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A Simple, Cost-Effective Method for Involving Stakeholders in Spatial Assessments of Threats to Biodiversity

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Human–nature interactions shape biodiversity and natural resources. Planning conservation and engaging stakeholders in dialogues about conservation require an understanding of indirect threats arising from socioeconomic and political conditions, plus participatory methods to build consensus for action. We present a method for spatial assessment of threats, which involves stakeholders in decision-making and planning for conservation. We developed and tested the method in wildlife conservation projects in Asia, Africa, Madagascar, and Central America. The method follows a five-step process: each participant lists the human activities that are the most damaging to biodiversity and natural resources in their region (direct threats) and the role that users, managers, and policymakers play to promote or facilitate these activities (indirect threats); all participants vote to rank the worst direct threats and to map the locations of these threats at their site. The output maps are amenable to use in GIS analysis. We show how these maps help to plan, monitor, and implement interventions in wildlife conservation projects.

Keywords participatory mapping, conservation planning, prioritizing threats

Introduction

Participatory appraisals are useful in development, economics, and environmental conservation (Bille & Mermet, 2002; Doolittle, 2003; Hartup, 1994; Heberlein, 2004; Jackson, Hillard, & Wangchuk, 2001; Ostrom, 1990). Participatory appraisals generally involve

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convening stakeholders to identify and discuss concerns and opportunities for progress. The conveners often seek insight into human activities and needs; they may collect qualitative, quantitative, or spatial information as part of the process. These procedures put respondents in the role of experts informing projects in their region.

Because systematic, scientific data on the dynamic and diverse interactions between humans and wildlife are often lacking, conservation planners increasingly make use of stakeholders as sources of expert opinion and to supplement other data collection efforts that may be more time-consuming and expensive as diagnostic measures (Hess & King, 2002; Pearce, Cherry, Drielsma, Ferrier, & Whish, 2001; Salafsky & Margoluis, 1999; Yamada, Elith, McCarthy, & Zerger, 2003).

Asking stakeholders to guide wildlife conservation can build trust, foster communication, and hopefully promote collaboration among other stakeholders in designing interventions or implementing monitoring strategies (Heberlein, 2004; Wilcox, 1994). Conservation projects usually require long-term relationships with multiple stakeholders (Bangs et al., 1998; Bille & Mermet, 2002; Jackson et al., 2001). Armed with stakeholders' perceptions of human activities believed to threaten biodiversity and/or sustainability, wildlife conservationists can identify meaningful overlap among stakeholder interests, while promoting collective actions to address these threats. Building consensus to protect wildlife is particularly challenging when human–wildlife conflicts occur or when users are unaware of their own impacts (Grossberg, Treves, & Naughton-Treves, 2003; Naughton-Treves, Grossberg, & Treves, 2003).

Two challenges routinely face wildlife conservation teams when they plan abatement of natural resource threats: (1) a shortage of spatial information on the location of threats relative to the distribution of their conservation targets, and (2) gaps in understanding stakeholders' perceptions of activities that may damage wildlife. Existing methods for spatial threats assessments often focus on human development goals, needs, or aspirations rather than wildlife or wildland targets, hence they appear inapplicable or are difficult for biologists to translate for their own use.

In this article, we present a method of participatory threats assessment tailored to biodiversity projects, particularly those concerned with wildlife conservation. This method uses workshop meetings to involve stakeholders in decision-making and planning for conservation. The major outputs include: (1) identification and inclusion of a wide range of stakeholders in decisions about wildlife conservation; (2) prioritized ranking by stakeholders of human activities perceived as threats to biodiversity and sustainable natural resource use; (3) quantitative assessments of threat locations and their change over time; and (4) maps delineating the spatial distribution of threat locations amenable to GIS analysis. We developed and tested this method in wildlife conservation projects in Asia, Africa, Madagascar, and Central America.

