Ecology and Behavior of Reintroduced Andean Bears in the Biological Reserve Maquipucuna, Ecuador: Implications in Conservation

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Summary

In December 1995, the first South American reintroduction of three young Andean Bears (*Tremarctos ornatus*) to their natural habitat took place after a rehabilitation process at the Maquipucuna Reserve, Ecuador. The selected bears were two females and one male nicknamed Chiquita, Tuta and Paddington. Of these bears, only two were successfully tracked through land radio telemetry because Tuta took off her radio collar after liberation. In the following 8 months in which they were tracked, Chiquita and Paddington occupied home ranges that varied from 4.1 to 61 Km^2 respectively and showed great diurnal and nocturnal activity. During the 8 months of tracking, 1440 minutes of direct observation were obtained during 127 encounters from distances between 5 and 30 meters, which allowed the study of their behavior, especially their feeding habits. The bears spent an average of 70.2% of the direct observation on feeding. Palms were the most important plants in the bears' diet, from which *Euterpe* sp. was their favorite species. This paper discusses the importance of these results in the field of conservation biology and analyzes the advantages and disadvantages of re-introduction programs to restore population levels of this species, based on the latest population genetics and molecular biology studies.

Key words: Rehabilitation, Andean bear, *Tremarctos ornatus*, radio telemetry, direct observation, Ecology, feeding behavior, conservation.

Introduction

Mammals constitute one of the better known and more studied groups of all living organisms. "Hotspots", "threat spots" and countries with the highest numbers of threatened species have been previously identified (Ceballos and Brown 1995,Cole et al.1994, IUCN 1996). Species richness, species diversity and ranges of endemism of mammals for each country have been used, together with measures of habitat loss and human population growth, to identify global antropic threats to biological diversity (Sisk et al.1994). However, many gaps still exist in the knowledge of mammals in Neotropical regions. One of these gaps unquestionably is the Andean bear, better known as the spectacled bear (*Tremarctos ornatus).* An analysis of the scientific literature published from 1988 to 1997 in the four well known conservation magazines conservation (Oryx, Biological Conservation, Conservation Biology, and Biodiversity and Conservation) revealed no articles on the Andean bear (Amori and Gippoliti 2000). Despite being placed in the vulnerable category for the IUCN (Hilton-Taylor 2000) due to the fragmentation of its natural habitat and its low population, this species is one of the least-known species of the family Ursidae. The few studies carried out have been based on the analysis of evidence of bear activity (tracks, excrement, foot prints, scratches, etc.) and did not include visual records or animal approaching (Mondolfi 1971, Suárez 1985, Goldstein 1988, Orejuela 1988, Rodríguez 1991, Yerena 1994a, Torres et al.1995). Although evidence of activity certainly can help us understand certain patterns of presence and distribution, records of visual observation are the most reliable data for interpreting spatial patterns and factors in the habitat selection and in feeding behavior.

The objective of the present study was to increase the limited knowledge that exists about the ecology of this species and to acquire experience in the process of reintroduction of the Andean bear. To fulfill this objective it was decided to rehabilitate and release three individuals in the Biological Reserve Maquipucuna and track them after liberation by means of terrestrial radio telemetry. This technique was designed to enable the investigator to approach the animal. Based on the direct observations obtained it is possible to verify or cast doubt upon various ethological data exposed by other researchers (Mondolfi 1971, Peyton 1980, Goldstein 1991, Zequera 1989; Rodríguez 1991, Weinhardt 1993, Torres et al. 1995). This paper also presents new information about feeding resources used by Andean bears in their diet, and the importance of habitat selection under altitudinal gradients and ecological alteration is reviewed herein.

We hope that the experiences and results obtained in this study will contribute to and motivate new efforts to reintroduce individuals in Andean countries where populations of the Andean bear still exist or where there are bears in captivity. We are sure that programs of this type are the only way to save this species from extinction, but they should be conceptualized and oriented in a way that not only involves the populational recovery of the species but also the protection and/or restoration of their natural habitat.

Methodology

Fig. 1. Location of Maquipucuna Biological Reserve in northwest Ecuador

This study was implemented in the Maquipucuna Biological Reserve (Fig.1.), located at 00º 00' north latitude and 78º 37' west longitude and occupying the cloud forests of the upper Guayllabamba River region, on the western slope of the Andes, in the northwest region of Ecuador. The Reserve consists of 4500 hectares, surrounded by a protective forest of 14000 hectares. Altitudes range from 1200m to 2800 m. Annual temperatures vary between 10 and 20°C. The flora includes species of three life zones (Holdridge 1993): Pre-montane humid forest, lower montane humid forest and montane humid forest.

Exemplars of study

Three juvenile bears were selected, two females and a male, to which were assigned the names of Chiquita, Tuta and Paddington, respectively. The bears were born wild, but their origin was not known. When they were between 4 and 5 months of age, the bears were confiscated by authorities of the Wildlife Department of INEFAN (Ecuadorian Institute of Forests and Natural Areas), now Ministry of Environment and the Civil Defense, from people that had them as pets, in areas near the city of Cuenca (2800 msnm), in the southern region of the country. The cubs were put into the custody of Jim and Teresa Clare, an English family living near the afore-mentioned city. The bears entered the program when they were approximately 17 months of age. Following the procedures recommended by the IUCN (1987) for programs of reintroduction, and after 8 months of rehabilitation, the bears were liberated (Castellanos 1998).

