



Essay

Progress and challenges in consolidating the management of Amazonian protected areas and indigenous territories

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Abstract: Effective management refers to the ability of a protected area or indigenous territory to meet its objectives, particularly as they relate to the protection of biodiversity and forest cover. Effective management is achieved through a process of consolidation, which among other things requires legally protecting sites, integrating sites into land-use planning, developing and implementing management and resource-use plans, and securing long-term funding to pay for recurrent costs. Effectively managing all protected areas and indigenous territories in the Amazon may be needed to avoid a deforestation tipping point beyond which regional climatic feedbacks and global climate change interact to catalyze irreversible drying and savannization of large areas. At present, protected areas and indigenous territories cover 45.5% (3.55 million km²) of the Amazon, most of the 60–70% forest cover required to maintain hydrologic and climatic function. Three independent evaluations of a long-term large-scale philanthropic initiative in the Amazon yielded insights into the challenges and advances toward achieving effective management of protected areas and indigenous territories. Over the life of the initiative, management of sites has improved considerably, particularly with respect to management planning and capacity building, but few sites are effectively managed and many lack sufficient long-term financing, adequate governance, support of nongovernmental organizations, and the means to withstand economic pressures. The time and money required to complete consolidation is still poorly understood, but it is clear that philanthropic funding is critical so long as essential funding needs are not met by governments and other sources, which could be on the order of decades. Despite challenges, it is encouraging that legal protection has expanded greatly and management of sites is improving steadily. Management of protected areas in other developing countries could be informed by improvements that have occurred in Amazonian countries.

Keywords: effectiveness, evaluation, finance, management, tipping point

Progreso y Retos en la Consolidación del Manejo de Áreas Protegidas y Territorios Indígenas Amazónicos

Resumen: El manejo efectivo se refiere a la habilidad que tiene un área protegida o un territorio indígena para alcanzar sus objetivos, particularmente en cómo se relacionan con la protección de la biodiversidad y la cubierta forestal. El manejo efectivo se logra por medio de un proceso de consolidación, que entre otras cosas requiere la protección legal de los sitios, la integración de los sitios dentro de la planeación del uso de suelo, el desarrollo y la implementación del manejo y los planes de uso de recursos, y asegurar el financiamiento a largo plazo para pagar los costos recurrentes. El manejo efectivo de todas las áreas protegidas y los territorios indígenas en el Amazonas puede ser necesario para evitar un punto de inflexión en la deforestación después del cual la retroalimentación climática regional y el cambio climático global interactúan para catalizar el secado y la sabanización irreversibles en grandes áreas. En el presente, las áreas protegidas y los territorios

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Article impact statement: Effective management of the Amazon's protected areas and indigenous territories is possible but requires a long-term financial and technical commitment.

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indígenas cubren el 45.5% (3.55 millones de km²) del Amazonas, la mayoría del 60-70% de cobertura forestal requerida para mantener las funciones hidrológicas y climáticas. Tres evaluaciones independientes de una iniciativa filantrópica a largo plazo y a gran escala en el Amazonas otorgaron conocimiento sobre los retos y avances hacia la obtención del manejo efectivo de las áreas protegidas y los territorios indígenas. A lo largo de la vida funcional de la iniciativa, el manejo de los sitios ha mejorado considerablemente, particularmente con respecto a la planeación del manejo y la construcción de capacidad, pero pocos sitios tienen manejo efectivo y muchos carecen de financiamiento a largo plazo, gobernanza adecuada, apoyo de ONGs, y los medios para sobrellevar las presiones económicas. Todavía se sabe poco sobre el tiempo y el dinero que se requieren para completar la consolidación, pero está claro que el financiamiento filantrópico es crítico mientras las necesidades esenciales de financiamiento no las cumplan el gobierno y otras fuentes, lo cual podría suceder durante décadas. A pesar de estos obstáculos, es alentador que la protección legal se haya expandido enormemente y el manejo de sitios esté mejorando continuamente. El manejo de las áreas protegidas en otros países en desarrollo podría informarse con las mejoras que han ocurrido en los países amazónicos.

Palabras clave: efectividad, evaluación, financiamiento, manejo, punto de inflexión

摘要: 保护地和原住民领地的有效管理是指其实现目标的能力，特别是涉及生物多样性和森林覆盖的保护。有效管理要通过不断的加强巩固来实现，这需要对保护地和原住民领地的位点进行立法保护、将其整合纳入土地利用计划，发展并实施管理和资源利用方案，保障长期资金投入以支付经常性费用。我们可能需要通过有效管理亚马逊所有保护地及原住民领地来避免森林采伐达到某个临界点，超出这个临界点后，区域气候反应和全球气候变化的相互作用会促使大片地区不可逆地变得干旱并转变为稀树草原。目前，保护地及原住民领地覆盖了亚马逊的45.5% (355万平方公里)，占维持水文和气象功能需要的60-70%森林覆盖的大部分。一项亚马逊长期的大尺度公益项目中的三个独立评估可以帮助我们深入理解实现保护地及原住民领地有效管理的挑战和进展。在整个项目中，保护地及原住民领地的管理有明显改善，特别是在管理规划及能力建设的方面，但得到有效管理的位点还很少，许多位点缺乏足够的长期资金支持、有效的治理、非政府组织的支持，以及抵抗经济压力的方法。我们还不清楚实现加强管理所需的时间和资金，但很明显，只要政府和其它来源的资金不足以满足基本的资金需求，公益资金就至关重要，这一情况可能还会持续数十年。虽然还存在这些挑战，但好在法律保护已经得到很大扩展，对各保护地的管理也在稳步改善。其它发展中国家的保护地管理也可以从亚马逊国家的保护管理进展中获得启示。【翻译:胡怡思;审校:聂永刚】

