

LETTER

Conservation performance of tropical protected areas: How important is management?

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Abstract

Increasing the coverage of effectively managed protected areas (PAs) is a key focus of the 2020 Aichi biodiversity targets. PA management has received considerable attention, often based on the widely held, but rarely examined, assumption that positive conservation outcomes will result from increased PA management inputs. To shed light on this assumption, we integrated data on PA management factors with 2006–2011 avoided forest degradation and deforestation across the Peruvian Amazon, using a counterfactual approach, combined with interviews and ranking exercises. We show that while increasing PA management input to Amazonian PAs tended to reduce likelihoods of forest degradation and deforestation, the associations were weak. Key challenges facing PAs ranked by PA managers included wider law enforcement, corruption and land title issues, rather than local management factors. We therefore encourage the post-2020 conservation targets to adopt holistic approaches beyond PA management, incorporating political, institutional and governance contexts across scales.

KEYWORDS

conservation outcomes, corruption, deforestation, forest degradation, governance, land title conflicts, law enforcement, politics, protected area management effectiveness

1 | INTRODUCTION

Protected areas (PAs) have been the cornerstone of global conservation strategies (Watson, Dudley, Segan, & Hockings, 2014). Member states of the Convention on Biological Diversity (CBD) have committed to protecting, by 2020, 17% and 10% of the world's terrestrial and marine areas, respectively, including through effectively managed PAs (Aichi target 11; CBD, 2010). While PA networks are approaching the coverage target in many countries (Tittensor et al., 2014), biodiversity loss and tropical forest conversion continue seemingly unabated (Butchart et al., 2010; Potapov et al., 2017). Rigorous impact evaluations are therefore required to assess the performance of PAs in reaching their conservation objectives

(Baylis et al., 2016; Sutherland, Pullin, Dolman, & Knight, 2004).

One key focus of the debate has been on the management of PAs (defined here as the suite of local or system-level factors that contribute toward the implementation of a PA). Numerous studies have highlighted that insufficient funding and staffing, amongst other assets, have hindered their implementation, with some asserting that many PAs only exist on paper (Bonham, Sacayon, & Tzi, 2008; Coad et al., 2013; Peres & Terborgh, 1995). At least 95 assessment tools have been developed for evaluating the so-called PA management effectiveness (PAME; Coad et al., 2015), sometimes used as indicators for conservation outcomes. The CBD Conference of the Parties and the Global Environment Facility

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(GEF), for example, have adopted the PA Management Effectiveness Tracking Tool (METT) as reporting requirement for GEF-funded projects.

These premises rest on the implicit or explicit assumption that there is a strong relationship between management factors and conservation outcomes. However, these links have received little scrutiny (Coad et al., 2015; Geldmann et al., 2013). The Protected Planet Report acknowledges that few assessments link PA management indicators with conservation outcomes, concluding that the “results on how management inputs relate to conservation delivery are still equivocal” (Juffe-Bignoli et al., 2014; p. iii). Only few studies have evaluated the links between management factors and changes in deforestation, forest fire incidence (Carranza, Manica, Kapos, & Balmford, 2014; Nolte & Agrawal, 2013) or species population trends (Geldmann et al., 2018). This is compounded by methodological difficulties of unequivocally attributing conservation outcomes to conservation interventions. Recent advances in applying counterfactuals have helped to eliminate competing explanations (Ferraro & Hanauer, 2014), allowing to couple PA management data with data on their conservation impacts. Examining these links is especially timely for the current discussions on setting goals to succeed the Aichi targets.

Here, we assess (1) whether key PA management factors (Tables 1 and 2) are associated with avoiding forest degradation and/or deforestation in Amazonian PAs, using a counterfactual approach, and (2) what the key challenges are for their implementation. Peru is an excellent country for such an assessment, being highly biodiverse and exhibiting a range of PA types. We combine data on the management and conservation outcomes of 43 PAs in the Peruvian Amazon, managed by government, private actors or civil society, while controlling for a large suite of potential confounding variables (Schleicher, Peres, Amano, Llactayo, & Leader-Williams, 2017). We further gauge the key challenges facing PAs as perceived by stakeholders through interviews and ranking exercises. To our knowledge, this is the first such study to evaluate to what degree PA management factors are associated with avoiding forest degradation, including PAs under different governance regimes. Unlike previous studies, we combine qualitative and quantitative datasets to provide insights into these issues, and include actual figures on financial investments and staff numbers in our analysis. We further discuss limitations of the existing literature and propose ways forward for future research.