Terrestrial Telemetry

Each liberated Andean bear wore a radiocollar model 500 (Telonics) with a movement sensor that transmitted two signals: a slow pulsation and another quick one, which were activated according to the movement of the animal. The speed of the pulsations indicated whether the bear was active (feeding, walking, climbing) or inactive (resting, sleeping). The collars were designed to be semi-expandable and partially biodegradable; the battery life was approximately 2.5 years.

For the tracking of the rehabilitated bears we used a model TR-2 receiver (Telonics). The fundamental purpose of the telemetry was to allow the approach of investigators toward the animal (Castellanos 1994, Joshi et al, 1995).

The monitoring lasted 8 months. Each bear was tracked 8 days per month, 12 hours per day; the search generally began at 06H00 and it finished at 18H00.The team of trackers was composed of three people. When the radio signal indicated the approach to the bear, the team of trackers dispersed to cover a bigger area, maintaining contact by means of communications radios. Once the animal was sighted, the trackers kept a distance of approximately 30 m and made observations with the help of binoculars, although in some instances we surprised the bear at distances as close as approximately 5 m.

The behavioral data were taken *ad libitum* (Altmann 1974) and each activity the animal carried out was recorded with the exact time it happened. The results obtained were placed on a form (Castellanos 1998). Behavior was only documented when the bear did not notice the presence of investigators. We assumed that the animal had discovered the investigator's presence when it began to sniff insistently and scrutinize the area in search of intruders.

When the animal went away, the plants eaten were quantified and the place of the encounter located by means of previously identified visual reference points - hills, farms, and towns. We marked the location of the bear on a map of the study area using triangulation. By means of plotting and planimetry (Amstrup and Beecham 1976), the sizes of home range (defined area and defined by the number of sightings) and core area (small area inside the home range, where the animal was observed more than 65% of the time) was estimated for each bear.

Feeding behavior

Every time that one of the bears was observed eating, the amount of time that was taken for that activity was measured. From these data percentages and averages of the time spent were obtained and used to determine their feeding preferences (Castellanos 1998).

The list of troffic resources used by the bears (Annex 1) was created by means of sampling during rehabilitation and direct observations during the period of tracking. Specimens were collected and identified by comparison with herbarium material and entomological collections and/or reviewing flora keys, insects and birds of Ecuador; and with the advice of specialists in Botany and Zoology of the Central University of Ecuador.

The radio telemetry allowed monitoring of the activity/inactivity of the study bears every hour of the day during the 8 months of pursuit. An actinogram was created based on the percentages of the readings obtained from the terrestrial radio telemetry.

Results

The study bears were followed for 8 months, 127 approaches between 5 and 30 m being achieved, for a total of 1440 minutes of direct observation. The approach to the animals was relatively easy when they were concentrating on obtaining the hearts of the palms (Arecáceas) and bijaos (Marantaceas) or when they had climbed a tree.

Use of space

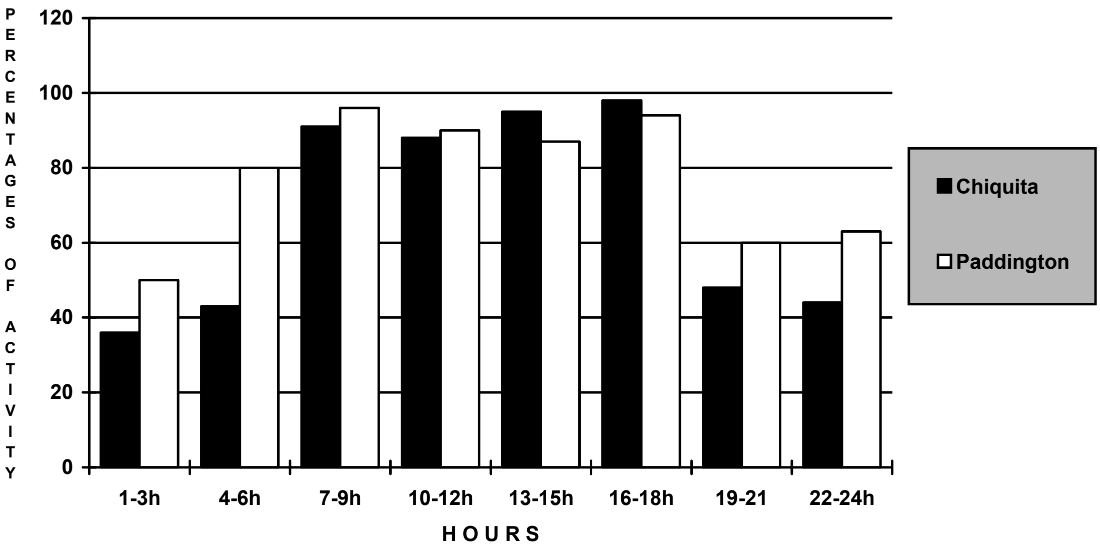
In Table 1, the home range and core area of two tracked study bears are shown. It is notable that the home range and core area of Paddington are 15 and 7 times bigger, respectively, than those of Chiquita.

