Excerpts from

TROPICAL FORESTRY ABSTRACTS II

Frank H. Wadsworth and Isabel M. Fernandez

FOREWORD

Frank Wadsworth: During 1942-1949 Frank learned from tropical forestry research based in Puerto Rico. During 1950-2000 Frank traveled much in the tropics, learning from forests and foresters in the Americas, Africa, Asia, and Australia. Based on these experiences, during 1976-2019, Frank selected key abstracts for the Tropical Forestry Notes for International Society of Tropical Foresters and the Society of American Foresters. Through the Notes, Frank hopes to help tropical foresters increase their understanding, including of tropical forest ecology and wildlife conservation.

Frank respects the scientists and science behind the selected abstracts. For the busy forester, at times he has strived to express more concisely the information they contain.

Isabel (Beba) M. Fernández: Isabel is an attorney in Puerto Rico, married to Attorney Ivan Fernández, and a resourceful mother of two. She facilitated the production of this volume of Tropical Forestry Notes by providing Frank with key information from each selected abstract in large print, assisting with the editing, and arranges and prints the Tropical Forestry Notes.

NOTES

This volume is a compendium of excerpts of selected abstracts from recently published tropical forestry research, followed by citations of that research. Many of these abstracts were obtained through the library of the USDA Forest Service International Institute of Tropical Forestry in Puerto Rico.

D = We thought this was of special interest.

Note: It is suggested to use the search function in your PDF reader to find articles on topics of interest.

2019-

TROPICAL FORESTRY NOTES (21)

AFRICAN CONSERVATION FROM TOURISM

Tourism is the principal source of local conservation funding in most African countries. Local commercial companies provide substantial funding for private reserves, communal conservancies, and public protected areas. They also provide local employment, which generates community support. Conservation projects influence purchases significantly for some clients, but not for the majority, nor for travel agents. Therefore, maximum contributions to future conservation finance can be achieved through differential marketing to these two groups. Mainstream marketing is targeted at tourists who want the best wildlife viewing in the greatest comfort. Conservation marketing is targeted at tourists who purchase products that contribute to conservation. Buckley and others. Private conservation funding from wildlife tourism enterprises in sub-Saharan Africa. Conservation marketing: Beliefs and practices. [Biological Conservation 218 57-63 2018] D

TEAK AND MIXED SPECIES IN COMPETITION IN AUSTRALIA

Improving community forestry in the Solomon Islands, mixed species plantations were established to assess the feasibility of interplanting teak (*Tectona grandis*) and flueggea (*Flueggea flexuosa*). Using N labeled ammonium sulfate the competition for nitrogen between the two species was investigated. The N labeled tracer was applied to isolated pots containing 2 and 4-year-old pairs of trees of the two species. After 12-18 months the trees were harvested and roots, stem, branch, and foliage weighed and analyzed for total N and N enrichment. There was no significant difference in the amounts of N tracer between teak and flueggea at either age, suggesting equal uptake of N tracer by both species. For teak, the N amount absorbed was greater in stem, followed by roots, foliage, and branches. For flueggea the order was branch, stem, roots, and foliage. About 42% and 55% of the applied N tracer was recovered by the two ages, respectively. In the 4-year plots teak had sufficiently greater stem growth, height, basal area, and volume than flueggea, and yet the teak uptake of N tracer was the same, which means that access to the resources was equal and growth rates differed between species. T. J. Blumfield and others Teak and other species in competition. [Australian Forestry 80 135-142 2017] D

CLIMATE CHANGE EFFECTS ON GROWTH OF BLUE GUM IN AUSTRALIA

Australia's forests have been identified as vulnerable to climate change impacts. Elevated CO2 and site conditions were used to predict the direct effects of climate change on Australia's blue gum (*Eucalyptus globulus*) plantation estate. Across the whole estate management can reduce risk. The drier parts of the estate are at risk. In all but the eastern areas of Western Australia and at the driest margins of the estate in South Australia and Victoria options can reduce risk and ensure production. In Western Australia rainfall decline significantly impacts predictions. Local site factors will play an important role in constraining responses to CO2 reduction. M. Battaqlia and others. Direct climate change impacts on growth and drought risk in blue gum (*Eucalyptus globulus*) plantations in Australia [Australian Forestry 80 (4) 216-227 2017] D

LEGAL REGULATION FOR FOREST PROTECTION IN AUSTRALIA

Formal regulation is a key mechanism by which governments seek to protect forests. Whether regulation can effectively protect the most threatened forests was addressed between 2000 and 2014 in Queensland, Australia under the Vegetation Management Act 1999. Application was mediated by deforestation pressure. Threatened forest types, which have already lost 70% of their original extent and should have the greatest level of protection under the Act, continued to be cleared 2.7-2.9 times faster than non-threatened forest types. This was because the added protection afforded to threatened, relative to non-threatened forests, is insufficient to counter the continuing higher level of deforestation pressure on threatened forests. A potential solution is to define in the regulation forest retentions below which no further forest loss is permitted. R. Rhodes and others. The effectiveness of regulations for protection. [Biological Conservation 216 33-42 2017] D.

HARVESTING FROM TEN TREE SPECIES IN THE EQUADORIAN AMAZON

The Ecuadorian Amazon is part of the Andes Amazon, an area covered by Venezuela, Colombia, Ecuador, Peru, and Bolivia. A study determined current trends with respect to mostly legal timber harvested forest species. Two harvesting programs aimed at small farmers prevail in the Region. Significant differences were detected between logging procedures and ecosystems. Two hundred and thirty-two tree genera are registered for harvest, and yet 52% of the timber harvesting volume comes from eight tree genera and ten species, in fallows of fragmented forest ecosystems. Sustainable production depends on the harvesting by small farmers of only fast-growing pioneer species. S. Bonilla-Bedoya and others. Patterns of timber harvesting and the relationship with sustainable forest management in the Western Amazon, Ecuador case. [Journal of Sustainable Forestry 36 433-453 2017] D

IMPACT OF CO-MANAGEMENT ON FOREST CONDITIONS IN MALAWI

Co-management forestry impact effectiveness on forest resources in Zomba-Malosa and Nichisi Forest Reserves were studied in Malawi. Tree density and forest richness were used as measures of forest condition. Human activities were measured as impacts. Co-managed plots have higher tree density than state managed plots. Indicators of human impacts, felled trees, farming, and grazing were found in co-managed and state managed plots. Some 70-80% of people in the two reserves see a positive benefit from co-management. Nevertheless, results vary with preexisting conditions and how communities understand the program. The program lacks baseline data for quantification and integration of participatory research into the study. L. L. Chinangwa and others. Impact of forest co-management programs on forest conditions in Malawi [Journal of Sustainable Forestry 37 (4) 338-357 2017] D

HABITATS FOR MIGRATORY BIRDS IN THE MATANG MANGROVE

A study aimed to identify the habitat requirements of two migratory families: Scolopacidae and Charadridae. Data on distribution were utilized. Software was used to model the relationship among the study parameters (climate, environment, elevation, and the population density of the birds). Pulau Kalumpang had the highest density. Pulau Sangga Besar and Kertang had the potential to be alternative habitats within 20 years. A. R. Azmah & M. Tarmiji. Habitat requirements of migratory birds in the Matang Mangrove Forest Reserve, Perak. [Journal of Tropical Forest Science 30 (3) 304-311 2018] D

HUMMINGBIRD INTERACTIONS IN CHIAPAS, MEXICO

Plant-animal interactions allow us to understand the dynamics of communities. We evaluated whether flowers with different pollination syndromes are used by hummingbirds and whether their characteristics affect the structure (core-peripheral species) of hummingbird networks. Observations were made in flowering patches where plant-hummingbird interactions were recorded at three altitudes (300-2500m) at El Triunfo Biosphere Reserve in Chiapas. We recorded 15 hummingbird species interacting with 58 plant species. The greatest number of interacting hummingbird species (11, 13) and plant species (28, 40) were found at middle altitudes and during the dry season, respectively. Most of the plant species visited (67%) had hummingbird-adapted flowers, but more hummingbirds visited plant species with unadapted flowers. At high altitudes, hummingbirds exhibited the greatest level of specialization towards plants, but at low altitudes the networks of plant-hummingbird interactions were generalist, that is visiting plants with and without adapted flowers. The core generalist hummingbird species remained constant with altitude and season, but the core generalist plant species varied between altitudes and seasons, according to species phenologies. R. Partida-Lara and others. Pollination syndromes and interaction networks in hummingbird assemblages in El Triunfo Biosphere Reserve, Chiapas, Mexico. [Journal of Tropical Ecology 34 (5) 293-307 2018] D

LAND USE INFLUENCES IN PROTECTED PACIFIC MANGROVES

Mangroves sustain millions of coastal livelihoods. Notwithstanding this, their area has been greatly reduced in the last century. A study on the Pacific shorelines of Colombia, Panama, and Costa Rica concerns land use and land cover change. We also evaluated the effectiveness of protected areas in halting deforestation between 2000 and 2012. Results show that during this period 564 ha of mangrove were lost, 75% in locations outside of protected areas. A conclusion is reached that current conservation policies for mangrove protection in the three countries are effective at reducing deforestation and set a positive example for regions where mangroves are in decline. J. Lopez-Angarita and others. Land use patterns and influences of protected areas on mangroves of the eastern tropical Pacific. [Biological Conservation 227 82-91 2018] D

PRESCRIBED BURNING IMPACTS ON BIRDS IN AUSTRALIA

Prescribed burning attempts to protect assets by removing accumulated flammable biomass. Heterogenous burning patterns are often favored in an attempt to balance fuel reduction and biodiversity under the “pyrodiversity begets biodiversity” paradigm. Impacts of the fire on bird assemblages were assessed in the woodlands of the Mount Lofty Ranges, in South Australia, where prescribed burning is increasing. Sites burnt 20 years previously accommodated 15% fewer birds than unburned sites. Sites burned in the previous year had 22% fewer birds. Fire also modified bird assemblages, favoring generalists and ground-feeding species. Of 60 species 37% were negatively impacted by recent burning, while burning reinforced trends in 30% of common, large species. Higher avian diversity was predicted for scenarios that retained unburnt forest relative to those that managed all sites. There is a trade-off between burning and biodiversity. Fire management planning should preserve long-unburned woodland habitat. T. A. Prowse and others. Prescribed burning impacts avian diversity and disadvantages woodland specialist birds unless long-unburnt habitat is retained. [Biological Conservation 215 268-276 2017] D

TROPICAL FORESTRY NOTES (22)

MAMMALS IN AFROMONTANE FORESTS OF TANZANIA

In African forests commercial and subsistence hunting are widespread, but assessments of mammal abundance and distribution patterns are often lacking. Patterns of abundance of 27 species of medium to large-bodied mammals were investigated in Tanzania's Udzungwa Mountain Afromontane forests, a global biodiversity hotspot. Twenty-two forest sites were sampled within 19 forests under varying degrees of protection, elevation, distance to extractive communities, and levels of law enforcement, covering 251.7 km of line transects during dry seasons (July-November) between September 2007 and July 2010. A strong positive effect was found of protection status on species richness and on encounter rates of the most commonly encountered species. Consistent with the levels of resources and enforcement within each Protected Area category, there was a significant progression of species richness and abundance from Forest Reserves through Nature Reserves to sites within Udzungwa Mountains National Park. Protective status closely reflected levels of disturbance. Findings demonstrate Protected Area effectiveness in Afromontane forests and reinforce the threat posed by snares. T. Jones and others. Effect of protection status on mammal richness and abundance in Afromontane forests of the Udzungwa Mountains of Tanzania. [Biological Conservation 229 78-84 2019]

CONSERVATION SUCCESSES AND CHALLENGES ON JAVA 1990-2015

While much has been published on forest loss in the Sundiac lowlands, deforestation rates on Java's endemic-rich mountains have been neglected. Nearly 1,000 Landsat images were used to examine forest loss in montane West Java over the last 28 years, and the effectiveness of protected areas in halting deforestation during that period. Around 40% of forest has been lost since 1988. Most of the deforestation occurred below 1000 m above sea level. Deforestation within protected areas was rife pre-2,000 but almost ceased by 2,007 in protected IUCN areas. There are only 5,234 km^2 of remaining forest. It must be recognized that most of the lower forest has disappeared, and what remains is fragmented. The biological value of these forests is still believed to be huge, and without strong intervention the authors anticipate imminent loss of populations of taxa such as the Javan Slow Loris *Nycticebus javanicus* and Javan Green Magpie *Cissa thalassina*. T. P. Higgenbottom and others. Deforestation dynamics in an endemic-rich mountain system: Conservation successes and challenges in West Java, 1990-2015. [Biological Conservation 229 152-159 2019] D

SOIL UNDER MONODOMINANT VS. MIXED FOREST IN REPUBLIC OF THE CONGO

The aim of this study was to compare the physical and chemical properties of soils under dominant *Gilbertodendron dewevrei* forests (G) of central Africa with those under an adjacent mixed forest (F) while controlling for topography. We set up sixteen 0.25 ha plots according to forest type and topography (plateau vs. bottomland) in the Yoko Forest Reserve, Democratic Republic of the Congo. In each plot we measured litter thickness and collected soil samples at depths of 0-5, 5-10, 10-20, 20-40, and 120-150 cm, for standard physical and chemical analyses. We found that most of the chemical properties of soils under G did not differ from those of soils under F, particularly acidity, caption concentration, total N and the C:N ratio. The litter layer was 2.3 times thicker under G than under F and for given texture, soils under G had a slightly higher

organic C concentration in the 0-5cm soil layer. *G. dewevrei* stands may modify organic matter dynamic which may be important to maintain the monodominance. M. Lokonda and others. Are soils under monodominant *Gilbertodendron dewevrei* and under adjacent mixed forests similar? A case study in the Democratic Republic of the Congo. [Journal of Tropical Ecology 34 (3) 176-185 2018] D

TEAK UNDERSTORY BIRDS IN CENTRAL JAVA

Four different teak plantation conditions were selected: clonal, conventional, agroforestry, and old-growth teak plantation in the forest management unit of Cepu, Central Java. Point-count samples were placed systematically to record species inhabiting the forest floor habitat. Species were grouped according to the guild and stratum of the floor. It was found that teak provided more habitats for insectivorous and omnivorous birds and less for frugivorous species. The encounter rates of insectivorous were highest in agroforestry, conventional, and old-growth teak plantation. The granivorous guild was highest in the clonal teak plantation. Further improvement of surrounding habitat, including riparian, is needed to support avian diversity beneath forest plantations. M. A. Inron and others. Understory avian community in a teak forest of Cepu, Central Java. [Journal of Tropical Forest Science 30 (4) 509-518 2018] D

TREE GROWTH IN THE CENTRAL AMAZON

The growth of trees in a forest plantation is affected by the resource supply (light, water, and nutrients), the fraction of resources acquired, and resource use efficiency. A study used 24 leaf morphological and physiological leaf traits to investigate whether simple leaf traits can explain the relative growth of 8 tree species native to the Central Amazon 15 months after planting. *Tachigali vulgaris* and *Tratinnickia rhoifolia* had the highest growth in height and diameter, which was two to three times higher than *Bombacopsis macrocalyx*. *Tachigali vulgaris*, *Ochroma pyramidale*, and *Ceiba pentandra* are efficient resource use species, have high light-saturated photosynthetic rates. *Endlicheria anomala* performed worst, based on functional traits, with the lowest photosynthetic rate. Twelve leaf traits were correlated with relative growth rate (RGR). Leaf area, chlorophyll content, leaf water potential, and leaf nutrient concentration were not good predictors of growth. Only stomatal conductance was related to RGR. Leaf traits related to nitrogen and phosphorus efficiency explain only 20 to 30% of tree growth in height and diameter. Photosynthetic efficiency-related traits are good predictors of tree growth potential, species with high efficiency, such as *T. vulgaris*, *O. pyramedale*, *T. rhofolia*, and *C. pentandra* can achieve high growth in Amazonian disturbed areas. The selection of traits most correlated with growth performance can be more informative for reforestation monitoring. Z. T. Matos. Guimaraes and others. Leaf traits explaining the growth of tree species planted in a Central Amazonian disturbed area. [Forest Ecology and Management 430 618-628 2018] D

BARRIERS TO PREDATORS OR SUITABLE HABITAT IN BRAZIL?

Jaguars and pumas are the largest felids of the American continent, and particularly jaguars are critically endangered in the Atlantic Forest of Brazil This forest has been converted to human land uses, including forest tree plantations with exotic species. Jaguar and puma habitat use were assessed in a productive landscape of exotic pine plantations and forest areas in the Atlantic Forest of Argentina. We estimated the availability of their main prey and evaluated the variables that affect their occupancy pattern. Camera traps were used in 2013 and 2014 in an area that

includes pine plantations, protected areas, and nonprotected areas. The proportion of plantation to forest did not affect habitat use by either of the two feline species, but human accessibility and distance to the continuous forest, did show an effect on these big cat species. Exotic tree plantations interspersed with forest areas do not constitute barriers for jaguars and pumas and can function as potential corridors. Forest plantations, as such, do not constitute optimal habitats for these felids. They can be supplementary habitat if there is a high proportion of native forest among the plantations. A. Paviolo and others. Barriers, corridors, or suitable habitat? [Forest Ecology and Management 430 576-586 2018] D

TREES IN AMAZONIA 13 YEARS AFTER REDUCED IMPACT LOGGING

In this study growth, mortality, and recruitment were assessed in different forests logged along 13 years, (2002 -2015) in the eastern Amazon. The data were collected in a control unlogged forest and in four 100-ha working units divided into 20 plots of 5ha (total of 100 plots in 500 ha sampled) and inventoried at 100% one year before harvesting and again in 2015. A total of 49 species were analyzed in the study. The highest mortality rate occurred in the first five years after harvesting (5.6%), with a reduction from the seventh year (3.2%), a period in which recruitment rate significantly increased for species from all ecological groups. Harvesting reduced both the number of individuals and species in the first five years after logging. Logged areas presented the highest growth rates five and seven years and only stabilized eleven years after logging. Within the range of 3-40 m^3/ha of logging intensity no differences were observed in growth rates of remaining trees >45cm DBH. Pioneer, light-demanding and shade tolerant species presented higher growth rates in the first five years after logging. From seven years after harvesting light-demanding species presented a higher growth when compared to the shade tolerant species. Larger diameter classes presented the highest relative growth rates. All diameter classes increased in relative growth rate up to eleven years after logging. L. Fernandez Silva Dionisio and others. Growth, mortality, and recruitment in the Amazon rainforest 13 years after reduced impact logging. [Forest Ecology and Management 430 150-156 2018] D

ARAUCARIA FORESTS IN BRAZIL FOR TIMBER?

Most Araucaria in Brazil exists on small farms and only 1% in protected areas of mature forest. Current law restricts forest management for timber production in native araucaria forests by prohibiting harvesting the main species, *Araucaria angustifolia*, and other important commercial timber species. As a consequence, the forested areas of some small farms have been illegally converted to other land uses, resulting in the area of native *Araucaria* forest coverage in southern Brazil having been significantly reduced in recent decades. We used a growth model to simulate nine different harvesting scenarios to simulate *A. angustifolia's* long-term recovery after harvesting. Four harvesting scenarios were considered sustainable for producing *A. angustifolia* timber: removing 10% of the *A. angustifolia* basal area in 5-year cutting cycles; removing 20% in 10-yr cutting cycles; 35% in 20-year cycles, or 40% in 25-year cycles. These four sustainable *A. angustifolia* harvesting scenarios remained sustainable when managing the forest as a whole by including some angiosperm tree species harvesting as well. E. Orellana and others. Could native Araucaria forests be managed for timber production on small farms? [Forest Ecology and Management 430 1-9 2018] D

CHANGES IN CLIMATE AND VEGETATION ON MOUNT BATILAMU, FIJI

To investigate changes in vegetation and climate with altitude, we established forest plots and recorded climatic data at 100-m intervals between 550–1100 m asl on the western slopes of Mount Batilamu, Mount Koroyanitu range, Viti Levu, Fiji. There were two vegetation types (grasslands and forests) and two distinct forest types (lowland and montane). Montane forest was found at >950m asl. and had significantly higher stem density. Mean temperature decreased significantly with altitude and was strongly moderated by vegetation type (lower average and less variation in forest). Average relative humidity significantly increased with altitude; it was also strongly moderated by both habitat and vegetation type (higher average and less variation in leaf litter and forest). Vegetation and microhabitats create unique climates to be considered on forested mountains. J. Anderson and others. Changes in climate and vegetation with altitude on Mount Batilamu, Viu, Levu, Fiji. [Journal of Tropical Ecology 34 (5) 316-325 2018] D

AUSTRALIA'S THREATENED FOREST-DEPENDENT SPECIES

Assessment information to support the listing of threatened species is required for indicator-based national and international "state of the forests" reporting. A database on threatened forest-dwelling species in Australia was therefore developed for the National Forest Inventory. At December 2012 a total of 1,352 forest-dwelling plant and animal species were listed as critically endangered, endangered, or vulnerable under the national *Environment Protection and Biodiversity Conservation Act 1999*. Forest-dwelling species comprise 80% of the listed species under the Act. Forest-dependent species represent 48%. These high proportions reflect the half of Australia's forest area cleared for development and the consequent focus on threatened forest-dwelling species. The most common causes of threat were land use change resulting from agricultural clearing and urbanization, unsuitable fire regimes, and invasive species. Forestry operations as a cause of threat ranked 9" out of 11 threat categories for forest-dwelling fauna and 11" out of 11" threat categories for forest-dwelling flora. Genetic threats are given as major listing reasons for many forest-dwelling species, particularly birds and invertebrates, and plants. Collection of rigorous data for monitoring forest-dwelling species continues important for their ongoing management and research into the causes of threats. S. M. Davey and others. Reporting Australia's forest biodiversity II threatened forest dwelling and forest dependent species. [Australian Forestry 81 (4) 214-220 2018] D

TROPICALFORESTRY NOTE (23)

LOGGING EFFECTS ON FOREST COMPOSITION IN GUIANA

The increase of human activities in tropical forests makes the conservation of biodiversity and associated services strongly dependent on the sustainability of these activities. Species richness and biomass provide an understanding of sustainability. We assessed the sustainability of common forest exploitation in the Guiana Shield by studying the recovery of two ecosystem services: carbon storage and seed dispersal by animals. We compared total and commercial biomass as well as seed size of animal-dispersed species in replicated forest plots before and 27 years after exploitation. Species richness was not affected by forest exploitation. But total and commercial biomass, as well as seed size of animal-dispersed species decreased 27 years after exploitation. These results show that ecosystem services and function likely did not recover even at the lowest intensity of forest exploitation studied, questioning the sustainability of the most common rotation applied in the tropics. B. Yguel and others. Impact of selective logging and silvicultural treatment on the functional composition of a neotropical forest. [Forest Ecology and Management 433 528-534 2019] D

SPECIES-SPECIFIC RESPONES TO DROUGHT IN SOUTH ASIA

The frequency and intensity of drought events in the tropics have increased, yet responses of many tropical trees to droughts are incompletely understood. This study concerns two tropical canopy species from a Bangladesh moist forest subject to two severe droughts in 1984 and 1999: *Chukrasia tabularis* (intermediate shade tolerant) and *Toona ciliata* (light demanding). The two species showed no differences in their drought resistance. During severe droughts, their diameter growth dropped by 44-56%. It was concluded that shade tolerant *C. tabularis* is more drought tolerant than light demanding *T. ciliata*. M. Rahman and others. Species-specific growth resilience to drought in a mixed semi-deciduous tropical moist forest in South Asia. [Forest Ecology and Management 433 487-496 2019] D

DIPTEROCARP FOREST RECOVERY IN VIETNAM

To determine the successional stages and recovery pathways for mixed dipterocarp forest in Dong Nai Biosphere Reserve in Southern Vietnam we used a dataset of 61 pairs of 1,000 m^2 plots representing a range of (21-38 year) recovery times, disturbances, and soil types with five categories of logging and other impacts. Results show that after 27 years of recovery, logged, mixed, dipterocarp forest in the Reserve can recover back to evergreen mixed dipterocarp forest or change to bamboo or deciduous forests. However, retrogression and deceleration of recovery were associated with invaders, like grasses, climbers and bamboos. H. T. T. Do and others. Recovery of tropical moist deciduous dipterocarp forest in Southern Vietnam. [Forest Ecology and Management 433 184-204 2019]. D

