Chapter 27 In Brief

Conservation measures to counter the main threats to Amazonian biodiversity

Grande área de garimpo com dezenas de barracões, rio Uraricoera, Terra Indígena Yanomami (Foto: Bruno Kelly/Amazônia Real)

THE AMAZON WE WANT
Science Panel for the Amazon

Conservation measures to counter the main threats to Amazonian biodiversity

Jos Barlow[a], Alexander C. Lees[b], Plinio Sist[c,d*], Rafael Almeida[e], Caroline Arantes[f], Dolors Armenteras[g], Erika Berenguer[a,h], Patrick Caron[d], Francisco Cuesta[i], Carolina Doria[j], Joice Ferreira[k], Alexander Flecker[e], Sebastian Heilpern[l], Michelle Kalamandeen[m], Nathália Nascimento[n], Marielos Peña-Claros[o], Camille Piponiot[p], Paulo Santos Pompeu[q], Carlos Souza[r], Judson F. Valentim[s]*

Key Messages & Recommendations

1) The Amazon's biodiversity and ecosystem functioning are threatened by a broad range of drivers originating within the basin and worldwide.
2) These include cattle ranching, agricultural expansion, and land speculation; hunting and overfishing; climate change; inappropriate infrastructure; mining and energy generation; invasive species; war and unrest; pollution; and the fragmentation of watercourses by small dams and impoundments.
3) Stressors often co-occur in the same regions, which can amplify their effects or create new problems.
4) Given this complexity, there is no single or simple solution to solve the Amazon's socioenvironmental problems. Instead, a broad set of initiatives need to be readopted, replicated, and scaled up, leveraging the Amazon's socioeconomic, cultural, and ecological complexity.
5) Actions taken within the Amazon must be accompanied by changes in non-Amazonian countries and regions, to limit climate change and avoid exporting environmental harms such as deforestation and river fragmentation.

Abstract Human activities destroy biodiversity and disrupt the functioning of aquatic and terrestrial ecosystems at different levels. This chapter provides sustainable approaches to address some of the biggest threats to the Amazon's biodiversity and ecosystems, i.e., deforestation, damming of rivers, mining, hunting, illegal trade, drug production and trafficking, illegal logging, overfishing, and infrastructure expansion. The role of restoration is addressed in Chapters 28 and 29.

Habitat loss and ecosystem degradation resulting from cattle ranching, agricultural expansion, and land speculation Deforestation, forest degradation, and the conversion of non-forest ecosystems threaten native biodiversity across the Amazon (Chapter 19).

Where deforestation is the major threat, conservation actions can be developed around the adoption,

[a] Lancaster Environment Centre, Lancaster University, Lancaster, UK, jos.barlow@lancaster.ac.uk
[b] Department of Natural Sciences, Manchester Metropolitan University, UK
[c] Agricultural Research Centre for International Development – France. CIRAD, sist@cirad.fr
[d] Université de Montpellier, UR Forests & Societies, Montpellier 34398, France
[e] Department of Ecology and Evolutionary Biology, Cornell University, 616 Thurston Ave., Ithaca NY 14853, USA
[f] Division of Forestry and Natural Resources, 325G Percival Hall, 1145 Evansdale Drive, West Virginia University, USA.
[g] Departamento de Biología, Facultad de Ciencias, Universidad Nacional de Colombia, Bogotá, Colombia.
[h] Environmental Change Institute, University of Oxford, Oxford, UK.
[i] Grupo de Investigación en Biodiversidad, Medio Ambiente y Salud - BIOMAS - Universidad de Las Américas (UDLA), Quito, Ecuador
[j] Laboratório de Ictiologia e Pesca, Departamento de Ciências Biológicas, Universidade Federal de Rondônia (UNIR), Porto Velho, Brazil
[k] Embrapa Amazonia Oriental, Trav. Eneas Pinheiro, Belém, Brazil
[l] Department of Natural Resources, Cornell University, USA
[m] School of Geography, University of Leeds, Leeds, UK
[n] Universidade Federal do Espírito Santo - UFES, Instituto de Estudos Climáticos, Vitória, Espírito Santo, Brazil.
[o] Forest Ecology and Forest Management Group, Wageningen University & Research, Wageningen, The Netherlands
[p] Smithsonian Conservation Biology Institute & Smithsonian Tropical Research Institute, Republic of Panama
[q] Departamento de Ecologia e Conservação, Instituto de Ciências Naturais, Universidade Federal de Lavras, Lavras, MG, Brazil.
[r] Instituto do Homem e Meio Ambiente da Amazônia (IMAZON), Belém, PA, Brazil.
[s] Agroforestry Research Center of Acre, Embrapa Acre, Rodovia BR-364, Km 14 (Rio Branco/Porto Velho), Rio Branco AC 69900-970, Brazil

