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Does monitoring matter? A quantitative assessment of management decisions from locally-based monitoring of protected areas

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Abstract. Biodiversity monitoring is criticized for being insufficiently relevant to the needs of managers and ineffective in integrating information into decision-making. We examined conservation management interventions resulting from 2½ years of monitoring by 97 rangers and 350 community volunteers over 1 million hectares of Philippine protected areas. Before this monitoring scheme was established, there was little collaboration between local people and park authorities, and park monitoring was restricted to assessments of the quantity of extracted timber. As a result of the scheme, 156 interventions were undertaken in terrestrial, marine and freshwater ecosystems. In total 98% of these interventions were meaningful and justified, 47% targeted the three most serious threats to biodiversity at the site, and 90% were implemented without external support, suggesting that the interventions were relevant and could be sustained over time at the local level. The mean time from sampling to decision-making was only 97 days, probably because 82% of the interventions were initiated by the same people and institutions that had compiled the underlying data, bypassing potential government bureaucracy. Many of the interventions were jointly undertaken by community members and the management authorities or consisted of local bylaws in support of park management. As a result of the monitoring, indigenous resource use regulation schemes were re-established with government recognition in several parks. The monitoring led to more diversified and realistic management responses on the part of the authorities, including a more socially acceptable and effective approach to enforcement. Of the four field monitoring techniques used, the most participatory one generated more interventions aimed at ensuring a continued resource supply for local communities ($\chi^2_3 = 69.1$, $p < 0.01$). Although this suggests that the interest of community members is associated with their possibilities to influence the flow of ecosystem goods and services, the 156 interventions targeted, directly or indirectly, all known globally threatened species of mammals, birds and butterflies in the parks.

Introduction

Biodiversity monitoring is claimed to be ineffective at integrating information into decision-making and insufficiently relevant to the needs of land and resource

managers (Danida 2000; Sheil 2001). The accuracy of these claims is of critical importance to policy and funding decisions. Committing resources to the design and operation of a monitoring system is a long-term and ongoing investment with outcomes only evident years into the programme (Watson and Novelly 2004). Those who are funding and/or implementing monitoring need to be confident that the monitoring is effective in achieving its objectives. Past assessments of monitoring initiatives have focused on their ability to detect trends (e.g., Thompson et al. 1998; Yoccoz et al. 2001; see also Brashares and Sam 2005; Hockley et al. 2005 (this issue)) but none has, to our knowledge, provided a quantitative assessment of effectiveness in terms of capacity to lead to conservation interventions on-the-ground, which is the goal of conservation efforts.

In this paper, we examine a simple monitoring scheme established by the Philippine government with project funding support in protected areas and used by rangers and community members with little formal education. This scheme is intended to improve the information available to decision-makers in parks through the regular collecting of data on natural biological resources and their utilisation. The focus is on identifying trends in the important biodiversity assets of an area and the use of the area's biodiversity in order to guide action in park management.

The monitoring scheme comprises four field methods: (1) focus group discussions with volunteer 'community monitoring groups' of particularly knowledgeable forest product gatherers, hunters and fishers; (2) systematic observations of wildlife and resource use during regular patrols (field diary method); (3) fixed point photography of selected hillsides; and (4) simplified line transect surveys (Danielsen et al. 2000). Philippine protected areas are obliged to carry out this monitoring as part of their routine park operations (DENR 2000; 2001). In each park, the monitoring focuses on a list of 10–15 taxa and 5–10 signs of resource use, selected by protected area staff in cooperation with local community members and staff of the national Protected Areas and Wildlife Bureau. Most lists include taxa of large terrestrial mammals, easily identifiable birds, crocodiles, marine turtles, fish and shellfish. Data are collected every 3 months with the exception of field diary data, which are compiled whenever rangers are in the field. The analysis is undertaken locally by the protected area staff. The scheme is entirely paper based but the information generated is possible to analyze using digital technology.

We explore whether this monitoring scheme is leading to conservation. By 'conservation' we mean the use of biological resources in such a way as to ensure their continuing availability for future generations. We use conservation management interventions as a surrogate measure of conservation impact. We also explore the time from data sampling to management action, who took actions on the basis of this monitoring, what kind of actions were taken, and the benefits of the individual field techniques. In addition, we assess whether recurrent funding for this scheme can be seen as a burden for the Philippine government, and we describe the status of the scheme 3 years after external support ceased.

Study areas

The biodiversity monitoring scheme has been established in protected areas at Apo Reef, Bataan, Batanes, Northern Sierra Madre, Mt. Apo, Mt. Kanlaon, Mt. Kitanglad Range and Siargao, the Philippines. The mean number of staff in the protected areas was 13. Staff members generally held first degrees in forestry or an associated field and had received training in biodiversity monitoring and other aspects of park management. Mean annual funding of the protected areas was 1.75 USD per ha (2001 data). These areas each contain 0–85,000 residents (mean = 21,200), who depend heavily upon forest and coastal resources to support their livelihoods (e.g. NORDECO and DENR 1998a; 1998b; 1998c). The protected areas were established pursuant to the National Integrated Protected Area System Act (DENR 1992), which provides resident communities with access and rights over some use of forest/wetland resources plus representation on a protected area management board (council). While people have been illegally exploiting the resources in the past, they are now allowed to undertake controlled harvesting in certain areas. This is important as it would otherwise be difficult to achieve the involvement of local communities in monitoring.

