree cover from 0 to 40% shade; and 3) participatory land use planning to help farmers and communities appreciate the value of preserving remnant forests. From our 2017 pilot in Nyame Nae community, we found that only 25% of 306 farms had land tenure documentation, and that 86% of farmers with documentation felt that it provided them greater ability to manage their farm and rehabilitate their cocoa trees. We also determined that our three-year farm rehabilitation payback model was highly sensitive to market prices of cash crops. I will highlight successes and challenges from our ongoing project scale up and implications for ecologically, socially, and financially viable solutions for achieving increased cocoa productivity and reduced deforestation and GHG emissions in Ghana.

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Geotecnology in conservancy of a tropical metallophyte biodiversity endangered site: An open access WebGis for Iron Quadrangle in Brazil

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The Iron Quadrangle (IQ) is located in southeastern Brazil and is one of the largest mineral provinces of the world. The IQ is considered a metallophytes' endemic center, having 46 species of plants restricted to the substrate with high concentrations of iron, manganese and other metals. The iron formations constitute the main aquifers of the region providing environmental services such as springs and rivers that supply water to seven million people. Recently the IQ gained international notoriety due to the environmental disasters caused by dam breaks of dams from iron mining activities in the cities of Mariana and Brumadinho generating huge environmental liabilities. A webgis system named "Atlas do Geossistema Ferruginoso do Quadrilátero Ferrífero" was created in face of this complex scenario, in which public information and its dissemination foster decision-making processes for the rational use of natural resources. This system can be seen in: https://www.institutopristino.org.br/atlas/geossistemas-ferruginosos-do-brasil/quadrilatero-ferrifero/. The main purpose of the Atlas is to provide cartographic basis related to over 80 different social-environmental topics (eg.: rare plants, water catchments, priority areas for biodiversity conservation, protected areas) and land use (eg.: dams, mining titles, and contaminated areas). Geoprocessing tools were developed and/or incorporated to the webgis system, so the user can interact with the information provided and create analysis, such as buffer areas from a point of interest. Google Analytics tool was used to monitor the access to the website and indicated that there were 62.940 accesses between citizens (67%), public institutions (16%), private institutions (6%), non-profit organizations (2%), and others (9%). Based in these results we can infer that the Atlas contributes with the socialization of knowledge and the active participation of public and private institutions, third sector, as well as decision-makers and citizens in discussions about conservation and preservation, taking into account the rational use of environmental resources

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Environmental DNA (eDNA) metabarcoding: Invasive species of three large plateau lakes in Yunnan China

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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. 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(eDNA) and high-throughput barcode technology (metabarcoding), 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. The number of animal species that invaded China's Yunnan Province in March 2019 exceeded 52. However, this figure is seriously underestimated due to the limitations of traditional sampling research methods. This study used new techniques and methods to collect water samples from five major lakes in Yunnan. A total of 46 samples of water samples were collected. Among them, the invasive species of crayfish were used as examples, and 42 of them were tested for crayfish. DNA, consistent with the data collected by the specimens, is consistent with the status of crayfish invading the major water bodies in Yunnan. eDNA metabarcoding is a unique method still in development and will likely remain in flux for some time as technology advances and procedures become standardized. However, as metabarcoding is optimized and its use becomes more widespread, it is likely to become an essential tool for ecological monitoring and global conservation study.

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Camera trap and line count survey for birds in the the Yaoshan National Nature Reserve, Yunnan Province, China

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Understanding the distribution pattern and dynamics of wild animal is the key to effectively protect regional wild animals. The Yaoshan National Nature Reserve lies in northeast of Yunnan Province, China. The bird species richness and composition in the reserve was not clear for no systematic bird survey conducted. From December 2016 to November 2018, we conducted two bird surveys by line counts. At the same time, we deployed 45 infrared cameras in Yaoshan National Nature Reserve to continuously monitor understory birds. Among 23,310 camera-days, we recorded a total of 1045 independent photos and 101 video clips of birds. We recorded 109 bird species of eight orders and 24 families by line counts and infrared camera traps. These included six species of Class II state key protected wild birds. 42 species of 12 families (two new families) are new records for the nature reserve. Combined with additional records from the literature and specimens of Kunming Natural History Museum of Zoology, compiled a total of 206 bird species for the Yaoshan National Nature Reserve. Our research updated the bird species list as a baseline for future long-term monitoring in the Yaoshan National Nature Reserve. Our results also provide preliminary data for bird composition and spatial distributions in Yaoshan, which are important for the further research and protection.

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Participatory long term monitoring of the Radiated Tortoise (*Astrochelys radiata*) in the Tsimanampesotse National Park, Madagascar

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The radiated tortoise (*Astrochelys radiata*) is an emblematic species of southern Madagascar. The wild population of the species is faced to an unprecedented poaching for traffic and for meat consumption. Data on ecological monitoring permits to trace the poaching impacts on its population, and serves also as a tool for making conservation decision. Since 2012, a participatory monitoring of tortoise was established in Andranovao research camp, Tsimanampesotse National Park. Paraecologists from the local community were trained and ensure the data collection on five quadrants of 20.4 ha area. Quadrants were visited three days per months in January to April and three days after the rain. If a tortoise was met, the following parameters were noted: species, sex, weight and plastron long. The actual density of radiated tortoise density is estimated to 0.26 ind. ha^{-1}. A decrease of this density is observed every year. Compared to data in the area in 2007 with a density of 0.65 ind. ha^{-1}, more than the half of the radiated tortoise was lost in ten years. Poaching constitutes the major threats for the Radiated Tortoise in Tsimanampesotse National Parks. This poaching system is formed by a mafia network, and was intensified during recent years. In 2017 and 2018, the number of seized tortoise from traffic reached a record (more than 22 000 individuals). The measures taken in the fight against traffic should be further strengthened at all levels.

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New taxa of fungi described from Madagascar

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Fungi play a significant role in forest ecosystems. Their presence assures the survival of terrestrial trees. However, more than 90% of Malagasy fungi are undescribed and natural habitats are rapidly vanishing. We studied selected species of fungi from Madagascar based on morphological and molecular data in order to better understand the fungal biodiversity and the evolution of the species. As a result, two species, *Hygroaster madagascarensis* and *Gloeocantharellus andasibensis*, are recognized as new species to science. They are the first species of these genera found from tropical Africa. Both species are terrestrial and found in habitats dominated by e.g. *Uapaca* (Phyllanthaceae), *Sarcolena* (Sarcolenaceae), Lauraceae, *Rhus* (Anacardiaceae), *Prothorhus* and *Eugenia*, in Andasibe. The results of this study will increase measures of species richness of Malagasy fungi.

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The Golden Mantella frog: A species on the way to recovery?

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The Golden Mantella frog, *Mantella aurantiaca*, was listed as Critically Endangered on the IUCN Red List in 2004. In 2008, we searched for the species throughout its potential range and located a large population south of Moramanga town, in the Mangabe area, and within the Ambatovy mining area to the north of Moramanga. A first strategy was elaborated in 2011 for its conservation and led to the creation of Mangabe-Ranomena-Sahasarotra protected area in 2015. Between 2013 and 2018, we have been monitoring the Golden Mantella and its breeding ponds in this new protected area. To date, the number of potential breeding ponds located in Mangabe has increased from 19 in 2011 to 143 in 2018, 85 of which were used by the species during the 2018-19 breeding season. The number of Golden Mantellas encountered at each pond during the monitoring was 8 ± 15.7 on average. These figures suggest that the species is probably on the way to recovery. However, 36% of the ponds we located have been disturbed by human activities through gold mining, logging or conversion into agricultural fields. Efforts should be continued to protect the species and its habitats through reducing threats.

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Endemism in the Malagasy bryophyte flora

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Madagascar is one of the world's biodiversity hot spots due to its diverse, endemic, and highly threatened biota. Despite its biodiversity hotspot status and ideal characteristics as a model system for the study of pattern and process in species diversification, common patterns of microendemism across taxa, the diversity of entire lineages of Malagasy organisms has been completely overlooked, namely for bryophytes. In 1144 species and infraspecific taxa recorded (751 mosses, 390 liverworts, and 3 hornworts), 30% are endemic. However, information on these endemics is largely missing. Therefore, a critical re-assessment of the diversity of the Malagasy bryophyte flora is urgently needed. The main goal of this project is to produce, from a thorough review of the literature and herbaria, a document including all the relevant information on Malagasy endemic bryophytes. This document will basically help sorting endemic species into two categories: (i) species with recent descriptions and illustrations and (ii) species for which recent information is lacking. We employed all available references citing Malagasy bryophytes and verified whether species names are rejected, accepted or placed in synonymy. The outcome of this study is a synthesis of endemic Malagasy bryophytes. The level of endemism in the Malagasy bryophyte flora will be compared with other island bryophyte floras.

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Planning a presentation guide for the bryophytes of Madagascar

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Bryophytes (moss, liverwort, and hornwort) are early land plants (450 million years ago). They are small non-vascular plants with wide range distribution from temperate to tropical region surround us in the nature. Though bryophytes are the most important plant in term of species richness after angiosperms, they are the least documented of the rich Malagasy biodiversity. The objective of this present work is to write a booklet allowing the targeted general public namely amateurs in the biodiversity, national parks visitors, tourist guides to learn about bryophytes, and to approach representative species in term of their morphology. The study is based on bibliographic synthesis. When necessary, bryophyte identification is done, using compound and dissecting microscope in the lab. The small booklet contains (1) simplified explanations on the biology, ecology, particularities, uses, threats, and conservation of bryophytes and (2) a presentation of selected most common and endemic species of Madagascar for each group. Hence, this work consists of an initiation to bryology and will be used as a step towards bryophytes conservation. The consideration of these plants in the context of the protection of the flora is a fundamental element for the biodiversity conservation.

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Detecting bat viruses and their transmission routes in Ankarana Special Reserve

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Ankarana Special Reserve in northern Madagascar is home to three species of endemic Madagascar fruit bat - *Pteropus rufus, Eidolon dupreanum,* and *Rousettus madagascariensis*. Previous work suggests that these fruit bat populations host filoviruses, lyssaviruses, henipaviruses, and coronaviruses. In this study, we aim to extend surveillance of bat viruses to Ankarana Special Reserve in northern Madagascar, building off existing efforts in the District of Moramanga. For all three fruit bat species, we have proposed longitudinal capture, sampling, and serological assay to assess seasonal patterns in seroprevalence and viral burden. In addition to surveillance, we aim to understand transmission dynamics within each bat species. First, we will apply mechanistic age-seroprevalence models to quantify the force of infection for all virus types circulating each bat population. Next, we will focus specifically on coronaviruses, using viral sequences to infer transmission routes. Lastly, we will compare these transmission routes with social networks in each bat population, characterized by tracing contacts between individual bats with ultraviolet-fluorescent dust. The results from this study will advance our understanding of both the distribution and transmission dynamics of bat viruses in Madagascar.

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Integrated biodiversity and socioeconomic monitoring with participation of local community in southwestern Madagascar

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The unique biodiversity of southwestern Madagascar provides important goods and services that are essential for human well-being, but is facing risks of extinction related with human activities and effect of climate change. Biodiversity monitoring has been considered as important tool to better understand the present and future state of the biodiversity from environment changes. It could integrate social, economic and natural systems and be used as an early warning system. The study has been undertaken in and around the Bezà Mahafaly Special Reserve, in southwestern Madagascar. It consists of monitoring biodiversity (ecosystem and species levels) and socioeconomic indicators in order to develop appropriate strategies to mitigate, adapt, and respond to biodiversity threats and pressures. Land cover changes show fragmentation of vegetation cover, mainly outside the protected Reserve. Community livelihoods and food security, which are based on agriculture and forests products, are strongly influenced by climate variability and its ecological implications. Monitoring biodiversity and socioeconomic are used to serve as an early warning system, allowing action to be taken well before irreversible damage. The participation of local community in this monitoring, including patrol and surveillance with mutual trust between stakeholders is a unique model for long term conservation strategies. The extension of conservation efforts at a larger scale has shown to be necessary to insure sustainability of natural ecosystems to harmonize biodiversity conservation and human well-being.

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Flexibility of cathemeral behaviour in Brown Lemurs according to light and climate fluctuation

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Cathemerality, a behavioural pattern of being active for periods during both the day and night, can provide information about the evolution of the diurnal lifestyle. Cathemerality in primates has been interpreted as the flexibility to cope with the seasonal change and the associated event such as food scarcity and predators. To well understand cathemerality, we separately test the influence of abiotic factors. We use GLMM to determine the seasonality of diurnal and nocturnal activities and to predict the diurnal and nocturnal activities of the Brown Lemur (*Eulemur fulvus*) based on the effects of light, climate. We collected data at Ampijoroa, in Ankarafantsika, northwestern Madagascar, from July 2015 to March 2016. We followed brown lemurs 46 all-day and 33 all-night and conducted 948 h of behavioural observations evenly distributed during the dry and wet seasons. During the daytime, Brown Lemurs are less active in dry season. The frequency of nocturnal activity did not differ seasonally. The lemurs were more diurnally active during days with long daylength, whereas they were inactive during heavy rains and at high temperatures. At night, the lemurs were more active at bright moonlight and less active under heavy rains. These results suggest the sunrise and sunset as zeitgeber (time giver) that schedule the diurnal activity. Moonlight has a positive masking effect associated with increasing nocturnal activity in lemurs. Although brown lemurs restrict their activities during hot daytime periods to avoid overheating, they probably mitigate this constraint under higher humidity. As humidity increase with the rainfall, humidity is probably a proxy of water availability for rehydration. This flexibility of diurnal activity as an advantage for cathemeral lemurs and the water availability suggests an evolutionary factor leading to diurnalization in primates.

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Ecological permanent plot monitoring and the natural regeneration of low altitude rainforest of Betampona Natural Reserve

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The Betampona Natural Reserve is a primary low altitude rainforest. As other eastern rainforests in Madagascar, this forest is threatened by human activities, as well as by the impact of cyclones and invasive plant species. The site presents an exceptional high biodiversity. The purpose of this study is to provide information for the conservation and protection of this forest, especially with regards to its sustainable and efficient management. Nine permanent plots for control and monitoring have been installing, according to the topographic situation. All data collected were used to evaluate the regenerative capacity of forest and the distribution of species according to topography. In each plot, changes were observed in the composition and structure according to ecological factors and/or degree of disturbance. 220 species divided in 138 genera and 57 families and the presence of endemic families are confirmed at the site, as well as a high specific endemism (82%). At the hill crests, often affected by cyclones, the regeneration rate is 373%. The mid-level of slopes has 430% regeneration rate, constituting the climax vegetation, which is better sheltered from disturbance. The flora in valleys is well protected from cyclones. However, invasive plant species affect the regenerative capacity. Regeneration rate is 436%.

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Social tolerance of dominant female of *Propithecus diadema* during feeding in Tsinjoarivo Forest

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As Malagasy lemurs are threatened by human pressures that impact their food resources, it is essential to understand these pressures by first understanding their feeding behavior and its social context. Lemur groups have a complex inter-individual interaction. Furthermore, many lemurs, including the Diademed Sifaka, *Propithecus diadema*, are female-dominant. We quantified the nature of female social dominance during feeding in four groups of this Critically Endangered species found in two different sites of the future new protected area of Tsinjoarivo-Ambalaomby. During two months, we collected data on the dominant female in the FRAG4/FRAG5 groups in the fragmented forest at Mahatsinjo and the CONT4/CONT5 groups with eight, three, seven and eight individuals, respectively. We used instantaneous sampling to quantify activity budget and continuous focal animal sampling to record her feeding behavior and her reaction (aggression, moved toward, moved away, stop feeding) when another intra-group individual was in proximity within a distance of five meters. As results, 49.8% of feeding bouts with a neighbor inside 5 m was found, which represent a difference between the groups (p-value = 0.0003). 24.1% of instances the female responds aggressively to a movement towards her. Juveniles and sub-adults were the most frequent individuals who approach the female for all groups. A lower rate of aggression was found compared to others reaction considered during the focal feeding. Finally, some of the individuals in the group have shared patch more than expected, which can be related to patch size. So, tolerance behavior occurs in *P. diadema*. This can be a response for maintaining social group cohesion. This research permit to understand the optimal social behavior of these species in different forest type which can be considered in order to develop conservation effort.

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Seasonal comparison of home range use by Aye-aye in Kianjavato Classified Forest, Southeastern, Madagascar

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Aye-aye (*Daubentonia madagascariensis*) have adaptations for accessing structurally defended foods. Males in the disturbed forest of Kianjavato predominantly eat invertebrates and *Canarium* seeds and have overall home range sizes of 821–973 ha. However, diets and home ranges can differ based on sex and age. Additionally, the home range of primates can alter based on seasonal resource availability. We examined feeding and home range behaviors of a female and subadult male Aye-aye in Kianjavato Classified Forest. Our goals were to determine the dietary composition of these Aye-ayes and evaluate how home range size changed with seasonal fluctuations in resource availability. We used focal-animal sampling method to collect behavioral data and phenological sampling to estimate food availability. A Mann-Whitney Test showed a significant difference in frequency of food types consumed, with the female eating more *Canarium* seeds ($p = 0.030$) and the subadult male eating more larvae ($p < 0.001$). Additionally, the female Aye-aye had a bigger home range during the wet season (50.0 ha), when *Canarium* seeds were plentiful, than during the dry season (43.8 ha), when *Canarium* seeds were scarce. Our preliminary conclusions are that Aye-ayes have intersexual differences in diet and that female home ranges may be influenced by seasonal resource availability.

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Mammalian presence to large mammals on roadways bordering Tarangire National Park

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Mammalian use of roadways and the effect of such use varies by species and human presence. The purpose of this project is to determine if, and which mammal species make use of the infrequently trafficked roadways on the eastern border of Tarangire National Park. This project aims to identify trends in the parameters of road use by various mammal species through the use of camera traps and a review of the contemporary research and literature to explore the possible effects of roadways on mammal species in areas with a low human population density. The objective of this study is to determine the frequency of large mammal species observations on roadways along Tarangire's eastern border and the possible impacts of road use on mammal behavior and dynamics. Methods of this study include determining mammalian presence by examining the results from five camera trap stations placed along roadways bordering Tarangire National Park. Data will be collected from November of 2018 until March of 2019 after which, data will be analyzed to determine frequency of species observations, time of use, and other trends in the parameters of mammalian use of roadways. In addition, a review of literature will be conducted to frame the results from data analysis in the broader body of knowledge around mammalian use of linear features. Literature will be selected based on its relevance to the consequences and effects of road use by mammal species. This review will explore possible impacts to wildlife and conclude with recommendations for further research in the field. Hypothesis for this study are that 1) carnivorous mammal species will be observed on roadways more frequently than off and 2) roadway use results in anthropogenic changes to the organic movement of species, even in areas infrequently used by people.

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Tree diversity and stand structure in the vanilla production landscape of northeastern Madagascar

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The forests of Madagascar harbour a remarkably high biodiversity. Especially trees and shrubs impress with more than 4000 native species, among which 96% are endemic. In the humid northeast, forests are undergoing rapid change as the agricultural production of subsistence crops and the cash crop vanilla transform the landscape into a manifold mosaic of forests, smallholder agriculture, and vanilla agroforests. The rapid forest loss and potential loss of ecologically and economically important tree species is a major conservation issue. Yet it remains unclear to which extend this landscape still harbours native tree species diversity and complex stands. Therefore, we conducted tree inventories and analysed stand structures on 60 plots in primary forests, vanilla agroforests, forest fragments, and woody fallow sites after slash and burn agriculture. Overall, we identified >180 tree species (dbh ≥ 8 cm) of which >70% are endemic. We found that tree species richness, endemism rate, and structural complexity were highest in primary forest and surpassed forest fragments and all other human-dominated sites. On average, vanilla agroforests exceeded woody fallows but fell short of forest fragments. Among vanilla agroforests, we found a large variability, which depends on land use history. Fallow-derived vanilla agroforests (originating from slash and burn agriculture) had a low tree species richness, a high share of non-native species and a low stand complexity, whereas forest-derived vanilla agroforests were more complex and comprised more species, including many endemics. Thus, our findings further emphasize the high conservation importance of the northeastern primary forests. However, vanilla agroforests revealed a considerable range of opportunities, pointing to land use options that may contribute to maintain native and endemic biodiversity.

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Local perception of the importance of *Jacaranda mimosifolia* D. Don. by the population living in Antananarivo

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Jacaranda mimosifolia D. Don comes from South America and was introduced to Madagascar during the XVIIth century as an ornamental plant in some urban areas like Antananarivo. The aim of this study is to know the legacy values of this species regarding its occurrence through time. Ethnobotanical surveys were carried out in different communities around the town of Antananarivo in order to establish its uses, history, and mainly its representation through the perception of local people. Interviewed individuals included the general public, local authorities, and artists. People use *J. mimosifolia* as a medicinal plant by smoking the leaves to heal sinusitis. In addition, its wood is exploited for carpentry. During the anthesis of this plant, many places in the town are ornamented by its beautiful flowers. The flowering period in October represents the beginning of the summer season. *Jacaranda mimosifolia* is among the signs of the colonial period, as around Lake Anosy, as well as one of the patrimonial plants in Antananarivo, which also include two species of native figs: *Ficus lutea* and *F. polita.* Unfortunately, some sites where *J. mimosifolia* occur are polluted and not well maintained by the state, which is in charge of plant protection. For the long-term survival of this species in urban areas, old individuals should be replaced and multiplication trials in specific places such as in gardens or along the avenues might be interesting.

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Diversity and conservation status of the plants of Bongolava (Madagascar)

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The Bongolava Forest Corridor (Sofia Region), an area of 110 000 ha, is a complex of deciduous forests, on laterite, unconsolidated red sand, and white sand. This biodiverse area is strongly threatened by pressures such as charcoal production, fire, and illegal forest logging. Before our work in Bongolava, only 500 plant species had been recorded and the CEPF Madagascar Profile 2014 only listed four threatened plant species. Within a CEPF grant project our studies aimed to survey and map the flora and vegetation of Bongolava and provide baseline data for improving the conservation management planning. Participatory intensive plant inventories were undertaken to develop community capacity for identifying and conserving priority taxa. Plant species were identified, databased in Brahms and on iNaturalist/Zavamaniry Gasy/Bongolava KBA projects (https://www.inaturalist.org/projects/bongolavakba) using smartphones. So far, more than 600 plant species have been recorded from the Bongolava, 39 IUCN Red List assessments prepared using the GeoCAT tool (http://geocat.kew.org) and 677 plant observations have been uploaded to iNaturalist/Zavamaniry Gasy/Bongolava projects. A checklist and distribution maps for the threatened species will be produced to help the managers of Bongolava develop conservation planning to mitigate or prevent the extinction of its species.

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Impacts of fragmentation on frugivory and seed predation of four rainforest tree species in the southern Western Ghats, India

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The seed dispersal cycle is a crucial ecosystem process aiding in the persistence and colonization of trees. Forest fragmentation has been shown to disrupt seed dispersal and seed predation, which are the two crucial stages in the cycle. This study examined the effects of fragmentation (proportion of forest cover in a 500 m radius around the focal tree) on frugivory and seed predation, for four rainforest tree species, *Persea macrantha*, *Heynea trijuga*, *Myristica dactyloides*, and *Canarium strictum*, with varying seed sizes. Effective frugivores were identified using the seed dispersal effectiveness framework and their response to the predictors was examined. The study was carried out in southern India in a site comprising primarily of tea and coffee plantations with pockets of forest fragments. For frugivory, 131 individual trees (≥ 30 per species) were observed for 623 hours. For seed predation, seed fate of ≥440 seeds per species was tracked using seed plots placed under at least 11 individual trees per species. The frugivore assemblage varied across the four tree species and frugivores varied in their response to forest cover and fruit crop size. Medium-seeded *P. macrantha* had lower visitations whereas the large-seeded *M. dactyloides* had higher visitations on trees with low surrounding forest cover. *H. trijuga* and *C. strictum* had low visitations but they were primarily dispersed by wide-ranging species which are less likely to be affected by forest cover loss in this landscape. Seed predation by vertebrates was not influenced by forest cover but by seed traits. Medium-seeded tree species and tree species with softer seed coat were more likely to be predated. This study highlights the variation in frugivory and seed predation to fragmentation and points towards the differential role of factors like forest cover, plant and frugivore traits, and the matrix in influencing frugivory and seed predation.

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How sensitive to light and CO2 are the tree saplings in Amazon Forest understory? An in situ open-top chamber experiment

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Tropical forest understory plants receive a small fraction of the light incident at above canopy, most of the time less than 2% of solar radiation. Therefore, they have developed strategies to increase light use efficiency in a diffuse radiation regime and also photosynthetic performance plasticity during events of brief direct radiation sunflecks. Despite the acclimation to the closed-canopy environment, photosynthesis of understory plants is highly limited by light. The CO_2 concentration near forest ground is often elevated in natural forest environments, however understory shaded plants show a response to CO_2 fertilization. Here we quantify the relative magnitude of response to light and CO_2 from gas exchange measurements of tree saplings in two pilot open-top chambers (ambient [CO_2] and ambient [CO_2] + 200 ppm) installed in an old-growth Amazon Forest. We hypothesize that understory saplings will be more responsive to light availability (i.e. higher magnitude of relative increase of assimilation rates and apparent quantum use efficiency - α) to a higher degree than to internal CO_2 concentration in stomata (i.e. magnitude and photosynthetic biochemical yield - θ), and the extent of responsiveness will differ between control and treatment chambers. On average, the magnitude of response of photosynthesis rates to light was +276% and to CO_2 was +53%. Other results indicate no statistical differences in α and θ between chambers, both given by the normalized index $(A_{high} - A_{low})/\Delta PAR$ or ΔC_i, respectively. In this understory environment, the sensitivity of plants to light was five-fold higher than CO2, agreeing with our hypothesis, while four months of elevated CO_2 concentration were not sufficient to modify the responsiveness of plants to both abiotic factors. Thus, two potential outcomes can be expected: changes in sensitivity may be observed with the continuity of the experiment (very preliminary results) or won't be observed unless light scarcity is overcome.

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West Nile Virus seroprevalence and risk factor in wild birds in Madagascar

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West Nile Virus (WNV), an important emerging zoonotic virus, is a major public health concern worldwide. Wild birds serve as the natural reservoir for WNV, but not all bird species play the same role in the life cycle of the virus. This virus is prevalent in many parts of the world, including the tropical island of Madagascar. However, only two studies report the circulation of WNV in wild birds in Madagascar. In this study, we aim to evaluate seroprevalence of WNV in wild birds in Central Highlands of Madagascar and identify which factors drive WNV exposure. We addressed this by analyzing blood samples from 352 wild birds of 40 different species, using standard protocols of testing WNV seroprevalence. We also performed logistic regression models to identify the geographical, ecological, and biological variable(s) most associated with the serologic status of birds. The results of our analyses indicate that 12.5% of the tested birds were seropositive. These individuals belong to 19 different species, seven of which inhabit forest habitats, six inhabit wetlands, and six open areas. Three of these species inhabiting wetlands are classified as threatened. We also found that taxonomic order of birds, their distribution area, region, and proximity to the wetlands were significantly associated to WNV exposure. In addition, interaction between region and proximity to the wetlands had the same pattern. Further work is required to investigate the clinical impact of WNV infection in these bird species. Identifying which wild bird species are more susceptible to WNV infection could allow the establishment of WNV monitoring program in wild birds in Madagascar, as has been done in other countries, both to address conservation issues and to use as an early warning tool. This could also have some important implications for the management of threatened bird populations.

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Mantella cowanii: Conservation effort in Madagascar

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Madagascar represents the one of the amphibian hotspots in the world, with currently around 300 described species. Malagasy frog species have a 99% endemism rate, 85 species are classified as Threatened with Extinction and nine as critically endangered. No extinctions of frogs have been reported from the island, but conservation plan activities are necessary for numerous reasons, including the presence of chytridiomycosis, a global threat for amphibians, which was recently detected in Madagascar. Here, we would like to present the conservation effort for one species of the Central Highlands, *Mantella cowanii*, which has very limited distribution and almost of the sites are outside of the protected area system. In 2007, national and international herpetologists decided with stakeholders to establish the first Action Plan for *Mantella cowanii*. At that time, the plan was to conduct activities at different sites, but in the end, almost of the activities were at Fohisokina near Antoetra. For a better protection of this site, activities were shared with the local community and by 2013, positive results were observed. In December 2018, a large workshop was held in Ambositra to create the second Action Plan for *Mantella cowanii*. This second strategy will be focused on creation of new protected areas and enhance the conservation efforts of this species.

