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Taking stock of nature in species-rich but economically poor areas: an emerging discipline of locally based monitoring

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Introduction

Conventional scientist-executed forms of monitoring are expensive and rely upon highly skilled scientists or technicians (Danielsen *et al.*, 2000). As such only a small amount of this type of monitoring is undertaken in developing countries, where funding and available expertise are limited. This is unfortunate as the developing countries have the greatest importance globally in terms of their assemblages of species, including those threatened by extinction, and also have a great diversity of habitats and important ecosystem services (Millenium Ecosystem Assessment, 2005). They are also the parts of the world where habitat loss is currently proceeding at the greatest speed, and where we know least about the trends in species abundance (Balmford, Green and Jenkins, 2003; IUCN, 2007).

Recently, experiments have been made to involve less educated local people in monitoring of natural resources in developing countries. Although there are still a number of scientific questions surrounding these approaches, and many schemes are still at an early stage of development, the new approaches show a great deal of promise (Danielsen, Burgess and Balmford, 2005a; Danielsen, Burgess and Balmford, 2005c). This chapter analyses the success and challenges of four schemes that stand out from the majority, because they have been replicated and scaled-up, and are now institutionalized and adopted nationally in the respective countries. We begin by describing and explaining the activities and outcomes for each of the four schemes, before presenting our own cross-cutting analysis of the benefits and challenges of such approaches.

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Ranger-based monitoring of Ghana's savannah reserves

What we did and why

The first formal wildlife monitoring in Ghana was established by the British colonial authorities in the early 1900s. At this time, monitoring focused on several hunting reserves which were designated for use only by the colonial elite (Ghana Wildlife Division, 2000). Many West African communities, however, had their own forms of wildlife monitoring which date back hundreds or even thousands of years. For example, in many areas, local chiefs required hunters to provide a leg or other body part of every animal taken on their lands. In this way, chiefs not only received a share of the meat, but were able to monitor the rate of wildlife off-take and implement reductions of harvest if necessary.

Following independence in 1957, Ghana adopted new monitoring policies in protected areas with the stated goal of sustainably managing wildlife resources to allow bushmeat harvest and other benefits to local communities (Ghana Wildlife Division, 2000). This relied on locally based employees of the Ghana Wildlife Division (GWD, initially the Department of Game and Wildlife) to record the type and number of larger vertebrates encountered on monthly walking patrols (Brashares, Arcese and Sam, 2001) and during daily activities around camp. These counts were conducted around ranger posts within at least 11 national parks and resource reserves starting in 1968, and continue in some form in several of these reserves today (Table 5.1). The number of posts in each ranges from two to 31 so the monitoring data can illuminate both temporal and spatial patterns (Brashares and Sam, 2005).

Employees of the GWD were often drawn from local communities and received limited training in animal identification or sampling methods. Parks officials viewed the collection of count data as one means of ensuring that Division staff were active in conducting foot patrols in the field. Staff collected the data because it was part of their job and a metric by which they were evaluated, but the goal was to ensure that wildlife use was sustainable, not to prevent its use altogether (Ghana Wildlife Division, 2000).

The monitoring data were collected regularly over more than 30 years, but were used only for internal, annual wildlife estimates and seldom were fed back into the management of the protected areas from which they came. In 1999, researchers from the GWD and University of California, Berkeley, began to summarize and analyse the data using more quantitative techniques, see

Table 5.1. *Summary characteristics of the locally based natural resource monitoring schemes in Ghana, The Philippines, Tanzania and Namibia*

Country[a]	Biome[b]	Land tenure system[c]	Type of participation by community members[d]	Who compiles data[e]	What is monitored[f]	Spatial scale Total size of area monitored (ha)[g]	Interval between successive bouts of data collection (days)	Community member time spent on data collection (person-hours/ha/yr)	Payment provided to community members involved in the monitoring (USD)	Indicative recurrent costs of monitoring (USD/ha/yr)[h]	Indicative total funding for management (USD/ha/yr)
Ghana	t	PA	II(0)	R	Use/Wildl	516 500(2)	30	No community members involved[i]	No community members involved	0.06 (2003)	0.18[j]
Philippines	t(m, fw)	PA	I(350)	R/C	Use/Wildl	1 090 000 (8)	90	0.005	0 (snacks)	0.04 (2001)	1.75
Tanzania	t	PA/non-PA	I(298)	C	Use/Wildl	144 403 (4)	Varies	0.201	0–2/day	0.05 (2003)[k]	0.23
Namibia	t(fw)	C-PA	I(200)	C	Use/Wildl	7 000 000 (30)	Varies	0.005[l]	100/mth[m]	0.01 (203)[lm]	0.05–0.65[l]

[a]Source of information: Danielsen *et al.*, 2005a, pp. 2512–2513.
[b]t = terrestrial; fw = freshwater; m = marine (bracketed biomes account for a minor portion of the area under monitoring).
[c]C-PA = protected area managed by the local non-PA = outside of protected area; PA = protected area under government authority.
[d]I = Monitoring scheme intended to involve the community members in the local design of the monitoring as well as in data collection, data analysis, data analysis, and monitoring-based decision-making; II = Monitoring scheme not currently intended to involve community members. The number of community members directly involved in the monitoring is indicated in brackets.
[e]C = community members; R = government rangers.
[f]Use = resource use; Wildl = wildlife species/populations and habitats.
[g]The number of areas monitored is indicated in brackets.
[h]Year in brackets; excluding depreciation of equipment.
[i]The rangers however often came from local communities.
[j]This figure includes the costs of monitoring.
[k]Funds generated locally from user fees.
[l]Many conservancies are located in large deserts.
[m]Funds generated locally from trophy hunting or tourism.

