Contributed Article

Population Ecology and Conservation of Baird's Tapir (*Tapirus bairdii*) in the Lacandon Forest, Mexico

By Eduardo J. Naranjo[1] and Richard E. Bodmer[2]

[1] Departamento de Ecología y Sistemática Terrestres, El Colegio de la Frontera Sur, Ap. 63, San Cristóbal de Las Casas, Chiapas 29290, México.
E-mail: enaranjo@sclc.ecosur.mx

[2] Durrell Institute of Conservation and Ecology, University of Kent at Canterbury, CT2-7NS, UK.
E-mail: R.Bodmer@ukc.ac.uk

Abstract

Baird's tapir (*Tapirus bairdii*) has an important role in the dynamics of tropical forests through herbivory, seed dispersal, and seed predation. This mammal has also been a food source for rural inhabitants of Mesoamerica. Tapirs are currently endangered due to habitat loss and over-hunting. The objectives of this study were: (1) to evaluate the status of the tapir population in Montes Azules Biosphere Reserve (MABR) and its surroundings in the Lacandon Forest of Chiapas, Mexico; and (2) to propose a strategy for the conservation and management of tapirs in collaboration with residents of the study area. We walked 1908 km of line transects in the study area to count tapirs and their tracks. We interviewed 232 local hunters and had meetings with local communities to discuss our results. We observed 19 individuals and 438 tapir tracks between May 1998 and April 2001. Most tapir records (79.3%) were obtained in slightly hunted sites within MABR and only 0.4% were found outside this protected area. We estimated an overall encounter rate of 0.9 tapirs/100 km and a density of 0.22 ind/km^2. Average density estimated in slightly hunted areas (0.24 ind/km^2) was considerably higher than density of persistently hunted areas (0.05 ind/km^2). We estimated a two-month home range of 0.67 km^2 for a radio-collared female tapir. The sex ratio based on hunting records at persistently hunted sites did not differ from the expected 1:1. From direct sightings, we estimated that the tapir population was composed of 78.9% adults (n=15), 15.8% juveniles (n=3), and 5.3% young (n=1). Using the production and the harvest models, we detected unsustainable hunting of tapirs at both regional and local levels in the study area. Through the stock-recruitment model, we estimated the status of the hunted tapir population at 21% of K. In order to promote tapir conservation in the study area, we recommend: (1) to protect remaining habitat within and outside existing reserves; (2) to encourage self-regulation of subsistence hunting by local communities; (3) to look for alternative sources of income for local people (e.g. tourism, and agro-forestry projects); (4) to establish environmental education and wildlife research programmes around MABR.

Introduction

Among the numerous wildlife species used by rural inhabitants of Mesoamerica, Baird's tapirs (*Tapirus bairdii*) are notable because of their meat yield and the usefulness of their skins. Apart from representing food resources for rural people, these mammals play an important function in the dynamics of tropical forests through the processes of herbivory and the seed dispersal of many plant species. However, as is the case with other large tropical mammals, Baird's tapir populations are particularly vulnerable to local extinction triggered by habitat loss and over-hunting (Naranjo, 2002). Baird's tapir is listed in CITES Appendix I, and is regarded as "vulnerable" and "endangered" by IUCN (2001) and SEMARNAP (2000), respectively. It is very likely that both the Lacandon Forest of Chiapas and the region of Calakmul, Campeche, shelter the largest Mexican population of tapir. Several conservation areas have been created in the Lacandon Forest (Figure 1). However, little has been done to promote wildlife management and conservation in and around such areas. Because of its large size and the diversity of its natural and cultural resources, Montes Azules Biosphere Reserve (MABR; 3,300 km^2) represents a very interesting study area for conservation scientists. In spite of this, quantitative information on the status of local wildlife populations is very scarce. Two recent, general assessments of wildlife use in the Lacandon Forest (March *et al*., 1996; Naranjo *et al*., 1997) revealed that tapirs are still locally hunted even within protected areas. In this study we obtained basic information on the status of tapir populations in the Lacandon Forest. This information was used to design a conservation strategy incorporating the sustainable use and monitoring of the species in collaboration with local people. The resulting strategy may be useful to conserve a wider array of