A Participatory Threats Assessment Process

The steps in the workshops: (1) explain the purpose of the workshop; (2) ask participants to list human activities that are most damaging to biodiversity and natural resources, and also describe the indirect threats promoting or facilitating each of the human activities he or she listed; (3) ask participants to vote on the worst threats from the entire list; (4) ask participants to map and characterize the worst threats in the region; and (5) discuss results and steps to initiate planning and action on interventions and monitoring.

Step 1. The purpose of the workshop and the contributions that conservation can make to human welfare are explained. Participants are acknowledged as experts on the human activities of their region and that their perceptions would help guide conservation action.

Step 2. Participants list human activities that they consider as direct and indirect threats to biodiversity or natural resources. We avoided asking about needs, aspirations, or development goals. Direct threats are those human activities that directly, physically diminish biodiversity or use resources unsustainably: (1) habitat loss—converting one habitat type to another; (2) species depletion—removing wild plants and animals; (3) pollution—biochemical, physical, or thermal changes; and (4) introduction of non-native plants, animals, or microbes—species that supplant local species or diminish their health. Indirect threats are the attitudes and responses of users, managers, and policymakers that facilitate or promote any given damaging activity. Indirect threats are classified into three categories: (1) users lack awareness of the damage caused by their own activities, lack incentives for conservation or sustainable use, or lack alternatives to a damaging activity; (2) managers lack information, capacity, or incentives to intervene effectively, to detect or monitor threats, or to communicate rules to users; and (3) policymakers lack awareness, resources, or incentives to provide adequate laws or support (financial or judicial) for law enforcement.

Step 3. Participants vote on the most severe human activities (hereafter referred to as threats). The threats are then ranked in order of priority to better allocate conservation resources where and when they are most needed.

Step 4. Participants form subgroups to map and characterize the loci of direct threats and to identify appropriate leaders to arbitrate if there were disagreements and to report on the map features. Subgroup leaders take notes on mapped features such as timing of the threat, time to recover following abatement, severity, and urgency.

Step 5. Next steps in planning interventions and monitoring are discussed with an emphasis on how indirect threat information helps to focus on whether to prevent the activity itself, persuade users to change their behavior, help managers to intervene, or influence policy. It is explained that both threats and low-ranked human activities would be monitored eventually and mapped threats would be verified at local levels before implementing interventions. Participants are asked how, when, and where they would report on the results to their respective constituencies, neighbors, and high-level policymakers.

Methods

This participatory threats assessment method was developed as part of the Wildlife Conservation Society's (WCS) Living Landscapes Program and tested in four field projects: Glover's Reef Atoll of Belize (Glovers), the Greater Virungas Landscape of Central Africa (GVL), the Eastern Steppe of Mongolia (Mongolia), and the Masoala-Makira-Antongil Bay land and seascape of Madagascar (MAMABAIE). These four sites differed in human population density, land use, sociocultural context, and biophysical conditions.

Glover's is the southernmost of 3 offshore coral atolls, located 45 km east of Belize. The atoll seascape was declared a marine reserve in 1993. Covering an area of 35,876 ha, the atoll has the greatest diversity of reef types in the Caribbean, with >800 patch reefs and 6 sand cayes. The reserve protects one of the few remaining viable spawning sites for Nassau grouper (*Epinephelus striatus*). About 100 fishermen from three coastal communities fish the atoll, targeting lobster, conch, and reef fish. Five small resorts on the cayes accommodate about 80 guests for snorkeling, diving, sport fishing, and kayaking. Nineteen participants attended a threats workshop in Belize City, which was co-hosted by the Fisheries Department. Participants included representatives of fishing co-operatives, government agencies, local authorities, landowners, the tourism sector, and international conservation organizations.

