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An Evaluation of Hunter Self-Monitoring in the Bolivian Chaco

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Community wildlife management is being tested across the tropics as a means of promoting the conservation and sustainable use of wildlife resources. Key to successful programs is the effective participation of local hunters and communities in monitoring, planning, decision-making and implementation. We evaluate one method to achieve this participation, namely hunter self-monitoring. Between 1997 and 2000, Izoceño hunters from 22 communities in the Bolivian Chaco have voluntarily participated in monitoring their hunting activities, measuring and recording data on captured animals and hunting methods in personal notebooks. Despite the lack of remuneration, participation exceeds 60% of active hunters. However, the written information and specimens provided are not complete, and are biased according to hunting methods and prey characteristics. Complementary research is essential to answer specific research questions. Nevertheless, hunter self-monitoring serves to raise awareness of wildlife management issues at the communal or indigenous territory level, as evidenced by preliminary actions taken by hunters and communities in the Izozog.

KEY WORDS: hunting; community wildlife management; Bolivia; Chaco; Izoceño-Guaraní.

INTRODUCTION

The future of wildlife in the tropics depends not only on conservation in protected areas, but also on sustainable utilization outside protected areas, for example by rural and indigenous populations (Robinson and Bennett, 2000). Traditional beliefs and customs in some senses provide

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management systems that may favor sustainable utilization for wildlife within traditional use areas (Bennett and Robinson, 2000; Redford and Mansour, 1996). But two factors are driving more comprehensive and intensive management of wildlife by indigenous groups in Latin America: first, increasing pressures on wildlife resources (population growth, access to markets, technologies, habitat conversion fragmentation); and second, the devolution of land and resource tenure rights to indigenous groups under formal legal conditions.

Community wildlife management would appear to be one way in which active scientific management can be reconciled with traditional beliefs and customs (Campos *et al.*, 1996; Ortíz and Mazzuchelli, 1997; Robinson and Bennett, 2000; Western and Wright, 1994a). The nature of community wildlife management programs varies considerably across regions, countries and continents. However a fundamental element is the participation of local hunters in monitoring, planning, decision-making, and implementation (Barrow *et al.*, 1993; Hackel, 1999; Little, 1994; Western and Wright, 1994b).

How can local hunters most effectively participate in community wildlife management? One answer is through self-monitoring (Bodmer and Puertas, 2000; Fitzgibbon *et al.*, 2000; Marks, 1994, 1996; Robinson and Bennett, 2000; Siren *et al.*, 2000). Hunter self-monitoring addresses the following objectives: (1) to identify principal wildlife resources and quantify offtakes (R. L. Cuéllar, 2000b; Noss, 2000), (2) to produce biological data as a basis for managing exploited species (see Cuéllar and Noss, 2002; Cuéllar *et al.*, 2002; Noss *et al.*, 2003), and (3) to involve local hunters in research and community wildlife management. In this article we assess the value of hunter self-monitoring to address the final objective, by reviewing participation rates and the nature of the data generated by voluntary participants in a program in the Bolivian Chaco.

STUDY AREA

Several programs are underway in lowland Bolivia (Guinart, 1997; Rúmiz and Solar, 1997; Townsend, 1997), including that described below with the Izoceño Guaraní communities of the Chaco (see also Ayala, 2000; E. Cuéllar, 1999; 2000; Noss, 1998, 1999). The Izoceño communities, through their political organization the Capitanía del Alto y Bajo Izozog (CABI), became involved in conservation and wildlife management early in the 1990s (Painter and Noss, 2000). They achieved the establishment in 1995 and subsequent comanagement of the 3.4 million ha Kaa-Iya del Gran Chaco National Park (Taber *et al.*, 1997). In addition, the government has charged CABI with the design of a natural resource and land use

management plan as a condition for granting the Izoceños an indigenous territory (Tierra Comunitaria de Orígen or TCO) of 1.9 million ha adjacent to the Kaa-Iya National Park. In 1996, under CABI's direction, and with support from the Wildlife Conservation Society (WCS) and the United States Agency for International Development (USAID) through the Kaa-Iya Project (1996–2003), we established a hunting self-monitoring program with the objectives described earlier.

The 22 Izoceño communities (8000 inhabitants approximately) are located along an 80-km stretch of the Parapetí river, 300 km to the southeast of the city of Santa Cruz (Fig. 1). Population density within the indigenous territory is less than one person per square kilometer. The region is part of the boreal Chaco with an average altitude of 300 m and average annual temperature of 26°C (0° to 42°). It is the driest portion of the Chaco: annual rainfall averages only 550 mm, and the dry season lasts from May to November. The xeric Chaco forest vegetation is generally dense, low, and thorny (Navarro and Fuentes, 1999; Taber *et al.*, 1997).