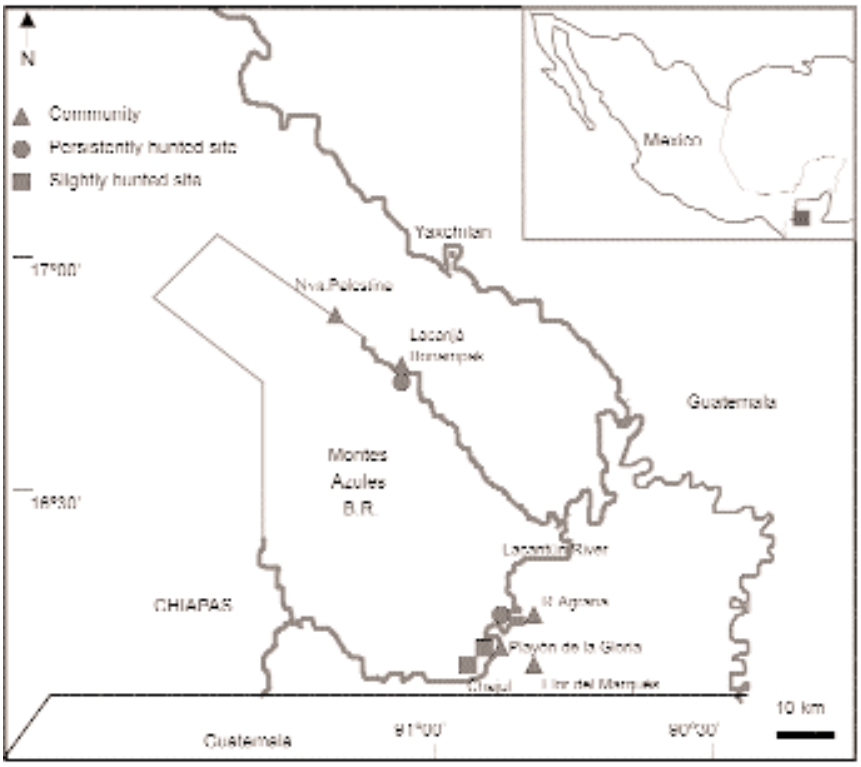

Figure 1. *Study sites in the Lacandon Forest of Chiapas, Mexico.*

game and non-game species with similar habitat requirements to those of the tapir (i.e., brocket deer, white-lipped peccaries, primates and cracids).

Study Area

The Lacandon Forest (16°05'- 17°15' N, 90°30'-91°30' W) is located in the northeastern portion of the state of Chiapas, Mexico, and is delimited by the Guatemalan border on the east, north, and south and by the Chiapas Highlands to the west. Average monthly temperatures range from 24°C to 26°C with maximum and minimum values in May (28°C) and in January (18°C), respectively. Mean annual rainfall is 2500-3500 mm, with roughly 80% of rainfall occurring between June and November. The area was originally covered by over a million hectares of rainforest, of which about half remains today (INE, 2000; Naranjo, 2002). Among the protected areas extant in the Lacandon Forest, Montes Azules Biosphere Reserve (MABR) is the largest with over 3,300 km^2, and harbours some of the largest Mexican populations of precious hardwood trees and large vertebrate species which are harvested by both Indian and Mestizo residents (Medellín, 1994; Vásquez & Ramos, 1992).

The interior of MABR is primarily covered by tropical rainforest (*selva alta perennifolia*), while the community lands show a mosaic of rainforest fragments surrounded by secondary vegetation, pasturelands, seasonal crops (corn, beans and chilli peppers), and cacao plantations (Castillo & Narave, 1992). A complete inventory of the fauna of the Lacandon Forest has not been undertaken. However, 67 fish, 23 amphibians, 54 reptiles, 341 birds and 116 mammals have been recorded in the area (INE, 2000; March *et al*., 1996). The human population of the area is composed of several ethnic groups of Mayan descent (Lacandon, Tzeltal, Tojolabal, Chol), and Spanish-speaking Mestizos. Except for the Lacandon, most of the local residents have emigrated from either the Chiapas highlands or from other Mexican states within the last 30 years.

Methods

Distribution and Abundance

From May 1998 through April 2001 we recorded tapirs and their tracks along 1,908 km of line transects established at two slightly hunted sites and two persistently hunted sites within Montes Azules Biosphere Reserve (MABR), Chiapas, Mexico. We walked transects during the first and the last hours of daylight, usually 7-11 AM and 4-7 PM, at a slow pace (about 1.5 km/h). We recorded the number of individuals seen, their perpendicular distance to the centre line of the transect and the numbers of tracks and/or faecal groups found in all the transects (Southwell, 1996). We estimated the encounter rate (number of individuals, groups or tracks/100 km) for every site, year, and season (Conroy, 1996). In addition, we assessed tapir population density (number of individuals or groups/km^2) through distance sampling (Buckland *et al*., 1993), using the computer software DISTANCE 3.5 (Thomas *et al*., 1998).

Home Range

We captured a female tapir using a pitfall trap measuring 2.20 x 1.50 x 2.0 m (Médici & Valladares, 1997). We covered the trap with 4 mm-thick asbestos sheets and a uniform layer of fallen leaves. We placed small amounts of bananas, mangoes and native fruit in the trap. Once the trap was set, it was checked every morning. When the tapir was caught, it was immobilized with a mixture of butorphanol hydrochloride (40 mg) and xylacine hydrochloride

(200 mg). Once the tapir was sedated, we fitted a radio-collar (Telonics Inc., mod. 500) around her neck, and then estimated her age class, weight, and reproductive condition. We also measured her total length and took tissue samples for future genetic analysis. After recovering, the tapir was allowed to escape by digging on one of the corners of the trap to reduce its depth. We radio-tracked this tapir from fixed stations located along the transects established within MABR. We assessed its home range using Kernell´s method and the Minimum Convex Polygon (MCP) estimator with 95% of localizations (White & Garrott, 1990).

