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Hunter self-monitoring by the Isoseño-Guaraní in the Bolivian Chaco

ANDREW J. NOSS*, IMKE OETTING and ROSA LENY CUÉLLAR
*Wildlife Conservation Society-Bolivia, Casilla 6272 Santa Cruz, Bolivia; *Author for correspondence (e-mail: anoss@wcs.org; fax: +591-3-332-8681)*

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Abstract. Declared in 1995, the 34,400 km^2 Kaa-Iya del Gran Chaco National Park is the first protected area in South America co-managed by an indigenous organization, the Capitanía del Alto y Bajo Isoso (CABI). In 1997, based on historical occupation by the Isoseño-Guaraní over the past 300 years, CABI formally demanded a 19,000 km^2 'Tierra Comunitaria de Orígen' (TCO) that adjoins, but does not overlap, the national park. The creation of TCOs and the co-administration of protected areas are elements of decentralization processes in Bolivia, whereby the management of land and natural resources is devolving to departmental and municipal levels of government. This paper examines biodiversity monitoring in the context of a community wildlife management program developed with CABI. Hunter self-monitoring (100–150 hunters per month) combined with monthly activity records for potential hunters (7637 observed hunter-months) permit estimations of total offtakes of subsistence game species for 1996–2003, as well as catch-per-unit-effort over the same time period. These data show considerable fluctuations from year to year and no declining trends that would suggest over-hunting. Monitoring populations of multiple game species can be relatively expensive, even with the voluntary support of hunters, considering data collection and analysis, as well as presentation and discussion through community meetings. At the same time, monitoring does not provide highly accurate assessments of short-term changes in wildlife resources. However, relatively simple participatory methods are important for generating information on long-term trends and for creating a context for community discussion of formal wildlife management.

Abbreviations: CABI – Capitanía de Alto y Bajo Isoso; KINP – Kaa-Iya del Gran Chaco National Park; TCO – Tierra Comunitaria de Orígen (Indigenous communal land)

Introduction

Conservation organizations, donors, and field practitioners are increasingly concerned with demonstrating returns on investment, especially benefits in terms of biodiversity conservation resulting from activities and interventions. Monitoring and adaptive management are mechanisms that allow us to do so (Kremen et al. 1994; Margoluis and Salafsky 1998; Salafsky et al. 2001, 2002; Hill et al. 2003; Royal Society 2003). An important body of monitoring literature focuses on the sustainability of hunting, evaluating changes in wildlife populations over time, changes in wildlife utilization, or both (Robinson and Redford 1994; Robinson and Bennett 2000). Numerous studies also focus on community wildlife management as the principal means for ensuring long-term conservation where local and/or indigenous communities have legal or *de facto* control over wildlife resources in and around protected areas (Western and Wright 1994; Campos et al. 1996; Redford and Mansour 1996; Hulme and Murphree 1999; Campos-Rozo and Ulloa 2003). Our question in this context is how simple and inexpensive methods for monitoring biodiversity and its utilization can be developed with community and indigenous partners (Danielsen et al. 2000; Tawake et al. 2001).

Study area

The Gran Chaco is one of South America's most extensive bio-geographical areas, covering a million square kilometers, and is characterized by diverse ecosystems that include palm savannas and marshes, semi-arid thorn forests, and open grasslands on sand dunes. The Chaco landscape contains high levels of biological diversity, particularly mammals, with at least 10 endemic mammal taxa, most notably the Chacoan guanaco (*Lama guanicoe voglii*) and the Chacoan peccary (*Catagonus wagneri*) (Ibisch and Mérida 2003). In order to protect the Gran Chaco's natural resources and their traditional use areas within it, the Isoseño-Guaraní proposed the creation of the Kaa-Iya del Gran Chaco National Park (KINP). Declared in 1995, this national park is the largest dry forest protected area in the world, covering 34,400 km^2 of south-eastern Bolivia, and is also the first protected area in South America created as the initiative of, and co-managed by, an indigenous organization. This organization, the Capitanía del Alto y Bajo Isoso (CABI), is the political authority representing the 10,000 Isoseño-Guaraní inhabitants of the Isoso. Isoseño livelihoods are based on agriculture, livestock, hunting, fishing, permanent, and seasonal wage labor. Prior to the creation of the KINP, most of the 23 Isoso communities had legal titles of their lands as community lands, summing a mere 650 km^2, encompassing settlements, farming, and livestock lands. In 1997, based on their historical occupation of the area over the past 300 years, CABI formally demanded 19,000 km^2 as a 'Tierra Comunitaria de Orígen' or TCO adjacent to, but not overlapping, the KINP (Figure 1). At that time and according to participatory appraisals and mapping, hunting took place in a 4000 km^2 area outside the KINP, but inside the present TCO Isoso demand, extending from community owned lands onto neighboring fiscal lands and private ranch properties.