In the self-monitoring program, we emphasized legal subsistence hunting, while complementary research focused on illegal market hunting. Given currently low prices for wildlife products and the transportation time and costs from the Izozog to the principal regional urban market of

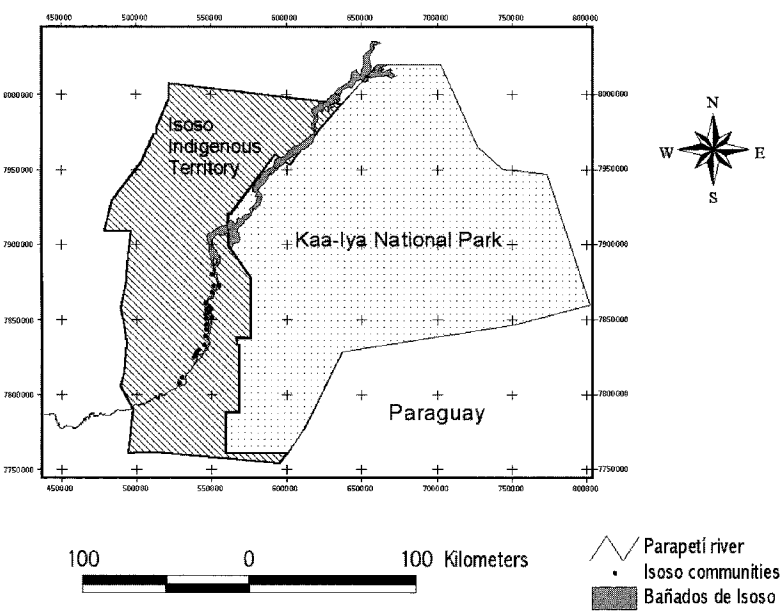

Fig. 1. Isoso (Izozog) study area and communities.

Santa Cruz, bushmeat is not marketed. Izoceño hunters do sell small numbers (<200/year) of tegu lizard (*Tupinambis rufescens*) skins valued around US$1 (Montaño, 2001), songbirds (troupial *Icterus icterus*, red-crested cardinal *Paroaria coronata*, etc., <500/year, US$1–2) (Saavedra, 2000), and approximately 15 hunters specialize in blue-fronted Amazon parrot (*Amazona aestiva*, <2500/year, US$3) and monk parakeet (*Myiopsitta monachus*, <2500/year, US$1) (Guerrero *et al.*, 2000). These sales are prohibited by law, and their legalization would require that the government formally approve a management plan for each species.

Hunting provides approximately one third of the meat consumed in the Izozog, the other two sources being fish and domestic livestock (Parada *et al.*, 2000; Rebolledo, 2002), and is estimated to represent 10–20% of aggregate household production (Beneria-Surkin, 2003). Izoceños hunt by day or by night, singly or with one or two companions, on foot or on horseback following trails or roads or crossing open grasslands. Hunters use firearms (16-gauge shotguns and .22 rifles), and frequently dogs to track and corner game animals, principally armadillos and ungulates (E. Cuéllar, 1999, 2000; Noss, 1998, 2000).

METHODS

Self-Monitoring

At the beginning of the program in 1996, the authors encouraged participation by visiting communities, presenting the objectives, and distributing materials. Together with Izoceño hunters we designed data sheets (see Appendix) for self-monitoring, accompanied numerous hunts to see what types of information could reasonably be collected, and to demonstrate data collection, and revised the data sheets in accordance with the hunters' observations. We provided pocket-size notebooks of data sheets to all hunters who expressed interest in participating voluntarily, together with tape measures and spring scales (12 and 50 kg). We also accompanied hunters in order to demonstrate in the field how to complete the information. In addition to completing data sheets, we asked hunters to provide specimens of hunted animals for laboratory analysis, particularly skulls and stomach contents. We provided no payment to hunters for data or specimens.

Assisted Self-Monitoring

In 1997, we hired 11 half-time wildlife monitors, each responsible for 1–2 communities, to explain the objectives of the program, distribute data

sheets and materials, and collect written data and specimens in their community(ies) which they passed on to the biologists on a monthly basis. Some monitors also recorded information on hunted animals that hunters had not recorded in writing but provided orally. The wildlife monitors visited hunters on a daily or weekly basis to collect specimens and record pertinent information on data sheets. In addition to the biannual community meetings where we presented results of the research to date (Noss and Cuéllar, 2001), we also met individually with hunters (Tamané, San Silvestre) or participated in community meetings at the invitation of the community wildlife monitor (Karaparí, Ibasiriri, Kopere Loma) during monthly visits to collect data from the wildlife monitors.

Monthly Activity Records

In order to derive total offtakes and evaluate hunting sustainability from the voluntary self-monitoring, we developed a complementary monthly activity survey (Noss, 2000). Wildlife monitors maintained a list of all potential hunters (boys and men aged 15 years or older) in their community, and assigned each individual to one of the following four categories each month: hunter participating in the self-monitoring program, active but nonparticipating hunter, not a hunter, absent from the community. We could therefore determine the proportion of hunters participating by community and by time period.

We evaluate participation rates according to two sets of data. The first set comprises the names of hunters providing data sheets and specimens of hunted animals, in comparison with the total number of *potential* hunters throughout the entire Izozog. The second data set comprises monthly activity records in 14 communities that distinguish *active* hunters from others in the set of potential hunters.

RESULTS

Written Data and Specimens: Participation of Potential Hunters

Census data indicate that potential hunters represent approximately 25% of the total Izoceño population. Approximately 36% of potential hunters from the entire Izozog, 728 individuals, voluntarily provided written data on over 9000 hunting events between 1996 and 2000 (Table I and Fig. 2). Although many hunters provided information on only a single hunting event, others recorded more than 100 events during the 4-year span (maximum 160, mean 12.9, SD 21.3). Given that only one hunt in three is successful, the average of 13 successful hunts per participating hunter over