Population Structure

We estimated age classes and sex ratios from direct sightings and hunting records. Age categories considered were: (1) Young (small individuals accompanied by their mother and with white spots and stripes); (2) Juvenile (solitary individuals with or without vestiges of white spots or stripes, but clearly smaller than adults); and (3) Adult (large animals without stripes or spots, with very little hair on the rump; Montenegro, 1998). We additionally examined tooth wear and eruption from skulls kept by local hunters (Dimmick & Pelton, 1994). All skulls donated by hunters were deposited in the mammal collection of Ecosur at San Cristobal de Las Casas, Chiapas, Mexico.

Hunting Sustainability

We interviewed 232 residents of five localities (Bethel, Flor del Marqués, Lacanjá-Chansayab, Nueva Palestina and Playón de la Gloria). We questioned residents of the study area about their use of tapirs and other wildlife species, as well as the methods, instruments, seasons and sites where they hunted. From these data we assessed annual harvest rates (individuals hunted/km^2/year). We applied the unified harvest model (Bodmer & Robinson, in press) to evaluate the hunting sustainability of tapirs in the Lacandon Forest. This model uses data on actual productivity, harvest rates, and population densities in slightly and persistently hunted sites to construct a graph that displays a vertical bar representing the status of hunted populations with respect to their K (x-axis), and with respect to their corresponding MSY (y-axis) (Bodmer, 2001; Bodmer & Robinson, in press). We assumed that a population was being harvested sustainably and safely if its vertical bar was well under its corresponding curve representing MSY (i.e. harvest did not exceed production), and on the right side of the graph (N approached to K; Bodmer, 2001).

Results and Discussion

Population Density and Abundance

We observed 19 individuals and 438 tapir tracks during the study. Most records (79.3%, n=380) were obtained in slightly hunted sites within MABR, and only two tracks (0.4% of all records) were found outside this protected area. We estimated an overall encounter rate of 0.9 tapirs/100 km and an overall population density of 0.22 ind/km^2 (Table 1). Density was almost five times greater in slightly hunted (0.24 ind/km^2) than in persistently hunted areas (0.05 ind/km^2). Similarly, tapir track frequency was considerably higher in persistently hunted than in slightly hunted sites (Mann-Whitney's U=1119.5; d.f.=1; P=0.047; Table 1). We did not detect significant variations in densities or track frequencies among years, months or between seasons (P>0.05).

Our estimates of Baird's tapir abundance in the Lacandon Forest are similar to those obtained in La Sepultura, Chiapas (Cruz, 2001; Naranjo & Cruz, 1998). However, tapir density was lower in our study area than in Corcovado National Park, Costa Rica (Foerster, 1998; Naranjo, 1995), but higher than in Honduras (Flesher, 1999) and Belize (Fragoso, 1991). Our estimates suggest that the status of tapir populations in slightly hunted and non-hunted sites of the Lacandon Forest is good. Yet, the situation is noticeably different at persistently hunted sites inside MABR, and especially outside this protected area. Tapirs have very low reproductive productivity (Eisenberg, 1989) and their populations do not recover easily from an intense or even a moderate harvest rate (Bodmer, 1995). In addition, because of its habitat requirements, this mammal is sensitive to habitat fragmentation and other effects of human activity (e.g., noise, odours, dogs and cattle; Matola *et al*., 1997; Naranjo & Cruz, 1998). In persistently hunted sites, habitat transformation and forest fragmentation combined with over-hunting have driven tapir populations to the point of near-extinction.

Population Structure

During the study we observed 78.9% adults (n=15), 15.8% juveniles (n=3), and 5.3% young (n=1). We were able to identify the sex of 14 of the 19 individuals observed. We saw eight females (42.1%), six males (31.6%), and five unidentified animals (26.3%; Table 2). The female-male ratio did not differ from the expected 1:1 (57.1: 42.9 %, respectively).

From our hunting records, we observed that the proportion of young tapirs was higher in persistently hunted than in

Table 1. Relative abundance (encounter rates) and densities of Baird's tapir in the Lacandon Forest, Mexico (1998-2001).

Variable	Slightly hunted sites	Persistently hunted sites	Overall
Distance travelled (km)	1309.9	598.2	1908.1
Number of tapirs seen	16	3	19
Population density (ind/km² ± SE)	0.24 ± 0.09	0.05 ± 0.04	0.22 ± 0.12
Encounter rate (tapirs/100 km)	1.22	0.50	1.00
Number of tracks found	361	87	436
Encounter rate (tracks/100 km)	27.56	14.54	22.95

Table 2. Age structure and sex ratios of Baird's tapir estimated through three different techniques in the Lacandon Forest, Mexico (1998-2001).

Technique	♀ : ♂	Unknown	Young and juveniles		Adults		Total
	n	n	n	%	n	%	n
Direct sightings	8 : 6	5	4	21.1	15	78.9	19
Collected skulls	?	3	2	66.7	1	33.3	3
Interviews	3 : 2	0	1	20.0	4	80.0	5

slightly hunted sites (x^2=13.4; df=1; P=0.0002). If hunters were not selective towards the largest animals within each population, then our data would reflect the actual age structure of persistently hunted populations, suggesting a probability that source-sink systems are functioning for tapirs (Naranjo, 2002). Considering the vulnerability of tapir populations to hunting (Bodmer *et al*., 1997), immigration of individuals from slightly hunted areas of MABR would be a key factor in maintaining the persistently hunted populations in the Lacandon Forest.