The creation of TCOs and the co-administration of protected areas are elements of decentralization processes in Bolivia, whereby the management of land and natural resources is devolving to departmental and municipal levels of government, offering an opportunity to recognize indigenous administrative and territorially explicit districts. Under the conditions of the land reform,

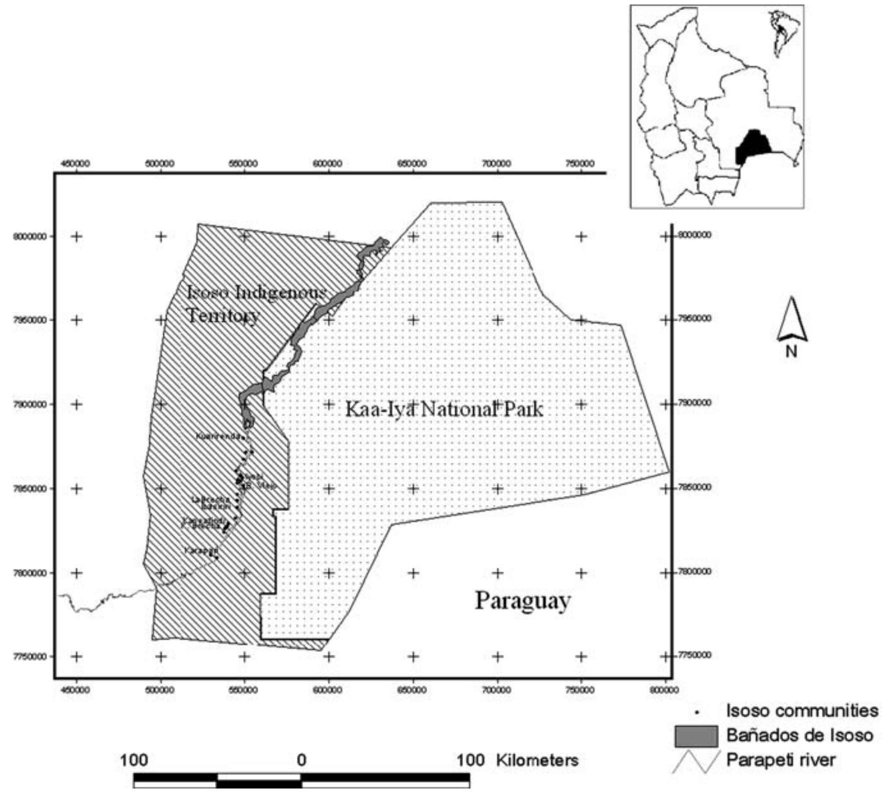

Figure 1. Map of study area in Gran Chaco, Bolivia.

newly titled communal (as well as private) lands must present land and resource management plans to the government to justify and guide their occupation of the land. The management of the TCO, once it is titled as communal land to the Isoseños, will thus require active and formal management of land and resources on a scale far beyond their experience. Principal threats to both the TCO and KINP include third party settlements and inappropriate management of land and natural resources with the conversion of Chaco forests to soybean farms and extensive cattle ranches (overstocking, no management of forage, minimal veterinary care), sport hunting by city-based hunters, and large-scale regional infrastructure programs that include international gas pipelines and highways.

Traditionally, like other indigenous groups in Latin America, the Isoseño-Guaraní believe that the 'kaa-iya' (spirit guardians) care for wildlife. Extinction does not occur, and if animals disappear from an area it is a temporary phenomenon resulting from the kaa-iya withholding animals from hunters or moving the game elsewhere (Riester 1984; Combès et al. 1998). In the Isoseño case, the hunter must follow certain rules in order to retain the favor of the kaa-iya and at the same time avoid punishment (fruitless hunting, injury, disorientation, death):

- do not hunt young animals;
- do not hunt excessively or beyond the needs of one's family;
- do no mistreat animals by wounding them and allowing them to escape;
- do not make excessive noise (according to some this would preclude dogs and firearms).