The GVL straddles the western border of Uganda, the northwest corner of Rwanda, and the eastern border of the Democratic Republic of Congo (DRC). The GVL comprises a group of contiguous protected areas spanning 1,310,000 ha. The GVL supports many habitats (e.g., alpine moorland, montane and sub-montane forest, wetlands). The GVL hosts 150 endemic species and 49 IUCN red-listed threatened species. Farmers, livestock producers, and fishermen inhabit the region, often in high densities (>200 people/km^2). Protected area authorities and international conservation groups of the three host nations are actively coordinating wildlife conservation efforts despite insecurity from civil war, genocide, intense poverty, refugees, and epidemics. We held the threats workshop in Beni, DRC, with 32 protected area managers, national wildlife authorities, and international conservation organization staff.

The Eastern Steppe of Mongolia covers approximately 25 million ha of high rolling plains; it is the last great swath of relatively pristine, temperate grassland in the world. The Eastern Steppe is home to most of the world's population of Mongolian gazelles (*Procapra gutturosa*). There are nine protected areas, two Ramsar sites (International Convention on wetlands), and numerous wetlands serving as critical staging grounds for threatened populations of migratory birds (e.g., great bustard—*Otis tarda*, white-naped crane—*Grus vipio*). The majority of people on the steppe are nomadic herders living at low densities (1.4 per km^2). We held two series of threats workshops in English and Mongolian. The first consisted of four workshops held in provincial centers for government and agency officials (including governors, resource managers, and environmental inspectors), local NGO staff, and other relevant stakeholders (n = 84). The second series of workshops convened over150 herder families.

The MAMABAIE land and seascape of northeastern Madagascar spans three provinces and 2.7 million ha. This area comprises various tropical marine, coastal, and inland ecosystems, and supports lowland and mid-elevation evergreen humid forests, littoral forests, marshes, lakes, mangroves, coral reefs, lagoons, and estuaries. In addition, it contains the last, largest extent of high quality Malagasy rainforest with high plant diversity and 30 of the 100 species found in the eight endemic plant families of Madagascar (Schatz, Birkinshaw, Lowry II, Randriatafika, & Ratovoson, 2000). MAMABAIE includes four protected areas co-managed by governmental and nongovernmental organizations (e.g., Masoala National Park). The area hosts >500,000 people engaged in shifting agriculture, mining, livestock production, vanilla production, fishing, and tourism. We conducted the threats workshop in Maroantsetra in French and Malagasy. The participants (n = 40) included representatives from local communities, private industry, public service institutions, and governmental and nongovernmental groups, including conservation and development organizations.

For each workshop we provided: (1) 400 index cards in 4 different colors for participants to write one human activity per card, (2) post-it page markers to streamline voting, (3) a large tarp that had been sprayed with an adhesive on the inside surface (the tacky surface does not dry out and allows paper to stick to it and be repositioned many times or flipped over to write on the reverse), (4) LCD projector, (5) laptop computer, (6) digital camera, and (7) poster-sized maps. For the latter, we prepared detailed maps showing a wider geographical region to allow participants to orient themselves prior to drawing threat locations. For two workshops (Glover's, Mongolia), participants drew on the base maps of the conservation area, whereas for the other workshops (GVL, MAMABAIE), participants drew on sub-regional base maps corresponding to their geographic expertise. The base maps contained only coastlines; reefs; and major rivers, roads, and towns—(without place names) to facilitate drawing; the detailed regional maps depicted features to help orient participants.

The threats workshops brought together the principal actors expected to work cooperatively to reduce threats within the region. The participants differed greatly in their knowledge, technical training, and authority. Some also had a history of mutual mistrust. We invited diverse participants precisely because they bring a broad range of interests, concerns, and priorities.

Co-hosting the workshop and developing invitations with a respected organization encouraged participation. We made an effort not to stigmatize or disenfranchise participants whose activities may have been viewed as threats. Marginalized actors (e.g., local people, women, minorities) were encouraged to attend by personal contacts. Partner organizations (e.g., natural resource mangers, international conservation groups) were invited to discuss their activities in the region at the workshop.

