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Let it Grow (Back): A Call for the Conservation of Secondary Forests as Medicinal Plant Habitat

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Abstract Costa Rica is widely regarded as a global leader in conservation practices. In the Maquenque National Wildlife Refuge (MNWLR), within Costa Rica's Northern Zone, a strong commitment to conservation has led to protecting highly biodiverse mature forests. However, a significant opportunity to strengthen conservation in this region is being overlooked at a great cost to the local community and environment: the protection of regenerating secondary forests. Secondary forests account for over 50% of global tropical forests and serve vital ecological and cultural functions. Within the MNWLR, many species in the secondary forests provide medicinal value to the rural communities where western medical care is difficult to access. Recent research, however, has shown that secondary forests in Costa Rica are re-cleared within 20 years, before they have accumulated the previously lost biomass and biodiversity. In this paper, we call for conservation and management strategies to incorporate community held knowledge about culturally significant species, and for there to be economic incentives for keeping secondary forests intact and for determining which forests are designated as Protected Areas. We discuss previous research with two trees that are common in secondary forests in the MNWLR (*Vismia macrophylla* and *Pentaclethra macroloba*), recognizing that these are some of the many species that have great potential to both the ecological and social communities. While our focus area is in the Northern Zone of Costa Rica, the integration of community use and local knowledge into conservation should be a global priority.

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Introduction

The impacts of deforestation coupled with the escalating impacts of climate change comprise a global emergency with serious implications for forest ecosystems and the Indigenous peoples and local communities (IPLC) who inhabit them. When the United Nation's biodiversity conference concluded on December 19, 2022, over 190 nations finalized a landmark agreement to preserve 30% of the planet's land and oceans as a means to protect the world's biodiversity by the year 2030. Importantly, this 30x30 agreement recognizes the traditional knowledge held by IPLC as integral parts of conservation decision making (Einhorn 2022). In the years leading up to this agreement, there was vigorous discussion of the importance of recognizing IPLC rights to territories and local community lands. IPLCs are the stewards of at least half the world's land, and their territories have some of the planet's richest biodiversity. In tropical forests, rates of deforestation and degradation are lower in areas traditionally owned, managed, used, or occupied by Indigenous peoples compared to other areas (Sze et al. 2022). The Nature Conservatory, therefore, argued that "The 30x30 target is only achievable if the rights and territories of IPLCs are fully integrated" (Dudley and Stolton 2022:27).

Unfortunately, the finalized agreement does not explicitly recognize IPLC lands and territories as a separate category of conservation areas. Therefore, organizations such as Amnesty International fear that they will not be protected from "…the predations they often experience in areas such as state-run national parks" (Amnesty International 2022).

Conservation efforts often fail to recognize the connections between local communities, biodiversity, ecological services, and economics. Furthermore, these efforts in tropical ecosystems have historically focused on primary, or old-growth forests. There is a commonly held belief that these ecosystems are "pristine" and characterized by greater levels of biodiversity than secondary forests that are recovering from disturbance, yet these previously damaged systems are essential habitat for biodiversity and provide vital ecosystem services (Chazdon 2014). With secondary forests now constituting more than half of the remaining tropical forests (Reid et al. 2019; Taylor et al. 2017), these ecosystems have risen recently as a global conservation priority. In fact, over the past two decades, there has been a significant increase in the research and interest in the role that tropical secondary forests play in local economies, species conservation and climate change mitigation (Chazdon 2014; Sheil et al. 2016; Taylor et al. 2017).

Through this perspectives paper, we call for community-based conservation efforts in Costa Rica that integrate local ecological knowledge into the management of secondary forests. We believe that knowledge of cultural uses of plants, such as for medicines, should be incorporated into land management decision making, specifically regarding forests that are designated as Protected Areas (PAs). Our perspective is based on our work in the Northern Zone of Costa Rica, where great strides have been taken by the government to conserve primary, or old-growth forests, but less of an emphasis has been on the conservation of secondary forests which house a great diversity of culturally significant plants.