Table 1. Home range and core area of two rehabilitated Andean bears in the Maquipucuna. Biological Reserve.

Individual Bear	Sex	Age (months)	Home Range Km^2	Core Area Km^2	Altitude m	Dates of Tracking	Number of Locations
Paddington	M	31	61	24.9	1200 –2660	12/95 - 08/96	90
Chiquita	H	36	4.1	3.5	1280- 1700	12/95 - 08/96	55

Figure 2. Percentages of activity of Paddington and Chiquita in different periods of the day, obtained by means of radio telemetry during 8 months.

Actinogram



The actinogram (Fig. 2) is based on 1498 readings of activity and inactivity. It indicates that Paddington began to move in the dawn from 04H00 to 06H00 (80%); he reached maximum levels of activity from 07H00 to 9H00 (96%) and from 16H00 to 18H00 (94%); he took small rests from 10H00 to 15H00 (90 and 87%). His activity fell (60%) toward the hours after twilight, from19H00 to 21H00. Night activity achieved its maximum levels (63%) from 22H00 to 24H00 and it declined drastically from 01H00 to 03H00 (50%).

Chiquita moved from 07H00 to 09H00 (91%), took small rests between 10H00 and 12H00 (88%); she reached maximum levels of daytime activity between 13H00 and 18H00 (95 and 98%), reduced her activity from 19H00 to 21H00 (48%); then activity diminished as it lapsed into night (44 to 36%).

There is no data for Tuta because she removed her collar 15 days after her liberation.

Behavior

Table 2 indicates that in the 1440 minutes of direct observation, the study bears used 70.2% of their time eating, 19.7% walking and 9.1% resting.

Table 2. Percentages of time spent in different activities of three Andean Bears rehabilitated and liberated in the Maquipucuna, Biological Reserve between 1200 and 2660 m. recorded from direct observation.

Activity	Bears						AVERAGES	
	Paddington		Chiquita		Tuta			
	Time (Minutes)	%	Time (Minutes)	%	Time (Minutes)	%	Time (Minutes)	%
Eating	728	70.8	244	66	34	74	335.3	70.2
Walking	103	10	86	23.2	12	26	67	19.7
Resting	171	16.6	40	10.8	-	-	70.3	9.1
Playing	6	0.6	-	-	-	-	2	0.2
Masturbating	20	2	-	-	-	-	6.7	0.7
TOTAL	1028		370		46		481.3	99.9%

The olfaction of these animals is extremely sensitive. They can perceive from ground level when a tree is loaded with ripe fruits. Their hearing is moderate and vision is not good. Therefore on several occasions we observed them from the top of a 3-meter high tree. In these encounters the bears appeared restless, constantly sniffing in search of intruders, but they were never able to locate the observer.

Six types of sounds were detected and differentiated:
· (Kurrrrr), when they feel curious or afraid.
· (Tuutuctttt). emitted from the tops of the trees, when they feel discovered.
· Screams, when they fight for food.
· Short blows, when attacking or surprised.
· Groans, (Eggmmmmm). Emitted when found in treetops and they are cornered.
·Vehement, (MMrnnMMrnn) this sound was heard only from Paddington during oral masturbation (quickly licking his penis). It is a penetrating noise and it could be heard approximately 30 m away during tracking.

Once liberated, the bears crossed torrential rivers without any more effort than going from one place to another. This was recorded on 4 occasions for Paddington and 2 for Tuta.

It appears that when they are threatened or surprised on the ground, the bears stand erect on their back paws or they stop to look for the intruder. Once the danger is located and if it is close, the bears run away or climb the nearest tree.

There were 8 terrestrial nests and two arboreal nests built by the bears of the present study, usually located inside gulches of mature forest, next to currents of water.

Feeding behavior

The most important wild plants in the feeding of the study animals are *Euterpe* sp. and Prestoea *acuminata* of the family Arecaeae, found as frequently in the humid pre-montane forest as in humid lower montane forest, respectively (Tables 3 and 4). In the humid lower montane forest *Pitcairnia spp*. and in the humid montane forest *Ficus cf. cuatrecasana* were the most important wild food resources for the bears.

Table 3. Percentages of the time spent on each vegetable species by the three Andean bears rehabilitated and liberated in the Maquipucuna Biological Reserve between 200 and 2660 msnm. Records obtained by direct observation.

Food Resource	**Individual Bear**						**Averages (%)**
	Paddington		**Chiquita**		**Tuta**		
	Time (Minutes)	**%**	**Time (Minutes)**	**%**	**Time (Minutes)**	**%**	
Euterpe sp.	150	20.6	15	62	9	26.4	36.3
*Saccharum officinarum**	106	14.5	76	31.1			15.2
*Psidium guajava**	54	7.4	78	31.9	2	5.8	15
Prestoea acuminata	96	13.2	10	4.1	7	20.7	12.6
Calathea cf. lutea	100	13.7	45	18.4	2	5.9	12.6
Nectandra acutifolia	123	16.9	15	6.2	4	11.8	11.6
*Musa paradisiaca**	23	3.1			9	26.4	9.8
Heliconia griggsiana	30	4.1			1	2.9	2.3
Guzmania spp	18	2.5	5	2			1.5
Ficus cf. *cuatrecasana*	28	3.8					1.2

* In cultivations

Table 4. Percentages by species of food traces left by the Andean bear in different zones of life between 1200m and 2700 m in the Biological Reserve of Maquipucuna.

