Andean bears and people in Apolobamba, Bolivia: Culture, conflict and conservation

Susanna L. Paisley

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Durrell Institute of Conservation and Ecology
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Abstract

This thesis deals in qualitative and quantitative terms with the interaction between Andean bears and people in Apolobamba, Bolivia. This mountain range is an important stronghold for this species, which is little-studied and yet of considerable conservation concern. Apolobamba is also a stronghold for traditional beliefs and attitudes towards bears. In addition, this area afforded the opportunity to compare human-bear interaction between people living in and outside of a protected area.

Key ecological findings include the first description of the activity patterns of the species – both bears having displayed diurnal activity with two peaks on either side of a midday trough. Movement patterns, also previously undescribed for this species, were characterised by highly overlapping moderately sized home ranges. Seasonal variation was documented in activity patterns and in habitat use according to changes in the availability of bear foods. In an omnivorous diet similar to what has been found in other studies, bromeliads were shown to be a staple food of markedly low nutritive value – highlighting the attraction of anthropogenic food sources such as maize and beef.

Myths and rituals relating to bears were documented. The famous "Bear's Son" tale was far from being the only bear-related story in circulation, contrary to what had previously been supposed. Accompanying the wide range of depictions of bears in these stories, there was also documented a wide range of bear-related beliefs and attitudes. At one extreme, the bear was thought merely a pest animal, no good for anything, dangerous to people and its possible extinction considered good. At the other extreme, the bear was thought God-like, possessing seven human souls, with a high medicinal value to its body parts and its possible extinction considered tragic.

Perceived depredation of crops and livestock was high, although this was not corroborated by investigations on the ground. Frustration about the restrictions of living inside the protected area focussed on the prohibition against killing problem animals. Despite the evident cultural salience of bears, most people in Apolobamba would be glad if there were no more in the future. However, tolerance was higher in certain valleys, amongst older people and those who did not keep livestock.

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GENERAL INTRODUCTION

The Ukuku or bear dance common in Bolivian festivals.

1.1 PEOPLE AND LARGE CARNIVORES

1.1.1 Large carnivores in culture

Cults venerating the large carnivores are the earliest known religions, dating back tens of thousands of years in both Africa and Europe (Campbell 1968; Grambo 2000). The ursids, canids and felids continue to be the most mythologised creatures in the world. They are the quintessential "charismatic megavertebrates" (Kellert et al. 1996). It has been suggested that the presence of such culturally salient creatures in the landscape "animates, directs, organises and emotionally charges the human response" toward the natural world more generally (Kellert 1996). Large carnivores inspire both veneration and intense vilification, and sometimes both attitudes exist within the same culture (Clutton-Brock 1996). It may be the very threat they pose to our supremacy that inspires such extremes responses (Ginsberg 2001). Because of this seemingly universal charisma, large carnivores are the subject of myth, ritual and homage amongst native people throughout the world and are the subject of comparable interest even in modern, industrialised societies far removed from the animals themselves (Serpell 1986; Shepard and Sanders 1985). Carnivores are the most popular animals amongst viewers of nature documentaries, animal magazines and zoo visitors (Balmford et al. 1998; Carvell et al. 1998; Serpell 1991). This charisma also makes large carnivores powerful "flagships" for conservation (Leader-Williams and Dublin 2000).

1.1.2 People-large carnivore conflict

Just as humanity has long venerated large carnivores, they have also feared, vilified and done battle with them (Clutton-Brock 1996). Conflicts between people and large carnivores arise when large carnivores prey upon game species (Sillero-Zubiri and Laurenson 2001) and endangered species (Berger 1994). Wild carnivores can also act as reservoirs for zoonotic human diseases such as rabies (Jenkins 1997). However, conflicts occur primarily because large carnivores represent a real and perceived threat to human life and our livestock (Singh and Kambooj 1996; Sillero-Zubiri and Laurenson 2001).

It is no coincidence that wealthy countries, including the United States, Japan, and those of Western Europe, have all but extirpated many of their top predators (Johnson et al. 2001). Sharing the landscape with large carnivores brings with it direct and often grave threats to the safety of people and livestock (Ginsberg 2001). For the individual herder, losses to predators can have severe emotional, financial and political consequences (Sillero-Zubiri and Laurenson 2001). On a larger scale, even in wealthy countries where expensive compensation programmes exist, the conservation of large carnivores can have a negative economic impact on the economy of reserve adjacent communities (Cozza et al. 1996). Some of the poorest countries in Africa, Asia and Latin America coexist with tigers, lions, and jaguars, their citizens sustaining substantial losses and making a disproportionate contribution to the conservation of endangered large carnivores (Rabinowitz 1996).

Another important related area of conflict is competition for space. Extensive areas in which large carnivores are protected from persecution are considered essential for their conservation (Clark et al. 1996). Rural people in developing countries are commonly excluded from such protected areas and the resources they formerly relied upon for subsistence (Hulme and Infield 2000; Homewood and Rodgers 1991). Enforcement may target poor rural people, while the wealthy elite are allowed use of those protected areas for activities that are less sustainable and have greater impacts on the environment (Abbot and Homewood 1999). Furthermore, brutal methods have been employed to implement conservation policies, such as forcibly evicting the residents of protected areas (Colchester 1997; Morris 1987; Pretty and Pimbert 1995), or using 'shoot-to-kill' tactics against poachers (Bonner 1993).

1.1.3 Conservation of large carnivores

There is widespread consensus that global biodiversity is being lost at unprecedented and accelerating rates, primarily due to anthropogenic factors (May et al. 1995). Several carnivore species have become extinct in recent times, including the Falkland island wolf, *Dusecyon australis,* the sea mink, *Mustela marcodon,* the Caribbean monk seal, *Monachus tropicalis,* the Japanese sea lion, *Zalophus californianus japonicus.* (Johnson et al. 2001). More ominous still has been the eradication of large carnivores from the majority of their previous ranges (Ginsberg 2001). Large carnivores are rarely tolerated where human populations have the means to eradicate them (Johnson et al. 2001). Threats to their survival are myriad and mounting. Carnivores have been determined to face more types of threats, such habitat loss, effects of introduced species, and rarity, than any other mammalian order (Purvis et al. 2001).

The position of top predators at the peak of the trophic pyramid dictates that they are large in size and sparse in numbers; they are the first to suffer when the ecosystem around them starts to erode (Wilson 1993). The disappearance of large carnivores may lead to increased numbers of smaller carnivores which can bring about drastic reductions in biodiversity through the disappearance of many bird and other vertebrate species (Crooks and Soulé 1999). Large bodied animals like large carnivores often range beyond protected areas and inhabit the wider ecosystem that includes the human-dominated landscape (Western and Ssemakula 1981; Woodroffe and Ginsberg 1998). The ranging of large carnivores outside protected areas, and subsequent human-caused mortality, is a crucial factor in species persistence or extirpation (Woodroffe and Ginsberg 1998). Moreover, it is often large carnivores and crop-pests that turn people who live inside or near reserves against these formal protected area systems (Naughton-Treves 1997).

Large carnivore conservation is challenged by the complex, emotional and polemical issues it encompasses. However, these animals also provide unusual opportunities for conservation, for both ecological and social reasons. Large carnivores serve as indicators of ecosystem health (Clark et al. 1996). Additionally, because their home ranges are large, their conservation safeguards the habitat and space needed by many other species (Simberloff 1998) may also foster conservation of resources needed by local communities such as watersheds, wildlife, firewood and non-timber forest products (Servheen 1999). As such, and because of the fascination with which they are viewed by both traditional and modern cultures, top predators are frequently used as a focus for ecosystem conservation (Clark et al. 1996). Some species of large carnivores may be capable of supporting a sustainable tourist trade (Sillero-Zubiri and Laurenson 2001). Hunting of large carnivores can greatly increase their value to their human neighbours (Stander 1993). Community conservation attempts to ensure community ownership of wildlife resources so that the sizeable revenues generated by hunting or tourism can be used to offset losses to local people (IIED 1994). All of these opportunities for large carnivore conservation require increased attention to be paid to "human dimensions" and community involvement (Bath 1998; Sillero-Zubiri and Laurenson 2001).

1.2 BEARS

The Ursidae is one of twelve families in the order Carnivora. Bears are the largest-bodied of the terrestrial carnivores, although they evolved from smaller tree-climbing Miacids. Polar bears are the largest extant non-aquatic carnivores, commonly reaching weights of up to 650kg (Herrero 1999). There are eight extant species of bears in three subfamilies (Figure 1-1). The eight extant species of bears, listed from the Arctic to the tropics, are polar bears, *Ursus maritimus,* brown bears (also known as grizzlies), *U. arctos,* and American black bears, *U. americanus,* pandas, *Ailuropoda melanoleuca,* Asiatic black bears, *U. thibetanus,* sloth bears, *Melrsus ursinus,* sun bears, *Helarctos malayanus,* and, finally, in South America, Andean bears (also known as spectacled bears), *Tremarctos ornatus.*

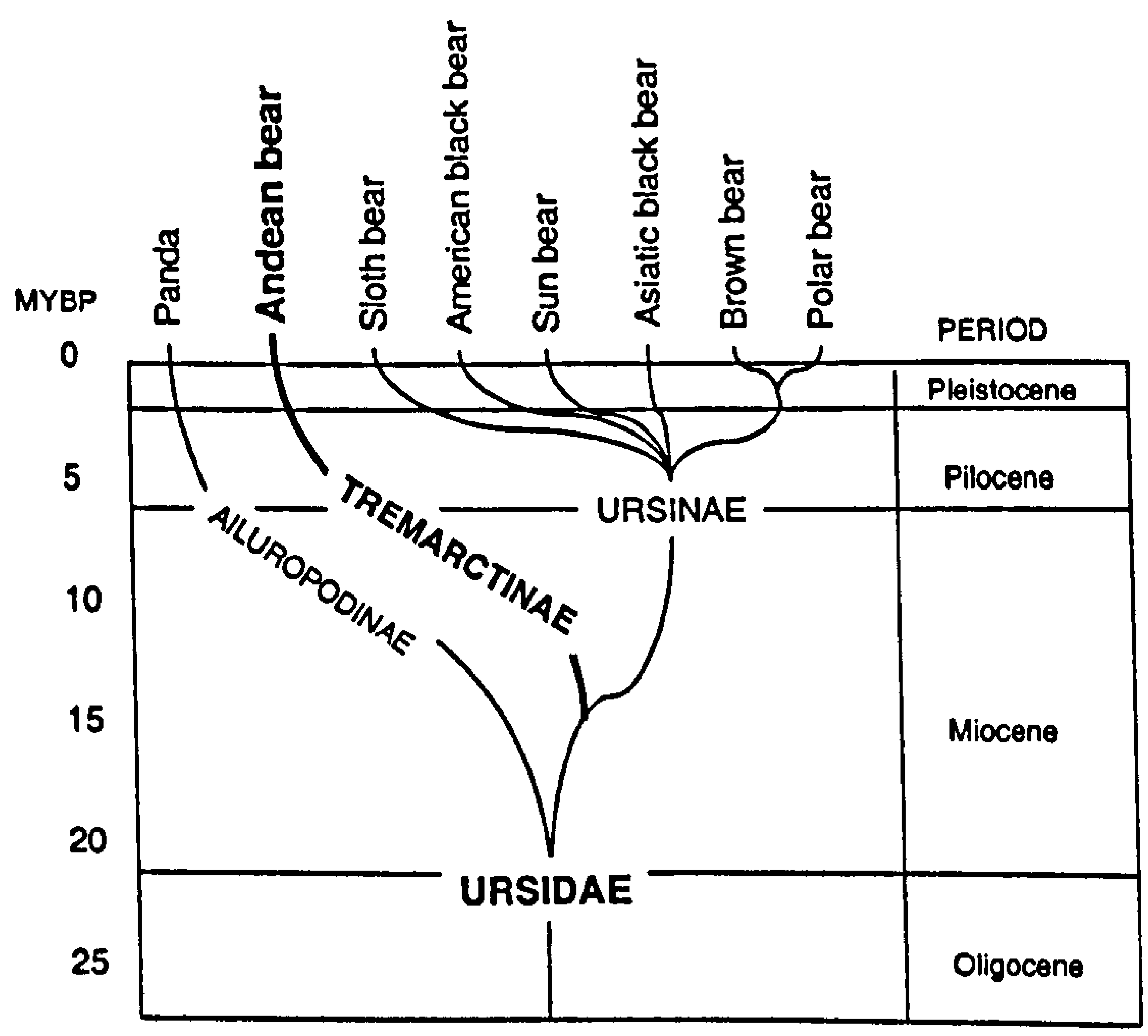

Figure 1-1 A phylogeny of the Ursidae including the three extant subfamilies, Ailuropodinae, Tremarctinae, and Ursinae, and the eight extant ursid species. Diagram based on data from McLellan, 1994.

The placement of bears in the order Carnivora belies dietary habits that are in fact omnivorous, except in the case of the predacious polar bear and the highly herbivorous panda. Ursid dentition attests to their adaptation to omnivorous diets they lack carnassials for shearing flesh and have flattened molars adapted for crushing and grinding vegetation (McLellan and Reiner 1994). All bears walk on flat feet. Bears have keen senses of smell and the highest ratio of brain mass to body mass in the Carnivora (Gilbert 1989). They apply this intelligence primarily to seeking out energy-rich food sources. Once the food has been located, bears are equally well equipped to acquire it, being both physically powerful and dextrous. Bears have separate tibia and fibula, enabling them to rotate their forelimbs, which facilitates food manipulation, digging and climbing (McLellan and Reiner 1994). Equally, when food is unavailable during the boreal and arctic winter, bears are capable of hibernating for as long as seven months without eating drinking, urinating, or defecating (Herrero 1999). Despite having, for the most part, highly adaptable omnivorous life history strategies, exploiting a wide variety of habitats and being notably evolutionarily plastic, the highest proportion of the Ursidae is threatened of all of families in the carnivores according to IUCN threat categories (Purvis et al. 2001). This is due to the direct competition between bears and people for space and resources, and to the perceived and real threat that bears represent to human life and livestock (Mattson 1990).

1.3 ANDEAN BEARS

1.3.1 Distribution

The Andean bear is the only extant South American bear. Andean bears are found in all three ranges of the Andes, from Venezuela, through Colombia, Ecuador, Peru and Bolivia to the border with Argentina (Figure 1-2). There are also reports of bears in Panama. An estimated 85% of bear populations live on the heavily forested eastern side of the Oriental Andes. Andean bears live in a wide range of habitats, from 250m above sea level in the hot coastal deserts of Peru, to 4750m at the foot of Andean glaciers (Peyton 1999). According to a 1999 assessment, 37.7 % of the total range of the Andean bear is in Bolivia- more than any other country in the species' range. It also boasts 52% of the area containing bears that is

Figure 1-2 The distribution of the Andean bear.

protected (Peyton 1999). Although Bolivia undoubtedly represents an important stronghold for the species, extensive surveys are needed to update the distribution of the Andean bears in the country, particularly in the south . Indeed, Andean bear populations in Bolivia were the least known in the bear's five-country range (Rumiz and Salazar 1999).

1.3.2 Evolution and morphology

Other than the panda, the Andean bear is the most evolutionarily distinct of the bears, having diverged from the ursid lineage 15-10.5 million years ago (McLellan and Reiner 1994) (Figure 1-1). The Andean bear is the last remaining descendant of the Tremarctine lineage. A now extinct Tremactine was *Arcdotus simus*, the giant short-faced bear, the largest mammalian predator ever to walk the earth which possibly reaching weights of up to 1000kg. The

Tremarctinae, also known as the short-faced bears, had a widespread distribution throughout the North and South America (Kurtén 1966).

Unique characteristics of Andean bears include the shortest relative muzzle length, and the strongest jaw muscles of the bears, adaptations that enable them to crush and grind the tough fibrous foods that form the mainstays of their diets (Peyton 1999). Andean bears also differ from the other bears in blood chemistry, and numbers of chromosomes (McLellan and Reiner 1994).

Andean bears, like South East Asian sun bears and American black bears, are excellent tree-climbers. Extensive arboreal activity including feeding on epiphytic bromeliads and the building of tree nests has been documented throughout the range (Peyton 1999). Their muscular front limbs are longer than their hind limbs (for gripping around a tree as they climb). Bare flat pads on the paws and long claws also help them to grip when climbing.

Andean bears are shy and secretive, and are well camouflaged by their dark fur that blends into the shadowy moss-covered trees in the cloud forest. They are no easier to see in the high alpine grasslands, where the bears resemble gnarled black bases of *Puya*, a favourite bear food, in the tall clumped grass. Andean bears may be shy and secretive due to evolving in the presence of much larger and more predatory Tremarctine bears for whom they could have been prey (McLellan and Reiner 1994).

The name spectacled bear comes from the rings of pale fur that often encircle one or both eyes. These markings are unique to each individual, and can extend to the muzzle, chest and forehead. There are many local names of Andean bears, but the most common, *Ukuku*, is though to be an onomatopoeic version of the vocalisation made by the bear (Peyton 1999). The name *Jucumari* is the most common name for the bear in Bolivia (Rumiz and Salazar, 1999). Body-weight varies widely, but generally females are smaller, weighting 2/3 as much as males. A large male can weigh up to 175 kg (375 lbs) (Peyton, 1980).

1.3.3 Ecology

Andean bears are the largest carnivores in South America, yet their elusive habits have ensured that many aspects of their basic ecology have never been described. The first research on the Andean bear was carried out in the 1970s in Machu Picchu, Peru (Peyton 1980). A classification and ordination of microhabitat types was carried out, identifying six of particular importance to bears: sub-alpine *páramo* and rain *páramo*, high steppe, humid montane forest, and both humid and very humid low montane forest (Peyton 1980). Bear sign was found in a wide range of elevations (475- 3658 m) although these extremes have now been expanded (250- 4750 m) (Peyton 1999). Andean bears occupy a much wider variety of habitats than those classed as optimal, ranging from dry thorn forests and coastal desert scrublands, to puna grasslands (Peyton 1999).

Andean bears have been documented to eat an enormous variety of foods. The mainstays of their diets are plants in the pineapple family called Bromeliads, of which they eat the leaf-bases, and palms, bamboo and the bulb-like base of orchids. Fruits, including berries, tree fruits and the fruits of cacti are important food items. Bears also eat insects, rodents, birds and mammals (Peyton 1999).

Little is known of the reproductive behaviour of Andean bears in the wild. Like other ursids, after mating with one or multiple males, females can delay the implantation of the fertilised embryo (and subsequent birth of cubs) to coincide with high availability of fruits (Peyton 1999). Litter size varies from one to four, with twins being most common. Cubs are tiny when born, weighing just 300-330 g (as little as 0.5% of the adult weight). We know from observing captive animals that mothers communicate with their cubs using a variety of vocalisations (Eldwson 1988).

1.3.4 Status and conservation

The Andean bear is listed as 'Vulnerable' in the 2000 IUCN Red List of Threatened Species (Hilton-Taylor 2000). They are vulnerable to extinction in the wild due to continuing population reduction and decline in the extent and quality of habitat. Andean bears are listed in Appendix I, of the Convention on the International Trade of Endangered Species, which prohibits international trade in Andean bear products (Peyton 1999). All bears produce a chemical in their gall bladders called ursodeoxyholic acid (Mills and Servheen 1991). This bile is considered a powerful remedy in Traditional Chinese medicine. The percentage of this chemical in Andean bear bile is low, but the seemingly insatiable demand for bile may turn towards Andean bears as Asian bear populations are depleted (Mills and Servheen 1991). They are also killed as pests because they, like bears the world over, are attracted to crops and livestock (Peyton 1999).

1.4 THE BOLIVIAN ANDES

1.4.1 The environment

The Andes are the second highest chain of mountains in the world. They were created relatively recently in geologic time – during the last 200 million years. The region continues to be tectonically active. Hydrological cycles are governed by moisture that evaporates from the Amazon basin and condenses as it rises in easterly winds. Most of this moisture falls as orographic rain rising over the eastern slopes of the Andes (de Morales 1990). In one day's trek in the Andes it is possible to descend from icy glaciers to hot tropical forest. "Nowhere else on earth are greater physical contrasts compressed within such small spaces" (Zimmer 1996). These extremes, and the agro-climatic zones between them, provide Andean people with the opportunity to cultivate a great variety of crops in a relatively small area. Vertical strategies of exploitation were developed in early pre-Hispanic times and continue to be in use today (Murra 1975).

Based on the indigenous Quechua classification system, there are eight life zones (Pulgar Vidal 1996). They are based on elevation above sea level and the consequent floral and faunal assemblages associated with each zone (Wilson 1999). This can be simplified to five that are of particular relevance to this study (Figure 1-3). The frigid high peaks of the Andes, which are often glaciated, are known as *rit'i,* meaning "pure". These peaks have no agricultural use but are important for mining, and in myth and ritual (see section 3.1.4). The *puna* zone (3,500- 4,700 m) is less cold but little other than quinua and barley can be grown. This is succeeded by the *jalca* zone (3,500- 4,000 m), in which cold-adapted crops such as potatoes, quinua, oca, oats and Andean lupine are grown in rotation. Below is the *quechua* zone (2,300- 3,500 m) (also known as the *valle*), where maize as well as wheat can be grown with legumes and squash. *Yunga* is the lowest zone (500- 2,300 m), in which sugar cane, coca and citrus can be grown. The limits of these elevational bands differ according to valley due to differences in temperature and rainfall. These zones are further subdivided into smaller bands that are exploited using different planting regimes (Wilson 1999)

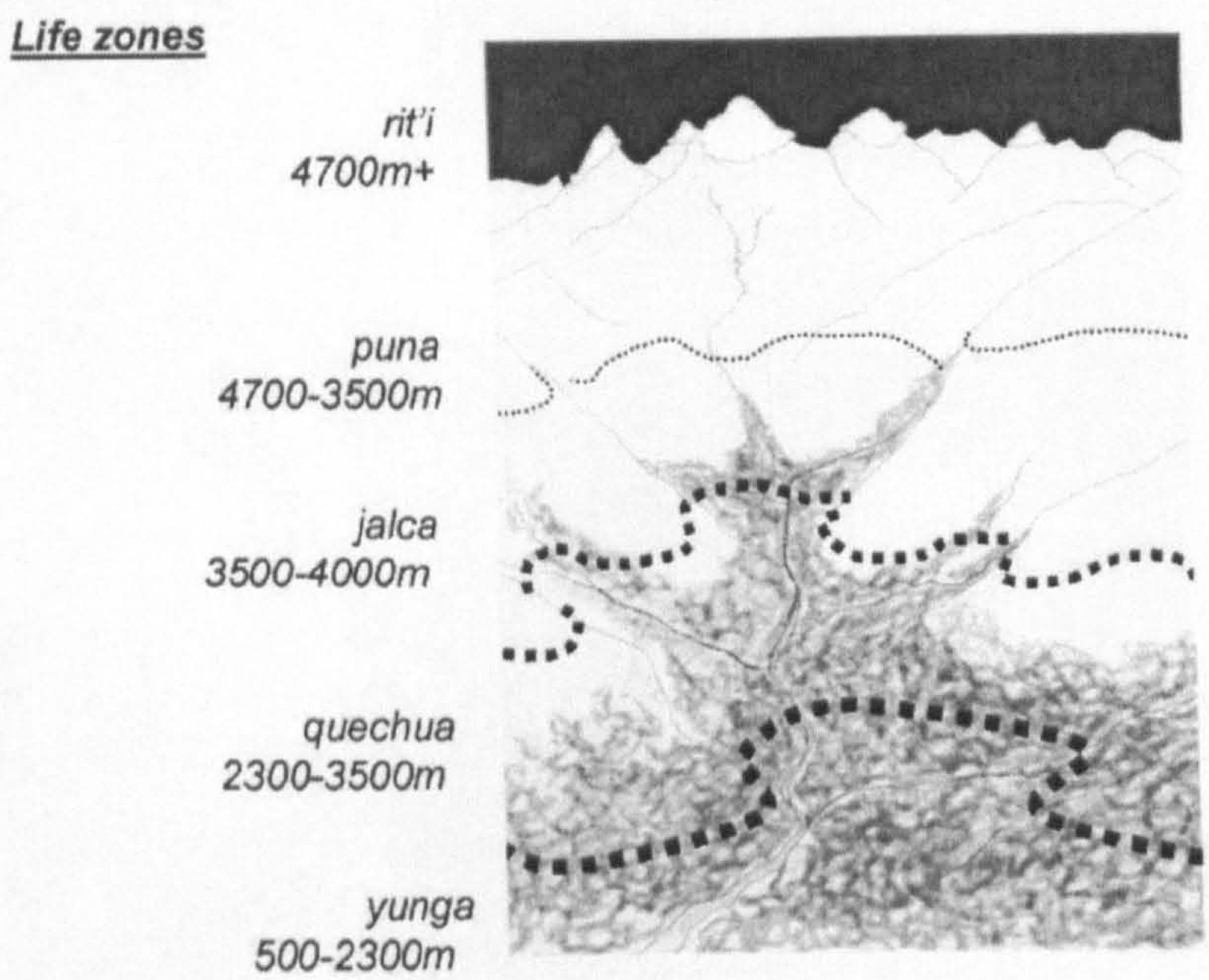

Figure 1-3 Five Andean life zones or environmental zones.

1.4.2 People

The Bolivian Andes were home to some of the great South American pre-Colombian civilisations. Most notably, the architecturally, astronomically and agriculturally advanced Tiwanaku culture developed at the southern end of Lake Titicaca around the sixteenth century BC. Roughly contemporaneous with the Tiwanakan culture, the Moxos in the eastern lowlands and the Mollos north of present-day La Paz also developed advanced agricultural societies. These civilisations had dissipated by 1300 AD (Pereira Herrera and Albarracín Jordán 1996).

The collapse of Tiahuanacan influence resulted in the rise of seven regional kingdoms of the Aymara, the most powerful of which were located in the densely populated area around Lake Titicaca. The Aymara lived in fortified hilltop towns and adapted to the severe climatic conditions of the region and increased their food supply through irrigation and the process of freezing and drying crops. The Aymara, however, were not able to resist the expansion of the Inca empire. The Quechua-speaking Incas who were based around Cuzco, Peru, conquered the northern highlands of Bolivia in roughly 1450. The Incas controlled the area until the Spanish conquest in 1525 (Pereira Herrera and Albarracín Jordán 1996).

Today, Bolivia's ethnic distribution is estimated to be 56%-70% indigenous people (Carter 1991). There are two main indigenous cultural groups in the Bolivian Andes, the Aymara and the Quechua. Living primarily on the *altiplano*, approximately 8.5 million people (27.1% of the population) speak Aymara. These people are herders of alpacas and llamas, producers of *chuño* and *tunta* (forms of desiccated potato) and are active in the transporting and commercialisation of goods. Living primarily in the valleys descending to the east from the Andes, approximately 2.8 million people (23.7 % of population) speak Quechua. The term Quechua means "warm valley" and these valleys, and the mountains from which they descend, are essential to the agriculture and cosmology of the Quechua-speaking people. Quechua hamlets are traditionally at the head of gorges just above the *yunga* and *valle* zones (Webster 1972). The lowlands and the forest are viewed with fear by both the Quechua and Aymara (Crandon-Malamud 1991). The forest is known by the Q'eros Quechua as the "irrational sanctum" and is associated with sickness and danger (Webster 1972).

The overarching unit of socio-economic organisation in the Andes is the *allyu.* The *allyu,* which existed before and through the Incan empire, combines distinct communities at different altitudinal and agro-ecological levels on the mountain into a self-sufficient whole. The *allyu* functions as a clan in which endogamous marriage is encouraged. But the *allyu* is more than that - it has a figurative interpretation as the very mountain on which it is based (Bastein 1985). The *allyu* internal organisation continues to maintain mechanisms for the relatively equal distribution of access to land and decision-making based upon social relations of mutual reciprocity to the present day (Rivera 1990).

In international terms, Bolivia is the second poorest country in the Western hemisphere after Haiti (Library of Congress 2001). According to the 1992 census, 80% of its people, many of whom are subsistence farmers, live in poverty and 20% are extreme indigents. More than half of the homes have dirt floors, only 39% have access to potable water and 20% have access to hygienic disposal of human waste. Rural illiteracy is 46.8% overall, and 60.4% for rural women. Life expectancy in rural Bolivia is 47.9 years. Infant mortality is extremely high: 21% of children die in their first year of life and 28.5% in the first five years (INE 1993). Population density ranges from less than 1/km^2 in the south-eastern plains to about 10/km^2 in the central highlands. Bolivia's high mortality rate restricts the annual population growth rate to around 2% (Library of Congress 2001).

1.4.3 Historical use of the land and natural resources

The mineral wealth of Bolivia has determined much of the country's history (Nash 1979). Copper was being mined by 1500 B.C., and when the Spanish arrived three millennia later, they too were quick to seize upon these resources. The silver mines of Bolivia produced much of the wealth of the Spanish empire, and Potosi, site of the famed Cerro Rico or "Rich Mountain" was, for many years, the largest city in the western hemisphere. Independence was claimed from a Spanish empire weakened from the Napoleonic wars in 1809 and the republic was established, after much struggle, in 1825. For the following 60 years, coups and short-lived constitutions dominated Bolivian politics. Bolivia's weakness was exploited during the War of the Pacific (1879-83) by Chile, to whom it lost its seacoast and the adjoining rich nitrate fields. An increase in the world price of silver brought Bolivia a measure of relative prosperity and political stability at the end of the century, further entrenching an élite class (Carter 1991).

Between 1889 and 1921 a series of laws appropriated communal lands belonging to indigenous people (Molina Barrios 1996). These lands were privatised and sold off cheaply primarily to people with some claim to élite status – which usually meant some Spanish blood – who became known as the *vecinos,* which literally means "neighbours" (Crandon-Malamud 1991). These new large ranches, or *haciendas,* were run using a feudal system in which indigenous people were forced to work for no pay. They were denied access to education, economic opportunity, and political participation.

Paraguay's defeat of Bolivia in the Chaco War (1932-35) marked a turning point in the exploitation of indigenous people in the Bolivian Andes (Carter 1991). Service in the army produced stirrings of political awareness among the indigenous peoples while at the same time great loss of life and territory discredited the traditional ruling classes. This nascent claim for justice took nearly twenty years to come to fruition in the 1953 Agrarian Reform, which was one of the first and most radical in Latin America. Before the revolution, 6% of the elite owned 92% of the land and 60% of the people, the *campesinos,* owned 0.2% of the land. Afterwards, the Institute of Agrarian Reform distributed 36 million hectares of land- 32 million of which went to business and only 4 million of which was assigned to 550,000 farmers. While this represented an improvement the allocation of land continued to be disproportionately in favour of the élite. The situation has since worsened in a spiral of growing subdivisions due to inheritance (de Morales 1990).

When global prices of tin and wolfram fell in 1985 the government closed the statue mines and 20,000 miners were dismissed. In order to solve the resultant unemployment crisis, the government offered the miners incentives to colonise forested valleys (areas of prime bear habitat), including the South and North Yungas Provinces of the La Paz Department and the Chapare region of the Cochabamba Department (Rumiz and Salazar 1999). With no experience of farming in this environment, these highlanders slashed and burned the forest and learned to cultivate the crop best suited to the steep slopes: coca, *Erythroxylum coca.* For millennia, the coca leaf had been chewed and used in traditional rituals in the Andes, but due to the government-sponsored colonisation of the Chapare and the emergence of the drug trade, coca cultivation underwent a rapid expansion. Roughly one-third of the world's cocaine is made from coca grown in Bolivia. The United States has spent millions in a campaign to eradicate coca from the Chapare (Library of Congress 2001). As coca eradication and subsequent social unrest continues, bear habitat may be at risk from similar government sponsored re-colonisation programmes.

1.4.4 Conservation

Bolivia is one of the most biodiverse countries in the world with approximately 2,500 species of vertebrates and 18,000 known species of vascular plants. Bolivia has been rated as eighth in the world for bird diversity and fourth for butterfly diversity (Myers et al. 2000). In South America as a whole, bear habitat is particularly biodiverse: approximately 76% of the continent's mammal species occur in the 3.2% of the land located on the eastern slops of the Andes (Mares 1992).

The first protected area in Bolivia, Sajama National Park, was created in 1939. Since that time the percentage of the country theoretically included in protected areas has grown to 17.5% in 22 reserves (Rumiz and Salazar 1999). Only 16 of these have been officially established and are administered by the National System of Protected Areas, representing 12% of the country. An estimated 40,000 people in 150 communities live inside or adjacent to the 22 reserves. Nearly all of these people live in conditions of poverty. The Government of Bolivia remains heavily dependent on foreign assistance to finance development projects and at the end of 1998, the government owed $4.3 billion to its foreign creditors (Library of Congress 2001). Conservation measures are looked upon kindly by international donors, and as a result much of the global conservation and development rhetoric has been adopted in Bolivia. The national government officially recognises the communal rights of local people to the access and use of protected area natural resources to support their traditional lifestyles (de Morales 1990).[1] However, in practising subsistence agriculture, the basic survival strategies of poor rural communities can lead to the contravention of wildlife protection laws. In addition, overt land tenure disputes are not uncommon. For example when Amboró National Park was expanded to 6,370km^2 in 1991 intense conflicts arose between local *campesino* groups and park managers, which led to the reduction of the park in 1995 to 4,425 km^2 (Rumiz and Salazar 1999). One of the main threats to this biodiversity is deforestation which between 1990 and 2000 has averaged 0.8% per annum. The road network in Bolivia

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[1] Article 171 of the Bolivian Constitution recognises "the social, economic and cultural rights of indigenous peoples that inhabit the national territory, especially to their communal lands of origin, warranting their use and sustainable management of their natural resources, their identity, values, language and institutions."

has increased 70% since the Agrarian reform in 1952 (Rumiz and Salazar 1999). The building of roads in La Paz was found to disrupt large mammals for up to 2 km, but this disturbance is minimal compared to the well-known appurtenant effects of increased human population along roads - including deforestation, erosion, hunting, and habitat degradation and fragmentation (Liberman 1991).

1.5 PEOPLE AND ANDEAN BEARS IN BOLIVIA

Bolivia is renowned for its thriving folklore, which has been the subject of much attention from anthropologists (Carter 1991). However, little research has been carried out into interactions between people and bears. It is known that the Aymara consider bears to belong to the forest and to be the shepherds of the other animals (Arnold et al. 1992). Another aspect of the Aymara view of bears identifies them as demonic, arising from the underworld (Schramm 1992). In a comparative study in Huacareta, Bolivia, Aymara and Quechua people expressed similar attitudes and beliefs about bears (Yañez 1990). Bears have been described as god-like, human-like or spiritual in nature (Costas Arguedas 1961; Rumiz and Salazar 1999; Eulert; Yañez 1990). Many people consider bears to be a physical threat to people, primarily because of their reputation for attacking livestock, but also for crop-raiding (Yañez 1990). In other sites depredation has been cited as a reason for fearing bears (Eulert 1995; Yañez 1990; Salazar and Anderson 1990). A story called The Bear's Son is considered the most widespread of Quechua folktales (Allen 1992), existing throughout and beyond the range of the Andean bear (Morote Best 1957) including in Bolivia (Anibarro de Halushka 1976). The colourful costume and rowdy dance of the bear is also a prominent feature in the Bolivian annual festivals (Paredes Candia 1966). Although little has been studied of the interplay of these myths, rituals, attitudes and interactions and their implications for bear conservation, in the recent Status Survey of Bears it was said of Bolivia that "the old positive attitude towards the bear is losing ground" (Rumiz and Salazar 1999).

1.6 RATIONALE FOR THE STUDY

The Andean bears serves as an ideal candidate for the examination of the previously described complex issues relating to large carnivore-people interaction and conservation.

Human survival is certainly not at risk, whilst, with dwindling natural habitat and increasing mortality from poaching and conflict throughout much of the bear's range, bear survival certainly is at risk (Hilton-Taylor 2000). However, in most of the range of this species, the bears' individual human neighbours have as tenuous a hold on survival as the bears; that is, they work hard at subsistence level to have enough to eat and to feed their children. The study is motivated by the concept that the interaction between bears and people, including losses suffered by people because of bears, must be evaluated and taken seriously if bear conservation is to succeed. This thesis is about Andean bears and people, and about how they impinge upon each other in one area of the bear's range in Bolivia. I examine not only the extent to which and how we interact, but also the more fundamental questions of why they interact in the ways they do, and how that interaction may play itself out in the future.

Bears and people throughout the world tend to have a mutually exclusive distribution (Mattson 1990). Where human populations are greater than 25/km^2, bears rarely survive due to the cumulative effects of human habitat modification and human intolerance of bears. This intolerance has resulted in the elimination of brown bears in much of Europe, North America and Asia. There are exceptions to this rule: European brown bears in Romania, American black bears in the Eastern United States, and Asiatic black bears in Japan (Mattson 1990). But generally it is people with lower human population densities in poorer countries who continue to coexist with bears.

Indeed in many parts of the world, individual bears and people share portions of their home ranges. The cores of the home ranges of each species, the areas in which they mate and care for their respective young, may have little overlap, but if we include trails, sources of food and even occasionally shelter, the overlap may be considerable. Hence it is important to determine where there are areas of sufficient difference in the spatial, temporal and specific use of resources such that contact is avoided, and where overlap gives rise to internecine conflicts. Moreover, it is important to understand whether human attitudes are immutable products of the need to protect themselves and the resources upon which they depend. Could it be the case that in one valley bears are looked upon as friendly allies while in another they are hated? This thesis seeks to examine this interaction, both at the scale the Apolobamba range in Bolivia and in the wider context of large carnivores and people.

1.7 RESEARCH AIMS AND QUESTIONS

To aid in the conservation of *Tremarctos ornatus* the study has three main aims: to characterise the interaction between Andean bears and people and quantify the extent of conflict; to collect new ecological data about the home range and habits of Andean bears; and to analyse the implication of these findings for management and conservation.

Hence, the following general research questions were pursued in Apolobamba:

1. What early and deep impressions do people form of bears through myths and rituals?
2. What variation exists in attitudes towards and beliefs about bears?
3. Upon what food resources do Andean bears rely?
4. What are the activity and movement patterns of Andean bears?
5. How does the behaviour and ecology of Andean bears influence interaction with their human neighbours?
6. What is the scale and nature of bear-people interaction (fear of attack, crop-raiding, livestock depredation)?
7. How do people respond to restrictions of living inside a Protected Area?
8. What factors correlate with high tolerance of Andean bears?

1.8 STRUCTURE OF THE THESIS

Chapter 1 has introduced the main themes of the thesis: large carnivores in culture, conflict and conservation. It has then presented the Andean bear as an ideal candidate for a case study of these issues. **Chapter 2** describes the study site and general methods employed in this study. The first data chapter, **Chapter 3** explores the myths, stories and symbolism related to Andean bears and therefore begins early in life and deep in the psyches of people in Apolobamba. This is followed in **Chapter 4** with explicit beliefs and attitudes towards the bear as determined through interviews both inside and outside a protected area. This chapter ends with an analysis of local knowledge of bear ecology which is succeeded in **Chapter 5** with an investigation of bear ecology using classic ecological field research methods. This portion of the research was conducted at the Pusupunko study site where two Andean bears were also radio-collared. **Chapters 6 and 7** provide the first analysis of the activity and movement patterns, respectively, of the Andean bear. Seasonal variation and social interaction are explored, and these patterns are discussed in relation to bears' interaction with people. **Chapter 8** examines how these previously described phenomena are manifested in terms of the physical and practical interaction between bears and people, particularly livestock depredation and crop-raiding. **Chapter 9** investigates management regimes including response to the restrictions of wildlife laws and the protected area. The factors that influence tolerance of Andean bears are analysed and the status and prospects for the conservation of the species are discussed. **Chapter 10** presents a synthesis of social and ecological findings and explores their implications for the future of the Andean bear and the improvement of human-bear interaction.

Chapter 2
STUDY SITE AND GENERAL METHODS

The cloud forest at the Pusupunko study site.(photo Jon Day)

2.1 STUDY SITE: APOLOBAMBA

2.1.1 Location and site selection

The Apolobamba range, north of Lake Titicaca and on the border between Peru and Bolivia, was selected for a comprehensive, interdisciplinary study of the interaction between bears and people. This region is especially suitable for such an investigation for several interrelated reasons. No previous research had been carried out in Apolobamba, though this region was suspected to be an important stronghold for the Andean bears (Peyton 1999), harbouring biodiversity that "rivals the richest known sites in the planet" (Remsen and Parker 1995). The Madidi National Park, the Ulla Ulla National Fauna Reserve, and two others with which they are contiguous, form one of the largest strongholds left for Andean bears, with at least 10,000 km^2 of suitable protected habitat (Peyton 1999; Rumiz and Salazar 1999).

It was thought that, in Apolobamba, it would be possible to study a population of bears still healthy enough to leave heavy sign, as was in evidence in an early survey of the area. This survey also revealed the local perception of intense interactions between bears and people – people who held a wide range of beliefs and attitudes about bears. An additional, related factor in selecting Apolobamba was the opportunity to document the rich tradition of bear-related myths and rituals hinted at by several authors (Peyton 1999), and to evaluate the extent to which these traditional beliefs influence local tolerance of bears. Finally, the study area provided the opportunity to compare management regimes, including a National Fauna Reserve, a newly established National Park and an unprotected area.

There were two main components of the project: one social and one ecological. The social research was carried out extensively, in an area referred to hereafter as the **wider study area**, and the ecological research was carried out intensively, in an ecological sub-site contained within the wider study site. This is referred to hereafter as the **Pusupunko study site**

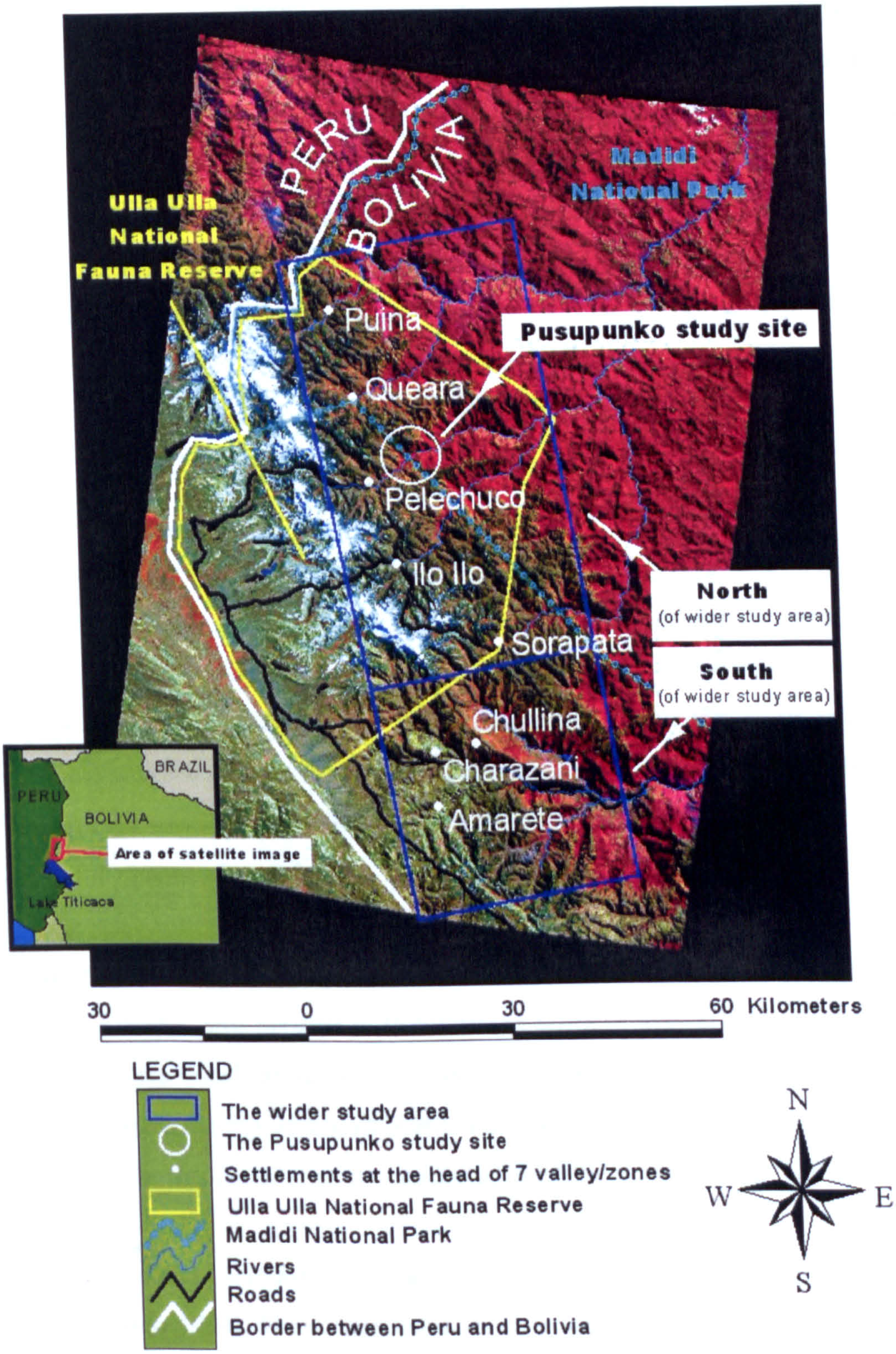

Figure 2-1 Location of the wider study area, divided into north and south, and the Pusupunko study site. The map is based on a 1991 Landsat 4 satellite image. The settlements at the heads of 7 valley / zones are displayed, as are the protected area boundaries. The colour red is indicative of forest cover.

The wider study area has the shape of a long rectangle, orientated from north-northwest to south-southeast, occupying 3000km^2 of steep hills and valleys on the eastern flanks of the Apolobamba range. These slopes are precipitously steep in some valleys, ranging from 50° to nearly vertical. In general, south facing slopes (30-45°) tend to be much steeper than north facing slopes (15-35°) (Seibert). Above, the mountains continue rising to a series of glaciers at nearly 6000m, and below the study area, the forests descend into the Amazon basin. The study area ranges in altitude from 2700 m in the Charazani valley and at the fallen bridge *La Itici* across the Pelechuco River, up to about 4,300 m. This upper limit is somewhat arbitrary and is chosen on the basis of being the highest local register of bear sign. It includes both protected and unprotected areas, and straddles two provinces: Franz Tamayo and Bautista Saavedra.

The Pusupunko study site (S 14° 47′, W 69 ° 01′) was selected because it fulfilled the following criteria: presence of bear sign, possibility of passage through the forest, and feasibility of access through the rainy season. The relative lack of malaria, chagas disease, and drug trafficking was also advantageous. The Pusupunko study site proved to be at the upper elevational and western limit of the bears' local range. Research headquarters were 6.5 km from Pelechuco, a town of about 700 people (INE 1993). The site was accessible only on foot. It was fully protected, located on the border between two protected areas.

2.1.2 Geology and topography

The central Andes become broader in Peru and the north of Bolivia. The mountains of the wider study area are called the Knot of (*Nudo de*) Apolobamba, because it is there that the east and west chains diverge and head south, with the high plateau (*altiplano*) spreading between them. On this plateau, on the border between Peru and Bolivia, is Lake Titicaca.

The Apolobamba and Charazani mountain ranges consist of very old Paleozoic rock formations (Seibert 1994). These mountains are very rich in gold deposits, the extraction of which is an important regional industry. Silver, lead, zinc, tin and limestone are also of economic interest. The silicate formations of the cordillera are also characterised by deposits of pyrite, hematite, quartz limonite and chlorite (RNFUU 1997). The soils of the area are poor and undeveloped, because of the extremes of climate, and the composition of the parent material. Erosion has escalated since the arrival of the Spanish (de Morales 1990). In addition, solifluction processes above the parent rocks cause mudflows and avalanches that occur during the rainy season (Seibert 1994).

2.1.3 Hydrology

Apolobamba is crowned by three groups of glaciers, which together comprise 37% of Bolivia's total. They amount to 220km^2 in area, and the main rivers of the study area are partially fed by their glacial melt-water (RNFUU 1997). The Apolobamba range represents the continental divide: all waters on its eastern side flow out into the Atlantic Ocean through the Amazon. Two watersheds divide the study area: the Mapiri river, into which flow the Charazani, Camata, Calaya and Kellhuacota rivers; and the Tuichi, into which flow the Pelechuco, Hilo Hilo and Sunchuli rivers. Countless seasonal rivers suddenly begin to flow when the tundra-like puna of the hanging valleys above become super-saturated and send heavy flows of rainwater cascading down these steep stream beds.

2.1.4 Climate

There are two main seasons, rainy and dry. Heavy rains fall during October-March, hereafter called the **rainy season**. Drier and cooler winter months were April–September, hereafter called the **dry season**. Throughout the study area, the great majority of the rain (81% during 1980-1985) falls in the six-month period from October to March (Figure 2-2). Climatic data was gathered at two weather stations in the study area: Pelechuco in the north and Charazani in the south. The Pelechuco valley, descending steeply from high peaks, is categorised as a cold, high mountain climate with wet summers. It is humid with an average of more than 800mm precipitation per annum (SNMH 1999). Charazani is backed by lower mountains that do not retain humidity in the same way as the Pelechuco valley, and is classified as a mild, semi-arid mountain climate with an average of 330mm precipitation per year (RNFUU 1997).

Figure 2-2 Percentage of the total annual precipitation falling in each month. Data combined from Pelechuco and Charazani weather stations 1980-1985.

In the Quechua calendar, the year is divided into a rainy season *Paray mita,* and a dry season *Rupay mita.* The months are named in relation to the agricultural cycles. For example, the time corresponding to the Gregorian month of April is called *Ayriway,* or the dance of the young maize.

The climate in Apolobamba varies strongly with elevation. Solar radiation is high. Mean air temperature is 18°C at 2,700m, and 3.5°C at 4,300m (calculated from Seibert). Frost does not normally occur below 3,200m, but increases slowly from there to an annual average of 50 days of frost at 3,800m. Above this elevation there is a rapid increase to around 200 frost days at 4,200m. At the Pusupunko study site, daily high temperatures hover around 13°C throughout the year (National Meteorology and Hydrology Service, unpublished data), whereas nightly lows average 5°C during the rainy season, and frequently dip to freezing during the winter dry season. Day-length fluctuates between 13 hours on the longest day of the year in December, to 10 hours and 40 minutes on the shortest in June.

2.1.5 Vegetation

Three main habitat types[1] existed at the altitudinal range of our study area (2900–4100 m), and all were used by bears: high Andean grassland; humid montane or cloud forest; and between them, the berry-rich shrubland ecotone (Figure 2-3).

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[1] Many classificatory systems are used to describe the Andean vegetation and life-zones. For more detailed analysis see (Mihotek 1996) and (de Morales 1990).

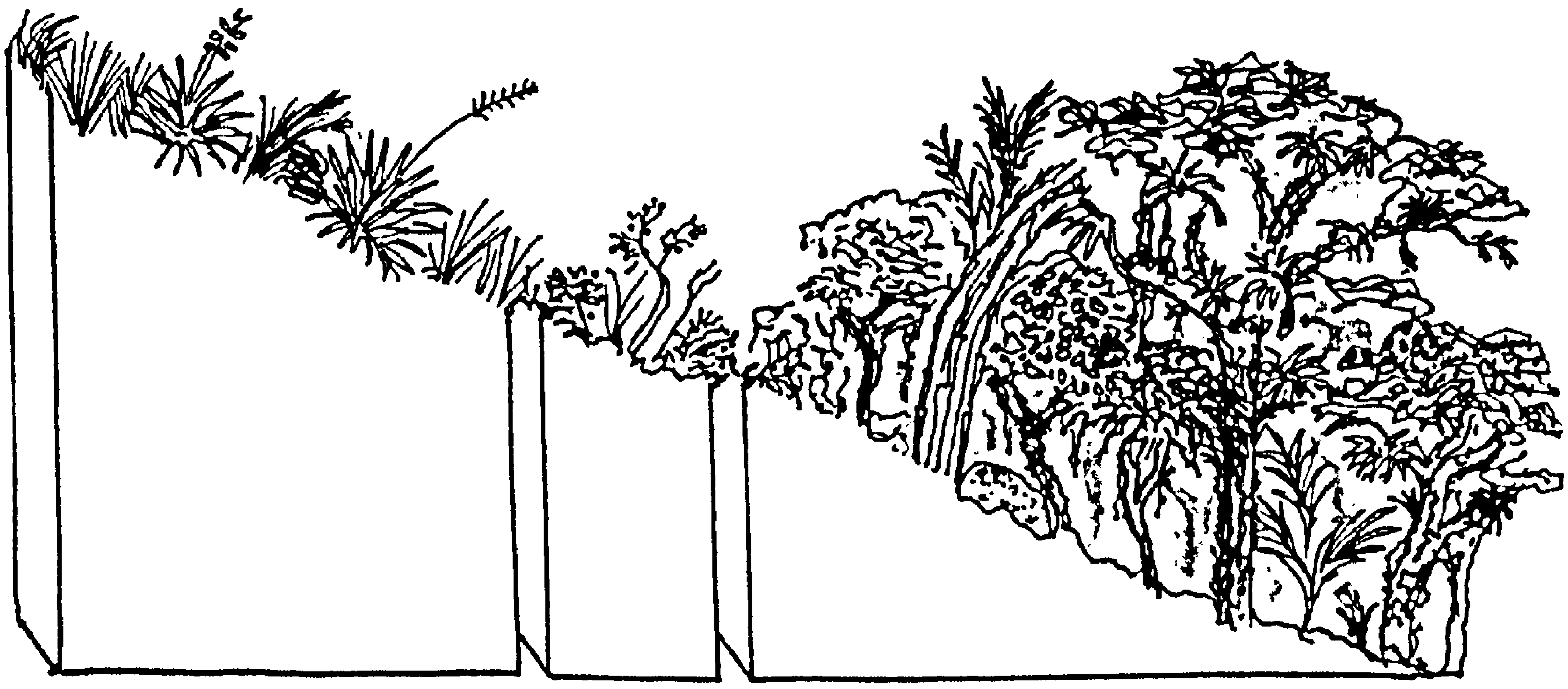

Figure 2-3 Diagram of three main habitat types in profile: high Andean grassland, the forest/grassland ecotone, and the cloud forest. (This and all drawings and maps are done by SLP unless otherwise indicated).

- **High Andean grassland**

The first major habitat type in the study area, high Andean grassland, is found above the oscillating tree line. In the grassland, particularly on the south- and east-facing slopes, are many terrestrial Bromeliads (*Puya* spp. and *Gregia* spp.), growing amid tussocky grasses in the genera *Ceyeuxia, Festuca* and *Stipa.* Shrubs of the genus *Miconia* are very characteristic, as are *Baccharis, Gaultheria* and *Brachyotum.*

- **Forest-grassland ecotone**

An ecotone of approximately 100 m, between the grassland and cloud forest, was characterized by shrubby Melastomataceas and Myricaceas of the genera *Miconia, Baccharis* and *Brachyotum,* and Ericaceas such as *Gaultheria vaccinioides, Pernettya prostata, Demosthenesia mandonii* and *Gaultheria glomerata.* This band was also rich in fruit-bearing vines such as *Rubus bullatus,* and *Ribes bolivianum* (Garcia 2000).

- **Cloud forest**

The forest in the wider study area, found below a markedly oscillating treeline, is in the range of 3,200 to 3,600m, extending down to approximately 2,500m. It is classified as cloud forest or elfin forest, and known locally as *Ceja de montana*, literally "brow of the mountain" (de Morales 1990). Trees are stunted by conditions of nearly constant mist and cloud (Doumenge et al. 1998), with the canopy at 5-10m, and emergents reaching no more than 15m. The forest is very dense and is composed almost exclusively of evergreen species. It is covered with epiphytes in all strata, from large water-retaining bromeliads on the branches, to mosses and lichens on the tree trunks and the forest floor. The forest in the Pusupunko study site was dominated by trees of the genera *Clethra, Gynoxys, Weimannia,* with rarer trees of the genera *Prunus, Persea, Symplocos* and *Schefflera.* Various types of bamboo such as *Chusquea* spp. are abundant in areas where there has been disturbance. In general, this forest is well conserved, owing to the difficulty of access and a climate not conducive to colonisation. At the lower reaches of the wider study area, this forest grades into *Yungas*[2] or tropical montane forest, which is found lower down the mountain slopes, generally between 2,500m and 1,500m. Recent botanical surveys of cloud forest and tropical montane forest in Apolobamba have shown considerable diversity of forest composition (Garcia E. 2000; Orellana R. and Paniagua Zambrana 2000; Sanjínes A. and Orellana 2000).

2.1.6 Fauna

Where the protected areas intersect with the wider study site (that is, in the north), mammalian diversity is high: 46 species have been identified in the Ulla Ulla National faiuna Reserve, and 45 in Madidi National Park. This latter number, based on Rapid Assessment methodology, is estimated to be half of the non-flying mammals present in the area, and 15-20% of the bats (Parker and Bailey 1991). The wider study area itself is too high for tapirs *Tapirus terrestres,* jaguars *Panthera onca* and black-faced spider monkeys *Ateles paniscus,* which are found further down the slopes to the east. Large mammals in the wider study area include the puma, *Felis concolor,* taruka, *Hippocamelus antisensis,* white-tailed deer, *Odocoileus virginianus,* brocket deer, *Mazama chunyi,* Andean fox, *Pseudolopex culpaeus andinus,* the rare Andean cat, *Felis jacobita,* the possum, *Didelphis albiventris,* and the skunk, *Conepatus chinga rex.*

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[2] The term *Yungas* is confusing, as it used in several different contexts. It is a life zone in the Quechua classificatory system (see section 1.1.4). Here it is used as a botanical term to describe tropical montane forest. South and North Yungas are also the names of Provinces of the La Paz Department (as mentioned in section 1.4.3).

Smaller mammals include a member of the chinchilla family, the vizcacha, *Lagidium viscaccia,* the vampire bat, *Desmodus rotundus,* 25 rodent species, and 9 micro chiropteran bat species. The ranges of the hare, *Sylvilagus brasiliensis* and the coati, *Nasua nasua,* are reported to be expanding within the study area. Reptiles, amphibians, fish, and insect species have been largely neglected (RNFUU, 1997).

Avifaunal diversity is high in the parts of the protected areas where the wider study site is located: 212 species have been identified in the Reserva Ulla Ulla, and 403 were identified during a two-week survey in Madidi (1000 are estimated). Bird diversity is higher in the north of the wider study area than in the more populated south: 73 species have been identified at the Pusupunko study site (3050-3800m), compared with 38 species in the Charazani valley (3150-3450m), and 19 in the Pajan (3300-3600m) (Sargot 1999). In the more altered habitats of the south, the proportion of species with a wide distribution is much higher than in the north, comprising 31.5% of the species identified in Charazani, and 42% of those identified in Pajan compared to a mere 3% at Pusupunko. Some of the more notable species include the torrent duck, *Merganeta armata,* the Andean condor, *Vultur gryphus,* the black-hooded sunbeam, *Aglaeactis pamela,* an endemic hummingbird, the local and very rare white-tailed shrike tyrant *Agriornis andicola,* and the vulnerable line-fronted canastero *Asthenes urubambensis* (Sargot 1999).

2.1.7 Human population trends

A shift has taken place in the human population of the Department of La Paz in the last 50 years. Many people have moved to the city, particularly after events related to *El Niño* in the 1980s. This trend has taken place on a national level as well: in 1976, 42% of Bolivians were urban and, by 1992, that percentage had climbed to 58% (Figure 2-4).

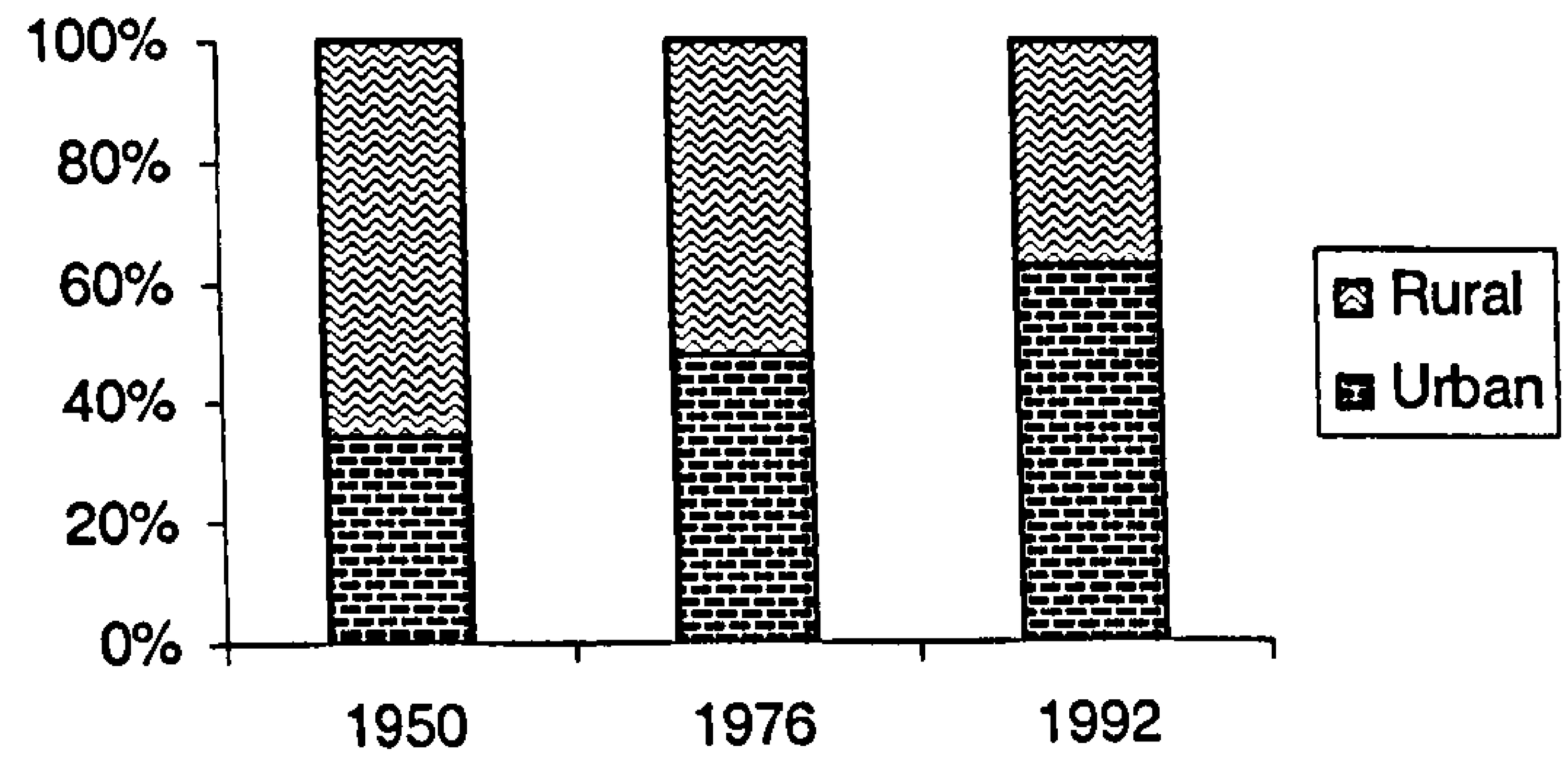

Figure 2-4 Percentage of rural and urban dwellers in the Department of La Paz, according to the censuses of 1950, 1976, and 1992.

The annual median rate of change in the population for rural La Paz between the 1976 and 1992 censuses was negative (–0.64). The population in the north of the study area has remained approximately the same during the last 25 years (Figure 2-5). As gold prices have risen, more people have abandoned *yungas* agriculture in favour of working in the mostly high-altitude gold mines. The population in the south has been less influenced by the gold boom, but the populations have generally remained stable. No settlement in the study area has reached a population of 2000 inhabitants, the limit for the Bolivian definition of an urban centre. Mojos and Pata have both experienced dramatic population crashes. At their height they harvested quinine as an anti-malarial drug. Apolo, the largest town in Franz Tamayo Department, existed at least as early as Inca times, and continued to grow during the colonial era, right up to the present. Amarete, not recognised in the 1900 census, is a village at the head of a large and thriving *allyu* of the same name. The land has probably reached carrying capacity. There is much crowding, the fallow period of crops is having to be abandoned, and many young people there are having to migrate to the city. Pelechuco, Chullina, Charazani and Puina experienced decreases in their censused populations until 1976. The census results may be unreliable, in part because the official names of villages and the boundaries of political units have changed throughout the years. However, it is clear that overall populations in the study area have not changed much in recent times.

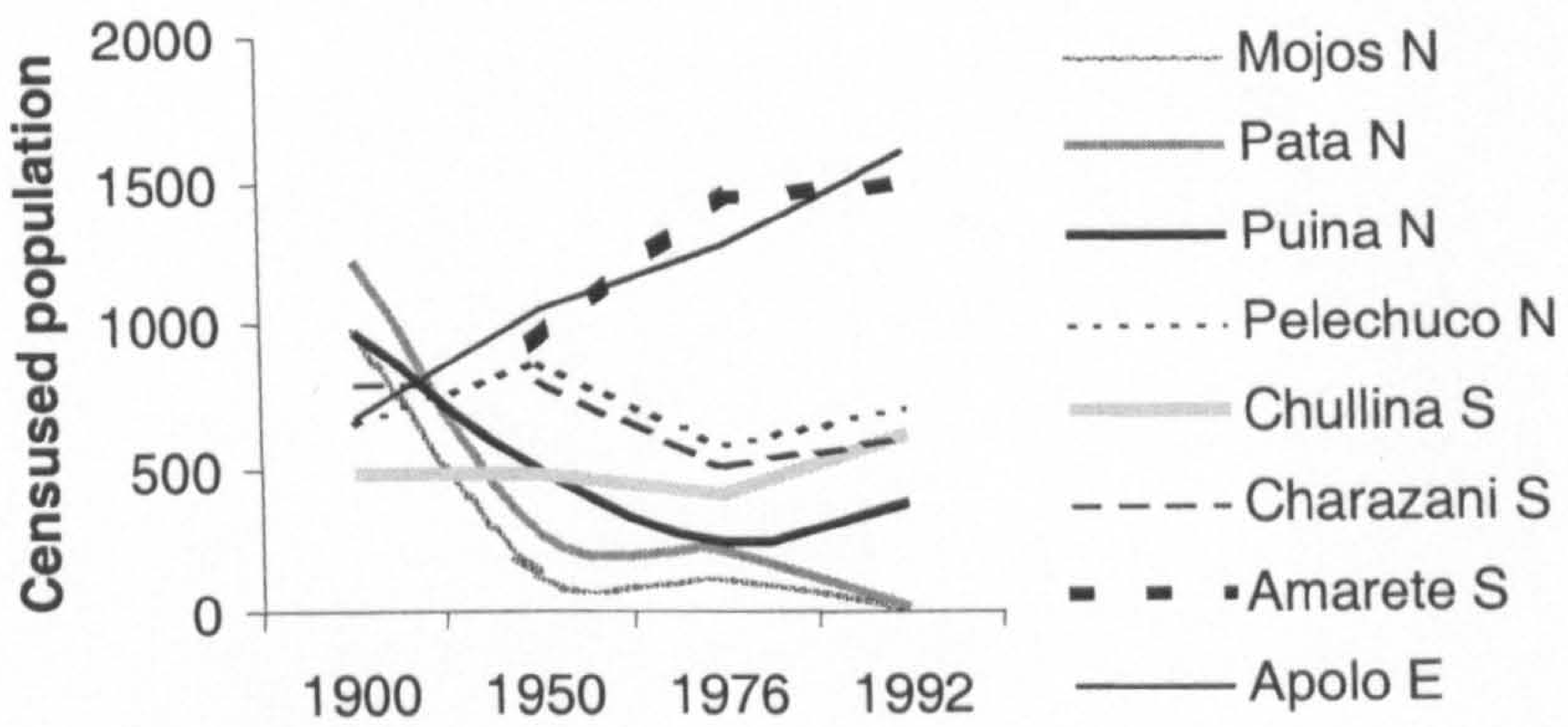

Figure 2-5 Census results for "centres of population", villages and towns in the study area in 1900, 1950, 1976 and 1992. Town names are followed by N in the north of the study area, S in the south and E for Apolo, which is to the east of the study area.

The south of the study area is more densely populated than the north (Figure 2-6). Densities in the populated areas are thought to average 6/km^2 in the Kallahuaya area of Bautista Saavedra, and 1.5/km^2 in the north of the study area (RNFUU 1997).

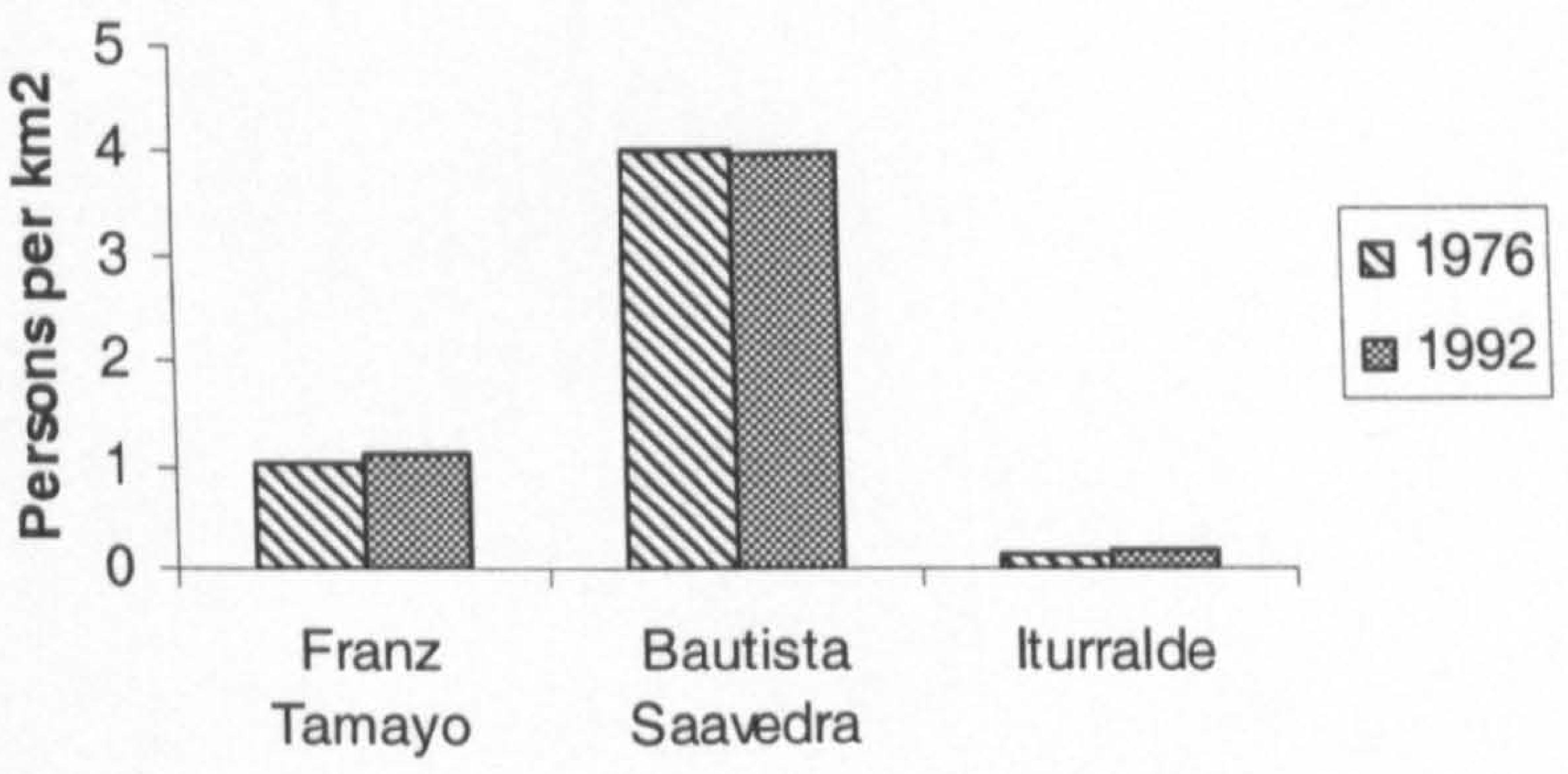

Figure 2-6 Human density in three provinces, Franz Tamayo (in the north), Bautista Saavedra (in the south) and Iturralde (much of the Madidi National Park) in the censuses of 1976 and 1992.

2.1.8 Towns, ex-haciendas and allyus

The settlements in the wider study area can be divided into three categories: towns, ex-*haciendas* and traditional *allyus*. The term **town** can be used to describe a community founded on the Spanish model, with a town square and a church, and at least several hundred occupants including members of the elite. They are also seats of local government. In the wider study area, there are two towns, Pelechuco and Charazani, in which live the vestiges of the ruling elite, the *vecinos*. During their heyday at the turn of the century (see section 1.4.3), the *vecinos* in Pelechuco and Charazani controlled trade, took up professions, occupied civil offices and taught in the schools. Pelechuco was an important post on the trade route between Apolo and Peru, and, at the time of the 1900 census, had several European and North American occupants, a post office and its own Peruvian embassy (INE 1902) (it now has none of these characteristics). The *vecinos* bought or built properties around the central square and opened small stores that continue to sell staple foods, alcohol, coca, llama foetuses and other items for ceremonial use.

