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Co-Managing Human–Wildlife Conflicts: A Review

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Conservationists recognize the need to work beyond protected areas if they are to sustain viable populations of wildlife. But ambitious plans to extend wildlife corridors beyond protected areas must consider the economic and political implications when wildlife forage on crops, attack livestock, or otherwise threaten human security. Traditionally, humans respond by killing "problem" wildlife and transforming wild habitats to prevent further losses. This traditional response, however, is now illegal or socially unacceptable in many areas, changing a simple competitive relationship between people and wildlife into a political conflict. Here we draw from experience in Bolivia, Uganda, and Wisconsin to outline a strategy for mitigating human–wildlife conflict based on participatory methods and co-management with twin objectives of wildlife conservation and safeguarding human security. Incorporating local stakeholders as partners in planning and implementation can help to win space for wildlife beyond protected area boundaries. We also show why systematic study of local people's perceptions of risk and participant planning of interventions are irreplaceable components of such projects.

Keywords stakeholder participation, community-based conservation, interventions, monitoring, planning, crop damage, livestock loss

Introduction

Around the world and for millennia, humans have defended themselves and their property from wild animals. Wildlife can pose serious problems when their activities intersect with those of humans. For example, the U.S. federal agency charged with controlling agricultural damages caused by wildlife spent over $60 million in control operations during 2001 and estimated losses at nearly one billion dollars (National Agriculture Statistics Service,

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2002). In addition to property losses, the occasional threats to human safety compound the vulnerability of rural communities. For example, between 1980 and 2003, more than 1,150 humans and 370 elephants died as a result of conflicts in NE India (Choudhury, 2004). Traditionally, the human response has been to kill the suspected wildlife and transform wild habitats to prevent further losses (Jorgensen, Conley, Hamilton, & Sanders, 1978; Karanth & Madhusudan, 2002; Koch, 1968). With rising concern for wild animals and their conservation status, however, traditional lethal retaliation against wildlife is now illegal in some areas or socially unacceptable in others (Breitenmoser, 1998; Knight, 2003; Treves & Naughton-Treves, 2005). Enforcement of environmental protections and non-utilitarian views of wildlife have changed what was once a simple competitive relationship between people and wildlife into a political conflict between people and between institutions (Hill, 2004; Knight, 2000).

At several sites, local resentment over property losses to wildlife precludes discussion of other environmental issues. For example, in Apolobamba, Bolivia, crop and livestock losses to wildlife draw more public debate in scheduled meetings than soil erosion, pollution, and watershed management. Research from both developing and industrial countries reveals human–wildlife conflicts (HWC) can make affected communities hostile to wildlife conservation initiatives and aggressive toward staff of protected areas (Bangs et al., 1998; Kangwana, 1995; Western, 1997). HWC derives yet greater importance because the fate of many wildlife populations depends on their capacity to coexist with humans. Thus HWC is now seen as a major challenge for conservation, as reflected in the burgeoning literature and meetings on the topic (Fascione, Delach, & Smith, 2004; Manfredo & Dayer, 2004; Woodroffe, Thirgood, & Rabinowitz, 2005).

Because the sociopolitical setting is as influential as the biophysical one for the effective management of human–wildlife interactions (Heberlein, 2004; Hill, 2004; Knight, 2003; Mascia et al., 2003; Treves & Karanth, 2003), one theme of this article is that HWC management teams must build their capacity for transparent, democratic, and participatory methods of planning and implementing projects. In addition, HWC exemplifies a fundamental challenge for biodiversity conservation: reconciling local concerns for security and economic growth with international concerns for saving threatened species. We emphasize how most sustainable solutions to HWC must protect or improve the welfare of rural communities, as well as the status of conservation targets. HWC management calls for interdisciplinary collaborations. Yet currently, most managers of HWC are trained in ecological sciences. To adapt social science methods effectively, these managers learn on the job in a trial-and-error process. We anticipate greater efficiency if lessons from around the world are analyzed in a structured manner and applied strategically. We present a step-by-step procedure for navigating the political, social, and strategic aspects of HWC management. Table 1 summarizes the steps, objectives of each and the critical components needed to attain the objectives.