2 | METHODS

2.1 | Study area

The Peruvian Amazon is highly species-rich and extends across 784 692 km², spanning the eastern slopes of the

TABLE 1 Summary table of key management inputs into PAs (n = 43) in the Peruvian Amazon

	Median (range)
Conservation activities	
Years of conservation work (n= 37)	7 (0–71)
Years of ecological monitoring (n = 39)	0 (0–16)
Patrols ^{*.1} (n = 39)	2.45 (0–311.9)
Personal	
Staff 2006 [*] (n = 36)	0.17 (0–62.6)
Staff 2011 [*] (n = 43)	0.75 (0–27.2)
Guards 2011 [*] (n = 43)	0.44 (0–18.8)
Staff with technical/higher education [*] (n = 42)	0.22 (0–39.4)
Staffing adequacy (scale: 0 to 6) ² (n = 39)	3 (0–6)
Staff shortfall (%) (n = 41)	42.86 (0–100)
Funding	
Funding 2006 ^{***.3} (n = 27)	34.32 (0–7507.0)
All Funding 2011 ^{***.3} (n = 39)	257.60 (24.85–12870.0)
Funding adequacy (scale: 0 to 6) ² (n = 37)	3.5 (1–6)
Funding shortfall (%) (n = 30)	54.98 (0–98.20)
Infrastructure	
Sites of staff presence [*] (n = 41)	0.21 (0–20.85)
Control points at area boundary [*] (n = 41)	0.14 (0–7.50)
Vehicles [*] (n = 27)	0.21 (0–3.18)

^{*}Number per 100 km².

^{**}Nuevo Soles per km².

¹These are conducted to monitor and detect illegal and other activities and processes in the area.

²These scores are on a scale of 0 to 6, where 0 represents fully inadequate and 6 represents fully adequate levels of available staff or funding to meet the conservation challenges of the areas.

³The funding data for 2006 and 2011 are not directly comparable because for government PAs 2006 includes only government funding, whereas 2011 includes funding from other sources going toward the PA where known.

tropical Andes and the lowland Amazon basin (Goulding, Barthem, & Ferreira, 2003). Key threats facing the forest and its biodiversity include conversion into agriculture, gold mining, and forest degradation from timber extraction. While the rate and extent of change has been lower than in neighbouring Brazil, they are expected to increase. To counter forest conversion, Peru has established a range of PA types, of which national government-controlled PAs and conservation concessions (CCs) are the most prominent in number and/or area coverage (Figure 1; Supporting Information).

2.2 | Assessing PA performance

The performance of PAs in curbing deforestation and forest degradation was assessed based on rates of avoided

TABLE 2 Spearman rank correlation and unpaired Wilcoxon signed rank tests between management indicators and avoided deforestation and forest degradation (%) in PAs (n = 43) in the Peruvian Amazon. Results are shown for tests with unadjusted *P* values below 0.1, including 95% confidence intervals (CI); all others are marked with ns (nonsignificant). *P* values were adjusted (adj. *P*) using a false discovery rate approach (Pike, 2011)