Table I. Hunter Participation by Community—Hunting Records and Specimens

Community	Population	Hunters[a]	Events	Events/ hunter	Hunters[b]	Specimens	Specimens/ hunter
Kuarirenda[c]	728	99	1265	12.8	93	943	10.1
Ibasiriri[c]	463	83	1342	16.2	53	339	6.4
Iyobi[c]	725	68	807	11.9	36	309	8.6
La Brecha[c]	899	65	375	5.8	31	89	2.9
Rancho Viejo[c]	378	64	697	10.9	26	242	9.3
Koropo[c]	370	55	788	14.3	18	143	7.9
Kopere Brecha[c]	229	41	510	12.4	16	71	4.4
Kapeatindi[c]	196	33	607	18.4	14	343	24.5
Kopere Loma[c]	287	31	386	12.5	6	62	10.3
Isiporenda	274	31	285	9.2	12	55	4.6
Tamachindi[c]	525	24	177	7.4	12	38	3.2
Karaparí[c]	85	24	581	24.2	17	183	10.8
Aguaraigua[c]	379	23	173	7.5	13	74	5.7
Yapiroa	780	17	118	6.9	3	4	1.3
Kopere Guasu[c]	124	15	296	19.7	8	39	4.9
Aguarati[c]	376	12	265	22.1	6	26	4.3
San Silvestre	145	12	207	17.3	4	25	6.3
Rancho Nuevo	870	5	16	3.2	0	0	0.0
Kopere Montenegro	108	4	15	3.8	3	8	2.7
Mini	50	3	8	2.7	2	4	2.0
Tamané	48	10	115	11.5	1	44	44.0
Paraboca	25	9	350	38.9	3	52	17.3
Total Izozog	8064	728	9383	12.9	377	3093	8.2

[a]Hunters: hunters who have completed self-monitoring data sheets. Events: records of captures and unsuccessful hunts.
[b]Hunters: hunters who have provided specimens of hunted animals. Specimens: skulls or stomach contents of hunted animals.
[c]Communities with wildlife monitors.

4 years suggests that active Izoceño hunters average less than one hunt per month. The most active hunters, however, with 40 or more successful hunts per year, are hunting two or more times weekly.

In addition to written records, approximately 19% of potential hunters, 377 persons, voluntarily provided over 3000 specimens of skulls and stomach contents from hunted mammals and reptiles during the same period (Table I and Fig. 2). Although many provided information only a single specimen, others provided over 100 (maximum 132; mean 8.1; SD 13.5).

Monthly Activity Records: Participation of Active Hunters

We collected a minimum of 14 months of activity records between August 1997 and February 2000 in 14 communities (Table II). The data

Table II. Monthly activity records by community ($N = 21205$ person-months)

Community	Months	Active hunters	Participating hunters	% hunters participating
Kuarirenda	18	99	99	100
La Brecha	32	65	65	100
Rancho Viejo	18	64	64	100
Kopere Brecha	24	41	41	100
Isiporenda	14	31	31	100
Karaparí	26	24	24	100
Ibasiriri	31	86	83	99
Kapeatindi	25	35	33	94
Tamachindi	32	28	24	86
Iyobi	18	80	68	85
Kopere Guasu	22	19	15	79
Koropo	21	78	55	71
Kopere Loma	18	44	31	71
Aguarati	19	40	12	30
Total		691	645	

Note. % hunters participating = proportion of *active* hunters who participate in self-monitoring program.

set includes a total of 21,205 person-months. The communities represent roughly two-thirds of the Izoceño communities (14 of 22) and two-thirds of the Izoceño population (5750 of 8064 inhabitants). With the exception of a single community, Aguarati, with only 30% of active hunters participating in the self-monitoring, participation rates ranged from 70 to 100% of active hunters in each community. Considering participation rates each month across all communities, between 62% and 98% of active hunters provided self-monitoring data. Participation among active hunters was consistently high over time, although the composition of the group of active hunters changed, and the number of persons surveyed on a monthly basis increased over the course of the program from 240 (August–December 1997) to 650–800 (August 1998–February 2000).

Species and Numbers Recorded

From August 1996 to February 2000, hunters reported over 5000 mammals (31 species), 3000 birds (15 identified species), and 280 reptiles (five identified species) (R. L. Cuéllar, 2000b; Leaños and Cuéllar, 2000; Noss, 1998, 1999). These animals were hunted for subsistence uses: we did not design the program to collect information on hunting for commercial, medicinal or artisanal purposes.

Species hunted for sale are underreported or entirely absent in the self-monitoring data, according to interviews and direct observation of

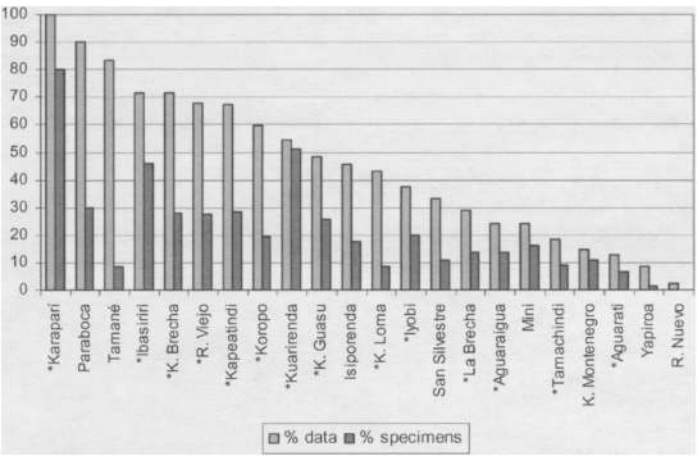

Fig. 2. Participation rates by community (proportion of potential hunters providing written data and specimens, respectively).

merchants and collectors (R. L. Cuéllar, 2000a,b; Saavedra, 2000). For example, a small number of hunters dedicated themselves to collecting live parrots and parakeets for sale, and did not begin to report their commercial offtakes until a specific project and team began work on psittacids. This team held meetings with the parrot hunters in order to solicit their support and participation (Guerrero *et al.*, 2000). The offtakes estimated in the focused study far surpass those reported in the general hunting monitoring (Table III). Likewise, from September 1997–September 1998, Saavedra (2000) recorded 6505 birds of seven species from five communities, whereas hunters from the same communities during the same period reported only 59 birds of four species collected for commercial purposes. Finally, by visiting individuals who collected skins for sale, Montaño (2001) recorded higher offtakes of tegu lizards (158 from October 1998–March 1999) than the numbers reported in the self-monitoring data (38 during the same period).

