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Feedbacks between conservation and social-ecological systems

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Abstract

Robust ways to meet objectives of environmental conservation and social and economic development remain elusive. This struggle may in part be related to insufficient understanding of the feedbacks between conservation initiatives and social-ecological systems, specifically, the ways in which conservation initiatives result in social changes that have secondary effects on the environments targeted by conservation. To explore this idea we sampled peer-reviewed articles addressing the social and environmental dimensions of conservation and coded each paper according to its research focus and characterization of these feedbacks. The majority of articles in our sample focused either on the effect of conservation initiatives on people (e.g., relocation, employment) or the effect of people on the environment (e.g., fragmentation, conservation efficacy of traditional management systems). Few studies in our sample empirically addressed both the social dynamics resulting from conservation initiatives and subsequent environmental effects. In many cases, one was measured and the other was discussed anecdotally. Among the studies that describe feedbacks between social and environmental variables, there was more evidence of positive (amplifying) feedbacks between social and environmental outcomes (i.e., undesirable social outcomes yielded undesirable environmental effects, and desirable social outcomes yielded desirable environmental effects). The major themes within the sampled literature include conflict between humans and wild animals, social movements, adaptive comanagement, loss of traditional management systems, traditional ecological knowledge, human displacement and risks to livelihoods, and conservation and development. The narratives associated with each theme can serve as hypotheses for facilitating further discussion about conservation issues and for catalyzing future studies of the feedbacks between conservation and social-ecological systems.

Keywords

conservation planning; adaptive management; politics and policy; protected areas; ecosystem management; land-use planning

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Supporting Information

A list of the original studies in our sample and the coding associated with them is available online (Appendix S1). The authors are responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

Introduction

Environmental conservation has a long history of unintended effects on human communities, which has rendered achieving both social and economic development and conservation elusive. Although conservation initiatives in some cases benefit local communities through the provision of economic opportunities and ecosystem services, they can also have negative social consequences, such as human relocation or restriction of access to resources (Cernea 2005). We suggest these outcomes also have less obvious, and perhaps less frequently studied, environmental effects that are relevant to whether conservation goals are achieved.

We examined the extent to which the peer-reviewed literature addresses whether conservation initiatives result in social changes that subsequently affect the environment. We also examined whether these interactions typically are characterized as positive or negative feedbacks. *Feedback* denotes a mutual causality wherein “the secondary effects of a direct effect of one variable on another ... cause a change in the magnitude of that effect. A positive feedback enhances the effect; a negative feedback dampens it” (Walker & Salt 2006: 164). We then identified the major themes and narratives within the sampled literature that address the feedbacks between conservation and social-ecological systems. We were motivated by our initial impression that there is relatively little research addressing how the cultural, economic, and political changes resulting from conservation initiatives translate into human effects on the ecosystems targeted by conservation efforts.

Conservation and Communities

We define *conservation* as any effort to protect or manage the environment, whether it falls under the rubric of biological diversity, land-cover type, water, ecosystem services, natural resources, or other nonhuman components of ecosystems. We specifically focused on collective, organized conservation initiatives and excluded individual actions. The term *conservation initiative* encompasses the implementation of policy (i.e., conservation practice or intervention) and the potential for implementation. We used this inclusive terminology because even the anticipation of new or modified policy can incite changes in the behavior of local resource users in advance of conservation action (Baird et al. 2009).

In professional conservation circles, the concept of a human community most consistently refers to a geographic cluster of individuals who may or may not be ethnically or culturally affiliated but who interact socially, economically, or politically. The tendency to treat these geographic groups as one decision-making unit has drawn substantial criticism from social scientists. The idea of a cohesive community is sometimes problematic because it can mask the considerable heterogeneity within a spatial, ethnic, or cultural group of individuals (Agrawal & Gibson 1999). Here, we define *community* as a group of local resource users who are directly affected by a conservation initiative, even if this group does not reflect a cohesive social or political entity. This definition encompasses the various human groups studied in the literature discussed below. We recognize that community heterogeneity and individual variation are important aspects of conservation-community interactions and may be central to processes that produce community-level responses; however, such variation is not central to our analysis.