Although much beleaguered after losing their lands in the Agrarian Reform, the *vecinos* are still very much in evidence, and often in power, in both Pelechuco and Charazani. The *campesinos,* who were formerly their peons, are now their *"ahijados"* or godchildren, and continue to exchange food and labour for assistance with legal or administrative matters, or for a simple recommendation to someone in power. This system, called *compadrazgo,* in essence furthers an exploitative and hierarchical relationship; however the *vecinos* do sponsor the lavish annual community festivals, and this serves as a form of redistribution of wealth (Crandon-Malamud 1991).

Many of these *ahijados* live in small (<200) communities that we can refer to as **ex-*haciendas*.** Before the Agrarian Reform, peons on the *haciendas* were a resident labour force, owing service to the landowner and receiving plots of varying sizes in return. After the Agrarian Reform, most of these people were granted title deeds to their plots. The present-day holdings of former peons to some extent reflect these initial inequalities, but in some cases also reflect different levels of success in the decades following land reform (Klein 1982). Culturally, the indigenous people who live in these towns and in the surrounding ex-haciendas may have lost some aspects of traditionalism in their dress and customs, but still adhere to many basic tenets of Andean life, such as making offerings to the *Pacha Mama* (the Earth Mother), and to the *achachilas* (the ancestral spirits). They believe in illnesses like *susto,* a severe illness resulting from trauma for which the only cure is for a loved one to call the sufferer's soul back to the body.

Nine traditional *allyu*s are found in the Bautista Saavedra Province (referred to in this study as the south): Kaata, Amarete, Chajaya, Chari, Chullina, Curva, Inca, Kaalaya, and Upinhuaya (Bastein 1985). Most of the people in these *allyus* were not subjugated to work on *haciendas,* but stayed as free communities (Klein 1982). Traditional *allyus* are not found in the north, in the Franz Tamayo Province. However, in the latter months of this study, national laws were passed that favour "original" people and their *allyus.* In order to take advantage of this legislation, the town of Pelechuco and the surrounding ex-*hacienda* communities in the Franz Tamayo Province, have elected to organise themselves into ad hoc *allyus.* Pelechuco will be an *allyu* with the communities of Queara, Puina, Mojos and Pata. Hilo Hilo is a separate *allyu* with Sorapata, Sunchulli, Laji, Chiata and Thapi. Charazani has also become an *allyu* with Jatichulaya and any other villages it can gather under its wing (Loayza Cossio pers.comm.).

2.1.9 Economic activities

In the north, most local people continue to grow tubers such as potatoes and other high Andean crops, and to keep free-ranging livestock (cattle, equids, and camelids). Much of the lower altitude cultivation of corn and other crops has been abandoned. Abandoned fields and trails indicate that agricultural frontiers have retreated in recent years as gold mining has grown in importance.

Gold has been exploited in Apolobamba since the Tiwanaku civilisation (INE 1993). In the last decade, there has been a local gold boom and men in the north of the study area (Puina, Queara, Pelechuco, Hilo Hilo and Sorapata) are dedicating more time to mining and less to agriculture, particularly at lower altitudes (Loayza Cossio pers.comm.). Informal, small-scale mining, particularly on the rivers flowing east from Apolobamba and the Cordillera Real, took total production to 14 tonnes in 1999. There are 141 mining concessions in Apolobamba, with 27 in active operation in 1997 (Loayza Cossio pers.comm.).

2.1.10 Protected areas

- **Ulla Ulla National Fauna Reserve**

In 1972, the Ulla Ulla National Fauna Reserve (hereafter UUNFR) was created in order to protect the remaining populations of vicuña, *Vicugna vicugna,* which were in serious danger of extinction. In 1997, the area was given the status of UNESCO Global Biosphere Reserve.

The development of the reserve was greatly boosted by the involvement of several national and international organisations, including the World Bank, which have monitored and aided the development of the llama and alpaca industries of the *altiplano* people. The reserve's mandate to protect the vicuña has been successfully fulfilled – there were 346 vicuñas in 1972, and 8245 at the 2000 census (Loayza Cossio pers.comm.).

- **Madidi National Park**

The extensive Madidi National Park and Natural Area of Integrated Management extends to over 18,000 Km^2 and, altitudinally, reaches from 250 to nearly 6000m. It forms a continuous protected area with Bahua Sonene and Tambopata National Parks in Peru, and, in Bolivia, with Ulla Ulla (now ANMI-Apolobamba – see below), and the Pilon Lajas National Park. Inside the park there are approximately 40 villages that are home to 3500 people. Other than the Quechuas in the upper altitudes, the main ethnic group in the park is the Tacana, a lowland group who are heavily dependant on hunting, fishing, rubber tapping and timber extraction. The Park is largely located in the vast Iturralde Province, in which two undisturbed groups of rainforest dwellers are thought to reside.

- **Apolobamba National Area of Integrated Management**

In February 2000, the 2400 km^2 Ulla Ulla National Fauna Reserve was expanded and reorganised as the 4800 km^2 Apolobamba National Area of Integrated Management. This change was in the planning stages during the latter part of this research project. The 1992 population in this area was 15,038 in 48 villages (RNFUU 1997).

2.2 GENERAL METHODOLOGIES

To shed light on the interaction between bears and people, as well as on the impacts of this interaction on the conservation of this species, both classic quantitative ecological research methods, and qualitative and quantitative social research methodswere employed. This study investigates a broad range of social, agricultural and ecological phenomena, as they relate to people-bear interaction. Multiple sources of evidence were gathered. This research topic itself necessitated a holistic and somewhat opportunistic approach. There were several reasons for this: the Andean bear is a cryptic species and notoriously hard to study; the conflict issues are sensitive, and the Quechua maintain a deeply ingrained fear of strangers (Bastein 1985). However, applied conservation research frequently necessitates an integrated and multidisciplinary approach (Caldecott 1996).

This research was conceived and carried out as a case study. The principal limitation of case studies is that results may not be applicable to other sites (Bernard 1995). Nevertheless, it has many advantages over large scale surveys: the case study is more flexible and allows for detailed analysis of relationships between parameters (Casley and Lury 1989); by allowing for this flexibility, case studies are particularly suitable for multidisciplinary studies; a case study also generates large amounts of specific information, which can subsequently be useful locally (Bernard 1995). Furthermore, multiple, in-depth case studies can lead cumulatively to a generalised understanding of particular issues (Skar 1981).

Full descriptions of the materials and methods, and of data analysis techniques, are presented in the relevant chapters. What follows in this section is a brief overview of the methods used to collect and analyse the data presented in the thesis. Two methods are fully described in this chapter. Firstly, the methods used for the semi-structured interviews are fully described (section 2.3.4) because results are used throughout the thesis. Secondly, the trapping and radio-collaring stages of radio-telemetry are fully described, as they are relevant to both chapters 6 and 7.

2.3 SOCIAL SCIENCE RESEARCH METHODS

In order to comprehend what it is like for people in Apolobamba to live with bears, and to understand their beliefs and attitudes towards bears, it is important for researchers to shed preconceptions stemming from a modern conservation ethic. Given my Western origins and deeply held beliefs in anti-extinction and pro-diversity (of ecosystems, species, cultures, languages, etc.), I was liable to perceive and interpret what I saw in Apolobamba from this perspective. Our tradition often casts local people as the enemies of the cause: the local poachers and hunters who have not yet been "enlightened" by environmental "education" (Gomez Pompa and Kaus 1992). It was important to recognise that the bears, about which people in Apolobamba would be asked to respond, were not the sentimentalised flagship species in *Save the Bear!* poster campaigns, but real animals who are neighbours, adversaries, and the subjects of many myths and beliefs that long pre-date the conservation banner-waving.

2.3.1 Participant observation

General techniques of participant observation (Bernard 1995) were employed in this study, although the purpose of this study was never a detailed ethnography of people in Apolobamba. The majority of my time was spent at the Pusupunko study site, half a day's walk from Pelechuco. As a result, the closest relationships I developed were with people in this town, but many weeks were also spent in Amarete, Charazani and Chullina. I helped plant potatoes and harvest corn; I gave salt to cattle and accompanied cattlemen when they found their cows dead and partially consumed by bears. I also danced in the traditional bear costume at the Amarete festival. I came to understand on a deep level the local mix of fondness for and irritation with bears – much more than may be reflected in the interview responses I amassed.

2.3.2 Key informants

Five people in particular were knowledgeable about bears: Reynaldo Lasso, Antonio and Beltran Roque Valencia, Ayda viuda de Ortuño and Jose Cayo. Their help was most useful in confirming and interpreting results of interviews, and in explaining complex phenomena, such as agricultural systems and land tenure. Another informant, Domingo Itusaca, was especially knowledgeable about myths, rituals and traditional beliefs. Observations derived from participant observation and key informants help clarify and enrich the data gathered by other means and are mentioned throughout the thesis.

2.3.3 Collection of stories

Young people's attitudes and ideas about bears were gathered by working with the secondary school in Charazani. The only complete secondary schools in the wider study area are those in Charazani and Amarete. The Charazani school was selected because its students come from a wider catchment area, including many isolated villages. Students participated voluntarily in a creative writing contest, in which school supplies were awarded as prizes. The aim was to generate original creative stories, as well as to gather non-fiction stories of encounters, and myths and folktales collected from elders in their communities. Stories were also opportunistically collected from adults during interviews, or at other times.

2.3.4 Semi-structured open-ended interviews

The main tool of social data collection was the semi-structured open-ended interview (Bernard 1995). This technique was selected over questionnaires for several reasons. Because of the distances involved and effort needed to reach people, the open-ended interview was more efficient in gaining as much detail from each interviewee as possible. A questionnaire necessarily limits the variety and detail of responses, and lacks qualitative insight. In contrast, semi-structured interviews, while maintaining a standardised framework of questions put to each interviewee, are flexible in terms of the scope, extent, order and emphasis with which different issues are explored (Henerson et al. 1995).

Interviews were carried out by myself (in Spanish), or by one of three local research assistants (in Spanish or Quechua). An interview guide (Appendix I) was followed (Bernard 1995). This written list of topics, and specific questions that need to be covered during the interview, was developed during a pilot phase (see section 2.3.4.4). Interviews were tape recorded, then transcribed and translated into Spanish. Only men were interviewed in this study for two main reasons. First, women reside more commonly in the villages and higher elevation fields, rarely venturing to the areas where they would have contact or conflict with bears. Secondly, the women rarely spoke Spanish and it was culturally unacceptable for the young male interviewers to engage in such discussions with women. Three research assistants were used consecutively to conduct interviews: Augusto Cuila Barrenoso from Amarete, Hilarión Cama Mamani from Pelechuco, and Herminio Ticona Chalco from Incasamana of the *allyu* of Amarete. They all speak fluent Quechua as their first language, fluent Spanish as their second language, and are highly adept at reading and writing. I speak fluent Spanish and rudimentary Quechua.

Standardisation and reliability of interviews was sought in two principal ways: prolonged training and re-translation of randomly selected interviews. I accompanied each research assistant on his first few interview trips in order to ensure that techniques were standardised. I was present at other interviews conducted by my research assistants (n=26) and 19 interviews were carried out by me alone. Interviews were conducted in Quechua (n=103) and Spanish (n=41). On their return from each research trip, the interviewers listened to the tapes, and transcribed the responses on pre-formatted sheets while translating into Spanish if necessary. Ten of the taped interviews in Quechua were randomly selected for re-translation by someone other than the interviewer. The only problem identified in this process was the omission of some minor details that were interesting to me but which had been deemed unimportant by the original translator. A total of 144 interviews were obtained, but seven were excluded from analysis on account of being incomplete.

Prior to the interview, a strict protocol was observed, in which each respondent was apprised of the goals of the project, assured of the confidentiality and anonymity of their responses, and asked if and when they could be interviewed. Many interviews took place in bear habitat, where the interviewee could point out plants eaten by the bear, or indicate places where bear-related stories had occurred. If the interview took place *ex situ,* such as during a market, the interviewers made sure that the interviewee did have some degree of interaction with bears. No one declined to be interviewed, although in one valley (Hilo Hilo), several respondents only agreed once others had been interviewed. Five people refused to have their interviews tape-recorded, and notes were taken instead. Interviews took 45 minutes to two hours to complete, depending primarily on the loquacity of the respondent. The interview was comprised of the following sections: Tolerance and encounters; Current and former beliefs; Myths and rituals; Crop-raiding; Livestock depredation; Ecology; and Management and status. Because of the large distances covered (on foot) to carry out the interviews, and the need to return to the various valleys on multiple occasions to fulfil the quota of respondents needed, data collection lasted from March 1998 until May 1999.

2.3.4.1 Research design and sampling

I employed a *two-group post-test only design* (Bernard 1995) when trying to determine the difference in attitudes reported by population 1 (the people in the north) and population 2 (people in the south). Only population 1 had been exposed to an intervention (the formal establishment of a protected area, the Ulla Ulla National Fauna Reserve).

Seven groups of approximately twenty people were interviewed in this study – four in the north, and three in the south. These seven groups were distinguished on a geographical and socio-political basis. This sampling strategy was initially based on the misconception that there were seven main valleys in Apolobamba and that human populations would be centralised in settlements at the head of each of these valleys. In fact this was not the case: settlements proved to be more spread out, so that there was often more than one settlement per valley; there are more people in the south; and the *allyus* are not clearly defined by valley. Nonetheless, this number of interviews provides a representative sample in the north and south of Apolobamba, and the division of the area into seven regions, referred to hereafter as **valley/zones**, did tally with local perceptions (Table 2-1). In the north, this number provided a near complete census of men in each valley/zone who had knowledge of or interaction with bears. In the south, it provided a small sample of such men in each of the three *allyus*. All analysis will be done on the basis of the north versus south comparison, except in the following section, which describes basic characteristics of each respondent, and in chapter 9, which analyses the determinants of traditional beliefs, tolerance, and level of conflict with bears.

Table 2-1 Distribution of interviews in seven valley/zones.

Valley/zone name	Valley/zone number	Other hamlets included in valley/zone	History	Number of interviews
North – inside the Ulla Ulla National Fauna Reserve				
Puina/Queara	1	None	Ex-hacienda	18
Pelechuco	2	None	Town	20
Hilo Hilo	3	Laji, Chiata, Thapi	Ex-hacienda	20
Sorapata	4	None	Ex-hacienda	20
South – non-protected area				
Chullina	5	Khasu, Carpa, Mataru, +	*Allyu* + *Ex-hacienda*	20
Charazani	6	Jatichulaya	Town	20
Amarete	7	Sapi, Sayhuani, Vizcachani	*Allyu*	19

In the south, random sampling was carried out in the absence of a reliable sampling frame. Lists of potential interviewees were generated by approaching town officials, shop owners and people in markets, and asking them if they could name people who had had contact with bears. Lists of 50, 89 and 74 men respectively were generated for valley/zones 5, 6 and 7. The names on these lists were attributed numbers randomly, and attempts were made to contact the first twenty people. This method may have biased the study towards people known to officials. If attempts to find those people proved impossible, and another person who had contact with bears was encountered in the process, the interview was done with that person instead.

2.3.4.2 Threats to validity

I will briefly mention some of the potentially relevant confounds, as they are identified by Donald Campbell (summarised in Bernard 1995).

- History confound – this problem refers to events occurring during the data collection period that may influence the results. Several changes took place over the 14 months of data collection. First, the possibility of the southern section of the study area being included in the expanded protected area seemed more and more likely, and the park began to hold workshops in many neighbouring communities (although in none of the communities sampled). Therefore, there was an increase in the awareness about impending restrictions, and about the benefits of being within a protected area. Second, the traditional *allyu* system was made official, after having been out of use for decades. This took place at the end of the study, and is unlikely to have had any impact on results.
- Selection bias – this threat to the validity of the results occurs when subjects self-select for some trait before the sampling takes place. It is a very common problem in quasi-experiments and natural experiments. In this study, it could be that people with higher degrees of connection to traditional beliefs about nature are the ones that choose to farm and herd, rather than mine in the highlands. As we only interviewed people who used the land and who had some contact with bears, the people interviewed could have been self-selected for increased connection to tradition. In reality, this would only be relevant to our study of human-bear interaction if people not selected for interviewing had an important influence on this interaction. This would have been a problem, had I been comparing the attitudes of people who had interaction with bears with those of people who did not. I did not seek to evaluate the way the entire population felt about bears.
- Diffusion confound – this occurs when a control group cannot be prevented from receiving the treatment in an experiment. This was not an issue in this study, as it was a post-test only design, but information about penalties for killing bears had begun to filter to the south of the wider study area, outside of the protected area. It was increasingly

rumoured throughout the period of the study that the protected area would be expanded to include the south.

- Fear – the most serious threat to the internal validity of the study was that fear of punishment might prevent people from responding honestly to certain questions. This is only a worry in the questions related to conservation and management, and every effort was made to assure respondents that there would be no repercussions from negative responses.

2.3.4.3 Community meetings

The first step in the more isolated communities was securing permission for the research in pre-appraisal community meetings (Bernard 1995). Before interviewers could wander around on people's properties, knocking on doors, and behaving in an inquiring or intrusive manner, it was necessary to explain the aims of the project in community meetings. Because of the burgeoning gold wealth of the area, most people are suspicious of any interference from strangers. These meetings had four primary goals:

- To describe the goals of the project (learning about bears, about the ways people felt and thought about bears and other predators, and about any difficulties people had with crop pests and livestock predators);
- To explain the use of the material (findings would be gathered and put in books and papers, in English and Spanish, and deposited in the new Charazani library, informing them that it was possible, but by no means not certain, that the findings could lead to changes in policy);
- To assure confidentiality and anonymity of interviewees, so that no one would be punished for expressing any view or describing illegal behaviour; and
- To secure permission of the community to carry out the research.

We tried to avoid much in-depth discussion of the research topic by the community at the meetings, so as to prevent *ad hoc* consensus forming. I was present at all of these meetings, and the research assistant who would be working in that area usually accompanied me. Meetings were carried out in Spanish with translations into Quechua.

In addition to the pre-appraisal community meetings, two focus groups were held. One was was held in Pajan, which belongs to the *allyu* of Curva. Crop depredation was discussed at this meeting. The other was held in Canizaya, which also belongs to the Curva *allyu*. Both of the focus groups were held in the south, because it was possible in this more populous area to have meetings with people who were not also being interviewed. This was done in order to maintain the independence of responses in the interviews, as consensus and collective opinions would influence the interview results.

2.3.4.4 Pilot interviews

The final interview guide was the result of two months of conversations with Apolobambans and experimentation with various versions of the points to be covered in the interviews (Henerson et al. 1995). This took place during July and August 1997, and was concurrent with searches for a study site for the radio-collaring and ecological research. Points that were hard to get across were either rephrased or excluded from the interview guide (for example, it proved difficult to ask about what patterns people had observed). Eighteen people were involved in this process. The views of seventeen of these people are represented in the final 137 interviews. Where there were deficiencies in information, once the final set of interview points were settled upon, these people were re-contacted and their views on these points recorded.

2.3.4.5 Coding of interviews

Discursive answers were summarised and coded *post hoc,* once the answers given had been analysed (Henerson et al. 1995). Attempts were made to code answers in an ordinal scale, progressing from negative to positive. For some answers this was impossible, and a categorical scale was employed. Twenty two questions were coded for analysis. The questions, and the coding of responses most relevant to the wider research questions, will be presented in each relevant results section.

2.3.5 Statistical analysis

The raw data was examined using a set of frequency distribution tables for variability (Bernard 1995). Descriptive statistics are given for the main twenty two questions on the interviews for the entire sample, split by valley and by north and south. Chi-square tests were used to test the null hypothesis that there is no relationship between the main independent variable of interest, north versus south (protected area versus non-protected area), and the interview responses. In this way, differences between north and south are only described if the chi-square test suggests that there is a relationship and that the observed responses differ significantly from expected (Bernard 1995). The expected distribution is derived from the overall frequency distribution combining north and south. The exact *P* value is reported for non-significant results and as greater than 0.05, 0.01 or 0.001 for significant results (Dytham 1999).

Factor analysis is a multivariate technique which allows the summarising and packaging of many measured variables into a few underlying dimensions (Bernard 1995). In this way the original unwieldy list of variables is reduced to a shorter list of factors that is easier to interpret. Factors account for chunks of variance in a correlation matrix. They are extracted from the correlation matrix in order of the amount of variance they explain in that matrix. Factor analysis attributes a score for every factor to each individual in the sample. These continuous scores (ranging from –2 to 2) are then used as the dependant variables in Generalised Linear Models (Bernard 1995). The importance of the following independent variables in the prediction of those factors was assessed: age of respondent (this continuous variable was simplified to fifty and over, and under fifty for one analysis); valley (north/south was an alternative to valley, which was used where possible); reliance on maize farming; reliance on livestock rearing; reliance on mining; and language(s) spoken. The SPSS for Windows – Release 7.5.1 programme was used for all analyses, except the Generalised Linear Models, which were carried out using GenStat 5 – Release 4.1. The parametric and non-parametric statistical analyses in this study follow procedures in Zar (1984) and Bernard (1995).

2.3.6 Archival material

The archives of the UUNFR were searched for records of correspondence regarding conflict with wildlife.

2.4 RESEARCH METHODS FROM NATURAL SCIENCES

2.4.1 Faecal analysis

The diet of the Andean bear was studied using faecal analysis. For any scat or feeding sign found, details were recorded of: location; habitat type; slope; aspect; distance to the closest bear trail; distance to the closest human trails; and relation to other bear sign. Samples of food plants were taken for identification of species. The following characteristics were recorded for each scat located: date; habitat type (forest/ecotone/grassland); content (approximate percentage volume by ocular estimate); age (ordinal scale) (Eulert 1995); humidity (ordinal scale); and the exposure of the location. Fibrous and long-lasting scats of the terrestrial bromeliad *Puya* spp. were the most commonly found during the study. These were generally examined on site because they were so numerous and because they rarely contained any other items. All scats that were not collected for further examination were broken up and dispersed, to avoid recounting them at some future time. Scats showing mixed composition or any constituent parts other than *Puya* spp. were collected. These scats were then dried, and transported to the laboratory in La Paz for analysis. There they were examined under a dissecting microscope and their composition identified and described using approximate volume. Seasonal variation in the diet was explored by examining the occurrence of food items in the scat by month.

2.4.2 Faecal decomposition

To provide a means of interpreting the diet from scats discovered in the study area, ten fresh scats were each divided into three portions of approximately 100 ml, and their rates of decomposition were studied. Each of these portions was placed in one of the following three environments: fully-exposed grassland; shaded grassland; or fully-shaded forest. Each portion was examined once a week to assess degree of decomposition, which was rated as: still intact; present but hard to recognise; and thoroughly disintegrated. Changes were measured in units of weeks and any change in category was attributed to the week in which it was discovered. A GLM was used to evaluate the influence on decomposition times of the original scat ID, type of scat, habitat type and season.

2.4.3 *Phenology*

To assess temporal patterns of food availability in the Apolobamba study site, general data were needed to investigate the periodicity of fruit production. Records were kept each month on the phenology of 10 species of plants in the study area. Three individuals of each species were monitored once per month and were classified as sterile, flowering, or fruiting.

2.4.4 *Nutritive analysis*

Ripe berries[3] of *Gaultheria vacciniodes* and *Pernyetta prostata* were harvested from different shrubs at the study site and were analysed fresh at the SELADIS laboratory in La Paz. Bromeliad samples were dried, sent to the United States and analysed by Dr Ellen Dierenfeld, Department of Nutrition, Wildlife Conservation Society, New York. The nutritive value of the samples was assessed using classic techniques of proximate analysis and the additional techniques for the more accurate assessment of composition of fibre, proposed in 1982 by Van Soest. Together these techniques provide information as to the chemical constituents of the plant, including cell content and fibre (McDonald et al. 1981).

2.4.5 *Geographic Information Systems*

A base map of the wider study area was generated in ARCVIEW 3.1, using bands 3, 4 and 5 of the 1991 LANDSAT 4 satellite image. The co-ordinates of prominent topographic features were recorded using a mobile Global Positioning Unit (Garmin 12X). These co-ordinates were used to geo-reference the satellite image. Features such as roads, settlements and trails were then also added, using GPS locations recorded in the field. The resultant map was used as a base for plotting locations of interviews, crop surveys and other data collected in the field. A simple map showing three habitat types was produced for the Pusupunko study site. This map was based on the reflectance values associated with different vegetation types. Polygons for their limits were drawn using on-screen digitising.

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[3] *Gaultheria vacciniodes* and *Pernyetta prostata* are in the Ericacea family, and are similar in taste and appearance to commercial blueberries (*Vaccinium corybosum*).

2.4.6 Radio telemetry

Two male bears were radio-collared in this study. All analyses were done separately for the two bears, on the basis that confidence in the results would be strengthened if both bears demonstrated the same patterns.

Trapping

Trapping began in September 1997, and the first bear (M1) was caught in April 1998, a one to two year old sub-adult male, weighing 34 kg. The second bear (M2) was caught in June 1998, an undersized adult male, weighing 30 kg, probably 4–5 years old or possibly older (based on cementum annulations and tooth wear[4]). The bears were fitted with 150–151 mHz radiocollars (Advanced Telemetry Systems, Isanti, Minnesota) containing a vertically mounted tilt-switch type of instant activity sensor. Data collection continued until the end of July 1999. The bears were captured in a barrel trap. The body of the barrel trap is made of two and a half fifty-five gallon drums welded end to end. A pivoting trigger supports the door of the trap. A wire pulls this trigger when the bait is tugged at the rear of the trap, releasing the guillotine-action door. Bears were immobilised using intra-muscular injections of Telazol©, a combination of Tiletamine and Zolazepam, at a rate of 6mg/kg. After the eyes were lubricated, and sex and vital signs checked, bears were instrumented with radio-collars. The bears were then weighed, measured, and observed for as long as possible into their recovery (Appendix II).

Monitoring of activity

The activity of the bears was monitored for at least one 24-hour period each month, (in addition to shorter periods), in which we attempted to sample all hours evenly. Activity was

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[4] The first premolar of M2 was removed in order to attempt to estimate age using the incremental layering in the cementum (Willey, 1974). A thin (12-15μm) longitudinal cross-section was taken and stained using Harris hematoxylin at Mattson's Laboratory (Milltown, Mont). The sections were mounted on albumin-coated slides and viewed under a compound microscope at x 48 and x 120 using transmitted light with the assistance of Pamela Coy, Department of Natural Resources (Grand Rapids, MN). The annuli were interpreted based on *Ursus americanus*, as this technique has not been used before with *Tremarctos ornatus* (Coy and Garshelis, 1992).

often monitored from a 3900-m ridge bisecting the study area, from which the signals of both bears could usually be heard. The motion-sensitive pulse rate of the radio signals was recorded for one minute every 15 minutes. Activity data were originally recorded as a continuous variable of 65 to over 200 pulses/minute. For analysis these data were recoded into a discrete binomial variable: 0 for inactive, 1 for active. Weather was recorded at the time of each activity reading.

To estimate the daily time budgets of bears, the hourly values for proportion of time active were averaged among the 24 hours of the day. Only data obtained during complete 24-hour monitorings were included. Time budgets were derived separately for each bear during each season and averaged for the two seasons to determine overall time budgets. The lengths of resting periods were examined by looking at consecutive inactive readings during a monitoring session.

Data collected in clumps are vulnerable to autocorrelation, which can lead to spurious conclusions. Therefore a data set of independent activity readings was constructed by eliminating data that were <5 hours apart. This data set was used for a generalised linear model to look for broad scale effects on activity of individual bear, month, season, time of day, precipitation, and cloud cover. The possible effect of the identity of the observer, of which there were six over the course of data collection, was also examined in this analysis.

Because achieving an independent data set required elimination of the majority of the data, for other analyses of activity patterns the risks associated with autocorrelation were accepted and all of the data were included. As with the independent data set, GLMs were used to carry out analysis on the full data set, and to examine effects on activity of individual bear, month, season, time of day, precipitation, and cloud cover. A separate GLM analysis was conducted, in order to examine season and weather-related effects on daytime rest periods.

Monitoring of movement

Radio collared bears were located up to twice a week when researchers were in the field. We radio-tracked from ridgelines that encircle the study area and from several prominent vantage points therein which were geo-referenced using a mobile GPS unit. Radio bearings were obtained using a Televilt receiver with built-in antennae, and a Telonics TR-4 receiver with a 3-element Yagi or 2 element H antennae.

In order to locate bears, I used two or more triangulated bearings with a minimum difference in angles of 30°. The radiolocations were determined first in the field using a 1:9000 map, and then later input into ARCVIEW 3.1 (Environmental Systems Research Institute, Redlands, California, USA) and analysed with the Animal Movement extension (V. 1.0). Reliable triangulation was sometimes not possible and records of disappearances and non-triangulated bearings are presented as a measure of tracking success, which is essential in order to avoid underestimating the home range size.

Three standard non-parametric methods were used to calculate the home ranges: minimum convex polygon, grid cell, and fixed kernel estimator. A fourth, descriptive method was included that takes into account tracking success and incorporates long-range, non-triangulated bearings. In order to examine the distances moved by bears, daily distances were compared to distances moved in larger time intervals. The longest-range daily movement observed is also described.

The overall utilisation of three habitat types by each bear is compared to availability using a chi-squared test (Neu et al. 1974). Habitat availability was estimated using the habitat map to produce percentages of each habitat type in the study area, defined for this procedure as the smallest rectangle in which the 100% minimum convex polygons were contained.

Seasonal effects on bear movement were investigated in several ways. Analysis of differences in seasonal home range was made possible by comparing the relative sizes of minimum convex polygons in the rainy season with those in the dry season. The locations found in each of these three habitat types were analysed by dividing the year into rainy, dry and intermediate months, and also into two-month segments, beginning with the first two months of the rainy season, November and December. Chi-squared analyses are employed to compare actual use with expected use, if all habitat types were used according to availability (Neu et al. 1974). The difference in daily distances travelled by each bear in the rainy and dry season was tested using a Mann Whitney U test.

Social interaction was explored in two ways: degree of overlap of home ranges, and correlation of utilisation distributions (Horner and Powell 1990). In order to explore how bears responded to areas used by humans, locations of human trails, fields and dwellings were noted, using a mobile GPS unit, and then plotted and compared to utilisation by bears.

2.4.7 Evaluation of livestock predation

A system for reporting livestock losses due to disease, accidental death and depredation was established in August 1997. We were notified of the deaths of livestock by UUNFR wardens, by the herders themselves, or by word of mouth. Sites were visited as soon as possible after we learned of them. A protocol for evaluating livestock deaths was developed and followed at each of eleven cases of suspected predation. Extensive consumption of most carcasses had taken place before they were examined, which hampered attempts to identify the cause of death.

2.4.8 Crop damage surveys

Maize fields were visited during May 1999, to determine the physical characteristics of the fields and to assess the damage caused by bears. The fields surveyed were those where the owner happened to be present on the day when visits were made. The area of each maize field was determined by pacing off its periphery. A compass was used to determine the angles of each sides of the polygon. The number of ears of maize in an undamaged 5m x 5m quadrat were counted, so that an estimate of total ears in the field could be generated. To determine percentage damaged we walked alternate rows in the field, looking to both sides and counting the number of ears on the ground that appeared to have been eaten by a bear.

The physical characteristics of the field were noted using six variables. The field was rated on a ranked scale in terms of: steepness (1= flat to, 5= hard to walk on); rockiness (1= no rocks to 5= boulder strewn); and attention (1= well cared for to 5= abandoned). The location of the field in relation to other fields was coded as (1= isolated from other fields, 2= on the edge of a cluster of fields, 3= internal in a cluster of fields). Distance to the closest river was coded as (1=<30metres, 2= 30-100m, 3= >100m); distance to the forest or other thick hiding cover as (1=<30metres, 2= 30-100m, 3= >100m). The influence of these six variables on whether or not fields had been raided by bears was evaluated using a logistic regression with a binomial variate as the dependant variable (1= damaged, 0= not damaged).

In order to determine extreme severity of raiding (without relation to area), we also paced off a 5m x 5m quadrat in the worst hit area of the field. The size of this quadrat was selected in order to encompass several rows. We then counted the ears eaten by bears, as well as the number still on the plant and on the ground that appeared to have been damaged by other species.

Chapter 3

MYTH, RITUAL AND IMAGINATION

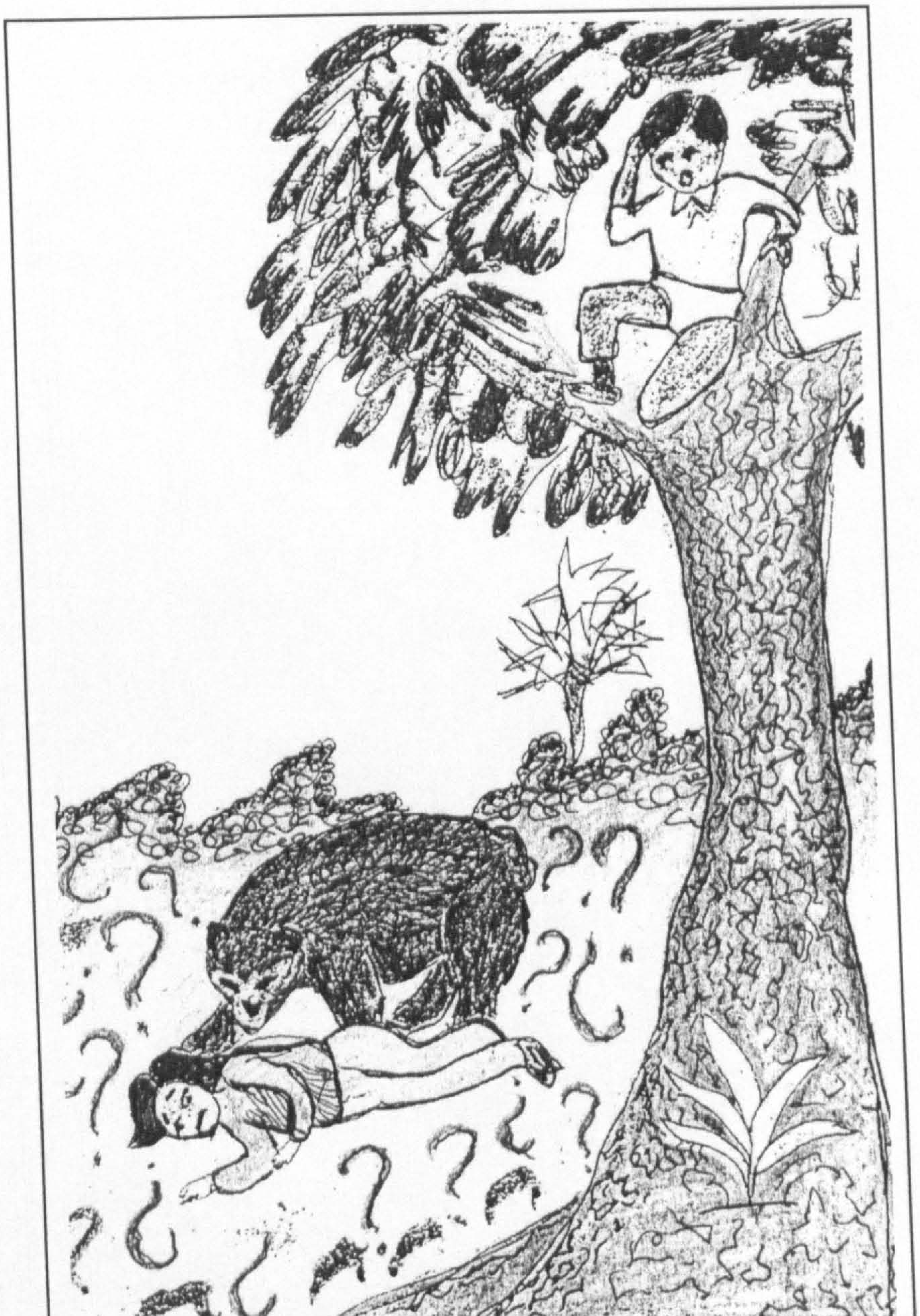


Illustration of a traditional story by 11 year-old Reynaldo *Mamani.*

3.1 INTRODUCTION

3.1.1 Human culture, animals and conservation

Humans, as described by E. O. Wilson, are "the poetic species, for whom symbols of art, music and language freight power well beyond their outward and literal meanings." (1984). This "power" has been harnessed by myths and rituals that dwell in, express, and influence the innermost depths of the individual and collective psyche (Jung and Kerenyi 1949; Campbell 1965; Lèvi-Strauss 1966). Hence, they are both individual and social in scope (Rosenburg 2000). Animals are central to human symbolic communicative systems such as myth and ritual (Wilson 1984; Shepard and Sanders 1985: Lawrence 1993), being, as Claude Lèvi-Strauss set out, "good to think with" (1966).

Animal myths and rituals[1] provide a reflection of how our human ancestors, as hunters and gatherers, shepherds and sedentary producers of crops and livestock, have related to a given species (Boitani 1995). Once in place, myths and rituals provide a set of lenses through which humans view and interpret our on-going interactions with animals (Kellert et al. 1996). These acquired perceptions of particular animal species have been shown to moderate physiological responses such as heart-rate and blood pressure when the animal in question is present (Friedmann et al. 1993) and often determine the very nature of human-animal interactions (Lawrence 1993). Consequently, perceptions are a prime factor governing animal conservation (Boitani 1995; Kellert et al. 1996).

3.1.2 Large carnivores and culture

The relevance of cultural heritage to animal-human interaction is best illustrated by the story of the annihilation of the wolf in North America. Colonisers brought with them the culture, religion and traditions of their mostly northern and central European roots. Anglo-Saxons and Germanic people viewed wolves negatively because of the threat they posed to

[1] The phrase "myth and ritual" is hereafter used to refer collectively to traditional symbolic communicative systems including also folktales, legends, dances, phrases, fables, and expressions in common parlance. These terms are defined in section 3.2.1.

themselves as nomadic shepherds (Lopez 1978). This negative attitude conspired with the colonisers' extensive animal husbandry practices (allowing large herds to range untended over vast areas) to make wolves despised. In that new environment, *theriophobia* (fear of the beast) became a societal neurosis, leading to the relentless slaughter of wolves, which were seen as the symbol of the dangerous wilderness that had to be conquered (Boitani 1995).

This recent antipathy towards the wolf is one manifestation of a wide range of strong emotional responses to large carnivores. Their prominence and predominance in the human mind is as widespread and as old as humanity itself. Twin cults, dating back literally to the dawn of our species, have venerated these large carnivores: the large felids and bears are thought to represent no less to humanity than "the two faces of god" (Campbell 1965). Many archaeologists believe that bear remains in caves used by Neanderthals in Germany and Switzerland and by early *Homo sapiens* sites in southern France indicate extensive Palaeolithic bear cults. These cults are likely to have been predated by African worship of large cats (Campbell 1968). More recently, in the region of 20,000 years ago, bears were being hunted and were the focus of such rituals as are evidenced in the cave of Montespan, where a headless clay bear was probably draped with bear skins, adorned with the skull of a bear and ritually speared (Grambo 2000). Together bear and cat cults comprise the earliest known religions (Campbell 1968).

Indeed, the importance of large mammalian carnivores in the contemporary human psyche cannot be underestimated. Bear cults extend around the Polar Regions through North America, Scandinavia, and through Russia to Japan (Hallowell 1926; Campbell 1965; Shepard and Sanders 1985). Tigers have been revered from Siberia to Southeast Asia and throughout India (Thapar 1998). Evidence of ritual burial and reverence for bears has been seen in nearly every culture where these animals exist (Black 1998). Other animals from elephants to bees have been worshipped, but no other creatures embody for humanity the spirit of nature like the large felids, canids and ursids. These animals are at the core of human affection for, myths about, and understanding of, the natural world (Kellert et al. 1996).

Several cross-cultural comparisons have investigated ritual and symbolic dealings with bears, commenting on their "remarkable similarities, concordances and even identicalness" (Black 1998). The possibility of multiple origins of these beliefs has been rejected (Hallowell 1926; Cipolletti 1983; Black 1998). Instead, these studies have concluded that the concept of the bear as a personification of the power of the universe, as a boundary-crosser, and as a mediator between separate worlds, has flowed through human culture as humans have successively colonised Eurasia and North America (Campbell 1968; Shepard and Sanders 1985; Black 1998).

3.1.3 Andean bears and culture

Human colonisation of South America took place during the late Pleistocene[2] (Irving 1985) throughout which time several species of Tremarctine and Ursine bears occupied both American continents (McLellan and Reiner 1994). Hence, colonists would have had no opportunity to lose touch with the primitive mythic theme of the bear. Yet amongst the rich collections of Andean pre-Colombian artefacts, bears are thought almost entirely absent from the archaeological record. A petroglyph of the partially masked face of a spectacled bear in a cave in Venezuela provides one of the few recognised indications of any pre-Colombian importance of bears in the Andes (Rodriguez and Cadena 1992). Archaeologists believe that the two species of large cats found in South America, the puma, and the jaguar, dominate pre-Colombian iconography, to the exclusion of the Andean bear (Reichel-Dolmatoff 1975).

The scarcity of recognised representations of bears before the arrival of the Spanish is notable, particularly given the role of the bear in contemporary Andean myth and ritual. There is some evidence from the early Spanish chroniclers that bears were considered a link between the Earth and the Gods previous to the Inca empire (see section 3.4.2). Garcilaso de la Vega wrote in 1609 that pre-Inca tribes worshipped bears, pumas and jaguars for their strength and that if they chanced upon one of these animals in the forest they would throw themselves on the ground and allow themselves to be eaten without making any attempt to

[2] Most scholars believe that humans colonized South America around 11,500 BP, while others argue that colonization took place 30-40,000 BP (Bray 1988).

defend themselves (de la Vega 1609). However, amongst the rich collections of Andean Pre-Colombian artefacts, the scarcity of recognised representations of bears is notable, particularly given the prominence of the bear in extant Andean myth and ritual (Torres 2001). For example, the bear is thought of as the half-brother to the Yukpa people of Venezuela's Perija Mountains and wears its fur only to conceal its resemblance to humans. The Tuneba people of Colombia have strong taboos against killing bears, also seeing them as half-brothers who watch over them (Torres 2001).

Whatever the scale of the bear cult in South America before the arrival of the Spanish in 1531, we know that Christian missionaries did their utmost to eradicate it and the rest of the colourful pantheon of Andean gods and spirits. Large carnivores in Christian symbolism are embodiments of cruelty, savagery and evil. In Isaiah 11:1-7, the second coming is described in terms of the conversion of carnivores to a peaceful way of life: "The cattle will graze amongst bears. Cubs and calves will lie down together. And lions will eat grass as livestock do." In Samuel 17:35, when a bear comes to steal a lamb from the flock and turns on David, he catches it by the jaw and clubs it to death. Christian missionaries tried to impose upon the earth-worshipping Andean polytheists a rigidly black-and-white structure, in which there is one God in heaven and everything below is essentially evil. The missionaries must be judged to have failed in this endeavour. Today most Andean people consider themselves good Catholics and venerate saints while, at the same time, they continue to respect previous divinities, the ancestors in the mountains, the Mother Earth, the God Lightning and the rest of the good and bad spirits (Girault 1987). However, the missionaries did tell good stories and much of the new imagery, superstitions and tales were readily assimilated.

3.1.4 Andean bear rituals

While few depictions of bears have been recognised in Andean artefacts, the place of bears in myth and ritual is undisputed. By far the most elaborate and striking manifestation of the South American bear cult is the festival of *Qollur Rit'i*, the festival of the Pleiades (Randall 1982). This complex annual event in Peru is celebrated at the austral winter solstice. Quechua men come from surrounding villages and, dressed as bears *(Ukukus)*, and rough-housing in bear-like fashion, they undertake the gruelling trek to the summit of the Colquepunku glacier. There they cut blocks of ice, and offer them to the spirit of the mountain in order to liberate their souls from mortal sins. In this pilgrimage to the mountain summit and back to the village, these dancers are believed to be mediating between the past and present, sickness and regeneration, the highland and lowland, humans and animals, nature and culture, childhood and adulthood, order and chaos. The symbolism and significance of this event has been suggested to have pre-Colombian roots (Randall 1982).

Other than *Qollur Rit'i*, the main ritual observed with relation to bears is the dance of the bear or *ukuku,* which takes place throughout Bolivia and Peru during the pre-Lent Carnival and at many other festivals (Morote Best 1957; Paredes de Salazar 1976). The character in the dance is described as a supernatural, being very prone to passionate love (Costas Arguedas 1961). The very name, *ukuku,* is described as imparting a mystical feeling. The dancer is treated with fear and superstition. Traditionally the costume is a tunic made of llama or some other fur. The dancer carries in one hand a three-pointed whip, or a coloured handkerchief. The dancers vary in number, but in their own dance they advance in two lines making slow jumps and imitating bears. More commonly, the *ukuku* will play the role of a buffoon, and be incorporated into other dances such as the classic *Diablada.* They head the processions, clearing the way for the more serious dancers through the crowd. They tickle children, steal food from vendors, make fun of the serious dancers, and perform lewd antics (Morote Best 1957; Paredes Candia 1966). This dance is still common in Bolivia, and when it takes place in the cities, most participants hire a heightened, synthetic costume (see photo on page 1). The one most often seen in Bolivia is white, and the elaborate, grimacing mask has bulging red eyes and large teeth. The dance is linked to the story of the Bear's Son, the *Ukuku* being born of the union of a bear and a human (Paredes Candia 1966).

3.1.5 A pan-Andean folktale: the Bear's Son

The Andean bear is the main protagonist in what is probably the most vital of Andean stories: the Bear's Son *(Ukukq Churin).* The vitality of this lengthy folktale is evidenced by its penetration beyond the distribution of the bear, from Venezuela to Bolivia into Argentina and Brazil (Cipolletti 1983). The pan-Andean distribution, and the Andean colour and flourish of this story, belie what many believe to be its European origin (Allen 1992; Payne 2000). It is certainly true that versions of this story appear in countries such as Germany, Holland, Scandinavia, Greece, Spain and Slavic and North American countries (Cipolletti

1983). However, some scholars argue that the *Ukukq Churin* story is actually the fusion of European and Andean traditions (Morote Best 1957; Paredes Candia 1966; Cipolletti 1983). Indeed, at least three sixteenth century documents written by Spanish chroniclers relate stories of girls being abducted and impregnated by bears as though they were fact (Cabello de Valboa 1586; Morote Best 1957). One of these was written in the sixteenth century, by Fray Reynaldo de Lizarraga in Cochabamba, Bolivia: "There are bred very large bears that pursue the women and, when the women see the bears, they make no resistance" (Morote Best 1957). This idea is also supported by stories of bear-human couplings from Northeast Argentina (Cipolletti 1983).

The structure of the Bear's Son story is essentially episodic (Payne 2000), and as a consequence it has many versions, individual tellers having chosen to include or exclude elements of the story (Allen 1992). However, certain elements are central to the narrative (Morote Best 1957). A person encounters a bear that, with varying degrees of seduction or force, conveys the person to its cave. A half-bear, half-human son is born (Payne 2000). The son has the great strength and intelligence of the bear but a human form. The son helps the human parent (sometimes mother, sometimes father) escape from the cave and they flee to the village. The bear-parent is often, but not always, killed. The son then has many escapades relating to his super-human strength, including the domination of wild animals. After many attempts on the part of the village to punish or kill him, he usually fulfils some heroic task and is lavishly rewarded (Morote Best 1957).

Three main interpretations of the meaning of the story have been put forth. First, the story is seen as Oedipal, expressing the son's need to protect the mother and slay the father (Morote Best 1957; Payne 2000). Second, the killing of the bear parent and the subsequent fight with the priest in the village epitomises the tensions inherent in the experience of the Quechua man. They embody the ethnic tension between the foreign, taming influence and wild indigenous nature; between mixed Spanish race (*meztiso*) and the indigenous race; the class tension between patron and peon; and the religious or cultural tension between the Spanish-Catholic and the Andean-Incan tradition (Allen 1992). The third, more ecologistic interpretation states that, "Human and civilised society cannot survive without establishing interchange and co-operation with wild beings from the other world" (Robin 1997).

Apolobamba provides a fascinating opportunity to explore the existence of bear-related myths and rituals, due to the strong traditional culture and the continuing existence of bear populations. Little is known of bear-related myths and rituals in Bolivia. Stories have been collected from the Puno district of Peru, near the Bolivian border (Morote Best 1957), and the existence of bear-related myths and rituals is suggested in several documents from Bolivia (Yanez et al. 1986; Eulert 1995; Rumiz and Salazar 1999), although none relating to Apolobamba. As instilled through myth and ritual, human responses to animals originate from deep, often irrational, emotional attitudes that are embedded in our cultures (Boitani 1995). Myths and rituals are, therefore, a natural starting point for a study of the interaction between people and Andean bears in Apolobamba.

In summation, these myths and rituals are products of human interactions with the species in question (Lopez 1978), and therefore give clues about the nature of these interactions both in the past and present. How humans learn from an early age to think of these animals through stories, influences our interaction with them. The stories that ring true enough to become folktales or myths engage us at a deep level and they do so from our child-hoods (Campbell 1965). Creative writing, like traditional stories, springs from the human imagination and therefore reflects how people feel and think about bears. The analysis of stories written about suggested topics has proven a useful instrument in the exploration of social attitudes and culture, as well as personality[3] (Tomkins 1974; Teglasi 2001). Therefore, asking adults and young people in Apolobamba to relate stories about bears not only provides the opportunity to see what traditional narratives circulate in their milieus, but it also provides insights into how they currently think of bears.

3.1.6 Research questions and structure of chapter

The main objective of this chapter is to document fully the depiction of bears in Apolobamban culture. This is carried out with the aim of trying to understand the symbolic and conceptual foundations that attitudes and beliefs about bears are built upon. Given what

[3] The Thematic Apperception Test is a standard psychological test developed in 1943 using stories to assess state of mind (Murray 1943).

has been established in studies carried out elsewhere about bears in Andean myth, ritual and imagination, the following research questions are pursued.

- Does the bear play a prominent role in the imaginations of young people and adults?
- Is the bear thought of as a horrific creature that must be destroyed?
- Is the bear venerated and depicted as powerful?
- Is the Bear's Son the only story of bears in circulation?
- Does depredation figure heavily in images of bears?
- Is it common for bears to be hunted and killed in myth, story and ritual?
- What implications does this cultural reservoir have for conservation of the species?

In this chapter, stories collected from adults and children are classified into eight main themes, and an example is given of each. This is followed by and analysis of the attitudes reflected therein. Rituals and other symbolic representation of the bear are then described.

3.2 METHODS

3.2.1 Terminology

Stories: Spoken or written accounts of connected imaginary or past events (Pearsall and Trimble 1996). In this study they refer to folktales and myths, creative writing and factual narratives.

Folktales: Popular or traditional stories having to do with people, supernatural beings or animals that can speak (Pearsall and Trimble 1996). They are symbolic or metaphorical expressions of a culture's strategies for dealing with the world in which they live. Folktales have no particular location in time or place (Rosenburg 2000).

Myths: Like folktales, myths are traditional stories having to do with people (Pearsall and Trimble 1996), supernatural beings or animals that can speak. They are symbolic or metaphorical expressions of a culture's moral values. Myths tend to be more firmly rooted in the past than folktales and can be further differentiated as being comparatively more sacred and more to do with the supernatural and the origins of phenomena (Rosenburg 2000). In practise myths and folktales are often hard to differentiate and will be combined for analysis under the term "traditional stories".

Traditional stories: The combined category of myths and folktales.

Creative writing: Original stories in which the authors have relied on their own imaginations to invent the plot.

Factual narratives: Stories in which the narrators relate events that they have observed or about which they have been told as if they had occurred in reality.

Allegories: Short simple stories that teach lessons about morality or human existence (OED 1999).

Ritual: The practise of a procedure in observance of beliefs. Ritual is considered the most potent symbolic communicative system; it engages all of our senses and thereby achieves an even greater ability to inculcate meaning than even myth (Black 1998).

Symbolism: The use of entities, often from nature, to represent or refer to an idea, quality or process (OED 1999).

3.2.2 Collection of stories from adults

Stories were collected both from interviewees and from people who were recommended because they had particular knowledge of folktales. Two types of stories were collected from adults: traditional stories (referred to as myths and folktales); and factual narratives. Stories were taped, transcribed and translated initially into Spanish by fully bilingual research assistants and then into English by SLP. Certain small changes were made in the grammar for clarity. For example, the stories were usually told as one long sentence with each phrase separated by "and". Another change was the addition of quotation marks. However, any ambiguities or inconsistencies in the story line are not resolved in the translation from Quechua through Spanish into English.

3.2.3 Collection of stories from students

A contest was held in the M. Isauro Pasten Secondary School in Charazani in which the students, aged 10 to 18, collected folktales and other stories relating to animals. Three types of stories were collected from students. The first type of story collected was that of traditional stories. Students were encouraged to go out to their communities and speak to their grandparents and other elders and to transcribe their stories as closely as possible. Stories were only classed as myths and folktales when they were classed as such by the narrator. In all cases it was established that these stories were traditional by having them corroborated by someone else who was unconnected with the source, but who was familiar with the story. The second type of story collected was that of factual narrative. Students wrote about encounters with bears or other wild animals that were experienced either by them or by people they could interview. A third type of story collected was creative writing, as it arose from the imaginations of the students. They were asked to clarify which sort of story they submitted. They were told that all categories of story were equally acceptable, regardless of how the bear was depicted. Students could also do art projects relating to these animals. The winners of the story and art contests within each year class were presented with a prize of school supplies.

Unfortunately, it was not possible to hold a similar event in the secondary school in Pelechuco in the north of the study area. Two attempts were thwarted by teachers' strikes. It would have been very interesting to observe any differences between the stories gathered in the south and the more sparsely populated, protected area in the north. Furthermore, the twelve stories collected from adults do not provide a sufficient sample to explore north versus south differences either.

There are therefore two major sources of bias in these stories collected from the adults and students. First, the majority (81%) come from the south of the study area. Second, it is possible that bears would have been depicted in a more sympathetic light in order to win the competition, if that is what the students thought would be favoured. Alternatively, in the case of the adults, bears could have been depicted in a more menacing light, in order to gain compensation for damages, or to register their dismay about depredation. In the event, this does not appear to be a genuine concern as the traditional stories collected from adults and students were genuine myths and folktales, repeated in many cases and areas.

3.2.4 Classification of stories

For the purposes of analysis, the collected stories are classified according to four criteria in this chapter.

1) Narrator: adult or student.
2) Type of story: traditional story, factual narrative or creative writing.
3) Main theme of the story: eight themes are identified, irrespective of type of story.

4) Tone of depictions of bears within the story: positive, ambivalent, or negative. The criteria for this classification are as follows:
   a) Positive:
      i) Bears are harmless or protective towards humans.
      ii) Bears do not come into contact with people and behave in a sympathetic manner towards each other or the other characters.
   b) Ambivalent
      i) Bears are depicted in a complex way, including both positive and negative qualities.
      ii) Bears are dangerous to people while at the same time showing emotional tenderness, kindness or other positive anthropomorphic characteristics.
      iii) Bears are depicted as animals without any discernible value judgement.
      iv) Bears engage in crop raiding and are dealt with as relatively harmless crop pests.

   c) Negative
      i) Bears are reacted to as if dangerous to people, without ever attacking a person in the story.
      ii) Bears threaten, attack or consume people or their livestock.

3.2.5 Semi-structured interviews

Questions relating to myth, ritual and imagination were a part of the semi-structured, open-ended interviews (see 2.3.4. for detailed methods, and section VII of Appendix 1 for interview guide).

3.2.6 Participant observation

To gain understanding of the perception and symbolic importance of bears I relied largely on the general fieldwork method participant observation. I also danced as a *jukumari* in the Amarete Festival of the Virgin of the Glaciers, which provided an opportunity to learn a great deal about this dance, and its associated costume, from people at the festival. In addition, observations were made of rituals surrounding the treatment of bear remains still practised in the town of Amarete. This chapter reports the main observations relating to the symbolic perception of the bear: the group of the four large pest predators (puma, bear, fox and condor); the relationship between the bear and the large felids; and the figure of the bear in daily conversation. These observations were derived from time spent in the company of a broad range of local inhabitants including men, women, children, the elderly, farmers, livestock herders, miners, in short, any interaction with local people in Apolobamba.

3.3 RESULTS

3.3.1 Stories

A total of 45 stories were collected during the study. Three stories have been excluded from the following analyses, as they were about condors, pumas and foxes and not bears. Of the remaining 42 stories, 12 were collected from adults and 30 from students. Of the stories collected from adults, nine were traditional stories and three were factual narratives. Of the stories collected from students most were traditional stories or pieces of creative writing with one factual account (Table 3-1).

Table 3-1Break down of type of story amongst 42 stories collected from adults and students.

Type of story	Adult	Student	Total	
	(N)	(N)	(N)	%
Traditional story	9	13	22	52%
Piece of creative writing		16	16	38%
Factual narrative	3	1	4	10%
Total	12	30	42	100%

Irrespective of the narrator or of the type of story, the 42 stories were classified into eight broad themes and ranked in order of popularity (Figure 3-1). They are grouped by characteristics seen as worthy of highlighting and as a basis for differentiation, although many of the themes present in one type arise in others.

1. The Bear's Son (n=9): versions of the classic Andean tale.
2. Other bear/human couples (n=7): stories in which the two fall in love, marry or become friends.
3. Conflict (n=7): stories in which the protagonists cope with bears in their maize fields or otherwise deal with bear-management issues. One factual biological description of bears eating corn was included in this group.

4. Bears as superheroes (n=5): tales that depict bears as super-heroes who vanquish their enemies and prove themselves to be superior to other animals.
5. Killing a bear (n=4): often stories describing how strong bears are, how hard it is to kill them and how brave the person must be to accomplish it.
6. Bears as jesters (n=4): stories in which bears dress up in people's clothing or are otherwise characterised as jesters and pranksters.
7. Bears as monsters (n=3): stories depicting bears as rapacious man-eaters and monsters.
8. Allegories (n=3): short simple stories that teach lessons about morality or human existence (OED 1999).

Figure 3-1 Percentages of collected stories that fall into each theme.

Following are translated examples of each of the eight types of stories collected. They are illustrated with art from the secondary school students in Charazani.

1) The Bear's Son,	a.)*The priest, the jukumari she-bear and Sanson*
	b.) *Doña Tomasa and the man-eating jaguar*
2) Other bear/human couples	*The bear and the shepherdess*
3) Conflict	*Señor Turelo's problem*
4) Bears as superheroes	*The six-headed snake*
5) Killing a bear	*The dancing cub*

6) Bears as jesters	*The cross-dresser*
7) Bears as monsters	*The man-eating bear*
8) Allegories	*The bear and the two friends*

3.3.1.1 The Bear's Son,

The story of the Bear's Son is well known throughout the Andes (see section 3.1.5), and this popularity extends through Apolobamba. This was the most popular story collected from adults and students, although many more versions could have been gathered, as the great majority of interviewees knew the plot of this story. Rather than repeat well-known versions of the tale, the two unusual versions are presented that still contain the basic elements of the classic story. By coincidence the bear-parent is female in both of these stories.

a.) *The priest, the jukumari she-bear and Sanson*

This version of the classic Bear's Son Tale was written by an 11 year-old student based on the story recounted to her by her grandfather in the village of Quiabaya. It interweaves a biblical story into the familiar Bear's Son plot.

> *A long time ago a priest and a very rich chola[4] woman were in love and had an engagement to be married. The chola told him that he was not to visit on Tuesdays and Fridays. The priest was surprised and thought, "Why would she say that to me? Surely she has dates with another man. I will find out." He went to his fiancé's house and hid nearby, thinking, "Who will arrive?" When it was night, the chola dressed up to go to "Miqali" where the devil lives. In that moment the priest appeared and the chola said to him, "Why have you come? I told you not to come! Alright, you stay here, I have to go before the devil because I have an appointment and I can't miss it." The priest said, "I want to go too." "Well alright, we'll go together," responded the chola, "but you'll have to cope with twelve different farts of the devil of very strong and unbearable odours and then you will be given gold, or, if you prefer, silver."*
>
> *The chola entered into the house of he devil at midnight and left, without any problem, with loads of silver. It was then the priest's turn. He had braved out eleven of the devil's farts, of different very strong and terrible odours, and*

[4] A chola is a woman who wears the Aymara-influenced dress of the indigenous trading class: a small bowler hat with two long plaits in the hair and a full skirt called a pollera.

lacking only one, because he couldn't take any more, it occurred to him to try to plug up the devil's bum with straw. The devil gave him a strong kick and sent him flying.

The priest could not move from where he landed until morning. He woke up deep in a ravine and found he had no eyes. He could go nowhere blind. There, a she-bear found him and carried him off to be her husband. They lived there together for years. The she-bear brought him raw corn and meat.

Years passed and they had a little son. With the passage of time he grew. One day while his mother was out looking for food he asked his father, "Why have you always lived with an animal? Where was your village?" His father told him the truth. The boy was very intelligent and extremely strong and worked out a plan: one day, while his mother was out searching for food he would carry his father away to be with his own family.

The day came that he did it. His mother used to leave the entrance to the cave blocked with a large rock. As the son had supernatural strength he was able to budge the rock and then push it out of the way. He took his father and carried him up the trail. Half way to the village they were caught by the she-bear. The boy busted her in two and threw one half up the trail, and one half down the trail. Then he carried his father up to the village and to his family. They were very surprised to see the priest and he told them everything that had happened.

They loved the boy very much and enrolled him in school. But he abused his schoolmates a great deal because of his supernatural strength. The children's parents didn't know what to do and thought of taking the son of the priest and she-bear to the tower and pushing him off. The boy was called José Josem, "The Little Sanson". So as time went little Sanson became a young man. The villagers thought of making him drunk and tying him up with string and wire, but it was all in vain- he broke them apart like they were nothing at all. The villagers could do nothing.

One day they thought to send him off with twelve wild mules to the forest to get firewood. They thought, "You won't be able to do this!" But Sanson, as he was so strong killed the twelve mules and then thought to himself, "Now what am I going to do?" I'll look for twelve jaguars and on their backs I'll carry the wood. And then he did it, just like that, which gave the villagers another big surprise. It gave them a big worry too: they had to beg Sanson to return the jaguars to the forest where he found them.

Figure 3-2 Illustration by Olga Elizabeth Cayo, age 16, from the town of Chullina.

The next day, he met the Inca who had been trying to move irons with various workers. José Josern said to the Inca, "I, all by myself, in one moment, can carry those irons if you will give me your daughter." The Inca, thinking this was impossible, accepted the proposal. Sanson achieved this feat and the Inca had no choice but to give up his daughter. They lived together, Sanson and the daughter of the Inca. He made her suffer, though, characterised as he was by having such great strength. When he was on a drinking binge he abused everyone.

One day the woman's family and the other villagers went to her and said, "Ask him, as you are his wife, why he is so strong." "I will," she said, "and I'll tell you what he says." When his wife sweetly put this question to him, Sanson confided in her: "I have in my head three colours of hair. That is my strength." The woman returned and told the people how it was.

So they got him drunk and cut off that part of his hair. From that moment, Sanson no longer had strength. It was then that they made him pay for hurting them and their loved ones: they abused poor Sanson and even tortured him and left him, like his father, without eyes.

But Sanson prayed day and night to God so that his shorn hair would grow. When everyone was gathered at Sunday mass he found a policeman and begged to be guided to the church. When he got there, he shouted from the door of the church, "Inca King and all of you who abused me and this whore, your daughter, now is when we are all going to die!" In that very moment with one push, he toppled the church and all of the people died, and Sanson too.

Cecilia Ticona Yujra

The Bear's Son, b.) ***Doña Tomasa and the man-eating jaguar***

A miner from Sorapata recounted this version of the Bear's Son story. Like the preceding story it is unusual in having a female bear as the protagonist. The she-bear is sympathetically depicted as protective of human life and as a caring, if domineering creature. The names Tomasito and Doña Tomasa are commonly used as names for male and female bears, respectively. The character of the hummingbird symbolises communication in many Andean traditional stories (Morote Best 1957).

> *Once upon a time, a group of people went to the forest to harvest incense. They found a spot to camp, and in the evening they all went to sleep. They were lying next to each other, and at midnight one of the friends went missing from the middle. The remaining friends were very frightened.*
>
> *The same thing happened successively, one by one, until they were all taken but one man. The men had been taken by the jaguar. The remaining man departed sadly for his house. On the trail he encountered a jucumari who said, "Hello, man. Why are you going away so sad?" The man responded, "My companions were all lost, one by one." The jucumari answered, "I know who has robbed you." The man said, "Well then tell me, Lady Jucumari." And she answered, "Yes, I will tell you, but with one condition. If you want to save your own life, you have to pair up with me. If you don't want to be my husband you will be killed. I know who is waiting in the path: the Jaguar." In that very moment the jaguar appeared and the man shouted, "Doña Tomasaaaaaa!"*
>
> *La Tomasa ran and grabbed the jaguar who scratched her, and the man was worried because he thought the jaguar would eat her, but just then she threw a punch which knocked the jaguar to the ground. The bear tore the jaguar to pieces.*
>
> *Doña Tomasa took the man as her husband and carried him to her cave. The cave had a door made of a giant flat stone. For food, she brought him only the meat of wild animals. In a short time the man became bored and soon Doña Tomasa became pregnant. In time she had her son, and she left him for the man to take care of. The cub grew rapidly. His father conversed with him, saying, "My son, I'm bored here. We could go but this rock is big and I can't move it." His son said he would try. One day he was able to move the rock and his father was overjoyed. They told Doña Tomasa to go and look for a cow of three colours and off she went to bring it for them.*

The next day she felt strange and a humming bird kept pursuing her to the left and to the right. La Tomasa said, "These damned hummingbirds, why are they pursuing me?" The hummingbird answered, "Beacause something is happening to you. I know what it is. I can tell you." "Well," said Tomasa, "then tell me!" The hummingbird told her that her husband was leaving her with her little son.

Full of fury and grief, Tomasa threw herself into a ravine and died.

Fernando Challco Ochoa

3.3.1.2 Other bear/human couples: *The bear and the shepherdess*

This story was one of seven stories that, like the Bear's Son, tells of a relationship between a bear and a person. However, unlike many Bear's Son stories, the person is not forcibly kept in a cave, and the exploits of the son are not central to the story. This traditional story was written by a student from the village of Niño Corín. She was 13 years old and in her third year of secondary school. She included many explanatory notes inside parentheses.

Once a shepherdess, looking at the mountain saw a cave and said to herself, "I wonder what's in that cave!" She always saw a man sitting at the door of the cave and one-day she thought she'd climb the mountain. When she went up there no one, not even he (the bear) was around. She went into the cave and saw a well-ordered house. She picked up one of the objects in the house and immediately put it down because a large bear appeared. When she saw him she shouted "O, Lord!" and fainted.

When she awoke she was very comfortable in the bear's bed and she saw a young man who attended to her well. He wasn't too tall or too short (it was the bear). The girl admired him thinking, "Where did this young man come from?" and in that moment she realised that the cave was his home. She thought that seeing the bear before she fainted had all been imaginary.

After they had been in the cave for who knows how long the shepherdess realised that she had forgotten about her sheep. It was late and she ran out of the cave in search of the sheep. She only found half, and when she arrived home her father and mother scolded her, "Where in the devil were you while the sheep were getting lost?!" The shepherdess didn't know what to say (she kept the truth to herself). So her father told her to go in search of the missing sheep. But she said, "I can't go at this hour!" (It was already night).

The next day at first light her father told her to go and look for the sheep that were lost. One week passed with no success. Her father scolded her saying that everything that was lost from their home was her fault.

One day, overcome with sadness and crying bitterly, the girl was tending to the remaining sheep when the young man appeared. He asked her why she was crying and she said, "It's nothing." Once again he asked her, "I don't believe that it's nothing- you are crying for some reason." The girl said, "I am crying because I have lost half of my sheep, and anyway, my father says everything that goes wrong is my fault. I wish you could find my sheep." "I think I have seen some sheep grazing over there," he said. "Now don't cry any more, I know where your sheep are." They went to look and soon they found the missing sheep. When they arrived to her house her father asked who had helped her to look and the girl responded that a young man had helped her. Her father was very enthusiastic and said he would like to thank him.

The daughter went to the young man and took him to her house so they could thank him. "You are the young man who has helped my daughter?" "Yes am I he who has helped to look for your sheep." The girl's father said, "In honour of your sincerity I give you my daughter's hand in marriage so that you can live together forever."

The bear accepted and the girl did too and so both were happy. They discovered, too, that he was a bear but it wasn't at all important to them. They had a little son who was like his father (a bear).
THE END

Cornia Ramirez G.

3.3.1.3 Conflict: Señor Turelo's problem

Many of the stories dealing with conflict between bears and people depicted the bear as a mischievous character capable of outsmarting people. The author of this interesting piece of creative writing was a student from the village of Mataru where crop raiding is a regular problem. An interesting characteristic of this story is the detailed description of bear behaviour and the management techniques used. It also demonstrates the enduring memory of the practically feudal system that was in place until 1952. The author's name was not written on the story.

In the forest they say that one time a young couple, a male and female jucumari, met. After they had been together for a while they felt hungry and *they saw a maize field. They went in and plucked the ears from the stalks and made a large pile in one corner of the field. There, they tore open the husks and ate the sweet kernels of corn.*

The field was part of the finca[5] *of Señor Turelo. His servant went and informed him that two bears were finishing off one of his maize fields, that is, making themselves owners. Señor Turelo was angry and went and got some other men to go and keep vigil. When they arrived someone began to throw large squashes at them like grenades that exploded when they hit. They couldn't tell if it was a bear or a person. Señor Turelo got his gun and tried to shoot, but it would not fire. He heard the bears laughing. "Just you wait," he said to them, "Tomorrow we'll see who laughs." He got a large can of alcohol and beat it making a loud noise. When they heard this sound the bears escaped immediately into the forest.*

Señor Turelo went and gathered all of his peons for the next night and they all waited ready to kill the bears in that field. But the bears were bandits and did not appear. They were finishing off all of the other fields in the finca. Then the bears saw Señor Turelo's animals. A mule appeared that looked good to the male bear. He attacked it, ate its testicles and left it there. They didn't eat the whole thing.

Later, when Señor Turelo found out about his mule he was furious. "These bears won't take warning. I'll kill them with one shot of my rifle." Just then the male bear appeared and Señor Turelo shot at him. The bear was not frightened and grabbed the bullet with his hands. The man thought, "How can I kill them if the bullets don't work?"

He made a trap to capture the bears. But the bears were very clever and worked out the trap easily. Then Señor Turelo decided to wait for the bears on horseback and club them on the head. As soon as he was ready, the male bear appeared. The man took courage and gave the bear a great whack in the head-but it had no effect. The bear grabbed Señor Turelo and took his testicles as he had done previously to his mule. The bear could do this because the bear was stronger. Not even the bullet did anything to him. At the end, the young male and female bears were left as owners of the finca of Señor Turelo. There ends the story.

Anonymous

[5] A finca is a large farm with one landowner and many labourers.

3.3.1.4 Bears as superheroes: *The six-headed snake*

This story is one of five focussing on the bear as having super-heroic strength over other animals. The great strength of bears also appears as a lesser theme in most stories (see for example also 3.3.1.3 and 3.3.1.5). An adult *campesino* from Zona Villaroel of Amarete recounted this traditional story. The bear is friends with the representatives of the two large South American cat species and proves himself to be dominant in this relationship.

One day some animals got together: the jucumari, the puma and the jaguar. The three decided to build a wide road. They worked away on the road for five years until they came upon a large rock. They struggled there for a solid week, and decided that they would have to build a shelter and camp. The next day, the jaguar stayed behind to cook while the bear and the puma went to work on the rock. At noon they went back to eat lunch. When they arrived, the jaguar was collapsed on the ground and covered with blood. The bear asked him, "What has happened, jaguar?" The jaguar answered, "From just here inside the shelter, a snake with six heads came out of the ground. We fought and he beat me." Hearing that answer the bear and the puma were left quite speechless, and remained that way for the rest of the day.

The next day, they made the puma stay behind to cook. The jaguar went with the bear to work. When the two arrived at noon for their lunch, they found that the puma too was sprawled on the ground inside the shelter. The bear was angry. "The puma, lying on the ground, has told exactly the same story as the jaguar," thought the bear. "I will stay tomorrow and you two will go and work."

So the next day the bear stayed and the other two went to work. The bear was cooking when suddenly a six-headed snake appeared. The bear rose and began to fight with the snake. There, in that very place, the bear knocked off five of the heads, and with only one left over, the snake cried out for mercy. And there the snake spoke, saying, "That rock is my home. That is why you haven't been able to move it. Now thank you, bear, for leaving me with one head. I will go right now and will abandon the rock, and you'll see that easily you'll be able to pass that rock."