replication, or return to interventions that were successful in the past or in other regions. These include (i) near-real-time monitoring of forest loss across the basin, (ii) effective on-the-ground enforcement actions, (iii) use of sanctions as allowed under environmental laws and credit restrictions for landholders in high deforestation zones, (iv) soy and cattle moratoria, (v) incentives for agricultural systems that avoid deforestation, (vi) the expansion and genuine protection of protected areas, including sustainable use reserves and Indigenous territories, and (vii) support for and recognition of grassroots actions including community led patrols and mapping.

Advancements in remote sensing can greatly support these interventions, allowing for real-time, finer scale, and higher-temporal resolution assessments of forest loss and an improved ability to track drivers of degradation such as fire and logging. Remote sensing also needs to track the loss and degradation of non-forest ecosystems, which can be much harder to detect.

The success of interventions designed to prevent deforestation and degradation require better governance and reduced corruption at all scales[1,2]. Evaluating the conservation of native vegetation on private lands requires up-to-date land registries (e.g., CAR in Brazil). Reducing the negative impact of commodities that are strongly associated with deforestation, such as beef, soy, and minerals, requires careful governance and transparency to track and remove deforestation from supply chains[3]. This will require changes in governance and financial accountability in countries that import Amazonian products.

Ecosystem degradation resulting from biological resource use

Hunting Illegal hunting of wildlife is widespread and culturally embedded in the Amazon, and represents a major threat to some Amazonian vertebrates and, ultimately, ecosystems. Protecting threatened species from hunting is crucial for their long-term persistence. Still, conservation interventions also need to consider potential impacts on local people for whom hunting is a critical aspect of culture, traditional knowledge, and dietary diversity[4]. Bragagnolo et al. (2019)[5] drew up a series of recommendations to mitigate the impacts of hunting while considering human well-being, including simplifying the process of registering to become a subsistence hunter, and extending licensing schemes and linking them to community-based wildlife management programs. Such actions could be supported by the creation of 'no-take zones' that foster source-sink dynamics[6]. In circumstances where hunting pressure needs to be reduced, interventions could include the provision of alternative livelihoods, modification of game supply chains through substitution, and utilizing education and social marketing campaigns to change the behavior of key demographics[5].

Overfishing Fishing in the Amazon embraces a gradient of intensity, from industrial to artisanal, and uses diverse gear and techniques, with impacts that vary spatiotemporally across different river ecosystems. This can lead to the depletion of stocks, but as with hunting, it disproportionately impacts some species more than others, with the greatest impacts on large-bodied fish. Many large-bodied species are also migratory, posing transboundary management challenges. Solutions that conserve terrestrial vertebrates apply equally to fisheries, with a focus on integrated fisheries management that may include community-based planning, careful stock assessments that consider species life histories, the implementation of no-take areas, and control of commercial activities. Enforcement of existing closed season limits and minimum size requirements would increase popu-lation productivity, limit overexploitation[7], and protect sexually immature individuals to guard against the collapse of fish stocks, even if fishing is not curtailed[8].

Illegal wildlife trade Trafficking is the main driver of declines in many aquatic ornamental fish and some terrestrial species, such as songbirds. *In situ* enforcement could be more effective if supported by additional measures to increase the legality and sustainability of animal-keeping, emphasizing the importance of captive-bred birds[9] and the foundation of pedigree-controlled captive lineages[10].

Illegal Logging Illegal logging can be a major driver of forest degradation, weakening forest resilience to fires and drought[11] and increasing the risk of commercial extinction of the most valuable timber species[12–14]. The greatest challenge for logging is the high prevalence of illegality, even within legal concessions[15,16]. Improved public systems to govern logging and transparent, traceable supply chains are urgently needed[15]. Big data, use of unmanned aerial vehicles (UAV)[17], and DNA technologies could support verification processes[18]. Improvements can also be made by creating stronger forest-related partnerships between multiple actors, including local communities[19].