Human welfare has not always been an explicit consideration of conservation initiatives, but conservation projects in less-developed countries increasingly include development. The propagation of this concept was fueled by the frequently undesirable social and economic outcomes of the establishment of protected areas (Andrade 2005; West et al. 2006). The integration of conservation and development has also been justified by the notions that the probability of achieving conservation goals can be decreased by poverty and that poverty

reduction depends on the conservation of natural resources (Adams et al. 2004). There are many types of conservation and development projects (e.g., integrated conservation and development, community-based conservation, community-based natural resource management) with different foci, strategies, degree and manner of community participation, and financial incentives, but they share the goal of meeting both conservation and development targets.

The relation between conservation and social and economic development has been analyzed in a multitude of settings from a variety of disciplinary perspectives. Despite enthusiasm for tackling conservation and development issues simultaneously, integrating development and conservation has proven difficult (Barrett et al. 2005). This is partly because conservation and poverty reduction are disparate policy goals (Adams et al. 2004). Although poverty and environmental change are linked, addressing them simultaneously can be complicated by incompatible approaches and priorities (for a review of the conservation-poverty debate see Roe [2008]). These limitations have hindered conservation and development projects, yielding mixed outcomes at best (Igoe & Croucher 2007).

Adaptive management (Holling 1978) has been proposed as a means of improving the social and environmental outcomes of conservation initiatives through an iterative process of planning, action, evaluation, and modification. Ideally, adaptive management assesses and responds to the processes that result in conservation and development, but this is not a necessary condition of adaptive management, which often is focused on project outcomes. Even adaptive comanagement, which incorporates stakeholder participation in adaptive management (Berkes et al. 2003), may not examine the social changes mediating conservation goals and outcomes. Endter-Wada et al. (1998: 892) clarify the distinction between these 2 aspects of ecosystem management: “One component concerns greater public involvement in decision-making... The other component concerns social analysis, or integrating social considerations into the science of understanding ecosystems and their management by humans.” Our analysis focuses on the latter.

Conceptual Framework

Conservation narratives and development narratives (i.e., common ways of understanding and describing conservation and development topics) have become increasingly unified over time as recognition of the theoretical linkages between their drivers and outcomes grows (McDonald 2008; McGeoch et al. 2008). Many researchers are now conceptualizing conservation and development as occurring within a single system (Wells & McShane 2004; Chhatre & Agrawal 2009) in which social and ecological components cannot be understood in isolation because of feedbacks between them (Berkes & Folke 1998). These feedbacks are fundamental to maintaining system structure and function in the face of disturbance.

Studies of social-ecological systems often discuss the relevance of system dynamics to conservation, but unlike other representations of social-ecological systems (e.g., McLeod & Leslie 2009; Ostrom 2009), we focused on the feedbacks between conservation initiatives and social-ecological dynamics (Fig. 1). This focus facilitates the identification of gaps in knowledge of these mutual effects by revealing the relation between different areas of conservation research. We believe that understanding these feedbacks is fundamental to the success of conservation practice.

We hypothesize that research tends to concentrate either on the effects of conservation on people or people on the environment. There is a need to link these topics through further study of how the social (i.e., economic, cultural, and political) effects of conservation translate into behavioral changes of local resource users and how these changes subsequently affect environmental outcomes relevant to conservation initiatives (Fig. 1). We

believe that understanding the feedbacks between conservation policy and social-ecological dynamics is fundamental to the success of conservation planning.

The phrases *social impacts* and *effects of conservation on people* encompass a range of response variables and covariates and include both the impetus for new activities (i.e., change in location, intensity, or type of human activities) and the prohibition or abandonment of past activities. Researchers have focused on conservation's relation to single social outcomes, such as attitudes (Holmes 2003) or income and employment (Salafsky et al. 2001) or multiple social outcomes, (e.g., Struhsaker et al. 2005; Brooks et al. 2006; Waylen et al. 2010), but generally have not analyzed these outcomes in the aggregate. To capture a broad range of possible definitions and analyses of social outcomes, we grouped the varied social outcomes of conservation together.