Methods

Conservation impact is difficult to measure on a standard scale across different habitats, and the true impact may only be discernible in the long term. We therefore used conservation management interventions as a proxy for conservation impact. We defined a 'conservation management intervention' as a purposeful action by a managing body to conserve or achieve a more sustainable use of the biological resources. The usefulness of the interventions and whether they had actually been carried out was examined by discussing them with protected area staff and local community members and by cross-checking with the minutes of protected area management board meetings and other written documentation. Decisions that did not lead to action and those that were only part of the management system (e.g. 'improve functioning of protected area council') were omitted from the analysis.

We assessed conservation management interventions undertaken in the parks between December 1998 and July 2001. We compiled data and reviewed documentation on the interventions at two national workshops on biodiversity monitoring with park staff and during 62 field visits of 3–7 days each. In addition, we reviewed 316 protected area council decisions and 60 quarterly reports on the results of the monitoring sent from local to central government.

We explored the relevance and sustainability of the conservation management interventions by:

(1) Comparing data on each intervention with existing information on each park from other sources and assessing whether the interventions were

meaningful, justified and soundly linked to the underlying observations. We defined 'meaningful interventions' as those with rational objectives, according to the socio-cultural, ecological and administrative contexts. We defined interventions that were 'justified and soundly linked to the underlying observations' as those which were appropriate in terms of target, intensity, timing and extent. Other important sources with which we compared the monitoring data included NORDECO and DENR 1998a, 1998b, 1998c and the following unpublished materials: DENR Integrated Protected Area System management plans; technical reports of DENR, Nipa and the Conservation of Priority Protected Areas Project on local government administration, park management, human use, indigenous people, marine resources, vegetation, flora, butterflies, shellfish, marine turtles, birds, mammals; and semi-annual World Bank supervision meeting briefing materials and aide-memoires 1996–2002.

(2) Examining whether the interventions addressed the three most serious threats at each site. We defined threats as the human activities with the most negative impact on the areas' conservation values. Based on existing information on each park from other sources, the main threats were identified as industrial and road development (4 sites), logging and timber poaching (4 sites), small-scale agriculture (4 sites), large-scale agriculture (3 sites) and commercial marine fishing (3 sites), along with gathering of non-timber forest and wetland products, grazing, wildlife hunting and quarrying (1 site each).

(3) Assessing the financial and institutional sustainability of the interventions by examining whether they depended on support from the outside, beyond the provincial level, or not.

We investigated the objective of the conservation management interventions by assessing whether they were primarily aimed at protecting natural habitats or particular species or at ensuring a continued supply of natural resources for local human communities. Some of the interventions simultaneously addressed more than one of these objectives. The number of interventions was compared between the four methods using chi-square tests (Fowler and Cohen 1988). Some interventions were associated with the simultaneous use of several monitoring methods, in which case they were attributed to each method (as each method alone was in other instances sufficient to trigger an intervention).

The species interventions were examined in more detail. We assessed whether they targeted globally threatened species by comparison with existing distributional and conservation status data on terrestrial mammals (Heaney and Mallari 2002), resident birds (Collar et al. 1999; Mallari et al. 2001; supplemented with Kennedy et al. 2000), and butterflies (Danielsen and Treadaway 2004).

We then identified the type of intervention (e.g. raising of awareness, establishment of bylaws governing resource use etc.), and who collected the data and took action (park staff, community members, municipal staff, etc.). In addition, we looked into whether the interventions addressed resource use by

local resident people or outsiders. We defined 'outsiders' as people not living in or adjacent to the protected area.

In order to examine the speed with which decisions were taken, we assessed the time from data sampling to decision-making for each intervention. Finally, we investigated the importance of the underlying data for the decision-making process by assessing whether the interventions were based on new data or not. We defined 'new data' as data not previously known to the senior local park staff or ourselves. Information on the status of the scheme in 2004 was obtained from a national workshop on biodiversity monitoring with park staff and by correspondence with each park.

Results

Relevance and sustainability of the management actions

Before the present monitoring scheme was established, the monitoring activity of park staff was largely restricted to regular assessment of the amount of extracted timber. Very few if any management interventions emanated from this. After 2½ years, the monitoring scheme had led to 156 documented conservation management interventions. These interventions addressed threats from a broad spectrum of activities, especially fishing (15% of 156 interventions), hunting (15%), gathering of non-timber forest products (14%), small-scale logging (13%) and shifting agriculture (10%) but also large-scale commercial logging and farming, quarrying and industrial development.