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Study of the effect of *Ficus sakalavarum* on obesity: Valorization of species and research an antihyperlipidemic phyto-drug

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Ethno-pharmacological investigations in Mahajanga City revealed that the bark of *Ficus sakalavarum* is used to treat diabetes and obesity. A large number of Malagasy people use it for their facial mask. In this study, we focused on the effect of this plant on obesity because it causes other pathologies such as hypertension and diabetes, which affect large numbers of the world population. Our objectives are to valorize this plant for this therapeutic virtue and take into account to keep its sustainability in its natural ecosystem. To carry out this study, we checked the effect of this plant (at doses 500 and 1000 mg/kg) on the feeding behavior of the mice: to reduce the amount of food ingested and to increase gastric emptying. Decreased body fat mass with *F. sakalavarum* extract to reduce weight. From the results, the control mice ingest 2.96 ± 0.15 g of food. In contrast, the crude extract of *F. sakalavarum* significantly decreases the cumulative amount of food ingested as a function of dose. The mice treated with the dose 500 mg/kg ingested only 2.09 ± 0.26 g ($p = 0.0068$) and 1.6 ± 0.34 g ($p = 0.0023$) for the dose 1000 mg/kg. For gastric emptying, only mice treated with 1000 mg/kg of *F. sakalavarum* significantly affected gastric emptying compared to control mice receiving only distilled water (94.75% ± 2.21 vs 63.21% ± 0.94 at $p = 0.0029$). Regarding the fat mass, mice treated with *F. sakalavarum* at doses 500 and 100 mg/kg, their total weight of adipose tissue is significantly lower than that of the control (1.14 ± 0.089 g and 0.77 ± 0.049 g vs 1.68 ± 0.11 g). Finally, as we have a promising result, this study would make it possible to better understand the use of *F. sakalavarum* for its treatment and would, therefore, be part of the prospects for recovery and conservation of a species.

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Sifaka (*Propithecus verreauxi*) population density estimation across areas of differing human use intensity at Bezà Mahafaly Special Reserve, southwest Madagascar

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Population density is among the most important criteria to determine the conservation status of a species. While Verreaux's Sifakas, *Propithecus verreauxi*, have been intensively studied within a small (80 ha) core protected area (Parcel 1) at the Bezà Mahafaly Special Reserve, southwest Madagascar, the population density in the surrounding forest (including a second core parcel, a newly protected area, and a sustainable use zone, is poorly known. We sought to determine the population density of sifakas in each of these zones and whether the densities are affected by intensity of human use. Our team surveyed 15 (500 m line) transects across the dry forest in the four management zones (Parcel 1, Parcel 2, the new core, and the sustainable use zone) bi-monthly from July 2016 to June 2018. We recorded the GPS location of all sifaka groups seen or heard along the transects and demographic information for each individual. We also recorded freshly cut trees along the transects, which we used as a proxy for intensity of human use. Sifaka density was highest in Parcel 1 where human activity is lowest. However, Parcel 2, which has the same protection status as Parcel 1 on paper, had comparatively higher human use and lower sifaka density. We found human use to be most intense in the new core area, but this zone surprisingly also had very high sifaka density. The sustainable use zone had the lowest sifaka density and relatively low human use. These results suggest that sifaka density is not necessarily correlated with human use—sifaka density is high in both areas subject to minimal and frequent human use at Bezà. This study provides critical density and abundance information for an endangered species and suggests that sifaka conservation can succeed in multiple-use landscapes.

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Realization of the Xper base of Polytrichaceae family of Madagascar

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Madagascar is a hot-spot of biodiversity with very high level of endemism. The bryophytes with regards to species richness of Madagascar flora are only second after angiosperms. They play a very important role in ecosystem functioning. The bryophytes of Madagascar are little studied by the local scientific community and with few trained specialists. A study was conducted to facilitate species identification, focusing on the Polytrichaceae, which is among large-sized terrestrial mosses. Madagascar's Polytrichaceae is composed of four genera and seven species. The objective was to create an information database of Malagasy species of this family using the Xper2 software, using descriptive morphological and anatomical characters. This study was based on herbarium specimens and published details. The resulting database contains 48 descriptors and seven items with illustrations, which will be useful identification and taxonomic revisions of Malagasy species of Polytrichaceae.

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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 under dominance-based gene drive system in the southern house mosquito to potentially transform and control wild mosquito populations with the goal of mitigating the decline of native Hawaiian birds. An under dominance gene drive has safety measures in that the transformed population is geographically stable and the transgene can be removed from the population if desired. Such a system has already been established in *Drosophila melanogaster* and was shown to remain stable for over 200 generations. In the current study, we perform the first steps to adapt this under dominance gene drive system for use in mosquitoes for the first time, by integrating a synthetic genetic construct containing a "self-docking site" in a lab colony of southern house mosquitoes. As a component of our overall gene drive system, this self-docking site is intended to allow subsequent constructs (e.g., disease refractory genes) to be site-specifically integrated in the mosquito genome. We have successfully used microinjection techniques to integrate our synthetic construct into the mosquitoes. Integration of the self-docking site gene was confirmed via PCR and sequencing data. We are now in the process of assessing efficacy of the self-docking site in the southern house mosquito. Possible future integration and expression of the under dominance gene drive in the southern house mosquito would open up possibilities to control wild mosquito populations, whether for animal or human diseases.

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POSTER SESSION 2

Role of vertebrate seed dispersal in gap regeneration in the southeastern rainforest of Madagascar

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Gaps are thought to be a fundamental process driving forest dynamics and maintaining diversity by enhancing heterogeneity at both spatial and temporal scales. Early studies have focused on trying to understand how community composition varies with gap size and subsequently affects diversity at a given time. While seed arrival is a strong determinant of plant community composition, the relative contribution of seed dispersal in gap regeneration has received little attention. We investigated the role of frugivores in structuring community composition patterns of seedlings and saplings in cyclone-created gaps of different ages in a tropical rainforest using a trait-based approach. We found that for both categories of recruits, community composition, and species richness did not significantly vary between gaps of different ages. Using a null modelling approach, we found that when we discriminated dispersed vs. non-dispersed recruits within gaps, non-dispersed recruits tended to display clustered functional traits, while dispersed recruits had functional diversity indices that did not significantly differ from random expectations. This was true for all gap ages and recruit categories. We also found that trees with a mixed dispersal syndrome were more likely to be dispersed into gaps than expected by chance, suggesting a potential advantage of having a generalist dispersal syndrome. Our study demonstrates that vertebrate mediated seed dispersal shapes early successional recruits in regenerating gaps by mediating functional trait dispersion, ultimately affecting plant-plant interactions and forest dynamics. Such a central role is likely to confer a strong resilience to tropical forests against increasing destructiveness and frequency of extreme climatic events like cyclones.

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Floristic composition and habitat segregation of vascular epiphytes in a Bornean tropical lowland forest

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Vascular epiphytes (hereinafter referred to as “epiphytes”) are plants growing on other plants. In tropics, epiphytes significantly contribute to biodiversity, regarded as the keystone component. Basic knowledge on epiphytes are, however, still limited especially in Asian tropics, even the Asian tropics is one of the hotspots of biodiversity. We conducted a field survey in a Bornean lowland tropical forest with the aims of creating epiphyte-flora and clarifying habitat segregation of epiphytes in the forest. The study was done in the Lambir Hills National Park, Malaysia. We sampled 98 canopy trees and surveyed by using tree climbing and canopy facilities. For habitat analysis, we used habitat factors like above ground height, substrate type, host tree species, host tree height and DBH, and presence or absence of lianas. We recorded 25 families, 63 genera, and 182 species of epiphytes, comprise about 39% of monocots, 39% of eudicots, 20% of ferns, and 2% of lycophytes. The proportion of eudicots was remarkably high compared with the data from Neotropical and African tropical lowland forest. Lambir was also characterized by high richness of ant plants (7%) and hemi-epiphytes (18%). Epiphyte diversity and amount peaked at internal canopy, few were found at trunk zones. And they were significantly affected by host species, substrate types, and emergence of host tree, zone, and presence of liana. The epiphyte flora in Lambir was distinctive in terms of the high proportion of eudicots, and high species richness of ant plants and hemiepiphytes. Habitat segregation of epiphytes in Lambir was clearly contrasted with Neotropical and African tropical lowland forest, where the epiphytes show clear vertical habitat segregation.

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Distribution and connectivity of sifakas (Propithecus verreauxi) in the Mahafaly region, southwest Madagascar

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Verreaux's sifakas (*Propithecus verreauxi*) are a Critically Endangered lemur species endemic to southwest Madagascar. While this species has been studied at several long-term research sites, landscape-wide studies are a crucial element of effective conservation strategies, and there have been none of this species anywhere in southern Madagascar until now. We conducted surveys of five forests (Ranomay, Belambo, Vohipagnany, Milomboke, and Ampasindava) within 50 km of Bezà Mahafaly Special Reserve (BMSR) between July and October 2018. At each site, we worked with members of the local community forest associations to survey sifaka groups in the area. We recorded GPS locations of every sifaka group encountered, as well as information on group composition. We found sifakas inhabiting all five forests, but abundance varied significantly between locations. The number of groups recorded in each forest ranged between one (Vohipagnany) and 14 (Ranomay) and abundances were overall lower than at BMSR. Despite this, these newly surveyed forests are important habitat areas and should be taken into consideration in sifaka conservation efforts and status assessments for the species. Additionally, our analysis of habitat connectivity in the study area shows several potential corridors linking these forest patches with each other and with the larger BMSR sifaka population. Increased collaboration between local forest conservation practitioners and a shift towards landscape-scale conservation planning could greatly improve forest connectivity and wildlife conservation efforts in this region.

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Improving seedling survival of forest native species and modeling their growth for a large-scale restoration in Kianjavato, Madagascar

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Classified as one of the 30 priority sites for primate conservation, Kianjavato is a key area for lemur conservation which is a part of the corridor Fandriana-Vohidrozo. Due to the slash and burn, the richness of biodiversity is decreasing. For conserving the remaining forests and to connect all fragments, reforestation and restoration efforts were launched to conserve this area. To improve trees survivals, mycorrhiza was used to inoculate the seedlings. Height, basal diameter, crown diameter, number of leaves and number of branches for all seedlings were monthly measured and noted. All seedlings were classed by ages as 1, 3, 6, and 12 months. Chemical properties (NPK) and ph of soils were analyzed. Five targeted species, *Uapaca thouarsii*, *U. ferruginea* (PHYLLANTHACEAE), *Canarium planifolium* (BURSERACEAE), *Noronhia introversa* (OLEACEAE), and *Cryptocarya myristicoides* (LAURACEAE) most used by lemurs were chosen following the availability of their seeds in the fecal materials. Preliminary results showed that inoculated seedlings had higher survival rates (SR) (Mean of SR = 86%; min = 78%; ma x= 95%) compared from the controls seedlings (Mean of SR = 64%; min = 59%; max = 70%) (n = 10,000). They were larger ($p = 0.0248$), had more leaves ($p = 0.0078$), and more branches ($p = 0.0047$) than the controls. We identify that the use of mycorrhiza is beneficial for restoration and for the sustainability of the ecosystem. It will make the seedlings more resilient of variations both of soils types and weather parameters.

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Analysis of viral persistence and feeding site overlap among Malagasy fruit bats

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Madagascar is home to three fruit bat species, *Rousettus madagascariensis*, *Eidolon dupreanum*, and *Pteropus rufus*, which are reservoirs for potentially zoonotic infections in the same viral families as Ebola, Nipah, and SARS. Island-wide population sizes for these bats fall below the critical community size needed to maintain similar viruses in other mammalian hosts, leading researchers to question the mechanism of viral persistence in these systems. Interspecies transmission for multi-host viruses offers one possible explanation for this persistence. Although all three Malagasy fruit bats can travel several dozen kilometers a night in search of fruit, habitat destruction may be forcing them to share feeding grounds, especially during the dry season when fruits become scarce. As individual roosting and feeding sites of each species declines, there is an increased likelihood of interspecies sharing of feeding grounds, which could elevate interspecies contact rates and facilitate pathogen transmission. We carried out isotope analysis of longitudinally-collected hair samples from three species of Malagasy fruit bat to demonstrate seasonal overlap in diet coincident with the resource-scarce dry season in Madagascar. To show how feeding sites have changed over time, isotope analysis from hair samples collected longitudinally were cross-referenced with geographical isotope data in the web-based application IsoMap. We then fit compartmental models in the SIR framework to age-structure seroprevalence estimates in this system, comparing the model's ability to recapitulate the data under assumptions of both single- and multi-species infections with seasonal sharing.

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Distribution and abundance of a Critically Endangered lemur species, Microcebus gerpi, in eastern Madagascar: Preliminary results

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The critically endangered GERP's Mouse Lemur (*Microcebus gerpi*) was so far only known from one single location (Sahafina), a small forest patch of lowland rainforest in eastern Madagascar. The goal of this study was therefore to study for the first time the distribution, abundance and the ecology of this largely understudied and threatened lemur species. In particular, we aimed to (1) determine the limits of the distribution of *M. gerpi*, (2) estimate its abundance throughout its distribution boundaries, (3) determine its sensitivity to habitat degradation, and (4) formulate recommendations for an effective conservation of the GERP's mouse lemur in view of intensified land use strategies and habitat loss. A total of seven sites, including three littoral forest sites (1 to 17 m a.s.l.) and four low to mid altitude montane forest sites (29 to 487 m a.s.l.) were visited between August and December 2018, and systematic census observations, capture sessions, and habitat characterization were carried out in each of them. *Microcebus gerpi* was present in all sites between the rivers Ivondro and Mangoro and its abundance ranges from 2.1 to 5.8 individuals per ha. It showed no clear general response to habitat fragmentation or disturbance. However, this species was found in higher abundance in less disturbed and protected habitats. In contrast, it had its lowest abundance in the long-term disturbed littoral forest and in a less disturbed montane forest which is bordered by slash-and-burn cultivation. Based on lemur census results and the general condition of the habitats, the Sahafina Forest is the most appropriate among all sites for the conservation of *M. gerpi*, but requires effective protection measures to assure the long-term survival of viable mouse lemur populations in this highly fragmented landscape. Moreover, sustainable development actions should be undertaken in this region in order to minimize the forest loss.

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Little Rangers of Madagascar – The future of environmental education

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The importance of environmental education and hands-on experiences in nature in early life are often neglected. Although Madagascar is a biodiversity hotspot and known for severe environmental degradation due to unsustainable human activities, environmental education is almost absent from school curricula. Experiences of children in nature are mostly of destructive character and motivated by exploiting natural resources for subsistence. The Menabe Antimena Protected Area (MANAP) includes one of the largest remaining dry deciduous forests of western Madagascar and is home to locally endemic species, such as the smallest primate of the world, *Microcebus berthae*, and the Giant Jumping Rat (*Hypogeomys antimena*). Deforestation is intense, and recent estimates reveal that the forest may disappear by 2030. We developed a three full-day environmental education camp for children and youth at Kirindy Forest, called "Little Rangers". This project aims to raise awareness for biodiversity conservation in future Malagasy generations and to contribute to a better understanding of the importance of environmental education in biodiversity conservation. During each camp, a group of children from schools of different communities within the MANAP visits Kirindy Forest. Using interactive and participatory approaches, including games, presentations, cinema, and nocturnal and diurnal excursions with local tourist guides and researchers to the forest, the participants learn about the importance of the forest and the consequences of its destruction. A total of 200 "Little Rangers" participated so far. During each camp attitudes and behaviors related to conservation are assessed and will be reassessed at a later point in time to investigate the behavioral impacts of being a “Little Ranger”. Preliminary results of this evaluation suggest that participation has so far a positive impact on behavioral attitudes towards biodiversity conservation. As the project could be easily adapted to other regions in Madagascar, it will contribute to advance environmental education in Madagascar.

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New important nesting sites for the Madagascar Pond Heron, *Ardeola idae*, in Ambatovy mine site

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The Madagascar Pond Heron (*Ardeola idae)* is a threatened waterbird and one of the target migratory species in the agreement on the conservation of African-Eurasian migratory water birds. The species has been observed in the Ambatovy mine site since 2016. Based on the national action plan for this migratory bird, more research on the breeding sites of the species is necessary. The study aims to monitor migratory birds, including *Ardeola idae* in natural and artificial habitats in Ambatovy. Methods include the monitoring of bird nesting activity, during the breeding season, in potential habitat (nesting sites) across Ambatovy’s forests and wetlands. The species occurs on site between October and March. During the 2018 season, 21 nests were recorded with 3 to 4 eggs per nest. Nests were constructed between 0.2 to 2 m above the water surface on dead trees situated in the lake. The brooding time was 28 days; and chicks were able to leave the nest after 15 days. Nests are located in colonies along with the Cattle Egret *Bubulcus ibis*, Western Reef-egret *Egretta gularis* and Long-tailed Cormorant *Microcarbo africanus*. The occurrence of dead trees is the particular feature of the lake that could affects the breeding of this species in this new location. The new nesting sites resulted from the modification of the habitat through the creation of dams on the site that could help in the long-term survival of the species. It also offers some opportunities to learn more about the breeding behavior of this species and to contribute to new insights.

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Conservation status of trees in the vanilla production landscape of northeastern Madagascar

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Madagascar is renowned for its unique fauna and flora. Especially Malagasy trees reach outstanding levels of biodiversity and endemism. However, this diversity is threatened by ongoing forest loss due to agricultural activities. Vanilla agroforests have the potential to integrate trees into the agricultural land while providing additional income for farmers. Therefore, we address the question if vanilla agroforests can contribute to provide habitat for endangered Malagasy tree species in the SAVA region of northeast Madagascar. Thus, we conducted tree inventories in 30 vanilla agroforests differing in land use history (forest derived vs fallow-derived after slash and burn) as well as on 30 plots in other prevalent tree-based systems of the region: woody fallow, forest fragment and primary forest. Together with a local tree expert and a botanist from Missouri Botanical Gardens we identified all tree species (dbh> 8 cm) with their local and scientific names and assessed their health status as well as their conservation status based on the IUCN categories. In the primary forest, we found tree species such as *Dalbergia andapensis, D. madagascariensis, Diospyros mangabensis* which are listed as endangered according to the IUCN citeria. Endangered and vulnerable tree species were also found but rarely in forest fragments and in forest-derived vanilla agroforest. But were not found in woody fallows or in fallow-derived agroforests. However, in many agroforests tree health appeared quite poor due to machete use and girdling, which indicates that tree occurrence in these systems might further decrease in the future. In conclusion, our results highlight the importance of primary forest conservation but we suggest that more sustainable tree management practices in vanilla agroforests could sustain habitat quality for various tree species of conservation importance.

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Propagation of bamboo and litchis: Preserving the primary food of the Greater Bamboo Lemur in Kianjavato, Madagascar

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Litchi and bamboo fill critical roles in income generation in many places throughout southeastern Madagascar. Hundreds of people go into the forest, disrupting the critically endangered greater bamboo lemurs, to harvest bamboo to make baskets to hold harvested litchis. The people depend on these resources to support their families, resulting in the destruction of bamboo patches - an important food resource for endangered species. This research aims to determine and analyze the relationships and impacts of basket production and the giant bamboo harvest, with local litchi production in Kianjavato. Bamboo propagation experiments were conducted in propagation beds in three nurseries. The effectiveness of different methods, including culm cutting, branch cutting offset, and rhizome cutting were investigated, with 30 samples per method. Air layering is being the most appropriate way to propagate litchi. A portion of the above-ground stem is girdled and covered with a rooting substrate. To determine the most beneficial air layering substrate, a test including 125 samples for four different substrates has been conducted. Both the bamboo culm cuttings and rhizome cuttings produced very poor results (0%). Fortunately, the offset method from mature rhizomes was successful (52.9%) as well as directly transplanting on the field (78.9%). For the litchi propagation, data were analyzed between four types of substrate used during the propagation experiment. Sawdust had the fastest rooting time, however, showed a low success rate after three months. The sphagnum moss had the highest success rate after three months (87.3%) but took a slightly longer time to produce roots (82 days). By determining the best methods of bamboo propagation and the most efficient air layering substrate can reduce the pressure on bamboo patches in the forest upon which Greater Bamboo Lemurs rely. Additionally, the propagation of high-quality litchi trees increases the potential for income.

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Habituation process of greater bamboo lemurs (*Prolemur simus*) in Vatovavy Forest

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Habituation is a term adopted by field biologists to describe reducing or neutralizing flight reactions of an animal to human presence. It is also used in research, mostly in primates such as on gorillas, but data are lacking on lemurs. This study describes the habituation process of Greater Bamboo Lemurs (*Prolemur simus*), a Critically Endangered species, and was conducted from November 2016 to April 2017 in Vatovavy Forest, southeastern Madagascar. Focal animal sampling with continuous recording method was used to register the data. Seven *P. simus* individuals were radio-collared in three groups and followed for 390 hours during which time we recorded start and end time, observer-primate distance and height, animal's behavior (avoidance, curiosity, ignoring, feeding, and others). The Chi-square test was used to analyze our data using R. The time taken to habituate *P. simus* was about four months. There is a significant difference between male and female individuals in which females were habituated sooner than males. Parameters such as distance and height also influenced the habituation process. Habituation was considered successful when the behavioral data from Vatovavy Forest were not significantly different from the data collected from the nearby Sangasanga Forest on Greater Bamboo Lemurs, which have been habituated for eight years. These results are crucial to the ongoing behavioral study that has extended over two years. This work was the first step in determining the population size and habitat use of *P. simus* in Vatovavy Forest and the exploration of this site as a possible ecotourism attraction that could provide socio-economic benefits to the local community.

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Mathematical model suggests a unique evolution of 24-hour time-keeping system in tropical environments

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In many animals, plants, and unicellular organisms, diel physiological and behavioral rhythms are controlled by the circadian clock. The circadian clock is an internal biochemical oscillator having properties of self-sustainability and entrainability: it oscillates with a period close to 24 hours under constant darkness or under constant light exposure (self-sustainability), and the period is adjusted to exactly 24 h when a 24-h periodic light/dark cycle is given (entrainability). Recently, some species (e.g., tropical marine cyanobacteria *Prochlorococcus marinus* and cnidaria *Hydra vulgaris*) were suggested to have lost the self-sustainability: they do and do not show biological rhythms under a light/dark cycle and under constant environment, respectively. The reason why such a simple, "biochemical sandglass" system has evolved in relatively few species remains unclear. To identify conditions for the evolution of the sandglass system, we developed a mathematical model of a gene regulatory network and performed computer simulations. The network consists of ~10 genes and inhibitory relationships between those genes. In addition, expression of one gene is assumed to be substantially inhibited by light. First, we randomly generated 1,000,000 networks to find that almost all of them can be entrained to a light/dark cycle while less than 5% of them show self-sustained oscillation. This suggests the existence of strong selection pressures favoring the circadian clock in the real world. We then performed evolutionary computations in which a network is assumed to be more adaptive when it displays a clearer sinusoidal gene expression pattern with its peak at dawn or dusk. Such a pattern is observed in some circadian genes and would require prediction of the timing of dawn (dusk). The simulation results indicate that the sandglass can evolve under the 12-h-light/12-h-dark cycle, i.e., in tropical environments, while the self-sustained circadian clock is more likely to fix in non-tropical environments.

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Effect of vegetative cover types on germination and growth dynamics of *Adansonia perrieri* baobab seedlings

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Adansonia perrieri is a Malagasy endemic baobab tree with a very low population density. However, its survival is threatened by habitat disturbance, lack of natural regeneration, and climate change. In this study, we evaluated the extent of variation in seed germination and seedling growth of *A. perrieri* at natural habitat according to vegetation types. Two different locations were considered. For the first location, 90 seeds were sown in each four experimental sites, in moist primary forest, dry secondary forest, riverfront, and in shrubby savannah to study the initial seedling growth in response to vegetation type. Surveys were conducted every seven days during the first month after sowing. Surveys were echeloned according to data on the ground. For the second location, growth response according to vegetative cover types was analysed by quantifying seedling growth in plantation site at four year ages. We found significant variation in seedling germination and growth responses among the four experimental sites. 31 days after sowing, the most abundant seed germination was in moist primary forest (83%), followed by the dry secondary forest (54%), then in riverfront (50%), and in shrubby savannah (18%). However, 357 days after, the highest number of survived seedlings was observed in shrubby savannah with 16 individuals, in riverfront with six, in primary forest with two, and in dry secondary forest with zero. About growth response, a significant positive correlation was observed between seedling growth in height and vegetation covering height. Seedlings growth in grass-shrub cover types showed the higher value in diameter and height across to the other cover types of the plantation site. Seedling mortalities were caused by moisture forest litter in primary forest, zebu grazing in secondary forest and shrubby savannah, and inundation in riverfront. Desiccation in open areas was also a cause of mortality. *Adansonia perrieri* species grows in a specific vegetative structure cover.

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A preliminary study on the activity, diet, and exploitation of the forest by Mongoose Lemur (*Eulemur mongoz*) within the forestry of Antrema, Madagascar

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The study of animal behaviour can make a significant contribution to conservation. The focus of my study was to investigate possible behavioural adaptations of Mongoose Lemur (*Eulemur mongoz*) with respect to (I) season and (II) habitat type (dry forest on dune and dry forest on soil clay). The study was carried out in northwestern Madagascar at the forestry station of Beankama (dry forest on dune) and Ankoririaka (dry forest on soil clay) between February-March and April-May 2003. We focused on three aspects of the behaviour of these animals: their activity, diet, and habitat use. The scan sampling method was used to record every 5 minutes the activities of all individuals composing the group. A change of activity was observed between dry and rainy season. *Eulemur mongoz* increased their resting time (up to 80%) during the dry season. 26 plant species were used as food resources. This species fed substantially more on fruits than leaves. The favoured plant species varied between season and habitat. *Eulemur mongoz* exploited mainly the middle part of the forest independent of the season. Our preliminary findings provide new information on this poorly known species.

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Primate tree hollow inhabitance in Madagascar

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Tree hollows, inhabited by 28 species of lemur, are keystone vegetation structures in Madagascar. In regions with high tree hollow densities and broad temperature variation, tree hollow inhabitants are expected to be more prevalent due to hollow abundance [hollow availability hypothesis (HAH)] and increased thermoregulatory demands [hollow thermoregulatory hypothesis (HTH)]. Due to the paucity of information concerning tree hollow densities across Madagascar, rainfall data were used as a proxy for tree hollow abundance because global tree hollow densities are positively correlated with precipitation. The best-fitting model included only mean yearly rainfall as a significant predictor of tree hollow inhabitance (coef. ± SE = -0.002 ± 0.001, P = 0.003). Locations with high mean yearly rainfall (suggesting high hollow abundance) were less likely to contain tree hollow inhabitants than locations with low mean yearly rainfall, contrary to the HAH. Maximum temperature was a significant (coef. ± SE = 0.616 ± 0.2338, P = 0.008) predictor of tree hollow inhabitance only when rainfall variables were excluded from the model, indicating that temperature data can be confounded by rainfall. According to these results, neither hollow abundance nor thermoregulation explain the widespread evolution of tree hollow inhabitance among Malagasy primates. If rainfall is an appropriate proxy for hollow abundance in Madagascar, hollows may be left uninhabited in locations with high rainfall due to water avoidance. Hollows containing water harbor parasites and decrease a primate's ability to thermoregulate. In addition, regional differences in predation and interspecific competition for tree hollow access likely influence hollow inhabitance. As natural tree hollows decrease in abundance due to deforestation, burning, and higher intensity cyclones, these results inform artificial tree hollow design for the preservation of hollow-dependent species. Additionally, investigating the characteristics of tree hollow inhabitant ecosystems across Madagascar is crucial to cultivating a better global understanding of the convergent evolution of tree hollow inhabitance that occurred repeatedly over the course of terrestrial vertebrate evolution.