It is important to distinguish between aspects of conservation initiatives that affect local people but have little effect on the environment and the processes through which conservation intentionally or unintentionally induces social (cultural, economic, or political) change that subsequently has environmental effects. Here, we examined the latter and refer to these interactions as conservation-community feedbacks.

Methods

To assess the state of research on conservation-community feedbacks, we systematically reviewed the peer-reviewed scientific literature. Our review was systematic in that we used a structured procedure to acquire a sample of the literature that represented the topic we were interested in. However, our review was not evaluated by the Centre for Evidence-Based Conservation for conformity with their definition of a systematic review.

Similar to the methods of Brooks et al. (2006), we searched the ISI Web of Knowledge over 8 months (between August 2009 and March 2010). We searched the database for combinations of the terms protected area, (environmental) conservation, development, people, humans, feedback, community, population, and *social change*. We did not set a temporal limit on publication date or a geographical limit on study area. To include publications not indexed in ISI, we extracted relevant citations from the reference lists of articles identified in the initial search.

We judged the relevance of all articles - those found through the ISI search and those extracted from reference lists - by the topic of research (i.e., whether the research explicitly addressed conservation and human communities). Other than our judgment of each article's relevance and depth of analyses (i.e., anecdotal evidence versus empirical measurement), we did not perform a structured evaluation of the quality of the research (e.g., the validity of research methods and inferences). The primary reason for not doing so was that reliably judging the quality of the surveyed literature would have required expertise in an extensive array of methods.

We compiled all literature selected for analysis in an EndNote (Thomson Reuters, New York) database and then coded articles according to their research focus and findings on the basis of 4 questions. (1) Does the research assess the effect of conservation on human communities? That is, we determined whether the authors quantitatively or qualitatively analyze conservation-induced changes in social factors, such as resource use or access, participation in conservation, empowerment, attitudes, income, employment, land tenure, traditional management of natural resources, or eviction. (2) Does the research assess the effect of local resource users on the environment? That is, we determined whether the authors analyzed some form of human-induced environmental change such as land-use

change, land-cover change, ecosystem restoration or recovery from disturbance, or changes in species richness or populations of native species.

On the basis of the answers to these 2 questions, we assigned each article to 1 of 5 categories: article did not address question 1, but did address question 2; article addressed question 1, but not question 2; article addressed question 1 and related findings to question 2 through anecdotal evidence or discussion; article addressed question 2 and related findings to question 1 through anecdotal evidence or discussion; article addressed questions 1 and 2 (i.e., examined the social-ecological feedbacks resulting from conservation initiatives). Articles in the third, fourth, and fifth categories were further categorized on the basis of the answers to questions 3 and 4.

(3) Does conservation have a relatively undesirable effect (e.g., access restriction, conflict between local resource users and management officials, dissolution or marginalization of traditional management) or a desirable effect (e.g., income generation or development, preservation of ecosystem services) on human communities? (4) Do the social changes among communities have a relatively undesirable effect (e.g., increased human population growth, reduction in natural resources) or a desirable effect (e.g., improved or supported stewardship of natural resources, indigenous management) on the attainment of conservation goals?

Four possible combinations of the effects of conservation on people and the subsequent effects of people on the environment resulted from these questions (Table 1). A fifth category contained articles that reported negative and positive social or environmental outcomes and thus could not be easily classified as pertaining to a positive or negative feedback. Two of us (B.W.M. and S.C.C.) coded each paper separately and then compared our findings. When discrepancies arose, we discussed the article's content until we settled on a category.

Our methods facilitated the characterization of conservation-community feedbacks and were not designed to assess the overall success or failure of conservation initiatives. Reviewing the social and environmental effectiveness of these initiatives necessitates different methods that address the complexities of project context, goals, application, and outcomes (e.g., Struhsaker et al. 2005; Brooks et al. 2006; Waylen et al. 2010).

Other researchers (e.g., Sunderlin et al. 2005; Chhatre & Agrawal 2009) conceptualize the relation between conservation and development as win-win, win-lose, lose-win, and lose-lose matrices. In these approaches, social and environmental outcomes are seen as simultaneous results of conservation initiatives. In contrast, our classification captures the sequential relation between conservation action, social dynamics, and environmental outcomes.