Step 1. We began each workshop by explaining our organization's interest in conserving wildlife and wildlands, and how we hope to ensure that ecologically functional and productive ecosystems provide intrinsic and economic benefits to people at local, national, and global levels. We portrayed unsustainable uses of natural resources as threats to biodiversity and natural resources, which also jeopardize the wealth of people who depend on natural resources for food and income. We gave a 15-minute presentation to explain each task that the participants would undertake during the workshop. This allowed participants to see what they were being asked to do at each step (a prototype is available on www.wcslivinglandscapes.org). We articulated the shared objectives of conservation and human welfare.

Step 2. We explained that in the absence of human influence, plant and animal populations fluctuate in abundance over time. Humans alter this variation in species' distribution and density in four general ways (habitat loss, species depletion, pollution, non-native species), which we associated with the four colors of index cards. We prepared an index card that described a hypothetical human activity considered threatening (unrelated to the region, but understandable to participants nonetheless) and presented it written in <10 words on an index card of the appropriate color.

Each participant listed human activities that they perceived as diminishing biodiversity or natural resources (the number of activities provided by each participant varied but we recommend 3 to 7; the upper bound being harder to manage with a large number of participants, while the lower bound may spuriously exclude threats of medium importance. We asked participants to write only one activity on each index card. We hoped that anonymity would promote candor. If some of the stakeholders appeared uncomfortable or had limited literacy or comfort with the language, we assigned a gender- or ethnic-appropriate facilitator to help. For the GVL workshop that had discussed wildlife as conservation targets and tools, we asked them to focus on threats to those species.

We also encouraged participants to specify one or more indirect factors related to users, managers, or policymakers that facilitated or promoted each direct threat. For example, although over-fishing is considered a direct threat to Nassau Grouper populations in Glover's, indirect factors such as weak law enforcement or lack of economic alternatives for poor households promote and facilitate unsustainable marine species depletion. Our three categories of indirect threats (users, managers, policymakers) identified the individuals or groups that must be engaged to promote change and effect conservation. We encouraged participants to identify multiple indirect threats if they held two or more classes of actors responsible. We discouraged remote or global factors such as poverty, over-population, and global warming, preferring instead to focus on proximate, stronger influences.

While participants wrote their activities, we prepared the adhesive tarp to display their cards. We arrayed the participants' finished index cards under the appropriate direct threat category by color (habitat loss, species depletion, invasive species, pollution). After the cards were collected, the facilitation team read and organized each one as follows: if an activity posed more than one threat, we created a second card and rewrote the activities separately. For example, fire can destroy habitat and cause species loss if the organisms cannot avoid the fire. If two index cards were similar (same activity, same actors), we rewrote and posted only one card, but noted the number of similar cards on the one posted. We retained all cards for subsequent analysis of indirect threats.

Combining similar index cards was a critically important simplifying step. We strove not to force it on the participants and involved them in the discussion of such simplifications, while emphasizing the need to reduce the number of different human activities so that action would be feasible. For example, participants may be happy to combine "hunting with snares" and "hunting with guns" because they both involve local hunters, but may want to keep "commercial hunting" separate, especially if non-local hunters engage in this activity. We made it clear that no cards would be discarded—irrespective of the votes it received. The facilitation team recorded the information.

Step 3. Each participant took 3 to 6 post-it page markers for voting and placed the markers on the threats that he or she deemed most critical. In the MAMABAIE threats assessment, we used different color post-it markers for different subregions to prioritize threats within sub-regions rather than across the region as a whole. After everyone cast their votes, we rearranged the index cards on the tarp in order of decreasing number of votes. When many human activities received votes, we looked for a natural break in the voting (e.g., gap of >2 votes producing a high-ranked set and a low-ranked set). Once there was consensus on the division of human activities into few/many votes, we defined all of the human activities that received high priority as threats. We then took a digital photograph of the tarp for the final report.