Definitions

We define several elements and restrict our scope, both steps taken to permit a deeper analysis of HWC co-management. We refer to local stakeholders only—affected communities and the nationally appointed, local authorities charged with wildlife management (together local stakeholders hereafter). We acknowledge the challenges of identifying the appropriate unit of social organization to manage collectively (reviewed in Gillingham, 2001), but also note the natural and obvious unit composed of the set of individuals/households affected by HWC in a given locality. We define management of HWC as planning,

Table 1
Steps, objectives, and critical components of co-managing human–wildlife conflicts

Step	Primary objective	Critical components
1. Baseline research	Study the timing and locations of conflicts, as well as the behaviors of the involved individuals (wildlife and human).	Measure perceptions of conflict and its management; perceptions are complementary and as important as systematic measures of conflict.
2. Participatory planning	Define joint objectives, build consensus on which interventions to implement and recruit participants.	Identify shared objectives between wildlife conservation and human welfare; analyze interventions by their likely effectiveness, sociopolitical acceptability, and sustainability.
3. Monitoring	Measure the success of the co-management project at three levels: (a) implementation, (b) threat-reduction, and (c) outcomes for targets.	Prepare two monitoring plans for approval by affected stakeholders; consider monitoring team composition carefully; and take maximum advantage of fortuitous controls or randomized control-treatment opportunities.

intervention, and monitoring, including baseline applied research. "Co-management" refers to management shared between affected communities and governmental agencies or nongovernmental organizations. We draw lessons from both developed and developing countries and discuss the commonalities and discrepancies in experiences from the sites at which we have worked: Kibale National Park, Uganda (Kibale hereafter), Apolobamba multiple-use protected area, Bolivia (Apolobamba hereafter) and gray wolf (*Canis lupus*) range in the state of Wisconsin, USA (Wisconsin hereafter). Throughout, we focus mainly on large (i.e., >1 kg) terrestrial vertebrates, not damage by smaller organisms that typically produce greater economic losses (Naughton-Treves, Rose, & Treves, 2000; Naughton-Treves & Treves, 2005), because smaller organisms rarely carry highly charged symbolism or immediate physical threat. Although we acknowledge habitat loss and species depletion are ultimately greater threats to biodiversity conservation (Treves et al., 2006), we restrict our scope to threats posed by wildlife to human safety and property because of the human retaliation that often follows.

Co-Managing Human–Wildlife Conflicts (HWC)

Ideally, an affected community would manage HWC itself without permanently damaging biodiversity. In reality, many conflicts occur at the borders of protected areas or involve endangered species, which may fall under the jurisdiction of wildlife managers (Bangs et al., 1998; Knight & Judd, 1979; KWS, 2000). Managing HWC may then require collaboration. Indeed, effective management without destruction of biodiversity depends on technical, material, and financial inputs that may exceed the training and capacity of rural wildlife managers (Curtin, 2002; Osborn & Parker, 2003; Raik, Lauber, Decker, & Brown, 2005). A third party may be needed to supplement the skills and resources

available to local stakeholders. A third party (e.g., NGO or outside researcher) can also potentially play an important role if there is a history of mistrust between affected communities and wildlife managers. However, outsiders bear a special burden to avoid being seen as allies of central authorities rather than local communities.