We categorized the general research topic of each article post hoc in order to identify the emergent themes. We generated themes by comparing the keywords and topics of each article and by searching for common theoretical frameworks and narratives.

Results

The sample included literature spanning 32 years (1978-2010) and subject areas such as ecology, geography, anthropology, and public policy. Of the 120 peer-reviewed journal articles we reviewed, we used 79 in our analyses (Supporting Information). The remaining 41 articles could not be categorized because their content addressed no portion of the feedback between conservation action, social dynamics, and environmental outcomes, even though their titles, keywords, and abstracts suggested they might be included in our

analyses. Nearly half ($n=39$) of the articles categorized addressed only effects of conservation on human communities or effects of local resource users on the environment (categories 1 or 2). A smaller proportion of the articles (39%, $n=31$) included some mention of feedbacks between conservation and human communities (categories 3 and 4), and 11% ($n=9$) provided extensive discussion or analysis of these feedbacks (category 5). Examples of category-5 articles were Western and Maitumo (2004), Hazzah et al. (2009), and Olupot et al. (2009).

Of the articles that referenced or examined feedbacks, 80% described situations in which the effects of conservation on communities and the subsequent effects of local resource users on the environment were either both desirable or both undesirable (Table 2). A far smaller proportion (5%) of the articles suggested either the effects of conservation on communities were undesirable, but the effects on conservation on the environment were desirable or the effects of conservation on communities were desirable, but the effects on conservation on the environment were undesirable (Table 1). Both of the latter types of articles describe negative feedbacks between conservation and social-ecological systems. The remaining 15% of the articles reported results that did not clearly reflect positive or negative feedbacks due to the variety of interactions and effects within the feedback loop.

Conservation-community feedbacks were explored from various starting points, some of which are included in our conceptual model (Fig. 1). For example, some articles reported on assessments of the influence of people on one or several environmental metrics, and then the authors suggested ways to alter management to change the magnitude or type of human effects. In these cases, the estimates of anthropogenic environmental effects can be treated as baseline data, and a change in management would allow the consequent social and environmental changes to serve as results for characterizing the conservation-community feedback. For example, Christenson and Heilmann-Clausen (2009) measured the effect of local harvesting practices on alpha, beta, and gamma diversity of 6 groups of organisms in a protected area in Nepal and suggested management changes to minimize undesirable effects of harvest. If management practices change, then it will be possible to assess the behavioral responses of local resource users and the subsequent changes in biological diversity, thus completing the feedback loop despite starting at a different point in our model.

We identified 7 broad research areas that represent relatively well-established themes: conflict between wild animals and humans, social movements, adaptive comanagement, loss of traditional management systems, traditional ecological knowledge, human displacement and risks to livelihoods, and conservation and development (Table 3). We do not report the proportions of articles within each theme because we generated these groupings post hoc; thus, these figures may not accurately represent the contents of the literature. However, it appears that conservation-community feedbacks were more often reported for themes with relatively observable causal pathways (e.g., human-wildlife conflict), as opposed to themes that are more difficult to observe (e.g., social movements).

Discussion

Our analysis excluded some types of literature; however, we focused on peer-reviewed publications because much empirical and theoretical research is presented in this form and databases such as ISI Web of Knowledge are often used as a starting point to ascertain which topics and questions have been addressed. Another limitation of our study is that we combined the diverse social effects (e.g., attitudes and economic changes) of conservation initiatives, rather than examining such varied outcomes individually. Moreover, differentiating between articles that present anecdotal versus empirical evidence can be difficult, and this type of misclassification is a possible source of error in our study. We

attempted to reduce this error by having 2 of us independently classify each article. With these caveats in mind, several inferences can be drawn from our results.

