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Authors

Brooks, J S
Franzen, M A
Holmes, C M
et al.

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TESTING HYPOTHESES FOR THE SUCCESS OF DIFFERENT CONSERVATION

STRATEGIES

J. S. Brooks (1)

M. A. Franzen (1)

C. M. Holmes (1,2)

M.N. Grote (3)

M. Borgerhoff Mulder, mborgerhoffmulder@ucdavis.edu (1,3,4)*

(1) Graduate Group in Ecology, University of California at Davis, Davis, CA 95616, USA

(2) Institute for the Conservation of Tropical Biology (ICTE), Department of Anthropology,

SUNY Stony Brook, New York, NY 11794, U.S.A.

(3) Department of Anthropology, University of California at Davis, Davis, CA 95616, USA

(4) Center for Population Biology, University of California at Davis, Davis, CA 95616, USA

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* Author for correspondence

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ABSTRACT

Evaluations of the success of different conservation strategies are still in their infancy. We used four different measures of project outcomes – ecological, economic, attitudinal, and behavioral -- to test hypotheses derived from the assumptions that underlie contemporary conservation solutions. Our hypotheses concerned the effects of natural resource utilization, market integration, decentralization, and community homogeneity on project success. We reviewed the conservation and development literature and used a specific protocol to extract and code the information in a sample of papers. Although our results are by no means conclusive and suffer from the paucity of high-quality data and independent monitoring (80% of the original sample of 124 projects provided inadequate information for use in this study), they show that permitted use of natural resources, market access, and greater community involvement in the conservation project are all important factors for a successful outcome. Without better monitoring schemes in place it is still impossible to provide a systematic evaluation of how different strategies are best suited to different conservation challenges.

INTRODUCTION

The critique of protectionism that emerged in the 1980s has spawned an array of conservation strategies that promote, to various degrees, the welfare and cooperation of the people living in and around protected areas. Such strategies provide a mix of conservation and development objectives (Borgerhoff Mulder & Coppolillo 2005) and employ a range of tactics, such as providing appropriate development opportunities (Abbot et al. 2001), emphasizing local community involvement (Western 1994; Getz et al. 1999), adopting shared management (Murphree 1994), ensuring local autonomy (Muller 2003), guaranteeing rights to harvest (Fearnside 1989; Browder 1992), promoting knowledge (Jacobson 1998), awarding cash compensation (Ferraro 2002), and encouraging tourism (Honey 1999).

Despite the prominence of such strategies linking conservation and development as primary conservation tools, and strong arguments for and against their effectiveness (Wells 1992; Barrett & Arcese 1995; Oates 1999; McShane & Wells 2004), there have been few quantitative comparative evaluations of their successes and failures. There are, however, exceptions. Bruner et al. (2001) studied vegetational changes associated with protectionism (and its absence), and Salafsky et al. (2001) identified design features of enterprise strategies for community-based conservation projects that produce successful outcomes. In a more recent study, Struhsaker et al. (2005) examined correlates of conservation success in Africa's forests and considered, among other factors, the presence of integrated conservation and development projects.

Following the call of Sutherland et al. (2004) and Saterson et al. (2004) for independent evaluation of the reasons why different strategies succeed and fail, we used data from 28 projects that purportedly link conservation and development to test quantitatively some of the assumptions that underlie current conservation strategies. Although specific projects become known for specific strategies (e.g., ecotourism in the Galapagos or community-based conservation in southern Africa), in practice more than one strategy is used in any one project (Borgerhoff Mulder & Coppolillo 2005). Accordingly we focused not on specific strategies per se but on the assumptions underlying the strategies currently embraced by many conservation

organizations. In particular, we considered the utilization-protection continuum, market integration, decentralization and community homogeneity. Although our results provide some support for the intuitions driving the conservation and development approach, existing data are insufficient to make substantive claims about the efficacy of the conservation and development paradigm as a whole or about specific characteristics that may result in success for a particular project. Our study should, however, stimulate further, more rigorous comparative analyses as more data become available.