Additional local practices that favor wildlife conservation include: (1) seasonal rotation of hunting areas that respond to seasonal movements of animals according to availability of food, as well as the accessibility of different areas due to high waters in rivers and seasonally flooded forest; (2) no hunting of certain vulnerable species (primates, guanacos); and (3) the substitution of other activities to hunting in particular seasons (fishing, farming, labor migration).

Seeking to integrate these traditional beliefs and local knowledge of wildlife with political/administrative requirements and scientific management, in 1996 a joint team of Wildlife Conservation Society and CABI personnel initiated a wildlife and hunting monitoring program in the 23 Isoseño communities. Our principal objectives were to: (1) determine whether subsistence (armadillos, peccaries, brocket deer, tapir) and commercial (parrots, tegu lizards) hunting by Isoseño communities is sustainable; (2) generate management recommendations to ensure that hunting would be sustainable in the Isoseño indigenous territory, thereby reducing potential pressure on the KINP; and (3) consolidate the concepts and practices of wildlife management together with hunters and communities (Painter and Noss 2000).

Methods

Our principal method to estimate hunting offtakes is an on-going hunter self-monitoring program with voluntary participation: hunters carry data sheets with them on hunting excursions to record information on the hunt and on any captured animals, and they collect specimens (skulls/jawbones, stomach contents, fetuses) of hunted animals. Community hunting monitors assist the hunters in recording data, collect and analyze the data and specimens for the entire community on a monthly basis, and summarize the data every 6–12 months (Noss et al. 2003, 2004). Hunters also participate in community meetings where the results of the monitoring program are presented and community wildlife management traditions and proposed new measures are discussed (see Noss and Cuéllar 2001). Photocopied data sheets, pens, tape measures, and spring scales are the inputs for hunter self-monitoring: all are available locally and hunters are both numerate and literate and familiar with their use. Monitors also register monthly activities for all potential hunters in the communities to estimate the proportion of active hunters participating in the self-monitoring program, in order to detail who hunts and registers, who hunts and does not register and who does not hunt (Noss et al. 2003). Finally, we extrapolate total hunting offtakes from reported offtakes and the proportion of potential hunters reporting the data to obtain an estimate for the whole Isoso, since not all hunters report their data (Noss 2000).

Secondly, we tested a number of methods to monitor game populations directly, focusing in particular on the nine principal game species (four ungulates and five armadillos) using line transect surveys (Ayala and Noss 2000), drive counts (Noss et al. in press), track counts (Noss and Cuéllar 2000), and surveys with trained dogs (Cuéllar 2002). Community monitors conducted 5 km line transect surveys twice a month, walking 1 km per hour. In the same transects, they register observed tracks in track plots (2×1 m, every 200 m), and then analyze and summarize the information themselves or with the help of a biologist, and periodically present it to the communities.

Hunters provide basic data and specimens that can be used by project biologists to determine total hunting area, reproductive patterns, and age structure of hunted populations (see Noss et al. 2003). Community monitors map and determine hunting areas manually, but also use hand-held GPS receivers to record hunting locations for more sophisticated analyses by project biologists. University students analyze reproduction and age structure of hunted animals for thesis projects. Combining all these sources, together with additional complementary radio-telemetry research to independently estimate population densities, we therefore compile much of the information from the study area required to apply the Robinson and Redford (1991) models and evaluate the sustainability of hunting.

A simpler way to evaluate sustainability focuses on catch-per-unit-effort, based on hunter information alone without the independent estimates of wildlife populations. Changes in catch-per-unit-effort are assumed to indicate whether a species is overhunted or not (Vickers 1991; Puertas 1999). Game densities are probably not decreasing if long-term harvest or return rates per hunter day are not declining (Hill et al. 2003). Project biologists estimate catch-per-unit-effort (for all hunters and all communities) by comparing total hunter-months recorded in the monthly activity records with total reported game offtakes (by species). This number of captures by species per 100 hunter-months suggests long-term patterns in hunted wildlife populations across years.