We found 2 major approaches to research on the relation between conservation and human communities; the majority of sampled peer-reviewed articles focused either on the effect of people on the environment or the effect of conservation on people. Few studies in our sample empirically addressed both the social dynamics and the subsequent environmental outcomes resulting from conservation initiatives. We believe this is a conservative estimate of the percentage of literature that addresses feedbacks because we deliberately searched for articles addressing the full feedback loop. These results indicate there are relatively few peer-reviewed publications on conservation-community feedbacks. Our findings are consistent with Brockington and Igoe's (2006) assessment of the literature on eviction of people from protected areas. They found that such eviction has been documented, but there have been few evaluations of the social effects of eviction and even fewer of the secondary environmental consequences.

There are several potential explanations for why such feedbacks are rarely examined in the literature. The first, and most likely, is that conservation is not the only factor influencing human behavior, and it is difficult to establish causation due to confounding variables (e.g., historical legacies, demographic changes, infrastructure development) (Turner & Berkes 2006). Second, baseline data on social and environmental variables often do not exist, making causal inferences difficult, if not impossible. Third, there may be considerable spatial or temporal lags between project implementation and social and environmental outcomes, and long-term studies that can capture these lags are few. Fourth, the space limitations and scope of peer-reviewed journals and the different research interests of social and natural scientists make it challenging to include social and environmental effects of conservation interventions in a single article.

The majority of the articles we reviewed presented the interactions between conservation and social-ecological systems as positive feedbacks, suggesting that conservation and development goals are synergistic. Given the small number of articles that examined conservation-community feedbacks, the reported proportions of articles depicting positive and negative feedbacks should be interpreted with caution. Nonetheless, the preponderance of articles depicting positive feedbacks may relate to the current state of a global discourse on the relations between human communities and their local environments. Positive feedbacks present a synergy between conservation and development goals. In negative feedback systems, only conservation or development can be achieved. It would be imprudent to argue that conservation is bad for people and therefore good for the environment, especially where people historically have been adversely affected by restricted access to resources. Similarly, it is not in the interest of human rights advocates to suggest that advancing human welfare has undesirable environmental effects. Thus, our finding that most studies describe a positive feedback loop between community development and environmental status may be either an artifact of ideological or political motivations, or a reflection of actual dynamics.

A relatively small proportion of articles did not present either a clearly positive or negative feedback. One possible explanation for this result is that most of the surveyed literature did not measure the full breadth of social and environmental effects of conservation initiatives. Inferences can be drawn from the few articles that reported mixed results. For example, Olupot et al. (2009) examined the extents and spatial patterns of resource harvesting, fire, livestock grazing, and agricultural encroachment in and adjacent to Bwindi Impenetrable National Park (Uganda). They found that imposed limitations on resource use curb anthropogenic effects inside the protected area, but increase it on the edges of the protected

area, thus shifting the effects spatially, but not necessarily reducing their magnitude. Robichaud et al. (2009) explored the trade-offs between tree conservation and nontimber forest products in Laos. They suggest that the restriction of swidden (shifting, slash and burn) agriculture is associated with an increase in the harvest of nontimber forest products (wild animals in particular) and restrictions on harvesting nontimber forest products are related to increased area of forest cleared for swidden. These studies indicate there are not only trade-offs between conservation and development, but also trade-offs between different conservation goals or different environmental effects.

Another inference can be derived from Siex and Struhsaker (1999), who measured actual and perceived crop damage by the Zanzibar red colobus monkey (*Procolobus kirkii*). They found that the perceptions of local farmers were not consistent with measures of actual damage. Their results highlight the information that can be gained by using diverse metrics to evaluate conservation initiatives. Human perceptions shape attitudes and behaviors and can thereby influence environmental outcomes, but these perceptions cannot always substitute for more direct measures of the social effects of conservation.

It appears that conservation-community feedbacks are typically reported for situations with relatively straightforward causal pathways. For instance, reducing harvest of an animal species may be directly associated with an increase in its population size and a subsequent increase in incidences of conflicts between this species and local resource users (e.g., predator attacks on livestock), and finally may result in defensive action or retaliation against the animals (e.g., Aust et al. 2009). In this case, researchers can assess whether the behaviors of local resource users were motivated by conflict by asking them directly, observing their behaviors, or consulting historical records.