Ecosystem degradation resulting from climate change and severe weather Climate change and climate extremes are major drivers of ecosystem degradation. Impacts can be direct and immediate, such as droughts that cause widespread mortality of trees and aquatic life[20,21], or damaging floods[22,23]. Extreme climatic events alter the availability of keystone resources, such as fruiting trees[24], and bring about major shifts in wildlife populations[25]. Climate change can also act slowly, over long time periods, altering temperature and rainfall patterns, increasing dry season length[26], and changing vegetation composition[27]. Climate change and climate extremes can also act in concert with other disturbances to increase the likelihood of large scale forest fires[28] and forest dieback[29] (see also Chapters 22-24).

Addressing pervasive climatic drivers is challenging, requiring action to reduce greenhouse gas emissions, including in non-Amazonian countries that have historically emitted the most carbon dioxide. However, actions within the Amazon are also key. First, the Amazon is in itself a critically important global carbon store and potential sink, and land-use change contributes the majority of greenhouse emissions from Amazonian nations. Local management to avoid deforestation and forest degradation and encourage restoration can play a key role in mitigating global climate change if accompanied by emission reductions elsewhere. Second, local management may be key to enabling ecosystems to retain their innate resilience to climatic stress[30]. For example, avoiding logging and buffering forest edges with regenerating forests could help retain humid forest microclimates[31], reducing the risk of forest fires. Stems in intact forests may also be more resilient to fire stress, with lower probabilities of tree mortality[32]. Local management that encourages free flowing rivers could also make aquatic systems more resilient to climate; for example, mega dams and extreme weather interact to exacerbate changes in ecosystem functioning in downstream forests[33].

Infrastructure as a driver of change: Roads and railways Past experience suggests that, without dramatic changes in governance, increasing access to new regions by building or paving roads will result in an inevitable increase in deforestation and environmental degradation (see Chapters 14 and 19). Changes in governance are unlikely in the short term, and have not yet proven effective on smaller scales; therefore, maintaining the Amazon's integrity requires a halt to new road construction and a very cautious approach to improving existing roads. This is especially important when road building or improvement schemes traverse previously inaccessible or remote regions; examples include the IIRSA, the road planned for the 'Calha Norte' of the Brazilian Amazon, and the paving of highways such as BR319 between Manaus and Porto Velho. There needs to be greater consideration of what are good roads (i.e., those important for the local economy and people) and bad roads (i.e., those which open up forest frontiers, encourage land grabbing and a wide range of illegal activities, and are motivated by geopolitical reasons or land speculation). Furthermore, large infrastructure developments must avoid protected areas and Indigenous territories.

Energy and mining as a driver of change Instead of constructing major dams, alternative sources of renewable energy should be harnessed in the Amazon, including off-grid solar[34], biomass, and wind.

Where dams are essential, the focus should be on smaller headwater hydropower stations along tertiary tributaries that minimize impacts on biodiversity[35]. Approval of new dams should also be accompanied by detailed and independent impact assessments and realistic analyses of future energy production under different climate scenarios[36]. Efforts to modernize older hydropower plants could lead to fewer additional ecological and social impacts. Still, a switch to alternative forms of renewable energy will likely provide the greatest benefits.

Gold mining is a source of mercury in river waters. It accumulates throughout the food chain up to humans, especially in populations that rely heavily on fish consumption, leading to severe neurological and motor damage, even in populations living kilometers away from pollution sources (see Chapter 21). These predominantly illegal activities need to be curbed immediately. Although regulated, large-scale mining must consider its indirect impacts – i.e., the increase in deforestation up to 70 km away from the concession are due to human migration (Chapter 19).

Invasive species Knowledge of the impacts of invasive species in the Amazon is limited. To date, most impacts have been demonstrated in riparian systems that experience higher propagule pressure from invasive non-native species. Examples from aquatic (carp and tilapia) and terrestrial (*Urochloa arrecta*, a.k.a. African Tanner-grass) environments demonstrate the need for enhanced biosecurity to stop the spread of invasive species. Monitoring can help ensure early detection, but needs to be accompanied by effective biosecurity protocols that prevent transport of invasive species into the Amazon. This requires coordinated management at various scales and the close cooperation of state and local governments.

Human intrusions: War and unrest Among drivers of deforestation, war and violent conflict affects forests and biodiversity in many countries in Latin America[37–39]. In some cases, armed conflict results in increased rates of deforestation[39,40], due mainly to shifts in land tenure and changes in agricultural practices, including the expansion of illicit crops[41]. In other cases, by limiting the access to the forest, armed groups have inadvertently reduced forest exploitation[42], prevented infrastructure and agriculture development[43], and even facilitated recovery[37]. Post-conflict situations require careful management. In Colombia, after decades of unrest, the recent 2016 peace agreement expanded unsustainable development practices, resulting in an increase in deforestation in some frontier areas. A disproportionate increase in fires was the first signal indicating large-scale forest degradation[44] and transformation at the heart of the key protected areas in the Colombian Amazon[45].