Family	**Food Resource**	**Nº of Samples**	**%**	**Altitude m**	**Type of Forest**	**Life Zones**
ARECACEAE	*Euterpe* sp.	143	20.4	1,200-1,700	Intervenido	bhPM
MUSACEAE	*Musa paradisiaca* [a]	77	11	1,200-1,700	Cultivated	bhPM
MARANTACEAE	*Calathea cf. lutea*	73	10.4	1,200-1,700	Intervenido	bhPM
ARECACEAE	*Prestoea acuminata*	69	9.8	1,700-1,900	Intervenido	bhMB
POACEAE	*Saccharum officinarum*	60	8.5	1,200-1,700	Cultivated	bhPM
BROMELIACEAE	*Guzmania* sp.	46	6.5	1,200-1,700	Mature	bhPM
HELICONIACEA	*Heliconia griggsiana*	43	6.1	1,200-1,700	Intervenido	bhPM
BROMELIACEAE	*Pitcairnia oblanceolata*	38	5.4	1,200-1,700	Cultivated	bhPM

MYRTACEAE	*Psidium guajava*	36	5.1	1,200-1,700	Cultivated	bhPM
LAURACEAE	*Nectandra acutifolia*	24	3,4	1.200-1.700	Intervenido	bhPM
BROMELIACEAE	*Pitcairnia* sp. 1	15	2,1	1.900-2.100	Mature	bhMB
CYPERACEAE	sp. 1	13	1,8	2.100-2.700	Mature	bhM
MORACEAE	*Ficus cf. cuatrecasana*	10	1,5	2.100-2.700	Mature	bhM
BROMELIACEAE	sp. 1	10	1,5	1.900-2.100	Mature	bhMB
BROMELIACEAE	sp. 2	10	1,5	2.100-2.700	Mature	bhM
ARECACEAE	*Aiphanes erinaceae*	8	1,2	1.200-1.700	Mature	bhPM
HELICONIACEAE	*Heliconia* sp. 1	8	1,2	1.200-1.700	Intervenido	bhPM
CYCLANTHACEAE	*Ciclanthus bipartitus*	8	1,2	1.700-1.900	Mature	bhMB
MARANTHACEAE	*Stromanthe stromanthoides*	6	0,8	1.700-1.900	Mature	bhMB
BOVIDAE	*Bos taurus*	3	0,4	1.700-1.900	Pasture	bhMB
TOTAL		382	100			

Discussion

The Andean bears of the present study were born wild, but their time spent in captivity caused them to have anthropophilic behavior and they ultimately became tame. However, when they left for the forest after rehabilitation, they "forgot" of their dependence on man and they began to manifest ¨wild¨ behaviors, including increases in natural escape behaviors (except Tuta). This behavior was also observed by John Beccham (pers. conv.) in similar studies with black bears (*Ursus americanus*). Therefore it can be assumed that the reported behavior of the study bears is that of animals in the recovery process and that it is possible to extrapolate from the data obtained from these bears to understand the ecology of wild bears.

During the tracking of the study bears, sometimes they noticed the presence of investigators at more than 30 m of distance, thanks to their olfaction. When they noticed the observer's presence, they changed their behavior drastically or they escaped. We opted not to bother the animal, and did not record this possibly slanted data of their behavior. The tracking continued after one or several hours, after the bear had calmed down. Meanwhile, as happened in many cases, if another bear was encountered first, we followed it.

Use of space

Among Ursids, the male moves over large areas, because of high metabolic demands that require the animal to explore extensive areas in search of food (Clevenger and Purroy 1990, Joshi et al. 1995). For this reason we can understand that Paddington has a bigger home range (61 Km^2) than that of Chiquita (4.1 Km^2).

The area of the Maquipucuna Biological Reserve, 45 Km^2, was too small to support the large movements made by Paddington, 61 Km^2, only covering his core area, 24.9 Km^2. Perhaps these vast movements were made by the study bear because he was trying to explore and colonize his new habitat. This behavior of moving long distances after liberation is very common in large translocated carnivorous animals, especially in bears (Linnell et al. 1997).

The core areas of Chiquita and Paddington were superimposed at a certain point in time, but this did not mean that they walked together. Although we observed them feeding simultaneously in overlapping areas on occasion, they remained at least 25 meters apart from each another and did not attempt to meet, confirming the solitary character of this species (Morris 1991, Ames 1994, PAHS 1995).

The core areas of Paddington and Chiquita were located inside the humid pre-montane forest (1200m-1700m), where the most important states of vegetal successionexist, such as remainders of mature forest, intervening forest, stubble, patches of sugar cane (*Sacharum officinarum*) and guayaba (*Psidium guajava*). Possibly, the bears preferred this life zone because it sustains a great quantity of palms that, together with nearby crops, helped satisfy their needs and nutrition requirements.