MEASURES OF SUCCESS

Much of the debate among those concerned with conservation strategy and policy results from an interest in different outcomes. Social scientists focus on a community's economic well-being and empowerment, whereas natural scientists pay closer attention to biological impacts of resource use. Consider, for example, the debate over extractive reserves. For Schwartzman et al. (2000*a*) a well-conserved forest is one that sequesters carbon, does not burn, has stable hydrology and soils, and provides a productive home for forest-living peoples. For others (e.g., Redford 1992) a well-conserved forest is one that harbors ecologically functional populations of all species within the ecosystem, thereby providing for the conservation of the full set of species, genes, and ecological relationships. Unsurprisingly, such authors disagree over the viability of extractive reserves (Schwarzman et al. 2000*b*), a disagreement that illustrates the different perspectives of social versus natural scientists (Naughton-Treves et al. 2005).

Recognizing these multiple perspectives, we included in our analysis four outcome measures as criteria for evaluating the success or failure of conservation and development projects: ecological, economic, attitudinal, and behavioral. We define *ecological success* in terms of the consequences for one or a set of species (or habitats) designated as targets of the conservation project. *Economic success* refers to the consequences for material welfare of the communities affected. Underlying these economic and ecological outcomes are the attitudes and behaviors of local residents: *attitudinal success* is defined in terms of the views of local residents to the goals of the conservation project, and *behavioral success* refers to changes in behavior likely to reduce threats to natural resources. Although changes in attitudes are an important consequence of a conservation project, positive attitudes do not ensure ecological success and are not necessarily correlated with economic success (Holmes 2003). Furthermore if positive attitudes do not translate into conservation-friendly actions, then they are strictly irrelevant to ecological outcomes (Adams 2001; Holmes 2003). Ideally all four outcomes should be considered together when studying conservation and development projects, with the recognition that there may be a temporal aspect to their emergence; for example, positive behavioral outcomes might occur prior to the observation of positive ecological outcomes.

HYPOTHESES

We tested predictions underlying the logic of the integrated conservation and development framework representing the view from the social sciences. The four hypotheses are stated in their most naïve form with the understanding that there are nuances, complications, and alternative predictions for each. These complexities are raised in the discussion, specifically with respect to

the suitability of different strategies in different contexts. We labeled our four hypotheses utilization/protection, market integration, decentralization, and community homogeneity.

First, we hypothesized that greater levels of utilization generate support for, and compliance with, conservation initiatives. Although high levels of protection contribute to ecological success (Caro et al. 1998; Bruner 2001), this may not be a general pattern and may compromise economic, attitudinal, and behavioral success. This is particularly likely when protected areas have been established without local consultation or when their management is underfunded (Balmford 2003). In such cases local communities may resent losing access to (or receiving insufficient compensation for) the resources they used previously and accordingly increase illegal offtake (e.g., Lindsay 1987). The general assumption underlying our prediction is that because income generation is linked to sustainable utilization of natural resources, local communities will recognize the importance of regulating resource use and their attitudes and behaviors toward conservation will change accordingly. Opening up areas to human use, whether as buffer zones or extractive reserves, may increase support for conservation while minimizing human impacts, yielding the prediction that projects emphasizing utilization will show increased economic, attitudinal, behavioral, and ultimately ecological success. This somewhat naïve prediction assumes that utilization generates income, is sustainable, and does not adversely affect other species (see Discussion).

Second, we hypothesized that where conservation projects facilitate increased market integration, there is greater local support for resource management and conservation. Integration of local communities into larger regional or national markets entails many changes (e.g., alternative sources of income, access to substitute subsistence goods, new markets for local products, changed material aspirations), each with distinct potential conservation outcomes. The dynamic we focused on is developed most fully by Godoy et al. (1995; see also Hulme & Murphree 1999): increased external income offered by markets can decrease dependence on local forests either through substitution of commercial alternatives or by devaluing forest goods in comparison with income earned through wage labor. Both pathways decrease the incentive to extract resources for sale in the market. The prediction then is that greater market integration will show increased economic, attitudinal, behavioral, and ultimately ecological success, although we realize that negative effects are a possibility (see discussion).