Home Range and Movements

The two-month home range of a 200-kg adult female tapir was estimated at 0.67 and 0.22 km² using Kernell's and the Minimum Convex Polygon estimators with 95% of localisations (n=10), respectively. The number of localisations obtained for this female was very small, probably because she was not a resident of the capture site. After the last localisation, we unsuccessfully tried to locate her signal in a radius of about 10 km for several months. Dispersing tapirs have been observed moving over 20 km in a few days to establish a new home range in the rainforest of Corcovado National Park, Costa Rica (Foerster, 1998). This could have been the case with our female tapir in the Lacandon Forest, even though she was the first radio-tracked individual of this species in Mexico.

Other information on tapir movement includes the observation, made on several occasions, of fresh tapir tracks coming out of the water in forest fragments outside MABR. Local fishermen and riverside dwellers confirmed this observation by describing occasional sightings of tapirs swimming across the Lacantún River towards community lands during the dry season, when the waters are calm, clear, and shallow. Dispersing tapirs coming from MABR are probably attracted by fruiting trees and forage growing in large forest patches across the river. However, we did not have observations or references of tapirs crossing the Lacantún River from community lands to MABR. This might be an indicator that MABR could indeed function as the source of individuals taken by hunters from neighbouring communities.

Hunting Sustainability

Harvest/Production ratios (H/P) estimated for tapir populations in the Lacandon Forest are shown in Table 3. Under the unified harvest model (Bodmer and Robinson, In press), Baird's tapir appeared to be over-hunted in the study area. However, a further analysis revealed that tapirs were actually over-exploited in the Tzeltal community of Nueva Palestina, one of the largest settlements in the region (Table 3, Figure 2). Tzeltal hunters took a little more than 100% of P, while Lacandon hunters extracted only 15% of P, and Mestizo hunters did not take tapirs at all.

Table 3. Sustainability of tapir hunting by three ethnic groups in the Lacandon Forest through the unified harvest model (Bodmer and Robinson, in press).

Variable	Lacandon	Tzeltal	Mestizo	Overall
Production (P; ind/km²) [a]	0.007	0.007	0.007	0.007
Harvest Rate (H; ind/km²)	0.001	0.007	0	0.003
H/P	0.15	1.00	0	0.44
Sustainable? [b]	Yes	No	-	No
Carrying capacity (K; ind/km²) [c]				0.24
Density of hunted population (D; ind/km²)				0.05
D/K * 100				20.8
Status				Risky

[a] Based on actual densities estimated in the Lacandon Forest and reproductive data from R.E. Bodmer (Personal communication).

[b] A sustainable harvest of tapirs should be lower than 20% of population production (H/P < 0.20; Bodmer, 1994).

[c] It is assumed that populations are at their carrying capacity (K) in non-hunted sites. Therefore, tapir density estimated in non-hunted sites is used as K.

The causes of these variations may be related to the geographical, cultural, and socio-economic contexts of hunters and their communities. Tzeltal hunters of Nueva Palestina (n=850) by far outnumbered Lacandon and Mestizo hunters combined (n=140), and used a larger catchment area than the other two ethnic groups. This implied that Tzeltal hunters had a higher probability of finding a tapir in their home ranges than Lacandon and Mestizo hunters. On the other hand, most Lacandon hunters interviewed in this study said that they did not like to hunt tapirs because they are too heavy and too bulky to transport back to their homes. Mestizo hunters, on their part, did not harvest tapirs basically because these mammals are rarely found in their community lands. In spite of this, the unified harvest model allowed us to infer that on a regional scale, tapir populations in hunted areas are at only 21% of K, which means that they could have been decimated by hunting in the study area (Table 3, Figure 2). Interestingly, the analysis of interviews with local hunters showed us that hunting pressure on tapirs has been relatively low during the last decade in the Lacandon Forest. In fact, the tapir does not appear within the top ten hunted species in the study area (Naranjo, 2002). However, the status of this ungulate does not appear hopeful on a more local scale: it has become extremely rare in most community lands outside MABR.