With respect to subsistence hunting alone, birds are underreported by hunter self-monitoring, while small birds killed by children are missed completely. Through direct observation and daily household visits in the community of Ibasiriri, Saavedra (2000) recorded 1074 birds of 25 species, whereas self-monitoring during the same period for Ibasiriri recorded only 95 birds of six identified species (Table IV). Extrapolating the observed Ibasiriri data to the entire Izozog suggests an annual offtake of over 16,000 birds, whereas self-monitoring reports for 3 years for the entire Izozog totaled only 3000 birds (R. L. Cuéllar, 2000b).

Table III. Commercial Hunting of Birds

Species	Common name	Mar. 1999–Mar. 2000[a]		Sep. 1997–Sep. 1998[b]	
		Self-monit.	Guerrero *et al*. (2000)	Self-monit.	Saavedra (2000)
Myiopsitta monachus	Monk parakeet	200	830	29	4610
Amazona aestiva	Blue-fronted Amazon		1950		445
Aratinga acuticaudata	Blue-fronted parakeet		115		42
Paroaria coronata	Red-crested cardinal			16	957
Coryphospingus cucullatus	Red-crested finch			2	7
Icterus icterus	Troupial				443
Rhea americana	Rhea			12	1
Total		200	2895	59	6505

Note. For comparative purposes, self-monitoring data are from same geographic range as alternative study.
[a]All Izozog.
[b]Five communities: Iyobi, Koropo, La Brecha, Rancho Nuevo, Rancho Viejo.

Table IV. Subsistence Hunting of Birds, Ibasiriri Community Only (Sept. 1997–Sept. 1998)

Species	Common name	Self-monitoring	Saavedra 2000
Zenaida auriculata	Eared dove	5	265
Columbina picui	Picui ground dove		256
Leptotila verreauxi	White-tipped dove	72	240
Columba picazuro	Picazuro pigeon		31
Ortalis canicollis	Chaco chachalaca	4	75
Empidonomus aurantioatrocristatus	Crowned slaty flycatcher		61
Megarhynchus pitangua	Boat-billed flycatcher		29
Tyrannus savana	Fork-tailed flycatcher		21
Myiodynastes maculatus	Streaked flycatcher		9
Inezia inornata	Plain tyrannulet		3
Elaenia sp.	Elaenia		3
Turdus amaurochalinus	Creamy-bellied thrush		35
Amazona aestiva	Blue-fronted Amazon	4	10
Aratinga acuticaudata	Blue-fronted parakeet	2	4
Myiopsitta monachus	Monk parakeet	1	2
Pheucticus aureoventris	Black-backed grosbeak		8
Coryphospingus cucullatus	Red-crested finch		7
Nystalus maculatus	Spot-backed puffbird		3
Taraba major	Great antshrike		3
Thraupis sayaca	Sayaca tanager		2
Crotophaga ani	Smooth-billed ani		2
Vireo olivaceus	Red-eyed vireo		2
Cychlaris gujanensis	Rufous-browed peppershrike		1
Melanerpes cactorum	White-fronted woodpecker		1
Cyanocorax chrysops	Plush-crested jay		1
Unidentified birds		7	
Total		95	1074

Information on Hunting Practices

The optimistic design of the data sheets included a wide range of entries intended to provide information on hunting practices. Table V presents details of how completely hunters filled the data sheets. Location information, subsequently complemented with coordinates recorded by hunting monitors using handheld GPS receivers, is extremely valuable for geographic analyses of species and hunting pressure distribution, upon which territorial-zoning proposals can be based. The duration of the hunt, which would assist with estimating hunting effort, was only reported on half the data sheets. At the same time, unsuccessful hunts were greatly underreported: only 384 unsuccessful hunts for 7760 captured mammals. In comparison, of 141 observed hunts during the same period, 93 were unsuccessful while 89 animals were captured on 48 successful hunts. Thus the 384 reported unsuccessful hunts represent only 4.7% of an estimated 8100 that could correspond to the 7760 captured animals self-reported by Izoceño hunters.

Biological Information on Captured Animals

Table V also presents details on biological information hunters provided for captured animals. Again, such a fundamental piece of information as sex was not always reported in mammals, although easily determined. Hunters recorded weights and measurements only about half the time, although we had provided all participants with spring scales and measuring

Table V. Self-Monitoring Data Sheets—Percent of Entries Completed

Entry	Total	Mammals	Birds	Reptiles
Hunting information				
Date	95.2	99.9	100.0	99.6
Place	90.4	91.4	92.0	76.4
Habitat	82.1	82.3	84.9	70.2
Weather	81.5	80.3	94.5	71.5
Weapon	77.6	76.3	93.4	72.7
Time	71.2	71.9	64.8	67.8
Duration	53.1	54.6	50.1	40.9
Biological information				
Sex	80.0	85.9	19.9	66.9
Age	67.8	72.0	26.0	56.6
Measurements[a]	53.0–57.1	59.3–60.4	9.0–11.2	59.5–81.0
Weight[b]	43.6–52.9	46.9–56.1	6.1–14.4	46.3–62.8

Note. $N = 7760$ recorded captures (6892 mammals, 623 birds, 242 reptiles, 3 unidentified), some of multiple individuals.
[a]Range for four measurements: total length, tail, hindlimb, ear.
[b]Lower figure is cleaned weight, higher figure is whole weight.

tapes. Hunters have difficulty determining sex of birds and reptiles, although they assigned a sex to two-thirds of reptiles captured. Most of these reptiles (239 of 242) were tegu lizards.