Our third hypothesis concerned decentralization: with greater local input in conservation decisions and greater community control over programs, the attitudes and behaviors of residents change in a positive way. Some support for this view comes from a study of local enterprise initiatives linked to conservation projects in Southeast Asia (Salafsky et al. 2000). The idea that empowering local communities should make them more responsive to conservation initiatives lies at the heart of community-based conservation programs (Wyckoff-Baird 2000; Ribot 2004). The benefits of decentralization derive from the assumption that local bodies will be more responsive to conservation initiatives than national governments. Again multiple lines of logic are implied. First, local communities are thought to have greater knowledge of the intricate dynamics of their natural resource base than outsiders and to have more incentive to sustain it over time. They are also presumed to have lower discount rates than a commercial intruder. The prediction then is that decentralization, defined here primarily in terms of the extent to which project design and implementation is devolved to local communities, is associated with increased

economic, attitudinal, behavioral, and ultimately ecological success. As we acknowledge in the discussion, successful decentralization depends on both the presence of functioning institutions within the community and on the socioeconomic and political conditions prior to decentralization.

Our final hypothesis concerned community homogeneity: the more homogeneous a community, the more successful the project is in all aspects. Cultural homogeneity is thought to facilitate the functioning of community institutions for resource management by increasing trust between community members and thus reducing transaction costs (Ostrom 1990) and has been identified as an important factor in success in the Zimbabwean CAMPFIRE program (Barrow & Murphree 2001). Compared with a more heterogeneous community, a culturally homogeneous community is expected to cooperate more often and more efficiently to solve collective action problems, such as common-pool resource management issues arising in and around project areas. Situations in which heterogeneity might boost rather than impede collective action are outlined in the discussion.

METHODS

Sample
The impetus for this project originated from case studies analyzed for Borgerhoff Mulder and Coppolillo (2005). We reviewed the bibliographies of these case studies and the bibliographies of integrated conservation and development projects (ICDP) by Brown (2002) and Flintan (2000) for additional papers. In addition, we conducted Web-based searches with ISI Web of Knowledge, Anthropology Plus, Biblioline, and JSTOR electronic databases. We searched for the terms *ICDP*, *integrated conservation and development project, community based conservation, and conservation and development* in each database. This search produced 124 relevant papers.

To be included in the final sample (see Supplementary Material below), a paper had to (1) have been peer-reviewed, (2) include monitoring, and (3) cover two or more of the four outcome measures (ecological, economic, attitudinal, behavioral). Reviews of conservation and development projects in edited volumes were not included. Papers giving only an overview of the project or a descriptive explanation of implementation and outcomes were not used. Papers examining the impacts of a national park on local communities in the absence of a conservation and development project were excluded. Fifty percent of the articles were excluded because there was no monitoring or evaluation or only one outcome measure was reported, and 22% were excluded because there was no project associated with the protected area. We excluded another 9% because the article reviewed either CAMPFIRE or ADMADE. For such projects with multiple locations that could count as distinct cases (Hulme & Murphree 2001) only one site was used, following the criteria of selection outlined above. Our final sample size was 28 projects from 24 papers (1 paper reviewed 3 projects, whereas 2 other papers reviewed 2 projects each).

Coding
We created variables to describe a project's local environment, protected area, community (or communities) affected, threats to the local environment, and monitoring information related to

the success of the project. We collected 60 pieces of information for each paper. Only those directly relevant to the major hypotheses are discussed here.

Two researchers (J.S.B., M.A.F.) coded each paper separately. When coders disagreed, they discussed their decisions and then chose the most appropriate code. Coders based their decisions only on the information presented. To pretest coding categories and test intercoder reliability, the coding protocol was applied to Wells' (1999) review of ICDPs in Indonesia. This publication was not included because it was not peer reviewed and did not contain a sufficient number of monitored outcome variables.

