

loss. Mexican forest policy encourages ex situ and in situ conservation of forest genetic resources. But work remains to be done for sufficient protection of populations and genetic resources of species under harvest for their long term sustainability. This presentation reviews long term viability and results for various ex situ trials and seed banks for mahogany and Spanish cedar in the Yucatan, especially for the 1996-1998 trials in Quintana Roo. Of two trials of mahogany and two trials of cedar established on community and private lands, only one remain of each. The remaining trials are being converted to seed orchards in Spring 2020. Also considered is the current status of in situ seed stands for these species, and the relative usefulness of ex situ and in situ strategies for maintaining genetic resources. In addition, current harvest policy and possible modifications for better maintenance of populations and genetic variation are considered.

Management of natural regeneration of *Araucaria angustifolia* in small farms in Southern Brazil: an alternative for the conservation of the species

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Araucaria angustifolia (Bert.) O. Kuntze occurs naturally in south and Southeastern Brazil. It has cultural and ecological significance as its seeds are traditionally consumed by local communities and are an important source of food for wildlife. It also has multiple potential uses for timber, paper, and the food industry. Its exploitation is forbidden by law and it is currently listed as critically endangered. Because of legal limitations, regrowth of araucaria trees is seen by landowners as problematic, thus inducing seedling removal. One way to promote its conservation is taking advantage of traditional agroforestry productive systems such as caívas and faxinais that integrate animal husbandry, erva-mate (*Ilex paraguariensis*), and other crop production in forested areas. Under these conditions, araucaria regeneration is abundant and can be managed for productive and conservation goals. We analyzed two examples of such agroforestry systems and confirmed the potential for maintaining high levels of forest diversity, income generation through livestock and erva-mate production, combined with important regeneration of araucaria. In one area we observed a predominance of *Araucaria* (48%) along with 46 other species, and *Araucaria* plants were distributed in various DBH classes. In the second property, we observed that *Araucaria* abundance corresponds to around 13% of the forest with a higher representation in larger DBH classes (up to 86%) while maintaining a diversity of 44 tree species. Overall, despite its economic potential, the species continues to be a poorly understood resource with limited interest in establishing plantations and maintaining natural stands.

From disaster to opportunity: examining the effects of hurricanes Irma and Maria on mahoganies in Puerto Rico and U.S. Virgin Islands, related policy responses, and potential for enhancing long-term sustainability

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In September 2017, two major hurricanes – Irma and Maria – passed through the Caribbean, resulting in significant loss of life, impacts on local economies, and effects on natural resources. Large areas of forest were nearly to completely defoliated and countless trees were uprooted, snapped, or damaged in natural to urban settings. Tree damage and death occurred throughout the islands, including high-value species, such as big-leaf, small-leaf, and hybrid mahoganies. These species are not native to Puerto Rico or the U.S. Virgin Islands, but have become naturalized with extensive planting since they were first introduced in 1790. Although significant volumes of hurricane-downed mahoganies and other timber species were collected in debris removals as part of the response and recovery efforts in Puerto Rico and the U.S. Virgin Islands, very limited volumes were salvaged for timber and other products, due in large part to limited industrial capacity for wood transformation as well as limited foresight or policy coherence on disturbance-downed wood. The local economic loss has been estimated at millions of dollars. We examine the effects of the 2017 hurricanes on planted and naturalized mahoganies in Puerto Rico and the U.S. Virgin Islands and the related short and long term management and policy responses. We discuss the implications for the sustainable management and use of these high value species, in the context of islands searching for solutions that increase resilience and decrease dependence on imports, including wood products, and which face a likely future of more severe and frequent storms and hurricanes.