关键词: 评估，管理，有效性，财政，临界点

Introduction

Deforestation has caused the loss of 13.3% of the Amazon biome's original forest cover (RAISG 2015). Climate scientists hypothesize that there is threshold loss of forest cover beyond which regional climatic feedbacks and global climate change will interact to catalyze the irreversible drying and savannization of large portions of the biome (Nobre & Borma 2009). Most regional and global circulation models indicate this tipping point may occur when 30–40% of natural forest cover in the basin has been lost (Lejeune et al. 2015; Nobre et al. 2016). Avoiding crossing this threshold requires reducing global greenhouse gas emissions to prevent some of the most extreme drying and warming climate-change scenarios for the region (Nobre & Borma 2009), retaining 15–25% of the Amazon's forest cover outside protected sites, and retaining the biodiversity and forest cover within the majority, if not all, of the 45.5% of the biome that is legally designated as protected areas and indigenous territories (RAISG 2015).

Effective management refers to the ability of a site to be managed to meet its objectives as they relate to the protection of biodiversity and forest cover. Whether the

Amazon's protected areas and indigenous territories are managed effectively depends on their context and vulnerability, which are determined by factors such as the level of law enforcement in the region and the ease with which illegal activities can be monitored; pressures on and threats to sites, which can be legal (e.g., tourism) or illegal (e.g., poaching or illegal logging) or internal (e.g., nontimber forest product harvesting by communities living within an indigenous territory) or external (e.g., highway construction); and inputs to management, such as management plans, staff, training, and supplies (Ervin 2003).

We conducted 3 external, independent evaluations of the Gordon and Betty Moore Foundation's Andes Amazon Initiative (AAI), and we drew on these evaluations to review progress in and challenges to improving the effective management of protected areas and indigenous territories across the Amazon. The AAI has invested nearly US\$369 million over 13 years to support the establishment and management of sustainable-use areas, indigenous territories, and strictly protected sites in the Amazon. These funds contributed to the establishment of 640,000 km² of new protected areas and improved management of 1.68 million km² at 256 sites (Fig. 1).

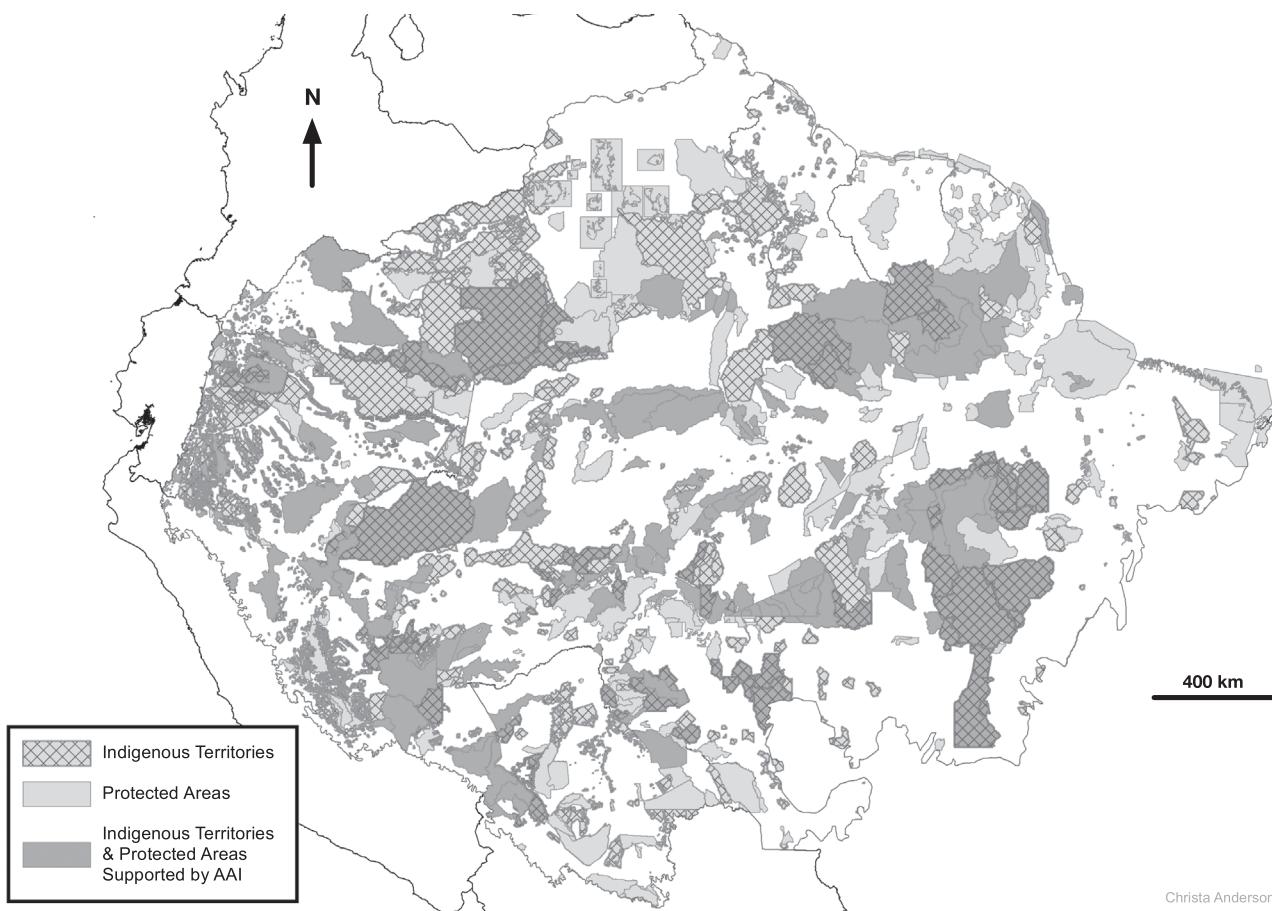


Figure 1. Protected areas and indigenous territories in the Amazon biome. Map developed by Christa Anderson for the Andes Amazon Initiative based on spatial data supplied by RAISG (2015).