Step 4. Participants formed subgroups to map and characterize each locus of a direct threat, in one of two ways depending on the size of the region and the expertise of participants. For small landscapes, we used multiple identical base maps, one for each threat, and asked participants to divide into subgroups based on their familiarity with a particular class of direct threat. For larger landscapes, we used base maps of separate sub-regions and divided participants into subgroups based on their familiarity with a subregion.

Participants could depict a threat locus as a two-dimensional perimeter around the area where a threat occurs (a polygon), as a line for narrow features, or simply as a point. For example, human activities are often distributed in a line along roads, rivers, and reefs. Invisible or poorly known threats (e.g., pollution) may be represented by points if the extent of the threat is not known. Participants worked in pencil at first, but then if consensus was reached they finished the map using a marker.

Each map leader recorded the following information about each threat locus on his or her map: (1) map number; (2) feature number; (3) human activity description; (4) when the threat occurs (e.g., all year, only in certain months, only once every "x" years);

(5) whether the present threat level today is greater or less than in the past (on 5-point scale from –2 = "much less now" to + 2 = "much greater now"); (6) time to recover once the threat is abated (0 = <1 year, 1 = 1–10 years, 2 = 10–100 years, 3 = >100 years or never); (7) severity of the threat (0 = none or positive, 1 = small but measurable effect, 2 = substantial effect but complete loss unlikely, 3 = complete destruction of the biodiversity or natural resources possible); and (7) urgency (0 = plan now, but immediate action unnecessary, 1 = Take action now, threat is ongoing).

In the Mongolia workshop, we encouraged participants to write a short description of the mechanisms causing differences in the spatial distribution and severity of threats, as well as areas of uncertainly or lack of knowledge about the threat. In the GVL and MAMABAIE workshops, we tabulated direct and indirect threats in relation to each other as a step in the analysis.

Some participants had expertise in more than one subregion or more than one threat type and wished to inform more than one map, so we asked leaders of mapping subgroups to remain next to their respective maps to receive questions and modify map features based on this peer review. Afterwards, the map leaders described features drawn on their map in a plenary session.

Step 5. In three cases, our facilitation team prepared highlights from the meeting including digital photos of the tarp and maps to distribute at the end of the workshop. While this summary was developed, we discussed possible next steps in planning for implementation and mitigation.

Results

The threats assessments at the four sites showed interesting similarities despite slightly different methods and different constituent participants. Similarities included the emphasis on habitat loss and species depletion as the most commonly mentioned and highest-priority threats. Unsustainable harvesting/poaching of wildlife played a role at all four sites. For example, over-hunting of gazelle and marmots (*Marmota sibirica*) was the highest ranked threat in the Mongolian workshops.. In the GVL workshop, poaching of elephants (*Loxodonta africana*), buffalo (*Syncerus caffer*), and other large mammals from protected areas was among the highest ranked threats. The marine site workshops (Glover's, Antongil Bay subregion of MAMABAIE) reported species depletion of fish, shellfish, and elasmobranchs as high ranked threats. The Glover's workshop stood apart by highlighting pollution, coral bleaching, in addition to species depletion, and habitat loss among the highest-ranked threats (Figure 1).

Participants listed numerous human activities that they perceived as damaging to biodiversity and sustainable use of natural resources, but voting reduced the list considerably. For example, Glover's participants listed 21 human activities, but only 9 (43%) garnered more than one vote. MAMABAIE, a much larger area with a workshop involving twice as many participants, yielded 31 human activities of which only 16 (52%) garnered more than one vote across the four subregions (Table 1). This suggests that the number of threats identified and ranked high in priority will increase with increasing numbers of participants, but not at the same rate and presumably leveling off as all human activities are identified and a subset receive priority in voting.