	Avoided deforestation			Avoided degradation		
	rho/W***	95% CI	adj. <i>P</i>	rho / W***	95% CI	adj. <i>P</i>
Conservation activities						
Conducting conservation activities (yes/no) (n = 41)	107.5 (+)	0.27, 3.68	0.375	ns	ns	ns
Length of conservation work (years) (n = 37)	ns	ns	ns	ns	ns	ns
Conducting ecological monitoring (yes/no) (n = 39)	ns	ns	ns	278 (+)	-0.02, 0.80	0.290
Length of ecological monitoring (years) (n = 39)	0.30	-0.03, 0.59	0.453	0.37	0.03, 0.65	0.220
Conducting patrols (yes/no) (n = 41)	ns	ns	ns	ns	ns	ns
Patrols* (n = 39)	0.27	-0.09, 0.58	0.453	ns	ns	ns
External project or support (yes/no) (n = 39)	ns	ns	ns	ns	ns	ns
Personal						
Staff 2006* (n = 36)	ns	ns	ns	ns	ns	ns
Staff 2011* (n = 43)	ns	ns	ns	ns	ns	ns
Guards 2011* (n = 43)	ns	ns	ns	0.28	-0.06, 0.58	0.290
Adequate staff capacity (yes/no) (n = 36)	ns	ns	ns	ns	ns	ns
Staff with technical or higher education* (n = 42)	0.26	-0.09, 0.57	0.453	0.29	-0.06, 0.60	0.290
Staffing adequacy (scale: 0 to 6) (n = 39)	ns	ns	ns	0.27	-0.07, 0.56	0.290
Staff shortfall (%) (n = 41)	ns	ns	ns	ns	ns	ns
Funding						
Funding 2006** (n = 27)	ns	ns	ns	0.45	0.03, 0.69	0.220
All funding 2011** (n = 39)	ns	ns	ns	0.29	-0.03, 0.57	0.290
External funding (yes/no) (n = 41)	ns	ns	ns	ns	ns	ns
Funding adequacy (scale: 0 to 6) (n = 37)	ns	ns	ns	-0.31	-0.59, 0.03	0.290
Funding shortfall (%) (n = 30)	ns	ns	ns	ns	ns	ns
Area generates income (yes/no) (n = 39)	ns	ns	ns	ns	ns	ns
Infrastructure						
Boundary demarcation of area (yes/no) (n = 41)	ns	ns	ns	ns	ns	ns
Staff presence in/around area (yes/no) (n = 41)	ns	ns	ns	ns	ns	ns
Sites of staff presence* (n = 41)	ns	ns	ns	0.38	0.03, 0.67	0.220
Control points at area boundary* (n = 41)	ns	ns	ns	0.26	-0.09, 0.58	0.290
More access routes than control points (yes/no) (n = 41)	ns	ns	ns	ns	ns	ns
Available vehicles with petrol (yes/no) (n = 36)	ns	ns	ns	ns	ns	ns
Vehicles* (n = 27)	ns	ns	ns	ns	ns	ns
Local people						
Local people involved in management/decisions (yes/no) (n = 38)	ns	ns	ns	ns	ns	ns
Local people obtain economic benefits (yes/no) (n = 39)	ns	ns	ns	ns	ns	ns

*Number per 100 km².

**Nuevo soles per km².

***This column shows the Spearman rank correlation coefficient (rho) for ordinal and continuous variables, or the Wilcoxon signed rank test result (W) for categorical (yes/no) variables.

deforestation and avoided forest degradation between 2006 and 2011. These rates were calculated by Schleicher et al. (2017) for 30 government PAs and 13 CCs, collectively referred to hereafter as PAs. Avoided deforestation and forest degradation are defined as the difference in percent

2006–2011 deforestation and forest degradation, respectively, between PAs and control sites, selected based on matching (Andam, Ferraro, Pfaff, Sanchez-Azofeifa, & Robalino, 2008). Schleicher et al. (2017) found that PAs on average avoided deforestation and forest degradation compared to

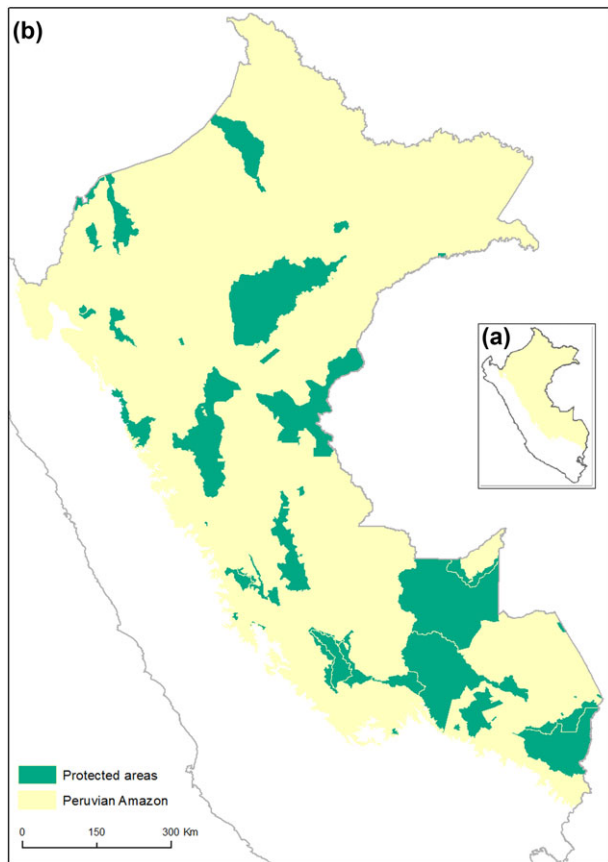


FIGURE 1 Map of (a) Peru and (b) the Peruvian Amazon showing the 43 protected areas included in this study

control sites in the unprotected landscape, but showed considerable variation across PAs. Here, we assess the degree to which key PA management factors contributed toward this variation.