The other zones of life present in the Reserve of Maquipucuna, such as the humid lower montane forest (bhMB) and the humid montane forest (bhM), located between the 1700 and 2700 msnm, have a very low density of palms; which was confirmed in this study when we followed Paddington, who occupied these areas temporarily.

The bears of the study used paths on the mountain ridges to make large movements, characteristic of other big Andean mammals like the Andean tapir (Castellanos 1994), confirming that the ridges are used by the Andean bears as routes between the high and low parts of the mountain (Peyton 1983, Castellanos 2000a).

Activity

The differences of percentages of nocturnal activity between female and male that is demonstrated in the actinogram, may owe itself to the fact that Paddington was bigger and heavier than Chiquita, necessitating more time spent on feeding. This concurs with the observations of black bears by Garshelis and Pelton (1980). However, one cannot assert the causes of these differences until more individuals of both sexes are observed.

The actinogram points out that study bears don't have long periods of deep sleep during the night, so they need to take naps or rest in the coolness of the interior of the forest, between 10H00 and 15H00, which coincides with the highest temperatures of the day.

Behavior

Some authors support the idea that the Andean bear seems to be more a night and twilight animal than day animal; while others sustain that it is both a day and night animal and that most of its time is spent sleeping and eating. (Nowak 1991, Partridge 1992, Peyton 1999). A day animal is defined as one that takes advantage of the light of the day (in Ecuador this occurs between 06H00 and 18H00) to complete their different activities. In the study bears it was observed that most of their daytime was spent eating, and a very low percentage of time resting. During the night, on the other hand, they showed significant activity that did not necessarily involve displacement.

Several terrestrial nests were found together or among the vegetation used by the bear in their feeding. The nests were built with leaves or waste of *Euterpe sp*., *Prestoea acuminata*, *Heliconia* *sp*. and branches of *Nectandra acutifolia*, since what is not discarded they also eat during the night, which would in a way explain the night activity recorded in the bears of the study. This was confirmed when we saw Paddington sleep next to a calf he had previously killed, and feed sporadically during the night.

Local informants reported that when the Andean bear is surrounded in the top of a tree he jumps the gap to escape. This could not be confirmed by the present study. The biggest height from which they were observed to jump was approximately 2 meters. When threatened, they generally went up as high as possible in the tree, looking for a place to sleep and take refuge. They emitted nervous groans and blows, broke and threw branches, leaves, moss and then feigned to build a nest. This behavior was reported by Castellanos (2000b) when observing a wild bear also trapped in a tree before hurtling from an approximate height of 8 m.

The Andean bear may be the least aggressive with man of all the bear species (Peyton 1999). This could be corroborated with the study bears when we had near encounters; they preferred to escape rather than to attack us. However in a study in progress in the Alto Choco Reserve, one researcher (Armando Castellanos) observed a change in the behavior of a tame bear, which in the course of reintroduction showed increasingly more aggressive behavior toward man. This may have been due to hormonal changes as a result of being pregnant.

The oral masturbation observed in Paddington has also been noticed in other Andean bears (Zequera 1989, Yerena 1994b). According to Dr. Fernando Nassar (pers. conv.) this behavior cannot be normal in these animals. However, there is not enough information to affirm or reject this argument. The sounds heard from the study bears were also reported by Zequera (1989) in mature bears of the Natural Reserve The Planada - Colombia. It appears that a communication system exists that is exclusive to the species.

The low visual acuity observed in the study bears, the sniffing to search for intruders, and the method of escaping from danger were also noted by Vélez and Azurduy (2000) in a wild bear in Cochabamba, Bolivia.

Feeding behavior

Andean bears emigrate to different habitat types according to the season, to take advantage of the readiness of food resources (Peyton 1980, Suárez 1985, Rodríguez 1991, Torres et al. 1995). This could not be confirmed in the present study because only 8 months were spent tracking the bears. The large displacements made by Paddington may have begun because the animal followed the cycle of maturation of fruits that only happen in certain altitudes and times of the year (Rodríguez et al. 1986). What can be asserted based on observation of the study bears is that they exploit any nutritional resource according to the habitat that they occupy, which confirms the statements of Dierenfeld (1988) and Rodríguez (1991); that is to say, they are dining room opportunists. In this sense they do not seem to be different from other species of bears (Yerena 1994a).

The most important vegetable family in the feeding of the study bears is the *Arecaceae*, with its products *Euterpe sp*. and *Prestoea acuminata* being the most consumed species.

To reach the hearts of palms that were too high, the bears climbed contiguous trees and ate them from there. When they didn't have enough stability and comfort to eat the hearts from the palms, they broke off branches by holding them with their paws and "hands", allowing them to fall, and eating the heart on the floor.

Sugar cane is an important species in the diet of the studied animals, of which they consumed considerable quantities; however they carried out sporadic trips to the forest to take other resources and balance their diet. This is not an abnormal behavior in the study bears, because wild Andean bears also eat in sugar cane fields and naranjilla (*Solanum quitoense*) plantations (Castellanos 1998, Jorge Morales com. pers.).