Step 1. Baseline Applied Research on Human–Wildlife Conflicts

Collecting baseline information is a vital first step in managing HWC because understanding the timing and locations of conflicts, as well as the behaviors of the involved individuals (wildlife and human) is essential to planning. Much HWC research falls into three broad categories: (a) identifying the involved parties, timing, and distribution of wildlife damage; (b) experimental or quasi-experimental studies of techniques to mitigate conflicts; and (c) surveys of people's attitudes, perceptions, and response to wildlife and candidate interventions. We address the latter in greatest detail because surveys of affected stakeholders have the greatest relevance to engaging local stakeholders in co-management and the former two categories of baseline research have been addressed elsewhere at some length (Hoare, 2001; Naughton-Treves et al., 2000; Smith, Linnell, Odden, & Swenson, 2000a; Smith, Linnell, Odden, & Swenson, 2000b; Treves & Naughton-Treves, 2005). Attitudinal surveys should be conducted again after interventions have been applied, so that factors contributing most to stakeholder satisfaction can be isolated.

Research often enjoys a measure of tolerance because it is generally minimally intrusive on people's lives and its product (knowledge) is often clear. Research findings may also be useful to catalyze dialogue about interventions, especially when the research has been invited and co-designed by local stakeholders (Curtin, 2002; Noss & Cuéllar, 2001; Wydeven, Treves, Brost, & Wiedenhoeft, 2004). However, this rosy scenario is not guaranteed. Rural people often want reimbursement or interventions against HWC, not research; one Kibale farmer facing elephant crop damage wanted "food, not numbers." Often conflicts, complaints, and resentment have built up over years, so a call to start research can fall on deaf ears or provoke hostility. In a vivid example from Aberdares, Kenya, repeated lengthy studies of HWC without tangible assistance to reduce crop losses eventually led farmers to chase researchers out of their fields with machetes (Nyamu, J., pers. comm.). Communities marginalized by their political conditions may distrust and reject research if it has been used to their detriment in the past. At Kibale, some farmers broke into tears or a nervous sweat when we showed maps that quantified risk of crop loss outside the Park because of the recent eviction of squatters in the south of the park (Feeny, 1998). Research itself can be politicized because the things one measures, how one frames questions, and how one interprets the results, may favor one side or another. At times, some stakeholders will use outsiders to legitimize their claims over contested resources (Doolittle, 2003). This becomes a serious problem if the resulting information is misused or misleading. Care should be taken to remain impartial as an honest broker of information, that is, the researcher must relinquish control over the outcome of negotiations between stakeholders.

Besides the political implications of HWC research, care is needed to avoid common pitfalls in study design. First, applied research must serve a near-term management goal. Second, the researcher may bias her or his results by identifying HWC as a serious problem before learning how local stakeholders prioritize it. This can happen innocently if one begins conversations by asking about HWC or if all one's questions revolve around it. A more illuminating approach is to ask local people to list concerns and satisfactions associated with wildlife to see if HWC rises to the top. Another common pitfall is to transform

HWC into a lightning rod for unrelated complaints. For example, Apolobamba and Kibale residents alike felt dissatisfaction with state restrictions on the extraction of natural resources from the protected areas. Complaints about HWC became more heated because of underlying resentment of conservation rules and the perceived failure of the government to protect the public and its resources. Unrequited complaints or research minimizing others' losses can generate added resentment.

Underlying the concerns described earlier are perceptions of HWC. Means to study and measure perceptions vary and vary in effectiveness (e.g., Carr & Halvorsen, 2001). Group meetings are valuable sources of insights into stakeholders' perceptions, but they often only air publicly sanctioned views or the modal experience (Bruskotter & Smith, 2004; DeKoninck, 2005). Capturing more representative opinions should help build a thorough understanding of the problems and build trust among all stakeholders (Halvorsen, 2003). Gender, economic, and political inequities will probably require confidential, small-group, or individual communications. Initial survey questions should be brief and designed for easy application to management: approval of various interventions; tolerance for a given sized population of wildlife; traditional mitigation strategies and compensation; valuation of wild animals both economic and non-materialist; threats to human safety, property, or recreation other than HWC (e.g., Naughton-Treves, Grossberg, & Treves, 2003; Noss & Cuéllar, 2001; Knight, 2003). Consider the culture, literacy and education level of respondents as well as the survey team, when designing the survey instrument. Avoid questions about illegal activities until much later in the project if at all. Participatory mapping exercises are usually helpful especially because HWC is unevenly distributed in space (reviewed in Naughton-Treves et al., 2000; Wydeven et al., 2004) and many people encode natural resource information spatially in mental maps (Treves et al., 2006; Yamada, Elith, McCarthy, & Zerger, 2003). The resulting hard-copy map can also be brought to individual interviews to gain more nuanced views of the social and spatial distribution of conflicts. However, two-dimensional representations of space are not salient to all individuals or cultures. For example, Pakistanis in remote mountain valleys did not understand topographic maps until the management team built up piles of rocks and used lines in the sand as elevation lines (P. Zahler, pers. comm.). Allowing participants to depict HWC in whatever way they wish may circumvent such problems.