Secondary forests have often become the predominant forest type in many tropical areas due to the destruction of old-growth primary forests. This shift in ecosystems, and the general proximity of these recovering forests to human population centers, has led local communities to rely heavily on secondary growth for resources. Indeed, ethnobotanical studies of the neotropics have found that IPLCs recognize secondary forests' wealth of medicinal species; and use these forests far more than adjacent old-growth forests (Chazdon et al. 2009, 2021; Chazdon and Coe 1999; Shebitz et al. 2020). This is particularly true in the Northern Zone of Costa Rica, where Chazdon and Coe (1999) found that secondary forests had a significantly higher density and relative abundance of medicinal trees compared to old-growth and selectively logged forest stands. The protection of these regenerating secondary forests therefore offers a significant opportunity to strengthen conservation efforts and have substantial benefits to local communities and environments.

Costa Rica's Forest Conservation Program

Costa Rica is widely regarded as a global leader in sustainability and land conservation. Over the past three decades, the country has taken strong actions to protect primary forests and limit agricultural expansion. These efforts were a response to over a half century of heavy land use and exploitation, with deforestation reaching 70,000 ha/yr in the 1970s. In 1985, national forest cover fell to its lowest point, with only 24.4–29.5% of forests remaining (Tafoya et al. 2020).

A nationwide ban on deforestation that was adopted in 1996 provides few exceptions for acceptable deforestation and allows only regulated logging under the country's guidelines for sustainable forestry (Fagan et al. 2013; Steed 2003). With 143 terrestrial PAs reported in the World Database on PAs, 28.4% of the country's land is now recognized as a PA. In addition, there are 51 biological corridors that have been identified in the country, which amounts to more than 38% of its land cover. The San Juan-La Selva Biological Corridor (SJLS) was created in 2001 to connect six highly biodiverse regions covering over 1,204,812 ha of Costa Rica's Northern Zone. The land use history in the SJLS is characterized by intensive agriculture following human colonization and associated deforestation in the 1970s and 1980s, which predated the 1990s forest conservation efforts (Shaver et al. 2015). The Maquenque National Wildlife Refuge (MNWR) is the nucleus of the SJLS and consists of 50,000 ha of various ecosystems, including humid Atlantic lowland primary and secondary forests. The MNWR contains the highest percentage of forest cover and has the most valuable habitats for biodiversity within the region (Chassot et al. 2005). Banning clear-cutting and establishing the SJLS to conserve primary forests' biodiversity have been essential efforts. Indeed,

research has shown that forest protection efforts in northern Costa Rica have likely slowed mature forest loss and succeeded in re-directing expansion of cropland to areas outside mature forest (Fagan et al. 2013).

Throughout Costa Rica, designating PAs has been successful at limiting agricultural expansion into forests, but establishing these PAs in productive agricultural regions can negatively impact the local economy by limiting income (Fagan et al. 2013). Therefore, Costa Rica has tried to implement other programs to reverse the trend of tropical deforestation including promoting ecotourism and Payments for Ecosystem Services (PES) that incentivize landowners to retain forest cover to compete with the returns from agriculture (Fagan et al. 2013; Tafoya 2020). In the 1996 Forestry Law, a voluntary PES system was established, using revenue from the 15% tax on fossil fuels. The diverse portfolio of PAs, PES and ecotourism has fostered an increase in forest cover from 24.4% in 1985 to over 50% by 2011, including over 237,550 ha of land enrolled in PES contracts and 32 national parks and 230 other PAs (Tafoya et al. 2020). Community support is the key to success for PA and community incentive programs such as PES. Therefore, Tafoya et al. (2020) argue that "…it is essential to improve understanding of which initiatives are more likely to not only encourage local participation, but also ensure that participation results in maintaining tropical forests and their ecosystem services they provide" (Tafoya et al. 2020:2).