Predictor Variables
For the utilization/protection hypothesis (Table 1), we used two predictor variables: the protected area IUCN ranking (IUCN) and amount of resource use permitted in the project area (use). We supplemented the former with the latter measure because in some contexts the IUCN ranking is a poor indicator of actual usage patterns (Naughton-Treves et al. 2005). To test the market integration hypothesis, we used four predictor variables, each dealing with a different aspect of market incursion (sell, purchase, labor) and the scale of the threat resulting from resource extraction (threat). To test the decentralization hypothesis, we used three variables: implementation (level of the organization responsible for implementing the project), decision (level of community involvement in a project's day-to-day running once it was implemented), and benefits (targeted beneficiaries of the project). The community homogeneity hypothesis had only one predictor variable, population (whether or not the source of local population growth is from local residents or from immigration). Few papers included appropriate ethnographic, cultural and social data on the population(s) in the project area, making a more precise measure of this variable difficult to obtain. All variables consisted of categories ordered (Table 1) so that positive associations between predictor and outcome measures provided evidence consistent with the four hypotheses.

Analysis
We examined two-dimensional contingency tables of predictors and outcomes, and used Monte-Carlo and false discovery rate methods (FDR; Benjamini & Hochberg 1995) to determine statistical significance. We used the Goodman-Kruskal gamma statistic (Goodman & Kruskal 1954; Agresti 1990) to summarize the association between a predictor and response and as a test statistic for Monte-Carlo significance tests. Gamma, which lies in the interval [-1, 1], is the difference between the sample frequencies of concordant and discordant pairs of observations when the ordinations of both predictor and outcome are considered. Unlike other measures of ordinal association (e.g., Agresti 1990), gamma does not require that numerical "scores" be assigned by the observer (often arbitrarily) to the levels of a variable. Hypothesis tests based on gamma have known drawbacks (e.g., Cohen & Sackrowitz 1992), but they are balanced by the natural interpretability of gamma for the present data. Because of the way the variable categories were ordered (Table 1), we interpreted a value of gamma relatively close to 1 as evidence in favor of the hypothesis under consideration.

With 10 predictors and four outcomes, there were 40 two-dimensional tables to be tested; and correlations within the sets of predictors and outcomes were likely to be present. These considerations and the small sample size made it necessary to mitigate problems of multiple

testing. We adjusted significance levels from the 40 hypothesis tests using q values (Storey 2002; reviewed in Roback & Askins 2005) to obtain approximate control of the FDR, defined as the expected proportion of false-positive tests among tests called significant. Storey (2002) describes algorithms which take ordered significance levels (p values) from multiple hypothesis tests, returning a corresponding sequence of q values connected to the FDR for the tests. Approximate control of the FDR is achieved by setting a threshold for the q values; for example, calling the tests having q values ≤ 0.05 significant implies that, of those tests, only about 5% are expected to be truly null-hypothesis cases.

We obtained a Monte Carlo p value and associated q value for each test of ordinal association as follows. For an observed table, 5000 random tables (having the same row and column sums as the observed table) were generated under the null hypothesis of independence of predictor and outcome. These tables were generated with the function "r2dtable" in the statistical software R (2004, version 2.0.1). For each random table, the Goodman-Kruskal gamma statistic was calculated and stored. Because the alternative hypothesis was directional (i.e., positive association between predictor and outcome), we calculated a "one-sided" p value as the number of random gamma statistics greater than or equal to the observed gamma, divided by 5000. The p values obtained in this way from the 40 observed tables were then supplied to the q value software (available at http://faculty.washington.edu/~jstorey/), which calculates q values for the Monte-Carlo significance tests. We used the bootstrap option in q value and allowed the tuning parameter lambda to range in $[0, p^*]$, where p^* was the seventy-fifth percentile of the Monte-Carlo p values.

RESULTS

There was a notable tendency overall for these gamma statistics to lie above zero, broadly confirming the positive associations underlying the four hypotheses (Fig. 1). Sample sizes for the tables ranged from $n=7$ (for purchase x ecological success) to $n=25$ (for threat x economic success); thus, the statistical power to detect association varied widely. We called eight of the tests significant. Control of the FDR by q values then implies that of these eight tests, about one (0.1 x 8) is expected to be a truly null case.

The results (Fig. 1) show evidence for greater attitudinal success among projects with more purchasing (purchase) and selling (sell) opportunities; greater behavioral success among projects with more community involvement in the establishment (implementation) and day-to-day running (decision) of a project; greater ecological success among projects in which the community was involved in day-to-day activities (decision); and greater economic success among projects that make fewer restrictions on the use of the protected area (IUCN) and provide more opportunities for selling natural products (sell) and more community input into day-to-day management (decision). There was therefore some support for three of the four hypotheses, with decentralization, market integration, and utilization of resources predicting, respectively, four, three, and one of our original measures of success.