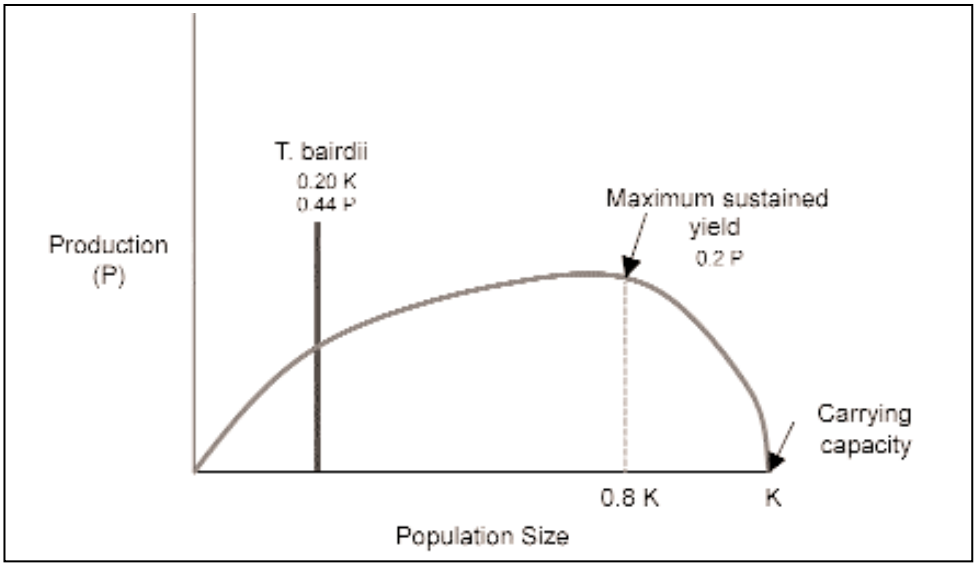

Figure 2. *Unified harvest model showing the sustainability of hunting and status of Baird's tapir populations at persistently hunted sites of the Lacandon Forest, Mexico. Note that the vertical bar representing the hunted tapir population is on the left side of the x-axis, denoting a very low density with respect to K. Meanwhile the bar is considerably higher than the MSY curve, which implies that hunting on this mammal is far from sustainable in the study area (Bodmer, 2001).*

Conservation Proposal

We organized workshops on sustainable hunting in the communities visited during the study. In addition to our own results, we also incorporated most of the suggestions made by residents of the Lacandon Forest in the conservation proposal presented below.

Habitat Protection

Large-sized, charismatic species requiring an extensive mosaic of habitat types can function as "flagships" and/or "umbrellas" for the conservation of entire communities and even ecosystems (Entwistle & Dunstone, 2000). Considering its size, habits and habitat requirements, Baird's tapir could represent such a species in the Lacandon Forest. Consequently, planned actions to conserve Baird's tapir populations can be beneficial for many other wildlife species in the area.

It is essential to maintain the most important protected areas in the Lacandon Forest (Montes Azules, Lacantún, Chankín, Yaxchilán and Bonampak) to ensure the long-term persistence of tapir populations. Connectivity amongst those reserves is also a relevant factor to allow for genetic flow between local populations. In this sense, we believe that it is extremely important to avoid further deforestation in the area known as Sierra de la Cojolita, which connects Montes Azules-Lacantún-Bonampak with the Yaxchilán and Chankín reserves. The latter reserves in turn favour the eventual dispersal of tapirs and many other species towards the rainforests of northern Guatemala (Figure 3). The creation and maintenance of smaller community reserves around MABR should be considered as valuable components for the conservation strategy of wildlife habitat. In spite of their relatively small size, these reserves may function as corridors that facilitate animal transit from, and to, larger and better areas for the survival of tapirs and many other terrestrial vertebrates.

Perennial water bodies are crucial elements in tapir habitat. Rivers and streams are particularly important not only as water sources, but also as suitable habitat for this mammal. The preservation of wide vegetation strips along tributary streams of main rivers (Usumacinta, Lacantún and Lacanjá, among others) will be favourable for the movement and foraging of tapirs and other herbivores.

Hunting Regulation

Residents of communities around MABR let us know during the workshops that tapirs represent interesting, charismatic and rare species for them. Therefore, they themselves, have recently discouraged tapir hunting on their lands, although this study did find over-hunting of this species in that area. On the other hand, local people regarded peccaries, deer, pacas, and other mammals as important game species that should be managed to increase their harvest. After researching the viewpoint of the local people, we deem it necessary to promote community organisation to regulate subsistence hunting. This organisation may be initiated through the election, by the residents themselves, of small "wildlife committees" to establish and encourage hunting regulation.

We propose that subsistence hunting may be regulated through land planning in each community. Hunting of vulnerable species such as the white-lipped peccary (*Tayassu pecari*), great curassow (*Crax rubra*), black guan (*Penelope purpurascens*), and parrots (*Amazona* spp.), may be temporarily or definitively banned (Table 4). A complementary strategy may consist of establishing har-