In collecting, analyzing, and reporting data on perceptions, skepticism is out of place. Rather than attempt to test the accuracy of people's risk perception, it is more useful to seek explanations for why people are disproportionately concerned about certain species. Later in the article we delve further into perceptions of HWC because these influence complaints, tolerance for management, and proposed solutions (Hill, 2004; Noss & Cuéllar, 2001; Treves et al., 2006).

Wildlife is a direct symbol of the wildness in which many rural communities feel surrounded, and the effect of this on the psyche and beliefs of local residents should not be underestimated (Knight, 2003; Manfredo & Dayer, 2004). Perceptions are shaped by costly or catastrophic events more than the frequent, small-scale losses to pests, notwithstanding potentially higher cumulative, economic impacts (Naughton-Treves & Treves, 2005). By contrast, most scientific studies of HWC emphasize variation around the averages. Regional averages may mask the few individuals, households, or communities that suffer devastating losses (Karanth & Madhusudan, 2002; KWS, 2000; Naughton-Treves, 1997, 1998; Oli, Taylor, & Rogers, 1994; Treves & Naughton-Treves, 1999). For example, Kibale's elephants could cause catastrophic damage but few farms were affected and only rarely. Yet many people complained bitterly about elephants while few mentioned the chronic, small-scale losses caused by redtail monkeys that affected most farmers

(Naughton-Treves, 1997, 1998). A focus on average losses may clash with emphasis on massive losses. Perceptions may also shape expectations about interventions (see later). Because affected communities and the broader public often find personal stories more convincing or comprehensible than scientific data, successful interventions against the common, small-scale pests may not reduce complaints about HWC even if economic losses are significantly lessened. By contrast, systematic measurements can be more compelling to some government authorities, scientists and outsiders, who will not be satisfied unless the numbers improve. Perceptions shape tolerance for types of interventions as well. For example, in Japan, a majority of surveyed farmers opposed lethal control of suspected crop-raiding monkeys because they perceived their similarity to humans (Knight, 2003). In the USA, approval for lethal control depended on the kind of property involved and the agents who would do the killing (Manfredo, Zinn, Sikorowski, & Jones, 1998; Naughton-Treves et al., 2003). Another difference between perceptions and systematic, scientific measures relates to the time scale and spatial scale over which they are collected. Human perceptions are distilled from a long time frame and often, broad spatial scale as people recall family histories and stories related by more distant associates. This breadth and depth is rarely captured in scientific measures of HWC, which more often sample a restricted study area and short time frame. Hence, perceptions of HWC are complementary to systematic, scientific measures of loss and, we maintain, equally important in managing the problem.