The AAI refers to the process of creating the conditions that lead to effective management as *consolidation*. Some of the key components of consolidation include the initial step of legally protecting sites; ensuring recognition of protected areas in regional planning; developing and implementing management and resource-use plans; furthering collaborations with resident and neighboring communities in on-the-ground management; enforcing conservation protections; monitoring biodiversity; and securing long-term funding to pay for recurring costs.

The 3 evaluations, conducted in 2005, 2010, and 2015, helped the foundation understand its progress in creating new protected sites, helped identify the most important remaining barriers to consolidating their management, and improved understanding of how the management requirements for each protected-area category differed (evaluation method described in Supporting Information). The AAI's experience has allowed it to develop at least a partial understanding of the time and money required to consolidate the effective management of all types of protected sites in the Amazon. An improved understanding of this relationship is critical so that

governments, donors, communities, and nongovernmental organizations (NGOs) can determine the magnitude of the challenge, assess its feasibility, and allocate sufficient resources for the job. Given that AAI has financed activities over nearly half of the area of all protected sites in the Amazon, AAI's experience is important in its own right. We also believe the lessons learned are relevant for the consolidation of sites in other developing countries that are trying to improve the effectiveness of protected-area management with limited resources (Bruner et al. 2004).

Establishment of Protected Areas and Indigenous Territories in the Amazon

Protected areas and indigenous territories cover 3.55 million km² (45.5%) of the Amazon biome (RAISG 2015), primarily due to enthusiastic political support over the last 30 years, especially in Brazil and Peru (Supporting Information). This movement has resulted in one of the most significant waves of conservation land-use designations in history, which has been accompanied by substantial improvements in institutional capacity for conservation within governments and the NGO community.

Strictly protected areas include International Union for Conservation of Nature (IUCN) categories I–IV (all nonextractive categories) and cover 11.9% (930,000 km²) of the Amazon (RAISG 2015). In most countries, the creation of strictly protected areas began before the large-scale recognition of indigenous and sustainable-use areas and has carried on at a low level until the present. Today, the establishment of additional strictly protected areas may be politically limited relative to the opportunities to create more sustainable-use areas and the recognition of additional indigenous territories.

Sustainable-use areas include IUCN categories V–VI (direct-use categories) and comprise about 10.0% (780,000 km²) of the biome (RAISG 2015). Extractive uses, such as hunting, fishing, Brazil nut harvesting, or forestry, are permitted in these areas and are state or federally regulated. In Brazil, where most sustainable-use areas are located, establishment peaked in 2006, with the designation of large areas of state and federal production forests and extractive reserves, after which the rate of establishment tapered off substantially (Supporting Information).

Indigenous territories cover more area (28.1%, 2.19 million km²) in the biome than any other protected-area type (RAISG 2015). Slightly more than half of this area is in Brazil, where the legal recognition of indigenous territories began in earnest with the country's return to civilian government (Le Tourneau 2015). In Colombia, 53.3% (260,000 km²) of that nation's Amazon region is designated as indigenous territories (RAISG 2015). Although the amount of titled indigenous lands is already very large, a substantial area of the Amazon is occupied by indigenous peoples but not officially recognized, and there may be more opportunities to recognize these lands, at least in Bolivia, Brazil, and Peru.

Consolidating Management Effectiveness

Once a protected area is established or an indigenous territory recognized, a great deal of work may be required to consolidate its effective management—that is, to put in place the systems and processes required to conserve the area. Doing so may require building institutional capacity, securing funding via government budget allocations and external donor assistance, management planning, scientific research, building stakeholder support among local and national constituencies, finding means to reduce threats from illegal exploitation of natural resources, among others. The best approach to address these needs may vary considerably according to the category of the area. For a conservation donor, the category of a site affects the choice of grantee, the size of their budgets, and the expected time frames for achieving objectives.

For strictly protected areas, management is most clearly aligned with forest and biodiversity conservation

objectives. Donors such as Moore may finance improvements at the systems level (i.e., to government agencies that provide supporting functions to entire portfolios of protected areas) or finance site-level actions to support on-the-ground management. At the systems level, donors may directly fund governments or fund NGOs to work with governments on actions such as establishing long-term financing mechanisms and developing monitoring and evaluation protocols. At the site level, donors may fund basic management activities, especially enforcement against illegal activities. Donors may also fund NGOs to provide site-level support, such as technical assistance in management planning, biological monitoring, or community engagement.

Sustainable-use areas are predominantly state and national production forests or inhabited multiple-use areas (e.g., extractive reserves). The consolidation of production forests requires developing management plans, establishing processes for granting rights to private entities to perform forestry operations, and overseeing their adherence to regulations that protect the forests and ensure appropriate public revenue. Centralized government authorities primarily do this work. Multiple-use areas such as extractive reserves are quite different. People reside in these areas and sustain themselves economically through low-impact use of renewable resources, such as the collection and selling of Brazil nuts (*Bertholletia excelsa*). Inhabitants are the core constituents for protection of the area and its resources, making them de facto stewards of the reserves. But making sustainable-use areas work requires maintaining a resident human population that can sustain itself and has access to basic needs, such as health care and education. In our experience, the technical assistance and advocacy needed to accomplish this work in Amazonian countries is typically undertaken most effectively by NGOs.