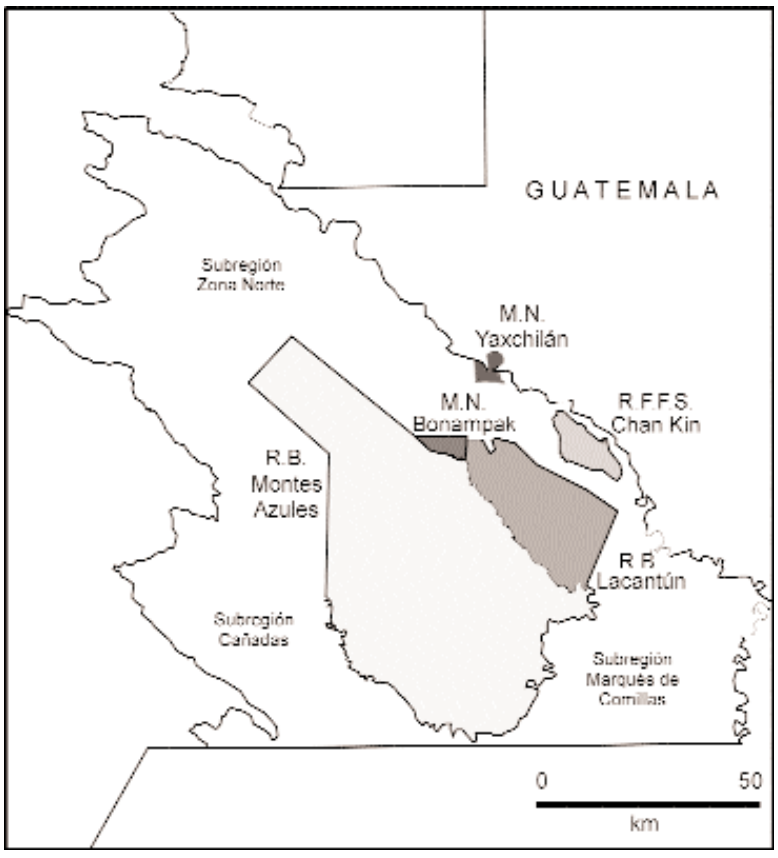

Figure 3. *Protected areas of the Lacandon Forest, Mexico.*

Table 4. Proposed strategies for sustainable use and protection of game mammals and birds in community lands of the Lacandon Forest, Mexico.

Permanently banned hunting	Spatially regulated hunting	Numerically regulated hunting
Alouatta pigra	*Tayassu pecari*	*Agouti paca*
Ateles geoffroyi	*Amazona spp.*	*Dasypus novemcinctus*
Panthera onca	*Crax rubra*	*Mazama americana*
Leopardus pardalis	*Penelope purpurascens*	*Odocoileus virginianus*
Leopardus wiedii		
Tapirus bairdii		
Ara macao		

vest quotas for species more tolerant to hunting, such as the paca (*Agouti paca*), nine-banded armadillo (*Dasypus novemcinctus*), collared peccary (*Tayassu tajacu*), red-brocket deer (*Mazama americana*), white-tailed deer (*Odocoileus virginianus*), and tinamou (*Tinamus major*). In regard to threatened species such as tapirs, primates, wild cats and scarlet macaws, we recommend a definitive ban on hunting in community lands (Table 4).

Environmental Education

We are convinced that local people constitute an essential component in the conservation of natural areas. Many residents of the study area made it clear that they are not concerned about maintaining protected areas and their species because they do not perceive any tangible benefit from such preservation. Therefore, we believe it essential to promote awareness about the potential benefits of natural areas and biodiversity among residents.

Economic Alternatives for Local People

As residents of areas inhabited by tapirs get more and better sources of income, they will probably develop a better attitude towards projects and programmes related to wildlife sustainable use and conservation. In this sense, some locals can be hired and trained as conservation promoters within their own communities instead of sending employees from the city. These promoters may in turn form part of the "wildlife committees" described above in order to help encourage wildlife management on their own land. In addition, several residents of communities around MABR have been employed for several years as field assistants in research projects conducted in the area (four people in our own project). This alternative could be encouraged by both the federal Wildlife Office (Dirección General de Vida Silvestre-INE) and the reserve authorities when institutions apply for research permits.

The Lacandon area has great potential for alternative tourism (i.e. "ecotourism") because of its wildlife and its scenic and archaeological richness. Tapirs, in particular, seem to be a very attractive species for nature-oriented tourists. Interested persons, groups, or even communities might be advised and trained to apply for their own credits or grants from government agencies or NGO's to initiate ecotourism or some other kind of environmentally sound project, such as agroforestry, around existing reserves.

Research and Monitoring

Scientific research and monitoring are fundamental for designing viable conservation strategies. We specifically recommend promoting research on the hunting sustainability and status of threatened game species in the northern (Zona Norte) and western (Cañadas) sectors of MABR, as well as in its neighbouring reserves: Lacantún, Chankín, and Yaxchilán. Additional research topics relevant for tapirs include their response to habitat fragmentation and human activities such as selective logging, extraction of non-timber products (i.e. *Chamaedorea* spp. and *Aechmea* sp.), traditional agricultural practices and road construction.

Acknowledgements

This study was supported by the U.S. Fish and Wildlife Service, The Mexican National Commission for Biodiversity (CONABIO), The Mexican National Council of Science and Technology (CONACYT), The Compton Foundation, The US Man and Biosphere Program (MAB), and Idea Wild. El Colegio de la Frontera Sur (ECOSUR) facilitated infrastructure, vehicles and logistic support at all times. The Dirección General de Vida Silvestre-INE and the staff of Montes Azules Biosphere Reserve allowed us permission to carry out this project. Conservation

International (Chiapas Chapter), the University of Florida, the Universidad de Ciencias y Artes de Chiapas (UNICACH) and the communities of Playón de la Gloria, Flor del Marqués, Reforma Agraria, Adolfo López Mateos, Nueva Palestina, Bethel and Lacanjá-Chansayab collaborated with us in different ways. We especially give thanks to Jorge Bolaños, Carlos Muench, Michelle Guerra, Rausel Sarmiento, Isidro López, Romeo Jiménez, José A. Jiménez, Celedonio Chan, Germán Hernández, Antonio Navarro Chankín, Pascual Pérez, Miguel Muñiz and Miguel Martínez Icó.

