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Contributed Paper

A global assessment of the social and conservation outcomes of protected areas

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Abstract: *Protected areas (PAs) are a key strategy for protecting biological resources, but they vary considerably in their effectiveness and are frequently reported as having negative impacts on local people. This has contributed to a divisive and unresolved debate concerning the compatibility of environmental and socioeconomic development goals. Elucidating the relationship between positive and negative social impacts and conservation outcomes of PAs is key for the development of more effective and socially just conservation. We conducted a global meta-analysis on 165 PAs using data from 171 published studies. We assessed how PAs affect the well-being of local people, the factors associated with these impacts, and crucially the relationship between PAs' conservation and socioeconomic outcomes. Protected areas associated with positive socioeconomic outcomes were more likely to report positive conservation outcomes. Positive conservation and socioeconomic outcomes were more likely to occur when PAs adopted comanagement regimes, empowered local people, reduced economic inequalities, and maintained cultural and livelihood benefits. Whereas the strictest regimes of PA management attempted to exclude anthropogenic influences to achieve biological conservation objectives, PAs that explicitly integrated local people as stakeholders tended to be more effective at achieving joint biological conservation and socioeconomic development outcomes. Strict protection may be needed in some circumstances, yet our results demonstrate that conservation and development objectives can be synergistic and highlight management strategies that increase the probability of maximizing both conservation performance and development outcomes of PAs.*

Keywords: biodiversity, management, new conservation, socioeconomic development, trade-offs

Una Evaluación Global de los Resultados Sociales y de Conservación de las Áreas Protegidas

Resumen: *Las áreas protegidas (APs) son una estrategia clave para la protección de los recursos biológicos, pero estas varían considerablemente en su efectividad y son reportadas frecuentemente por tener impactos negativos sobre los habitantes locales. Esto ha contribuido a un debate divisivo y sin resolución con respecto a la compatibilidad de los objetivos de desarrollo socioeconómico y ecológico. Esclarecer la relación entre los impactos sociales positivos y negativos y los resultados de conservación de las APs es esencial para el desarrollo de una conservación más efectiva y más justa socialmente. Realizamos un meta-análisis de 165 APs usando datos de 171 estudios publicados. Evaluamos cómo las APs afectan al bienestar de los habitantes locales, los factores asociados con estos impactos y significativamente, la relación entre los resultados socioeconómicos y de conservación de las APs. Las APs asociadas con resultados socioeconómicos positivos tuvieron una mayor probabilidad de reportar resultados positivos de conservación. Los resultados positivos, tanto socioeconómicos como de conservación, tuvieron una mayor probabilidad de ocurrir cuando las APs adoptaron regímenes de co-manejo, les otorgaron poder a los habitantes locales, redujeron la inequidad económica y mantuvieron los*

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beneficios culturales y de sustento. Mientras los regímenes más estrictos de manejo de APs intentaron excluir las influencias antropogénicas para alcanzar los objetivos de conservación biológica, las APs que integraron explícitamente a los habitantes locales como actores tuvieron la tendencia de ser más efectivos en la obtención de resultados conjuntos de desarrollo socioeconómico y de conservación. La protección estricta puede ser necesaria en algunas circunstancias, pero nuestros resultados demuestran que los objetivos de desarrollo y de conservación pueden ser sinérgicos. También resaltan las estrategias de manejo que incrementan la probabilidad de maximizar tanto al desempeño de la conservación como a los resultados de desarrollo de las APs.

Palabras Clave: biodiversidad, compensaciones, desarrollo, manejo, nueva conservación

Introduction

An alarming erosion of taxonomic and functional biodiversity is occurring in half of tropical protected areas (PAs) (Laurance et al. 2012). The magnitude of this decline is directly linked to human mediated habitat disruption, including land-use change, hunting, and exploitation of other forest-related resources. These human-induced pressures on PAs and conflict between biodiversity conservation and the needs of local people are predicted to increase due to numerous factors, including market forces and a reduction in distance between PAs and human population centers (Joppa et al. 2008; McDonald et al. 2008). Conflicts between local people and conservation initiatives have generated one of the greatest and longest running debates in conservation science (Roe 2008). At one end of the spectrum is the fences-and-fines approach, which contends that to deliver successful conservation outcomes people must be excluded, even forcibly, from PAs (Brockington & Igoe 2006). Opponents of this approach consider such exclusionist protection arrangements ethically troubling because they frequently result in PAs having disadvantageous social outcomes for local people that ultimately result in ineffective long-term conservation outcomes (Adams et al. 2004). An increasingly advocated strategy is that to deliver effective and long-term environmental protection PAs must accommodate the needs of local people so as to secure sustainable livelihoods and enhance their well-being (Roe 2008). The debate between adherents to these two approaches and the importance of considering human well-being in conservation remains lively, intense, and unresolved (Soulé 2013; Marvier 2014).