So that's how the bear vanquished the snake. In the very moment while they were fighting, the puma and the jaguar were able to move the rock. After that they went back to have lunch. The bear was exhausted in the shelter and the two asked him, "Has the snake come?" The bear responded, "The snake has come and I sent five of its heads flying and he called out for mercy and I let *him go (if not, I would have sent them all flying). According to what he told me, that rock was his home and that's why he bothered us. Now I'm going to abandon it and soon they will be able to move the rock, that's what the snake told me." And with that, the puma and the jaguar both responded, "Yes! That must be so because we were able to get rid of that rock." The bear was so happy and the three hugged each other. That's why, to this day, the bear is the most powerful of all. That's the story of the bear. That's the way it was before.*

Teodosio Limachi Challko

3.3.1.5 Killing a bear: *The dancing cub*

With the exception of the following story, all of the stories with the theme of killing bears were factual narratives told by adults. They describe episodes of shooting a bear that was invariably hard to kill. The author of this piece of creative writing was a boy in sixth grade in primary school from the town of Charazani. He did not give his age but was probably 11-14 years old. It is a story both about people killing a bear and a bear killing people, but it is full of sympathy for the bears.

There were two bears in the Yungas[6]*, a male and a female. They had a baby jucumari. The male went to search for food and on his way he saw three people. After a while, the female went to find the male and left her baby to wait for her in their cave. But the baby waited dead because the three people had entered the cave and killed it. Later the mother bear returned and cried for her baby and she made it dance, the baby, as if it were just a doll. She said, "Little one! Chiquituy! Little one!" over again as she tried to make her baby dance. The male arrived with food for the baby, but the baby awaited him dead. The father went and looked for the people. There were 10 of them together now. He was full of anger and he fought them all and won.*

Gabriel Palluca Barrera

3.3.1.6 Bears as jesters: *The cross-dresser*

Stories of bears as jesters correspond closely with the character of the bear as enacted in dance (see section 3.1.4). Four stories were collected of this thematic category, three from adults and one from a student, but similar stories were heard throughout the Apolobamba including in Queara, Aguas Blancas, Laji, Sorapata and Chullina. They are funny stories and always make people laugh. These stories, which seem to represent a mass-scale collective

[6] Yungas is a region of tropical montane forest in Bolivia. It is used as a term for this type of habitat as well as two Provinces in the La Paz Department about 100 km to the south-south east of Apolobamba.

hallucination, were reported as if they were factual narratives, but were classed as folktales. This story is related by an elderly gentleman of Amarete, who was extremely knowledgeable about bear myths and rituals.

When we used to go to the forest for llokena[7] *we would leave our change of clothes in the place where we would spend the night. While we were out harvesting incense, the bear used to get our clothes and dress up just like us. The bear walks around on two feet, dressed in our clothes. We can only look on from afar. If we approach, the bear might kill us. But the bear is just happy. You could hear it laugh. Then usually the bear takes the clothes off and leaves them, as they were, as if nothing had happened. If we leave the bear alone it goes away calmly and slowly. Only then do we go and see how the bear left our things.*

But once a bear entered the house of a miner and his family. He put on a cholita's pollera[8] *and shawl and was playing their drum. Because those things are of too much value to lose, the miner chased the bear. When the bear saw he was being chased he fled, taking off the pollera and shawl, but he ripped up the clothes as he ran away. The bear kept the drum and kept playing it into the forest. The bear would stop, capriciously, and wait behind a rock or tree to scare the miner. The miner was too tired and scared. He gave up and went back to collect the torn clothes. That occurred in 1994 or 1995. That's what used to happen to us in the forest.*

Domingo Itusaca

3.3.1.7 Bears as monsters: *Man-eating bear*

The author of this piece of creative writing was a boy in his seventh year of primary school. The story was accompanied by an illustration, which is shown here. It portrays a bear that kills an unspecified number of men. Another story summarised the idea of the monstrous bear thus: "The *jucumari* is bad. It wants to eat people. You can't approach a *jucumari* or it can eat you and tear you to shreds with its strength." In this story, the bear's desire to kill is prompted by more than thirst for blood; he kills to keep his cubs safe.

[7] *Llokena* is a type of incense made of crystallised tree sap that is highly valued for use in religious ceremonies.

[8] The full skirt with a many-layered petticoat worn by many indigenous Bolivian women who are known, because of this dress, as cholas or cholitas.

"I am going to eat those people", said the bear, "because they walk through my house, the forest. My cubs want to come down and play and why should I allow them to be harmed?" The people approached with all of their weapons and wanted to fight with the bear. "Fine, but I'm going to eat you," warned the bear. The men argued amongst themselves and decided that they were ready to fight. The men used all of their weapons, their guns and whips and machetes, but they were afraid of the bear. There was blood. And then suddenly, all of the bear's friends appeared, and the men were startled. It was then, in front his friends that the bear killed the people. The bear began to eat the dead men. All of the animals gathered around, the pumas, foxes, condors and jaguars and all of the other animals. They began to fight amongst themselves. In a moment, the bear escaped and hauled the men up into a tree to eat them there. He gave some to his cubs. Afterwards, the pumas asked him why he had disappeared that day. The bear replied that he had killed those men by himself that and didn't want to share their meat.

Roman Aduviri Gonzales

3.3.1.8 Allegories: The bear and the two friends

The three stories in this thematic category were all told by students. They are simple and end with a moral lesson. One told of a bear that ate too much honey and the other of a mouse that helped a bear escape from a trap set by a person. This traditional story, written by an 11 year-old from the village of Saphi, does not resolve the intention of the bear and therefore portrays it in an ambiguous light: both threatening and timid or possibly benevolent. The story was accompanied by a drawing, which is used as the illustration on the title page of this chapter.

Two children went to the forest and began to play there, deep in the middle of the forest. Soon a bear appeared and one of the boys saw him and was scared. "Now what am I going to do?" said the trembling boy, "The bear is going to eat me." And then he thought, "I won't tell my friend- let the bear eat him- what do I care about him, I have to save myself." He thought, "I won't tell my little friend. I will escape alone. Where can I hide? I will sneak away and hide in the inner branches of the tree."

The bear was close by then and quickly he ran and hid himself in the centre of the tree. His friend looked around and was frightened. Only then did he realise *what was happening. "What's going on? My friend, why have you gone?" he was shouting. The bear was ready to grab him.*

Only then did the friend look behind him. He threw himself on the ground like a corpse. The bear was sniffing at the boy. It smelled his mouth and his nostrils and felt no movement of air. The bear thought the boy was a cadaver and fled in fright saying, "What sort of thing is this? I have never seen anything like this. I'm going to go away from here because this corpse has scared me."

Then the coward finally climbed down from the tree and ran to his friend. He hugged him though he seemed dead and asked him, "What fortune is this that I find you with no wounds? You know, I saw that the bear said something to you. He gave you some message."

"He gave me excellent advice. Don't remain friends with the person who abandons you when things get tough."

Reynaldo Mamani C.

3.3.2 Analysis of stories

Although differences between the north/south could not be evaluated for the collected stories, 137 interviewees were asked if they knew any stories about bears. These results reveal that myths and folktales about bears are known by the great majority of people in the study area. The Bear's Son was the story mentioned by 67% of respondents, 20% mentioned another story in addition to the Bear's Son and 13% said they did not know bear stories. Knowledge of stories did not differ between the north and south (χ^2=2.64, df=2, P=0.27).

The 42 stories collected are classed as positive, ambivalent or negative according to a set of criteria set out in section 3.2.4. For most of the traditional stories, factual narratives and pieces of creative writing this classification is straightforward. However, the Bear's Son story, in all of its permutations, is difficult to deal with in this kind of analysis because the main character of the story is half bear and half human. The bear parent was usually kind at the beginning, a good carer, bringing food and indulging the wishes of his spouse and child, but then goes on to hold the person captive and is usually killed by the bear son. The son is very violent and dangerous while at the same time being sympathetic and ending up as the hero. All of these stories would have to be classed as ambivalent in their characterisation of the bear parent and the bear-human son. The depiction of bears in the traditional stories collected from adults and students is more ambivalent than in the creative writing of students, whether or not the Bear's Son stories are included (Figure 3-3). This difference is statistically significant when including the Bear's Son stories (χ^2=6.91, df=2, P<0.05), but not when excluding them (χ^2=1.42, df=2, P=0.49).

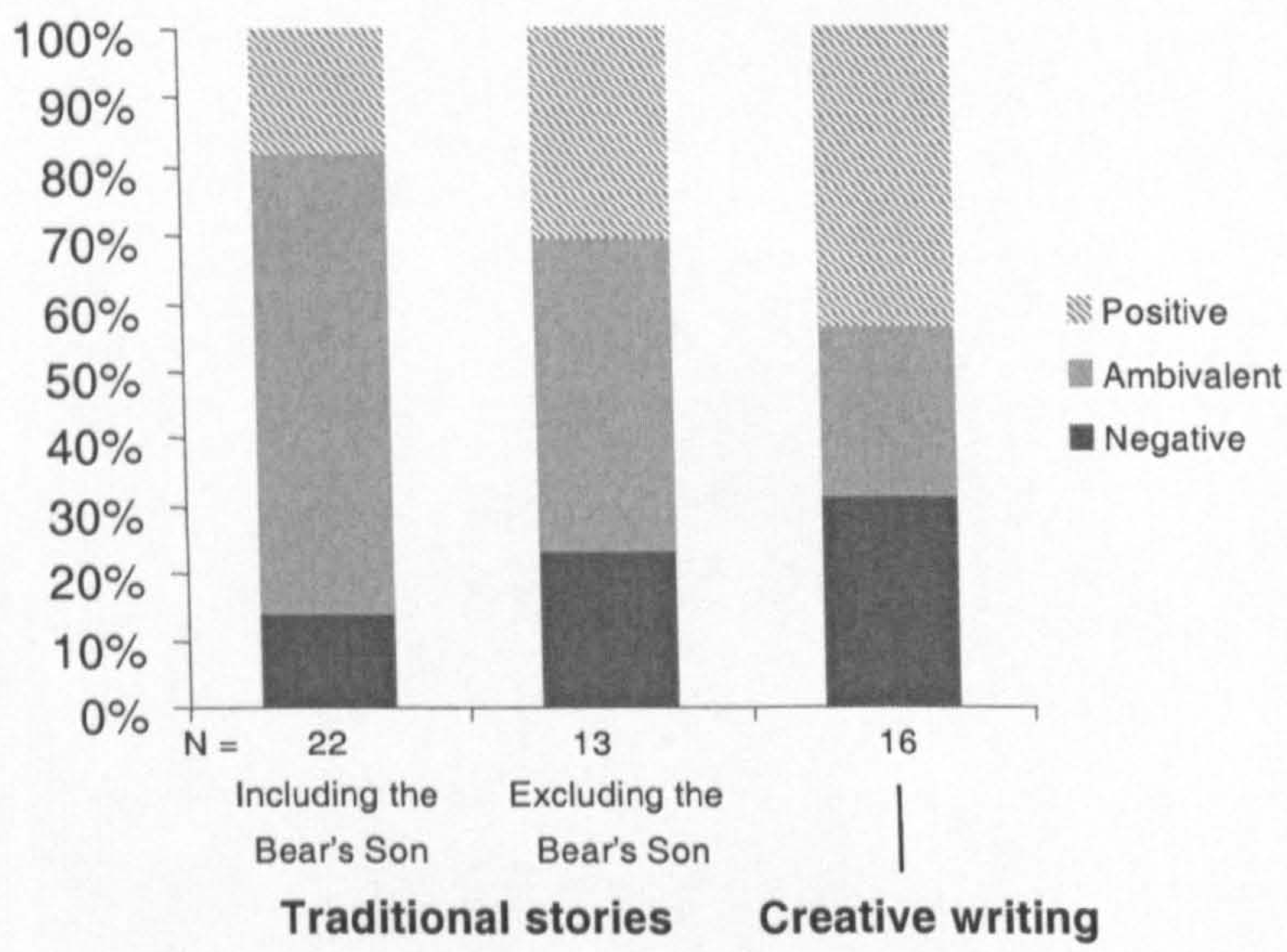


Figure 3-3 The depictions of bears in 22 myths and folktales (including nine of the Bear's Son), in the myths and folktales excluding the Bear's Son, and in 16 pieces of creative writing, are classified as positive, ambivalent or negative.

The presence of definable characteristics of the stories (i.e. such as whether or not the bears in the stories speak, or metamorphose into people, or raid crops) can be quantified and may provide insight into how bears are seen. The following summary statistics refer to all collected stories. Bears interact with people in the great majority (81%) of the stories, while the degree of explicit anthropomorphism varies. Bears are capable of speech in 31% of the stories[9]. Bears in 10% of the stories are capable of "shape-shifting", a term used to describe creatures such as werewolves that are able to assume human form at will (Lopez 1978;

[9] In the Bear's Son stories, the bear parent is occasionally capable of speech, while the half-bear, half-human son is always able to speak and has human form. Included in this percentage is only the ability of the bear parent to speak.

Porter and Russell 1978). When courting a person, bears are thought to appear as a handsome youth, often dressed in a suit and collared shirt. The perceived resemblance between bears and people is explored in another two stories, in which there is confusion caused by a bear looking like a person.

Bears are not necessarily thought of as male, and the idea of animals seducing people is not always male bears seducing women. Three stories were especially about female bears and two were about bear couples, one of which had a cub. The rest of the stories are explicitly about either male bears or bears of unspecified sex.

One quarter of bears in the stories are killed, but the majority of these (8/10) are accounted for by the Bear's son, an animal-human hybrid, slaying his bear parent. The other two were factual narratives about shooting a bear. This means that none of the creative writing ended with a bear dying. Bears raid maize fields in 20% of the stories and kill livestock in 12%. The bear-human hybrid from the Bear's Son stories is always threatening to people and displays incredible strength when moving the rock from the cave entrance, killing the bear parent and interacting with people. Excluding these stories from analysis, bears are threatening and frightening to people in 36% of the stories; they have colossal super-natural strength in 30% of the stories; and they interact with other animals in 25% of the stories.

3.3.3 Ritual

A surprising ritual venerating and propitiating the spirit of the bear was documented in the south of the study area, in Amarete: the ritual treatment of Andean bear hides. The hides are kept at an altar where incense is burned and offerings such as coca leaves are left. The hides are "worshipped as you would a second Lord". If the spirit of the bear is not mollified by such offerings, he may become vengeful and bring bad fortune to the hunter and his family.

In contrast, in the north, no ritual treatments of bear parts or other rituals specifically directed to bears were documented. However, offerings and prayers relating to bears were made. These are directed to the *achachilas,* the ancestors who have long-since become one with the mountain, and who are the owners of all the wild animals that live thereon. The *achachilas* are entreated to protect people from the bears and other animals. The ritual normally consists of the preparation of twelve plates full of specific offerings. The number of plates is an example of syncretism between indigenous Andean beliefs and Christianity, in that one plate is for each of twelve *achachilas*, who are conflated with the disciples, and the months of the year. The plates are arranged in a *sabildo*, a sacred place on the mountain, whilst the participants solemnly engage in much chewing of coca leaves, cigarette smoking and *ch'allas*, an Andean custom of drinking alcohol and then spilling an equal amount on the ground as an offering. The participants appeal to the local *achachila*, the "master of the mountain and the year", with something like the following prayer: "You are powerful. You rule. We ask you, Owner of everything from where the sun rises (God forgive us) that you take care of our wealth, that you take protect us, that you always keep us warm and that you take care of our livestock and our crops. We ask that you restrain your chicken the condor, your house cat the puma, your dog the bear, and your puppy the fox. May the time be good to us." After the ceremony, the *sabildo*, usually marked by a cairn, is left sodden with alcohol, and festooned with streamers, coca leaves and other offerings such as llama fat, sweets and shiny paper. If a spate of livestock predation or some other disaster has occurred, the *achachilas* may be propitiated with a dried llama foetus. Bears are, therefore, seen as one more potentially harmful aspect of the natural world from which people in the north pray to be protected.

Two sorts of bear dances were found to be performed traditionally in Apolobamba. First, in preparation for *Todos Santos* (Halloween) in Amarete it is traditional to kill wild animals, from coatis and foxes to condors and bears and wear their skins for the festival. Dancing in the costume of the bear is thought to impart the power of the bear to the dancer. This more solemn ritual is rarely practised now because of increasing awareness of wildlife protection laws. There is a second long tradition of dancing bears being jester-like troublemakers. For this dance, shaggy costumes were traditionally made from a long pale-grey hair-like moss, with a mask covered in pigskin and llama fur. It is now common to hire a more modern version of this costume from the city, as is done for most dances. *Ukuku* costumes are commonly white, probably stemming from the special magic attributed to albino or white bears, and from the tradition of using pale moss to make bear costumes. The masks are now highly ornate and resemble Chinese dragon masks with eccentric eyes and jagged teeth (see section 3.4.2 for possible roots of this costume). The semi-structured interviews revealed that the ritual dance of the bear is of less prominence in the north of the study area than in the south (χ^2=28.96, df=1, P<0.001). Two thirds of interviewees in the north did not know of the costume or dance, while 80% of interviewees in the south were familiar with this ritual. People in the south would know about this costume and dance from attending local festivals or alternatively by travelling to La Paz during Carnival, in which the bear is always well-represented, particularly joining dances such as the *Diablada.* This dance was not found to be enacted in the north of the study site.

3.3.4 Bears in perception and symbolism

At the beginning of the study there was concern that, although the research was attempting to focus on bears, the stories told were frequently about pumas, foxes and condors as well. These four species are widely conceived as one group or group in Apolobamba and were often referred to as "the bad four" (*los cuatro malos).* It is interesting that in other sites the Bear's Son story has been documented with the bear replaced by condors and pumas (Morote Best 1957).

In the course of fieldwork, one particular "confusion" arose too many times to be ignored. Bears were called pumas and vice versa. On several occasions a horse or cow had been killed and I was told a bear had been identified as the culprit when the perpetrator was known to be a puma. This kind of mistake could be easily attributed to two causes. First, people know that, although I was interested in studying any case of predation on large livestock, my primary interest was in bears. They may then simply have told me what they thought I wanted to hear. Second, as bears are often caught "red-handed" (or "red-fronted", as they in fact get called due to blood on their muzzles) in the act of consuming the carcass, they are subsequently assumed to have been the killers.

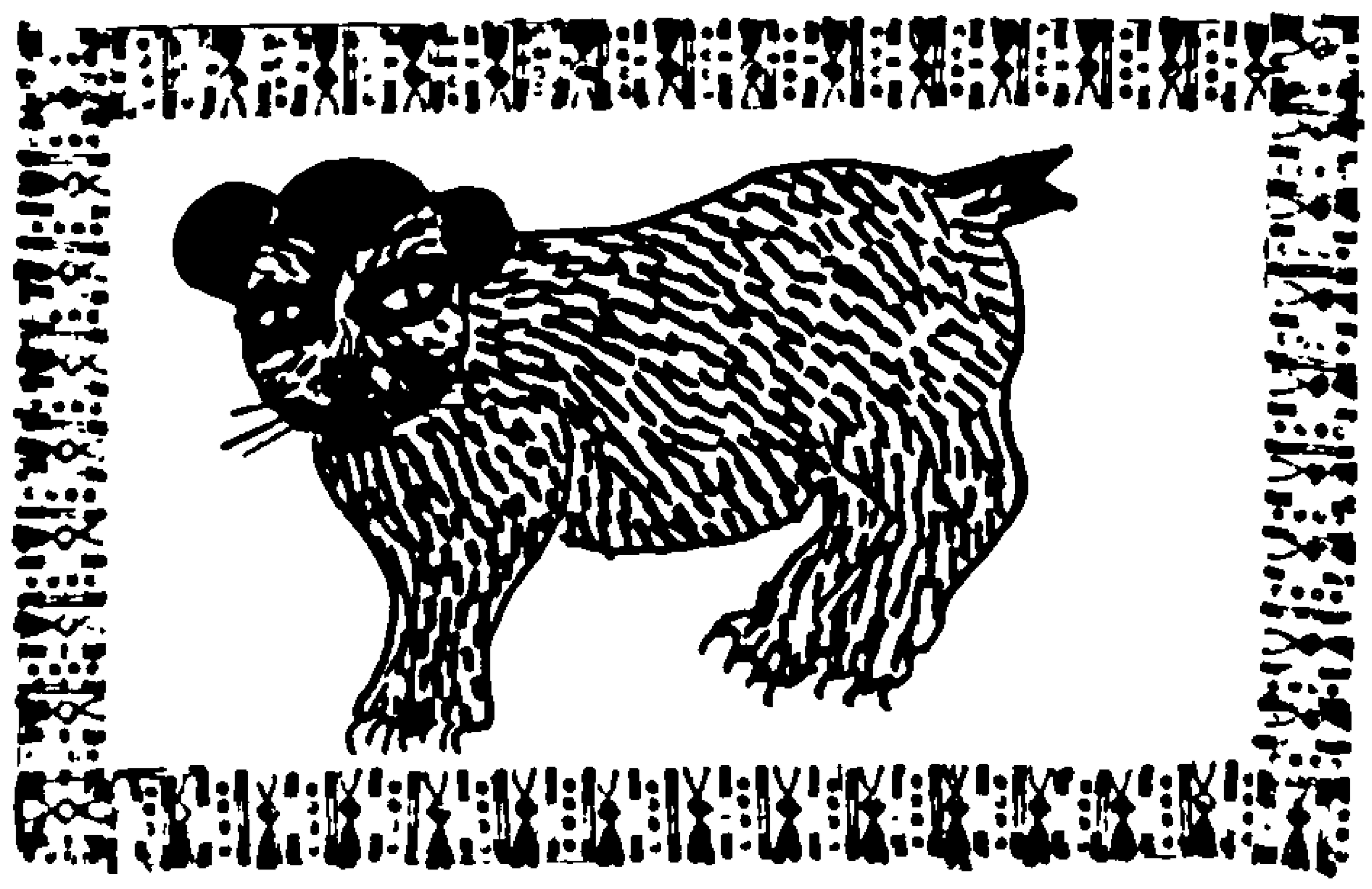


Figure 3-4 Drawing of a cat-like bear. Digitigrade, whiskers, large eyes, backward bending legs. Note also banner end to tail. Illustration by Emilio Arian Quispe, age 14.

It appeared, however, that there was a deeper explanation for the phenomenon. It became apparent that the two creatures, the puma and bear, were intimately connected if not almost combined in people's minds. One interviewee in Queara explicitly stated, "The bear and the puma (*machu kara)* are the same. The bear is like the shadow of the puma. But the bear is the stronger half". Though this was the only time I heard this explanation, the vagueness with which they were differentiated was common. People started out talking about bears and switched in mid flow to talking about pumas.

The relationship between the bear and the jaguar is somewhat different. As exemplified in the story of Doña Tomasa and the man-eating jaguar, bears are commonly associated with protecting people from jaguars. As Domingo Itusaca explained, "In the time before, when all of the animals spoke, they say the jaguar was our enemy. It was always killing people and eating them. The bear was the only one who used to defend us in that time, and the only one who could beat the jaguar. Because they say that the bear is part of the people. If it weren't for the bears, the jaguars could even today kill all of our population." This idea arose throughout the study area, but particularly in Amarete and Sorapata.

The figure of the bear arose frequently in daily conversation. Many times I heard a man being called a bear. This nickname was always met with knowing laughter on the part of bystanders and more than a little pride on the part of the so-called "bear". It was explained to me that saying a man was a bear meant he was lewd, mischievous, overbearing, and ungainly. It is also worth noting the relish with which stories about bears are swapped. Any description of an encounter with a bear given in the main square of a town inevitably drew a crowd. It was also apparent that exaggeration and hyperbole were expected and praised in such situations.

Another question posed during interviews concerned dreams about bears, whether or not people had them and what they signified if they did. More people in the north dream about bears (60%) than in the south (37%) (χ^2=7.08, df=1, P<0.01). There are two main meanings attributed to these dreams in both the south and north: that the dreamer will see a bear or that a stranger will visit, particularly a person from the lowlands.

3.4 DISCUSSION

This study is the first to demonstrate the thriving diversity of myth and ritual associated with bears in an Andean region. Although there had been previous reports of men being called "bears" in southern Peru (Allen 1992), this study further explored the natural prominence of bears in the imaginations of young people and adults. This prominence is evidenced by the variety of stories in circulation, the use of bears in speech and metaphor, and the notable enthusiasm with which tales of bears are swapped. Contrary to what is suggested by the literature, the story of the Bear's Son is not the only story about bears in circulation. This evidence supports the theory that the bear mythic theme in South America had pre-Colombian origins, a theory widely discounted by anthropologists. The Apolobamban variants of the Bear's Son story and the other collected stories reflect universal themes, as well as political and agricultural issues keenly felt in Apolobamba.

3.4.1 Diversity of depictions of the bear

The *jucumari* is the subject of a wide variety of myths and folktales in Apolobamba. It is perhaps the diversity of depictions of bears that is the most striking feature of this collection. Amongst the bear's incarnations are as crop-raider (*Señor Turelo's problem*), as super-hero (*The six-headed snake*), as jester (*The cross dresser*), as monster (*Man-eating bear*), and as source of moral wisdom (*The bear and the two friends*). Bears are depicted as having feelings, and sympathy with bears is common in the stories even when they are causing harm or danger to people (*Dancing cub*). Traditional stories of female Andean bears sequestering men have been referred to in Venezuela (Herrera et al. 1994) and Santa Cruz, Bolivia (Eulert 1995) and one story has been collected before those in the present study, amongst the Quechua of Cuzco, Peru (Robin 1997).

Anthropomorphism is highly prevalent; bears talk, act and think like people and in some stories can even turn into people at will. Don Domingo Itusaca of Amarete explained that, "In the time before, all of the animals spoke." Anthropologists call this the "primordial state of Supernature" in which all creatures speak the same language. This is a concept common, though by no means unique, to South Amerindian thought (Poe 1994). It is interesting, however, that the attributing of the power of laughter and speech to bears extends beyond those stories which take place in "the time before": they extend to those which happen just the other day (see for example 3.3.1.3 and 3.3.1.6). In such stories human and animals affairs are placed in the same context (Herrera et al. 1994). The presence of Andean bears in the contemporary imagination is further attested to by the presence of bears in dreams, a phenomenon also described as common in Huacareta, Bolivia (Yañez 1990).

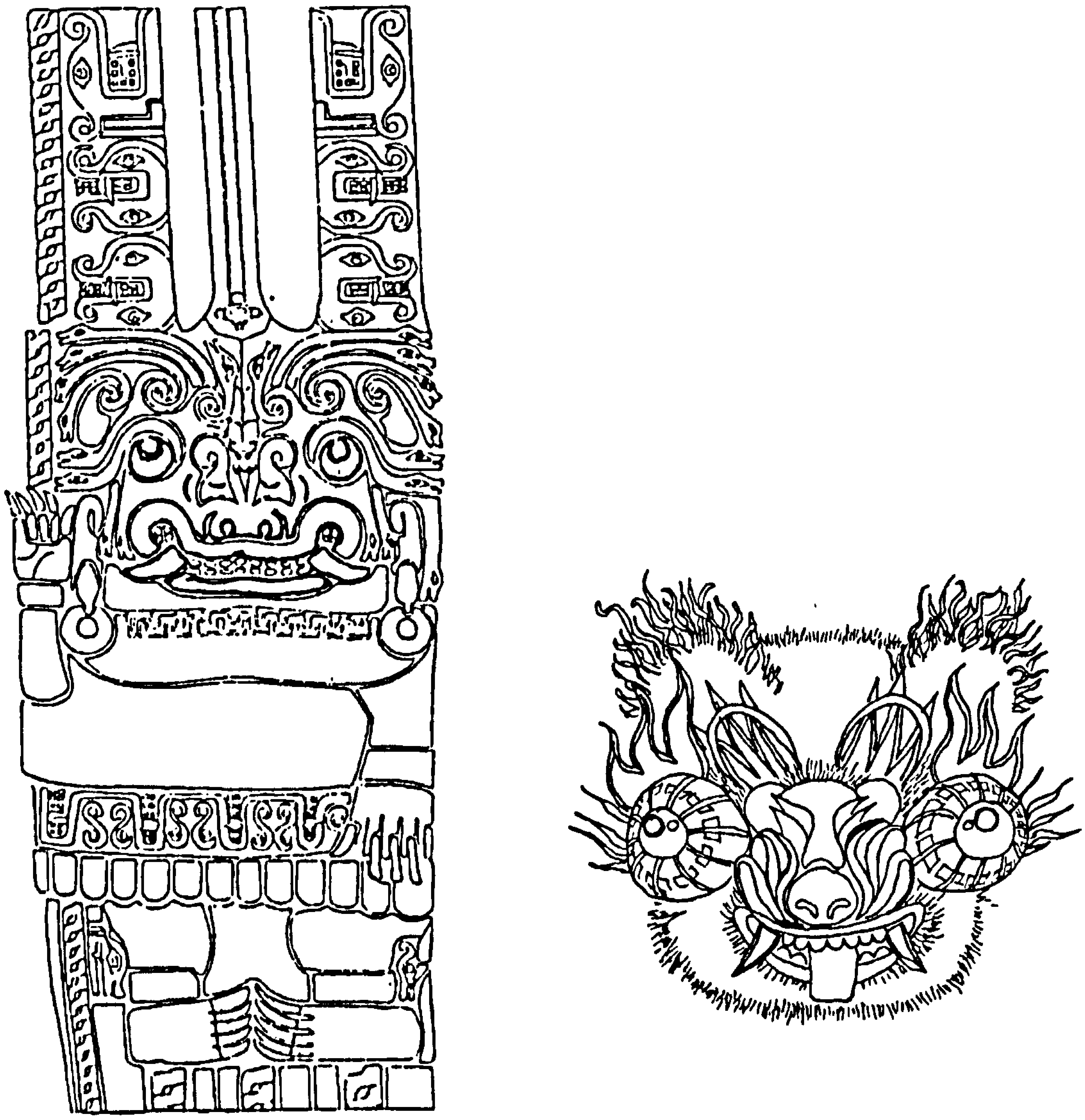
Traditional stories are more ambivalent and complex in their depictions of bears than are the examples of creative writing collected (Figure 3-3). Perhaps this is attributable to their having had longer to evolve and mature in the collective mind than off-the-cuff creative writing, which tends to be more simplistic. Another possibility is that the attitudes of young people are diverging into more positive and more negative attitudes according to their education and the issues faced by their families and communities.

3.4.2 Pre-Colombian origins of the bear mythic theme

Despite the prominent place of bears in modern Andean myth and culture, they do not feature in accounts of Incaic or early colonial Quechua mythology (Allen 1992; Torres 2001). Bears are also believed to be almost entirely absent from pre-Colombian zoomorphic iconography (Allen 1992). Additionally, it is the prevailing orthodoxy amongst archaeologists that the two species of large felids found in South America, the puma, *Puma concolor*, and the jaguar, *Panthera onca*, dominate pre-Colombian iconography, to the exclusion of the Andean bear (Reichel-Dolmatoff 1975: Allen 1992). However, the Chavín de Huantar site offers striking evidence that bears were not only present in the Pre-Colombian imagination, but at its very epicentre.

South America's oldest complex culture arose at Chavin de Huantar, during the first millenium BC and it was there that it created its earliest city (Wilson 1999). The complex iconography of the Chavin culture dominated Peruvian art and architecture for hundreds of years and influenced all that came afterwards, throughout the central Andes from Ecuador to Bolivia (Burger 1992). The principal deity of the Old Temple of the Chavin de Huantar site is an erect figure with clearly bear-like characteristics that would, within the North American context where bears are culturally pre-eminent, be unequivocally described as a bear. These characteristics (Figure 3-1Figure 3-5a) include: in-turned plantigrade feet; five long curved claws on each paw; one forepaw up and one down; large canines in a smiling mouth; eccentric pupils in the eyes; and small rounded ears. Even a cursory comparison of this figure with the costume of the dancing *Ukuku* bear, worn currently in festivals throughout Bolivia, demonstrates the striking similarities between the two figures (Figure 3-5) (see also page 1). They seem to represent the same jester with a head like a Chinese dragon, scrolling embellishments radiating from the ears and eyes and the same gill-like parentheses on the muzzle (Paredes de Salazar 1976).

One paw of the Chavin god is raised, as one paw of the dancer carries a staff, whip or more commonly a handkerchief. The bear of *Qollyur Riti* is described as a mediator or interlocutor between opposing elements (see 3.1.4), just as the Chavin bear represented the voice of the oracle, mediating between man and the gods.



a.) b.)

Figure 3-5 a.) The principal deity of the Old Temple of Chavin de Hauntar, located at the centre of a cruciform passageway below a hole through which an oracle could have spoken to pilgrims. b.) The *Ukuku* costume, used today by dancers throughout Bolivia.

No explanation has been put forth for the bizarrely heightened and surreal representation of the classic Bolivian bear costume (Paredes Candia 1966). The similarities between these two figures offers persuasive evidence that the modern *Ukuku* costume harks back nearly 3000 years to the Chavin bear god. Andean craftspeople have, perhaps unwittingly, kept alive an extraordinary and ancient conceptualisation of the bear.

There is, moreover, much evidence amongst the collected stories that the Bear's Son story has Pre-Colombian roots (Morote Best 1957; Cipolletti 1983). Stories of bear-human couples (such as the *Bear and the shepherdess*) were the most numerous after those of the Bear's Son (Figure 3-1). Those in the former category have little resemblance to the more famous tale beyond the occurrence of animal seduction. Tales of animal seduction are an important theme in the mythology of the South American lowlands (Poe 1994). Indeed, there are many commonalities between the animal iconagraphies of the lowlands and highlands. Some anthropologists believe that the present cultural and geographic boundaries between jungle and mountain may have been less significant than they are today (Burger 1992; Poe 1994).

Bears and pumas were often conflated in the comments of interviewees in this study. This may suggest another way that bears are present in the Andean worldview. This conflation has also been expressed in Venezuela, where pumas were described as a yellow bear with a round face (Herrera et al. 1994). Another mention of a link between bears and pumas comes from Peru, where the role of bears in the Amazonas Province is described thus, "The importance of bears in Amazonas is fundamental. In local Quechua, bears are known as black 'pumas' and they share the fearful strength and super-human powers that characterise (the large cats)."(Taylor 1997). The occurrence of other multiple species combined figures is well known from Andean archaeological sites (Wilson 1999). A reassessment of typical feline images (such as in Figure 3-6) from Pre-Incan sites may result in the rethinking of the current no-bear orthodoxy.

Table 3-2 Distinguishing characteristics of bears and pumas for symbolic comparison.

Characteristic	Bear	Puma
Colour	Dark	Light
Main habitat	Forest (see chapter 7)	Grassland
Activity	Diurnal (see chapter 6)	Nocturnal
Movement patterns	Local- the same bears can be seen regularly (see chapter 7)	Itinerant-large home ranges
Movement style	Lumbering	Graceful
Physical appearance	Lumpen	Sleek
Tail	No visible tail	Long tail
Tread	Plantigrade	Digitigrade

As the two largest carnivore species in South America, bears and pumas do share strength and size, yet a comparison of distinguishing characteristics of these two species provides striking contrasts (Table 3-2). The idea of dynamic dualism, between an internally opposed yet complementary pair (such as exemplified in the yin-yang symbol), is thought to be an ancient and peculiarly South American cognitive cultural style (Poe 1994). Sixteenth century Andeans were described as worshipping bears and pumas alike (de la Vega 1609). This evidence of conflation suggests that what has been interpreted as the almost total absence of bears from pre-Colombian iconography may in fact be a lack of recognition of the group of large carnivores, or at least bears and pumas, being worshipped as one.

Figure 3-6 A typical "feline" image from the Pre-Inca Tihuanaco site near Apolobamba. Note stocky body, masked facial markings and flat feet.

3.4.3 Universal themes

Whether or not it has Pre-Colombian origins, the Bear's Son story has picked up elements from eclectic sources in its evolution. The story of Sanson is a clear conflation of the Bear's Son and the story of Samson from the bible (Judges 14-15). There is very little religious instruction in Apolobamba today and it is therefore likely that this story has been weaving its way into the Bear's Son story for decades, if not centuries. In the biblical story, the lengthy hair of the Nazarite Samson is the source of his strength. In the Andean version, his hair has been replaced with the three-coloured fur of an Andean bear.

The global mythic theme of the Queller of Wild Beasts (Campbell 1968), recognised from China to England over thousands of years, appears strongly in many of the stories about bears. The story of the Six-*headed snake* is one example but there are many more amongst the stories of the bear as super-hero and Bear's Son stories (such as Figure 3-2 in which the Bear's Son returns to the village victorious after having quelled the wild jaguars and loaded them up to carry his firewood). In the biblical story, Samson is a Queller of Wild Beasts, and tears apart a lion as if it were a young goat (Judges 14: 4-5). Later in the story Samson catches three hundred foxes and sets their tails on fire so that they go and set alight the fields and orchards of the Philistines (Judges 15: 5-6). The bear is the Andean version of the Queller of Wild Beasts and it is this link that may have led to the conflation with the story of Samson. In another version of the Bear's Son, the bear ends up as Rambo. Such is the power of syncretism, that any aspect of modern culture can be subsumed within the body of ancient ideas and re-emerge as entirely belonging to a tenacious traditional culture, such as that of the Quechuas.

The rituals associated with the worship of bears and ritual treatment of bear hides observed in this study (section 3.3.3) have strong corollaries in other societies. The ritual preservation of the hide, bones or skull is considered a universal feature of how human societies venerate bears (Black 1998). A study in Ecuador describes the syncretism alive in the popular religion of Oyacachi, Ecuador, in which, "bears and virgins share altars and supplication" (Camacho et al. 1999).

3.4.4 Apolobamban themes

Although bears were never depicted as horrific creatures that must be destroyed, 25% of the collected stories ended fatally for bears. The examples of bears being killed were either factual narratives or the fictional cases of the bear parent being killed by his or her half-human son. Bears are rarely killed by people in traditional stories other than in the Bear's Son or in creative writing. Rather, the bears are impervious to attempts on their life (as seen in *Señor Turelo's problem*). However, the idea of the bear as a threat to human life and property emerges even in light-hearted stories (such as *The cross-dresser)*. Issues of depredation arose in a sizeable minority of stories: bears raid crops in 20% of the stories and kill livestock in 12%. In this context, bears are depicted as almost impossible to thwart in these depredations.

One of the main ways that the Bear's Son story has been deconstructed interprets the main character as embodying the Quechua people's dilemma of being caught between two conflicting worlds, the Incan and the Spanish-*mestizo* cultures. In many versions of the Bear's Son both in the rest of the Andes and amongst the stories collected in Apolobamba, the half-bear half-human ends becoming the king Inca, or lord of the manor (*hacendado)* and thereby providing wish-fulfilment for the oppressed people (Allen 1992). The story of *Señor Turelo's problem* provides corroboration of the idea that the bear is acting on behalf of the Quechua when he vanquishes the lord of the manor, and ends up as owner of the hacienda. Most people in Apolobamba who are over 50 years old were severely subjugated as serfs in a feudal system until the 1952 Agrarian Reform. The ability of the bear to act on behalf of the people, in giving a landowner his comeuppance, is gratifying even in the present day.

In trying to understand the symbolic and conceptual base upon which attitudes and beliefs about bears are built in Apolobamba, the evidence presented in this chapter shows bears as strong, multi-faceted, mischievous and closely related to people. The exercise of collecting these stories seemed to awaken increased interest in bears amongst interviewees and students alike. This suggests the potential of using this kind of technique to reinforce interest in species and its conservation in the future.

The bear as a super-hero, the bear as jester, the bear as part human and the bear as a monster: from the results presented in this chapter, it is apparent that bears are important and multifaceted figures in local Andean lore. These are the ideas of bears that would be instilled in local people from early in life. However, amongst adults having to cope with the practical realities of making a living, what attitudes and beliefs are prevalent? The mythological and ritual importance of an animal, while certain to have a bearing on attitudes and beliefs, does not determine them entirely. In the following chapter, the conscious attitudes and beliefs are explored surrounding the relationship of people to bears in practical as well as conceptual terms.

3.5 SUMMARY

1. Forty two stories were collected, 12 from adults, which were either descriptions of encounters (3) or myths (9), and 30 from secondary school students of which 13 were traditional stories, and 17 were pieces of creative writing.

2. Stories were classified into eight themes which were, in descending order of popularity: the Bear's Son; other bear/human couples; stories related to conflict; stories of bears as super-heroes; stories about killing bears; stories of bears as jesters; stories of bears as monsters; and allegories involving bears.

3. Traditional stories were more ambivalent in their portrayal of bears than were original stories, which tended to portray bears in either negative or positive lights. Both traditional stories and creative writing tended to be more positive than negative when not ambivalent.

4. In some stories bears shape-shift, that is, turn into people and back into bears at will. Bears in stories were usually male, but were female in three stories (one of the first times such documentation has occurred).

5. Bears raid maize fields in 20% of the stories, kill livestock in 12%, and threaten people with attack in 36% (excluding the Bear's Son). The idea of the bear having super-human strength appears in 30% of the stories. Stories ended fatally for bears in one quarter of the collected stories.

6. The dance of the bear, or *Ukuku*, in which the bear is a marshal of festivities and a jester, is enacted in Apolobamba. The ritual treatment of bear parts was also documented.

7. Symbolic mention of bears occurs in speech, particularly when teasing a man for being lewd, mischievous, overbearing, and ungainly.

9. Bear are closely associated with three other animals: pumas, foxes and condors, who are often collectively referred to as "the bad four" (*los cuatro malos*). Of these, bears are particularly closely associated with pumas.

Chapter 4

BELIEFS AND ATTITUDES

In front of graffiti reading "Oso Rojo" or Red Bear in Chullina.

4.1 INTRODUCTION

Beliefs, attitudes and knowledge are fundamental to conservation. As we have explored in the previous chapter, myths, rituals and cultural symbolism provide the subconscious background to how we perceive large carnivores. It has also been suggested that even deeper impulses may determine our behaviour: that the urge to kill large carnivores is a part of our instinctive behavioural repertoire (Kruuk 1976). However, it is the foreground of conscious beliefs, attitudes and knowledge held by people who interact with large carnivores that primarily governs the outcome of these interactions (Bath 1998).

Large carnivores are central to people's perceptions of the natural world (Kellert et al. 1996). Consequently, attitudes towards them, as well as being a key determinant of large carnivore conservation in itself, are deeply enmeshed with attitudes towards wildlife and nature more generally (Kellert 1994; Bath 1998). Over the past two decades, within the context of the emerging ecological crisis, the relationship between humans and the natural world has been explored with increasing interest (Morris 2000).

4.1.1 Attitudes towards nature: the trap of the dichotomy

The relationships between people and the natural world are often divided into two main types. The most pervasive dichotomy recognised is between the "Western", Promethian or anthropocentric visions of the natural world on one hand and the "non-Western", Sacramental or eco-centric on the other. The former, the "Western" world-view is associated with the "domination" of nature, which is viewed as separate from the human domain. The rest of the world's cultures and religions are then lumped into the "non-Western" eco-centric category, the description of which is based on the cultures of hunter-gatherers, who perceive themselves as part of nature, and emphasise inter-relatedness. Lumping all "non-Western", non-industrialised cultures into the latter category has received substantial criticism as a misleading oversimplification (Morris 2000).

Recent work on the question of how humans view the animal world has identified a much more fundamental dichotomy than "non-Western" versus "Western": the attitudes of hunter-gatherers on one hand versus farmers and herders on the other (Serpell 1986). Hunter-gatherers tend to view nature with understandable respect and egalitarianism, given their success depends upon the ongoing abundance of plants to gather and animals to hunt. In contrast, farmers need constantly to oppose nature by keeping weeds out of their gardens, and by defending their crops and livestock from wild animals (Morris 2000). Thus the "ethic of domination" is not a product of industrialised Western society arising in the 16th and 17th centuries. Rather, this ethic arose much earlier in the Neolithic, when people first learned to dominate and manipulate living creatures (Campbell 1968).

Although such dichotomies may provide much insight, it is important to recognise that from the perspective of conservation they are implicitly associated with value judgements. Humans classified in these dichotomies are either conservers or destroyers of nature. The traditional western conservation movement implicitly saw local people in high bio-diversity sites as the enemies (Colchester 1997). A reprieve then came in the form of community conservation: these previous destroyers of nature came to be known as "stakeholders" to whom, in theory, responsibility for wildlife was devolved and benefits allowed to accrue (Bell 1987; Gibson and Marks 1995; IIED 1994). The improvement of the image of local people arose in tandem with the concept of the "ecologically noble savage", and with studies of the degree to which rural subsistence-level communities make sustainable use of wildlife (Alvard 1997; Alvard 1993; Bodmer 1997). In analysing attitudes towards the natural world, many anthropologists persevered with a dualistic paradigm in which "Westerners" seek dominion over nature, and "non-Westerners" seek oneness with nature (Holm 1994). However, such simplified characterisations conceal the diverse, multi-faceted and often contradictory attitudes that human beings maintain towards nature and animals (Morris 2000).

A typology of ways that people value nature is used in this study, to provide a framework in which to consider and discuss the results (Kellert 1996). The nine universally relevant values in this typology allow the analysis of complex and even contradictory beliefs, attitudes and interaction in a way that defies the customary good-guy/bad-guy dichotomy. They are thought to have a biological origin and to signify basic structures of human adaptation to the natural world. This typology has been used to examine the "biophilia hypothesis", the idea that humans have an innate tendency to affiliate with life and nature (Wilson 1984).

4.1.2 *Attitudes towards large carnivores*

Humans have been interacting with large carnivores (ursids, canids and felids) for at least the last half a million years (Clutton-Brock 1996). Gradually, large carnivores, having evolved at the peak of the ecological pyramid, have had to give way to the new master predator, man, armed with fire and projectile weapons, and with the domesticated dog (Clutton-Brock 1996). Despite the fact that humans have ascended to a position of relative power over large carnivores, these animals have not ceased to fascinate us and provoke in us a wide range of often polarised attitudes. A primary cause of negative attitudes is that many species of large carnivores represent a perceived and real threat to human life. Many human lives are taken every year by bears (polar, brown, American black and sloth) and by large felids (tigers, lions, leopards and pumas) (Sillero-Zubiri and Laurenson 2001). Because of the risk of predation on people, as well as on our livestock and game species, coexistence with large carnivores is often not tolerated (Mattson 1990; Boitani 1995; Herrero 1999; Woodroffe 2000).

Bears impinge upon people even more than other large carnivores because not only are we and our livestock vulnerable to becoming their prey, but we share a large proportion of the rest of our omnivorous diets with bears. In many parts of the world, bears and people are both predominantly diurnal. They overlap spatially as well as temporally, preferring areas where high primary productivity leads to rich food sources (Mattson 1990; Lynch 1993). Bears remind humans of themselves, because unlike other large carnivores, bears can stand and walk upright and on flat feet. It is also the case that a skinned bear looks uncannily human (Herrero 1999).

Bears figure heavily in human consciousness for the aforementioned reasons, but it is additionally for their size, strength and intelligence that bears are revered. Many cultures worship bears, seeking to appease the spirit of a bear that has been killed, and/or trying to incorporate the perceived power of the bear. This is done in numerous ways: by consuming body parts, by wearing bear claws or bones, and through ritual, dance, song, and myth. In-depth studies of these attitudes and beliefs have been carried out in Europe, Japan, and North America (Hallowell 1926; Shepard and Sanders 1985; Rockwell 1991; Black 1998), but none so far in South America (other than of the festival of *Qoyllur Rit'l* and of the Bear's Son story, described in sections 3.1.4 and 3.1.5, respectively).

4.1.3 Traditional environmental knowledge

Detailed knowledge and beliefs are held by indigenous people about uses of animal parts, but also about the lives of the animals themselves. The fields of ethno-ecology, ethno-zoology, anthropology and human ecology have given rise to an increasing awareness of traditional environmental knowledge (Johnson 1992). As well as documenting the knowledge itself, such studies record indigenous classification systems and locally adapted strategies for the use of resources (Berlin 1973; Johnson 1992). Native Americans have been shown to possess a detailed knowledge of the ecology of bears (Shepard and Sanders 1985). One study of traditional environmental knowledge in relation to Andean bears has been carried out in Venezuela, where bears were described by most people as carnivorous. They were said to rely heavily on the meat of wild animals including rabbits, *Sylvilagus brasiliensis,* sloths *Bradypus variegatus*, paca *Agouti paca,* deer and livestock. Their diet was also said to include bromeliads, fruits, ferns, palm trees and crops (Herrera et al. 1994). This study showed well-developed knowledge of bear habits. Field biologists have used local people as expert guides in bear habitat. Concordance was high between reported and confirmed bear foods in Peru, suggesting that local people possessed a detailed awareness of the bears' feeding habits (Peyton 1980).

4.1.4 Perceptions of bears in Bolivia

More general studies of Andean perceptions about the natural world have been made amongst the Aymara, a culture with whom the Quechua have much in common (Buechler and Buechler 1971)(see section 1.4.2). Amongst the Aymara, the belief is that wild animals were at one time human, and were created by the gods of the earth (Arnold et al. 1992). Animals are divided into two groups: birds and beasts, the latter being further subdivided into small and large. These animals are then further sub-divided according to their habitat: water, hills or forest. For the Aymara, bears belong to this last group and are considered shepherds of the other forest animals (Arnold et al. 1992). Another aspect of the Aymara view of bears seems to conflict with this, identifying them as demonic, and arising from the underworld (Schramm 1992). In Huacareta, Aymara people and Quechua people expressed similar attitudes and beliefs about bears. Most said that they were animals that were harmful to people, primarily because of attacking livestock, but also because of crop raiding. Some respondents did describe bears as human-like or spiritual in nature, and most said they possess a soul (Yañez 1990).

Medicinal and magical powers are often attributed to the body parts of large carnivores (Sillero-Zubiri and Laurenson 2001), and, as the largest carnivore in the Andes, it is not surprising that bear parts are featured in ritual and medicine. However, the popular use of bear parts as medicine has not been as thoroughly researched. The Kallahuaya, world-renowned itinerant medicine men, originate from Curva and Kaata, villages in Apolobamba. Yet bear parts do not figure amongst the 32 mammal parts described in Girault's famous and exhaustive study of their pharmacopoeia. The only mention of bears is in relation to an amulet called the *jucumari sepja*, which is said to protect people from a terrifying demon bear (Girault 1987). However, mentions of the medicinal use of bear parts in the Andes do exist outside the Kallahuaya tradition (Herrera et al. 1994).

4.1.5 Research questions and structure of chapter

There are two overall aims in this portion of the research: first, to explore the nature of attitudes, beliefs and knowledge about bears in Apolobamba, and second, to determine the differences in attitudes and beliefs between people living inside and outside the protected area[1]. To address these aims, the following research questions were posed.

- Do attitudes towards and beliefs about bears differ between the north and south?
- Are encounters with bears a frequent occurrence, and how are they tolerated?
- How are bears perceived in terms of their essential nature?
- How are bear parts used in Apolobamba?
- What is known about the ecology of bears?
- How are bears valued in terms of the universal typology of values of nature ?

[1] The subjects of crop-raiding and livestock depredation, although relevant to attitudes and beliefs, will be dealt with separately in chapter 8.

Following a description of the basic characteristics of respondents, the chapter is divided into the following categories: encounters and tolerance; beliefs; use of body parts; and traditional ecological knowledge. In the results section, each interview question is presented, and followed by the summarised coded responses. In cases where answers were not numerical or simple *yes/no/don't know* variables, a bar chart is given when results differed significantly between the north and south. This is followed by a brief description of the results.

4.2 METHODS

4.2.1 Semi-structured interviews

Questions relating to beliefs and attitudes were a part of the semi-structured, open-ended interviews (see 2.3.4. for detailed methods, and sections I, II, V, VI & VIII of Appendix 1 for interview guide).

4.2.2 Kellert's typology of values of nature

The results of this study are discussed in terms of the typology of nine basic values of nature (Kellert 1996):

Naturalistic – the direct experience and exploration of nature.
Ecologistic-scientific – the systematic study of the structure and function of nature.
Aesthetic – the physical appeal and beauty of nature.
Humanistic – strong emotional attachment to, and "love" for, aspects of nature.
Utilitarian – the practical and material exploitation of nature.
Symbolic – the use of nature for language and thought.
Moralistic – spiritual reverence and ethical concern for nature.
Dominionistic – the mastery of, and physical dominance over, nature.
Negativistic – fear of, aversion to, and alienation from, aspects of nature.

4.3 RESULTS

4.3.1 Basic characteristics of each respondent

Respondents ranged in age from 17 to 102, the mean age being 43.75 (median = 44, mode = 47, sd = 13.12). The majority of people (70%) described themselves as bilingual (Quechua and Spanish), while 15% described themselves as monolingual (Quechua), and another 15% as multi-lingual (Quechua, Spanish and Aymara). No one described himself as a monolingual Spanish speaker. It is probable that more people speak basic Aymara than the impression given by these figures, because this ancient language is spoken on the *altiplano* and is a common language in commerce (see 1.4.2) (Crandon-Malamud 1991). However people do not identify themselves as Aymara speakers. There were no significant differences between valleys or between north and south, in terms of languages spoken.

People were not asked to state an occupation but rather were asked about their involvement in four activities: keeping livestock, farming maize, mining and other salaried employment. The last of these categories was abandoned in analysis because we received only five affirmative answers (two in Pelechuco, and three in Amarete). A ranked scale described levels of involvement in each of these activities: (1=never, 2 =no longer, 3=as a side or occasional occupation, 4=as a main occupation). Initially, to look at these data in a simplified form, the ranked variables were collapsed into a dichotomous variable: yes (comprised of 3 and 4) or no (comprised of 1 and 2). In all of the data combined, 72% keep livestock, 66% raise corn, and 56% mine for gold. However, the importance of these activities differed markedly between the north and south (Figure 4-1).

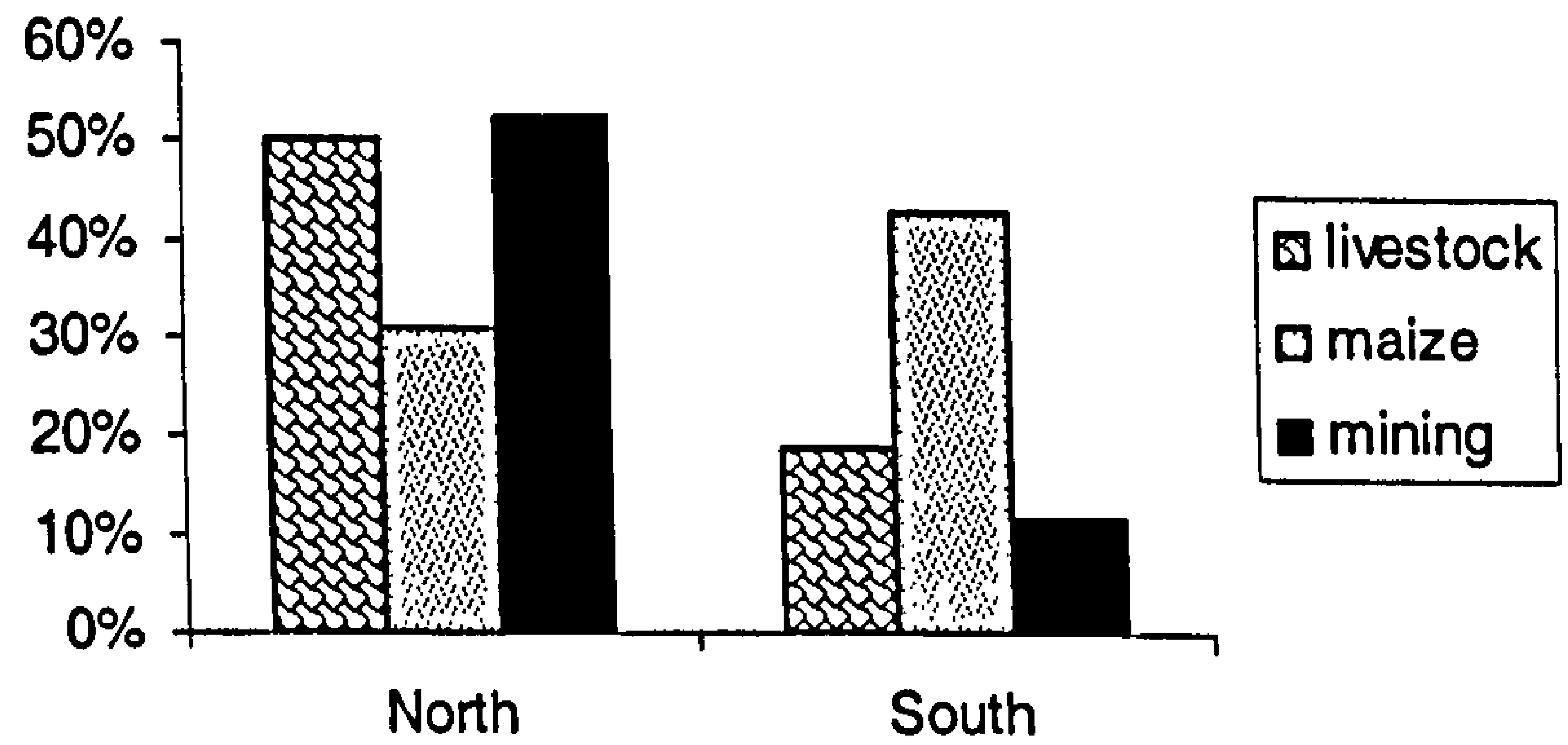


Figure 4-1 Percentage of people who described each activity as a main occupation in the north (protected area), and the south (non-protected area).

Using the ordinal scale, the keeping of cattle, equids, and camelids as livestock was relatively more important in the north (χ^2=37.61, df=3, *P<0.001*), where 84% of interviewees kept these animals, and 51% considered it a main occupation. In contrast, in the south, 57% kept large livestock, and only 19% considered it a main occupation. The cultivation of maize was considered more important in the south (χ^2=7.91 df=3, *P<0.05*), where 70% had maize fields and 42% described this as a main occupation. In the north, 63% of interviewees cultivated maize and 31% described it as a main occupation. Mining was much more important in the north (χ^2=20.20, df=3, *P<0.001*), where 72% of interviewees are at least part-time miners and 53% considered this their main occupation. In the south, only 36% mine and 19% do so as a main occupation.

There was variation between valley/zones as well as between north and south. Maize farming is important throughout the seven valleys, except in valley 2 (χ^2=32, df=3, *P<0.001*). It is of particular importance in valleys 3 (χ^2=14.49, df=3, *P<0.01*) and in valley 5 (χ^2=26.74, df=3, *P<0.001*). Livestock is of less than expected importance in valley 5 (χ^2=16.44, df=3, *P<0.001*), and of high importance (though not significantly different from what was expected) in valley 1 (χ^2=7.62, df=3, *P=0.056*). Mining is of greater than expected importance in valleys 1, 2 and 4 (χ^2=10.15, 8.44, 9.85, df=3, *P<0.05*), and of less than expected importance in valleys 5 (χ^2=24.72, df=3, *P<0.001*) and 7 (χ^2=9.44, df=3, *P<0.05*).

Table 4-1 Importance of three occupations to interviewees: maize farming, livestock herding and mining

Valley/zone	Maize farming	Livestock	Mining
1. Queara-Puina (N)	Some/ occasional	Main occupation	Main occupation*
2. Pelechuco (N)	Never***	Main occupation	Main occupation*
3. Hilo Hilo (N)	Main occupation**	Main occupation	In the past
4. Sorapata (N)	Some/ occasional	Some/ occasional	Main occupation*
5. Chullina (S)	Main occupation***	In the past*	Never***
6. Charazani (S)	Some / occasional	Some/ occasional	Past & occasionally
7. Amarete (S)	Some / occasional	Some/ occasional	Never*

*P< 0.05, ** P< 0.01, *** P< 0.001

Modal responses and significant deviations from expected, using chi-squared contingency table. Expected values are derived from the overall frequency distribution of responses in the study area. Note that the described importance of one activity has no bearing on the described importance of other activities.

4.3.2 *Encounters and tolerance*

Four questions were asked in relation to encounters and tolerance. These questions address how recently people had seen a bear, how they felt about, and how they might respond to, encounters with bears.

When is the last time you saw a bear?

Summarised responses
1= less than 6 months ago, 2= less than a year ago, 3= less than three years ago, 4= less than ten years ago, 5= never

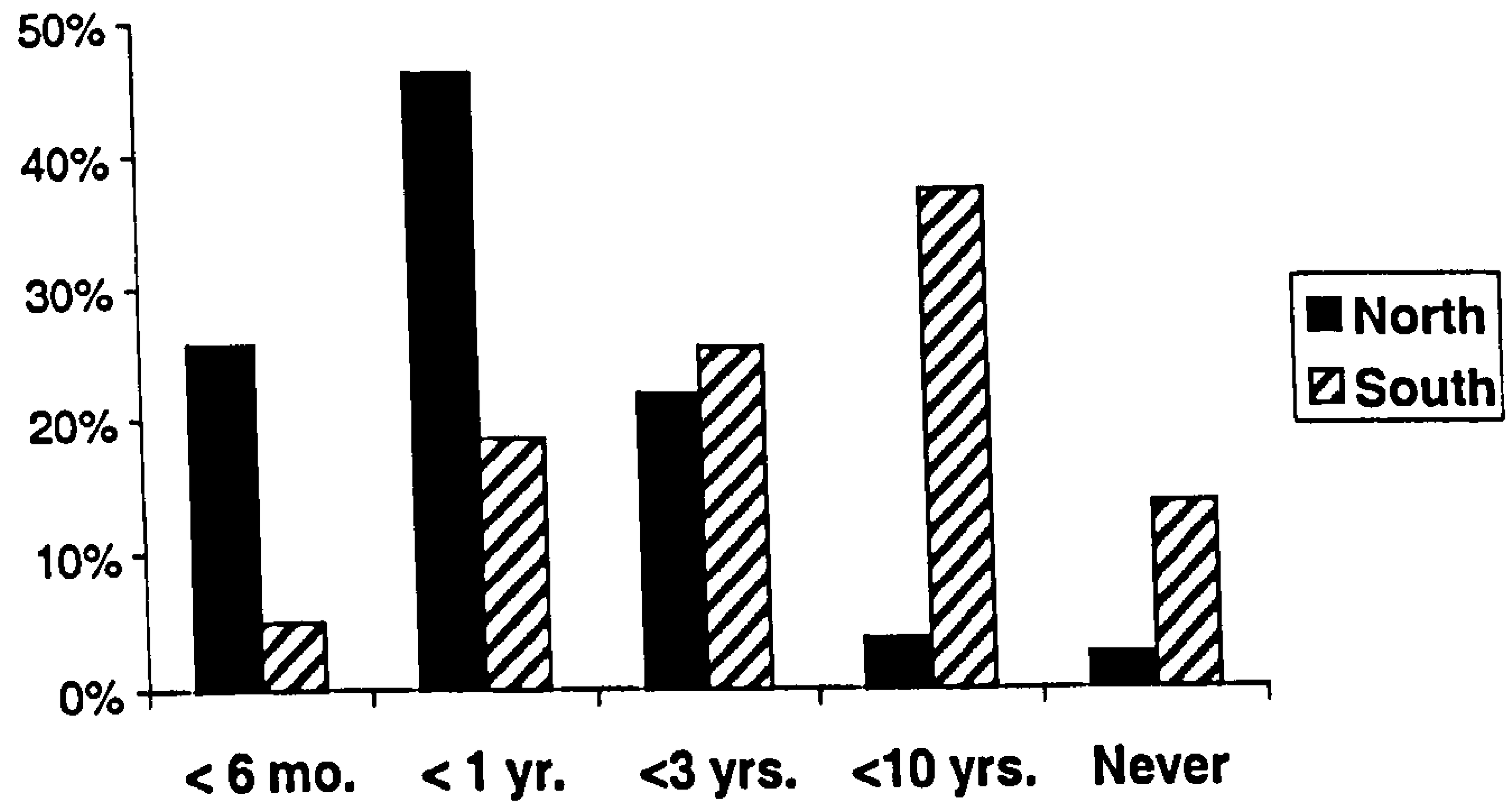


Figure 4-2 Date of most recent encounter with a bear.

People in the north described their last encounter with a bear as more recent than did people in the south (χ^2 =36.64, df=4, P<0.001)(Figure 4-2). This suggests that encounters with bears were more frequent[2] for people in the north of the study area. Out of 137 people interviewed, 127 had seen a bear. Most people in the north described encounters in the last six months to three years, while, for people in the south, encounters were described as rarer

[2] During the pilot study, the date of the most recent encounter was selected as an indication of frequency of encounter. Alternative questions, such as *How often do you see bears?*, tended to elicit vague responses such as, *"All of the time"* or *"Every now and again."*

events. Interestingly, several people in the south reported having seen bears for the first time recently.

How do you feel if you see a bear? Are they scary?

Summarised responses
1= not scary, 2= other people afraid (women and children or less macho men), but not me, 3= man and bear are afraid of each other, 4= conditionally scary (if alone, if the bear sees you, or if female is with cubs), 5= bears are simply scary

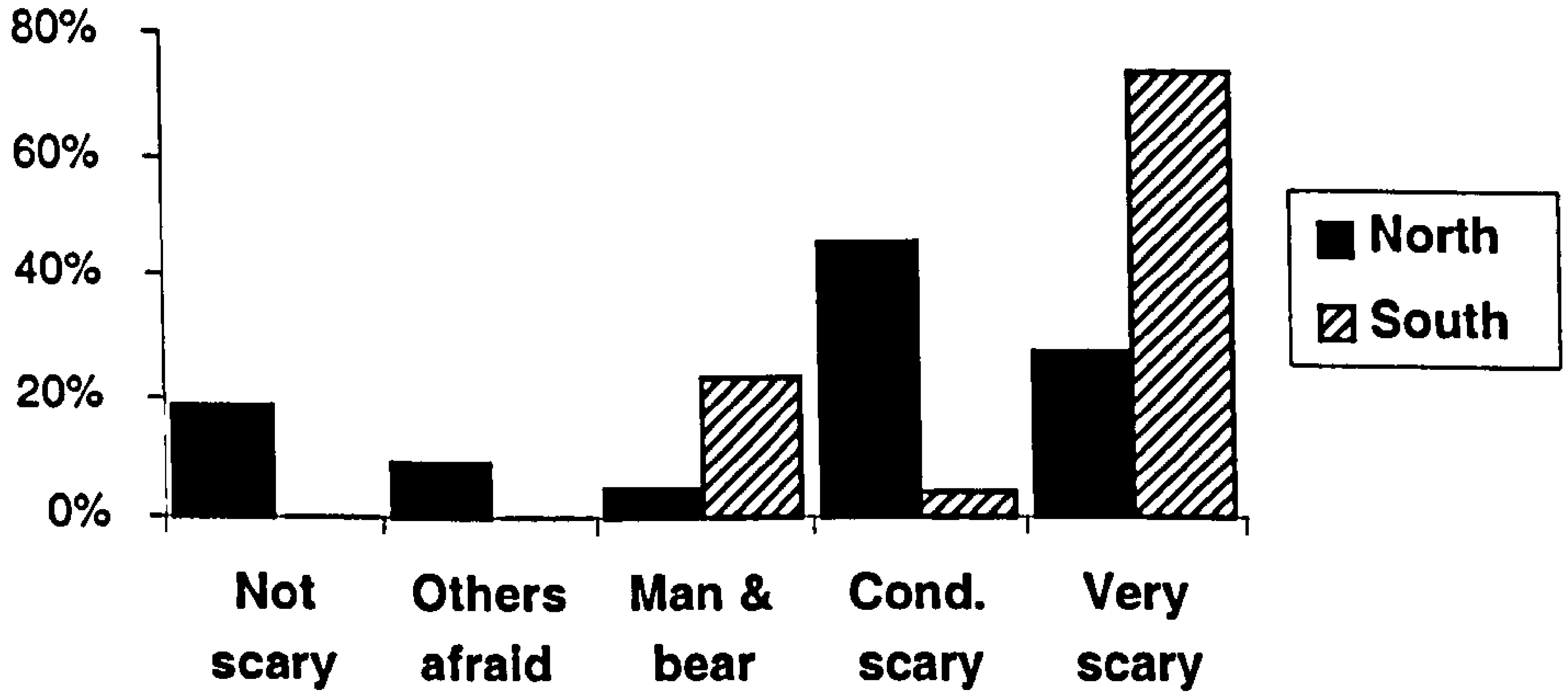


Figure 4-3 Extent to which people are scared of encounters with bears.

There was a marked difference (χ^2=51.83, df=4, P<0.001) between north and south in terms of how scared people felt about bears (Figure 4-3). Most people in the south (64%) were very scared of bears, and all people in the south were scared of bears to some extent. In contrast, 29% of people in the north were not scared of bears themselves, but most people in the north (40%) were conditionally scared of bears, depending on circumstances. Hence, there is generally a more confident attitude to bears in the north and a more apprehensive and fearful attitude to bears in the south.

What are you most likely to do if you see a bear?

Summarised responses
1= flee, 2= watch but leave alone, 3= combination or conditional, 4= throw rocks or otherwise try to scare away, 5= try to kill

Most people in both the north and south said they would flee from the bear (37%) or watch but leave alone (26%)(χ^2=7.02, df=4, P=0.10). Fewer people either said they would take bolder action, such as trying to scare the bears away by throwing stones, or that they could not say without knowing more about the situation. A few respondents (4%) in the north and south stated that they would try to kill the bear.

Would a bear attack a person?

Summarised responses
1= bears never attack people, 2= in very rare cases, 3= under certain conditions any bear can be aggressive 4= some bears are aggressive by nature and can attack a person (i.e. red-fronted bears) 5= bears are very aggressive and do attack people

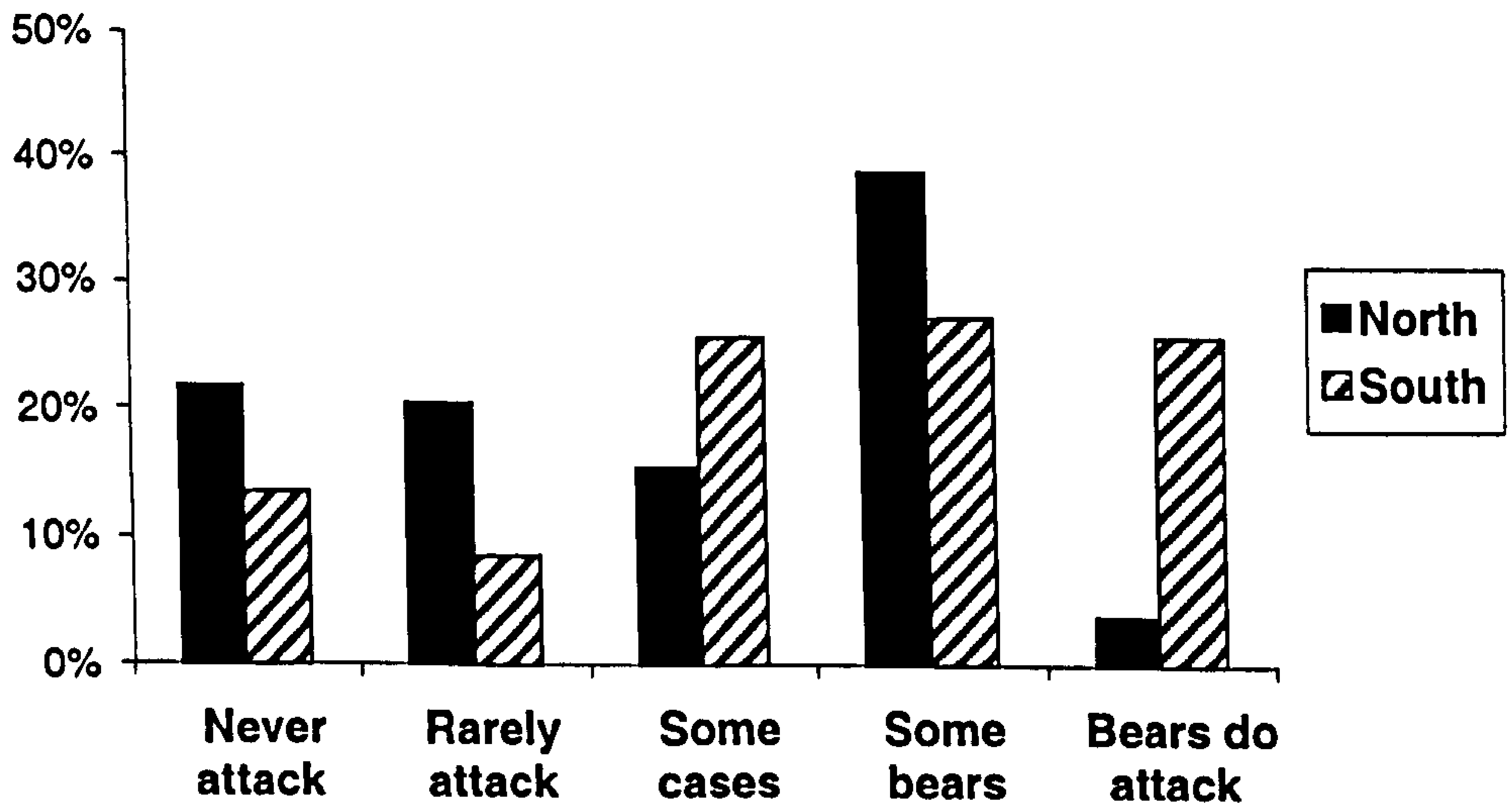


Figure 4-4 Perception of the aggressiveness of bears.