EUCALYPTUS PLANTATIONS AS HYBRID ECOSYSTEMS

Hybrid ecosystems can assist conservation strategies for biodiversity. Eucalyptus plantations are hybrid ecosystems and have increased in the highly threatened Atlantic Forest region. We evaluated biotic components (dung beetles), and abiotic components (local environmental variables), within historical (Atlantic Forest remnants), and non-historical (pasture) environments in the Atlantic Forest biome in Bahia state, Brazil. Our results show that

eucalyptus plantations should be classified and managed as a hybrid ecosystem in this biome. Of the 21 dung beetle species found in eucalyptus, ten were shared with historical forests (52.6% of eucalyptus species) and 6 with pastures (31.5%). Our results highlight the potential conservation value of eucalyptus plantations in the Atlantic Forest region as complementary habitat for historical species. A. Taveres and others. Eucalyptus plantations as hybrid ecosystems: Implications for species conservation in the Brazilian Atlantic Forest. [Forest Ecology and Management 433 131-139 2019] D

AMAZON VARZEA FOREST HYDROPERIOD AND SUBSTRATE PROPERTIES

The role of abiotic variables related to climate conditions and edaphic parameters for patterns of above-ground woody biomass are still under debate. For Amazonian forests subject to periodic floods these patterns are even more uncertain. A study is aimed to evaluate above-ground woody biomass stocks in Amazonian floodplain forest and investigate the importance of forest structure, hydroperiod, and edaphic parameters for above ground woody biomass. Study results are based on floristic inventories conducted in twelve hectares of forest distributed across four floodplains. All trees >10 cm DBH were measured with their heights. Allometric equations were applied for calculating above-ground woody biomass. Hydroperiod was estimated for each sample plot and soil chemical and physical components analyzed. The family Fabaceae contributed the most overall to biomass, and hydroperiod was more important than soil fertility in explaining variation in biomass. Amongst the edaphic variables iron influenced biomass the most, followed by aluminum and phosphorus This last is the first suggestion that phosphorus is of some importance in varzea forests. R. L. de Assis and others. Above-ground woody biomass distribution in Amazonian floodplain forests. Effects of hydroperiod and substrate properties. [Forest Ecology and Management 432 365-375 2019] D

GROWTH CONSEQUENCES OF THINNING IN DEPLETED BRAZILIAN FOREST

There is urgency in restoring the integrity of dwindling intact forests. The purpose may be to halt the accelerating loss of biodiversity or to achieve sustainability goals. Removal of large trees can diminish habitat. Restoration thinning can be an effective management tool where there is excessive stem density to return a more desirable forest structure. . A key objective of such thinning has typically been the enhancement of growth of retained stems and associated environmental attributes (habitat) that provides benefits for forest flora and fauna. The Box Ironbark forests of southwestern Australia have been excessively exploited and lost many of the ecological attributes considered beneficial for effective function and biodiversity conservation, especially large trees. Three thinning treatments differing in their density and pattern of retained trees were compared with controls to determine the most effective approach for restoring these systems and increasing the rate of recovery for biodiversity benefits. In the thinning treatments, the average tree diameter growth response was 0.32-0.57 cm/yr compared with 0.20-0.27 cm/yr for the controls. G. W. Brown and others. The influence of different restoration thinning treatments on tree growth in a depleted forest system. [Forest Ecology and Management 437 10-16 2019] D

TEAK AGROFORESTRY WITH CROPS IN LAOS

Teak planting in Laos is done on small farms at high density and left without management until selective harvest begins after 15-20 years. A study emulated what might be achievable on such

lightly stocked lands by companion cropping under an agroforestry system with teak. Tree size was maximized at spacings between 637 and 1020 trees/ha. Companion cropping demonstrated that modest yields of maize, cassava, and pigeon peas were possible under established teak, where the spacing between trees exceeds 8 m. Both maize and cassava achieved yields of over 2 t/ha at 8 m between trees, while pigeon peas achieved 3 t/ha at 10 m between trees. The results demonstrate that the adoption of reduced initial stocking (>1000 trees/ha) can significantly increase the growth rates of teak, improving individual tree volumes and potentially reducing time to commercial harvest. Further, where row spacing is at least 8-10 m, these results suggest that extended periods of companion cropping (2-6 years) may be possible. Serious consideration should be given to the promotion of simple regimes for teak woodlots using an initial spacing rate of around 600 trees/ha. Alley widths of 10 m are recommended for farmers wishing to grow teak in an agroforestry system and extend the period for companion cropping. A. Nahuel A. Pachas and others. Initial spacing of teak in northern Lao PDR: Impacts on the growth of teak and companion crops. [Forest Ecology and Management 435 77- 88 2019] D

TROPICAL FORESTRY NOTES (24)

THINNING TO REDUCE AUSTRALIAN FIRE HAZARD

In southeastern Australia large areas of forest have been fire-killed with loss of human lives and property and impacting carbon sequestration and greenhouse gas emissions. A revaluation is underway in many countries of fuel reduction as a key strategy. A study investigated the impact of commercial thinning in *Eucalyptus delegatensis* forest on fuel hazard and wildlife behavior eight years after the thinning. The treatment reduced the overstory by more than 50% which increased canopy openness and stimulated the growth of retained trees. It also encouraged the regeneration of over 1,000 saplings /ha of *E. delegatensis*, compared with no sapling regeneration in unthinned forest. The above- ground tree carbon was 433MgC/ha in the unthinned forest and 322 MgC/ha in thinned forest. Thinning reduced surface fuel hazard but had no significant effect on the mass of coarse woody fuels. Simulation under severe weather conditions indicated that the thinning created an almost 30% reduction in fireline intensity and about 20% reduction in the rate of spread and spotting distance, compared to unthinned forest. L. Volkova and others. Impact of mechanical thinning on forest carbon, fuel hazard, and simulated fire behavior in *Eucalyptus delegatensis* forest of southeastern Australia. [Forest Ecology and Management 405 92-100 2017] D

VALUE OF FOREST INCOME FOR PEOPLE OF CENTRAL AFRICA

This paper assesses the contribution of forest resources to livelihoods in Cameroon, Republic of Congo, Gabon, Central African Republic, and the Democratic Republic of Congo. Data were collected from the Forest Poverty Linkages Toolkit between 2012 and 2014 on stratified samples of 616 Bantu and indigenous households in 15 villages. Forest resources accounted for 48% to 63% of the total revenue of rural households. In Bantu households income from the forest per day ranged from $ 0.18- $1.30. That is about double that received by indigenous people outside the Congo. Non-cash income is about twice as high as cash income. On average, cash income reaches only about 23% of the World Bank $1.25 a day income level for chronic poverty. It is suggested that much more data of this kind are needed to shape approaches to sustainable forest management. D. Endamada and others. Rapid assessment of the value of forest income for people in Central Africa. [Journal of Sustainable Forestry 38 (4) 343-368 2019] D

EUCALYPTUS PLANTATIONS IN BRAZIL AND URUGUAY

The TECHS project examines productivity in 36 locations in Brazil and Uruguay. Across all sites, stemwood in the middle of the 6-year rotation of growth peak averaged 22 Mg/ha/yr. The best clones at each location grew 1.5-4 Mg/ha/yr. more than the average, indicating the importance of matching genotypes to local site conditions. *Eucalyptus* production dropped 2.5 Mg/ha/ye for each increase in temperature of 1-degree C. Stemwood production increased 1>5 Mg/ha/yr. for each 100 mm/yr increase in precipitation, but the covariation of temperature and precipitation reduced this increase. D. Binkley and others. The interactions of climate, spacing, and genetics on clonal *Eucalyptus* plantations across Brazil and Uruguay. [Forest Ecology and Management 405 271-283 2017]

RESIDUAL NATURE OF PROTECTED AREAS IN BRAZIL

Protected areas now cover 10% of the earth. However, protected areas have been consistently established on marginal lands in conflict with extractive uses rather than importance to biodiversity. We present a panorama of the current network in Brazil and examine the biases in relation to slope and land use. We measured protection bias by accounting for differences between protection areas and municipalities in which they were established, including the direction and strength of the bias. Brazil has 18% of its land under protection, but 70% of this is in the Amazon. Brazil's other biomes hardly reach 10% of their territories under protection and have strong protection bias. Generally, protection areas are strongly biased towards lands with low intensity of use before they were established compared to their background landscapes. Most protection areas had the same slope profile as their background landscapes. Trusting percentages of area under protection as a measure of conservation success risks misdirecting conservation actions to areas of lower biological importance. To promote effective conservation actions more evidence-informed strategies should be used. R. R. S. Vieira and others. Residual protected areas in Brazil. [Biological Conservation 233 152-161 2019] D

TREE HOLLOW CREATION FOR AUSTRALIAN WILDLIFE

Tree hollow scarcity is a threat to cavity-dependent vertebrate wildlife. Only nest boxes are commonly used to offset cavity-bearing trees. A number of shortfalls was recorded using this technique. There is need for alternative techniques to improve cavity provisions. This study investigates the use of carving hollows directly into tree trunks using chainsaws. Sixteen hollows of two simple cavity types were created in a timber production forest in southeastern Australia. One cavity type had a 38 mm diameter with a space above for bats. The other cavity type provided a space below a 38 mm or 76 mm entrance intended for marsupials and birds. Five species used the hollows over a 15-month cavity monitoring period: feathertail glider (*Acrobates pygmaeus*) in 75% of the hollows, brown antechinus (*Antechinus stuartii*) (75%), sugar glider (*Petaurus breviceps*) (63%), long-eared bat (*Nyctophilus spp.*) (50%), and white-throated tree creeper (*Cormobates leucophaea*) (25%). Camera monitoring revealed hollow inspection after only one day post hollow creation. White throated tree creepers were nest-building after three days. No tree host failed with either size of opening. Tree hollows have a broad application potential with the prospect to overcome some of the reported drawbacks of nest boxes. More research is required to document long-term term performance and effectiveness of the technique. N. Rueegger. Artificial tree hollow creation for cavity-using wildlife: An attractive method to that of using nest-boxes. [Forest Ecology and Management 405 404-412 2017] D

DIVERSITY AND AVAILABILITY OF RAINFOREST PRODUCTS IN MEXICO

Here we assess the extent to which the frequency, abundance, diversity, composition, and productivity of tree assemblages with potential forest products change across three landscape units that differ in soil and topographic conditions. The study was carried out in old-growth tropical rainforest in southeastern Mexico. Three plots of 0.5ha each were established per landscape unit, in which all trees ≥10 cm DBH were inventoried, taxonomically identified, and assigned to one of eight forest product categories. General linear models, multiple regression and ordination analysis (CCA) were used to assess structural and compositional changes in the tree assemblages supplying different products among landscape units and soil gradients. More than half of the identified species (165) had one or more potential forest products. The abundance of

species with different potential forest products mostly relates to changes in soil nitrogen, pH, and aluminum saturation. Variation in tree biomass was strongly driven by soil available phosphorus and soil depth. Each landscape unit had a different potential to provide forest products across landscapes, as well as changes in the environmental factors that govern this spatial variation. A. Navarrete-Segueda and others. Availability and species diversity of forest products in a Neotropical rainforest landscape. [Forest Ecology and Management 406 242-250 2017] D

HUMMINGBIRDS IN BRAZILIAN CITIES PREFER ADAPTED TREE FLOWERS

There has been increased concern about the conservation of pollinators in urban environments. We evaluated how urbanization affects plant-hummingbird interactions at two spatial scales. First, in southeastern Brazil in a medium-sized city (population: 600,000), we contrasted interaction in urban and natural areas. Second, we compiled data on six urban-hummingbird interaction networks from south and southeastern Brazil to identify the characteristics associated with the most important plants. Locally, urbanization affected hummingbird communities by promoting higher generalization and dominance by more aggressive hummingbirds. Long-billed hermits were absent from urban interaction and also from nectar feeder stations in the city. Across networks, trees were more important for hummingbirds than shrubs and herbs. They preferred flowers adapted for birds to those not so adapted. Plant origin (native/exotic) did not matter. Our results indicate that urban plant-hummingbird communities are organized differently than their counterparts from natural areas. Since hermits provide important pollination service for specialized plants with hummingbird-adapted flowers, initiatives such as green corridors and preference for native plants with specialized hummingbird-pollinated flowers in urban landscaping may contribute to community restoration and ecosystem functioning. P. K. Maruyama and others. Plant-hummingbird interaction networks in urban areas. [Biological Conservation 230 187-194 2019] D

ANTS TO INDICATE SOIL QUALITY OF BRAZIL ATLANTIC FOREST

The devastation of the Brazilian Atlantic Forest stresses the need for recovered areas within this biome and the study of potential indicator organisms to assess the forest recovery process and the intensity of human interference. We aimed to identify the richness and abundance of ant genera in forests at different stages of recovery and to identify soil attributes that help to differentiate these stages. Four areas with different periods of recovery were used: one undisturbed and others with 5, 10, and 20 years without human disturbance. In each site a 10 x 10 m sampling grid with 30 random points was selected within which ants were collected to a depth of 0-20 cm. Physical, chemical, and biological properties of each site were determined to tie them to ant genera. Ant genera abundance was useful for separating the vegetation recovery stages. Atta correlated with the 5-year stage and *Brachymyrmex* with undisturbed forest. The ant genera in the 5-year and 10-year stages are also correlated with environments of low vegetation complexity and urban areas. Genera predominated in the undisturbed forest and 20-year stage are common to areas with a more structured floristic composition. J. Cora Segat and others. Ants as indicators of soil quality in an on-going recovery of riparian forests. [Forest Ecology and Management 404 338-343 2017]

TROPICAL FORESTRY NOTES (25)

BRAZILIAN IGAPO FORESTS WITH RARE TREE SPECIES

Igapó forests grow on areas of major Amazonian rivers with a seasonal monomodal flood pulse, a phenomenon that determines ecological and biogeochemical processes in adjacent floodplain forests. River damming transforms the natural pattern of flood pulses downstream to one for which the native biota might be poorly adapted. Severe modification of flood pulses was recorded in the Uatuma River after the initiation of the Balbina Dam in central Amazonia. Flood pulse regulation increased mortality of flood-adapted species in the black-water floodplain (igapó) forest. No previous studies have investigated impacts of flood pulse regulation on the species composition and forest structure of igapó forests. Therefore, we examined species composition and forest structure of igapó forests along a regulated river in comparison to a pristine tributary, the Abacate River, evaluating soil texture characteristics and flood duration. In order to assess potential encroachment of species less sensitive to flood alteration, we also inventoried adjacent non-flooded upland forest in each river section. An inventory of all trees >5cm DBH was carried out in low igapó, high igapó, and adjacent upland forests, totaling one half hectare in each river. Species richness was highest in upland forest and lowest in low-igapo forest. In the regulated river, flood intensification in the low igapó forest increased dominance of a few flood-adapted species, . High igapó forest showed higher similarity to secondary upland forests. G. de Sousa Lobo and others. Flood forests (igapó) with rare tree species. [Forest Ecology and Management 434 110-118 2019] D

IMPROVING REFORESTATION SUCCESS IN SUMATRA

A study was carried out on the growth, susceptibility to damage, and capacity to resprout of 38 Sumatran lowland tropical tree species in a restoration planting trial in several typical post-disturbance microhabitats. A total of 3,200 seedlings were planted in four two-hectare blocks in February 2013 at the Hutan Harapan Ecosystem Restoration Concession in Sumatra, Indonesia and censused every six months for two years to assess performance and changes in microhabitat conditions. By the end of the experiment overall survival was only 41% with damage incurred by 55% of the surviving plants. Habitat conditions (light-shade, presence-absence of bamboo and shrubs) and their interactions affected survival in complex ways. Bamboo negatively affected survival whereas shrubs had a positive effect, except where bamboo was also present. Growth rate and height increased with light exposure. Defining 50% survival as success, only two species could be classified as generalists. Eighteen other species were characterized as specialists with good performance in one to three habitat types. Restoration success evidently could be better achieved through better site matching. R. Kardiman and others. Restoration of tropical Atlantic forest success improved by selecting species for specific habitats. [Forest Ecology and Management 434 235-243 2019] D.

IMPLEMENTING PAYMENTS IN OAXACA, MEXICO FOR ECOSYSTEM SERVICES

Payments for ecosystem services are widely implemented in indigenous communities. This study attempts to identify a relevant group of variables in implementing payments in Oaxaca, Mexico. Nine focal variables were seen as pertinent: forest cover, opportunity costs, livelihoods, trust and cooperation, motivations toward conservation, management practices, internal organization, land tenure, rules for management and use, and presence and experience with civil society

organizations. Among the determinants of success, the incidence of trust and cooperation and internal organization bear on the success of equitable payments for ecosystem services. It is also important to link payments for conservation to sustainable production schemes. K. J. Rodríguez-Robayo & L. Merino-Pérez. Experience in implementing payments for environmental services in two indigenous communities of Mexico. [Journal of Sustainable Forestry 37(5) 504- 524 2018] D

SEARCHING FOR CACAO POLLINATORS IN BOLIVIA

Pollination knowledge of wild cacao is non-existent. Glue was applied to 2,237 flowers of wild and cultivated cacao trees in Bolivia to trap floral visitors. This caught 631 insects belonging to seven orders, a mean capture rate of 0.3 insect per flower. The most abundant and diverse insect order in both cacao types was Hymenoptera. Hymenoptera were more abundant on wild cacao, whereas species richness was higher on cultivated cacao. The species composition and proportion of *Diptera* species differed between wild and cultivated cacao. Ceratopogonidae (biting midges) were represented by only 13 individuals belonging to seven species. Cacao pollen was carried by only a single specimen of Encyrtidae (parasitic wasps). Thus actual pollinators could not be identified. There were significant differences among the visitor assemblages between wild and cultivated cacao. Midges alone were probably too rare to act as a main pollinator of cacao in the study region. Potential additional pollinators would be small Diptera and Hymenoptera. C. Chumacero de Schawe and others. Abundance and diversity of flower visitors on the wild and cultivated cacao (Theobroma cacao) in Bolivia. [Agroforestry Systems 92 (1) 117-125 2018] D

TREE GROWTH RELATIVE TO SITE IN GUNUNGKIDUL, INDONESIA

In Indonesia smallholder farmer's choice of tree species has been limited by a lack of management information. Three species, *Tectona grandis*, *Swietenia macrophylla*, and *Acacia auriculformis*, were selected to help inform farmer choices for agroforestry systems by developing diameter growth models and estimating the contributions of site quality to diameter growth. A total of 48 farms were selected for three slope ranges and two soil types with a 10 m radius plot in each. Diameter growth varies with tree age and responds differently in each slope and soil type. A set of site quality variables permits prediction of tree diameter performances for each tree species in two group ages and two soil types. These results suggest that the models can help inform farmer's choices for species and management. G. E. Sabastian and others. Tree diameter performance in relation to site quality in small holder timber production systems in Gunungkidul, Indonesia. [Agroforestry Systems 92 (1) 103-115 2018] D

HONEY BEES REQUIRED FOR SHEA (VITELLARIA) IN WEST AFRICA

Shea (*Vitellaria paradoxa*) is an important fruit tree in West African parklands and its successful pollination is a requirement for fruit production. Honey bees (*Apis melifera jemenitica*) a have been shown to be important for pollination and thereby the production of fruits and seeds. Pollination by stingless and solitary bees is less, but can partly compensate when honey bees are absent. Local bee-keeping with honey bees and stingless bees is likely to have a positive influence on fruit production of the shea trees in West African parklands in Burkina Faso. K. M. Lassen and others. Honey bees are essential for pollination of *Vitellaria paradoxa* (Sapotaceae) in Burkina Faso. [Agroforestry Systems 92 (1) 23-34 2018] D

FOREST MANAGEMENT AFFECTS FRUITS IN THE BRAZLIIAN SAVANNA

The management of plant populations result in phenotypic changes leading to more productive plants and large fruits. The traditional management of pequi (*Caryocar coriaceum*) in the Chapada do Araripe region of northern Brazil was studies using a morphometric and ethnobotanical approach. Plants were assigned to three different management regimes: cultivation, collection, and protection. The fruits from individuals grown under a cultivation system were significantly different from those grown under the collection and protection systems. The study showed that local people perceive diversity among the study populations. Based on these results *C. coreaceum* could be said in an early stage of domestication. J. R. Sousa and others. Traditional management affects the phenotypic diversity of fruits with economic and cultural importance in Brazilian Savanna. [Agroforestry Systems 92 (1) 11-21 2018] D

NON-TIMBER REVENUES IN BURKINA FASO

Non-timber forest products constitute substantial components of West African agroforestry systems and contribute considerably to local livelihoods. We focused on the following questions in studying two villages: what is the share of non-timber products in household income? Which socio-economic variables affect total household income and non-timber product dependency? How does non-timber income vary by two villages, ethnic groups, and income groups? Does non-timber income have an equalization effect? The study covered 155 households. Non-timber forest products accounted for 45% of the total income, more than crops, livestock, and off-farm income. Poorer farmers depend more on non-timber forest products. The two villages and the three ethnic groups differed in NTFP dependency, reflecting different species compositions in their surroundings and different traditional uses and harvesting practices. The overall effect was to help equalize inequalities. Management recommendations for agroforestry systems and poverty alleviation need to consider species composition as well as ethnic habits. A. Lessmeister and others. The contribution of non-timber forest products (NTFPs) to rural household revenues in two villages in southeastern Burkina Faso. [Agroforestry Systems 92 (1) 139-155 2018] D

TROPICAL FORESTRY NOTES 26

LUMBER VOLUME OF BRAZILIAN TIMBER HARVEST

No accurate estimates of lumber production are made for Amazonian commercial species. The objective was to generate equations of lumber volume for commercial species in Brazilian Amapa by adjusting and selecting regression models. Data from 50 logs processed from 10 commercial species were collected, as well as the quantity and volume of sawn products. Sixteen (16) statistical models were adjusted, and statistical weights were performed to evaluate the quality of the estimates and to select the best equation by species. Precise estimates of lumber volume can be obtained from the 16th model for *Carapa guianensis*, while 13th and 15th models are the most recommended for *Dinizia excelsa* and *Hymenolobium petraum*, respectively. Model 7 performed the best adjustments for *Hymenea courbaril* and *Vochysia guianensis*. Equations using only log diameter gave less precise estimates. Log volume should be considered as an important predictor to obtain the sawn lumber volume for the different Amazonian commercial tree species. R. B. de Lima and others. Lumber volume modeling for Amazon Brazilian species. [Journal of Sustainable Forestry 38 (3) 262-274 2019] D

SHEA (*VITELLARIA* SPP.) IN AGROFORESTRY IN GHANA

Agroforestry parklands, with scattered trees within cultivated crop fields, is the most widespread agricultural system in semi-arid West Africa. Agroforestry trees offer many ecological and socioeconomic benefits, such as added income, food, and medicine. They are currently under threat in this region due to recent changes in agricultural and land use practices. A reduction in traditional fallow rotation periods led to decreased regeneration of a common agroforestry tree, shea (*Vitellaria paradoxa*), which has been an important economic resource for women. The aims of the study were to determine beneficial spatial distributions of shea to maintain high yields of staple crops and to better understand male and female farmer perceptions of shea maintenance. We compared maize (*Zea mays*) vegetative growth, grain yield, soil moisture, and light availability associated with individual shea trees and clumps of trees on 5 farms in Ghanaian agroforestry parklands. We also interviewed local farmers to better understand their management perspectives. Maize vegetative growth increased with light availability but was not limited by soil moisture. Conversely, and contrary to farmer perceptions, grain yield was not influenced by light availability, but increased with increasing soil moisture. Also contrary to common beliefs of local farmer perceptions grain yield was greater under clumps of shea compared to scattered individual distributions of trees. We therefore recommend the maintenance of clumped distributions of shea, as they provide beneficial microclimates for staple crops and could assist in improving the productivity of shea products that are considered the domain of women farmers. F. Baziari and others. Understanding farmer's perceptions and the effects of shea. [Agroforestry Systems 93 (2) 557-570 2019] D

GROWTH OF COMMERCIAL SPECIES IN AMAZONIA

Despite all efforts to promote sustainable use of timber resources in tropical forests, growth patterns and ecological features, the current management criteria still require adjustments at a species level, considering specific growth patterns and ecological features. Forest management criteria in upland forests (terra firme) of the Brazilian Amazon region are generally applied to all commercial tree species a common minimum logging diameter of 50 cm DBH and a felling

cycle varying according to the harvest intensity between 25 and 35 years. In this study we define species specific felling cycles and minimum logging diameters (MLD) for the two commercial tree species, *Hymenaea courbaril* and *Handroanthus serratifolius* from the terra firme of the Southern Brazilian Amazon, applying growth models based on the relationships between estimated tree age, diameter, height, and volume. A total of 37 transversal cross-sections (20 stem discs from *Hymenaea* and 17 from *Handroanthus*) were obtained at a height of 20 to 60 cm above soil level in a private forest concession close to the Municipality of Novo Aripuana. The two species are common in terra firme forests and have high wood densities of 0.76 to 0.96 gcm (*H. courbaril*) and 0,85 to 1.08 gcm (*H. serratifolius*). Their mean age, estimated by ring counting, varied from 104 to 241 years and both species had similar diameter increments of 3.9 and 4.1 mm/year. The two species have similar tree growth, resulting in a felling cycle of 24 and an MLD of 65 cm for *H. courbaril* and a felling cycle of 26 years and an MLD of 69.5 cm for *H. serratifolius*. These results demonstrate the need to adjust selective logging systems to increase the sustainability of selective logging. V. H. Ferreira Andrade and others. Growth models for two commercial tree species in upland forest of the Southern Brazilian Amazon. [Forest Ecology and Management 438 215-223 2019] D