Specimens Collected

One benefit of specimen collection is to provide proof of reported captures. As participation was voluntary we could not require specimens as proof, but collected any specimens we could as material for additional research. Table VI indicates the proportion of skulls and stomach contents collected relative to the number of hunted animals reported by species. Skull collection for large ungulates (tapir *Tapirus terrestris*, collared peccary *Tayassu tajacu*, white-lipped peccary *Tayassu pecari*, and Chacoan peccary *Catagonus wagneri*) is most successful because these animals have large strong skull bones that are not easily destroyed or carried off by dogs and do not quickly decompose. Izoceño hunters frequently collect jawbones from peccaries they have hunted and hang them as trophies on a branch in their yard. Gray brocket deer (*Mazama gouazoubira*) skulls are somewhat more fragile and therefore collected less frequently. In contrast to the ungulates, where hunters provided skulls for 61.4% of hunted animals, armadillos have very fragile skulls and hunters provided only 13.9% of skulls from hunted animals. With respect to stomach contents, hunters provided a higher proportion from hunted armadillos (12.3%) than from ungulates (5.1%). Armadillos are small animals that are frequently brought whole to the community, whereupon the stomach contents can be delivered to the wildlife monitor. Ungulates are large animals which hunters prefer

Table VI. Specimens Collected as Proportion of Hunted Mammals (*N*)

Species		*N*	Skulls	%	Stomach contents	%
Ungulates						
Mazama gouazoubira	Gray brocket deer	1816	900	49.6	110	6.1
Tayassu tajacu	Collared peccary	1028	786	76.5	37	3.6
Tayassu pecari	White-lipped peccary	343	263	76.7	16	4.7
Tapirus terrestris	Lowland tapir	79	54	68.4	2	2.5
Catagonus wagneri	Chacoan peccary	17	13	76.5	2	11.8
Armadillos						
Dasypus novemcinctus	Nine-banded armadillo	1352	148	10.9	163	12.1
Tolypeutes matacus	Three-banded armadillo	978	96	9.8	141	14.4
Chaetophractus villosus	Large hairy armadillo	519	120	23.1	39	7.5
Euphractus sexcinctus	Yello armadillo	281	61	21.7	33	11.7
Chaetophractus vellerosus	Screaming armadillo	176	34	19.3	29	16.5
Other		320	80	25.0	17	5.3
Total		6909	2555	37.0	589	8.5

to eviscerate upon capture rather than transporting whole. Hunters also provided skulls and stomach contents for carnivores (puma *Puma concolor* and Geoffroy's cat *Oncifelis geoffroyi*), rodents (agouti *Dasyprocta azarae*, tuco-tuco *Ctenomys conoveri*, Vizcacha *Lagostomus maximus*, porcupine *Coendou prehensilis*), and other mammals. Thesis students conducting species-specific research projects with our support in the Izozog were also voluntarily provided with specimens of tegu lizards (Montaño, 2001) and chachalacas (*Ortalis canicollis*) (Mamani, 2000) by notifying hunters and wildlife monitors of their interest.

DISCUSSION

Justification

While we have not systematically surveyed hunters to quantify their motives for participation, from informal discussions and testing adaptations of the methods over time we have determined a number of motives of an indirect and social nature.

The program developed out of CABI's efforts, and is comanaged by CABI. One justification for CABI is that the hunter self-monitoring and related research can contribute to ensuring long-term sustainable utilization of wildlife. Having occupied the Izozog for over 400 years (Combès, 1999), and with the consolidation of a legally titled indigenous territory, the Izoceños have a long-term commitment to the region as well as tenure over land and resources. Furthermore, Izoceños are proud of their culture and enjoy hunting, sharing their knowledge with biologists who take an interest in their livelihoods and value their abilities, and demonstrating their skills to their peers and to the community. Hunters also participate to support the wildlife monitors employed by the CABI/WCS program, who are their friends and neighbors and whose income is shared partially and informally within the community, and out of a sense of duty to community authorities and consensus in supporting a community project.

Remuneration

From the beginning of the program we insisted on voluntary participation for two reasons. First, with 22 communities and as many as 2000 hunters in the Izozog, costs would have been prohibitively high to recompense all hunters who participated. Second, payment in cash or in kind for data or specimens can encourage hunting, particularly when few alternative economic options exist.

An alternative, where the objective focuses more narrowly on hunting offtakes, is to select a small sample of hunters or households who could

be remunerated for collecting data and specimens. However, we wanted to encourage broad participation and encourage interest in wildlife management in the communities. We also did not want to create the expectation that participation would always be compensated. Despite the lack of direct remuneration, we were able to achieve participation rates exceeding 60% across communities and throughout the 4-year study period.

Data Quality

High participation rates alone do not represent success for the hunter self-monitoring program. The data sheet was designed with Izoceño hunters who can read and write, and it therefore lacks the drawings or symbols more appropriate for less literate hunters (Rúmiz and Solar, 1997; Siren *et al.*, 2000; Townsend, 1999). Nevertheless, unaccustomed to recording their activities, hunters did experience difficulties in providing coherent or complete information, and required support from community hunting monitors. When entries were incomplete or of doubtful accuracy, i.e., inconsistent with other data from the region, we questioned the monitor or hunter directly.