Bears are thought to be aggressive and capable of attack by more people in the south than in the north (χ^2=19.33, df=4, $P<0.001$)(Figure 4-4). The modal response in both the north (38%) and south (27%) was that particular bears or types of bears (such as red-fronted) are aggressive by nature and can attack a person. Despite this similarity, differences arose with the more extreme answers. Many more people in the south (25%) believed that bears are aggressive by nature and do attack people. At the other end of the scale, more people in the north believe that bears never attack people (23%), or that they would only in exceptional circumstances (21%). People who responded that bears could attack in some cases described that increased aggressiveness was related to a bear being startled, threatened or wounded. An additional, often-repeated idea was that if you have courage and walk with your machete, a bear would not appear, but that if you are afraid and have no weapon you are in danger of attack.

There were two reports of bears killing people, but both had the quality of myth. One man from Atiyqui said that when he was 8 years old, a huge grey bear came into town and tried to get into all of the houses. He remembers barring the door with everything in the house. The bear was finally scared away with dynamite, but not before it ate two people. This story was not repeated by anyone else from this village. In the other story, from Sapiwalla, two men were fishing for trout in the Sapi river when a bear appeared from the bushes behind them. The bear administered great blows, sending one man flying into the river, where he drowned. The other man was mauled by the bear in the course of a long and heroic fight. He claimed to have scars from this fight but was not willing to show them or have them photographed.

4.3.3 Beliefs

Four questions were used to investigate mystical or superstitious beliefs about bears. These questions addressed the essential nature of bears, where they fall in the spectrum of good to bad, and what sort of power, if any, they possess.

What sort of being is a jucumari?

Summarised responses
1= God-like, 2= a creature with special powers, 3= person-like, 4= animal

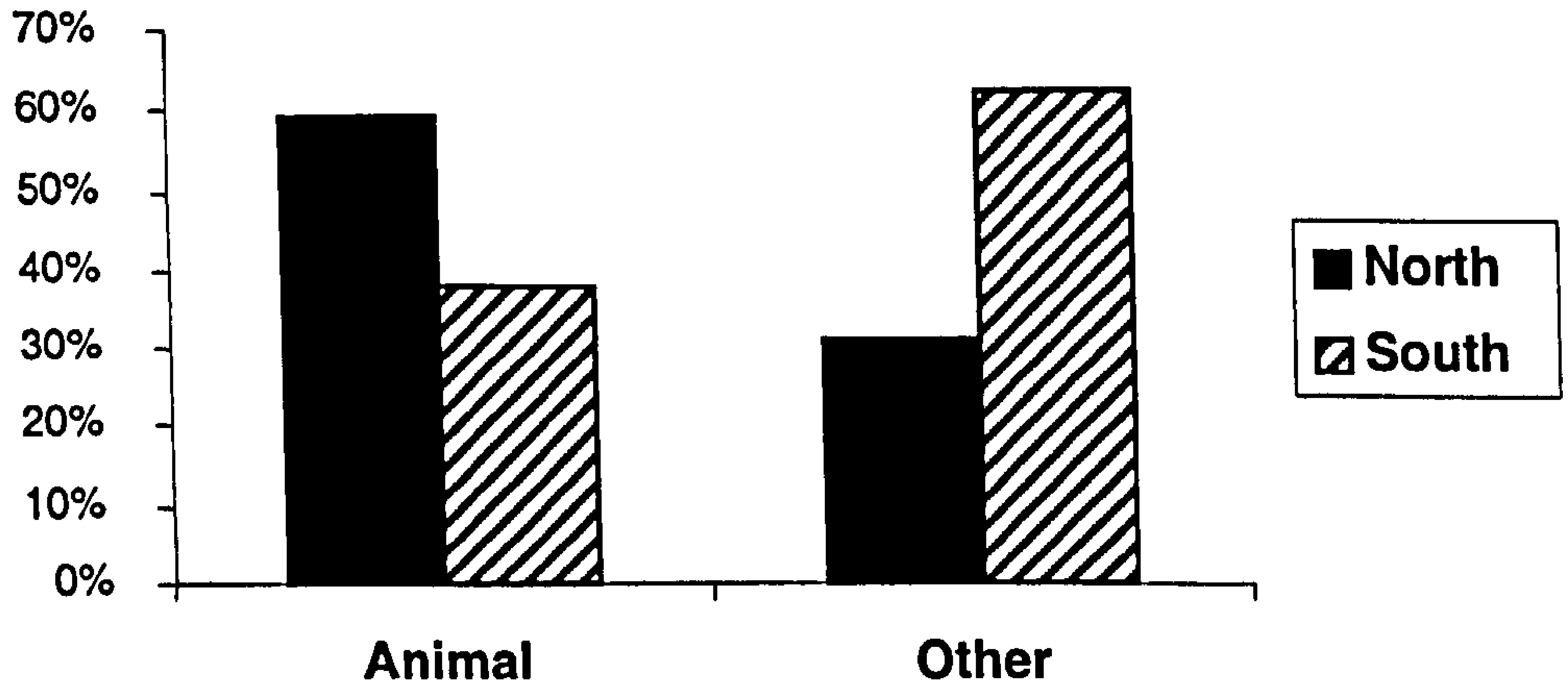


Figure 4-5 Responses to inquiry: What sort of being is an Andean bear?

People in the north were more practical about bears being animals, while in the south, bears were perceived as something other: as a creature with special powers, as a person, or as god-like (χ^2=26.60, df=3, P<0.001). The difference can be most clearly summarised by combining the responses describing bears as something other than an animal (Figure 4-5). The majority (62%) of people in the south perceived bears as something other than an animal, including 19% who described them as god-like. In contrast, the majority of people in the north (59%) perceived bears as just animals, while 27% and 14% respectively described bears as creatures that had some special powers, or as like people. No one described than as god-like.

Are jucumaris good or bad or both?

Summarised responses
1= very good, protective (actively defend people), 2= good, benevolent or innocent, 3=a combination of good and bad, or some individuals good, others bad, 4= bad because they are pests, 5= bad by nature, vengeful, evil

Figure 4-6 Value judgement on the nature of bears: good or bad?

Bears are perceived in a more ambivalent light in the south than in the north, where bears are predominantly perceived to be bad (χ^2=36.06, df=4, P<0.001)(Figure 4-6). This badness, as perceived in the north, is justified by their being pests (40%), or being innately vengeful, "mafiosos", or evil creatures (32%). The combined negative response of 72% can be compared to that in the south, where 27% think of bears as bad, and where, in justifying this perception, people refer to the vengeful nature of bears, rather than to depredation. The modal response in the south (44%) was either that bears were a combination of good and bad, or that individual bears could be either good or bad. Bears were thought of as good by a surprising 28% of people in the south, and by 12% of people in the north. A few respondents in both the north and south claimed that bears were good because they actively defend people against threats from animals like the puma, and are generally protective of people.

Do you believe that jucumaris have powers?

Summarised responses
1= extremely powerful, of mystical nature, 2= physically strong and powerful, 3= limited powers, 4=no

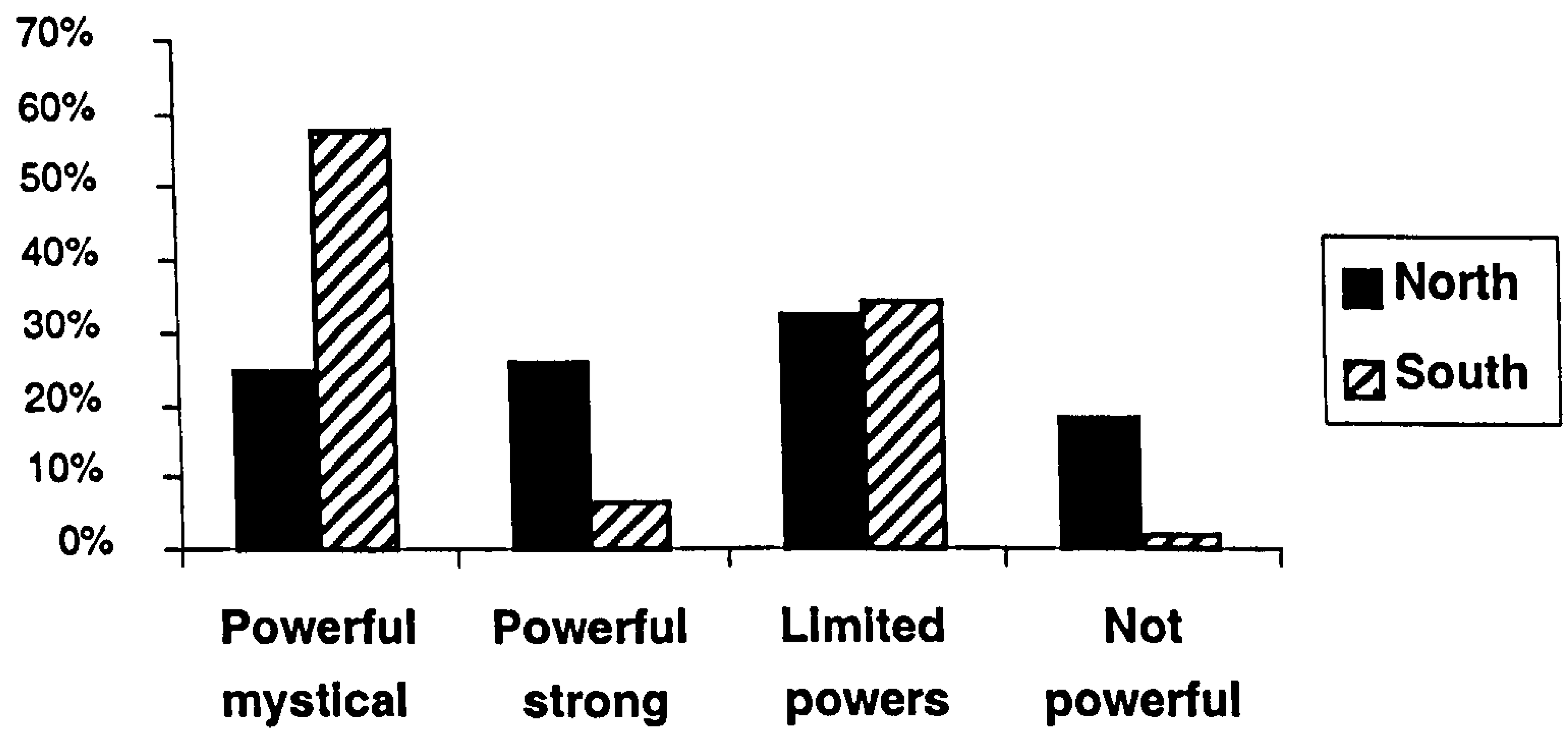


Figure 4-7 The perceived power of bears.

The north and south differed significantly in how they described the power of bears (χ^2= 24.57, df=3, *P<0.001*) (Figure 4-7). In the north, summarised responses were quite evenly spread amongst the four options, ranging from using superlatives to describe their power either in a mystical or physical sense, to dismissing the question, saying that bears are not powerful (or special) at all. In contrast, most people in the south (58%) spoke of bears as extremely powerful in many ways, and the remaining large group (34%) described certain powers they had, such as making you tremble. Their focus was generally less on the physical power of bears on particular.

4.3.4 Use of body parts

A series of questions addressed the use of bears parts relating to: their medicinal value, the edibility of bear meat, and the use and commercialisation of bear parts.

Do bears provide medicine for people? What is it for?

Summarised responses
1= there is no medicinal value to bear products, 2= they say that it makes you strong but I don't know, 3= it is a remedy for specific illnesses (rheumatism, anemia, common cold, loss of vigour), 4 = bears provide extremely powerful medicine (makes you immune to illness, and/or achieve great longevity)

Given the difference in views about the nature and powers of bears, opinions about the medicinal value of bear parts showed surprising similarity between the north and south (χ^2=4.60, df=3, P=0.24). Most people (41%) believe that bear parts are an extremely powerful medicine providing great longevity and vigour. Some people (17%) described bear parts as a remedy for more specific maladies such as rheumatism, anaemia, common cold or general decline and loss of vigour. The same percentage of people were not personally convinced about the power of bear parts as medicine, but mentioned that some people do believe in their utility. The remaining quarter of people interviewed denied any medicinal value of bear parts.

There was a significant difference between north and south in the number of types of bodily tissue that people described as useful (χ^2=20.53, df=3, P<0.001). Most people (48%) in the north mentioned only meat and blood. A greater variety of parts are used in the south, including meat, blood, fat and bone marrow. The fat and marrow are rubbed on the body to help with the pain of rheumatism. Other people rub the bones and paws against the body to help with rheumatism. The marrow is consumed for common colds. Some people say it is only good to eat a fat bear, and that a thin bear is bad for you and has foul smelling meat. Consuming bear meat is widely believed to make a person as strong as a bear, and to confer great longevity. It is also thought to make whoever consumes it a bit slow and awkward like a bear.

One man from Jatichulaya in the south stated, "I have eaten the meat and drunk the blood straight from the animal. Now I'm not afraid of anything. I would even fight a bear. It's like I am crazy with courage." Another elderly man from Queara in the north attributes his great longevity to having eaten bear meat, "The body of the jucumari is strong medicine for *campesinos.* I have drunk its blood and eaten its meat and now I do not know illness and I have the strength of a bear. I am 102 years old and I continue to be strong enough to work like a young man."

Is bear meat eaten?

Summarised responses
1= the meat is not eaten, 2= the meat is edible and like any other meat, or the bear is eaten to give the strength of a bear

All interviewees in the south, and the great majority of people in the north (88%), described bear flesh as edible (χ^2=7.28, df=1, P<0.01), and mentioned a great variety of ways to cook the meat (such as fried with salt and cumin, boiled, dried to make jerky, baked, or deep fried to make crackling). Many people likened the meat to pork or beef. The proportion of people who admit to having eaten the meat (about a quarter) was similar in the north and south (χ^2=0.04, df=1, P=0.84).

The other main use of bear parts that people reported was that of hides. Most people (92%) in the south thought that bear skins are useful mats, extolling their virtues over other skins in terms of strength and warmth. This was quite different (χ^2=19.18, df=1, P<0.001) from responses in the north, where only 58% agreed that they are good mats, and 42% disagreed. Very few people in either area admitted to having bear parts in their homes. Of the five people who showed us skulls or hides, three were willing to sell them to us for the Museum of Natural History in La Paz. Another use was of the bear's nose, which is fashioned into a toy ball. In the south of the study area several people mentioned this and said that such a ball has perfect aim.

Are bear parts sold? Who sells and who buys? Why?

Summarised responses
1= no one may sell bear parts because of a taboo, 2= no, we don't sell parts for other reasons, 3= we used to sell but now we don't, 4= we do sell parts

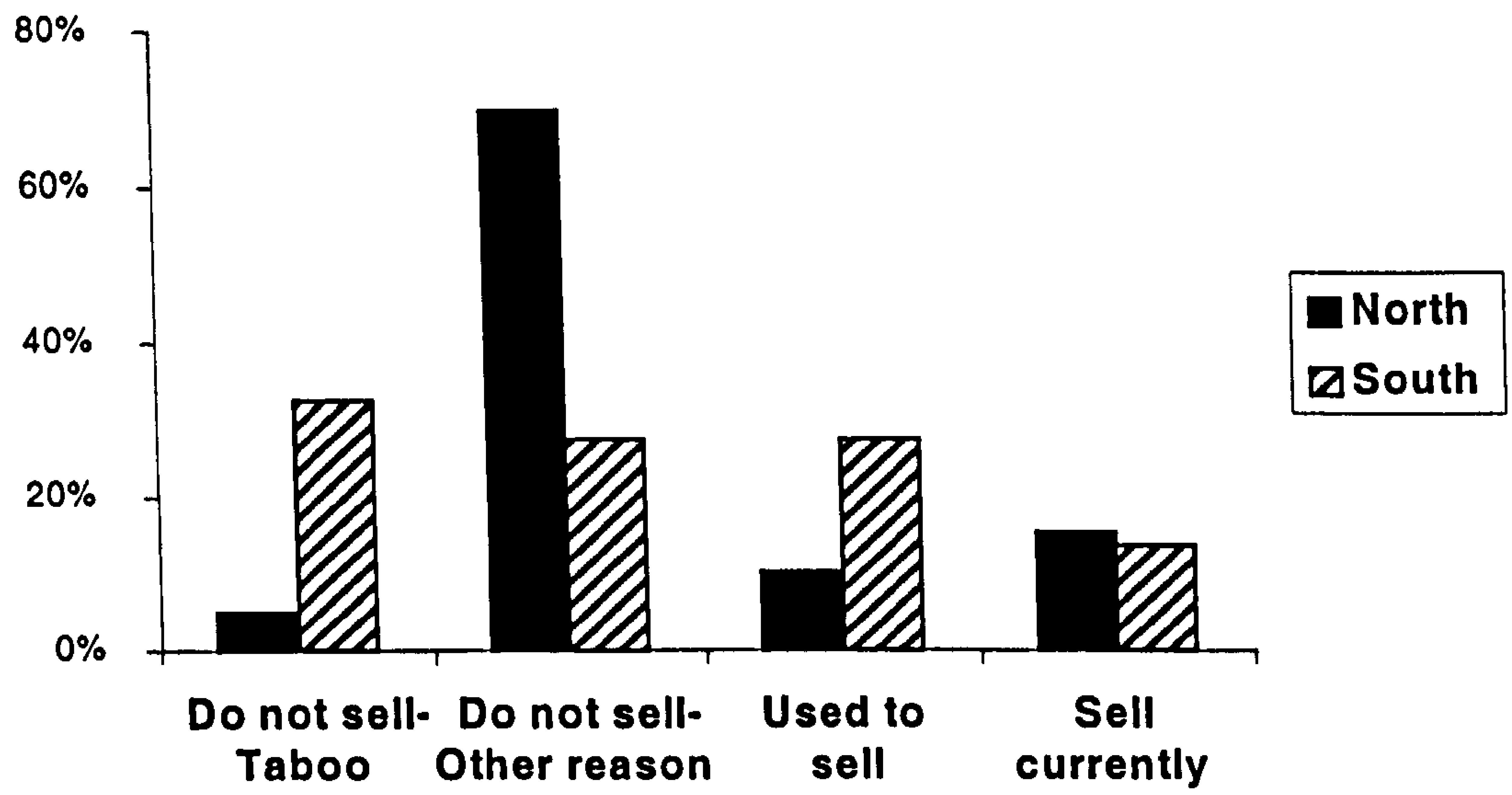


Figure 4-8 Commercialisation of bear parts.

The commercialisation of bear parts differed highly significantly between the north and south (χ^2=27.30, df=4, P<0.001). The great majority (69%) of the people interviewed in the north denied that bear parts could or would be sold. Most people explained that this was because of wildlife protection laws and fear of prosecution. In contrast to this, the modal response (32%) in the south was that bear parts must not be sold for superstitious reasons, the belief being that bad things would happen to the seller and their family. Despite this strong taboo in the south, a greater percentage of people there said that bear parts used to be sold. Approximately one in ten people in both areas reported that bears parts are still occasionally sold.

One elderly man from Amarete explained, "You can't sell parts of a bear or you and your family will be punished by the bear's spirit which can be vengeful. The hide has to be worshipped as you would a second lord because the bear is powerful." Although the taboo about selling bear parts is much stronger in the south, many interviewees in that area did not report knowledge of the taboo. In the north, this taboo was rarely mentioned.

Most people in both the north and south, regardless of what they reported about selling bear parts, explained that if a bear is killed, the meat and blood is shared out with neighbours and family. Those that said bear parts could be sold claimed it was the hide that could be sold (either in La Paz, or to *gringos* who came to the area as tourists). People added that they didn't know why the tourists wanted them, but that the hides fetched good prices. There seems to be no local market for the hide or other parts in the villages themselves. This also applies to regional markets such as the Huancasaya and Chejepampa markets on the Peruvian border. Rather, hides could be sold at the La Paz *mercado de brujos* (witchcraft market), which is the centre for buying and selling wild animal parts in northern Bolivia. The research team made six separate visits to this market, but few bear parts were found, and no whole hides. What we were shown came from Peru, or so it was claimed. They were talismans containing small portions of bear bone or tongue. One woman produced a ball of fat, which she said came from a bear. She claimed it was good for rheumatism. It cost 18 *Bolivianos*, or about £2. Bear parts were hard to find, either by me as a foreigner, or by the Bolivian researchers in the market.

4.3.5 Traditional ecological knowledge

The level of detail that interviewees provided about bear diets was higher in the north than in the south (χ^2=16.01, df=4, P<0.01). The average number of food items mentioned in the north was just over three, as compared to just over two in the south. By far the most common diet items mentioned were Bromeliads; in fact, no one interviewed failed to list this group of plants as a staple bear food. There was an interesting difference in the frequency of other bear foods mentioned (Table 4.2): the second most commonly mentioned type of food in the north was meat, followed by fruits, maize and then other native foods. In the south, maize was the second most commonly mentioned food followed by meat, fruit and other native foods. This suggests that anthropogenic food sources are more recognised than other native foods (after Bromeliads, the use of which is conspicuous owing to the amount of plant matter that is discarded). It further suggests that perceptions of bear diets are strongly correlated with the type of conflict prevalent in both areas: livestock depredation in the north, and crop raiding in the south.

Table 4-2 Food items mentioned by interviewees in the north and south of the study area.

North	South	Types of reported food items
X	X	Bromeleacea (terrestrial: *Puya* spp, *Gregia* spp.)
X	X	Bromeleacea (epiphytic: *Tillandsia* spp.)
X	X	Livestock (cows, llamas, horses, mules and donkeys)
X	X	Crops (*Zea mays* and sugar)
X	X	Ericacea (*Pernyetta* sp. and *Galutheria* spp.)
X		Laureacea (*Nectandra* sp.)
X		Rosacea (*Prunus* sp., *Herperomeles* spp., *Rubus* sp.)
	X	*Chusquea* spp.
X		Bambusoidea
X		Insects (earthworms, maggots and grasshoppers)
X	X	Hares, vizcachas and other rodents
X		Birds and eggs

Most (65%) people, in both the north and south, mentioned seasonal changes in diet and seasonal movements between habitat types (χ^2=3.01, df=1, P=0.83). A common pattern described in the north was that of bears ascending to the high grasslands in the rainy season (when people less frequently) so they can they eat livestock, and in the dry season descending to the forest to eat fruits. Some people described the opposite pattern (rainy low and dry high), attributing this to the presence of horseflies (*tábanos*) in the forest during the dry season. The bears escape their nasty stings by climbing up to the grasslands. Many people in the north also described bears exploiting ripe berries after the rainy season. Interviewees in the south mentioned seasonal movements associated with raiding of crops. Other people (35%) said that bears could appear anywhere and at any time, without a seasonal pattern.

Biologists have long been tantalised by the intimation that there are actually two separate species of bears in the Andes. Indeed, in Apolobamba, 62% of people interviewed described two types of bears. Red-fronted bears are thought to be more aggressive than white-fronted bears, and to be the killers of livestock. Only 21% of people interviewed described only one type of bear, while 17% described three types, usually including the red- and white-fronted bears and a dark grey bear. These ideas did not vary regionally (χ^2=2.31, df=3, P=0.51). The most common basis for differentiation was colour (red-fronted and white-fronted), followed by size and by sociality (whether seen alone or in groups). Length of fur was occasionally also used as a distinguishing feature.

The number of cubs that people had seen with a sow did not differ between north and south, averaging 1.8 (χ^2=5.45, df=3, P=0.41). One respondent in the north reported having seen four cubs, and there were five reports of three cubs. The modal response (58%) was that bears have two cubs. Several people described having seen sows carrying cubs on their backs or legs. Cubs stay with their mothers for one year or less, according to 74% of interviewees, and for one to two years according to the rest. People in the north and south had similar ideas about the general length of time that cubs are with their mothers, but more people (60%) in the north gave answers specific to the level of month (χ^2=26.08, df=3, $P<0.001$), often saying 9-10 months, and more people in the south (17%) said they weren't sure or that the time period was variable. Another common statement was that females teach their cubs everything about how to live and climb trees.

Most people (38%) in both the north and south described adult bears as travelling in groups (sloths) of up to ten animals, or as sometimes solitary and sometimes in groups (χ^2=2.33, df=3, P=0.54). Some people explained that large bears were solitary and smaller bears formed groups. Bears were described as solitary by 30% of interviewees, as forming monogamous pair bonds and living as 'husband and wife' by 24%, and as being either or both by the remaining 9%.

Questions about where and in what habitat bears lived elicited quite different responses in the north and south. More detail was given in the north: people nearly unanimously described bears as living in both the grassland and the forest, and sleeping at night in caves. They also often added detail about the importance to bears of the border between the forest and the grassland. In the south, people were more general in their responses, almost always saying that bears lived "anywhere". Some people who suffer crop depredation from bears explained that, from their perspective, bears "disappear" for half of the year. After the maize is gone in May, the bears go down into the forest. No one interviewed had ever seen a bear that had died of natural causes, and many people believed that bears never fall ill or die.

Three people had seen a bear with mange or alopecia. Many people described how bears are impossible to kill with a gun, that they raise their paws and deflect bullets, and that if shot, they stuff grass into the wound and run away, holding the wound with one paw. Another frequent comment was that bears avoid people and rarely come close to areas of human use unless people are absent.

4.4 DISCUSSION

This is the first systematic attempt to explore the attitudes of rural people towards bears in Bolivia, and the first of this depth in the Andes. Bears were highly valued in utilitarian terms throughout Apolobamba: a wide variety of uses of body parts was described in the study, including deeply held beliefs to do with the medicinal power of bears. Basic Andean bear ecology was described in both the north and south, expressing a fundamental naturalistic awareness of bears. However, marked differences were found between attitudes and beliefs in the north, inside the Ulla Ulla National Fauna Reserve, and those in the south, which is not a protected area. In the north, contact with bears was more frequent and bears were thought of in dominionistic and negativistic terms. Their ecology was described in comparatively greater detail by those residing within the protected area. In the south bears were seen less frequently, and were thought of more in symbolic and moralistic terms. These results suggest that, overall, bears are valued in six main ways in Apolobamba: utilitarian, dominionistic, negativistic, symbolic, moralistic, and naturalistic (see section 4.2.2 for definitions).

4.4.1 Similarities in beliefs and attitudes throughout Apolobamba

Comparing beliefs about, and attitudes towards, bears in the north with those in the south of Apolobamba, reveals a great many important differences. There are, however, other areas of similarity (Table 4-3), particularly in relation to how people behave. For example, the first response of people in both the north and south to seeing a bear was to avoid contact. The practical and material value of bears was much in evidence: the use of hides for sleeping mats, medicinal uses of bear parts and consumption of the meat are all examples of the utilitarian value of bears to people. A further utilitarian value is the rare sale of bear parts.

Some people gave the usefulness of bears to people as the main reason they would be sad if bears were to become extinct.

Likewise, bear meat and blood is thought of as powerful medicine throughout Apolobamba, and if a bear is shot, the meat and blood are shared among family and neighbours. A wide variety of uses of body parts was described in the study, including deeply held beliefs to do with the medicinal power of bears. The researchers were occasionally approached by ill people, who, knowing that we were trapping bears, asked if we could get them some bear fat. The utilitarian view of bears is, therefore, strong. It seems that these uses increase the overall cultural value of bears.

Table 4-3 Summarised similarities in attitudes and beliefs in the north and south of Apolobamba.

Topic	Response
Response if you saw a bear?	Watch or flee
Do bears provide medicine?	Yes, bears provide powerful medicine
Have you eaten bear meat?	One out of four answered in the affirmative
What is done with bear if killed?	If poisoned, left; if shot, meat is shared, hide kept
Knowledge of bear ecology:	Seasonal changes exist in movement and diet
	Two types of bears
	Bears have 1-4 cubs, usually 2
	Can be solitary or in groups
	Tend to avoid people

Another important congruity throughout Apolobamba is a common awareness of basic Andean bear ecology. Despite differences in the level of detail of this knowledge, it nonetheless indicates a pervasive naturalistic appreciation of the Andean bear. It is important to point out that this knowledge of bear natural history does not result from its being taught in any formal way by schools or by the protected area officials. Rather, the knowledge is shared amongst people who have personally observed bears and field sign. Levels of environmental knowledge tend to be correlated with nature-friendliness (Arcury 1990; Van den Born et al. 2001). Teaching people about conserving large carnivores has been shown in some sites to have a significantly positive effect on how these species are perceived (Garshelis et al. 1999; Sillero-Zubiri and Laurenson 2001; Tefera Ashenafi 2001). However, it is clear that, in Apolobamba, any conservation education initiative involving bears would build upon an already solid foundation of knowledge about their natural history.

4.4.2 Differences in belief and attitude between the north and south

The results reported in this chapter show that despite these similarities, bears are more common, better known and more of a nuisance in the north, whereas in the south they are rarer and more magical. Putting this in terms of Kellert's typology, it can be said that while utilitarian values are in evidence throughout Apolobamba, dominionistic and naturalistic values are predominant in the north. Symbolic, moralistic and negativistic values are stronger in the south.

Table 4-4 Summarised differences in attitudes and beliefs in the north and south of Apolobamba.

Topic	Reference	*P*	North	South
Last encounter	Figure 4-2	*P*<0.001	More recent	Less recent
Are bears scary?	Figure 4-3	*P*<0.001	Sometimes	Always
Would a bear attack a person?	Figure 4-4	*P*<0.001	Bears less aggressive	Bears more aggressive
What sort of being is a bear?	Figure 4-5	*P*<0.001	Just animals	Like a person or god
Are they good or bad animals?	Figure 4-6	*P*<0.001	Bad- pests and evil	Combination good/bad
Additional difference			12% good	28% good
Do bears possess any powers?	Figure 4-7	*P*<0.001	Certain powers	Extremely powerful
Additional difference			18% no powers	2% no powers
Medicinal bear parts?	4.3.4	*P*<0.001	Less detail	More detail
Is bear meat good to eat?	4.3.4	*P*<0.01	Some people - No	Yes
Are the hides good as mattresses?	4.3.4	*P*<0.001	Some people - No	Yes
Are bear parts sold?	Figure 4-8	*P*<0.001	No, they are not sold due to other reasons	Taboo: must not be sold or parts were sold in past
Knowledge of bear ecology	4.3.5	*P*<0.01	More detail	Less detail

In the north, people have more contact with bears and hence describe Andean bear ecology with comparatively greater detail. They tend to think of bears in more practical terms: as animals that are rarely aggressive. Fewer people expressed fear of bears in the north. The dominionistic value of bears, the value of mastery and physical dominance over a large and potentially dangerous animal, may be stronger in the protected area in spite of (or perhaps because of) its being more forbidden there. Killing bears confers benefits to the hunter in terms of respect in the community. Stories of bears being shot, or even nearly shot, are told and re-told, and embellished into fantastic yarns. In areas where bears are poisoned this is less the case, but a person who has killed a bear retains that reputation and is thought of as brave. It is common that any encounter with a bear is interpreted in terms of the bravery of the person involved.

Negativistic fear of, aversion to, and alienation from bears are experienced more amongst people who have less contact with bears. However, throughout Apolobamba, many people are afraid of the *jucumari*. People in the south also tend to think that bears are not normal animals, and are immortal or in possession of fearsome powers. It is difficult to determine whether people in the south are more afraid of bears because of alienation from the reality of the animal or because they retain more traditional beliefs which include these views. This negativistic fear of and aversion to bears would certainly be adaptive in that it would help to maintain a respectful distance between people and bears and so further diminish the already small chance of attack.

A more generally negative, dominionistic relation to nature was expressed in the attitudes and behaviour of many people in Apolobamba. This was exemplified in a story told by one of key informants. He was camping one evening near a small pond where frogs were chirping loudly. He said he was carrying with him some sulphuric acid for use in the mines, and that he poured some into the pond. In a few hours all of the frogs and everything else in the pond were floating on its surface and, gratifyingly, silent. This type of attitude and practice may exist amongst certain members of any society (young males in particular) , but must be considered as a sobering reality in any case.

A moralistic, spiritual reverence was stronger in the south. The occasional description of bears as god-like creates the impression of enduring reverence for bears (as discussed in Chapter 3). A wider variety of uses of bear parts was described in the more mystical south, and although this knowledge may seem counter to conservation goals, it provides a strong utility for the species. A number of studies have shown that access to benefits from natural resources increases the likelihood of people supporting wildlife conservation efforts (Newmark et al. 1993). If bears were of no utilitarian value, the motivation for their conservation would be harder to stimulate. In this case the utilitarian values of bears are strongly linked to moralistic and symbolic values.

4.4.3 Diversity of values

Viewed collectively, these results suggest that bears are valued in five main ways in Apolobamba: utilitarian, symbolic, moralistic, dominionistic and negativistic. At least the first four of these values provides the seeds of potential good will for conservation. An encouraging implication of these results for bear conservation is that despite the existence of antagonistic or negativistic attitudes, positive attitudes are also present, and knowledge levels are high, as is interest. There are positive attitudes in both the north and south, amongst all ages and occupations and there is, therefore, scope for building upon this endemic positivity.

4.5 SUMMARY

1. The mean age of interviewees was 44, and all interviewees spoke Quechua, 70% describing themselves as bilingual in Quechua, Spanish. In the north of the study area, inside the protected area, people are more reliant on livestock and mining. In the south, outside the protected area, people are more reliant on farming including maize cultivation.

2. In the north, bears were encountered more often and a more negativistic and dominionistic attitude was prevalent. Due to awareness of wildlife laws, people were afraid of punishment for killing, using or selling bears or bear parts. In the south, a more respectful and mystical or moralistic and symbolic attitude prevailed – they were more afraid of bears, but thought of them in more positive terms.

3. There is a wide range of attitudes and beliefs about bears. An extreme negative attitude might be summarised in the following way: a bear is just an animal; it is of no utility to people; it is bad, vengeful, "mafioso", and a danger to people. An extreme positive attitude could be summarised as follows: a bear is God-like, possessing the equivalent of seven human souls; its parts must never be sold; the hide must be kept and worshipped.

4. The medicinal uses of bear parts are widely known to people (74%) in this study. Blood and meat are taken as general tonic imparting the strength of a bear and great longevity. The meat, fat, bones, marrow and blood are used to treat rheumatism, anaemia, the common cold and general weakness and decline.

5. Bear meat was widely considered edible and the hides are used as sleeping mats. Bear parts do not seem to be widely commercialised, although some hides are sold in La Paz and to tourists.

6. Details of bear ecology were described in both the north and south. However, knowledge of bears' feeding habits was more detailed in the north where people have more contact with bears.

Chapter 5

FEEDING ECOLOGY

The terrestrial bromeliad Puya atra, an important bear food in Apolobamba.

5.1 INTRODUCTION

Understanding feeding ecology is essential to understanding the behaviour, social system, and movements of carnivore populations (Macdonald 1983). Hence, the diet and feeding ecology of the ursids have been given more scientific attention than has any other aspect of their life histories (Lynch 1993). Of the eight bear species, the herbivorous panda, *Ailuropoda melanoleuca*, and the largely carnivorous polar bear, *Ursus maritimus*, are positioned at opposite extremes of the dietary continuum. Between these extremes, the other bears are dietary generalists. They feed on the most concentrated energy sources available in a given season, such as fruits, nuts, insects, fish, and mammals. When these items are unavailable, green vegetation is also selectively eaten (Herrero 1999). The food habits of bear populations vary annually according to the autecology of specific foods. Inter-annual variation in the availability of high-energy foods is also a key determinant in patterns of depredation by bears and of other conflicts between bears and people (Beeman and Pelton 1980).

In addition to varying between years, the availability of bear food in most environments may fluctuate within a given year. The seasonal cycles of other animals influence the diets of bears, such as, in the case of brown bears, *Ursus arctos*, the spawning of salmon, the calving of elks and seasonal aggregations of insects such as army cutthroat moths. Fruit availability is also periodic (Bahuchet 1987). Fruit is important in the diets of all of the temperate bear species except pandas: American black bears, *U. americanus*, brown bears, and Asiatic black bears, *U. thibetanus* (Peyton 1980; Craighead and Mitchell 1982; Schaller et al. 1989; Mattson 1990). Even polar bears, in the midst of a highly carnivorous diet, are known occasionally to eat berries in the summer (Derocher and Stirling 1990; Hobson and Stirling 1997). Fruit is thought to play a crucial role in the diets of the two mostly tropical bear species, sun bears, *Helarctos malayanus*, and sloth bears, *Melursus ursinus*, as well as in the diets of Andean bears, the only bear whose range spans the tropics (Peyton 1999).

5.1.1 The food habits of the Andean bear

How Andean bears balance their energetic budgets, given the specific conditions in the Neotropics, is an important question remaining to be explored. Fruit is an especially important resource in tropical forests, where at least 50% to 75% or more of the tree species produce fleshy fruits adapted for consumption by birds or mammals (Howe and Smallwood 1982). Fruit in the Neotropics is also relatively constantly available, in contrast with the temperate zones, where it is only available from mid-summer to the end of autumn (Fjeldsa and Krabbe 1990). Nonetheless, even in the Neotropics, fruiting plants tend to be a patchy resource, widely separated both temporally and spatially (Fjeldsa and Krabbe 1990). In the Neotropical montane forests, palm nuts are the only source of highly nutritious hard mast, which is an essential seasonal food for bears in temperate forests.

The basic food habits of Andean bears are relatively well understood in comparison with other aspects of their life-history strategy. The reports of early explorers describe the conspicuous feeding sign left by these arboreal bears and their use of tree nests (Monardes 1577; de la Condamine 1735; Humboldt 1885). Naturalists have described signs of bears feeding on fruits in the desert of Peru (Osgood 1914), and on the nuts and fruit stalks of palms in the montane forests of Ecuador (Tate 1931) and Venezuela (Gines and Ocando 1953). In addition to feeding on forest and cactus fruits, Andean bears were early identified as relying on the leaf bases or hearts of bromeliads as the mainstays of their diets and have long been described as highly herbivorous (Cabrera and Yepes 1960). The first detailed field study of Andean bear ecology was begun in 1976 in Peru (Peyton 1980). In this pioneering multiple-sited study, 83 different food items were identified, of which 94% (volume) was plant matter. Other studies describing a varied and highly vegetarian diet[1] have been carried out in Venezuela (Goldstein 1986), Colombia (Lozada 1990), Ecuador (Suarez Martinez 1985; Castellanos Peñafiel 1997) and Bolivia (Eulert 1995; Velez and Azurduy 2000; Brown

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[1] Amongst the plant parts that Andean bears have been documented to eat are the leaf bases and meristematic tissue of species in the families Bromeliaceae (*Puya* spp., *Pitcairnia* spp., *Gregia* spp. and *Tillandsia* spp.), and Gramineae (*Chusquea* spp. and *Bambusa* spp.) and Palmacea (*Ceroxylon* sp.), orchid pseudobulbs (*Epidendrum* sp.) and tubers (*Ullucus* sp., *Oxalis* sp., and *Solanum* sp.) and fruits of species in the families Cactaceae (*Opuntia* sp. and *Trichocereus* sp.), Agavaceae (*Agave* sp., and *Fourcrea* sp.), Rosaceae (*Rubus* sp.), Ericaceae (*Pernettya* sp., *Vaccinium* spp. and *Schinus* sp.), tree fruits such as (*Ficus* spp., *Cecropia* spp., *Clusia* sp., and *Carica* sp.), various crops (such as *Zea mays* and *Cucurbita* sp.), and herbs of the family Astaraceae, and Passifloraceae (Peyton 1980; Goldstein 1986; Eulert 1995; Suarez Martinez 1985; Rodriguez et al. 1985; Yañez 1995).

and Rumiz 1989). Although Andean bears are principally vegetarian they, like all ursids, are known to prefer animal matter and animal products when they are available (such as, in the case of Andean bears, rabbits, deer, goats, sheep, cows, birds, rodents, eggs, insects, and honey) (Peyton 1999).

Bromeliads play an intriguing role in Andean bears' feeding ecology. The 2000 or so species of the Bromeliacea order are almost entirely restricted to the New World (Benzing 1980). The 168 *Puya* species have more in common with their cousin the pineapple than just the spiky leaves; many have a crystallised yellow gelatine reminiscent in sweetness and flavour of the pineapple (Benzing 1980). In Bolivia alone there are 60-70 species of *Puya*, 40-50 of which are endemic (Smith and Downs 1974). In Peru and Venezuela, researchers have noted the occurrence of large concentrations of *Puya* in bear scats and also of feeding sign (Peyton 1984; Suarez Martinez 1985) and commented that these may result from intensive feeding sprees (Goldstein 1986). Two field studies of Andean bears have focussed on *Puya* (Suarez Martinez 1985) and on the patterns of exploitation thereof (Goldstein and Salas 1993). Several authors have commented on the importance of bromeliads in bear diets, and on the idea that they may serve as a keystone resource, enabling the continued sustenance of bears through nadirs in fruit availability (Peyton 1984; Suarez Martinez 1985; Goldstein 1986; Goldstein 2000).

5.1.2 Assessment of diet from scat

Any assessment of the importance of bromeliads and other foods in Andean bear diets may be complicated by differing rates of faecal decomposition. Scat may decompose or become unrecognisable at different rates according to the type of scat, the season and habitat type. Marked seasonal variation in the decay rates of bushbuck, buffalo and elephant droppings has been shown in tropical montane forest and open habitats in Africa (Plumptre and Harris 1995). Little, however, is known about faecal decomposition rates for bears in any environment, or for scats of any provenance in the cloud forest. The age of Andean bear scat made up of the tough fibres of the terrestrial bromeliad, *Puya* sp., is difficult to assess. If it were the case that a scat of this type has an endurance of many months, and a berry scat decomposes in days, the question arises of how diet could be assessed from the record of scats encountered. The numerous *Puya* scats found often together (i.e. 37 scats on 1 km of trail, and a latrine site with approximately 4 litres of scat, were found early on in the study) suggest an extremely high density of bears, and may lead to an overestimation of the importance of *Puya* in the diet.

Although diet is probably the best understood aspect of the ecology of the Andean bears, the relative importance and nutritive value of food items within the diet has hardly been evaluated. The only published study to consider the nutrition of wild Andean bears to date was based on Peyton's 1980 list of food items identified in Peru (Dierenfeld, 1988). In the absence of actual food samples, data on the chemical composition of some of these foods were gathered from other published sources. The foods for which nutritive content were described include several fruit species, maize, and bamboo (for selected results see Table 5-6) (Dierenfeld 1988), but the nutritive value of bromeliads was not assessed.

5.1.3 Research questions and structure of chapter

This study of the feeding ecology of Andean bears in Apolobamba, Bolivia, was carried out as a vital foundation for understanding bear behaviour and interactions with people (topics arising in the following chapters). In addition to using existing observations by explorers and previous work by field biologists as a background, local knowledge was also considered a vital resource in understanding Andean bear feeding ecology. Indigenous people throughout the world possess detailed knowledge about the habits of conspicuous members of the local fauna (Patton et al. 1981; Johnson 1992; Morris 2000). Having reviewed local knowledge of bear ecology in the previous chapter, this information is now utilised in identifying the issues to be studied in this chapter. The following research questions were pursued.

- What food resources were exploited during the study period by the bears in the vicinity of the Pusupunko study site?
- Do bear diets as confirmed in the study coincide with what was described by interviewees?
- Is there evidence of food resources that were exploited in years previous to the study, with particular reference to those food resources mentioned by interviewees?
- Do bear scats decompose at a similar rate regardless of environment, season and type of scat?
- What is the periodicity of fruit production during the study?

- Do Andean bear diets in Pusupunko vary seasonally?
- Is the importance of bromeliads in bear diets explained, at least in part, by their high nutritive value?

The chapter begins with collected evidence of bears' feeding habits in the study area, and how this evidence tallies with lists of bear foods given by interviewees. The difficulties of interpreting diet from scat are then explored. The phenology data follows, accompanied by the seasonal variation in diet. This is succeeded by analysis of the nutritive value of bromeliads and other bear foods.

5.2 Methods

5.2.1 Diet

In order to describe the diet of bears using the study area, three sources of evidence were utilised: interviews with local people, the analysis of scats and observations of feeding sign. The methods used for interviews are detailed in Sections 2.3.2 and 2.3.4. Bear diets as described by interviewees were used as a starting point for searching for feeding sign, and as a supplement to the direct evidence of diet gathered in the field. Food items reported by interviewees are shown in comparison to field evidence in Tables 5.1 and 5.2.

Searches for scats and other feeding sign were made in the course of field work between September 1997 and July 1999. Following bear trails constitutes the most effective way to find scat and other sign (Suarez Martinez 1985). These trails are clearly recognisable and easily differentiated from the trails of other animals using the study area. The majority of these trails run parallel to the ridges and rivers and connect clumps of exploited *Puya* to other resources in the forest. These trails are additionally often the safest means of travel on precipitous mountain slopes. Areas recently inhabited by the radio-collared bears were targeted for searches when access was possible and if the radio- monitored bears had vacated the area.

For any feeding sign found, details were recorded of: location; habitat type; slope; aspect; distance to the closest bear trail; distance to the closest human trails; and relation to other bear sign. Samples of food plants were taken for identification of species. The following characteristics were recorded for each scat located: date; habitat type (forest/ ecotone/ grassland); content (approximate percentage volume by ocular estimate); age (new/ recent/ old)[2] (Eulert 1995); humidity (ordinal scale); and the exposure of the location. It was noted whether the scat was part of a deposition of multiple scats, and whether it contained bear hair (many scats contained a few bear hairs, probably ingested while feeding or grooming themselves). The length and width of the largest scat, the distance from the closest bear trail, the distance from the closest human trail and the approximate volume of the scat were also recorded.

Fibrous and long-lasting scats containing the terrestrial bromeliad *Puya* spp. were the most commonly found during the study. These were generally examined on site because they were so numerous and rarely contained any other items. The grey runny scats resulting from feeding on cow carcasses were also examined *in situ*. All such scats that were not collected for further examination were broken up and dispersed to avoid recounting them at some future time. Scats comprised of any food items other than *Puya* spp. or cow meat were collected. These scats were then sun dried, and transported to the laboratory in La Paz for analysis. There they were examined under a dissecting microscope and their composition identified and described. Frequency of occurrence of each food item was calculated as follows: $FO_i(\%)=(n_i/N)*100$ where N was the total number of fecal samples and n_i the number of samples containing food item i.

5.2.2 Interpretation of diet from scat

To aid in the interpretation of the diet from the scats discovered in the study area, ten fresh scats were each divided into three portions of approximately 100 ml. Their rates of decomposition were then observed. A difficulty of this technique is that each scat was reduced in size, so decomposition rates may have been increased. Each of these portions

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[2] In a study of bear sign in Amboró Bolivia, a relatively rapid and fixed decomposition rate of bear scat was assumed. Newly discovered scats were classified into three categories: new (a few hours to 3 days) if the scat was moist and undisturbed by coprophages; recent (3 to 7 days) if the scat was partially moist, a little disturbed by coprophages, or partially covered with detritus; and old (7 or more days) if the scat was dry, disturbed by coprophages and covered by leaf litter (Eulert 1995).

was placed in one of the following three environments: fully-exposed grassland; shaded grassland; or fully-shaded forest. Each portion was examined once a week to assess degree of decomposition, which was rated as follows:

- Still intact (not damaged beyond recognition by beetles or other animals), visible (not covered by leaf litter) and readily identifiable (not blended in with ground due to rain),
- Present, but would not have been found without knowledge of its location
- Thoroughly disintegrated.

Changes were measured in units of weeks and any change in category was attributed to the week in which it was discovered. The influence of the original scat ID, type of scat, habitat type and season on decomposition times was evaluated using a generalised linear model.

The scats used in this experiment were divided into two groups for analysis, *Puya* and "mixed". *Puya* scats were comprised entirely of fibre from this plant. The mixed scats each had different primary compositions: two were composed of thousands of the small grainy Ericaceous seeds and plant part remains of *Gaultheria vacciniodes;* two were composed of the slimy fibre of the epiphytic Bromeliad *Tillandsia* sp.; and one was of *Bos taurus* with an unidentified hay-like plant fibre.

The results of this experiment highlighted the need for caution in interpreting the record of scats encountered in the field as representative of what bears were eating. There was a bias towards locating scats in the grassland, due primarily to the difficulties of locating scats in the forest, and the faster decomposition of scats in this wet environment. In the grassland it was common to locate large groups of scats in one area, around a patch of *Puya,* or a cow carcass where bears consumed large quantities of food and defecated frequently. Scats were located less frequently in the forest and they were more widely dispersed. In order to compensate for this bias, the records of scats collected are displayed in two ways (see Table 5.3). In the first more traditional method, all scats classed as new or recent were treated as independent sample units. Second, to avoid overestimating *Puya* and cow flesh in the diet, when multiple defecations of a similar age were found in one area of $<10m^2$, they were classified as feeding episodes. In the absence of a more complete sample of scats throughout the year and from all habitat types used by the bears, the latter method may provide a more representative estimate of what bears were eating throughout the year.

5.2.3 Phenology and seasonal variation in diet

To assess temporal patterns of food availability in the Apolobamba study site, general data were needed to investigate the periodicity of fruit production. Records were kept each month on the phenology of 10 species of plants in the study area. Three individuals of each species were monitored once per month and were classified as sterile, flowering, or fruiting. Individual variation was not explored, as the aim was to determine general fruiting patterns as they relate to overall fruit availability, rather than the autecology of the individual plant speices. If one part of any of the three specimens were in flower, the species was coded as flowering for that month. Similarly, if any part of one specimen was fruiting, the species was coded as fruiting. Likewise, if plants carried dried fruits that had not fallen to the ground, the species was designated as fruiting.

The individual plants monitored were found within the altitudinal range of 3100 to 3700 metres. The monitored species were: *Gaultheria vacciniodes, Herperomeles lanuginosa, Clusia* sp., *Schefflera* sp., *Rubus bullatus, Pentacalia orinocensis, Ribes bolivianum, Puya atra* and *Prunus brittonianus*, and *Polylepsis racemosa.* Nine species were selected for monitoring because of their suspected importance to bears (based on local knowledge or studies of Andean bears in other areas). The remaining species, *Polylepsis racemosa*[3], was not known to be of importance to bears but was monitored opportunistically on account of being a conspicuous and notable member of the flora surrounding the research headquarters.

Seasonal variation in the diet was explored by examining the occurrence of food items in the scat by month.

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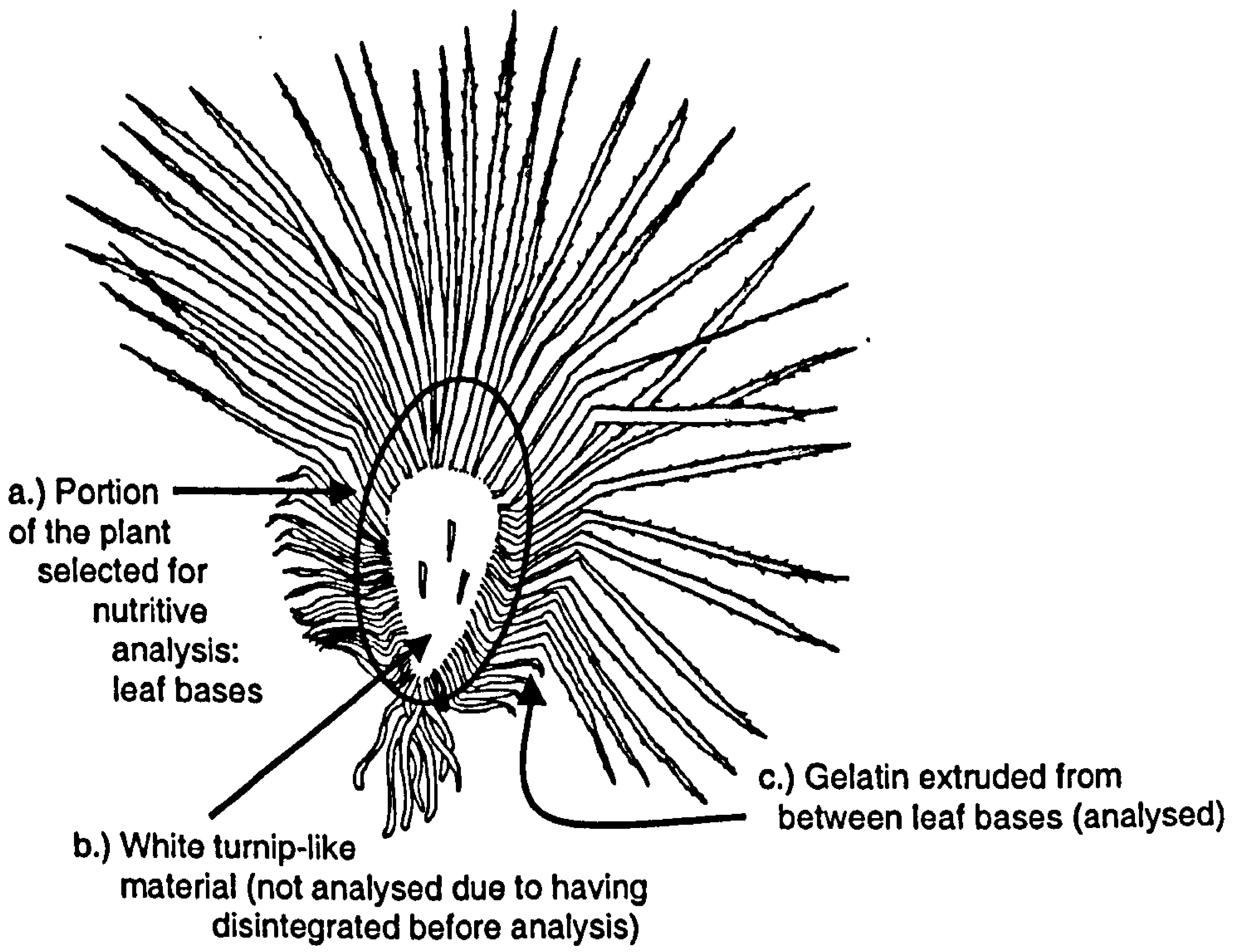
[3] *Polylepsis racemosa triacontandra* is a large tree with bright coppery bark that peels off in thin layers. This species, probably the fastest-growing Polylepsis species in Bolivia, is restricted to a small range in the Cordillera de Apolobamba and is therefore of great ecological and conservation interest (Fjeldsa and Kessler 1996) although it is not known to be of value to bears.

5.2.4 Nutritive analysis

Ripe berries[4] of *Gaultheria vacciniodes* and *Pernyetta prostata* were harvested from different shrubs at the study site and were analysed fresh at the SELADIS laboratory in La Paz. I also collected Bromeliad samples, four *Tillandsia sp.* and two *Puya atra*, which were dried, sent to the United States and analysed by Dr Ellen Dierenfeld, Department of Nutrition, Wildlife Conservation Society, New York.

The bases of *Puya* plants have a complex structure (Figure 5-1). Bears eat *Puya* much as we might eat a globe artichoke, stripping and consuming the tender portion from the leaf bases and consuming the "heart". The "heart" or centre stalk of the plant is filled with a white matter similar in consistency to turnip. One plant examined in the field contained almost two litres of this matter. However, this material has a high water content and disintegrated when the plants were dried, and so was not analysed for nutritional content. *Puya* also exudes a copious gelatinous substance between the leaf bases. This material was dried and analysed.



[4] *Gaultheria vacciniodes* and *Pernyetta prostata* are in the Ericacea family, and are similar in taste and appearance to commercial blueberries (*Vaccinium corybosum*).

Figure 5-1 Portions of the leaf bases of the *Puya* plant exploited by bears (a, b, and c) and analysed for nutritive content (a and c).

The nutritive value of the samples was assessed using the classic technique of proximate analysis as well as the techniques for more accurate assessment of fibre composition proposed in 1982 by Van Soest. Together these techniques provide information the chemical constituents of the plant including cell content and fibre (McDonald et al. 1981). The relative proportion of cell wall to cell content and the availability of both to the animal determine the nutritive value of a plant (Schaller et al. 1985).

5.3 RESULTS

5.3.1 Diet

Thirteen food items were identified in scats found in the study area (Table 5-1). Four of these food items were species of bromeliad: two terrestrial species of the genus *Puya* and two epiphytic species of the genus *Tillandsia*. Three food items were fruits: one Ericaceous berry, and two tree fruits. Two unidentified plants, a moss and a grass were found in small quantities in meat scats when bears had consumed cattle, horse, rodents or birds. Evidence was also gathered for the consumption of food items not represented in scats (Table 5-2).

The number of plants reported as consumed by bears was greater than the number of plants for which corroborative scats were found (Table 5-1). In many cases there was direct or indirect evidence of previous use of a resource by bears, such as repeated scratch marks on the trunks of *Prunus brittianus*, accompanied by broken branches, both of which suggest feeding by bears. Of twenty-seven species reported as eaten by bears, ten were confirmed through scats and another three by direct feeding sign. Of food items that had not been reported by interviewees, only three were confirmed through scats, and two through direct feeding sign. This data collectively suggests that local people have a high degree of awareness of bear habits. This evidence also suggests that bears vary their use of food resources from year to year.

Table 5-1 Food items in the diet of Andean bears in the Pusupunko area, within the home ranges of the radio-collared bears.

Food Items		Scat	Direct Feeding sign	Indirect Feeding sign	Reported use
Bromeleacea					
	Puya atra	X	X	X	X
	Puya sp.	X	X	X	X
	Tillandsia rubella	X	X	X	X
	Tillandsia sp.	X	X	X	X
	Gregia kessleri		X	X	X
	Gregia sp.		X	X	X
Ericacea					
	Gaultheria glomerata			X	X
	Pernettya prostata			X	X
	Gaultheria vacciniodes	X	X	X	X
Laureacea					
	Nectandra cuneatocordata	X	X	X	X
Rosacea					
	Prunus brittianus		X	X	X
	Hesperomeles ferruginea			X	X
	Hesperomeles lanuginosa			X	X
	Rubus bullatus			X	X
Compositae					
	Pentacalia orinocensis		X		
Saxifragacea					
	Ribes bolivlanum			X	X
Symplocacea					
	Symplocos cf. cemua	X	X	X	
Clethracea					
	Clethra sp.		X	X	
Graminacea (unidentified grass)		X			
Cryptogam (unidentified moss)		X			
Animals					
	Bos taurus	X	X	X	X
	Equs calabus	X	X		X
	Birds	X	X	X	X
	Rodents	X	X	X	X

The table includes confirmed, suspected and possible food items. Crosses indicate that evidence of feeding came from the following sources: presence of item in scats, of direct feeding sign such as repeatedly climbed trees, torn plants, remains of the food item in caves or nests or broken branches associated with other bear sign such as hair, or indirect feeding sign such as repeatedly climbed trees or bear trails meandering through a patch of this resource. An additional column indicates that local informants have reported use this food item by bears in the area.

Table 5-2 Possible additional food items[5] in the diet of Andean bears in the Pusupunko area.

Possible additional food items	Indirect feeding sign	Reported use
Earthworms	X	
Grasshoppers	X	
Eggs	X	
Moths		X
Other ungulates	X	
Mushrooms	X	
Clusia sp.		X
Bambusoidea in Tojoloque area		X *
Eryngium rauhianum		X *
Gregia kessleri		X *
Vaccinium floribundum		X **
Pernettya prostrata		X **
Cecropia sp.		X

* food items identified in the study area by Isaac Goldstein on a survey of the area in August 2000
** food item present in the study area and found to be eaten by bears in Cochamamba (Azurduy, 2000)

Crosses indicate that evidence of feeding come from indirect sign such as ambiguous claw marks (possibly not associated with feeding) or, in a separate column, from reports by local informants.

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[5] Following, a brief justification for including resources as possible additional food items.

Earthworms-Large earthworms (i.e. >80 centimetres) are common in this area. In the rainy season these worms rise to the surface of the soil to avoid drowning. They must provide a nutritious food resource for many animals. On several occasions I saw turned up earth in association with other bear sign, and yet never found any remains in scat.

Grasshoppers- In December 1998, during a sunny day in the rainy season, I observed the adult bear watching the ground and pouncing repeatedly in the grassland before disappearing into a complex of rocky outcrops. At this time the grasshoppers were unusually abundant. No scat was found.

Eggs- In August 1998 I watched the adult bear at close range. He was extremely attentive to the activities of a mixed flock of frugivorous birds that alighted several times in the tree in which he was sitting. He seemed to stalk the birds, although he had no success in killing any while I watched. Being attentive to birds would lead bears to eggs. Eggs are easy to eat, may be relatively easy to find and obtain by arboreal animals, and represent a complete source of the nine amino acids essential for tissue maintenance (Schaller et al. 1989). Captive bears readily eat eggs without consuming the shell, so it is likely no remains would be found in the scats of wild bears either.

Moths- Grizzly bears are known to subsist and even gain weight eating nothing but moths. Moths were very plentiful in the study area particularly in the dry season.

Other ungulates- Some of the bones of a medium sized ungulate (possibly Andean deer, *Hipocamelus antisensis*, or white-tailed deer *Odocoileus virginianus*) were found in a cave used extensively by bears.

Mushrooms and other fungi- are abundant in the forest during the rainy season. A patch of large and conspicuous mushrooms was cropped by an animal in the days during which the adult bear was in that area of the forest. No tracks, hairs or other sign of any animals were identified.

Other possible food items have been identified by field researchers subsequent to this study: These include a large bambusoidea species in the area of Tojoloque and ***Eryngium rauhianum***, (Goldstein 2000). Carola Azurduy and Ximena Velez identified two food items in the Rio Jacinto drainage of Cochabamba , Bolivia that were abundant in the study area (Azurduy 2000).

Orchid pseudobulbs were reported as eaten by bears in Peru (Peyton 1980), but though there were at least three species of terrestrial orchids in the area, I saw no sign of them being consumed by bears. Similarly, feeding was reported on the **segmented bamboo** *Chusquea* sp., a plant highly abundant in Pusupunko, but no sign of its being used as a food item was identified (Eulert 1995).

A total of 181 scats were found during the study period. Only 66 of these are considered to represent different feeding episodes (Table 5.3). The remaining 115 scats were found with many others of a similar age and composition, and considered to be the result of one feeding episode. Using ocular estimates, the remains of one type of food comprised at least 95% of the volume of most scats. Meat scats all contained some plant fibre. The only other scats of a more diverse composition found (*n*=2) contained both *Puya* and berries.

Bromeliads were the most common food item identified in scats, even when only counting one scat per feeding bout. More than half of the scats found were comprised completely of bromeliad fibre. The next most frequently occurring food item in different feeding bouts was fruit, followed by the remains of the meat of cattle, horses, rodents or birds. When basing the frequency of occurrence on all scats encountered, meat ranks higher than fruit. In any case, the bears displayed an omnivorous diet heavily based on plant matter.

Table 5-3 Frequencies of occurrence of food items in the total number of scats found in the study site and adjusted using the feeding episode as the sample unit. [6]

Food Item	Frequency of occurrence in all scats encountered (*n*=181)	Frequency of occurrence using feeding bout as sample unit (*n*=66)
Puya spp.	60.77%	34.8%
Tillandsia spp.	7.18%	19.7%
Ericacea	9.94%	27.3%
Tree fruits	3.31%	9.1%
Livestock	17.13%	4.5%
Rodents	1.10%	3.0%
Bird	0.55%	1.5%

Five bear latrines, containing scats from multiple defecations and of varying ages, were found. All were in the ecotone; three were located outside caves, and two near depressed

[6] Only two scats were not comprised solely of one type of food; they were part *Puya* and part *Gaultheria vacciniodes*. In the above chart, one was attributed to each category. Scats containing tissue and hair also contained fibre of Bromeliad or, in the case of the scats resultant from feeding on dead cows, unidentified plant fibre that looked like hay. For the above chart, these scats were counted as the animal they contained.

vegetation, indicating a daybed or resting place. They varied in volume from approximately 1 to 6 Litres. Multiple defecations were also found near carcasses that were consumed by bears, but they were not classed as latrines, but as indicative of one feeding bout. Goldstein also found scat piles in Venezuela that varied from 0.5 to 8.0 Litres (1986).

5.3.2 Interpretation of diet from scat

The influence of the following variables on the decomposition rates of bear scat was evaluated using a generalised linear model (Table 5-4): the ID of the original scat before it was divided into three parts; type of scat (*Puya* or assorted); habitat type (grassland, grassland/forest ecotone, or forest); and season (rainy, dry, or cross-season, i.e. spanning all or part of both 6-month seasons). The final model includes all terms evaluated: ID, the type of scat, the habitat and season.

Table 5-4 Variables influencing the number of weeks until scats were unrecognisable.

Parameter	Coefficient estimate	Deviance	Dispersion	d.f.	$\chi 2$	P
Scat ID	-0.0110	-0.44	1.16	4	-0.379	NS
Type of scat	-0.794	93.80	4.57	2	20.525	$P<0.001$
Habitat type	0.4057	15.70	1.68	2	9.345	$P<0.01$
Season	-0.1779	67.87	3.61	2	18.80	$P<0.001$

A generalised linear model with Poisson errors and corrected for overdispersion was fitted to the number of weeks until scats were unrecognisable. "Deviances" refer to changes in deviance obtained when dropping significant terms from the model or including nonsignificant terms.

The identity of the original scat was not significant in explaining the variance in the model, but the type of scat was. *Puya* scats decomposed and became unrecognisable much more slowly than scats of other composition (Figures 5-2 and 5-3). The *Puya* scats tested were all similar in consistency. Of the mixed scats, the meat scat decomposed and became unrecognisable most rapidly, followed by the *Gaultheria vacciniodes* scats. The *Tillandsia* sp. scats took longer than the others in both seasons, though not as long as *Puya* scats.

All types of scat became unrecognisable most rapidly in the forest. This was, in many cases, because leaf litter accumulation hid the scat from view, but also because of increased rates of decomposition due to moulds and fungi. Despite the potentially degrading effects of the direct sun and direct exposure to rain, scats became unrecognisable most slowly in the grassland. Results for the ecotone were more similar to those for the grassland. Season was another significant explanatory variable in the model, scats of both types becoming unrecognisable most rapidly in the rainy season (Figure 5-2).

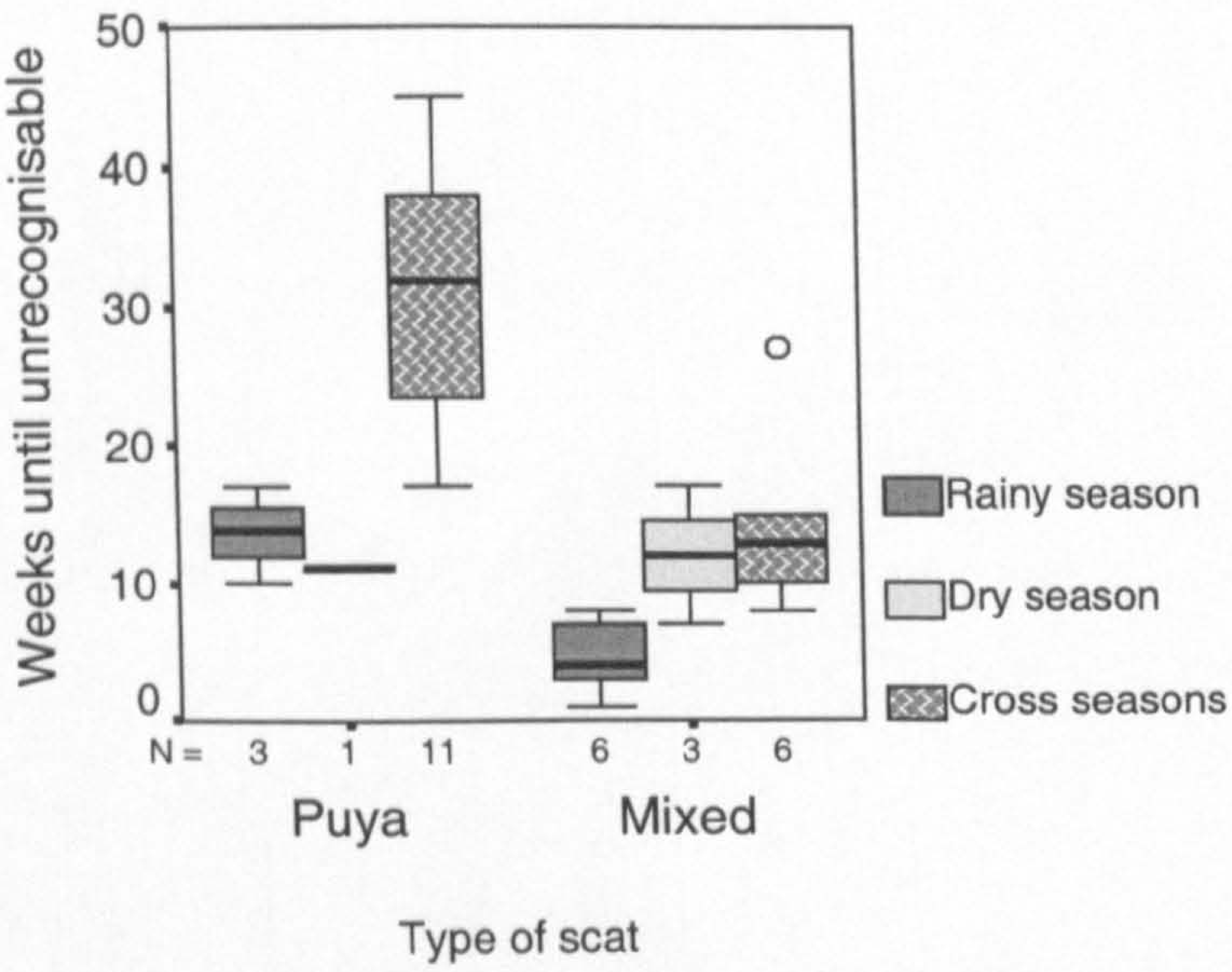

Figure 5-2 Comparison of the weeks until unrecognisable for *Puya* and mixed scats in different seasons, showing median, interquartile range and outliers.

Season was another significant determinant of scat decomposition rate (Figure 5-3). Eleven of fifteen *Puya* scats lasted through from one season into the next. Only one became unrecognisable in the dry season, and that was because it was obscured by a large clump of moss, which fell in the forest. The mixed type of scats decomposed faster in the rainy season, with a median time of four weeks, as opposed to eleven weeks in the dry season and twelve weeks in the cross-season period. The outlying point in the decomposition of the mixed scats was a scat of epiphytic bromeliad in the grassland, which held together for 28 weeks.

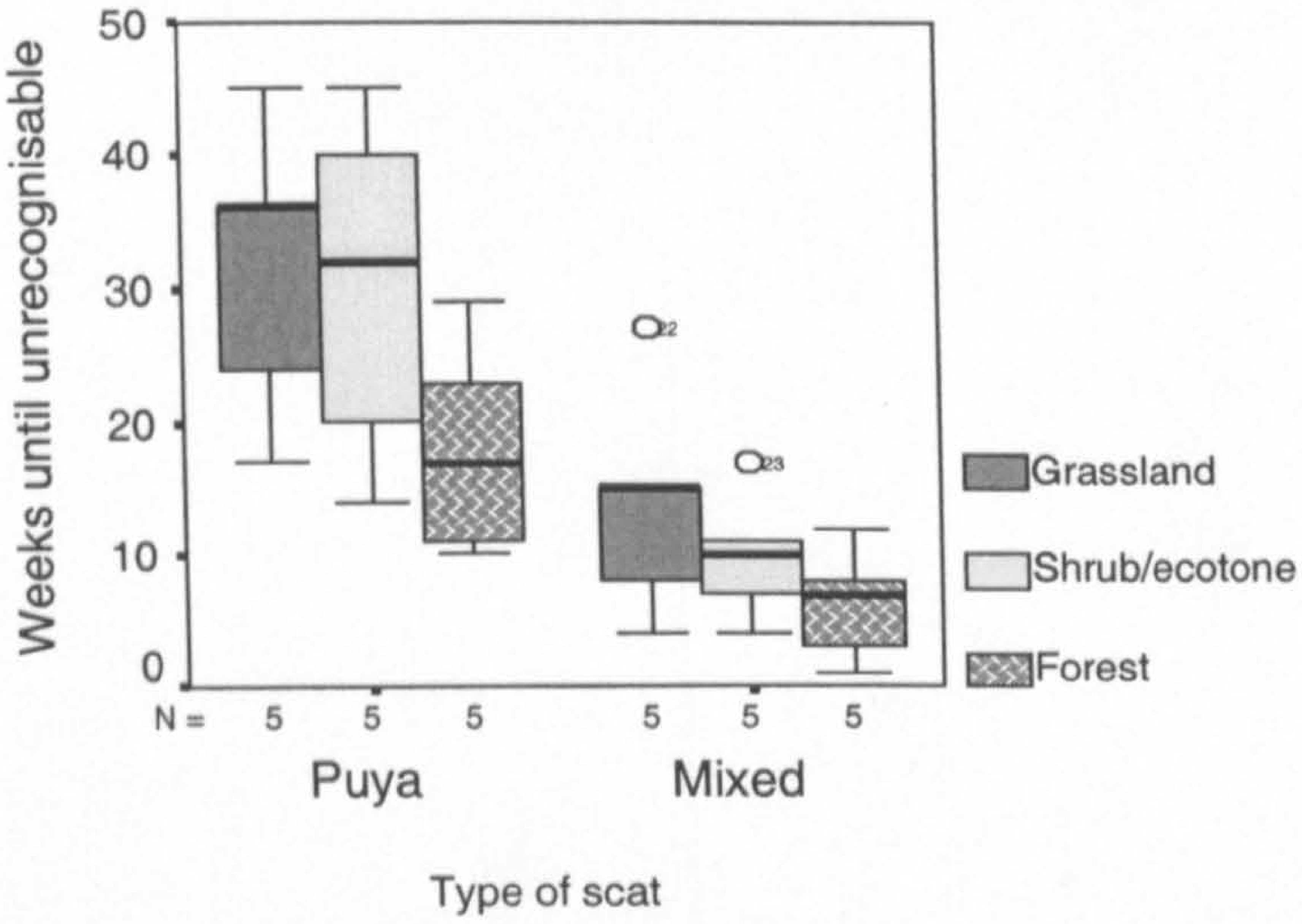

Figure 5-3 Comparison of the weeks until unrecognisable for *Puya* and mixed scats in different habitat types, showing median, interquartile range and outliers.