Araucaria angustifolia breeding program at Embrapa Florestas

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Araucaria angustifolia (Bert.) O. Ktze is a native species from Brazil which plays an important social and economic role, especially in the southernmost region of the country. Currently it is threatened on extinction, and consequently its remnants cannot be exploited. Conservation by use is one feasible way to conserve this tree through plantations ensuring adequate variability. However, the seed supply with high physiological and genetic quality to this plantation is a major problem which could be overcome through breeding programs. Embrapa Florestas (CNPq), together with Instituto Florestal de São Paulo (IF-SP) started a breeding program nearly 40 years ago as provenance/progenies tests, covering a wide natural area. As *Araucaria* occurs in an over a wide geographical region, southern and Southeastern Brazil, differences between them must be considered in breeding and conservation programs. The introduced tests were submitted to a thinning of 50 % intensity. From recombining of the remaining trees seeds a second generation provenance/progeny tests were established in Curitiba-SC, Ponta Grossa-PR, Caçador-SC, and Monte Belo do Sul-SC. Consequently, a higher productivity gain is expected in relation to the current seed sources. Moreover a participatory improvement is being considered aiming to promote the increasing of variability and the development and use of adapted germplasm to specific conditions. For this purpose a cooperative araucaria breeding project is being implemented among Embrapa Florestas and partners aiming to develop genetically improved seeds and clones of araucaria, based on a wider genetic base to ensure the potential for genetic improvement for consecutive generations.

Threatened by conservation: addressing policy gaps for the maintenance of high-density Brazil nut tree clumps

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Considered a cornerstone species in Amazonian forest conservation strategies, the Brazil nut enjoys a unique status. It is immune to cutting and most of its distribution is under some category of protected area. Nonetheless, both nut-gatherers and researchers consistently report insufficient natural regeneration

levels and the population decline of high-density stands, including at strict nature reserves. The initial hypothesis of seed overharvesting lacks consensus as later studies identified the scarcity of canopy gaps at mature forests as the main cause for the recruitment failure of this gap-loving species. This observation supports the anthropogenic origin hypothesis and is consistent with the abundant recruitment observed in traditional swiddens, where the regeneration density increases with the number of cultivation cycles. This is due to a number of factors, including the scatterhoarder habit of the natural disperser, gap-clearance frequency, species' resistance to fire and remarkable re-sprouting capability. Nut-gatherers intuitively understand the role of swiddens for the maintenance and expansion of high-density Brazil nut stands, and many voluntarily protect their spontaneously enriched fallows from further cultivation cycles. Surprisingly, the very conservation policies end up hindering such traditional management practices. For example, when forbidding nut-gatherers/swidden-farmers from clearing new plots of forest in exchange for those fallows they chose to protect. Expensive, labor-intensive and unpopular recommendations like enrichment planting are puny alternatives for what the ubiquitous swiddens can do, provided revised policies allow them to. Failing that, densities of senescent Brazil nut stands will continue to decrease until hardly justifying the "sustainable alternative to deforestation" discourse.

Morphometry of *Araucaria angustifolia* at different altitudes in Southern Brazil applied in the identification of critical growth points

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The aim of this study was to use morphometric characteristics of *Araucaria angustifolia*, as basis to elaborate management plans. Data was collected in three sites of Santa Catarina State: S1 (altitude of 1,350 m), S2 (1,150 m) and S3 (950 m). Random sampling and Bitterlich method were applied using 2 as basal area factor. We sampled 247 individuals (77 at S1, 93 at S2 and 77 at S3). The degree of indexes association was examined by Pearson correlation coefficient. S2 was constituted by larger trees, indicating better growth conditions. S3 presented the highest density of trees (403 trees.ha⁻¹), while at S1 and S2 there were 362 and 188 trees.ha⁻¹, respectively. At S3 most trees had a crown proportion greater than 50% and crown formal smaller than 1, reflecting trees with narrower and longer crowns. The height/diameter ratio was similar among sites (0.4 to 0.5). Diameter correlation with slenderness ratio was negative and bigger than 70%. In all sites diameter at 1.30 m from ground level (DBH) showed positive relation with crown diameter, indicating that as trees increase in DBH, crown diameters also increase. The removal of competing trees becomes essential to increase growth rate by increasing space and light incidence. Morphometric indexes can be used to support sustainable forest management plans, allowing the identification of critical points related to the trees development pattern.