The 1996 Forest Law was successful at banning the clearing of forests in Costa Rica, within the definition of a "forest" as having at least 70% cover over 2 ha and having 60 tree species that are greater than 15 cm DBH and have varying ages and sizes (Chazdon et al. 2007). This definition, however, does not include most naturally regenerating, or secondary forests, even some that may be over 15 year of age (Miller 2006). Perhaps because of this strict definition for forest protection as well as a lack of adequate enforcement, recent research has found that secondary forests in Costa Rica have short lifespans with approximately half of the country's secondary forests re-cleared within 20 years and 85% re-cleared within 54 years of regrowth (Reid et al. 2019). These shortened lifespans negatively impact Costa Rica's secondary forest biodiversity, ecosystem functions, and the IPLC who rely on them. Secondary forests that are undergoing natural regeneration following agricultural use are socio-ecological systems in transition, i.e., experiencing a series of non-linear societal and biophysical changes (Lambin and Meyfroidt 2010). When conditions are favorable and the natural vegetation regenerates over decades, this system is likely to recover the site's original structural and functional properties, restoring ecosystem function and services (Chazdon et al. 2021; Reid et al. 2019). However, in the presence of negative external pressures and a depletion of essential resources in the forest system during post-agricultural recovery, the resulting degradation can lead to a major loss of ecosystem functions, often with cascading effects (Lambin and Meyfroidt 2010). For example, soil erosion can lead to sediment and nutrient discharges that ultimately deteriorate soil and water quality (Pacheco et al. 2021) leading to an environment that is less suitable for restoration.

While Costa Rica celebrates that mature forest loss has decreased 40% in its Northern Zone, the region's pineapple production has tripled since the early 2000s. Fagan et al. (2013) used satellite imagery of the region to determine that despite Costa Rica's deforestation ban protecting primary forests, intensive agriculture has replaced unprotected forests, including secondary forests and wetlands. Additionally, agriculture's reliance on monocultures (e.g., pineapple or banana) and chemicals threatens the remaining forests.

An Example of Local Knowledge that Can Inform Conservation

In the summer of 2015, the authors of this paper were part of the Research Experience for Undergraduates (REU) program for Ecosystem Studies in the MNWLR of Costa Rica funded by the National Science Foundation of the United States. Participants and researchers explored and studied a remote, densely forested area in northern Costa Rica at a town called Boca Tapada (population approximately 250), 15km south of the Nicaraguan border. For six weeks, the group slogged through mud and torrential mid-day rains, exploring the diversity of the lowland tropical wet forests, and trying to absorb the expertise and plant names shared by Israel Mena, a traditional healer who is recognized by botanists as an expert in the local forest ecology (Shebitz et al. 2013, 2020; Zamora, personal communication 2010). Due to the proximity of the northern border, much of the "local knowledge" in this region is influenced by Nicaraguan

immigrants who have been arriving in Costa Rica since the United States occupied Nicaragua between 1927 and 1932 (Mitchell and Pentzer 2008). Here, the Costa Rican and Nicaraguan cultures blend, particularly their shared use of plants, thus deepening the plant knowledge pool (Shebitz et al. 2013). Even though local cultures rely on many of the 12,000 species of Costa Rican plants as medicine, the vast majority of their medicinal properties are undocumented in scientific literature (Gargiullo et al. 2008).

The Laguna del Lagarto Eco-lodge in Boca Tapada, where we stayed during our 2015 fieldwork, is within the MNWLR and is an ecotourism escape for those interested in rare tropical birds and getting far away from other tourist destinations. The Lodge is surrounded by two ecologically distinct forests: the primary forest, relatively undisturbed by humans, and the secondary forest, a large tract of previously untouched primary forest that was cleared in the early 1990s for cattle grazing and has been regenerating naturally since. When we sampled, these secondary forests were approximately 20 years old. Surrounding these forests are vast acres of pineapple and cattle pastures that are increasingly encroaching upon the remaining protected forests.

The rapid secondary forest deforestation rate in the Northern Zone has led local people to recognize the urgent need to conserve and promote the cultivation of medicinal species by sharing these species' medicinal value. This need is further emphasized by Dr. Nelson Zamora, a leading botanist in Costa Rica, who stated that there is poor documentation of the identity, ecological requirements, and distribution of many culturally significant species (Shebitz et al. 2013). Therefore, deforestation represents more than the loss of the forest, it represents the unjust and physical loss of the local peoples' culture and identity.

As part of an earlier REU project, Shebitz and students documented 60 medicinal plants that were used as medicine by Boca Tapada's healers. They documented that half of the plants used were found in the forest and the other half were cultivated or found along roadsides. Of those growing in the forest, the majority occur in the secondary forests and were recognized by local healers as being important for treating a wide range of ailments including gastritis, skin infections, colds/fevers, anemia, cancer, snake bites and diabetes (Shebitz et al. 2013).

