

years, creating a fragmented landscape of secondary forest patches within an existing matrix of agriculture, mature forests, and human development. It has created unique combinations of previous and surrounding land uses, patch structure, distance between remnant patches, and environmental variables. We are investigating how these variables determine the spatial variation of the structural, compositional, functional, and phylogenetic characteristics of these forests. We established 25 0.25-ha plots in which trees, saplings, and seedlings were recorded and measured, along with soil samples. Functional and reproductive traits are being analyzed. Phylogeny data will be obtained from current databases and analyzed using Phylomatic and Phylocom software. Multivariate Mantel correlograms indicate that distance decay relationships were similar for environmental variables and composition and diversity across plots. Floristic and environmental variables were significantly autocorrelated up to 30 km, indicating that distance between patches is a strong predictor. With these results, we will be able to quantify the relative importance of landscape and environmental variables driving succession of secondary forests.

Current pictures and feasibility of quasi-clearcutting in Japan. Toyama, K. (*University of Tokyo, Japan; toyama@uf.a.u-tokyo.ac.jp*).

In Japan, forest cover rate is about 66%, and about 40% of total forest is planted softwood forest for timber production. However, many stands are unprofitable due to severe geographical conditions or past unsuitable management. Recent governmental policies are promoting commercial thinning based on enhancement of forest road networks, which is hard to apply to stands with less profitability. This research focuses on feasibility and drawbacks of quasi-clearcutting and small-scale harvesting in Japanese forestry, which is expected to lead to better profitability in logging and successive natural regeneration in stands with less profitability. A case study showed, in an example of quasi-clearcutting, that marginal areas of a clearcut stand can be left uncut mainly for passive and economic reasons, whereas standing trees can be left uncut and isolated as shelterwood with a more active intent by woodland owners and managers. Simulation showed that both can be reasonable in profitability. This research also analyzes the spatial tendency of natural regeneration of hardwood trees in planted old softwood stands, which can be applied to create a potential map of stands suitable for quasi-clearcutting and natural regeneration.

B-09 What future for tropical silviculture?

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Dry forests of Ecuador: potential for natural forest management and carbon sequestration? Guenter, S. (*Thünen Institute of International Forestry and Forest Economics, Germany; sven_guenter@yahoo.de*), Cifuentes Jara, M., Villalobos, R., Casanoves, F. (*CATIE, Costa Rica; mcifuentes@catie.ac.cr; rvillalo@catie.ac.cr; casanoves@catie.ac.cr*), Segura Ramos, D. (*Ministry of the Environment, Ecuador; dsegura@ambiente.gob.ec*).

Dry forests worldwide suffer high land use pressure, deforestation and fragmentation. Many authors give this ecoregion highest priority for conservation due to its high vulnerability and high level of endemism. Only 17% of the original dry forest cover remains in Ecuador. High land use pressure accompanied by exploitation of timber species, fuel wood collection, and general low growth rates frequently results in limited potential for timber production in seasonally dry forests in comparison to humid forests. Non wood forest products and payments for carbon sequestration are frequently discussed as alternative or complementary solutions to improve the potential for natural forest management. The recently finished national forest inventory of Ecuador provides a solid database for discussing these questions for the specific case of seasonally dry forests. In this paper we analyze the datasets from 207 plots distributed in seasonally dry forest in order to identify the potential for natural forest management, carbon sequestration, and conservation. We analyze harvestable volumes and diameter structures of species and compare them with potential post-harvest structures. Based on growth data from other authors we conclude on most critical species and regions for recovery of post-harvest structures within the legal framework of Ecuador.

Tropical shelterwood system and its impact on the heterogeneous forests of West Africa: the Nigerian experience.

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The tropical shelterwood system (TSS) was introduced to the forests of West Africa in the early 1940s. In 1944, TSS treatment commenced in Nigeria with a number of silvicultural prescriptions which included canopy opening, frill-girdling, poisoning of undesirable species, and climber-cutting. By the time the system was annulled in the early 1970s, >250 000 ha of forests had been treated. This paper examines, 3 decades after treatment cessation, the effects of TSS on tree demography in a plot consisting of four treatments: heavy poisoning and climber-cutting (Treatment 1), selective poisoning and climber-cutting (Treatment 6), climber-cutting only (Treatment 12), and control (Treatment 13). Logging impacts on classes I and II economic trees were also considered. Results reveal a regrowth forest dominated by juveniles: saplings (40.8%) and poles (48.9%). The listed classes I and II economic species constituted 32% of total species and 34% of families encountered. *Guarea cedrata* and *Celtis* spp. were third and fifth, respectively, among the top 10 species with most abundant individuals. The preponderance of juveniles (saplings and poles) of listed economic species, despite the paucity of mature trees, suggests TSS treatment effects.

Adaptation of eucalypt trees to water and nutrient deficiencies: insights from Brazilian experiments question conventional recommendations.

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Drought is a major abiotic stress that will be exacerbated by climate changes in many forest ecosystems. A scarcity of fertilizers for the management of tropical plantations is also predicted due to finite reserves of phosphorus and potassium (K) worldwide. Identifying management practices enhancing tree tolerance to drought and nutrient deficiencies is, therefore, of primary interest.

Carbon, water, and nutrient fluxes have been monitored intensively over entire rotations in experiments manipulating rainfall and nutrition in *Eucalyptus grandis* plantations in southern Brazil. These studies question the relevance of some silvicultural practices well established in regions with relatively high annual rainfall. The early tree growth does not always need to be maximized; weeding can also be important after canopy closure; K fertilization is not always beneficial to face drought; it is not always necessary to split the applications of N and K fertilizers to prevent losses by leaching; and sodium application can enhance tree growth in K-deficient soils. We show that studies carried out at a single site can have broad applications for the management of tropical plantations, provided that they improve our comprehension of the mechanisms driving tree growth. In addition to multi-local trials, multidisciplinary research at a few sites associated to modelling and remote sensing is needed to adapt silvicultural practices to global changes.