DISCUSSION

The associations we observed consistently supported predictions stemming from the social-science framework that emphasizes utilization, decentralization, and market access as conservation strategies. These results suggest there are strengths to integrated conservation and development programs, at least under some circumstances, despite cogent critiques of some of the logic behind them (e.g., Robinson & Redford 2004). We stress, however, that we view our results as provisional due to the paucity of reliable data on project characteristics and outcomes. Because the majority of projects in our initial sample were inadequately monitored and assessed, the possibility remains that our final sample of 28 projects differs systematically with regard to characteristics and outcomes of "typical" ICDPs. Furthermore, the small size and incompleteness of some project records in our final sample make drawing conclusions a precarious task. The addition of even a few projects meeting our criteria would potentially change the results. These observations reflect the poor standards of monitoring and assessment – a shocking situation given the considerable budgets of many ICDPs. We discuss our findings as they pertain to the four original hypotheses.

Utilization/Protection
Greater access to natural resources within buffer zones or extractive reserves (as measured by IUCN status) was associated with economic success. This relationship provides some support for our hypothesis, although only economic outcomes are affected. The short time frame of the studies precludes us from determining whether economic success might presage other types of success in the future. For instance, we have no evidence that harvests are sustainable or that people permitted to enter buffer zones and harvest natural resources are more willing to limit their harvests or to respect fully protected zones. Such behavioral consequences are possible. For example, they might be responsible for the positive ecological outcomes observed in Costa Rica, where legal collection of turtle eggs through a permit system reduced illegal offtake, increased community protection of the resource, and appear to have led to increased turtle numbers (Campbell 1998). More generally, detecting links between utilization and conservation outcomes requires a detailed analysis of the extent to which utilization is permitted, its potential to generate income, its sustainability, the effectiveness of policing, and broader impacts of harvests on nontarget species. Although some studies have begun to unravel some of these dynamics at specific sites (Marcus 2001; Walpole 2001; Struhsaker et al. 2005), data are not yet available to do this in a comparative context.

The hypothesis that most ecologists favor, that low protection and high utilization are associated with poor ecological outcomes, was not supported in our study. Although there is undeniable evidence that many natural resources cannot survive use (Alvard 1998; Robinson & Bennett 2000; M.A.F., unpublished data), sustainable harvesting of some species (often plants and sometimes aquatic resources) can be a viable strategy in some cases, where institutions regulating sustainable management are strong, as in fisheries comanagement (Katon et al. 1999) or when population sources remain protected (Hill et al. 1997). Our results suggest that ICDPs are being set up at just such sites.

Market Integration
We predicted that higher levels of market integration would be associated with success in all four outcome measures. Projects in communities that were strongly affected by markets showed positive conservation attitudes. Furthermore projects where communities sell heavily in local markets also tended to be successful economically. Although we have no measures of whether it is natural resources or other goods that are sold (or purchased) in markets, these findings are consistent with Godoy's (2001) suggestion that certain levels of market integration can potentially reduce indigenous impacts on game (see Godoy 1995 for more tentative claims related to non-timber forest products).

We stress, however, that there is a great deal of evidence that commercialization, road access, and technology acquired through the market can jeopardize the sustainability of traditional resource exploitation patterns (e.g., Kaplan & Kopishke 1992; Freese 1997; Robinson & Bennett 2000). Ultimately, the impacts of economic development on local environments will depend on the nature of market access and the regenerative nature of the product(s) being marketed (Demmer et al. 2002). The potential conservation benefits contingent on local people obtaining access to substitute goods or alternative sources of income may be negated by the arrival of outsiders in search of natural resources, such as oil, timber, precious metals, or land for soybean production. We could not make such distinctions because they were not addressed in sufficient detail in the literature we used for coding.

Decentralization
The data suggest that greater community input into project implementation is associated with behavioral success and that community involvement in day-to-day decision making is associated with behavioral, ecological, and economic success, supporting the claims of community-based conservationists (e.g. Western & Wright 1994) and allied approaches (Getz et al. 1999).