Over the last 15 years, the conservation community has increased its work with indigenous territories, but they still do not receive the same level of attention as strictly protected areas. As a result, it is less clear how best to support indigenous groups in improving the management of their lands. We have observed that the capacity of government institutions and NGOs to support consolidation of indigenous territories is weaker than for protected areas. Indigenous territories are arguably the most complex to consolidate because they are not, sensu stricto, conservation areas. Rather, they are traditional lands of culturally distinct communities whose views may vary considerably toward development and conservation. Some believe the cultural values, traditional organization, and communal decision making of many indigenous groups in the Amazon will prevail to preserve a sustainable balance between human populations and nature (e.g., Schwartzman & Zimmerman 2005). But certain groups may prioritize economic development, even if it affects biodiversity and other environmental values (Carneiro da Cunha & de

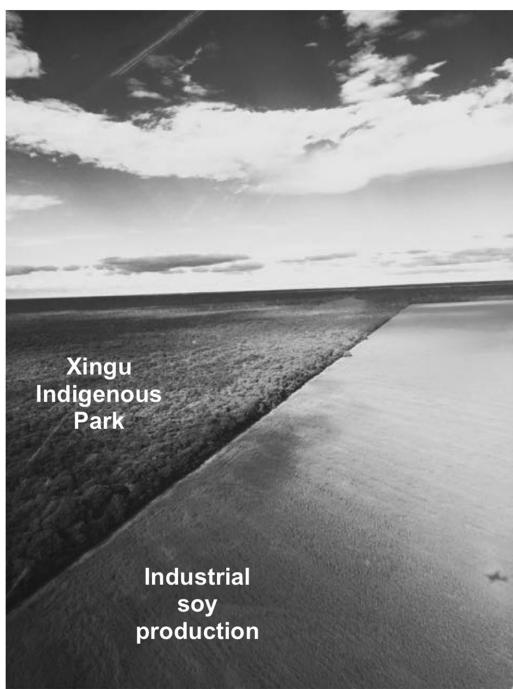


Figure 2. The border between Xingu Indigenous Park, an indigenous territory in southeastern Brazil, and large-scale soybean agriculture. Photo by Jared Hardner (May 2014).

Almeida 2000). The stark contrast between the deforestation caused by commercial soy plantations bordering the expansive natural forests of the Xingu Indigenous Park (Fig. 2) in southeastern Amazon is a palpable example that supports the conservation-oriented view. Similarly, a recent study in Peru shows that titling indigenous lands leads to immediate reduction in deforestation (Blackman et al. 2017). However, indigenous communities are increasingly pressured by illegal miners, loggers, and others seeking to exploit their land and its resources. One of the most effective means through which these interests gain access to indigenous territories is to divide communities by coopting segments of them, which in turn degrades communal decision making and eventually traditional organization. Efforts to undermine indigenous groups have reached a point where some Brazilian politicians have attempted to enact legislation that would weaken the legal basis for indigenous collective ownership (APIB et al. 2016).

Fundamental to consolidating an indigenous territory is advocating for and strengthening communities that are vulnerable to external pressures. This poses major challenges because working within the traditional cultural processes of these communities is complex, nuanced, and time consuming. Such a commitment requires committed individuals and NGOs dedicated to building and sustaining long-term relationships with communities and building governance structures within these communi-

ties so that all abide by agreements made by their representatives. To some, this may appear overly complex and time consuming; however, given the extent of indigenous territories in the Amazon, the effective conservation of these lands is likely to be a mathematical necessity to achieve large-scale forest conservation in the Amazon.

Measuring Progress Toward Consolidation

We were challenged to identify appropriate methods to evaluate the impact of AAI. Reduction of deforestation is a potentially important indicator of consolidation. Geldmann et al. (2013) conducted a systematic review of studies of the effectiveness of protected areas in reducing deforestation and concluded that the majority of studies reviewed show that protected areas are effective in this regard. Data available for the AAI portfolio generated by RAISG show that deforestation is lower in protected areas and indigenous territories than in landscapes where they are located (Supporting Information). However, these data do not meet best practices for incorporating counterfactual scenarios that control for differences in the economic viability of the land (Geldmann et al. 2013).

The most important question for our evaluations was how do different amounts and types of support provided to these sites influence their effectiveness? This question is very difficult to answer, not the least because it is impractical to implement the sort of carefully controlled experimental designs that would address this question definitively (Ferraro & Pattanayak 2006). Another consideration is that deforestation levels away from the deforestation frontier may be a poor indicator of the degree of consolidation. An AAI-funded study attempting to correlate management consolidation with deforestation rates proved statistically inconclusive (Nolte et al. 2013). We discussed this finding with Imazon, an AAI-grantee that tracks and publicizes deforestation in Brazil (A. Veríssimo, personal communication). The organization recently reported that of the 1.5 million ha deforested in the Brazilian Amazon from August 2012 to July 2014, 10% occurred in protected areas (Martins et al. 2012). The majority of this deforestation was focused in a few protected areas characterized by lack of management plans, insufficient staff and finance, and were located in the area of influence of major infrastructure projects that catalyzed pressure for settlement and resource exploitation. Imazon warns against relying on deforestation as the sole indicator for assessing consolidation because it is a delayed result of on-the-ground processes that take years to develop. As a result, management needs to be in place and effective long before deforestation becomes measurable.