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Change in indigenous people's subjectivity in relation towards conservation projects

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Biodiversity has become a major political issue, both internationally and nationally. For Madagascar, the State's objective is to reforest 40,000 ha of trees within five years. On this basis, several approaches, projects, institutions, and even citizens are mobilized to achieve this ecological policy. Madagascar, in collaboration with international and national organizations, is carrying out various activities to reduce deforestation. The latter still remains one of the major threats to the destruction of forest resources in Madagascar. Hence the increase and multiplication of nature reserves in recent years to delimit the destruction of natural areas. Despite all these measures, the country is still exposed to various threats that contribute to climate change. We can therefore conclude that there are gaps in terms of conservation. Does it have a change in the subjectivity of local populations in relation to the rules governing forest resources? Studies have been conducted to understand indigenous behaviours and perceptions of various conservation modes/rules, particularly in the Menabe region, in the central west. The latter is still an endangered area and a victim of massive deforestation. Need we remind you that the population is attached to natural resources to survive, at all levels? For indigenous people, natural space is a social, economic and cultural heritage. And the implementation of the rules governing the use and exploitation of nature are only sanctions in the eyes of the indigenous people. For them, these resources are considered as legacies, bequeathed by their ancestors to their descendants. Thus, maintaining and having a relationship with nature is only perpetuated in the practices and gives great respect to the ancestors.

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Intraspecific variability drives community assembly in a tropical white sand forest

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Understanding the processes underlying the origin and maintenance of species diversity in communities is a central goal in ecology. In a local scale, environmental filter operates by restricting the occurence of organisms while the process of limiting similarity acts pressing differentiation in species co-occurences. The functional approach has been used to test the processes responsible for species coexistence and consists in the comparison of species functional similarities. Restinga white sand soil forests are suitable to test species coexistence hypotheses, because it presents a well marked environmental gradient, defined by resource availability. Thus, this study evaluated: i) the effect of soil condition (drained and flooded) on functional traits and ecological strategies of restinga trees species and, ii) the effect of functional traits on plant's habitat preference. We conducted this study in a restinga white sand forest at Cardoso Island (SP, Brazil), which comprises two principal soil types: drained and flooded. We collected leaf functional traits and wood density of 44 tree species. Our sample comprise 30 individuals of each species, 15 in each soil type. We used linear mixed models to assess soil type effect on trait and ecological strategies. We found soil effect on the coefficients of variation of LDMC and SLA, which was higher in the flooded soil. We found no soil effect on the other functional traits and on ecological strategies variation, neither on ecological strategy type. Despite functional traits are not or weakly related to species habitat preference, functional traits intraspecific variation is a good predictor for species population density and biomass in the community. Our results points that limiting similarity is the dominant process structuring this community, mainly in flooded soil, differing from other studies in tropical forests. Also, our results reinforce the importance of phenotypic plasticity to define species occurrence in different habitats.

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Range dynamics of the Western Reef Heron and Dimorphic Egret in East Africa

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The Western Reef Heron and Dimorphic Egret are two taxa of the family Ardeidae that share many morphological similarities. The distribution of these two dimorphic taxa overlaps in East Africa. During the last century, many reports of interbreeding between these two taxa have been published. Although the taxonomic relationship of these taxa has not to be clarified completely, many ornithologists believe the interbreeding is the consequence of environmental changes. In this project, I tried to reveal the existence of any relationship between annual movement and environmental changes. I used records from eBird of the Dimorphic Egret and Western Reef Heron in the East African countries of Kenya, Tanzania, Mozambique, and Madagascar to assess possible clustering and similarity between the recorded observation of the Dimorphic Egret and Western Reef Heron and their overall clustering changes through the last 20 years. For my analyses I used the single-cluster dissimilarity network joining analyses, calculating the best number of fitted clusters to each of the taxa. Finally, comparing the clustering and density of recorded birds based on their distance and pattern and a set of random points in a study region, by using the F function method. Also, using Species Distribution Models (SDMs) helped to predict the distribution of each of the taxa in more detail. I found that yearly observations of the Western Reef Heron grouped into three and the Dimorphic Egret into five different clusters. In case of environmental changes, freshwater resources changes and habitat loss, both taxa show higher density and more clusters during the studied time period. The clusters were overlapped more and increase the probability of hybridization among these two taxa.

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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 animal 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.

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Ecological and social dimensions of leopard-livestock coexistence in Sri Lanka

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How do we balance economic development and poverty alleviation with coexistence among species competing with humans for habitat and potential prey? Large carnivores are often top predators that significantly influence ecological communities, but face global declines as they increasingly interact with human settlements and livestock. Understanding the complex interactions between carnivores and livestock farming communities means addressing *both* the social and ecological dimensions. As Sri Lanka expands its dairy farms to improve livelihoods and broaden development, there are reports of livestock depredation by leopards - but this has not been quantified and modelled in local ecological contexts. Using camera traps, GIS and a two-step generalised linear mixed-modeling approach, 8 hypothesised ecological and husbandry predictor variables were modelled against the responding level of conflict (livestock depredation) experienced at 113 dairy farms. Initial results suggest that livestock husbandry practices and distance from protected forests are the most significant drivers of livestock depredation, preceding further data collection. At these same 113 farms, semi-structured interviews were conducted to measure respondent's attitudes towards a) leopards, and b) willingness to adopt mitigating husbandry techniques (that require minimal behavioural change), modelled against predictor variables such as socio-demographics, costs, knowledge and experience. Preliminary results for the worst affected region show promise for coexistence, with 80% of respondents claiming leopards are the biggest threat, yet 84% of respondents being concerned about their conservation. By identifying what factors are creating conditions where conflict is more likely to occur, and by putting that in the larger context of mitigations supported by the communities, we can assess high-risk areas and suggest feasible, affordable coexistence strategies. Local contexts vary greatly, and though results from Sri Lanka may have narrow applicability, the interdisciplinary approaches taken to address this socio-ecological phenomenon can help inform the prioritization of limited conservation resources beyond the island nation's borders.

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Protecting orchid species in Ambatovy

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Ambatovy is an open-pit nickel and cobalt mine, located in the rainforest area of Madagascar. The area is recognized for its rich regional biodiversity and high degree of endemic fauna and flora, particularly orchids. A flora management plan has been established to improve the conservation of orchid species at the mine. The study aims to describe orchid diversity in the Ambatovy Mining zone, the salvage of orchids from the various clearing zones, and efforts to avoid the loss of species as well as limit the impact of the mine activities on endangered orchid species. Approaches include the inventory of shade dwelling and heliophilous orchids from zones due to be cleared. Mitigation measures include manual salvaging of orchids from the clearing area followed by transplantation to the orchid shade house. At the shade house orchids may be used for seed production before transplanting them to natural habitats such as the orchid park or in the conservation zones. As a result of these efforts, 283 orchid species have been identified and recovered with 27 taxa potentially new to science. 22 orchid species evaluated as threatened in the IUCN Red list (1 CR and 21 EN) are particularly important. 80 orchid species have been transplanted from the orchid shade house to conservation zones with a survival rate of 90%. 28% of the orchids described in Madagascar are found and protected at Ambatovy. The implementation of management plans for threatened orchid species (CR and EN) are well in progress as well as efforts to support the *ex situ* conservation of threatened orchid.

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Functional recovery of secondary tropical forests

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About one third of all Neotropical forests are secondary forests that regrow naturally after agricultural use through secondary succession. By analyzing communities in terms of their traits we can understand the mechanisms of succession and assess ecosystem recovery. Here we analyse functional recovery using community data on seven plant characteristics (traits) from 30 chronosequence sites across the Neotropics. Dry and wet forests show opposite successional pathways for several traits that increase drought tolerance in dry forest, but come at the expense of fast growth in wet forest. Within plots, the range in functional trait values increased over time, more strongly so for dry forests. These results have large implications for ecosystem functioning and for global commitments to restore tropical forests.

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Linking plant-soil feedback to the effect of frugivore treatment on seed germination

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The high mortality of seeds under parent trees has been assigned to the soil microbiota - a process called negative plant-soil feedback (NPSF). A strong NPSF may limit the spatial distribution of some plant species, which then, occur at low density. Few studies, however, investigate the contribution of seed dispersal by frugivores in reducing the effect of the negative feedback. This study aims to understand how plant species with different adult densities are affected by the manipulation of frugivores: seed cleaning and the dispersal away from parent trees. We expect that low-density species, likely to experience a strong NPSF, have a greater germination success at long-distance than abundant species. We are now conducting a field experiment with 8 plant species that occur in different densities in the Amazonian Forest at Mato Grosso, Brazil. We applied four treatments to 1200-1500 seeds of each species: seeds with fruit pulp, seeds without pulp (hand-cleaned), whole fruits with fungicide and lastly, cleaned seeds with fungicide. The treatments are placed both near and away from five conspecific trees to test the effect of removal from parent trees. We will estimate the effect of seed cleaning and removal from conspecific on the germination and recruitment success. We are also identifying the fungi pathogenic groups most dominant in the treatments. The NPSF plays an important role in modulating the biodiversity of tropical forests. Studies on common species, which the NPSF is low, have suggested that the distance effect could be a secondary effect to increase germination success. For these species, the manipulations by frugivores such as pulp removal were sufficient to reduce seed pathogen infestation. In contrast, species occurring in low-density experience a strong NPSF, which reduces the survival of seeds/seedlings under conspecifics. Therefore, rare species may be more likely to benefit from removal from conspecific trees.

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Inventory of medicinal plants used to treat animal diseases in Amboasary Atsimo and Tsihombe districts, Madagascar

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Traditional practices related to animal health are well developed in the southern part of Madagascar, but to date, remain largely unknown by the international scientific community. We aimed to census the plants used to treat animal diseases in Amboasary Atsimo and Tsihombe districts, where *Agronomes et Vétérinaires Sans Frontières* (AVSF) has been running long-term projects. To do this, we conducted an ethnoveterinary study in enquiring farmers. We also collected herbarium specimens and identified them at Parc Botanique et Zoologique de Tsimbazaza (PBZT). Finally, bibliographic study was conducted to have more informations about the plants' property. 82 semi-directives interviews led to the identification to the species of 82 plants, and 421 remedies recorded in writing. This research gives preliminary results of the plants used to heal animals' pathology in the southern part of Madagascar. However, more studies have to be undertaken to value these traditional practices.

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The utilization of dry forest from Sakalave ethnic in a protected area Antrema, NW Madagascar

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The world forests diminish under the impact of climate changes and human activities. While intense researches have been done on rainforest protection and restoration in the last decade, the dry forest – making up about 42% of global forest – remains to be studied. Despite of the fact that tropical dry forests are the most threatened of all the major lowland tropical forest habitats, they experience unprecedented anthropic degradation as they are easily accessible to human beings. A research has been conducted at a protected area of Antrema, northwestern Madagascar, where the forest timber is the main resource of household material. In this paper, about 15 local families were interviewed, and 30 houses were recorded for analyses. 12 species are involved in building constructions; among those species, *katrafay beravina* (*Cedrelopsis grevei* Baill.), and *manjakabenitany* (*Baudouinia fluggeiformis* Baill.) are preferred due to theirs solid and resistant qualities. A standard house in Antrema village requires around 38 pinnacles, 26 rafters, and 25 pillars corresponding to 0.77 m^3 of wood in total. The diameters of log vary from different structures; in general, the frameworks using beams and two main pinnacles have greater diameters than those in other structures. The result of this study reveals changes of biomass in dry forest area, and complements our knowledge of human impact on the dry forest. Although restrictive order of cut has been introduced by the local government, the huge consummation of timber and illegal logging still cause great pressure on the dry forest, we propose that only with a better understanding of dry forest, and selection of species for household planting could resolve the problem of degradation of dry forest in Antrema.

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Amazonian trees resistance to water stress depends of local hydrological regime

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Understanding hydraulic strategies of Amazonian trees enables the prediction of their resilience to drought. Vulnerability to xylem embolism (P_{50}) is a functional trait that indicates species tolerance to drought and help to explain species distribution patterns across environmental gradients. Here we evaluate how distinct precipitation regimes and local landscape features that influence water availability (plateau and valley) select hydraulic traits and drive the distribution of species. We determined P_{50} for 28 tree species occurring in two areas (southern Amazon [SA - Dry]: 1500 mm year^{-1} and central Amazon site [CA - wet]: 2200 mm year^{-1}). In each area, we studied plateau specialist species (4 at SA and 10 at CA) and valley specialist species (8 at SA and 9 at CA). We observed a large hydraulic diversity as P_{50} values ranged between -5.2 and -0.7 MPa. At the drier site, average (± standard deviation) P_{50} was -2.02 ± 0.69 MPa for valley trees and -3.53 ± 1.29 MPa for plateau ones, resulting on higher embolism vulnerability for valley trees (42%; t-test p = 0.030). For the wetter site, valley trees showed an average P_{50} of -1.86 ± 0.68 MPa, while plateau species averaged -2.99 ± 1.18 MPa, being valley species 37% (t-test p = 0.032) more vulnerable to embolism than plateau ones at this site. However, species from sites with contrasting precipitation regimes show similar vulnerability to embolism. We show that P_{50} contributes to niche segregation between valley and plateau species in the Amazon, and thus to species coexistence. Local species distribution was associated to drought tolerance, being lower for trees in plateau compared to valley. Wet forest species have been selected for conservative traits and higher drought tolerance. These results suggest that forests with high water availability are less resilient than upland forests, and more susceptible to climate-driven changes.

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Drivers of spatial variation of mangrove forest in southern Mexico

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Mangrove forests are recognized as providers of essential ecosystem services to humans. Unfortunately, they are highly threatened due to unchecked human action. Proper conservation and management of mangrove forests should consider their internal heterogeneity. Yet, these systems are often viewed and treated as homogenous vegetation masses; the magnitude of this variation is not well known, and their causes are little understood. Here, we evaluated the spatial variation of a Neotropical mangrove forest, and related this variation to environmental factors such as terrain features and distance to the coast line. We conducted the study in the Pantanos de Centla Biosphere Reserve, Tabasco State, southern Mexico. In 48, 625-m^2 plots of well-preserved mangrove forest, we measured density, crown cover and basal area, and recorded species composition, for trees >= 5 cm DBH. Mean (± SD) values for structural and floristic attributes were: richness, 3.94 ± 0.86 species per plot; density, 473.67 ± 285.70 ind./ha; basal area, 20.57 ± 11.96 m^2/ha; and crown cover, 1,189.40 ± 1,414.54 m^2/ha. Among these variables, crown cover had the largest variation (CV = 118.93%) and richness the smallest one (CV = 21.86%); in turn, density of individuals and basal area had similar levels of variation (CV = 58.12 and 60.32, respectively). Distance to the coast had a stronger effect on the structural and floristic variation of this mangrove forest than distance to the main river channel. *Avicennia germinans* was restricted to those sites near the coast, whereas *Rhizophora mangle* dominated away from it, around the Cometa Lagoon where water is less saline, and *Laguncularia racemosa* was broadly distributed. Distance to the coast (0-30 km) is a main driver of the floristic and structural variation in this mangrove forest, thus it should be considered the main axis of conservation and management efforts in this mangrove.

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Single vs. compound leaves in tropical montane forests: Why "compoundness" decreases with elevation?

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Leaf traits such as photosynthesis rate or SLA have contributed to understand the ecological strategies displayed by plants to cope with the surrounding environment, although very few studies have explored the ecological advantages or disadvantages of compound versus single leaves. The first references on this topic, published more than fifty years ago, described compound leaves as more common in lowland tropical forest than in montane forest. Other more recent studies describe that compound leaves species are more common among the highest trees than among those in the understorey, suggest that they may not provide an advantage against herbivory or drought or propose that they could promote rapid growth, since they tend to be more common among pioneer species and in forest gaps. However, a lack of consensus still exists about compound leaves ecological significance. To shed light on this topic, we have investigated richness and abundance of compound versus single leaves tree species across seven altitudinal gradients of tropical montane forests located along a latitudinal gradient which comprises Colombia, Ecuador, Peru, Bolivia and the north of Argentina. Besides, we characterized functionally those species. Our preliminary results confirm that both compound leaves species richness and abundance decrease with altitude in a consistent manner along the latitudinal gradient. Furthermore, compound leaves species have lower wood density than simple leaves ones. We suggest that displaying compound leaves could be an advantage at lower elevations that decreases as elevation increases. Compound leaves species' rapid growth, based on their cheap disposable branch-like structure, might be an advantage at lower elevations, where competition for light is stronger, but turns into a disadvantage at higher elevations, when environmental conditions get harsher.

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Disentangling the mechanisms of litter breakdown by anuran tadpoles in Malagasy rainforest streams

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With ongoing amphibian population declines that occur in various regions in the tropics, understanding their ecological role is urgently needed to predict how changes in a community may cascade down to affect critical ecosystem functions. We investigated the contribution of anuran tadpoles to litter breakdown, one central component of stream ecosystem functioning. In theories, freshwater animals can decompose litter through consumption (physical effect) and/or indirectly by enhancing microbial activities through their excretory products (i.e., nutrient recycling, chemical effect), yet the relative contribution of each pathway has never been explicitly elucidated. We conducted mesocosm experiments to disentangle these mechanisms using the tadpole community in forest streams in Andasibe, eastern Madagascar. In mesocosms, we manipulated tadpole density (low, medium, high), and two types of leaf litter (*Bridelia* sp. and *Allophylus* sp.) were either exposed to the physical contact of tadpoles or were enclosed in mesh bags to prevent consumption. After 45 days, we terminated the experiment and quantified the final mass of each litter type in each of the 80 mesocosms. We found that the tadpoles influenced litter breakdown, and, to our surprise, tadpole density weakly affected the process. Overall, the relative importance of each mechanism depended on litter type. For *Bridelia sp*., indirect effects (microbial decomposition) mainly mediated litter breakdown, almost 3 times stronger in magnitude than consumption. *Allophylus* sp. was hardly decomposed and consumption effect, though weak (1.18 times in magnitude), was the only mechanism operating in the process. While tadpoles have been typically thought to play a minor role in litter breakdown in streams, this study clearly revealed that tadpoles can affect this process through direct and indirect pathways. The relatively high abundance of tadpoles compared to macroinvertebrate decomposers in Madagascar rainforest streams suggests that tadpoles could be of paramount importance in maintaining stream functions in these ecosystems.

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Spatial variations of soil and plant characteristics relevant for ecosystem silicon cycling in four tropical forests

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Silicon (Si) is a beneficial element for many higher plants, and plant species vary widely in degrees of Si accumulation. Many aspects of ecosystem Si cycling remain unexplored in tropical forests. We aimed to assess the spatial variation of water-extractable soil Si and local variation in leaf Si concentrations within tropical forests. Soil samples (0-10 cm) were obtained on a 40 to 50 m grid within four large-scale (25-52 ha) forest dynamics plots (253 to 625 samples per plot): Barro Colorado Island (BCI; Panama), Fushan (Taiwan), Lambir Hills and Pasoh (Malaysia). Water-extractable soil Si was assessed after shaking dried soil samples in distilled water for 20 hours. For BCI, leaf Si concentration was determined for 240 tree species and for up to 12 individuals per species. The four forests differed in overall water-extractable Si as well as its within-plot spatial patterns (BCI > Pasoh > Fushan > Lambir). These among-plot differences may reflect differences in geological substrates, climate and plant community composition. On BCI, water-extractable soil Si was positively correlated with pH and slope, and negatively with elevation. The spatial auto-correlation of water extractable Si was present up to ca. 200 m distance. Leaf Si concentration varied greatly among species (0.2-53.6 mg g^{-1}) and positively correlated with water-extractable soil Si. The relationship, however, was not significant across species in the same family. The strong phylogenetic signal of leaf Si concentration suggests that plants, rather than soil Si availability, regulate Si uptake to a large extent. Our results suggest that leaf Si concentrations, which differ widely among tropical tree species, are relevant for ecosystem Si cycling in tropical forests. Plants, rather than soil Si availability, may regulate Si uptake, thereby modulating ecosystem Si cycling.

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Managing for ecological complexity of savanna states revealed through herbivore and habitat structure

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African savannas are characterized by a mosaic of trees and grass. The ratio of trees and grasses exists along a continuous gradient in savannas, resulting in savannas that range from open, grassy savannas to denser, closed-canopy savannas. However, climate change is leading to woody thickening in African savannas, and predictions suggest that by 2100 savannas will become forests thereby threatening the ecosystem services provided by savannas. Herbivores play an important role in maintaining savanna structure because herbivore abundances and distributions are strongly related to habitat structure (e.g., composition of grasses and trees). Consequently, the ecological complexity that exists between herbivores and vegetation structure needs to be explored in parallel. Thus, to reveal opportunities for effective management of bush encroachment, we aimed to determine whether there are distinct states within African savannas in which the vegetation structure and herbivore community compositions are unique. To explore this complexity, we used herbivore counts from survey data collected in a South African savanna from both the wet and dry seasons that link with savanna vegetation structure (i.e. tree-grass ratio). We used model-based clustering to identify unique herbivore-vegetation structure states. The model-based clustering revealed multiple distinct states within African savannas that varied both seasonally and structurally (i.e., along a gradient of tree: grass ratio) with the greatest complexity existing in herbivore communities at intermediate ratios of trees and grasses. Our results also suggest that both bush encroached areas (i.e. very dense, closed-canopy savannas) and large-scale bush cleared areas, implemented to achieve low woody vegetation levels (i.e. very open, grassy savannas), result in states that have depauperate wildlife communities compared to intermediate woody states. As such, our results provide a powerful management tool that provides insight into promoting diverse herbivore communities and maintaining savanna ecosystem services in the face of bush encroachment.

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Interconnections among tree hydraulic strategies, response to extreme drought, and growth patterns in an Amazon rainforest

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The increased severity of seasonal drought and frequency of strong interannual droughts in the Amazon region have highlighted the need to better understand rainforest vulnerability to heat- and drought-induced stresses. Increasingly recognized is the critical role of multiple hydraulic strategies that confer a spectrum of trade-offs ranging from drought avoidance to drought tolerance. We present evidence of such variations using ecohydrologic data on intrinsic xylem hydraulic traits, tree seasonal growth patterns, and leaf gas exchange and stem water dynamics collected in a seasonal rainforest in eastern Amazonia, the Tapajos National Forest. Specifically, we rely on machine learning algorithms to identify patterns of tree ecophysiological response to canopy environment during the unprecedented 2015 El Niño drought using data from nearly 50 high-frequency sapflow sensors, snapshot measurements of stomatal conductance and branch water potential (a dozen of species), as well as seasonal stem growth data (~250 species). We then relate these patterns to intrinsic hydraulic traits expressed at the genus and species levels. We find a broad spectrum of strategies among co-occurring trees, ranging from the tight control of canopy conductance guarding against xylem embolism, to loose regulation of the water flux through leaf stomates. Using a metric of stem-growth seasonality, we find a similarly broad spectrum of growth strategies structured by the species abundance, such that the range of expressed strategies shifts from nearly uniform, among rare species, to unimodal and narrow, among the most abundant species. Our integrated view of hydraulic traits, growth strategies, and plant community structure provide new insights for mapping traits to emergent forest function in the next generation of predictive models of tropical forest dynamics.

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Relationship between plant phenology and diet of *Propithecus coronatus* in the dry forest of Antrema, western Madagascar

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Propithecus coronatus is one of the endangered species which needs urgent conservation measure. However, the dry forest of Antrema is providing a potential habitat for this lemur. The future of this species are strictly related to the conservation status of its habitat. The effect of season on food availability for this lemur species is less understood. This study aims to determine the seasonality variation of diet fin relation with plant phenology. The data were collected during the wet and dry season of 2016. To do this, phenology of plant consumed by *P. coronatus* were noted and identified. We were also determined which portion of the plant was eaten. We recorded 67 species of plants consumed. The wet season is characterized by foliage (97.5 %), flowers (10.3 %), and fruits (25.6%) in the diet of this lemur. However, during the dry season, several plant species are without leaves (32.5 %), resulting in the reduction of leaves for this folivorious species. Phenological variability of plants consumed was conditioned by the two different seasons. This study provides new information this lemur's diet and highlights the importance of season in food availability. Several aspects of protection have to be considered to ensure that *P. coronatus* can live sustainably in its natural habitat. These findings underlines plant species which are crucial for lemur conservation and it will be a guidance to a restoration project.

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Biotic and abiotic controls on tropical forest regeneration in the Andaman Islands: Combining manipulative experiments with long-term data

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Tropical forests are globally important biodiversity hotspots and carbon sinks, but their persistence is under threat due to land use as well as climate change. Besides direct loss, forests across the tropics are shifting to drier, deciduous species because of past logging and current climate change causing irreplaceable losses to biodiversity and associated ecosystem functions. In the Andaman Islands, India, this transition was identified by the UNDP as a "key vulnerability to climate change", but mechanisms that regulate regeneration of evergreen forests are poorly understood. Our objective is to understand the mechanisms that regulate tropical forest regeneration in the Andaman Islands, a critical factor for forest conservation. We hypothesise that deciduous canopies facilitate deciduous seedlings through increased light, causing a positive feedback. But this feedback can be buffered by biotic interactions with other plants and insect enemies. Through field-based manipulative experiments (n=54) on tree seedlings of nine native species and comparing these to permanent seedling plots (n = 50) in a long-term forest monitoring setup in the same ecosystem, we explore how abiotic factors like shifting light regimes interact with biotic factors like plant competition and herbivore damage impacting forest regeneration. From long-term field data, we observe that although there is significant variation in the abundance of seedlings across plots, seedling abundance within a plot is relatively constant over a three-year time period. However, evergreen species experience declines at the plot scale. Preliminary results from the manipulative experiment indicate large variation among native species in seedling survival success under different canopy closure regimes. It remains to be seen whether biotic buffering in multispecies plots improves survival and growth of species with low success in monocultures. These results can directly be applied to improve replanting strategies in the forests of the Andaman Islands to prevent a functional shift and maintain carbon storage.

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The impact of a tropical storm on the forest habitat and feeding ecology of Red Ruffed Lemurs (*Varecia rubra*) in northeast Madagascar

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Tropical storms and cyclones are known to have devastating, and sometimes long-term effects on entire ecosystems. These stochastic weather events can severely damage habitat and phenological processes, which have drastic effects on wildlife. This is evident in northeastern Madagascar, a region that is particularly susceptible to severe weather events from the southern Indian Ocean. Relatively little information is available, however, on the immediate impact of these events in Madagascar. On 19 March 2018, severe tropical storm Eliakim made landfall and moved directly over Masoala National Park, with sustained wind speeds of 110 km/h, and wind gusts reaching 151 km/h. Once the storm passed, we immediately examined its effects on the forest structure in the Andranobe Forest, recording all damaged trees within visual distance of our trail system. We also recorded the dimensions of newly created tree-fall canopy gaps. In total, we recorded 35.26 damaged trees per km, contributing to 93 new tree-fall canopy gaps. We then sought to determine how this event affected the flagship lemur species for the region, the Critically Endangered Red Ruffed Lemur (*Varecia rubra*). Ruffed lemurs are known to be the most frugivorous extant primate in Madagascar, and are patchily distributed throughout the eastern humid forests. We conducted full-day focal follows, recording all food items consumed via continuous sampling. Following Eliakim, Red Ruffed Lemurs fed mostly on unripe fruits, likely due to ripe fruits being more easily dispersed by sustained high winds. While it appears that red ruffed lemurs may have temporarily shifted their diet after the storm, in subsequent months they resumed their more typical pattern of feeding on ripe fruits most often. Despite the devastating impact of the storm on forest structure, the impact on feeding and available food items did not seem to be as extensive; red ruffed lemurs demonstrated short-term resilience.