Perceptions of HWC are shaped not only by the severity and frequency of losses but by numerous social and biophysical factors relating to individual vulnerability (Carter, 1997; Hill, 2004; Liverman, 1990; Naughton-Treves & Treves, 2005). We follow Carter (1997) and define vulnerability as ". . . the interaction of the hazards of place . . . with the social profile of communities" (Carter 1997, p. 532). The environmental hazards literature differentiates risk of exposure (common to everyone in the same locality) from vulnerability, defined as the individual or household capacity to cope with risk. To understand vulnerability, one must study how people cope with the risks they face. For example, a farmer might face high levels of risk because she plants crops in an area frequented by bears, but she may cope effectively if she has other sources of income or food. Gold-miners in Pelechuco, Apolobamba face particularly high livestock losses (from disease, theft, accidents, weather and occasionally, predators), in part because they supervise their herds infrequently. This risk may be offset by a coping mechanism in which livestock are of secondary economic importance to gold mining.

Coping mechanisms range from individualized self-protection to collective insurance based on social reciprocity (Carter, 1997). The former depend heavily on individual access to land, labor, and capital, which depend in turn on wealth and political influence (e.g., field scattering, crop diversification, using guards, erecting barriers on individual property). By contrast, communal coping mechanisms depend on kinship networks, traditions of sharing, reciprocity, and joint land management (e.g., voluntarily sharing public spaces, reciprocal labor, and aiding less fortunate neighbors). The poorest, migrant households face compounding vulnerability (Carter, 1997; Naughton-Treves, 1997). Without large landholdings or kin networks they cannot buffer themselves from wildlife conflict, nor can they hire additional labor. Of course there is a continuum between individual and social coping mechanisms and affected communities may participate in both. For example, in Apolobamba, many communities engage in inter-household cooperation in planting crops, but usually do not share livestock management. Finally, some settings limit the use of social coping mechanisms (e.g., recent migration by new ethnic groups, political or economic incentives for individual land ownership) (Gillingham, 2001; Hill, 2004).

Around Kibale, immigrant Bakiga farmers were more vulnerable to wildlife crop-raiding because their settlement choices and opportunities to purchase land (coping strategies) were constrained by the majority, longer-term resident Batoro.

Step 2. Participatory Planning

When local stakeholders identify HWC as a priority, participatory planning may improve perceptions of projects, partners, and outcomes (Carr & Halvorsen, 2001; Gillingham, 2001; Gómez, Wallace, Painter, Copa, & Morales, 2003; Halvorsen, 2003; Heberlein, 2004; Jackson, Hillard, & Wangchuk, 2001; Raik et al., 2005; Wilcox, 1994). Subsequent co-management activities will require access to private properties and possibly other intrusions on people's lives, so efforts to build community ownership of a HWC project may pay dividends. Participatory planning will also generate ideas that one party alone might not have envisioned. Successful participatory planning hinges critically on managing expectations and communicating roles and responsibilities clearly. Co-management implies that all parties be willing to relinquish personal preferences for methods of implementation—a delicate balance of feasibility, rigor, and politics.

Participatory planning of HWC projects also requires defining joint objectives, identifying obstacles (or indirect threats, sensu Treves et al., 2006) and opportunities (the facilitating environment that will improve the probability of successful intervention), followed by strategic design of interventions and monitoring systems. Joint objectives should include both protecting human welfare and abating threats to wildlife (Figure 1). However, one common pitfall of projects that aim to improve livelihoods at the same time as