CANOPY HEIGHT RECOVERY AFTER SELECTIVE LOGGING

The effects of selective logging on canopy height were studied in a lowland tropical forest in Pasoh Forest Reserve, Peninsular Malaysia. Canopy height was measured in 2003 and 2011 by using an airborne light detection and ranging system (LIDAR) and mapped on a 2.5 m grid over logged and primary forest plots. The logged forest plot was in an area where selective logging operation had been conducted in 1958, whereas the primary forest plot has no trace of any major induced disturbances. The average canopy height in the logged forest plot increased from 23.6 m (2003) to 25.8 m in (2011) but both of these heights were still significantly lower than those in the primary forest plot (28.7 m in 2003 and 30.4 m in 2011). The coefficient of variation and canopy height diversity were also lower in the logged forest plot, suggesting that the highly heterogeneous canopy height commonly seen in the primary forest of the region had not fully recovered even in 53 years after the logging operation. Simulation an analysis revealed that it will take at least another 16 years from the last canopy mapping (2011) for full recovery. T. Okuda and others. Canopy height recovery after selective logging in a lowland rain forest. [Forest Ecology and Management 442 117-123 2019] PD

SELECTIVE LOGGING EFFECTS ON FOREST COMPOSITION

What is little known is the extent to which selective logging affects floristic composition and its recovery process. Understanding how floristic composition is affected by logging is essential for determining subsequent cutting cycles, for the maintenance of carbon stocks, and for biodiversity conservation. This research investigates the effect of logging on long-term trends on the recovery of species composition using a unique logging experiment where measurements have been taken annually over 25 years. Changes in 12 long-term, 1-hectare permanent plots were assessed where different selective logging intensities occurred in the first years after logging. In the first years after logging, floristic composition differed widely between intact and selectively logged forests, with exploited areas deviating from pre-logged composition. Over time, exploited areas shifted towards the original composition, with more pronounced changes in this trend after 13 years. Shifts in floristic composition were caused mainly by a significant increase in light-demanding, fast growing pioneer species and their subsequent continuous high mortality rates after 13 years

of the recovery process. In contrast, the control plots showed similar shifts in composition over time, suggesting external factors such as climate change may be driving these shifts. The results suggest that 25 years after an experimental selective logging has taken place, floristic composition tends to become closer to the pre-logged status. T. Dias Gaui and others. Long-term effect of selective logging on floristic forest composition. [Forest Ecology and Management 440 258-266 2019] D

CARBON EMISSIONS FROM LOGGING IN THE CONGO BASIN

To estimate carbon emissions from selective logging in Central Africa we employed the reduced-impact logging for carbon emissions reductions (RIL-C) protocol to quantify baseline carbon emissions from legal timber harvests by source (felling, skidding, and hauling) We modeled the relationships between emissions and biophysical conditions, logging practices, and forest policies. We then used these models to estimate potential emission reductions from full implementation of RIL-C practices. We applied the method in 8 forest management enterprises in the Democratic Republic of Congo, 9 in Gabon, and 6 in the Republic of Congo. Logging emissions expressed per cubic meter of timber harvested (to control for differences in logging intensities) ranged from 0.6 Mg C/m^3 to 4.9 Mg C/m^3, with an overall average of 2.1 Mg C/m^3. Logging emissions were dominated by damage caused by road and log landing construction (hauling 50%; felling 43% - includes carbon in extracted logs). Total emissions represented only about 9% of unlogged forest biomass carbon stocks. Average emissions were highest in Gabon (2.65 Mg C/m^3), followed by 1.84 Mg C/m^3 from Democratic Republic of Congo, and 1.54 Mg C/m^3 from the Republic of Congo. Emissions from concessions certified by the Forest Stewardship Council and those that were not certified did not differ. Nearly half (51%) of logging emissions could be avoided without reducing timber yields if all best examples of RIL logging practices observed were applied in the same forest management enterprise. At the country level, if all forest management enterprises were to utilize these practices, emissions reductions would be 34% in Republic of Congo, 45% in the Democratic Republic of Congo, and 62% in Gabon. When combined with country-level logging statistics, emissions from selective logging as currently practiced in the Congo Basin are equivalent to 40% of the region's total emissions from deforestation. P. M. Umunay and others. Selective logging emissions and potential emission reductions from Reduced Impact logging in the Congo Basin. [Forest Ecology and Management 437 360-371 2019] D

TROPICAL FORESTRY NOTES (27)

BIOMASS ACCUMULATION IN MANGROVE PLANTATIONS IN VIETNAM

In many tropical nations, mangrove forests are essential for climate change mitigation and adaptation in coastal regions since they provide important forest resources as well as a suite of other benefits to communities including carbon sequestration. Empirical growth and yield modelling methods derived from terrestrial forestry which are often robust with respect to forestry forecasting have not often been assessed in mangrove forests, yet they are important for underpinning sustainable forest management. We surveyed 89 *Rhizphora apiculata* mangrove plantations with age ranges from 4 to 26-year-old in Vietnam, destructively harvesting 25 trees for biomass measurements and 70 for stem analyses, to assess increments in biomass and standing timber. We found that conventional forest growth modelling methods fitted the observed data well. Similar to terrestrial forests, stand height is a good indicator of site productivity. These methods are applicable to evenly aged monoculture plantations in Vietnam. Our research also indicated high variation in mean annual increment of biomass in the surveyed plantations due to a wide range of age and site conditions. Some *R. apiculata* plantations in Vietnam can reach a peak aboveground biomass MAI of 22.7 Mg/ha/year which is among the highest of published values from plantations of the same species worldwide. Further studies addressing the application of terrestrial forest growth methods to mangrove systems are suggested in order to develop reliable and useful tools for sustainable management of this important ecosystem. S. Minh Phan and others. Modelling aboveground biomass accumulation of mangrove plantations in Vietnam. [Forest Ecology and Management 432 376-386 2019] D

PRODUCTIVITY GAINS FROM WEED CONTROL AND FERTILIZATION

Land use conflicts, high land prices, or owners' objectives have motivated forest managers to apply more intensive silvicultural treatments to increase site productivity. Understanding how intensive practices such as weed control and fertilization weed control affect productivity will permit managers to select the best treatment to increase it. Our objectives were (1) to estimate the gap between current and attainable productivity of *Eucalyptus* plantations and (2) to determine the effect of treatment on light use and light use efficiency. To estimate the gap between current and attainable productivity we established 53 pairs of plots, which were measured for two years. Each pair consisted of a control plot which received the management regime that is regularly applied to the stands, and a treated plot, which received intensive silvicultural treatment (fertilization + weed control) in addition to the operational management applied to the control plots. At 25% of the sites a third plot (weed control only) was established. Stem biomass growth in the control and treated plots were 12.4 and 14.8 Mg/ha/yr, respectively. We found significant differences in light use between control and treated plots, averages of 1344 $MJ/m^2/yr$ and 1406 $MJ/m^2/yr$, respectively, responding to a 4.6% increase. On average the control plots had a light use efficiency of 0.9 DM/MJ compared with 1.10 DM/MJ for the treated plots. This information is important to estimate the expected responses to intensive silviculture and will help to decide where silvicultural treatments should be applied to maximize the gains obtained from the investment. O. Carrero and others. Productivity gains from weed control and fertilization of eucalyptus plantations in Venezuela. [Forest Ecology and Management 430 566-575 2018] D

LOGGING INTENSITY PROLONGS ECOSYSTEM RECOVERY

Implementation of effective forest management strategies that are ecologically beneficial plays a central role to prevent forest degradation. However, to identify effective forest management strategies, there is a need for methods supporting the decision-making process. The main objective of our study is to analyze the mid- and long-term impacts of different management intensities, such as varying the minimum stem diameter of harvestable commercial trees, on the dynamic and structure of a species-rich tropical lowland forest of French Guiana. Therefore, we have applied the management module of a dynamic forest model and analyzed simulation experiments for undisturbed forest growth and selective logging. For the first time we were able to quantify the mean recovery times of multiple ecosystem functions and properties (biomass, gross primary production, leaf area index, Shannon diversity, timber volume) after selective logging. Accordingly, we valued simulation results (biomass, number of trees harvested) of selective logging with forest inventory data from the last 32 years. The forest model reliably reproduces the observed pre-logging biomass, tree size distribution, and logging intensity (10 trees/ha, 39m^3/ha). In addition, it became clear how strongly management with higher logging intensities influences the forest in the long term: (1) the mean recovery times of the investigated ecosystem functions were significantly extended. With very intensive logging (116 m^3/ha) the average recovery time of forest biomass was almost twice as long as in a moderate simulation scenario (138 vs. 77 yrs). Similar values were observed for timber volume (138 vs. 62 yrs). (2) The functional composition shifted, since up to 30% pioneer tree species invaded the forest. The innovative use of forest growth models may help in the development of ecologically reasonable forest management strategies. U. Hitner and others. High selective logging intensities prolong ecosystem recovery times. [Forest Ecology and Management 430 517-525 2018] D

PRUNING DECAY IN SANDALWOOD

Heartwood rot, a fungal disease, has the potential to significantly reduce the sandalwood oil production of *Santalum album*. With new plantations being established with sandalwood as the major product it is imperative to know the consequences of routine form-pruning in tropical areas. Examining pruning wound responses in 1 and 5-year-old trees at the end of the dry and wet seasons; it was possible to ascertain the best pruning age and season in relation to occlusion. Pathogenic wood fungi were isolated from wounds and fungal spore monitoring was undertaken at the two trial sites at time of pruning. Younger trees had smaller wounds which were quicker to occlude and produced a lower decay rating which decreased over time. Wood inhabiting fungi were isolated from all pruning wounds and identified, using the ITS gene region. There was a total of 531 fungal isolates identified in 75 fungal taxa. Older trees had significantly more fungal species compared to younger trees. Pruning season did not significantly affect occlusion, the amount of resultant decay nor the total number of fungal species isolated. Entophytes were isolated from every tree, comprising 52% of isolations. Younger trees had more endophytes but less rot fungi than older trees. Canker fungi were isolated from almost all the older trees. This study has shown that it is better to prune *S. album* when they are young to decrease the prospect of potential decay. T. I. Burgess and others. Pruning induced decay in tropical sandalwood. [Ecology and Management 430 204-218 2018] D

TROPICAL FORESTRY NOTES (28)

PROTECTED AREA EFFECTIVENESS SURROUNDED BY SUMATRAN PALM OIL

Despite the establishment of a national protected area system at the beginning of the 20th century to protect some of the world's most biodiverse forests, Indonesia has one of the highest deforestation rates in the world, due in part to the expansion of the global palm oil industry. The unique ecosystems of Sumatra, Indonesia provide habitat for critically endangered Sumatran tigers (*Panthera tigris sumatrae*), Sumatran elephants, and two species of orangutans. In this study we use a matching method with generalized boosted models to determine the effectiveness of three nationally protected areas in preventing deforestation from 2002 to 2016. We also examine leakage – an increase in deforestation directly outside of protected areas relative to the wider landscape, to provide a clearer picture of the effects of agricultural expansion in this landscape. We found that Tesso Nilo National Park with its lowland rain forest and conditions suitable for oil palm offered the least protection from deforestation. Tigapuluth National Park, which may experience some de facto protection with its mountainous terrain and difficult access that the highest, avoided the highest deforestation rate but also had relatively high leakage. The low level of avoided deforestation at Tesso Nilo could be due to high localized human population or other socioeconomic factors we were unable to control for this study. The quantitative evidence of deforestation and effectiveness of protected areas in this heavily modified landscape supports the need for increased enforcement around protected areas locally, and globally in other oil palm production regions. E. E. Poor and others. Protected area effectiveness in a sea of palm oil. [Biological Conservation 234 123-130 2019] D t

CLOSING THE SCIENCE/PRACTICE GAP

Professionals working in practical conservation management and scientists often complain about an information gap between science and practice. Which kinds of information sources are important to professionals, and which do they use in their every-day work? Answering these questions and knowing more about the information sources used by conservation professionals would promote effective knowledge transfer from science to practice. We conducted a survey to identify the information sources used by Swiss professionals in nature conservation, including the forest sector. Experience-based information sources (personal experience, direct exchange with colleagues and experts) are more important for professionals in nature conservation than in evidence-based sources (guidelines, specialized journals in national languages, and text books targeted to professionals). They were also more often used. Articles from international scientific journals are hardly ever consulted by conservation professionals. It is thus important that scientists engage as experts and take time for direct personal contact and exchange with conservation professionals (by offering field trips). Given that professionals have little time in their daily business for searching and implementing new scientific knowledge and results, short, audience-targeted and synthesizing publications in national languages as well as specialized websites should be provided by researchers (See Tropical Forestry Notes). These measures are key to reduce the gap between science and practice in nature conservation. Y. Fabian and others. How to close the science/practice gap in nature conservation. [Biological Conservation 235 93-101 2919] D

FACTORS THAT CONTRIBUTE TO PRIVATE PROTECTED AREAS

Privately protected areas (PPAs) make important contributions towards global conservation goals. Private protected areas must be monitored for effectiveness at protecting and managing biodiversity. The key drivers of maintaining and improving the effectiveness of private protected areas are often conservation covenants and easements owned and managed by private landholders. We surveyed 527 covenant landholders across New South Wales, Tasmania, and Victoria in Australia to provide a benchmark for monitoring and evaluation activities. We found that landholders are mainly motivated to participate in order to protect their land in perpetuity but come to expect financial and technical assistance as a benefit of the program. While 71.1% (n = 344) reported achieving their land management goals, 44.7% (n = 242) of landholders struggle with covenant management because of age, and financial and time constraints. Covenant landholders are generally satisfied with the program (92%). 8% of landholders feel disaffected with their participation, relating to their perceived inability to personally manage the biodiversity on their land and the lack of interaction they have with representatives with convening organizations. Where compliance monitoring and semi-annual technical assistance are limited, some landholders are concerned that the efficacy of the covenant is reduced. To increase effectiveness, we suggest that private programs regularly monitor protected area programs, landholder satisfaction, and management needs, schedule conservation actions based on landholder capacity, and utilize landholder networks to spread information and foster communities of stewardship. Additionally, given the older demographics of landholders, programs should engage in private protection area successional planning. M. J. Selinske and others. The social and psychological dimensions that contribute to privately protected area program effectiveness. [Biological Conservation 229 170-178 2019] D

IDENTIFICATION OF HIGH VALUE TAXA FOR CONSERVATION AND TOURISM

Evaluating flagship species and their potential for biological preservation and ecotourism development is a key issue for many audiences within the conservation and social fields. Despite several methods available to identify flagships, their application is often constrained in remote, poorly studied regions. Developments are needed in statistical and spatially-explicit approaches to assess species traits influencing flagship appealing, to identify flagship fleets, and to map the location of flagship hotspots. Here we developed a new method to identify flagship species in regions with knowledge gaps, using a two-stage statistical approach (ordination and clustering algorithms) to assess variables contributing to appeal and to group species sharing similar characteristics into flagship fleets. We then mapped areas concentrating the highest richness of flagships. Unique morphologies and behaviors, conservation status, endemicity, body size and weight, and feeding habits were the traits contributing the most to the flagship appeal. Nine flagship fleets were identified, from which two were the most suitable for conservation marketing and ecotourism promotion in Sahara-Sahel: Fleet A comprising 36 large-bodied species (18 mammals, 18 reptiles) and Fleet B including 70 small-bodied species (10 birds, 6 mammals, 54 reptiles). A total of 19 and 16 hotspots were identified for large-bodied and small - bodied flagships, respectively. The methodology was suitable to identify flagship species for conservation and marketing and for developing tourism operations in the Sahara-Sahel to independently assess which species traits are relevant for flagship appeal, and to organize fleets for multi-species-based marketing campaigns. The framework is scalable and replicable worldwide. F. Santarem and others. New method to identify and map flagship fleets for promoting conservation and tourism. [Biological Conservation 229 113-124 2019] D

TARGETS FOR CONSERVATION AND PRODUCTION IN BRITISH COLUMBIA

Criteria and indicators are frequently used for assessing sustainable forest management. Less attention is given to translating them into strategic forest management planning processes and practices that are of cross-cultural compatibility. Such compatibility is particularly relevant in landscape-level plans that involve indigenous communities or multiple groups with variable interests. Our study develops targets and compatible practices that can complement criteria and indicators suitable for integrating indigenous forest management goals and timber production interests. The process for developing criteria and indicators is informed by values pressed by four indigenous communities in British Columbia, Canada through close revision of traditional use studies, land use plans developed by communities, one focus group discussion, and validation of the results by community representatives. The set of targets and compatible forest management practices we propose is based on a precautionary approach and a synthesis of studies conducted within the country. The outcomes are suited to inform both stand- and landscape-level forest management planning and can be considered a reference system to monitor change and facilitate the resolution of multiple interests on the land, reconciling holistic indigenous values and timber production. J. Spies and others. Value-oriented criteria, indicators and targets for conservation and production: Biological Conservation 230 151-168 2019] D

SOCIOECONOMIC PATHWAYS FOR TIGER CONSERVATION

Over the last century numbers of wild tigers (*Panthera tigris*) have crashed, while human populations boomed. Here we investigate future trajectories of human population within tiger range through analysis of the shared socioeconomic pathways. These five pathways describe urban, rural, and total population distribution by decade through 2100, based on plausible but contrasting scenarios of economic, education, migration, and utilization policy. In 2010 approximately 57 million people lived in regions defined as tiger conservation landscapes; 8% of sympatric people lived in towns and cities that occupied 4% of tiger range. We show that tigers could share these same geographies with as few as 40 million (30% decline compared to 2100) or as many as 106 million people (an increase of 85%) by 2100. Those populations could be as much as 64% or as little as 17% urbanized, depending on the pathway. Urban areas are likely to expand, displacing between 6 and 22% of tigers' current range, depending on how urban growth is managed. Human population thresholds comparable with tigers vary by region from 140 persons/km^2 in the Indian subcontinent, to 10 persons/km^2 in the Russian Far East and northern China. A future where nations indulge regional rivalries would make conservation more difficult, whereas focus on well managed urbanization and education could help relieve pressures. Tigers are conservation-reliant species and will likely remain so through the 21st century. Therefore, we suggest coupling continued site-level protection with efforts to develop constituencies for conservation in Asia's burgeoning cities. E. W Sanderson and others. Shared socioeconomic pathways for tiger conservation [Biological Conservation 231 13-23 2019] D

TROPICAL FORESTRY NOTES (29)

WORLD'S LARGEST MANGROVE BECOMING HOMOGENOUS

Knowledge gaps in spatiotemporal changes in mangrove diversity and composition have obstructed mangrove conservation programs across the tropics, but particularly in the Sundarbans (10.017 km^2) the world's largest remaining natural mangrove ecosystem. Using mangrove tree data collected from Earth's largest permanent sample plot network at four historical time points (1986, 1994, 1999, and 2014), this study establishes spatially explicit baseline biodiversity information for the Sundarbans. We determined the spatial and temporal differences in alpha, beta, and gamma diversity in three ecological zones: hypo (<2 dS/m), meso (2-4 dS/m), and hypersaline (>4 dS/m), and also uncovered changes in the mangroves' overall geographic range and abundances therein. Spatially, the hyposaline mangrove communities were the most diverse and heterogenous in species composition while the hypersaline communities were the least diverse and most homogenous at all historical time points. Since 1986, we detect an increasing trend of compositional homogeneity (between site similarity in species composition) and a significant spatial contraction of distinct and diverse areas over the entire ecosystem. Temporally, the western and southern hypersaline communities have undergone radical shifts in species composition due to population increase and range expansion of the native invasive species *Cerops decandra* and local extinction or range contraction of specialists including the globally endangered *Herinera fomes*. The surviving biodiversity hotspots are distributed outside the legislated protective area network. In addition to suggesting the immediate coverage of these hotspots under protected area management, our novel biodiversity insights and spatial maps can form the basis for special conservation planning, biodiversity monitoring, and protection initiatives for the Sundarbans. S. K. Sarker and others. World's largest mangrove becoming homogenous. [Biological Conservation 236 79-91 2019] D

BIRD RESPONSE TO FOREST PRODUCT HARVESTING

The ecological impact of forest harvesting is poorly understood, despite the reliance of millions of impoverished households on forest resources. As birds are indicators of environmental change and essential for the function and regeneration of forest ecosystems, this study aimed to assess the response of bird species richness and functional diversity to unregulated forest product harvesting, to illuminate the impact of harvest disturbances on forest biodiversity., Five forest ecotypes in the Eastern Cape Province, South Africa were sampled by means of circular plots within which bird communities, habitat structure and harvest intensities of sub-canopy trees harvested for poles, canopy trees harvested for timber, and bark harvested for medicinal use, were recorded. Generalized linear models were used to assess the response of bird diversity to harvesting activities measured on a continuous scale, and forest ecotype. Correlations between feeding traits and environmental variables relating to habitat structure and harvest disturbances were investigated using RLQ and fourth-corner analysis to better understand which traits were sensitive to harvest disturbances. Results indicated that forest ecotype was an important driver of variation in species richness and functional diversity. Additionally, harvesting disturbances negatively affected two measures of functional diversity, while species richness and functional richness were unaffected by harvesting. Specifically, functional evenness was negatively affected by timber harvesting, while function dispersion declined in response to pole and bark harvesting. Bird traits relating to feeding ecology (primary diet and feeding strategy) were associated with

habitat structure and harvest disturbances, indicating that harvest activities affected community structure. Specifically, frugivores and granivores were negatively affected by pole and bark harvesting, respectively, while omnivorous species were positively affected by these harvest activities. Conversely, timber harvesting negatively affected omnivores, and positively affected nectarivores. Bark and timber harvesting, which resulted in canopy gaps, negatively affected species which forage in the understory or on the forest floor, while pole harvesting, which reduced tree abundance but not canopy cover, negatively affected canopy-foraging species. These results suggest that current, unregulated forest product harvesting in the Eastern Cape may negatively affect forest productivity and ecosystem functioning. Specifically, this is the first study to measure the effects of harvesting of poles and medicinal bark on the functional diversity of avian forest communities. J. Leaver and others. Bird responses to harvesting of forest products. [Forest Ecology and Management 445 82-95 2019]

CONSERVATION AND MANAGEMENT OF *CEIBA* IN COLOMBIA

In Columbia, <10% of the original seasonally dry tropical forest remains. This calls for urgent conservation measures and restoration efforts. Understanding the genetic diversity and structure of tree species is critical to inform not only conservation measures but also sourcing of planting materials to ensure the long-term success of tree planting efforts, particularly in light of climate change. We assessed the genetic diversity distribution and structure of *Ceiba pentandra* from twelve representative locations of seasonally dry tropical forest in Colombia, and how they may have been shaped by past climate changes and human influence. We found three different genetic groups which may be the result of differentiation due to isolation of the Caribbean region, the Upper Cauca River Valley, and the Patia River Valley in pre-glacial times. Range expansion of seasonally dry tropical forest during the last glacial period, followed by more recent range contraction during the Holocene can explain the current distribution and mixture of genetic groups across temporary seasonal dry tropical forest fragments. Most of the sampled localities showed heterozygosity scores close to Hardy-Weinberg expectations. Only two sites, including the Patia River Valley, an area with high conservation value, displayed significantly positive values of inbreeding coefficient, potentially affecting their survival and use as seed sources. While the effects of climate change might threaten *C. pentandra* populations across their current distribution ranges, opportunities remain for the in-situ persistence of the most genetically diverse and unique ones. Based on our findings we identify priority areas for the in-situ conservation of *C. pentandra* in Colombian seasonal dry tropical forest and propose a pragmatic approach to guide the selection of appropriate planning material for use in restoration. K. T. Bocanegra-González and others. Conservation and management of Ceiba pentandra. [biological Conservation 227 29-37 2018] D