Due to the limitations of using deforestation as an indicator of consolidation, we used a combination of desktop research, online surveys, and hundreds of semistructured interviews to apply 2 other methods to evaluate the

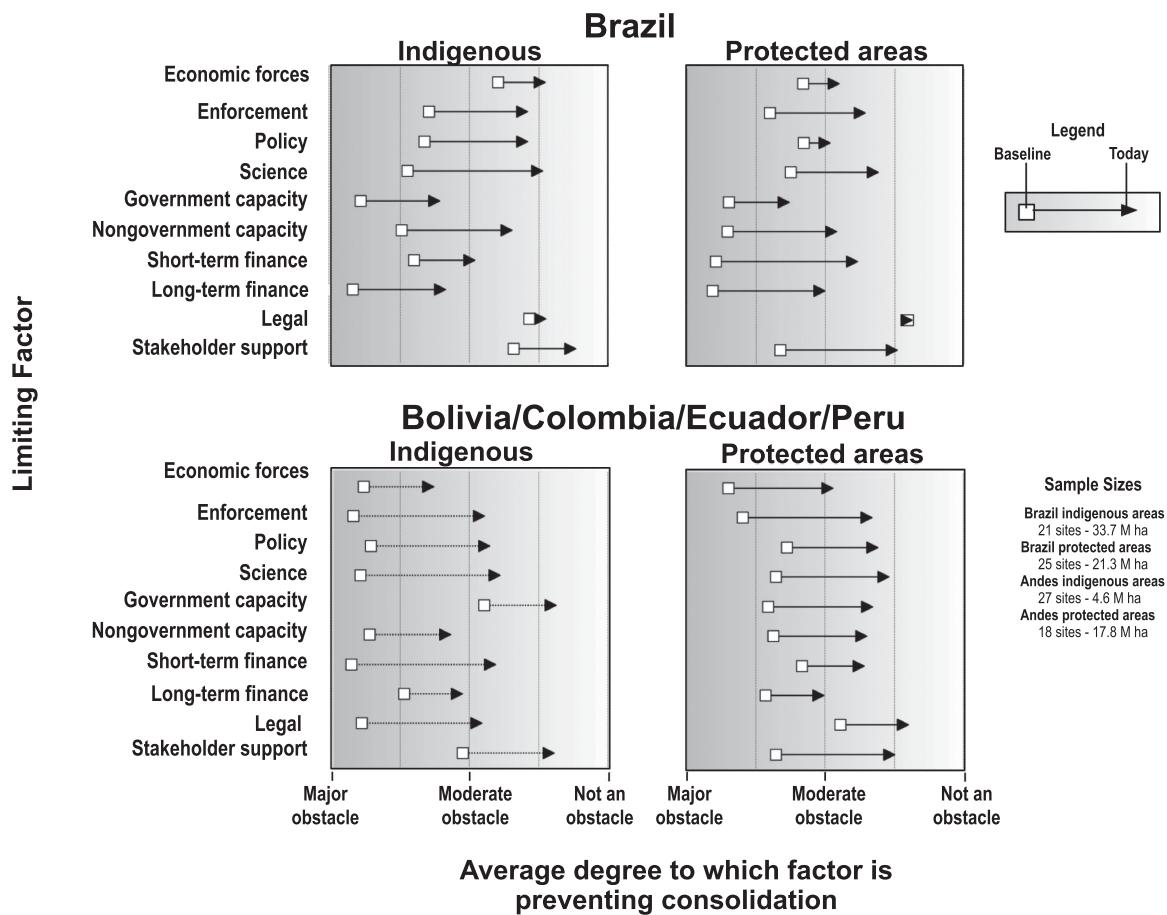


Figure 3. The degree to which factors limit the consolidation (i.e., securing the conditions that allow for effective management) of protected areas and indigenous territories in the Amazon basin. Scores range from 0 (a major obstacle) to 4 (not an obstacle) and are weighted by the area of each site. Data collected through desktop research, online grantee surveys, and interviews of Moore grantees and their stakeholders.

AAI portfolio (Supporting Information). First, we used a generalized set of evaluation criteria, called *limiting factors* (Fig. 3), to determine the extent that different internal and external factors, such as economic forces and scientific knowledge, present barriers to the consolidation of sites (Gullison & Hardner 2009). Based on our analysis of limiting factors, steady advances in consolidation occurred over time (Fig. 3), but some factors remained problematic and were formidable barriers to effective management, especially long-term financing. In Brazil, a lack of government capacity to perform its management functions in protected areas and to provide public services to indigenous areas was also limiting. In the Andes, the lack of long-term financing was followed in importance by economic drivers of land use, which place considerable pressure on protected sites. Over half the total area supported by AAI currently had 1 or more problematic factors that strongly limited progress toward consolidation.

The second method we used to evaluate AAI's progress in consolidating its portfolio of protected areas was

the rapid assessment and prioritization of protected areas management (RAPPAM) method (Ervin 2003). This method provides a detailed assessment of the status of specific elements deemed necessary for effective protected-area management. Again, results showed steady progress in consolidation relative to when AAI began supporting these sites 1–14 years ago (detailed results given in Supporting Information). Examples of management elements that most challenged consolidation were lack of long-term financing, insufficient staff, staff turnover, lack of resources for enforcement, and land tenure conflicts within protected areas. Our results for Brazil were largely consistent with a 2014 audit of the nation's Amazonian protected areas conducted by Brazil's government accountability office (Tribunal de Contas da União 2014).