2.3 | Assessing PA management

Management factors were assessed through a questionnaire survey with PA managers or their representatives. The questionnaire covered 29 management indicators on staffing, funding, local population, conservation activities and infrastructure (Supporting Information; Table S1). These indicators were selected based on *a priori* expectations of factors likely to influence deforestation and/or forest degradation based on (1) the PA management literature, (2) existing PAME tools, particularly the METT (Laurance et al., 2012; Leverington, Costa, Pavese, Lisle, & Hockings, 2010; Stolton, Hockings, Dudley, Mackinnon, & Whitten, 2007), and (3) our knowledge of the national context. To address shortcomings of the METT on the subjective assessment of management level adequacy (Carbutt & Goodman, 2013), we obtained empirical government data on actual 2011 government funding and 2012 staffing levels of each government PA. These data were used to complement and triangulate the questionnaire data. After

piloting the questionnaire in June 2013, a slightly revised version was administered between June and September 2013, lasting 30–45 minutes.

2.4 | Statistical analysis

We applied nonparametric Wilcoxon and Spearman rank correlation tests to assess whether PA management indicators were associated with avoided deforestation and forest degradation (Carranza et al., 2014), using the *wilcox.test* and *cor.test* functions in R version 3.0.3 (R Core Team, 2014). We calculated 95% confidence intervals for Spearman rank correlation coefficients by bootstrapping 10 000 times using the *spearman.ci* function. Not all respondents answered all questions, so sample sizes varied between management variables. To account for multiple comparisons when assessing individual indicators, we adjusted *P*-values through a false discovery rate approach based on the two-stage sharpened method developed by Verhoeven and colleagues (2005) and Pike (2011). This approach is less conservative than conventional Bonferroni approaches, yet yields better results in controlling for type I errors while simultaneously reducing type II errors (Verhoeven, Simonsen, & McIntyre, 2005). We also developed two composite indicators of (1) staff and funding and (2) conservation and monitoring activities. These indicators were adapted from Geldmann et al. (2018)'s management dimensions, based on our knowledge of the study area, calculating the mean of the normalized individual indicators (Supporting Information).

2.5 | Assessing key challenges

JS conducted 177 semistructured interviews with PA stakeholders between 2011 and 2013, to assess key opportunities and challenges facing PAs across the Peruvian Amazon (Supporting Information). Key informants were selected through a combination of purposive sampling and snowballing (Ritchie, Lewis, & Elam, 2003), and were asked for their consent to be interviewed. Interviews were conducted face-to-face, except for a small number held via telephone, and lasted 30–120 minutes. Following a thematic analysis, interviews were attributed detailed codes, which were grouped into clusters to extract the key challenges expressed by participants, captured in 29 statements (King & Horrocks, 2010). Twelve CC managers or their representatives were given these statements to rank according to their relative importance on a scale from 0 to 6 from least to most important challenge. The research project underwent review and approval of the Research Ethics Review Group of the Department of Geography, University of Cambridge.

3 | RESULTS

3.1 | Management factors of Amazonian PAs

Management inputs and processes varied across different PAs (Table 1). Nearly all PAs (93%) had undertaken some conservation activities by 2011, over an average of 7 years. In nearly all PAs (90%) these activities included conducting patrols. Prior to 2011, about half (49%) of the PAs had not conducted any ecological monitoring.

Few staff and little funding was available for each PA. On average, less than one staff per 100 km² per PA were available in 2006 and 2011, despite substantial increases in staff levels in the 5-year period since 2006. Furthermore, only 0.2 staff per 100 km² had technical or higher education. Nearly half (47%) of the respondents felt that any given PA was insufficiently staffed in terms of management capacity, with average staff and funding shortfalls perceived to be 43% and 55%, respectively. Most (75%) respondents reported that the PAs received at least some funding from external sources in 2011. However, a similar percentage (74%) of PAs did not generate any income, and the few that did so, mainly received revenues through tourism.