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Lemur distribution in relation to tree-fall canopy gaps in Masoala National Park, northeast Madagascar

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Madagascar is considered to be a biodiversity hotspot due to its many endemic species listed as threatened or worse by the IUCN, and 95% of lemurs are threatened with extinction. There are myriad potential reasons for this, including anthropogenic and stochastic disturbances that lead to habitat degradation, deforestation, and fragmentation. While these pressures are widespread throughout Madagascar, Masoala National Park remains among the largest continuous blocks of humid forest, and is home to approximately 10 lemur species. Unfortunately, 50% of these are listed as either Endangered or Critically Endangered. This region is seasonally prone to cyclones, contributing significantly to tree-fall canopy gaps, which may influence the distribution of arboreal species. To determine current population density estimates for the lemurs of Masoala and how tree-fall gaps may affect their habitat use, we conducted diurnal and nocturnal lemur surveys at Andranobe, a primary forest site located along the west coast of the Masoala Peninsula. Six transects were repeatedly walked, covering a total of 42.8 km for diurnal lemurs, and a total of 25.8 km for nocturnal lemurs. We collected microhabitat data for each individual recorded, as well as measured their distance to the nearest tree-fall canopy gap. Red Ruffed Lemurs (*Varecia rubra*) and White-fronted Lemurs (*Eulemur albifrons*) were found to be in high densities, as were the nocturnal Masoala Woolly Lemurs (*Avahi mooreorum*) and Masoala Sportive Lemurs (*Lepilemur scottorum*). Compared to all observed lemurs, *V. rubra* utilized significantly larger trees. Considering habitat disturbance, nocturnal lemurs appeared to avoid forest canopy gaps, maintaining farther distances from them compared to diurnal lemurs. This may be a strategy to avoid detection by predators, whereas diurnal species may utilize habitats closer to gaps based on potentially more abundant, higher quality food items. Understanding these species-specific responses to habitat disturbance is crucial when developing conservation strategies.

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Ecosystem typological classification used in legends of Madagascar land cover map

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A land cover map is an effective way to manage and protect ecosystems. Associated with this type of map, nomenclature has an important role in both its understanding and the interoperability of data with other maps. Thus, the objective of this study is to ameliorate the environment management by the optimization of land cover map. Inventory and comparison of national and international nomenclature formed a basis for the elaboration of the nomenclature. This synthesis has combined with use of the FAO Classification System to allow to propose an internationally recognized standard nomenclature. This method is based on the Land Cover Meta Language rules applied by using Land Cover Classification System software version 3. To apply the nomenclature, three localities were mapped using Landsat images: the Biocultural site of Antrema, the Strict Nature Reserve of Betampona, and the Itampolo bush. The study made it possible to describe in an exhaustive manner the observed biophysical surface of Madagascar and the proposed nomenclature showed a detailed structural physiognomic description of the classes. These biophysical entities concern at the first class level artificial surfaces, agricultural areas, vegetation, open spaces, and water bodies. Landsat satellite image classifications have also shown the applicability of the proposed nomenclature. In general terms, this study is an introduction to in-depth work on land cover nomenclature that requires collaboration of each concerned entities and may lead to the establishment of a national database.

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Monitoring the population of Meller's Duck *Anas melleri* in Ambatovy Madagascar to understand the nesting territory

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Ambatovy is an open pit mine located in the eastern rain forest of Madagascar, an area recognized for its high regional endemism in biodiversity. Ambatovy, through the Ambatovy Environment Management System, has committed to avoid biodiversity losses by implementing a series of mitigation measures and conservation actions to reduce the potential impacts of mining activities. Conserving the bird population and species is one of the main activities. The transformation of the landscape through the creation of four sediment control dams at Ambatovy has created new wetland habitat that attracts water birds. Our objective is to monitor the population of priority water bird species such as Meller's Duck, *Anas melleri*, occurring in the dams in order to reduce possible impacts and to inform conservation actions. Trying to understand population trends, Ambatovy conducted trapping, marking, and fitting tags to bird species in November 2017. The annual surveys show a significant decline in *A. melleri* population between November and March at the mine site. From the three individuals tagged, monitoring found that the nest territory of the species was located in abandoned ricefields, which had turned into marshlands located downstream of the dams, over a surface area of 12.68 ha. The vegetation comprised *Cyperus* sp. and dense tufts of other herhaceous vegetation. Two females were observed, one with eight offspring and the other one with five ducklings. This study provides additional information about nesting habits of *A. melleri* in Madagascar. Continued monitoring is needed to understand the landscape and habitat requirements of these water birds.

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Community-ecological analysis of lianas in a seasonal evergreen forest in northeastern Thailand

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Lianas are known to impact forest tree growth and regeneration. Understanding liana ecology is important for forest dynamics. We aimed to understand interactions between lianas and trees as a part of liana ecology. This study was conducted in 50 subplots (10 × 10 m) of a forest dynamics monitoring plot (50 × 500 m) in a seasonal evergreen forest in northeastern Thailand. We tagged all liana stems ≥ 1 cm diameter at breast height (DBH) and recorded their species, DBH, and host tree information in 2018. Combining these data with tree census data in 2018 and canopy height class data of gap (< 10 m), building (10–20 m), or mature (≥ 20 m) phases in 1993 and 2018, we examined a size relationship between lianas and host trees, and liana abundance along tree stem density or canopy height class gradient. We found 445 individuals (511 stems) of lianas including 34 species from 17 families. Liana DBH had a positive allometry with host tree DBH with a slope less than one on a log-log plot. Liana stem density showed no correlation with tree stem density on a subplot scale. Liana stem density in 2018 was higher in sites which were gap or building in 1993, than where were mature in 1993. Canopy height classes in 2018, on the other hand, showed no significant difference in the liana stem density. While tree stem density may not simply explain liana abundance in this forest, old treefall gaps rather than new gaps seem important in explaining current spatial distribution of lianas. We concluded that it should be important for liana abundance examination to take past decades of treefall gap dynamics into consideration.

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Community ex-situ conservation of the endemic wild yams in northern Madagascar

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Wild yams, *Dioscorea*, are an important part of Madagascar's biodiversity, with 7% of global wild yams, most endemic. The wild yams have an important role in Malagasy diet as their tubers constitute a source foods and income during the hungry season. The north has the highest diversity with 15 edible endemic yams and two new species, most of them are threatened by habitat degradation due to shifting agriculture and tubers over collection, now often at unstainable levels. Within the project funded by Darwin Initiative our objective is to ensure the survival of wild yam species in the forests and improving communities' food security and livelihoods. We have adopted participatory approach by involving local communities and households. They were trained in yams planting and seeds collecting. Demonstration plots have been established as a tool for wild yams conservation in each community and region. Each household has been sensitized to have their own plots where they grew both cultivated (*D. alata*) and local wild species via vegetative propagation material that is supplied by the project or obtained from habitat near the community. In total, we have worked in two regions (Diana and Sofia) with 45 communities (14 in Antsiranana, 15 in Ambanja, 12 in Analalava, two in Antsohihy, and two in Port Bergé) covering 2395 households growing *D. alata*, and 12 wild species that six of them are threatened. 111 seeds collections were realized. As crops got during the harvesting (78 tonnes) increase more and more the project we are currently undertaking marketing study and planning to train communities in transformation and processing technics.

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Seed dispersal & germination by native vs. exotic avian frugivores of Hawai‘i Island

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On islands worldwide, mass avian extinctions related to anthropogenic activity have allowed smaller avian generalist to inadequately fill ecological niches left open by larger native specialist. Consequently, ensuring the survival of Hawai‘i Island’s remaining native frugivores, the threatened ‘ōma‘o (*Myadestes obscurus*) and critically endangered ‘alalā (*Corvus hawaiiensis*), is integral in preserving seed dispersal function and native plant recruitment in Hawaii’s declining forests. In lieu of relying completely on exotic birds as proxies for native seed dispersers, conservationist have begun re-introducing native frugivores into historic ranges to refill the empty niches previously left open by their localized extinction. In light of this, I compared how exotic and native birds influence the dispersal and recruitment of Hawaiian fruiting plants. To identify native plant species dispersed by avian frugivores, I used seed rain traps and collected fecal samples from native ‘ōma‘o and ‘alalā and exotic Japanese white-eye (*Zosterops japonicus*). Seed rain traps were used to identify fruiting plants dispersed in the landscape while fecal samples were used to distinguish the diversity of plant species dispersed by each avian species. Additionally, these seeds were placed in growth media to compare gut-passage effects on seed germination for each avian species. The preliminary results show that in native dominated forests both native and exotic frugivores benefit the seed dispersal of native plants. However, a higher diversity of native seeds was dispersed by native frugivores. Exotic frugivores were limited to dispersing fewer of number plant species which mainly consisted of small seeded plants. This pattern is likely due to the exotic frugivores smaller gape and body size. These results substantiate the use of ‘ōma‘o and ‘alalā reintroductions as a strategy to increase their ranges while simultaneouly promoting the regeneration of native Hawaiian fruiting plants.

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Fire and carbon balance of the Miombo woodlands of Niassa National Reserve, northern Mozambique

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The Miombo woodlands are the most extensive warm dry forest type in southern Africa, covering ca. 2.7 million km2 across seven countries. In Mozambique, this formation covers two-thirds of the national territory. Being an important hotspot of plant biodiversity Miombo is a key provider of goods and services, supporting the livelihoods of more than 65 million of people in the region. The ecology of Miombo is strongly influenced by woody vegetation, which is in turn influenced by a combination of climate conditions and disturbances, including: drought, fire, and herbivory, primarily by elephants and human activities. Growing population in the region over the last 20-25 years has resulted in increased woodland degradation and deforestation. Global climate changes constitute another important factor in southern Africa and Mozambique in particular. This study was conducted in the Niassa National Reserve (NNR) in northern Mozambique, which is the most important conservation area in Mozambique (circa 42.000 km2; 25% of the total conservation area in the country) and of Miombo woodlands in the World. In this study we used the individual-based forest model (FORMIND) to analyze the carbon balance in the Miombo woodlands. The main processes of this model are tree growth, mortality, regeneration, and competition. Model parameters were calibrated using forest inventory data from a Miombo forest in NNR. Preliminary results indicate that the the model successfully reproduced important characteristics of the woodlands (aboveground biomass, stem size distribution, and basal area).

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Inventory and Redlist assessment of plants in Ambatofinandrahana for conservation

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With natural vegetation ranging from humid forest to spiny forest, Madagascar is home to more than 12,000 plants species, 90% of which occur no where else in the world. Ambatofinandrahana KBA is in the Central Highlands of Madagascar, occurs on a variety of soil and rock types, and its vegetation is dominated by grassland with *Tapia bojeri* and *Loudetia simplex*. There is a lack of management information about plant species of the area, whereas their extinction risks are high due to human activities. Within the CEPF grant our studies aimed to survey and map the flora and vegetation of Ambatofinandrahana KBA and compile the baseline data to help in the conservation management plan. To meet these objectives participatory intensive plants inventories were undertaken. The plant species were recorded in Brahms and in iNaturalist zavamaniry Gasy by using smartphone. The preliminary IUCN assessments were done by using the GeoCat tool (http://geocat.kew.org) developed by the Royal Botanic Gardens Kew. So far, 336 species, 221 genera, and 85 families have been inventoried, 226 species have been recorded in iNaturalist (https://www.inaturalist.org/projects/ambatofinandrahanakba) and 47 species have been submitted to IUCN (CR: 6; EN: 19; VU: 11; NT: 3; LC: 8). These numbers will increase when we complte the planned fieldwork, specimen identifications, and IUCN assessments. As the Ambatofinandrahana KBA is well known by plant hunters who collect illegally orchids and succulents, we hope that the results of our studies would be important to the decision makers in the development of new conservation management plan of the species at risk of extinction.

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Evaluation of the functional infrastructure services and biodiversity of Bombetoka, NW Madagascar

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Diverse benefits are provided by ecosystems; however, human activities are a source of degradation of biodiversity. The ecosystem services account estimates the capacity of an ecosystem to provide services. This study was conducted in 2017 in the New Protected Area (NPA) of Bombetoka, in northwestern Madagascar, Boeny Region. Ecological studies of all the existing vegetation formations (dry forest, mangrove, and savanna) and a cartographic study were undertaken for ecological characterization and ecosystem accounting. Several methods were employed in this study: ecological surveys, investigations, visits to institutions, and map processing. The results obtained on the dry forest of of the site show that despite the local anthropogenic pressures, this formation is still pluristratified with a high rate of endemism (78%). The baseline assessment of functional ecosystem services shows that the land cover stock has declined over the past 10 years, with decreases of 632 ha in mangroves, 3638 ha in savannah, and 1211 ha in wetlands. All odf this is associated with ecosystem infrastructure having a negative value and the capacity of the ecosystem services have declined. Further, the existence of illegal logging in this protected area, the local ecosystems have deteriorated in their health with an internal unit value of ecosystem infrastructure inferior 1. Therefore, it is crucial to sensitize the local population about the importance of existing resources at this site.

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Potential mechanism of invasion success of *Psidium cattleianum* in Madagascar rainforest ecosystem from the perspective of herbivory

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Psidium cattleianum has been introduced in Madagascar over two centuries ago and is currently amongst the world worst invasive plant species. It is known to alter community structure and threatens the habitats of many fauna and flora species in rainforests. However, very little is known about its invasion ecology. We investigated the effects of *P. cattleianum* on native plant communities and tested whether herbivory could be a proxy mechanism of its invasion success in newly invaded ecosystems. Taking the case of Analamazaotra, eastern Madagascar, we first investigated how the presence of *P. cattleianum* affects the survival and performance of native seedlings. Then, we followed up herbivory rates on the seedlings of native species in invaded and non-invaded sites. We further conducted clipping experiments on *P. cattleianum* and on species that are phylogenetically close or distant to *P. cattleianum*. Different survival rates and performance of native seedlings in the absence of *P. cattleianum* indicates adverse or synergetic interactions with *P. cattleianum* while different performance of seedlings at different clipping rates indicates whether herbivory attacks affect the interactions between native and invasive species. This study has strong conservation implications and helps better understand how and why this non-native plant species has been successful in recently invaded ecosystems.

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Diet of re-introduced diademed sifakas in Analamazaotra Special Reserve-Andasibe, Madagascar

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The disappearence of diademed sifakas (*Propithecus diadema)* at Analamazaotra Special Reserve was the result of hunting in the 1970's. This research is based on the re-introduction and translocation of six groups of lemurs in this protected area two years after their release and the objective is to determine the diet of the re-introduced groups and find out how these lemurs survive in their new habitat. Three methods were used: plant species identification, plant phenology characterization, and scan animal sampling to continuously record the activities of these lemurs, including resting, moving, social activities, and feeding. These data were collected over two years. As a result, 134 species of plants, as well as soil, were identified as food sources. The feeding behaviour of the lemurs demonstrated that their diets were 74% folivorous. However, fruits and seeds became the main food source during ther fruiting season (Febraury and March), representing 80% of their diet. The main results regarding the conservation of this endangered species confirms that the re-introduced animals have adapted to their new habitat.

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Study of uses and local perceptions of the Ankorabe rainforest, eastern Madagascar

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Vohilahy is a tropical humid dense forest located in eastern Madagascar, Fokotany of Ankorabe, near Ranomafana-Est. In this region, an important loss of the forest is caused by both sedentary agriculture and slash-and-burn cultivation, as well as illegal logging. In order to understand the role played by this endangered ecosystem toward the local population subsistence and thus well-being, ethnobotanical surveys were carried out in the peripheral villages of the forest. The identification of plant uses and the local perceptions of the remaining forest were possible by using ethnobotanical interviews with 159 informants (sampling was stratified by age, gender, and residence groups). About 106 plants, a majority of tree species distributed in 44 families were listed. These species belong to different categories of use ranging from construction, medicines, cultural uses, and basketry. Of these species, 61 are used as material in house-building and only eight species as medicinal plants. The use frequency and the saliency index allowed us to identify the two most used forest species by local the population, *Iabrama bojerii* and *Uapaca littoral*, and are notably rare in the Vohilahy Forest: Furthermore, we identified a vulnerable species which is culturally important to the local populations: *Phylloxylon xylophylloides*. Otherwise, concerning the local perceptions, Vohilahy Forest is a source of raw materials, especialy timber. Today, the Vohilahy Forest has two major pressures: the *tavy* exercised by local people and the exploitation of timber intended for commercial sale. This ethnobotanical study on the uses and perception of the forest by the local population would allow them to use in a rational manner these plant resources in the near future. Thus, it could serve as a tool for forest conservation and the preservation of biodiversity.

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Building a future for the amphibians of Madagascar: Three years effort to achieve the Sahonagasy Action Plan

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According to the IUCN, 85 species of Malagasy frogs, out of 300 described species (28%), are listed as Endangered, and nine are Critically Endangered. About 200 additional species are waiting for formal descriptions. Madagascar has one of the richest worldwide levels of amphibian diversity and endemicity. At the species level, no extinction or catastrophic declines have been reported, nevertheless, habitat loss, new emerging diseases, and climate change make Madagascar a top priority for amphibian conservation. A new conservation Strategy for the Amphibians of Madagascar was established in 2016 and participants agreed on the urgency of defining priority areas for amphibian conservation. Long-term research projects at several important sites are used to develop strategies for the near term and for modelling species' conservation planning. Capacity building and networking have been identified as priorities within the action plan. Communication, education, information, and awareness campaigns are being delivered to Malagasy society and at the same time, engagement of the local community based organisations is promoting the biodiversity conservation and a sustainable use of the resources.

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Monitoring moths with photo recordings - A case study from Paraguay

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Monitoring biodiversity in the Anthropocene, especially that of insects, is critically important to detect changes in species distributions and population sizes. This monitoring, however, can be both labour intensive and costly, both are particularly limiting factors in tropical regions. Also, difficulties of storing the material make specimen collection an unrealistic option at most of the places. In this study we show a simple modular way for recording moth diversity based on standardized photography method. One single light trap with standardized bulbs was used to lure moths at the hyperdiverse Laguna Blanca, Paraguay, in 2015-16. Lepidoptera were recorded on a daily basis, on a consistent surface area within a 30-minute time-window. First an overview photo of the sheet was taken, then every morphospecies were photographed individually. Individuals off the sheet or outside of the recording time window were not registered. Over a year period, 1231 morphospecies were recorded by three volunteer parataxonomists. Although the identification is still ongoing, 384 species have been identified, belonging to 19 families, with Noctuidea being the most species rich. Nightly species numbers were greatly influenced by moon phases and heavy rains, and a clear seasonal separation was visible. Although the method is only suitable for recording visually distinguishable species, it can collect a valuable dataset on moth phenologies and distributions with ease, especially from remote tropical and subtropical regions. This simple method has the potential to be extended in many ways. Artificial intelligence can be used to automatically recognize species, both from the individual photos, or from the overview photo. Machines can be trained to count individuals of some common species, and thus, provide valuable information on the, otherwise unknown, flight activities of tropical species. Furthermore, moth DNA from the falling scales can easily be collected on a daily basis and identified using metabarcoding methods.

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Use of scenses by lemurs in fruit foraging

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Fruits and frugivores interaction is extremely important in Malagasy ecosystems because fruits and most of frugivore and their fruits-eaten are coevolved. Such interaction could display fruit choices by frugivores because fruits change their chemical composition as signal to attract frugivore. While a large body of literature has advanced our understanding of the interactions between fruits and lemurs in Malagasy ecosystems, few studies relate to the use of sensory perception in fruit selection by wild members of the genus *Eulemur*, specifically olfactory cues when foraging on high quality of foods and their selection. With a focus on *E. rubriventer*, this study aims to investigate the importance of sensory use: olfaction cues, vision, and sense of taste in fruit selection. Data was collected in the humid forest of Ranomafana National Park, during October-November 2016, through direct observations of a focal individual in three groups. Data show that feeding behavior depends on ripeness, chemical compounds, and color of fruits eaten. Sniffing index is higher when the chemical distance between ripe and unripe fruit is larger. Foraging efficiency is higher with conspicuous fruits and 45% of fruits eaten by this species are ripe. The uses of a logistic regression model showed that sense of taste helped animals the most in fruit foraging efficiency. Knowing about fruits that fit with lemur capacities and could be dispersed raises new discussion regarding lemur-plant interactions, an additional apprehension in establishing a priority of conservation toward plants and acquiring an innovative perspective in lemur conservation ex-situ.

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Conservation efforts towards contributing to the plant conservation strategies in Sabah, Malaysia

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Sabah is one of the mega-biodiversity hotspots which sits in the northern portion of the island of Borneo. More than 8300 taxa of seed plants are estimated to occur in Sabah, of which 13% are endemic to the state. Due to the rapid land use change in the state, efforts have to be taken to reduce biodiversity loss. In order to curtail the loss of plant diversity, an initiative to assess the conservation status of the flora of Sabah was started by the Sabah Forestry Department in collaboration with Universiti Malaysia Sabah in 2009. This initiative goes hand in hand with the global Aichi Biodiversity Target 12 and the Malaysian National Strategy for Plant Conservation. We compiled species distribution data and conducted botanical surveys across the state for targeted priority species, to produce threat status assessment using the IUCN Red List Assessment Criteria and Categories 3.1. In spite of the challenges faced, the initiative continues to strive to contribute to the global and national conservation targets. This paper will highlight some of the achievements of the initiative since its inception. The outcome of this initiative will also feed into the state's High Conservation Value assessment which aims to identify critical area of high conservation value that require urgent protection.

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Study of the plant community in areas of raffia, Boeny Region, western Madagascar

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Madagascar is a megabiodiversity country with an important endemism of flora and fauna. The Boeny Region in the western portion of the island is rich in forest resources such as dense forests, savannahs, mangroves, and raffia areas. *Raphia farinifera*, a monoecious plant, occurs in some areas managed by local grassroots communities or COBAs, such as at Ankilahila; managed by local authorities, such as at Beharafa Mangapaika Miadana; or restored raffia areas, such as at Tanandava Mariarano. This study was conducted via ecological surveys to understand the dynamics of raffia ecosystems. The Duvigneaud transect method and the Braun-Blanquet plating methods were adopted. The MARP method was carried out to complete the ecological surveys in order to identify the pressures and to provide recommendations for the local population, as well as members of local committees and local and/or national authorities, with the aim of habitat restoration. A total of 48 plant species belonging to 44 genera and 34 families were identified at thel study sites. The floristic compositions of the areas according to their management type are different. However, for raffia habitat in the same study area, the floristic composition seems similar. The density of raffia is very dense in the areas of management transfer and restoration but low in areas managed by the local communities. Many products from raffia palm are used for different purposes. Anthropogenic and natural pressures are the factors of degradation of the raffia areas. To ensure the sustainability of raffia palm, especially regeneration, in face of different pressures, to protect, restore, and train local people for sustainable development and biological conservation, different forms of information exchange are needed.

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Analysis of the potentialities of Anjiabory raffia palm in the Boeny Region, western Madagascar

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Madagascar is a country with a very famous biodiversity. There are many wood and non-wood forest products on the island. The raffia palm, *Raphia farinifera*, is a non-wood product that is very important and unique natural resource both in the daily life of the Malagasy people and in the natural forest ecosystem. The raffia areas of Anjiabory in the Boeny Region of western Madagascar are managed by the local grassroots community. Studies were carried out between 2011 and 2017 via plots and transects to learn about these natural resources and the different pressures they are undergoing. Surveys are also being conducted with the local population to assess pressures on raffia. During the study period, stand density and abundance decreased, particularly individual trees producing seed. The raffia areas are often an important water source for rice fields and for the local population. However, climate change, among the different pressures on the raffia areas, leads to the degradation of these resources. In fact, certain rice fields have become silted and the raffia palms fall during very intense cyclones. In addition, to counter act the effect of climate change and to have a balance between economic recovery and biological conservation, measures such as protection and restoration are needed to ensure the sustainability of raffia, especially regeneration.

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Phosphatase activity in response to soil depth and elevated CO2

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Root and microbial phosphatase enzymes, which mineralize organically bound phosphorus, provide a crucial mechanism to increase phosphorus availability in phosphorus-limited ecosystems. To inform models of phosphorus controls on tropical tree productivity, we conducted two investigations on different aspects of phosphatase in relation to environmental variation. Current models often include a distribution of roots within the soil profile, but they do not ascribe differential function, e.g., in phosphorus uptake, with root distribution. We measured soil phosphatase down to 1 m at four sites in Puerto Rico differing in phosphorus availability and related phosphatase to the depth distribution of inorganic phosphorus and fine roots. Using the para-nitrophenyl phosphate method, we found that soil phosphatase decreased with soil depth and varied by site. The highest levels of soil phosphatase occurred in ridge sites in the top 5 cm of soil. Model results suggest that phosphorus limitation will constrain the response of tropical trees to elevated atmospheric CO_2, but some of this constraint could be alleviated if CO_2 enrichment stimulates phosphatase activity. We tested this hypothesis with seedlings of four tropical tree species: *Inga spectablis*, *Adenanthera pavonina*, *Tabebuia rosea*, and *T. guayacan*. We grew the plants at the Smithsonian Tropical Research Institute in either 400 ppm CO_2 or 800 ppm CO_2 and measured the response of phosphatase activity. Three of the four species showed increased root phosphatase in elevated CO_2, supporting the hypothesis but increasing the challenge to identify plant traits associated with this response. Soil phosphatase varied with tree species but did not respond to elevated CO_2. Phosphatase activity, particularly in roots, varies with tree species, CO_2 concentration, and soil depth. We aim to use these datasets to parameterize current models under development as part of the Next Generation Ecosystem Experiments-Tropics project.

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Identifying conservation priorities in the dry deciduous of northwestern Madagascar

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The Ankobohobo wetlands and adjacent Mariarano forests are part of a matrix of wetland, mangrove, and dry forest ecosystems located in the Mahamavo region of northwestern Madagascar. The area supports important populations of endemic and globally threatened species, including the Endangered Coquerel's Sifaka (*Propithecus coquereli*) and the Critically Endangered Madagascar Fish Eagle (*Haliaeetus vociferoides*). Despite their ecological importance, Malagasy dry deciduous forests are some of the most degraded and fragmented in the country, with as little as 2% of natural forest cover remaining. As such, they are one of the most threatened biomes in the world. In the case of the Ankobohobo and Mariarano region specifically, we have observed deforestation activities and consequential declines in threatened species during a June-July monitoring programme, which has run annually since 2012. For many years, one breeding pair of *H. vociferoides* used the same tree within the study area to nest. Unfortunately, this tree was destroyed recently apparently due to logging for charcoal production or potentially as a targeted attack against this species. Given that Ankobohobo is one of only a handful of sites where this species, which has a global population of just 240 individuals, is known to breed, the destruction of this known nesting site is of great conservation concern. Local deforestation is also impacting the ranging patterns of *P. coquereli*, which has a sizeable population in the area despite the lack of formal protection. These sifakas use both dry forest and mangrove habitat, while also exploiting highly disturbed areas around human settlements. Incidental sightings suggest their use of mangroves has reduced, likely in response to the rapid deforestation in the area. We now plan to implement a year-round monitoring program in association with local people to both explore these changes in more detail and engage the community with protecting this area.

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Synanthropic bats as potential suppressors of multiple agricultural pests: A case study from Madagascar

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The conversion of natural habitats to agriculture is one of the main drivers of biotic change. Madagascar is no exception and land conversion is impacting the island's exceptional biodiversity. Although most species are negatively affected by agricultural expansion, some, such as synanthropic bats, may benefit from man-made agricultural ecosystems. In this context, insectivorous bats may be preferentially roosting and foraging within agricultural areas, potentially providing important pest suppression services. To investigate this, we i) assessed roost selection by synanthropic bats in villages around Ranomafana National Park; ii) conducted acoustic surveys of insectivorous bats in five landcover types (irrigated rice, hillside rice, secondary vegetation, forest fragment, and continuous forest) across an agricultural-forest frontier; and, iii) conducted diet analyses for the six most common bat species using DNA metabarcoding. During November and December 2015, ten villages were surveyed, with bats occupying 21 of the 180 evaluated buildings. Of those, 17 were public buildings harbouring large molossid colonies. The acoustic surveys yielded 9,569 bat passes from 19 species. Total bat activity was higher over rice fields when compared to forest and bats belonging to the open space and edge space sonotypes were the most benefited by the conversion of forest to hillside and irrigated rice. Two economically important rice pests were detected in the faecal samples collected - the paddy swarming armyworm *Spodoptera mauritia* was detected in *Mops leucogaster* samples while the grass webworm *Herpetogramma licarsisalis* was detected from *Mormopterus jugularis* and *Miniopterus majori* samples. We also detected presence of pests of other crops as well insect disease vectors. In light of our results, we argue that Malagasy insectivorous bats provide important ecosystem services at the forest frontier. It is important to retain and maximise Malagasy bat populations as they may contribute to higher agricultural yields and promote sustainable livelihoods.