Finally, we support periodic community meetings in order to present and review data on hunting patterns/offtakes and wildlife populations, as well as to propose and analyze management recommendations. With initial facilitation by outside technical assistants, these meetings are now generally led by Isoseño parabiologists and/or monitors and community authorities who then deal directly with the respective government authorities, and discussions are motivated to promote decision-making on management of certain species. CABI's bi-annual General Assembly meetings also provide a formal context for collective decision-making for the entire Isoso (Noss and Cuéllar 2001).

In all of these activities, voluntary participation of Isoseño hunters is the key to data generation, discussion, and corresponding management action. According to hunters themselves and Isoseño technicians hired by the program, hunters participate for a combination of personal and community motivations: pride in traditional activities, support for a community undertaking backed by neighbors and authorities, and expectations of benefits to the indigenous territory. The communities proposed Isoseño parabiologists and hunting monitors, the majority with an elementary and some with high school education. Following an initial 6-month volunteer period, those who expressed the most interest and initiative were hired by the program. Monitors (7–10 individuals each living and working in their home community) are hunters hired part-time to support the recording of hunting data in communities (by encouraging hunters to participate in the self-monitoring program, and by periodically collecting information from hunters in their community). Parabiologists (6–8 individuals working in their home community or other research sites in the Isoso) are hired full-time to support wildlife research according to their individual specialization. Through field courses and practical experience, these Isoseño technicians are assuming responsibility for designing and implementing research programs with hunters.

Results

An earlier published evaluation based on 1996–2000 data, using Robinson and Redford's (1991) model that compares absolute offtakes with productivity within a given area, suggested that subsistence hunting was sustainable for most principal game species. Exceptions were tapir, white-lipped peccary, and possibly three-banded armadillo (Noss 2000). A simpler longitudinal analysis of estimated total offtakes (Figure 2) and catch-per-unit-effort (Figure 3) indicates considerable variation from year to year for the nine most important game species, but no patterns of general decline that would suggest overhunting. The absolute figures are not important, as this analysis focuses on long-term trends where a steady decline in offtakes or catch-per-unit effort would suggest overhunting. We excluded 1996, 1997 and 2002 because observed totals represented less than 20% of potential hunter-months or estimated total hunting in the Isoso (resulting from relatively few hunters registering information), and because extrapolations varied by an order of magnitude or more from estimations for other years. We assume that small sample size of participating hunters distorts extrapolations, with impossibly high tapir offtakes for example.

At present, 11 of the 23 Isoseño communities are involved in hunting monitoring and receive assistance in data collection and analysis from hunting monitors or parabiologists. At the individual Isoseño community level, data