Literature cited

Bodmer, R.E. 1995. Managing Amazonian wildlife: Biological correlates of game choice by detribalised hunters. *Ecological Applications* 5:872-877.

Bodmer, R.E. 2001. Evaluating wildlife sustainable use in the Amazon: the unified harvest model. In: P. Sánchez, A. Morales & H.F López (eds.), *Proceedings of the Fifth International Congress on Wildlife Management in Amazonia and Latin America*, p. 55. Fundación Natura, Bogotá, Colombia.

Bodmer, R.E., Eisenberg, J.F. & Redford, K.H. 1997. Hunting and the likelihood of extinction of Amazonian mammals. *Conservation Biology* 11:460-466.

Bodmer, R.E. & Robinson, J.G. (In press). Evaluating the sustainability of wildlife in the Neotropics. In: K. Silvius, R.E. Bodmer & J.M. Fragoso (eds.), *People in Nature: Wildlife Conservation in the Neotropics*. Columbia University Press, New York, NY, USA.

Buckland, S.T., Anderson, D.R., Burnham, K.P. & Laake, J.L. 1993. *Distance Sampling: Estimating Abundance of Biological Populations*. Chapman & Hall, London.

Castillo, G. & Narave, H. 1992. Contribución al conocimiento de la vegetación de la Reserva de la Biósfera Montes Azules, Selva Lacandona, Chiapas, México. Pp. 51-85. In: M.A. Vásquez & M.A. Ramos (eds.), *Reserva de la Biósfera Montes Azules, Selva Lacandona: Investigación para su Conservación*. Publ. Esp. ECOSFERA no.1, San Cristóbal de Las Casas, Chiapas, México.

Conroy, M.J. 1996. Abundance indices. In: D.E. Wilson, F.R. Cole, J.D. Nichols, R. Rudran & M. Foster (eds.), *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals* pp. 179-192. Smithsonian Institution Press, Washington, D.C., USA.

Cruz, E. 2001. *Hábitos de Alimentación e Impacto de la Actividad Humana sobre el Tapir (Tapirus bairdii) en la Reserva de la Biosfera La Sepultura, Chiapas, México*. M.S. Thesis, El Colegio de la Frontera Sur, San Cristóbal de Las Casas, Chiapas, México.

Dimmick, R.W. & Pelton, M.R. 1994. Criteria of sex and age. In: T.A. Bookhout (ed.), *Research and Management Techniques for Wildlife and Habitats*, pp. 169-214. Fifth edition. The Wildlife Society, Bethesda, Maryland, USA.

Eisenberg, J.F. 1989. *Mammals of the Neotropics. Vol. I, The Northern Neotropics*. University of Chicago Press, Chicago, IL, USA.

Entwistle, A. & Dunstone, N. 2000. *Priorities for the Conservation of Mammalian Diversity*. Cambridge University Press, Cambridge, UK.

Flesher, K. 1999. Preliminary notes on the conservation status of Baird´s tapir in north-eastern Honduras. *Oryx* 33:294-300.

Fragoso, J.M. 1991. The effect of selective logging on Baird´s tapir. In: M.A. Mares & D.J. Schmidly (eds.), *Latin American Mammalogy; History, Biodiversity and Conservation*, pp.295-304. University of Oklahoma Press, Norman, OK, USA.

Foerster, C.R. 1998. *Ambito de Hogar, Patrón de Movimientos y Dieta de la Danta Centroamericana (Tapirus bairdii) en el Parque Nacional Corcovado, Costa Rica*. M.S. thesis, Universidad Nacional, Heredia, Costa Rica.

Instituto Nacional de Ecología (INE). 2000. *Programa de Manejo, Reserva de la Biósfera Montes Azules, México*. Secretaría de Medio Ambiente, Recursos Naturales y Pesca, México, D.F.

IUCN. 2002. *2000 IUCN Red list of threatened animals*. IUCN, Gland, Switzerland. (http://www.redlist.org).

March, I.J., Naranjo, E.J., Rodiles, R., Navarrete, D.A., Alba, M.P. & Hernández, P.J. 1996. *Diagnóstico para la Conservation y Manejo de la Fauna Silvestre en la Selva Lacandona, Chiapas*. Informe final para la Secretaría de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP). El Colegio de la Frontera Sur, División de Conservation de la Biodiversidad. San Cristóbal de Las Casas, Chiapas.

Matola, S., Cuarón, A.D. & Rubio-Torgler, H. 1997. Status and action plan of Bird's tapir (*Tapirus bairdii*). *In:* D.M. Brooks, R.E. Bodmer, and S. Matola (eds.). *Tapirs: Status, Survey and Conservation Action Plan*, pp. 29-45. IUCN, Gland, Switzerland.