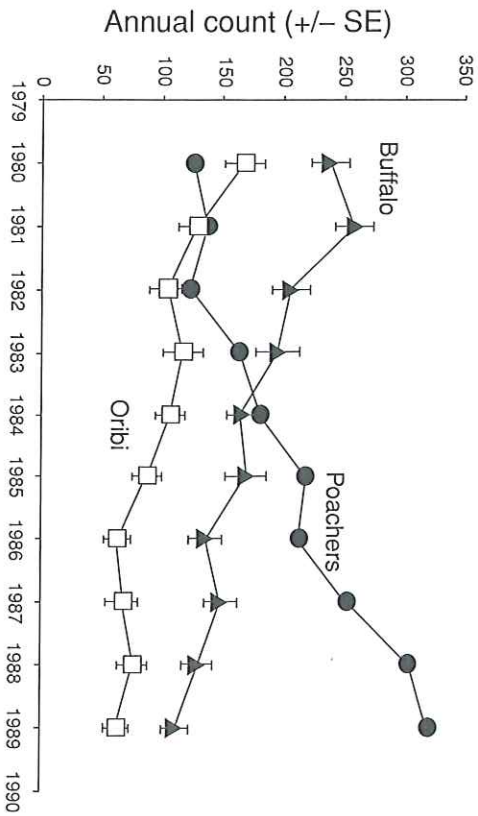

Figure 5.1. Annual counts of African buffalo (*Syncerus caffer*) (▲), oribi antelope (*Ourebia ourebi*) (□) and poachers (●) observed in Mole National Park, 1980–89, based on the locally based natural resource monitoring scheme in Ghana. Each point, except for poacher counts, represents the mean of monthly count totals ±SE. Poacher counts represent the sum of observations across months.

Figure 5.1 (Brashares and Arcese, 2002). Starting around 2001, monitoring efforts were modified and consolidated in a smaller number of defined areas within several of Ghana's parks (B. Volta-Tineh, personal communication). Field staff no longer were based at remote field camps but travelled to defined stations each month from a central park headquarters to conduct patrols and surveys. Today, wildlife data collected from field patrols are summarized in spreadsheets by park personnel and often are consulted by senior park officials when making decisions about focal areas for community outreach or allocation of patrol effort. Thus, these monitoring data are involved in the local decision-making process, and linked directly back to management at the local scale.

What was the outcome and why?

Prior to 1999, count data collected by the GWD were used only sparingly, in the formulation of annual summaries for each protected area, for example to produce species lists for a park or to ascertain whether a given species could be found in a certain region of Ghana. Surprisingly, the data were rarely used in formulating or evaluating management plans and initiatives, despite the value of the spatially explicit data.

Nor has ranger-based wildlife monitoring contributed to management decisions at a national scale. However, this is likely to change in the near future as the government of Ghana and external funding agencies look for ways to quantify the effectiveness of wildlife conservation initiatives. For example, the GWD has begun a programme to facilitate community-based management of wildlife in lands adjacent to protected areas, intended to provide communities with direct benefits from wildlife conservation while also creating habitat buffers around reserves. Measuring the effectiveness of these programmes for maintaining or enhancing wildlife in reserves requires monitoring data collected before, during and after community-based management is implemented. Thanks to its long-term wildlife monitoring efforts, Ghana has exactly those data.

Perhaps because of the more recent collaboration with an international research team, the use of GWD's monitoring data in the past five years has focused on global rather than local issues. The data were analysed to show long-term changes in wildlife abundance in relation to human demography (Brashares *et al.*, 2001). This research revealed for the first time that the density of humans around a protected area is a strong predictor of the rate of local extinction of wildlife within that area. In so doing, it suggested that understanding patterns of human demography may be a key first step in predicting future challenges for managing natural resources. Additional work using these count data showed that wildlife species differ greatly in their sensitivity to human disturbance (Brashares, 2003). Species requiring large areas of contiguous habitat were those most likely to be affected negatively by human development and activities around protected areas.

The long-term nature of the count data also provided a rare glimpse into the factors that affect human reliance on wildlife at a regional scale (Brashares *et al.*, 2004). By comparing changes in wildlife abundance and intensity of hunting across years of high and low fish supply, this research showed that rural people hunted and consumed more wildlife when alternative sources of animal protein were scarce. By identifying links between management of natural resources at such a large scale, this research emphasized the importance of considering the big picture in any conservation or management initiative. The monitoring programme in Ghana also provides a potentially powerful example for initiatives only now starting in other natural areas by illuminating the frequency and intensity of monitoring needed to accurately detect trends in animal populations (Brashares and Sam, 2005). Taken together, these more recent examinations of the monitoring data have inspired evaluation of international policies and conventions (e.g. the role of distant water fishing fleets in the decline of African fisheries), but they are yet to have a strong effect on natural resource management in Ghana.

Community-based monitoring of Philippine protected forests

What we did and why

Since 1996, protected area staff and community members have kept track of the wildlife and resource use in protected areas in the Philippines, where many people live and depend on protected area resources. Until the 1990s most protected areas in the country existed only on paper, but government was starting to question the effectiveness of the traditional top-down approach to protected area management. In 1992, the National Integrated Protected Area System Act (DENR, 1992) allowed for community participation in protected area management but was supported by little practical experience in how this could be achieved meaningfully.