A key factor limiting the resolution of this debate is the insufficient evidence base, which is currently limited to individual case studies, with few studies specifically testing causal pathways (e.g., Andam et al. 2010) and lack of a global analysis (Geldmann et al. 2013). Available case studies do, however, usefully highlight several key issues (Table 1). First, social impacts of PAs take different forms, including economic, livelihood, and cultural impacts, and can result directly from PA policies, such as hunting regulations, or indirectly through wider social and economic changes, for example the effects of increased tourism (Holmes & Brockington 2012). Second, how local people experience and respond to the social impacts of PAs is influenced by socio-political contexts at both local and regional scales (Brockington & Igoe 2006; Nelson & Agrawal 2008). Third, impacts of PAs are unevenly distributed. They are felt most intensely at local rather than national scales and within communities along lines of class, gender, ethnicity, and caste; benefits tend to accrue to the wealthiest and most powerful and costs fall on the weakest and poorest (Holmes 2007).

The lack of a global study on the impact of key recurring factors affecting PA socioeconomic and conservation outcomes has resulted in three specific knowledge gaps (Adams & Hutton 2007; Mascia & Claus 2009): how the socioeconomic and biodiversity conservation outcomes of PAs are linked to specific social impacts; how social impacts are influenced by the management and other characteristics of PAs; and how social impacts relate to socioeconomic and biodiversity conservation outcomes, given the insufficient performance of many PAs. Addressing these questions is critical for the design of efficient and effective conservation and development interventions that meet both biodiversity conservation targets and socioeconomic needs.

We conducted a global review and analysis of the scientific literature that addresses these knowledge gaps regarding the principal drivers of the social impacts of PAs and their consequences for biodiversity conservation. We used data from 160 terrestrial and marine PAs distributed across six continents and that were representative of all International Union for Conservation of Nature (IUCN) PA management and governance categories (Supporting Information). We quantified and determined how PAs' geographical, physical, and management characteristics were associated with their social impacts (Table 1). We then evaluated how these geographical, physical, and management characteristics were associated with overall PA socioeconomic and biodiversity conservation outcomes and assessed whether these two contrasting types of outcomes trade off against each other or are positively associated.

Table 1. Protected area (PA) properties and impacts.*

PA property	*Definition*	*Justification for inclusion in analysis*
Protection arrangement	PA protection categories included in the WDPA IUCN categories (I-IV, strictly protected; V-VI & biosphere reserves, sustainable use)	Strict protection can increase costs for local people (West et al. 2006).
Governance	entity responsible for PA management (state, community, co-managed)	Community and co-managed areas may benefit communities and lead to better conservation outcomes (Berkes 2004).
Geographical region	Africa, Europe, Oceania, North America, Central America, South America, Central Asia, Southeast Asia, Southern Asia	Regional differences in political contexts and histories may lead to variations in impacts (Nelson & Agrawal 2008).
Size	PA size (km^2) included in the WDPA	Large PAs may have greater impacts on people (Brockington & Igoe 2006) than small PAs.
Biome	terrestrial or marine	Marine resource governance differs from terrestrial resource governance (Schlager & Ostrom 1992).
Social impacts		
Displacement	voluntary or involuntary displacement, including moves in response to livelihood changes	Displacement is an often cited impact but its frequency is uncertain (Brockington & Igoe 2006).
Monetary	increases or decreases in monetary wealth of any section of local communities resulting from the existence of a PA	PAs may increase or decrease income within neighboring populations (Andam et al. 2010).
Livelihood	positive or negative livelihood impacts outside the monetary economy (e.g., subsistence farming, hunting, and gathering of natural resources)	PAs may restrict non-monetary livelihood activities (West & Brockington 2006).
Cultural	impacts on cultural identity or community cohesion, access to culturally important sites and resources, and aesthetic appreciation of surroundings	PAs may increase or restrict access to spiritually important sites (Dudley et al. 2009).
Compensation	acts by PA authorities designed to offset negative impacts of PAs	Compensation can lessen negative impacts or lead to positive conservation outcomes (Beazley 2009).
Conflict	heavy handedness, corruption, or extortion from PA staff toward local people and local resistance to these impacts	The creation of PAs may lead to direct conflicts between PA authorities and local communities (Holmes 2013).
Empowerment	increased control over lives and livelihoods, including control over natural resource management, or increased land-tenure security	Empowerment may improve socioeconomic and conservation outcomes (Karanth 2007).
Unequal distribution of impact	PA impacts differ among sections of neighboring communities	Impacts of protected areas are not felt equally among local people (Holmes 2007).