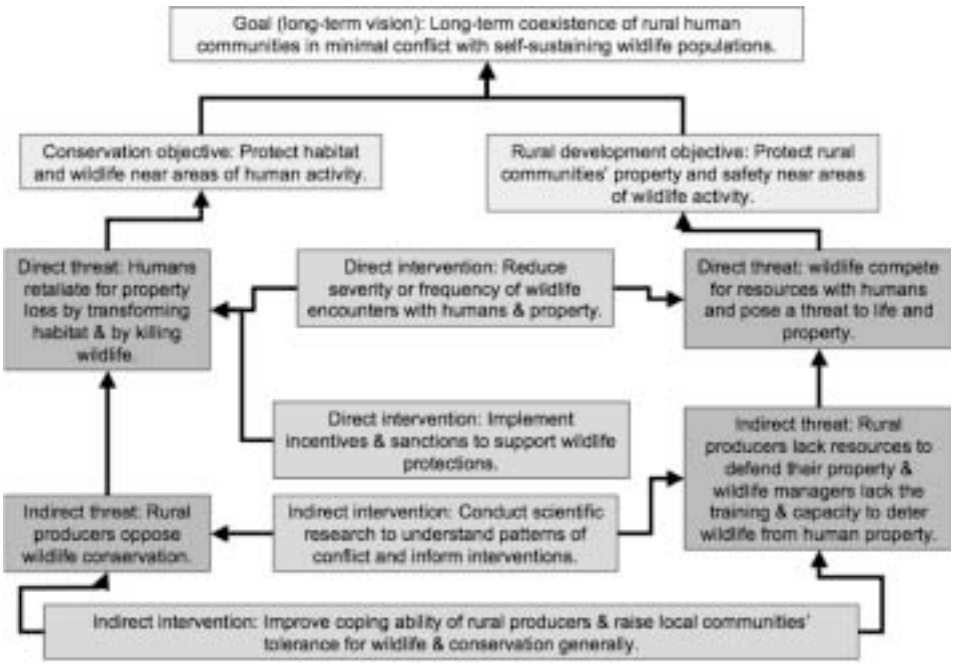

Figure 1. A generic model of causal logic depicting the shared objectives of wildlife conservation and human welfare embodied in many human–wildlife conflict management projects. Arrows indicate how one element affects another.

they conserve wildlife is failing to make an explicit link between development interventions and wildlife conservation (Brandon, 2000; Wells, Guggenheim, Khan, Wardojo, & Jepson, 1999). Including dual objectives of human welfare and wildlife conservation often requires explicit incentives for wildlife-tolerant behavior and sanctions against unsustainable use of or retaliation against wildlife or habitats (Gillingham, 2001; Mishra, Allen, Mccarthy, Madhusudan, Bayarjargal, & Prins, 2003). Sanctions are clearly the hardest element of co-management schemes to negotiate and enforce but essential, lest interest in wildlife conservation be subordinated entirely to development activities, which are easy to persuade stakeholders to accept.

The objectives of participatory planning of interventions is to find consensus on which interventions to implement; to recruit individuals or households to put these in place; to divide up the necessary tasks among participants; and to set a timeline for action and monitoring. Interventions in HWC situations are any activity designed to reduce the severity or frequency of encounters between people and wild animals or any activity that increases tolerance of people for those conflicts (Treves & Karanth, 2003). Examples of the former include barriers, guards, deterrents, wildlife removal, and changes in the locations or types of human activities. Examples of interventions to raise the tolerance of people for remaining encounters include compensation programs, incentive schemes, environmental education, and regulated public harvests.

Naturally, many people suffering losses to wildlife want outsiders and government agents to provide compensation or final solutions to conflicts. From the outset, it is important to dispel hopes for money or "silver bullet" interventions if they will not be possible. At Kibale, we explained that our project would call park managers' attention to the problem (it did), and give people numbers to use in their ongoing efforts to negotiate resource use rights from the park (it did, but only indirectly via NGO action). This explanation carried weight with some communities, but two others refused to participate when they learned they would receive no compensation. In Apolobamba, when we reduced incentive payments paid to maize growers for guarding their crops, some participants in the crop-guarding scheme stopped guarding and reduced the amount of maize they planted (Morales et al. unpubl.). Subsequently, work with livestock producers in Apolobamba focused on technical and material inputs—given to the communities as matching grants, which producers had to match with labor and materials to complete installation. This established a different relationship of supporting improvements to husbandry that would reduce carnivore attacks on livestock, rather than paying for changes in behavior. In Apolobamba, it proved useful to account openly for the use of project funds explicitly and in detail, for transparency and because it made community-members aware of the project's limitations.