Establishing legitimate government control and governance in former conflict zones, such as in parts of Colombia, is critical to ensure that deforestation rates do not increase during transition periods. In Colombia, this necessitates working with communities in Indigenous territories and lands collectively held by Afro-Colombians to set conservation objectives within the broader context of local development aspirations[41]. These activities are undermined by the murder of environmental and community leaders in Colombia[46] and recent increases in the area covered by illicit crops[45]. Political, technical, and financial support for small farmers to ensure the transition from coca to legal land uses are needed and must be promoted.

Some solutions lie outside of the Amazon. For example, deregulation and legalization of drugs in the developed world would reduce gangs' income and open up opportunities for sustainable development and conservation in regions affected by growing and trafficking[37].

Agricultural, aquacultural, and industrial waste; plastic waste; heavy metals and mercury The Amazon needs a water quality monitoring network that extends across the many different river basins, providing a way of linking changes in quality with changes in biodiversity and ecosystem conditions. This is also key for human communities, given that rivers are the region's chief source of drinking water, and that it is consumed untreated in many areas[47]. Although water is treated for consumption in Amazonian cities, wastewater treatment is often inexistent or ineffectual and requires urgent investment (see Chapter 33). Monitoring also needs to cover industrial and mining zones, such as Manaus (Amazonas) and Barcarena (Pará), respectively, where industrial waste tailing basins pose a major risk to human and ecosystem health[48]. Pollution from these and other mining activities – especially gold mining (see Chapter 21) – needs to be tackled with effective command and control activities. Urgent research is needed to understand the impact of pesticides on biodiversity and ecosystem services in both aquatic and terrestrial ecosystems. Solutions involve more rigorous screening and licensing of chemicals and better training for farmers in their use. These issues are especially pertinent in the south of the basin[49]. Plastic pollution is a growing issue, and country-specific actions (see Chapter 28) need to be supported by basin-wide regulation.

Small dams resulting from agriculture and road infrastructure Watercourse fragmentation in the Amazon is also associated with inappropriate road crossings and culverts. Although these barriers are small, they have landscape-scale consequences for species assemblages[50]; the small reservoirs they create upstream of roads are an important component of instream habitat change[51]. Inappropriate road crossings also isolate aquatic populations by interrupting dispersal pathways[52], potentially hindering recolonization opportunities following extinction events[53,54], and shifting distributions due to climate change[55]. Since many road crossings in the Amazon require annual repairs, replacing them with less-damaging structures (bridges) could have an attractive benefit-cost ratio. Despite growing awareness of the benefits that can be gained from adapting the small but pervasive stream barriers created by road crossings[56], actions required to bring about this change are discouraged by their legal status; these barriers are considered to have a low environmental impact by the Brazilian Environmental Council (CONAMA, 2006, resolution 369).

Ecosystem degradation from interactions between stressors Many of the aforementioned stressors co-occur, and one set of stressors can amplify both the prevalence and impact of other stressors, or create new problems. Forest fires are a key example of such an interaction, as they are encouraged by a combination of local and climatic stressors. While tackling climate change remains a global priority, this is a slow process and preventing forest fires in the coming decades will require conservation measures that address their local causes[58]. Conservation policies need to help farmers adapt existing farming practices to prevent fire use, while considering local perspectives[59]. Fires could also be reduced by preventing illegal logging, as the high offtake rates and lack of pre-cut planning or follow-up management make conventionally logged forests especially vulnerable to fire, due to changes in the mciroclimate[31]. Finally, forest fires can be tackled by enhanced near-real-time monitoring and forecasting of drought intensity and fire risk, especially if linked to responsive, resourced, and capable local fire brigades. Fire brigades are fundamental to effective park management in the Bolivian and Brazilian Amazon, but remain chronically under-resourced[60].

Conclusions Conserving Amazonian ecosystems and species will require a broad suite of measures that address the diverse set of threats and risks encountered. These measures need to be implemented at various scales and jurisdictions; for example, local interventions and changes in national policies within Amazonian countries need to be supported by international commitments to reduce climate change, remove deforestation from supply chains, and tackle illegal trade.

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