Medellín, R.A. 1994. Mammal diversity and conservation in the Selva Lacandona, Chiapas, México. *Conservation Biology* 8:780-799.

Medici, P., & Valladares, C. 1997. Biologia e conservacao danta (*Tapirus terrestris*) no Parque Estadual Morro do Diablo, Sao Paulo, Brasil. Pp. 32-33 in: R.E. Bodmer (ed.), *Proc. Third International Conf. of Wildlife*

Management in Amazonia. Santa Cruz de la Sierra, Bolivia.

Montenegro, O.L. 1998. *The Behavior of Lowland Tapir (Tapirus terrestris) at a Natural Mineral Lick in the Peruvian Amazon*. M.S. Thesis, University of Florida, Gainesville, FL, USA.

Naranjo, E.J. 1995. Abundancia y uso de hábitat del tapir (*Tapirus bairdii*) en un bosque tropical húmedo de Costa Rica. *Vida Silvestre Neotropical* 4:20-31.

Naranjo, E.J. 2002. *Population ecology and conservation of ungulates in the Lacandon Forest, Mexico.* Doctoral thesis. University of Florida, Gainesville, FL, USA.

Naranjo, E.J. & Cruz, E. 1998. Ecología del tapir en la Reserva de la Biósfera La Sepultura. *Acta Zoológica Mexicana* 73:111-125.

Naranjo, E.J., Rangel, J.L., Vásquez, I. & Hernández, H.G. 1997. *Diagnóstico y plan de manejo para la fauna silvestre de la subregión Marqués de Comillas, Chiapas, México*. Report to the Secretaría de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP). San Cristóbal de Las Casas, Chiapas.

Secretaría de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP). 2000. Norma Oficial Mexicana NOM-059-ECOL-2000. *Protección Ambiental, especies de Flora y Fauna Silvestres de México, Categorías de Riesgo y Especificaciones para su Inclusión, Exclusión o Cambio, y Lista de Especies en Riesgo*. Diario Oficial de la Federación 488:1-61.

Southwell, C. 1996. Estimation of population size and density when counts are incomplete. Pp. In: D.E. Wilson, F.R. Cole, J.D. Nichols, R.Rudran, & M. Foster (eds.), *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals*, pp.193-210. Smithsonian Institution Press, Washington, D.C., USA.

Thomas, L., Laake, J.L., Derry, J.F., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Strindberg, S., Hedley, S.L., Burt, M.L., Marques, F., Pollard, J.H. & Fewster, R.M. 1998. *Distance 3.5.* Research Unit for Wildlife Population Assessment. University of St. Andrews, UK.

Vásquez, M.A. & Ramos, M. 1992. *Reserva de la Biósfera Montes Azules, Selva Lacandona: Investigación para su Conservación*. Publ. Ocas. Ecosfera no.1. San Cristóbal de Las Casas, Chiapas, México.

White, G.C. & Garrott, R.A. 1990. *Analysis of Wildlife Radio-tracking Data*. Academic Press, San Diego, CA.

IUCN/SSC Tapir Specialist Group Membership Directory

1. AGORAMOORTHY, GOVINDASAMY (Taiwan)
Ph.D. Associate Professor, Sun Yat-Sen University
P.O. BOX 59-157, Kaohsiung, TAIWAN 80424
Phone: ++886-7525-2000 Ext. 3623 /
Fax: ++886-7525-3623
E-mail: agoram@mail.nsysu.edu.tw

2. ALDAN, EPIGMENIO CRUZ (Mexico)
M.Sc. Researcher, Instituto de Historia Natural y Ecología
Calz. Cerro Hueco, s/n, P.O. BOX 6, Tuxtla Gutiérrez, Chiapas, MEXICO 29000
Phone: ++961-44765; 44459; 44701 / Fax: ++961-44700
E-mail: cruz5910@prodigy.net.mx

3. ANDRADE, DARIO MARCELINO GUIRIS (Mexico)
M.Sc. D.V.M. Jefe de Operaciones, UN.A.CH. / Policlinica y Diagnóstico Veterinario
Blvd. Angel Albino Corzo # 635, Zona Militar, Tuxtla Gutiérrez, Chiapas, MEXICO 29079
Phone & Fax: ++01-9-614-4214
E-mail: dguiris@islagrande.cu

4. ARENAS, SERGIO SANDOVAL (Colombia)
Research Assistant, La Planada Nature Reserve
Apartado Postal 15-62, Pasto Narino, COLOMBIA or AA 9925, Bogota, COLOMBIA
Phone & Fax: ++57-1-289-1570
E-mail: ornatus@lycos.co

5. AYALA, GUIDO (Bolivia)
M.Sc. Ecólogo de Vida Silvestre, Wildlife Conservation Society Bolivia
Calle 21 de Calacoto No. 1100, Edif. San Miguel Bloque 1100, Oficina 102, La Paz, BOLIVIA
Phone: ++591-2-277-2455; 2-211-7969; 2-212-6905 /
Fax: ++591-2-277-2455
E-mail: gayala@supernet.com.bo /