Case Studies in Effective Management

Although much work remains to implement effective management across the majority of the Amazon's

protected areas and indigenous territories, examples of consolidated sites of different types are now emerging and can serve as models to emulate more broadly in the region.

Peru's 1.35-million-ha Cordillera Azul National Park provides an excellent example of a well-managed strictly protected area. In 1996, a scientific study funded by the German Technical Cooperation Agency placed the area on a national list of 38 priority areas for conservation in Peru. Over the next 5 years, the site moved through the steps necessary to become a protected area. A rapid biological inventory in 2000 justified a category of strict protection for the area (Alverson et al. 2001). Collaborations led to the successful completion of the remaining necessary steps, and Cordillera Azul National Park was officially declared in 2001. Since then, AAI, the U.S. Agency for International Development and the MacArthur Foundation, among others, funded Centro de Conservación, Investigación y Manejo de Areas Naturales (CIMA), and The Field Museum to consolidate the management of the area. Grantees have undertaken such tasks as management planning, capacity building, building of a park-ranger force to patrol the area, engaging local communities in the park's management committee, and supporting economic and quality-of-life activities near the park's boundary that were compatible with the management objectives of the park. Park management has prevented virtually all deforestation inside the park, and areas deforested before the establishment of the park are regenerating. In the buffer zone, the rate of deforestation has decreased. An important milestone was reached in 2013, when the Cordillera Azul REDD (Reducing Emissions from Deforestation and Forest Degradation) project (a collaboration of CIMA, The Field Museum, and TerraCarbon) was validated and verified. In 2014, CIMA signed an agreement with a European company to provide a loan-based financing for protection of the Cordillera Azul landscape. The long period required to create and consolidate Cordillera Azul—some 20 years—is indicative of the time that other sites will likely require once they have attracted the attention of donors and NGOs that can provide adequate financial and technical support.

Our first exposure to extractive reserves in the Amazon was in the mid-1990s, and we were skeptical of their economic viability—the production of small volumes of low-margin products (e.g., Brazil nuts) far from market seemed unlikely to succeed. When we visited the 400,000-ha extractive reserve Rio Iriri, Brazil, in 2015, it had a government management staff of 1 person, who was responsible for multiple protected areas. The AAI grantees Instituto Socio-Ambiental (ISA) and Instituto de Manejo e Certificação Florestal e Agrícola (IMAFLORA) (both NGOs) were also supporting the area. The ISA assisted by advocating for residents to receive free health care and education, and IMAFLORA helped by certifying

the origin of products produced within extractive reserves and assisting in their marketing—a campaign that was beginning to show commercial success. What impressed us 20 years after our first encounter was that despite ongoing economic challenges, the residents of extractive reserves, such as Rio Iriri, had maintained their interest in making a life within the areas and serving as land stewards. Although some may not view this as the optimal combination of conservation and economic development, a degree of stability of land use and conservation in some areas has been achieved for now.

The AAI grantee experience working with indigenous communities and their lands illustrates the long-term nature of this work and demonstrates that real success is possible. For example, since 2003, Moore has been funding the work of the Wildlife Conservation Society (WCS) in the Madidi-Tambopata region of Peru and Bolivia. Here, there is significant overlap between traditional and legally designated indigenous areas and the protected areas where WCS wished to work. The WCS began with a focus on traditional biodiversity conservation activities but quickly learned that it needed to support indigenous peoples to achieve its conservation objectives. For example, WCS observed that without the provision of health and educational programs throughout an indigenous territory, migration of communities to population centers to obtain basic services occurs, which depopulates the territory and reduces the ability of the community to monitor and defend its land base.

The WCS has worked with the Central Indígena del Pueblo Leco de Apolo (CIPLA) since 2006 to build capacity, support land titling, develop management plans, monitor communities with appropriate indicators, access funds from government and private donors, and report on projects. The WCS has learned that supporting activities to retain indigenous culture helps generate cultural cohesion and definition of identity and distinctness, which in turn helps indigenous groups justify to society the large land allocations that many indigenous groups have. Finally, WCS has benefitted from working with communities on extractive activities. Benefits include providing an alternative platform to engage communities (traditional political entities can be difficult to work with); providing a human presence to monitor and control illegal activities while extractive activities are carried out; and helping indigenous groups demonstrate economic use of their forest and the contributions this use makes to national economies, thereby dispelling criticisms that territories are vacant and unproductive lands. The WCS has supported Takana and Tsimane indigenous groups to develop sustainable and financially viable extractive industries and to manage subsistence wildlife hunting at sustainable levels. Across the Amazon, not all indigenous groups have the same technical capacity as the Takana and Tsimane, but WCS's experience shows that success is possible with the right

approach and a long-term commitment. Within Moore's portfolio of grantees, there are other excellent examples of how long-term commitments by individuals and institutions have helped indigenous groups build the capacity to manage their lands. The work of Instituto Socioambiental with indigenous communities in the Xingu Indigenous Park is a case in point (Schwartzman et al. 2013).

Overall, the experience of AAI grantees and others indicates that progress can and is being made in consolidating management of sites in the Amazon Biome. However, more work is needed to complete the job. The small number of well-managed sites prevents the development of a general understanding of how best to consolidate the management of the majority of protected areas and indigenous territories in the Amazon and estimate the magnitude of the resources required to do so.

Completing Consolidation

Despite being able to measure progress toward consolidating management, we could not determine when it will be complete. To do so, 2 additional questions must be answered. First, how does consolidation advance as a function of the duration and amount of external donor funding received (and possibly other variables such as the type and degree of threats to the area)? Second, how far must consolidation advance to produce self-sustaining conservation outcomes that can endure the cessation of external donor support?