Rodríguez (1991) suggests that the Andean bear does not consume the fruits in the trees, but rather it forages them on the forest floor; we observed our study bears feeding on fruits both on the ground and in the trees, including reaching the fruits on very high branches. The animals didn't always have secure enough balance and they could not use their claws, in which case they opted to break off the branches, so the fruits fell smoothly and were within their reach. These actions made by the bear in the higher strata of the forest cleared the canopy. For Rodríguez et al. (1986), this supposes an important function of the bear as a modifier of the microclimatic conditions of the lower strata, stimulating the natural regeneration of the forest.

Although there have been several reports of livestock pillaging on the part of Andean bears (Peyton 1983, Suárez 1985, Domico 1988, Mondolfi 1989; Goldstein 1988, 1991; Poveda 1999), this animal is not a true hunter; it can be more scavenger than predator (Peyton 1980). Also the Andean bear is anatomically designed to crush and to squeeze the vegetation on which it feeds, therefore it is the most herbivorous of all the bear species (Peyton 1999).

Paddington hunted, killing 3 calves of approximately 2 and 3 months of age, one at a time. From the wounds found on the bodies, tracks and information from witnesses, we deduced that the bear attacked in the open fields, and dragged the calf about 30 meters to his terrestrial nest in the interior of the forest, in a similar situation to the one reported by Goldstein (1988) and Poveda (1999). The purpose of this behavior was to hide the calf and to devour it peacefully; to do this the bear held the victim strongly with his jaws at the height of the loin. In the struggle and when trying to hold it, it broke the neck and other bones of the prey. In all three cases, he opened a hole in the same place from where he held the prey, tore into the abdominal cavity, stopping to ingest the viscera first and continuing later with the meat. Once satisfied, he did not abandon his prey, but rather continued hunting in the area where he kept his prey. He also took belongings like blankets, utensils, and provisions that he "stole" from loggers to his terrestrial nest.

CONSERVATION IMPLICATIONS

Among the different management strategies, reintroduction is one of those that offer many possibilities for the conservation of species in danger of extinction. The objective of reintroduction is to reestablish extinct populations in their natural habitats within an area of historical distribution or, in its less restricted application, to reinforce populations in decline. The origin of the liberated individuals can be captivity or the wild. This definition is in accord with the concepts proposed by the IUCN (1995) relating to reintroduction, translocation and reinforcement. Nevertheless, in the last twenty years defenders (Cade 1988, Campbell 1980, Conway 1980, Seal 1988, Soule et al. 1986) as well as critics (Dodd and Siegel 1991, Griffith et al. 1988, Povilities 1990, Varner and Monroe 1990) of breeding in captivity and reintroduction, have generated a debate on the true potential of these techniques in the conservation of threatened species. Perhaps the biggest concern is centered on the possible processes of population depression caused by endogamy in the case of breeding in captivity and for exogamy in the case of reintroduction. However, there are also logistic, economic and ethical limitations in the application of these techniques, which in developing countries become obstacles difficult to overcome in any program of conservation of a threatened species.

The Andean bear (*Tremarctos ornatus*) is a specific case in which it is possible to determine the utility of these techniques in the conservation of a threatened species. This mammal is extremely important in the Neotropic cloud forests because it modifies the strata of the forest, opening gaps and propitiating the natural dynamics of the Andean ecosystems. This condition could be more of a reason to sustain its choice as an umbrella species. Also, from the genetic point of view this species is unique within the *Ursidae* since it possesses a diploid number of 52 chromosomes with two branches, while the six species of the Ursus genus possess practically identical kariotypes composed of 74 acrocentric chromosomes. The separation of *Tremarctos* from the basal line constituted by *Ursus* would have occurred about 12 million years ago (Ruiz-García, in press). In consequence, *Tremarctos ornatus* constitutes a unique genetic and phylogenetic line. Therefore, their biological preservation should be carried out at all costs.

However, in Ecuador, as in the international community, there are defenders as well as detractors of these handling strategies. The present study does not seek to impose criteria or discredit previous studies on the ecology and conservation of the Andean bear. Rather, it tries to gather all the information possible about the individual ecology of this vertebrate and, by means of monitoring, to infer and/or to predict the state of its populations before the development of a national program of reintroduction, which is expected to have regional and continental transcendence. In particular, the reintroduction of the bears in this study has been questioned due to ignorance of the origin of the animals. Surely this concern is founded on the possible existence of several subspecies or races of Andean bear, which could cause a decrease in population due to exogamy. However, the available data indicate that there is no subspecies of this bear in South America (Kurten, 1966; Torres, 1992; Poveda, 1993).

For Suárez (1998) the translocation and the reintroduction of different populations' individuals can be indispensable to increase populational densities. This is an approach based on an international consent on handling strategies to save species in extinction danger (IUCN 1995). In Europe, brown bears (*Ursus arctos*) form three populations with minimal genetic differentiation, however this has not been an obstacle for translocation of specimens of brown bear from Slovenia to the French Pyrenees (Camarra, 1996; FAPAS and FIEP, 1996); in Greece bears of populations separated by 220 km were reintroduced; in Russia 30 orphan cubs were liberated in different places during the last 6 years; and in Italy bears were translocated from Slovenia (Mertzanis, et al. 1996; Pazhetnov, et al. 1997; Genovesi, et. al. 1999). But it is important to specify the status of conservation of the Andean bear in order to decide whether or not implementation of the aforementioned management techniques is necessary.