The decomposition of one final scat found in June 1998 was observed, though it was not included in the model, due to not having been found fresh. The scat was composed entirely of the large seeds *Symplocos cernua.* These were divided into sample piles (8 seeds per sample) and set aside for the experiment. The pile of these conspicuous seeds in the grassland was still recognisable 60 weeks (14 months) later, whereas the seeds in the shrubland and those in the forest were unrecognisable much sooner, in 21 and 17 weeks respectively. None of the seeds germinated in any of these settings during the time of the study.

5.3.3 Phenology and seasonal variation in diet

The ten species monitored showed staggered fruiting peaks throughout the year (Table 5-5). The data illustrates that plant part production is not synchronous in the study area.

Table 5-5 The staggered flowering and fruiting of ten species of plants within the study area.

	Rain			Dry season						Rain		
	J	F	M	A	M	J	J	A	S	O	N	D
Pentacalia orinocensis	FRUIT	FRUIT	FRUIT	flower	flower	FRUIT	FRUIT	FRUIT	FRUIT	FRUIT	FRUIT	FRUIT
Gaultheria vacciniodes	flower	flower	FRUIT	FRUIT	FRUIT	v	v	v	v	flower	flower	flower
Herperomeles lanuginosa	flower	FRUIT	FRUIT	FRUIT	FRUIT	FRUIT	FRUIT	FRUIT	v	v	flower	flower
Ribes bolivianum	flower	flower	FRUIT	FRUIT	FRUIT	FRUIT	v	v	v	v	v	v
Polylepis racemosa	v	v	flower	flower	FRUIT	FRUIT	v	v	v	v	v	v
Rubus bullatus	v	v	v	flower	flower	flower	flower	FRUIT	FRUIT	FRUIT	FRUIT	v
Puya atra	v	v	v	flower	flower	flower	flower	?	?	?	v	v
Prunus brittonianus	v	v	v	v	flower	flower	flower	FRUIT	FRUIT	FRUIT	v	v
Schefflra sp.	v	v	v	v	v	flower	flower	FRUIT	FRUIT	FRUIT	FRUIT	FRUIT
Clusia sp.	FRUIT	v	v	v	v	v	flower	flower	FRUIT	FRUIT	FRUIT	FRUIT

Flowering and fruiting were spread throughout the year for the species monitored, but looking at numbers of species in each phase per month, clear peaks and troughs did arise (Figure 5-4). The majority of the species monitored seemed to maximise vegetative growth during the rainy season. Flowering was most prevalent during the dry season. More species were in fruit during August through November (at the end of the dry season and beginning of the rainy season) than during or just after the rainy season. Nonetheless, rainy season fruiting was observed in some species, such as *Clusia* sp. and *Pentacalia orinocensis*.

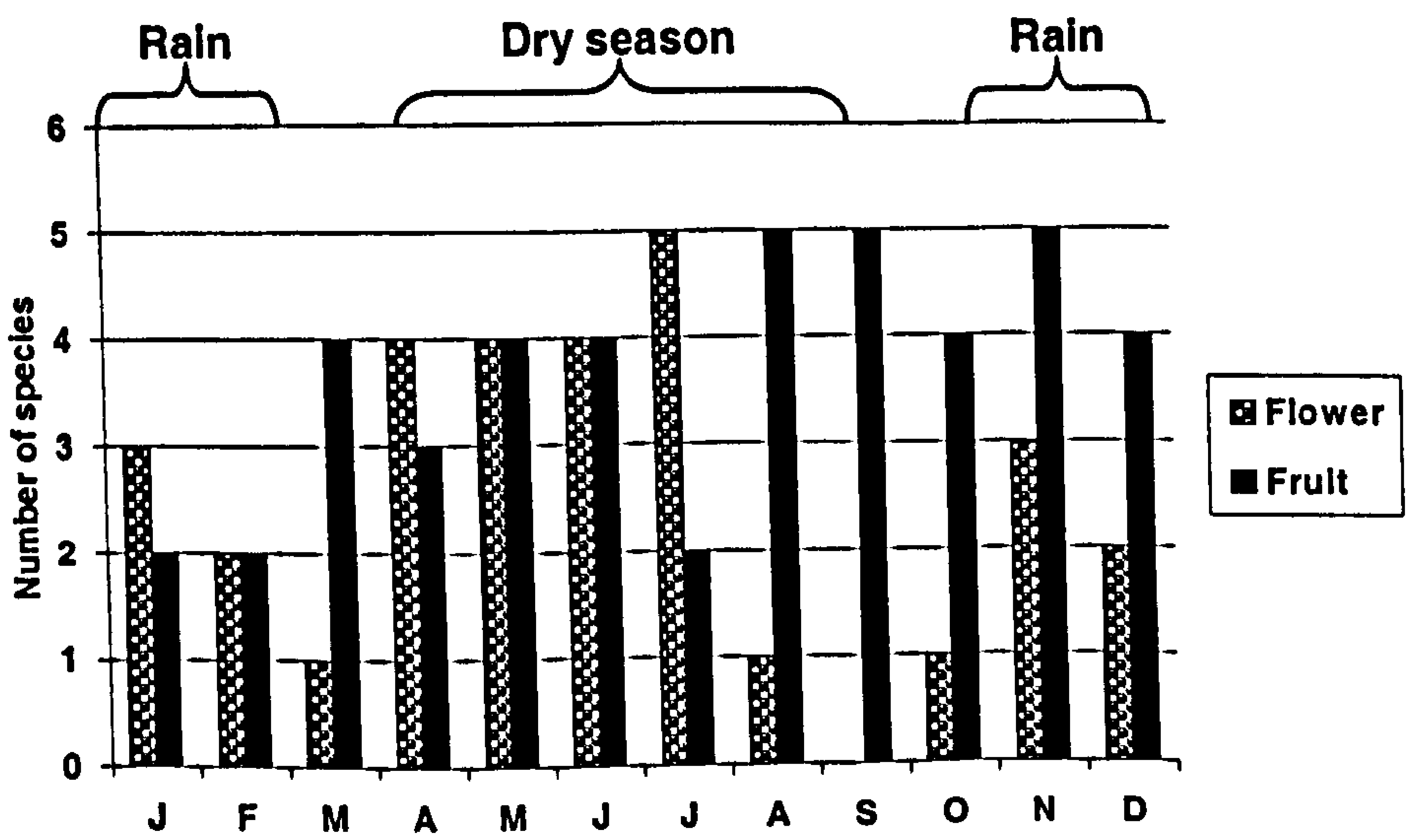

Figure 5-4 The number of monitored species that were sterile, flowering or fruiting per month.

A seasonal pattern appears when examining incidence of direct feeding sign and scats (Table 5-5). Bromeliads were consumed throughout the year. Berries were consumed from March until June. Tree fruit was consumed in the late dry season and early rainy season. Almost all of the evidence of feeding on animals occurred during the rainy season. Feathers were found in a scat at the end of the rainy season in April.

Table 5-5 Pattern of consumption of food types by months as evidenced by scat and direct feeding sign.

	Rain				Dry season					Rain		
Food type	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bromeleacea	X	X	X	X	X	X	X	X	X		X	X
Ericacea			X	X	X	X						
Tree fruit						X	X	X	X	X		
Animals	X		X	X						X		X

5.3.3 Nutritive analysis

The nutritive value of the Bromeliads tested was conspicuously low (Table 5-6). The samples were generally rich in fibre, but poor in readily digestible cell content such as proteins, fats and carbohydrates. The exception was the gelatine of *Puya atra,* which was markedly lower in fibre than the leaf bases, but higher in fat and Nitrogen Free Extractives (NFE). Soluble carbohydrates or sweet sugars are the most highly digestible components of the NFE. The gel also showed high levels of these soluble carbohydrates (16.9%) relative to those present in the leaf bases (4.1%), indicating that different parts of the plant vary in nutritive value.

In order to compare the nutritive value of Bromeliads with that of other food items, overall digestibility can be roughly estimated using coefficients derived from other ursids: protein and fat are 90% digestible; NFE is 80% digestible; and fibre is 20% digestible (McDonald et al. 1981). According to this algorithm, the tested sample of *Gaultheria vaccinioides,* an important food item for the bears in this study, was 85.6% digestible. The berry samples tested were higher in protein and much lower in fibre, resulting in a higher digestibility. In contrast, the high-fibre Bromeliads were much less digestible: *Tillandsia,* 22% and *Puya atra* 31.5%. Even the more nutritious gelatine exuded by *Puya atra* was only 44% digestible.

Table 5-6 Nutritive analysis of Andean bear foods. Figures given are in g/100g. [7] When multiple samples are analysed, the mean value is reported.

Sample	Source	Protein	Fat	NFE	Fibre	Ash
Bos taurus	USDA	47.6	50.2			2.2
Zea mays	USDA	13.4	4.9			2.6
Zea mays	Dierenfeld 1988	13.8		68.3	7.9	
Opuntia sp.	Dierenfeld 1988	5.2	2.6	61.2	14.0	17.0
Pernyetta prostata	This study	60.7	2.7	25.3	12.7	
Gaultheria vacciniodes	This study	27.8	3.3	38.9	11.1	
Rubus sp	Dierenfeld 1988	13.0		34.0	5.0	3.0
Bamboo	Goldstein, unpupl.	38.0		79.0	7.0	7.1
Chusquea sp.	Dierenfeld 1988	8.8	3.9	40.9	36.7	9.7
Tillandsia sp.	This study	3.8	1.0	16.6	74.4	4.3
Tillandsia sp.	Goldstein, unpupl.	7.3		64.2	20.5	8.0
Puya sp.	Goldstein, unpupl.	11.2		44.9	20.4	13.3
Puya atra gel	This study	1.9	4.2	37.3	53.3	3.3
Puya atra	This study	1.6	2.7	19.9	73.6	2.2

Another way to compare foods is using caloric value. For each food item, the digestible energy (DE in kcal) in a given amount of dry matter can be estimated by summing the portions of each macronutrient fraction (multiplied by its approximate caloric value and by its digestibility coefficient[8]).

[7] **Protein**-Crude protein as calculated from the nitrogen content of food. Includes proteins, amino acids, B-vitamins and nucleic acids. Amino acids are essential for body growth and maintenance (Schaller et al, 1985)
Fat- Crude fat obtained as ether extract. Includes fats, oils, waxes, pigments, sterols and vitamins A, D, and E.
Nitrogen free extractives- NFE can contain sugars, fructans, starch, and pectins, amongst many chemicals and water-soluble vitamins. It may also contain differing amounts of cellulose, hemicellulose and lignin. It is calculated as the sum of the amounts of moisture, ash, crude protein, ether extract and crude fibre.
Ash- Ash is an indication of the inorganic constituents of the food. Includes major salts and minerals calcium, potassium, magnesium, sodium, phosphorous, sulphur and chlorine as well as trace elements such as zinc, iron, selenium, and iodine.
Fibre- Polymers that are unavailable to mammalian digestive enzymes and are therefore largely indigestible to non-ruminants. It is comprised of cellulose, hemicellulose and lignin.

[8] Caloric values come from human studies and are adjusted for estimates of digestibility. Values do not, therefore, represent total combustion. However, Andean bears' ability to extract energy from food may be less than is indicated by the digestibility estimates used in the calculations (Goldman et al. 2001) – this in turn compensates for the low caloric values used.

$$(\%\ \text{Protein})(4\ \text{kcal/g})(0.90) + (\%\ \text{Fat})(9\ \text{kcal/g})(0.90) +$$
$$(\%\ \text{Fibre})(4\ \text{kcal.g})(0.20) + (\%\ \text{NFE})(4\text{kcal/g})(0.80) = \text{kcal/g in the dry matter}$$

When foods have a low energy density like these Bromeliads, an animal is forced to consume larger quantities in order to fulfil energy requirements (Figure 5-5). The optimal diet for captive Andean bears is estimated at 3100 to 5700 Kilocalories per day, based on a weight range from 60 to 140 Kg (Dierenfeld 1988). A wider range of bear weights has been observed in the wild (35 to 200 Kg) (Peyton 1987). Both individuals in the present study fall at the lower extreme of the scale (at least at the time of capture in the case of the subadult). Following the same equation,

$$140\ \text{kcal}(\text{body mass})^{0.75}$$

their energy needs for maintenance would be met with 2100 kcal/day.

We can also estimate the quantity of fresh food, if eaten exclusively, that would be required to meet caloric requirements of a 35kg bear (Figure 5-5). The energy needed per day is divided by the percent dry matter of the food multiplied by the digestible energy (DE in kcal/g) in dry matter of the food. For example, beef provides 5.78 kcal/g of energy in dry matter and is 39.6% dry matter (i.e. beef is 60.4% water).

$$\frac{(2100\ \text{kcal/day})}{(0.396)\ (5.78\ \text{kcal/g})} = 917.5\ \text{g}$$

Hence, a 35 kg bear's daily requirement can be met with less than a kilogram of fresh beef, or 2.6% of its body weight. Because the bromeliad samples in this study were analysed dry, the percentage of water in the samples must be estimated and 75% was chosen as a conservative estimate (*Puya* sp. leaf bases samples may contain as much as 90% water (Azurduy 2000)). Even with this conservative estimate, a 35 kg bear would need to consume four to eight kilograms of fresh *Puya* (depending upon the nutritive value of different samples) or 11.4% to 22.8% of its body weight.

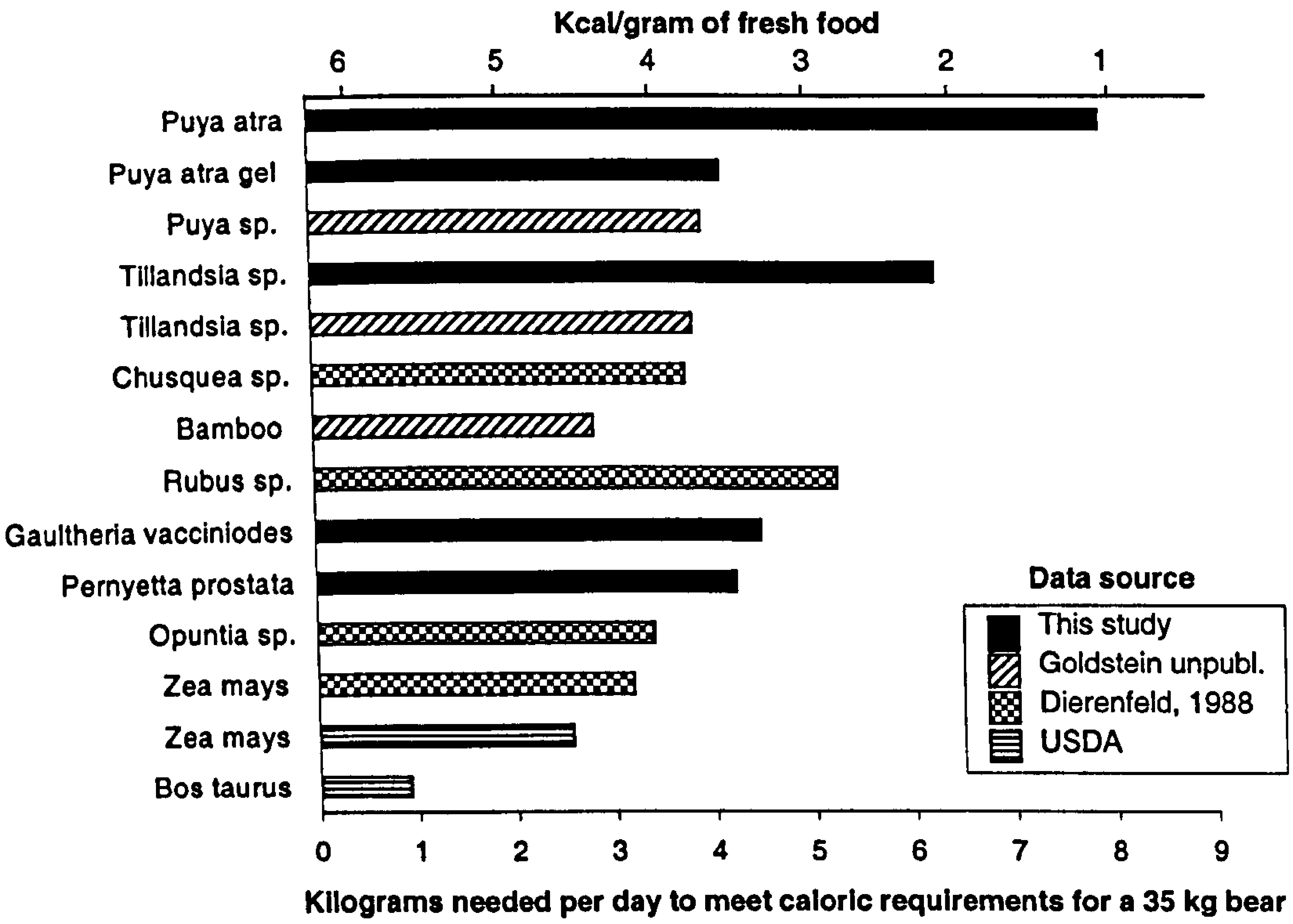

Figure 5-5 Relative caloric values of Andean bear foods. On the top x axis is the estimated caloric value of each food in kilocalories per gram of dry matter. On the bottom x axis is Kilograms of each food necessary to fulfil the daily requirements of a 35kg Andean bear. The differences in estimates from the various sources are the result of differences in sampling and analysis techniques.

5.4 DISCUSSION

This study has presented a profile of the feeding ecology of Andean bears in the Pusupunko study site. Andean bears in Apolobamba were observed to have a varied, omnivorous diet that tallied closely with the list of food items collected from interviewees. Bears were observed to depend heavily on Bromeliads throughout the year. Feeding on berries and tree fruits varied seasonally according to the fruiting phenology of the environment. The consumption of meat, which was of obvious importance to bears due to its high nutritive value, was also shown to be somewhat seasonal.

5.4.1 Described and observed diet

Bear food habits, as described by interviewees corresponded closely to evidence found in the field (Chapter 4)(Table 5-1). The described importance of Bromeliads, fruit and meat was verified. The majority (77%) of food items identified in the field were separately identified by interviewees, and of those three that were not, two were small quantities of grass and moss consumed while eating meat. The total list of bear foods as described by interviewees was more extensive than that compiled from direct feeding sign and scats. Unless this was the result of insufficient research effort, it would appear that Andean bear diets vary annually according to availability of high-energy foods. Much of the information about ecology given by interviewees related to feeding on crops, which was not witnessed in this study site (but see Chapter 8). However, in general, concordance between observed and described bear foods was high. These data collectively suggest a high awareness of bear habits amongst people in Apolobamba.

The diet of Andean bears in Apolobamba, as confirmed by scats, was more limited than diets described in Peru (Peyton 1980) and Venezuela (Goldstein 1986). Both of these studies, however, encompassed a wide range of habitats and geographic extent. Although Andean bears as a species have been shown to be opportunistic omnivores and to exploit an extensive and diverse variety of food resources throughout their range (Dierenfeld 1988), bears in each site would be expected to consume only a small subset of this overall variety. Furthermore, because of the differences in faecal decomposition rates, and in the habitats and seasons in which scats are deposited, the record of scats found is unlikely to be fully representative of what bears were consuming in any given year. In order to make a rough comparison between the diets of Andean bears in different locations, I divided food items into Bromeliads, other plants including fruit, and animals (Table 5-7). Although the proportions of food groups in the diet vary across the study, the consumption of Bromeliads emerges as an important component of bear diets in most sites.

Table 5-7 Percent composition of Bromeliads, other plants and fruit and animals in Andean bears scat from eight sites.

Site	Bromeliads	Other plants including fruit	Animals	Source
Venezuela, multiple sites	43%	57%	-	Goldstein, 1986
Colombia, check	90%	10%	-	Rodriguez, 1985
Ecuador, Antisana	~84%	~10%	~6%	Suarez, 1985
Peru, multiple sites	13%	75%	12%	Peyton, 1980
Rio Jacinto, Bolivia	59%	35%	6%	Azurduy, 2000
PN Amboro, Bolivia	34%	61%	5%	Eulert, 1995
Bolivia, La Paz	~60%	~40%	-	Yañez, 1995
Bolivia, Apolobamba	68%	13%	19%	This study: all scats
Bolivia, Apolobamba	55%	36%	9%	This study: adjusted

The food items consumed in all of these studies are derived from ocular percentage estimates except Peyton and Azurduy who use percentage of total volume.

5.4.2 The role of bromeliads

Bromeliads are of great importance to bears in this study. All bears are non-cecal monogastrics, lacking the adaptations for the digestion of fibre used by most herbivores such as fermentation aided by bacteria or protozoa or specialised mechanical grinding (Macdonald, 1995). Because of their inefficient digestion of fibre, it may be stressful for Andean bear populations to subsist entirely on Bromeliads, or on the leaves and stalks of other plants (Welch et al. 1997) (Goldman et al. 2001). Nonetheless, from the data thus far available, it seems that Bromeliads, despite being a low-energy food, may be sufficient to meet an Andean bear's nutritive requirements for long periods of time, similar to the way in which bamboo meets the needs of the panda. This is due to their abundance and the ease of consuming large quantities in a short time. Even for the predaceous brown bear, grass represents a similarly stable and predictable food resource, which sustains them through times when higher energy foods are unavailable (Craighead and Mitchell 1982).

Patterns of exploitation of these terrestrial Bromeliads seem erratic, with many plants remaining untouched between those that are chosen for consumption by bears. Bears are described as never exploiting more than approximately 10% of *Puya* available in Venezuela (Lozada 1990). Three possible explanations arise for this pattern. The first is that bears are selecting on the basis of ripeness, as detectable by smell or appearance. The second is that they make choices based on the chemical makeup of each plant, because individual plants differ in palatability. If either of the former two explanations is correct, the samples tested may not be representative of the more nutritious plants that the bears actually choose. A third possibility is that bears stop and eat periodically as they travel and that exploited plants are simply those that happen to be in the bear's path when it comes time to eat again.

Macronutrient levels in all of the Bromeliad samples analysed were low. The samples analysed in Venezuela were consistently higher in nutritive value. It may be that in our study the wrong portions of the plants were analysed and that more protein and other macronutrients are available in the leaf base core. Another possibility is that the samples were attacked by fungal or microbial deterioration, which would have diminished the cell content in the samples analysed, and thereby raised proportionately the fibre levels. This would have caused the samples to appear lower in nutritive content than they would if analysed fresh or preserved perfectly.

It is notable that the fruits analysed were relatively high in crude protein. While berries and other fruits may have higher levels of macronutrients and digestibility than Bromeliads, they are also more widely spaced and less is consumed in each bite.

5.4.3 The role and seasonal availability of fruits

Forest fruits have been suggested to be the most important food resource for Andean bears (Peyton 1995). While berries were found to be an important seasonal food, limited evidence of bears feeding on other fruits was found in this study. However, bears at the Pusupunko study site may have been exploiting more sources of fruit than those identified. Andean bears have been described as congregating in groups of as many as nine individuals to exploit a rich food source (Peyton 1999). This fluid response to concentrated food sources, termed "ecocentres", has been witnessed in brown bears (Craighead and Mitchell 1982), American black bears (Beeman and Pelton 1980), and polar bears (Stirling 1984). Fruiting trees such as Laureaceas and *Ficus* spp, another common and important food resource in the tropics, may well serve such a purpose in the lives of Andean bears (Peyton 1995), though no evidence of such large groups of bears feeding together was obtained during this study.

In the eastern slopes of the Andes in Peru, where the weather follows much the same pattern as in Bolivia, plants are described as producing fruits after the winter rains that fall between November and March (Peyton 1980). On the basis of this study in Peru and of conversations with local botanists, I expected the main fruiting peak to occur after the rainy season, and that as a result, the consumption of fruit by bears would be highest at this time. Surprisingly, fruiting peaked at the end of the dry season and beginning of the rainy season. In Central America, the main peak of fruit production occurs during the dry season (Morton 1973). This is thought to be caused by a competitive need to maximise vegetative growth during the rainy season (Janzen 1967).

Even though the species monitored did not display a peak in fruiting during the rainy season, parrots (*Amazona mercenaria* and *Pionus tumultuosus*) and mixed flocks of frugivorous birds (e.g.

Anisognathus igniventris and *Buthraupis montana)* were observed most frequently at the study site during the rainy season from November – February, suggesting that key species exploited by these birds were indeed fruiting at the height of the rainy season.

The phenology data collected were not structured to take into account relative abundance or relative biomass of vegetative or reproductive plant parts. They simply give an indication of the periodicity of phenophases. This is not necessarily a good representation of overall fruit production or how it is used by bears. There are several reasons for this: the subjective selection of the species chosen for monitoring; the lack of species from lower down in the bears' home ranges; the preponderance of grassland and ecotonal species; and the disturbance of *El Niño* to the entire plant and animal community. Nonetheless, the data were sufficient to illustrate that, overall, fruit is relatively constantly available throughout the year, and that fruiting peaks did occur. This pattern is supported by the year-round presence of frugivorous birds in the area and the observed rolling cycles of fruiting and flowering displayed by non-monitored plants.

An event of the southern oscillation, or *El Niño*, occurred during 1997-1998. These climatic events have a strong 24-month periodicity, creating a tendency towards dry sunny years that enhance fruit production, followed by wet cloudy years that reduce it. This fluctuation in fruiting has been shown to limit frugivorous mammals on Barro Colorado Island in Panama (Wright et al. 1999). Fruit production in the tropics is known to be much less predictable than in temperate climes, and never more so than during El Niño years (Kricher 1997). Long-term phenology and weather data were not available, however, and it is likely that the unusual weather experienced during the study would have had an impact on fruit availability.

5.4.4 The role of meat

Bears are blamed for depredation of livestock throughout the Andes (Mondolfi 1989; Peyton 1999). There is debate about whether or not they kill the animals they are often found consuming (Pyke et al. 1999; Peyton 1999)(see Chapter 8). In any case, the nutritional and gustatory value to bears of these animals is indisputable. When meat was placed in an open habitat, upwind of the bears, the response was rapid[9], which supports the idea that bears may be very skilled scavengers. In an environment where Andean foxes and Andean condors are competing for these valuable resources, it is important to detect a carcass quickly and arrive there before the meat is consumed. Bears seem well equipped to do this, and may also, as local people believe (Chapter 4), be able to scare away a fox or condor from a carcass and even to steal kills directly from pumas. As in other areas, scavenging of livestock in Apolobamba seems to represent an important food resource for bears where their home ranges overlap with grazing areas (Peyton 1999; Pyke et al. 1999; Mondolfi 1989).

The fact that livestock meat seems to be more available in the rainy season is probably related to two main factors. First, the steep terrain is more dangerous in the rainy season and many animals slip or are frightened into falling by a passing bear. Second, herders visit the mountain grazing areas of their cattle on a much less frequent basis during the rainy season. Most births of calves occur during the rainy season, and stillborn and weak animals are another attraction in these months. The fact that the hairs and bones of a small rodent and vizcacha *(Lagidium peruanum)* were also found in the rainy season is less easily explained (unless the animals were affected adversely by the heavy rains). As previous authors have noted about animals' remains in Andean bears scats, it is impossible to know whether they were killed or scavenged. Food items of animal origin seem to represent a helpful source of

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[9] During the trapping phase of the project, beef was found to be the most effective bait. To explore the attraction of bears to beef I placed a chunk of cow meat (approximately 500g) in an open area when the two radiocollared bears were at least 1.5 km away in the next valley. In the first such trial, the subadult took the meat within 16 hours. On the second occasion, the adult ate the meat within 5 hours. The third time the meat was taken by a condor *(Vultur gryphus)*, but the adult bear travelled to the site to investigate, arriving about 15 hours after the vulture departed. Other meats did not seem to have the same appeal for bears. Dried and fresh fish were used because of their strong smell, but though they were tasted and pulled apart, they were not consumed. Vicugna *(Vicugna vicugna)* meat, thought in the past to be a food item for bears (Tschudi 1844), was similarly investigated by bears, but was ultimately not eaten. However, dried alpaca meat re-hydrated was consumed by bears on five occasions.

protein for this bear population. The low nutritive quality of Bromeliads and the patchiness of higher quality fruits, highlight the attractiveness of highly nutritious anthropogenic food sources such as maize and cattle which, once accessed, are available in high concentrations.

In October, 1998, the adult bear, M2, killed and consumed the viscera of an orphaned bear cub with which an effort at rehabilitation and reintroduction was being carried out at the Pusupunko Study Site (Paisley 1999). This is the first documentation of infanticide in this species, although this phenomenon is recognised in American black, brown and polar bears. One of the reasons that male bears are thought to kill cubs is as a source of food (Taylor 1994).

5.4.5 Feeding ecology in Apolobamba

There is conflicting evidence about the overall quality of the habitat for bears in Apolobamba. The best habitat for Andean bears is assumed to be within a 500-1000m wide elevational band, comprised of cloud forest between 1000m and 2700, depending on latitude (Peyton 1999). In Apolobamba, however, much of the bear feeding sign found was in the grassland or the grassland/forest ecotone. However, a bias existed towards food items that occur in the upper altitudinal reaches of the bear habitat, due to the easier access in those areas and the increased probability of locating scats in the grassland. Nonetheless, in a recent survey of the Pusupunko study site and several other sites in Apolobamba, the grassland and grassland/forest ecotone were described as containing an extraordinarily high number of available food resources for bears while the forest was termed "extremely poor" (Goldstein, 2000). During the study period, although epiphitic Bromeliads were conspicuous and abundant, fruiting trees were rarely found in the forest. This poses the question of whether bears may actually be dependant on these upper regions of grasslands and grassland/forest ecotone for vital resources. Livestock was another resource found to be concentrated at these higher altitudes.

The Pusupunko study site is the uppermost and westernmost limit of the local range of Andean bears. Bolivian botanist Emilia Garcia, who carried out the studies of the site's flora in October 1999, described Pusupunko as diverse (a preliminary list includes 120 species), particularly the grasslands and open areas (Garcia 2000). Moreover, out of nine surveyed in

Apolobamba, the site was found to be the most diverse and least disturbed area for birds (Sargot 1999). The area does show signs of slow recovery from anthropogenic alteration (Garcia 2000; Sargot 1999). Some fields are abandoned and grow wild, whilst other grassland areas are selectively burnt. The resultant mosaic of habitats may, as in other sites, increase the amount and also the variety of bear foods in the habitat (Mattson 1990). On the other hand, the stunted growth of the adult bear, M2, could be interpreted as an indication of low habitat quality at the site (Blanchard and Cipriano 1987; Stringham et al. 2001). Understanding how individual bears in Apolobamba utilise different habitat types is a complex question, which can be addressed using radio telemetry.

Although many questions remain unanswered about the long-term feeding ecology of Andean bears, this research has provided a context for the first study of the activity and movement patterns of free-ranging Andean bears (Chapters 6 and 7, respectively). Understanding the comparative value of different bear foods also serves as a background for the study of the conflicts between people and bears in Apolobamba (Chapter 8).

5.5 SUMMARY

1. Bromeliads were eaten throughout the year and comprised more than half of the diet, as observed from faecal analysis. Berries were eaten from March to June, and tree fruits were consumed from June to October. Evidence of feeding on animals occurred primarily during the rainy season.

2. The feeding ecology, as determined by this research, tallies closely with what was described during the interviews. Of twenty-five species reported as eaten by bears, ten were confirmed through scats and another three by direct feeding sign.

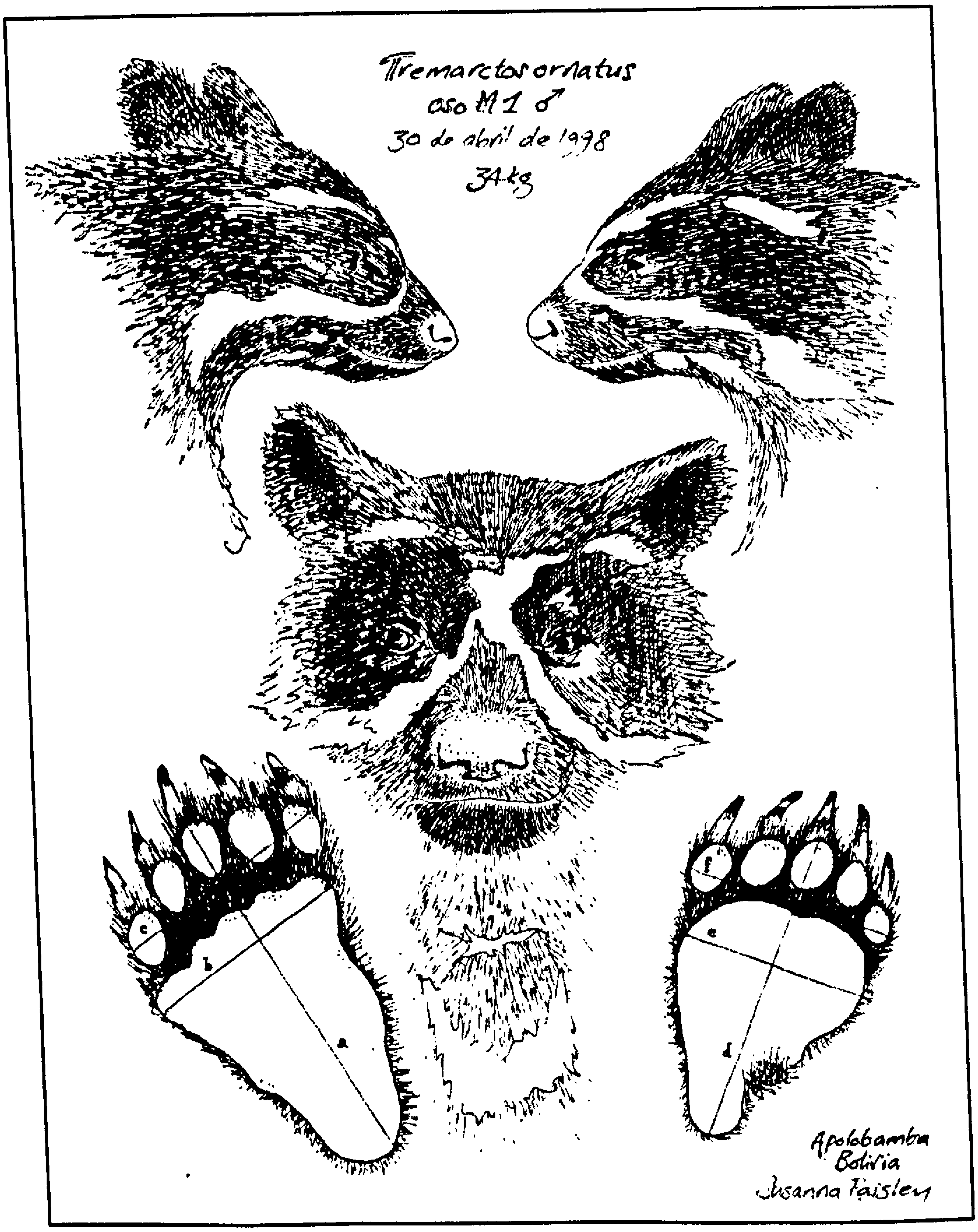
3. Faecal decomposition trials demonstrated that diet descriptions based on all located scat suffer from three sources of bias: scats decompose more rapidly in the forest than in the grassland, more rapidly in the rainy season than in the dry, and when composed of foods other than highly fibrous Bromeliads.

4. Flowering and fruiting was staggered throughout the year for ten species of plants monitored at the study site.

5. Bromeliads are abundant and plentiful, but of low nutritive value. Fruits are of higher nutritive value, but are a scarce and patchy resource consumed at low intake rates. Anthropogenic food sources such as maize and cattle are both high in nutritive value and, once accessed, available in high concentrations.

Chapter 6

Activity Patterns



The facial markings of the first bear radio collared, M1.

6.1 INTRODUCTION

The activity patterns of large carnivore species are key factors in determining the nature of their interactions with people and thus their conservation (Kellert et al. 1996). In North America this is exemplified by the relative tolerance of the primarily nocturnal puma in contrast to the crepuscular wolf and the largely diurnal black and brown bears. Despite the considerable threat that the puma poses to livestock and even human life it has generated a much less negative image and has subsequently been less persecuted than more easily observed wolves and bears (Kellert et al. 1996). Because diurnal animals are more persecuted, large carnivore species, including bears, have been shown to alter their activity patterns towards a more nocturnal habit in response to disturbance by humans (Kaczensky et al. 2001; Mattson 1990).

Motion-sensitive radio collars, developed in the late 1960's, provide a powerful tool for research into the activity patterns of free-ranging cryptic species (Garshelis et al. 1982). During the last 30 years numerous studies, most using radio-telemetry, have examined activity patterns of bears in northern latitudes. Results of this work have provided insights into the life history strategies of these northern bears, including their feeding efficiency, seasonal utilisation of food resources, social interactions, and their response to predators, competitors, and people. Until the 1990s, this sort of detailed direct research was entirely lacking for bears in the tropics.

The present study is the first to employ radio-transmitters to investigate the activity of wild-born Andean bears in situ. As with many cryptic species, Andean bears have been assumed to be largely or wholly nocturnal (Nowak 1991; Weinhardt 1993). Non-specialists have also assumed that they would, like many northern bear populations, hibernate (Allen 1992). Previous researchers have not used radio-telemetry to study wild Andean bears due to steep terrain, thick vegetation, and concern about political and drug-related violence within their range. Field biologists have described encounters with bears in the daytime (Peyton 1980; Velez and Azurduy 2000). Two captive-born and raised Andean bears were occasionally monitored using radio-telemetry during an attempted release in Macipacuna, Ecuador. While the activity patterns of these bears were generally irregular (Castellanos Peñafiel 1997) they did display two activity peaks, in the morning and afternoon.

6.1.1 Research questions and structure of chapter

Motion-sensitive radio-telemetry was used to address the following research questions:

- What are the basic activity patterns of Andean bears (diurnal, nocturnal, crepuscular or arrhythmic)?
- What are the daily time budgets of Andean bears and how do they compare with those of northern bears?
- Do Andean bears demonstrate seasonal variation in activity despite minimal temperature fluctuation throughout the year and the availability of bromeliads, an abundant year-round food source?

This chapter will describe, in turn, basic activity patterns, time budgets and seasonal variation in activity patterns of the study animals. These results will be discussed in terms of optimal foraging theory and compared to data from other ursids. The implications of these results for the interaction between Andean bears and people will also be discussed.

6.2 METHODS

6.2.1 Activity monitoring

Trapping began in September 1997, and the first bear (M1) was caught in April 1998, a one to two year old sub-adult male weighing 34 kg. The second bear (M2) was caught in June 1998, an undersized adult male weighing 30 kg, that was probably 4–5 years old or older based on cementum annulations and tooth wear. The bears were fitted with 150–151 mHz radiocollars (Advanced Telemetry Systems, Isanti, Minnesota) containing a vertically mounted tilt-switch type of instant activity sensor. The movement of 2 conductive brass balls inside a cylinder operated the switch. Any jerky or bouncing motion opened and closed the switch, thereby inserting extra pulses above the base rate of 65–66 pulses per minute (ppm) (sometimes >200 ppm).

The activity of the bears was monitored for at least one 24-hour period each month, through July 1999, except when they made forays outside the study area. Their activity was also monitored for shorter periods, while attempting to sample all hours evenly each month. Activity was often monitored from a 3900-m ridge bisecting the study area, from which the signals of both bears usually could be heard. During an activity monitoring session, radio signals were recorded for one minute every 15 minutes. Thus, for each hour there were typically four activity readings (sometimes less if the signal could not be heard).

Weather was recorded at the time of each activity reading. Cloud cover was described as: 1= no clouds; 2 = partial cover; or, 3 = very cloudy. Precipitation was recorded as: 1= no rain; 2 = rain within 24 hours; 3 = rain within 3 hours; 4 = drizzling; or, 5 = raining. The area was frequently misty, so drizzle was difficult to distinguish; thus, codes 1, 2 and 4 were later grouped and recoded as not raining. Codes 3 and 5 were grouped together as rain falling or having fallen in the last 3 hours. In order to examine the possible effects of precipitation on resting periods, rain was recorded as having fallen if rain had fallen anytime during the rest period.

6.2.2 Data analysis

Activity data were originally recorded as a continuous variable of 65 to over 200 pulses/minute. For analysis these data were recoded into a discrete binomial variable — 0 for inactive, 1 for active. To determine what types of signals represented activity, pulse rates were recorded while visually observing the two collared bears (n = 128; Figure 6-1). This was possible after M1's capture and recovery from anaesthesia and after two recaptures of M2. Their activity was recorded as resting, travelling, foraging or climbing. No clear differentiation in pulse rates was apparent between travelling, foraging and climbing, so all these activities were simply coded as active. Bears were always inactive when their radiocollars emitted signals of 65-67 ppm, and were always active when their signals exceeded 74 ppm. Between the range of 68–74 ppm bears were usually but not always active. Hence, a cutoff value of 69 ppm was selected to differentiate active from inactive (>69 pulses/min = active).

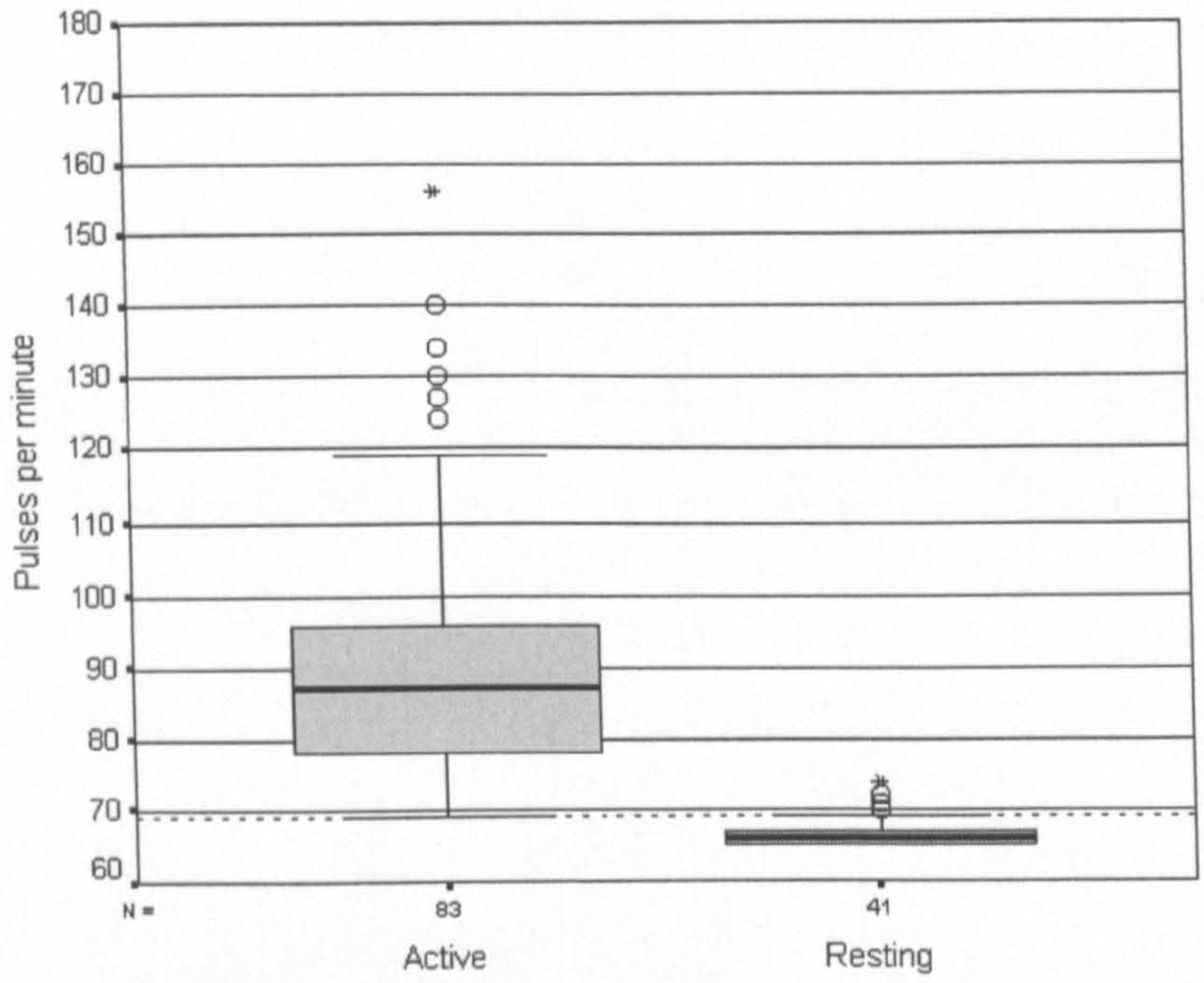


Figure 6-1 Pulse rates (pulses per minute = ppm) emitted by motion-sensing transmitters on two Andean bears while they were visually observed to be active versus resting (n = 128 observations). Plot shows median and inter-quartile range in box, and range and outliers outside box. The dashed line indicates the chosen cut-off point above which (>69 ppm) bears were classified as active.

To ascertain the daily activity pattern, the median pulse rate of the four samples collected within each hour was coded as either basically active or inactive based on the 69 ppm criterion for differentiating activity. All the ones and zeros were then tabulated, corresponding with each hourly increment from the various monitoring sessions. Thus an estimate of the proportion of time that each bear spent active during each hour was obtained. To estimate the daily time budgets of bears, the hourly values for proportion of time active were averaged among the 24 hours of the day, including only data obtained during complete 24-hour monitorings (n = 17). Time budgets were derived separately for each bear during each season and the two seasons were averaged to determine overall time budgets.

The lengths of resting periods were examined by looking at consecutive inactive readings during a monitoring session. In this analysis the pulse rate for each 15-minute interval was considered separately. To calculate daytime resting periods, the number of consecutive inactive readings (not interrupted by active readings) were measured, and the number of distinct resting periods that occurred during 1000–1600 hours. For analysis of daytime resting periods, the longest of these sequences of inactive readings were chosen. Night resting periods were longer and less interrupted by active readings. To ensure that the beginning and end of night rests were identified, inactive periods were only considered when they were that were preceded and succeeded by at least 2 hours of activity. After some experience, I learned when bears generally went to sleep and awoke, and monitored night rests accordingly.

Data collected in clumps are vulnerable to autocorrelation, which can lead to spurious conclusions. Autocorrelation was examined by sequentially shifting the binary time series data of active and inactive readings for each 24-hour monitoring, by 1 hour, then 2 hours, etc, and correlating it with itself at each shift (so 1200 is matched against 1300, then 1400 etc.). The correlation coefficient for each shift was plotted against the corresponding lag period to give an indication of the pattern of autocorrelation in the series. Using ANOVAS, a 5-hour time lag between readings was found necessary to ensure statistical independence (M1: $F_{1,238} = 1.197$, $P = 0.705$ and M2: $F_{1,203} = 0.144$, $P = 0.275$). Therefore a data set of independent activity readings was constructed by eliminating data that were <5 hours apart. This data set was used for only one analysis: a generalised linear model to look for broad scale effects of individual bear, month, season, time of day, precipitation, and cloud cover, on activity. The possible effect of the identity of the observer, of which there were six over the course of data collection, was also examined in this analysis.

Because achieving an independent data set required elimination of the majority of the data, for other analyses of activity patterns, the risks associated with autocorrelation were accepted and all the data was included. As with the independent data set, a GLM analysis on the full data was undertaken, set to examine effects on activity of the individual bear, month, season, time of day, precipitation, and cloud cover. A separate GLM analysis was carried out to examine season and weather related effects on daytime rest periods. However, all analyses were done separately for the two bears on the basis that confidence in the results would be strengthened if both bears demonstrated the same patterns.

6.3 RESULTS

Activity data were recorded during 56 days for M1 (n=1635 readings) and 60 days for M2 (n=1759 readings). Both bears made periodic movements outside the study area, during which time their signals were heard only occasionally. M1 was almost completely out of range during August–September 1998, and January and April 1999; M2 was out of range during November 1998 and May 1999.

6.3.1 Daily activity patterns

Both bears monitored in this study were active diurnally. Moreover, their daily patterns of activity were remarkably similar (Figure 6-2). Very little activity (<20%) occurred during hours of darkness. Activity generally began at sunrise, 600– 630, and lasted until sunset, 2000–2100. Peaks in activity occurred around 0900–1000 and 1700–1800, with a midday lull between 1100 and 1400. Both bears were active, on average, 53% of the time.

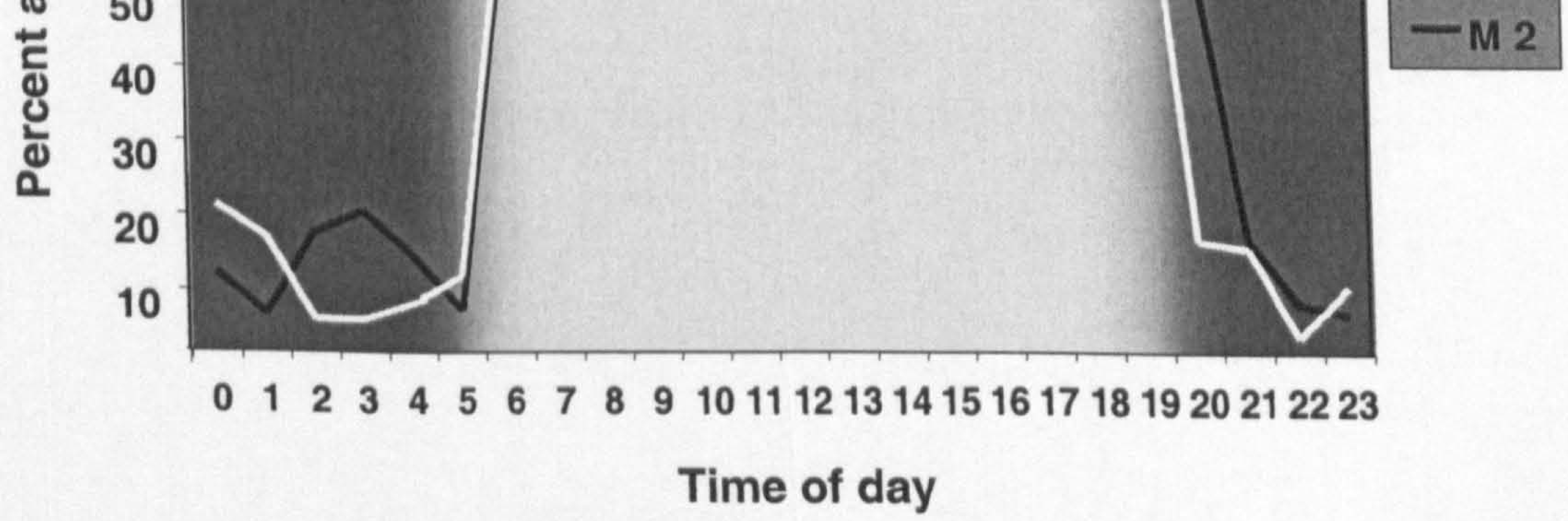


Figure 6-2 Daily activity patterns of two radiocollared Andean bears, in Apolobamba, Bolivia, during 1998-1999. Daily activity patterns are based on the pulse rates emitted by motion-sensitive transmitters subsequently classified as being active or inactive. The dark to light shading represents

night and daylight.

An examination of the destructively sub-sampled independent data set indicated that the only significant variable of those examined affecting the bears' activity was hour of day (χ^2=76.8, df = 1, P<0.001). Hence this generalised linear model did not show any monthly, seasonal or weather related differences with the reduced data set. A GLM analysis of the full data set, in contrast, showed cloud cover as emerging with significant explanatory power (χ^2=4.2, P<0.05). Cloud cover was suspected to be a surrogate for season which prompted the following analyses carried out using the complete data set. The following subtle but nonetheless statistically significant differences were found between the seasons, with the caveat that this dataset contained some records that were likely autocorrelated.

6.3.2 Seasonal effects

Both bears were more active during the April–September dry season (M1 = 55%, M2 = 54%) than during the rainy season (M1 = 51%, M2 = 52%; Figure 6-3). This difference was significant for both bears combined (t = 3.39, df =15, P < 0.001) and for M1 alone (t =2.77, df =7, P < 0.05), but not for M2 (t =1.64, df = 6, P = 0.15).

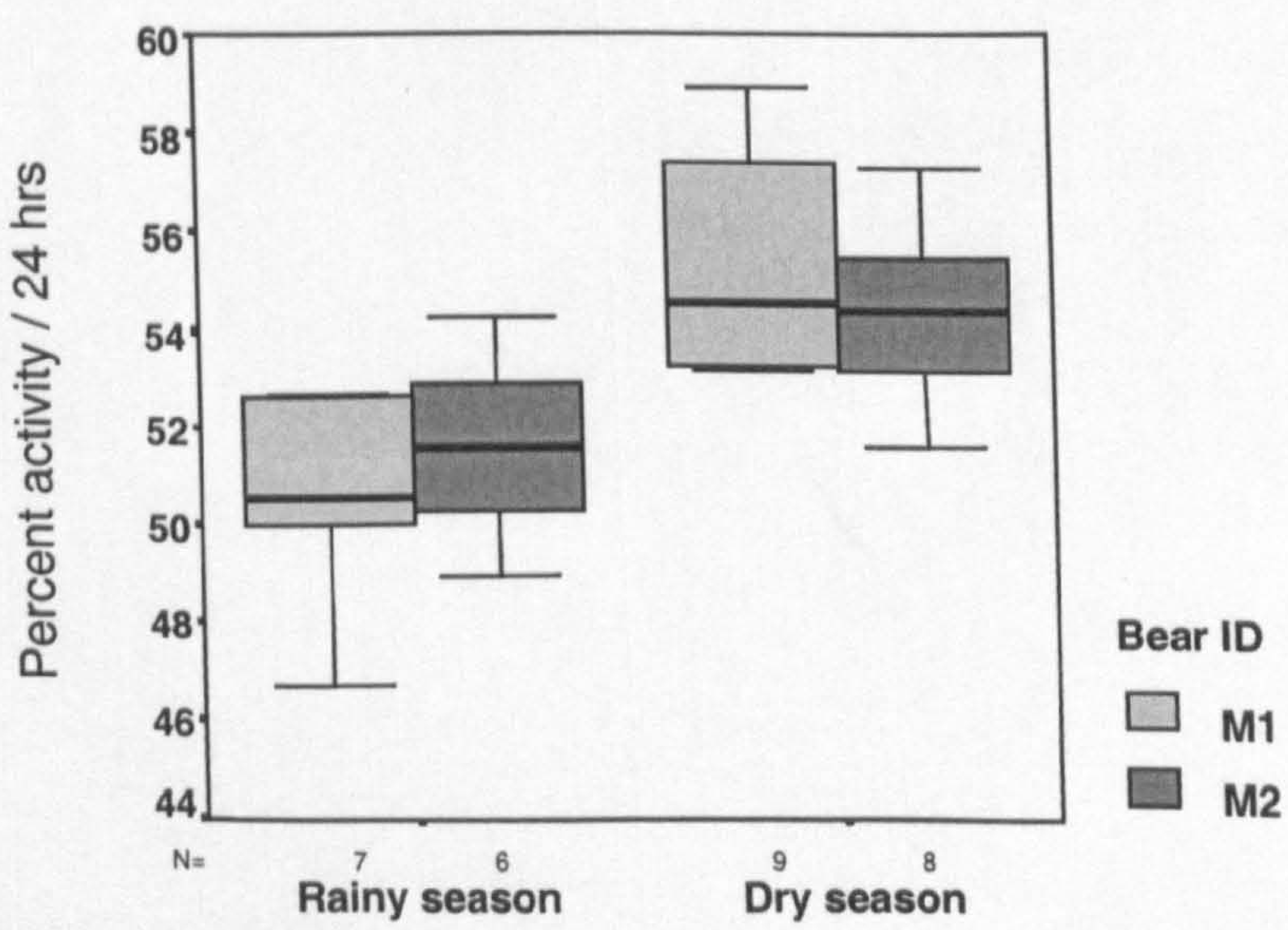


Figure 6-3 Overall percent activity for each of 2 Andean bears during the rainy (Oct–Mar) and dry (Apr–Sep) seasons, obtained from 24-hour monitorings of motion-sensitive radiocollars, Apolobamba, Bolivia, 1998-1999. Plots show median, inter-quartile range and total range.

In addition to seasonal differences in time budgets, the daily pattern of activity showed some seasonal changes. The duration of night resting periods ranged from 9–12 hours ($n = 20$). Night resting periods tended to be longer during the dry season ($r = 0.4$, df = 20, $P = 0.072$ for the 2 bears combined). This difference corresponded with longer periods of darkness between sunrise and sunset and was much greater for the sub-adult bear M1 than M2 (Figure 6-4). Excluding those months in which nighttime darkness was of intermediate length (March, April, September, and October), the difference between seasons was stronger, but was only significant for M1 ($U = 0.00$, $P = 0.05$)(M2: $U = 4.5$, $P = 0.6$).

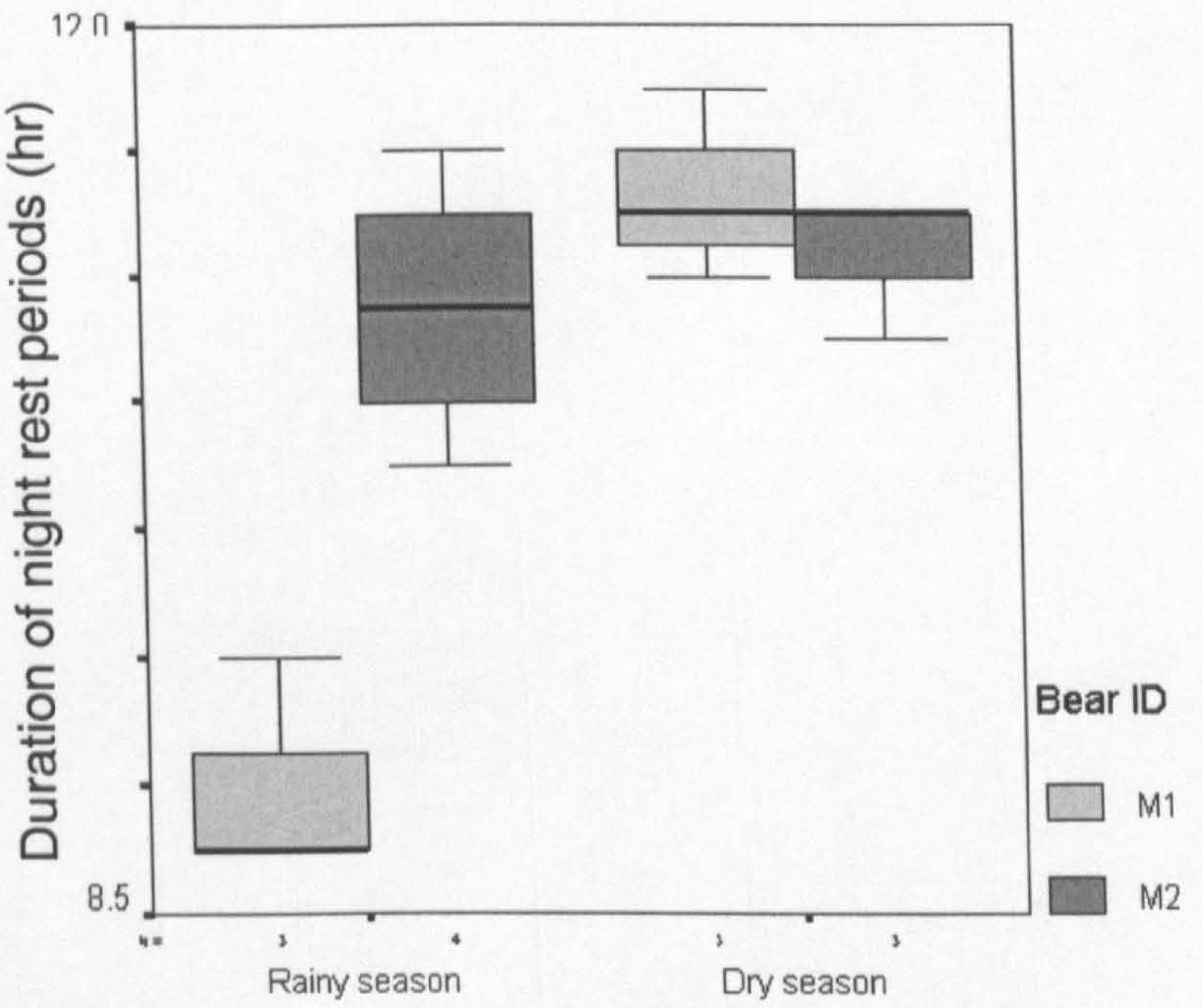


Figure 6-4 Duration of night rest periods for each of 2 Andean bears during the peak of the rainy (Nov–Feb) and dry (May–Aug) seasons. Plots show median, inter-quartile range and total range of night rest periods.

Daytime rests, in contrast, were longer during the rainy season. The longest daytime rest (inactive readings not interrupted by active readings) during each monitoring session averaged 16–44 min (2 consecutive readings, 15 min apart) in the dry season and 46–73 min (4 readings) in the rainy season (M1: $t = 5.02$, df = 20, $P<0.001$; M2: $t = 5.82$, df = 20, $P<0.001$)(Figure 6-5). No seasonal difference was observed in the number of rests during

1000–1600 hours (U = 59.5, $P = 0.97$).

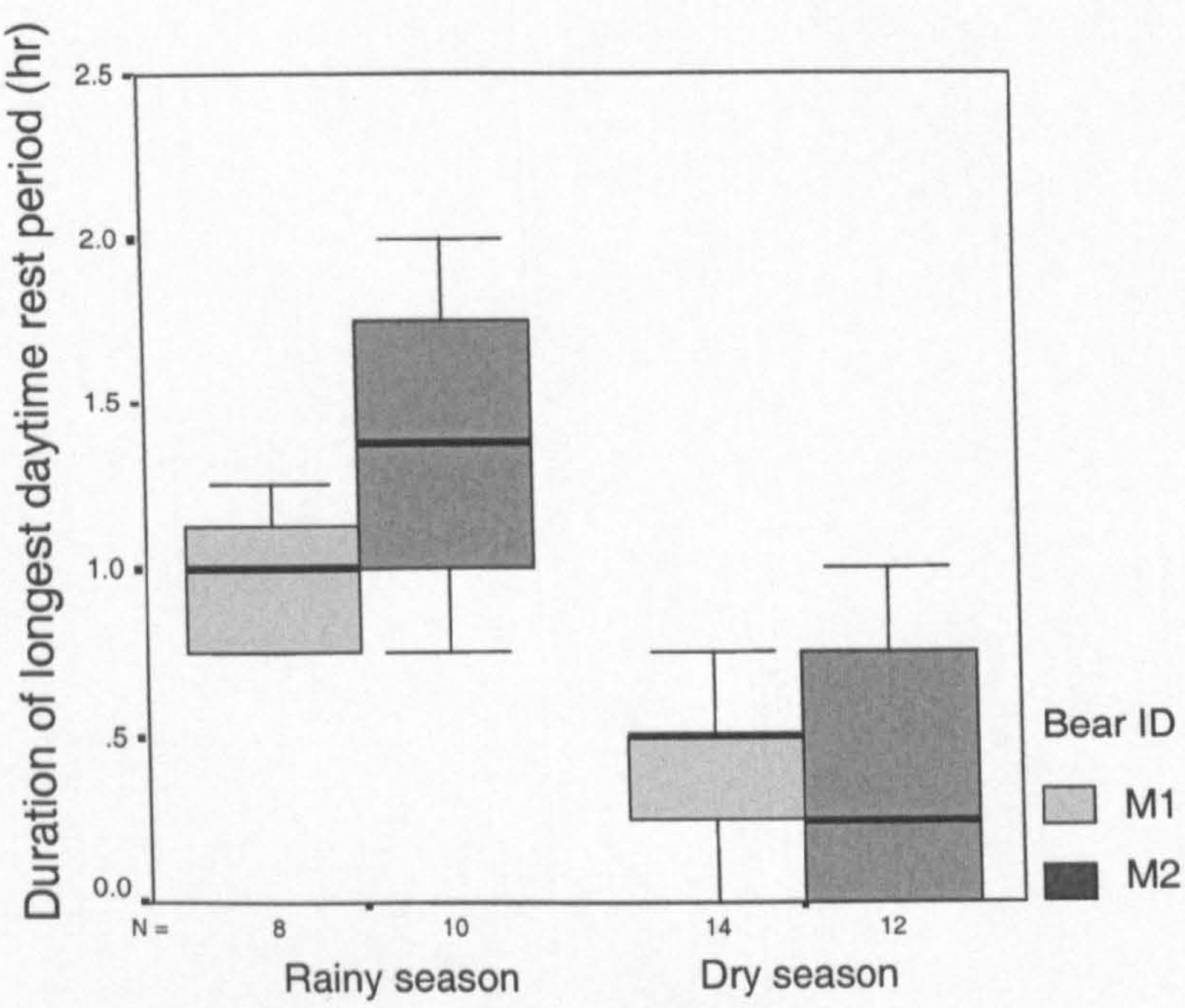


Figure 6-5 Median and interquartile range of longest daytime rests for M1 and M2 in the rainy season (October to March) and dry season (April to September). On the Y-axis is longest consecutive number if 15 minute readings in which the bears were inactive.

In both seasons bears rested more during the day when it was raining (or had rained within the past 3 hours) than when it was dry (GLM, df = 1, $\chi^2 = 5.02$, $P = 0.019$) (Table 6-1).

Parameter	Coefficient estimate	Deviance	Dispersion	d.f.	χ^2	*P*
Bear ID	0.182	-0.71	0.882	1	-0.81	NS
Cloud cover	0.237	-1.05	0.886	1	-1.19	NS
Precipitation	0.467	4.93	0.982	1	5.02	0.019
Season	-1.092	27.44	1.6	1	17.15	0.000

Table 6-1 Generalised linear model with Poisson errors corrected for over-dispersion, fitted to the median duration of daytime rest periods. The table shows changes in deviance obtained by dropping each significant term from the model and adding non-significant terms.

6.4 DISCUSSION

This is the first study to use motion-sensitive radio-telemetry to provide in depth insight into the activity patterns of wild Andean bears. Contrary to previous supposition, the basic activity patterns of Andean bears in this study were diurnal. The study animals spent just over half of their daily time budgets active, which is well within the range of American black bears and pandas, the ursids with which the Andean bear may be most readily compared. Although the Andean bears did not hibernate, activity patterns did vary seasonally. The data collectively suggests that the weather and the timing of sunrise and sunset also influenced the bears' activity patterns. Optimal foraging theory provides a framework for interpreting seasonal variation. The prominence of Andean bears in local human perception may be partially attributed to the fact that both local people and bears are active during the day.

6.4.1 Diurnal activity

Whereas the majority of mammals are nocturnal (Vaughan 1986), bears seem to be predominantly diurnal. Most of the foods exploited by bears are available during both day and night, but diurnal activity enables bears to use their sense of sight to forage, as well as to climb and travel more efficiently. Vision in Andean bears has not been studied, but American black bears (*Ursus americanus*) are known to possess colour vision (Bacon and Burghardt 1976). This may be particularly useful when searching for colourful ripe berries. Consistent with this idea, black bears are much more diurnal during the summer months when berries form a large part of their diet (Garshelis and Pelton 1980, Swanson 1990). Fruits and berries are also important in the diet of Andean bears during some seasons (Peyton 1999; see Chapter 5). Increased wind during the day (Barry 1981) may be another advantage of diurnal activity, as air movement facilitates olfaction. The sense of smell is essential to Andean bears (Peyton 1999). In this study area, volatile molecules released by ripe fruit and decomposing carrion would have been carried more readily by the convection-caused movement of air up the valleys during the day.

Heat stress may be the principal disadvantage of diurnal activity. As well as being covered with black fur, bears, like all large animals, have a low ratio of surface to volume, and thus have difficulty in dissipating heat (Macdonald 1995). Maximum daily temperatures in this study area were typically only ~13°C, and varied monthly by <1°C (section 2.1.4). However, the heat of direct sun can be intense due to the low latitude and thin air at high altitude. The tendency of bears to decrease activity at midday even in this relatively cool study area would support the view (from rather anecdotal evidence) that in warmer environments (e.g., coastal deserts of Peru) these bears have a more crepuscular activity pattern (Peyton 1980). Most animals have a bimodal activity pattern (Aschoff 1966). This pattern was observed in Andean bears, and has also been reported for American black bears (Garshelis and Pelton 1980, Ayres et al. 1986, Swanson 1990).

These two bears displayed strikingly similar activity patterns, but this may have been a function of the fact that they both lived in the same area, were about the same size, and were both males. It is possible that, as in some other species of bears, activity patterns vary by geographic area, sex, age and individual (Garshelis and Pelton 1980, Ayres et al. 1986, Joshi et al. 1999). In this study, the two bears seemed to differ in their seasonal responses: the younger bear, M1, altered its activity much more so than M2. On the other hand, M2 seemed more responsive to varying weather, being especially active during electrical storms in the rainy season. Both bears tended to be less active during and following heavy rain. In American black bears, activity was depressed while it was raining but increased immediately afterwards (Garshelis and Pelton 1980). In this study, even after it stopped raining, moisture continued to drip off trees for several hours, so bears may have perceived it as still raining and remained more restful (Schaller et al. 1985). The reason for their decreased activity during the rain is not altogether clear, but likely has to do with thermo-regulation.

6.4.2 Time Budgets and other ursids

Predation and food availability are thought to be the principal factors governing activity patterns and time budgets of vertebrates. These two factors often have competing effects, in that animals might prefer to feed more, or feed in certain areas, or feed at certain times, but are restricted from doing so by the risks of predation. So-called "time-minimisers" feed only until satiated and then find cover; in their case, as food increases, activity decreases, because less time is required to obtain adequate nutrition (Schoener 1971; Begon et al.

1996). Conversely, "energy maximisers" attempt to increase fitness by maximising their food intake. Animals employing this strategy eat more when food is plentiful, building up fat stores.

Most bears are likely to adopt the latter approach for two main reasons, both related to their large body size. First, their bulky frames are built to carry lots of weight so they can store energy in the form of fat, to better withstand periods of food scarcity. Second, due to their large size, bears, except females with cubs, generally have little fear of predation (Stirling and Derocher 1990). Temperate bears, which are forced to hibernate during winter, may be the ultimate energy maximisers, living on what has been described as a "boom or bust" economy (Schaller et al. 1985). An American black bear, for example, may consume 20,000 kcal in one day when food is plentiful and store that energy for use during hibernation when food is not available and activity is reduced to near zero (Nelson et al. 1983). But what about non-hibernating bears? Should they be energy maximisers as well?

Polar bears, *Ursus maritimus*, in the Canadian Arctic showed elevated activity when seals, their primary prey, were especially vulnerable (Messier et al. 1992). Non-hibernating Asiatic black bears, *Ursus thibetanus*, living in semi-tropical forests responded to radical changes in food availability with significant changes in activity budgets, increasing their activity to nearly 70% during the acorn season (Hwang et al. 2000). Giant pandas (*Ailuropoda melanoleuca*), on the other hand, showed the reverse response to increased availability of high quality food. During spring, when their food was apparently most nutritious, they were least active (Schaller et al. 1985), suggesting that they did not employ an energy-maximising strategy.

Giant pandas differ from other bears in having a diet composed almost entirely of green vegetation (bamboo). Even so, their daily time budgets, averaging 48–58% activity (Schaller et al. 1985, 1989), are quite similar to the 45–60% daily activity exhibited by the more frugivorous and omnivorous American and Asiatic black bears (these calculations from: Amstrup and Beecham 1976, Lindzey and Meslow 1977, Garshelis and Pelton 1980, Ayres et al. 1986, Schaller et al. 1989, Reid et al. 1991, Larivière et al. 1994, Hwang et al. 2000) and brown bear (presented by or calculated from: Roth 1983, Roth and Huber 1986, Stelmock and Dean 1986, Clevenger et al. 1990). It was discovered that the daily time budgets of the two Andean bears fell within this same range.