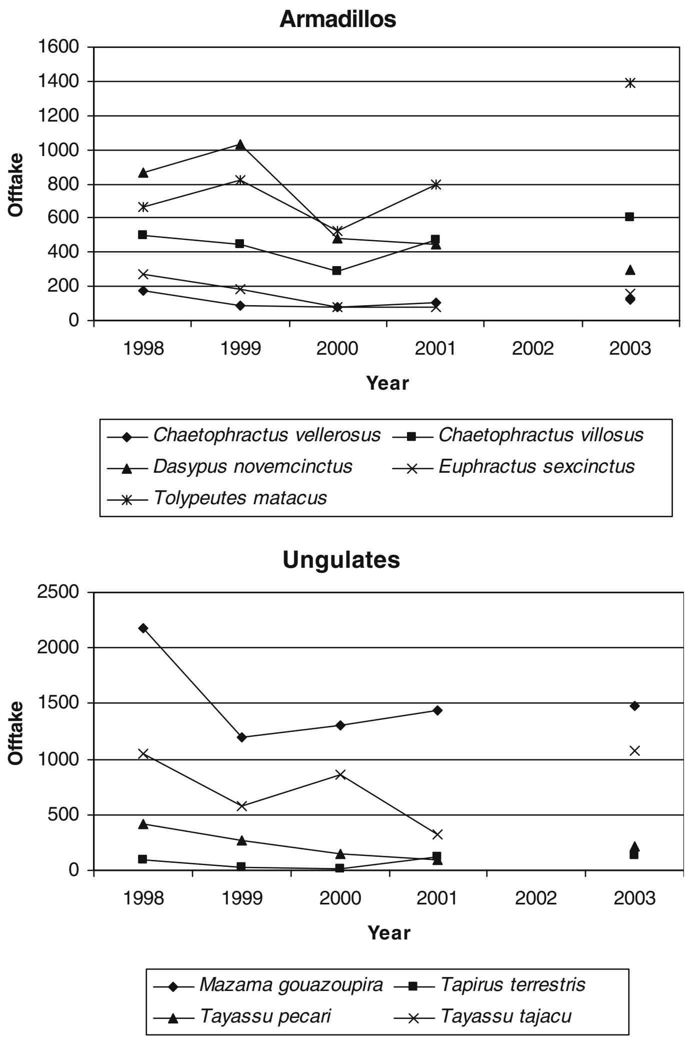

Figure 2. Total estimated offtakes of nine species of armadillos and ungulates by year and by species (excluding years where less than 20 potential hunter-months were recorded, see text), based on hunter self-monitoring.

present considerable variation in number of animals by species hunted from year to year; Tables 1 and 2 present data for the two game species most vulnerable to hunting pressure. Though the mosaic of habitat types is similar for all Isoseño communities, few tapirs are hunted in the west or center of the Isoso, while the greatest number of records come from the northernmost (Kuarirenda), southernmost (Isiporenda and Karaparí), and easternmost communities (Iyobi and Rancho Viejo). But even in these communities, zero tapirs may be recorded in a given year, and more than 10 in another (1/3 the

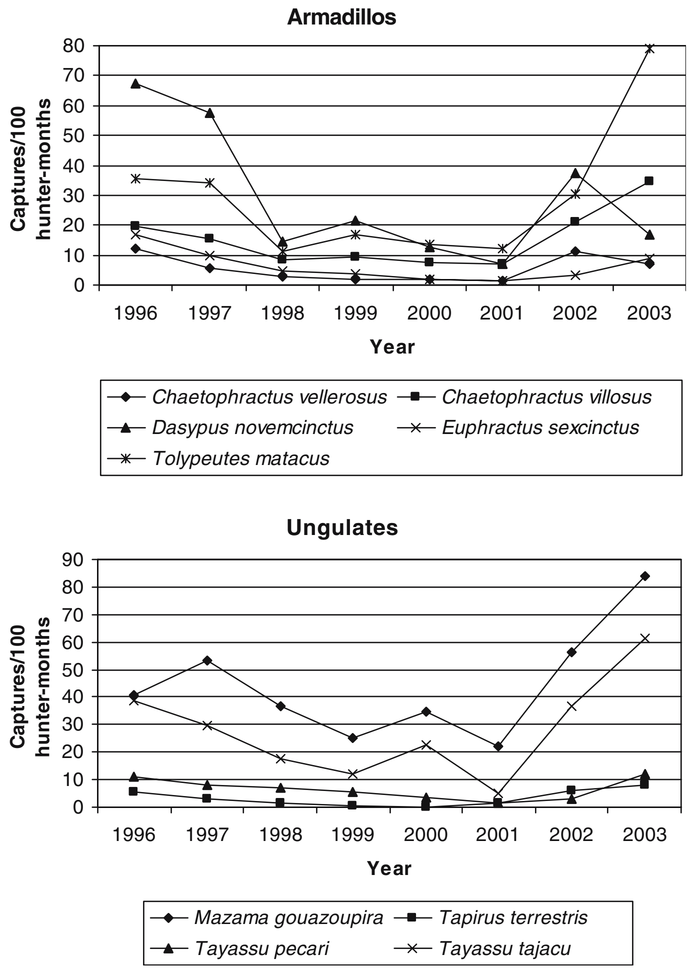

Figure 3. Catch-per-unit-effort of nine species of armadillos and ungulates by year and by species, based on hunter self-monitoring (individuals per 100 hunter-months, $n = 7637$ observed hunter-months). Observed hunter-months are months for which monitors recorded a potential hunter as being active and participating in the self-monitoring program.

Table 1. Annual records of Tapir *Tapirus terrestris* hunted by Isoseño community, based on hunter self-monitoring.

	1996	1997	1998	1999	2000	2001	2002	2003
Iyobi	0	2	1	1	0	3	4	16
Rancho Viejo	0	0	2	1	1	4	10	1
Isiporenda	4	7	13	1	0	0	3	4
Karaparí	0	5	0	1	0	0	2	1
Kuarirenda	0	0	4	6	0	0	3	8

Table 2. Annual records of White-lipped Peccary *Tayassu pecari* hunted by Isoseño community, based on hunter self-monitoring.