The data sheets request a wide range of information. The quality of the information recorded by hunters can be improved significantly by focusing the data sheet more narrowly, or by emphasizing through discussions and demonstrations the specific information required to respond to particular research questions. More complete and useful information also results when hunters and researchers together design the data instrument with careful attention to defining mutually meaningful variables and classifications.

CONCLUSION

Hunter self-monitoring is an important tool for community wildlife management efforts, but cannot be applied on its own nor ubiquitously. In the Bolivian Chaco, a set of factors favors its implementation: support from community leaders and organizations, legal conditions that permit subsistence hunting and devolve wildlife use and land rights to indigenous peoples, literacy levels with most hunters having completed several years of primary school, and the financial and technical support of the CABI/WCS wildlife management project. At the same time, to answer specific research questions, independent and complementary research is necessary: monthly activity records, participant-observation of hunting activities, household surveys of resource use, informal interviews or questionnaires, and focused research on particular species. The ultimate objective, however, is not to

perfect self-monitoring as a data collection method for outside researchers, but to foster wide participation in management efforts by facilitating hunter involvement directly in research on principal game species, so that hunters can assume responsibility for monitoring and managing the resources upon which they depend (Barrow *et al.*, 1993; Hackel, 1999; Noss and Cuéllar, 2001; Western and Wright, 1994a,b).

The issue of responsibility is particularly urgent and important for the Izoceño-Guaraní, whom the Bolivian government has charged with the management of a vast area nearly the size of Costa Rica: the 3.4 million ha Kaa-Iya del Gran Chaco National Park and the 1.9 million ha adjoining indigenous territory. International infrastructure projects including highways and gas pipelines are improving access to the Izoceño territory, both for external hunters to enter, and for Izoceños to market wildlife products. The Izoceño population is growing at a rate of over 2% per year. Regional livestock programs to eradicate foot-and-mouth disease are likely to increase cattle numbers and land dedicated to cattle both on the part of Izoceño communities as well as third-party ranchers with properties inside the indigenous territory. Although under current conditions hunting is sustainable for most game species (Noss, 2000), all these factors are increasing pressure on wildlife resources.

Titling of the indigenous territory is underway, and in parallel CABI is developing a zonification and natural resource management plan which will incorporate specific wildlife management practices derived from hunter self-monitoring data: managed commercial use of certain species (Cuéllar and Noss, 2002; Cuéllar *et al.*, 2002), managed subsistence hunting of ungulates and armadillos (Noss and Cuéllar, 2001), designation of livestock versus hunting areas, and conservation areas within the indigenous territory. Anticipating formal CABI adoption of the comprehensive management plan, and the completion of the land titling process which will provide the legal framework for community wildlife management, several communities and hunters have already taken positive steps: parrot hunters from Karaparí now leave one chick per harvested nest; hunters in Tamané and San Silvestre decided to stop hunting tapir (*Tapirus terrestris*); the first 160,000 ha of the indigenous territory to be titled has been divided into research and hunting areas respectively, with hunters voluntarily registering themselves and their captures at the research camp; and Isiporenda has demarcated a community hunting reserve with a rotation of hunting plots, defense from outside hunters, and full protection of the highly endangered Chacoan guanaco *Lama guanicoe voglii*. While we cannot demonstrate that hunter self-monitoring has resulted in widespread adoption of appropriate land use practices (Lewis and Phiri, 1998), it is clearly useful in what is an extended, gradual and on-going process.

APPENDIX: HUNTER SELF-MONITORING DATA SHEET WITH ENGLISH TRANSLATION

CACERIA Comunidad_____
Quienes salieron?_____
_____
Cuántas horas o días duró la salida_____
Dónde cazó?_____Clima_____
Qué cazó?_____
No. de etiqueta _____
Fecha_____Hora_____Tipo de monte_____
Cómo lo consiguió? Montados_____Cuántos perros_____
Con qué arma_____
Sexo: Macho_____Hembra_____Tiene leche_____
Cuántas crías en la barriga_____
Peso: Con tripas_____Sin tripas_____
Medidas: Total_____Cola_____Pata trasera_____Oreja____
Edad: Juvenil_____Adulto_____
Animales heridos pero no cazados:_____
_____
Otros animales encontrados pero no cazados_____
_____
Por qué?_____
Observaciones:_____
_____

HUNTING Comunity_____
Who hunted?_____
_____
How many hours or days did the trip last?_____
Where did you hunt?_____Weather_____
What did you hunt?_____
Specimen no. _____
Date_____Hour_____Habitat type _____
How did you hunt? Horseback_____no. of dogs _____
With what weapon?_____
Sex: Male_____Female_____Lactating _____
Number of fetuses _____
Weight: Whole _____Cleaned _____
Measurements: Total____Tail____Hindlimb _____Ear____
Age: Juvenile_____Adult_____
Animals injured but not captured:_____
_____
Other animals encountered but not hunted _____
_____
Why?_____
Observations:_____
_____

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REFERENCES

Ayala, E. W. (2000). Participación de los comunarios izoceños en el manejo de fauna. In Cabrera, E., Mercolli, C., and Resquin, R. (eds.), *Manejo de fauna silvestre en Amazonía y Latinoamérica*, CITES Paraguay, Fundación Moises Bertoni, University of Florida, Asunción, Paraguay, pp. 529–534.