In addition, the boundaries of over half of PAs (56%) had been poorly demarcated physically. However, 85% of PAs had staff present at control points, research stations or an office, with an average of 0.2 manned sites per 100 km². In addition, two-thirds of all PAs (66%) had operational vehicles with fuel at their disposal, even though the number available was low (Table 1). As a result, 83% of PAs could be accessed via entry routes without control points. Encouragingly, 61% of all respondents reported that their PA involved local communities in the management and decision making of the area.

3.2 | Management predictors of avoided deforestation and forest degradation

Prior to adjusting *P*-values to control for false discovery rates, we could reject the null hypothesis of no association at *P* < 0.05 for only one management indicator: whether or not any conservation activities had been undertaken in the PA since establishment (Table 2). PAs with conservation activities had avoided more deforestation than those without.

Among the estimated associations between management indicators and avoided degradation, we could reject the null hypothesis of no association at *P* < 0.05 for three indicators. Avoided forest degradation increased with increasing (1) amount of funding available per unit area in 2006, (2) density of sites at which staff were present within or around the PA, and (3) length of time during which ecological monitoring had taken place (Figure 2).

However, after adjusting *P*-values for multiple comparisons (Table 2), none of the individual management indica-

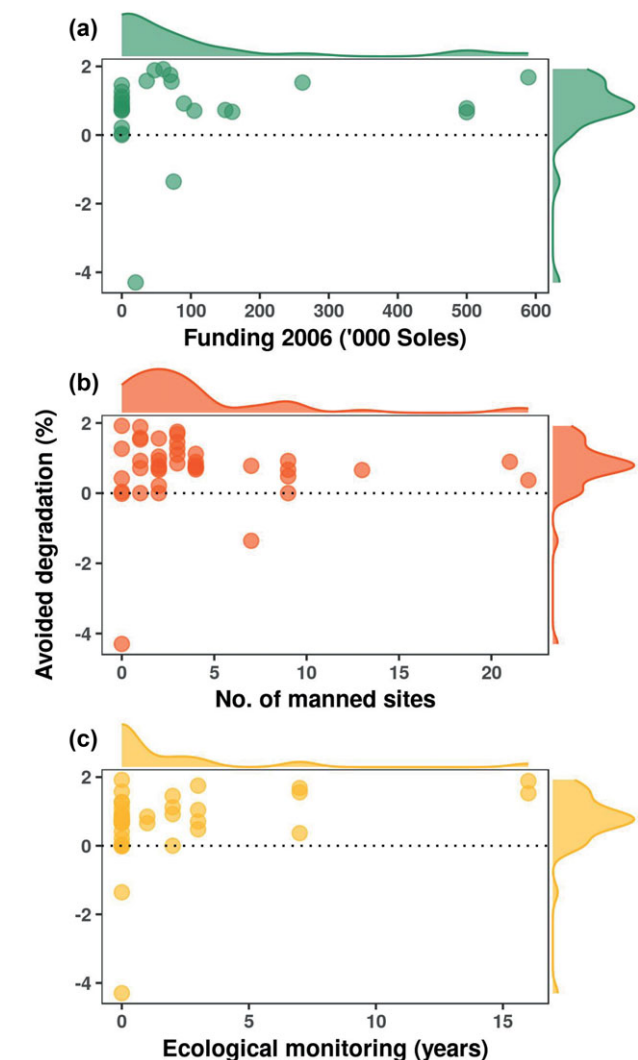


FIGURE 2 Changes in avoided forest degradation between 2006 and 2011 (%) inside Peruvian protected areas plotted against (a) 2006 funding levels, (b) number of manned sites, and (c) length of time ecological monitoring had taken place inside the area

tors were significantly associated with avoided forest degradation or avoided deforestation. These results remained robust after excluding one outlier, analysing government PAs and CCs separately, or using composite indicators of (a) funding and staffing and (b) monitoring and conservation activities (Table S2).