After this investigation, a genetic study of populations and molecular biology of the Andean bear was carried out with 82 samples coming from three Latin American countries, Venezuela, Colombia and Ecuador, by means of 5 hyper variable micro satellites (Ruiz-García and Castellanos in preparation), which allowed determination of the following fundamental aspects: (1) a strong fragmentation of the populations of bears in those three countries; (2) low levels of genetic variability -- alarmingly low was the heterozygosity level in the population from Ecuador, being the lowest reported for a population of bears and one of the lowest detected for any mammal species analyzed so far; and (3) low levels of genetic flow. These results show that the populations studied are completely disconnected from a genetic standpoint. In conclusion, the low levels of heterozygocity levels, the absence of genetic flow and the fragmentation of the populations could have begun with the arrival of man to America (16.000-30.000 years), or even earlier (60.000-150.000 years), and not in recent times. However, ecological problems such as hunting, deforestation, destruction of habitat and changes in the use of the earth could have contributed to make this populational decline more critical.

With these antecedents it is clearly demonstrated that the Andean bear is a biologically unique and ecologically important species in danger of extinction, and that there does not exist, at least for the population in Ecuador, valid scientific foundation to impede the realization of experimental studies of reintroduction and/or translocation of individuals.

Although this study did not have the benefit of the genetic studies of Ecuadorian Andean bears before the liberation phase in the Maquipucuna Reserve and later in the National Park Sangay, due to lack of resources and specialized personnel, it is important to point out that the study may have helped the population of wild bears to increase its genetic variability.

Also, reintroduction has as an objective not only to increase the effective number of individuals in a population in decline, but also to show that individuals can adapt to their natural habitat, and consequently be able to reproduce in the wild. For example, during this study the animals were nutritionally self sufficient for the 8 months that the tracking lasted, and within two years of having finished this study Chiquita was observed with a couple of cubs. This means that there is reproductive success and a flow of genes coming from these new individuals. Consequently we can infer that Chiquita had not lost or had recovered important aspects within her social, sexual and feeding behavior that allow her to interact like any wild bear.

The approaches of Tuta and Paddington to farms near the study area could still be indications of an anthropic dependence. If we analyze this behavior under strict criteria within the rehabilitation then we could say that it did not have the desired success. These approaches to farms are not unique; such approaches are also made by wild bears in the Andean region (Peyton, 1983; Weinhardt, 1993; Castellanos, 1998), black bears in North America (Hewitt and Kleberg, 1998) and brown bears in Spain (Clevenger and Purroy, 1990). In general, this behavior is associated with antropic changes inside the historical range of distribution of this species, which has produced a concentration of nutrition resources in relatively easily accessible fields of crops and livestock. Another factor that could impact negatively on the process of these individuals' reintroduction is the presence of farms, which basically surround the Reserve. This was the reason the two bears had to be transferred to the National Park Sangay, in the Central region of the Ecuador.

In conclusion, before this study there was little scientific information on the individual ecology of the Andean bear in Ecuador. A great part of the existing information was based on anecdotes, speculation and extrapolations of results of populational studies of other species of bears, resulting in inaccurate information on important aspects of their ecology and behavior. The data collected and analyzed in this study includes such important aspects of the diet of the Andean bear as its composition, abundance and distribution; use of space based on terrestrial telemetry and altitudinal and geographical displacements; feeding behavior, determined by function of frequency, intensity and time of forage. These are important tools to select potential areas of reintroduction, which should embrace the basic requirements of quality and quantity of habitat. Additional data on the natural history of these reintroduced bears, like the daily activity and behavior presented here, which are based on the time that the individuals spend looking for food, resting, sleeping and playing, are crucial to develop good monitoring programs with a true scientific foundation. We are confident that all the information here, including conservation activities in situ, and ex situ, represents the first and fundamental step for the handling of wild Andean bears, the main objective of which is to save this important species of the Neotropics from extinction.

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Annex 1

NUTRITION RESOURCES USED BY THREE SPECIMENS OF ANDEAN BEAR REHABILITATED IN MAQUIPUCUNA BIOLOGICAL RESERVE, ECUADOR

The numbers in italics refer to the literature cited at the end of the chart; the position of the same indicates the taxonomic level reported

FOOD ITEM		FAMILY	REPORTED	CONFIRMED	PARTS USED
VEGETABLES					
Saurauia (15)	sp.	ACTINIDACEAE	X	X	Fruits
		ANACARDIACEAE?		X	Fruits
Aiphanes (3,9,10)	*erinaceae*	ARECACEAE	X	X	Palm heart (cogollos) , buds
*Ceroxylon** (13,14)	sp	ARECACEAE	X	X	Palm heart
Chamaedorea	*pinnatifrons*	ARECACEAE		X	Palm heart (cogollos)
Euterpe (2)	sp.	ARECACEAE	X	X	Palm heart (cogollos), Fruits and stems
Prestoea (3,9,10)	*acuminata* (14)	ARECACEAE (11)	X	X	Cogollos, Fruits and Inflorescence
Ananas (14)	*comosus* (1)	BROMELIACEAE	X	X	Soft base of leaves
Guzmania (2,3,5,6,9,11,14)	spp.	BROMELIACEAE	X	X	Soft base of leaves
Greigia (2)	sp.	BROMELIACEAE*	X	X	Soft base of leaves
Pitcairnia	*oblanceolata*	BROMELIACEAE	X	X	Soft base of leaves
Pitcairnia (2,3,6,7,9)	spp.	BROMELIACEAE	X	X	Soft base of leaves
Vriesea (6)		BROMELIACEAE	X	X	Soft base of leaves
Hedyosmum	*racemosum*	CHLORANTHACEAE		X	Fruits
Carludovica	*palmata*	CYCLANTHACEAE		X	Cogollos
Cyclanthus (3,9)	*bipartitus* *(2)*	CYCLANTHACEAE (14)	X	X	Cogollos
		CYPERACEAE		X	Soft base of leaves