	1996	1997	1998	1999	2000	2001	2002	2003
Iyobi	2	1	5	2	0	0	8	2
Rancho Viejo	0	0	0	1	2	3	0	1
Isiporenda	3	8	3	0	2	0	3	1
Karaparí	5	4	5	11	2	5	0	3
Kuarirenda	13	10	49	56	28	0	0	33
Kopere Brecha	0	0	14	2	0	0	0	2
Ibasiriri	4	5	0	5	0	2	0	2

total number of tapirs recorded for the entire Isoso in any given year). Likewise, communities may not register a single white-lipped peccary the entire year, but then capture over a dozen when a herd of peccaries comes through the community itself (as occurred in Kopere Brecha during 1998).

Discussion

Monitoring methods

A number of factors could explain the high variation in catch-per-unit-effort of tapir and white-lipped peccary captures from year to year, complicating the evaluation of whether hunting is sustainable or not (whether biodiversity is being conserved or depleted). Several factors are independent of the methods used: activity patterns of Isoseño community members, rainfall, forest cover and land use, livestock pressure, wildlife dispersal from neighboring source areas such as the KINP, natural variation in wildlife populations, etc. (Pulliam 1988; Hill et al. 2003). Other factors are related to the methods themselves: the accuracy of hunting and activity records (despite efforts with hunters to complete data records), and the proportion of potential hunters recording data (8–35%, depending on the number of hunting monitors employed to support the recording of information). For example, species hunted for market (parrots, songbirds, tegu lizards *Tupinambis rufescens*), and unsuccessful hunts, are under-reported by hunters (Noss et al. 2004).

Monitoring game populations is particularly difficult in the Chaco given the variety and characteristics of the nine game species and the dense, thorny vegetation. We have found that line transect surveys do not work for the most abundant game species such as brocket deer and armadillos, because they are small, solitary and cryptic. Population densities of white lipped peccaries and tapir are extremely low, requiring several thousand kilometers of surveys to produce sufficient observations, making the effort prohibitive in terms of cost and labor (Ayala and Noss 2000). Drive counts provide density estimates for only the most abundant ungulate, the grey brocket deer (Noss et al. in press).

Track counts provide data on relative abundance, but not on population density. Surveys with trained dogs, which depend on encountering recent (less than 2 h old) tracks of armadillos where they have crossed hunting roads or trails (Cuéllar 2002), appear to underestimate population densities.

Costs of monitoring

As described above, we have emphasized low-tech though labor-intensive methodologies for monitoring wildlife and its utilization in the Isoso. Data analysis and extended rounds of community discussions imply significant time inputs from project biologists and Isoseño technicians. A round of community meetings in each of the 23 Isoso communities requires nearly a month to complete. Resources dedicated to the program by CABI and Wildlife Conservation Society over several years include part-time salaries for 10 community wildlife monitors ($150/month each), full-time salaries for six parabiologists ($250/month each), one full-time biologist ($1000/month), fuel/maintenance/food ($1000/month), materials and supplies ($500/month). The total of over $50,000 per year (which includes time and resources spent on training local technicians) roughly matches expenditures on wildlife research alone, though disaggregation is difficult because most personnel and field activities simultaneously supported both hunting monitoring and wildlife research.

The national government does provide resources for operating expenses of the neighboring Kaa-Iya National Park (approximately 140.000 USD spent in 2003 from GEF II (Global Environment Facility), the Inter-American Development Bank, and the Foundation for the Development of the National System of Protected Areas, FUNDESNAP). In addition, CABI receives government funds under the Popular Participation Law for infrastructure programs in the indigenous territory, but no government resources are directly available for biodiversity monitoring or management activities in the Isoso. CABI is gradually assuming some of the operating and personnel costs of the program through resources generated from private sources – negotiations with gas pipeline companies operating in the Isoso or Kaa-Iya National Park (Painter et al. 2003; Winer 2003). At the same time, Wildlife Conservation Society maintains a long-term commitment to accompany and support CABI – financially as well as technically in designing monitoring methods and analyzing data – in order to promote biodiversity conservation through sustainable resource use in the Isoso TCO. Programs elsewhere will require similar subsidies, because only in few cases such as in Namibia and miombo woodlands of Tanzania (Stuart-Hill et al. 2005; Topp-Jørgensen et al. 2005 (this issue)) can wildlife utilization generate sufficient surplus resources to finance management activities. Should external funding disappear, CABI would be forced to rely entirely on voluntary monitoring at the community level supported by the local technicians trained to date, with long-term trends in catch-per-unit effort the most useful data on wildlife resources and their utilization in the Isoso.