CRITICAL LIMITS IN OIL PALM COVER FOR MAMMAL CONSERVATION

As oil palm plantations continue to expand in Neotropical regions, identifying critical transitions in land use at which animal communities can be drastically altered is crucial for conservation planning. Here we investigated potential unexpected change points (thresholds) in the response of terrestrial mammal richness and community composition to increasing oil palm cover in the Llanos region of Colombia. We deployed camera traps to detect species across 56 sites (landscapes of 220 ha each) and used Segmented regresssion and Threshold Indicator Taxa Analysis for the identification of these thresholds. We found negative linear relationship between the proportion of oil palm and species richness, but no evidence of a threshold. In contrast, we

found strong signs of a community threshold when oil palm cover in the study area reached 45-75%, at which mammalian species composition (taxon specific changes of abundance and occurrence frequency) drastically changed. When species were assessed individually, a significant threshold relationship to oil palm cover was found to occur in 10 of the 15 examined species, with four (squirrel, agouti, spiny rat, common opossum) having a negative drastic change at approximately 45% oil palm cover. Five species showed no evidence for any critical threshold (giant and lesser anteater, jaguarondi, white tailed deer, and raccoon). We used the community threshold identified above as a baseline to estimate the conservation status of the four oil palm production zones in Colombia. We found that approximately 41% of the total area covered by oil palm in Colombia has crossed the identified threshold of 45-75% suggesting urgent need for forest restoration to increase its extent if a collapse of their resident mammal communities is to be avoided. These findings provide guidance for the design of sustainable landscapes within production areas in Colombia to promote the conservation of terrestrial mammals. L. E. Pardo and others. Identifying critical limits in oil palm cover in the conservation of terrestrial mammals in Columbia. [Biological Conservation 227 65-73 2018] D

BENEFICIARY TYPE INFLUENCES CONSERVATION MESSAGE EFFECTIVENESS

Many in the conservation community assume that more people are willing to support conservation when emphasis is placed on the human benefits of nonhuman nature, rather than the value of nonhuman nature for its own sake. To test this assumption, we designed an online survey investigating how the type of beneficiary (human, nonhuman, or both) depicted in outreach messages affects two metrics of support: 1) attitudes toward the message and 2) donations for a conservation organization. Each respondent viewed one message highlighting humans, nonhumans, or both as conservation beneficiaries. Predicting that the effect of the beneficiary type would depend partially on individual differences, we also measured respondents' moral inclusivity (the values and beliefs they hold with regard to human and various nonhuman entities). Although beneficiary type did not affect attitudes, we report several key findings for donation. Compared to messages depicting only nonhuman beneficiaries, messages depicting only human beneficiaries were associated with lower likelihood of donation overall and among less morally inclusive respondents, lower donation amounts. At the same time, messages depicting both human and nonhuman beneficiaries were not associated with more positive donation outcomes than messages depicting only nonhuman beneficiaries. Our results suggest that highlighting humans as conservation beneficiaries may not most effectively generate social support for conservation. Messages advocating the protection of nonhuman nature for its own sake may produce the most consistently positive donation outcomes. C. Batavia and others. How type of beneficiary influences effectiveness in conservation messages. [Biological Conservation 228 158-166 2018] D

USES OF PASTURE TREES IN THE MOUNTAINS OF TABASCO, MEXICO

The rapid deforestation in the state of Tabasco due to extensive livestock farming has resulted in the decrease of the original forest cover. Only 4% of the original vegetation remains and that vegetation is concentrated in the mountainous regions of the state. This destructive process continues due to support by the current government livestock policies. Under these circumstances, the traditional silvopastoral systems of dispersed trees can present an option for reversing and mitigating deforestation practices. The objective of this study was to generate information on the tree species common to silvopastoral systems of dispersed trees in the

pastures for two mountainous areas in Tabasco. In the study 64 tree species representing 26 plant families were identified. All species were characterized as multipurpose, with at least three reported uses and a maximum of seven for each species. In total, nine categories of local uses were identified for the trees. The main category of use was fuel (firewood), followed by timber and shade for the livestock. Although leguminous species (Fabaceae) were dominant, these species were utilized for uses other than the prevision of fodder. Although 12 of the total species identified were recognized as sources of food for animals, apparently livestock farmers do not consider using these species for improving production yields. The results suggest that there is a potential need to expand research and offer further education on the subject in Tabasco. C. R. Villanueva-Partida and others. Traditional uses of dispersed trees in the pastures of the mountainous region of Tabasco, Mexico. [Agroforestry Systems 93 (2) 383-394 2018] D

WOOD PROPERTIES OF FOUR AGES OF *CEDRELA* WITH CACAO

The present work studies the morphological, physical, mechanical, and chemical properties of *Cedrela odorata* trees growing in agroforestry with *Theobroma cacao* at four ages (4, 5, 6, and 7 years) in Costa Rica. It was found that the morphological properties (heartwood, pith, and bark) together with the physical properties: (specific gravity, green density, shrinkage, and green moisture content) presented few differences at the four ages. The wood from the four-year-old trees was the only exception, showing less resistance in compression, flexion, and lateral hardness. The content of lignin, carbon, and extractives in hot water were not affected among the different ages, contrary to the rest of chemical properties. In relation to decay resistance in accelerated tests with the fungus *Trametes versicolor*, the wood is classified as highly resistant, while with the fungus *Lencites acuta* it is classified as moderately resistant. As concerns properties related to industrialization it was found that the wood can be preserved through vacuum-pressure methods, obtaining similar results as those from other plantation timbers. As for workability tests, the wood from the 4-year-old trees show acceptable to very poor performance, differing from trees of the other ages. C. Tenorio & R. Moya. Evaluation of wood properties of four ages of *Cedrela odorata* trees growing in agroforestry systems with *Theobroma cacao* in Costa Rica. [Agroforestry Systems 93 (3) 975-988 2019] D

SELECTIVE MANAGEMENT EFFECTS ON FOREST SUSTAINABILITY

We analyzed the effects of a selective management system on the biomass structure (frequency distribution and spatial distribution of biomass) of a tropical rainforest in Peninsular Malaysia. The sum of the aboveground and belowground biomass of all individuals >5 cm diameter at breast height was analyzed in a forest logged under a selective management system and compared with that of an unlogged natural forest. We also analyzed new approaches to improve the logging system using unlogged natural forest census data. Mean total biomass value and its variance were lower in the logged forest (256 Mg/ha) than in the unlogged natural forest (464 Mg/ha). Logging operations also changed the spatial pattern of the total biomass, as spatially clustered and random distributions were observed in the logged forest and the reference forest, respectively. To mitigate the impacts of logging on the original biomass structure, we recommend reducing the logging ratio by adopting a maximum cutting limit, as well as uniform logging intensity throughout a stand. This will ensure a spatially random arrangement of remaining emergent trees and vital forest regeneration processes. V. R. Kubola and others. Effects of selective management on forest sustainability. [Journal of Tropical Forest Science 30 (2) 259-268 2018] D

TROPICAL FORESTRY NOTES (30)

PRINCIPLES, FOR SUSTAINABLE FOREST MANAGEMENT IN GABON

We show how the African Timber Organization principles, criteria, and indicators for the sustainable management of African forests can help timber companies assess their progress towards this goal in Gabon. Through a partnership between international Tropical Timber Organization project PD 124/01 Rev. 2(M), The World Wildlife Fund, and the ministry responsible for forests in Gabon, audits were conducted between 2012 and 2014 to evaluate the management in 14 forest concessions in Gabon. In general, results show that Principle 4, linked to the wellbeing of workers and local populations, proved the most difficult principle to implement, while Principle 3, dealing with maintaining ecological functions, was the least problematic. A number of companies were found to be experiencing significant difficulties in implementing management plans. It is also clear that independent forest certification has become a key element for ensuring the successful implementation of sustainable forest management. J. B. Mikissa and others. Implementing principles, criteria, and indications of sustainable forest management in Gabon. [Journal of Sustainable Forestry 38 (1) 46-53 2019] D

HYDROLOGY IN SUPPORT OF SUSTAINABLE MANAGEMENT

Forests are among the most important ecosystems that provide various hydrological services, including water production and protection, because the vast majority of the water available on the earth comes from forested catchments. Forests provide quality and continuous water yield as well as protective services such as flood control, soil protection, landslide protection, and prevention against rock falls, which are related to water. However, the quality and quantity of all forest functions are influenced by forest ecosystem structure and composition characteristics, such as forest type, tree species, age class distribution, biomass, leaf area, basal area, crown closure, and stand development stages. This study provides an assessment of hydrological services of forest ecosystems and mainly focuses on water-forest relations and explains how forest ecosystem structure and composition affect water production, quality, and sustainability. Then. a general framework integrating hydrological services into forest management is included in the context of sustainable management of natural resources. S. Keles. An assessment of hydrological functions of forest ecosystems to support sustainable management. [Journal of Sustainable Forestry 38 (4) 305-326 2019] D

FOREST PRODUCTS TRADE, CONSUMPTION, AND CONSERVATION

Trade barriers of forest products are often advocated in the name of protecting forest resources. Whether the promoting of trade of forest products will increase or decrease the global forest resources is still a matter of debate. We offer an assessment of how forest product trade helps shape observed forest change, by relating wood consumption to trade of forest products based on cross-section data from 61 countries in 2010. The result shows that wood outputs have positive effects on wood consumption. Compared to domestic production, the result suggests that imports of forest products can help reduce wood consumption. This may indicate that trade liberalization can promote the allocation efficiency of timber resources across the globe, which can improve the utilization efficiency and reduce the wood consumption in the world, to protect the global forest resources. It is suggested that the high-efficiency harvest and wood-processing technological transfer should be advocated in the international community to contribute to global

forest conservation. M. Tian and others. Forest products trade, consumption, and conservation. [Journal of Sustainable Forestry 36 (7) 717-728 2017] D

PIONEER TREE RESPONSES TO SOIL VARIATION IN BRAZIL

The occurrence of pioneer tree species inside tropical forests is usually associated with canopy openness due to disturbances. The distribution of these species under different environmental conditions, aside from light presence, can be influenced by other variables such as soil attributes, water availability, and non-arborous species. This work evaluates pioneer tree distribution in the Pindorama Biological Reserve, Brazil, with respect to altitude, soil attributes and non-arborous species in 65 400 m2 plots in two toposequences of semi-deciduous forest. We evaluated physical and chemical soil attributes: altitude, basal area, height, and number of individuals of tree species with diameter at breast height of >5 cm in a randomly chosen quadrant in each plot. *Acacia polyphylla*, *Aloysia virgata*, *Casearia sylvestris*, and *Croton floribundus* were the pioneer species with higher occurrence. Cluster analysis suggested five similar groups among sampling plots. For each group, the mean of altitude, physical and chemical soil attributes, and degree of non-arborous species infestation were calculated. Principal components analysis correlated variables with pioneer tree data. *C. floribundus* occurred in lower fertility plots, and *A. polyphylla* and *A. virgata* occurred in higher altitude plots. M. T. V. N. Abdo and others. Pioneer species response to soil attributes in Brazil. [Journal of Sustainable Forestry 36 (2) 134-147 2017] D

LOGGING IMPACT ON ENTIRE VEGETATION OF BORNEO

The impact of logging was assessed on the forest structure, richness, and composition of trees, lianas, and ground herbs. There were no significant differences in tree height, diameter, basal area, or abundance between unlogged and logged forest. Liana abundance was higher in logged than in unlogged forest, but the difference was marginally nonsignificant. There was also no significant difference in the percentage cover of the ground herbs. Tree species richness was similar between unlogged and logged forest, while liana species richness was higher in logged forest and herb species richness between unlogged forest. Tree and liana compositions differed significantly between unlogged and logged forest, but logging explained only a small part (<7%) of the variance in composition. In contrast to trees and lianas, ground herb composition did not differ significantly between unlogged and logged forest. Our findings indicate that the modest extraction intensity practiced did not have a severely adverse impact on forest structure or plant composition. This highlights the important role that logged forests may play in conserving biodiversity and the need to protect forests from further disturbance. D. F. R. Cleary and others. Logging impact on trees, lianas, and herbs in Borneo. [Journal of Sustainable Forestry 36 (8) 806-817 2017] D

PARTICIPATORY FOREST MANAGEMENT IN KENYA

The study used the access analytical framework to investigate how introduction of Participatory Forest Management has changed the various actors' ability to benefit from forest resources of the Eastern Mau Forest Reserve. Data collected through key informant interviews and a household survey showed that implementation of participatory forest management has triggered new income opportunities for forest adjacent communities in seedling production and beekeeping. However, participatory forest management bestowed no real decision-making powers to the

established Community Forest Associations over important forest resources such as timber and firewood. Members of the local communities and other actors have continued to access these resources through various structural and relational means, in the same way as before the introduction of Participatory Forest Management. Further, it is documented that participatory forest management has introduced additional burdens on the local communities, especially the poorest households as a result of increased enforcement of rules. Based on these findings, it is suggested that the participatory forest management policy in Kenya, in its current form is unlikely to realize its dual objectives of forest conservation and livelihood enhancement. To attain them would require a further devolution of rights to Community Forest Associations. J. M. Mutune and others. Implementation of participatory forest management in Kenya. [Journal of Sustainable Forestry 36 (3) 230-249 2017] D

STRUCTURE AND COMPOSITION AS INDICATORS OF RESTORATION

This study evaluated a 5-year-old riparian forest in an anthropometrically affected region restored with the purposes of erosion control and other ecosystem functions, and to monitor indicators of structure and composition. The forest was monitored via data collection of the diameter and height of trees for phytosociological analysis, including the identification of species and their classification with regard to life form, origin, weed status and successional stage. The forest was not very structurally developed and overall, 111 species were recorded, consisting of 66% herbs, 24% trees, and 10% other types of life forms. About 71% of species were natives, 29% exotics, and 65% weeds. The high abundance of exotics and weed species (some aggressive such as *Leucana leucocephala*) of various life forms may negatively affect the restoration success in terms of seedling recruitment and diversity of native species, but may constitute a neutral or even positive accomplishment for erosion control (with species composition as a secondary effect). Results also reinforce the knowledge that choice of species for restoration must be in accordance with major local filters (floods), and areas within urban matrices may deserve special attention, including periodic management actions to control undesirable species. V. Londe and others. Structure and composition as indicators of restoration success in an urban riparian forest in southeastern Brazil. [Journal of Sustainable Forestry 36 (5) 503-515 2017] D

PROFILE OF PRIMARY MALAYSIAN HILL DIPTEROCAP FOREST

A systematic sampling of a primary hill dipterocarp forest in Ulu Muda Forest Reserve Kedah, Peninsular Malaysia was made to study the variations of forest profiles in relation to topography. The structural variations are presented in 14 profile diagrams. Forest profiles showed two to three canopy layers structurally not different from the original tabonuco forest of Puerto Rico. The most distinguishing structural variation among the profiles was the higher canopy on gentle sloping ridgetops with comparatively dense middle story and scattered emergent trees. Another structural variation was the low stature of the forest on hillsides with main canopy height averaging 23 m. Ridgetop profiles were generally vertically continuous, whereas on hillsides there were vertical discontinuities mainly due to tree fall gaps. The structural patterns described in other studies elsewhere did not match the profiles of the study site, possibly due to the fact that previously published forest profiles were on level ground. As it appeared in the profiles of the study site, rare species contribute to the maintenance of forest structure. Thus the conservation of rare species should be a concern for the management. I. Saiful & A. Latiff. Stand profile topography of a primary hill dipterocarp forest in Peninsular Malaysia. [Journal of Tropical Forest Science 29 (2) 137-150 2017] D

TROPICAL FORESTRY NOTES (31)

FOREST EDGE PROXIMITY REDUCES TIMBER PRODUCTION

Increased competition near a standing forest may result in a decrease in the growth of targeted timber species which in return may impact on timber yields. This study examined the impact that standing forest adjacent to regenerating forest has on the height of eucalyptus spp. regeneration in the wet temperate forests of Tasmania, Australia. We used LIDAR data to test whether the height of the regenerating forest varied with proximity to the adjacent forest following harvesting and regeneration treatments. The distance response was examined across two silvicultural systems (aggregated retention, and clear fell, burn and sow), and across two broad age classes (1-7 years and 1-24 years). Height growth was reduced within 23 m of a retained edge, with a maximum reduction of 12% occurring closest to the edge. The edge effect was similar across ages and between silvicultural systems. Understanding productivity losses associated with increasing forest edges provides important information for forest managers balancing economic and biodiversity conservation requirements. T. P. Baker and others. Do forest edges reduce timber productivity? [Forest Ecology and Management 448 208-217 2019] D

MAYA RAINFOREST INTEGRATES CONSERVATION AND LAND-USE

The present study, carried out in the lowland Maya area of Mexico, aimed to investigate local meanings of rainforest conservation and dynamics of land use in two Maya common property holdings or "ejidos" (Noh Cah and X-Maben). The study used a Social-Ecological Systems approach, comprising (1) the Maya communities and their local meanings of conservation as a Social Subsystem, and (2) the rainforest of each studied ejido - which was regarded as an Ecological Subsystem and assessed through satellite images (from 2000 to 2012). In the former, interviewees were asked, when you hear the phrase, "conservation of the rainforest", what do you think is being said? They were also asked if there were local words in Maya or Spanish that were similar in meaning to the aforementioned phrase. The results relating to the meaning of conservation, demonstrate that Maya people, who rely on the rainforest for multiple livelihoods, understand two types of meanings for looking after the rainforest: one pronounced by governmental programs, and the other called Kaman Kdax, a Maya phrase that represents the customary or community-based rainforest conservation. Differences between these two models of conservation encompass differences with respect to scale, gender, and the Maya peoples own cultural practices. The results of the local dynamics of land use demonstrate that the landscapes of both study sites are dominated by mature rainforest (74%-83%) and are therefore in good state of conservation and that their agricultural frontiers have not expanded. Our empirical results are valuable in terms of informing the scientific community about the state of rainforest conservation in the Maya Zone and providing policy-makers with information for more inclusive conservation policies that take full account of the indigenous cultural practices of rainforest management. M. Pac-Alcocer and others. Maya Zone meanings for rainforest conservation. [Forest Ecology and Management 448 300-311 2019] D

ADVANCED TECHNOLOGY FOR PULP AND PAPER IN INDIA

This paper exploits the information obtained in the Annual Survey of Industries during 1999-2010 to gauge the degree of value-added owing to the use of traditional inputs (capital, labor, energy, indigenous materials, and imported materials) and advanced industrial production

technology (communications technology and pollution control equipment) in two main subsections of the pulp and paper industry in India categorized according use of different types of raw material. The use of traditional inputs and advanced industrial technologies by the two subsections have varied effects on value-added. These findings are important for promoting higher value-added production in different sectors within the resource-based industry. S. Kumar Kujur and others. Advanced technology in the pulp and paper industry of India. [Journal of Sustainable Forestry 39 (6) 542-557 2019] D

SUSTAINABLE TOURISM AND FOREST CONSERVATION IN MALAYSIA

Ecotourism is a sustainable use of forest resources, as compared to traditional uses such as logging and milling. However, whether turning forests into tourist sites can generate incomes comparable to the lucrative traditional activities is less clear. We estimated the recreational values of the Belum-Temengor Rainforest Complex in Perak, Malaysia, and compared it with the alternative of one-time consumptive revenues from logging. Based on data from an on-site survey of 367 visitors to the Rainforest Complex, direct non-consumptive use values were compared using the individual travel cost approach and the truncated Poisson count data model. The annual direct non-consumptive use value was RM 14 million based on the estimated number of nights spent and willingness to pay per trip. The future cash flows of recreation demand were RM 6 million, RM970 million, and RM1.8 million for the next 30, 50, and 100 years, respectively. Own-price, cross-price, and income elasticities of recreation demand was also compared. Visitor's on-site travel cost, alternative-site travel cost, income, ethnicity, and single marital status were associated with recreation demand. Our main conclusion is that the direct nonconsumptive use values from recreation demand and other indirect uses and non-use values from forest conservation exceed the one-time consumptive revenues from logging. S. L. Gwee and others. Sustainable tourism and forest conservation in India. [Journal of Sustainable Forestry 38 (4) 327-342 2019] D

SUSTAINABILITY THROUGH PARTICIPATORY CONSERVATION IN INDONESIA

The delivery of sustainable development goals (SDGs) through a participatory land and forest conservation initiative was evaluated in South Kalimantan Province, Indonesia. The initiative focused on the rehabilitation of a 410-ha forest that was managed by local villagers. A forest rehabilitation and management initiative were developed through participatory action, establishing a well-managed rubber plantation that provided new livelihood opportunities. Poverty reduction was promoted, evidenced by a reduction in inequality amongst the local community. Between 2010 and 2018 the Gini coefficient of inequality declined from 34.6% to 31.3%, demonstrating a contribution to SDGs 1 (no poverty) and 10 (reduced inequalities). In addition, forest rehabilitation resulted in improved carbon stock and biodiversity management contributing to SDG 15 (life on land). Cooperation amongst local villagers categorized as living in poor households was improved, facilitated by capacity building which SDG 17 (partnerships towards the SDGs). Results from a socioeconomic survey demonstrated that group activities and cooperation amongst were essential to improve both livelihoods and forest management practices. M. Hiratsuka and others. Achievement of sustainability goals through participatory means. [Journal of Sustainable Forestry 38 (6) 558-571 2019] D

THINNING EFFECTS ON FOREST STRUCTURE IN AUSTRALIA

Forest thinning has potential particularly for regrowth in low rainfall forests and woodlands. It may also provide benefits for biodiversity, but there is little direct evidence for this. This study examined the long-term effects of thinning on structural attributes of white cypress pine (*Callitris glaucophylla*) in the Piliga forests of eastern Australia. A chronosequence approach was used which included six replicates of five forest management treatments; Unthinned (>80 years) with high density regrowth, Recent thinning (<8 years); intermediate thinning (8-20 years); old thinning (21-40 years). Long undisturbed (>80 years) with large *Callitris* and *Eucalyptus* trees present. Thinning reduced the dominance of species that form dense single-aged stands (*Allocasuarina luehmannii* and *Callitris* ssp.). Following thinning there was a four-fold reduction in small stems (<10 cm DBH); 6,030 stems/ha (unthinned) com compared to 1,583 stems/ha (recently thinned). The reduction in small stemmed vegetation was associated with lower cover in both the mid-story (2-6 m) and the sub-canopy (6-14 m) which persisted for 21-40 years, while the long undisturbed treatment had mid-story densities which were similar to the unthinned treatment. Density for medium-sized *Eucalyptus* spp. (10-30 cm DBH) was highest (>90 trees/ha) where thinning had occurred (recent, intermediate, and old treatments) or where stem density of *Allocasuarina* and *Callitris* regrowth was low (long undisturbed), suggesting that both of these species competitively exclude recruitment of *Eucalyptus* spp. The post-thinning reduction in woody vegetation was accompanied by an initial increase in the volume of downed coarse woody debris which was long-lasting (21 to 40 years) and four to eight times greater than in long undisturbed sites, with greatest mean hollow diameter occurring in the old thinning treatment. Commercial thinning, in which some residue is removed from sites, still supported up to four times the coarse woody debris volume as the long undisturbed treatment. There was a trend for a negative effect of thinning on the density of dead trees but no effect on density of hollow bearing and large trees. (>50cm DBH). Overall, our results indicate thinning had a mixed effect on key structural attributes that contribute to habitat structural complexity, indicating a need to record the direct responses of biodiversity. Thinning in forestry remains a recourse in stands with excess trees with some inferior due to wood species quality, branchy tree form, small mature tree size, growth rate, and competition with superior trees left for the future. C. M. Waters and others. The effect of thinning on forest structure. [Forest Ecology and Management 409 571-583 2018] D

FOREST MANAGEMENT EFFECTS ON BIODIVERSITY AND HABITAT PRESERVATION

This study applied a structured expert elicitation technique, the Delphi method, to identify the impacts of five forest management alternatives and several forest characteristics on the preservation of biodiversity and habitats in the boreal zone of the Nordic countries. The panel of experts consisted of a number of scientists in the field. The data were collected using a semi-structured questionnaire distributed via email in two rounds. Our finding demonstrated that an increase in management intensity for timber production is likely to have a negative effect on the biodiversity and habits, with such intense alternatives as clear-cutting system resulting in the strongest adverse impact. The presence of deadwood, mixture of trees of different sizes, and increase in stand age were expected to promote biodiversity and habitat preservation. However, there was little agreement among experts regarding the functional relationship between preservation of biodiversity and forest characteristics. The Delphi method was useful in investigating the existing knowledge base, contributed to a more comprehensive assessment for

decision support, and it was a valuable addition to on-going empirical and modelling efforts. These findings could assist forest managers in developing forest management strategies that generate benefits from timber production, while taking into account trade-offs with biodiversity goals. A. Filyushikina. Impacts of forest management on biodiversity and habitat. [Forest Ecology and Management 409 179-189 2018] D

NOCTURNAL TRANSPIRATION OF 18 TREE SPECIES

Global increase in night time compared to day time temperatures results in an increased nocturnal vapor pressure deficit (VPD), which possibly increases nocturnal transpiration of plants. However, there are few studies on nocturnal transpiration of plantations in the tropics. We investigated the ratio of nocturnal to daily transpiration and its seasonal differences in timber plantations of tropical angiosperm tree species in lowland seasonal tropical botanical gardens in southwest China. We measured sap flow in 18 trees of nine evergreen and nine deciduous species, during three months in the wet season and three months in the dry season between 2012 and 2013. We partitioned the nocturnal sap flux density (SFD) into nocturnal transpiration and trunk water recharge. We also measured wood density to investigate its relationship with nocturnal sap flux density. Our results showed that the mean nocturnal (whole night time) VPD was linearly correlated with mean nocturnal SFD in both the wet and dry seasons. During the wet season, the ratio of nocturnal SFD to daily SFD was 0.12-0.19 and 0.15-0.2 among evergreen and deciduous species, respectively. During the dry season, the ratio increased to 0.18-0.28 for evergreen species. For evergreen species, the nocturnal trunk water recharge and nocturnal transpiration in the wet season were between 11.37-59.80% and 40.20-88.62% of nocturnal SFD, respectively. For deciduous species, these values were 18.10-66.26% and 81.90-33.73%, respectively. We found an inverse relationship between nocturnal SFD and wood density across the 18 studied species. In conclusion, this study demonstrates a substantial amount of nocturnal transpiration in a number of tropical tree species, even in the wet season and increased nocturnal transpiration in evergreen species in dry season. However, there was not any significant difference of the nocturnal SFD between evergreen and deciduous species during the wet season. Nocturnal transpiration is constrained by wood density across species. High nocturnal air temperature will result in increased transpirational demand and hence water loss at night. Our findings revealed important implications for nocturnal transpiration and hydrology of forest ecosystems in the seasonal tropics. Z. Siddiq & K.-F. Cao. Nocturnal transpiration in broadleaf timber species under a tropical climate. [Forest Ecology and Management 418 47-54 2018] D

TREE REGENERTION RESPONSES IN THE SOUTHERN CENTRAL ANDES

The reproductive phase of plants is especially vulnerable to environmental change. Global environmental changes normally act collectively with nonlinearities and synergetic interactions being reported. Here we combined two techniques (a space-for-time substitution approach and a full factorial experiment) to assess the combined effects of climate and land-use change on the regeneration (seed production, seed germination, and seedling survival, and growth of four subtropical tree species of the southern Central Andes in Argentina. We focus on temperature and precipitation changes and on decreased shading at the forest floor, a likely impact of changing land use and management. We detected species-specific and phase-specific responses. Seed mass and quality were influenced by elevation (here, seed as a proxy for temperature change), while germination, seedling survival, and growth were mainly affected by changes in the seedbed conditions (i.e., changes in shading and in moisture related to precipitation change).