Adapting the Prodan method for sampling species associated with *Araucaria angustifolia* (Bertol.) Kuntze / Adaptação do uso do método de Prodan para amostragem de espécies associadas a *Araucaria angustifolia* (Bertol.) Kuntze

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Este trabalho objetivou a adaptação do método de amostragem de área variável de Prodan para o estudo de espécies de porte arbóreo que ocorrem com maior frequência próximas à Araucária (*Araucaria angustifolia*), considerando estas como espécies associadas desta espécie. Para tanto, percorreram-se cinco transectos equidistantes paralelamente em 100 metros, totalizando 1.830 metros de caminhada em um fragmento de Floresta Ombrófila Mista de 22 hectares no Parque Natural Municipal das Araucárias, em Guarapuava, PR. A aplicação do método consistiu na demarcação de indivíduos de Araucária ao longo de cada transecto, utilizando-os como ponto central para a unidade amostral e a cada destes, determinou-se o raio das seis árvores mais próximas, as quais foram identificadas taxonomicamente e classificadas quanto à sua frequência absoluta. Foram mensurados 55 indivíduos de Araucária ao longo de todos os transectos, cujo os diâmetros variaram em média 71,5 ± 26,8 cm, contemplando uma área total amostrada de 0,54 hectares e um total 38 espécies encontradas. As espécies mais frequentemente identificadas consideradas como associadas da Araucária foram: *Campomanesia xanthocarpa* O. Berg, que ocorreu próxima de 51% das Araucárias observadas, *Casearia decandra* Jacq. (34,5%), *Gymnanthes klotzschiana* Müll. Arg. (30,1%), *Araucaria angustifolia* e *Cinnamodendron dinisii* Schwanke (27,3%), *Allophylus edulis* (A. St-Hil., Cambess e A. Juss.) Radlk (20%) e *Matayba elaeagnoides* Radlk. (18,2%). A adaptação do método de Prodan mostra-se uma ferramenta útil para o entendimento da ecologia e fitossociologia da *Araucaria angustifolia*, podendo ser utilizada para projetos de manejo e conservação desta espécie icônica e tão ameaçada no Brasil devido a sua importância econômica.

Genetic analysis of growth curves of individual trees and country-wide provenances of *Araucaria angustifolia* shows huge potential for enhanced domestication, breeding and conservation of this iconic Brazilian conifer

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Understanding the growth behavior of forest tree species is important for early selection, and to understand ecological patterns, predict future biomass and adaptive tree fitness. We investigated the genetic variation for growth traits of *Araucaria angustifolia* in a trial involving 122 families from 15 provenances from three Brazilian regions. Measurements at ages 7, 24, 32, 33 and 35 were used to adjust continuous growth curves based on nonlinear mixed-effect models for all 2,158 trees, providing estimates for unmeasured ages in the 7-35 interval. Estimated values closely matched observed ones and a reduction of the coefficient of residual variation was observed in the estimated data, possibly due to removal of random error in observed measurements, making the estimated curves more reliable to predict growth patterns. Genetic variation within provenances was greater than between, with a trend of increasing heritabilities over time for most provenances. Growth curves show that trees invest first in DBH and later in height, and even at age 35 *A. angustifolia* does not show biomass growth stagnation. Provenances with great potential for breeding and genetic conservation were identified with variable adaptation to support global climate and landscape change. The data clearly indicate potential for early selection at age 7-10 with 85% accuracy of selection at age 35, and possibility of shortening rotation age to 15-20 years by selecting the best individuals and families. These results underscore the huge potential of expanding investments in breeding and plantation forestry of *A. angustifolia* with a concomitant enhancement of conservation efforts.