Sustainable pathways for primary forest under a changing climate: ecological, social, and economic constraints. Mackey, B. (Griffith University, Australia; b.mackey@griffith.edu.au), DellaSala, D. (Geos Institute, USA; dominick@geosinstitute.org), Kormos, C. (The WILD Foundation, USA; cyril@wild.org), Zimmerman, B. (International Conservation Fund of Canada and the Environmental Defense Fund, Canada; b.zimmerman@wild.org), Young, V. (Forests Alive Pty Ltd, Australia; virginia@forestsalive.com).

This paper reviews the evidence for ecologically sustainable forest management in primary tropical forests in terms of wood supply, biodiversity conservation, greenhouse gas mitigation, and adaptation to projected climate change impacts. We identify ecological, social, and economic constraints on the sustainable use of primary tropical forests and recommend approaches that will retain their defining characteristics. Globally, only around 18% of the world's natural distribution of primary forests persists. Tropical primary forests are under increasing pressure as developing countries seek to exploit their natural resources. Furthermore, it is now 95% certain that rapid, human-forced climate change will impact on all biomes including the tropics. Decades of monitoring and evaluation now point to the limitations of industrial-scale logging as a conservation strategy in primary tropical forests. A development pathway is needed that maintains the defining characteristics of primary tropical forests so that their greenhouse gas mitigation function is maximised and to help ensure their resilience and adaptive capacities remain intact. Two case studies are presented of community-based forest management in the Brazilian Amazon and Southeast Asia which illustrates how alternative development pathways can be designed and implemented.

Forest resilience depends on stand variations: forest dynamics of an Amazonian forest 30 years after logging. Mazzei, L., Ruschel, A. (EMBRAPA, Brazil; lucas.mazzei@embrapa.br; ademir.ruschel@embrapa.br), Silva, J. (Federal Rural University of the Amazon, Brazil; silvanatalino734@gmail.com), Schwartz, G. (EMBRAPA, Brazil; gustavo.schwartz@embrapa.br), de Carvalho, J. (Brazilian National Council for Scientific and Technological Development, Brazil; olegario@pq.cnpq.br), Kanashiro, M., Lopes, J. (EMBRAPA, Brazil; milton.kanashiro@embrapa.br; carmo.lopes@embrapa.br).

A polycyclic selective cutting system has been used in the Brazilian Amazon; current protocols were mainly developed through harvesting experiments established since 1975. Such experiments represented a remarkable start on the further application of reduced impact logging in Brazil. One of those experiments, specifically about logging for timber production, was carried out at the Tapajós National Forest in 1979. The timber volume harvested was 72 m³/ha or 16 trees/ha that immediately removed 25% of the total carbon stock in the forest. In the present study, the circumstances where natural forest management can be applied as a conservation tool were evaluated using data from the Tapajós National Forest logged area. Hence, three types of forest ecosystem values were assessed along 30 years of forest dynamics to determine forest resilience: 1) commercial volume, 2) floristic composition and diversity, and 3) carbon stock. The results showed that variations in stand structure and forest composition due to harvesting led to a recovery of the carbon stock, which provided 62 m³/ha of merchantable volume. The forest resilience for timber production depends on these variations through time, representing the silvigenesis stage 30 years after logging.

Harvest regulation for multiresource management, old and new approaches. Mendoza, M. (Colegio de Postgraduados, Mexico; martimmendoza@yahoo.com).

Current Mexican forest management is the product of a history started in 1926. The earlier approaches aimed directly or indirectly to attain the normal, fully regulated forest model. Around 1980 the first considerations about multi-resource and environmental impact were mandated over all private timber operations. Concerns about water quality, biodiversity, legally protected natural areas, and endangered species were the motives for promoting in 2012, and afterwards, voluntary best management practices, because timber-oriented silviculture was deemed insufficient to take proper care of non-timber values in the forest. In this research, two Mexican traditional forest management schemes (SICODESI, Plan Costa de Jalisco), enhanced with best management practices, were compared with a management method specifically designed to manage landscape attributes. Results from a full 10-year cutting cycle for the three management techniques showed that traditional schemes, even when modified to comply with best management practices, failed to secure a forest dynamic favorable to responsible stewardship of non-timber values. The landscape technique used multiple means to drive forest dynamics to fulfill multi-resource objectives constrained by self-financing and competitive profitability in private and communal ownerships, relative to similar timber operations from the international scene.

Past, present, and possible futures of the western Congolian lowland rainforest. Pietsch, S. (University of Natural Resources and Life Sciences, Austria; stephan.pietsch@boku.ac.at), Gautam, S. (Tree Canada, Canada; sisir_gautam@yahoo.com), Bednar, J. (University of Vienna, Austria; bednarje@gmail.com), Petritsch, R., Schier, F. (University of Natural Resources and Life Sciences, Austria; richard@petritsch.or.at; schier.franziska@googlemail.com), Stanzl, P. (VMS, Gabon; stanzl225@aon.at).

Past climate change caused severe disturbances of the Central African rainforest belt, with forest fragmentation and re-expansion due to drier and wetter climate conditions. Besides climate, human-induced forest degradation affected biodiversity, structure, and carbon storage of Congo basin rainforests. Information on climatically stable, mature rainforest, unaffected by human-induced disturbances, provides a means of assessing the impact of forest degradation and may serve as benchmarks of carbon carrying capacity over regions with similar site and climate conditions. Biogeochemical (BGC) ecosystem models explicitly consider the