**Abbreviations: PA, protected area; WDPA, World Database on Protected Areas; IUCN, International Union for Conservation of Nature.*

Methods

Case Study Selection

We created a database of peer-reviewed articles on the social impacts of PAs by conducting systematic searches in ISI Web of Knowledge using the following Boolean search terms: topic = ("protected area" OR "reserve" OR "national park") AND topic = ("social impact" OR "cost" OR "benefit" "eviction" OR "displacement" OR "livelihood" OR "compensation" OR "culture" OR "gender" OR "class" OR "caste" OR "indigenous" OR "income" OR "community") AND topic = ("Conservation") NOT topic = ("Species"). To minimize bias in our searches, we chose keywords that were either neutral (14 of 19 keywords) or identified general or specific known negative impacts (3 keywords, i.e., *displacement*, *eviction*, and *cost*) and keywords related to measures of restitution or general positive impacts (2 keywords, i.e., *compensation* and *benefit*). We refined our search further by focusing on the following research areas: environmental sciences and ecology, biodiversity conservation, forestry, sociology, anthropology, government law, ethnic studies, and social issues. Following Waylen et al. (2010), we also entered the search terms in Google Scholar and reviewed the first 500 results. We purposefully excluded the substantial body of non-peer-reviewed studies on social impacts of PAs because of potential biases and lack of detailed statistical analysis within much of this material (Holmes & Brockington 2012). Peer-reviewed studies were only selected if we could clearly identify impacts on local communities resulting from a protected area.

Our initial search yielded 1635 studies. Inclusion in our final selection required studies to meet precise criteria (Supporting Information). To be included, studies had to have assessed the impacts of a specific, named PA. The impacts could have resulted directly from PA policies, such as hunting regulations, or indirectly, such as through increased tourism to the PA. Impacts also had to be directly linked by the authors to the presence of a PA and its institutions, rather than to the natural resources contained within the PA. This meant, for example, that ecosystem services provided by a PA were only classified as a PA benefit if the authors concluded that these services would be under serious threat should a PA and its institutions not be present (e.g., Allendorf 2006). Similarly, negative effects of predation and crop raiding by wild animals were only considered if the authors provided evidence that the presence of a PA increased exposure to this impact (e.g., Ogra 2008). Furthermore, because impacts tend to be distributed locally (West & Brockington 2006), we included only impacts affecting people living within PAs, people living within 10 km of PA boundaries, or, in the case of mobile peoples, people who customarily used PAs. Finally, we included only impacts that could be considered as likely having occurred during the adult lifetime of a local resident and excluded all impacts occurring prior to 1950. We excluded national level studies (e.g., Andam et al. 2010) because they cannot be used to relate the outcomes and impacts of specific PAs to their characteristics.

Based on these selection criteria, we identified 171 articles (Supporting Information) that covered 165 individual PAs (inter-rater agreement for the inclusion of studies Randolph's free-marginal $\kappa_{48} = 0.67$) and reported information on eight social impacts and on socioeconomic and conservation outcomes (Supporting Information). Socioeconomic targets identified in individual studies were met in 23 PAs, whereas overall negative socioeconomic outcomes were recorded in six PAs. These negative outcomes stem from one study (Schmidt-Soltau 2003), which we excluded due to ongoing disputes over its methodology and results (Holmes & Brockington 2012). We are not aware of any disputes regarding the methodology and results of any of the other papers included in our final selection, and this exclusion resulted in a final sample of 160 individual PAs. North American PAs were represented by three case studies and privately protected areas by two case studies. We thus excluded these cases respectively from regression models that included geographical region and management regimes as predictor variables but retained them in all other analyses. We were constrained by data availability to use of self-reported outcomes, rather than using quantitative data to assess impacts and outcomes. Such self-reported data can, however, be used reliably to assess the outcomes of protected areas (Hockings 2003; Laurance et al. 2012).