In 1996–98, the Philippine Protected Areas and Wildlife Bureau (PAWB) of the Department of Environment and Natural Resources (DENR) developed a simple community- and ranger-based scheme for monitoring biodiversity and resource use in protected areas, with support from the World Bank and Danida, over three years. The process involved protected area staff, local non-governmental organizations and protected area communities. Rather than designing the 'ideal' monitoring scheme, it aimed to develop a feasible minimum starting point which could evolve over time as more resources and skilled people become available to manage and monitor biodiversity (Danielsen *et al.*, 2000). It intended to show, at the protected area level, whether or not management interventions in the area are effective in conserving biodiversity, and to enhance the participation of communities in protected area management. It focused on identifying trends in important biodiversity existence and use, to guide action in protected area management. The focus is at the field level, where most day-to-day management decisions are taken. Methods are kept simple and practical, to be easily integrated into other work activities and sustained with the locally available resources (Table 5.1).

The scheme was designed to build upon and strengthen existing community-based resource management systems. In many areas of the Philippines, traditional measures to oversee and manage natural resources still form an important part of the everyday regulation of local natural resource use. For instance, community leaders and 'ordinary' community members regularly discuss and

assess the availability and quality of particular natural resources, and thereby establish a collective overview of the status and trends of these resources. If they perceive a resource to be declining or threatened, they may impose regulations to limit use.

Data were collected by government rangers and volunteer community members. By allowing rangers to participate in field assessments, the scheme encouraged them into the field and improved their capacity for management. Four field methods were used. The *focus group discussion* method involved establishment of volunteer 'Community Monitoring Groups' who collected information on resource use and biodiversity on a regular basis between quarterly discussions with protected area staff. This method was intended to indicate changes in perceived harvest volume per unit effort. The *field diary* method comprised standardized recording of routine observations and records provided by local people of biodiversity and human use of wild flora and fauna by protected area staff in a simple pocketbook during patrols. This method was intended to indicate changes in the relative abundance of species and resource use. The *fixed point photography* method comprised on-the-ground fixed-point photographing of selected hillsides in priority forest blocks at regular intervals. This method was intended to indicate changes in size of vegetation type blocks and in land-use of priority areas. The *line-transect* method comprised line-transect surveys of wildlife and resource use along permanent routes. This method was intended to indicate changes in wildlife population size, human intensity of resource use, and/or shift in range of wildlife and human resource extraction. When the monitoring scheme was designed these four methods were selected because they were field-based, possible to use in areas where 'specialist staff' are lacking, and believed to be cost-effective (Danielsen *et al.*, 2000).

In each park, the monitoring focuses on a list of 10–15 taxa and 5–10 indicators of resource use, selected by local community members together with protected area staff. Data are collected every three months. The protected area staff and community members interpret the data together, and present a small report every quarter to the Management Council of each protected area (copied to PAWB at national level).

The report is structured so as to encourage park staff to both organize, analyse and interpret the data as well as to propose specific conservation management interventions. It includes the dataset, a list of important observations of 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 (Danielsen *et al.*, 2005b).

PAWB staff are supposed to regularly review the reports and provide feedback to the park staff, to keep errors at an acceptable level and assist the parks when local management interventions need back-up. It was also envisaged that the PAWB staff would extract data to prepare annual reports for the Secretary of the Environment. This work at national level, however, has suffered from under-funding and weak institutional support.

There are several reasons for the weak capacity of DENR. First, there is no programmatic approach in DENR to environment and natural resource management. Most priority setting is short term and politically or even individually driven, and shifts with the appointment of the departmental Secretaries. In recent years, the average terms of the Secretaries have been only one year. The rapidly shifting priorities have a serious impact on the follow-up and sustainability of longer-term efforts such as monitoring of natural resources. Second, the institutional structure of DENR and the roles and responsibilities of the staff are unclear and ambiguous. There is no single unit in charge of natural resource monitoring, and regularly staff supposed to be in the main responsible for the implementation of the Department's monitoring efforts are simultaneously assigned to perform a multitude of other tasks. Other key reasons include frequent re-assignments of trained staff, and lack of a results-oriented staff performance monitoring and incentive system.

What was the outcome and why?

Although direct project support ceased in 2001, the scheme continues in most sites where it was established, although efforts depend on staff availability and budgets. The government has made it mandatory for their staff to use the scheme as a management tool in protected areas (DENR, 2000) and, as a result, the scheme has spread to new sites. Some NGOs have on their own initiative begun using the scheme. There is, however, a need for further training of park staff 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.

The conservation management interventions arising from this scheme have been examined (Danielsen *et al.*, 2005b; Table 5.2). 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 two-and-a-half years of operation of the scheme by 97 rangers and 350 community volunteers, 156 interventions were undertaken in eight protected areas (Figure 5.2).