Fully understanding the diverse social and environmental effects of conservation initiatives - including changes in human behavior that are indirectly influenced by conservation (e.g., the introduction of new resource management institutions that undermine longstanding rules and norms governing community resource use) - requires a research approach attuned to the complexities of social and behavioral change. In particular, frameworks for analyzing social-ecological systems can help guide research on the varied influences of conservation initiatives. Ideally, such a systems approach would include analyses of the attributes and interactions of resource users, governance and resource systems, and resources units (Ostrom 2009).

This systems approach is also pertinent to advancing adaptive management. Some scholars argue that adaptive management should focus on using experimental designs in environmental management (Grumbine 1997); others envision adaptive management as a process by which communities alter their management practices (Stringer et al. 2006). Our results support the argument that these 2 perspectives are not mutually exclusive (McClain & Lee 1996; Endter-Wada et al. 1998). Adaptive management could be more effective if it takes conservation-community feedbacks into account.

Monitoring of conservation or natural resource management initiatives can overlook substantial environmental changes or misattribute the causes of detected change if social dynamics are not examined. Conservation initiatives and the actions of human communities may be best conceptualized as interdependent processes, wherein social-ecological interactions mediate conservation actions and outcomes (Fig. 1). Information on the social dimensions of environmental conservation can contribute to a clearer understanding of the proximate and distal consequences of conservation initiatives and the processes that affect whether conservation goals are achieved (Stem et al. 2005). Knowledge of these social-ecological dynamics can inform the selection of metrics for monitoring and evaluation and

enhances the capacity to predict social and ecological changes, thus increasing awareness of the implications of management actions for human welfare and conservation of biological diversity.

We view the example narratives in Table 3 as a set of hypotheses for facilitating discussion about these issues and for catalyzing future studies. Comprehensive examination of feedbacks between conservation and social-ecological systems requires long-term, collaborative projects, but short-term projects could focus on the social changes that result from conservation initiatives and evaluate these changes in terms of their projected or realized environmental effects. Although it can be challenging to conclusively demonstrate causality in feedbacks between conservation initiatives and social-ecological systems, rigorous study designs for examining feedbacks are possible to achieve and valuable for ecosystem management.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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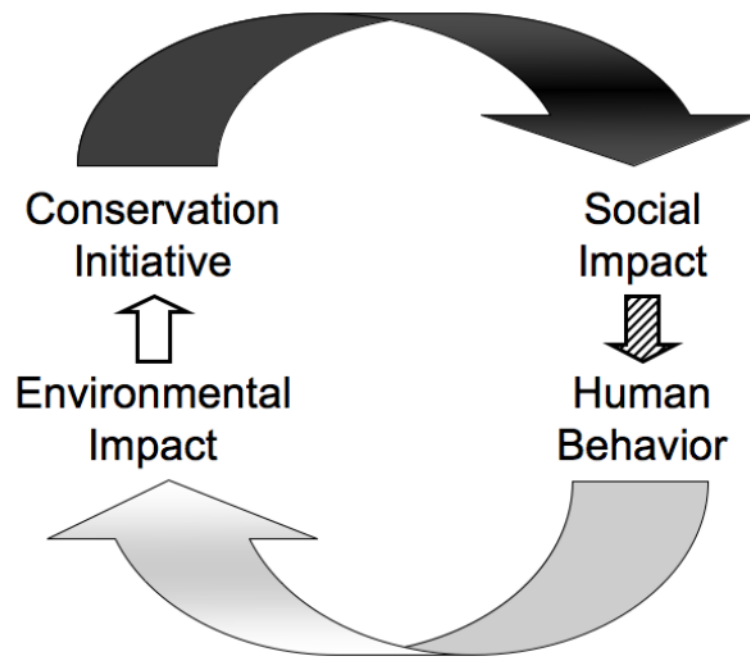


Figure 1.

Conceptual framework depicting the feedbacks among conservation initiatives, human communities, and environmental outcomes (black arrow, effect of conservation on the economic, cultural, and political characteristics of proximate human communities; hatched arrow, behavioral responses of local land users to the social changes brought about by conservation; gray arrow, effect of local resource users on the environment; unshaded arrow, environmental effects may stimulate changes in conservation policy or practice).