Ecologically, Andean bears fall between giant pandas and American black bears. A large part of their diet consists of fibrous, vegetative matter from arboreal and terrestrial Bromeliads, which are available year-round. However, they also eat fruits, when available, as well as meat (Peyton 1999; see Chapter 5). All bears are relatively inefficient at digesting fibre (Welch et al. 1997). Bromeliads are low in nutritive value (see Chapter 5). Thus, Bromeliads may not be sufficient to meet the nutritive requirements of Andean bears in the same way that bamboo does for giant pandas. The addition of items higher in protein may be essential. Their consumption of fruits and meat may enable Andean bears to rest most of the night, like black bears (at least during some seasons: Garshelis and Pelton 1980, Ayres et al. 1986, Reid et al. 1991, Larivière et al. 1994, Hwang et al. 2000) and unlike giant pandas (Schaller et al. 1985).

6.4.3 Seasonal effects and optimal foraging

The two Andean bears in this study were somewhat more active during the April–September dry season than during other months. This heightened activity corresponded with increased availability and increased consumption of fruits (based on scat analysis; see Chapter 5). However, most evidence for meat consumption by bears in this study occurred during the rainy season, probably reflecting more ungulate deaths and calving during this period. During this season, the two bears had larger home ranges and moved longer distances each day, possibly seeking sources of meat (see Chapter 7). Thus, the relationship between food availability and activity of Andean bears is as yet equivocal. The seasonal differences observed may have been simply a response to weather, a corroboration of the finding that bears were less active during the rain.

In studies of cryptic animals, particularly in mountainous and densely-vegetated environments, it is often the case that most data are interpreted from signals of radiocollars, with rare visual sightings. Food habits data can be obtained from scats and other sign, but food availability is typically difficult to assess. That was certainly the case in this study, and the possibility that activity data might be a useful index of food availability was investigated. It was observed that Andean bears are not buffeted by the extreme seasonal pulses of productivity seen in black and brown bears, and therefore do not hibernate and do not show such extreme seasonal variation in activity. However, neither their daily pattern of activity nor their time budgets yielded much insight into the foraging and other life history strategies employed by these animals. Future research may decipher the link between food availability and activity patterns for Andean bears.

6.4.4 Interaction with people

The activity patterns of Andean bears in the study closely echoed local human activity patterns. The implications for conservation of the synchrony of human and bear activity patterns can be considered in two main ways: in terms of direct internecine conflict (bears attacking people or people killing bears) and in terms of the prominence of bears for Andean people (in cultural history and contemporary awareness).

Bears are occasionally observed feeding in maize fields and on carcasses during daylight hours (Peyton 1986; see Chapter 8). Because they are observed in acts of depredation bears are more vulnerable to being shot than nocturnal animals such as the puma which are observed evenly more rarely. That Andean bears rarely attack people and are considered the least aggressive of all bears towards humans (Peyton 1999) cannot be ascribed to temporal avoidance of people. Other ursid species have been shown to alter their activity patterns as a response to human disturbance or in order to exploit anthropogenic food sources (Mattson 1990). This can operate on two scales, as a behavioural adaptation in a single lifetime or a result of selective pressure over many generations. Future studies of bears involved in higher levels of contact with people may show increased levels of nocturnal activity.

As seen in Chapters 3, bears occupy a central role in contemporary Andean rural culture. This is in keeping with the supposition that activity patterns are an important factor in determining the prominence of animals for people (Kellert et al. 1996). As mentioned in section 6.1, the fact that pumas are active primarily at night is one factor used to explain the lower contemporary and historic profile of this species when compared with bears or wolves amongst both Native Americans and European colonists (Kellert et al. 1996). It is interesting to note that in terms of historic profile, the opposite would be true in South America where the large cats, the puma and jaguar, are considered by archaeologists to be the most prominent animals of the large carnivore guild in pre-Colombian mythology and iconography (see Chapter 3). This is another piece of evidence suggesting that a re-assessment of this orthodoxy might be in order.

This study into the activity patterns of Andean bears in Pusupunko, Apolobamba has dispelled two misconceptions: that Andean bears hibernate (Allen 1992) and that they are nocturnal (Weinhardt 1993). In the following chapter, the spatial requirements of Andean bears will be addressed. This is another area in which basic research had not been attempted. Taking into account the observed variation in both diet, in Chapter 5, and activity in the present chapter, whether or not that variation is also reflected in movement patterns can now be investigated. Having explored local beliefs and perceptions about interactions with bears in Chapter 4, the following chapter will also assess the degree to which the home ranges of Andean bears overlap with areas of human use.

6.5 SUMMARY

1. The activity patterns of Andean bears in the Apolobamba range of northern Bolivia were studied using motion-sensitive radiocollars. Two males were captured and monitored for 1 year, 1998-1999.

2. As with many cryptic species, Andean bears often have been assumed to be largely or entirely nocturnal, but both bears in this study were diurnally active. Both bears had a bimodal activity rhythm, with peaks on either side of a midday (1100–1400) lull, and little activity (< 20%) during hours of darkness.

3. The daily time budgets of two male Andean averaged 53% activity which was central to the range of 45-60% activity exhibited by American and Asiatic black bears and brown bears in non-denning months. Unlike these species, Andean bears did not hibernate. The daily time budget of Andean bears may therefore be more similar to the non-denning panda, averaging 48–58% activity.

4. Duration of night resting periods ranged from 9–12 hours. Resting periods at night tended to be longer during the dry season (April-September), corresponding with longer periods of darkness between sunset and sunrise.

5. The duration of midday rests was longer during the rainy season (October-March). Overall, bears were more active during the dry season (55%) than the rainy season (51%). This relationship may have been related to weather and food availability; bears tended to be less active during rainy weather in both seasons.

6. The activity patterns of Andean bears in the study closely echoed local human activity patterns.

Chapter 7
MOVEMENT PATTERNS

An orphaned bear cub playing with a Puya flower stalk at the Pusupunko study site.

7.1 INTRODUCTION

The value of familiarity is perhaps the most basic principle underlying patterns of animal movement. It is greatly advantageous to animals to have an intimate knowledge of one area, including its dangers, food resources, available hiding cover, and neighbouring conspecifics (Linn 1984). These limited areas within which the lives of most mammals are carried out are known as home ranges (Burt 1943).

An animal's home range, "the area traversed by an animal in its normal activities of food gathering, mating and caring for young" (Burt 1943) can be identified by using a variety of different methods to obtain a series of locations in which the animal has been observed. For some species, locations can be obtained using methods such as visual observation, scratch boards, tracking of markers in faeces, and repeated trapping (Linn 1984; Macdonald 1995). Radiotelemetry has made it possible to remotely monitor the movements of large and cryptic free-ranging animals like large carnivores (White and Garrott 1991)

Understanding the movement patterns of large carnivores such as bears is essential for developing conservation strategies (McLellan 2001). Contact with people accounts for a high proportion of large carnivore mortality; ranging behaviour is a key determinant of this contact (Woodroffe 2001). As a result of conflict with people at reserve boundaries, wide-ranging carnivores have been shown to be more extinction-prone in a reserve of a given size than carnivores with smaller home ranges (Woodroffe and Ginsberg 1998). Thus, it is particularly important to consider the movement patterns of large carnivores when planning for their conservation.

Bear populations generally require large areas of land to survive (Herrero 1999). However, home range estimates for bears exhibit a high degree of variability at all scales: species, populations and individuals. Of the eight species of bears, polar bears have the largest home ranges, from 7000 to 600,000 km^2. Brown bears, inhabit the next most northerly regions and have the next largest home ranges, from 100 to 2000 km^2. There are bears in all of the remaining six species who have home ranges under 10 km^2. The largest recorded home ranges for sloth, panda and sun bears are under 30 km^2, while they are much larger, 500 km^2 and 150 km^2 for American and Asiatic black bears, respectively (Garshelis 2001). The home ranges of polar, brown, American black, Asiatic black, and sloth bears have been shown to be seasonally labile in many studies (Joshi 1995). These seasonal changes are attributable mainly to changes in food availability (Joshi 1995). The success of opportunistic omnivores such as bears depends particularly on an encyclopaedic knowledge of the land and its seasonally-available food resources such as fruiting trees (Stirling and Derocher 1990).

All bears are basically solitary, but by no means asocial (Stirling and Derocher 1990). Some degree of social awareness is necessary because every home range, regardless of degree of overlap, is circumscribed either by habitat that is unsuitable for the species or by the home ranges of other conspecifics (Schaller et al. 1985). Bears, communicate using little-studied olfactory, visual, auditory and signals to maintain their spacing, achieve reproduction and determine pecking order when a concentrated resource is shared (Lynch 1993). The closest social bond is formed between a mother and her cubs (Stirling and Derocher 1990). Bears may stay with their mothers for one to three years. Female sub-adults often establish home ranges in or near their natal range. In contrast, as male bear cubs become sub-adults they disperse more widely in seeking to establish their own home range (Powell 2000). Groupings of sub-adult males help to increase their rank in the hierarchy at concentrated food sources or as a general defence against larger males (Reynolds and Garner 1979).

Tolerance of human presence differs amongst bear populations and species. Generally though, throughout the world, there is little overlap between occupied bear habitat and areas of high human densities (>25/km^2) (Mattson 1990). Most bears tend to minimise contact with humans, even when exploiting anthropogenic food sources (Mattson 1990). Examples of this avoidance by brown bears include the demonstrated underuse areas within 1 km of campsites (Gunther 1984), within 3 km of roads (Mattson 1987) and within as much as 5 km of human dwellings (Mattson 1987). Human recreational activities such as hiking, mushroom and berry picking resulted in the alteration of movement patterns of European brown bears (Roth 1983) whereas the response of some brown bear populations in North America to such activities was comparatively short-lived and not energetically costly (reviewed in Mattson 1990).

Little is known about the movement patterns of Andean bears. Published speculative estimates of Andean bear home ranges have been in the region of 2.5 km^2 (Yañez 1995) and 48.57 km^2 (Yerena and Torres 1994). Seasonal movements have been reported in various studies (Peyton 1984; Velez and Azurduy 2000; Goldstein and Salas 1993; Suarez Martinez 1985; Lozada 1990). Little is known of social interaction, but description exists of groups of Andean bears feeding together in corn fields, and Opuntia cactus groves (Peyton 1999). The only mentions of daily movement have been fragmentary resulting from a few hours or minutes of observation in three studies (Velez and Azurduy 2000; Peyton 1984; Yañez 1995).

7.1.1 Research questions and structure of chapter

In light of the preceding information, the following research questions were investigated using radiotelemetry:

- Do the home ranges of Andean bears lie within the range of the other three species of tropical bears lie in the range of 4-30 km^2, and close to the allometrically predicted home range size for the species (Harestad and Bunnell 1979)?
- Do bears display seasonal shifts in their activity centres and habitat use due to seasonal peaks of fruit production and the year-round availability of vegetative foods such as bromeliads (see Chapter 5)?
- Do bears, other than a mother and cubs, spend time in close association?
- Do the home ranges of bears overlap with areas of human use?

In this chapter the following aspects of the movement patterns of two Andean bears will be described: home range estimation, daily movements, habitat use, seasonal movements and social interaction. The overlap of areas of bear and human use is also described.

7.2 METHODS

7.2.1 Monitoring

Radiocollared bears were located up to twice a week when field workers were in the field. To avoid biasing the distribution with non-independent data points, any radio-locations recorded less than one day (20 hours) apart were excluded from the analysis in order to allow the time interval necessary for the animal to realistically move between any two points in its home range (Swihart et al. 1988). We radio-tracked from ridgelines that encircle the study area and from several prominent overlooks therein which were geo-referenced using a mobile GPS unit. We obtained radio bearings within a 30 minute interval from multiple points using two observers in radio communication, each with a receiver. Bearings were also taken by one mobile observer when the they could be taken within 30 minutes of each other. Radio bearings were obtained using a Televilt receiver with built-in antennae and a Telonics TR-4 receiver with a 3-element Yagi or 2 element H antennae.

Radio-locations were originally plotted in the field on a 1:9000 topographic map produced using a 1:100,000 topographic map (DMA H63223040) overlaid with an aerial photograph (IVFAB 22/75 4 Jun S 6/84 RILJ/86) with features such as ridge lines, forest edges, rivers geo-referenced using a mobile GPS unit. For the subsequent data analysis including home range estimation this field map was replaced with an improved base map created using a 1991 LANDSAT 4 1991 satellite image as described in Chapter 2. The radio-locations were input into ARCVIEW 3.1 (Environmental Systems Research Institute, Redlands, California, USA) and analysed with the Animal Movement extension (V. 1.0).

The thick forests and precipitous slopes complicated radiotelemetry. In order to locate bears I used the intersection of at least two bearings with a minimum difference in angles of 30° taken. Nonetheless, because of the mountainous terrain which can cause signal bounce, it was sometimes necessary to take ten or more bearings before establishing a location about which the field workers felt confident. I tested the accuracy of the telemetry system using a radiocollar placed by someone other than the tracker in the forest, ecotone or grassland (n=20), and found no difference in accuracy between these habitat types (Harris et al. 1990). The accuracy of locations was estimated to be <2° at 1km, which was similar to studies in less difficult terrain (Valenzuela and Ceballos 2000).

Reliable triangulation was sometimes not possible. These situations can be divided into two categories: disappearances and non-triangulated bearings. Disappearances occurred when the bears were on the other side of large barriers or beyond the area from which signals could be detected. In contrast, during other occasions, bearings were taken but could not be triangulated due to the topography and distances involved. When these signals consistently (over a period of more than one hour) and with strong signal integrity, emanated from one area (ie. were judged not to be the result of signal bounce) they did provide general information about the location of the individual (O'Brien et al. 2000). By plotting these non-triangulated bearings, areas of additional probable use were estimated. These areas are described by the geographical limits of the mountain slopes, in the direction of the bearings, to which there was straight-line visibility from the tracking positions. Tracking success, defined as the number of successful radio-locations divided by the number of attempts, is reported. Although several authors mention tracking success, it is usually ignored in home range analysis. I have found no published home range model that takes into account the percentage of the time that an animal is not located within the area that the researcher is able to recognise as the home range. This information is essential in order to avoid underestimating the home range size.

7.2.2 Home range estimators

Four methods were used to estimate home range. Three standard non-parametric methods were used to calculate the home ranges: minimum convex polygon, grid cell, and fixed kernel estimator. The fourth method takes into account tracking success and incorporates long-range non-triangulated bearings.

The minimum convex polygon (MCP) method is the oldest and still the most common method for estimating home range size (Mohr 1947; White and Garrott 1991). The size and shape of a minimum convex polygon is determined by the outermost radio-locations. These fixes are connected so that the angle toward the inside of the polygon formed by any three consecutive points does not exceed 180° (Southwood 1966). Its main advantages are comparability across studies, simplicity and ease of calculation (Plumptre and Harris 1995). Because home range estimates should not include occasional "sallies" (Burt 1943), certain percentages of the outliers or locations furthest from the core are often peeled from the estimate (Powell 2000). The minimum convex polygon method is almost always calculated for the sake of comparison with other studies. Because it ignores the internal structure of the home range, it is often used in conjunction with other methods (Plumptre and Harris

1995). However, the visual information communicated about the clumping of locations by the simple display of fixes within the MCP may be as intuitively informative as other more complex methods.

The grid cell approach recognises that when resources are unevenly distributed across the landscape, most animals will spend more time where resources are concentrated (Powell 2000). The concept of a home range core, that part of the a home range most important to the animal, is as old as the concept of home range itself (Burt 1943). However techniques for analysing the intensity of use of space, or utilisation distribution, have only been developed more recently (Siniff and Tester 1965; Samuel et al. 1985; Seaman and Powell 1990; Powell 2000). A simple non-statistical utilisation distribution within a home range can be estimated by counting the number of independent radio-locations in each grid cell. A 500m grid size was selected for this analysis because they encompass multiple fixes per cell and leaving a minimum of adjacent cells empty (Mizutani and Jewell 1998).

Fixed kernel estimators evaluate the probability that an animal will be in any part of its home range at any given time. They emphasise central tendencies of the home range, and do not change each time an animal explores a new area as minimum convex polygons do (Powell 2000). This technique is one in a range of more sophisticated probabilistic estimators of home range areas and utilisation distributions, all of which have certain strengths and weaknesses (Boulanger and White 1990). This method, in which band width is chosen using least-squares cross-validation, has been shown to yield the most accurate estimates of home range with the smallest variance of methods commonly in use (Powell 2000). The validity of this technique is compromised by incomplete tracking success.

In order to expand the area of the home range beyond what can be estimated using only triangulated locations, areas of probable additional use are estimated. As described above, these are areas from which consistent signals with strong integrity were emitted. The areas of these additional "fans" of use are described by the lowest and highest angles from which signals were received and then bounded at the furthest edge topological boundaries of the mountains. These fans are then added to minimum convex polygons. This emphasises the idea that because of the less than complete tracking success, the so-called 100% MCPs represent areas of core use.

7.2.3 *Daily movements*

In order to examine the distances moved by bears, daily distances moved were compared to distances moved in larger time intervals. Twenty pairs of locations were selected randomly for each time interval (locations separated by one day defined as 18 to 30 hours, two days or 31 to 60 hours, 3-4 days, 5 to 10 days, 11 to 30 days, 31-90 days and more than 90 days). The median and inter-quartile range of linear distance between consecutive radio-locations were plotted for each bear. The longest range movement observed is also described.

7.2.4 *Habitat utilisation*

A vegetation map of the study area was generated in ARCVIEW 3.1 using bands 3, 4 and 5 of the 1991 LANDSAT 4 satellite image. The reflectance values associated with thick vegetation, which in Apolobamba means the cloud forest, were represented by the red range of the colour spectrum. The grassland, the other main habitat type in the study area, appears yellow-brown. The two main habitat types, forest and grassland were clearly differentiated, and polygons for their limits were drawn using on-screen digitising.

A third habitat type was estimated based on field experience to represent the ecotone between forest and grassland. It was drawn as band of roughly 50 metres on either side of the border between forest and grassland for two reasons. First, the ecotone was of variable thickness, and could not be identified more accurately from the satellite image. Second, this approximately 100 m strip is important to bears because of the variety of bear foods it offers, including berries and epiphytic bromeliads (Goldstein, pers comm.) (Velez and Azurduy 2000)[1].

Habitat availability is estimated using the habitat map to produce percentages of each habitat type in the study area, which was defined for this procedure as the smallest rectangle in which the 100% minimum convex polygons were contained. The overall utilisation of three

[1] The ecotone is referred to as *matorral* in Velez, 2000

habitat types by each bear is compared to availability using a chi squared test (Neu et al. 1974). In habitat use assessments there will always be a bias against locations falling in smaller habitat patches (in this case the ecotone), and discarding locations because of telemetry error has been shown to increase this bias (Nams 1989). For this reason, all locations are used for these analyses.

7.2.5 Seasonal effects

Analysis of differences in seasonal home range was carried out by comparing the relative sizes of minimum convex polygons in the rainy season to those in the dry season. The locations found in each of these three habitat types were analysed by dividing the year into rainy dry and intermediate months, and also into two month segments beginning with the first two months of the rainy season, November and December. Chi squared analyses are employed to compare use with expected use if all habitat types were used according to availability (Neu et al. 1974). In order to look for seasonal variation in distances travelled, the year was divided into rainy season (November to February) and dry season (May to August) with months of intermediate rainfall (March and April and September and October) excluded from analysis. The difference in daily distance travelled by each bear in the rainy and dry season was tested using Mann Whitney U test.

7.2.6 Social interaction

The way that two animals living as neighbours relate to each other in terms of their movements can provide important insight into social behaviour (Horner and Powell 1990). This can be explored in two main ways using radio-locations: static and dynamic interaction, the latter of which was not employed due to the small sample size. Static interaction measures the intensity of use of the overlapping portions of two home ranges (two animals could occasionally visit sites in a shared area, but concentrate their activities in unshared portions of their home ranges, or conversely, maintain separate areas on their home ranges' periphery but spend most of their time in shared core areas). To determine static interaction I used degree of overlap of home ranges and correlation of utilisation distributions (Horner and Powell 1990). Three categories of core area used were defined following Horner and Powell, 1990: first, the cells in which the number of locations was greater than the mean expected if all used cells were used evenly, second, the category of the minimum number of grid cells comprising 50% of all locations and, third, the innermost core of the minimum number of grid cells comprising 25% of all locations. Degree of core area overlap is considered high if 25%-core areas overlapped, moderate if 50%-core areas overlapped and low if only cells used more than expected overlapped.

7.2.7 Overlap with areas of human use

In order to explore how bears responded to areas used by humans, locations of human trails, fields and dwellings were noted using a mobile GPS unit and then plotted and compared to utilisation by bears.

7.3 RESULTS

M1 was located on 75 days from May 1998 to June 1999, and M2 was located on 71 days from July 1998 to June 1999 (Figure 7-1). Radio-signals were totally or virtually inaudible from the normal tracking stations, and all other positions attempted, on 23 days for M1 and 16 days for M2. These data are used to describe tracking success and to give an indication of additional areas apparently used by the bears but to which triangulation was not possible due to distance or topography. Clear but non-triangulated bearings were recorded on an additional 19 days for M1 and on 14 days for M2.

Table 7-1 Tracking success is presented in order to give an index of effort expended in obtaining the triangulated radio-locations.

Individual	Days of attempted radio-tracking	Tracking success: Percentage of days in which triangulated locations obtained	Percentage of days in which some radio signals audible
M1	117	64 % (75 days)	80 % (19 days)
M2	101	70 % (71 days)	84 % (14 days)

7.3.1 Home range estimates using the commonly used methods

It is important to emphasise that the following three methods of analysing home range do not take into account the absences of the bears from the study area. They therefore describe the home ranges of the bears during roughly two-thirds of the sampled dates. Occasional forays beyond these areas may be of crucial importance to the bears.

7.3.1.1 Minimum convex polygon

The estimated home ranges of the bears, using 100% of the fixes obtained, were 7.4 km^2 for M1 and 6.6 km^2 for M2. Home range asymptotes were calculated to evaluate the sufficiency of the sample size of locations (Harris et al. 1990). Flattening in the lines signifies that newly attained points during that time were within the periphery of the polygon. If the entire home range had been sampled sufficiently, the line should reach a clear asymptote (White and Garrott 1991). There was a cumulative increase in the percentage of the total home range estimate with an increase in number of fixes (Figure 7-1). However, it appears the area used by the sub-adult, M1, did not approach an asymptote during the 14 months that his movements were monitored. In contrast, the area used by the adult bear appears to have increased steadily and then levelled out by the end of the year of monitoring.

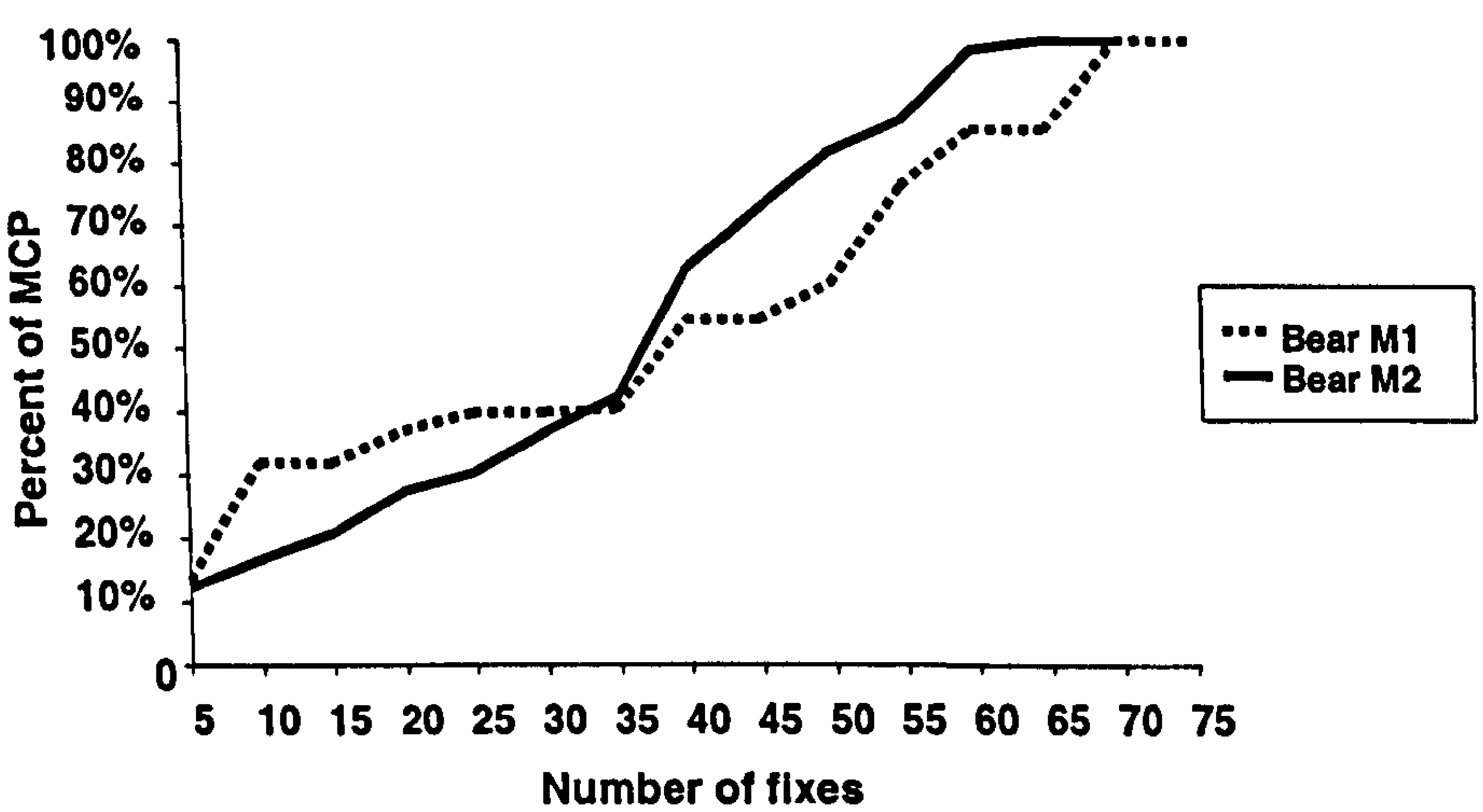


Figure 7-1 The relationship between the number of fixes and the percentage of total home range area estimated by the MCP method for bears M1 and M2.

In order to test further the effects of sample size on the area of the minimum convex polygon, a bootstrap simulation was carried out using 100 different combinations of points in the data set for each number of fixes (increasing in increments of five). This test shows the effects of an increase in sample size without regard to chronology or seasonality of data collected. The estimate of home range area increased with the number of fixes (Figure 7-2). In contrast to the sequential plotting of points (Figure 7-1), the lines for both bears were closer to reaching asymptotes using this analysis, suggesting that the number of fixes was adequate to obtain a representative home range estimate using the MCP method.

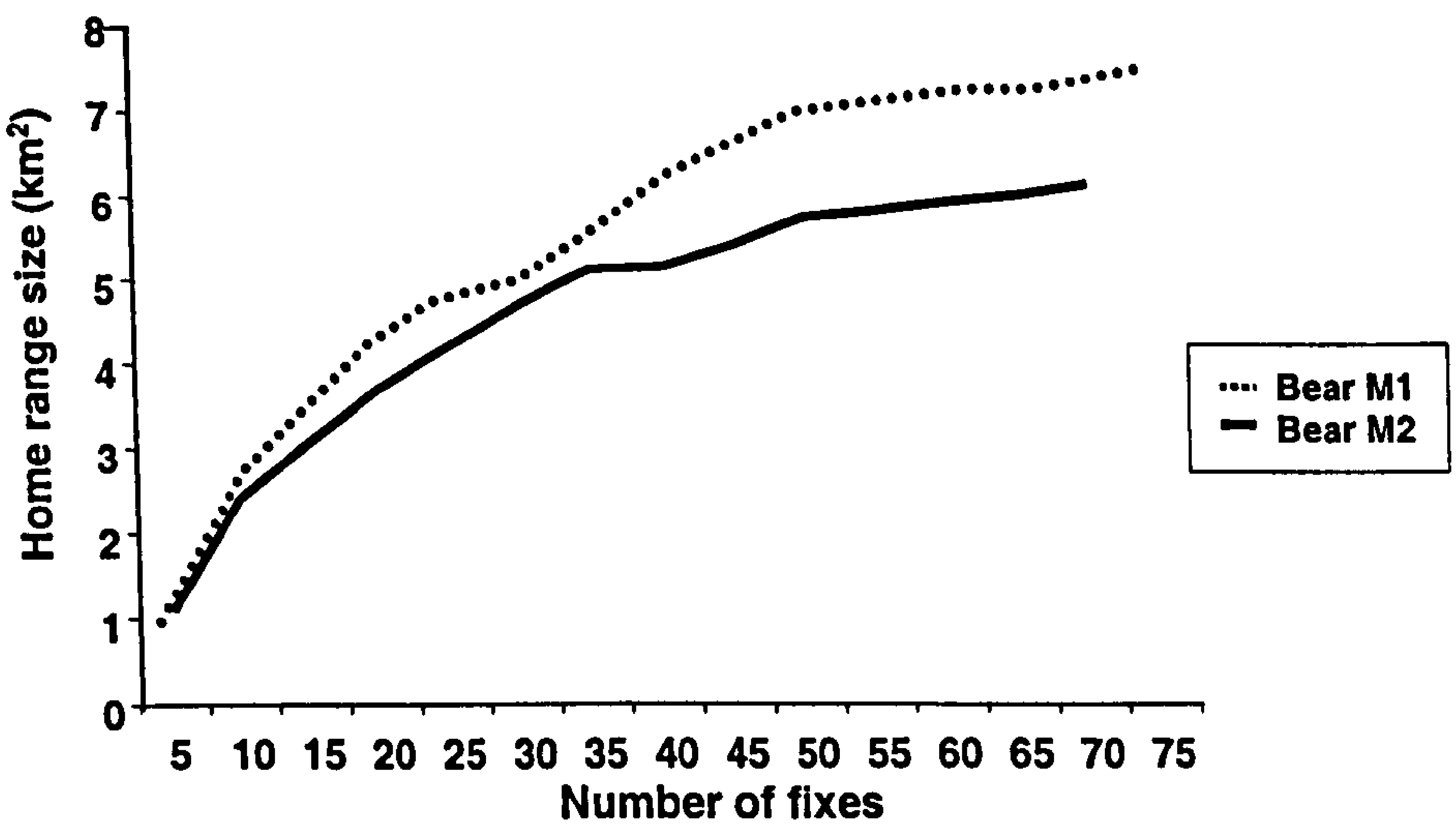


Figure 7-2 Bootstrap simulation using 100 different combinations of points in the data set for each number of fixes. Home range sizes given are the mean values.

The 100% minimum convex polygons for M1 and M2 are notably similar in size and shape (Figure 7-3). Despite the high degree of overlap in home ranges between the two bears, M2 was more often found in the Pulluni watershed, in which the research base camp was located, than was M1 (22 and 7 locations respectively). The Pasto Grande watershed to the east was used by both bears (59 locations for M1 and 45 for M2). The area where their core home ranges overlap is located on the ridge between the two valleys. In this study area, both bears seemed to have home ranges limited to the north side of the Pelechuco River and mainly in two watersheds. M1 was located three times across the Pelechuco River and some of his unidirectional bearings did originate farther east across the river. Other bears were observed on the opposite side of the river in August and December 1998.

One of the problems with the minimum convex polygon method is its high sensitivity to extreme data points. For example, the northern-most points were generated when both bears fed on the carcass of a cow which had fallen to its death in January 1999. This area was otherwise not used by bear M2. Outlying fixes were removed to create 95%, 90% and successively smaller minimum convex polygons (for areas of smaller MCPs see Figure 7-7). In individuals who have stable home ranges, as seemed to be the case with bear M2, outlying positions are likely to result from occasional sallies (as referred to in the original description of the home range concept) rather than normal movements (Burt 1943). Points were selected for removal using the harmonic mean method in which points furthest from the harmonic mean of the range are removed (as computed in the ARCVIEW Animal Movement programme, V.1) (Dixon and Chapman 1980; White and Garrott 1991).

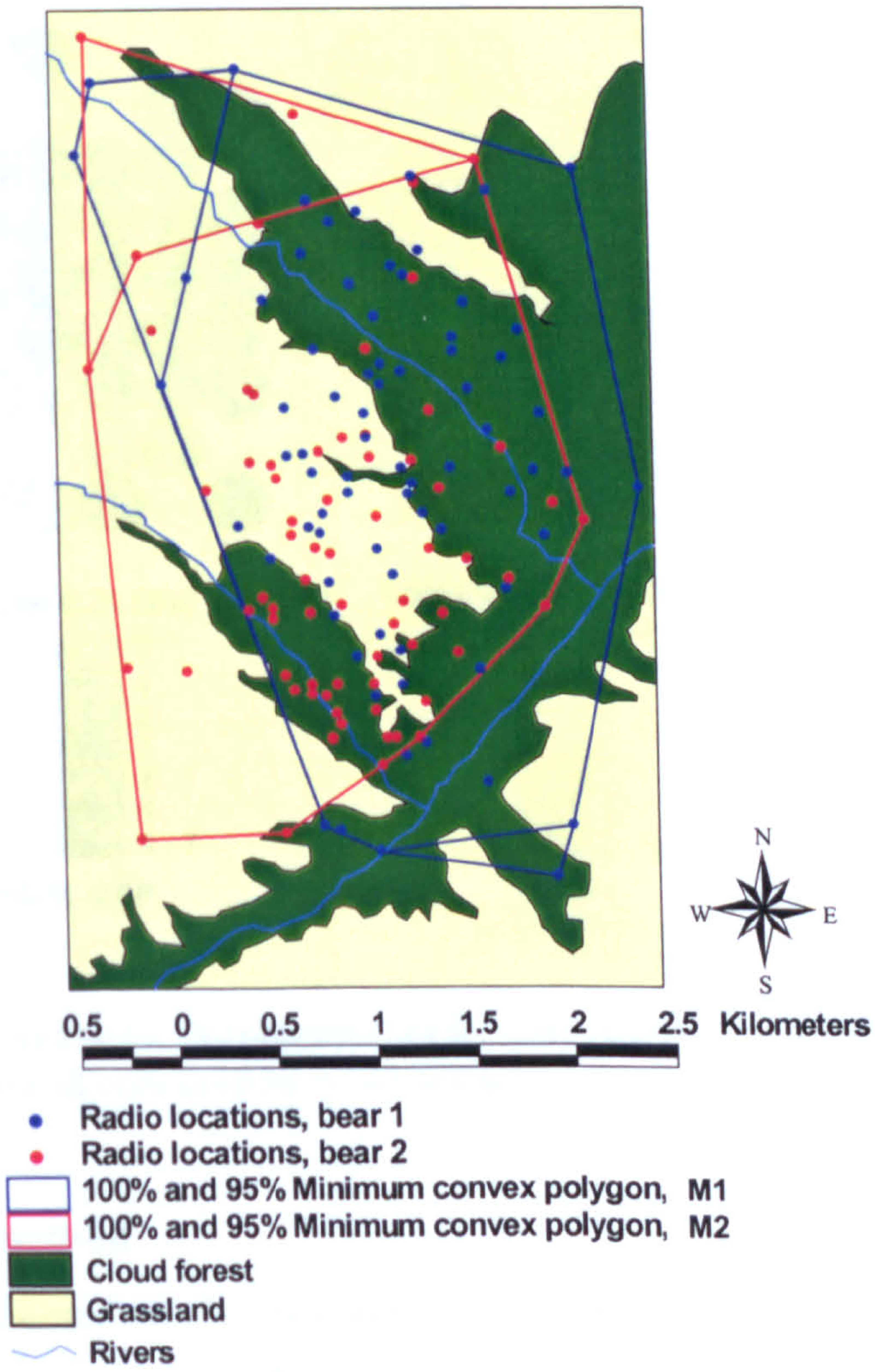


Figure 7-3 100% and 95% minimum convex polygons for bears M1 and M2.

7.3.2 Grid cell method

The intensity of grid cell utilisation, calculated as the number of locations per 500m x 500 m (0.25 km^2) grid cell, is depicted by colour rather than the alternative method of using height of columns for each grid cell (Figure 7-4)(Horner and Powell 1990). M1 was located in 29 cells which contained from 1 to 7 locations each, creating a total range of 7.25 km^2. M2 used

27 adjacent cells containing from 1 to 9 locations each and two cells which were added to the range estimate using the Queen's rule by which disjoint areas can be connected (Mizutani and Jewell 1998), creating the same total range of 7.25 km^2. These data on the core areas of home range utilisation provide the basis for examining static interaction (see section 7.3.7 on social interaction).

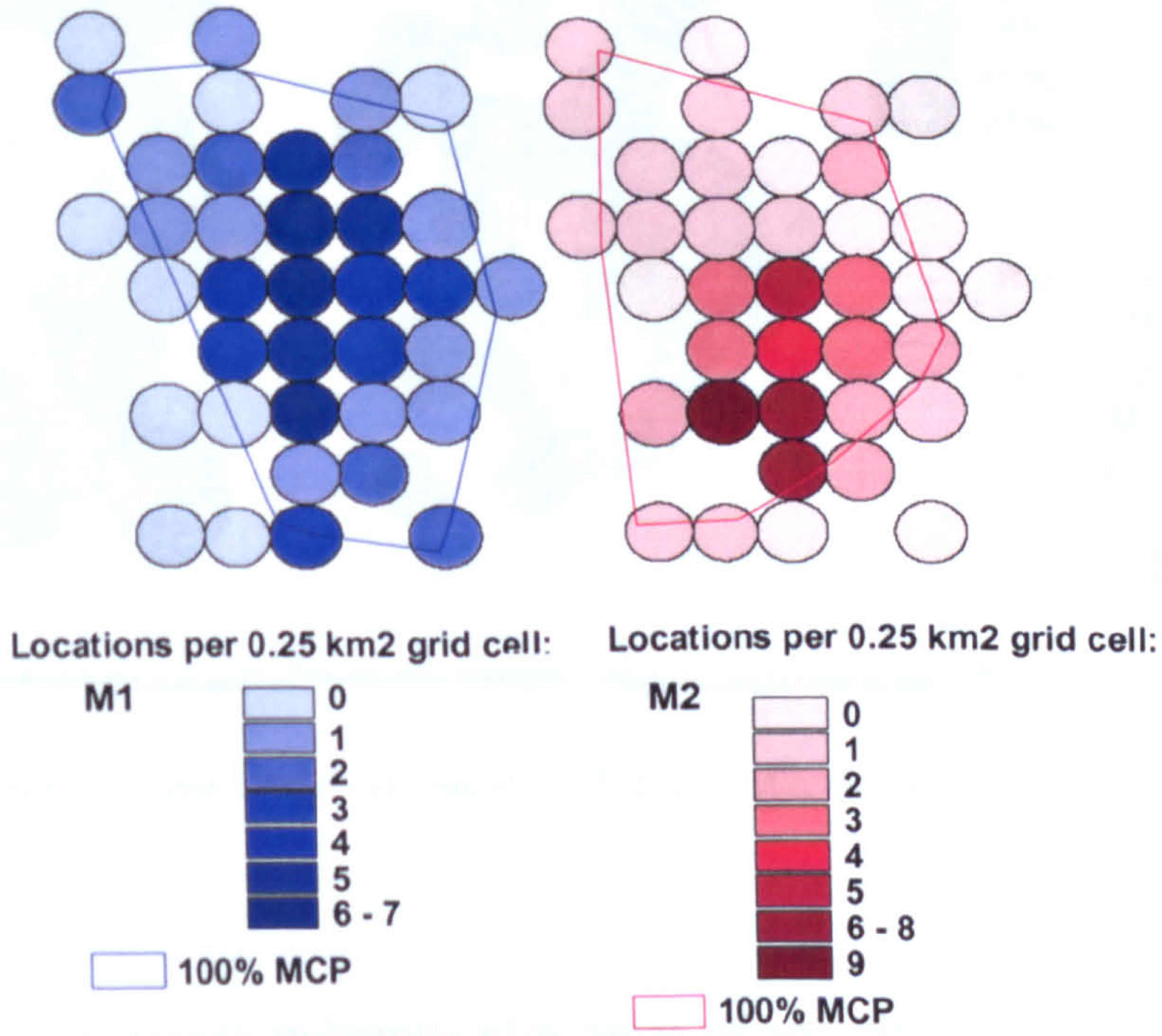


Figure 7-4 Grid cell plot of utilisation distributions for M1 and M2 are shown with 100% MCPs for comparison. Both plots show all cells used by either animal.

7.3.2.1 Fixed kernel method

The fixed kernel method estimates the theoretical probability that an animal will be in any part of its home range at any one time (Figure 7-5) (Powell 2000). For this reason the distribution isoclines for the 95th percentile include convoluted shapes and disjunct islands– there is a 95% probability that the bear would be located within the area circumscribed by that line. As with other methods, less than complete tracking success compromises the validity of this technique for estimating home range. Nonetheless it is useful for examining the internal structure of core areas utilisation. One notable aspect is that the inner 50% core area of the adult, M2, was half that of the subadult, M1.

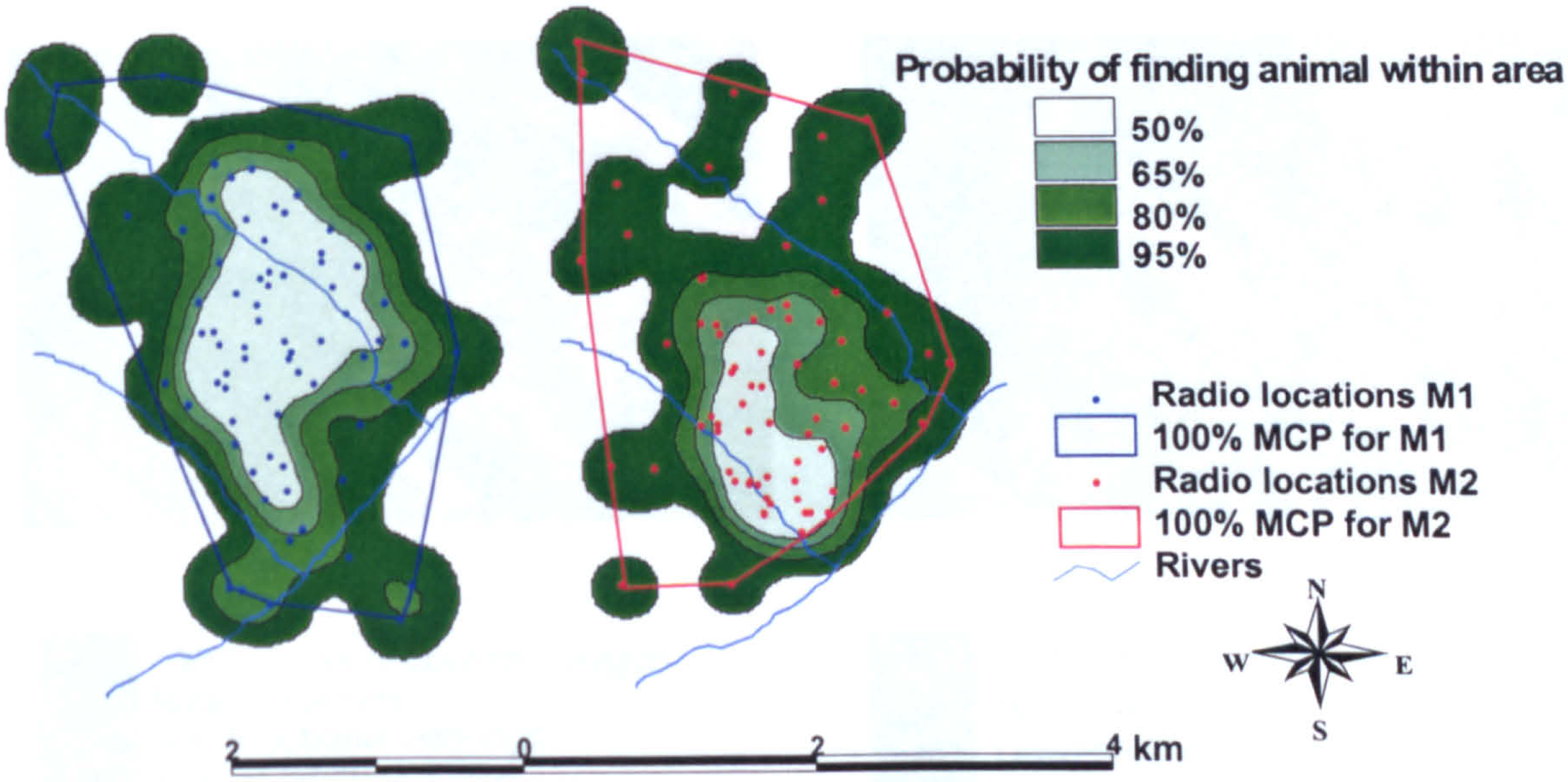


Figure 7-5 Fixed kernel home range estimator for M1 and M2, also showing MCPs for comparison.

7.3.2.2 Minimum convex polygons plus areas of non-triangulated bearings

M1 used one large additional area where reliable triangulation was not achieved. He was located within this "fan" on 16% of the days in which location was attempted. This area was to the north-west of the minimum convex polygons of both bears. M2 had two smaller areas of additional use where consistent signals were received but triangulation was not attained. One area was to the east-north-east, and the other was to the west-south-west. He was located within either of these areas on 14% of the days in which location was attempted. These azimuths were only noted if they were judged to be consistent: clear signals emanating from the same area over a period of hours, rather than diffuse signals that shifted and were judged to be the result of signal bounce. If these areas are added to the 100% MCPs, the home range estimate for M1 more than doubles to 19 km^2, and for M2 increases relatively less, to 10 km^2 (Figure 7-6).

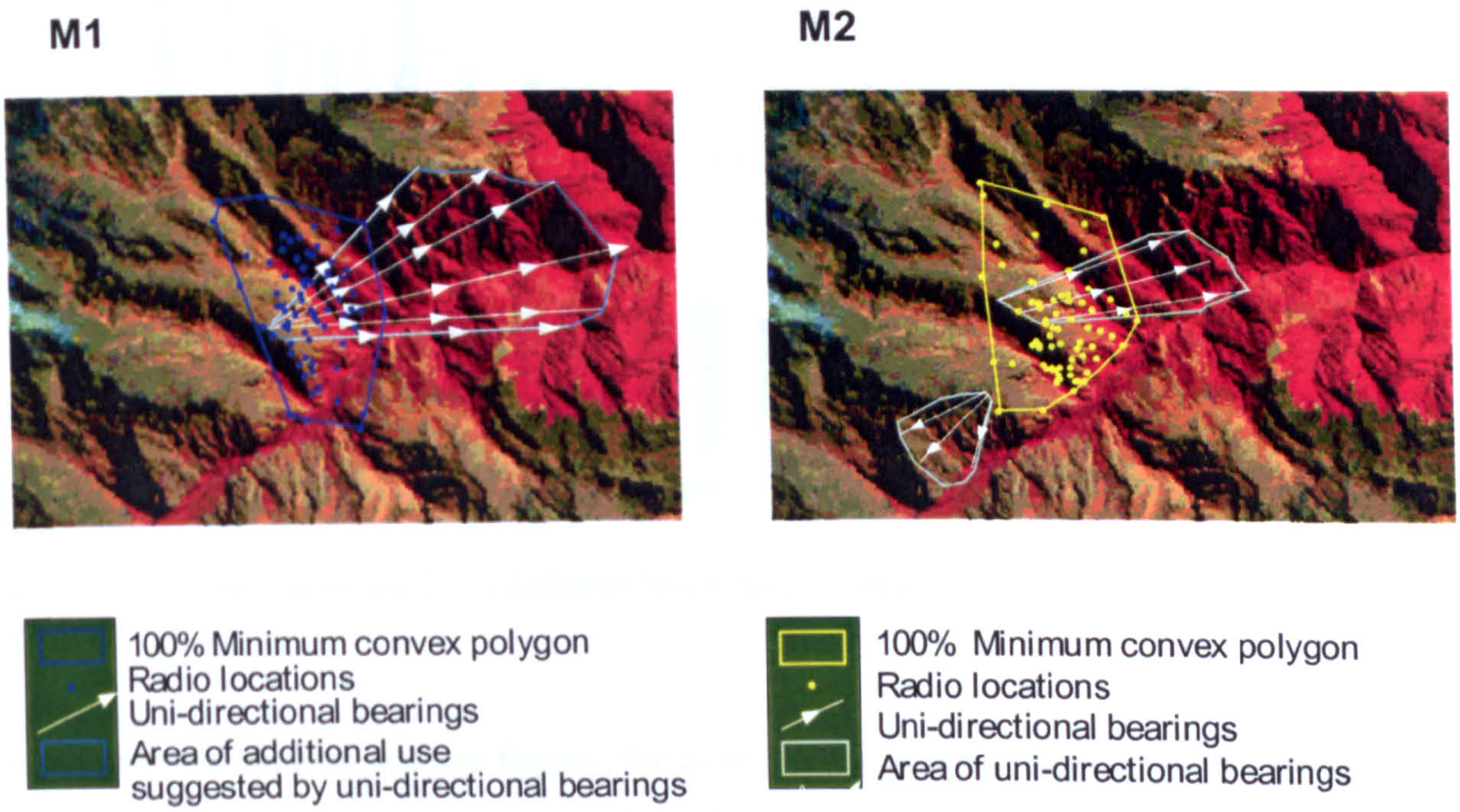


Figure 7-6 Minimum convex polygons plus areas from which consistent unidirectional bearings were taken during 16% and 14% of attempted locations for bears M1 and M2, respectively.

7.3.3 Comparison of results of home range estimators

The home range sizes derived from these three traditional home range estimators differ only minimally (Figure 7-7). The grid cell home range estimates were similar to those from the MCP. In the case of the fixed kernel estimator, the results presented above are for the probability contours associated with each percentage. They are therefore not theoretically comparable with the results of the MCP. For example, the programme estimates that there would be an 80% probability of finding M2 within a 2.4 km^2 area around the central tendency of the clumped locations. The 80% MCP result is the area in which 80% of the fixes closest to the harmonic mean (centre) are located. However, it is worth noting that in most but not all cases the kernel estimator resulted in larger areas than the MCP method.

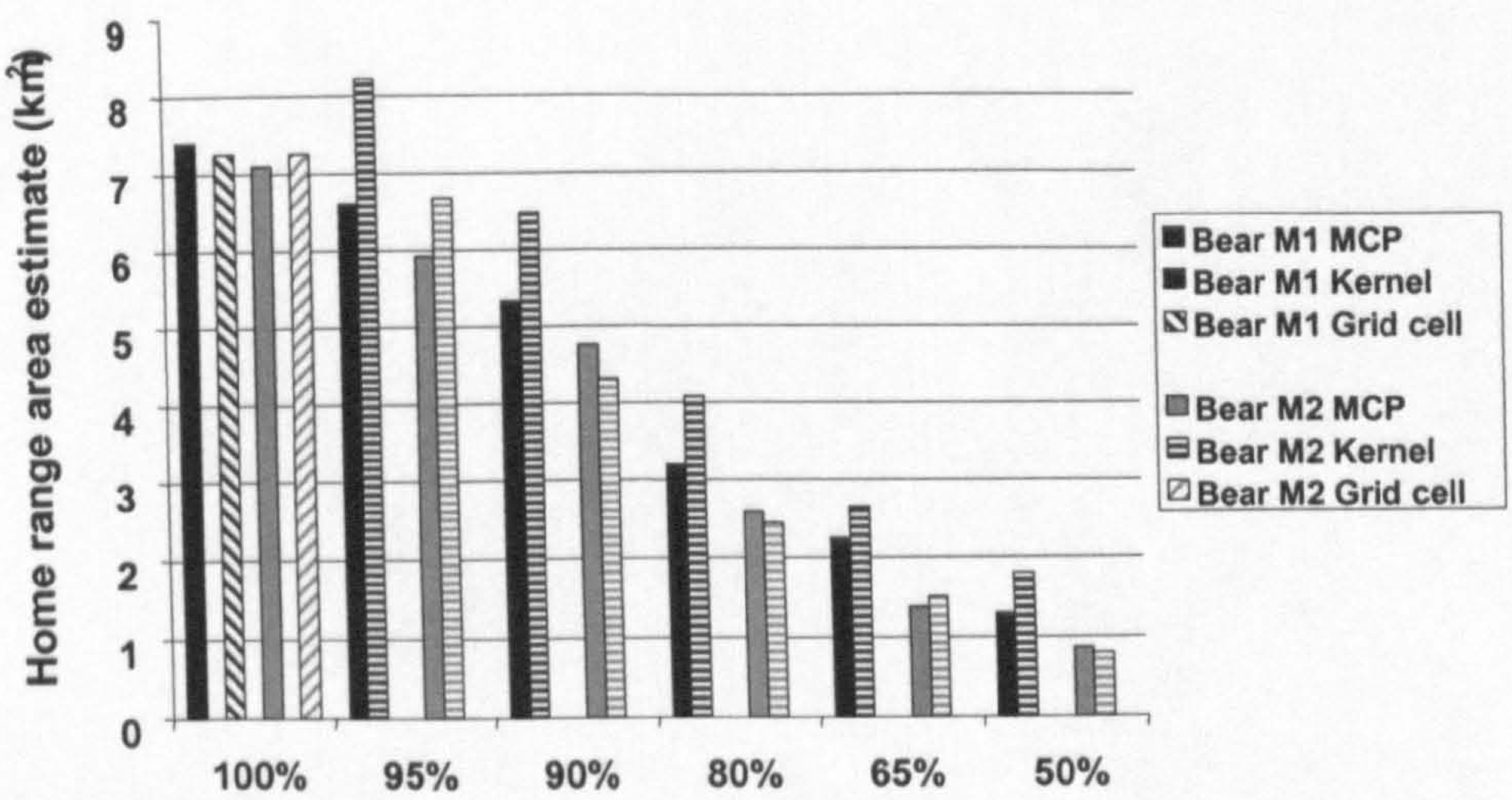


Figure 7-7 Comparison of results of different home range estimators: MCP, grid cell and fixed kernel.

To reiterate the tracking success figures, the above home range estimates for M1 and M2 refer to the bears' use of a core area in which they were found 64% and 70% of the time respectively. Additional areas used by the bears, as suggested by non-triagulated bearings, are represented in order to glean maximum insight from the radiotelemetry data. Although the boundaries of these areas are uncertain, they expand the home range estimates and consequently come closer to describing the real spatial demands of the bears.

7.3.4 Daily movements

The median linear distance between radio-locations recorded in an interval of one to two days (18 to 60 hours) was approximately 800 metres for both bears. This was lower than the median linear distance travelled in longer intervals which was approximately 1200 metres (Figure 7-8). Maximum linear distance travelled in 18 to 36 hours (one day) were 1915 m and 2435 m for bears M1 and M2, respectively. Movements were in fact usually meandering and covered much more distance than is suggested by the straight-line distance between any two points on such a path. The adult bear, M2, travelled a minimum of 6 kilometres during one day in April 1999. This journey also involved a change in elevation of an additional 2000 metres (>1 km ascent and >1 km descent) on what seemed to be a reconnaissance mission around the periphery of his home range.

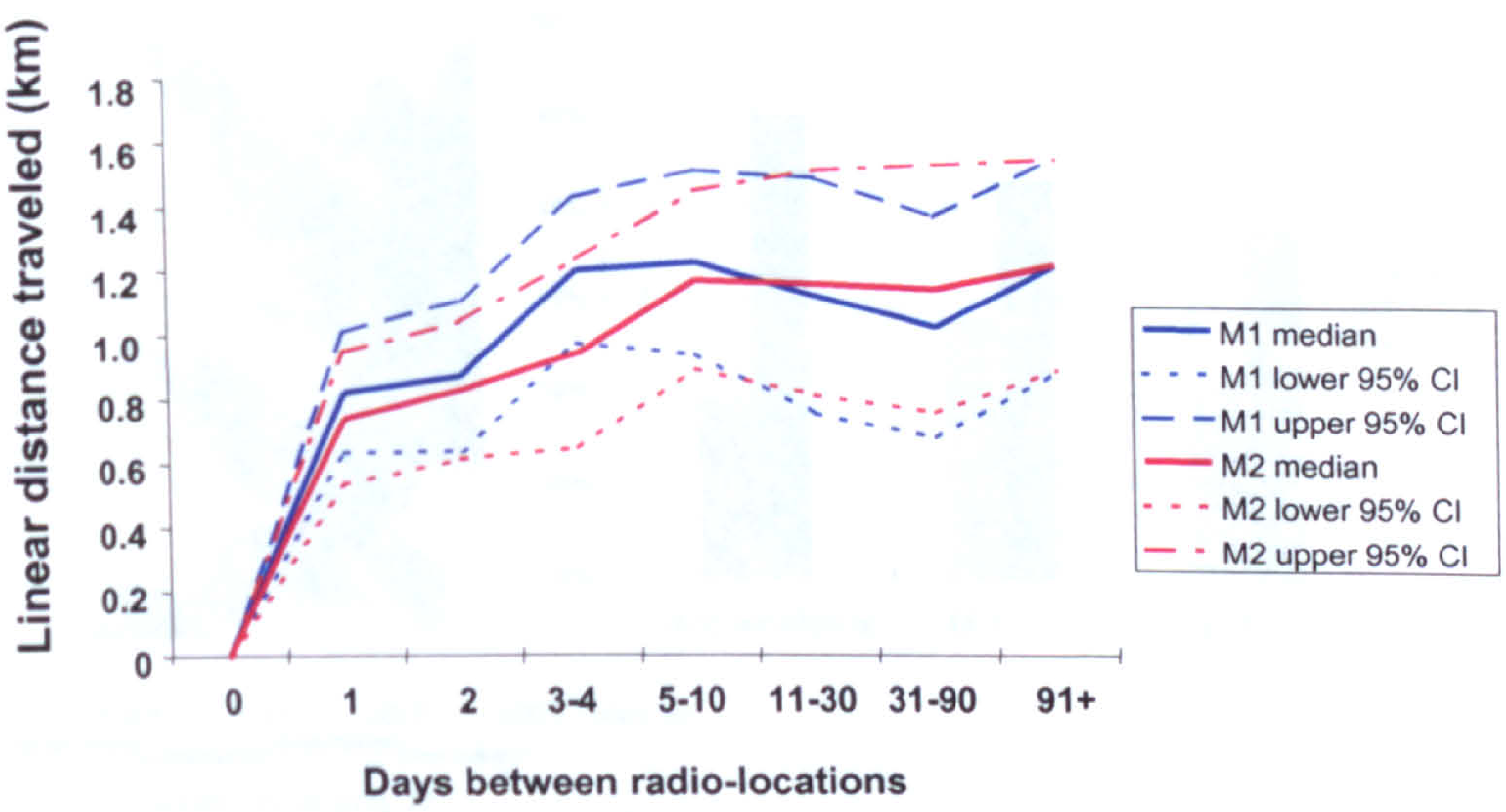


Figure 7-8 Linear distance between radio-locations, using 20 randomly selected pairs of locations at each time interval.

7.3.5 Habitat utilisation

Although the size and shape of the home ranges used by the two bears were surprisingly similar (Figure 7-3), the percentage of locations found in each habitat type tended to differ, particularly in relation to availability of the three habitat types (Figure 7-9). The sub-adult, M1, made more use of the ecotone and forest. In contrast the adult, M2, tended to be more frequently located in the grassland, hugging the highest and most westward margin of the bears' local distribution. However, chi square tests show that overall use differed significantly from availability only for M1 (χ^2=12.90, df = 2, P<0.01) because of the larger percentage of fixes in the ecotone. Despite his seemingly larger use of the grassland, results were not significant for M2 (χ^2=2.49, df = 2, P=0.2).

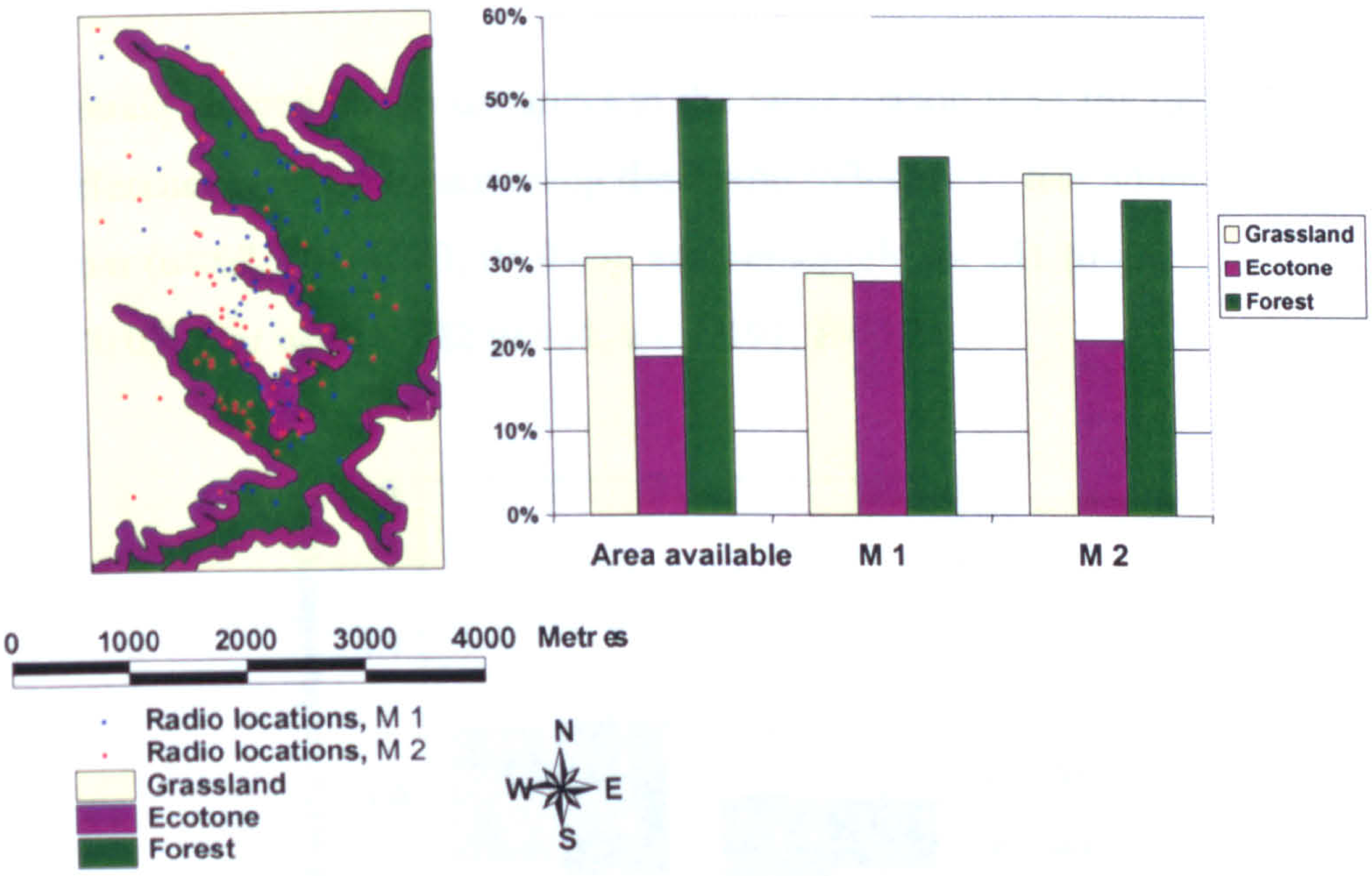


Figure 7-9 Radio-locations in three habitat types. Percentage area available and percentage of radio-locations in each habitat type for bears M1 and M2.

7.3.6 *Seasonal effects*

Habitat use varied markedly through the year (Figure 7-910). The grassland was used most during the rainy season, with its use diminishing through the rest of the year. The forest was used least during the rainy season, with its use increasing through the rest of the year to September-October when it was used 70-80%. The ecotone was used most from January to April. It is noticeable that some use of all three habitats occurred throughout the year.

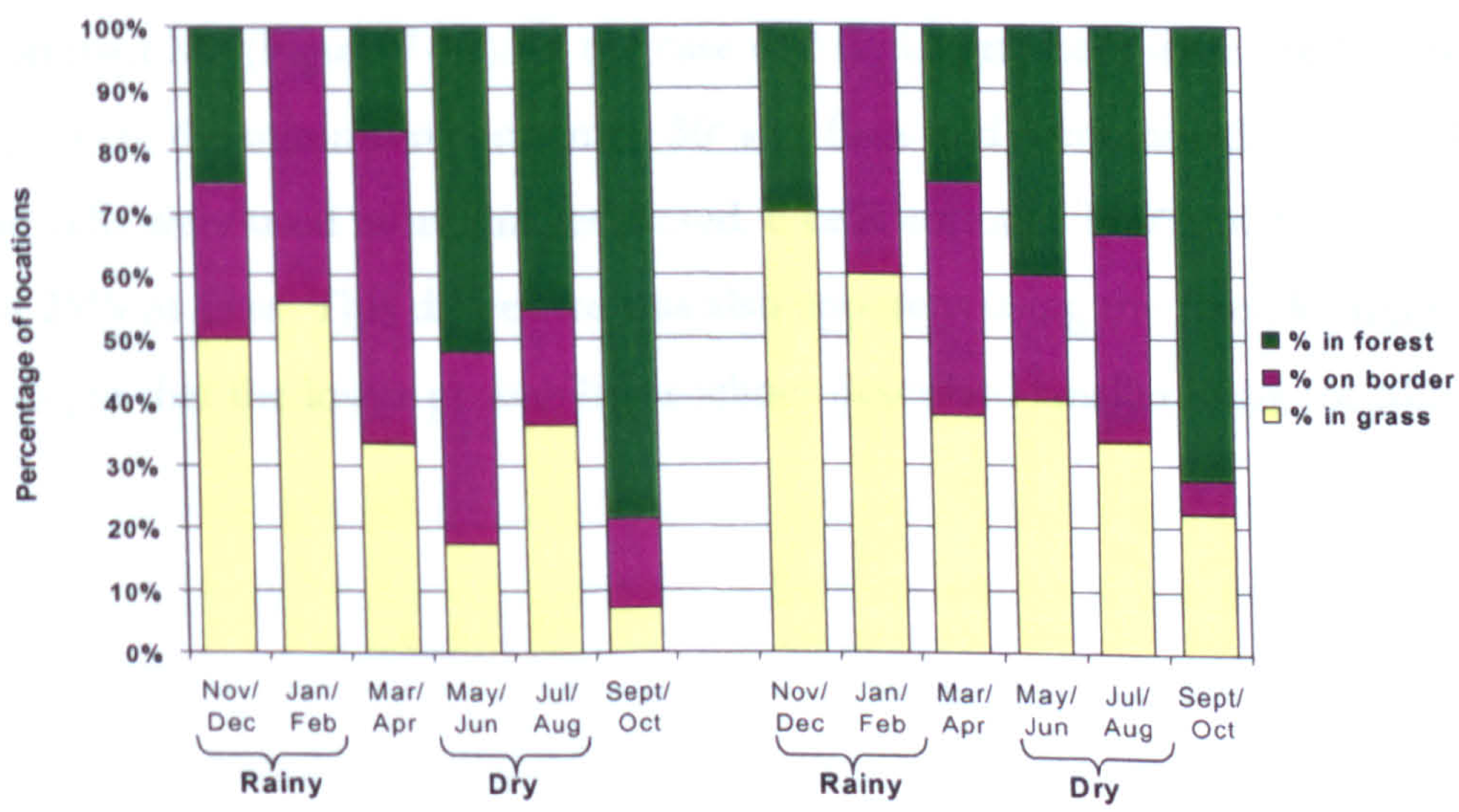


Figure 7-10 Percentage of locations in each habitat type in two-month periods starting at the beginning of the rainy season.

The bears generally moved longer distances in the rainy season than the dry season (Figure 7-11). This difference was significant using the Mann-Whitney U test when both bears were lumped together ($n=62$, $U=-2.203$, $P<0.05$), and separately for M1 ($n=31$, $U=-0.940$, $P<0.05$), but not for M2 ($n=31$, $z=-1.191$, $P=0.246$).

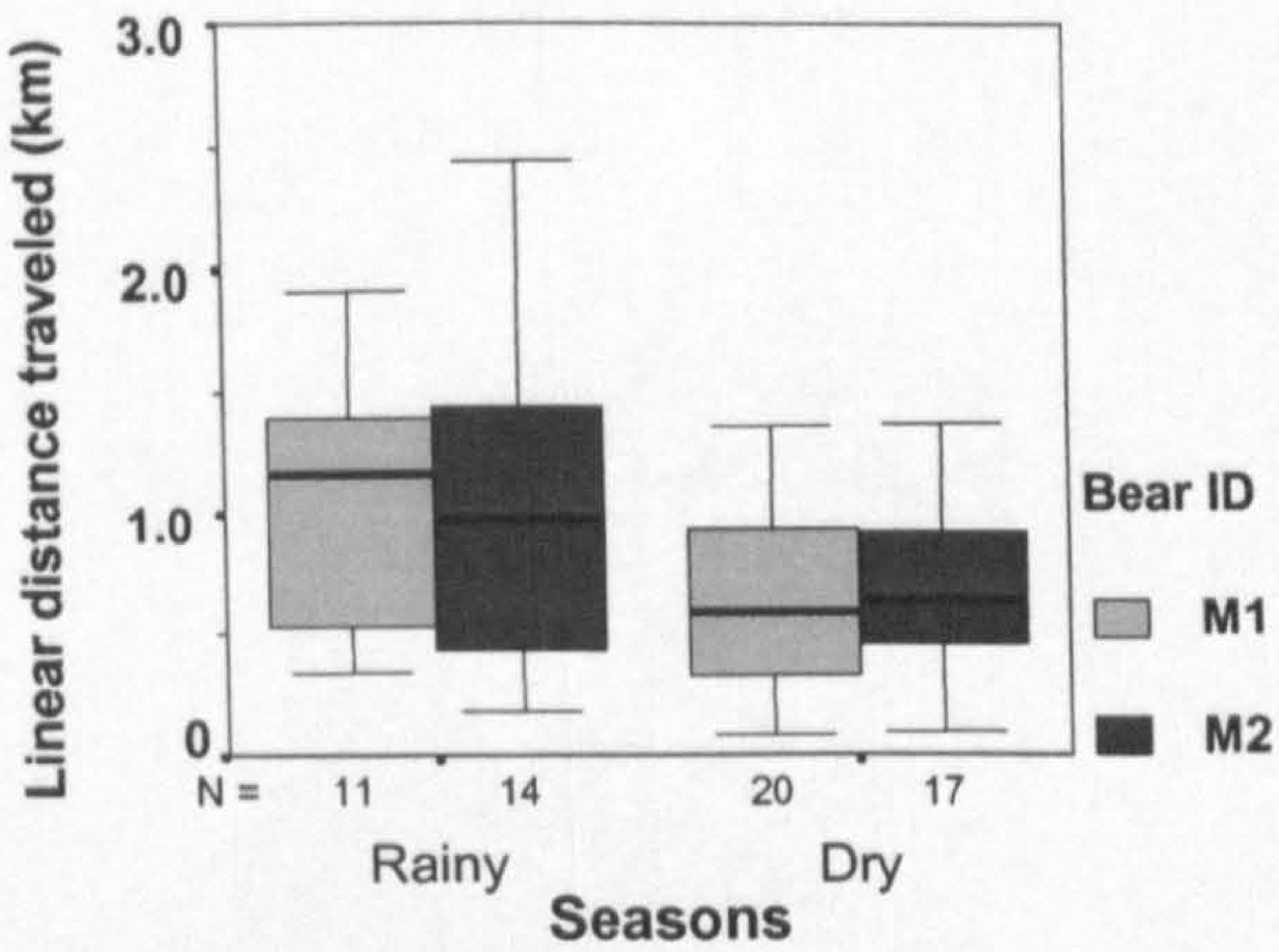


Figure 7-11 Comparison of mean and total range of linear distance travelled in the rainy and dry seasons, with intermediate months excluded from analysis.

7.3.7 Social interaction

Using the grid cell method to evaluate social interaction relies on analysis of the utilisation distributions of two animals. Degree of overlap in each $0.25km^2$ cell results in the overall designation of degree of overlap for the two bears. M1 had a more dispersed utilisation distribution than M2 (Figure 7-12). In the case of M1, 12 grid cells were used more than expected, 7 were the minimum containing 50% of fixes and 3 contained 25%. In the case of M2, 9 grid cells were used more than expected, 6 cells contained 50% of fixes, and 2 cells contained 25% of fixes. This difference was also apparent using the fixed kernel method (Figure 7-5), in that the lower probability isoclines described smaller areas for M2..