Many interventions require a change in human behavior. No one likes being told what to do, especially if long-held traditions are put in jeopardy, hence affected individuals/households are more likely to accept changes if they have defined the need for change and identified the change they wish to make or at least chosen among options offered to them (Jackson & Wangchuk, 2001; Jackson et al., 2001; Noss & Cuéllar, 2001). Self-sustaining interventions—those that require little new technology and minimal change to existing behavior—are most likely to succeed (Ogada, Woodroffe, Oguge, & Frank, 2003; Osborn & Parker, 2003). For example, a snow leopard conservation team provided technical support to build a communal corral after villagers identified this as the most appropriate intervention (Jackson & Wangchuk, 2001). In this case, corrals were in wide use, but communal herd management was not traditional. Reciprocal contributions can be a very powerful tool for encouraging participation and compliance with established norms or specified agreements (Jackson et al., 2001).

Interventions against HWC should not appear one-sided in addressing humans; this can be seen as "blaming the victim." Interventions against wildlife behavior include barriers, deterrents, and removal. This can mean implementing two or more interventions, which also fits with recommendations from recent studies that show single interventions rarely work for long (Bangs & Shivik, 2001; Ogada et al., 2003; Shivik, Treves, & Callahan, 2003).

Consensus on interventions may be difficult to achieve because vulnerability to and benefits of wildlife are distributed unequally—a worldwide feature of HWC (Manfredo & Dayer, 2004; Naughton-Treves et al., 2000). Sometimes the benefits of interventions are distributed unequally, especially when large animals range widely (Noss & Cuéllar, 2001). For example, during the dry season, elephants attract tourists to a park in Cameroon and generate local revenue. In the wet season, the elephants move >100 km and raid farms in another area without tourism (Tchamba, 1996). In Wisconsin, an influential, cattle-producing family has had 3 wolf packs removed over the past 10 years and been offered >$80,000 in compensation for a number of calf losses. Yet they have not implemented standard anti-predator defenses such as guarding, calf relocation, and improved fencing. Meanwhile, smaller livestock operations have voluntarily changed practices with state compensation, without demanding removal of wolves (Treves, Jurewicz, Naughton-Treves, Rose, Willging, & Wydeven, 2002; Wydeven et al. unpublished). Government agencies may intervene (or not act) in ways that are politically effective (Hill, 2004) Wealthier and better educated rural citizens may be more likely to register a complaint than their counterparts (Graham, 1973; Naughton-Treves et al., 2003). In sum, those who complain loudest may not be the most vulnerable and interventions directed to help the vociferous may not resolve the problem.

Step 3. Monitoring

Monitoring is essential to judge the effectiveness of interventions (Curtin, 2002). Strategic monitoring should include three hierarchical measures of performance:

1. Were interventions implemented as planned?
2. Was the threat abated? (Did the level of HWC diminish?);
3. Did we achieve our project goals? (Were conservation targets maintained or restored? Were human welfare targets attained?)

At a minimum, monitoring should be able to distinguish natural fluctuations from the effects of interventions (i.e., monitoring must be robust to temporal and spatial variation in indicators) (Curtin, 2002; Naughton-Treves et al., 2000). The best evaluation of an intervention requires some form of control, but these are often politically difficult to implement because placebos are not attractive to affected stakeholders. Yet careful negotiation might yield some level of control by offering reverse-treatment designs (in year one, half the recipients are controls whereas in year two the other half become controls and roles are reversed). Quasi-experimental controls may arise fortuitously if non-participating actors permit monitoring of their property. Beware, if problem wildlife happen to be repelled by interventions in the treated community, the wildlife may be displaced to the control community, thereby inflating the apparent effect of the intervention. Within-community controls are usually superior to inter-annual or inter-community comparisons, which may contain more spatial and temporal variation in the pattern of human–wildlife interaction.