3.3 | Key challenges facing PAs

Stakeholders perceived various challenges to affect PA implementation and conservation performance (Table 3). These included a number of factors linked to PA management, such as lack of funding, inefficient coordination and communication, as well as insufficient logistical and technical capacity of PA managers. However, none of these management factors were ranked by respondents as the four most important challenges, namely lack of law enforcement, corruption,

TABLE 3 Statements of challenges facing Peruvian protected areas (PAs) based on semistructured interviews with PA stakeholders, order according to mean rank from most (6) to least important (0)

Challenges facing protected areas (PA)	Mean rank \pm SD
1. Lack of law enforcement	4.33 \pm 1.37
2. Corruption	4.33 \pm 1.67
3. Overlaps with other land titles	4.33 \pm 1.87
4. Lack of respect for land titles	4.25 \pm 1.86
5. Ecological threats impacting the PA	4.00 \pm 1.48
6. Insufficient funding for the PA	4.00 \pm 1.21
7. Inefficient coordination between government entities	3.92 \pm 1.31
8. Insufficient logistical capacity of government entities	3.83 \pm 1.64
9. Lack of a unified land title registry	3.75 \pm 1.91
10. Local population needs alternative, sustainable livelihoods	3.75 \pm 1.42
11. One's life being under threat	3.75 \pm 2.05
12. Inefficient administrative processes in the government	3.58 \pm 1.67
13. Insufficient political will from government to support PAs	3.58 \pm 2.07
14. Economic value of resources	3.50 \pm 2.11
15. Insufficient number of people working in the PA	3.41 \pm 1.51
16. Insufficient technical capacity of government entities	3.33 \pm 1.72
17. Staff turnover in government	3.33 \pm 1.72
18. Government has insufficient funding	3.33 \pm 1.61
19. Insufficient number of people working in government entities	3.00 \pm 1.65
20. Relationship between people in charge of PA and local population	3.00 \pm 1.65
21. Difficult access to information or education by population	2.92 \pm 1.56
22. Communication between government and people in charge of PA	2.75 \pm 1.29
23. Insufficient logistical capacity of people in charge of PA	2.75 \pm 1.48
24. Long time to obtain results from conservation activities	2.75 \pm 1.54
25. The accessibility of the PA	2.08 \pm 1.24
26. Insufficient technical capacity of people in charge of PA	1.83 \pm 1.19
27. Lacking social, ecological, and/or economic information	1.67 \pm 1.23
28. Inefficient coordination between people managing the PA	1.33 \pm 1.15
29. The size of the PA	1.08 \pm 1.44

overlaps with other land titles, and a general lack of respect attributed to land titles. Respondents highlighted law enforcement challenges beyond the reach of PA management. This included the difficulty of mobilising the few relevant government officials to inspect illegal activities and the limited number of cases taken to court.

4 | DISCUSSION

Over the years, studies have argued that many PAs cannot count on sufficient investments to meet their conservation objectives (Leader-Williams & Albon, 1988; UNEP-WCMC and IUCN, 2016; Watson et al., 2014), leading some to conclude that numerous tropical PAs are merely “paper parks” (Coad et al., 2013). By contrast, we showed that most PAs across the Peruvian Amazon had implemented conservation

activities by 2011, and therefore did not exist only on paper. However, average levels of management inputs were relatively low: even though overall funding levels were 31% higher than those reported in 1996, the average levels of PA personnel and funding in 2011 were still well below those recommended for Peru in 1999 (James, Green, & Paine, 1999). Given these limitations on funding and staffing, compared to Peru's globally important biodiversity, James and colleagues (1999) identified Peru as a global priority for foreign investments into PAs.

Our findings suggest that while increasing PA management inputs in Amazonian PAs tended to reduce the likelihood of forest degradation and deforestation, the associations were at best weak. Indeed, none of the composite or individual PA management indicators showed a significant effect after accounting for multiple comparisons. The lack of any stronger links seems surprising at first. However, this is in line with all three previous counterfactual studies that examined the

relationships between avoided deforestation or fire occurrence, and PA management factors in neighbouring Brazil (Carranza et al., 2014; Nolte & Agrawal, 2013; Nolte, Agrawal, & Barreto, 2013). There was no evidence for significant relationships between avoided deforestation for 26 PAs in the Brazilian Cerrado and scores of the Rapid Assessment and Prioritization of PA Management (RAPPAM) tool (Carranza et al., 2014). Nolte et al. (2013) came to the same conclusion when comparing RAPPAM scores and deforestation rates in Brazilian Amazon PAs. Furthermore, Nolte et al. (2013) found that only one indicator was significantly associated with reduced fire occurrence in 29 Brazilian Amazon PAs: whether or not PAs had experienced land tenure conflicts. Similarly, interviews with PA managers of 93 PAs globally suggested that only one factor was significantly correlated with PAs' ability to deter habitat change, namely the density of guards in the PA (Bruner, Gullison, Rice, & Fonseca, 2001). This finding could result from a higher median guard density (1.7 guards per 100 km²), as the median guard density in the 15 "least effective" PAs included in their study was equivalent to the median guard density of the PAs assessed here (both 0.4 guards per 100 km²). The absence of effects in our study could be due to low levels of management input. It would therefore be valuable to investigate whether, similarly to marine PAs (Gill et al., 2017), there are management input thresholds above which management decisively affects conservation outcomes in terrestrial PAs, by assessing these relationships across a range of management levels.