We find it helpful to think about these questions using the heuristic concept of consolidation curves. A consolidation curve describes how the consolidation of a site improves as a function of time and money invested (Fig. 4). Possible shapes of consolidation curves include logarithmic, in which marginal gains in consolidation increase rapidly with early investments after the establishment of a protected site; sigmoidal, with multiple inflection points where impasse problems are resolved and subsequently allow rapid progress in consolidation; linear, whereby incremental investments of time and money produce equal marginal benefits; and exponential, in which little benefit is derived from establishing a protected area without significant investment of time and money.

One challenge we faced when describing actual consolidation curves relates to our concept of limiting factors. Our experience has taught us that for consolidation to occur a suite of necessary and sufficient conditions must be fulfilled; no factor in this set can be ignored. If it is, it will undermine progress toward overcoming other limiting factors. For example, an improvement in the scientific knowledge of management requirements of an area is of limited use if there is insufficient institutional capacity to implement and enforce changes in management (for a forestry example, see Blundell & Gullison [2003]) and vice versa. As a result, progress toward consolidation may not be uniform with each additional dollar invested.

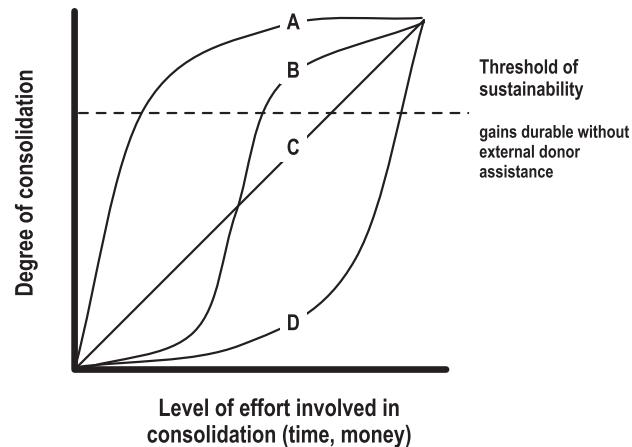


Figure 4. Heuristic models of protected-area-management consolidation curves and a theoretic threshold at which gains become durable or self-sustaining (consolidation refers to securing the conditions that allow for effective management): A, logarithmic; B, sigmoidal; C, linear; and D, exponential. See text for explanation.

Rather, it may advance slowly until the most limiting factor is addressed and then improve rapidly as the benefits of work on other limiting factors can then be realized. The importance of each potential limiting factor may vary according to context, such as the relative importance of law enforcement on the frontier of agricultural expansion versus less accessible areas in the interior of the Amazon. In addition to these confounding factors, it is possible that every category of conservation area has a different consolidation curve and that these consolidation curves differ for the management objective in question (e.g., stopping deforestation vs. stopping illegal hunting).

We found that the factor most commonly limiting consolidation was long-term financing. Basic management functions in nearly every protected area and indigenous territory in our sample of sites were underfunded, despite these sites having the good fortune of grant funding from an external donor such as AAI (Fig. 5). As a result, an incremental increase to the budget is not always best spent advancing a site's consolidation status (e.g., writing a management plan or training staff) but may instead be most needed to cover recurring costs of existing staff and infrastructure or to respond to unforeseen crises.

The financial situation of conservation in Amazonian countries is challenging, but significant progress has been made in developing sources of long-term financing for protected areas. One of the most notable achievements has been the establishment of the Amazon Region Protected Areas (ARPA)-for-Life fund in Brazil. This is a multidonor agreement with the Brazilian government that will provide financial support to protected areas in the Brazilian Amazon. The level of financial participation of the government will rise incrementally each year until it

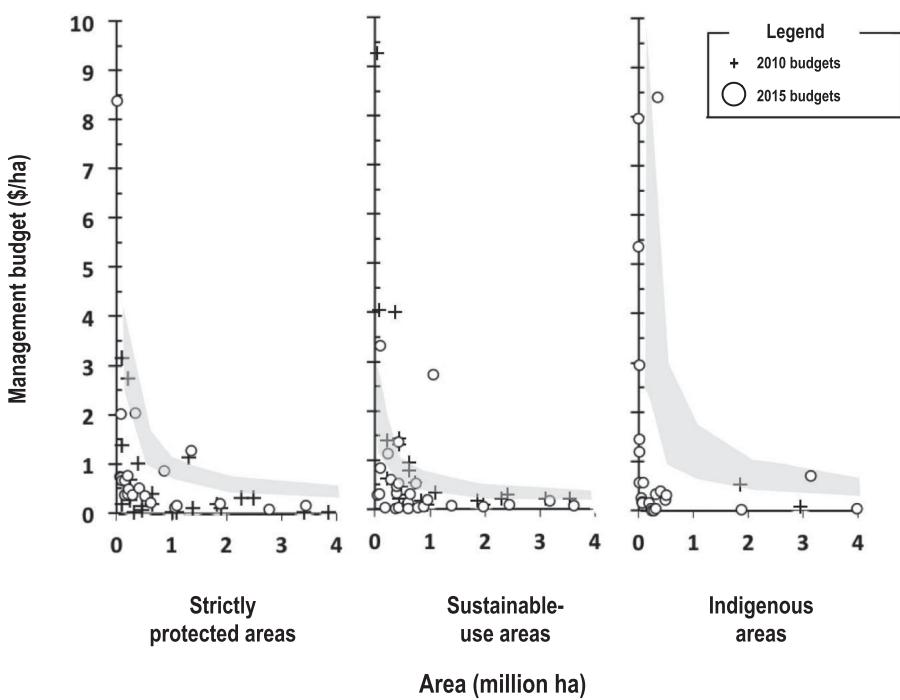


Figure 5. Budgets of Brazilian and Andean (Bolivia, Colombia, Ecuador, and Peru) protected areas and indigenous territories in 2010 and 2015 relative to estimated budget requirements as a function of protected area size (shading: lower boundary, basic management; upper boundary, comprehensive management). Data collected through online grantee surveys and interviews of Moore grantees and their stakeholders.