We examined the usefulness of these interventions and found that most (98%) of them were, or probably were, meaningful and justified and soundly linked to observations of changes in the occurrence of species/resource use. Three interventions did not fulfil this requirement. Two of these included the establishment of village bylaws that banned cutting of 'narra' (*Pterocarpus* sp.) and electro-fishing by outsiders, both in response to community monitoring group data that indicated a decline in the local catch of freshwater fish. Villagers argue that floating of fresh 'narra' on rivers impacts on fish populations but, to our knowledge, this linkage is as yet unproven (although forest degradation may well lead to increased siltation and declines in the diversity and abundance of fish). Likewise, banning only outsiders' non-selective fishing is irrational. The third intervention was a municipal ordinance to establish a crocodile rescue centre in response to field diary records of unsustainable hunting of the critically endangered Philippine crocodile *Crocodylus mindorensis*. A rescue centre is unlikely to reduce the threat to crocodiles from hunting (although long term awareness-raising associated with a rescue centre may generate local support for conservation of reptiles).

Moreover, we found that 73 (47%) of the interventions targeted the three most serious threats to each site's biodiversity. Furthermore, 140 (90%) of the 156 interventions were undertaken without financial, staffing or other

institutional support from the outside beyond the provincial level; the remaining interventions depended on funds for establishing income-generating initiatives (12 interventions) or on applied research and training on the part of national institutions (4).

Our findings suggest that locally relevant and sustainable management interventions emanated from the scheme; but were these actions taken in order to protect the biodiversity values or the supply of resources to the local people, and which monitoring technique did they emanate from?

Habitat interventions

We explored the purpose of the interventions and found that 79 of the 156 interventions were aimed at protecting natural habitats, whereas 61 were aimed at protecting particular species and 63 at ensuring a continued supply of biological resources for local human communities.

Among the 79 habitat interventions, most were targeted at forests (77%), coastal areas (14%) and grasslands (4%). The forest habitat interventions mainly addressed small-scale logging and shifting agriculture and focused on enforcement, raising awareness about resource management, and coordination between government agencies.

Far more habitat interventions emanated from the focus group discussion and field diary methods than from the fixed point photography and transect methods ($\chi^2_3 = 53.2$, $p < 0.01$; Figure 1a). This result holds both when we look at interventions to address local peoples' resource use and resource use on the part of outsiders (Figure 1a).

Species interventions

Moving from habitats to species, 48 of the 61 species interventions were focused on specific taxa, including eight that are globally threatened (Table 1) whereas 13 species interventions were targeted at species found within a certain area and habitat, or species with a specific local use (medicinal plants, non-timber forest products). Most of the species interventions addressed threats from local people, particularly hunting, and comprised awareness-raising and enforcement, but at least 10 other types of management activity were also involved. Most of these interventions emanated from the focus group discussion and field diary methods ($\chi^2_3 = 28.7$, $p < 0.01$; Figure 1b).

How many of the globally threatened species in the parks were targeted by the species interventions? To examine this, we compared data on the interventions with existing published data on the distribution and conservation status of three of the better known taxonomic groups. The parks are known to hold or probably hold populations of 68 globally threatened species of terrestrial mammals (17 species), resident birds (34), and butterflies (17). Only five