Barrow, E., Bergin, P., Infield, M., and Lembuya, P. (1993). *The People's Voice: Partnership and Community Conservation*, African Wildlife Foundation, Nairobi.

Beneria-Surkin, J. (2003). *Decentralization Questioned: The Structuring and Articulation of Guaraní Participation in Conservation and Development in Izozog, Bolivia*, Doctoral Dissertation, UCLA, Los Angeles.

Bennett, E. L., and Robinson, J. G. (2000). Hunting for sustainability: The start of a synthesis. In Robinson, J. G., and Bennett, E. L. (eds.), *Hunting for Sustainability in Tropical Forests*, Columbia University Press, New York, pp. 499–519.

Bodmer, R., and Puertas, P. E. (2000). Community-based comanagement of wildlife in the Peruvian Amazon. In Robinson, J. G., and Bennett, E. L. (eds.), *Hunting for Sustainability in Tropical Forests*, Columbia University Press, New York, pp. 395–409.

Campos, C., Ulloa, A., and Torgler, H. R. (eds.). (1996). *Manejo de fauna con comunidades rurales*, Fundación Natura, Bogotá, Colombia.

Combès, I. (1999). *Arakae: Historia de las comunidades Izoceñas*, Kaa-Iya Project, Santa Cruz, Bolivia.

Cuéllar, E. (2000). Automonitoreo de la cacería de armadillos en Izozog, Gran Chaco, Bolivia. In Cabrera, E., Mercolli, C., and Resquin, R. (eds.), *Manejo de fauna silvestre en Amazonía y Latinoamérica*, CITES Paraguay, Fundación Moises Bertoni, University of Florida, Asunción, Paraguay, pp. 113–118.

Cuéllar, E. (1999). *Hunting of Armadillos by Izoceño Indians of the Gran Chaco, Bolivia*, Master's Thesis, University of Kent, Canterbury, England.

Cuéllar, R. L. (2000a). *Para qué sirven los animales del monte en Izozog?* Kaa-Iya Project, Santa Cruz, Bolivia.

Cuéllar, R. L. (2000b). Uso de los animales silvestres por pobladores Izoceños. In Cabrera, E., Mercolli, C., and Resquin, R. (eds.), *Manejo de fauna silvestre en Amazonía y Latinoamérica*, CITES Paraguay, Fundación Moises Bertoni, University of Florida, Asunción, Paraguay, pp. 471–484.

Cuéllar, R. L., Fitzgerald, L., and Noss, A. J. (2002). *Plan de manejo para el uso comercial del peni (Tupinambis rufescens) en el Izozog*, Technical Report #75. Kaa-Iya Project, Santa Cruz, Bolivia.

Cuéllar, R. L., and Noss, A. J. (2002). *Plan de manejo para el uso comercial del taitetú (Tayassu tajacu) en el Izozog*, Technical Report #74. Kaa-Iya Project, Santa Cruz, Bolivia.

Fitzgibbon, C., Mogaka, D. H., and Fanshawe, J. H. (2000). Threatened mammals, subsistence harvesting, and high human population densities: A recipe for disaster? In Robinson,

J. G., and Bennett, E. L. (eds.), *Hunting for Sustainability in Tropical Forests*, Columbia University Press, New York, pp. 154–167.

Guerrero, J., Arambiza, A., González, L., and Ity, E. (2000). *Contribución al conocimiento de los Psittacidae sometidos a cacería por comunidades Guaraníes-Izoceñas y propuestas para su conservación, Izozog, Provincia Cordillera, Santa Cruz, Bolivia*, Technical Report #62, Kaa-Iya Project, Santa Cruz, Bolivia.

Guinart, S. D. (1997). *Los mamíferos del bosque semideciduo neotropical de Lomerío (Bolivia): interacción indígena*, PhD Dissertation, Universidad de Barcelona, Barcelona, Spain.

Hackel, J. D. (1999). Community conservation and the future of Africa's wildlife. *Conservation Biology* 13(4): 726–734.

Leaños, F., and Cuéllar, R. L. (2000). Monitoreo de cacería en las comunidades Izoceñas: datos del auto-monitoreo. In Cabrera, E., Mercolli, C., and Resquin, R. (eds.), *Manejo de fauna silvestre en Amazonía y Latinoamérica*, CITES Paraguay, Fundación Moises Bertoni, University of Florida, Asunción, Paraguay, pp. 83–88.

Lewis, D. M., and Phiri, A. (1998). Wildlife snaring—An indicator of community response to a community-based conservation project. *Oryx* 32(2): 111–121.

Little, P. (1994). The link between local participation and improved conservation: A review of issues and experiences. In Western, D., and Wright, R. M. (eds.), *Natural Connections: Perspectives in Community-Based Conservation,* Island Press, Washington, DC, pp. 347–372.

Mamani, A. M. (2000). *Historia natural y uso de Ortalis canicollis (charata) en Izozog, Provincia Cordillera, Departamento de Santa Cruz*, Undergraduate Thesis, Universidad Autonoma Gabriel René Moreno, Santa Cruz, Bolivia.

Marks, S. A. (1994). Local hunters and wildlife surveys: A design to enhance participation. *African Journal of Ecology* 32: 233–254.

Marks, S. A. (1996). Local hunters and wildlife surveys: An assessment and comparison of counts for 1989, 1990 and 1993. *African Journal of Ecology* 34: 237–254.

