Novel methodology projects growth of native trees, enhancing return on investment in forest restoration

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The researchers developed a model that projects the time taken for trees native to the Atlantic Rainforest to reach the ideal size to be harvested for the timber industry. Credit: Pedro Brancalion/LASTROP-USPM

Interest in forest restoration has increased in recent years, both on the part of companies and financial markets and in academia and government. This is particularly the case in Brazil, whose government has pledged since the 2015 Paris Agreement to restore 12 million hectares of native forest. However, tree planting is costly, while data on species growth and other aspects of reforestation is scant.

A study published in the journal *Perspectives in Ecology and Conservation* helps fill the gap by showing how the production of timber from native trees can make restoration financially viable. The article proposes native species growth models, defines harvest times, and outlines an optimized scenario for timber production in biodiverse restoration plantations, reducing pressure on natural biomes like the Amazon.

The authors conclude that to achieve high productivity; the forest restoration value chain must be driven by management and harvesting plans based on species-specific criteria relating to models of tree growth, combinations of native species, silvicultural treatments, and research and innovation.

Led by forest engineer Pedro Medrado Krainovic, the researchers developed a model that projects growth time for species native to the Atlantic Rainforest until they reach the ideal harvesting age.

Commercially viable growth rates are usually based on the time taken for trees to reach 35 cm in diameter at breast height (DBH). The novel methodology developed by the researchers reduced mean time to harvest by 25%, bringing the ideal harvest age forward by about 13 years, and increased mean basal area (stand density) by 38%.

"We calculated patterns of productivity versus time to obtain timber for the market, using parameters for management of each native species. This can assure the feasibility of large-scale forest restoration, making it attractive to landowners while also helping to meet the targets set by global climate agreements."

"Based on our data, we projected a scenario for the improvement of silviculture to develop a restoration strategy that is worthwhile to the multiple stakeholders involved," Krainovic explained. He participated in the study while he was a postdoctoral fellow in the Tropical Silviculture Laboratory at the University of São Paulo's Luiz de Queiroz College of Agriculture (ESALQ-USP) in Piracicaba, São Paulo state, Brazil.

Although the Trinational Atlantic Forest Pact—a coalition involving Brazil, Argentina and Paraguay—has been considered a World Restoration Flagship and one of the "top ten pioneering initiatives that are restoring the natural world" by the United Nations, the Atlantic Rainforest has lost more forest area than any other Brazilian biome. Its vegetation originally covered in Brazil an area of 140 million hectares, of which only 24% are left. The SOS Mata Atlântica Foundation estimates that about half of this area still corresponds to well-conserved forest.

Efforts to stop deforestation and degradation have achieved positive results, with a 42% reduction year over year in January-May 2023 (from 12,166 ha to 7,088 ha deforested), and restoration projects are moving ahead robustly.

The United Nations Decade on Ecosystem Restoration, which runs from 2021 to 2030, is a global movement coordinated by both the UN's Environment Program and the Food and Agriculture Organization to prevent and reverse the degradation of natural spaces across the planet for the benefit of people and nature.

"Restoration needs more data to point to favorable land-use horizons. Public policy requires more information to support decision-making. This article serves these purposes in several ways, including a list of species that can be profitable for landowners. It opens the door to the economic enrichment of forest restoration by making initiatives in this area more attractive and capable of achieving multiple purposes, such as the reinstatement of ecosystem services in specific areas," Krainovic said.

The results of the study will be used by Refloresta-SP, a program coordinated by the São Paulo State Department of Environment, Infrastructure, and Logistics to restore degraded ecosystems and areas, develop multifunctional forests and implement agroforestry systems.

Krainovic lived in the Amazon for 12 years, working on forest restoration projects in degraded areas that use tree species with economic potential and on non-timber forest products for the cosmetics industry, such as seeds, essential oils, and butter. "I'm not your typical academic. I've been around. I know what business wants and how to interface with traditional communities in these value chains. I also know the science," he said.

Methods and results

In the study, the researchers analyzed 13 forest restoration sites in different parts of São Paulo state, with varying mixtures of native tree species (30 to 100 species) and different ages (six to 96 years since planting). They formed a chronosequence that represented the potential growth performance of ten targeted timber species and the ecosystem services typically found in spontaneous forests. A chronosequence is a set of sites that are similar in soil types and environmental conditions but differ in age. The sites are replicated in space to replace replication in time.

The ten species were selected for having different wood densities and for having been historically overharvested for timber production. They were Balfourodendron riedelianum, Cariniana legalis, Cedrela fissilis, Centrolobium tomentosum, Esenbeckia leiocarpa, Hymenaea courbaril, Peltophorum dubium, Handroanthus impetiginosus, Astronium graveolens, and Myroxylon peruiferum. Most are protected by law and can no longer be legally sold, as they are endemic to the Atlantic Rainforest and Cerrado (savanna-like biome) and are officially classified as endangered. However, some (e.g., Hymenea courbaril and Handroanthus impetiginosus) are still harvested in the Amazon.

For each species, the researchers developed growth models based on data collected from the sites and used the method known as growth-oriented logging (GOL) to determine targeted management criteria, including an optimized timber production scenario based on growth and bole quality assessment.

After initial tests, they modeled DBH growth and basal area for selected species and constructed productivity scenarios using the 30% highest DBH values found for each species per site and age. The use of silviculture management techniques to boost productivity was assumed in the optimized scenario.

The species were classified on the basis of the time required to reach the ideal size for harvesting (DBH of 35 cm) as fast (under 50 years), intermediate (50-70 years), and slow (over 70 years). When the GOL approach was used, they were grouped into four growth classes: fast (under 25 years), intermediate (25-50), slow (50-75), and super-slow (75-100).

In the optimized scenario, the mean time to harvest decreased by 25%, and the mean basal area increased by 38%, for a reduction of 13 years in the ideal harvest age and a 48% increase in basal area (295 cm^2 per tree).

C. legalis and H. courbaril were exceptions: the ideal time to harvest was longer, but the basal area increased by over 50%. In the case of C. fossils, however, the basal area fell by 36% (646.6 cm^2 per tree), but the time to harvest decreased by 47 years (51% faster than the GOL measure).

Nine of the ten species reached a DBH of 35 cm in under 60 years. The exception was E. leiocarpia, albeit with high wood density.

More information: Pedro Medrado Krainovic et al, Potential native timber production in tropical forest restoration plantations, *Perspectives in Ecology and Conservation* (2023). DOI: 10.1016/j.pecon.2023.10.002

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