Despite the influence of environmental conditions on all the phases of plant regeneration studied here, we show that the major bottleneck of the regeneration phase of these species is germination. Interactive effects among the elevation of the seed provenance, precipitation, and shading underpin the importance of studying the collective effects of environmental changes on plant regeneration, to better forecast the effects of climatic and land-use changes on Yungas forest in Argentina. M. M. Caron and others. Forest regeneration responses to climatic and land-use changes in Argentina. [Forest Ecology and Management 417 110-121 2018] D

TROPICAL FORESTRY NOTES (32)

LANDSCAPE SUSTAINABILITY WITH BIRD POPULATIONS FOR MANAGEMENT GUIDELINES

Balancing the needs for increasing yields of productive ecosystems while adhering to principles of sustainability is one of the most pressing challenges of the 21st century. However, baselines for management guidelines aimed at mitigating the impacts of working landscapes on biodiversity are lacking for the most biodiverse regions. In addition, there is a scarcity of empirical examples of how information collected using community-based approaches can be used to both define management guidelines and measure outcomes for sustainability. In this study we used bird observations collected by community monitors to identify the functional relationships between bird occupancy and habitat traits to inform management of productive landscapes. Our results indicated that relationships between bird occupancy and habitat traits depended on species residence status and their affinities to urban-crop field areas. Percentage of shrub cover was found to significantly influential in the probability of occurrence across species, followed by tree diameter, tree species richness and time since anthropogenic disturbances. Tree species richness was the only habitat trait that was found to have appositive relationship across all species groups. Seasonal variation in the number of bird species related to habitat traits was only important for shrub cover. Following our results, we identified specific management targets for current land use categories: (conservation forests, forestry plots, urban crop field areas) to benefit birds. Overall, we concluded that selective forest management was not entirely detrimental for birds, as it preserves habitat heterogeneity and vegetation structure. In contrast, intensive forestry management was found to be unfavorable for most bird species, likely driven by the clearing of critical vegetation from the area. Our participatory approach for defining research objectives and collecting data to inform management guidelines for communal lands while using robust analytical tools shows great potential for promoting sustainable working landscapes in biodiverse regions. R. Ortega-Alvarez and others. Improving the sustainability of working landscapes, data on bird populations to inform management guidelines. [Forest Ecology and Management 409 56-66 2018] D

EFFECTS OF FOREST REGENERATION ON MATURE FOREST BIRDS

Changes in forest structure that result from silviculture, including timber harvest, can positively or negatively affect bird species that use forests. Because many bird species associated with mature forests are facing population declines, managers need to know how timber harvesting affects species of birds that rely on mature trees of forests for breeding, foraging, and other purposes. We used to generalize linear mixed models to determine effects of clearcutting, shelterwood, and single-tree selection, and group selection on detection of 18 species of birds associated with mature forests in the Ouichita Mountains of Oklahoma and Arkansas. We surveyed birds for 16 years after harvest. Most species (67%) responded positively to partial harvest that retained some overstory. Less intensive harvests had positive effects on more species and negative effects on fewer species than more intensive harvests, but responses to different treatments varied among species. Five species showed a positive response to the most intensive harvest (clearcut), whereas 2 species showed a negative response. For the second most-intensive harvest (shelterwood), 7 species showed a significant positive response, and 1 species showed a negative response. For the less-intensive harvests, 9 species showed a positive response and 7

species had positive responses to group selection. The ovenbird and scarlet tanager responded negatively to all timber harvests; the ovenbird appeared to be particularly susceptible to timber harvest, especially more intensive harvests such as clearcutting and shelterwood. A variety of regeneration methods, including some more intensive treatments, along with maintenance of mature forest stands that retain well-developed midstories can be used to maintain the full suite of forest birds. R. W. Perry and others. Effect of regeneration on mature forest birds. [Forest Ecology and Management 408 183-194 2018] D

AFRICAN FOREST SOILS AND IMPLICATIONS FOR RESTORATION

The study evaluates the characteristics of soil seed bank in two types of central African rainforests: *Celtis* forest on clay and *Manilkara* forest on sandy soils. In each study site, 30 samples were collected per soil layers (litter, 0-5 cm, 5-10 cm, and 10-2- cm depth)). The species diversity and abundance of the soil seed bank were estimated after soil samples were brought to germination. We observed 297 seedlings of 53 species for the *Celtis* forest and 222 seedlings of 39 species for the *Manilkara* forest. The total densities of germinated seeds were 330 seedlings/m^2 and 247 seedlings/m^2, respectively. Herbaceous species dominated with percentages of 41 and 45%, respectively in the *Manilkara* forest and the *Celtis* forest. Both forest types displayed a regeneration potential through the soil seed bank. However, this potential seems higher in the *Celtis* forest. Pioneer taxa were more abundant in the soil seed bank of the *Celtis* forest (13 woody pioneer species) than the *Manilkara* forest (9 woody pioneer species). The values of Sorensen similarity index between the standing tree vegetation and the soil seed bank in each site were relatively low :11% for the *Celtis* forest and 8.8% for the *Manilkara*. But these similarity values were higher when only the pioneer species were considered: 47% in the *Celtis* forest and 39% in the *Manilkara* forest. The highest species richness was obtained in the first two soil layers (0-10 cm depth) in the *Celtis* forest, while 21% of the species were exclusively found in the deepest layer (10-20 cm) of the *Manilkara* forest. Among the timber species found in the forest, only three were observed in the soil seed bank of the two sites: *Nauclea diderrichii, Erythrophleum suaveolens* and *Staudtia kamerunensis*. *N. diderrichii* was particularly abundant in the soil seed stock of the two sites. (14.4 and 34.4 /m^2). Results suggested that to improve regeneration of timber species planting in open forest habitats with seedling coming from tree nurseries should be more efficient. C. Douh and others. Central African forest restoration from soil seed bank. [Forest Ecology and Management 409 766-776 2018] D

FOREST HABITAT FOR THE KIRTLAND'S WARBLER

Kirtland's warbler breeds in the temperate zone and yet is a winter resident in the tropical Bahama Islands. Here we applied established population-habitat relationships based on decades of monitoring and research-management collaborations for the Kirtland's warbler (*Selophaga kirtlandii*), to project potential impacts of changing environmental conditions to breeding habitat distribution, quality and quantity in the near future. Kirtland's warblers are habitat specialists that nest exclusively within dense jack pine (*Pinus banksiana*) forests between 5-20 years of age. Using Random Forests to predict changes in distribution and growth rate of jack pine under future scenarios, results indicate the projected distribution of jack pine will contract considerably (75%) throughout the Lake States region in response to projected environmental conditions in 2099 under RCP 4.5 and 8.5 climate scenarios, regardless of climate model. Reduced suitability for jack pine regeneration across the Lake States may constrain management options, especially

for creating high stand-density plantation nesting habitat. However, conditions remain suitable for jack pine regeneration within the warbler historical and current core breeding range in northern lower Michigan and several satellite breeding areas. Projected changes in jack pine growth rates varied within the core breeding area but altered growth rates did not greatly alter the duration that habitat remained suitable for nesting by the Kirtland's warbler. These findings contribute to Kirtland's warbler conservation by informing habitat spatial planning for plantation management to provide a constant supply of nesting habitat based on the spatial variability of potential loss or gain of lands environmentally suitable for regenerating jack pine in the long term. D. M. Donner and others. Managing forest habitat for the Kirtland's Warbler. [Forest Ecology and Management 430 265-279 2018] D

LANDSCAPE CHANGE EFFECTS ON LA MESA WATERSHED, PHILIPPINES

The La Mesa watershed is considered the last Ecological Frontier of the Philippines' National Capital Region. Metro Manilla is among the many watersheds in the country that suffered severe deforestation in the past. Nevertheless, over the past few decades reforestation programs for the watershed have also been initiated. Spatiotemporal monitoring of landscape pattern (composition and configuration) is needed to inform policy and support forward-looking management planning toward landscape sustainability. However, the changes in the landscape pattern of the watershed, including the extent of forest loss and gain over the past decades, have not been quantified, hence this study. We used remote sensing data (Landsat) to classify the land use/land cover of the watershed in 1988, 2002, and 2016. We subsequently used spatial metrics to quantify the changes in the landscape pattern of the watershed. We found that between 1988 and 2002, a period that largely preceded the start of the watershed's major rehabilitation the watershed had a net forest cover loss of 259 ha. From 2002 to 2016 it had a net forest cover gain of 557 ha. The detected increase in forest cover was supported by the percent tree cover analysis based on MODIS data. The deforestation of the watershed resulted in landscape fragmentation as indicated by the decrease in the area of the forest and mean patch size and the increase in forest patch density. Forest restoration activities have helped improve the watershed's landscape connectivity as signified by the increase in the area of the forest and mean patch size and the decrease in forest patch density. The results also revealed that rapid urbanization has been a major factor driving landscape changes around the watershed and this requires proactive, forward-looking, management planning. Overall, the watershed case presents some valuable learning experiences and insights regarding public/private partnerships for watersheds and forest related rehabilitation initiatives. On a national scale the Philippine government has embarked on a massive national greening program. The findings of this study suggest that such efforts could lead to enhancement of denuded forest areas, if done properly. R. C. Estoque and others. Landscape pattern changes affect the La Mesa watershed in the Philippines. [Forest Ecology and Management 430 280-290 2018] D

TROPICAL FORESTRY NOTES (33)

FOREST RESIDUE REMOVAL DECREASES WOOD PRODUCTIVITY

Forest residues are frequently used as energy sources by Brazilian forest companies. The removal of such residues is known to reduce wood productivity, especially when fertilizer application rate is low. This study aimed to evaluate after two forest rotations the effects of forest residue management on wood productivity when fertilizer is applied at a high rate, and the effect of timber harvest intensity on soil organic matter and microbial activity. We assessed tree growth and soil microbial biomass and activity, and we fractionated soil organic matter via its oxidation resistance. These assessments were performed after conducting a field trail comparing harvest residue management over two successive rotations in the same plots. We found no significant effect of treatments on wood productivity when the residues were removed for the first time; however, wood productivity reduced by 15% during the second rotation with residue removal even with high rates of fertilizer application. Further, 40% reduction in microbial biomass and soil respiration was noted with forest residue removal. At the reestablishment time, the soil organic matter in the topsoil (0-0.05 m) was 25% lower at the site where the forest residues were removed, and this difference increased to 50% at 300 days after the reestablishment. This reduction was found mainly in the soil organic matter label faction. J. H. Tertulino Rocha and others. Forest residue removal decreases wood production, even with high rates of fertilizer application. [Forest Ecology and Management 430 188-195 2018]D

INVASIVE EARTHWORM DAMAGE THREATENS A FOREST FERN

Adequate detection and monitoring of threatened, endangered, and sensitive species present a challenge to forest managers seeking to balance managed and activities with conservation and forest health. This is especially true for cryptic plant species that are difficult to detect, like golden fern (*Botrychum morimo*) which is small and does not emerge from the duff layer of the rich hardwood forests it inhabits every year, even when present. Imperfect detection of this species makes it difficult to monitor, because lack of plants detected at a specific site does not necessarily indicate that the species has been extirpated there. In this study 80 historic locations of *B. morimo* were surveyed for occurrence over three consecutive years to assess probability of occupancy and environmental factors expected to impact occupancy, including earthworm damage and canopy closure, while accounting for detectability. We found that probability of occurrence is most strongly related to earthworm damage and were able to identify levels of earthworm damage at which the species is more likely to remain present or be extirpated. These results suggest that use of a simple metric for quantifying ecological impact of earthworm damage can be used during monitoring to assess the likelihood that *B. morimo* is still present. With this information forest managers can prioritize sites for habitat preservation and better shape policy and management decisions to protect and enhance habitat for the species. In addition, our study demonstrates the utility of occupancy modelling for management and conservation of rare and elusive plant species. K. J. Zionis & B. W. Henderson. Earthworm damage threatens forest fern. [Forest Ecology and Management 430 291-298 2018] D

WOOD DENSITY KNOWLEDGE FOR SUSTAINABLE ATLANTIC FOREST

To achieve sustainable forest management foresters, scientists, and m managers require ecological data, such as tree size, growth rate, wood density, species abundance, and forest

structure. Lack of specific knowledge on these values may compromise the sustainable use of natural resources. Considering tree species, wood density may be considered as the most integrative trait, usually associated with two major growth syndromes, setting apart pioneer and climax species and driving potential uses of wood. Therefore, we chose this trait as an indicator for the knowledge level about Atlantic forest tree species under the assumption that it is important for their management and conservation. We use logistic regression models to test if wood density is less known (1) due to species restricted distribution, (2) due to species abundance, and/or (3) species unknown use value). As an alternative to fill this gap we test if it is possible to predict wood density from related species using a null model? We could not find any wood density record for 73% of the studied species. We also detected a consistent spatial bias with collection data closer to research centers than expected by chance. Also, larger distribution area and more recognized use value of a given species is associated with a higher chance of having wood density records in the literature. It was possible to use available knowledge about wood density of related species in a genus for 15 of the 57 studied genera. Our results show that, beside the lack of information on wood density, existing data is apparently insufficient for insights into trait variability for Atlantic Forest trees. Therefore, to assure adequate wood supply and species conservation it is imperative to fill knowledge gaps on wood density in the Atlantic Forest. D. L. Padilla and others. Wood density knowledge is impediment to develop sustainable use of the Atlantic Forest. [Forest Ecology and Management 424 448-457 2018] D

DYNAMICS OF FIRES IN THE SOUTHWESTERN AMAZON

The synergism between climate change and human action has provided conditions for the occurrence of forest fires in Brazil's state of Acre. We used annual mapping to reconstruct the history of fire in Brazil's state of Acre to understand the forest-fire regime over a period of 33 years (1984–2016). The burn- scar index derived from the fractions of soil and of photosynthetic and nonphotosynthetic material was generated by CLASlite© software using Landsat-TM and OLI of the satellite images. The area of forest fire scars totaled 525,130 ha in the period analyzed. This total included forest that fire affected only once (388,350 ha.), twice (59,800 ha.) and three times (5,727 ha.). The years 2005 and 2010 represent 90% of the total area of forest fires in Acre, coinciding with severe droughts caused by the anomalous warming of the tropical North Atlantic Ocean. The most heavily impacted portion of Acre was in the eastern part of the state, which has the greatest forest fragmentation, consolidation of agricultural activity, and presence of settlement projects. In 2005 the municipalities of Acrelandia, Placedo de Castro and Senador Guiomard accounted for more than 50% of the forest remnants impacted by fire, Of the total extent of forest fires in Acre, 43% occurred in settlement projects administered by the National Institute for Colonization and Agrarian Reform (INCRA) and 16% in conservation units administered by the Ministry of Environment (MMA). The area of forest fires was 36 times greater in the 16 years after 2000, compared to the 16 years after 2000. The frequency of fires increased dramatically from one fire episode every ten years (period from 1984 to 2004) to one fire every five years (2005 to 2016). With projections of warmer climate and advancing deforestation the forest fires in Acre will be more intense and frequent. S. Souza da Silva and others. Dynamics of forest fires in the southwestern Amazon. [Forest Ecology and Management 424 312-322 2018] D

NICOBAR ISLANDS (INDIA) MANGROVE COMPOSITION

The 2004 Indian Ocean Tsunami and tectonic subsidence that ranged between 1.1 and 2.85 m severely impacted the mangrove habitats at the Nicobar Islands. The subsidence resulted in the loss of mangrove habitats; meanwhile new inter-tidal habitats potential for mangrove colonization were also formed at the erstwhile terrestrial habitats. We assessed the impacts of these large-scale natural disturbances on the mangrove habitats of Nicobar Islands and studied the initial patterns of mangrove succession. Surviving mangrove patches were observed at only three sites for the entire Nicobar Islands and the estimated mangrove cover loss is 97%, which is much higher than the previous reports. We report the presence of 20 mangrove species for the Nicobar Islands, which includes new distributional records and local extinctions after this major natural disturbance. The landward man groves seem to be more vulnerable to such disturbances. The initial community structure of the successional mangroves is dominated by *Rhizophora mucronata* and *Bruguiera gymnorhiza* with a cumulative abundance of 70%. The community structure that included 3,182 individual mangroves at the successional habitats showed a significant difference among the three islands groups (Northern, Central, and Southern) in the Nicobar Islands. Habitat and species loss are inevitable with intense disturbances, in this case tsunami and subsistence. But facilitating mangrove growth at potential habitats may be vital to restoring the functionality of the coastal system and the livelihood of social communities. Therefore, the outcome of our study is critical for forest managers to regrow mangroves in the Nicobar Islands. Also, we suggest that long-term monitoring of these sites is required to understand the overall, long-term impacts of tsunamis and subsidence in the mangrove habitats of Nicobar Islands. P. Nehru and others. Mangrove composition post-tsunami and subsidence in Nicobar Islands (India). [Forest Ecology and Management 427 70-77 2018] D

TROPICAL FOREST DIFFERENCES ACCORDING TO LASER SCANNING

Increasing anthropogenic pressure leads to loss of habitat through deforestation and degradation in tropical forests. While deforestation can be monitored relatively easily, forest management practices are often subtle processes that are difficult to compare with satellite monitoring. Conventional measurements are well established and can be useful for management decisions, but it is believed that Terrestrial Laser Scanning (TLS) has a role in quantitative monitoring and continuous improvement of methods. In this study we used a combination of laser scanning and conventional forest inventory measures to estimate forest structural parameters in four different forest types in a typical mountain cloud forest in Kafa, Ethiopia. Here, the four forest types (intact forest, coffee forest, silvopasture, and plantations) are a result of specific management practices (e.g., clearance of understory in coffee forest) and not different forest communities or tree types. Both conventional and TLS derived parameters confirmed our assumption that intact forest had the highest biomass, silvopasture had the highest canopy gaps, and plantations had the lowest canopy openness. Contrary to our expectations, coffee forest had higher canopy openness and similar biomass to silvopasture, indicating a significant loss of forest structure. The 3D vegetation structure (plant area vegetation density or PAVD) was different between the forest types, with the highest PAVD in intact forest and plantation canopy. Silvopasture was characterized by a low canopy but high understory PAVD, indicating regeneration of the vegetation and infrequent fuelwood collection and/or non-intensive grazing. Coffee forest canopy had low PAVD, indicating that many trees had been removed, despite coffee needing canopy shade. These findings may advocate for more tangible criteria such as canopy openness thresholds in sustainable coffee certification schemes. TLS as tool for monitoring forest structure

in plots of different forest types shows potential as it can capture the 3D position of the vegetation volume and open spaces at all heights in the forest. To quantify changes in different forest types, consistent monitoring of 3D structure is needed and here laser scanning is an add-on or an alternative to conventional forest structure monitoring. However, for the tropics, laser scanner based automated segmentation of trees to derive DBH and biomass is not widely operational yet, nor is species richness determination in forest monitoring. Integration of data sources is needed to fully understand forest structural diversity and implications of forest management practices in different forest types. M. Decuyper and others. Assessing structural differences between tropical forest types with laser scanning. [Forest Ecology and Management 429 327-335 2018] D

TROPICAL FORESTRY NOTES (34)

PARTIAL RECOVERY OF POLLINATION IN MONOSPECIFIC PLANTATIONS OF *INGA VERA* IN ATLANTIC FOREST

In the last decades several approaches have been adopted for tropical assisted forest restoration from monospecific plantations to the establishment of highly diverse tree stands. However, the long-term viability of restored forest and their capacity to provide the required services demand continuous evaluation to guide future initiatives. We aimed to evaluate the existence of pollination in monospecific tree plantations in a hyper fragmented landscape of the Atlantic Forest in northeast Brazil. By using *Inga vera* as a model species, we compared several relevant aspects relative to tree reproduction, such as reproductive phrenology, floral structures, nectar consumption, fruit and seed set between monospecific plantations and native conspecific populations. Populations of *I. vera* from both native forest stands and planted areas flowered in overlapping periods in the dry season, while fruiting occurred in the beginning of the rainy season. Flowers of planted populations were significantly larger (11% in the size of the calyx, corolla, and androecium – staminal tube and filaments) relative to natural populations. Flowers of both planted and natural populations secrete ca. 46 μl. of nectar with concentrations of 20% and 45% mg of sugars throughout anthesis. However, the average volume of nectar consumed by visitors per flower in planted populations was 30% lower than in natural populations. The frequency of pistils with pollen tubes and the average number of seeds per fruit were similar between natural and planted populations. Nevertheless, surprisingly the natural fruit set was 49% lower in planted relative to natural plantations. Lower consumption of nectar and natural fruit set in planted populations of *I. vera* in relation to the natural populations, indicate a partial recovery of the pollination process through the practice of single species of a tree in clusters of individuals. Our results add some doubts about the long-term viability and the ability of monospecific plantations in delivering services such as increased pollination capacity in human modern landscapes. O. Cruz-Neto and others. Partial recovery of pollination across monospecific plantations in the Atlantic Forest. [Forest Ecology and Management 427 383-391 2018] D

TOPOGRAPHIC AND CLIMATIC IMPACTS ON FOREST TREE SPECIES IN SOUTH KOREA

The effects of climate and topography on timber trees in South Korea are poorly understood. The main objective of this study was to develop a tree-level radial growth model incorporating topographic and climatic factors for *Pinus densiflora*, *Quercus spp*., *Larix laempjeri*, and *Pinus koraiensis* in South Korea. The model was developed and then validated using increment cores sampled from country wide permanent plots in the Korean National Forest Inventory. The Standard Growth (SG) of each increment core, which eliminated the effect of tree age on radial growth, was derived using an SG model. Spatial autocorrelation was detected for the SGs of each species, but not for the original radial growth data. The results showed that using the SG model to standardize radial growth for age was successful explaining impact of topographic and climatic factors on radial growth. The influence of climate (warmth index and precipitation effectiveness index) and topographic (topographic wetness index) factors on the Standard Growth of each species was evaluated by the estimated (eSG) model. The results show that for all species each variable was correlated to SG. The R^2 of the final radial growth model of the

four species ranged between 0.65 and 0.71. In addition, for every tree species the time sequence for estimated annual radial growth exhibited similar characteristics to that of the observed annual radial growth on an individual tree scale. Thus, this growth model can contribute to understanding the impacts of topographic and climatic factors on tree radial growth and predict the annual growth changes of major tree species in South Korea, given climate change. M. Kim and others. Impacts of topographic and climatic factors on radial growth of four timber species in South Korea. [Forest Ecology and Management 404 269-279 2017] D