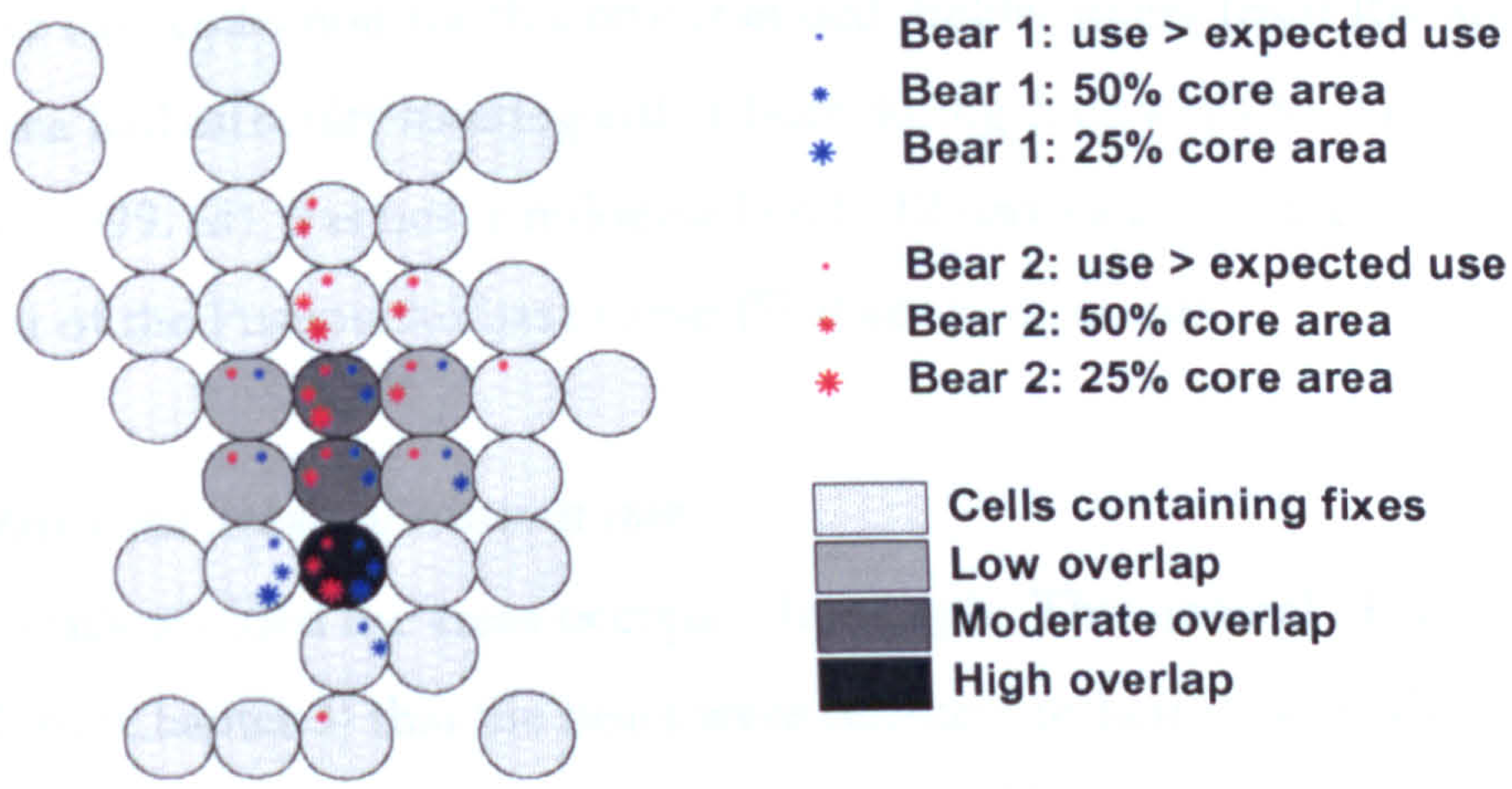


Figure 7-12 Home range overlap using three categories of use for bears M1 and M2.

The two bears showed a high degree of overlap in the cores of their home ranges (Figure 7-12). One 0.25 km^2 cell was part of the innermost core for both bears. This area is on the crest of the Uyuni Mountain. As well as having resources like both epiphytic and terrestrial bromeliads and berries, it provides the best vantage point from which to smell the wind coming up the valley. The bears repeatedly used certain sites for their nocturnal rests. Most of these sites seemed to be open caves or sheltered rock outcrops up high on the crest of the Uyuni Mountain. M1 shared 73% of his home range (MCP) with M2, who in turn shared 76% of his home range with M1.

The median distance between the two bears on the 38 days that they were located simultaneously was approximately 1 km. However, they were located within 100 metres of each other on eleven days in the months of January, April and July. The two bears travelled together during July 21-24 1998. During this time, their activity patterns were roughly synchronised, their radio-locations were consistently within 100 metres of each other, and their signals disappeared in synchrony when they crossed to the other side of the ridge out of range of the receivers.

During the latter part of the study, both bears left the two main watersheds in which they were usually located, although they were never absent at the same time. M1 was out of range during April 1999 and June 1999. M2 was out of range during most of November 1998 and May 1999. After data collection for this report ended, fieldworkers Josef Rechberger and Herminio Ticona had difficulty locating either bear during four visits to the study site from July to October 1999. M1 was never re-located and M2 was located once about 15 km to the north-northeast of the Pusupunko base camp (Wallace pers. comm.).

7.3.8 Overlap with areas of human use

The bears generally avoided the areas occupied by people. This general observation echoed the local wisdom (Chapter 3) that the bears were sensitive to human arrivals, and would only explore areas of intensive use when people were absent. The only evidence of bears approaching and exploring the research camp occurred when the site was vacated during January and February 1997. Bear tooth and claw marks were found on small trees and a thick plastic water bag was chewed. Overlap between the local owners of the mountain and the bears occurred when the owners occasionally entered the forest to cut wood, or cut and burn small patches of forest to cultivate corn (Figure 7-13).

Cows also occasionally descended to the forest/grassland ecotone shown to be of importance to bears. However, cows, mules and donkeys spent most of their time grazing in high valleys that were seldom used by bears. The practice of burning the grasses at the end of the dry season to encourage growth of succulent new shoots has long caused overlap between bears and cows, both of whom are attracted to this resource. This practice has been losing popularity as people have observed the cows climbing to dangerously precipitous areas in search of these sweet young shoots and then falling to their deaths. Burning did, however, take place across the Pelechuco River during the study period and bears other than the study animals were observed in this area when the new shoots were growing.

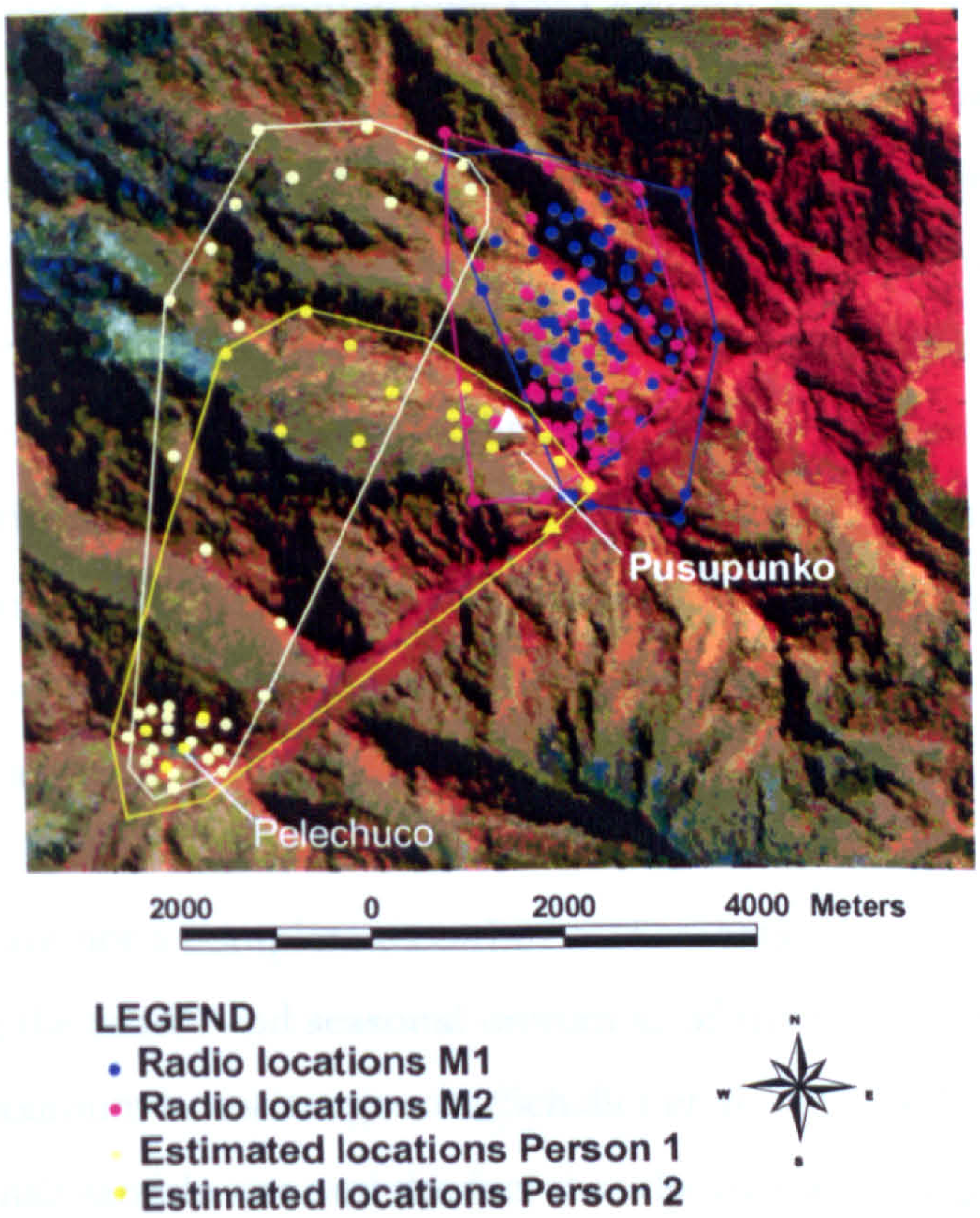


Figure 7-13 Overlap of radiotelemetry locations for bears M1 and M2 with areas of human use.

Potato cultivation, the other main activity at this altitude and distance from the town, took place at high elevations in areas not used by the bears. During the study, no bears visited the small maize fields at the bottom of the valley, although fields were within the home ranges of both monitored bears. These maize fields were located in small flat areas near the Pelechuco River. While they were heavily predated by parrots and rodents, no sign of bear exploration or exploitation was found, nor were the bears ever located within 200 m of these fields during radio-tracking. This is surprising given that the fields were largely untended and that human presence was rare.

7.4 DISCUSSION

This is the first study of the home ranges and movement patterns of Andean bears. Radiotelemetry has never been attempted with wild Andean bears due largely to the thick forest, cold and rainy weather and the precipitous terrain. This study has shown that radiotelemetry is a viable technique for studying the movement patterns of Andean bears, although these factors did hinder tracking success. Nevertheless, important characteristics of the movement patterns of two Andean bears were revealed in this study through the use of radiotelemetry. In accordance with theoretical predictions, the two bears occupied relatively small home ranges. Both bears demonstrated seasonal variation in their habitat use. Overlap between the two home ranges was extensive, and the interaction between the two bears suggests a generally solitary habit with occasional tolerant contact. Contact with people, on the other hand, was avoided.

The data presented are not a complete record of movements. Nonetheless, the insights presented regarding the spatial and seasonal utilisation of the home range may be of more importance than maximum home range size (Schaller et al. 1985). Obvious short-comings of this study are the small sample size and the fact that the two individuals monitored were probably not key players, in reproductive terms, in the local population. There is, however, reason to believe that the movement patterns exhibited by the two bears studied would be representative of other male bears in the study area. The core home range size of the two bears was similar, suggesting that their minimum energy requirements were the primary determinants of their use of space. Furthermore, their patterns of seasonal variation in use of space were also very similar.

7.4.1 Home ranges of Andean bears

The bears radio-tracked in this study inhabited extensively overlapping core home ranges which are, by ursid standards, quite small (Joshi 1995), but within the 4-30 km^2 range of the other tropical bears (Garshelis, 2001). This finding conforms to three theoretical predictions made across animal groups that seem to hold true for the ursids. First, home range size is positively correlated with body mass (Harestad and Bunnell 1979; Gittleman and Harvey 1982). Second, home range size relates to the quality of food required; herbivores require smaller areas to provide foliage, and omnivores require larger areas to provide higher quality foods such as fruits, nuts and flesh which are necessarily more spread out (Linn 1984; Gittleman and Harvey 1982). A third correlation is geographical: animals need smaller home ranges as latitude approaches zero due to the increasing solar energy available for basic production (Gompper and Gittleman 1991). Because Andean bears are relatively small, highly herbivorous omnivores and tropical, these three factors would all point to small home range size.

American black bears have been used as the basis for conjecture about Andean bear home range size and population density (Yerena and Torres 1994; Peyton et al. 1998) for several reasons. Of the well-studied species (American black, polar, and brown) they are the most similar to Andean bears in terms of body size, and diet. However, the differences are many: American black bears hibernate (necessitating a hyperphagic phase never undergone by Andean bears); they are heavily hunted in most populations; and they inhabit temperate, boreal habitats which are generally lower in primary production but which benefit from hard mast and augmented cervid populations. Pandas are another species with which instructive comparisons can be made due to their herbivorous diet. But the species that should use space most like Andean bears are the other tropical species: sloth bears (though less so because of their myrmecophagy) and sun bears. If the minimum convex polygon areas plus the areas of uni-directional bearings are used as home range estimates, Andean bears are within the 4-30 km^2 home range sizes that have been reported for pandas and the other tropical bears.

The home ranges of the Andean bears in this study, found to be just over 7 km^2 using 100% minimum convex polygons, were very close to allometrically predicted home range size for an omnivore of 30 kg which would be 7.76km^2 (Harestad and Bunnell 1979). The home range size should increase with weight so that a bear of 100kg (Andean bear mean body mass) (Suarez Martinez 1985) would have a home range of 23.5 km^2. This improves on the estimate of 48.5 km^2 for a 100 kg animal (Yerena and Torres 1994) which seems to have been based on an incorrect calculation of Harestad and Bunnel regression. An omnivore is defined in this study as an animal with more than 10% meat in its diet, a requirement not quite met by these bears according to the results of the faecal analysis in this study (see

Chapter 5). Were the percentage of dietary meat less, as it is in other studies, these bears would be classed as herbivores and would have an allometrically predicted home range size of 0.73km^2 (or 2.5km^2 for a 100kg bear). However, the Harestad and Bunnel relationship has been re-evaluated extensively with the conclusion that the scaling of home range is, in fact, very poorly understood (Reiss 1988).

Latitude and precipitation can be used as surrogate variables for habitat productivity (Harestad and Bunnell 1979; Leith and Whittaker 1975), hence, habitat becomes more productive and home ranges smaller and with increasing precipitation and as latitude approaches the equator. Considering the low latitude of the study site (14°S) and the high precipitation (>1800mm), a home range size fitting so neatly with the regression equation derived with temperate data is larger than would be expected (especially given that the real home ranges were larger than the MCP estimates). This might be related to one of three explanations: an abnormally unproductive habitat, inaccuracy of the model, or the confounding influence of altitude. A similar correlation with precipitation and latitude has been reported for productivity of Andean bear habitat using observed population density and reported litter sizes as a measure (Peyton 1999). The best bear habitats would then be from Colombia to northern Peru, with Venezuela in the north and then southern Peru to Bolivia being relatively poorer (Peyton 1999).

Beyond energy requirements (related to body size) and distribution of foods (related to trophic status), factors that determine home range size are reproductive requirements, and intraspecific relations (Gittleman and Harvey 1982; Gompper and Gittleman 1991; Mizutani and Jewell 1998). In this study little evidence is available about these two latter factors. While females will have come into oestrus during the study period, any movements by the adult associated with attempts to mate were not identified as such. It is possible that intraspecific interactions curtailed or indeed expanded the home ranges of both bears.

7.4.2 Seasonality

Andean bears display seasonal shifts in their habitat use due to changes in food availability (Figure 7-10). Bears travelled further in the rainy season, and had larger home ranges. Food resource availability seems likely to be the primary determining factor in the movement patterns of the bears in this study. In Chapter 5 it was shown that bears' diets varied throughout the year and in Chapter 6 that activity patterns also showed seasonal variation. Carcasses were more available in the rainy season, and travel in the open is safer for bears during these months because of reduced human traffic. The carcass of a cow may represent enough of a bonanza that patrolling for them may be worth the extra energy expended. Tree fruit in this study was consumed in the late dry season and early rainy season (Chapter 5). Trees of the Laureacea family are known to fruit during the dry season, providing important bear food throughout the bears' range (Peyton 1980). The bears' use of smaller areas in the forest during this time is likely to be related to fruit availability. It has been reported in primate studies that patterns of range use are related to distribution of fruit rather than other foods such as arthropods or young leaves (Terborgh 1983; Hill 1991).

Ursids commonly shift their seasonal ranges following changes in the distribution and abundance of foods (Joshi 1995). The seasonal changes in ranging patterns observed in this study are not large in comparison with what has been observed in other species such as American black bears, in which distances between often disjunt seasonal ranges can measure many kilometres. Seasonal ranges overlapped in this study. Although use of habitat varied, the full range of habitats was visited throughout the year.

There is a paradox in relation to the data presented in the previous chapter, given that in the rainy season mobility is increased at the same time that percentage activity is decreased. This may be explained in terms of the optimal foraging model (Schoener 1971; Begon et al. 1996). Andean bears in this study travel more widely in the rainy season, regularly exploiting *Puya sp.* and other terrestrial bromeliads, in search of the nutritive bonanza of dead cows. However, they travel on a low energy diet, necessitating more rests.

7.4.3 Social interaction

The two Andean bears in this study spent limited time in close association, travelling together for days at a time. If the two bears radio tracked are representative of male bears in the study area, we might picture the male population as being composed of a dynamic mosaic of individuals with extensively overlapping home ranges. There was no indication of territorial behaviour, although this is not surprising for male ursids. Rather, the animals fluidly adjust their movement patterns to exploit locally abundant food resources (Mares et al. 1992). They might therefore make periodic patrols of ridges around the peripheries of their home ranges not to defend them against conspecifics, but in order to keep informed of food resources available and the whereabouts of other bears. The males would come together and even form rudimentary social groupings when concentrated food resources made that arrangement advantageous.

Their movement patterns were characterised by sporadic trips outside the main watersheds in which they usually resided. Excursions at long, irregular intervals are reported for pandas (Schaller et al. 1985). This sort of movement has been anticipated in Andean bears due to the importance of tree fruit in their diets and the irregular fruiting cycles of many of these species (Peyton 1980). The alternating "disappearances" of the two bears may have other explanations. The more dispersed and peripatetic movements of M1 are in keeping with what would be expected from a sub-adult male bear. His disappearances are likely to have been exploratory movements resulting from investigations of potential new areas in which to establish a home range (Garshelis and Pelton 1981). The home range of adult, M2, was more stable with a smaller core area. Tracking success was also higher for M2. The fact that M2 was an undersized animal suggests that this was a marginal area to which he had been forced to retreat as larger more dominant animals occupied the more desirable habitat at lower altitudes. His two disappearances in November 1998 and June 1999 may have been related to forays in search of breeding females or, indeed, visits to a locally abundant food resources.

Another aspect of social interaction revealed by radiotelemetry was the occurrence of infanticide. The adaptive significance of infanticide has been speculated about but never fully determined. It is thought to confer benefits on the male by bringing the female into oestrus more rapidly at which time the male can inseminate her and try to be more certain of the next cubs' paternity. It may also reduce competition of those cubs with the male for limited resources in his home range (Taylor 1994). One effect of the risk of infanticide is that females avoid males when they are with cubs (Mattson 1990).

The movement patterns of females are likely to differ from those of males. In the typical ursid reproductive strategy males have larger home ranges encompassing those of various females (Stirling and Derocher 1990). In solitary mammals, including black and brown bears, females tend to be philopatric, remaining in or near their natal ranges throughout their lives, while males disperse greater distances to establish their home ranges (Alt 1978; McLellan 2001). Panda females seem to have comparatively small home ranges in gently sloping, forested areas. These areas are not shared by other females (Schaller et al. 1985). Likewise, female American and Asiatic black bears in some populations have home ranges exclusive of other females and thus could be considered territories (Garshelis 2001; Rogers 1987). In the Pusupunko area there have been numerous reports in the last three years of a female with cubs. On five occasions during the study I observed a medium sized individual (approximately 75 kg) that I assumed to be this female. Though I never saw her with any cubs, she may have been the mother of M1. In October 1999 a cub was observed (Garcia E. 1999). This may have meant that she did not successfully reproduce during 1998 but stayed in the area and avoided capture.

7.4.4 Interaction with areas of human use

Overlap with areas of human use was observed, although the bears seemed to use temporal avoidance of people more than spatial avoidance, exploring areas of human use when people were not present. The avoidance of maize fields observed in this study is surprising given that many bear species including Andean bears are known to make extensive use of maize in isolated fields such as these (Mattson 1990). This avoidance may have been the result of negative encounters with people. The Pusupunko study site is at the westward limit of the local range of the species, although there are a few reports of bears wandering closer to the town of Pelechuco. The forest to the east of the study site has few if any human inhabitants for at least 40 km. Any contact taking place between bears and people, therefore, is likely to occur in the region of this study. Many bear food resources were available in the forest/grassland ecotone, as well as the grassland. These grassland areas are also utilised by people for herding and cultivating tubers. Despite the shared use of this habitat type, contact between bears and people is by all indications minimal. Bears have been shown generally to avoid humans unless given no option or attracted by rich foods (Mattson 1990).

Stories of the struggle to defend crops and livestock from bears arose amongst the folktales and original stories of Chapter 3. In Chapter 5 the bromeliads that form a large part of Andean bears' diets were shown to be of low nutritive value, increasing the relative importance of more protein-rich foods such as forest fruits and wild carrion and also anthropogenic foods such as maize and livestock. In the previous two chapters it was shown that bears were active at the same time as people, and that their home ranges overlap to a minimal degree with those of people. With some background on myths and attitudes and knowing now something about the activity and movement patterns of Andean bears, let us turn to the issues that arise when the activity and movements of bears bring them into contact with people.

7.5 SUMMARY

1. Less than complete tracking success was achieved for the two bears. The home range estimates in the range of 7-9 km^2 should therefore be treated as representing only a core area used approximately two thirds of the time. This estimate is, however, in keeping with allometric predictions of home range size, and within the home ranges found for other tropical bears.

2. The bears' median daily distance travelled was approximately 800 m. The longest recorded daily movement was > 6 km.

3. Both bears had larger home ranges in the rainy season. They also displayed a clear pattern of varying seasonal use of three habitat types. Use of the grassland was greatest at the beginning of the rainy season, diminishing thereafter through the year. Use of the ecotone was greatest from January to April. The forest was used least in the early rainy season, its use increasing until September/October when it was used in 70-80% of the fixes. The bears made longer daily movements in the rainy season.

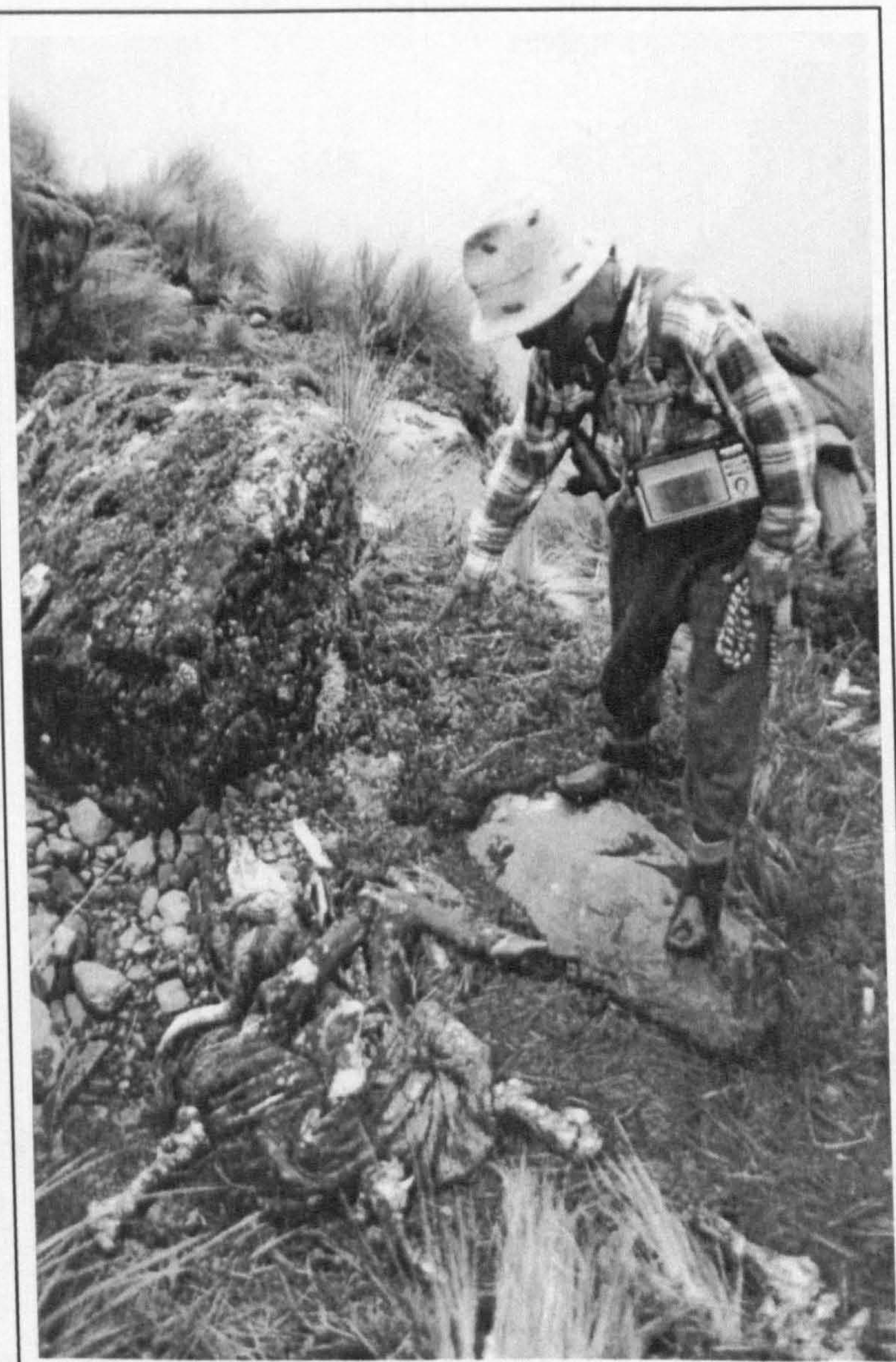
4. The two bears showed a high degree of home range overlap. Their innermost core areas overlapped in the forest/grassland border on the ridge in the middle of the study area as it descends to the river. This was an area of abundant food resources and access to olfactory information gathering as the winds rise up the valleys.

5. The two bears spent at least four days in close company. They were also found within 100 metres of each other in the months of January, April and July.

6. As well as overlapping with each other, the home ranges of both bears overlapped to some degree with the home ranges of the occasional native human inhabitants of the mountain as well as with those of the researchers.

Chapter 8

LIVESTOCK PREDATION AND CROP-RAIDING



Reynaldo Laso with the carcass of his cow, "Siete", surrounded by bear faeces.

8.1 INTRODUCTION

Wildlife conflicts are of paramount concern for conservation. Where people experience depredation they often have to invest considerable time, energy and other resources in protecting their crops and livestock, and ineluctably they come to oppose wildlife conservation (Hill 1997). Grass-roots leaders of the agricultural community in the United States have reported massive losses to wildlife, reaching into hundreds of millions of dollars annually. These conflicts were widespread, with 89% reporting damage caused by wildlife, and 59% claiming that this damage exceeded tolerance. Because of the potential threat to their livelihoods caused by such damage, over half of these farmers would oppose the creation of a protected area in the vicinity of their farm (Conover 1994).

Conflicts with bears are more complex than those with other predators. Bears are intelligent, inquisitive and expert at foraging for the richest energy foods (Gilbert 1989). Most of the energy-rich food resources have been commandeered and augmented by human society (Mattson 1990). Because of this life history strategy, bears come into conflict with people more extensively than do other carnivores. Bear/people conflicts arise in endeavours such as agriculture, apiculture and forestry. Particular problems include depredation of maize, berries, grain, orchards and bee hives, stripping trees of bark, raiding stored and processed human foods and garbage dumps, as well as killing livestock (Herrero 1999). Despite the diversity of conflicts between bears and people, it is the threat of bears killing people or livestock that emerges as the most serious issue (Mattson 1990).

8.1.1 Livestock predation

Significant use of cattle by brown and American black bears has been documented throughout Russia and western North America (Mattson 1990). Although predation does occur, scavenging is also common, and is often falsely interpreted as predation (Knight and Judd 1983). Studies of livestock depredation in the Cantabrian mountains of Spain have shown brown bears to be efficient scavengers of wild and domestic ungulates (Mysterud 1973; Clevenger et al. 1992). In this site livestock densities are high and provide bears with a steady, year-round supply of carrion, which forms an important portion of bears' diets.

Predation on livestock was infrequent, but did occur in Spain, Norway, and North America (Clevenger et al. 1992) [Mysterud, 1973 #576]. Data on bears' killing and feeding behaviour have been collected and analysed in North America and Europe, in order to identify bear predation in sites where compensation programmes are in operation.

Bear populations display remarkable variation in styles of killing. Bites can be administered to the face, head, neck or withers (Acorn and Dorrance 1990). Heavy blows are often evidenced by broken bones in the spine (Wade and Bowns 1985). Preference is shown for the viscera in most European populations, but Spanish and French bears also consume muscle tissue from the hind and forequarters (Couturier, 1954). American black bears and brown bears generally consume meat before viscera. The hide is usually peeled back, and the bones are not scattered and broken as they are by other predators. The relatively blunt claws do not pierce the skin (Acorn and Dorrance 1990). Black bears are known to attack lactating ewes and consume their udders (Wade and Bowns 1985).

Andean bears are alleged to be livestock killers in many parts of their range. Opinions differ on the prevalence of predation versus carrion feeding (Rumiz and Salazar 1999). Suspected predation has been reported in Venezuela (Mondolfi 1989; Goldstein 1991), Colombia (Poveda 2000), Ecuador (Suarez Martinez 1985), Peru (Peyton 1980), and Bolivia (Rumiz and Salazar 1999). Bears are commonly convicted, and sentenced to death, on the circumstantial evidence of scats and feeding sign around a carcass (Goldstein 1991; Rumiz and Salazar 1999). Andean bears may be adept at locating carrion, but this does not constitute evidence of predation (Goldstein 1991). Predation has been confirmed by only two published reports from Venezuela (Goldstein 1991, 1998). Predation was supported by evidence of a struggle at the kill site, and by the cessation of predatory events after the bear suspected of predation was destroyed (Goldstein 1991). Regardless of whether or not they kill the animal, Andean bears follow a pattern of feeding behaviour: the carcass is dragged to hiding cover, where it is consumed. The skeleton and peeled-back hide are left relatively intact. The carcass may be moved several times during consumption. Tree nests, and resting sites on the ground, are associated with these feeding sites and many, often loose scats are apparent in the near vicinity (Peyton 1980; Goldstein 1991, 1998).

8.1.2 Crop-raiding

Few studies of crop depredation by vertebrates were carried out until the mid-1990s, when studies began on vertebrate pests, most notably on elephants and primates in Africa. Studies in Uganda, Kenya and Tanzania have identified predictors of damage that include human population density, distance from forest edge, and hunting (Baldus 1988; Naughton-Treves et al. 1998; Newmark et al. 1994). Additional factors identified in explaining elephant damage in Tsavo include distance to the protected area, distance to water, and possibly traditional elephant migration routes (Smith and Kasiki 2000). Baboons have been studied as crop pests in Uganda, where proximity to the forest, and isolation of the field increased the likelihood of damage to maize and cassava crops (Hill 2000).

Bears make substantial use of agricultural crops, particularly oats and maize, in any site where they are available (Mattson 1990). Depredation of maize by bears has also been studied and described in many sites in North America and Japan (Mattson 1990). Bears are not among the worst agricultural pests in the United States, being listed as a problem by only 3% of farmers (Conover 1994). However, bear depredation can be locally intense, with more than half of respondents describing bear depredation in certain sites in that country (Garshelis et al. 1999). Additionally, bear damage is conspicuous; American black bears are perceived to be messy, leaving large areas destroyed (Garshelis et al. 1999). Most bear use of corn occurs in isolated fields, or on the peripheries of more extensive areas of cultivation, hiding cover being a principal determinant of crop-raiding patterns (Mattson 1990; Garshelis et al. 1999). Depredation of crops by bears is most severe at the interface of wild- and croplands (Mattson 1990).

Crop depredation by Andean bears has been described in Colombia (Orejuela and Jorgenson 1999), Ecuador (Adams and Mazariegos 1994; Suarez 1999), Peru (Peyton 1980), and Bolivia (Rumiz and Salazar 1999). The attractiveness of maize for bears is undisputed. In Bolivia, maize field raiding has been described in June and July, and linked with a concurrent absence of fruits in the forest (Rumiz and Salazar 1999). Anecdotal reports of bears feeding on maize have been made in Peru (Peyton 1980). Bears were observed raiding during the day, after cautiously entering the fields from adjacent hiding cover. They plucked and cleanly ate the maize in situ, or carried it into the forest to feed there. He described the use of crop guards and plastic flagging to keep bears away. Neither the clearing away of vegetation from the field's periphery, nor the burning of tyres on the entry trails were effective at deterring the bears. In 20% of the fields surveyed he found that bears had consumed approximately half of the crop. He also found three fields in which the maize had been completely consumed by bears (Peyton 1980). Several authors have pointed out the vulnerability of maize-habituated bears to hunters (Peyton, 1980; Rumiz, 1999).

8.1.3 Research questions and structure of chapter

The following research questions provide a framework in which to examine the two main types of depredation caused by bears in Apolobamba: alleged livestock predation, and crop-raiding.

- What are the predator and livestock species most involved in conflicts in Apolobamba?
- Are Andean bears perceived to be a threat to livestock inside and/or outside the protected area?
- Do bears kill livestock in Apolobamba?
- What animals are perceived to cause the most damage to crops?
- Are bears are considered serious crop pests?
- How severe was the problem of crop-raiding during the study period?
- What are the determinants of crop-raiding by bears?

This chapter looks first at livestock predation, as it is perceived by interviewees, and then as it could be documented in the field. Crop-raiding is then investigated. The agricultural scene is set using data from a meeting in the farming community of Pajan. Participatory techniques were employed in gathering this data. This is followed by qualitative and quantitative interview results, and by surveys of maize fields in which damage, and determinants of that damage, are evaluated.

8.2 METHODS

8.2.1 Semi-structured interviews

The final sections of the semi-structured, open-ended interviews were devoted to questions of conflict and management (see 2.3.4. for detailed methods and sections III & IV of

Appendix 1 for interview guide). It is difficult to observe predation events and indeed, in the extensive mountainous pastures where livestock are kept, even to locate a carcass early enough that the cause of death may be determined. In assessing livestock losses, it is important to take into account the knowledge of local people. This is often much more extensive than that of researchers, who visit their areas infrequently. The knowledge and beliefs of livestock owners themselves are of great importance to conservation, inasmuch as it is they who often kill whatever predators they believe killed their animals. The attitudes and knowledge of local people about livestock predation and crop-raiding were documented as part of the larger series of interviews throughout the Apolobamba area.

8.2.2 Livestock predation – reporting and investigation

A system for reporting livestock losses from disease, accidental death and depredation, was established in August 1997. Notification of livestock deaths came to us either from official sources (the RNFUU wardens), from the herders themselves, or from local word of mouth. Sites were visited as soon as possible after we learned of them. Without the promise of a reward, it proved difficult to stimulate broad participation. Many livestock deaths were not reported, and were only discovered long after the event, during visits to the community. This was partly due to negative feelings about the protected area, and about the necessity of reporting the deaths through the wardens, who were often disliked by the farmers.

A new protocol for evaluating livestock deaths was developed subsequently. This document had a particular focus on predation, and drew both on our experience in Apolobamba and on earlier studies in North America (Acorn and Dorrance 1990; Wade and Bowns 1985) . The following is a summary of these steps. However, due to the extensive consumption of most carcasses before they were examined, some steps were often impossible to follow through. In each case of suspected predation, the following procedures were attempted:

1. Locate the carcass and the kill site.
2. Note the position of the carcass.
3. Look for evidence of struggle, such as trampled vegetation, trails of blood, and clumps of fur.
4. Look for sign of predators, or scavengers around the carcass (while recognising that feeding does not necessarily indicate predation).

5. Consider evidence of a fall (inspecting the terrain, as well as examining the animal's body for signs of broken neck, horns, other bones).
6. Examine the carcass for haemorrhage and tooth punctures.
7. Examine the carcass for other signs of health failure (dehydration, disease, diminished fat reserves).
8. Examine females for problems in pregnancy.
9. Observe the general health of other livestock in the area.
10. If newborn, had it walked and breathed?
11. Consider weather conditions at the likely time of death, including lightning (and in the case of newborn animals, hypothermia).

8.2.3 Community meeting

On May 17, 1999 a meeting was held in the community of Pajan, which belongs to the Curva *allyu,*. This town was selected because semi-structured interviews were not being carried out there. There were several goals of this meeting. For the community, it was an opportunity to air grievances to do with crop-raiding, and the groundwork was laid for possible future projects related to this issue. The community provided details of their yearly calendar of main agricultural activities, the local uses and importance of maize, the economic impact of crop-raiding and other hazards to agricultural production. We also carried out a participatory mapping exercise to aid discussions about patterns of crop-raiding in the community. This information sets the scene for the semi-structured interview data.

8.2.4 Crop-raiding – surveys of maize fields

Twenty-one maize fields were visited during May 1999, in an attempt to determine the physical characteristics of the field, and to assess the damage caused by bears. It was not possible to sample maize fields randomly due to logistical constraints. Fields that were far from human habitation, and isolated from other fields, could be explored without the owner being present. However, in the Wasa area (valley/zone 5), entry into fields was only possible with the consent of individual farmers. Hence, the only fields measured were those where the owner happened to be present on the day when visits were made. This did not provide a representative sample of fields, as the farmers who were present may have spent more time guarding their crops than other farmers. Because of this bias, and the small sample size, the results of subsequent analyses should be viewed with caution.

The area of each maize field was determined by pacing off its periphery, using a compass to determine the angles of each side of the polygon. The number of ears of maize in an undamaged 5m x 5m quadrat were counted, so that an estimate of total ears in the field could be generated. It was easy to distinguish damage caused by bears from that caused by other crop-raiding animals. From published descriptions (Peyton 1980), observations of indirect sign and from descriptions given by farmers, we learned that bears break the ears of maize off the stalk, split the husks open and then eat the kernels cleanly off the cob. The peeled-away husks remain attached to the cobs. In contrast, other animals peck or chew through the husks, leaving varied patterns of damage on the ears[1], which are usually left still attached to the stalks. To determine the percentage of crops damaged, we walked alternate rows in the field, looking to both sides and counting the ears that had been eaten by a bear.

The physical characteristics of the field were noted, using six variables. The field was rated on a ranked scale in terms of: steepness (1 = flat, to 5 = hard to walk on); rockiness (1= no rocks, to 5 = boulder strewn); and attention (1 = well cared for, to 5 = abandoned). The location of the field in relation to other fields was coded as (1= isolated from other fields, 2 = on the edge of a cluster of fields, 3 = internal in a cluster of fields). Distance to the closest river was coded as (1 = <30metres, 2 = 30-100m, 3 = >100m). Distance to the forest or other thick hiding cover (1 = <30metres, 2 = 30-100m, 3 = >100m). The influence of these six variables on whether or not fields had been raided by bears was evaluated using a linear regression, using a binomial variate as the dependant variable (1 = damaged, 0 = not damaged).

We also paced off a 5m x 5m quadrat in the worst hit area of the field, in order to determine the most severe example of raiding damage. The size of this quadrat was selected in order to

[1] For example rodents climb up the stalks and eat through the husk and kernels "using their teeth like scissors". They leave small patches entirely consumed on the ears, and a sand-like residue. In contrast parrots perch on the stalk and tear strips off the husk until they reach the kernels.

encompass several rows. We then counted the number of ears eaten by bears, and the number still intact on the stalks.

We used the farmer's help, and our own experience, to determine which other animals were damaging crops. We made a sketch-map of each field, including the paced periphery, estimated distances to the river, to the forest, to the closest houses and to the main community, as well as to other fields. We also noted any shelters in the field, what bear sign (scat, tracks, hair) was in the field and where it was found. If the bear had been stockpiling the maize, we described the site and counted the cobs in the pile. We collected data on the history of the plot if possible. For example: was it a new field this year? Was it a young plot, re-used after being left fallow the previous year? Was it in use for a few years, continually cultivated as a maize field, or with rotating crops?

8.3 RESULTS

8.3.1 Livestock predation: Interview results

There was a marked contrast between the north and south (χ^2=52.12, df=4, P<0.001) in the perception of depredation of livestock by bears (Figure 8-1). In the north, the modal response (36%) was that bears were amongst the four worst killers of livestock, along with pumas, Andean foxes and condors. Bears were considered the worst killers by 27% of respondents. This contrasts with the south, where most (54%) people believed that bears never kill livestock, there or anywhere else. These interviewees explained that the bears come and feed on the carcass, but don't actually kill.

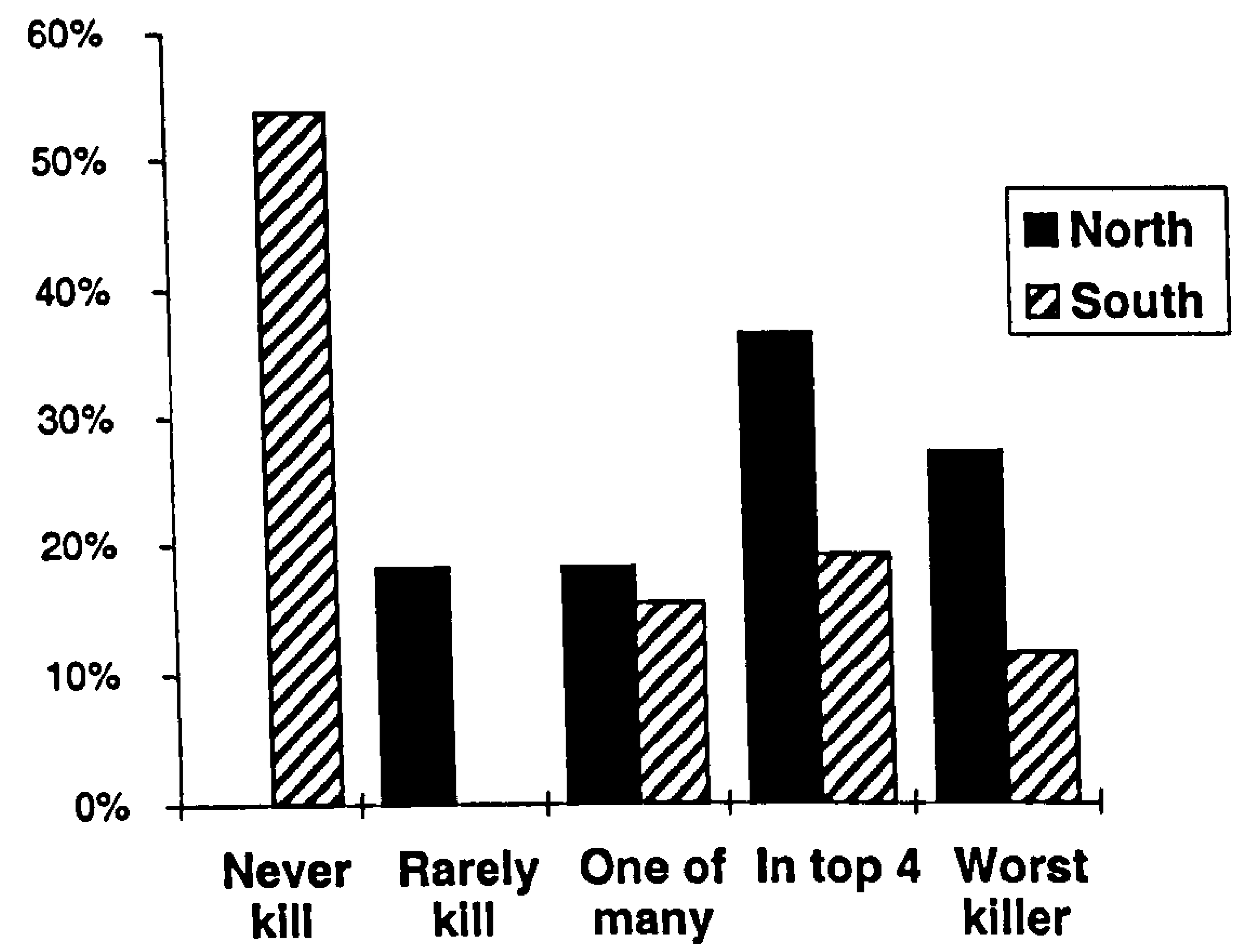


Figure 8-1 Responses to the question of whether or not bears kill livestock.

Livestock losses to the puma (χ^2=2.95, df=2, P=0.23) and fox (χ^2=0.24, df=2, P=0.88) were perceived as important in both the north and south. However, perceptions of the importance of condors as livestock killers differed highly significantly (χ^2=70.70, df=1, P<0.001) between the north and south. Of the 57 people who mentioned condors as livestock killers, 87% were from the north. It is likely that if condors are seen feeding on the carcass of a dead animal, they may, like bears, be assumed to have killed that animal. The perceived importance of condors as livestock killers in the north is probably an indication of healthier condor populations in this less populated and more protected region.

Table 8-1 The species of large predators that cause important losses to the herders interviewed. Percentage of interviewees who mention each species is given, and predators are ranked on this basis.

Common name	Scientific name	Percentage of people who mention each animal	Rank by number of mentions
Puma	*Felis concolor*	88 %	1
Fox	*Pseudolopex culpeaus andinus*	73 %	2
Bear	*Tremarctos ornatus*	64 %	3
Condor	*Vultur gryphus*	57 %	4

The animal most frequently implicated in livestock losses was the puma, followed by the fox, the bear, and the condor (Table 8-1). More than half of interviewees who described having knowledge of livestock depredation mentioned each of these species. These four species are frequently discussed as a clade: "the bad four" (see chapter 3). Several smaller predators were also mentioned, though less frequently, none being mentioned by more than 5% of respondents. These animals included the ocelot, *Felis pardalis,* the possum, *Didelphis marsupialis,* the mountain caracara, *Phalcobboenus megalopterus,* vampire bats, *Desmodus rotundus,* (which can spread rabies), and finally, poisonous snakes.

Table 8-2 The main livestock species vulnerable to predation, with percentage of interviewees who mention each species. The animals are then ranked by number of mentions.

Common name	Percentage of people who mention each animal	Rank by number of mentions
Cattle	82 %	1
Sheep	62 %	2
Horse	39 %	3
Llama	37 %	4
Pig	17 %	5
Alpaca	15 %	6
Mule	9 %	7

Cattle, sheep, horses, llamas, pigs, alpacas and mules were all mentioned as vulnerable to large predators (Table 8-2). There was also minimal (<5%) mention of donkeys, guinea pigs *(Cavia porcellus),* dogs and chickens, the latter of whose killings were attributed to possums, ocelots and foxes. Clear associations were made between species of livestock and the predators that kill them (Table 8-3). Pumas were described as killing all of the large hoofed stock. Pumas, bears and condors were all deemed culpable of heavy cattle predation. Condors were also thought to kill sheep and the domestic camelids – alpacas and llamas. Bears were not blamed for the death of camelids, sheep or pigs, but were blamed for those of horses and mules, as well as for cattle depredation, which emerged as the most serious problem. A prevalent idea was that pumas and bears kill the largest and healthiest cattle, while foxes and condors kill newborn animals. Interviews indicate that somewhere between 160 and 200 large livestock animals were lost in Apolobamba between 1995 and 1998. This number is based on estimates made by interviewees of losses for each valley in that time period.

Table 8-3 Matrix of the species of wild predators that are perceived to prey on particular species of livestock. Crosses symbolise percentage of interviewees who mention each interaction.

		Predator species			
		Puma	Fox	Bear	Condor
Livestock species	Cattle	❖❖		❖❖	❖❖
	Sheep	✱	❖		
	Horse	❖		✱	
	Llama	❖	✱		✱
	Pig	✱			
	Alpaca	✱	✱		✱
	Mule	❖		✱	

❖❖ > 50% report interaction
❖ 25% to 49% report interaction
✱ 5% to 24% report interaction

There emerged few temporal or spatial patterns in the predation of livestock. Of all patterns described, a temporal pattern was the most common (19%), in which livestock depredation is said to occur mainly during the rainy season, from November to February. Others broadened this interval to extend from October to March. This was attributed by some to the decrease in human presence on the hills during these months, though most did not give any explanation. This pattern was associated more with foxes, condors and bears than with pumas. In contrast, it was frequently commented that pumas kill in spurts during any season, and that they travel widely. Several people said pumas go away for long, specified intervals, such as three to six months at a time. They then reappear when and where you least expect them, and kill several animals in one night before disappearing again.

Many people stated their belief in the "problem individual" phenomenon, in which particular animals develop the habit of killing livestock, while other animals never do. Theories about which bears were most likely to kill livestock included: females with cubs, solitary bears and large males. Bears are also thought to drag carcasses to the hiding cover of the forest, in order to consume the meat there. Many people described their hauling large sections of cows[2] or horses up into their tree-nests. Another belief is that bears prefer meat when it begins to rot, having a special predilection for maggots.

[2] The word "cow" refers hereafter to both male and female cattle.

A sizeable constituent in both the north and south believe that bears rarely, if ever, kill livestock. They explain that, during the rainy season, many cows tumble to their deaths on the steep, slippery mountainsides. At the end of the dry season in August and September, many herders burn the grass on the slopes. The sweet, green shoots of the young grass are very tempting to cows, which climb to extraordinarily precipitous spots, foreseeing nothing beyond the next mouthful. Proponents of this theory explain that condors and bears can arrive within one day to feed on a fresh cow carcass. However, even when forensic evidence such as damaged horns indicates a fall, angry cattlemen will often blame a bear for purposefully frightening the cow into falling.

8.3.2 Livestock predation: Reporting and investigation

Eleven sites of predation were visited over the twenty months from August 1997 to March 1999 (Table 8-4). All of these predation events were said to have occurred in the three months previous to the visit. Three events were in the south of the study area (two sheep and one horse), and eight were in the north (six cows, one horse and one event in which two llamas were killed). At 10 of the 11 sites, the remains of the carcass were found. All of the carcasses found (except the llamas) were in the late stages of consumption by the original predators, or by other carrion feeders. Internal organs and the majority of muscle tissue had been consumed.

Table 8-4. Summary of characteristics of the eleven alleged predator kills investigated in Apolobamba during 1998-1999.

No.	N/S	Season	Species	Cause of death	Evidence of feeding by				Dragging	Feeding platform	Original habitat
					bear	puma	fox	Condor			
1	N	Rainy	Cow	Fall	X				Yes		Grass
2	N	Rainy	Horse	?	X			X	Yes	Yes	Grass
3	N	Rainy	Cow	Fall	X			X	Yes		Grass
4	N	Dry	Cow	?	X						?
5	N	Dry	Llama (2)	Fox			X				Grass
6	N	Rainy	Calf	Predation?			X	X			Grass
7	N	Rainy	Cow	Disease?	X			X	Yes	Yes	Grass
8	N	Rainy	Cow	Fall	X			X	Yes		Grass
9	S	Dry	Sheep	Fox			X				Grass
10	S	Rainy	Sheep	Fox			X				Grass
11	S	Rainy	Horse	Puma		X	X				Forest

In five cases, bears were confirmed to have been feeding on the carcasses of cows. Condor faeces were also observed at three of these sites. In a sixth case, a cow was reported missing, and a two-day search failed to locate the animal, although bear scat containing hair was located. Evidence of a struggle was not found in any of these cases involving cattle. Three of these carcasses were at the bottom of steep ravines, or slopes in the grassland, and damage to the horns and spine suggested a fall as the cause of death. One was in a flatter area, where a fall could not have taken place. It had been dragged from a secluded area, near a large rock to which the (probably) sick cow may have withdrawn to die. The hide of this animal did not show bites or scratch marks around the head or neck. However, canine-tooth punctures were visible on various parts of the hide, but they did not seem to have caused bleeding and were probably the result of the bear having dragged the already-dead animal to a rocky outcrop, in the midst of scrubby vegetation. In four cases, the cow's body was dragged to forest cover, leaving a clear trail of flattened grass. The hide was peeled back and most of the bones were intact. Day beds were found near each of the feeding site (<10 m). Loose, greyish bear faeces were also in evidence (>6 litres). In one case, a tree nest was found to contain the scapula of a cow. The rest of the remains of this cow were ~30 m from the tree nest. The animal had been dragged approximately 350 m.

A newborn calf was also killed. There was evidence that it had been alive and then killed, rather than having died during birth. Small hoof-marks were found in the ground, and the hooves themselves showed signs of wear. There was no evidence of feeding by a bear, but there was sign of condor and fox feeding. Two llamas were killed by a fox, quite close to the Pusupunko research headquarters, and this was investigated the following day. Bites were taken from the rear of the animals, and the snouts were lacerated with bite marks. Puma sign was associated with a horse killed in the south. A second horse, killed in the north, was fed upon by a bear, with evidence including a drag trail, and bones in a tree nest. Most of the deaths occurred during the worst part of the wet season, the time of most difficult access for investigation (and, therefore, of minimal vigilance by herders). It was also the time when the steep slopes were at their most sodden, and the danger of slipping at its greatest.

8.3.3 Crop-raiding: Community meeting in Pajan.

Two yearly calendars were made, describing the cycles of production and depredation of four main crops: maize, *Zea mays* (Figure 8-2), potatoes, *Solanum* sp., oca, *Oxalis tuberosa*, and wheat, *Triticum saivum* (Figure 8-3). It is particularly noteworthy that the tilling and fertilising of soil in potato fields and the harvesting of oca all occur while the maize is ripening. These activities necessarily impinge upon time that could be spent guarding the ripening maize, which grows in fields at a lower altitude than that of the potato and oca fields. The maize fields are left unprotected and therefore vulnerable to raids by bears and other animals. Crop rotation is carefully practised throughout the Andes. In many places fields are cultivated with rotating crops for seven years and then left fallow for the same length of time. A fast-growing potato is cultivated in the maize fields in the three months after the maize is harvested. Wheat, *Triticum aestivum*, and peas, *Pisum* sp., are other crops cultivated at the same altitudes as maize, although they both grow at higher altitudes as well. Other crops grown with the maize include beans, *Paseolus vulgaris.*, and squash, *Cucurbita* sp.. In higher fields, potatoes and lima beans, *Phaseolus lunatus macrocarpus*, are grown in the first year, oca in the second, and oats, wheat or barley, *Hordeum* sp. in the third. The field is then left fallow for three years. In order to diffuse the risk of loss, people try to plant in several different fields every year.

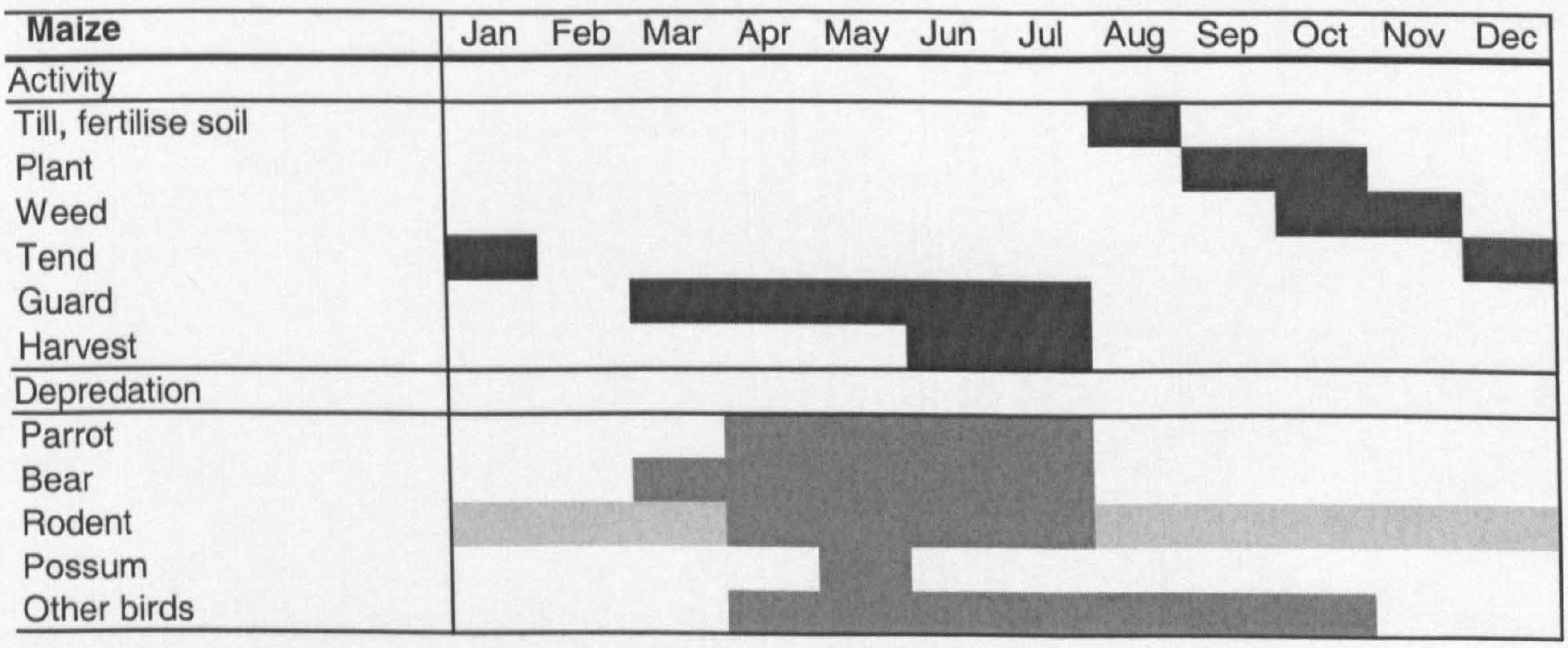


Figure 8-2 Yearly production and depredation cycles of maize. Palest grey represents the continuous attack by rodents on maize in storage.

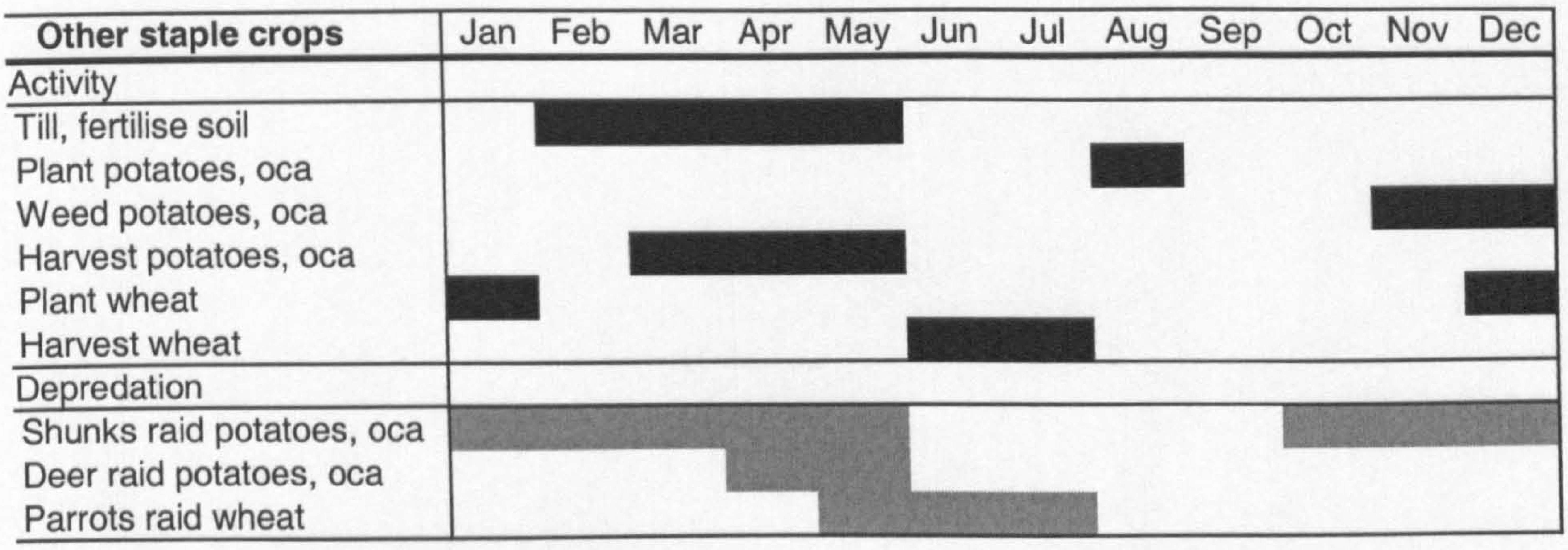


Figure 8-3 Yearly production and depredation cycles of potatoes, oca and wheat.

In Pajan, the top five vertebrate pests in order were: parrots, bears, rodents, doves and possums. Vertebrate pests are not the only cause of crop damage in Apolobamba. Plagues of worms and *gorgojo* beetles have occurred in the past. Moreover, the area's climate is highly unpredictable. Heavy rains, hard frosts and high winds can have grave impacts on a year's production. Drought, however, is one climatic threat not faced in Apolobamba. With the vagaries of climate, and/or depredation by mammalian, avian and other crop pests, a year's yield can easily be reduced to one tenth of its optimal size.

Table 8-5 Primary threats to agricultural production in Pajan, Apolobamba – other than mammalian and avian pests.

***Local or English term-* definition and comments**
Sirk'e- a worm that cuts the stalk as if with a knife.
Gorgojo- a small beetle that does devastating damage to standing crops.
Polilla- a tiny brown moth that does damage to crops once in storage
Rain- too much rain is disastrous to maize, potato and oca crops. If rain falls too heavily from September through May, as it does in some years, crop yields can be extremely low.
Wind- July and August are the months when there is a high risk of winds that can flatten fields.
Frost- June is the month when frost can damage crops. Rabbit pellets are spread and fires are lit in attempts to deter the frost from ruining the maize crop.

For a field of a standard size (~½ hectare), a good year's production of maize would be 15 to as much as 30 mule-loads (46 to 69 kg per mule). A bad year would be 3 to 5 mule loads. In 1999, one *arroba* (12 kg) of maize sold in the closest market (in Peru) for the equivalent of

US $5 to $6 (£3 to £4). If, in the worst-case scenario, 27 mule loads were lost, this would be a monetary loss of $775-$930 (£465 to £558), and the almost total loss of a crucial dietary staple, as well as an essential resource for exchange. Maize is a staple food, consumed in a variety of ways by people residing in the areas where it is grown, as well as by people throughout the *allyus* (Table 8-6). Maize is bartered for meat and potatoes with the people from higher elevational bands such as the *altiplano*.

Table 8-6 Primary ways that maize is used in Pajan, Apolobamba

***Local term*-** **definition and comments**
***Tostado*-** toasted kernels of maize eaten as a snack and as sustenance when working away from home.
***Chicha*-** Alcoholic fermented maize beer of great importance in rituals.
***Mote*-** hominy, the inner pulpy part of the maize.
***Lawa*-** thin soup with peas and meat if available.
***Pito*-** thin porridge made from finely ground maize meal.
***Pan de maiz*-** Maize flower is used together with wheat flour to make maize bread and maize biscuits.
***Sopa*-** maize is used as an ingredient in many soups.
***Choclo*-** eaten as corn on the cob.
***Huminta*-** like hard Italian polenta or the tamales of Mexico – sweet stodgy lumps of maize meal steamed in the husks.
***Trueque*-** used in bartering for meat and potatoes with the people from higher elevational bands like the altiplano.

The fields in Pajan that were described as worst hit by bears were those isolated and surrounded by forest, or those at the edges of a cluster of fields, near the forest or river. Fields in the centre of a larger cultivated area are the safest from crop-raiding bears. Hiding cover was seen as the determining factor in crop-raiding by bears. However, parrots and other birds, rodents and possums, were not thought to make this distinction and were said to raid any field.

8.3.4 Crop depredation – interview results

A wide range of views was expressed, throughout the study area, about the severity of the problem of crop-raiding by bears (Figure 8-4). The most notable difference between the north and south was amongst those who did not have problems with crop-raiding bears (χ^2=23.32, df=4, P<0.001). In the south, 24% of interviewees had never experienced direct problems with crop-raiding bears, while no interviewees in the north denied that bears were crop pests. This is probably because some areas in the south are so populated by people that bears are simply not present. At the same time, bears are attracted to intensive maize cultivation in areas in the south (such as valley/zone 5) and become major annoyances locally. In the north, bear populations are higher, and human densities lower. Hence, while people there all know that bears can be a problem, fewer people experienced direct problems with crop-raiding by bears mainly because they rely less on maize and other low altitude crops.

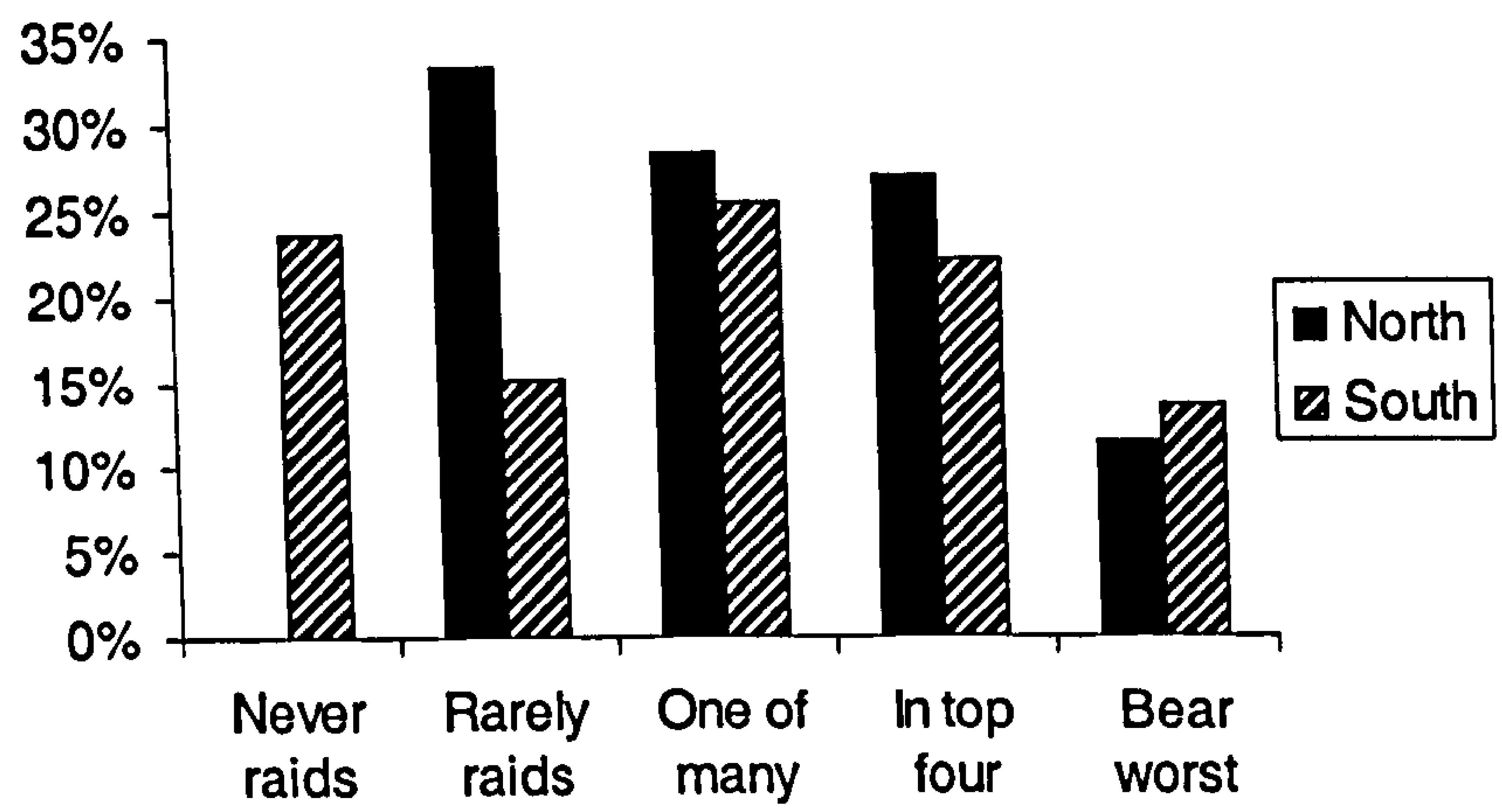


Figure 8-4 Perception of crop-raiding by bears.

Although there were some differences between the north and south with regard to the severity of crop-raiding by bears, responses to general questions are combined hereafter for the sake of clarity. The following data on crop-raiding refer to the 114 farmers who discussed raiding. The lists and ranking of crop pests include animals that depredate crops other than the ones favoured by bears. Fourteen animals, or groups of animals in the case of rodents, insects and birds (which are referred to hereafter as animals), were implicated as crop raiders[3]

[3] A fifteenth speces, the very rare mountain cat, *Felis jacobita*, was mentioned as a crop pest by two interviewees from the village of Jatichulaya in the south. It seems more likely that these cats may be preying upon rodents in maize fields. Hence they were not included in

Table 8-7.

Table 8-7). Skunk, deer, parrots (including parakeets), and other birds, were all mentioned by more than one third of interviewees.

Table 8-7 Animals mentioned by interviewees as crop pests, with which they have had problems.

Common name	Scientific name	Percentage of people who mention each animal	Rank by number of mentions
Bear	*Tremarctos ornatus*	80 %	1
Skunk	*Conepatus chinga rex*	62 %	2
Parrot	*Psittacidae* (various)	44 %	3- tie
Deer	*Hippocamelus antisensis*	44 %	3- tie
Other birds	*Tinamidae, Columbidae*, etc.	35 %	5
Fox	*Pseudolopex culeaus andinus*	19 %	6
Rodents	*Muridae* (various)	13 %	7
Agouti	*Agouti paca*	10 %	8
Coati	*Nasua nasua*	9 %	9
Cattle	*Bos Taurus*	6 %	10
Insects	(Various)	5 %	11
Dog	*Canis familiaris*	3 %	12- tie
Possum	*Didelphis marsupialis*	3 %	12- tie
Monkey	Possibly *Lagothrix* sp? *	2 %	14

Animals are then ranked on the basis of the number of times they were mentioned.
(*Wallace pers. comm.)

After listing the animals that caused problems to their crops, people were asked to identify the one animal that caused the most damage. In order to examine the prominence of raiding species in farmers' minds, these responses can be considered in two ways. Firstly, animals can be ranked on the basis of the overall percentage of people who identify each animal as the worst crop raider (

Table 8-8). For example, bears were described as the worst crop pest by 15% of interviewees (17/114), and were therefore ranked in second place, together with skunks. Parrots were ranked first, rodents fourth, and insects were tied in eighth place with coatis.

Table 8-8 Animals described as the worst crop pests overall by 114 farmers.

Common name	Scientific name	Overall percentage of interviewees who describe it as the worst crop pest	Rank by percentage of interviewees who describe it as the worst crop pest
Parrots	*Psittacidae* spp.	23%	1
Skunk	*Conepatus chinga rex*	15%	2 - tie
Bear	*Tremarctos ornatus*	15%	2 - tie
Rodents	*Muridae*	11%	4
Fox	*Pseudolopex culeaus andinus*	10%	5
Deer	*Hipocamelus antisensis*	7%	6 - tie
Other birds	*Tinamidae, Columbidae, etc.*	7%	6 - tie
Agouti	*Agouti paca*	6%	8
Insects	(Various)	4%	9 - tie
Coati	*Nasua nasua*	4%	9 - tie

The second way of ranking the worst crop pests is for animals to be ranked in terms of the percentage of people who mentioned each animal and who additionally described them as the worst crop pest (Table 8-9). For example, although only 13% (15/114) of interviewees mentioned rodents as crop pests, 86% of those people (13/15) described them as the worst. This method of evaluation controls better for the farmer's tendency to neglect to mention less conspicuous animals or groups of animals. For example, while rodents were ranked as the fourth worst crop raiders overall, they received top ranking when using the second method. This was because they were most frequently described as the worst pests by farmers who thought to mention them at all. In this ranking, bears slid to ninth place, behind other less conspicuous species, including rodents, insects, birds and medium-sized mammals such as foxes and coatis.

Table 8-9 Animals or group of animals described as the worst crop pest by the interviewees who mentioned them.