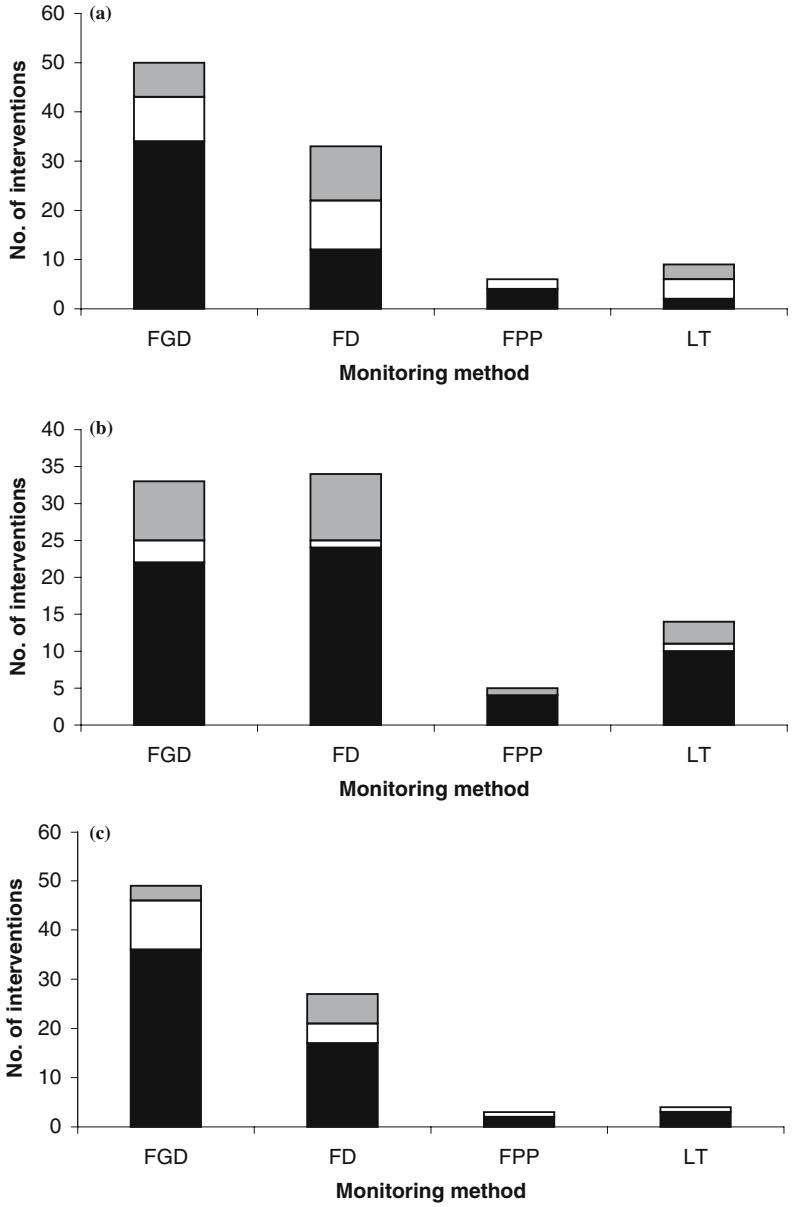

Figure 1. Effectiveness of the monitoring methods in generating conservation management interventions intended to improve the way local people (black), outsiders (white) and both (grey) manage the resources. (a) The number of interventions aimed at protecting natural habitats. (b) The number of interventions aimed at protecting particular species. (c) The number of interventions aimed at ensuring a continued supply of natural resources for local human communities. Abbreviations are: FGD, focus group discussion; FD, field diary; FPP, fixed point photography; and LT, line transect.

Table 1. Taxa targeted by management interventions emanating from the monitoring and aimed at protecting particular species, including their conservation status, local use, the origin of the threat to the population of the species, and the type of intervention.

Taxa	Latin name	Category IUCN[a]	Local use	Threat from local or outsider[b]	Type of intervention[c]
PLANTS					
Trees			Multiple	OL	Awa, coo, enf
Rattan	*Calamus* spp.		Food, house construction, medicinal, furnituremaking, handicraft	L	Awa, coo, enf, par
Orchid			Ornamental	L	Awa, coo, enf, liv, par
ARTHROPODS					
Tetanus beetle			No information	O	Enf
Butterflies	Rhopalocera		Pollinator of crops and fruit trees, ornamental	O	Enf
SHELLFISH					
Giant clam	Tridacnidae	LR-cd	Food, lime for betel chewing, garden decoration, animal feeding troughs	OL	Awa, enf, par, res
Giant triton	*Charonia tritonis*		Ornament, food	L	Awa, byl, coo, par
Coconut crab	*Birgus latro*	DD	Food	L	Awa, byl, san, sea, siz
FISH					
Coral reef fish			Food	OL	Enf
Freshwater fish			Food	L	Coo, liv
REPTILES					
Green turtle	*Chelonia mydas*	EN	Food (meat, eggs) and sold for cash (meat, eggs, carapace)	OL	Awa, coo, enf, san
Hawksbill turtle	*Eretmochelys imbricata*	CR	Food (meat, eggs) and sold for cash (meat, eggs, carapace)	OL	Awa, coo, enf, san
Estuarine crocodile	*Crocodylus porosus*		Food (eggs), dog food (juveniles), superstitious belief	L	Awa, byl, coo, enf, oth, par, san

Philippine crocodile	*Crocodylus mindorensis*	CR	No information	L	Awa, byl, coo, enf, oth, par, san
BIRDS			Food	L	Par, san
White-bellied sea eagle	*Haliaeetus leucogaster*		Food	L	Awa, enf
Philippine eagle	*Pithecophaga jefferyi*	CR		OL	Awa, coo, enf, par, san
MAMMALS					
Golden-crowned flying fox	*Acerodon jubatus*	EN	Food	L	Awa, coo, per
White-winged flying fox	*Pteropus leucopterus*	EN		L	Awa, coo, per
Philippine warty pig	*Sus philippensis*	VU	Food, sold for cash, body ornament (teeth)	L/OL	Awa, byl, coo, enf, ext, sea
Philippine brown deer	*Cervus mariannus*	DD[d]	Food, cash source (meat, antlers), home ornament, internal organs used to treat stomach ache, antlers used to treat measles	L	Awa, byl, coo, sea
Dolphin	Cetacea		Food	L	Awa
Dugong	*Dugong dugon*	VU	Food, cash source, body ornament, amulet (tusks). Tusks are used for medicine	L	Awa
Philippine tarsier	*Tarsius syrichta*	DD	Burnt fur used for convulsion	L	Awa, enf