FREQUENT FIRES ELIMINATE FLESHY FRUIT PRODUCTION

Recent literature has reported a decline in frugivores wildlife in frequently burned landscapes raising concern for fire-regime effects on fruit production. Thus, an assessment of the effects of fire frequency on fleshy fruit abundance. An assessment of the effects of fire frequency on fleshy fruit abundance is needed. In a replicated field experiment following 4 or more rotations of a 1 yr., 2 yr., and 3 yr. fire return interval, we measured fruit production each month of the growing season (May-September) in the critical threatened longleaf pine ecosystem, an ecosystem where frequent fire interval commonly is recommended. Compared to the 3 yr fire return interval cumulative understory fruit production was 99% less, following a 1 yr or 2 yr fire return interval. In fact, all of the fruit detected in 1 yr and 2 yr treatments were detected in patches of vegetation unharmed by the previous fire. Additionally, no fruits were detected on any transect in the understory and overstory strata. These results suggest that applying fire on <3 yr fire return intervals across large land areas could have negative effects on soil mass dependent wildlife species. Moreover, without a mosaic in fire-spread, even a 3yr fire return interval may eliminate understory and overstory fleshy fruit production over time. M. A. Lashley and others. Frequent fire effects on fruit production. [Forest Ecology and Management 405 9-12 2017] D

TREE GROWTH RATE TO IDENTIFY FAST GROWING NATIVES

The Atlantic Forest biome in Brazil possess many suitable tree species for conservation and restoration purposes. This biome was the most rapidly and extensively exploited forest type in Brazil and it displays areas ill-suited for eucalyptus cultivation. Since tropical tree species usually do not form growth rings and long-term data are still not available in Brazil this study addressed a new approach to diameter growth rate estimation. The approach was developed in order to alleviate the shortage of species growth information for the Atlantic Forest biome. The two reasons for developing the approach were (1) the possibility of increased ecological and economic diversification of plantation forests beyond eucalyptus, and (2) the potential to identify suitable tree species for restoration programs in the biome. Either reason requires growth models with sound biological properties. The data used in this study came from 20 native forest fragments and included six tropical tree species. Forest inventory to assess forest growth was first conducted in 2003, while the remeasurement was conducted in 2008. Anon-linear exponential model containing an asymptote parameter as a function of stand density was fit to estimate tree species diameter growth rate for each of the six tree species in the study. Additionally, based on the exponential model, a formulation of the time required for each tree species to reach a given diameter was developed. The fitted models exhibited high variability among the six tree species, but they performed well with aspect of the growth behavior. Since the model accounted for stand density, it was possible to predict how different stand densities would affect each species tree growth over time. Finally, the tree species *Triplaris gardneriana*, *Inga vera*, and *Xylopia brasiliensis* showed promising potential for both restoration and production

programs. H. F. Scolforo and others. A new model of tropical tree diameter growth and identification of fast-growing species. [Forest Ecology and Management 400 578-586 2017] D

CAMERA-TRAP EVIDENCE OF HABITAT PREFERENCES AND THREATS TO GROUND THRUSH

The spotted ground thrush (*Zoothera guiana*) is a globally endangered forest specialist whose distribution is poorly understood in the critically endangered Indian Ocean Coastal Belt forest biome on the east coast of southern Africa. More than 70% of the Belt forest has been lost to development, resulting in fragmented forest remnants within a mosaic of different land uses. We conducted camera-trap surveys with 5,796 trap-days in 82 forest patches of various sizes across a gradient of land-use types in the Belt during the winter seasons of 2014-2016 to establish occupancy (Ψ) of the bird. We used occupancy modelling and incorporated forest microhabitat characteristics and surrounding land-use classifications to compare sites and determine the spotted ground thrush's distribution across the habitat mosaic. The top model estimated an average Ψ =0.39 and detection probability =0.11. At the landscape scale, larger, less isolated patches had a higher Ψ for the bird, while the detection probability P decreased with proximity to cultivated land. At the microhabitat scale, a high percentage of bare ground influenced Ψ positively, but detection probability negatively, as did short grass cover. However, short herbaceous cover and high stem density of large (11-15 m) trees influenced detection probability positively. These results detail the influence of landscape-scale factors, including forest fragmentation and conversion to agriculture in conjunction with forest microhabitat scale characteristics, on patch selection and distribution of a cryptic, ground-dwelling species that is both threatened and under-studied. Given its endangered status and dependence on larger and more mature forest patches, the spotted ground thrush may be an effective flagship species for the conservation of Indian Ocean Coastal Belt Forest Patches. D. A. E. Smith and others. Habitat requirements and conservation threats to the spotted ground thrush. [Forest Ecology and Management 400 523-530 2017] D

USING TREE RINGS TO PROJECT TIMBER YIELD

Worldwide, over 400 million hectares of tropical forests are set aside for timber production. Several certification schemes exit to assure more sustainable exploitation and large areas of forests are currently certified. Under such schemes, logging companies are required to evaluate that species are not overexploited and, if necessary, adapt their logging activities. However, the data needed to project exploitation intensities – growth, mortality, and regeneration rates of trees -are scarce or non-existent. Tree-ring analysis provides lifetime species-specific growth data that can be used to allow or improve the projections of timber availability during following logging cycles. In this study we integrated growth data from tree rings with logging inventory data to forecast timber yields in the next harvest round for four timber species in Cameroon. We compared projections using tree-ring data with projections using fixed growth rates. As set by law and customarily applied in Cameroon. Additionally, we assessed the effect of increasing logging cycles and of using field-based species-specific logging intensities on the next cycle's yield projections. Under current logging practices, timber volumes available at next logging cycles are projected to be 21-36% of the volume obtained at first harvest. Simulations using fixed rates often resulted in lower yields with lower volume ingrowth from trees that were below minimum cutting diameters in the first harvest. Lengthening the logging cycle increased yield

projections during the next harvests, but yields were still not sustained over time. This problem can be resolved by using species-specific logging intensities, which led to projected yields of up to 73%of the initial harvested volume. Th growth data provided by tree-ring analysis allows conducting such species-specific projections and thus helps to provide the knowledge base necessary for sustainable forest management. Yet the low overall yields are a concern as loss of economic value may lead to conversion of forests to other land uses. P. Groenenajk and others. Using tree-rings to project timber yield. [Forest Ecology and Management 400 396-407 2017] D

EFFECTS OF POST-FIRE SALVAGE LOGGING ON RUNOFF AND EROSION

Research has been undertaken on the hydrological and erosional impact of forest fires, but remarkably little work has been conducted on the salvage logging operations that often follow them. We assessed the effects of mechanical salvage logging following wildfire on soil physical properties, ground cover, and runoff and erosion response on a eucalypt stand in Portugal. We compared two levels of mechanical disturbance: skid trails by a wheeled forwarder tractor ("skid-low") and skid trails by the same tractor followed by a tracked feller-buncher ("skid-high") as a control (no mechanical disturbance). Three plots (16 m^2) by level of soil disturbance were installed after a moderate intensity fire and subsequent logging operations, and monitored during the first post-fire year. In two control and two skid low plots runoff was also measured. Soil bulk density was higher with increasing mechanical disturbance. Soil compaction reduced porosity 7-16% but as the control porosity was 70% the reduced porosity was still 60-65%. Soil resistance to penetration significantly increased for the most disturbed area, whereas soil shear strength was significantly reduced in the intermediate disturbance level. Mechanical disturbance did not induce significant effects on soil moisture or ground cover. Initial greater coverage by bare soil in the disturbed plots compared to the control was compensated by a more rapid vegetation recovery in these plots.

Annual runoff amount was not higher in the skid-low than in control plots. Absence of runoff difference was due to high soil porosity of 65%, even after tractor trafficking and a greater surface roughness on the skid-low plots compared to the control. Sediment production increased with increasing soil disturbance. The mean sediment rate was 1.6-3 times greater for the disturbed than the control plots. This increase could be explained by the higher soil compaction and reduced soil shear strength on the mechanically disturbed plots and initial differences in ground cover. Organic matter content of the eroded sediments was higher for the control than the disturbed plots, due to initial higher ash cover on the control plots.

Overall, sediment production was significantly related to rainfall intensity. Sediment rates tend to decrease with time since the initial fire and logging disturbance, highlighting the importance of a rapid implementation of erosion. Organic matter content of the eroded sediments control measures. Specific management practices are needed to minimize the impacts of logging on burnt soils which area already subject to greater erosion risk and soil degradation. M. C. Malvar and others. Effects of post-fire salvage logging on runoff and soil erosion. [Forest Ecology and Management 400 555-567 2017] D

EFFECT OF FOREST PATCHES ON BIRD BREEDING ACTIVITY

Restoration planting is an increasingly common management technique to address habitat loss in agricultural landscapes. Native fauna, including birds, may occupy planted areas of vegetation. However, unless restoration plantings support breeding populations their effectiveness as a conservation strategy may be limited. We assessed breeding activity of birds in box-gum grassy

woodland restoration plantings in the Southwest Slopes Bioregion of New South Wales, Australia. We compared breeding activity in plantings of different size (1.3-7.7ha) and shaped (linear and block-shape) to breeding activity in a set of remnant woodland sites. Contrary to expectations we found that bird breeding activity was greatest per hectare in small patches. This trend was driven by the superb fairy wren -the most abundant species in the woodland assemblage. We also found a negative effect of planting age. With younger planting supporting more breeding activity per hectare. We found no effect on patch type or shape on breeding activity and that species relative abundance was not predictive of their degree of breeding activity. Our results highlight the value of small habitat patches in fragmented landscapes and indicate that restoration plantings are as valuable as remnant woodland patches for supporting bird breeding activity We demonstrate the importance of breeding studies for assessing the conservation value of restoration plantings and other habitat patches for avifauna. D. J. Belder and others. Influence of patch attributes on bird breeding. [Biological Conservation 236 134-152 2019] D

RIPARIAN FOREST RECOVERY IN COLOMBIA AFTER A DECADE WITHOUT GRAZING

To meet their large-scale forest and landscape restoration targets, countries must find ways to accommodate areas for conservation alongside agricultural production. In some pasture dominated regions of Latin America intensive silvopastoral systems (SFS) are being promoted to increase cattle productivity on certain lands while facilitating the removal of cattle from marginal areas for forest restoration. However, the recovery of these forests and their contribution to the overall conservation value of the landscape has not been assessed rigorously. We evaluated forest structure and composition in 20 sites in a region of the Colombian Andes where a decade ago farmers transitioned to SPS and fenced off riparian areas to enable forest recovery. We compared these restored forests to a reference model based on the remaining riparian forest across the region, all of which has been subjected to human management. We found that woody species richness was higher in restored than in reference forests, and the proportion of large-seeded, later successional, animal-dispersed species were similar in both forest types. Whereas we found a similar suite of dominant tree species in restored and reference forests, *Guadua augustifolia*, a native giant bamboo was more abundant in the reference forest due to human management. Total tree basal area was highest in restored forests due a small number of very large trees likely present in the pastures at the time of site protection. These findings highlight (1) the potential for recovery of diverse forests in riparian sites despite previous grazing use and (2) the role of remnant trees in facilitating natural succession. Overall, rapid forest recovery with minimal intervention in previously farmed lands is good news for conservation. A. Calle & K. D. Holl. Riparian forest recovery following a decade of cattle exclusion[Forest Ecology and Management 452 117563 2019] D

TROPICAL FORESTRY NOTES (35)

TOURISM IMPACT ON DUNES POLLINATION NETWORK

Coastal dune ecosystems are increasingly threatened by the mass tourism phenomenon. Intense concentration of human activities and mass tourism are leading to local dune loss and fragmentation. Besides the loss and fragmentation of coastal dunes. mass tourism has considerably affected remnant natural areas. To prevent degradation of remnant natural areas, it is mandatory to understand whether and under what conditions tourism can be allowed. In the present study I addressed the problem by evaluating the impact of tourism on the structure and resilience of pollination networks in coastal dune ecosystems freely accessible to tourists. Pollination networks represent ecological community structure and depict interactions among species providing the opportunity for a holistic assessment of ecosystem structure and functioning.

I conducted the study on coastal dune sites of the North Adriatic coast with different levels of tourist pressure. I recorded pollination interactions together with descriptors of human disturbance along sea-island transects. A moderate level of human disturbance was positively related to the richness of animal-pollinated plant and pollinator species. Besides species richness, the resilience of pollination networks was also highest at moderate disturbance. By assessing the impact of human disturbance on coastal dune ecosystems from the perspective of pollination interactions, evidence arises that moderate disturbance and long-term conservation of pollination networks of coastal dunes can co-exist. However, to achieve this goal tourism should be regulated and visitor access to coastal sites managed, so as to prevent intense human disturbance from compromising both the structure and function of coastal dune ecosystems. E. Fantinato. Protect coastal dunes from tourism. [Biological Conservation 236 70-78 2019] D

LEAF AREA UNDEX BASED ON LASER SCANNING

The leaf area index (LAI) of 16 sample plots was estimated based on terrestrial, three-dimensional laser scanning. The point-cloud data of stand canopy was first scaled and projected onto a hemisphere according to a Lambert azimuthal equal-area projection or stereographic projection and the resulting hemispherical point-cloud images were used to extract the canopy porosity coefficients. Then the single-angle inversion and Miller formula inversion methods were used, respectively, to calculate the effective leaf area indices with canopy porosity coefficients. Results showed that the effective LAIs estimated by the single-angle inversion method with Lambert projection and stereographic projection were within a range of 2.14-5.36 and 1.83–4.67, respectively. The effective LAIs obtained by the Miller formula inversion method with Lambert projection and stereographic projection were within the range of 1.94-4.67 and 1.55-4.34, respectively. As a comparison, the LAI measured with a fish-eye camera ranged from 1.55 to 3.87. The LAI values estimated with four different calculation methods were linearly correlated with those measured by a fish-eye camera. The highest coefficient of determination (R^2 = 90.28%) was obtained by the Miller formula inversion method combined with stereographic projection, and Duncan's new multiple range test also further showed that this method had a relatively higher precision compared to other three methods. Y. Meng and others. Leaf Area Index, by laser scanning. [Journal of Sustainable Forestry 38 (3) 244-261 2019] D

DEVELOPING FOREST USERS BY PARTICIPITORY MANAGEMENT

Participatory forest management is credited for supporting social learning processes and fostering capacity of forest users for collaboration and collective actions. Despite more than a decade of practice, the empirical evidence substantiating the contribution of participatory management for the capacity development of forest users is scarce. This study assesses a participatory forest management program in Madhupur Sal Forest in Bangladesh by comparing the capacity of de-facto groups of participants and non-participants and identifies factors that influence capacity development. Data were collected using a mixed method approach which combines both qualitative and quantitative methods of data collection. Results indicate that participants differed from non-participants significantly in terms of various capacity dimensions related to collective actions. Extend service, credit support trust within society information and communication influence the level of capacities in tribal population to adapt and respond to changes. The initiatives to manage natural resources are likely to be more successful if the forest management program initiators consider several factors that influence the development of resource users. K. H. Kabir and others. Developing capacity of forest users through participatory forest management. [Journal of Sustainable Forestry 38 (2) 149-170 2019] D

TREES AND PALMS IN AMAZON HOMEGARDENS

Many studies have shown the important role of agroforestry in food security but few studies in the Amazon include regional coverage and a large number of samples. This makes a more thorough assessment of the importance of these agroforestry systems in agrobiodiversity conservation difficult. The objective of the present study is to assess the factors that determine the floristic composition and tree and palm diversity of homegardens at different spatial studies in the Central Amazon. 334 homegardens were sampled in rural and urban areas of 14 municipalities on the state of Para. Owners were interviewed for the collection of socioeconomic data. A total of 16,049 individual tree and palm were recorded, distributed in 108 species. Most species were fruit bearing. The correlations between socioeconomic and environmental factors and the floristic gradient established in each ordination were significant only at the local scale. Species richness was related to family income, homegarden size, and topographic environment. The criteria for selecting the species comprised in these homegardens are aimed at food security of the families that own the homegardens. Thus, the floristic composition of homegardens in the Central Amazon is more strongly influenced by owners' decisions at a local level than by socioeconomic and environmental factors at broader scales. The importance of homegardens to food security and the autonomy of Amazon families indicate that public prices should be designed to simulates more diverse production systems as a strategy to strengthen family agriculture and agrobiodiversity conservation in the Central Amazon. B. P. Rayol and others. Tree and palm diversity in homegardens in the Central Amazon. [Agroforestry Systems 93 (2) 515-529 2019] D

CAN AGROFORESTRY SYSTEMS THRIVE IN ARID REGIONS?

Agroforestry systems are a strategy for rural communities to manage environmental change through contributions in agrobiodiversity, livelihood diversity, labor availability, and economic stability. The majority of research in agroforestry has focused on tropical humid and sub-humid environments and the characteristics of agroforestry systems in arid and semi-arid regions have not been extensively documented in Latin American countries. Here we document the

characteristics of replicable, widely practiced agroforestry systems in five climatic regions across the arid and sub-arid regions of Latin America (dry, sub humid, warm semi-arid, temperate arid, cold arid, and warm arid regions). The research was conducted on 4-6 farms per region using the design and diagnosis method, highlighting that the combination of multi-purpose trees with subsistence crops and livestock is highly context-specific. The analysis was corroborated by semi-saturated interviews and focus group discussions on farmer perceptions of the challenges and benefits of implementing agroforestry. In general, farmers perceive significant contributions to economic and ecological sustainability, including the improvement of soil fertility and resilience to climate change. L. Krishnamurthy and others. Can agroforestry thrive in arid conditions? [Agroforestry Systems 93 (2) 503-513 2019] D

FORESTRY PRACTICES FSC-CERTIFIED AND NON-CERTIFIED

The Forest Stewardship Council aims to promote environmentally responsible forest management globally. However, quantifiable evidence of effects of FSC on forest management is lacking. FSC has been present in the Russian forestry arena for over 20 years. In this case study we compare ecological indicators of forest management in FSC-certified and non-certified companies in Primorsky Krai, of the Russian Far East. Those indicators include percent of forest cover loss and gain on forest concessions managed by three certified and three non-certified companies. We also interview a range of stakeholders involved with forest management or in forest policy planning in Russia to provide context for this case study. Results indicate no difference between certified and non-certified companies with regard to forest cover loss from 2008 to 2015 or forest cover gain from 2000-2012. Stakeholder interviews reveal that while forest certification is viewed positively an considered an efficient mechanism to improve forest management, the stakeholders doubt its ability to stimulate quantifiable changes in forest management practices in Russia and the Far East specifically. We focus on Primorsky Krai because of its unique geographic location, where its neighbors China and Japan significantly influence Primorsky Krai's export market. A. S. Nikolaeva and others. Management differences due to FSC certification. [Journal of Sustainable Forestry 38 (5) 471-485 2019] D

BUTTERFLY DIVERSITY IN AGROFORESTRY IN INDIA

Agroforestry plays an important role in food security, sustainable development, and biodiversity conservation. For understanding the role of agroforestry in biodiversity, a study was undertaken to assess butterfly diversity in coffee, cashew, and guava plantations in Eastern Ghats of southern Odisha during February-April 2016. A total of 1,075 individuals of butterflies belonging to 60 species and 46 genera under 5 families were recorded during the study. Species richness as well as Shannon diversity were found to maximum in coffee, followed by cashew and then guava. Butterfly abundance was found to be maximum in coffee, followed by guava, then cashew plantations. This shows coffee plantation was the best habitat for butterflies among the three agroforestry habitats studied. The reason for this was habitat heterogeneity in coffee plantations supporting maximum exclusive butterfly species and it was least human-influenced plantation type with close canopy forest. Overall, the family Nymphalidae was found to be the most abundant and Lycaenidae was the least abundant. The findings of the present study are promising and may set new directions for management of agroforestry plantains in the region to support a rich biodiversity. A. Mahata and others. Butterfly diversity in agroforestry plantations. [Agroforestry Systems 93 (4) 1423-1438 2019] D

SHADE TREE COMPOSITION IN CACAO AGROFORESTRY

Agroforestry systems are important in synergy with socio-environmental aspects, especially with cacao crop, a commodity mainly produced by smallholders in the humid tropics. In southern Para farmers manage native shade trees growing with cacao. But species selection may not be appropriate to agroforestry maintenance over time. The objective of this study was to understand the shade tree transition between successional management phases of cacao agroforestry, considering its initial shade (IS) and secondary shade (SS). Shade trees were sampled in 10 plots in each situation (20,000 m^2 total) identifying individuals with CBH >15cm. As expected, floristic composition was different and SS had greater species richness and diversity than IS, where only 17% of species were shared between them. *Musa* spp. and *Carica sativa* were found only in IS and were dominant species representing almost half of the individuals. Although there was increase of late succession species from IS to SS, SS still kept high abundance of early succession species such as *Cecropia* spp. The result shows an unexploited potential products and gap of services provision, such as N-fixing. The conclusion highlights the necessity of long-term succession planning and management practices to guarantee cacao crop maintenance and improve diversification with other income sources such as fruits and wood. The role of biodiversity conservation provided by shade trees, should be the target of political strategies to encourage its maintenance, such as payment for ecosystem services or other economic incentives. D. P. P. Braga and others. Shade trees in cacao agroforestry. [Agroforestry Systems 93 (4) 1409-1421 2019]

TROPICAL FORESTRY NOTES (36)

TECHNICAL ANALYSIS OF WOOD PELLET PRODUCTION IN THE PHILIPPINES

A techno-financial analysis was performed to determine production cost of wood pellets manufactured in the Philippines using woody biomass as feedstock. Capital and operation costs of the pelleting operation were estimated using three framework conditions. Effects of plant capacity and choice of feedstock on production cost were determined. Results showed that wood pellets could be economically produced in the Philippines with a production cost of about 88-92 USD/tonne at production rate of 1 tonne per hour, using woody residues such as sawdust and shavings at a price of 30-40 USD/tonne. The specific cost of the pellets produced could significantly be reduced at a higher plant capacity. Cost of feedstock, equipment, and personnel were the major cost factors in pellet production. Pelley production cost was significantly influenced by production rate and cost of raw materials. A. A. Jara and others. Analysis of wood pellet production in the Philippines. [Journal of Tropical Forest Science 28 (4) 517-526 2016] D

SILVICULTURAL PRACTICES IN FOREST PRODUCTION SYSTEMS IN INDONESIA

Many factors influence adoption of smallholder agroforestry systems as part of the farm business. This paper reports farm and household factors affecting the adoption of timber and non-timber forest product management practices by farmers in Gunungkidul, Sumbawa, Timor Yengah Selatan dairies districts in Indonesia and how understanding those factors can facilitate the adoption of silvicultural practices for enhancing timber and NTFP production. The research uses logistic regression models to identify the significant factors influencing farmer's agroforestry adoption and management decisions. When considering a total of 16 factors equally, the models confirmed that farmers that have access to extension services, farmer's groups, and knowledge of government policy are more likely to adopt timber and NTFP production technologies. The probability of management practices increasing with the greater land area was due to space for growing more timber and NTFP species. Also, the possibility of adopting timber and NTFP management increased as farmers had more income from on- and off-farm activities. These findings suggest that when designing extension programs, farm and household factors should be considered by policy makers, researchers, and extension providers. G. E. Sebastian and others. Silvicultural practice adoption in Indonesia. [Agroforestry Systems 93 (2) 607-620 2019] D

EFFECTS OF PLANT DIVERSITY IN AGROFORESTRY IN COSTA RICA

Optimal use of resources in agroforestry requires the evaluation of multi-species and multi-strata cropping systems. The current study evaluated the effect of plant diversity on the performance of agroforestry systems in Talamanca, Costa Rica. Plants in nine 100-m2 plots in each of 20 fields were classified into five groups (banana, cacao, other fruits, timber, and firewood) and diversity was assessed by the Shannon-Weiner index. The production of each individual plant was estimated and converted into income according to local market prices. Our results indicated that as plant diversity increased, the income derived per plant increased for other fruits, firewood, and timber and also when all cultivated plants were considered as one group. In contrast, the income derived per plant. In contrast, the income derived per plant decreased for banana and cacao as diversity increased. This suggests that complementarity between plants was stronger than

competition for those plants occupying the higher strata of the canopy (i.e. other fruits, firewood, and timber), but that competition was stronger than complementarity for plants occupying the lower strata of the canopy (i.e. banana and cacao). These results increase our understanding of how the composition and the organization of these agroforestry systems may be optimized. R. Salazar-Diaz and others. Effect of plant diversity on income generated by agroforestry systems in Costa Rica. [Agroforestry Systems 93 (2) 571-580 2019] D