Variable Construction and Coding

We identified potential predictor and response variables based on the current state of knowledge about the social impacts of PAs (Table 1). To assess potential trade-offs and associations between socioeconomic and ecological outcomes, we coded whether studies concluded that specific biodiversity conservation or socioeconomic objectives set by PA management authorities had been met. The conservation objectives related to a range of ecological attributes from specific species to components of ecosystems (such as habitat cover or quality). Socioeconomic outcomes referred to any objectives relating to improving or maintaining any aspect of the social, economic, cultural, or political life of populations residing inside or within 10 km of the PA. Information about the IUCN status (i.e., category) of individual PAs was obtained from the World Database on Protected Areas (IUCN & UNEP 2013) or from individual case studies when the IUCN status was reported in a study but absent from the database. The great majority of our case study PAs were single category PAs, but some had multiple categories. In cases where PAs had more than one category, we used information presented in the original papers to identify the management strategy of the particular section of the PA in which the published study was focused.

The IUCN protected areas in category V have a primary objective of maintaining conservation values created by interactions with humans through traditional management practices, and sub-objectives include providing natural products, conserving agro-biodiversity, and acting as models of sustainability. The primary objective of category VI PAs is conserving ecosystems and traditional natural resource management systems when conservation and sustainable use are mutually beneficial (Dudley et al. 2010). We thus classified IUCN PAs in categories V and VI as sustainable use. We classified PAs in IUCN categories I-IV, for which objectives are much more focused on biological conservation, as strictly protected. We also classified biosphere reserves as sustainable use because although they contain zones of strict protection, overall they aim to increase people's ability to sustainably manage resources while delivering effective nature conservation (UNESCO 1996). This classification has been clearly defined (Bridgewater et al. 1996) and was confirmed as appropriate for the seven biosphere reserves and five special designation sites.

Although studies varied greatly in their methods, from quantitative studies focusing on changes over time (Naughton-Treves et al. 2011) to ethnographic accounts (Beazley 2009), most studies focusing on the social impact of PAs used qualitative approaches to analyze specific costs and benefits and their distribution among affected populations. We used a subset of studies to develop a coding protocol that focused solely on the presence of specific impacts and whether they were distributed unequally among the affected populations (inter-rater agreement for individual variable coding Cohen's $K_{160} = 0.97$). We coded PA impacts as being present if costs or benefits were specifically evaluated and combined data on individual PAs analyzed in more than one paper. Monetary, livelihood, cultural impacts, and the unequal distribution of impacts were coded into costs, benefits, or a mixture of costs and benefits. This approach is similar to that used in previous studies in which quantitative and qualitative socio-ecological data were combined (Oldekop et al. 2010; Waylen et al. 2010). Impacts not mentioned by specific case studies were coded as not reported. This coding system is not based on the assumption that these impacts are absent or do not occur; rather, we assumed they have not yet been recorded for a particular location. Including not reported impacts in the analysis allowed us to elucidate specific relationships, isolate gaps in the literature, and identify further areas of research.

Analyses

We performed all statistical analyses in *R* (R Development Core Team 2014). Due to the number of potential predictor variables and unequal balance in the data, we used an area-under-the-curve (AUC) corrected random forest analysis in the package party (Hothorn et al. 2014) to identify key predictor variables that explained substantial variation in overall reported socioeconomic and conservation outcomes. Random forests is increasingly used to select variables for subsequent use in regression and classification analyses. It robustly handles small data sets with a large number of correlated or interacting predictor variables (Geneur et al. 2010).