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Description of *Microcebus tavaratra* and *M. arnholdi* distribution in northern Madagascar with environmental and anthropogenic factors

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Mouse lemurs are small forest-dependent primates that have been shown to be also present in disturbed environments. There are still uncertainties regarding their ability to live in different types of environments. In this study we describe, the distribution of *Microcebus tavaratra* & *M. arnholdi* in the north and northeast of Madagascar, which we correlate with three physical measures of habitat type and one mesure of the human footprint. Between 2010 and 2018, we observed 3,392 individuals over an area of 14'000 km². We estimated the density (D) of the mouse lemur populations in all visited forests. We then analyzed the influence of two environmental variables: elevation (DEM) and the discrete component of vegetation geology (VEGEOL). We tested a mixed anthropogenic and environmental variable: percentage of forest cover (FC). And finally, an anthropogenic variable: the human footprint (HFP), to describe the spatial distribution of the two species of Microcebus present in the north and north-east of Madagascar. We are integrating the 2018 field data to analyze all the complete dataset. We can already say that, according to our observations, *M. tavaratra* occurs in: altitudes up to 550 m (DEM preliminary data), densities between 150 and 250 ind / km² (preliminary DEM data), deciduous dry season western forests covered with rocks, lava and *tsingy* (preliminary VEGEOL data), forests with 55-75% vegetative cover (preliminary CF data), and human footprints between 4/50 and 7/50. While the results of *M. arnholdi* are not ready yet they, could be used together with those of *M. tavaratra* to help forest planners to build conservation programs. This approach could be extended to other genera such as *Lepilemur*, whose species are often co-distributed with *Microcebus* species but are even more threatened.

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Use of degraded habitats in *Propithecus coronatus* along the southern Mahavavy River (Antanimalandy and Antsoherikely), Madagascar

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Propithecus coronatus is a diurnal species and lives in groups. Its range in western Madagascar is between the Betsiboka River to the east and the Mahavavy River to the west. Because of the destruction of its habitat, it is in Criticallly Endangered in the IUCN Red List. Studies were carried out during the dry season (between August-October 2009) in the forests along the southern Mahavavy River (Antanimalandy and Antsoherikely). Despite the decrease in forest area, *P. coronatus* is struggling to survive, but there is a small remaining area left for these animals to feed and large trees to move (DBH greater than 95 cm). Cultivation and charcoal production are the major factors for the loss of this species' habitat.

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Ecological permanent plot monitoring and the natural regeneration of low altitude rainforest of Betampona, eastern Madagascar

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The Betampona protected area is a primary low altitude rainforest. As other eastern rainforests in Madagascar, this forest is threatened by human activities, as well as by the impact of cyclones and invasive plant species. The site presents an exceptional high biodiversity. The purpose of this study is to provide the conservation and protection of this forest, especially with regards to its sustainable and efficient management. Nine permanent plots for control and monitoring were installed in different topographic situations. Collected data focus on the evaluation of the regenerative capacity of the forest and the distribution of species based on topography. In each plot, differences were observed in the composition and structure according to ecological factors and/or degree of disturbance. 220 species divided in 138 genera and 57 families and the presence of endemic families were identified, as well as a high specific endemism (82%). On the slope summits, often affected by cyclones, the regeneration rate is 373% and on mid-level slopes the figure is 430%, constituting the climax vegetation, which is better sheltered from disturbances. The forest in bottom valleys is well protected from cyclones, although invasive plant species affect this topographic formation, which was a regeneration rate of 436%.

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Do inquiline termites actually feed on their host's nest material?

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Termite mounds often shelter termite species other than the builder. These inquiline species may forage for food outside the host's nest, but some species apparently do not, living their whole life feeding on the host's food stores or on the nest material itself. The Neotropical species *Cavitermes tuberosus* (Termitidae: Termitinae) is a broad-spectrum inquiline, commonly found in nests built by other termite species, sometimes still occupied by the builder. *Cavitermes tuberosus* seems not to forage outside the nest. Here, our aim was to investigate the actual feeding niche of this species. We combined ecological data, stable isotope ratios and Illumina MiSeq sequencing of the 16S rRNA gene to analyse termites and nest materials from different builder hosts and to identify bacterial communities. We found that the colonization by *C. tuberosus* gradually modifies the physico-chemical composition of the nests. Stable isotope ratios suggest that *C. tuberosus* actually feeds on nest organic matter. Its gut microbiota is very diverse, and most similar to one of its main hosts, *Labiotermes labralis*. Nitrogen depletion might be prevented by N-fixing bacteria, present in substantial proportions in the nests. Our results therefore confirm *C. tuberosus* as an obligatory, yet non-specific inquiline species, whose ecological success may have benefited from its adaptability to several hosts.

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Water account of the three protected areas in Region of Boeny (Madagscar): Antrema, Bombetoka, and Mahavavy-Kinkony

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The use of water resources is increasing worldwide. The sustainability of this use can be assessed by comparing the volume of used water and the amount of water available in the environment. However, few 'water' accounts are available. This study applies the ecosystem natural capital accounting for water to three protected areas in northwestern Madagascar: Antrema, Bombetoka, and the Mahavavy-Kinkony. The objective is to assess the current status and flow of water resources in these areas to improve management. In addition to surveys of water use and socio-economics in these areas, MODIS images were also used and processed. The results of the analysis show that water stocks in these areas is decreasing slightly by 1 to 2% in 10 years. This results in a reduction in the net excess of accessible water in the ecosystem. On the other hand, the use of water by the local population has increased but the degradation of forest cover in these areas has led to a decline in the total use of ecosystem water in 10 years. The health of ecosystem water remains stable during these periods, without degradation or improvement. Despite the long-term decline in the water supply, the use of current water resources in these three protected areas is still sustainable. Accessible and exploitable water resources are still sufficient to sustain ecosystem functioning and human use needs in the coming years provided that there is no change in the economic structure that requires an increase in the water need.

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Nests characteristics of Madagascar Buzzard *Buteo brachypterus* in Bemanevika Protected Area, north central Madagascar

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Few studies have been conducted on the breeding biology of the Madagascar Buzzard (*Buteo brachypterus*). During the 2017 and 2018 breeding seasons, 18 and 14 (respectively) active nests of this species were followed in the Bemanevika Protected Area. Nest locations and distance measurements were recorded using a GPS. The behaviors of adults were recorded by direct and continuous observations and different measurements made with respect to nest height and DBH of nest trees. 11 out of 32 nests observed were not used in 2018, including four nests containing one egg, six abandoned nests, and one destroyed nest. Of 25 nests followed, 15 (60%) were inside the forest 10 (40 %) at the forest edge. The period of nest construction required 15 to 33 days (n = 2 nests). The male collected 51.9% of nest material (n = 145 times, n = 279, 5 couples) and females 48.1% (n = 134 times); females were largely responsible of nest construction. Nest height averaged from 17.1 ± 4.4 m (range 11 to 28 m, n = 25 nests). Nest tree DBH averaged 58.9 ± 25.5 cm (range 22 to 110 cm, n = 25 nests). The current study shows that the reoccupation nest rate of the Madagascar Buzzard is higher at Bemanevika than in the other rainforests on the island, such as Masoala.

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Assessment of Madagascar Fish Eagle *Haliaeetus vociferoides* population ten years after the last global population survey

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Madagascar is home 17 diurnal and 6 nocturnal raptor species, of which 12 are endemic and 3 are listed among the rarest birds in the world, including the Madagascar Fish Eagle (*Haliaeetus vociferoides*). The current study is mainly focused on updating data on the population size and distribution of this species, which is a large raptor species, endemic to the island, and classified as Critically Endangered. Between July 2016 and January 2017, the study was carried out at 12 different sites in western Madagascar, which overlaps with 40% of the known range of the species, and including from Nosy Hara in the north to the Morombe District in the south and in a range of different aquatic ecosystems. The census was conducted by direct observation using binoculars and a telescope. This technique was combined with informal surveys of the local people and fishermen. A total of 197 individuals consisting of 59 pairs, 11 trios (2 males and 1 female), 5 solitary adults, 7 subadults, and 34 juveniles were recorded. This data shows an average population growth of 1.2 % per year between 2006 and 2016. The current geographical range is between Nosy Hara and Belo-sur-Tsiribihina District (in the south) and up to 140 km inland around the Districts of Maevatanana and Miandrivazo. A significant difference was found between the number of individuals in protected areas and non-protected areas. The study has helped protected area managers at four sites in the northwest to include this species in the list of their target species for conservation and management actions.

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The effect of landscape variables on the habitat suitability of cougars (*Puma concolor*) in the Critically Endangered Tumbesian Dry Forest

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Large predators help to maintain a healthy ecosystem by avoiding the hyper-abundance of herbivores and mesocarnivores; however, their populations are declining because of anthropogenic impacts. The Tumbesian dry forest (TDF), in Peru and Ecuador, is a Critically Engendered ecosystem in which jaguars are extinct. Cougars (*Puma concolor*) are the only remaining top predator in this ecosystem, yet their conservation is hindered by a lack of empirical information on habitat suitability. Our main objective was to inform habitat suitability by quantifying the effect of five landscape variables on Cougar presence: forest cover, elevation, aspect, slope, and road distance. We evaluated this effect using survey data from 259 camera trapping sites within 14 localities distributed across the TDF. We used zero-inflated generalized linear mixed models to relate number of Cougar detections per camera site to the predictor variables characterized from published data (forest), online data sets (USGS: elevation-(DEM), OpenStreetMap: roads), or extracted using DEM and ArcGIS 16.1 (slope and aspect). We treated locality as a random effect to account for non-independence among camera sites within localities; and used AIC to select the best models. We tested 21 candidate models using the package glmmTMB in the R software. The best models indicate that Cougar detections decrease with proximity to roads, aspect, and forest cover, and increase with elevation. These results are consistent with previous studies that suggest Cougars avoid areas of high human impact. However, our results contradict studies from other regions that characterize Cougars as forest-dependent species. We suggest that this difference relates to Cougar behavior of moving through the landscape using trails and foraging near the forest edge. Because Cougars are the only large predators in this ecosystem, improving our understanding of their habitat needs will help managers conserve the species and maintain a healthy ecosystem.

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Development and digitizing the bryophytes collections at the TAN Herbarium, Tsimbazaza

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To answer the lack of biodiversity data for Malagasy bryophytes, focussing on mosses, liverworts, and hornworts. These tiny plants, mostly unknown by the public, have crucial ecological functions in humid forest (water storage with slow release) and in open, dry ecosystems (first colonizers of naked soils or rocks, humus initiators). Since the end of the 19th-century more than ca 3000 dry bryophytes specimens have been deposited in the (TAN) herbarium at the Parc Botanique et Zoologique de Tsimbazaza, Antananarivo, and remain mostly unexploited. A project BRYOTAN aimed to build a database on Malagasy mosses (751 species reported) and to make taxonomic, geographical, and temporal specimen data available. First, data from herbarium labels will be gathered and adapted to computerization, including new geolocalization. The data was recorded on a database manager: BRAHMS (Botanical Research and Herbarium Management System). An identification and training workshop was organized in 2018 in Antananarivo, welcoming international specialists and local botanists. This enhanced efficient taxonomic data production from herbarium specimen, and training of Malagasy bryologists for future. The bryophytes specimens at TAN was repacked and arranged in a new cabinet. Occurrences data were shared through GBIF portal, more than 3000 entries estimated. Data mobilization was completed by images acquisition of few interesting taxa. The project involved three Malagasy partners, with strong skills in herbarium management, computerization, web development, and bryology (Parc Botanique et Zoologique de Tsimbazaza, Missouri Botanical Garden representative in Madagascar and Mahajanga University). French partner, Muséum National d`Histoire Naturelle was involved associated with bryophyte systematics. The project shared high quality data to complete a checklist to Malagasy bryophytes, to elaborate a plan for taking in account bryophytes in conservation, and desimminate information to local people and institutions in charge of the biodiversity management about this poorly known group of plants.

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Evaluation of tree tubes and coconut fiber to improve the survival and growth of native tree seedlings as part of forest restoration endeavors at Oronjia PA, Madagascar

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The Oronjia Forest Protected Area is a dry deciduous forest in northern Madagascar. While the forest is degraded due to mainly historic anthropogenic activities it retains an important biodiversity and merits conservation. While some parts of the forest are now naturally regenerating, woody plants are very slow to naturally colonize abandoned fields within the forest and the site's managers would like to intervene to hasten the process. However, native trees planted previously at this location had a very high mortality and survivors had a very slow growth. These results were likely due to the harsh environmental conditions at this location including an 8-month dry season, strong desiccating winds, full exposure to sun, sandy soil non-retentive of water, and foraging goats, sheep, and cattle. Possible approaches to mitigate these conditions and improve seedling survival and growth include use of tree tubes and the addition of shredded coconut fiber into the planting holes. To test the efficacy of such interventions we monitored survival and growth of a total of 464 seedlings of seven native woody plants under four treatments: coconut fiber in planting hole and tree tube; coconut fiber in planting hole, and no tree tube; non coconut fiber in planting hole and tree tube; and control. The six-month results are presented here.

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Mimosa latispinosa, an asset for an ecological restoration of the mining site of QIT Minerals Madagascar (Fort-Dauphin)

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Madagascar, known for being both a mega-biodiversity and a hotspot of biodiversity must today, for its development, be able to exploit its mineral resources while preserving or even restoring its biodiversity. In the southeast of Madagascar, the QIT Minerals Madagascar (QMM) mine is located on almost all the last littoral forest patches in the region. The restoration of the site therefore becomes a necessity and should render the expected ecosystem services. Among the biological tools that can be valued are the symbiosis plants-microorganisms, hence, the choice focused on *Mimosa latispinosa*. Indeed, this native pioneer species, is able to form symbiosis not only with mychorizhian fungi but also with bacteria such as nitrogen-fixing bacteria. Thus, this study aims to evaluate the ability of this species to improve the chemical and microbiological properties of degraded soils after exploitation over time. To do this, chemical analyzes (pH, N, P, K) and microbiological (total microbial activity, phosphatase activities) were performed on soils occupied by *M. latispinosa* for one to three years. The results obtained showed: (i) the capacity of *M. latispinosa* to significantly improve the fertility of the degraded soils of the mine site over time, for all parameters tested and (ii) that three years of occupation of *M. latispinosa* on degraded soil bring the properties of soil to that of the forest soils present in the mining site. This study shows that *M. latispinosa* is a good candidate for the ecological restoration of the QMM mine site.

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Multi-scale variation in height-diameter relationship in central Africa

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Tree height and diameter relationship (H–D) is known to strongly vary across forest types and thus constitutes a major driver of above-ground biomass. Studies have shown that a wide variation of H–D among biogeographic regions were poorly explained by environmental variables. Yet less is known about how H–D varies within a given biogeographical region. Here, we examined how H–D varies within and between sites in central Africa and aimed at identifying the drivers of these variations. We established 83 1-ha plots in ten sites from three central African countries. We measured 39,006 trees for diameter and 4,933 trees for total height. We collected soils within each plot, analysed ten variables and extracted ten bioclimatic variables from the *Worldclim* database. We fitted log-linear regression on (i) all the H–D dataset irrespective of sites (regional H–D) and (ii) by considering plot identity as a fixed effect in the model (plot specific H–D). Model coefficients associated with plots were extracted as a measure of plot-to-plot variability, which was then partitioned into within-site and between-site variances. We used these coefficients and ecological predictors in linear models to select best models leading to the highest decrease in root-mean-square-error via a leave-one cross-validation scheme. Our analyses revealed strong local plot-to-plot variation in H–D; within-site H–D variation accounted for 71% variance while between-site variation accounted for only 29% of the variance. This indicates that large scale bioclimatic gradients can explain 30% variance in H–D at best. The best predictors of H-D variation were plot-level basal area, height above nearest drainage and stem density. To conclude, most of the variance in HD is local, driven by forest structure properties. Thus tropical forest carbon stock assessment should account for this local variability to avoid large errors in carbon stock estimates.

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Diet composition and key food plants of *Eulemur rubriventer* and *Varecia variegata editorum* in Maromizaha Protected Area, eastern Madagascar

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The Red-bellied Lemur *Eulemur rubriventer* (2.0 kg) and the Southern Ruffed Lemur *Varecia variegata editorum* (3.6 kg) are known to be predominantly frugivorous. To expand our knowledge about their dietary flexibility particularly in the dry season, we collected feeding data on three groups of each lemur species in Maromizaha Protected Area (MPA), eastern Madagascar. We employed focal animal sampling and continuous data recording of all feeding events during our observation, spanning from August to December 2018. We found that, contrary to previous studies, the main diets of *E. rubriventer* and *V. v. editorum* during this time were leaves (66.9% vs. 50.9% of total time observed feeding, respectively). The lemurs also consumed fruit and flowers although with different emphases; whereas *E. rubriventer* incorporated more fruit in its diet than *V. v. editorum* (28.8% vs. 17.3%), *V. v. editorum* ate more flowers than *E. rubriventer* (30.9% vs. 4.4%). In terms of diet richness, *V. v. editorum* consumed many more plant species than *E. rubriventer* (56 vs. 20 plant species), and nine plant species were shared by both lemurs. Additionally, *V. v. editorum* had a more diverse diet than *E. rubriventer* (*D* = 0.882 vs. 0.439). In *V. v. editorum* the key food plants, as represented by >75% of total feeding time, included 10 species, of which *Symphonia tanalensis* (Clusiaceae) was the main food source (29.5%). On the other hand, the key food plants of *E. rubriventer* consisted of only five species. Specifically, the leaves of a tree fern *Cyathea* sp. (Cyatheaceae) alone accounted for 56.2% of the lemur's total feeding time. We discuss our findings with respect to the two lemurs' home range, activity, and other aspects of their behavioral ecology. Further studies are needed to determine seasonal fruit availability in MPA and how these lemurs exploit food resources year-round.

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Frugivory and seed dispersal patterns of Black-and-white Ruffed Lemurs in the fragmented forest of Torotofotsy-Ihofa, eastern Madagascar

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Frugivorous vertebrates can play an important role in shaping forest tree community structure, by setting an initial template for later recruitment stages through seed dispersal. By doing so, they could also help in the regeneration of degraded habitats such as those resulting from anthropogenic fragmentation. Here, we aim to assess the importance of seed dispersal by Black-and-white Ruffed Lemurs *(Varecia variegata*) in the fragmented forest of the Complexe Torotorofotsy-Ihofa in the eastern part of Madagascar. We report on some quantitative components of seed dispersal effectiveness by three lemur groups. We collected data for three months, through direct observations of feeding and dispersal events, and assessment of the microhabitats in which seeds were deposited. Fruits accounted for 76% of the plant items in their diet, with up to 99% of the consumed fruits were ripe and with a rate of 2.38 fruits removed from a tree per min. The dispersed seed species accounted for 84% of the fruit species they consumed (n = 19 species). They dispersed seeds in microhabitats with different canopy covers; however, a large proportion of the dispersal events (on average 58%) occurred mostly under more open canopy (*i.e.* < 50% cover). These seeds reach the ground either in clumps or in scattered pattern, with a distance of 3 m between each seed on average (up to 8 m). The present findings could have important implications for understanding their role in shaping plant community structure and maintenance of plant diversity in fragmented habitats.

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The sustainability of indigenous livelihoods in the Amazonian forests: Is deforestation changing with Conditional Cash Transfers?

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The Brazilian Amazon is the largest world's tropical forest, 23% of which are occupied by indigenous territories, thus their fate is essential for biodiversity conservation. Evidence suggests that, under low human density, land uses by indigenous societies produce low deforestation rates. Yet increased access to cash income may imperil the sustainability of indigenous livelihoods if it increases deforestation rates. Nowadays, even in Amazonian remote areas, Brazilian indigenous people have access to cash income through Conditional Cash Transfers (CCTs), a strategy aimed at breaking the poverty cycle through human capital enhancement. Despite the worldwide popularity of CCTs, few studies have investigated their long-term impacts on natural resource use by forest inhabitants. Moreover, existing studies adopt rationalist decision-making models, which disregard two peasant economies peculiarities. First, time allocation decisions may depend on the trade-offs between income and the drudgery of work (Chayanovian theory). Second, people may mentally treat time as "work" and "non-work" (Thaler's Mental Accounting model). Decision model rules directly impinge upon the expected time people allocate to subsistence activities, thus they likely affect crop area sizes and, consequently, deforestation predictions. Hence, understanding how decision models alter the predictions of CCTs long-term impacts is important. We, therefore, simulated CCTs impacts on deforestation caused by agriculture, and if/how alternative decision models affected predictions for the Brazilian Bolsa Família CCTs to the Kĩsêdjê people. We did so through an agent-based model, parameterized with empirical data gathered using a panel survey based on interviews, time allocation, weigh day and measurement of agricultural plots. Preliminary field results show a positive relationship between crop area and household size, which indicates time allocation decisions might follow a Chayanovian model. Moreover, CCTs were not associated with changes in time allocated to subsistence activities, indicating a minimum work-time budget exists and people do mental accounting of time.

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Occurrence of forest stream dragonflies and damselflies (Odonata) in an agriculture-dominated landscape in southern Costa Rica

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Even though dragonflies and damselflies are frequently used as indicator species to assess the quality of freshwater ecosystems, our knowledge on how tropical forest stream odonates react to forest conversion and to what extent they are capable of utilising anthropogenically modified habitats is still insufficient. Therefore, our study conducted in the Pacific lowlands of Costa Rica aims to evaluate how the landscape configuration and particularly forest structures (e.g. strips of gallery forests) embedded in the human-dominated countryside facilitate the dispersion of forest species. We further assessed to what extent oil palm plantations, an increasingly important land-use system in our study area, may act as suitable habitats for forest odonates. A total of 38 sampling points along streams and 180 points across the landscape matrix were selected to sample odonates between 2015 and 2019 within an area of 35 km² in vicinity to the Tropical Field Station La Gamba. In total, we collected almost 5000 individuals belonging to more than 70 species, including 35 forest species. Our results suggest that the human-dominated landscape matrix, mainly characterized by pastures and oil palm plantations, acts as a crucial dispersal barrier for the majority of forest odonates. Oil palm plantations harbour a considerably different set of odonate species compared to forest sites and may only represent a suitable habitat for a small fraction of generalist forest species. To mitigate the current barrier function of the anthropogenically modified landscape matrix for forest species, the creation and maintenance of forest corridors (e.g. continuous strips of forest along streams and rivers) and stepping stones (e.g. secondary forest patches) is highly recommended.

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Mapping movements of herded livestock in a tropical dry forest of S Madagascar with respect to season and security: Differentiating between frequently-visited areas and high-duration visitation spots

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Livestock are an integral part of the economy in the communities around Bezà Mahafaly Special Reserve (BMSR) in southern Madagascar. Herders move livestock through the landscape to take advantage of seasonal resources and at times, they rely heavily on tropical dry forests in the reserve for livestock fodder (from coppiced trees), forage, and shelter. These forests are also home to a rich biota including lemurs, tortoises, and birds. Livestock movements that are concentrated in time and/or space can have detrimental impacts on forest structure. The goal of this study was to document pastoralist's use of forests by documenting spatio-temporal patterns of livestock movements. The study area includes both the 4,600 ha BMSR, as well as surrounding unprotected lands. The movements of two livestock herds were tracked between 2007 and 2016. One herd uses lands in the northern part of the study area while the other uses lands in the south. The two share no grazing spaces in common. We used T-LoCoH to model utilization distributions that allow differentiation between frequently-visited areas (e.g., trails) and high-duration visitation spots (e.g., grazing grounds). We calculated monthly maps of livestock movements summarized to season. Movements of both herds vary by season, but the northern herd ranges more widely resulting in a higher number of both high-duration spots and frequently-visited areas. The southern herd relies more heavily on dry deciduous forests within the Reserve and its daily movements vary far less. During times of cattle insecurity, livestock movements were restricted. During times of drought, livestock movements were concentrated in forests. Results have important management implications for dry forests in the region. To minimize livestock degradation to forests at BMSR, it is important to manage for both food security (e.g., crop residue) and cattle security to allow herders to range widely with their livestock.

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Ontogeny of Greater Bamboo Lemur during the first three months in Ambalafary, eastern Madagascar

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Before reaching maturity, juvenile Greater Bamboo Lemurs, *Prolemur simus*, as other juvenile mammals show many development phases, each characterized by a period of long dependency. The aim of the study is to find how juvenile *P. simus* inhabiting Ambalafary interact with their mother and the other members of the group during the first three months of life. We investigate mother and other group members on by a focal animal sampling method of both mother and juveniles, and at the same time other member of the group. Juveniles depend completely on their mother during the first months of life: 90% of the juvenile's activity budget is associated with the mother, which includes exploring its surroundings by using arms and mouths without leaving mother contact. When juvenile reach the age of 2 or 3 months, they depend less on its mother (79.1% of all activity) and shows more frequent contact with other group members. At this age, juvenile *P. simus* dispaly interest in feeding on plants and explore independently. Overall the results indicate that mother and other individuals influence the activity budget of juvenile of *P. simus* during the first three months of its life, although exploring activity is acquired spontaneously.

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Advances in our knowledge of the Malagasy bryoflora through an international effort, the MADBRYO project

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Bryophytes (mosses etc.) are small terrestrial plants that primarily disperse via spores. They are the second most speciose group of land plants and play essential roles in water and nutrient cycling in many ecosystems. The latest checklist of bryophytes from Madagascar, a globally recognized biodiversity hotspot, contains 1144 taxa, but comparisons with other regions suggest that this number is a considerably underestimate of the actual richness of the island's bryoflora. The MADBRYO project aims to close the gaps in our knowledge by gathering together the specimen and taxonomic data that are currently scattered across multiple institutions, supplementing them as necessary with targeted collecting effort, and using them to develop a comprehensive flora for the bryophytes of Madagascar. Herbarium specimens represent a large and mostly untapped source of vital taxonomic and biogeographic data, but many of them have not been fully curated and are consequently difficult to use. In turn, the inaccessibility of the information they contain hampers scientific research into all aspects of the biology of Malagasy bryophytes. During the past two years, several institutions have worked to compile specimen for Madagascar. In Paris Herbarium (PC), more than 10,000 specimens have been sorted and databased. The same effort is ongoing in several other herbaria (G-Switzerland, MO-USA, EGER-Hungaria). The specific project BRYOTAN has established a dedicated herbarium for bryophytes within the collection at the Parc Botanique et Zoologique de Tsimbazaza, Antananarivo (TAN). More than 3,000 specimens were curated and data transferred to the GBIF database. An identification workshop was organized in September 2018, involving international and local specialists. Seven new species records for Madagascar were identified among unstudied herbarium specimens. Taxonomic studies on Malagasy bryoflora have been initiated on specific taxa, using an integrative taxonomy framework, including the knowledge database, Xper. Here, we aim to provide preliminary results.

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Ecosystem Natural Capital Accounting, a new environment managing tool

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The Convention on Biological Diversity has highlighted the fact that the failure to take into account the monetary values of ecosystems is one of the major causes of the global degradation of biodiversity. Ecosystem accounting is an inventory of the ecosystem services that ecosystems can provide to humans. It allows assessment of monetary values of ecosystem services. The CBD therefore recommends that Parties incorporate these monetary values of ecosystems into their national accounts. It has also made available to everyone a method for implementing the ecosystem natural capital accounting. We applied this method on the Antrema Protected Area in northwestern Madagascar. In this communication we present the different information extracted from the land use account alone, one of the basic accounts of the Ecosystem Natural Capital Accounting (ENCA). Knowledge about the state of ecosystem services and their temporal flow allows us to appreciate the quality and sustainability of an environment. Ecosystem accounts also show the level of use that humans make of their environment. Indices are computed to allow us to quantify the sustainability of this use. The biophysical ecosystem accounts of a protected area or national park can be carried out systematically and at regular intervals to make the right information available to managers.