In general, participants left the workshops enthusiastic with the findings and energized to abate the threats. Every workshop facilitation team reported that participants were eager to map their understanding and willing to quantify threats. Discussion of threats was characterized by open dialogue, even between actors that traditionally disagreed. Many

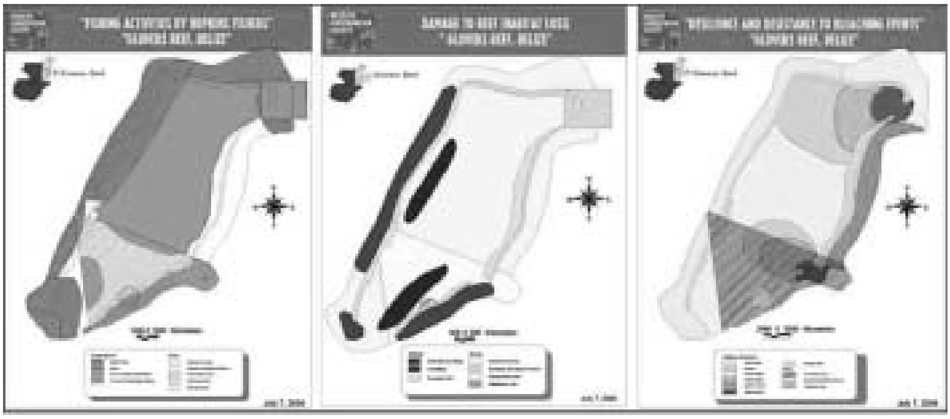

Figure 1. The three most severe threats around Glover's Reef Atoll, Belize (species depletion, habitat loss, pollution) digitized from hand-drawn maps.

Table 1
Threats to MAMAAIE with Votes each Received by Sub-region

Human activity	Sub-region			
	Northern	Western	Bay of Antongil	Eastern
1. Habitat conversion for agriculture and materials	13	8	3	19
2. Selective removal of precious timber	8	5	0	16
3. Beach fishing using fine mesh nets	0	0	26	2
4. Slash and burn agriculture	0	3	0	13
5. Lemur hunting	7	3	0	6
6. Slash and burn agriculture erodes soil that pollutes waters	2	2	5	0
7. Commercial wildlife collection	1	5	0	1
8. Fires favor invasive plants	2	0	0	5
9. Quartz mining destroys habitat	0	4	0	2
10. Octopus fishing destroys reefs	2	0	2	1
11. Population growth encroaches forest	0	3	0	0
12. One plant species exploited for building materials	0	2	0	0
13. Industrial fisheries ravage small fish	0	0	2	0
14. Over-fishing generally	0	0	2	0
15. Unhygienic latrines pollute water	0	0	2	0
16. Use of anesthetics for fishing	0	0	1	1
17. Swidden fires pollute the air	0	1	0	0

participants displayed impatience to act, armed as they were with consensus among participants. No participants commented that our approach was politically insensitive by portraying human activities as threats.

A threats workshop provided the launching point for intervention planning for several reasons. First, the major output was a prioritized list of direct threats linked to information on actors responsible, facilitating indirect threats and spatial, quantitative information on individual threat loci. Systematic classification of indirect threats and identification of their interactions with many different direct threats will help to identify interventions that can efficiently address a single indirect threat with cascading effects on many direct threats. For example, during the GVL workshop, participants held managers (32%) more responsible than policymakers (13%) despite participants themselves serving as managers. Therefore, building the capacity of managers and training them to monitor and intervene may be the most efficient point of intervention. Conversely, the MAMABAIE workshop participants (users, managers, and policymakers) held managers (20%) less responsible than policymakers (29%). As such, policy reform rather than concentration on managers might be a more fruitful starting point. In these two workshops, users were held nearly equally responsible for the direct threats. This suggests that focusing on work at the community-level will be important at both of these African sites. In particular, interventions aimed at changing user attitudes, promoting alternative activities, or giving incentives for conservation should be promoted. In comparing direct threat classes, the two African sites were relatively similar (GVL: 6% exotic species invasions, 53% habitat loss, 3% pollution, 38% species depletion; MAMABAIE: 2% exotic species invasions, 44% habitat loss, 13% pollution, 40% species depletion).