We used the relative variable importance values of predictor variables from 10,000 trees of our random forests analysis to select a subset of predictor variables for the construction of multiple regression models that evaluated quantitative predictions for socioeconomic and conservation outcomes (see Supporting Information for variable importance plots that identify predictor variables for socioeconomic and conservation outcomes). To ensure the robustness of our random forest analyses results, each analysis was performed in triplicate with random seeds. Variable importance thresholds were set as the value above the absolute value of the lowest negative-scoring variable (Strobl et al. 2009). We followed the same procedure to identify a set of PA biophysical and management characteristics explaining substantial variation in PA social impacts (see Supporting Information for variable importance plots identifying predictors of PA social impacts).

We subsequently ran all possible model combinations of predictor variables identified through the random forest analysis using the nnet package's multinom function (Ripley & Venables 2014) and controlled for quasi-complete separation in parts of our data set by using bootstrapped samples of our data ($n = 100{,}000$) to calculate deviance (D) and Akaike information criterion (AIC) values and model parameter coefficients. We subsequently selected all models with $\Delta AIC < 2$ of the model with the lowest AIC value and performed model averaging to calculate individual predictor variable partial D^2 and parameter coefficients. Partial D^2 values are used as a measure of explanatory power in ordinal regressions (equivalent to partial r^2 for linear regressions) and were calculated as D^2 = (null deviance – model deviance) / null deviance (Guisan & Zimmermann 2000). We cross-validated our bootstrapped results by comparing bootstrapped AIC and D values of binomial regressions with those generated using the brglm package's Firth bias correction function (Kosimidis 2013), which addresses issues of near perfect separation in logistic regressions (Heinze & Schemper 2002).

Results

PA Impacts and Socioeconomic and Conservation Outcomes

Reported positive conservation outcomes were associated with reported positive socioeconomic outcomes (partial $D^2_{(2, 160)} = 0.16$). Sustainable-use PAs were more likely to report overall positive socioeconomic outcomes than more strictly protected ones (model averaged partial $D^2_{(1, 142)} = 0.05$) (Fig. 1a, Supporting Information), and positive socioeconomic outcomes were more frequently reported from PAs in which local people experienced empowerment (model averaged partial $D^2_{(1, 142)} = 0.11$) (Fig. 1b, Supporting Information), positive cultural outcomes (model averaged partial $D^2_{(1, 142)} = 0.11$) (Fig. 1c, Supporting Information), and relatively fewer negative livelihood impacts (model averaged partial $D^2_{(1, 142)} = 0.07$) (Fig. 1d, Supporting Information). Similarly, positive cultural (model averaged partial $D^2_{(2, 156)} = 0.05$, Fig. 1e, Supporting Information) and livelihood impacts (model averaged partial $D^2_{(2, 156)} = 0.06$, Fig. 1f, Supporting Information) were associated with positive conservation outcomes. These models also retained empowerment (model averaged partial $D^2_{(2, 156)} = 0.01$) (Fig. 1g, Supporting Information) and PA size (model averaged partial $D^2_{(2, 156)} = 0.02$) (Supporting Information), but their explanatory capacity was particularly poor. There was no evidence for regional variation in the reporting of successful conservation or socioeconomic outcomes.

PA Impacts and Management and Physical Characteristics

Governance of PAs was, to some extent, associated with empowerment (model averaged partial $D^2_{(1, 148)} = 0.06$), monetary impacts (model averaged partial $D^2_{(3, 149)} = 0.07$), livelihood impacts (model averaged partial $D^2_{(2, 134)} = 0.06$), and the unequal distribution of impacts (partial $D^2_{(3, 157)} = 0.09$). Co-managed PAs were associated with more empowerment (Fig. 2a, Supporting Information), monetary benefits (Fig. 2b, Supporting Information), and less unequal distribution of costs (Fig. 2c, Supporting Information) than community- or state-managed PAs, but they were associated with