The agreement of the few studies that assessed the relationships between management factors and PA conservation outcomes raises the important question of why the relationships uncovered were weak. This and previous studies assessed a variety of partly complementary management indicators through different approaches (Carranza et al., 2014; Nolte & Agrawal, 2013), yet reached similar conclusions. The observed results are therefore unlikely simply due to omitting key management indicators or not adequately capturing them (Cook, Carter, & Hockings, 2014). Instead, it could be that (1) the relationships between management factors and conservation outcomes are more complex than captured through bivariate analyses; (2) management factors are less important than other factors in influencing conservation outcomes; and/or (3) hidden biases were not controlled for in the analysis. The reality is likely a combination of these reasons. In this and previous studies, management levels were not randomly allocated. This can influence the observed relationships between management factors and conservation outcomes, if the factors influencing management allocation also impact conservation outcomes. For example, if high levels of management inputs are allocated to PAs where they are least beneficial for avoiding deforestation, the observed relationship between management levels and avoided deforestation can be negative, even if the actual underlying relationship is positive. This highlights

the urgent need to consider the factors influencing management allocation and how they impact conservation outcomes. In Peru, key factors include how iconic a PA is and PA managers' negotiation skills, aspects not expected to be related to conservation outcomes, reducing the likelihood of this biasing the results. Nevertheless, other factors, such as perceived conservation pressure inside a PA, might also impact management allocation, highlighting the importance of controlling for such factors in the future. Doing so has in part been hindered by the relatively small sample sizes in published studies. Future studies would therefore benefit from conducting meta-analyses of existing studies (and publishing results and metadata at levels of detail conducive for such analyses). The resulting larger sample sizes would increase statistical power, and allow PAs to be grouped according to conservation pressure or other factors influencing management allocation.

Given the complexity of conservation realities, other factors than management regime might more strongly influence conservation outcomes. Indeed, in this study the challenges facing PAs ranked as most important were linked to the wider political and institutional contexts, rather than local PA management. In particular, respondents highlighted widespread lack of law enforcement, systemic corruption, and issues around land titles. Although the scope of PA management assessments has expanded and such factors have been highlighted previously (Corrigan, Robinson, Burgess, Kingston, & Hockings, 2018; IUCN and WCPA, 2017; Robinson, Kumar, & Albers, 2010), they have been relatively neglected in the conservation science literature compared to PA management (Chhatre & Agrawal, 2008; Gore, Ratsimbazafy, & Lute, 2013; Robbins, 2000; Smith, Muir, Walpole, Balmford, & Leader-Williams, 2003). This emphasises it is necessary to pay increased attention to the politics and governance of conservation interventions at different scales.

Our findings are particularly timely given the ongoing discussions for setting post-2020 biodiversity targets and the role PA management will play therein. An extensive literature and numerous assessment tools focus on PA management indicators, widely highlighting inadequate levels of funding and staffing (e.g., Coad et al., 2013; Leader-Williams & Albon, 1988). This is often based on the untested assumption, whether explicit or implicit, that strengthening PA management efforts will necessarily lead to improved conservation outcomes (e.g., Leverington et al., 2010; UNEP-WCMC and IUCN 2016). Reporting on management factors is part of the Aichi targets (CBD, 2010) and often a requirement for compliance with donor demands. For example, GEF-funded projects have to complete METT assessments repeatedly during the project cycle. However, close scrutiny shows there is little empirical evidence for such strong relationships. This study provides good reasons to be cautious about presuming such straightforward relationships. This is not to say that PA management does not influence their conservation outcomes.

However, our findings highlight that the relationships between management indicators and conservation outcomes are likely more complex than widely assumed. We therefore encourage the post-2020 targets and conservation literature to take a more holistic and ambitious approach, that goes beyond PA coverage and local management, to incorporating wider political, institutional and governance issues across scales.

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SUPPORTING INFORMATION

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