SEED SOURCE SELECTION FOR A DRY FOREST TREE

A major obstacle faced by reforestation/restoration programs is an insufficient supply of high-quality seed. Seed collection is commonly based on opportunistic strategies that only consider availability and distance to seed source, but not seed quality. Although for commercial timber species from temperate ecosystems the selection of individuals with above-average phenotypes often results in high quality seed and seedlings, the validity of this criterion has not been assessed in tropical dry forests. By using the abundant tree *Contieria platyloba* as study model and piecewise structural equation modelling (pSEM), we examined the associations between germination success and seedling growth, and various tree, fruit, and seed characteristics, for seeds from two provenances (natural vs. managed populations) that were either scarified or not. Unexpectedly phenotypic attributes of trees, fruits, and seeds had no effect on germination success, as this response variable depended on scarification only. Also, fruit quality was unrelated to tree size, but it was related to provenance. According to pSEM the best supported path resulting in high quality seedlings established a relationship between managed populations, high quality fruits and seedlings with better root systems, but only for seeds that were scarified and did not germinate very rapidly. Overall, the assessed relationships were complex, weak, and sometimes difficult to interpret. Nonetheless, these results provide guidance to improve seed source selection efforts that consider operation costs of nurseries and the success of future plantations. In tropical dry forest, selecting trees with above-average phenotypes does not necessarily favor the quality of seedlings used to restore degraded areas. In these ecosystems we recommend a seed collection strategy that combines managed and natural populations as seed sources to maximize genetic variability in future plantations while improving nursery operation efficiency. A. L. Luna-Nieves and others. Guiding seed source selection for dry forests. [Forest Ecology and Management 446 105-114 2019] D

MANGROVE TREE STEM GROWTH AND STAND WOOD PRODUCTION

Mangrove forests provide important ecological and economic services including carbon sequestration and storage. The conservation and restoration of mangroves are expected to play an important role in mitigating climate change, and understanding the factors influencing mangrove stem growth and wood production are important in producing and improving predicting and improving mangrove responses to environmental change. In this study, we collected data on individual diameter (DBH) growth rates and stand level above-ground wood production in both non-plantation (natural) mangroves and mangrove plantations around the world. Climatic factors, proxies of edaphic factors as well as biological factors (e.g. mangrove species) were included as explanatory variables in the analysis to determine factors influencing global patterns of tree growth rate and stand wood production. We also found different global patterns of tree growth rate and stand wood production between non-plantation mangroves and plantations. Climatic conditions were the most important factors influencing the global pattern of tree DBH growth rate in non-plantation mangroves, with edaphic and biological characteristics also playing a role

under specific climatic conditions. Our study provides parameters for a global estimation of long-term carbon sequestration in both non-plantation mangroves and mangrove plantations. In addition, our results help us better predict the dynamics of tree growth and carbon sequestration of non-plantation mangroves under changing climate. Y. Xiong and others. Global patterns of mangrove stem and stand growth. [Forest Ecology and Management 444:382-392 2019] D

HIGH ECONOMIC AND LIVELIHOOD VALUE SPECIES FOR ZAMBIA

The sustainable management of dry forests and woodlands of Sub-Saharan Africa (SSA) is crucial for the SSA economy and people's livelihoods, but it remains a key challenge to address. Maps of tree species distributions of economic value are lacking for the region, yet this information is essential for supporting sustainable use. We capitalized on new nation-wide field survey data for the Republic of Zambia (Southern Africa) to generate the first suite of baseline species distribution models (SDMS) for 20 tree species of economic significance to support for sustainable management and conservation. We employed one regression and two machine learning techniques to model and predict tree distribution. For each species we compared the three model results for the relative importance of different predictive variables, revealing the most important predictors of each species niche and providing insight into how human activities influence current tree species distribution. Overall, environmental predictors that best explained the tree species distribution were related to water availability, including mean potential evapotranspiration (PET), annual rainfall, and the variation in PET, as well as elevation and soil fertility. Human impact on distribution was notable for tree species used for charcoal and timber, including the proximity to roads for charcoal-favored species and the proximity to settlement for timber species. For all species fire did not stand out as a variable of importance, contrary to expectations. The SDMs generated from this study will provide essential baseline information to support national conservation and management efforts, especially for preferred timber and charcoal species, for which selective harvesting has had an impact on their distribution. Our results highlight the importance of rainfall for the distribution of tree species in this seasonally dry region and call for future research to forecast the impacts of climate change on habitat suitability. J. Pelletier and others. Tree species with high economic and livelihood values for Zambia. [Forest Ecology and Management 441 280-292 2019] D

TROPICAL FORESTRY NOTES (37)

HIGH ROOT PRODUCTION RATES IN MANGROVE, MALAYSIA

Mangroves often allocate a relatively large proportion of their total biomass production to their roots, and the below-ground biomass of these forests contributes to globally significant carbon stocks. However, little information is available on root production in mangroves due to difficulties in carrying out measurements of below-ground processes, particularly if there is regular flooding. In this study we examined fine coarse root production in the east coast of the Malaysian Peninsula. Ingrowth cores were used over the course of 17 months. In September 2014, twenty cores were randomly placed in each of five plots. Fifteen cores in total were collected every three months. Each core was divided into five 10-cm layers and root dry mass was recorded. Standing root biomass was also measured at the time of final collection, using an additional 15 cores. There was a seasonal pattern in root production which peaked in March and December 2015, after and during the monsoon season. Root biomass in the cores peaked at 33.23+6.3 t/ha and 21.45+7.31 t/ha in March and December, respectively. Standing root biomass in February 2016 in the forest was 20.81 +2.81 t/ha. After 17 months the final root biomass in the cores was 14% less than the standing root biomass. These data suggest surprisingly rapid growth rates and turnover for mangrove roots. Total root biomass significantly increased with root depth and 78% of the roots, in all soil layers consisted of the roots (<3mm diameter). Soil carbon, nitrogen, and phosphorus concentrations were investigated in relation to below-ground production, as were soil temperature, salinity, and dissolved oxygen. A data review of global studies reporting similar work was carried out. The results are discussed with consideration to the significance of monsoon rainfall for mangrove ecology. S. M. Muhammad-Nor and others. High mangrove root production in a Malaysian delta. [Forest Ecology and Management 444 214-224 2019] D

FOREST DIVERSITY AND CANOPY REDUCE SOIL EROSION

Biodiversity plays a crucial role in forest ecosystem sustainability. However, it is unclear how tree diversity and especially the relationship between diversity and ecosystem functioning affect soil erosion. Based on a forest biodiversity and ecosystem experiment established in sub-tropical China, we measured soil erosion at four tree species richness levels (monocultures, 8 tree species, 16 tree species, and 24 species stands) during the rainy seasons from 2013 to 2015. The result showed that mean annual soil erosion rates decrease with tree species richness significantly over the observed three years. Leaf area index and biological soil crusts were the two main factors affecting soil erosion within tree stands of different species richness. Positive effects of tree species richness on tree canopy structure and biological crusts might drive the reduction of soil erosion in the earlier successional stage after afforestation of tree plantations. Therefore, we highlight the important influence of tree species richness on soil erosion control, Hydrologic processes, and thus sustainable ecology services. Z. Song and others. Forest soil erosion reduced by diversity and canopy. [Forest Ecology and Management 444 69-77 2019] D.

SOIL NUTRIENTS MAINTAINED IN BRAZILIAN EUCALYPTUS

Intensive management in tropical plantation forestry has increased global wood production per unit of time and land. *Eucalyptus* trees in southeastern Brazil grow exceptionally fast, even on the highly-weathered and nutrient-poor soils of the Atlantic Forest and Cerrado biomes. By

remeasuring plantation soils after 12 years and 1-2 rotations we investigated how established plantations alter soil stocks of carbon, nitrogen, calcium, potassium, and phosphorus, and whether any changes might limit future plantation productivity. We hypothesized that each harvest cycle would deplete soil stocks of nitrogen because less nitrogen is often added in fertilizer than is removed in wood, and that the balance between harvest and fertilizer would also dictate changes in stocks of other nutrients. In 2004 and 2016 we sampled soils to a depth of 100 cm in plantations and adjacent pastures and native vegetation reserves, and compared total nutrient stocks across time and vegetation type. We found that nutrients were not significantly depleted, and that soil stocks of carbon and nutrients in the plantations all tended to increase, with significant increases of the top 20 cm or 20% for potassium in the Atlantic Forest biome, and 23% for carbon and more than 500% for calcium in the Cerrado. Changes in soil nutrient stocks can be attributed in part to both fertilizer inputs and redistribution from changing stocks of biomass. We also observed changes over time and substantial spatial heterogeneity in nutrient stocks under non-plantation vegetation, highlighting the difficulties of using other vegetation types as static "controls" to assess the effects of plantations on soils. Overall, soil nutrient depletion does not appear to threaten sustainability in these intensive plantation forests over the time period studied. D. E. McMahon and others. Soil nutrient stocks maintained over rotations in plantations. [Forest Ecology and Management 448 364-375 2019] D

TREE IMPROVEMENT AND GENETIC DIVERSITY OF SUGI PLANTATIONS

The main purpose of this study was to investigate how a shift in seed sources owing to the implementation of a tree improvement program affected the genetic diversity of plantation forests. We investigated the genetic diversity and pairwise relatedness between individuals in sugi (*Cryptomeria japonica*) plantations established before (pre-B) and after (post-B) the start of the Japanese tree improvement program. Based on SSR and SNP markers, most genetic diversity indices and the degree of relatedness within plantations were comparable between pre-B and post-B. However, there were large variations in the proportion of closely related pairs within plantations in both groups. Additionally, in post-B plantations, parental contributions greatly diverged among plus-tree clones. The results of this study indicated that the shift in the seed sources, caused by implementation of a tree improvement program, did not have a significant effect on the genetic diversity of plantations. However, the results also indicated that the degree of relatedness within plantations varied significantly according to how seeds are collected regardless of the type of seed sources. Furthermore, it was also revealed that genetic diversity in post-B plantations could have decreased because of a deviation from equal paternal contributions in seed or orchards. Our results indicated that effective management of seed orchards is important to secure the genetic diversity of plantation forests. H. Iwasaki and others. Impact of tree improvement on the genetic diversity of sugi plantations. [Forest Ecology and Management 448 466-473 2019] D

IMPROVED *EUCALYPTUS* DUE TO GENETIC ORIGENS AND DIVERSITY

To better understand the genetic variability among and within *Eucalyptus grandis* populations introduced in Brazil, we use microsatellite loci to investigate the mating system, genetic structure, and Australian origins of several introduced provenances. Our sample includes 981 trees from ten Brazilian populations and 254 trees from 18 Australian populations. Significant higher observed heterozygosity and significant lower fixation index (F) was detected in grouped Brazilian provenances (Ho = 0.753, F = 0.140) than in Australian samples (Ho = 0.68, F = 0.22).

However, Brazilian samples presented significantly lower genetic differentiation (GST) among populations (0.541) than Australian populations (0.838), indicating that the overall genetic diversity captured in the Brazilian collection is low due to the limited number of populations represented. All sampled Brazilian populations showed 100% correct expectation of attribution to their reference population, showing consistency with historical information. A lower fixation index was detected in Brazilian seed trees (-0.101) than their offspring (0.14), suggesting selection against inbred individuals between seedling and adult stages. The outcrossing rate was high (0.994) with low variability among populations (0.921-0.969). However, some mating occurred between related trees (tm-ts = 0.149) and were correlated (rp (m) = 0.113) indicating that some offspring are inbred, and families are composed of different levels of relatedness. The coancestry ($\Theta = 0.141$) was higher and the effective size within families (Ne = 3.09) lower than expected for half sub families ($\Theta = 0.125$; Ne = 4). Brazilian *E. grandis* populations offer the possibility to develop new breeding populations with high genetic variability due to their differing origins combined with individual selection. A. C. Miranda and others. Origin and genetic diversity in Brazil's improved *Eucalyptus grandis* plantations. [Forest Ecology and Management 448 130-138 2019] D

BRAZIL NUT FRUIT YIELD REFLECTS SPACE AVAILABLE

Brazil nut (*Berthollenia excelsa*) is one of the most important non-timber forest products (NTFP) species in the world. Better management and conservation practices will only be possible with an in-depth knowledge of tree species ecology. This study aimed to address the spatial association of fruit yield of *B. excelsa* trees in two forest types (old growth terra firme forest and Amazon cerrado transitional forest) in the Brazilian Amazon. Fruit yield was measured in both forest types during 2010. For each forest type, fruit yield was divided into different yield classes (number of fruits) for subsequent special modelling. The bivariate Ripley's K function was applied to quantify spatial association of fruit yield of *B. excelsa* trees over different fruit yield classes. The results revealed that the forest type influences the spatial association of *B. excelsa* fruit yield. The old growth terra firme forest presented random spatial association for fruit yield across different yield classes, which implies that fruit yield of *B. excelsa* trees in this forest type is not limited by tree location and site resources. On the other hand, the Amazon-cerrado transitional forest presented significant negative spatial association for fruit yield across different yield classes, which means that under some conditions fruit yield of a given tree influences the fruit yield of the neighboring tree in this forest type. Site resources in the Amazon-cerrado traditional forest are limited and naturally favor inter- and intra-specific competition. Finally, the results imply the need for adoption for different management and conservation strategies for *B. excelsa* in different forest types in the Brazilian Amazon. A. P. B. Batista and others. Spatial association of Brazil nut fruit yield in the eastern Amazon. [Forest Ecology and Management 441 99-105 2019] D

STAND-LEVEL *EUCALYPTUS* PLANTATION GROWTH DUE TO AVAILABLE WATER

Growth and yield (G&Y) model systems aim at forecasting forest productivity. The lack of environmental variables to account for how water availability constrains eucalyptus production in Brazil, however, is argued to be a major drawback of these model systems. Thus, this study aimed to develop a stand-level G&Y model system that accounts for water availability (G&Y with SWD), highlighting the usefulness when applied for clonal *Eucalyptus* stands under drier

climatic conditions. The dataset is composed of remeasurement information of sixteen research sites that span all climatic regions in Brazil. A total of eleven eucalypt clones were planted in single block plots at each site and extra replications under the rainfall exclusion system were also installed in these eleven clones in fourteen sites. Linear algebra techniques were used to simultaneously fit a compatible set of prediction and projection basal area equations. A stand-level volume equation was also developed. These equations were validated through the use of an independent dataset composed of the rainfall exclusion plots. Finally, the accuracy and usefulness of a conventional G&Y model system applied to clonal eucalypt stands in Brazil was compared to the new proposed G & Y model system, which accounts for the impact of water availability in eucalyptus productivity. The prediction and projection basal areas equations accounting for water displayed estimates in the order of 5% more accurate, compared to the conventional basal area modeling. Stand-level volume estimates were 40% and 74% less biased through the use of the new G&Y model system. This result highlighted how useful and powerful the newly developed approach is, since the model system was capable to provide accurate estimates through the use of the rainfall exclusion plots. The new G & Y model system is a powerful alternative to estimate forest afforestation yield and is fully capable to accurately update forest inventories. The model system can also be used for projecting how forest growth may be impacted by short-term climate variation. H. F. Scoloro and others. Stand-level growth and yield model for eucalyptus plantations. [Forest Ecology and Management 448 22-33 2019] D

MIXED SPECIES PLANTATION INCLUDING A NITROGEN-FIXING SPECIES VS. MONOCULTURES

The inclusion of N_2-fixing tree species in tree plantations has the potential to increase biomass production compared to monocultures. Both successes and failures have been described in the literature. However, it is still difficult to distinguish a general pattern and to disentangle the factors influencing the mixture effect. The first objective of this study was to provide an overview of the published data on the effect of the introduction of N-fixing trees in plantations through a meta-analysis approach and to calculate a mean effect of mixed-tree-plantations on biomass production compared to monocultures of the non-nitrogen-fixing species in stands 2-20 years of age. The second objective was to evaluate the effects of (1) climatic zone (temperate vs. tropical), (2) the species used (eucalyptus vs. other non-nitrogen fixing species and leguminous tree species vs. other N-fixing species), (3) the proportion of N-fixing species, compared to the non N-fixing species, and (4) plant developmental stage. A total of 148 case studies from 34 experimental plantations under tropical (68 case studies) and temperate (80 case studies) conditions were identified from the literature. The global mixture effect is significantly positive, mixed-tree plantations being 18% more productive than the non-N-fixing monocultures. The effect was significantly different from zero under temperate conditions (24% more productive) but not under tropical conditions (12% more productive). The sites where the positive mixture effect was significantly different from zero were mostly located in a temperate climate, where soil nitrogen is generally considered less available than in tropical latitudes. Intermediate and high proportions of N_2-fixing species gave similar positive results (27% more productive) while low proportions had no significant impact. Neither plantation age nor type of N-fixer (legume trees vs. other N-fixing species) had any significant effect. In conclusion, it appears that climate is the main factor influencing the success of the mixture. However, it also seems that the degree of mixture success is more marked on sites with low biomass production where the monoculture

is the least productive. N. Marron and others. Comparative production: monoculture vs. mixed species with an N-fixer [Forest Ecology and Management 441 242-252 2019] D

TROPICAL FOREST NOTES (38)

ENVIRONMENTAL EFFECTS ON JUVENILE *PINUS RADIATA* WOOD DENSITY GROWN IN CHILE

At 31 sites that encompassed the range of conditions over which *Pinus radiata* is grown in Chile measurements of basic density (D), stand dimensions, and soil properties were taken and combined with climatic data. Using this dataset, the objectives of this research were (1) to quantify between and within site level variation in D and partition the relative importance of these sources of variation, (2) identify the key determinants of D across and within sites, (3) develop a robust site level model to predict D across the environmental range over which *P. radiata* is grown in Chile, and (4) further develop the site level model to incorporate stand variability in D through inclusion of tree characteristics.

Variance components analysis showed that between site variations in D was slightly larger than within-site variation, with those two components accounting for 54.8% and 45.2% of the total variability, respectively. Across sites, mean D for juvenile wood was 377 Kg/m^3 and ranged 37% from 338 to 462kg/m^3. The mean within site variation was 87.8kg/m^3, ranging from 37.4 to 143kg/m3.

The site level model showed that variables associated with soil fertility explained far more of the variance in D than climatic variables. Basic density was most strongly related to boron and carbon:nitrogen ratio (C/N ratio) and positive linear relationships with these variables accounted, respectively, for 32 and 20% of the variance in D. The final site level model of D had an R^2 of 0.65 and included B, C:N ratio, mean height, and mean minimum temperature during May. Through using linear mixed effects modelling, we developed a tree level model that incorporated all site level variables and included a random intercept between tree height and D. The final tree level model, which exhibited little apparent bias, had a R^2 of 0.61. M. S. Watt & G. Tincado. Modelling influence of environment on density of *P. radiata* wood. [Forest Ecology and Management 448 112-118 2019] D

CEDRELA WITH *GLIRICIDA* INFLUENCE ON *HYPSIPYLA*

Gliricidia sepium has the capacity to recruit and release nutrients, increasing primary productivity of forest sites. There are no reports documenting intercropping of *G. sepium* and *Cedrela odorata* and few studies examining nutrient supply as strategies to decrease incidence of Hypsipyla grandala in *C. odorata* plantations. In this study intercropping of *G. sepium* and *C. odorata* and fertilization with N and P were tested in order to examine the effects of such factors on growth, nutrient status, and incidence of *H. grandella* on *C. odorata* trees. Twelve treatments fourfold replicated and derived from a 3 x 2 x 2 set of factors were randomly established within the experimental site. During 12 months, growth and pest-incidence variables were measured quarterly and monthly, respectively. K and Mg were the most deficient nutrients in the experimental site. Interplanting three *G. sepium* trees pro plot increased K and Mg availability, thus improving *C. odorata* nutrient status and minimizing incidence of the pest during the first year. N supply and did not improve *C. odorata* growth, nor did it affect the incidence of *H. grandella*. P promoted tree height. F. M. Montero-Solis and others. *Gliricidia sepium* and fertilization effects in a *Cedrela odorata* plantation [Agroforestry Systems 93 (3) 813-823 2019] D

RESPONSES IN LOGGING GAPS WITH TENDING AND PLANTING

Technical and scientific information on medium-term effects of post-logging silvicultural interventions on the recovery of harvestable growing stocks are hardly available. To mitigate uncertainties about these effects our study aimed to answer the following question: What is the medium-term effect of post-harvest silvicultural treatments on mortality, growth, and the structure of commercial tree species in canopy logging gaps under tending and enrichment planting? We studied individuals planted and naturally regenerated in 72 logging gaps opened by tree felling during reduced-impact logging under different silvicultural treatments: (1) natural regeneration tending (TNER); (2) enrichment planting in logging gaps (EP1); and (3) enrichment planting in logging gaps previously cleaned of harvesting residuals (EP2). Mortality increased through time; EP1 presented the highest mortality rates of all treatments in the first, sixth, and 11^{th} year. TNER had the lowest mortality during the same period. TNER and EP2 presented the highest basal area and EP2 the highest periodic annual increment. Effects of the silvicultural treatment TNER were positive since it presented the highest survival and a high mean basal area of the initial trees. The medium-term effects of silvicultural treatments applied over individuals of commercial trees in logging gaps indicate higher survival and growth that was reflected in the structure of treated individuals, when compared to the outcomes of the standard procedures of reduced impact logging. These results point to the possibility of reaching more sustainable future cutting cycles in the Brazilian Amazon and other tropical forests worldwide. R. L. Prado Neves and others. Post-harvest silviculture in logging gaps with tending and enrichment planting. [Forest Ecology and Management 451 117521 2019] D

INTER-TREE COMPETITION PROCESSES IN EARLY *EUCALYPTUS* GROWTH

Individual tree diameters, heights, and crown dimensions were measured over four growth periods, from 2.5 to 6.6 years of age in a plantation experiment with blackbutt (*Eucalyptus pilularis*) on a highly productive site in subtropical eastern Australia. The experiment compared several stocking densities at planting (816- 1,667 stems/ ha) and rectangularities of tree spacing (1-6). The effects of inter-tree competitive processes on individual diameter growth rates were examined using both a partial differential diffusion equation to describe the change with time of the frequency distribution of diameters, and by examining which tree size classes were dominating growth. Over all four growth periods, it appeared that inter-tree competition for the light and soil resources necessary for growth was largely symmetric. That is, whilst larger trees would have been occupying more of the above- and below-ground space from which to obtain those resources of smaller trees, all trees would have been able to obtain quantities in such amounts proportional to their sizes and grow at rates accordingly. However, even in these young ages a tendency for larger trees to display disproportionally large growth rates relative to their sizes gave early evidence of asymmetric inter-tree competition developing. That involves taller trees denying light to shorter trees trough shading, the reverse of which may not occur. These inter-tree competitive interactions became more pronounced both as tree sizes increased with age and when trees were planted more closely to each other. Asymmetric competition is expected to be a major determinant of individual tree size development for a large part of the subsequent growth of the forest. The results were consistent with the forest showing a transition from the first to the second phase of the Brinkley et al. model of individual tree growth and development in forest stands. P. W. West and R. G. B. Smith. Inter-tree competition and early growth of eucalyptus. [Forest Ecology and Management 441 1117450.] D

THE CONTRIBUTION OF CONSERVATION EASEMENTS TO CONSERVATION

Private lands are critical for conservation of ecosystem diversity and sustaining ecological processes. Increasingly, conservation easements (CE) are used as a tool to protect private land from future development, yet few studies have examined whether contemporary patterns of CE effectively contribute to landscape-scale biodiversity and ecosystem conservation goals. We analyzed the distribution of 1223 CE established between 1976 and 2016 in the High Divide, a region dominated by public lands and of national importance in the Rocky Mountains of the United States, with respect to ecosystem representation and landscape connectivity, two common large-scale conservation goals. We found that CE were frequently located closer to water and land protected for biodiversity (e. g. GAP 1 and 2 status) than were private land more generally. CE provided increased representation within the protected area network for 10% of the ecosystems within the region, particularly for mesic and riparian areas. Despite the addition of CE to the protected areas network, for 10% of the ecosystems within the region, [particularly for mesic and riparian areas. we found insufficient representation for 43 out of 87 ecosystems (< 5% representation on land managed for biodiversity). Protection of priority ecosystems varied across CE and illustrated potential mismatches between regional and national scale conservation goals. Furthermore, while public lands contributed the most toward conserving important areas for connectivity, CE protected potential landscape connectivity only slightly more effectively than randomly allocated areas, CE provide important complements to public lands in terms of ecosystem diversity and landscape connectivity. However, conservation planners and land managers could increase conservation benefits from CE by prioritizing under represented ecosystems and more explicitly targeting lands to maintain landscape permeability. R. A. Graves and others. The conservation contribution of conservation easements. [Biological Conservation 232 83-96 2019] D