Second, the maps produced during the threats workshops were digitized into a GIS database. Large landscapes can be split into sub-regions, which allows participants to either map based on local spatial knowledge (MAMABAIE, Table 1; GVL, Table 2), or from their expertise with specific threats (Figure 1). For example, the Glover's participants familiar with fishing worked on a different copy of the same map as those familiar with reef damage or coral bleaching. This can help a team determine where to act first and where to monitor threats perceived to be rapidly changing (Table 2).

If desired, threats assessments can be tailored to a set of focal species, as was done with two species in GVL (Figure 2). The importance of collaboration between Uganda and the Democratic Republic of Congo (DRC) for controlling poaching is reflected in the proximity of the wildlife species' ranges to the frontier and the polygons for poaching

Table 2

Threat Change Since 1995 (Top) and Severity of Threats (Bottom), as the Percentage of Threat Features Drawn by Participants in the Three Sub-regions of the GVL

	Threat change since 1995				
Region	Much less	Somewhat less	No change	Somewhat greater	Much greater
North	3.3	16.7	30.0	16.7	33.3
Central	23.6	25.5	9.1	21.8	20.0
South	0.0	21.4	42.9	35.7	0.0
	Severity				
Region	None	Little	Substantial	Severe	
North	0.0	30.0	70.0	0.0	
Central	12.7	36.4	32.7	18.2	
South	0.0	40.7	44.4	14.8	

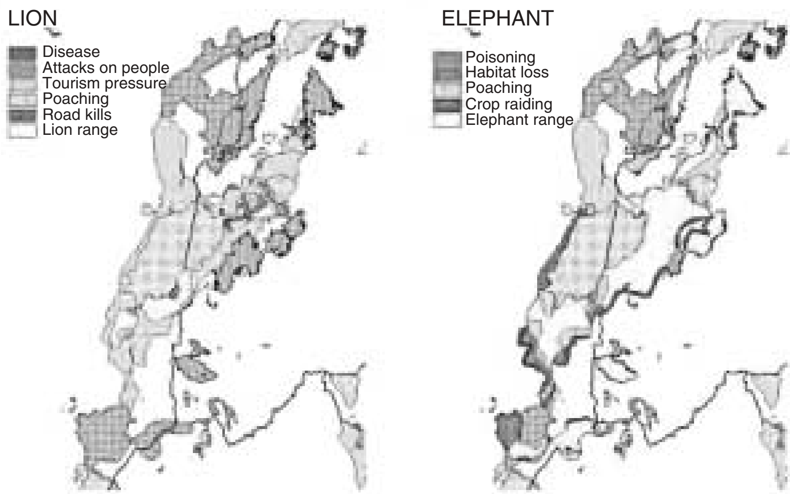

Figure 2. Maps for two focal species of the GVL, demonstrating how our threat mapping method can apply to species-specific threats. The lion and elephant were chosen as focal species for conservation planning because their wide-ranging habits, vulnerability to hunting and persecution, and their endangered/threatened status make them particularly difficult to conserve. A focus on wildlife was deemed attractive for this group of stakeholders because of the perception that parks were not large enough to ensure viability of populations of wildlife species such as elephant and lion. The border between Uganda (east) and the Democratic Republic of Congo (west) is shown by the nearly straight black line running north to south through both maps.

threat. This approach can help situate interventions to protect wildlife. For example, following the GVL workshop, the Ugandan and DRC authorities requested support from the Wildlife Conservation Society to stop trade in elephant and buffalo products.