Table 1
Classification scheme used to characterize the feedbacks between conservation initiatives and social-ecological systems described in the peer-reviewed literature on conservation and human communities

	<i>Desirable effect of conservation on human communities</i>	<i>Undesirable effect of conservation on human communities</i>
<i>Desirable effect of local resource users on environmental outcomes</i>	a. positive feedback: conservation improves human welfare, which encourages people to conserve or sustainably use their proximate environment	b. negative feedback: conservation adversely affects human welfare, capacity of people to unsustainably use the environment is reduced thereby increasing the probability of achieving conservation goals
<i>Undesirable effect of local resource users on environmental outcomes</i>	c. negative feedback: conservation improves human welfare, but social and economic development reduces probability of achieving conservation goals (e.g., due to increased levels of consumption)	d. positive feedback: conservation adversely affects human welfare, which discourages sustainable resource use and reduces probability of achieving conservation goals

Table 2
Number of peer-reviewed articles by research focus and nature of the feedbacks
between conservation and social-ecological systems

<i>Nature of feedback</i>	<i>Research focus category</i>			<i>Total number of articles (%)</i>
	<i>category 3: effects of conservation on human communities</i>	<i>category 4: effects of local resource users on the environment</i>	<i>category 5: feedback between conservation and social-ecological systems</i>	
<i>positive: conservation initiatives benefit communities, which increases the probability of achieving conservation goals</i>	7	2	2	11 (27.5)
<i>negative: conservation initiatives adversely affect communities, but this increases the probability of achieving conservation goals</i>	0	1	0	1 (2.5)
<i>negative: conservation initiatives benefit communities, which decreases the probability of achieving conservation goals</i>	1	0	0	1 (2.5)
<i>positive: conservation initiatives adversely affect communities, which decreases the probability of achieving conservation goals</i>	9	6	6	21 (52.5)
<i>mixed: both desirable and undesirable feedbacks between conservation and social-ecological systems reported</i>	3	2	1	6 (15.0)
Total	20	11	9	40 (100)

Table 3
Research themes in the literature on conservation and human communities

<i>Research theme</i>	<i>Example narrative</i>	<i>Example citations</i>
Conflict between wild animals and humans	Conservation initiatives increase probabilities of persistence of wild animals, which increases interactions and conflicts with humans who develop negative attitudes toward conservation and may respond with actions that reduce probabilities of persistence of wild animals.	Siex & Struhsaker 1999; Marker et al. 2003; Hazzah et al. 2009
Social movements	Conservation initiatives marginalize local resource users and suppress human rights, which engenders discontent and leads to collective protest, subversion, or resistance.	Peluso 1993; Klooster 2000; Holmes 2007
Adaptive comanagement	Local people are integrated into conservation planning and implementation, so effects on humans and the environment are mediated by iterative decision-making processes. This fosters positive attitudes and cooperation.	Wilhere 2002; Tompkins & Adger 2004; Fernandez-Gimenez et al. 2008
Loss of traditional management	Indigenous resource management institutions achieve conservation objectives; however, top-down conservation initiatives can undermine local traditional management structures and decrease management capacity.	Johannes 1978; Stave et al. 2001; Kajembe et al. 2003
Traditional ecological knowledge	Conservation practices are altered to include traditional practices and knowledge, and the probability of achieving conservation objectives increases.	Drew 2005; Gilchrist et al. 2005; Mathooko 2005
Human displacement and risks to livelihoods	Human communities are relocated or human access to resources is restricted or threatened, which results in a variety of undesirable effects on humans. People develop alternative livelihood strategies that may reduce the probability of achieving conservation objectives.	Homewood & Brockington 1999; Brockington & Igoe 2006; Borghesio 2008
Conservation and development	Human communities benefit economically (e.g., jobs, income, resource protection) via mechanisms such as ecotourism, integrated conservation and development, and community-based management. These incentives increase the probability of achieving conservation objectives.	Gillingham & Lee 1999; Wells & McShane 2004; Struhsaker et al. 2005