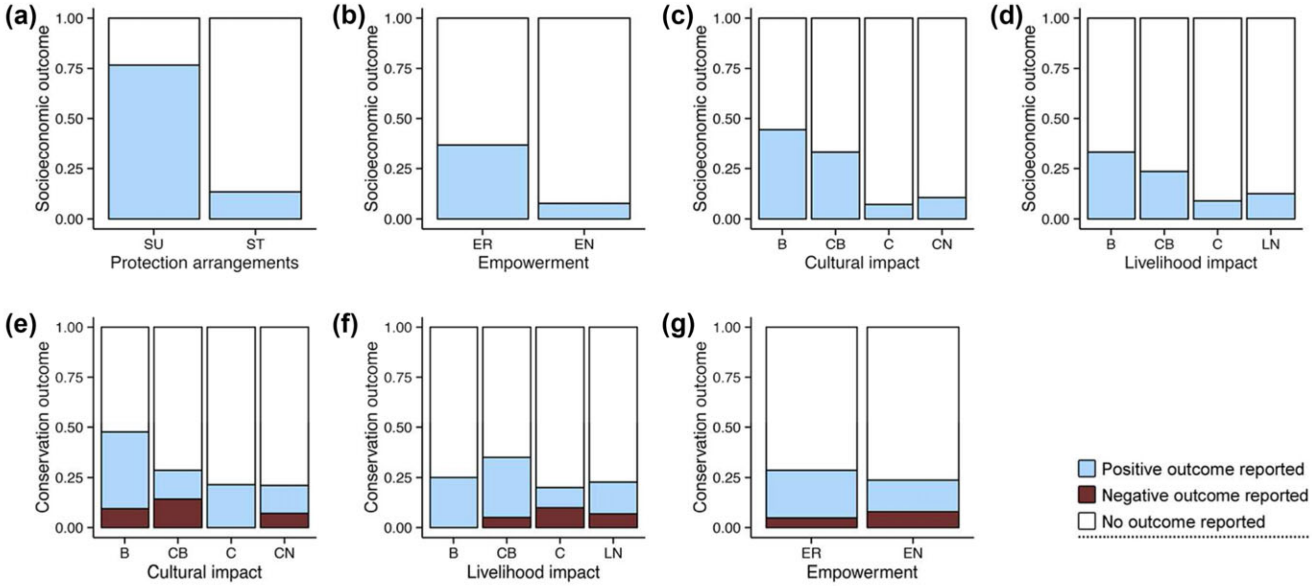

Figure 1. The proportion of studies reporting positive, negative, or no impact of protected areas on (a-d) socioeconomic and (e-g) conservation outcomes. Socioeconomic outcomes are relative to (a) protection arrangements (SU, sustainable use [IUCN categories V and VI], n = 30; ST, strict protection [IUCN categories I-IV], n = 112), (b) empowerment (ER, empowerment reported, n = 38; EN, empowerment not reported, n = 104), (c) cultural impacts (B, benefits reported, n = 21; CB, costs and benefits reported, n = 7; C, costs reported, n = 14; CN, cultural impacts not reported, n = 114), and (d) livelihood impacts (B, n = 12; CB, n = 34; C, n = 56; LN, livelihood impacts not reported, n = 40). Conservation outcomes are depicted in relation to (e) cultural impacts (B, n = 21; CB, n = 7; C, n = 14; CN, n = 114) and (f) livelihood impacts (B, n = 12; CB, n = 40; C, n = 60; LN, n = 44), and (g) empowerment (ER, n = 42; EN, n = 114).