[a]Using the criteria of IUCN (2003): CR, critically endangered; EN, endangered; VU, vulnerable; LR-cd, lower risk-conservation dependent; DD, data deficient.
[b]Outsider defined as 'people not living in or adjacent to the protected area'. L, local; O, outsider.
[c]Intervention type abbreviations are: Awa, awareness-raising; byl, bylaws at tribal, village or municipal level; coo, cooperation between authorities; enf, enforcement of existing regulations; ext, extraction method ban; liv, livelihood assistance; oth, other type of intervention; par, Protected Area Management Board resolution; per, permit system establishment; res, research; san, sanctuary establishment; sea, seasonal closure; siz, size-limit for harvesting.
[d]Should be classified as globally threatened according to Heaney and Mallari (2002).

of the larger and more obvious of these species (Philippine eagle *Pithecophaga jefferyi*; and four mammal species) were the direct object of taxa-specific interventions, however the remaining 62 species were all indirectly targeted by other interventions emanating from the monitoring, especially habitat interventions to protect forests (61 species) and wetlands (one species, *Anas luzonica*). Most of the threatened species in the parks suffer from degradation and destruction of their forest habitat.

While only the larger and relatively easily identified threatened species in the parks were directly targeted by species specific interventions, the scheme provided data on 47 taxa listed in the appendices of the Convention on the International Trade in Endangered Species (11 taxa in App. I; 35 taxa in App. II) and 75 globally red-listed taxa of plants (21 taxa) and animals (54 taxa), including 15 critically endangered, 13 endangered and 20 vulnerable taxa (NORDECO and DENR 2002). Some of these data have been reported to international agencies and may contribute to future management interventions.

Resource supply interventions

Among the 63 interventions aimed at ensuring the continued supply of resources, 74% dealt with particular resources, especially taxa of plants (15 interventions), marine fish and shellfish (12) and freshwater fish (11), and the remaining dealt with protected area or forest resources in general. Most resource supply interventions emanated from the focus group discussion method ($\chi^2_3 = 69.1,\ p < 0.01$; Figure 1c). This result holds both when we look at interventions to address local people's resource use and resource use on the part of outsiders (Figure 1c).

Who took action?

Before the present monitoring scheme began, there were few attempts to involve local people in the management of the parks, even though legislation (DENR 1992) allowed for it. To explore whether the scheme had made a difference, we examined who took action on the basis of the monitoring.

The point of departure of the monitoring scheme was that the protected area council would take decisions on the basis of the findings from the park staff's data analysis but, in reality, decisions were taken at four different levels: by protected area staff (83% of 156 interventions), local community members (49%), the protected area councils (44%), and government institutions at village and municipal level (19%).

Community action was mobilised particularly effectively by one of the monitoring techniques, the focus group discussion. A total of 62 of the 76 interventions made by local community members emanated from this method. Moreover, 70% of the 89 management interventions generated overall by this

method were undertaken by local communities (the corresponding figures for the other methods were 21–29%).

When we looked at the ability of the techniques to generate joint government/community member interventions, we also found that the focus group discussion method was the most effective ($\chi^2_3 = 74.8$, $p < 0.01$; Figure 2).

Type of activities included in the interventions

We then examined the type of intervention activity emanating from the monitoring. We found that the most frequent activities were raising awareness about resource management (69% of 156 interventions), strengthening the coordination between protected area stakeholders (49%) and enforcement of restrictions on access and resource use (50%). Most of the 78 enforcement interventions comprised enforcement in parallel with awareness-raising or other activities. Only 22 interventions involved enforcement in isolation, and these were mainly targeted at outsiders.

Many of the interventions involved policy-making within local government and community institutions. A total of 58 (37%) of the 156 interventions involved the issuing of resolutions or other policy-making on the part of the protected area councils. These interventions mainly emanated from the field diary and focus group discussion methods.

Local bylaws governing resource use were the focus of 35 (22%) of the interventions; these were mainly established by indigenous people, villages and municipalities. It is our experience that local bylaws are usually more effective in changing people's behaviour than national Philippine laws. Thirty of these

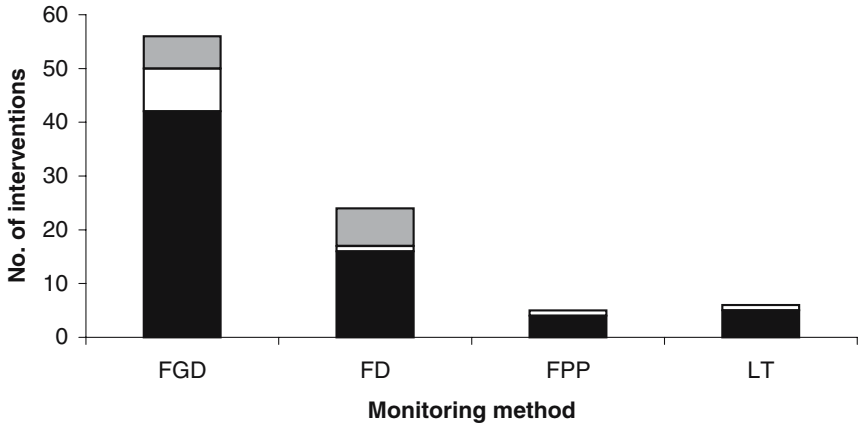

Figure 2. Effectiveness of the monitoring methods in generating joint government/community member interventions intended to improve the way local people (black), outsiders (white) and both (grey) manage the resources. Abbreviations are: FGD, focus group discussion; FD, field diary; FPP, fixed point photography; and LT, line transect.