Consider also the make-up of the monitoring team early in the project. When one interviews people of similar ethnicity, culture, occupation, and sociopolitical background,

one may capture more nuance and insight into perceptions, as we found in Wisconsin. In Apolobamba, interviews with women were at times impossible because men blocked access. Around Kibale, councilmen were reluctant to allow women to respond to interviews or engage in public debate over HWC. By conducting interviews in women's ambits (e.g., cassava plots), we learned that they had distinct concerns from men regarding worst crop-raiders and most vulnerable crops (Naughton-Treves, 1997). Host-country nationals should probably lead monitoring teams, and even better if local community-members do so (Curtin, 2002; Noss & Cuéllar, 2001; Obura, Wells, Church, & Horrill, 2002). This is especially true if one wishes to collect information on illegal activities.

Having designed long-term monitoring, planners would be well advised to prepare an alternative monitoring strategy that is less intrusive on the people whose activities, properties, and perceptions will be measured. Having two or more options gives the subjects a choice as to the level of intrusion in their affairs. The two alternatives should be nearly equal in information gained, but they should differ in logistical features that affect community involvement or interruptions to community schedules. For example, our team discussed two plans to study and ameliorate cattle losses in Pelechuco, Apolobamba. The first was simplest for the wildlife managers (ask livestock owners to pool their small herds in one valley with a communal system for rotating between valleys) but we expected low tolerance for such a plan given the community's reputation for individualism. We devised a second proposal that was deemed simpler for livestock owners (park guards located in town would inspect cattle carcasses in every valley). In both cases, most incidents of cattle mortality would be detected and investigated (less quickly or reliably in the second plan) but the first plan involved more change in traditional activities.

Conclusions

This article offered three critical steps to engage affected communities and wildlife managers in the co-management of human–wildlife conflicts (HWC). Although our steps are common sense and simple, site-specific details can be maddeningly complex. The impetus for this article was our realization that most projects to manage HWC are directed or designed by ecologists without social science input. Social science input is critical because the politics and sociocultural constraints can preclude certain interventions or monitoring plans. Managing HWC without destroying wildlife or human welfare requires a delicate balance of agricultural extension and wildlife conservation. Social scientists and the methods they have developed for participatory planning, measuring perceptions, and understanding socioeconomic practices are essential for the design and implementation of politically viable HWC co-management projects. This is apparent at local levels but also for broader political forces that may scrutinize the project or its outcomes.

HWC is rarely limited to local actors but commonly draws in wider groups. For example, U.S. farmers long employed poison and traps on their own properties to limit agricultural losses (Newby & Brown, 1958). Yet, the 20th century saw a gradual shift to agricultural producers and hunters demanding the U.S. government limit predator populations proactively with federal bounties, trapping, and broadcast poisoning campaigns. The use of federal land and tax revenues for lethal control spurred a political backlash, resulting in ballot initiatives and public demonstrations against wildlife commissions, followed by reduced flexibility in wildlife management strategies (Evans, 1983; Harbo & Dean, 1983; Torres, Mansfield, Foley, Lupo, & Brinkhaus, 1996). To avoid such polarization, we propose a standardized co-management approach.

Finally, we echo the call of several recent authors (Heberlein, 2004; Manfredo & Dayer, 2004; Mascia et al., 2003) for more constructive collaboration between social scientists and ecologists to manage wildlife. Specifically, we highlighted how important it is to understand how perceptions influence complaints about HWC, acceptance of research and its findings, and the acceptability of management actions. In addition social science research can advance our understanding significantly of the following topics:

- Economic feasibility and long-term sustainability of interventions.
- Conditions under which interventions that raise tolerance for HWC also reduce resistance to conservation efforts.
- Processes by which people opt to change livestock or crop husbandry to reduce conflicts, including relocation of human activities; and the outcomes of such interventions.

In conclusion, the capacity to manage wildlife-related threats to human safety and property effectively—without compromising wildlife population viability or human life and livelihoods—is within our grasp. To do so, we believe co-managers must combine technical expertise with local knowledge and embrace transparent and democratic processes of participatory planning, with the sacrifices this entails.

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