Table 5.2. *Examples of monitoring results and conservation management interventions resulting from the locally based natural resource monitoring scheme in the Philippines (Danielsen* et al., *2007)*

Monitoring method	Example of monitoring result	Conservation management intervention emanating from the monitoring result
Focus group discussion	A community monitoring group reported a decline in the abundance of marine fish in Basco Bay of Batanes Island (Batanes Protected Sea and Landscape).	The municipality of Basco issued an ordinance allowing fishing with hook and line but banning the use of nets and compressors in the bay. The abundance of fish in the bay reportedly increased after only seven months.
Field diary	Reports from local people of sightings of crocodile and the presence of crocodile hunters near San Mariano village (Northern Sierra Madre Natural Park).	The municipality of San Mariano issued an ordinance declaring the critically endangered Philippine crocodile *Crocodylus mindorensis* a municipal 'flagship species' and establishing penalties for violation of previous ordinances intended to protect this species.
Fixed-point photography	A new photo of a forested hill tract in the protected zone of the park showed that a swidden had been opened (Mt Kitanglad Range Natural Park).	Park staff showed the before and after photos to the head of the village. He obtained a promise from the violators not to extend the swidden without permission from the protected area management council.
Line-transect	Fewer records of giant clams (Tridacnidae) than before on the transect swim routes in the sustainable use zone (Apo Reef Natural Park).	The park staff raised awareness among local fishermen of the existing regulations on giant clam collection via the local radio and in person with fishermen when they requested permits to fish inside the park. In addition, staff requested assistance from a university on how to propagate the species and thus restock the wild population.

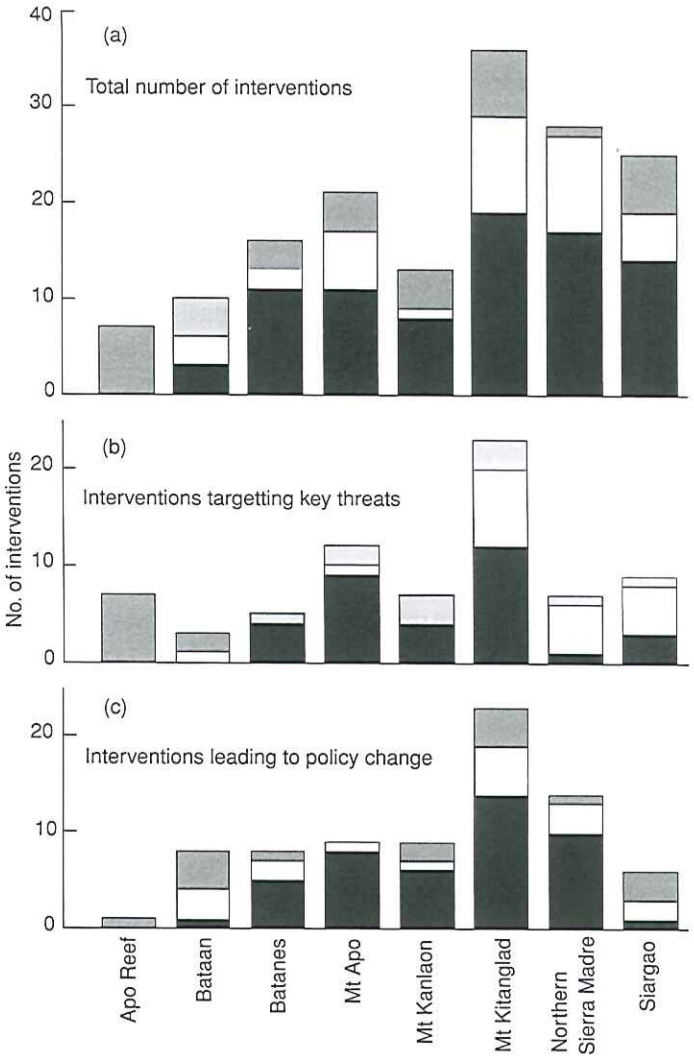

Figure 5.2. Conservation management interventions emanating from the Philippine locally based natural resource monitoring scheme and intended to improve the way local people (black), outsiders (white) and both (grey) manage resources in eight protected areas over two and a half years of operation of the scheme (a). The lower panels show the results if the analysis is restricted to those interventions that only target the three most serious threats to species populations and habitats at each site (b), and those interventions that led to policy change with a potential long-term impact on sustainable development (i.e. new resolutions or bylaws) (c).

To analyse the effectiveness of outcomes, we defined 'meaningful and justified interventions' as those with rational objectives, according to the socio-cultural, ecological and administrative contexts, and appropriate in terms of target, intensity, timing and extent (Danielsen *et al.*, 2005b). In total, 98% of these interventions were, or probably were, meaningful and justified, 47% targeted the three most serious threats to biodiversity at the site (see also Figure 5.2b), and 90% were implemented without external support, suggesting that the interventions were relevant and could be sustained over time at the local level. 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 management responses on the part of the authorities, including a more socially acceptable and effective approach to enforcement.

Community-based monitoring of village forests in Tanzania

What we did and why

Our third example is from Tanzania, where community members record resource extraction and disturbance in village woodlands and forests. Since the early 1990s, the Tanzania forest sector has been undergoing a radical process of decentralization and devolution. A number of donor-funded projects have experimented with different forms of community-based and joint forest management, and these approaches were enshrined in revisions to the forest policy and legislation in 1998 and 2002 (Blomley and Ramadhani, 2006). Currently, mainland Tanzania has one of the most progressive community forestry jurisdictions in Africa as reflected in policy, law and practice (Wily, 2000; Blomley, 2006).