Despite the associations in the predicted direction, decentralization is no guarantee of success. Without solid community-level institutions for regulating common-pool resource use, decentralization may simply shift control to the elite in the community, doing little to solve the problem of resource exploitation (Wyckoff-Baird et al. 2000). Furthermore, the success of devolution depends critically on the nature of the institutions to which power is devolved (Borgerhoff Mulder & Coppolillo 2005). Ultimately, when external funding dries up, the success of any project will depend on the ability of the local communities to manage their resources over the long term. Successful management is often determined by the effectiveness of community institutions (Agrawal 2002; Ribot 2004), which are frequently a function of our final variable, community homogeneity.

Community Homogeneity
Community homogeneity could not be properly addressed due to the high number of missing values in the one variable available to measure homogeneity. The prediction that cultural homogeneity should lead to success is also quite simplistic. Although homogeneity among group members is often listed as a characteristic necessary for community-level institutions (Wade 1988; Ostrom 1990; Baland & Platteau 1996), some heterogeneity can be beneficial. The intuition here is that those with the most at stake may shoulder the costs of monitoring and enforcement and therefore contribute to the project's success (Olson 1965). Results from both

modeling exercises and empirical investigations support this prediction (Agrawal & Yadama 1997; Ruttan & Borgerhoff Mulder 1999). Tremendous strides have been made in determining what community and environmental attributes contribute to successful resource regulation, but there is still uncertainty as to the role that cultural and economic homogeneity of the community plays.

Data Quality
Our lack of strong findings points to the urgent need for better, quantitative monitoring of conservation and development initiatives (Stem et al. 2003; Sutherland et al. 2004). Less than a quarter of the originally reviewed articles could be used in this study because of a lack of monitoring. Of the 28 projects we did use, only 8 monitored all four aspects of success, and of the remaining 20, 7 monitored only two categories. Additionally, many of the project assessments lacked rigor. Only 1 project quantitatively monitored all four aspects of success, and only 2 projects quantitatively monitored three of the aspects (Campbell 1998; Marcus 2001). Ten projects had no quantitative monitoring, instead relying on qualitative findings that were, at best, only suggestive of success or failure. In addition, measures of ecological success (or limited success) were not ideal. Examples of ecological assessment in our study sample ranged from quantified measures of declining rates in deforestation (Community Initiative Program [CIP], Brazil) or linear regressions of the percentage of land a household has in forest cover (Corcovado National Park / Pierdras Blancas National Park, Costa Rica) to qualitative observations regarding the decision to set aside land for a mahogany reserve (CI-Brasil Pinkaiti Research Station Project), success in managing grass collection inside a reserve (Royal Chitwan National Park, Nepal), or an effective tree-planting scheme (Kilum-Ijim Forest, Cameroon).

Comparisons with other Studies
Our results pertaining to the decentralization hypothesis are largely consistent with those of Salafsky et al. (2001) who found that the extent to which community members are involved in the management and design of a project was particularly important for ecological success. Our results are inconsistent with Bruner et al.'s (2001) demonstration of the success of protectionism but are not strictly comparable because we evaluated a suite of alternative hypotheses and outcome measures, whereas Bruner et al. addressed only protectionism. Bruner et al. found that ecological success was associated with protectionism, but we found no such effect. Rather we found significant behavioral and economic success in the absence of protectionism. Struhsaker et al. (2004) found that ecological success was associated with many predictive variables (such as effective law enforcement, low population level, and large reserve size) but not with employment benefits, multiple forms of extension (such as conservation education and conservation clubs), or with the presence of integrated conservation and development initiatives in the area, findings that are again inconsistent with our results.