Montaño, R. R. (2001). *Monitoreo de cacería y aspectos de la biología de Tupinambis spp. (Sauria: Teiidae) en el Izozog, Provincia Cordillera, Santa Cruz, Bolivia*, Undergraduate Thesis, Universidad Autonoma Gabriel René Moreno, Santa Cruz, Bolivia.

Navarro, G., and Fuentes, A. (1999). Geobotánica y sistemas ecológicos de paisaje en el Gran Chaco de Bolivia. *Revista Boliviana de Ecología y Conservación Ambiental* 5: 25–50.

Noss, A. J. (1998). El monitoreo comunitario de cacería en el Izozog: datos preliminares. *Ecología en Bolivia* 31: 53–66.

Noss, A. J. (1999). Manejo de fauna comunitario en el Gran Chaco, Bolivia. In Fang, T. G., Montenegro, O. L., and Bodmer, R. E. (eds.), *Manejo y conservación de fauna silvestre en América Latina*, Instituto de Ecología, La Paz, Bolivia, pp. 109–116.

Noss, A. J. (2000). La sostenibilidad de la cacería de subsistencia Izoceña. In Cabrera, E., Mercolli, C., and Resquin, R. (eds.), *Manejo de fauna silvestre en Amazonía y Latinoamérica*, CITES Paraguay, Fundación Moises Bertoni, University of Florida, Asunción, Paraguay, pp. 535–544.

Noss, A. J., and Cuéllar, R. L. (2001). Community attitudes towards wildlife management in the Bolivian Chaco. *Oryx* 35(4): 292–300.

Noss, A. J., Cuéllar, E., and Cuéllar, R. L. (2003). Hunter self-monitoring as a basis for biological research: Data from the Bolivian Chaco. *Mastozoología Neotropical* 10(1): 49–67.

Ortíz, B., and Mazzuchelli, S. (eds.). (1997). *Evaluating Eden: community wildlife management*, IUCN/IIED, Quito, Ecuador/Buenos Aires, Argentina.

Painter, M., and Noss, A. (2000). Conservación de fauna con organizaciones comunales: Experiencia con el pueblo Izoceño en Bolivia. In Cabrera, E., Mercolli, C., and Resquin, R. (eds.), *Manejo de fauna silvestre en Amazonía y Latinoamérica*, CITES Paraguay, Fundación Moises Bertoni, University of Florida, Asunción, Paraguay, pp. 167–180.

Parada, E., Guerrero, J., and Cuéllar, R. L. (2000). Encuestas sobre el consumo de carne de monte y carne doméstica en las comunidades Izoceñas. In Cabrera, E., Mercolli, C.,

and Resquin, R. (eds.), *Manejo de fauna silvestre en Amazonía y Latinoamérica*, CITES Paraguay, Fundación Moises Bertoni, University of Florida, Asunción, Paraguay, pp. 499–508.

Rebolledo, G. P. (2002). *La ictiofauna del río Parapetí y su uso por una comunidad del Bajo Izozog en el Gran Chaco, Provincia Cordillera, Departamento de Santa Cruz*, Master's Thesis, Institute of Ecology, Universidad Mayor de San Andrés, La Paz, Bolivia.

Redford, K. H., and Mansour, J. A. (eds.). (1996). *Traditional Peoples and Biodiversity Conservation in Large Tropical Landscapes*. The Nature Conservancy, Washington, DC.

Robinson, J. G., and Bennett, E. L. (eds.). (2000). *Hunting for Sustainability in Tropical Forests*. Columbia University Press, New York.

Rúmiz, D., and Solar, L. (1997). *Primer encuentro de cazadores para el manejo de vida silvestre en Lomerío*. Technical Paper 56/1997, BOLFOR Project, Santa Cruz, Bolivia.

Saavedra, Z. A. M. (2000). *Uso de aves por comunidades indígenas del Izozog*, Undergraduate Thesis, Universidad Autonoma Gabriel René Moreno, Santa Cruz, Bolivia.

Siren, A., Machoa, J., and Santi, C. (2000). Investigación participativa sobre cacería de subsistencia en la Amazonía con énfasis en su patrón espacial. In Cabrera, E., Mercolli, C., and Resquin, R. (eds.), *Manejo de fauna silvestre en Amazonía y Latinoamérica*, CITES Paraguay, Fundación Moises Bertoni, University of Florida, Asunción, Paraguay, pp. 545–558.

Taber, A., Navarro, G., and Arribas, M. A. (1997). A new park in the Bolivian Gran Chaco—An advance in tropical dry forest conservation and community-based management. *Oryx* 31: 189–198.

Townsend, W. R. (1997). La participación comunal en el manejo de la vida silvestre en el oriente de Bolivia. In Fang, T. G., Bodmer, R. E., Aquino, R., and Valqui, M. H. (eds.), *Manejo de fauna silvestre en la Amazonía*, Instituto de Ecología, La Paz, Bolivia, pp. 105–109.

Townsend, W. R. (1999). Algunas técnicas para ampliar la participación en el manejo de la fauna silvestre con comunidades rurales. In Fang, T. G., Montenegro, O. L., and Bodmer, R. E. (eds.), *Manejo y conservación de fauna silvestre en América Latina*, Instituto de Ecología, La Paz, Bolivia, pp. 141–145.

Western, D., and Wright, R. M. (eds.). (1994a). *Natural Connections: Perspectivs in Community-Based Conservation*, Island Press, Washington, DC.

Western, D., and Wright, R. M. (1994b). The background to community-based conservation. In Western, D., and Wright, R. M. (eds.), *Natural Connections: Perspectives in Community-Based Conservation*, Island Press, Washington, DC, pp. 1–12.