Discussion

Accurate threat maps can provide invaluable information for conservation of wildlife and wild lands. Failure to identify and locate threats accurately can doom a project to inefficiency. Stakeholder participation in decisions about threats can help to avert irrelevancy and build partnerships for intervention and monitoring (Heberlein, 2004). The method described here offers one approach to produce spatial and quantitative estimates of human activities that threaten wildlife and natural resources; these data are often difficult to collect directly, especially for illicit activities like poaching. The outputs included quantified, classified, and mapped direct and indirect threats. This can help to initiate plans for interventions, as well as help to identify gaps in conservation teams' expertise. For example, if participants identified direct threats from pollution with indirect threats from policy failures, but they lack expertise in these issues, the workshop will highlight a direction for future training and capacity building.

Given that stakeholders list human activities and rank the worst as threats, our method promotes their fundamental decision-making role in conservation projects. If managed effectively, stakeholders' perceptions of threats become part of a public record and the results become the basis and justification for changes in policy, enforcement of rules, or other interventions. Taking a role in decision-making fosters acceptance of interventions and monitoring activities, which are often intrusive on people's lives (Heberlein, 2004).

Threat workshops bring together stakeholders to build familiarity and trust among groups who might otherwise not interact because of their different interests. This can help to identify overlap, common ground, and competing interests among groups regarding economic and conservation objectives.

Our method for participatory mapping of threats was tested at four sites representing different biophysical and social conditions. This approach is general enough to apply to marine and terrestrial systems or combinations of both. It works equally well for sparsely and densely populated regions, although we acknowledge the need to involve more stakeholders and conduct several workshops in densely populated regions. The workshops are best suited to groups of ≤40 participants. Beyond this size, the processes for listing, organizing, prioritizing, and mapping threats can become unwieldy and confusing. However, inadequate participation may result in threat assessments being based on the intuition of a few project leaders, which is problematic for conservation efforts in areas where there are many stakeholders and complex human–environment interactions. We have had the most success with a mix of politicians, natural resource managers, and users for whom literacy, quantification, and mapping are reasonably familiar.

We recommend conducting threat mapping workshops early in a project cycle (e.g., conceptualization stage of a project prior to development of conservation strategies) (Conservative Measures Partnership, 2003; Salafsky, Margoluis, Redford, & Robinson, 2002). The threat prioritization and quantification may aid a conservation team to focus intervention and monitoring schemes, as well as evaluate project outcomes over time. However, the choice of threats to abate remains a decision by the conservation team and not all high-ranked threats perceived by stakeholders must be addressed. Eventually, the list of threats will need to be compared to the team's mission and goals for the region. This may reveal where stakeholder interests converge and depart from those of the conservation team. But one cannot make such judgments before collecting information.

In summary, the threat mapping method described here focuses attention on activities that threaten wildlife and wilderness rather than asking participants about their needs, economic concerns, or development goals. The spatial and quantitative outputs are vital in planning subsequent interventions and monitoring, and they aid in developing consensus among stakeholders.

Perceptions and Scientific Monitoring

Threats assessment workshops should not replace systematic, scientific measures of threats to biodiversity and natural resources. However, we caution that time and resources may be wasted when using sophisticated systematic measures for human activities that turn out not to be major threats.

We also caution that data on stakeholders' perceptions must be handled carefully, as they tend to capture both personal experience and stories told by others. In turn, this can exaggerate the likelihood of dramatic events, but can also capture threats occurring over a broad region and many years. Few scientific studies capture such a broad temporal and spatial range. Gathering information on perceptions is also important to avoid proposing interventions that do not accord with perceptions of problems and thus engender opposition to management itself. Perceptions often shape people's behavior and their acceptance for interventions. Information on perceptions and personal testimony may be more persuasive or intelligible to rural communities and lay audiences, whereas systematic, quantitative measures are often more salient to managers, outsiders, and policymakers. We believe both perceptions and systematic scientific measures are complementary and help to serve different purposes and different audiences.

In conclusion, we offer this simple, inexpensive method of sampling stakeholders' perceptions of threats to biodiversity and natural resource management. Participant satisfaction with the method and the impetus it generated for planning implementation support its use in other settings. However, the applicability of this approach to developed nation settings and other types of stakeholder groups remains a topic for further investigation.

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