There are many reasons why our results might differ. First Struhsaker et al. (2004) look only at tropical forest ecosystems, and only in Africa. Most likely, different strategies will be suited to different kinds of conservation challenges. Second, it remains a strong possibility that ICDPs and other kinds of extension services are established precisely in those areas where the most acute conservation challenges exist. This would account for the association between poor ecological outcomes and ICDPs in Struhsaker et al.'s (2004) study. Our study was immune to this particular problem because only ICDP sites were sampled. Third, their findings are inconsistent with

evidence from Tanzania showing (through multiple logistic regression) that differences among individuals in their attitudes to Katavi National Park are largely a function of the perception of park outreach activities (Holmes 2003). This highlights the fact that although overall outreach may not be associated with success (in a between-project comparison such as in Struhsaker et al.), within-project variability in perception of outreach services can have major conservation impacts. This distinction must be kept clear when considering management implications of apparently contradictory studies. Fourth, Struhsaker et al. (2004) rely on questionnaires with managers and scientists and personal observations, whereas we relied on published peer-reviewed reports. Which source of data is less problematic is an open question. Both are clearly fraught with potential bias, although Struhsaker et al.'s strategy provides a much cleaner data set with fewer missing values, thereby affording greater statistical flexibility. Without independent measures of the various biases entailed in both strategies, it seems wise to pursue both approaches.

FUTURE DIRECTIONS

Clearly we concur with Sutherland et al. (2004) that a comprehensive remedy lies in concentrating more funds and study into collecting relevant monitoring data. High priority should be given to longitudinal rather than cross-sectional studies in evaluating the success of any strategy because of the problem of endogeneity (such as ICDPs being set up in troubled areas). To facilitate comparative analyses in the future, primary researchers and evaluation teams need to be clear about the specific problem that the project is designed to address and the goals of the project in each of the four outcome areas.

We also emphasize the importance of including multiple measures of success. Rigorously collected data that cover only one or two measures of success have limited analytical value because conservation and development projects almost inevitably have ecological, economic, and social consequences. Without measures of success that span these distinct dimensions, the effectiveness of the conservation and development paradigm cannot be determined. We originally intended to use only projects with data on all four dimensions, with the aim of analyzing the interdependencies among different measures of success. In our final sample there was consistency among outcomes in 75%, 31%, and 100% of projects with four, three, and two outcome measures, respectively. Until a more statistically powerful study of the consistencies (and inconsistencies) among outcomes can be made, conservationists face a situation in which a particular project, for example an extractive reserve, may be judged a success by an economist based on increased income for local inhabitants and a failure by an ecologist and an anthropologist based on, respectively, a critical population decline within the ecosystem and an absence of changed community values regarding conservation. Insofar as the conservation and development paradigm is founded on the assumption that human and ecological well-being are inextricably linked, proper support for this paradigm will need to demonstrate empirically such an interdependence of measures of success.

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Table 1. Variables used in analysis of conservation and development projects and descriptions of variable categories[a]

Hypotheses and Variables	Explanations and Categories

Utilization/Protection

IUCN[b] IUCN ranking of the protected area from most protected to least (http://www.iucn.org/themes/wcpa/ppa/protectedareas.htm), three categories
  strict nature reserve
  national park
  other (national monument, habitat/species management area, protected landscape, managed resource area)

use[b] amount of resource use permitted in or around the protected area from least use to most, three categories
  ecotourism
  ICDP emphasizing substitution, compensation or some combination of the two
  ICDP where enhancement is emphasized in an addition to any other goal
Compensation refers to development projects, substitution refers to alternatives that remove pressure from the threatened resource, and enhancement refers to improving the market for the resource to increase value and control (for definitions see Abbott 2001 and Brandon 1997).

Market Integration

sell how involved the local community is in market sales, scored from least involvement to most, three categories
  minimal, moderate, large

purchase how involved the local community is in market purchases, scored from least involvement to most, three categories
  minimal, moderate, large

labor how involved the local community is in wage labor, scored from least involvement to most, three categories
  minimal, moderate, large

threat[b] Threats to the protected area, three noted for each project, including commercial poaching, subsistence poaching, fuelwood poaching, grazing, subsistence agriculture, commercial agriculture, tourism, commercial industry, commerical timber. Coded by motivation (subsistence, cash) and severity (minimal, moderate, large). Subsistence / minimal, moderate or large, and cash / minimal: 1, cash / moderate: 2, cash / large : 3. Sum of three threats is total score (1-9) and is condensed into four categories
  1-2, 3, 4-5, 6-9