35 bylaw interventions were generated at the initiative of members of the community monitoring groups, as part of the focus group discussion method. These actions were primarily taken to ensure a continued supply of resources for local people (22 interventions) rather than to protect species (11) or habitats (10) but they almost certainly also had a positive impact on both habitats and populations. The majority of the bylaw actions addressed threats from local people's activity (27 of 35 interventions). The main human activities addressed were fishing, hunting and gathering of non-timber forest products.

Time from data-collection to decision-making

To explore the efficiency of the scheme in integrating information into decision-making, we examined the speed with which management decisions were taken on the basis of this monitoring. We found that the average time from data sampling to decision-making was 97 days (for the 154 interventions with available data). The response time varied from 89 days (average for the field diary method) to 122 days (the transect method). The short response time can probably be explained by the fact that most interventions were implemented by the very same people and institutions that had compiled the underlying data: 61 (69%) of the 89 interventions generated by the focus group discussion method were partly or fully implemented by members of the community monitoring groups, indigenous people or local villages. Likewise, 74 (90%) of the 82 interventions generated by the field diary method were partly or fully implemented by the head of the protected area and his staff. The corresponding figures for the transect and photo documentation methods were 95% (of 21 interventions) and 79% (of 14).

Is the dialogue more important than the data?

Just how important are the data for decision-making? Is it the stakeholder dialogue prompted by the monitoring activity rather than the monitoring information that encourages action? To test this, we examined whether the underlying data for each intervention were new. A total of 139 (89%) of the 156 interventions were based, or probably based, on new data on the occurrence of species, resource use or threats not previously known to senior local protected area staff or the authors, indicating that the collecting of data is vital for decision-making.

Benefits of the individual methods

Our findings suggest several important, previously neglected characteristics of the four monitoring techniques used in this scheme. The focus group discussion

method was strikingly powerful at generating local bylaws, joint government/community actions (Figure 2) and interventions to ensure a continued supply of resources for local communities (Figure 1c), suggesting that this method may be very important in areas where the management objectives include sustainable resource use by local people. One weakness is that the success of the method is context-specific: in areas (such as Bataan Natural Park) with poor relationship between the authorities and the local people, this method is less effective.

The field diary method was powerful at generating management intervention to protect natural habitats and particular species (Figures 1a and b), and its effectiveness was less dependent on the local social context. Another advantage of this method is that it is simple and easy to grasp, even for people without training.

The simplified ranger-implemented transect method was capable of providing data for analysis of vertebrate population trends on a larger-scale (see Figure 1 in Danielsen et al. 2005 (this issue)), whereas the fixed point photography method was particularly useful for generating convincing inputs to local level awareness-raising and education work.

Linkage to national level

Every 3 months, the head of each park prepares a report to the protected area council. This report is copied to the Protected Area and Wildlife Bureau (PAWB) at national level. The report is structured such as to encourage park staff to both organize, analyse and interpret the data as well as to propose specific conservation management interventions. The report includes the dataset, a list of important observations of observed changes in species and resource use, and a list of proposed management interventions with a description of the issue identified (e.g. 'conversion of forest for farming of vegetables'), the location and the proposed action to be taken by the protected area council.

The staff of the PAWB are supposed to regularly review the reports and provide feedback to the park staff in order to keep errors in the recording at an acceptable level and to assist the parks when national level action is required to back up local management interventions. It was also envisaged that the PAWB staff would extract data with which to prepare annual reports for the Secretary of the Environment. This work at national level, however, has suffered from underfunding and weak institutional support.

Discussion

Two important caveats apply to the use of conservation management interventions for quantitative assessments of the effectiveness of biodiversity

monitoring schemes. First, we do not fully know if the recorded interventions accurately reflect the actions taken on-the-ground. Data were collected from protected area staff and villagers, from places within the parks where we knew that the monitoring methods were being used. Some interventions may have been overlooked, particularly actions taken by members of the community monitoring groups. In addition, it is possible that a few interventions would have been taken even without the monitoring. The long time-frame over which data were collected could also potentially limit the accuracy of information, but this problem was minimised because 151 (97%) of the 156 interventions were supported by resolutions or other written documentation. Although the definition of management interventions was intended to be clear, objective and straightforward, its consistent application sometimes proved difficult, particularly when several management initiatives were taken simultaneously as a result of findings from the monitoring. This problem was minimised, however, due to the fact that all the interventions were scrutinized and evaluated by the same person. Our assessment of the usefulness of the conservation management interventions may also be biased by insufficient or inaccurate park information coming from other existing sources. Knowledge of the human use, habitats and species of Mt. Apo, Mt. Kanlaon and Siargao, in particular, is very limited.