COST-EFFECTIVE CONSERVATION IN THE AMAZON

The western Amazon needs to expand its protected area system to ensure the conservation of its immense and threatened biodiversity. However, potential expansions often meet with resistance because of scarce government resources and competing social priorities. Here, we proposed an expansion of the protected-area system for the western Amazon that increases biodiversity conservation at minimum cost. We started by evaluating biological data to establish conservation targets for enhancing protection of 2,419 species of plants and vertebrates. We then built a map that shows the variation in the costs of effectively managing lands as protected areas. We also adapted an opportunity cost layer for agriculture and livestock to approximate realistic foregone incomes when a particular extent of land is protected. These cost estimates were used as a decision-support tool to find the most inexpensive places to achieve the conservation targets. We found that this cost-optimized expansion could reduce annual costs by 22% in comparison to an expansion planned without cost data. Moreover, without collaboration with indigenous peoples and without compensation among the Western Amazon countries costs would be 39% and 49% higher, respectively. The cost of the proposed expansion, estimated at US$ 100 million annually is only a fraction of the gross domestic product (0.018%). Thus, the study may help governments and conservation agencies to improve financial planning of the region’s reserve network by maximizing species protection at more affordable costs. J. Lessmann and others. Cost-effective protection of biodiversity in the western Amazon. [Biological Conservation 235 250-259 2019] D

GAPS IN BUTTERFLY DATA: A GLOBAL ANALYSIS

Species distribution data are crucial in assessing the conservation status of species (red listing IUCN) and supplementing international conservation targets, such as those set by the International Convention on Biological Diversity. Although there have been a number of efforts aimed at aggregating biodiversity data, information on the distribution of many taxa is still scanty (i.e. the Wallacean Shortfall). In this study we use a large database, including over 19 million species occurrence records, to identify knowledge gaps in biodiversity inventories for butterfly records at a global level. Bayesian hierarchical spatial models were used to quantify the relationship between gaps in inventory completeness and the density of roads, protected areas, and evolutional range the former variable being a proxy for accessibility, the latter two for attractiveness for recorders. Our results show that despite >100 years of butterfly sampling, knowledge of the distribution of butterflies is still limited in tropical areas. The results revealed that gaps in butterfly inventories are largely concentrated in gaps of low elevational range, low density of protected areas, and low road density. We conclude that the Wallacean shortfall is a problem even for one of the best suited insect groups. In the light of these data elections we discuss prospects for filling gaps in butterfly inventories at the global scale within relatively short time frames. We argue that a combination of citizen science and quantitative tools may help conservation decisions. M. Girardello and others. Gaps in butterfly data. [Biological Conservation 236 289-295 2019] D

BUSH MEAT AND FOOD SECURITY IN THE AMAZON

Wild vertebrates play a decisive role in the subsistence economy of human populations worldwide. The food security value of wild meat extracted from natural ecosystems remains poorly quantified. Here we provide an economic valuation of the nutritional and monetary benefits of year-round wild-meat hunting across a large traditional region of Southwestern Amazonia using data from indigenous and non-indigenous settlements from 30 sites. We then build scenarios to explore whether three ubiquitous sources of regional-scale, household income (wage labor, horticultural revenues from manioc flour production, and the harvest of Brazil-nuts) could match the purchase costs of alternate meat demand to meet domestic consumption of animal protein, should game stocks collapse for any reason. We also considered a fourth valuation scenario in terms of game meat substitution with bovine beef. We conservatively estimate a total annual consumption of ~1,432 tons of undressed animal carcasses, equivalent to mean per-capita meat consumption of 54.75 Kg per person per year, or 10.9 Kg of annual protein per person per year. This overall consumption of terrestrial wildlife meat provides US$7.875 million/year across the study region. However, household income levels were too low to enable transitions into domestic livestock consumption indicating low adaptation capacity to alternative animal protein. Replacement purchases of domestic meat would amount to 90% of aggregate annual wages, 194% of overall income from manioc flour ,and 67% of all Brazil nuts collected. Complete beef replacement by the population in this region would require further inputs of US$2.658 million/ year and the conversion of 4,310 ha of Amazonian forests into pasture. Our results emphasize the extraordinarily valuable and irreplaceable value of wild meat in the food security of tropical forest dwellers. Proposing consumption of alternative sources of animal protein for deprived forest dwellers is clearly unrealistic, if not environmentally damaging strategy. Conservation scientists, wildlife biologists, and policy makers should therefore prioritize adding value to standing forests by managing sustainable wild-meat off take from

natural ecosystems. A. V. Nunes and others. The value of wild meat for the population of the Amazon. [Biological Conservation 236 171-179 201]

TROPICAL FORESTRY NOTES (39)

BIODIVERSITY RESEARCH QUESTIONS FOR SE ASIA

S Asia holds high regional biodiversity and endemism levels but is also one of the world's most threatened regions. Local regional and global threats could have severe consequences for the future survival of many species and the provision of ecosystem services. In the face of myriad pressing environmental problems, we carried out a research prioritization exercise involving 64 experts whose research relates to conservation biology and sustainability in SE Asia. We received a total of 333 questions through three rounds of elicitation, ranked them by votes following a workshop, and grouped them into themes. The top 100 questions depict SE Asia as a region where strong pressures on biodiversity interact in complex and poorly understood ways. They point to a lack of information about multiple facets of the environment, while exposing the many threats to biodiversity and human wellbeing. The themes that emerged indicate the need to evaluate specific drivers of biodiversity loss (wildlife harvesting, agricultural expansion, climate change, infrastructure development, pollution and even to identify which species and habitats are at most at risk. They also suggest the need to study the effectiveness of practice-based solutions (protected areas, ecological restoration), the human dimension (social interventions, organizational systems and processes, and the impacts of biodiversity loss and conservation interventions on people). Finally, they highlight gaps in fundamental knowledge of ecosystem function. These 100 questions should help prioritize and coordinate research, conservation, education, outreach, and the distribution of scarce conservation resources in SE Asia. J. L. Coleman and others. Top research questions for biodiversity conservation. [Biological Conservation 234 211-220 2019] D

THE SCIENCE - PRACTICE GAP INFORMATION SOURCES

We sampled the bee fauna at 27 randomly selected sites along a 140-km (89-mile) segment of a transmission line that extends from Connecticut to New Hampshire. Each site contained two plots, one within the powerline corridor and another in a closely adjacent forest. Data were collected over a 12-week study period (late May to early August) with corridor plots including more than twice as many bee species and more than ten times the number of individuals than the forest plots. The aggregate richness for the 54 plots (205 species) represents nearly half of the bee fauna of New England, with species estimation curves, suggesting that many additional species were resident but went unsampled. Two globally rare species, *Epeiloides pilosulus* and *Macroptis ciliate,* were documented from the powerline plots. The time-extended (five-year) vegetation management cycles currently used by many utility companies in New England result in a dynamic array of vegetation composition and structure that supports a multitude of bees as well as other insects, reptiles, and, amphibians, shrubland birds, small mammals and other early successional taxa. L. W. Kenneth and others. Transmission corridors for native bees and other wildlife. [Biological Conservation 235 147-156 2019] D

BIRD VULNERABILITY TO CHANGE IN BRAZILIAN CERRADO

Estimating species vulnerability to global changes and understanding what drives their vulnerability has become an important task in the last decades. Here we evaluated the cerrado bird species to climate and land use changes projected to take place up to 2050, compared our vulnerability estimates to the national red list of threatened species, and evaluated the level of

protection of vulnerable species. For 103 species we gathered information on biological traits and assigned them to three components of vulnerability (sensitivity, adaptive capacity, and exposure). For each trait we assigned high or low scores according to their relationship with climate and land use changes. We considered as exposed, sensitive, and with low adaptive capacity those species that reached a high score in any of the traits. Species that reached a high score for all three components were classified as highly vulnerable. We found that 67%, 71%, and 39% of species were sensitive, had low adaptive capacity, or were exposed, respectively; 25% of them were highly vulnerable. Among these species, 10 are currently threatened in Brazil. Overall, the network of protected areas harbors a small extent of highly vulnerable species ranges, with 19 species (71%) having 10% of range coverage within protected areas. Understanding which species are the most vulnerable and where they are found is crucial to establish conservation priorities aiming to mitigate the negative impacts of environmental change on species. F. J. A. Borges and others. Bird vulnerability to changes in the cerrado. [Biological Conservation 236 347-355 2019] D

DO PROTECTED AREAS PROMOTE PRO-ENVIRONMENTAL BEHAVIOR?

Halting the ongoing biodiversity crisis requires large individual behavioral changes through the implementing of more pro-environmental behavior (PEB) by every citizen. People's experiences of nature, such as outdoor activities, have been identified as great enhancers of such behaviors. Yet, these experiences of nature got scarcer in the last decades, due to an increased spatial segregation between human and nature, particularly in societies that follow a Western way of life. In this context we wondered if protected areas (PAs) because they offer more opportunities for people to be in contact with natural landscapes and other more ecological information and governance than other places, could enlarge the implementation of PEBs for people living or close from them. We addressed this question by modelling the link between three types of PEBs in Metropolitan France (i.e. voting for green party candidates, joining or donating to biodiversity conservation NGOs, and participating in a biodiversity monitoring citizen science program) and the proximity to large PAs. Innovatively, we addressed this question at national level, with exhaustive data collected in more than 16,000 French municipalities with more than 500 inhabitants. All models controlled for difference in population size, average income and proportion of rented people between municipalities. We found that each of the studied PEBs decreased with distance of the municipality to PAS even after controlling for the naturalness of municipalities' surroundings. Our results suggest that beyond their effect through exposure to natural landscapes, PAs affect PEBs by the institutional context they create. Additionally, PEBs were higher inside PAs than in close surroundings, suggesting that besides restrictions brought by PA on inhabitants, a fraction of the population responds positively to their implementation. Our results suggest that PAs can play a role in enhancing environmentally friendly ways of life by conserving human's connection with nature. V. Cazalis & A.-C. Prévot. Protective areas in support of human environmentally friendly behavior. [Biological Conservation 236 549-555 2019] D

DRIVERS OF MAMMAL RICHNESS DIVERSITY AND OCCURRENCE

Agroecosystems dominate many landscapes through the world, and it is crucial to understand the patterns of wildlife communities thriving in these forests, and the drivers shaping these patterns. Thus, we evaluated the effects of vegetation structure and landscape composition on the richness, diversity, and occurrence patterns of medium and large mammal in a heterogenous Amazonian

landscape, composed of planted forests and native habitats. Based on line transects and camera trap surveys. In three different environments (eucalyptus plantation, savannas, and forests) we detected 17 mammal species, including two species threatened nationally and worldwide. Mammal richness and diversity were similar among the environments. Mammals were more recorded in eucalyptus plantations, in heterogenous areas (few edges) in sites with fewer roads, and with larger proportions of natural environment. The detection of Primata, Carnivora, Rodentia, and Pilosa was positively corrected with the distance to savanna, while Cingulata, Artiodactyla, and Perissodactyla show the same pattern towards forest patches. Primates, Carnivora, and Rodentia were also associated with taller vegetation. Didelphimorphia was registered mostly in heterogenous areas (higher total edge) while five orders were mainly recorded in heterogenous areas. Eucalyptus plantations immersed in a landscape containing significant patches of savanna and forest can maintain part of the local biodiversity, although plantations alone may not be enough to support populations of most mammal species. Indeed, eucalyptus plantations, savannas, and forest patches have a complimentary role in mammal richness and occurrence patterns. Since distinct drivers influence occurrence patterns of different taxonomic groups the existence of areas with different characteristics in the same landscape will favor higher total biodiversity. T. E. N. Pina and others. Drivers of mammal richness, diversity, and occurrence in Brazil. [Forest Ecology and Management 449 117467s. 2019] D

SPECIES-LITERACY GAP EXISTS BETWEEN PROFESSIONALS AND LAY PEOPLE

Biodiversity is in worldwide decline and it is becoming increasingly important to expand biodiversity awareness and achieve broad-based support for conservation. We introduce the concept of species literacy, as knowledge about species can be a good starting point for engaging people in biodiversity. However, concern has been raised about a general lack of knowledge about native species. We explored species literacy via a species identification test in the Netherlands and we investigated potential drivers of the dataset included 3,210 general public participants, 602 primary school children aged 9-10, and 938 biodiversity professionals. A considerable gap in species literacy was found between professionals and lay people. Knowledge about common native animals was particularly low in children. Mammals received relatively high identification scores as compared to birds. Lay people’s species literacy increased with age and educational level, associated with positive attitudes towards nature and animals, media exposure and having a garden. The results indicate that a considerable part of Dutch lay public is disconnected from native biodiversity. Our assessment can help bridge the gap between lay people and professionals, as it can help set up communication and education strategies for native biodiversity that fit prior knowledge. M. J. D. Hooykaas and others. Gap in skills between professionals and laymen. [Biological Conservation 238 108202 2019] D

TROPICAL FORESTRY NOTES (40)

EXCESS OVERSTORY TREES: THREAT TO ATLANTIC FOREST

Tree planting is the most widely used technique for tropical forest restoration because it accelerates the recovery of forest structure and ecosystem functioning. Despite the importance of tree size distribution to the ecological function and habitat quality of restored forests, it has received title attention. Here we ask if the structure of reference forests has been recovered by planting tree seedlings and discuss the implications of skewed tree-size distributions for sustainability of restored forests. We sampled 11 tropical forest sites that had undergone restoration between 16 and 53 years after planting and nine reference ecosystems (old growth, secondary, and degraded forests) in Brazilian Atlantic Forest and compared them by the abundance of individuals in five diameter classes. Restored forests presented 93% greater abundance of large trees (>20 cm DBH), 41% lower abundance of saplings ($1 \leq DBH < 5$ cm) and 43% lower abundance of small trees ($5 \leq DBH < 10$ cm). The abundance of smaller individuals (DBH < 1 cm) however, did not differ between restored and referenced forests, indicating successful colonization of the understory. Low mortality in the large class (DBH>20 cm) results in excess of big trees which constrains recruitment of small plans to the intermediate size classes, likely due to competition for light. The excess of large trees demonstrates that gap dynamics can take longer to naturally establish in these even-aged forests, likely due to the high density of long-lived trees planted at the same time. Thinning may be a possible adaptive management strategy. To reduce the density of the big trees and stimulate recruitment of intermediate sized classes. C. D. Cardoso and others. Excess large trees in prospect, a constraint on reforestation. [Forest Ecology and Management 449 117453 2019] D

DIRECT SEEDED SPECIES FOR EARLY RESTORATION IN AMAZON.

South Amazon forests have been highly deforested, including the legally protected riparian forests. The Xingu watershed restoration program used direct seeding of native trees to restore 5,000 ha of forests from 2006 to 2018. Direct seeding is a low-cost method, easy to implement at large scales. The literature on this method concludes that only a few species manage to establish successfully, resulting in an impoverished forest. In this study we aimed to (1) assess changes in species composition over a 10-year chronosequence in direct seeded sites, 2) evaluate life history traits of direct seeded and colonizer species, and (3) investigate whether colonizer arrival is influenced by landscape, structure, and dispersal syndrome. We sampled 721 10-year-old direct seeded sites along a latitudinal gradient of 600 km at the upper Xingu basin, state of Mato Groso, Brazil. From the 152 direct seeded species, 90 species established themselves and 67 species colonized the restored sites. Succession started off dominated by a single pioneer species, then shared dominance with five other light-demanding species, while slow-growing species were present in the understory. Direct seeded and established species are disproportionally more orthodox, wind dispersed seeds, usually dispersing during the dry season. Colonizer species are similar in proportion of animal-dispersed and recalcitrant seed to those found in the reference forests. We found no relationship between forest cover and colonizer richness. Direct seeding imposes a fundamental diversity filter due to the short period of seed harvesting, storage limitations, and field emergence. However, established species constitute diverse successional classes, which from an initial structure they facilitate species colonization, reducing the biodiversity filters caused by the direct seeding method over the years. S. Barbosa Rodrigues

and others. Direct seeded and colonizing species for early Amazon recovery. [Forest Ecology and Management 451 117559 2019] D

20-YEAR AMAZON LIBERATION

Five species were selected for diameter growth modeling on terra firme forest in the Amazon: *Astronomium lecointei, Chysophyllum lucentifolium, Lecythis lurida* and *Manilkara paraensis*, and *Manilkara elata*. The aims were to (1) investigate the tree diameter growth rates with and without liberation, and (2) determine species-specific minimum cutting diameters (MCDs) and cutting cycles (CCs). Individual tree non-age explicit growth models were tested with calibration data from trees of ≥35 cm DBH whose growth was monitored over 20 years. The diameter growth was projected to 100 years. We found that liberation can reduce the time necessary for trees of 35 cm to attain an MCD of 50 cm by up to 70 years and can accelerate diameter growth even after growth stagnation. Its effect may be strong on both small and large trees, depending on the species. Both the diameter growth and the liberation effect depend on the species, thus reinforcing the need for more discussion of species-specific management in the Amazon. *M. elata* had the fastest diameter growth rate among the studied species. *A. lecontel* can grow under liberation as fast as *M. elata*. An MCD of 50 cm is suitable for both species because trees reach this DBH while still growing quickly. The number and length of the CCs for *A. lecointeri* and *M. elata* should allow trees to reach a dbh between 60 and 70 cm. The species *C. inconfolium* and *I. lurida* experienced growth stagnation at dbhs of 40-50 cm. However, liberation accelerated the slowed growth of trees in that diameter range. Similar studies in the Amazon are encouraged in order to contain the slow growth of *C. lucentifolium* and *L. lurida* at other sites and then recommend reducing their MCD with species-specific regulation. *M. peraensis* was the only species for which the effect of the liberation increased with tree size. An MCD of 50 cm is suitable for this species. CCs should allow *M. paraenesis* trees to reach a diameter no larger than 60 cm without liberation and 70 cm with liberation. C. David and others. Tree liberation for diameter growth in the Amazon. [Forest Ecology and Management 453 117584 2019] D

***EUCALYPTUS* PLANTATION EFFECTS ON STREAMFLOW,**

Eucalyptus plantations play an important role in the Brazilian community, and they are the observed animal relative water yield *QF) and the aridity index (established by an exponential model, which was used to understand the possible effects of forest plantations at the municipality level in Brazil. The main findings of the paper are as follows (1) Evapotranspiration (ET) exceeded 80% of precipitation for most observations*71%) and exceeded 90% of precipitation for 50% of the annual observations (60 years of data) (2)streamflow represented 5-11% precipitation for plantations aged 1-7 years with a slight but not significant decrease for older (9-7 years plantations (3) in the 19 sites. The annual average runoff ratio declined exponentially with increasing values of the utility index (PFTP) and the 4r sites with aridity index 0-76 had a water yield ratio<, 0,1 (4) 41% of eucalyptus plantations in Brazil had aridity indexes 0.76% implying that these areas proposed to identify regions where forest management should be more focused to balance timber production and ecosystem services. F. B. de Ferraz and others. Eucalyptus plantation effect on streamflow. [Forest Ecology and Management 453 117571 2019] D

HUNTERS AND TRADERS IN A LIBERIAN BUSHMEAT SYSTEM

Hunting provides livelihoods and food security for a large number of people across the tropics but endangers wildlife populations. Effective management requires understanding both social and economic dynamics of local bushmeat systems; yet social elements such as relationships actors are often overlooked. We provide the first detailed description of a rural hunting system in Liberia from interviews with 205 hunters and 50 traders in the Goia Forest. We found bushmeat contributed substantially to local livelihoods and earnings from hunting and trading were high relative to local alternatives (medium $120 and $262/month, hunters and traders, respectively. Most of hunters' catch was sold to traders (85% of harvested biomass) and subsequently transported to urban markets) 65% of all harvested biomass). Local consumption accounted for 27% of local harvest. Financial risks from meat confiscation were primarily born by traders, many of whom were women and 60% of this perceived as a motivation to reduce trading. By contrast, the most commonly stated motivation to reduce hunting was the time demanded by alternative activities such as farming. This discrepancy implies that livelihood support initiatives and law enforcement tools may play distinct roles across groups. Relationships between hunters and traders were complex and involved a variety of credit arrangements. Interpersonal trust played an important role with mistrust of hunters being cited by 12% of traders as the principal barrier for profiting from bushmeat trade. Our findings provide context for designing conservation strategies and suggest that underlying social processes deserve closer attention in bushmeat research. S. Jones and others. Relationships in a Liberian bushmeat system. [Biological Conservation 237 338-347 2019] D

CATTLE GRAZING IN A SAVANNA WETLAND EXPOSED TO LIONS

In Africa's pastoral conservation landscapes apex predators frequently kill livestock. Retaliatory persecution such as poisoning threatens predators, but also non-target biota. Several factors influence conflict severity, including livestock husbandry, overlap in seasonal habitat use, and the degree to which livestock perceive and are able to respond to a landscape of fear. We investigated these factors by GPS tracking 42 Tswana beef cattle (*Bos taurus*) from 29 herds in 2017 and six lions (*Panthera leo*) from different prides.(May 2016- Dec. 2017) in the northern Obavango Delta, Botswana where cattle depredation significantly impacts the livelihoods of rural agro-pastoralists. Cattle exhibited seasonal habitat selection patterns similar to wild ungulates in the region. They preferred woodland habitats with more digestible grasses, during the wet season. During the dry season they preferred wetland habitats with reliable forage and available water. Cattle also preferred areas close to human settlements, but the necessity to forage in wetlands during the dry season exposes them to significant depredation risk, especially >4 km from settlements. Lions killed most cattle in wetlands during the late dry season, but the intensity of recent lion presence (previous 14 days) only had a weak negative effect on cattle habitat selection patterns. Cattle used rangelands according to nutritional requirements, irrelevant of the associated predation risk, suggesting that socio-ecologically acceptable conflict solutions cannot rely on the exclusion of livestock from seasonal wetlands. Curbing depredation by lions will best be achieved by a combination of resource- and predation-cognizant seasonal herding strategies with adequate livestock protection. Understanding the ecological constraints that intensify the conflict is pertinent to any livestock production landscape with predator presence. It is also a central prerequisite for future land use planning and devolution of legal, controlled resource access rights through policy. Coexistence strategies must account for the strong reliance of people, the livestock and wildlife on shared key resources. This is particularly important in

large trans-frontier conservation areas where the successful emerging of biodiversity conservation and rural development is a strategic goal. Omission will foster resentment and resistance to coexistence with apex predators, particularly if livestock productivity and human livelihoods are negatively affected. F. J. Weise and others. Cattle grazing among lion predators. [Biological Conservation 237 253-266 2019] D

GIANT PANDA HABITAT RESPONDS TO DISTURBANCES

Through decades of conservation efforts at the national and worldwide scales, the giant panda (*Ailuropoda melanoleuca*) has been downgraded from "endangered" to "vulnerable" on the IUCN Red List. The decision has not gone unquestioned, however. Although the population has increased, pandas still face series human disturbances (livestock grazing and logging). Human disturbance is a crucial factor affecting the distribution of wildlife and their habitats and evaluating the change in habitat quality in response to this disturbance is vital to wildlife conservation. However, this qualification of human activity variables that result in habitat changes has been rare. To fill this knowledge gap, we used human disturbance (livestock grazing, logging, farming, collection of bamboo shoots, collection of medicinal plants, road construction), environmental (forest cover, elevation, slope), and panda GPS location data to evaluate panda habitat suitability and space use, the impact of human disturbance on panda habitat, and the distribution characteristics of human disturbances over time. Our results show that panda habitat suitability has improved, with substantial areas of stabilizing and increasing habitat across our Liangshan Mountains study area between the third national surveys of the giant panda (2000) to the fourth national survey of the giant panda (2012). The percent contribution of human disturbance variables to MaxEnt panda habitat suitability models decreased greatly between the 3rd and 4th surveys, 93% to 59% which was essentially driven by the decrease in logging's contribution (78% to 19%). The percent contribution of environmental variables increased (6% to 40%), the largest growth occurring in the forest cover vehicle (2.7% to 14.2%). Our results also indicated that panda space use expanded between the two surveys. It is concerning that human disturbances are still widely distributed and the percent contribution of some distance variables to panda habitat suitability increased. For example, livestock grazing went from 1.4% to 13.1% contribution between the 3rd and 4th national surveys and indicates a need to strengthen management in this area. The methods used in this study could also be applied to the assessment of human disturbances effects on habitat quality for other species. And our results provide scientific support to relevant management departments for wildlife and biodiversity conservation in south-central China. C. Li and others. Effect of human disturbances on the habitat of the giant panda. [Biological Conservation 237 445-455 2019] D