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Fungal-mediated plant-soil-feedbacks affect secondary succession of tropical rainforests

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Secondary forests are increasingly prominent features of tropical landscapes, with their area now exceeding that of primary forests. The often slow recovery and unpredictability of species composition through succession limits the potential for restoration of ecosystem services. Improved understanding of the mechanisms that drive tropical forest dynamics after severe disturbance is urgently needed to promote the recovery of ecosystem functionality and inform restoration policies. Plant-soil feedbacks (PSF), by which soil-borne fungi and their plant hosts reciprocally affect each other's presence and performance, have been shown to drive the generation and maintenance of tropical tree diversity. However, the impact of PSF on the rate and direction of species turnover during secondary succession remains unclear. In a shade-house study in Panama we tested the interacting effects of fungi, light availability, and successional soil age on seedling emergence and performance of 10 woody plant species. The species differed in their life-history strategy and association with early-successional to old-growth-forest. They were sown in sterile (fungal growth suppressed by steam-sterilization plus fungicide) and live soils from four successional forest ages (2-yrs, 15-yrs, 25-yrs, and 115-yrs after agricultural abandonment). Seedling emergence, growth, and survival were monitored for three months under two different light levels (10% vs 40%). Seedling emergence varied greatly with soil age and fungal suppression, indicating that seedling establishment is affected by the interaction of plant life-history strategy and the soil fungal community present at specific successional ages. Moreover, light conditions influenced seedling growth and development, suggesting that PSF and abiotic conditions together affect trajectories of secondary succession in Neotropical rainforests. In conclusion, plant-fungal interactions play a larger role in tree community dynamics than previously acknowledged, and may be key to a full understanding of species turnover during secondary succession of tropical rainforests.

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Tourism and lemurs: The fate of indriids at popular tourist destinations

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The diurnal indriids are charismatic species which both foreign and domestic tourists enjoy seeing and photographing. Several legal tourist facilities in Madagascar have translocated indriids on premises. We used popular photo sharing websites and apps (Flickr, TripAdvisor, Instagram) to view publicly shared photographs of indri (*Indri*) and sifaka (*Propithecus*) residing at tourist facilities in Madagascar. Our aims include understanding broadly, how many indriids are translocated and kept at tourist facilities, how tourists interact with the animals, and what foods these folivorous lemurs may be provisioned with. We analyzed several hundred photographs spanning the years 2004-2018 and determined that *I. indri*, *P. diadema, P. coronatus*, P. verreauxi, and P. deckenii were present in tourist facilities. Additionally, humans frequently touched, held, and fed the indri and sifaka, and that bananas were the most common food given. We aim to stimulate a larger conversation about the legal/illegal capture and trade of endangered animals within Madagascar, and in future, determine the exact number of lemurs residing at tourist facilities over time (and ergo, the number of wild-captures taking place) via primate facial recognition software.

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EcoHealth perspective on ectothermic vertebrates in the Toamasina region of Madagascar

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Madagascar is the fourth largest island globally and has a population of approximately 22 million people, of which 77% live below the poverty line. This results in these communities often being very dependent on the environment for subsistence. Infectious diseases may threaten every aspect of the environment, from lower vertebrates to humans. Whether diseases are transmitted between these two host groups may be dependent on direct contact with the animals or through various indirect routes resulting from contact with the environment. The Asian Common Toad (*Duttaphrynus melanostictus*), which is currently an invasive species along the east coast of Madagascar, may aid in these transmission processes between multiple native host species and humans. In an effort to assess the ecohealth status of the Toamasina region, we will determine the pathogen burden of amphibians, reptiles, and palatable fresh water fish. Common pathogens that we will be targeting include Ranavirus in all three host groups, Chytrid fungus in amphibians, and *Salmonella* in reptiles. Of these pathogens, only *Salmonella* from reptiles is considered potentially zoonotic. However, compromised animal populations lead to reduced ecosystem health, and once the ecosystem health declines, communities dependent on these systems for subsistence are negatively impacted. The implication of this study is the development of a risk model for public health based on the ecohealth status of a region as reflected by ectothermic vertebrate pathogen burden and transmission risk to humans.

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Taxonomy and conservation of Dalbergia (palissander, rosewood) of Madagascar: progress and prospects

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Madagascar is a biodiversity hotspot and its forests harbour a vast diversity of precious woods, including rosewood and palissander (*Dalbergia* spp.). It is a pantropical genus containing 48 species currently described on the island, 90% endemic. However, the final number is likely to be closer to 60 or even higher. Even though one reason for the difficulty in controlling the international trade of illegally logged timber is that logs and sawn wood are difficult to identify to species. The most recent taxonomic work on *Dalbergia* has been published in 2002. Typically, the morphological traits used in species identification, flowers and fruits, are unavailable. In this contribution systematic details have advanced since 2014, in particular new species described, and it is necessary to develop more practical, user-friendly identification tools that can be employed when flowers or fruits are lacking. This will require additional fieldwork and careful study in herbarium specimens and to be reinforced by linking taxonomic reassessments and conclusions to information from ongoing studies using DNA, wood anatomy, and spectral characteristics. The currently available taxonomy clearly needs to be refined and updated. Furthermore, without the ability to identify species accurately and authoritatively the implementation of robust controls would not prevent unscrupulous operators from simply applying the names of authorized species to all harvested precious wood regardless of its true identity. Indeed, taxonomic work is compromising any attempt to determine which species might be exploitable, which ones require conservation action and thus undermining any effort to establish control, enforcement, and sustainable exploitation of Malagasy rosewood and palissander. The development of a truly sustainable market for Madagascar's precious woods will require careful control and regulation for conservation and sustainable management of *Dalbergia* spp.

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POSTER SESSION 3

Plants for therapeutic uses within the Loky-Manambato Protected Area, northern Madagascar

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The forest blocks of Loky-Manambato in northern Madagascar are floristically diverse, where a project about the therapeutic uses of plants by local people was carried out. As part of this project, we investigated the knowledge about their traditional uses in therapy and established a floristic list of the plant species used in traditional medicine. Ethnobotanical surveys were conducted in 11 villages surrounding the protected area. We interviewed 83 persons regrouped into different categories such as traditional healers, talismans, midwives, healers, special or divine therapists, farmers, etc... Then we collected the plant specimens from the forest block of Binara and the data about their habitat. The scientific names were determined at the Tsimbazaza herbarium (TAN) of Antananarivo. As result, the surveys showed 149 plant species belonging to 75 families and 139 genera. The most abundant families are Fabaceae, Euphorbiacae, Moraceae, Rubiaceae, and Apocynaceae. The species with the highest use index value are *Mauloutchia parvifolia* and *Perichlaena richardii*. Biological types are prevalently phanerophytes. The most used parts of the plants are the leaves (49.4%) as remedies using decoction to treat seasonal and common diseases like stomach ache due to digestive disorders. Otherwise, there are four categories of usage concerning the inventoried plant species: for traditional medicine, for extraordinary (ritual) use, for cosmetic use, and for the toxicity propriety. Thus, all these ethnobotanical data constitute a cultural richness. This study could help to evaluate the impact of plant collection for therapeutic uses in this forest, in order to ensure their conservation, and their sustainable use. The originals findings can also be used as baseline information for further studies on the medicinal flora in the region, which can be used by future generations.

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Habitat fragmentation in Madagascar: Connecting fragmented findings

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Despite classifying fragmentation as an important global threat to conservation, and the ubiquity of fragmented landscapes themselves, the impact of fragmentation on biodiversity is not well understood. Madagascar, a country known as a biodiversity hotspot, is also characterized by its extensive habitat loss and resultant fragmentation. In order to synthesize reports of the effect fragmentation has on Malagasy biodiversity, an extensive literature review was conducted. A meta-analysis examined a subset of sources that compared biodiversity metrics, such as species richness and abundance, between fragmented and continuous sites. 62 peer-reviewed articles, representing research testing the impact of fragmentation on species biodiversity (41.9% of studies), genetics (25.8%), health (9.7%), and other factors were analyzed. A further 93 studies conducted research in fragmented landscapes but did not test fragmentation's impact. Over 75% of examined studies reported significant negative results of fragmentation on Malagasy species, while two studies presented positive results. Across examined taxa, mammals demonstrated a negative response to fragmentation ($p < 0.001$), while lemurs, recently described as the most imperiled group of vertebrates, did not show a significant response ($p = 0.47$). Considering IUCN status of the 435 Malagasy species represented by examined sources, species threatened with extinction (VU, EN, CR), did not demonstrate a significant response ($p = 0.49$). Disparate definitions of what constitutes forest fragments and how to test fragmentation's influence emphasizes the need for continued research in fragmented landscapes and a standardization of its approach.

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The effects of land-use change on avian communities of a tropical montane forest in Rwanda

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Among the leading causes of biodiversity loss worldwide, land-use change figures prominently. Before the designation as a National Park in 2004, Nyungwe forest, a tropical montane rain forest in Rwanda, underwent a massive degree of transformation including: human-induced forest fires; non-native forests establishments; and agricultural encroachment driven by a continually increasing human population. There is scant information on the extent to which such habitat changes have affected birds and associated ecosystem services in Rwanda, and the Afrotropical region at large. The study aimed at determining how different degrees and forms of habitat transformation have affected avian species composition, taxonomic diversity, functional trait structure and phylogenetic diversity within the Nyungwe landscape. Data on morphological traits of study birds were collected from museum specimens. Further data on occurrence, abundance, and functional traits indicative of habitat type and use were collected using point counts, and vegetation sampling conducted in major land-use types. To quantify avian diversity, Inverse Simpson index, functional dispersion (FDis) and phylogenetic diversity (ses MNTD) were used. In comparison to pristine areas, land-use change altered species composition, and reduced species diversity and phylogenetic diversity. In contrast, functional diversity remained stable across the land-use types. Major habitat parameters driving avian diversity were found to be elevation and tree-related characteristics. Land-use change exerted varying effects on the three facets of avian diversity studied. This emphasises the need to apply complementary metrics when quantifying ecological resilience to anthropogenic changes. Long-term conservation of bird communities in the Nyungwe landscape necessitates halting wide-scale destruction of trees and extending reforestation of degraded habitats.

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Temporal β-diversity of Brazilian Atlantic rainforest passerine birds

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Temporal distribution of species in a community is influenced by several factors across space and time as resource availability, temperature, and precipitation. A good way to unveil the temporal dynamics of species includes the understanding of β-diversity over time. Here, we assessed the β-diversity for passerine birds and tested whether it changes through time. We conducted the study in a Brazilian Atlantic rainforest for 24 consecutively months. To test if species composition changes across time we used additive partitioning of diversity. To assess the contribution of each sampling level to total diversity, additive partitions of the data were made with four degrees of diversity: (α) diversity within month, (β_1) diversity between months, (β_2) diversity between seasons, and (β_3) diversity between years. Then, we decomposed β-diversity to test if species dissimilarity were due to turnover or nestedness. We captured a total of 831 birds comprising 72 species, some of them endemic to Brazil. *Platyrinchus mystaceus* (10% of total captured birds), *Hemitriccus diops* and *Pyriglena leucoptera* (both with 9% of total captured birds) were the most abundant species. These species, *Platyrinchus mystaceus*, *Pyriglena leucoptera* and *H. diops* were also most frequent presenting in 22, 21, and 19 months, respectively. Alpha diversity was higher than expected by chance ($p < 0.001$) and β_1 was lower than expected by chance ($p < 0.01$). The diversity within month (α) corresponds to 24% and β-diversity (β_1, β_2 and β_3) accounted for 76% of species richness. The temporal changes in β-diversity were mainly due to the high turnover of species (95%), instead of species loss or gain thought time (i.e., nestedness 5%). Our findings indicated a higher dissimilarity of passerine birds among months. However, bird community does not modify over time even among dry and wet seasons.

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Parides burchellanus, an endangered butterfly from Brazil threatened by toxic mud

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Among around 3,000 butterfly species that occur in Brazil, 63 are in some threatened criteria following the Red List. The most causes for the insertion are the lost and fragmentation of habitat with anthropic activities such as agriculture, urban expansion, and mining activities. On 25 January 2019, in a small city in Brazil, called Brumadinho, happened a greater disaster: a dam full of rest material of iron ore mining collapsed releasing 11.7 million cubic meters of toxic mud and killed hundreds of people, and destroyed roads and rivers. In one of these destroyed rivers used to live a very endangered butterfly, *Parides burchellanus* (Lepidoptera: Papilionidae). *Parides burchellanus* is associated with riparian forest in the Brazilian Savanna (Cerrado), where its host plant *Aristolochia chamissonis* occurs. From 2006 and 2007 an extensive mark-release-recapture study was made in one of the populations of Brumadinho, and we found that the population size had less than 50 individuals, a common number for Papilionidae, but the area was in great urban expansion. Since 2006 we look for the butterflies along the riparian forest of the Cerrado (basically in three states and the district area), and it is only found in Planaltina (Federal District of Brazil), Serra da Canastra (a protected area) and in Brumadinho more than 300 km apart from each other. After the disaster, we are looking for the butterfly in Brumadinho, monitoring its populations, and giving resources for the butterfly.

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Taxonomy and ecology of the invasive species of *Opuntia* in Lavavolo, Toliara, Madagascar

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Lavavolo spiny forest is threatened by *Opuntia* which is classified by the IUCN in 2000 as among 100 invasive species in the world. The main goal of our study is to provide taxonomical and ecological information about the *Opuntia* species in Lavavolo, Toliara, Madagascar. Such information will serve as a solid basis for further management plans against the invasion of *Opuntia* species in that region. Eight morphospecies of *Opuntia* were identified within the Lavavolo area according to our observations and information from the local people. The local names of these morphospecies are "Raketa Mena" or red *Opuntia*, "Raketa Mavosoloke" or yellow *Opuntia*, "Raketa koso" or *Opuntia* without thorns, "Raketa vilovilo" or *Opuntia*, "Raketa Nosy" or *Opuntia* with a few spines, "Raketa Notsiky" or light green *Opuntia*, "Raketa Gevoke" or *Opuntia* with long spine, and "Raketandambo" or bush pig *Opuntia*. By conducting taxonomic studies, we aim to (1) identify the species of *Opuntia* occurring in Lavavolo, and (2) investigate their geographical and topological distribution. Voucher specimens were collected and photographs taken highlighting the morphological characters of each morphospecies. Transects of the vegetation were conducted from the littoral to the limestone plateau of Lavavolo. Information of the chemical and physiological characters of the substrate at different elevations along the transect were recorded. The geographical coordinates as well as the presence or absence of *Opuntia* morphospecies were recorded, too. The preliminary results of our ecological survey suggests that *Opuntia* morphospecies occur in three distinct elevations: 9 m, 14-18 m, and 95 m. The morphospecies "Raketa Nosy" and "Raketa Kosy" seem to have a restricted distribution in agricultural fields at 24 m elevation. The identification of the *Opuntia* morphospecies at Lavavolo is still in progress, as is their spatio-temporal evolution of each morphospecies.

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Population density and body condition of the echinoid *Echinometra lucunter* in the northern coast of Puerto Rico

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Human impact in coastal areas such as contaminants from industrial processes, land development, erosion, and overfishing has created many challenges to coastal marine biota. Previously in the literature, the echinoid *Echinometra lucunter* or Rock-boring urchin, has been used as a bioindicator because it accumulates pollutants in its tissues. The data of this evidence is limited to Puerto Rico. The objectives of the research are (1) to estimate the population status of *E. lucunter* and (2) estimate the body condition of them to understand possible effect of contaminants in the physiology. We selected three localities within the San Juan Bay Estuary (Isla de Cabras, Condado Lagoon, Cibuco, and Escambrón Beach) that vary in water quality. Density of *E. lucunter* was estimated using transect/quadrant methodology. Body condition was estimated by measuring length, width, height (spines not included), and weight of at least 25% of the urchins per square meter. All measured urchins were divided in three classes (small, medium, and large). Rock-boring urchins were significantly more abundant in Ebambrón Beach than Condado's Lagoon with 70.80 ± 30.33 and 3.31 ± 2.86 individuals per m^2, respectively. Population size structure is indicative of more recruitment occurring at Cibuco. Body condition was highest at Cibuco and lowest at Condado Lagoon. Density, size structure and body condition indicate that the Condado's Lagoon is sub optimal, possibly related to higher concentration of contaminants at this site.

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Eco-biology of Mandrozo Lake, western Madagascar: Fish and analysis of core area effectiveness

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The present study is the first one focused on the ecology and biology of fishes in Mandrozo Lake and the analysis of its core area effectiveness. The objective of this study is to evaluate the lake's fish resource with the aim, proposing adequate measures for the management of the protected area. It was conducted from 19 August to 23 September 2017 in the Mandrozo Protected Area, western Madagascar. 43 sampling stations were established at the shoreline and in deep water. Abiotic parameters such as depth, turbidity, temperature, conductivity, pH, and nature of substrate were recorded at each station. Apart from direct observations and surveys on local fishermen, sampling by the use of gillnets and purse seines was carried out for the fish inventory. Mandrozo Lake is characterized by a basic pH (8.3 ± 0.59), a high temperature (24 to 31°C), and a substrate dominated by sand. It is shallow (1.25 ± 0.44 m), moderately conductive (226 ± 10 µS/cm), and turbid (19 ± 1.5 cm). 13 species of fishes, dominated by euryhaline species, were inventoried. The core area is evaluated as effective, in which the fish are more abundant with a high density of 166,000 individuals/km². This area is home to the milkfish, *Chanos chanos*, a species considered very rare around the lake. It also shelters large individuals including *Megalops cyprinoides*, *Oreochromis niloticus*, and *Glossogobius giuris*. The recorded threats include illegal fishing, core area crime, and non-respect of taboos. Optimization of control and monitoring effort at Lake Mandrozo is recommended to enhance the management and the sustainability of fishery resources for the future generation.

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Study of the dynamics of pastural strata according to the frequency of fires in the ecodevelopment zone of the Antrema Protected Area, western Madagascar

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Every year, bushfires devastate the great island. It is particularly frequent in savanna areas and is vaguely recognized as a key factor in its evolution. A study on the dynamics of pasture-based strata by inter-annual fire frequency was carried out in the Antrema Protected Area, western Madagascar. The objectives were to characterize structural and functional changes after vegetation fire has passed and identifying the different plant groups according to the age of the fire. For this purpose, ecological studies and floristic were carried out to determine vegetation cover, composition, and floristic richness and to characterize plant groups, and the results obtained show that fire frequency reduces vegetation cover, floristic richness, and also reduces floristic diversity. Four plant groups by based on the time of last passage of fire were identified. To limit the use of fire and for rational use, this study proposes some ways to manage fire, such as: early fire initiation; fire break installation; regular monitoring of the fire by more advanced and effective methods such as remote sensing; and awareness and education of the local population in firefighting.

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The importance of mangroves for Mahajanga city: No mangrove means no house

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Mangroves are an irreplaceable and unique ecosystem, hosting incredible biodiversity and ranking among the most productive ecosystems in the world. They shelter a wide variety of life of fauna and flora. The aerial roots of their trees form a complex web, hosting a multitude of animal species (fish, molluscs, crustaceans) and they operate as zones for mating, refuges, and nursery areas for a large number of other species. However, numerous changes that have taken place over the last few decades resulted in mangrove destruction or degradation. In five mangroves of western Madagascar, excessive wood extraction has taken place linked to obtaining wood for smoking fish, building materials, fuelwood, and charcoal production. The population of Mahajanga city depends on mangroves wood, in the face of increasing scarcity and cost of roundwood resources from the dry land forest. Our objective is to show the importance of mangroves for the population of Mahajanga city. Surveys were carried out in 2018 on 24 sellers of mangroves wood, mangrove timber ship-breaking sites, which included 170 users in 26 fokontany of Mahajanga city, on-site builders, and the building permit issuer of the urban commune of Mahajanga. Wood volume was calculated according to Huber's formula and Multiple Correspondence Analysis was applied for statistical analysis. On average, 3,988,740 m3 of mangrove wood is extracted per year, intended for fencing, firewood, construction, and many other uses in the city, of which 1,324,881m3 or 25% is only for construction. Use for construction represents the main pressure explaining the rate of deforestation of mangroves. Thus, mangrove large-scale restoration programs are needed, in addition to the application of legislation. Mangroves should be allowed to continue to play the role they have traditionally: to ensure local peoples' livelihoods through the conservation and wise use of their rich biodiversity.

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Rainforest Lab&Kitchen

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Tropical rainforests worldwide are under threat because of unsustainable food production practices that need to be addressed urgently. To adapt to climate change, a radical, new attitude towards food and food-production, what we eat, how and where we grow what we eat, and how we distribute our food will be essential. The Cascoland Lab&Kitchen brings farmers, scientists, creatives, and chefs together around a kitchen table to connect, exchange knowledge, and implement new trans-disciplinary solutions to farming; a test ground for ideas that conciliate land restoration, conservation, food production, and better livelihood in rural regions. An interdisciplinary response a lack of connection between key disciplines towards sustainable futures. Cascoland is an international Amsterdam-based network of artists, architects, designers, and performers sharing a fascination for interdisciplinary interventions in public space aiming at the development of ecological and socially sustainable societies. On invitation by the University of Mexico (UNAM) and Wageningen University, Cascoland is designing a communication platform where a cross-disciplinary community can grow and take action: The Rainforest Lab&Kitchen. The Rainforest Lab&Kitchen, will be an incubator for new interdisciplinary approaches towards forest restoration and environmental community resilience. A multidisciplinary collaboration between arts, design, science, and culinary practices to inspire and empower communities towards sustainable developments at the border of the diminishing Lacandona Rainforest. The programme has been piloted in 2018 in the area of Marqués de Comillas, Chiapas, Mexico, and is taking shape in the building of a physical exchange platform. While in the process of establishing a permanent Lab&Kitchen in the Mexican rainforest, the project is to gather, connect, and share knowledge with stakeholders to contribute towards forest restoration and sustainable food systems worldwide.

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Bioecology of Calumma hafahafa and Chamaeleonidae community in the Bemanevika Protected Area, north central Madagascar

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The “hotspot approach” considers that endemism and threatened species are key factors in biological conservation. The main objective of this study was to collect bioecological information on the critically endangered and endemic *Calumma hafahafa*, and to investigate the Chamaeleonidae species associated with it. This study was conducted from March to April 2016 in the Bemanevika Protected Area, north central Madagascar. Three sites were surveyed: Matsaborimena-Matsaborimaitso, Andriakanala, and Ankiakalavahely. Nocturnal searches along transect lines were carried out using headlamps to locate animals by the reflection of eye shine. 12 species of chameleon were recorded including *C. hafahafa* at the survey sites. Three species, *C. crypticum, C. gastrotaenia,* and *C. malthe*, were common in the forest area, and four, *C. hafahafa, C. peltierorum, C. peyrierasi*, and *Furcifer petteri* were frequent at the marsh edge. A total of 51 individuals of *C. hafahafa* were recorded, composed of 35 juveniles, 6 subadults, and 10 adults. This species shows sexual dimorphism in total body length and body coloration. This species was very widespread at heights 100 to 200 cm above the ground and less abundant above and below this vertical zone. 44% of the individuals were perched on shrub stems and 6% on fern fronds and creepers. Currently, the Bemanevika area is the only known site the recently described *C. hafahafa* occurs. This indicates the particularity of Bemanevika Forest and marks its conservation importance.

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Local knowledge of Vohibola's human population use of plant species

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The Vohibola Forest, which is a relict of Malagasy Eastern littoral forest, has an exceptional biodiversity strongly threatened by anthropic activities and natural phenomena. Acquaintance of local knowledge in terms of use, conservation and enhancement of valuable plant species is very important for the preservation of the forest. Hence, this study was undertaken in order to support the local communities in the forest stock management. An ethnobotanic survey was carried out to highlight the practices and knowledge of the local communities in terms of use of the forest resources. The survey allowed to count 74 useful species from 69 genera and 45 families, especially for construction, traditional medicine, food, and cultural use. Other uses included the manufacture of canoes, fencing, crafts, and fuelwood. Plants have always played a very important role in the daily life of the local population. So, in order to conserve the most used species, it is hoped to support the basic communities in the management and the conservation of the forest.

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Ethnobotanic value of useful palms in the Central Highlands of Madagascar

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With 207 recorded species, Madagascar has an important palm flora. According to the IUCN Red List assessment, 83% of these species are threatened due to human activities. Palms are encountered across the island and their diversity varies in each phytogeographic zone. The diversity of palms is low in the Central Highlands portion of the island but they play an important role in the subsistence of the local population as food, construction material, and household tools. These utilizations have an impact on the survival of the local palm species. The present study focuses on the utility of useful palm species in the Ambositra and Anjoma Ramartina areas, in the central zone. Ethnobotanic surveys were performed with 44 informants. The interviews consisted of asking about the forms of utilization, the collecting method, the quantity harvested, and the potential plants that can substitute for palms. Across the study area, three species of palm were reported to be useful: two endemics (*Dypsis decipiens* and *D. madagascariensis*) and one introduced (*Elaeis guinensis*). These species are distributed into six categories of uses: construction, agriculture, food, household tools, medicine, and as ornamental plant. According to the results, construction is the most cited as form of utilization (74%). Palm leaves are more resistant and can last more than a decade when they are used as thatching compared to other plant materials. Falling a palm tree is not usually forbidden, so local people over exploit them. As for the employment of palms in medicine, such traditional usage is being lost in the two regions because people tend to buy pharmaceutical products. This information will be used to evaluate the threats to palm species in order to elaborate appropriate conservation actions in the Central Highlands of Madagascar.

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A herpetological assessment of the littoral forests of Sainte Luce (southeastern Madagascar): Using genetic tools to ascertain the true level of biodiversity

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Sainte Luce represents one of the last examples of relatively intact southern littoral forest in Madagascar, a country renowned for its remarkable species richness and biodiversity. Total estimates for the number of amphibians present on the island are believed to be close to 500 species, with similar estimates offered for the reptiles. This grand herpetological diversity is given further significance when levels of endemism are considered, with 99% of amphibians and 97% of the Squamata being found nowhere else on Earth. Unfortunately, Madagascar is now almost as renowned for its disturbing levels of deforestation and habitat degradation as it is its biological wealth. Sainte Luce has been subject to two previous herpetological studies (2006 & 2012), but has never been subject to a comprehensive genetic study. Between September 2014 and October 2016, we examined and collected tissue samples from the herpetological community of Sainte Luce, with the aim of assessing the entire community. Both morphological and genetic markers (16s, COI, ND1, ND2, and ND4) were employed to validate species identity. Our study concluded a total of 17 new candidate species, and a grand total of 75 species. Candidate species were found within multiple genera, including the families Mantellidae, Chamaleonidae, Gekkonidae, Lamprophiidae, and Scincidae. This new evidence enables a more comprehensive and robust assessment of the biodiversity present in the Sainte Luce littoral forests. We also provided a novel set of gene sequences for all markers in order to bridge the current gap in knowledge that exists in and around the study area. So far this study has contributed towards the description of a new amphibian genus and the taxonomic revision of a charismatic microhylid frog.

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Youths for lemurs: An optimistic approach to conservation

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Youths in rural Madagascar in general, and from around the Mangabe Protected Area in particular, seem to be doomed to become farmers practising slash-and-burn agriculture and hunting due to poor education, long distance of their villages to the nearest town, and lack of employment in the town. They, therefore, represent a threat to biodiversity, now and in the future. In 2016-2017, we ran a project aiming to address reverse this situation and make youths 'lemur conservation ambassadors'. The project was designed as a contest game between youth teams of Mangabe in three areas: (i) implementing poultry husbandry (alternative to lemur hunting) or improved rice farming (alternative to itinerant agriculture), (ii) raising awareness campaigns within their villages on lemur conservation, and (iii) team cohesion. They were trained in these areas and their progress was monitored. By December 2017, 45 youths in seven teams were established in the Mangabe Protected Area and adopted sustainable rice farming technique. Other community members followed their examples. Although our support was halted in 2018, the teams continued to run awareness campaigns in their villages and were considered by local authorities in decision making. Through this project, we strongly believe in the power of youths to bring change and their critical role in conserving (or depleting) the unique biodiversity of Madagascar. This approach should, therefore, be reinforced, adapted, and replicated at all important biodiversity areas in the country.

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Ecological characterisation of *Ravenala madagascariensis* in the *savoka* of Brickaville in view of sustainability

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Ravenala madagascariensis (Strelitziaceae), commonly referred to as the "Traveler's tree" is an endemic plant to Madagascar well known by the fan arrangement of its leaves. Furthermore, this plant is considered to be an invasive species of open areas of lowland eastern Madagascar; a zone with considerable rainfall. Providing ecological knowledge on these species and promoting rational exploitation of this resource are the main objectives of this project. Yet, it is also considered as an orientation on the sustainable management of the biological resource of Madagascar. In this respect, three vegetation types were identified: *bemavo* and *horonorona* and their distribution varies depending on topography and soil substrates. Frequently found from 300 to 500 m altitude, on high slopes, soils drained with silty texture, the *bemavo* variety is unique. In contrast, the *horonorona* form prefers the low-area. As far as natural regeneration is concerned, the multiplication of the *horonorona* variety is the fastest with a regeneration rate of 981 percent.