Decentralization

implementation[b]	administrative level of the organization responsible for implementing the project, scored from least community involvement to most, two categories
	national, international or some combination
	regional, community, household, individual

decision	level of community involvement with respect to day-to-day decision-making, scored from least community involvement to most (Berkes 1991), three categories
	no community control: locals informed of regulations, local concerns addressed
	some community involvement: advisory partnership, involvement of management boards, use of local knowledge and field assistants
	complete community control: power to community or joint management

benefits[b]	targeted beneficiaries - up to two beneficiaries noted for each project, scored from least community benefit to most, three categories
	no community: benefits are directed to either the regional level or above (regional, national, international)
	community/other: benefits are directed in part to the community level or below (household, individual)
	community: benefits are directed exclusively to the community level or below (community, household, individual)

Homogeneity

population	source of population growth in the area, scored from least homogeneous to most, two categories
	immigrant
	local

Outcomes

ecological	project outcomes with regard to ecological goals, three categories
	failure, limited success, success

economic	project outcomes with regard to the economic impact on the local people, three categories
	failure, limited success, success

attitudinal	project outcomes with respect to local attitudes toward conservation, three categories
	failure, limited success, success

behavioral	project outcomes with respect to decreasing the occurrence of illegal or targeted activities, three categories
	failure, limited success, success

a. The coding protocol, data, and R language scripts used in data analysis are available (see Supplementary Material). Most variables contain missing values. Abbreviations: IUCN, World Conservation Union; ICDP, Integrated Conservation and Development Project

b. Variables were analyzed using fewer ordered categories than in the original protocol. Because of the small sample size, variables with several (e.g., greater than five) categories in the original protocol tended to have few observations in each category. Adjacent categories were combined for such variables when appropriate given the natural ordering of the categories.

Figure 1

Goodman-Kruskal gamma statistics for contingency tables of predictors (in columns) and outcomes (column headings). The value of gamma for the table is plotted along the y-axis. Gamma relatively close to 1 indicates a positive association between the ordinal levels of predictor and outcome. Double asterisks indicate tables having q values in [0, 0.05], single asterisks q values in (0.05, 0.1]. The eight tests having one or two asterisks are called significant. Significance levels are adjusted for the false discovery rate of the series of tests as described in the text ("Implem" denotes the variable *Implementation*, and "Pop" *Population*).

	Attitudinal	Behavioral	Ecological	Economic

Goodman–Kruskal Gamma

- Implem — Attitudinal (~1.0)
- Purchase* — Attitudinal (~0.98)
- Implem** — Behavioral (~0.96)
- Implem — Ecological (~0.87)
- Sell** — Attitudinal (~0.75)
- Decision** — Ecological (~0.74)
- IUCN* — Economic (~0.75)
- Sell — Behavioral (~0.64)
- IUCN — Behavioral (~0.62)
- Decision* — Behavioral (~0.60)
- Threat — Behavioral (~0.57)
- Purchase — Behavioral (~0.54)
- Sell* — Economic (~0.64)
- Purchase — Economic (~0.61)
- IUCN — Ecological (~0.55)
- Decision* — Economic (~0.52)
- Labor — Ecological (~0.48)
- Implem — Economic (~0.48)
- Decision — Attitudinal (~0.43)
- Labor — Attitudinal (~0.41)
- Threat — Attitudinal (~0.39)
- Labor — Economic (~0.42)
- Pop — Ecological (~0.38)
- Sell — Ecological (~0.36)
- Use — Ecological (~0.25)
- Pop — Behavioral (~0.20)
- Threat — Economic (~0.19)
- Use — Economic (~0.17)
- Pop — Economic (~0.15)
- Benefits — Attitudinal (~0.09)
- IUCN — Attitudinal (~0.05)
- Pop — Attitudinal (~0.01)
- Benefits — Behavioral (~0.06)
- Purchase — Ecological (~0.01)
- Threat — Ecological (~0.00)
- Use — Behavioral (~-0.04)
- Benefits — Ecological (~-0.17)
- Labor — Behavioral (~-0.23)
- Benefits — Economic (~-0.22)
- Use — Attitudinal (~-0.38)