Monitoring and adaptive management

Our experience in the Isoso TCO matches the somewhat contradictory positions expressed in the literature. On the one hand, simple approaches such as hunter self-monitoring or line transect surveys require considerable effort by both project staff and volunteers in order to provide sufficient or appropriate information for management interventions in favor of biodiversity conservation. Facing a large number of species and/or large study areas, as is the case in the Isoso, with only basic tools and non-professional personnel, it is even more difficult to get precise and detailed population density estimates (Karanth and Nichols 2002). Ideally, adaptive management would include continuous population monitoring over long time periods using selected indicator species assemblages, detailed studies of ecological principles and processes, and studies of population trends in sink and source areas (Kremen et al. 1994; Hill et al. 2003). Such detailed monitoring is prohibitively complex and expensive for most indigenous peoples within territories under their jurisdiction, and for most protected areas as well. On the other hand, even costly (in terms of finances as well as time) and sophisticated biological approaches may not provide appropriate or satisfactory information. Presence–absence and line transect surveys may not detect population declines less than 30–50% (Strayer 1999; Plumptre 2000; see also Brashares and Sam 2005; Hockley et al. 2005 (this issue)).

Instead, we consider adaptive management in a broader context focusing on informed decision-making. Communal decision-making is the key, participatory methods provide the inputs and framework for discussion, and detailed scientific information with sophisticated analyses may not be essential, as long as we utilize information with which resource managers and assistants are familiar and confident (see also Danielsen et al. 2005 (this issue)). Hunter self-monitoring provides a means to engage large numbers of community members in data collection. Simultaneously, as community members – hunters themselves, and community monitors who analyze and present the information – generate the data on hunting practices and game species, the data bear greater weight and value in community discussions. Outside experts are not blamed for inventing or misrepresenting information, and if community members do not trust or accept the data or conclusions presented, additional or complementary information gathering can be organized together in order to provide a more solid ground on which to base decision making. By generating data, people become conscious of underlying problems, for example perceived or actual over-hunting of a certain species. In turn, reflection processes can lead to preliminary management action that can be consolidated in an adaptive management process.

Approaches that integrate internal traditional and external scientific knowledge and methods, and that integrate community members with specialists, can move conservation forward (Tawake et al. 2001; Becker et al. 2005; Townsend et al. 2005 (this issue)). In the Isoso case, this integration takes place at several levels. At a first level, community members indicate through discussions the most important game species and describe hunting practices and traditions regarding wildlife management. Through hunter self-monitoring and observation of hunting activities, hunters themselves and trained community members (parabiologists and monitors) confirm and quantify what hunters do in practice. Community meetings serve multiple purposes: to present and discuss information generated by community members, to elicit wildlife management recommendations (either traditional practices or new ideas), and to explain and discuss the formal legislative requirements for wildlife management in the newly created indigenous territory. Next, CABI authorities must consolidate elements currently being developed (vegetation mapping, infrastructure, hydrology, wildlife use, etc.) into a formal management plan for the indigenous territory, including mechanisms for its implementation and continued monitoring of both wildlife resources and their utilization, and negotiate its approval both by the communities themselves and by the government. Wildlife management plans for different communities under hunting monitoring initiatives are a crucial element towards management measures at the TCO level. This iterative and participatory process, demonstrated in the Kaa-Iya National Park management plan presented in 1999 and approved in 2000 (published as Kaa-Iya Project 2001), and subsequently implemented by CABI with the national park service SERNAP, assures the translation of Isoseño traditions and priorities into viable formal instruments that are acceptable to regional and national government authorities. Success in the case of CABI, or other indigenous groups following CABI's experience, is predicated upon a strong traditional authority structure and community organization, a favorable legal/institutional framework, the ability of government authorities to comply with their responsibilities, and financial and technical support from private partners to the process.

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