In Boca Topada the closest doctor's office is over two hours away by car, over unpaved roads that are often obstructed by flooding or tree falls. Western -trained medical professionals visit the region monthly, but lack the time or resources to treat the needy. Therefore, Boca Topadans often use the medicinal plants in the adjacent forests. Our main participant in the initial ethnographic survey, Israel Mena, has had minimal formal education, yet he can identify every tree, liana and understory plant in the forest and describe its ecological role and medicinal use (Zamora, personal communication 2010).

In the summer of 2015, our research objective was to document the cultural and ecological role of species that were identified as being important for skin infections. We focused on two trees that are common in early succession (*Vismia macrophylla* and *Pentaclethra macroloba*) as a means of taking an ethnobotanical approach to ecological research. Israel explained their medicinal preparation and use amongst local communities: the two trees are applied to the skin to treat fungal skin infections. Israel harvested the inner bark with a machete, using a palm leaf to catch falling bark shavings.

Ecologically, both species are early colonizers of recently disturbed forests. They are also some of the first species to grow within the forest gaps of the primary forests resulting from storm damage or logging road clearings (Eaton et al. 2020; Shebitz et al. 2020). To learn more, we worked collaboratively to evaluate the effects that the trees had on reclaiming soil nutrients and fostering plant diversity in the primary as well as in the secondary forests as they recovered from disturbance (Eaton et al. 2020; Shebitz and Eaton 2013; Shebitz et al. 2017, 2020). As a Nitrogen (N)-fixer, *Pentaclethra* is both a strong competitor to early successional plants and a facilitator of N inputs into the surrounding soils. While it is recognized as a "climax" species, it is also prevalent in early succession in the Northern Zone of Costa Rica (Taylor et al. 2017). *Vismia,* which is not a N-fixer, was documented as a pioneer species that thrives in secondary forests and within gaps of primary forests. While we did find that it takes advantage of light and lower densities of neighboring plants, *Vismia* did not apparently limit the growth of competing species (Shebitz et al. 2020),

Our research focused on the ecology and ethnobotany of these two species, and we realized that they are important players in succession and

recovery in a way that is part of a dynamic human-environmental system (Eaton et al. 2020; Shebitz et al. 2020). We believe that by understanding the ecological and cultural importance of individual species, we can better understand the value of secondary forest ecosystems. As relatively common species in our study site, *Vismia* and *Pentaclethra,* as well as the secondary forests that they are a part of, are not recognized and protected under current policies. They therefore can serve as a means for us to consider the importance of conservation policies to incorporate culturally and ecologically important plant species so that they can continue to be sustainably used by the local community.

Uniting Three Community-based Conservation Strategies: PAs, PES, and Ecotourism

Creating PAs, such as the SJLS is an effective method of conserving tropical biodiversity, but it cannot be the single conservation strategy employed. In fact, as Tafoya et al. (2020) point out, countries are often ill equipped to effectively safeguard PAs, especially where people rely heavily on natural resources for subsistence and environmental laws are regularly broken. In those situations, conservation policies that focus on local communities by providing economic incentives have become increasingly important tools (Reid et al. 2019, Tayofa et al. 2020; Allen et al. 2021). Without inclusion of local communities in decision-making and management responsibilities, PA rules are not upheld when the control of land is not ceded to local people. Tafoya et al. (2020) therefore advocate for providing incentives for local community participation in order to improve tropical forest conservation.

In addition to PAs, Costa Rica's other approaches include 1) PES programs that financially reward landowners who protect their forests, and 2) embracing ecotourism that increases local profits, protects biodiversity, and minimizes tourists' ecological harms. Through the integration of these approaches into environmental protection policies, Costa Rica has reversed primary forest deforestation and restored forest cover more than 50% in 2011 (Tafoya et al. 2020). Despite this success, we believe that there is an opportunity for these approaches to incorporate more local and Indigenous knowledge into the management of the secondary forests that provide great ecological and cultural benefits.