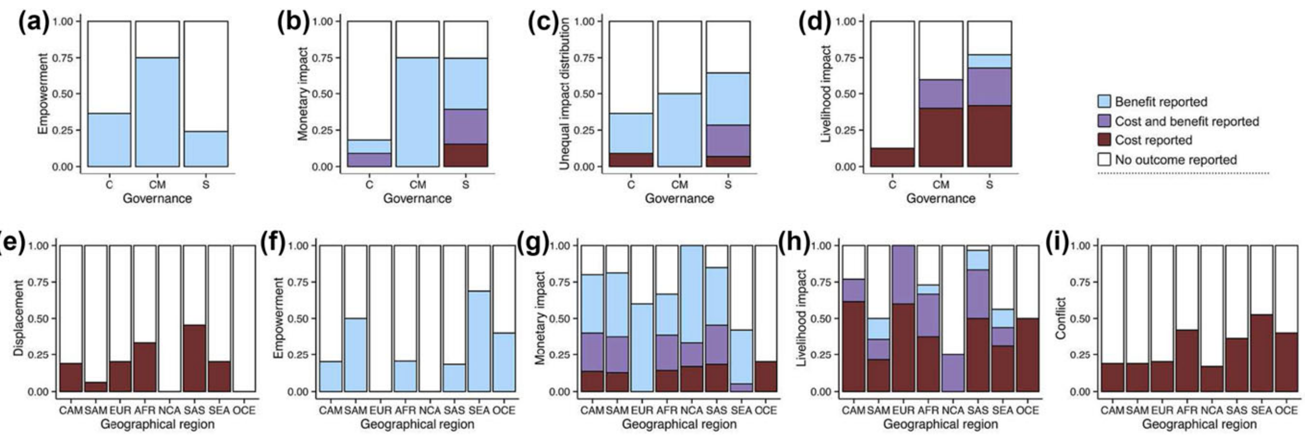

Figure 2. Proportion of studies reporting benefits, reporting costs and benefits, reporting costs, and not reporting outcomes of (a-d) the impact of protected area governance arrangements on (a) empowerment (C, community, n = 11; CM, co-managed, n = 8; S, state, n = 129), (b) monetary impacts (C, n = 11; CM, n = 8; S, n = 130), (c) the unequal distribution of impacts (C, N = 11; CM, N = 8; S, N = 130), and (d) livelihood impacts (C, N = 7; CM, N = 5; S, N = 122) and the impact of region (e-i) on (e) displacement (CAM, Central America, N = 16; SAM, South America, N = 16; EUR, Europe, N = 5; AFR, Africa, N = 57; NCA, north and central Asia, N = 6; SAS, south Asia, N = 33; SEA, Southeast Asia, N = 19; OCE, Oceania, N = 5), (f) empowerment (CAM, N = 15; SAM, N = 16; EUR, N = 5; AFR, N = 54; NCA, N = 4; SAS, N = 33; SEA, N = 16; OCE, N = 5), (g) monetary impacts (CAM, N = 15; SAM, N = 16; EUR, N = 5; AFR, N = 54; NCA, N = 5; SAS, N = 33; SEA, N = 16; OCE, N = 5), (h) livelihood impacts (CAM, N = 13; SAM, N = 14; EUR, N = 5; AFR, N = 48; NCA, N = 4; SAS, N = 30; SEA, N = 16, OCE, N = 4), and (i) conflict (CAM, N = 16; SAM, n = 16; EUR, N= 5; AFR, N = 57; NCA, N = 6; SAS, n = 33; SEA, n = 19; OCE, n = 5).

livelihood costs similar to state-managed PAs and more livelihood costs than community-managed PAs (Fig. 2d, Supporting Information).

Geographical region was associated with empowerment (model averaged partial $D^2_{(1, 148)} = 0.18$), displacement (model averaged partial $D^2_{(1, 157)} = 0.13$), monetary impacts (model averaged partial $D^2_{(3, 149)} = 0.13$), livelihood impacts (model averaged partial $D^2_{(3, 134)} = 0.17$), and conflict (model averaged partial $D^2_{(3, 157)} = 0.08$). People affected by African and southern Asia PAs experienced more displacement (Fig. 2e, Supporting Information) and, together with Central America, less empowerment (Fig. 2f, Supporting Information) than other regions, whereas monetary and livelihood impacts varied substantially across regions (Figs. 2g & 2h, Supporting Information). Conversely, African, Southern Asia, and Southeast Asian PAs and those in Oceania experienced more conflict than those in other regions (Fig. 2i, Supporting Information).

Protected area size was retained as an explanatory variable for empowerment (model averaged partial $D^2_{(1, 148)} = 0.03$) (Supporting Information), unequal impact distribution (model averaged partial $D^2_{(3, 157)} = 0.001$, Supporting Information), and livelihood impacts (model averaged partial $D^2_{(1, 134)} = 0.04$, Supporting Information), but their overall explanatory capacity was poor.

Discussion

We found that PAs in which socioeconomic benefits were reported were also more likely to report positive conservation outcomes, and these socioeconomic benefits were more likely to arise when PAs were managed to promote sustainable resource use rather than enforcing stricter protection of biological resources. Although strict protection may be needed under certain circumstances (e.g., extreme poaching pressure), our results strongly suggest that conservation initiatives should consider whether enforcing strict protection on the exploitation of natural resources is essential for protecting biodiversity. Conservation targets of PAs were met more often when the PA empowered local people, improved cultural benefits, and decreased livelihood costs. Furthermore, trade-offs between positive conservation and human development outcomes were not inevitable, rather the two outcomes were often (65% of cases) compatible. Indeed, we found that conservation outcomes were predicted by socioeconomic outcomes more reliably than they were predicted by the physical and management characteristics of PAs. The later certainly play a role in determining positive conservation outcomes of PAs, but our results provide evidence that the attention given to them by conservation initiatives should not come at the expense of the socioeconomic outcomes of PAs.