Secondly, we used conservation management interventions as surrogate information for the overall conservation impact. Since an intervention implies that somebody has taken an action intended to improve the conservation or sustainable use of resources, management interventions may have a conservation impact in a wider sense. The scale of the impact can, however, differ substantially from one intervention to the next, both in space and in time. For instance, the impact of a tribal-level bylaw permanently banning the hunting by tribesmen of Philippine warty pig *Sus philippensis* during the breeding season is very different from the impact of protected area staff raising the awareness of villagers on the location of the park boundary, based on photos of infringing slash and burn agriculture. In addition, we know the interventions were made but we have limited information on their subsequent outcome i.e. whether the actions led to a reduction in the intensity of the threats, or arrested declines in the extent and biodiversity content of the natural habitats. For instance, the level of respect that local bylaws solicit among villagers may differ from one area to the next, even within the same protected area.

What worked and why?

Despite the limitations, this study demonstrates several important points. Firstly, the park staff and villagers' monitoring of biodiversity and resource use led to relevant and sustainable management actions to protect biodiversity and the flow of ecosystem benefits on a local scale in terrestrial (92 interventions), marine (28) and freshwater ecosystems (16). The regular collecting of data by

park staff and community members appeared to be a vital element in the decision-making process.

The fact that the data analysis was made and the management decisions taken within existing institutions at the local level probably encourages local ownership and increases the likelihood of successful management (see also Obura et al. 2002; Sheil and Lawrence 2004). On the other hand, the individual local management action often has limited impact beyond the local scale. Larger-scale impacts of the monitoring would, however, be possible if the data were also analysed nationally and the findings made available to national-level policy makers in an appropriate format (see Balmford et al. 2005; Danielsen et al. 2005 (this issue); Green et al. 2005) or if copies of the data were regularly submitted to existing international monitoring schemes (Loh et al. 2005; Roberts et al. 2005 (this issue)).

Secondly, the effectiveness of the monitoring in generating management action may be associated with the short response time, as a result of minimal institutional distance between data recorders, decision-makers and action takers. Most actions (82%) were taken by the very same people and institutions that had compiled the underlying data, bypassing potentially bureaucratic institutions and communication channels.

Thirdly, local people's interest in collecting data and participating in monitoring-based decision-making appears to be directly associated with their ability to influence the flow of ecosystem benefits because, among the four monitoring methods used, the most participatory one generated strikingly more interventions aimed at ensuring a continued supply of ecosystem goods and services to the local communities (Figure 1c; see also Hockley et al. 2005 (this issue)).

Although the level of public participation in the monitoring differed from site to site (Barcelona 2004), this monitoring scheme has shown how local people can in practice participate meaningfully in the management of protected areas, as indicated, e.g., by the high number of local bylaws generated in support of protected area management (35). Moreover, the perception of the monitoring as a credible and independent source of information as opposed to personal observations substantially changed the agenda of some of the protected area councils. Sensitive issues such as commercial logging by powerful local politicians inside protected zones began to be openly discussed.

The monitoring also provided concrete opportunities for indigenous people to be heard by the park authorities and for the authorities to benefit from indigenous knowledge. Indigenous community members were directly involved in the monitoring in six of the eight protected areas examined. Many of these people began reporting immediately and directly to the protected area head and rangers on matters such as violations of resource use regulations by outsiders. Likewise, in three of the sites, indigenous zoning and resource use regulation schemes were being re-established with local government recognition and indigenous people were increasingly being recognized as resource co-managers.

The management interventions emanating from the monitoring involved a wide range of activities. The proportion of the 156 interventions involving enforcement (50%), and the fact that most of these actions were combined with other activities such as awareness raising, suggests that locally-based monitoring has not reduced the level of enforcement but that its use is now built on a greater acceptance and consensus among the local people. In support of experiences from Madagascar (Andrianandrasana et al. 2005 (this issue); and J. Durbin in litt.), our findings indicate that locally-based monitoring has led to a more socially acceptable and effective approach to enforcement. Threats from slash and burn agriculture inside protected zones have traditionally been addressed by enforcement, frequently with minimal impact. Only one of the 15 interventions aimed at slash and burn agriculture comprised enforcement alone, suggesting that the monitoring may also have led to more diversified and maybe realistic management responses on the part of the authorities in the field.

Current information is insufficient to assess the extent to which the monitoring methods are able to detect true trends in the abundance of species and resource uses. The worst case scenario is that the findings from the monitoring are outright wrong or misleading, that the actions are detrimental to conservation, and that the activities are wasting limited conservation opportunities and resources. Our findings showed, however, that 47% of the interventions targeted the three most serious threats to each site's biodiversity, and that almost all (98%) were, or probably were, well justified and meaningful. Important mechanisms for improving the validity of the data and for correcting mistakes in the scheme are the triangulation of results between the four methods, as well as the discussions with community members in the community monitoring groups and at the annual village meetings.

