SYNTHESIS CENTRE ON BIODIVERSITY AND ECOSYSTEM SERVICES

Photo: Catarina C. Jakovac

WHEN IS NATURAL REGENERATION AN EFFECTIVE SOLUTION FOR TROPICAL FOREST RESTORATION?

POLICY BRIEF

HIGHLIGHTS

- **Natural regeneration** is one of the best ways to restore tropical forests because it is a low-cost solution that ensures the provision of ecosystem services and ecological restoration;
- The Brazilian legal framework acknowledges natural regeneration as a strategy for reestablishing native vegetation under the Native Vegetation Protection Law;
- The forest, however, is not always able to regenerate naturally with quality. The concept of ecological integrity of natural regeneration enables the assessment and monitoring of natural regeneration through ecological indicators and reference values;
- The identification and application of indicators and reference values are necessary to evaluate and monitor the effectiveness of natural regeneration as a strategy for restoring ecosystems and providing ecosystem services.


Photo: Catarina C. Jakovac

USING NATURAL REGENERATION TO RESTORE TROPICAL FORESTS: WHERE DOES IT WORK?

Natural regeneration occurs when forests are allowed to regrow naturally after deforestation. It is considered a **nature-based solution** for large-scale restoration. After 20 years, regenerating forests can attain nearly 80 percent of mature forests' soil fertility, carbon stocks and tree species. However, not all deforested areas regrow with the same quality, i.e. the same ecological integrity.

Ecological integrity is an ecosystem's ability to support a community with species composition, diversity, and functional organization comparable to natural habitats. In other words, the more similar the regenerating ecosystem is to natural systems, the greater its ecological integrity.

Natural regeneration with high ecological integrity occurs where there is little or no anthropogenic impact and the process of **ecological succession** can occur without barriers to seed dispersal and plant development. Intensive, extensive and long-term land use (such as repeated fire or use of heavy machinery), and forest fragmentation reduce the ecological integrity of natural regeneration and, thus, its ability to restore biodiversity and **ecosystem services**.

Regenerating forests with high ecological integrity regenerate quickly and have high species diversity. Forests with low ecological integrity regenerate extremely slowly and are dominated by few species. They are unable to restore ecological processes. Therefore, successful large-scale forest restoration requires an understanding of the drivers of ecological integrity and the ecological indicators adequate to monitor it.

Nature-based solutions: are strategies that integrate environmental, social and economic benefits through biodiversity recovery and ecosystem services provision to address current societal challenges.

ASSESSING THE ECOLOGICAL INTEGRITY OF NATURAL REGENERATION

Assessing the ecological condition of a given area requires comparing its diversity, function, and structure with reference values. Reference values are extracted from forests regenerating under little or no human influence, which are following a successional pathway closer to the natural one.

The advantage of a comparison to a regenerating forest rather than to a mature forest is that the ecological integrity can be assessed along the successional pathway without needing to wait decades to know if it resembles the mature forest. This strategy allows us to assess whether or not forests at any age are regenerating with high ecological integrity.

At each forest's successional stage and age, regeneration must meet the reference values to be considered of high ecological integrity. The regeneration process can be monitored and evaluated over time using the reference values of a set of **ecological indicators**.

Photo: Catarina C. Jakovac

ECOLOGICAL INDICATORS TO ASSESS AND MONITOR NATURAL FOREST REGENERATION

Vegetation metrics can be used to determine whether naturally regenerating forests are fulfilling the ecosystem restoration goal or require management actions. Vegetation metrics should be sensitive to changes in ecosystem conditions to serve as ecological indicators, such as biomass, basal area and species richness. To assess the level of ecological integrity, one should compare the values of each ecological indicator in the area with those found in regenerating forests following an optimal successional trajectory that results from low anthropic impact (reference of high ecological integrity).

Ecological integrity has no metric or index. Its interpretation derives from analyzing indicators of diversity, structure, function, and composition altogether. For example, an area may have lower species richness (diversity indicator), but similar biomass (function indicator) and basal area values (structure indicator) compared to the reference trajectory. This area will be considered as having low ecological integrity, requiring specific management actions to increase species richness and achieve the ecological restoration goal.

Natural Regeneration: is the re-establishment of plant populations and communities without human intervention following natural or anthropogenic disturbances. In deforested areas, it is governed by ecological succession. In the context of ecological restoration, the term refers to a passive method that requires no further intervention apart from protecting the area from degradation drivers.