As part of this trend, the Danish government supported a pilot project in Iringa Region between 1999 and 2004 to facilitate Participatory Forest Management in 23 villages, covering 140 000 hectares of highland, evergreen forests and lowland miombo woodlands. The management agreements provide user rights to local communities including rights to collect and spend revenue from sale of natural resources extraction permits. In turn, the Village Natural Resource Committees (VNRC) are the designated forest managers and must demonstrate an ability to manage forest lands to the benefit of their constituents (the community) and in a sustainable manner (to the District Forest Officer).

The project developed a participatory monitoring scheme which does this by feeding data upwards (to district forestry staff), downwards to the wider village community and laterally (to the members of the VNRC). The scheme is built on existing village government structures, and complies with the regulations and legal duties set out in local government and forestry legislations. The aim was to be simple and cost-effective, and empower community managers to more effectively manage their woodland and forest resources (Topp-Jørgensen *et al.*, 2005; Table 5.1).

As the responsible forest managers, the VNRC maintains records of forest patrols, income, expenditure, meetings and any problems encountered. These records are compiled into a monthly summary sheet and forwarded to the district authorities for review and, where necessary, action. They are also used during routine meetings of the VNRCs to inform discussions about management strategies, harvesting volumes, patrol and enforcement and revenue collection. Since the beginning of the scheme it has been important to ensure that information gathered at village level has direct use value for the forest managers themselves – rather than just generating data for higher-level stakeholders. This created local incentives to continue the monitoring system beyond the life of the project.

The government agency responsible for supervising forestry activities in Tanzania, the Forestry and Beekeeping Division, is currently establishing a national monitoring framework as part of the National Forest Programme, that will track national indicators related to forest extent, condition, revenues, harvesting volumes and products as well as the extent of community involvement and benefits arising from participatory forest management systems (United Republic of Tanzania, 2007). Development partners supporting the forest sector in Tanzania (Danida, Ministry of Foreign Affairs of Finland and the World Bank among others) have agreed to adandon project-specific indicators and to embrace these national indicators. Similarly, rather than constructing time-bound and donor-specific monitoring systems, they have agreed to harmonize these efforts by investing in a single, long-term monitoring system which is embedded in existing government institutions (such as the VNRCs, District Councils and the Forestry and Beekeeping Division) and tracking a commonly agreed set of indicators.

The design of this new system, the National Forestry and Beekeeping Database ('NAFOBEDA'), builds strongly on the community-based models described above. Data on forests under the management of community institutions are captured, stored and compiled at the village level by VNRCs and fed through a district platform to a national database (Akida, 2007). The system, which has recently been finalized following extensive pre-testing, will soon

be introduced to an initial 35 districts in the eastern and southern parts of the country through targeted training. District staff will in turn train VNRCs and other village council staff to ensure that data capture is standardized across all participating villages. Data generated at the national level will feed into policy processes such as annual ministerial budgets, annual joint donor reviews of the forestry sector, and higher-level systems tracking progress towards the goals of the Poverty Reduction Strategy (known in Tanzania as the National Strategy for Growth and Reduction of Poverty).

What was the outcome and why?

The community forestry monitoring scheme in Tanzania has operated since 2002 and continues despite the end of direct project support in 2004. Between November 2002 and June 2004, villages in the montane forest areas maintained an average rate of report returns, of 80%, while villages from lowland woodland sites maintained a slightly lower return rate (Topp-Jørgensen *et al.*, 2005). In total, 181 management interventions had been suggested as a result of monitoring and, of these, 131 had been tabled for discussions during routine meetings of the VNRCs (Figure 5.3). Of the 131 issues discussed by the VNRCs, 50% had been approved by the District Forest Officer and subsequently acted upon. Others have not yet been acted on, because they require a modification of the village forest management plan or joint forest management agreement. This process takes time and resources, and involves District staff, who have limited capacity to make changes rapidly.

Assessment of monitoring forms at Iringa District Forest Office in November 2006 showed a decrease compared with previous years (Poulsen *et al.*, 2007). Visits to nine villages, however, showed that they all continued monitoring efforts, albeit at a reduced level in some places.

Monitoring level is linked to incentives, and villages that obtain revenue to compensate local forest managers generally monitor more frequently. Although it has not been observed yet, this may have implications for long-term continuation of the scheme in montane forests where revenue is limited, as only harvest of non-timber products is permitted. Payment for other ecosystem services (e.g. water, biodiversity value, etc.) might be needed to ensure long-term monitoring in biodiversity rich areas with limited resource extraction potential.

Management interventions raised during routine monitoring at village level were analysed to assess whether they addressed 'scientifically identified threats', which in the miombo woodlands include over-harvesting of wood, and in the highland forests include fire and hunting (Figure 5.3b). Of the 23 villages, 21 had suggested management interventions that targeted the most