has taken on the full cost of managing the sites in 25 years. There has been a learning process as ARPA has become operational. For example, Brazilian protected areas have had trouble utilizing funding for some core needs, including their inability to attract and retain staff that meet arguably inappropriate legal requirements written into Brazil's constitution. Donors are exploring the potential to establish funds similar to ARPA in Peru and Colombia. Despite these promising developments, more is needed. These funds typically do not support state or regional protected areas or the extensive community-based work generally undertaken by NGOs in and around protected areas and, most importantly, indigenous territories.

Prospects for long-term financing are not necessarily limited to national governments and donors. Payments for ecosystem services such as carbon sequestration and storage also represent a significant potential source of revenue for protected areas and indigenous territories. For example, the governments of Norway and Germany and the Brazilian company Petrobras have made US\$1.13 billion available as performance-based payments to Brazil for projects that reduce forest loss and degradation (The Amazon Fund 2016). Norway has made US\$300 million available for similar projects in Peru.

But resolving the financing problem addresses only 1 limiting factor and will not achieve the consolidation of Amazonian sites on its own. Providing more money to weak institutions may accomplish little because institutional capacity to manage and spend this money wisely would be lacking. We typically observe donors working somewhat independently of one another and providing earmarked assistance for activities that may or may not adequately address all necessary and sufficient factors

required for consolidation. To be effective, donor funding must address all the factors that challenge conservation, some of which are internal to the protected area and some of which relate to the context in which the protected area or indigenous territory is located. The latter include dynamic economic drivers, political will, and the support of communities and stakeholder groups for conservation. The growth of urban centers causing increased pressures on fisheries and wildlife (Tregidgo et al. 2017), an exponential increase in the number of hydropower projects (Latrubesse et al. 2017), the growth of commodity production, such as beef and palm oil (Furumo & Aide 2017), and the expansion of transportation infrastructure (Gallice et al. 2017) are examples of evolving threats.

Another consideration is that progress in consolidation does not necessarily ratchet forward and remain durable over time. For many criteria we evaluated, site managers stated that a hiatus in external donor support would result in deterioration of the consolidation gains made.

Conclusion

On balance, our message is largely positive. Legally designated protected areas and indigenous territories cover nearly half the Amazon. Periodic surveys of the consolidation of these sites, such as the ones we presented here from our evaluations of AAI, generally show progress over time in consolidating their effective management. There are now excellent examples of well-managed sites of different types that demonstrate consolidation is possible and that can serve as models for other sites to emulate. Despite this progress, there are still significant and perhaps

surprising uncertainties concerning the amount and duration of support required to complete consolidation of the Amazon's protected areas and indigenous territories. The duration of necessary external financing will undoubtedly be longer than most external donors contemplate. We expect that if governments are supportive, strictly protected areas could consolidate the soonest. Even then, the process of building institutional capacity may take a decade or more. Protected areas requiring direct local community involvement—especially extractive reserves—will require even more time. The consolidation of indigenous areas will require the greatest commitment of time because engagement with communities must work at a pace that is consistent with the culture and the current state of development of these groups.

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Supporting Information

Evaluation methods (Appendix S1), supplementary results and information including historical protected area and indigenous territory creation in Brazil (Appendix S2), RAPPAM scores for Brazil and Andean countries (Bolivia, Colombia, Ecuador, and Peru) (Appendix S2), deforestation rates within and surrounding Amazonian indigenous lands and protected areas (Appendix S2), and a Spanish translation (Appendix S3) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

Figura 1: Áreas protegidas y territorios indígenas en el bioma amazónico. Mapa desarrollado por Christa Anderson para la Iniciativa Amazonía Andes, basado en datos espaciales suministrados por RAISG (2015).

Figura 2: El límite entre el Parque Indígena Xingu, un territorio indígena en el sureste de Brasil, y la agricultura de soya a gran escala. Foto de Jared Hardner (mayo de 2014).

Figura 3: El grado en que los factores limitan la consolidación de las condiciones que permiten un manejo efectivo de las áreas protegidas y los territorios indígenas en la cuenca del Amazonas. Los puntajes van desde 0

(un obstáculo importante) a 4 (no es un obstáculo) ponderados por el área de cada sitio. Los datos recopilados a través de la investigación de escritorio, las encuestas en línea a los beneficiarios, y las entrevistas de los beneficiarios de Moore y sus partes interesadas.

Figura 4: Modelos heurísticos de curvas de consolidación de manejo de áreas protegidas y un umbral teórico en el que las ganancias se vuelven duraderas o autosostenibles (la consolidación se refiere a asegurar las condiciones que permiten un manejo eficaz): A, logarítmica B, sigmoidea C, lineal D exponencial. Ver texto para explicación.

Figura 5: Presupuestos de áreas protegidas brasileñas y andinas (Bolivia, Colombia, Ecuador, Perú) y territorios indígenas en 2010 y 2015 en relación con los requisitos presupuestales estimados en función del tamaño del área protegida (sombreado: límite inferior, gestión básica, límite superior, gestión integral). Datos recopilados a través de encuestas en línea a beneficiarios y entrevistas de los beneficiarios de Moore y sus partes interesadas.

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