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Floristic diversity under the influence of the mode of use: case of the palm tree of Agnalazaha littoral forest, in the rural commune of Mahabo-Mananivo (Farafangana)

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Agnalazaha Forest is the area protected managed by the Missouri Botanical Garden. This area situated in the commune of Mahabo-Mananivo, District of Farafangana. This area puts on the most variety of the palm. However, this palm is very threat by the human activity in their locality. The overall objective of this study is to know the diverse utilization of the palm by the local population in Commune of the Mahabo-Mananivo in order to put the local status of conservation for the threat palm and very useful in the protected area of Agnalazaha. The Ethnobotanical and ecological studies are realized. The results obtained through ethnobotanical and ecological studies allowed to identify six (06) target species that are *Dypsis fibrosa*, *D. lutescens*, *D. pinnatifrons*, *D. scottiana*, *D. utilis*, and *Ravenea sambiranensis.* Among the target species, *D. pinnatifrons* and *R. sambiranensis* are the species very threatened in the littoral forest Agnalazaha. The knowledge for each threat status local is very important because it is a necessary to take the measure management and the conservation for the threat palm.

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The duality aposematic – cryptic does not suffice to explain antipredator strategies in poison frogs

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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, and higher metabolic rate. In comparative studies, the duality cryptic–aposematic is used to summarise the phenotypic correlations, to infer the adaptive value of individual traits, and to address the evolutionary route of both antipredator strategies. We measured a combined set of phenotypic (toxicity, conspicuousness, dietary specialisation, metabolic rate, body size, wariness, foraging activity, behavioural syndromes) and genotypic (aminoacid sequences for sodium channels) traits and estimated their correlations using subsets of phylogenetically related frogs and their predators. 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, supporting a system of intraspecific mimicry. Toxicity is not only an attribute of the frog species; it rather 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. Lastly, behavioural syndromes are not consistent with vulnerability, or escape and foraging behaviour. Altogether, our evidence implies a more complex scenario for the evolution of aposematism than the dual concepts of crypsis and aposematism.

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Co-occurrence or conflict: An evidence based study of peoples' attitude and perception towards wildlife with respect to the economics of staying near protected areas, Madhya Pradesh, India

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400 million of 1.3 billion Indians reside in and around the forested areas with wildlife in their backyards. Majority thrive on extracting natural resources. This extreme environmental stress results in higher interface with wild animals leading to conflict. Human-wildlife conflict costs are significant in tropical developing countries because of the mosaic of forested patches and human habitation and majority of the population living below poverty level with trifling compensation schemes. For detailed insights the economics of staying near Pench Tiger Reserve, one of the important source populations of tigers in the Central Indian tiger landscape facing extreme anthropogenic pressure was estimated. Close-ended structured questionnaire along a gradient of distance of settlements from the core area was used to determine the magnitude of realized property loss and availed benefit of provisioning services by people. Information thus generated was cross-validated using reliable secondary sources and market prices. The cost incurred by the local community remained same along the gradient of distance from the core area and exceeded the benefits. The extent of losses was a crucial factor in determining their attitude towards wildlife and conservation. More losses led to warranting for stricter enforcement regime for ‘problem animals’. Overwhelming costs sustained by people co-occurring with wildlife in their backyards compel them to become antagonistic and apathetic to the cause of conservation. Conservation without active participation of the locales is analogous to a mirage. To succeed in conserving wildlife adequate compensation at par with the market value of lost property along lost opportunity cost and peoples’ participation in decision making strategies is imperative. The native ‘Gond’ population’s religious belief revolves around protecting biodiversity which needs to be incorporated in a scientific to make this conservation struggle a success. People co-occurring in harmony with wildlife can make long term survival of both plausible in future.

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Free-ranging dogs vs. native mesocarnivores: Spatio-temporal interactions in agroforestry landscapes

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Interspecific interactions are essential for the dynamics of ecosystem communities, acting as ecological filters to determine species co-occurrence. However, these interactions could be negatively impacted by land use changes, hunting, and the presence of exotic species. Dog (*Canis familiaris*) are the most abundant exotic mammal in human-modified landscapes; and cacao agroforestry systems in the Atlantic Forest are unique scenarios to study its influence on native mammals. Because native mesocarnivores share taxonomic and ecological similarities with dogs (which are also used for hunting), they may be negatively impacted by this invasive species. With camera traps, we surveyed for seven years cacao agroforests (45 sites) from three landscapes with different amounts of forest cover and one control area (15 sites) of forest remnants. Multi-season occupancy modeling and activity patterns analysis were used to evaluate the influence of free-ranging dogs on the spatio-temporal patterns of the native mesocarnivores. We found that dogs negatively influenced the spatial or temporal patterns of most native mesocarnivores. Crab-eating Fox (*Cerdocyon thous*) and South American Coati (*Nasua nasua*) temporally avoided dogs ($p=0.04$ and $p<0.001$, respectively) that also negatively influenced in the detection probability of N. nasua (AICc Weight=0.73, betadogs= -0.11, SE=0.05, $-0.21 \leq$ IC 95% ≤ -0.01). Dogs may negatively influence the occupancy of Tayra (*Eira barbara*, AICc Weight=0.66,), but not its activity patterns. However, this negative effect on tayras occupancy is uncertain (betadogs=-0.97, SE=0.59, $-2.12 \leq$ IC 95% ≤ 0.18). Finally, we did not find evidence for a dog impact on Crab-eating Raccoon (*Procyon cancrivorus*). These results confirm the impact of dogs in wildlife, and can be extrapolated to similar agroecosystems, and possibly around protected areas. Thus, actions to control free-ranging dog populations (i.e. sterilization and removal campaigns) should occur in agroforestry landscapes and around native forests, as well as education programs focusing on responsible dog ownership.

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Impact of habitat fragmentation on diurnal squirrels in lowland tropical forests of northeast India

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Habitat destruction is the largest threat to global biodiversity, being rampant in the tropical forests of developing countries. Lowland tropical evergreen forests of Upper Assam in northeast India have undergone extensive deforestation since the last century for extraction of timber, oil, coal, and tea cultivation, leading to depletion and fragmentation of these forests. Squirrels are especially diverse in these lowland forests and are obligate arboreal species with low dispersal abilities. We are investigating the status of diurnal squirrels and their behavioural responses to limiting conditions in these isolated fragments (study to be completed in May 2019). Diversity of squirrels, their diet, activity patterns, and nesting requirements are being studied. We selected four fragments ranging in size from 2-24 km^2 and compared them with contiguous forests. Trails were walked to assess richness, densities, time activity budget, and diet of squirrels. Focal sampling was done to record time-budgets (n=25h) and feeding bouts (n=20h). In total, seven species were recorded. *Callosciurus erythraeus* is the most common squirrel and the only species in small fragments. Bark and seeds of climbers constitute important components of the diet in fragments, while flowers and fruits in contiguous area. *Ratufa bicolor* spent greater proportion of time resting (60%) in the fragment than in contiguous area (40%). Mean nest height was found to be significantly greater ($p=0.018$) in contiguous area (22.45 m, n=34) than in fragments (18.30 m, n=20). There has been alarming species loss in fragments. Loss of certain species could be due to loss of specific habitat types, while continuous degradation has taken a toll on most species. Squirrels could be conserving their energy by minimizing their activity in nutritionally poor and open environments. Fewer, more exposed nests at lower heights in fragments indicate scarcity of mature trees to nest, which might impact their reproductive behaviour. Forest fragmentation is thus significantly altering the species composition and behaviour of squirrels, which will impact the services of seed dispersal and forest regeneration.

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Fostering inter and transdisciplinarity in discipline-oriented universities to improve conservation science and practice

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Many problems we face today, including conservation issues, are complex and encompass intertwined systems. As such, they are difficult to understand, to define and reach agreement on due to pluralism of values within society. Technocratic solutions then may be perceived as improper by stakeholders, detaching citizens from urgent issues. Moreover, different scientific perspectives can be appropriated by distinct groups in political debates. Avoiding politicizing science, appropriately incorporating values in science and making science relevant to real-world problems can be achieved through inter- and transdisciplinary approaches. Here, we present a heuristic model on how scholars working in discipline-oriented universities can either reinforce disciplinarity or foster transition to inter- and transdisciplinarity. We base the model on our experiences as scholars in discipline-oriented universities and we describe strategies we implemented to promote this transition. Our model represents interactions scholars establish to perform academic activities and factors influencing how they develop such activities. According to the model, scholars' interactions overcome disciplinarity when they are diversified and bidirectional, requiring that they work outside the mainstream, crossing the boundaries of traditional training, and using this expertise to influence academic policy and culture. Our strategies to foster inter- and transdiciplinarity encompassed learning-by-doing and influencing academic policies and culture by engaging in policy processes. The main challenges were associated with advancing our academic training, while simultaneously navigating the discipline-oriented system of scholar evaluation. We hope our model and initiatives stimulate other scholars to confront discipline-oriented policies and culture, helping to close the gap between academic rigor and social relevance, and to integrate conservation science, practice and policy.

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Sustainable community development through the triangulation of Fokonolona - Territory - Heritage for priority landscapes, Global Environment Facility, Madagascar

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In relation to Sustainable Community Development and the National Development Plan of Madagascar for the period 2015 to 2019, it is necessary to know how extreme poverty and the strong dependence of the communities or *fokonolona* on its environment are dependent on better governance and management of their territory, as well as their heritage and on a better efficiency of the biodiversity conservation. For the methodological levels, a systemic and an analytical approach focused on the influential models around the Hardin Commons and Sen's Capability approaches adopted for better efficiency of the tropical biodiversity conservation and for an in-depth analysis of the models and strategies of sustainable community development based on the triangulation of *fokonolona* - territory – heritage. Research action oriented development, as well as conceptual and application modeling, are also used to deepen Fokonolona's support and recognition mechanisms, improve its well-being, capitalize the security process of the territory and to analyze the strategies for the safeguarding and sustainable enhancement of its heritage. In terms of results and impacts, these works enhance the knowledge and analysis on the triangulation of the three key concepts with their effects on the conservation of tropical biodiversity, the reduction of poverty, and sustainable development. Moreover, the state of the art, the expression of points of view from experience feedback with contextualization/justification, the implementation of innovative, and original research, as well as the analysis of new devices, are the main contributions in these scientific research works in collaborative mode.

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Litter production in response to nutrient addition in an old growth forest in Central Amazon

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The Amazon rainforest account for about 25% of the global net primary land productivity (NPP). To maintain high productivity on low fertility soils of lowland tropical forests, efficient conservation and cycling of nutrients is important. A large-scale nutrient addition experiment was established in an old growth forest in Central Amazonia to test the hypothesis that soil phosphorus limits forest productivity on highly weathered soil. The Amazon Fertilisation Experiment (AFEX) aims to understand ecosystem responses to the addition of nitrogen (N), phosphorus (P), cations in a fully factorial experiment with eight treatments that started in April 2017. We hypothesize that if NPP is limited by phosphorus, litterfall production will increase with P additions compared to other nutrients. Using 160 littertraps, of 0.25 m² at 1 m height, we examine litterfall responses to nutrient additions over one year (July 2017 to August 2018). The mean fine litterfall production was 9.17 ± 0.48 ($Mg.ha^{-1}.yr^{-1}$), the total litterfall produced was 11% higher in treatments with phosphorus than without P ($F_{1,30}$ = 4.57, P = 0.04). The litterfall fractions responded differently to nutrient additions, leaves (9%), wood (17%), and others (24%) increased with P, and reproductive material (24%) increased without cations. Litterfall nutrient inputs also increased the amount of P cycling in treatments receiving P (35.8 ± 3.04 $g.ha^{-1}$) than without P (27.41 ± 1.77 $g.ha^{-1}$; $F_{1,22}$ = 8.66, P < 0.01), as well with Calcium ($F_{1,26}$ = 8.96, P < 0.01) and Potassium ($F_{1,21}$ = 5.36, $P < 0.05$). The strong responses to phosphorus alone and in combination with other nutrients supports the hypothesis of phosphorus limitation of NPP in this lowland tropical forest. Futhermore, the nutrient additions increased the leaf turnover in just one year, indicating that trees adapted to low fertility soils are capable of rapid changes in response to nutrient availability.

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Phosphorus availability controls the response of soil microbes to increased labile C in tropical lowland forest soils

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Soils in large regions of the Amazon Basin are characterized by low levels of total and available phosphorus (P), which could constrain the tropical forest Carbon (C) sink capacity in response to elevated atmospheric CO_2 (eCO_2). In such P poor soils microbial decomposers play a key role in liberating P from organic matter. The metabolism of heterotrophic microbes is generally limited by C and nutrients, thus one strategy of plants can be the release of labile organic carbon (LOC), like root exudates, to increase microbial decomposition activity and increase availability of P. However, these interactions are still unclear, and a better mechanistic understanding is needed to improve model projections of forest feedbacks to climate change. To study the response of microbial activity to LOC inputs at different levels of P availability we conducted an incubation experiment using two Amazonian forest soils (plateau and valley soils) that differ in their texture and nutrient availability. In both soils we evaluated the response of microbial respiration, biomass and enzyme activity to additions of citric acid and glucose, simulating two different forms of roots exudates, at three different P availability scenarios (natural concentration, increased labile P, and reduced labile P using resins) at controlled temperature and humidity. We found that the additions of LOC stimulated microbial respiration, extracellular enzyme activity rates, and increased microbial biomass. Generally, the responses were stronger when P was also added, indicating that P supply controlled the response of microbes increasing C availability. Our results highlight the tight coupling between P and C cycling in the high weathered tropical soils of the Central Amazon, and we conclude that even if extra C is provided by plants under eCO_2 it may not relieve microbial P limitation.

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Is trait-based vegetation modeling improving our understanding of functional ecology? Scientific questions, methods and outcomes so far

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In the last 10 years ecosystem modeling is increasingly relying on the so-called trait-based Dynamic Global Vegetation Models (DGVMs), which claim a better representation of global plant functional diversity. Even though previous generations of DGVMs relied considerably on plant traits (and as such were also trait-based), this new generation of models provide a more detailed and less discretized representation of plant functional traits than previous DGVMs. Here we analyze five existing models that use this approach, seeking to understand their scientific questions, their performance regarding the representation of biogeochemical cycles, the scientific questions they have addressed so far and the remaining knowledge gaps that can be potentially filled by trait-based models. Our analysis show that the models bring small improvements in terms of biogeochemical cycles simulation. They employ more than twenty different functional traits, ranging from three to twenty-one with a small overlap among them. This fact leaves opened questions about what traits are more important to be flexible in the models. Most models do not explore functional concepts about the links between functional diversity and ecosystem functioning and what are the dimensions of plant function that must be addressed in these models. Only two teams have compared model outputs of functional diversity with observed data despite of the growing number of datasets and maps depicting functional traits patterns globally. Hereafter the trait-based modelers should focus on integrated methods of data analysis where the ecosystem processes and the functional diversity responses to environmental changes are visualized together enabling the clarification of mechanisms that cause compensations among functional diversity and ecosystem functioning. The analysis of hypervolumes is an example of this kind of integrated method. Finally, this kind of modeling experimentation and analysis can indicate priority data of plant functional traits to be collected in the next years.

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Every dog has its prey: Rangewide assessment of links between Dhole diet patterns, livestock consumption, and negative interactions with people

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Global increase in spatial overlap between humans and large carnivores presents several challenges for carnivore conservation. Livestock depredation by carnivores remains the most ubiquitous type of negative interaction, necessitating research on causes, patterns and dynamics of depredation. We focused on the endangered Dhole *Cuon alpinus*, for a rangewide assessment of diet patterns, livestock consumption, and human-Dhole interactions. We first performed a reanalysis of Dhole diet from all published studies (1973–2013) incorporating a recently-developed non-linear correction factor for measuring quantities of prey biomass consumed. We then determined the relative numbers of livestock consumed by Dholes over time and across the species' geographic range, compared these with earlier estimates, and investigated the importance of wild vs. non-wild prey in Dhole diet. Using information extracted from >70 studies, we explored links between livestock consumption by Dholes, availability of wild versus non-wild prey, sympatric depredation-prone carnivores, and people's perception of Dhole as a livestock predator. We found that (a) there were regional differences in Dhole diet profiles, (b) this species consumed much lower numbers of livestock compared to previous estimates, (c) livestock consumption by Dholes was influenced by densities of wild and non-wild prey, and presence of competing co-predators, and (d) people's negative perception of Dholes was shaped by pack sizes, levels of livestock depredation, and number of sympatric large carnivores. Persistence of carnivore populations beyond protected reserves will depend on how their interactions with humans are managed, particularly in areas where people view them negatively. Based on our results, we suggest that global efforts for dhole conservation should prioritize (1) improving efficiency in dispensing monetary compensation for livestock losses in south and central India, (2) investing in better husbandry practices, implementing insurance schemes and education programs in the northeast Indian region, and (3) recovery of wild prey populations in southeast Asian reserves.

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State of mangrove swamps on Sainte Marie Island, off-shore eastern Madagascar: Contribution to management strengthening

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The mangrove of Sainte Marie Island spread over an area of 300 ha, principally found in Forbans Bay (west) and Ampanihy (east), the latter in a better state. Forbans Bay Mangrove was largely destroyed in 2014 during the renovation of the dam that joins two touristic localities on Sainte Marie and when the exchange between freshwater and sea water was cut for eight months and caused the deterioration of the mangroves resources. This work aims to understand the state of the mangrove swamps at Forbans Bay two years after the reopening of the water exchange, as well as to improve the management of the local community based association protecting mangrove (known as a VOI). The Ampanihy mangrove is used as a reference for comparison to Forbans Bay. Cartography, forest inventories, water physical, and chemical analysis, tree investigations, and statistical analyses were used. The results show that the two sites represented have seven species, dominated by the family Rhizophoraceae and the populations are generally homogeneous. The mangrove of Forbans Bay has a weak potentiality and more damaged compared to Ampanihy, even thoughregeneration is considerable (569.3%). Most households depend on these mangrove products and they are used for house building and heat for drying fish, crabs and mollusks, sources of income and food. Construction of the îlot Madame dam, deforestation, urbanization, and domestic pollution are the main causes of the mangrove declines on Sainte Marie. Considering these threats, this study is the first conducted in this area and to propose concrete solutions. The empowerment of the VOI followed by the Blue economy steps are then the most required actions.

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Swimming dynamics of Humpback Whale (*Megaptera novaeangliae*) calves accompanied by their mother

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A study of the swimming dynamics of Humpback Whale (*Megaptera novaeangliae*) calves accompanied by their mother was conducted off Ile Sainte Marie, a near-shore island off eastern Madagascar. It aims to prove the existence of specific swimming configuration offering energetic advantages for the calf in mother-calf dyad, and to compare swimming behavior of calves and mothers. Through kinematic analysis, opportunistic underwater video clips of travelling mother-calf dyads were used to investigate the variation of calf's relative swimming effort (tailbeat frequency based parameter) according to the swimming configuration. Dive datasets from digital tags were used to compare the swimming control and stability. Analysis of 21 short video clips extracted from 4.5 hours of videotapes showed that calf swims mainly in echelon (close to its mother's mid-lateral flank) to save energy, as evident by a 23.5% reduction of swimming effort, and displays a right-biased lateralized behavior. Analysis of 129 dive datasets from three tagged dyads showed that calves' active swimming behavior is much less elaborated compared to the mother. These findings highlight the importance of the proximity between mother-calf pairs and the necessity of strict regulations for their observations in order to minimize the risks of rupture.

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Management of invasive species *Lantana camara* and livelihood in South India

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Lantana camara is one of the world worst weeds of dry tropical forests. ATREE studies have indicated that the spread of the invasive *L. camara* has adversely affected the biodiversity in the forests and hence measures have to be taken to curb the spread. The idea was that "when one cannot control proliferation of *Lantana*, why not make use of it?" With this idea in mind, ATREE team have encouraged the Soliga indigenous community to make handicrafts and other household articles using the stem of *Lantana*. Established community Lantana Craft Centres (LCCs) and it is a collective of Lantana craftsmen, bringing in external artists and designers to improve the craftsmanship and market linkages for the products. These centres have been registered under the Indian Societies Registration Act and linked to the Department of Handicraft and Marketing Extension, Karnataka state and recognized by the Tribal Cooperative Marketing Development Federation of India Limited (TRIFED). Effort has been made to generate household income. Apart from making various attractive furniture, craftsmen have started making life size elephant sculptures in collaboration with the Shola trust. Each life-sized elephant sculpture, earns 1500 USD and as many as 25 elephant sculptures have been crafted till date and some of the samples have been sent to UK to be exhibited in the Royal Parks Museum in London. Currently, there are about 20 master crafts people, who have trained around 300 people within their community. Around 150 households are involved in making Lantana furniture and their annual income has increased by 42%.

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Changing diets of Milne Edwards Sifaka in Ranomafana National Park: Is this the impact of climate change?

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Long-term monitoring of Milne-Edwards' Sifakas (*Propithecus edwardsi*), a Critically Endangered lemur, has been conducted since 1986 within the Ranomafana National Park (RNP) rainforest, Madagascar. The Centre ValBio (CVB) biodiversity team follows the sifakas five days a week all year round, and records feeding behavior every five minutes. Data collected for each individual includes not only time and approximate quantity, but also plant part, and tree species, genus, and family. The Milne-Edwards' Sifaka is the largest lemur in RNP, and its diet is on average 1/3 seeds, 1/3 fruits, and 1/3 leaves, with a mean of 16 species eaten per day. In 2018, the diet of Milne-Edwards' Sifaka drastically changed, due to many of the tree species which the sifakas usually eat not bearing fruits. In addition to following lemurs, the CVB team measures and monitors the fruit availability in RNP. The 32 years of fruiting phenology data include 71 plant species which are eaten by sifakas. These data for 2018 showed that 32 tree species (43%) in 18 plant families did not bear fruits. Sifakas replaced fruit eating with leaf eating. We then compared on a month by month basis the diet changes of sifakas, the fruiting phenology, and weather pattern data in RNP (e.g., amount of rainfall and temperature changes). These data were compared to 10 years of previous data, including sifaka infant birth and survival. We found that rainfall and temperature changes might be negatively impacting fruit availability and consequently the growth of the endangered lemur population.

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Interaction between nutritional/medicinal practices of humans and *Propithecus coquereli* at Anjajavy, Sofia Region, Madagascar

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The health of wild animals depends on their habitat and the proprieties of their foods. *Propithecus coquereli*, a lemur species endemic to western Madagascar, has an ephemeral plant-based diet. Little is known about the potential medicinal aspects of their diet. This study examines the plant food species used by *P. coquereli* at Anjajavy Private Reserve and the medicinal plants used by local people. An observational study was conducted for recording all items consumed by *P. coquereli*. A survey was conducted to interview local people and traditional healers from three villages close to the private reserve about the uses of these plants. Between November and December of 2017, 47 plant samples were observed being consumed by *P. coquereli*. Of these, 55% were also used by local healers and people for medicinal purposes. Moreover, 72% of these plant species are noted in the scientific literature as having medicinal properties. This research has implications for flora and fauna conservation in Madagascar, in addition to potential welfare of captive *Propithecus*, and the search for bioactive compounds in anthropogenic medicines.

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Community of epiphytic orchid host-trees in the Isyo Hills, Rhepang Muaif, Papua

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Orchids are one of the Isyo Hills ecotourism charms, which are managed by Kemtuk Gresi tribe in Rhepang Muaif, Jayapura, Papua. As a charm, very little is known about species of orchids and the host trees in this area. The purpose of this research is to understand the diversity of epiphytic orchids, and the composition of the host trees in Isyo Hills ecotourism area. A survey of vegetation was conduct in an area of orchid host trees, with 13 plots distributed in 10 ha observation stations. Measurements of micro-habitat condition included the physical factors, specifically humidity, light intensity, and vertical position of the orchid on the host tree. Results showed 15 species of epiphytic orchids were observed in the study area. Epiphytic orchid host trees consist of 11 species, each representing a different plant family. Tree species with the greatest important value index (IVI) were *Areca* sp. (54.3%), followed by *Poikilospermum* sp. and *Intsia* sp. (39.0% and 34.7%). At the pole level dominated by *Areca* sp. (111.0%), followed by *Pandanus* sp. and *Intsia* sp. (50.4% and 38.4%). ANOVA test showed a correlation between light intensity and vertical position of the orchids on the host tree, with adaptations of orchids to face low light availability in areas covered by the forest canopy. The family Arecaeae with trees of dbh around 20 - 28 cm are important host trees for epiphytic orchids. The monopodial structure of Arecaceae give a suitable area for orchids to attach. Based on these results, the composition of orchid communities is also associated with host characteristic and the plant families of host species; hence, in order to preserve the orchid-host community special attention needs to be given to conservation of Arecaceae trees in the Isyo Hills ecotourism area.

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Sustaining resources and people with science at Ranomafana National Park, Madagascar

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Madagascar is one of the world's hotspots for endemic species, yet 10% of the natural habitat is left. In 1991 Ranomafana National Park was created to preserve its rainforest biodiversity. To secure the preservation of these wildlife treasures, we made a pact with 50 villages that we would improve their lives with the establishment of the park. In the past 28 years the number of tourists has increased from 10 to 35,000 a year, the number of hotels from 1 to 36, and the annual income of the on-road residents has significantly increased. We have established a mobile health team and an education team, which visits 50 remote villages with health care and conservation. We employ 130 local residents full time in science and outreach. The research station is a training center for Malagasy and international scientists, and the laboratories allow molecular biology and infectious disease studies at the edge of the rainforest. CVB has produced over a thousand scientific publications, 55 PhD dissertations, and 280 Masters/DEAs. Through ecological and community long term monitoring, we have gained insights into climate change, wildlife behavioral ecology as well as understanding the interface between the forest and villages. This integrated approach to science, development, and conservation shows that forests are less at risk when local residents are productively involved.

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Characteristic of the habitats of Madagascar Fish Eagle *Haliaeetus vociferoides* across its distributional area

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The Madagascar Fish Eagle, *Haliaeetus vociferoides*, is one of the rarest species of raptor in the world, and classified as an Endangered. It is an endemic and largest raptor on Madagascar. Its distribution range extends from Nosy Hara Marine Protected Area in the north to the District of Morombe in the south. This species is demanding in terms of habitat quality, specifically important levels of available fish and low levels of human disturbance. A study was carried out to improve knowledge about the characteristics of habitats used by the species. In 2016, we visited 12 sites in western Madagascar. Direct observation combined with interviews were conducted to locate nests. Different parameters related to nest location and surroundings areas were recorded. This species uses coastal ecosystems such as bays and estuaries, often associated with mangroves, or islands and islets, and continental ecosystems such as lakes and rivers surrounded by forest. A total of 40 nests were recorded on lakes, 18 along the coasts and nearby islets, and four in trees along river banks. Regardless of the ecosystem, Madagascar Fish Eagles always place their nests on the top of emerging trees near a permanent water body. Significant differences were observed between the two ecosystem types with regards to nest tree height, tree DBH, and the distance from shore. 11 trees species were recorded as nest trees in the continental zone and 14 of the 16 nests found in the littoral zone were built on *Sonneratia alba*. This species inhabits mainly the continental ecosystems, but in coastal areas, largely mangrove ecosystems.

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Population dynamics of chimpanzees in an isolated anthropogenic habitat at Bossou, Guinea: Lessons from 40 years' experiences

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To understand the living conditions of wildlife inhabiting anthropogenic habitat is having a growing importance today, in particular, in rural tropical Africa, where natural landscapes are largely threatened from various human factors. In the case of wild chimpanzees, most ecological investigations, thus far, have concentrated on the populations in natural habitat, and have produced some important datasets, e.g. demography, have been virtually absent for the populations inhabiting agro-pastoral landscapes. At Bossou, Guinea, a group of chimpanzees have survived in an agricultural village of shifting cultivation. The conservation of these chimpanzees is under friendly support from local people for their religious importance and the chimpanzees are well habituated to the presence of humans. The demography of this population of chimpanzees has been continuously recorded since 1976. The population was small and around 20 individuals at the onset of the study. It further decreased to seven in 2019. It has not been easy to confirm directly the causes of death, except for an epidemic in 2003 that resulted in the loss of five of 19 wild chimpanzees. The absence of immigrants to this isolated population is a key threat for the population decrease and has gradually led to extreme population-level aging in the group. The serious conservation issues which the group has faced, are probably caused by the over-habituation of the chimpanzees to humans. For the isolated population in an anthropogenic landscape, habituation is likely dangerous, and it needs to take a good balance between conservation, research, and tourism.