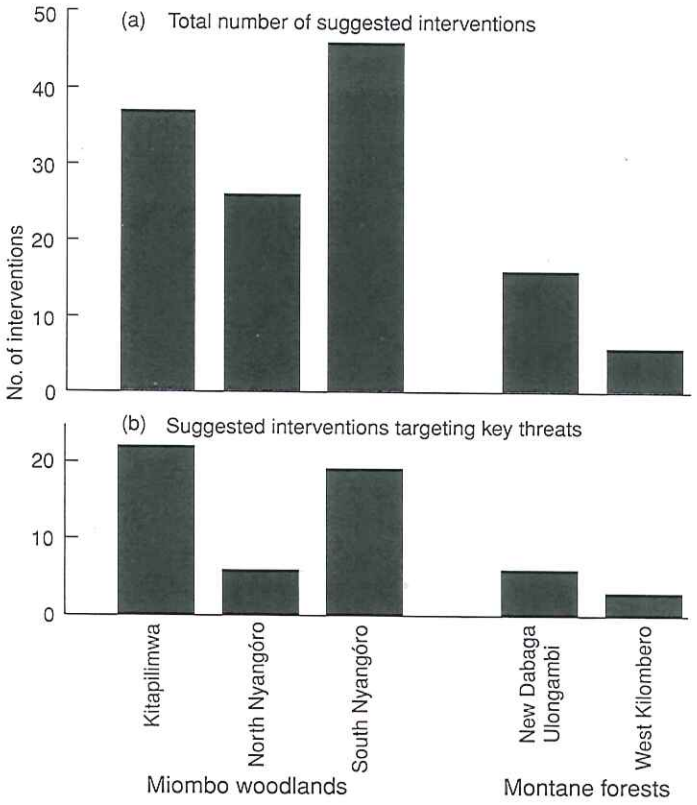

Figure 5.3. Suggested management interventions emanating from the locally based monitoring scheme in miombo woodland and montane forest areas of Tanzania after ten months of operation (a). The lower panel shows the conservation management interventions that only target the most serious threats to species populations and habitats in each area (b). The most serious threats were identified independently; they were wood extraction in the woodlands and hunting and fire in the montane forests.

important threats to their respective forests. Seventy-five percent of interventions targeting the most immediate threats had been implemented while most of the others were awaiting approval by district authorities.

A spin-off benefit from this local monitoring scheme has been its incorporation into the national forestry monitoring scheme described above. When fully operational, this will be the first time in Tanzania that data gathered, compiled and presented by village forest managers have been combined with data gathered by forestry professionals into a single national dataset.

Community-based monitoring of Namibian conservancies

What we did and why

Our final example is from Namibia, where community rangers record various aspects of their conservancy, ranging from wildlife numbers, through economic returns, to infringements of the rules. Namibian legislation provides for the establishment of 'conservancies'. Conservancies can be found in any type of habitat but often comprise large desert areas. Conservancies allow communities on communal land to benefit from wildlife in return for assuming responsibility for the sustainable management of natural resources.

One of the management tools required is a local-level monitoring scheme, to see if objectives are being reached, and to guide any corrective actions. During 2001–2003, and in response to requests for assistance from rural communities, scientists involved in Namibia's Community Based Natural Resource Management programme, with support from USAID, helped conservancies to develop a monitoring scheme known locally as the 'Event Book System'. This is designed to meet the information needs of the local community (Stuart-Hill *et al.*, 2005). Its fundamental principle is that the community decides what they want to monitor, and the technicians respond by facilitating the design (i.e. how to monitor). Conservancy employees collect and analyse the data, and are paid from funds generated locally through trophy hunting or tourism (Table 5.1).

To support the principle of local control, yet provide a rigorous methodology, the monitoring system has over time been modularized by topic, for example: problem animals, poaching, vegetation, predators, and fish. Thus conservancies adopting the system freely select what they want to monitor, and the technical support team then provides a complete kit of Event Book cards for each monitoring topic. No conservancy is ever forced to accept any module and they are free to design their own.

The Event Book is a personalized ring file maintained by each community ranger. The file contains a set of (yellow) cards, one card for each monitoring theme or topic. There is a card for poaching, a card for problem animal incidents, a card for rainfall and so on. As events occur, the ranger selects the appropriate card and records the event. At the end of the month a line is left blank, and the same card used for subsequent events in the ensuing months. At the end of the year, all of the old cards are removed, archived and a fresh set of cards inserted into the book.

It is essential that people collecting the data should also analyse and interpret them, even if the analysis is sub-optimal. This principle emerged through experience with conventional systems, where data sheets are handed over to external experts, resulting in a loss of ownership, so local people stopped collecting data. Data 'analysis' is simple. There are three types of reporting: monthly incident chart reports; annual reporting maps; and long-term trend-chart reports. On a monthly basis, all field rangers collectively complete the monthly (blue) reporting charts by colouring in boxes indicating the total number of incidents for the month (generally, one observation = one box). Incidents are recorded by hand onto the reporting map using different symbols to differentiate between types of incidents.

At the end of each year, the totals for the year are transferred onto the long-term trend (red) reporting charts. The essential difference between the 'blue' and 'red' cards is that the x-axis on the latter is years rather than months. Colour coding the different reporting timescales has proved to be important to avoid confusion by semi-literate community members.

The entire system is paper-based. All papers are filed in a specialized filing box, indispensable where conservancies often have no office. Such a simple, hard-copy based system is critical in remote environments where advanced computer technology is not realistically viable.

However, whilst primarily designed and managed to meet local information needs, the system also provides input to data analysis and decision-making at national level. Each year data are copied during an annual review of each conservancy and are captured within a national monitoring and evaluation database. This database belongs to the Ministry of Environment and Tourism and is used by the government and the Namibian Association of Conservancy Support Organizations to guide strategic decisions such as setting quotas, allocating technical support, and monitoring compliance.

Original raw data never leave the community. This is a key principle when data are extracted beyond the individual conservancy. The data are archived by the conservancy, and copied from paper into digital format for central storage and analysis, thereby allowing more sophisticated analysis by scientists. All data also have a spatial element and are used within a national GIS system for national map-based reporting and analysis.

What was the outcome and why?