Cost

Is operation of this monitoring system prohibitively expensive? Philippine government expenditure on travel and materials (excluding equipment) was USD 16,500 per year (2001-data; 55 PhP per USD, July 2004). Government staff time devoted to field work related to the focus group discussion, fixed point photography and transect methods was 61 person-months. The time devoted to the field diary method was less than for the other methods but hard to quantify because this method formed an integral part of the patrolling. If we assume that roughly 10 person-months were devoted to fieldwork under the field diary method, that a similar time was used on analysis and reporting on field work for all the methods, and that an average government employee's salary is USD 150 per month, the approximate costs of government salaries for field work, analysis and reporting were USD 21,300 per year. With a total of 1.09 mill. ha of protected land and sea covered by this study, the average annual funding was USD 0.0151 per ha for travel and materials and USD

0.0195 per ha for government staff salaries, a total of USD 0.0346 per ha. This represents a mere 2.0 % of the average annual funding to Philippine protected areas, and is within the means of most developing country governments.

Status of the scheme in the Philippines

When this monitoring scheme was established, we considered it a feasible minimum starting point. If this minimum scheme could not be sustained over time then no biodiversity monitoring would be sustainable in the country.

Three years have passed since external involvement in the scheme ceased (December 2001). Despite the fact that the government's annual budget deficits have reached unprecedented levels, the scheme continues to be implemented in the majority of the sites where it was established but the efforts depend on the local availability of park staff and operational budgets.

The Protected Area and Wildlife Bureau has promoted the scheme as a standard management tool in protected areas (DENR 2000) and, as a result, the scheme has spread to new sites. Likewise, some parks have on their own initiative begun using the scheme (M. Mendoza pers. comm.). As of 2004, a total of 25 protected areas are using the scheme to the extent that the protected area councils and the heads of the protected areas make decisions and take actions on the basis of findings from the scheme (A. Tagtag in litt.). In addition, several NGOs, including the Foundation for Philippine Environment, Kabang Kalikasan ng Pilipinas, and the Soil and Water Conservation Foundation have adopted the methods and begun using them in new areas.

All four methods are still used but in some protected areas they have only one monitoring site for each method, clearly too little sampling effort to sufficiently inform management. In addition, in some of the new sites, the rangers have found it difficult to enlist the community's participation in the focus group discussions. This is especially demonstrated in the hesitance among some people to provide information and the non-attendance of others at the meetings of the community monitoring groups.

It appears that at the protected area level, in those parks where they have sufficient funds and staff for monitoring, there is a need for further training of park staff by the PAWB in participatory approaches, as well as in species identification, data analysis and application of the field methods in aquatic habitats. At the national level, there is a need to build further capacity in effectively making the locally-derived data available to national policy-makers.

Experiences with the scheme in other countries

Through experience exchange workshops and follow-on activities, the approach and lessons from this scheme have also spread to other countries. We know of concrete attempts to establish locally adapted versions of the scheme

in Indonesia, Laos, Tanzania, Nepal and Chile. In Indonesia, CARE staff tested the scheme in two national parks in Sulawesi in 2000. The scheme is still being used as part of the co-management system in one of these parks (G. Shea in litt.).

Parts of the scheme were established in the lowland forests and freshwater wetlands of Laos (Xe Pian, Champasak) and in the montane forest and miombo woodlands of Tanzania (Iringa District) in 2000 and 2002 respectively, building on efforts already being made by externally-funded protected area projects in these areas (experiences described in Poulsen and Luanglath 2005 and Topp-Jørgensen et al. 2005 (this issue)). Elements of the scheme are now being institutionalised within the Forestry sector in Tanzania.

In Nepal, the Department of National Parks and Wildlife Conservation and CARE Nepal attempted to establish the scheme in the heavily populated *terai* buffer zone of the Royal Bardia National Park in 2001 but the work had to be abandoned after the initial planning workshop because of insurgency in the area. In Chile, the scheme was established on a pilot basis in protected areas of Patagonia (Aysén, Region XI) in 2003 by the Corporación Nacional Forestal and the National History Museum of Santiago (D. Aldridge pers. comm.).

Evaluation criteria for the effectiveness of monitoring

Methods for monitoring biodiversity are usually evaluated only on the basis of their power to detect a trend in species abundance within a certain level of significance and not for their ability to impact management (an assessment of the statistical power of the transect method of the present scheme is provided in Danielsen et al. 2000; see also Brashares and Sam 2005; Hockley et al. 2005 (this issue)). While a management intervention is not an ideal measure of conservation impact, it may be useful from a conservation perspective because it encourages a holistic approach whereby monitoring is seen as an integrated aspect of management (see also Uychiaoco et al. 2005 (this issue)). The 'management intervention' unit is close to the end-point: conservation and sustainable resource use on-the-ground (see also Robertson and Hull 2001). Management interventions are, however, impossible to track through desk work but require concerted efforts in the field by experienced people. Our experiences suggest, however, that it is useful to track management interventions because they can indicate the possible management impact of the scheme and provide direction.

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