Ecological succession: is the process of ecosystem development and regeneration following disturbances, that involves the replacement of species and life forms over time. Over the course of ecological succession in forest biomes, there is an increase in biomass, diversity and ecosystem complexity.

Ecosystem services: the benefits that ecosystems provide to people, such as carbon sequestration by plants, protection of river waters by riparian forests, and provision of forest products such as timber and food.

Ecological indicators: Ecosystem attributes or measures of environmentally relevant phenomena used to depict or evaluate ecosystem conditions and their changes or to set environmental goals.

Figure 1: Schematic profile illustrating the successional pathway of natural regeneration over time since the deforestation of the mature forest.

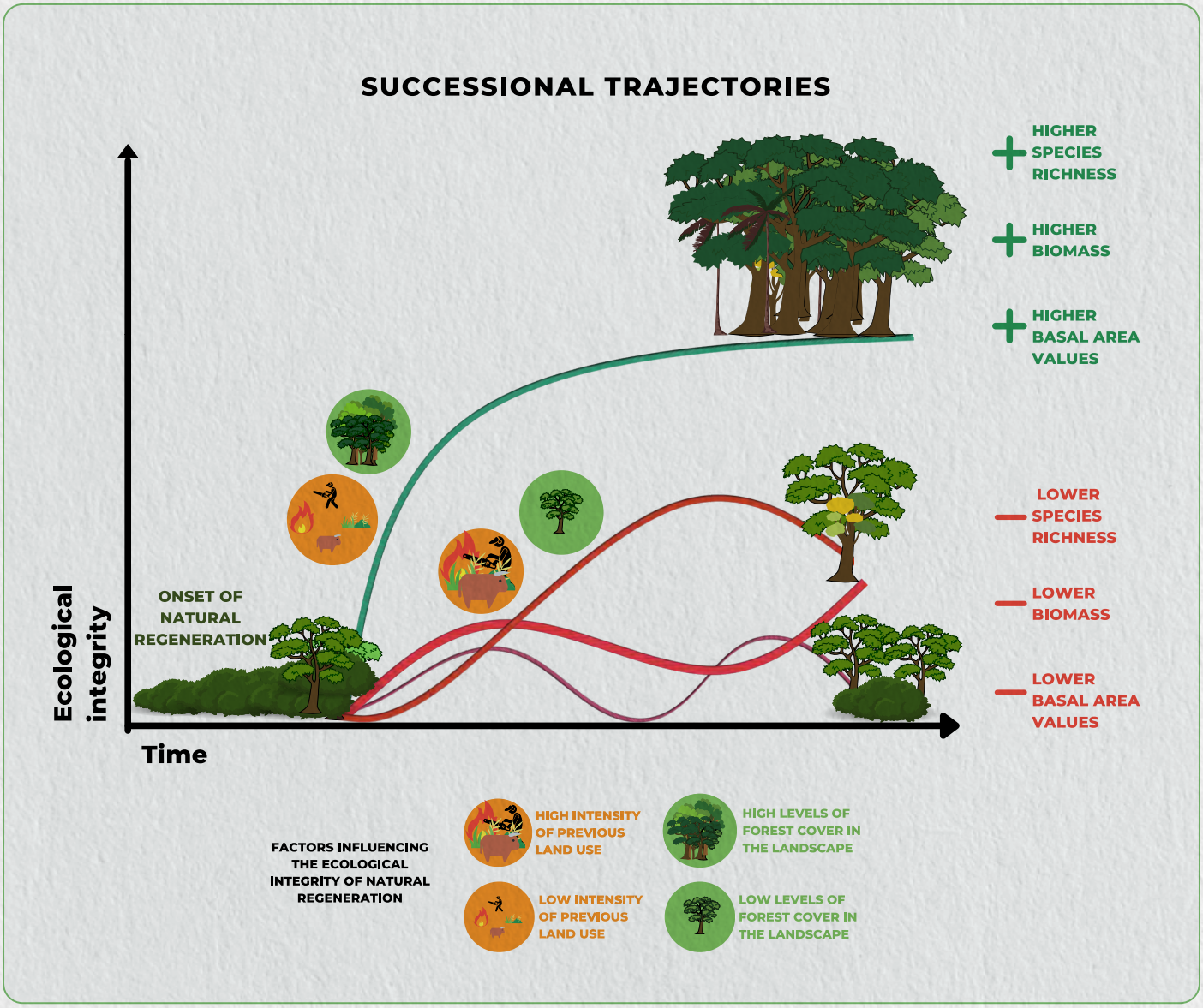

Figure 2: Diagram illustrating the concept of ecological integrity applied to natural regeneration. The green line represents the optimal successional trajectory (high ecological integrity), which occurs at low intensities of previous land use and high levels of forest cover in the landscape, resulting in forests with high values of the ecological indicators (shown on the right of the figure). Red lines represent trajectories with low ecological integrity (EI).