Over 2.6 million tourists annually contribute $2.85 billion to Costa Rica's economy, constituting a third of the country's national revenue. Despite the financial benefits of ecotourism, scholars have long questioned the negative ecological and social effects of tourism on forest degradation, stress on wildlife, and increasing inequality on tourist areas and local communities (Tafoya et al. 2020). Ecotourism often favors landowners who conserve their forests or who market their ecolodges to tourists over the local community. This economic disparity unjustly fails to serve the local people who often have the greatest needs (Hunt and Stronza 2011). So, while ecotourism can provide some much-needed jobs to remote regions like Boca Tapada, there is no direct link between incentive funds and the communities. The people who rely on forests for medicine, natural resources, and their cultural practices must therefore also rely on a landowner's (private or government) financial or ethical motivation to choose forest conservation over agriculture or logging. This dynamic further entrenches the unjust power dynamic between socioeconomic classes wherein lower-income locals' health, culture, and means are at the landowner's whims.

To educate and persuade decision-makers to conserve forests, environmental economists have begun assigning economic value to biodiversity and ecosystem services. PES programs compensate landowners for ecosystem services including carbon sequestration, hydrological services, biodiversity protection, and provisioning of scenic beauty. Yet their implementation has yielded mixed results with some researchers claiming that government-coordinated PES cause negligible or modest reversals of deforestation while smaller-level and user-financed PES programs are effective (Pattanayak et al. 2010; Tafoya et al. 2020). There is also increasing recognition that the definition of ecosystem services is culturally constructed and context-dependent, based on value systems that in turn determine the value of ecosystem services. Therefore, there are inherent issues with PES, which make ecosystem services reducible to a simple monetary exchange that can be incorporated into policy (Allen et al. 2021). The Millennium Ecosystem Assessment defines Cultural Ecosystem Services (CES) as "the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values" (MA 2005:40). CES are defined by the relationship between diverse cultures and their

local governments and must include the historical and cultural complexity that defines IPLC's interactions with, and valuations of, their ecosystems (Allen et al. 2021).

Within the SJLS, the government gives PES as conservation incentives to landowners to maintain forests by not clearing their land for agriculture (Tayofa et al. 2020). The SJLS is targeted for PES because of the population's lower socioeconomic power and because its geography is suitable for linking national parks. In their research, Tayofa et al. (2020) applied an integrated social-ecological approach to measure deforestation, primate diversity and abundance, and local community participation in conservation incentives across various regions of Costa Rica. They found that despite these incentives, from 2001-2017, the SJLS region experienced a loss of 5.19 km^2 of forest annually, totaling a loss of 82.97 km^2 of forest. Of that total, the vast majority, 78.65 km^2, were in non-PAs, such as secondary forests. The authors explained that of the four regions they evaluated, the SJLS had the second lowest level of local community participation (44%) and second highest deforestation rate, with most of this deforestation occurring in its non-PAs (94.97% of total deforestation). Public participation is a necessary component for PES's success, and should be prevalent throughout the PES development and implementation process. Allen et al. (2021:16) recognized a "thin line between research, community engagement and environmental action" and argue that inviting stakeholders to participate in discussion and deliberation through workshops that establish community values for ecosystem services and associated challenges can help in "developing shared action steps towards CES conservation".

With our work focusing on culturally useful species, it is important to note that despite medicinal plants being listed as a provisioning ecosystem service in the United Nations Millennium Ecosystem Assessment of 2005, they are not emphasized within the PES system. Scholars such as Sucholas et al. (2017) argue that local communities' medicinal plants should be recognized as part of the PES framework. It is possible that if the SJLS stakeholders were to engage in dialogue to elucidate cultural values for ecosystem services as they did in Allen et al.'s (2021) workshops in the rural Central Pacific region of Costa Rica, these stakeholders would understand and incorporate more of the culturally significant services that the secondary forests provide. In addition to the medicinal importance of many of the secondary forest plants, the forest ecosystems in Northern Costa Rica provide a rich diversity of useful species for timber and construction materials, food, thatch, firewood, hunting and crafts (Chazdon and Coe 1999). While some may argue that these cultural traditions associated with harvesting necessary resources are invaluable, an economic view may help public and private land decision makers to understand the true value of ecosystem services and biodiversity and therefore support that local and Indigenous communities have the means and access to sustainably use and care for nature (Sucholas et al. 2017).