Vaccinium (1,2,5,11)	spp.	ERICACEAE* (9)	X	X	Fruits
Heliconia	*griggsiana*	HELICONIACEAE (10)	X	X	Cogollos
Heliconia	sp. 1	HELICONIACEAE (10)	X	X	Cogollos
Heliconia	sp. 2	HELICONIACEAE (10)	X	X	Cogollos
Nectandra (3,6,9,11,12)	*acutifolia*	LAURACEAE (6,14)	X	X	Fruits
		LAURACEAE?		X	Fruits
Calathea	*lutea*	MARANTACEAE		X	Cogollos
Calathea ?	sp.	MARANTACEAE		X	Cogollos
Stromanthe	*stromanthoides*	MARANTACEAE (10)	X	X	Cogollos
Miconia (15)	sp.1	MELASTOMATACEAE* (10)	X	X	Fruits
Miconia	sp.2	MELASTOMATACEAE		X	Fruits
Ficus (1,2,3,5,6,7,9, 10,11,14)	*cuatrecasana*	MORACEAE	X	X	Fruits
Musa	*paradisiaca*	MUSACEAE		X	Fruits y cogollos
Ardisia	sp.	MYRSINACEAE (12)		X	Fruits
Myrcia (110)	sp.	MYRTACEAE (11)	X	X	Fruits
Myrcianthes (6,10)	sp.	MYRTACEAE	X	X	Fruits
Psidium (2,9,10)	*guajava*	MYRTACEAE (3)	X	X	Fruits
Chusquea (1,6,10)	*scandens*	POACEAE	X	X	Cane
Guadua (7,10)	*angustifolia*	POACEAE	X	X	Buds
Sacharum	*officinarum*	POACEAE	X	X	Cane

	(7)	(10)			
Rubus	*robustus*	ROSACEAE		X	Fruits
Rubus	*urticifolius*	ROSACEAE		X	Fruits
Rubus (1,2,13)	spp.	ROSACEAE	X	X	Fruits
Gonzalagunia	sp.	RUBIACEAE		X	Fruits
Palicourea	*perquadrangularis*	RUBIACEAE		X	Fruits
Sabicea	*villosa*	RUBIACEAE		X	Fruits
		RUBIACEAE		X	Fruits
Pouteria (6,10)	*lucuma*	SAPOTACEAE		X	Fruits
Solanum	*quitoense* (17)	SOLANACEAE	X		Fruits
		URTICACEAE		X	Fruits
ANIMALS					
Actinote	sp.	ACRAEIDAE? (15)		X	Ejemplar
		BLATOIDAE (7)		X	Ejemplar
Bos (3,4,6,13)	*taurus* (2,7,8)	BOVIDAE[a]	X	X	Ejemplar
		CASTNIIDAE		X	Larva
		GRILLIDAE (1)	X	X	Ejemplar
Martiodrilus	spp.	GLOSSOSCOLECIDAE		X	Ejemplar
Pontoscolex	*corethurus*	GLOSSOSCOLECIDAE		X	Ejemplar
Thamnodrilus	*baloghi*	GLOSSOSCOLECIDAE		X	Ejemplar
		MELIPONIDAE (7)	X	X	Ejemplar
Nyctidromus	*albicolis*	NYCTIBIDAE		X	Eggs
Myioborus	*miniatus*	PARULIDAE		X	Ejemplar
		PASSALIDAE (3,12,13)		X	Ejemplar
		PHASIANIDAE		X	Eggs
		TABANIDAE (15)	X	X	Ejemplar
Ramphocelus	*icteronotus*	TRAUPIDAE		X	Eggs

Laterallus	*albigularis*	RALLIDAE		X	Eggs
Heterocomphus	spp.	SCARABAEIDAE (3,12)	X	X	Ejemplar y larvas

(1)Paz y Miño (1988); (2) Goldstein (1988); (3) Orejuela (1988); (4) Novak (1991); (5) Peyton (1983);(6) Mondolfi (1989); (7) Peyton (1980); (8) Suárez (1985) (9) Valderrama (com. pers*); (10)* Información Local; (11); Peyton (1984); (12) PAHS (1985); (13)Rodríguez, *et al.* . (1986); (14)Rodríguez (1991); (15) Zequera (1989); (16) Jorge Morales (com. pers.).

* Tracks in Sangay National Park