RECOMMENDATIONS

- Use natural regeneration as a method for recovering native vegetation only in areas that experienced the low intensity of previous land use and/or are close to forest fragments;
- Promote the use of natural regeneration in processes for environmental law compliance, ecological restoration in protected areas and other contexts where environmental degradation has been minimal;
- Define easily measurable ecological indicators in federal, state, and local laws to monitor the development of natural regeneration forests and to assess whether restoration is proceeding with high ecological integrity or whether management actions are needed;
- Improve the definition of concepts associated with natural regeneration and their ecological indicators in the Native Vegetation National Plan. These indicators should be sensitive to levels of ecological integrity and applicable to natural regeneration, not just tree plantings;
- Strengthen the discussion on the use of natural regeneration for forest restoration within the National Executive Commission for the Control of Illegal Deforestation and the Restoration of Native Vegetation (Comissão-Executiva para Controle do Desmatamento Ilegal e Recuperação da Vegetação Nativa-CONAVEG, in Portuguese), including mechanisms for monitoring the ecological integrity of large-scale natural regeneration in public lands.

ABOUT THE PROJECT

The Regenera-Amazonia Project has identified, compiled and synthesized results from field research, scientific literature and remote sensing data to propose a concept of ecological integrity of regenerating forests and identify good indicators and reference values for assessing the ecological integrity of natural regeneration in the Amazon Region.

ABOUT SinBiose

The Brazilian Synthesis Center on Biodiversity and Ecosystem Services (SinBiose) supports the development of knowledge synthesis to tackle current issues in biodiversity and ecosystem services. The initiative is led by CNPq, with the support from the Ministry of Science, Technology and Innovation (MCTI) and state research foundations. Learn more at www.sinbiose.cnpq.br


Photo: Catarina C. Jakovac

References

Jakovac, C. C., Junqueira, A. B., Crouzeilles, R., Peña-Claros, M., Mesquita, R. C. G., & Bongers, F. (2021). The role of land-use history in driving successional pathways and its implications for the restoration of tropical forests. Biological Reviews, 96(4), 1114–1134. https://doi.org/10.1111/brv.12694

Poorter, L. et al. Multidimensional tropical forest recovery. *Science* 374.6573 (2021). 1370-1376. https://doi.org/10.1126/science.abh3629

Rosenfield, M. F., Jakovac, C. C., Vieira, D. L. M., Poorter, L., Brancalion, P. H. S., Vieira, I. C. G., de Almeida, D. R. A., Massoca, P., Schietti, J., Albernaz, A. L. M., Ferreira, M. J., & Mesquita, R. C. G. (2023). Ecological integrity of tropical secondary forests: concepts and indicators. Biological Reviews, 98(2), 662–676. https://doi.org/10.1111/brv.12924

Contact Information:

Rita Mesquita, Regenera Principal Investigator, National Institute of Amazonian Research. E-mail: rita@inpa.gov.br
Catarina Jakovac, Regenera Co-Principal Investigator, Federal University of Santa Catarina. E-mail: catarina.jakovac@ufsc.br
Marisa Mamede, SinBiose manager, Brazilian National Council for Scientific and Technological Development, marisa.mamede@cnpq.br.

To cite this document:
Catarina C. Jakovac, André Giles e Rita Mesquita. **When is natural regeneration an effective solution for tropical forest restoration?** Sinbiose/CNPq, 2023, 4p. Avaible at http://www.sinbiose.cnpq.br

Produced by: Marisa Mamede, Érica Speglich e Paula Drummond de Castro, in June 2023.

EXECUTORS

SIN BIO SE — SYNTHESIS CENTRE ON BIODIVERSITY AND ECOSYSTEM SERVICES

INPA — INSTITUTO NACIONAL DE PESQUISAS DA AMAZÔNIA — UNIDADE DE PESQUISA DO MCTI

UNIVERSIDADE FEDERAL DE SANTA CATARINA

SUPPORTERS

CNPq — MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO

GOVERNO FEDERAL BRASIL UNIÃO E RECONSTRUÇÃO