It is not uncommon for conservation professionals and the media to refer to invaluable and largely untapped sources of new pharmaceutical products as further rationale for protecting tropical forests (Caniago and Stephen 1998). Despite the reliance of 80% of people in developing countries on traditional medicines, discussions in non-subsistence cultures tend to highlight only the global consequences of biodiversity loss for pharmaceutical development, making little or no mention of the local consequences of biological impoverishment for the health care of local communities who depend on plant-based medicines (Shanley and Luz 2003). So, while the loss of potential resources for the pharmaceutical industry can rightly be understood as an *additional* harm of deforestation, it is unjust to view it as the *primary* harm to human enterprise, especially as local communities such as Boca Topada depend heavily on secondary forests for their medical needs.

Global demand for medicinal plants continues to increase by 8-15% annually (Chen et al. 2016). Although we advocate for medicinal plants to be valued as part of the PES system, it is essential that assigning economic value to plants does not open the secondary forests to widespread pharmaceutical bioprospecting. On the contrary, the conservation and sustainable use of these species should be prioritized. With increasing demand for herbal medicines, approximately 15,000 of the 50,000-80,000 flowering plant species used as medicine globally are threatened with extinction from overharvesting and habitat destruction (Chen et al. 2016). Both *Vismia* and *Pentaclethra* are relatively common in the Northern Zone of Costa Rica, but it would be incredibly detrimental to their population and their forests if they were subject to indiscriminate and uncontrolled

collection. The protection of secondary forests allows for a *in situ* conservation opportunity (Chen et al. 2016; Shebitz et al. 2020) to protect these plant species, and the intricate network of ecological and cultural relationships that they foster. While we do advocate for an economic value to be placed on medicinal plant species in the secondary forests as a conservation strategy, it is essential that this value prioritizes the sustained local harvesting accessibility and use.

Applying Martin Lipton's "*The New Paradigm*" (2016) reasoning could advance the interest of all forest stakeholders. This essay has become an emerging corporate governance framework in which Lipton argues that corporations responding to economic pressures have errantly maximized their short-term gains at the expense of "long-term value and the local and national communities in which they operate." Instead, corporations should reject actions or policies that threaten sustained, long-term growth and embrace stewardship to maximize long-term value. Lipton's analysis parallels the story of deforestation: as economic pressure mounted, landowners (managers) have for too long errantly maximized their short-term gains by allowing agricultural interests to clear-cut forests at the expense of "long-term value and the local and national communities in which they operate."

Like the corporations in Lipton's analysis, if IPLCs are central to conservation decision-making, they may realize long-term value. By embracing community-based stewardship in their forest management practices, private and public land managers might favor sustainable bioprospecting, paying local communities for their deep medicinal plant knowledge, and lobby for stronger conservation systems before deforestation occurs. There is potential for landowners, local communities, and the government to all recognize stronger long-term returns by integrating local knowledge into conservation decision making.

Conclusion

While each tree that is cut down within a remaining patch of forest is a loss for the local ecological, economic, and social communities, the global loss of forest cover represents a crisis for climate stability and biodiversity conservation, as well as a devastating humanitarian disaster. The United Nations (2021) estimates that 1.6 billion people, or 25% of the global population, rely on forests for their subsistence needs, livelihoods, employment, and income. The potential human impacts of deforestation underscore the data's staggering nature: in the two decades between 1980 and 2000 alone, 100 million ha of tropical forest were lost (UN 2021). Over 12 million ha of tropical forests, including 4.2 million ha of undisturbed primary tropical forests were lost in 2020 (World Resources Institute 2022). The remaining 7.8 million has were secondary forests that were destroyed during their transition, before they were given the time to recover.

We advocate expanding tropical forest protection to secondary forests under the PA system. In the face of deforestation, there must be a greater emphasis on incentivizing and empowering long-term forest management. Moreover, these incentives must benefit local communities by ensuring that they can sustainably use the forest's resources.

Secondary forests are considered the "forests of tomorrow" (Chua and Potts 2018), but they are the forests of today too. Allowing them to fully develop as PAs presents a unique opportunity to implement community-based conservation efforts. As local people continue to sustainably harvest resources from the forests, the forests simultaneously mitigate climate change and foster biodiversity. But deforestation will inevitably force these local communities to increasingly depend on a vanishing resource. It is therefore essential to gain a deeper understanding of the social and ecological benefits of these young forests and ensure their continued global presence.

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