Our results also draw attention to the links between the governance of PAs and their outcomes. Comanagement of PAs by local communities and conservation bodies were typically associated with delivering greater benefits to local communities than community- or state-managed PAs. This finding potentially challenges a key justification for the rise of community-managed protected areas; that is, they provide more benefits to local people than PAs under other forms of governance (Berkes 2008). Local institutional capacity building and project design are likely to be important for successful and equitable community-based natural resource management projects (Brooks et al. 2012), but communities co-managing PAs alongside other organizations are likely to benefit from additional institutions that strengthen tenure rights and participatory decision-making processes while also promoting monetary benefits and more equal distribution of these benefits.

Finally, we found that regional context determined how PA effects differed among local communities. Although national contexts might not always be as important as community characteristics in determining successful socioeconomic outcomes (Kabra 2009), regional differences in the representation and empowerment of rural peoples in national politics (Galvin & Haller 2008), differences in economic stability, and the robustness and transparency of national governance can drive divergence of PA outcomes in different regions (Nelson & Agrawal 2008). We confirmed that factors affecting positive socioeconomic outcomes of PAs are influenced by regional characteristics, suggesting that blanket conservation initiatives are less likely to succeed if they do not consider regional socioeconomic and political contexts.

Collectively, our results provide further support for the involvement of local people as stakeholders in decision-making processes, particularly as co-managers of protected areas (such a role may include agreement to more stringent conservation measures). Protected areas are not inevitably linked to negative social impacts for resident or neighboring human populations (Andam et al. 2010), and the strengthening of resource management and land-tenure rights can lead to successful livelihood and conservation outcomes (Oldekop et al. 2010; Persha et al. 2011; Nolte et al. 2013).

We defined levels of protection and governance arrangements according to IUCN management categories but could not take into account any variation in precise arrangements within a management category or in how effectively management policies are implemented (Dudley 2008). These variations may have affected how social costs and benefits were perceived, managed, and reported and created additional noise in our data set. The paucity of studies reporting conservation and socioeconomic outcomes and the focus of studies we considered on specific targets meant we could measure outcomes only as unidimensional variables. Our inclusion of eight social impacts helped capture some of the nuances related to different socioeconomic outcomes. Our measure of conservation outcome, however, did not account for multiple outcomes or trade-offs where protection and management arrangements might be targeted toward or benefit some focal taxa or ecosystem components but not others. Finally, sample size limitations also meant we could not evaluate the effect of different types of ecosystems on socioeconomic or conservation outcomes. Therefore, future studies should aim to elucidate some of the nuances between protection arrangements, subsistence use, ecosystems, regional factors, and multiple conservation outcomes.

Our study moves debates on the social impact of protected areas and its relevance for nature conservation forward in three significant ways. First, we have provided a novel, global analysis showing a positive association between the socioeconomic and biodiversity conservation outcomes of PAs; these two objectives thus need not be considered as conflicting. Second, we found that sustainable-use PAs were more likely to report successful socioeconomic outcomes than more strictly protected areas. Taken together these two results suggest that sustainable use PAs can perform as well for conservation as those with stricter management regimes. Finally, we have provided evidence that PA initiatives aiming to deliver joint positive socioeconomic and conservation outcomes should consider specific regional socioeconomic and political contexts, support co-management arrangements that promote empowerment of local people alongside other institutions, reduce inequalities in the distribution of these benefits, and help maintain cultural and livelihood benefits from local PAs.

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Supporting Information

A global map of protected areas contained in the IUCN and UNEP world database on protected areas and how our sample of studies compares with the information contained within the database (Appendix S1), the selection path for research articles and case studies (Appendix S2), the number of protected areas associated with specific impacts and socioeconomic and conservation outcomes within our sample (Appendix S3), representative variable importance plots for random forest analysis (Appendix S4 - S5), tables containing bootstrapped model parameters, coefficients, and confidence intervals for all regression analyses (Appendix S6 - S13), and a list of the articles included in our analysis (Appendix S14) 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.

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