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Preliminary behavioral ecology of Crowned Sifaka in gallery forests of Madagascar

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Madagascar is known for its biodiversity coupled with high anthropogenic threats across different types of habitat. More research and conservation programs are implemented in the eastern part, where the humid forest. It has been reported that the dry deciduous and gallery forests in the western and southern parts of the island are neglected for research and conservation. This study examines the ecology of one Critically Endangered lemur species, the Crowned Sifaka (*Propithecus coronatus*), occuring mostly in dry forests and the remaing gallery forests. The study was conducted in Mandrava gallery forests, Madiromirafy-Maeavatanana, aiming to provide the first information on behavioral ecology of Crowned Sifaka in gallery forests in Madagascar. Data were collected between December 2017 to March 2018, during which time two groups of Crowned Sifaka were followed from 8 am to 4 pm each day. Group scan and focal animal sampling were conducted to assess the daily activity budget, the diet, and habitat use in gallery forests. The feeding activity of the Crowned Sifaka comprises 20% of their active time. Social interactions, mostly dominated by affiliatve behavior occurs 7.5% of the time. The diet is composed of fruits and seeds (45%) and leaves (31%). Food is domnated by one plant species, comprising 61% of feeding time and four other plant species amounting to 28%. Crowned Sifaka occupy in gallery forest the lower 5 m of the forest vertical height. These results demonstrate the flexibility of the behavioral ecology of this species to cope with forest fragmention; shifts in diet, particularly frugivory, based on food availability; use of lower portions of the forest structure; and small home range size. This study contributes new information on the species and is important to help the ongoing sifaka conservation progam for the reamining the Crowned Sifaka across western Madagascar.

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Evolution of Tapia woodland on the fire-prone grasslands of Ibity Massif from 1947 to 2016

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Tapia woodland is a distinctive vegetation type located patchily in the Central and Southern Highlands of Madagascar. It is characterised by the dominance of the tapia tree (*Uapaca bojeri*) that has an open canopy permitting savannah grasses to grow underneath. Tapia woodlands burn more or less frequently and tapia trees have a number of adaptations enabling resistance and resilience to these fires. Four Malagasy protected areas include areas of tapia woodland and in the past their managers have endeavoured, albeit with little success, to totally prevent the penetration of wild fires, many of human origin, into these areas. Now it is more widely recognised that fire is a natural part of this ecosystem but the optimal fire regime for biodiversity conservation in tapia woodland is unclear. To explore this issue, we first mapped fire frequency using data from MODIS during the period 2000 to 2017 in different parts of Ibity Massif Protected Area - containing tapia woodland. Then, using aerial photos and satellite images, we compared the evolution in area of tapia woodland from 1947 to 2006 in zones that burned frequently according to our fire frequency map, zones that burned occasionally, and zones that never burned. This analysis showed that the areas occupied by tapia woodland are very stable under all fire frequencies. However, we also present information on tapia size class structure from replicated vegetation plots that suggests that regeneration of this tree is lower in areas that frequently burn compared to areas where fire is rare or occasional. Thus, it would seem that tapia woodland may be impacted by high fire frequencies but that these impacts may take centuries to become fully apparent in terms of a reduction of the area occupied by this vegetation.

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Effects of cash crops prices fluctuation to the farmer's societal organization from a social learning perspective: Threat or opportunity for conservation and environmental management in northeastern Madagascar?

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Despite the importance of farming, contributions of agriculture to Madagascar's economic development are weak, farmers still belong to the most vulnerable and poorest parts of the population. This is also true for the northeastern regions of the island, particularly in Maroantsetra, where cash crops such as vanilla and cloves dominate agricultural production. Beside agriculture, the region is also known as a "biodiversity hotspot", two protected areas (Masoala and Makira) has been implemented in the area. Over the years, cash crop prices are highly variable, but the prices fluctuation during the last four years has exhorted farmers to suddenly intensify their cash crop production, extending existing vanilla and clove parcels and multiplying new land acquisitions. Consequently, production of subsistence crops such as rice was reduced and forests also was cleared. This acceleration of spontaneous land transformations has raised major concerns towards farmer perceptions on conservation and forests preservation. Against this background, we investigated the land acquisition process in four villages of northeastern Madagascar particularly productive in cash crop but remoted and located near-by the protected areas.144 semi-structured surveys were conducted across the study sites. In addition, two workshops were organized per village site. In this presentation, we will characterize the change in farmer's motivation and how this change is translated not only in the societal organization but also to their knowledge system, what are the current sustainability issues generated and what could be the opportunities from a social learning perspective for conservation and environmental management in northeastern Madagascar.

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Bionomics of the Malagasy Comet Moth *Argema mittrei* (Saturniidae) around Ambatofinandrahana

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Argema mittrei (Guerin-Meneville, 1847) the Malagasy Comet Moth, as well as being a popular icon of Madagascar's biodiveristy worldwide, is also of significant socio-economic importance in areas where it is harvested. However, few data on bionomics of *A. mittrei* have been recorded. Biological and ecological studies, and a survey of the economic value of this moth were carried out around Ambatofinandrahana in 2007. The *A. mittrei* population in higher elevation areas (>1200 m) is monovoltine, whereas it is bivoltine at lower elevation (600 - 900 m). Few wild host plants of *A. mittrei* have been reported. Its caterpillar turns out to be polyphagous: eight host plant species belonging to seven families were inventoried in the study area. Several of them (Hamamelidaceae, Rubiaceae, and Burseraceae) are newly reported for the moth. In the field, monthly density appears to follow the abundance of its host plants. Threats and pressures on the moth population locally include bush fire (main threat), tree cutting, over-harvesting, and the indiscriminant use of insecticides against locusts. There is a healthy market for Comet Moths in the area. Protection and restoration of habitat along with standardization of colection techniques would contribute to the sustainable use of this resource. Appropriate management must therefore be set up in the Ambatofinandrahana region and this will also contribute to conservation of other endemic biodiversity. Indiscriminate use of insecticides should be avoided in areas of high biodiversity.

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The future of music trees: Species distribution patterns of Brazilian trees used for instrument making

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In Brazil, the pau-brasil (*Paubrasilia echinata* Lam.) is probably the most famous tree as it provided the inspiration for the country's naming. But this tree is also well-known because one essential part of the classic violin which is played all over the world, the bow, is made of its wood. Therefore, pau-brasil has been also named the 'music tree'. However, there are more trees equipped with wood of characteristic quality which are valuable for instrument making. In addition to pau-brasil, this talk focuses on two more Brazilian music tree species, the Jacaranda da Bahia (*Dalbergia nigra* (Vell.) Allemão ex Benth.) and the Brazilian Tulipwood (*D. decipularis* Rizzini & Matt.). While the Jacaranda da Bahia provides the material used for the making of guitars, the Brazilian Tulipwood is needed for the building of flutes and woodwind instruments. All three music tree species are protected under the international CITES Convention. The aim of this research is to explore potential past, present, and future distribution patterns of these music trees based on coordinates of herbaria specimen. The Maxent software which has been shown capable of modelling species distribution patterns of small sample sizes was used in combination with projected climate data for the three different periods. Resulting maps show trends in distribution pattern dynamics and form the basis to develop strategies for music tree conservation. Such strategies on the one hand promote natural occurrence of the music trees, and on the other hand seek to explore the potential of sustainable cultivation of these species with the aim to produce legally the materials highly in demand for instrument making.

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Resilient cultural and natural heritage: Potentials for conservation and sustainable management of Pau-brasil in the Mata Atlântica, Brazil

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The Brazilian Atlantic Forest represents a biodiversity hotspot of international importance, and the remaining protected areas of the Brazilian Atlantic Forest are declared as UNESCO World Natural Heritage sites. Several of its endemic tree species, especially precious timber species, are highly endangered due to historical overexploitation. In consequence, the legal extraction of timber from wild forests is completely prohibited and legal extraction from plantations of native tree species is strictly regulated. Pau-brasil (*Paubrasilia echinata* Lam.) – Brazil's national tree - is one of them. However, it is not only the tree, which is protected by UNESCO; also, the traditional violin making craftsmanship in Cremona is declared as Intangible Cultural Heritage of Humanity. This cultural heritage is tightly linked to the tradition of bow making which uses the precious pau-brasil wood – natural heritage - as raw material for high quality violin bows. While alternative wood species exist, which have been proven to meet the high technical standards of wood characteristics which pau-brasil guarantees for premium bows for bow instruments, these are rarely accepted by professional musicians, bow makers, and violin makers. Therefore, an integrative conservation and sustainable management of Pau-brasil is required, in this research the past, current and future potential distribution of pau-brasil were analyzed and compared with legal regulations (international, national and regional ones), with requirements on wood quality, as well as with restauration and cultivation experiences for the species. The combination of results allowed to identify potentials for long-term restauration, reintroduction and cultivation of pau-brasil to cover future timber demand for instrument making, thus safeguarding the cultural heritage, while at the same time aiming at promoting the occurrence of Pau-brasil, thus safeguarding the world natural heritage of the Brazilian Atlantic Forest.

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Plant nutrient acquisition strategies under elevated CO2 in a Central Amazon rainforest

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Low phosphorus availability in weathered soils in large parts of the Amazon rainforest may prevent increased forest growth in response to elevated atmospheric CO_2 (eCO_2). Increased belowground carbon allocation could enhance plant nutrient acquisition and alleviate this nutrient constraint. In temperate forests, eCO_2 increased carbon allocation to fine roots, to alleviate nitrogen limitation. However, it is not clear, if similar responses will occur in lowland tropical forests where soil phosphorus availability is low. We are testing the hypotheses that eCO_2 increases fine root productivity, more precisely specific root length and specific root area, and root phosphatase activity. These mechanisms may allow plants to exploit a larger soil volume and to enhance organic phosphorus mobilization. In addition, we expect that root exudation of labile carbon compounds could stimulate microbial activity, and also increase phosphorus mineralization. We set up the first CO_2 enrichment experiment in Central Amazonia at a low soil phosphorus site, and elevated CO_2 levels by 200 ppm relative to ambient concentrations using open top chambers (OTC) in the forest understory. We are monitoring root productivity and morphological traits in the litter layer and in the soil. Moreover, we are studying nutrient availability and biochemical interactions in the rhizosphere, such as root phosphatase activity rates, microbial biomass and extracellular enzymes rates. Our first data showed that fine root productivity differed in the litter layer and the soil, and moreover, that roots in the litter layer responded differently to the initial pulse of eCO_2 than roots in the soil. Moreover, both root and soils phosphatase activity rates varied over time, but were not affected by the initial pulse of eCO_2. Our results are relevant for improved understanding of tropical plant-soil-microbial interactions under eCO_2, which can be incorporated into ecosystem models to allow more reliable predictions of forest productivity under eCO_2.

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A need of a new coherent management model of mangrove ecosystem for Antsohihy and its surroundings

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Mangroves are crucial ecosystems for climate change mitigation and providing key goods and services to coastal communities. Yet worldwide they are rapidly declining, driven mostly by anthropogenic pressure. An interministerial decree put a ban on any form of mangrove wood exploitation in Madagascar since 2014 to tackle the constant loss of mangrove ecosystems and the depletion of the mangrove wood resource. This study analyzes and compares the effectiveness of the two main mangrove management strategies in the estuarine mangrove ecosystem of Antsohihy's surroundings. The ecosystem was divided in two populations: the first one managed under the ban, and the second one managed by the local community under a NRMTA. A sylvicultural analysis, a remotely sensed monitoring and a landscape analysis of these populations were conducted to compare their health and the evolution of their structure from 2013 to 2017 and project their expected evolution until the next 50 years. A socio-economic survey assessed the local mangrove wooden products value chain. The study pointed out that under the ban, the mangrove population were degrading at a slower pace with a net loss of 3.87% compared to the 9.51% loss under the NRMTA from 2013 to 2017. But neither the ban or the NRMTA were able to manage the mangrove ecosystem sustainably, because the two populations are expected to have constant degradation tendency for the next 50 years. Moreover, applying the ban on the NRMTA managed population would deprive the community of Antsohihy and its surroundings with their main source of energy and building material, hinder the means of subsistence of more than 150 families, and shatter a market valued up to 104,580,000 Ariary (approximately $27,000). Hence, there needs to be a coherent management model able to address the urgent need to conserve the mangrove ecosystem whilst ensuring the satisfaction of basic well-being needs.

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Characterization of the ecological distribution of *Scylla serrata* mangrove crabs on the west coast of Madagascar

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The demand for crabs on the international market has been increasing lately. Concerned about the rapid depletion of mangrove crabs, the Malagasy government has set an MSY of 7,500 tonnes/year for the entire territory. This estimate was calculated on a productivity basis of 2.5 tons/km2/year for 3,000 km2 of mangrove without taking into account other parameters that could influence the distribution of crabs. Carried out along the west coast of Madagascar, particularly at three sites such as Morombe District, Mahavavy Delta, and Mahajamba Bay, this study was conducted to identify the type of preferential habitat for crabs to dig their burrows. For this purpose, 100 m2 plots were used and installed according to the following criteria: distance from the channel, sea front, rear mangrove, inner part, and coverage rate. In each plot, the parameters: mangrove species, tree height, vegetation cover, DBH, soil consistency, water height at high tide, number of crabs, and number of burrows were collected. Results show that crab burrows are abundant in estuarine mangroves (north: 5.2 burrows/Mahajamba plot, 3.7 burrows/Mahavavy plot) compared to coastal mangroves (south: 2.4 burrows/plot). The differences in significant variables between these two types of mangroves can be explained by the difference in the values taken by these variables between the sites. These results are insufficient. Several models will have to be established, distinguishing at least between coastal and river mangroves. Other distinctions (latitude, mangrove size, food) could also be involved (directly or indirectly) in the crab burrowing strategy and, therefore, require the development of dedicated models.

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The role of dung beetles in nitrogen recapture in tropical forest soils

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Understanding the mechanisms governing nutrient cycling in the tropics is critical for safeguarding ecosystem productivity and assessing the influence of anthropogenic change in human-modified landscapes. Dung beetles are important for numerous ecosystem functions which contribute to soil fertilisation. However, our understanding of the role that dung beetles play in soil fertility and plant-available nutrients remains limited in the tropics. We describe a new method for dung labelling, which is both affordable and can be traced through multiple nitrogen pools into aboveground plant biomass. We investigate the role of dung beetles in assimilation of dung-derived nitrogen (DDN) by aboveground biomass. We found evidence for differential nutrient cycling in the two ecosystems, affecting rates of either (i) nitrogen mobilisation or (ii) assimilation into plant material. In tropical logged forest we found that assimilation of DDN by seedlings commenced approximately 20 days after first exposure to dung, and that dung beetle presence reduced the assimilation DDN into plant biomass across the duration of the experiment. However, in the presence of dung beetles, DDN was both more prevalent and more quickly incorporated into the soil matrix. In the oil palm ecosystem, we found no difference in DDN assimilation by seedlings over time regardless of dung beetle presence. Our study suggests a new labelling method for mammalian dung, allowing assessment of the impacts of dung beetles on nitrogen cycling and associated biological processes in the tropics. However, the differences in ^{15}N assimilation between oil palm and logged forest suggests that both labelling requirements, and underlying nutrient dynamics, are ecosystem specific.

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Forest biomass, productivity, and carbon cycling along a rainfall gradient in West Africa

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Net Primary Productivity (NPP) is one of the most important parameters in describing the functioning of any ecosystem and yet it arguably remains a poorly quantified and understood component of carbon cycling in tropical forests, especially outside of the Americas. The first comprehensive analysis of NPP and its carbon allocation to woody, canopy and root growth components at contrasting lowland West African forests spanning a rainfall gradient has been provided. Using a standardized methodology to study evergreen (EF), semi-deciduous (SDF), dry forests (DF), and woody savannah (WS), it was found that (i) climate is more closely related with above and belowground C stocks than with NPP (ii) total NPP is highest in the SDF site, then the EF followed by the DF and WS, and that (iii) different forest types have distinct carbon allocation patterns whereby SDF allocate in excess of 50% to canopy production and the DF and WS sites allocate 40%–50% to woody production. Furthermore, it was found that (iv) compared with canopy and root growth rates the woody growth rate of these forests is a poor proxy for their overall productivity and that (v) residence time is the primary driver in the productivity-allocation-turnover chain for the observed spatial differences in woody, leaf, and root biomass across the rainfall gradient. Through a systematic assessment of forest productivity, the importance of directly measuring the main components of above and belowground NPP is demonstrated and the establishment of more permanent carbon intensive monitoring plots across the tropics is encouraged.

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Multi-level impacts of an invasive predator on behavior, survival, and ecology of an island avifauna

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Invasive species are one of the primary drivers of global biodiversity loss and often have cascading impacts on the ecosystems they invade. A textbook example is the brown treesnake (BTS – *Boiga irregularis*), which was introduced to the island of Guam after WWII and caused the subsequent extinction of 10 of 12 native forest bird species. However, avian extinctions occurred synchronously and rapidly within a decade, precluding a mechanistic understanding of how BTS drove the collapse of Guam's avifauna. Furthermore, current impacts of BTS on the island's surviving bird populations remain largely unexplored. Explore ongoing multi-level (i.e. population, community, ecosystem) impacts of BTS on Guam's surviving avifauna. We used radio-telemetry to study behavior, survival and ecology of Guam's only remaining native frugivore, the Sali (Micronesian Starling – *Aplonis opaca*). We surveyed night roosts to explore the avifauna's roosting behavior in the presence of the nocturnal BTS. On the population level, we found that (1) BTS caused the majority of Sali mortality in all age classes, (2) the fledgling survival rate was extremely low (<25%), and (3) the population's age structure was highly skewed (~90% adults). On the community level, we found concordant spatial patterns of roosting across all bird species, including avoidance of forest habitat and extensive evidence of interspecific communal roosting (six species, n = 48 roosts), both likely adaptations to reduce BTS predation risk. On the ecosystem level, we found that BTS presence altered Sali movement behavior and habitat use, impacting seed dispersal and spatial patterns of seed deposition across the landscape. We provide a comprehensive picture of the ongoing impacts of the BTS and demonstrate how one of the world's most destructive invasive predators continues to affect population, community and ecosystem level processes.

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Trophic interactions and resource availability regulate community structure of litter dwelling invertebrates

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Tropical forests litter layer has a very complex and diverse food web with important implications for ecosystem functioning. For instance, such brown food web process about 90% of all litter that reaches the forest floor, converting it into soil organic matter, CO_2, mineralized nutrients and body tissues. Since litter organisms convert nutrient poor materials into nutrient rich body biomass it is likely that the structure of their community should be direct of indirectly dependent on the availability of essential nutrients. Similarly, space availability and how it relates to the abundance of predators and their prey should influence on trophic interactions and their community structure. We investigated: 1) the effect of moisture seasonality, ecosystem space availability, and microbial CNP over the community structure of litter dwelling invertebrates; 2) how litter nutrient availability influences microbial biomass and CNP, regulating resource availability for microbivores as well as the substrate quality for detritivores; and 3) we also tested the effect of litter depth on the invertebrate community structure. We sampled 80 l quadrats in two independent, nutrient poor, pristine forest sites near Manaus, Brazil. Litter samples were placed in Berlese extractors for 10 days with invertebrates collected in 1% formalin solution. Microbial biomass CNP and litter chemistry were also measured. Litter dwelling invertebrates were identified to order level and grouped as microbivores, detritivores, and predators according to their feeding habits. Litter depth increased by 46% during dry season, but the number of invertebrates did not vary (average 9878 individuals, 32 orders). However, predators increased by 10.5% during dry season, benefiting from more ecosystem space. Predator: prey ratio was 1.56 and 1.83 for dry and wet season, respectively. Litter microbial biomass C and P positively influenced Collembola, but the effect of resource availability seemed counterbalanced by top down regulation by predators during dry season.

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Back from the brink— saving critically endangered sportive lemurs (*Lepilemur tymerlachsoni*) endemic to Nosy Be, NW Madagascar

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Among the most threatened mammals on Earth are Madagascar's unique and endemic lemurs. Restricted to the island of Nosy Be, off the NW coast of Madagascar, Hawk's Sportive Lemur (*Lepilemur tymerlachsoni*) is on the brink of extinction due to a limited extent of occurrence of < 75 km^2 and a decrease in the availability of their nesting/resting tree-holes due to deforestation. In 2015, three local lemur species were surveyed along eight 500 m transects in degraded forests east of Lokobe National Park borders. Next, since nocturnal sportive lemurs require tree holes as daytime sleeping sites but these are lacking in degraded forests, iFrogs team built and installed 25 wooden nesting boxes to mimic nesting holes along five of the eight transects (*i.e.*, five boxes per transect, placed every 50 m). Sportive lemurs moved into these man-made boxes within one week and after three months, >50% of the boxes were occupied including mother-offspring pairs. Within three years, most wooden boxes had rotted; thus, in September 2018, 40 new boxes were built. 10 boxes were placed every 50 m along four of the original transects, and some were occupied by *Lepilemur* in < 24 hours. Within weeks, photographic evidence revealed that five mother-infant pairs moved in, and now nearly all boxes are occupied by this Critically Endangered primate. To quantify the success of these boxes in increasing lemur abundance, we plan to re-survey all transects and monitor nesting box use by collared individuals to document *Lepilemur* social behaviors. Data gained could aid conservation action plans to conserve >20 endangered sportive lemur species throughout Madagascar. Moreover, iFrogs' research and outreach programs educate and empower Malagasy children, women, guides, and elders in Nosy Be to serve as environmental stewards of Lokobe.

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An integrative overview of structure, dynamics, and functional traits in a central Amazonian forest

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The AmazonFACE study site is likely the most intensively studied forest of Amazonia. In order to develop an understand of all processes that may change under elevated CO_2, more than 38 ecological processes have been simultaneously measured during the last four years, with particular attention to forest carbon cycling and processes and strategies to overcome nutrient limitations. Soils at the AmazonFACE site are very low in rock derived nutrients, particularly of P, with an average concentration of 80 mg kg^{-1}. Processes of carbon uptake, nutrient acquisition, biomass, and root production are followed closely in association with decomposition. A total of 2069 individuals with DBH ≥ 2 cm and a species richness of 441 is found in our eight plots, each with 706.5 m^2. Physiological data was measured across a vertical profile and the average carbon uptake calculated. Canopy trees showed a photosynthesis rate 43% higher than subcanopy and 108% higher than understory, with similar pattern also occurring with leaf nutrients and leaf mass per area. Between 2016 and 2017 the annual biomass increment was of 9.320 Kg C m^{-2} and the litterfall productivity was 0.4 kg C m^{-2}. Accordingly, nitrogen and phosphorus input through litterfall was 373 mg of nitrogen and only 3.24 mg of phosphorus per m^2. The net primary productivity (NPP) was calculated as 1.28 Kg C m^{-2} y^{-1} consisting of the sum of litterfall, coarse wood biomass increments and root productivity per m^2 $year^{-1}$.

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Selection of nesting habitat for passerines in the humid fragmented forest of Bemanevika Protected Area, north central Madagascar

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Understanding the factors determining of nesting habitat selection for passerines in fragmented forests is essential in order to improve conservation strategies for birds. In this study, we examined the distribution of passerine nests based on forest fragment size and distance from the edge. Particularly for species of the Philepittinae subfamily, endemic to Madagascar, we identified the vegetation structure around the nests. This study was carried out in Bemanevika Protected Area, north central Madagascar, during a breeding season. Seven forest fragments of different sizes, ranging between 10 ha to 1050 ha, were surveyed. We searched for active nests in the sampling plots (25 m x 25 m) placed at every 100 m along the transect lines. A total of 219 nests belonging to 18 species of passerines have been located. The nests of six forest-dependent species (*Xanthomixis cinereiceps*, *Tylas eduardi*, *Newtonia amphichroa*, *Neodrepanis coruscans*, *Philepitta castanea*, and *P. schlegeli*) amongst the 18 were not detected in the four smaller fragments (10 ha to 29 ha). In addition, these species built their nests from 260 m from the edge. The three last species mentioned above were from the Philepittinae subfamily. Their nesting sites (n = 11 nests) are characterized by a large canopy cover (mean = 82.4 %; SD = 6.8) and an important density of large trees (D_{mean} = 421.3 trees/ha; SD = 103.8; for DBH ≥ 30 cm). The large forest fragments have ecological conditions favorable to the nesting sites of the forest-dependent birds, unlike the small forest fragments and the biological and physical changes are generated by fragmentation. In conclusion, fragmented forests provide habitat for bird species even for those which avoid smaller fragments and edges, and this should be considered in the conservation strategies.

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Poaceae occurrence data mobilization and mapping: The GBIF BID Madagascar grass atlas

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Grassy communities cover at least 65% of Madagascar. The country is home to more than 500 species of Poaceae. The majority of Malagasy Poaceae herbarium specimens are held at the Muséum national d'Histoire naturelle, Paris (P herbarium) and are not reliably accessible in Madagascar due to poor internet connections which often make it impossible to view specimen images. Within our project *Alien, native, and endemic grasses of Madagascar*, funded by the European Union and GBIF, the objective was to mobilize occurrence data on the grasses of Madagascar and surrounding islands, to make them available to researchers, protected area managers, and decision makers, and to produce the *Madagascar Grass Atlas*. Grass specimen images from Paris were transcribed and recorded in BRAHMS. All data concerning collectors, collection date, location, habitat, plant description, and other relevant information seen on the specimen image were recorded in a Rapid Data Entry (RDE) file. Georeferencing was carried out thoroughly and an accuracy assessment was recorded for each occurrence point. We extracted the coordinates of each specimen collection from the database and mapped them onto the protected areas map of Madagascar, using ArcGIS pro online with custom Python scripts. The occurrence data were used to produce maps for the *Madagascar Grass Atlas*. At the end of the project, 21,664 specimen images were transcribed and georeferenced. The final clean database comprises 20,000 herbarium sheets, which are part of 16,000 collections, for Madagascar and the surrounding islands. Among these, 14,000 collections are from Madagascar, of which 88.9% were successfully georeferenced. 577 distribution maps have been produced. We hope data mobilised by this project will speed up the taxonomic and evolutionary studies of the Poaceae of Madagascar. We also hope to encourage a national strategy to study, identify, and record alien invasive grasses, and plan their management.

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We may be small but many: Mammal abundance compensation in half-empty Amazonian forests

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Large-bodied tropical forest vertebrates are often highly threatened from overhunting. Local declines in large-bodied frugivores can disrupt key forest ecosystem services such as effective seed dispersal of heavy-wooded tree species, thereby triggering profound cascading effects on forest regeneration and carbon storage. Furthermore, low densities of large vertebrates can promote local compensatory dynamics, particularly on small-bodied forest granivores, such as terrestrial rodents, that may further have important negative feed-backs on forest regeneration. Here we examine the degree to which abundance compensation occurs along a gradient of hunting pressure in Amazonian forest. We surveyed 30 upland (terra firme) forest sites along a major white-water tributary of the Amazon using a novel camera trapping grid design including 20 cameras (16 understorey and four arboreal camera traps) which were exposed for a minimum of 30 days per site. Large-bodied vertebrates such as tapir, peccaries, and large monkeys were not found at forest sites near a medium-sized urban center and larger local semi-subsistence communities which exerted higher levels of hunting pressure. Conversely, small mammals, mainly spiny rats, had higher abundances at those sites. Our results suggest that post-depletion equilibria involving large-bodied vertebrates at overhunted forests are associated with elevated densities of small seed predators of large-seeded plant species, which likely have additive effects on the fate of heavy-wooded tree species. Compensatory abundance of small-bodied granivores may therefore amplify the cascade effects of large-bodied vertebrate depletion driven by overhunting. This process can result in changes in floristic composition with consequences to the maintenance of forest carbon stocks.

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