More than 44 communal conservancies covering more than seven million hectares have adopted the Event Book System. In 2004 the Namibian Ministry of Environment and Tourism officially adopted the same approach for its national protected areas, and the scheme is also beginning to be used in neighbouring countries.

At the local level, a number of management decisions have arisen from the scheme. One of the most significant results is improved understanding and communication between community members. For example, communities have felt that lion *Panthera leo* represented the greatest threat to their livestock but the data have shown that hyaena *Hyaena* sp. and cheetah *Acinonyx jubatus* cause much more damage. This has influenced their strategies for dealing with problem animals, with the result that fewer livestock are lost to predators. Most of the conservancies use the data for setting sustainable wildlife harvesting quotas. One conservancy decided to move its crop lands away from a flood plain with the almost immediate result that crop damage incidents were reduced to a third of previous years. In a number of conservancies, declining population trends in certain species have prompted them to improve their patrolling activities.

At national level, the government and NGOs have used data from Event Books to inform decisions including:

allocation of regional wildlife harvest quotas of high value species (elephant);
design of problem animal compensation schemes;
compliance reporting of conservancies to government, e.g. showing that the annual harvest of various wildlife species is within sustainable limits;
displaying community commitment to conservation to satisfy private sector and donor investment;
allocation of technical and financial support to different communities;
contribution to a national State of Conservancies Report;
supporting Namibia and Botswana's case for limited trade in ivory at the meeting of the Convention on International Trade in Endangered Species (CITES) in 2002.

The potential for positive developments from locally based monitoring

A number of lessons have emerged from these four case studies, and other locally based monitoring schemes in developing countries. We summarize these below and offer some suggestions on what further research is required to fully evaluate the effectiveness of this strategy for monitoring natural resource values in developing countries. We base our structured overview of the key lessons on a recently proposed typology of monitoring, from conventional scientist-executed approaches through to those fully owned by local communities (Table 5.3).

Table 5.3. *Summary of different types of monitoring approaches (adapted from Danielsen* et al., *2009)*

Category	Main characteristics	Primary data gatherers	Primary data users
1. Externally driven professional-researcher executed monitoring	External monitoring undertaken by professional researchers. Accuracy and precision may be high, but link to local decisions and empowerment is weak	Professional researchers	Professional researchers
2. Externally driven monitoring with local volunteers or employees	Partly external monitoring that involves either paid staff or unpaid volunteers to collect the data. Analysis undertaken away from area of data collection	Professional researchers, volunteers, paid staff	Professional researchers
3. Collaborative monitoring with external data interpretation	Local stakeholders involved with collecting the monitoring data but data are then analysed elsewhere	Local people with professional researcher advice	Local people and professional researchers
4. Collaborative monitoring with local data interpretation	Local stakeholders involved with monitoring and data analysis, but design provided by outsiders	Local people with professional researcher advice	Local people
5. Autonomous local monitoring	All steps of the monitoring and design undertaken locally	Local people	Local people

In this typology, the ranger-based monitoring scheme in Ghana can be categorised as a category-2 'employee monitoring scheme' because the primary data gatherers are paid staff and the analysis of data is undertaken by scientists away from the area of data collection. The community-based monitoring schemes in the Philippines, Namibia and Tanzania can all be categorized as category-4 'collaborative monitoring schemes with local data interpretation' because the data gatherers are local people supported by advice from scientists, and the primary users of data are local people.

There is a great difference between these categories in terms of results and effectiveness. As participation progresses from category-2 to category-5 monitoring schemes, there is less control over who collects the data, and hence who is trained by outsiders and by how much. But as participation increases there is also an increase in local interest and relevance. Therefore, while one might expect an inverted relationship between accuracy and participation, this is not *necessarily* true, although this needs further research.

Here, we examine five factors that we consider important to making a monitoring scheme relevant and useful: costs, ability to detect trends, promptness of decision-making, potential for local empowerment, and ease of feeding into national and international schemes.

Cost to local stakeholders

Locally based monitoring incurs a significant cost to local people, although resources can also be provided by external agencies. Local time input in the cases described from the Philippines, Tanzania and Namibia varied from 0.01 to 0.20 person-hours per hectare per year (Table 5.1). Available data indicates a median time input of around 0.04 person-hours per hectare per year for locally based monitoring in eight developing countries (Danielsen *et al.*, 2005a). In fully locally based monitoring (with no external involvement) the costs may be considerable, especially when measured against the overall economy of the area. Costs and benefits to local communities therefore need to be considered in the design of local monitoring to ensure a fair workload in relation to local incentives.

Careful design may reduce costs to local stakeholders in locally based monitoring with external input, e.g. by locating monitoring sites in carefully selected but easily accessible areas. There is an abundant literature on how this might be achieved (e.g. Bibby *et al.*, 2000), but as the level of engagement by scientists declines, so does the potential to influence the design of the monitoring programme and thus minimize the costs while maximizing information quality.

Another cost is that of obtaining the relevant expertise to undertake the work. Often this is provided through training by outsiders, but in other cases it is internalized. The expertise required at local level can become considerable, especially where species that are difficult to identify need to be monitored.

Cost to others

As monitoring becomes increasingly locally based then the costs to others of implementation declines. The schemes in our four examples each had recurrent costs of USD 0.01–0.06 per hectare per year to the government and NGOs (Table 5.1). In the most locally based schemes (autonomous local schemes) there are no costs to external people as no external expertise is involved.

There are a variety of different requirements for external expertise during the establishment and training phase of a monitoring programme, as compared with the requirements during implementation. In locally based monitoring the engagement in day-to-day implementation declines and necessary skills relate more to participatory approaches and empowerment. For category-4 schemes there is a need to combine both science (e.g. from foresters and biologists) with social science (sociologists and anthropologists). Careful design might reduce the level of external skill required to instigate a locally based monitoring scheme and ensure it is sustainable.

Accuracy and precision

Local stakeholders typically favour monitoring schemes that are effective, in that the minimum amount of work provides the maximum benefit in terms of taking informed decisions. Accuracy is, however, important because it is necessary for the results to be as robust and defensible as possible.

Currently there is little literature on accuracy and precision within locally based monitoring schemes. An assessment of a locally based marine scheme in the Philippines found that out of four community-collected measures (of reef-benthic cover and fish abundance), only one was correlated with the equivalent data collected by professional biologists, with local stakeholders' measures of fish abundance being far more variable than those of professionals (Uychiaoco *et al.*, 2005). This indicates an urgent need for scientific comparisons of the accuracy and precision of locally based schemes.

Through careful training and sampling design, it should be possible for locally based monitoring to yield results which are as reliable as those of conventional techniques (Yoccoz, Nichols and Boulinier, 2003), and which can shed light on aspects of biodiversity which are hard to monitor conventionally.

To ensure this, it is necessary to consider likely biases at the design stage, to plan sampling effort to minimize their impact, and to train data gatherers and data interpreters accordingly.

Promptness of decision-making

Part of the reason for monitoring natural resources is to inform policy- and decision-makers and to facilitate management interventions. We looked for prior studies on the speed of decision-making in monitoring schemes but found little information. To our knowledge, only the scheme in the example from the Philippines has examined the speed with which conservation management decisions were taken by assessing the time from data sampling to decision-making for each of 156 conservation management interventions (Danielsen *et al.*, 2005b). The mean time from sampling to decision-making in this scheme was only 97 days, probably because most (82%) of the interventions were initiated by the same people and institutions that had compiled the underlying data, sidestepping multilayered bureaucracies.

To obtain the full benefit of rapid decision-making linked to locally based monitoring also requires a supportive policy and legal environment. If local stakeholders have no ownership or control over resources, their monitoring is unlikely to lead to prompt decision-making. Features such as corruption and hidden political agendas may constrain the speed and direction of local decision-making. Careful design may improve the speed of decision-making of all categories of schemes, and in particular, each scheme needs a mechanism for feeding results from the monitoring directly into management.

Potential for local empowerment

Monitoring alone does not empower people, but locally based monitoring can be integrated with processes of local empowerment in natural resource management. This includes the application and generation of local knowledge, and greater influence on and involvement in management decisions. Locally based monitoring should be coupled to local stakeholder's rights and responsibilities, which can be set up by appropriate negotiated agreements. This also helps ensure real local interest in local monitoring.

Few quantitative data exist on the empowerment potential of monitoring schemes. In the scheme in the Philippines, one in three conservation management interventions was jointly undertaken by local community members and government authorities (F. Danielsen, unpublished data). In the Tanzanian scheme, 50% of suggested management interventions were implemented by the communities themselves (Topp-Jørgensen *et al.*, 2005). Overall, the potential for local empowerment rises with the involvement of local stakeholders in monitoring.

Ease of feeding into national and international schemes

The ability of monitoring schemes to contribute data to national and global schemes probably declines as they become more local. Data from locally based monitoring are beginning to be aggregated for national-level analysis in the examples in the Philippines, Tanzania and Namibia. These initiatives, although promising, are still in their infancy. If well done, they can bring government and communities together in a new way, improve co-ordination and decision-making, clarify roles in broader natural resource management, and raise the profile of Community Based Natural Resource Management efforts among policy-makers and scientists, as datasets are aggregated and presented in wider fora.

Analytical tools such as meta-analysis (Gurevitch, Curtis and Jones, 2001) offer substantial opportunities for analysing data from locally based sources, to provide input into tracking larger-scale trends in the status of populations and habitats (e.g. Loh *et al.*, 2005), the services they provide, and the threats they face. To do this, schemes need to use a small number of methods, each well replicated, across a large number of sites (e.g. Côté *et al.*, 2005).

Research needs

Our study shows the need for rigorous comparisons between locally based and conventional scientist-based monitoring methods. Since the conference on locally based monitoring in Denmark in 2004, a new project has been funded by the Danish Government – 'Monitoring Matters: Comparative Analysis of Innovative Approaches' (MOMA). This project is working in six countries – Ghana, Madagascar, Namibia, Nicaragua, Tanzania and the Philippines (Danielsen *et al.*, 2005c). The aim of the project is to answer some of the basic scientific questions about the importance of locally based monitoring, particularly whether locally based monitoring is able to detect changes in the abundance, distribution and utilization of resources, and whether this approach is an effective resource management tool, when compared with conventional methods.

It would, however, be a mistake to see this approach as an untested pipe dream. Locally based monitoring is already underway, and methods are being further improved. We believe the approach holds promise, but it requires rigorous testing to determine whether local people are best able to monitor changes

in habitat, large animal abundances, cryptic species changes, or changes in ecosystem services. Already some important lessons have emerged from the case studies we highlight in this chapter and we expect more as the schemes mature and ways are found to embed them at the local level and within the systems of governments in developing countries.

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