Common name	Scientific name	Percentage of people who mention animal who also describe it as the worst crop pest	Rank by percentage of people who mention animal and who describe it as the worst crop pest
Rodents	*Muridae*	86%	1
Insect	*(Various)*	66%	2
Parrot	*Psittacidae* spp.	64%	3
Fox	*Pseudolopex culeaus andinus*	50%	4 - tie
Coati	*Nasua nasua*	50%	4 - tie
Agouti	*Agouti paca*	45%	6
Skunk	*Conepatus chinga rex*	24%	7
Other birds	*Tinamidae, Columbidae,* etc.	20%	8
Bear	*Tremarctos ornatus*	19%	9
Deer	*Hipocamelus antisensis*	16%	10

Fifteen crops were mentioned as vulnerable to crop-raiding (Table 8-10). Maize was the crop most frequently mentioned as vulnerable, followed by potatoes and oca. Other crops mentioned were yucca, sugar cane, oats, squash, beans, coffee and fruit trees. Crops raided by bears were limited to maize, sugar cane and occasionally fruit trees.

Table 8-10 Main crops mentioned as damaged, and ranked in order of the percentage of people who mention each crop as vulnerable to depredation.

Common name	Scientific name	Part damaged	Percentage who mentioned	Ranking
Maize	*Zea mays*	Pulpy kernels	78 %	1
Potato	*Solanum* spp.	Leaves	64 %	2
Oca	*Oxalis tuberosa*	Leaves	46 %	3
Yucca	*Yucca* sp.	Leaves	11 %	4 – tie
Granadilla	*Passiflora* sp.	Fruit	11 %	4 – tie
Sugar	*Saccharum officinarum*	Sweet stems	11 %	4 – tie
Oats	*Avena sativa*	Grain	9 %	7
Squash	*Cucrbita moschata*	Leaves and fruit	8 %	8 – tie
Chiles	*Capiscum pubens*	Leaves and fruit	8 %	8 – tie
Tumbo	*Passiflora* sp.	Fruit	7 %	10
Other fruit trees	Various	Fruit	3 %	11
Beans	*Phaseolus vulgaris*	Fruit and leaves	2 %	12 – tie
Wheat	*Triticum sativum*	Grain	2 %	12 – tie
Peas	*Pisum sativum*	Fruit and leaves	2 %	12 – tie
Coffee	*Coffea Arabica*	Leaves	2 %	12 – tie

Interviewees almost unanimously reported that bears are more likely to raid fields that are peripheral or isolated, as opposed to some other raiding species, which do not follow this pattern. As one farmer in the south explained, "My field is in the middle of a group of fields, so I don't get bothered by bears. When fields are on the edges, near the river or when they are isolated in the forest, that is when the bears can destroy them." This farmer from Chullina went on to say, "Parrots and parakeets, rodents and skunks don't make this distinction. They damage crops wherever they are located." Presence of hiding cover was considered by farmers to be a determinant of raiding by bears. Several interviewees mentioned that bears' movements were tied to the ripening of maize, beginning with the lowest fields, which ripen earlier, and ending up in the highest fields in June.

Several other observations about crop-raiding were repeated in the interviews. Bears were described as clean eaters, "When a bear comes into the field, he sometimes eats the kernels off the cob in place, but if someone is nearby, he makes piles just like a man and eats them off to one side lying down." People additionally commented that not all bears raid crops, just the brave ones. There was no clear pattern to the descriptions of the age and sex of raiding bears. Mothers with cubs are seen, as are solitary, small and large individuals, as well as groups of 3-10 bears. Crop-raiding takes place, depending on the altitude, from March to June. Bears begin to visit when maize is in the milk stage, and continue to visit until it is ready for harvest. It was also said that often, when bears raid a field, they come and live near the field temporarily. However, interviewees agreed that these visits are sporadic and by no means a daily occurrence.

8.3.5 Crop-raiding- Surveys of maize fields

Damage to maize fields was evaluated in May 1999, and maize field raiding was likely to have continued during the succeeding month. Hence the following estimates of damage may fall short of describing the real picture. We visited fourteen fields that showed some evidence of use by bears. Comparing the percentage of crop damaged in the worst-hit $25m^2$ portions of these fields, the maximum was 15% of ears taken (median = 6.6%). Using whole fields as a unit of measurement, the maximum damage was 6% of ears taken by bears (median = 2.4%). Bear damage was concentrated around the edges of the field, closest to hiding cover. Clear trails and scats were visible where raiding had taken place. On four occasions, these trails were followed, and evidence was found that the bears had carried ears of maize to nearby high spots, which were safe and where there was good visibility, and consumed them there. Cobs eaten by other animals amounted to another 19% of the crop in the worst hit field (median = 9.1%).

The location of the fields was a highly significant explanatory variable, using a logistic regression with a binary variate of 'damaged' or 'undamaged' by bears as the dependant variable (χ^2=-13.14, df=1, P< 0.001). The relative slope of the field had significant explanatory power, but only when analysed alone (χ^2=-3.91, df=1, P< 0.05). The location of the field is strongly auto-correlated with all of the other variables measured, except distance to the river. Isolated fields, and those on the edges of clusters of fields, were the most vulnerable to depredation by bears, regardless of their distance from the river at the valley bottom.

Distance to the river, rockiness, and field maintenance were not shown to be significant factors determining use by bears. However, due to the small sample size, these characteristics may have a complex interaction with raiding. For example, fields that are isolated are often steep (the flatter lands being cultivated by more than one person and on a consistent basis). They are also often rocky and have low maintenance. Fields that were closer to the river did tend to be more damaged by bears, and, in some areas such as Mataru, fields by the river are no longer cultivated, due to excessive depredation by bears.

8.4 DISCUSSION

Practically and physically, human-bear conflict in Apolobamba is minimal, or so it seems from the data gathered during this study. Certainly some bears supplement their diets of wild foods with maize. Yet in no field was the impact of crop-raiding by bears found to represent more than a 6% loss. The meat of livestock animals is likely to be integral to the ecology of many bears that live within reach of this extremely high-quality food. Yet no indication of active predation by bears could be found. Can human-bear conflict be dismissed with this information?

I would argue that because of the bear's prominence in the minds of farmers and cattlemen, bear-human conflict cannot be dismissed. The very same characteristics that make the bear such a potent flagship species for conservation, and that make it a charismatic mega-vertebrate, also make it a "focus for local animosity towards wildlife", a phrase used to describe elephants in Zimbabwe (Wunder 1997). The attitudes and perceptions of farmers are as important an element of wildlife management as biological or ecological data (Kellert 1994). Community support for conservation has been shown to be seriously impeded by human-wildlife conflict (De Boer and Baquete 1998; Gillingham and Lee 1999; Naughton-Treves 1997; Newmark et al. 1994).

Livestock depredation and crop-raiding were the main two areas of perceived conflict. Bears were considered serious killers of livestock in the north, but not in the south. AS seen in Chapter 4, people in the north are more accustomed to seeing bears, and are therefore less fearful of encounters, but the majority of people in both the north and south considered bears frightening. Overall, bears loom large in people's minds, and contact with bears is perceived to be considerable.

8.4.1 Livestock depredation

Camelids have many advantages over sheep and cattle in terms of adaptations to the environment, displaying efficient assimilation of food from unburned pastures and having soft, flat soles that do not cause erosion (Fjeldsa and Kessler 1996). However, introduced livestock are more numerous in Bolivia than native stock: in 1989 there were 7.7 million sheep, 5.5 million cattle and 2.1 million pigs, but only 1.5 million llamas and 175,000 alpacas (Fjeldsa and Kessler 1996). In *mestizo*-influenced areas such as the north of the study area, cattle, despite the many problems to which they are prone, are a symbol of prestige, civilisation and development (Fjeldsa and Kessler 1996).

In 1720 one thousand head of cattle were brought to the Pelechuco area from Peru (Machicao Gamez 1990). Cattle are still greatly valued in this area, but they are rarely slaughtered, and they are not used to produce milk or cheese. Since 1946, when they were described as having "no real economic importance" (Stewart 1946), cows in the Quechua areas have been sold only on rare occasions, due to the great effort required to get cattle to the market in Peru, or to Achacachi, which would involve a 100km walk across the cordillera.

Although no census of cattle in the area has been carried out, one study estimated that in the north of the study area, each family has an average of 5 to 7 heads of cattle (RNFUU, 1997). Leaving aside often-repeated sarcastic remarks such as "we only raise them for the wild predators", it is possible to identify two main functions served by cattle in Apolobamba. First, they are kept as an investment, each animal being worth \$100 to \$140 (£60 to £84). For example, instead of monetary gifts, people are sometimes given a cow as a wedding present. Second, cattle have connotations of prestige in the context of community rituals. The annual festival of Pelechuco involves *la corrida de toros,* the running of bulls, in which the animals are herded in from the surrounding mountains and kept in corrals at one corner of the central plaza. They are poked and kicked in the testicles, and have beer blown up their noses before being released into the plaza, where drunken men run around teasing them and trying to avoid being gored. Being a cattleman carries with it considerable cachet in terms of machismo and is a very important part of community identity in the north of the study area.

In this study, cattle were perceived to suffer the biggest losses to depredation. This is probably due to a variety of factors. Camelids have had thousands of years in which to adapt to these extreme environments (as opposed to cattle, which were introduced in the 18th century); they are more carefully herded and are unlikely to fall to their deaths. Sheep are not left to range freely, but are brought into corrals at night. Pigs are usually kept around the house. Horses are often free-ranging, but may be less popular with predators due to being harder to kill.

Cattle may be the most common victims of large carnivore depredation, but they also undoubtedly die of many other causes, including ingestion of poisonous plants, disease and falls caused by the steep and often slippery terrain. This last cause of death may be behind the increased consumption of meat by bears during the rainy season, as suggested by the scat record and interviews. Cattle slip when they climb high in search of green shoots, which sprout after the grass is burnt at the end of the dry season. The possibility of a sort of passive predation or "fatalities from harassment" (Acorn and Dorrance 1990), in which cows may also be frightened into falling by an innocent passing bear, was suggested by interviewees in this study as well as in Goldstein's research in Venezuela (1986). Many people in this study also expressed the belief that certain animals learn to kill livestock, an idea that is shared in other Andean sites. Indeed, the cessation of cattle losses after an Andean bear has been shot is the principal evidence of predation by bears (Goldstein 1986). The removal of "problem individuals" is considered an essential large carnivore management technique (Linnell et al. 1999; Mishra 1997; Sillero-Zubiri and Laurenson 2001).

The only solution to predation of livestock by large carnivores (other than killing predators) is likely to be modification of grazing methods (Linnell et al. 1999). Cattle are free ranging, and are currently raised with almost no input, other than a visit once every month or two to provide salt (Goldstein 2001). The possibility of intensifying and improving livestock husbandry should be explored. In some areas, cattle could be kept in corrals and fed with leguminous crops such as alfalfa (Fjeldsa and Kessler 1996). More research into the causes of cattle mortality and better veterinary assistance in mitigating them, may go a long way towards increasing tolerance of bears, and of the other members of the "bad four" clade: pumas, foxes and condors.

8.4.2 Crop depredation

Maize has been present in South America for approximately 6000 years, probably having been domesticated independently from Mexican maize; it was a key resource for Inca society (MacNeish 1971). It is an integral part of the diets and lives of people in Apolobamba (Repocarrasco and Hoyos 1993). Exchange or barter of higher altitude crops and animals for lower altitude crops has been part of the basic ecological adaptation to Andean life. People in the same *allyu* can specialise in certain elevational bands and trade within the same social unit (Wilson 1999).

Maize has been shown to be particularly vulnerable to crop pests; farmers persist in its production, partly because it gives high yields for low input of labour (Hill 1997). Research in Africa has shown that the appeal of maize is such that the local abundance of forest fruits did not diminish maize field raiding by primates (Naughton-Treves et al. 1998). American black bears cause damage to maize fields in North America and conflicts have proliferated when hunting regulations have become more restrictive (Garshelis et al. 1999). Andean bear raiding habits differ from those of American black bears; black bears trample large areas of maize stalks (Garshelis et al. 1999) while Andean bears have not been reported to trample stalks but, rather, are careful and meticulous eaters. Another difference observed in this study, and in Peru (Peyton 1980), is that Andean bears occasionally carry away ears of maize to a sheltered point out of the field, where they consume the kernels, leaving piles of cobs behind. Andean bears have been described as timid in comparison with other bear species (Peyton 1999) and this shy and delicate raiding behaviour confirms this impression. However, Andean bears have also been described, from direct observation in Peru and from the interviews and community meeting in this study, to be occasionally tenacious in their raiding behaviour (Peyton 1980).

While little research has been published about crop-raiding and other forms of human-wildlife conflict in the neotropics, many parallels can be drawn with African research. There are, however, some important differences. Human densities are much higher in the African study sites: 272 people/km^2 in areas surrounding the Kibale National Park in Uganda (Naughton-Treves et al. 1998). The presence of maize in Africa dates back only as far as the mid-17th century, as opposed to the situation in South America, where maize and crop-raiders have coexisted for millennia (Vansina 1990). On the whole, African protected areas may be more insular than those in South America (Amend and Amend 1995) . The potentially high tourist revenues associated with game viewing and hunting have meant that community-based conservation initiatives in Africa have been able to marshal funds which could then be invested in community projects (Gibson and Marks 1995).

As in the African studies, proximity to the edge of the forest was the main spatial factor identified in this study as a predictor of both crop-raiding and livestock consumption. Edges are vulnerable on several scales. The bands of agricultural land at the edges of protected areas have been identified as focal points of wildlife conflict in Africa (Naughton et al. 1999). Fields on the edges of cultivated areas are more vulnerable to crop-raiding by large vertebrates including bears (rodents, birds, insects and pathogens do not show this raiding pattern). Further reducing the scale, in this and other studies, it is the edges of the fields themselves that are the hardest hit (Garshelis et al. 1999).

Tropical farmers face problems that differ notably from those faced in temperate climates, particularly when it comes to crop pests (Naughton et al. 1999). Chronic levels of loss are higher in the tropics, while temperate regions are prone to periodic outbreaks of pest species (Yudleman et al. 1998). In the tropics there is a greater variety of pests, though the density of each species tends to be lower than in temperate systems (Porter and Shepherd 1998).

As has been documented in Africa, crop depredation is a vital issue for smallholders but it is difficult to measure and evaluate (Naughton et al. 1999). Main difficulties arise because: 1) tropical farmers plant spatially varying polycultures, in fields on ill-defined areas, 2) planting densities vary greatly between and within fields, and 3) depredation events occur sporadically (Naughton et al. 1999) and crops may be harvested suddenly in response to such events. All of these issues were found in this study. More efficient estimates of area damaged by bears used in other studies (Garshelis et al. 1999) were inappropriate, given Andean bears' feeding habits. Surveys were carried out in late May, but raiding may have continued during the following weeks. The exaggeration of claims of crop damage has been demonstrated in numerous studies (ranging from perceived damage levels being twice as much as measured damage levels, to being ten times as much) (Maddrey and Pelton 1995; Garshelis et al. 1999). Farmers in this study were not asked to estimate the extent of crop damage in the fields surveyed.

Vulnerability of smalholders to crop-raiding is mitigated by two main insurance strategies: individualist and those of social reciprocity (Naughton et al. 1999). The most prevalent individualist strategy discovered in Apolobamba is field scattering. Insurance policies of social reciprocity are also in effect: in the event that someone experiences a complete failure of their staple crop, *compadrazgo* ties are called upon to ensure that community members do not starve.

The fact that bears were mentioned by more people than any other animal could be seen to be biased by the overall topic of the interviews. However, due to the bear's large size and the potential threat it poses to human safety, bears seem to be the most conspicuous of crop raiders. Birds and rodents were observed to do much more damage than bears although a quantitative comparison was not carried out (see Appendix II for bird species observed raiding crops). Having looked at attitudes towards bears, their ecology, and issues of depredation, we turn in the final data chapter to management options: those available, and those employed, as well as attitudes towards these policies and practices. Explanatory variables determining levels of tolerance toward the Andean bear will be analysed. Finally, the perceived status of Andean bear populations in Apolobamba will be discussed, as will the implications of these findings for the future.

8.5 SUMMARY

1. It was not possible to confirm predation of livestock by bears. Bears were documented to have fed on six cows, one new-born calf, and two horses during the study. Feeding behaviour did not differ from previous descriptions from Venezuela.

2. The species thought by interviewees to be the biggest killers of livestock were, in descending order of frequency of mention: puma, fox, bear and condor. Condors and bears were rarely mentioned as livestock killers outside of the protected area. Livestock losses were described as occurring more frequently in the rainy season.

3. Most people who thought bears were livestock killers thought that certain animals became habituated to killing livestock.

4. Bears were mentioned most frequently in lists of crop-raiding animals, with rodents ranked sixth and insects ranked tenth in the list. While 80% of farmers mentioned bears as crop raiders, only 15% described them as the worst. Bears were ranked ninth on a list based on the percentage of people who mention the animal and who also describe it as worst. Insects, rodents and birds, particularly parrots, were higher.

5. The field most severely damaged by bears displayed 6% of the ears consumed with 15% consumed in the most severely damaged $25m^2$ quadrat. Isolated fields and fields on the edges of cultivated areas were the most vulnerable to crop depredation by bears.

Chapter 9
MANAGEMENT AND CONSERVATION

A warden of the Ulla Ulla National Fauna Reserve.

9.1 INTRODUCTION

A crucial issue in large carnivore conservation is how to implement policies that are good for the species in question, without disenfranchising and antagonising local people (Hough 1988). Is it possible for rural people to coexist with large carnivores without suffering losses that they find unacceptable? Human density has been shown to be a good but not absolute predictor of patterns of large carnivore extirpation. Dramatic regional and temporal variation in these patterns has been postulated to reflect both the local people's tolerance of large carnivores and their ability to kill them (Woodroffe 2000). Yet tolerance of large carnivores is an elusive commodity. It is hard to quantify and even harder to account for thoroughly. Factors thought to be related to tolerance of large carnivores include: traditional myths and beliefs (Kumar and Wright 1999); the vulnerability of people to livestock losses (Boitani 1995); education (Kellert et al. 1996); the benefits accruing to the community through hunting or eco-tourism (Sillero-Zubiri and Laurenson 2001); government policies (Woodroffe 2000); and compensation for livestock losses (Wagner et al. 1997; Sillero-Zubiri and Laurenson 2001).

The type of relationship that humans through history have had with the environment has been an important determinant of their tolerance of large carnivores. Nomadic herders had greatest reason to fear carnivores (Boitani 1995). Sedentary herders with housings for their livestock have feared large carnivores, but have tended to view them as just another natural hazard, like poisonous plants or lightning. Arable farmers have generally had an even easier relationship with large carnivores (Boitani 1995). Because bears are perceived to depredate both crops and livestock, they provide an opportunity to compare the attitudes of people heavily reliant on livestock husbandry with those of arable farmers.

9.1.1 Management and conservation of large carnivores

Killing large carnivores, previously a perilous undertaking, has become comparatively easy over the last 300 years, as the use of firearms has become widespread. This method of dealing with problem carnivores has eclipsed other, non-lethal methods of deterring carnivores that developed in the centuries before the age of the gun. Today, many people who are genuinely threatened and economically compromised by large carnivores are prohibited from killing them by national legislation and protected area authorities (Mishra

1984; Saberwall et al. 1994). Given these restrictions, it is worth reviewing the types of weapons that humans have in their arsenal of non-lethal deterrents (Table 9-1).

Table 9-1 A review of non-lethal deterrent methods used against large pest animals.

1. **The domestic dog** has been a universal companion of humans for at least 10,000 years and is one of the best defences against large carnivores. For example the Carpathian bear dog has been bred to defend people and sheep against bears and wolves (Smith et al. 2000b). Donkeys and other animals have also been used to defend livestock (Marker 2000)
2. **Physical barriers** such as walls, ditches and electric fencing are used to keep away animals such as elephants and bears (Levin 2000; Mishra 1971; Seidensticker 1984). Non-palatable crops such as tea and chillis are also planted around parks.
3. **Aural deterrents** such as bells, firecrackers, whistles, drums and dynamite are used all over world to scare away predators.
4. **Visual deterrents** such as scarecrows, flashing lights are also used. Masks of a human face are worn on the back of the head to deter tigers, which prefer to attack from behind (Sillero-Zubiri and Laurenson 2001).
5. **Olfactory deterrents** such as smoke, scented soap, urine and dung are used in or around the peripheries of fields; aversive agents are also sprayed on lambs (Landa and Tommeras 1997)
6. **Conditioned taste aversion** uses chemicals such as still lithium chloride to train carnivores that consuming livestock will make them ill (Fortham 2000; Nicolaus et al. 1989; Ternent and Garshelis 1999).
7. **Projectiles** like sling shots, rubber bullets, and cracker shells are used against bears (Shideler 1995).
8. **Clearing undergrowth** or using fire to create buffer zones around crops without hiding cover (Hill 1997).
9. **Airborne irritants** like pepper spray and mace have been used with bears and elephants, with some degree of success (Kendall 1995).
10. **Aversive conditioning**, attempting to traumatise animals so that they associate the act of approaching people or their resources with negative experiences, has been attempted in several sites. Polar bears in Churchill, Alaska are kept in polar bear jails without water . Dummies of fishermen are electrified to aversively condition tigers. Brown bears are trapped and chased by Carpathian bear dogs. Review in (Smith et al. 2000a).
11. **Relocation** of problem animals is extensively used in the United States, in particular with bears (Sillero-Zubiri and Laurenson 2001; Linnell et al. 1999)
12. **Reduction of attractants** - closing down dumps; securing garbage disposal
13. **Manipulation of key resources** such as water, as has been used in Tsavo with elephants (Naughton et al. 1999)
14. **Herdsmen or guards** are used throughout the world to protect livestock.
15. **Prayer** ritual and offerings are resorted to in many parts of the world. In the Sundarbans in Bangladesh, elaborate shrines to the goddess of the forest are erected by people who suffer heavy human losses to tigers (Jackson 1999).

9.1.2 Protected areas and wildlife laws in Bolivia

Several key laws form the somewhat shaky legal framework that governs the use of wildlife in Bolivia. The *Ley de Vida Silvestre, Parques Nacionales, Caza y Pesca,* (the Law of Wildlife, National Parks, Hunting and Fishing), passed in 1972, assigns the control and regulation of wildlife exploitation to the state. A ban on hunting, trading and transporting of bears and of other endangered species went into effect in 1979. This ban was extended to all wildlife for an original three years in 1986, but was then extended indefinitely the following year. This ban was made law in 1990 - *La Ley de Veda Total* (the Law of Total Ban). In contradiction, the *Ley General del Medio Ambiente,* (the General Law of the Environment), ratified in 1992, talks about supporting integral use and management in favour of *campesino* and indigenous communities.

In recent years, momentous legal changes have been afoot in relation to these communities in Bolivia. When the Supreme Resolution was passed on 17 February, 1989, it was the first time a national government had recognised the rights of "original ethnic groups" in Bolivian Amazonia to own land and to have a way of life based on that land. As a result, "indigenous territories" were established. In a 1994 Constitutional Reform, Bolivia was officially redefined as "multicultural and multiethnic" and the protection of indigenous people's rights to the sustainable use of their natural resources was ensured. In addition, the Law of Popular Participation now ensures that more power and resources are given to local communities.

The contradictions inherent in the wildlife laws, in which indigenous people are allowed to use the land but not the components of the ecosystem upon which their livelihoods depend (including animals), have been highlighted by the *Confederación de Indígenas de Bolivia, CIDOB* (Confederation of Indigenous People of Bolivia). In their *Proyecto de Ley de Pueblos Indígenas,* (Project of Law of Indigenous Communities) they demand the explicit ownership, use and administration of renewable resources. Ownership of wildlife resources has been identified as crucial for the success of community conservation initiatives (IIED 1994).

These national issues are exemplified in Apolobamba. People residing within the Ulla Ulla National Fauna Reserve are certainly under the impression that it is illegal to kill any wild animals, in accordance with the policy of the protected area. However, in Madidi, subsistence hunting is allowed in the lowlands (Loayza Cossio pers. comm.), and many people believe that a llama-killing puma could also be legally shot in the highlands (Kemper 2000). It might be deduced from this that many people might think a cattle-killing or maize field-raiding bear could also legally be shot. In fact, according to the Law of Total Ban, no wild animals should be killed. These ambiguities and contradictions leave the laws open to multiple interpretations (Flores de Capriles 1999). Although the

CIDOB proposal has arisen from lowland communities and not from highland Quechua and Aymara communities (Molina Barrios 1996), Apolobamba is currently in the process of officially establishing itself into *allyus* so that communities can take advantage of the new laws (Loayza Cossio pers. comm.). In this climate, it appears that highland people may increase their demands in line with the CIDOB proposals and demand a resolution to these wildlife issues.

In practise, bush meat hunting, which tends to focus worldwide on forest ungulates and primates (Ginsberg, 2001), seems to be negligible in the areas above 2700m where this study was carried out. It is rumoured that in the area surrounding Apolo, the largest human settlement in bear habitat in Apolobamba, bush meat hunting including the hunting of bears has been common, with the result that populations of these game species are severely depleted. In the lower altitude region of the Madidi National Park, where bears are not present, bush meat hunting is common.

9.1.3 Research questions and structure of chapter

With this background in mind, the following questions will be dealt with in this chapter.

- Do people's attitudes inside the protected area regarding management and protection differ from those outside?
- Is the protected area appraised of wildlife-people conflict through official channels?
- To what extent are deterrents used in dealing with bear depredation?
- What is the perceived status of bear populations?
- How do people respond to the possibility of the extirpation of bears in Apolobamba?
- What factors are correlated with high tolerance of bears?
- What roles do levels of conflict and traditional beliefs play in determining tolerance of bears?

The structure of the chapter follows the aforementioned research questions. Attitudes towards the protected area and wildlife laws are examined, followed by an overview of official complaints to the fauna reserve, and a summary of lethal and non-lethal deterrents used against bears. Perceptions of bear population trends are then described, along with an evaluation of existing motivations to conserve bears. Finally, multivariate analyses examine the determinants of tolerance towards bears, as well as of traditional beliefs, and of levels of conflict.

9.2 METHODS

9.2.1 Semi-structured interviews

Questions relating to management and conservation were a part of the semi-structured, open-ended interviews (see 2.3.4. for detailed methods and sections IX & X of Appendix 1 for interview guide). Data were described using descriptive statistics and compared using Chi-square tests.

9.2.2 Official complaints to the Fauna Reserve

The RNFUU was aware, before the initiation of this project, about burgeoning carnivore-people conflicts in their area. They were beginning to receive letters of complaint about livestock losses and verbal complaints about crop-raiding animals (see Table 9.2). The archives of the RNFUU were reviewed, and correspondence regarding pest animals was collected.

9.2.3 Factor analysis

Twenty two questions in the interviews provided answers that were varied and consistent enough to code. Factor analyses were attempted on all of the ranked responses, but there was too much scatter to be able to get coherent answers. A simplified list of nine key questions (Figure 9-7) (previously described and compared between north and south) was used to reveal latent or underlying psychological variables in the data. The emergent factors were grouped by the procedure, and classified according to my interpretation.

9.2.4 Generalised linear models

Scores from the factor analysis were then attributed to each interviewee on each emergent latent variable. These normally distributed scores are then used as the dependent variables in generalised linear models (GLMs). The models examine the effects of the following independent variables: age; language; valley/zone; reliance on livestock herding; reliance on maize cultivation; and reliance on mining. North and south cannot be used in the same GLM as valley/zone because of the exact match (valleys 1-4 are in the north and 5-7 in the south). In the GLMs the seven valley/zones are used instead of north and south, as this finer scale of resolution explains more of the variation in the data set and allows a more detailed exploration of geographical patterns of attitudes.

9.3 RESULTS

9.3.1 Attitudes towards the protected area and wildlife laws

At the end of the interviews three questions were used to inquire about knowledge of the laws, protected area and opinions about both. It was conspicuous that the section of the interview relating to laws and management was the only one that received a low response rate. This section did come at the end of the interviews and one explanation for the low response rate might be that people were tired. On the other hand, the research assistants thought that people did not want to state that they know the laws in case they were somehow implicated in breaking them.

What do you know about any laws relating to wildlife?

Interviewees in the north were more aware of wildlife laws (χ^2=30.16, df = 2, P<0.001). In the north, inside the protected area, 62% of interviewees reported that they were aware of laws prohibiting them from killing wild animals. A further 3% reported a vague or confused knowledge of the laws, and no one said they were not aware of the laws. This left 35% of interviewees who refused to answer the question. In the south, 43% of interviewees said they knew about the ban on killing wild animals, and 40% said they had heard something about it. No one said they didn't know anything about wildlife laws. The remaining 17% did not reply to this question. In describing their knowledge of the laws, other details added included: park wardens claim to "own" and jealously defend the wild animals; if you kill a wild animal you can spend up to five years in prison and your firearms will be sequestered; and, all wild animals are "computerised" and individually monitored.

Have you heard of the RNFUU *or Madidi?*

Almost everyone (91%) in both the north and south knew about the Ulla Ulla National Fauna Reserve (χ^2=0.86, df=1, P=*0.35*). People were much less familiar with the newly-established Madidi National Park – 31% had heard of it in the north, and 12% in the south (χ^2=5.50, df= 1, P<0.05). In the north, the wildlife protection laws and the Ulla Ulla National Fauna Reserve were inextricably linked in people's minds. When people said what they knew about wildlife protection laws they tended to respond that it was the UUNFR which forbade them from killing animals. In contrast, in the south, few of the people who said they knew about the wildlife laws mentioned the UUNFR.

What are your opinions about the protected area and the wildlife laws?

Summarised responses
1= opposed and angry, 2= theoretically opposed, but no problems yet 3= no response given

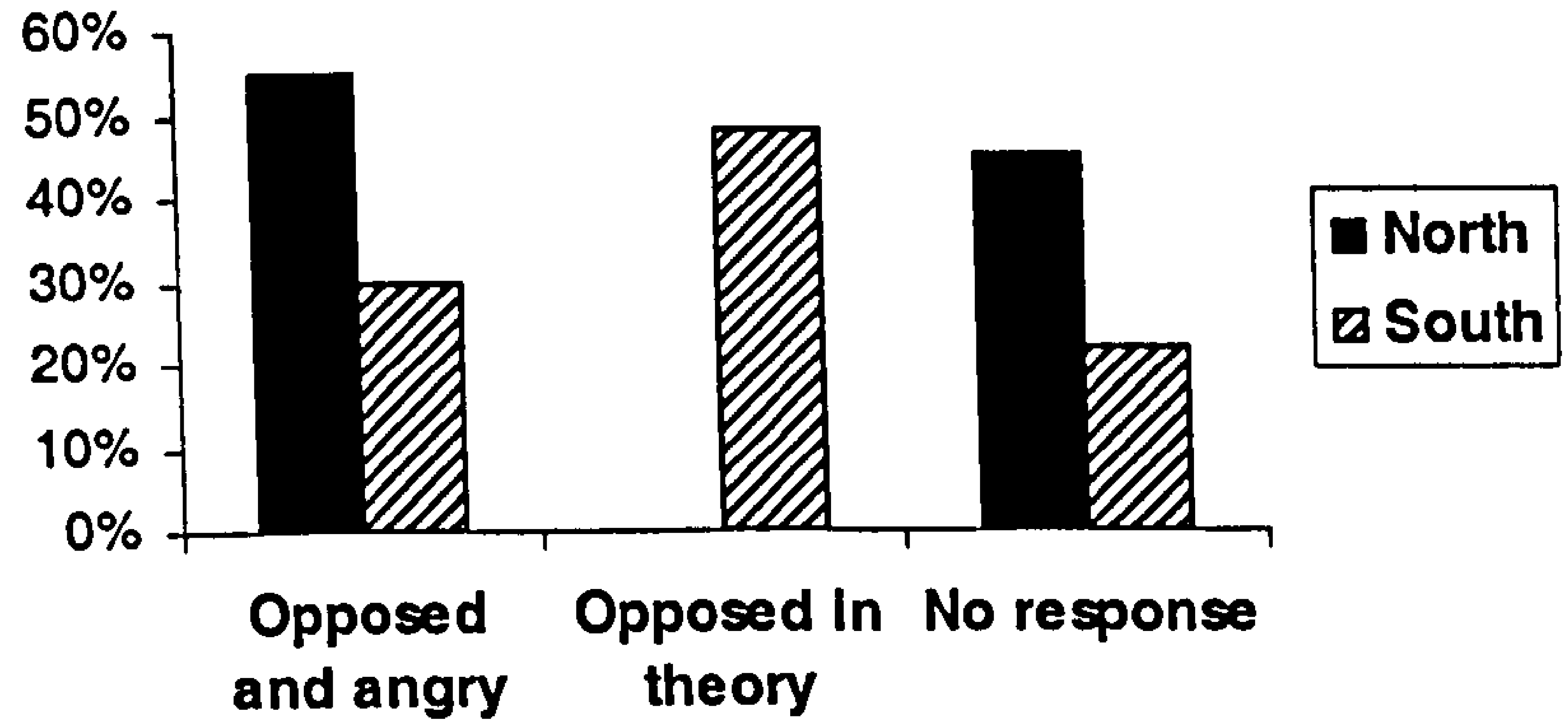


Figure 9-1 Attitudes about protected area and wildlife laws.

People in the north were more angry in their opposition to the protected area and wildlife laws, but everyone who responded did so negatively (χ^2=47.24, df=2, *P<0.001*). This unequivocal response amounted to 55% of interviewees in the north and 30% in the south, although another 48% in the south added that they hadn't yet had any problems, but that they were opposed to pest-wildlife protection in theory. The high rate of no response to certain questions has been interpreted as negative in other studies (Mehta and Kellert 1998), as it should be in this one, as it seemed related to fear of punishment. Their objections to the RNFUU were generally to do with the organisation itself, and rarely to do with disliking people who worked for it. Responses were exemplified by that of one man in Chiata, "We are not in agreement. It is fine that they protect the vicuña but not the pest animals." Before the Agrarian Reform, people said they were encouraged to kill animals and that their grandparents had killed bears. They resented this change and believed they should have the right to kill problem animals.

9.3.2 Official complaints to the Fauna Reserve

A series of letters were written by communities inside the Ulla Ulla National Fauna Reserve, complaining about losses of livestock to wild predators. The following letter to the head of the RNFUU was sent by the community of Queara in the north of the study area and in the heart of the reserve. It is translated and presented (in a slightly abridged form) as an indication of the feeling about this issue.

The Great General Assembly celebrated in the office of the Agrarian Syndicate of this Community of Queara, Jurisdiction of the capital, 2nd Section, Pelechuco, Franz Tamayo Province of the Department of La Paz, 12th of May, 1997

After wide consideration about diverse matters we respectfully address the head Park Warden, Headquarters, and the corresponding authorities of this Institution.

Considering...the motive of the present Resolute Vote...a very urgent complaint to make you aware that these regions, given the law of the preservation of the environment and the fauna, have been very affected by the breeding of pest animals, especially the puma, condor, bear and fox that kill our domestic animals. These indicated animals exterminate all of the domestic animals, not just here in Queara, but of all of this sector. Approximately five thousand rural people...we suffer many losses of large livestock such as horses, mules, cattle, llamas, and small livestock such as sheep, pigs and many others.
In sum, nearly all of this group of animals, which for us is our sustenance because they … are how we maintain out homes.

Thus, suddenly each night these four pest animals kill three or four livestock. In some families they have wiped out the little that they had and even more so in the countryside away from the houses where we normally live, the killing of large livestock goes on continually.

Therefore we ask you, as you are the ones who prevent us from hunting, that you be the ones who compensate us for the high value of our losses, or whatever solution of this type you can offer with the aim of preventing more losses. Otherwise we ask that you send a commission so that they see the losses suffered in each home of these sectors.

In the case that you don't respond to the petitions and complaints that we make, very respectfully to the dignified authorities of this institution, **our necessities will oblige us to eliminate these pest animals. We will also organise a march to the seat of government, the approximately five thousand rural**

people affected in these regions. Without any other items of business, we take our leave awaiting an adequate solution to our petitions.

Very attentively,

all of the officials of the community of Queara

This was not the only letter of this type received by the protected area since 1996. Previous to this date no such complaints had been documented. Following is a summary of correspondence regarding predators to the UUNFR director (Table 9.2).

Table 9-2 Correspondence regarding livestock losses sent to the Ulla Ulla National Fauna Reserve 1996-1999.

Community	Date	Predator	Livestock	Demand
Katantica	August 10, 1996	Fox	All	Permit to kill
Nube Pampa	August 15, 1996	Fox	1516 llama, alpaca, sheep	List animals killed (ever?), request help
Ulla Ulla	January 17, 1997	Fox	Alpacas	Permit to kill
Ucha Ucha	March 2, 1997	Losses to pests	Old alpacas	Not specified
Magno Ampliado Syndicate	April 27, 1997	Fox, condor, puma	Llama, alpaca, sheep	Assistance
Queara	May 12, 1997	Fox, puma, condor, bear	All	Permit to kill, or compensation
Aguas Blancas	September 12, 1997	Fox	Sheep	Permit to kill
Aguas Blancas	January 12, 1998	Fox	Sheep	30 boxes of firecrackers
Pelechuco[1]	No date, 1998	Puma, condor, bear and fox	Cow, horse, mule, sheep	Compensation or permit to kill
Cololo	February 13, 1999	Fox	60% of young alpacas	Permit to kill

[1] The letter from Pelechuco also complains that "the *gringa* Susy traps and puts collars on bears and lets them go again. This is in no way convenient for us as these same bears will do damage to us when they are big. She should trap them and take them away to somewhere far away because it's not just us that are affected but those from other sectors have the same problems, our brother campesinos."

9.3.3 Use of lethal and non-lethal deterrents

How can crop raiding be prevented?

Less than 10% of interviewees in either the north or south could be drawn out on methods of preventing depredation of crops. The few methods utilised are mentioned below in reference to Table 9-1.

Table 9-3 Non-lethal deterrent methods used against bears in Apolobamba.

From review	Use in Apolobamba
1. **The domestic dog**	No
2. **Physical barriers**	No
3. **Aural deterrents**	Yes, exploders, dynamite, fire crackers, clapping Large cans on poles like bells move in the wind
4. **Visual deterrents**	Scarecrows (*Espanta pajaros* or, in Quechua, *Saywa*) The shiny tape from cassettes strung up between posts, moves and glints in the wind Sheets of blue or red plastic like flags
5. **Olfactory deterrents**	Yes, scent on farmers clothes (once they know that person is a threat) Smoke is quite effective at keeping the animals away
6. **Conditioned taste aversion**	No
7. **Projectiles**	Yes, slingshots
8. **Clearing undergrowth**	Yes, although rarely possible due to topography
9. **Airborne irritants**	No
10. **Aversive conditioning**	No
11. **Relocation of problem animals -**	No
12. **Reduction of attractants**	No
13. **Manipulation of key resources**	No
14. **Herdsmen, or guards**	Crop guarding sometimes effective with bears and parrots, but impossible to guard everywhere
15. **Prayer**	Yes (see section 3.3.3)

The most commonly mentioned strategy, and the one in which people expressed the most confidence, was the use of smoke. Farmers in Queara explained that making small fires near the borders of a field is very effective at keeping animals away. Obviously, this technique requires the presence of the farmer, who would be increasing the simple utility of the fires by also acting as a crop guard.

The second technique is the use of passive visual and auditory deterrents. Small flags of plastic are hung on top of poles. Some of these, called *saybas* are imbued with special magic and were described to me as ghosts. Some people make scarecrow-like figures using their own used clothes. Farmers from Chullina stress that it is the smell of the clothes that works, as much as the appearance. Cans are also tied to posts so that they rattle in the wind.

There was disagreement about whether or not crop guarding works. The great majority of people said that bears do enter fields when a person is present, but that they may enter from the other side of the field, staying 100 m or so away. Some farmers throw rocks at bears or try to scare them off by shouting. Charges and fireworks are also used. Interviewees also commonly described bears throwing rocks or maize cobs at them. One man in Sayhuani explained, "I was watching a bear eating all of my maize. I approached him and he wanted to attack me. They pursue people, as if they were the owners instead of us. Now that we don't kill them, these problems are getting worse. With this *jucumari* you can't do anything because they now want to kill us. That's why I'm now afraid and I don't bother them if they come to feed." A few dissenting voices claimed that a bear will only raid fields in "times of silence" or when no person is present.

Giving up of maize cultivation has been the final recourse for farmers in Carpa and Mataru, who, year after year have lost too much of their crops and time. Another form of modification of basic farming patterns resulting from severe crop raiding is harvesting earlier than the time of optimum ripeness. The other technique used to protect crops is killing crop pests, either by shooting or poisoning them. For foxes, poison is left in piles of maize, and is injected into eggs to kill skunks, possums and rodents. Farmers visit fox dens and kill pups there. Arrows are used in attempts to shoot parrots and other birds. Bears and deer are particularly vulnerable to being shot while raiding maize fields.

How can predation be prevented?

Few non-lethal alternatives were described in answer to this question in either the north or south. People almost unanimously threw their hands in the air, shook their heads or said, "Unless we kill the pest animals, there's nothing we can do." The few possibilities mentioned such as flags of plastic, dynamite and other loud noises were more relevant to crop raiding animals than to livestock killers. One cattleman burned a swathe of grassland surrounding the forest near where he kept his cattle, because he believed that bears did not like to cross open areas. He recognised, however, that the fresh shoots of grass subsequent to burning served to attract both bears and cattle to this area. No one discussed improving herding methods to keep the animals under a closer watch. Dogs are not used to protect animals.

Would you kill a bear under extreme circumstances?

Summarised responses
1= would kill a bear if they were being attacked or if they saw a bear attacking their livestock
2= would not kill a bear under any circumstances

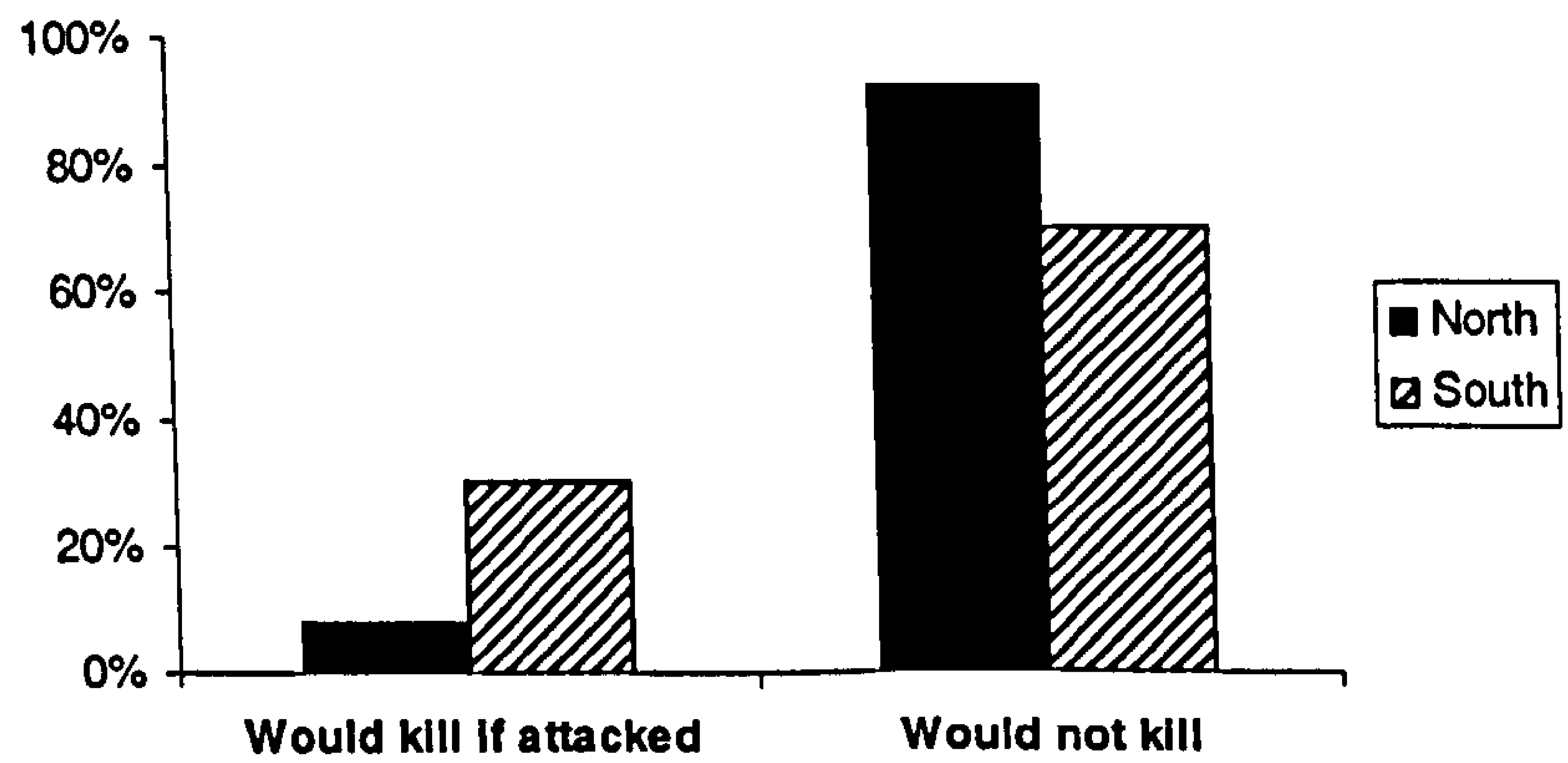


Figure 9-2 Theoretical preparedness to kill a bear under extreme circumstances.

Responses to this question were quite different in the north and south (χ^2=25.02, df 3, P<0.001)(Figure 9-2), 30% of people in the south feeling that they could kill a bear if it were attacking them or their livestock. The remaining 70% said that fear of punishment would stop them killing bears. In the north 92% said they would be too afraid of punishment to kill a bear under any circumstances. The other 8% said they would kill a bear if they saw it eating an animal of theirs or if it threatened them. No one in either site offered that they would kill a bear in their maize field, and this was not probed.

How do people kill bears?

Methods for killing bears were similar in the north and south (χ^2=2.45, df 3, P=0.48). When asked about the best way to kill a bear, 46% said you had to use a gun. The guns most commonly kept are antique Mauser rifles that were given out during the Agrarian Revolution. The second most common response (27%) was that it was almost impossible, that bears were notoriously hard to kill. Poison was held to be the best way to kill bears by 19% of interviewees. They described putting strychnine into piles of corn or the carcass of an animal, usually adding that it was easy to kill foxes and condors this way, but that bears were usually too clever to eat poisoned bait. The least common response (8%) was that bears could be killed using traps. Three kinds of traps were described. The first and most common trap utilises a trip wire on a forest trail, with a gun set to fire at the animal. The other two were variations of a pitfall trap, but no one I interviewed was very specific about how to make one.

How many bears are killed a year in this valley?

This question elicited no firm estimates in the north and only a few in the south. People either stated that bears are no longer killed or made vague speculations (i.e. maybe one bear is killed each year in all of Bolivia). Other respondents mentioned the last time a bear had been killed that they knew of. Based on these descriptions, many of which repeated descriptions of the same kills, I estimate that approximately one bear has been killed per year for the last five years. Reports of bears killed in the last ten years come from Carijana (young male), Sapji (small female), Sayhuani (adult male), Kasu (pregnant female) and Mataru (large adult male), all of which are settlements in the south. It is harder to estimate bears killed in the north. It is possible to hear stories of people killing or trying to kill bears in Queara, Puina, Pelechuco and Hilo Hilo, but all are described as being many years ago. The only anecdotal report of a more recent killing in the north comes from Sorapata (an adult male).

9.3.4 Population trends and motivation to conserve bears

What changes have you observed in the number of bears in this area in your lifetime?

Populations of bears were widely viewed as stable or increasing throughout the study area (Figure 9-3); there was a highly significant difference (χ^2=32.78, df 3, P<0.001) between the north and south. Bear populations were described by 43.5% of interviewees in the north as increasing a lot, and by the same percentage as increasing, with only 13% describing them as stable. In the south, the modal response (36%) was that bear populations were increasing; 15% described them as increasing a lot, comprising the biggest contrast with the north; 29% of interviewees described bear populations as decreasing from previous years or decades.

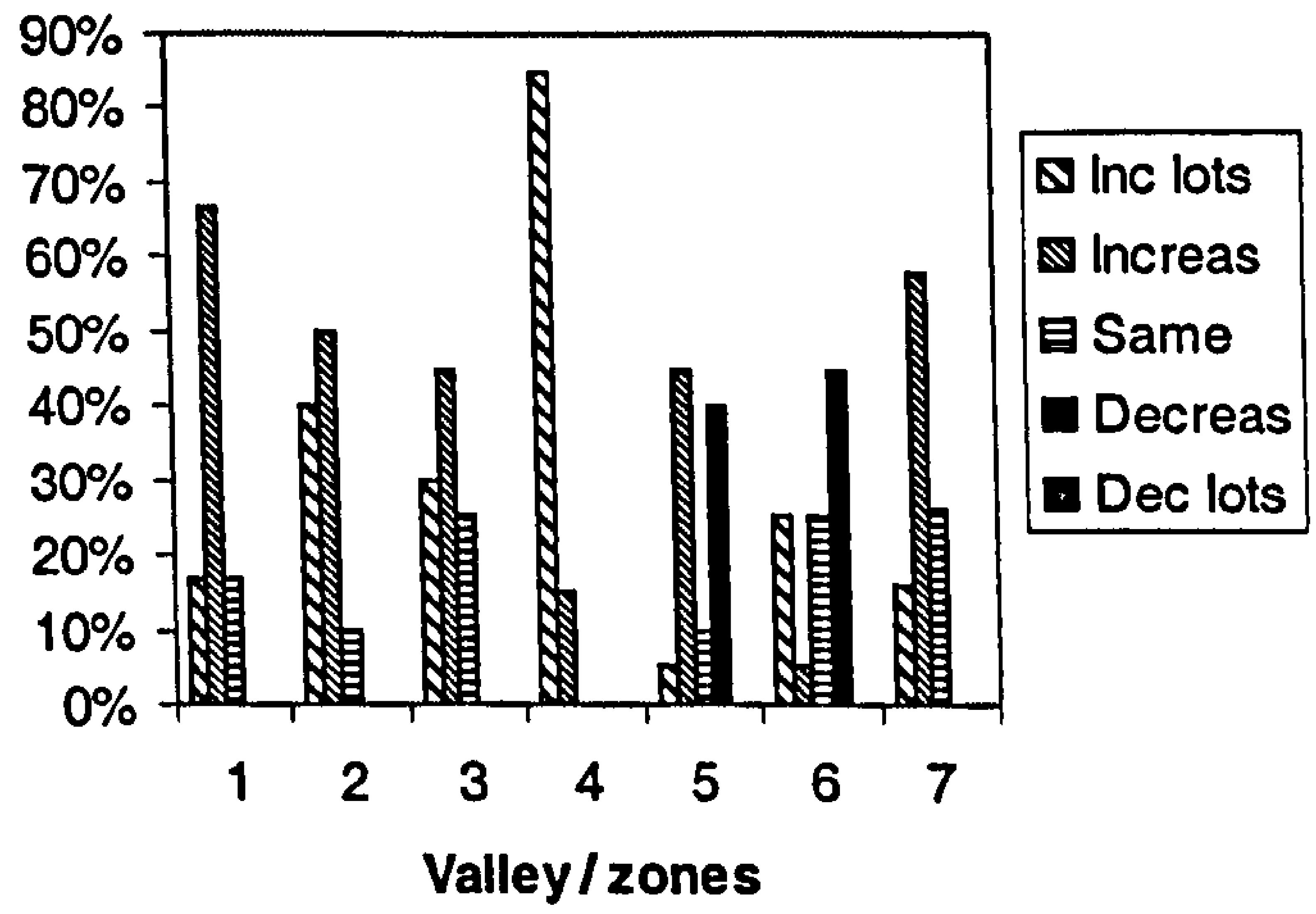


Figure 9-3 Described trends in bear populations. Valley/zones 1-4 are inside the protected area and 5-7 are outside.

How would it be if there were no more bears in Apolobamba?

Most people (58%) in this study would be glad if there were no more bears and explained that it would be better for the people because they would no longer be afraid; they could grow their crops and leave their livestock to graze in peace (Figure 9-4). Surprisingly, given the differences in so many attitudes between the north and south, attitudes about extinction did not differ significantly between the north and south (χ^2=3.45, df 2, P=0.39). Neutral views were expressed by 27% of interviewees, and 15% reacted negatively to the idea of no bears in the future.

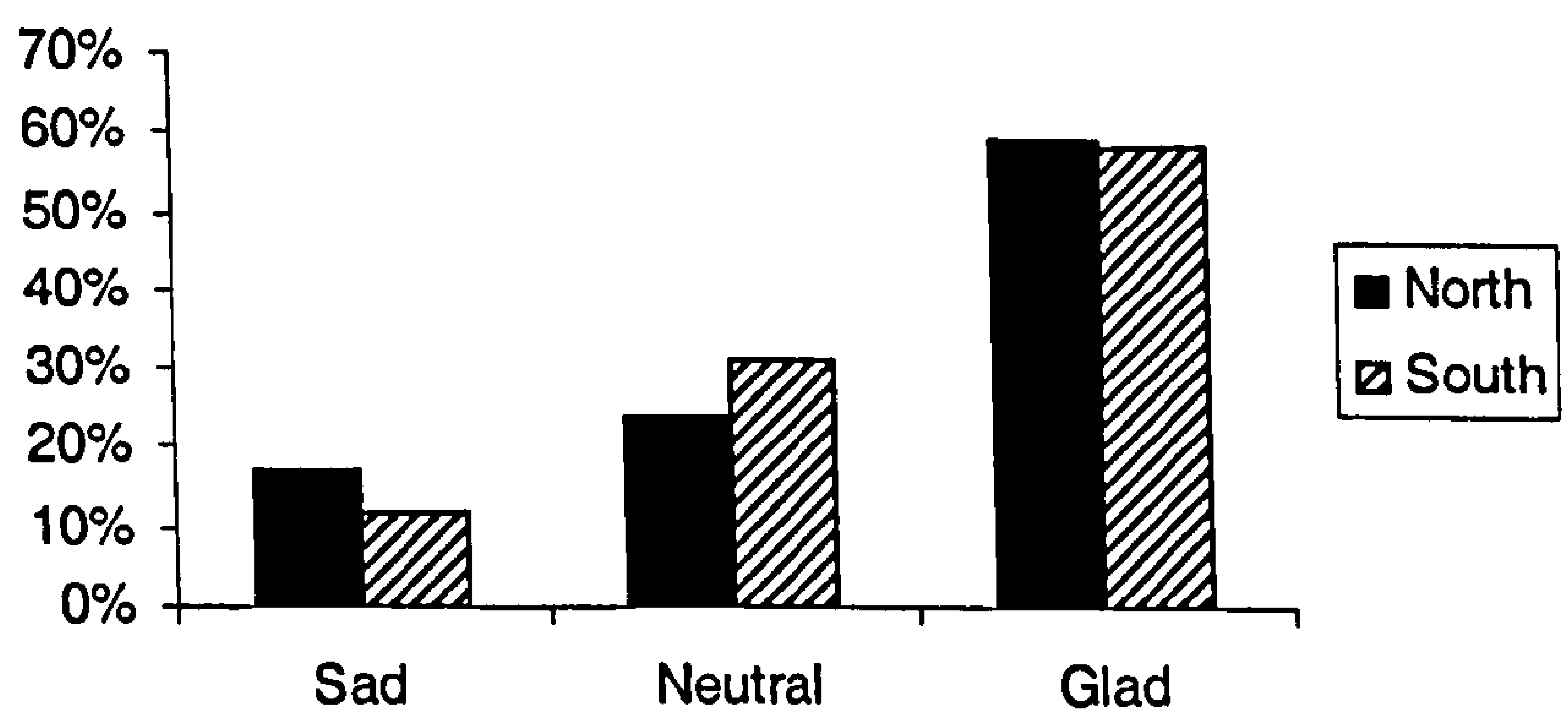


Figure 9-4 Response to the idea of the extirpation of bears.

The few negative reactions to the idea of extinction in the north were related to local identity, pride and utilitarian reasons. As one man from Chiata stated, "In one way it would be good if there were no more bears because of the problems they cause us, but in another sense it would be bad - it is a matter of pride that we have these animals." In the north, utility to people was given as a reason why the loss of bears would be a bad thing. In contrast to this, in the south, the people who would react negatively to the idea of extinction did so on moralistic or symbolic grounds. In Amarete, several people talked about extinction as unthinkable, "There have to be bears because there have always been bears". Another reason was the supremacy of bears: "There must always be bears because they are the most powerful animal, and they rule and control other animals like the puma."

9.3.5 Determinants of tolerance towards bears

Table 9-4 Questions used in factor analysis. The coding and distribution of responses is presented in previous sections.

Question	Section
a) Do bears kill livestock in this valley?	Fig 8.1
b) Do bears raid crops in this valley?	Fig 8.4
c) How do you feel if you see a bear? Are they scary?	Fig 4.2
d) Do you believe that jucumaris have powers?	Fig 4.6
e) Do bears provide medicine for people?	Section 4.3.3
f) What sort of being is a jucumari?	Fig 4.4
g) Are jucumaris good or bad or both?	Fig 4.5
h) How would it be if there were no more bears in Apolobamba?	Fig 9.4
i) Would you kill a bear under extreme circumstances?	Fig 9.2

Three factors emerged from this analysis, explaining 65% of the variation in the data. The emergent factors have been grouped by the procedure, and classified according to my interpretation. The letters in parentheses refer to the question above and are followed by their component coefficient.

1. Level of Conflict is comprised of livestock conflict *(a= 0.702)*, crop damage conflict *(b=0.630)*, and level of fear of encounter *(c= -0.678)*. Factor scores increase with increasing level of livestock and crop damage, but with decreasing fear of encounter. People who have more contact with bears are actually less scared of them. This factor explains 32% of the variation.

2. Level of Belief (in the mystical or healing powers of bears) is comprised of the power people attribute to bears *(d=0.755)*, the utility of bears as medicine *(e= -0.833)* and the classification of bears *(f=0.806)*. It explains 20% of the variation.
3. Tolerance of Bears is comprised of the good to bad continuum *(g=0.696)*, the issue of whether or not people would kill a bear under any circumstances*(h=0.614)*, and people's responses to the idea of extinction *(i=0.787)*. It explains an additional 13% of the variation.

9.3.5.1 Conflicts

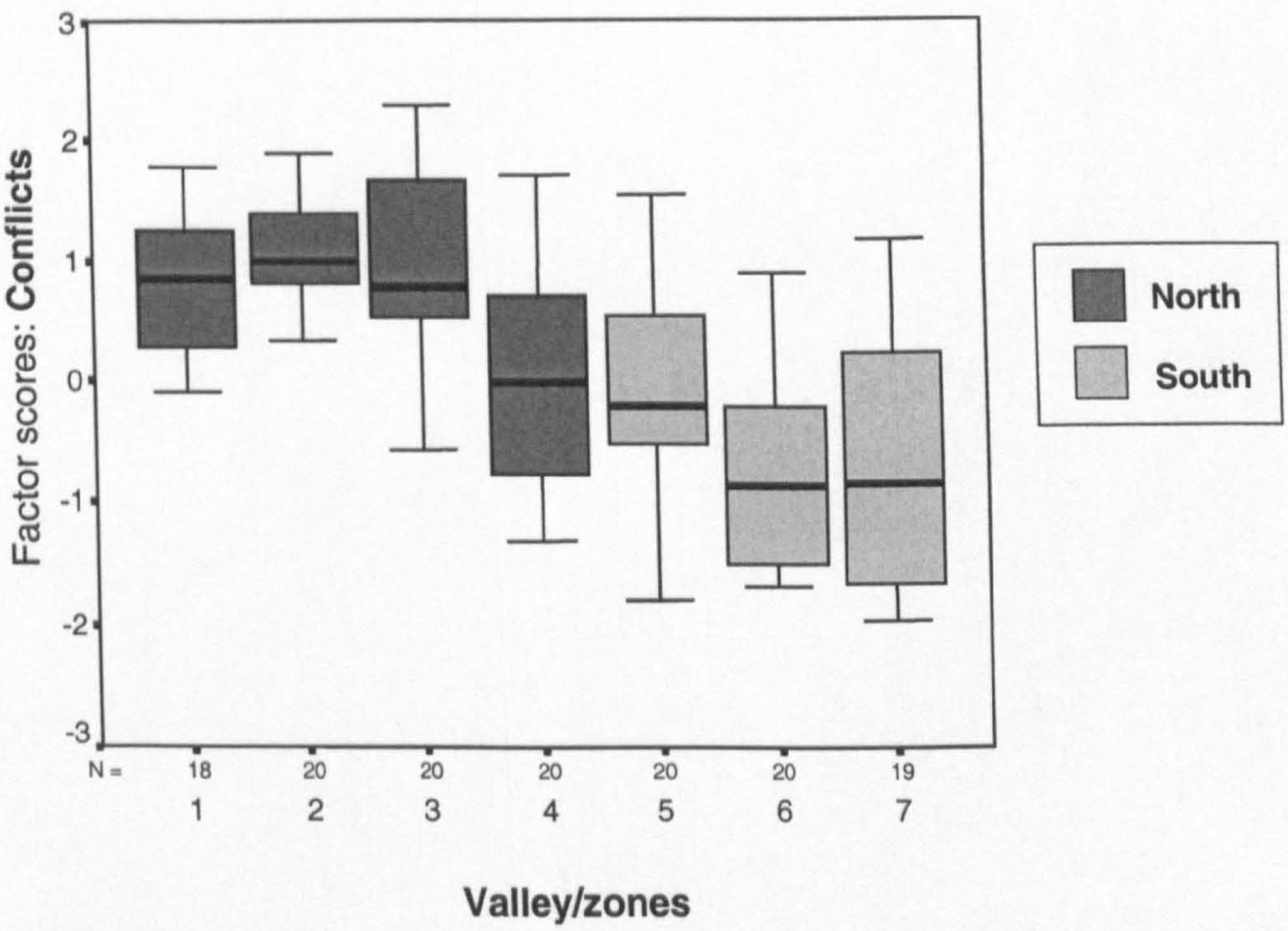


Figure 9-5 Factor scores for Conflicts shown in each of seven valley/zones. Box plots show median, inter-quartile range and total range.

The Conflict model explained 54% of the variation in the data set. Not surprisingly, those people for whom livestock husbandry and maize cultivation is a more important part of their livelihoods have more contact and conflict with bears (Table 9-5). Degree of conflict also showed significant geographical variation (Figure 9-5).

Table 9-5 Conflict: generalised linear model using the normally distributed factor score for Conflict as the dependent variable.

Explanatory variable	df	F-ratio	Significance
Corrected model	8	19.07	$P<0.001$
Valley/zone	6	9.04	$P<0.001$
Livestock herding	1	11.99	$P<0.001$
Maize cultivation	1	23.93	$P<0.001$
Language	2	0.37	$P=0.692$
Mining	1	0.14	$P=0.711$
Age (over 50)	1	0.11	$P=0.737$

Adjusted R^2=54%

9.3.5.2 Belief

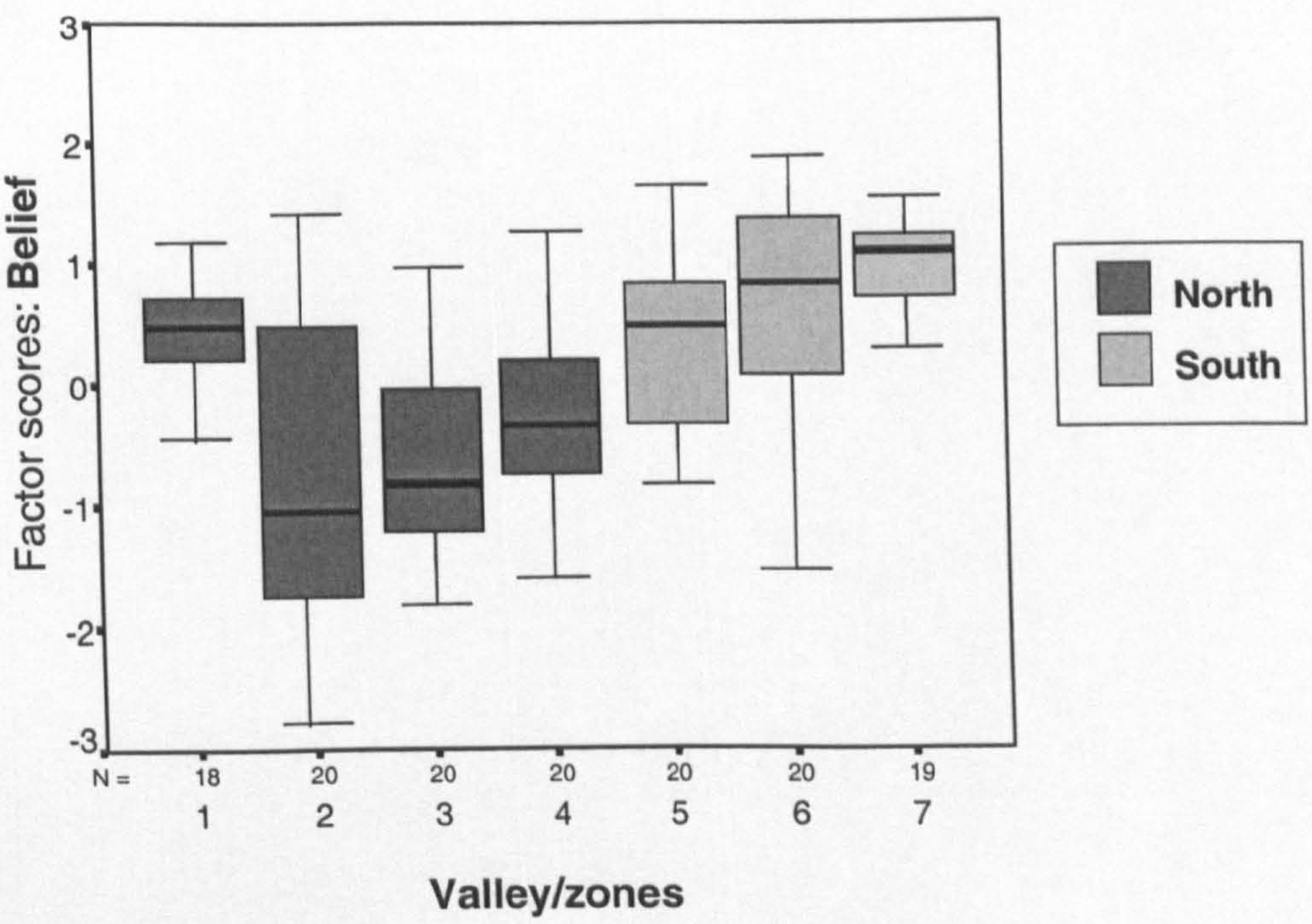


Figure 9-6 Factor scores for Belief shown in each of seven valley/zones. Box plots show median, inter-quartile range, total range.

The model for Belief was the strongest of the three generalised linear models, and explained 61.2% of the variance in the data set (Table 9-6). Belief was most strongly predicted by valley/zone, with the northernmost (Puina/Queara) and southernmost (Amarete) valley/zones having the highest levels of traditional beliefs (Figure 9-6). Belief was not predicted by language or age alone, but these variables did explain significant amounts of variation when interacting with each other. Older people are more likely to be monolingual and both have higher levels of traditional beliefs than young people in most circumstances. Language was also important in predicting variation in beliefs, in interaction with valley/zones, and tended towards significance on its own. Language may be a surrogate for degree of acculturation, as learning to speak Spanish brings opportunities that can erode traditional culture.

Table 9-6 Belief: generalised linear model using the normally distributed factor score for Belief as the dependent variable.

Explanatory variable	df	F-ratio	Significance
Corrected model	19	4.92	$P<0.001$
Valley/zone	6	10.22	$P<0.001$
Language with valley	11	3.39	$P<0.001$
Language with age (over 50)	2	3.30	$P<0.05$
Language	2	1.36	$P=0.076$
Mining	1	1.37	$P=0.245$
Age (over 50)	1	0.77	$P=0.223$
Livestock herding	1	0.13	$P=0.723$
Maize farming	1	0.45	$P=0.880$

Adjusted $R^2=62\%$

9.3.5.3 Tolerance

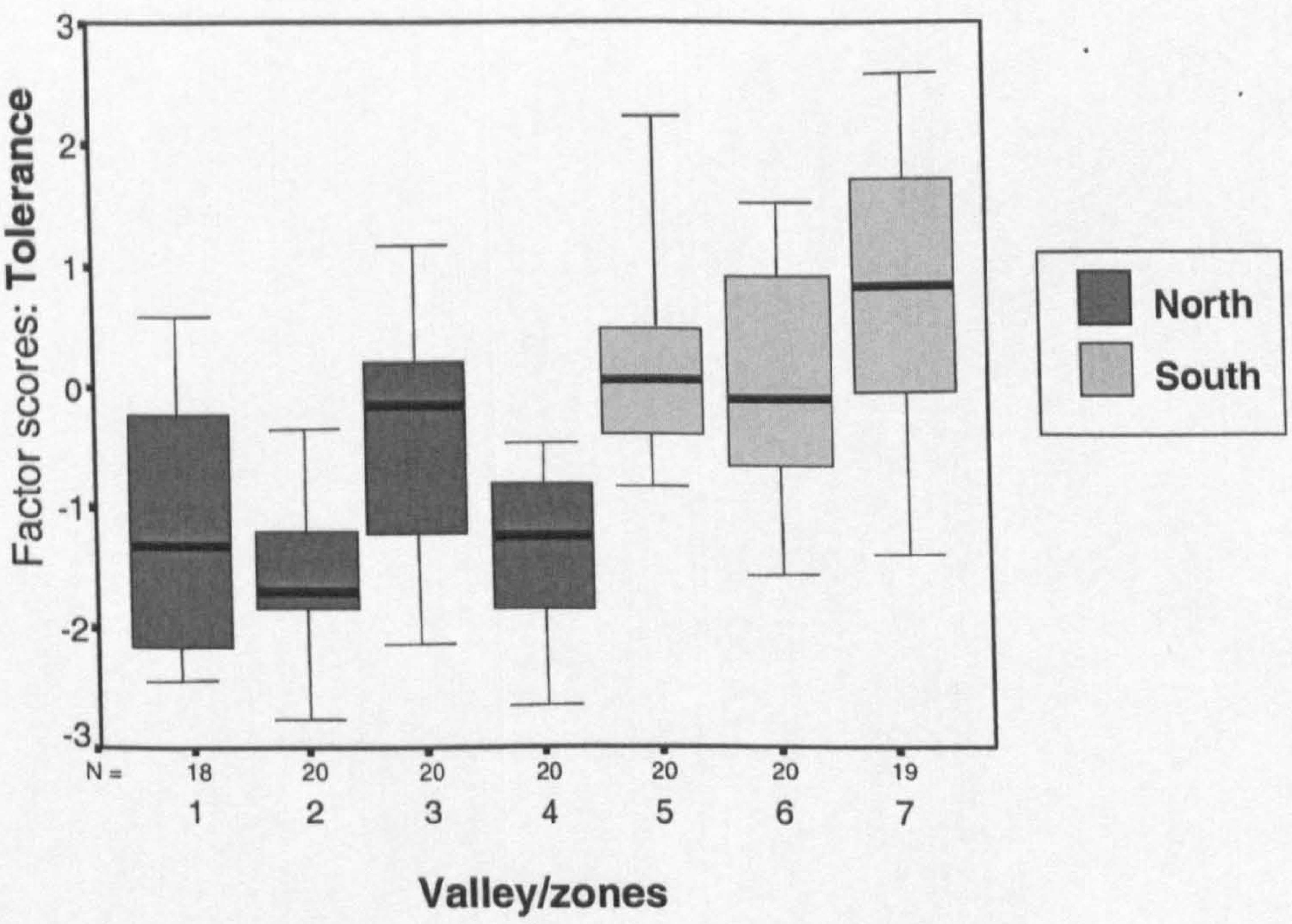


Figure 9-7 Factor scores for Tolerance in each of seven valley/zones. Box plots show median, inter-quartile range, total range.

The model that assessed the independent variables correlated with Tolerance of bears was the weakest of the three, explaining only 21% of the variation in the data set.

Geographical variation was the most important explanatory variable (Figure 9-7). In addition, people who relied on livestock rearing were less tolerant of bears than those relied more on maize farming or mining (Table 9-7). Age also tended towards significance, with people over 50 being more tolerant than younger people. The valley/zone with the highest Tolerance scores was the southernmost valley, Amarete. This valley also has the lowest Conflict scores, the highest Belief scores and the highest human population.

Table 9-7 Tolerance: generalised linear model using the normally distributed factor score for tolerance as the dependent variable.

Explanatory variable	df	F-ratio	Significance
Corrected model	7	4.06	$P<0.001$
Valley/zone	6	10.22	$P<0.001$
Livestock herding	1	3.24	$P<0.05$
Age	1	1.81	$P=0.061$
Language	2	1.43	$P=0.149$
Mining	1	0.48	$P=0.492$
Maize farming	1	0.12	$P=0.728$

Adjusted R^2= 21%

9.4 DISCUSSION

Attitudes towards wildlife protection and the protected area were generally negative, but more so inside the protected area. The level of antagonism directed towards the protected area seems to be increasing, as a result of wildlife conflicts. Management alternatives are suggested by successes in other sites, although the contradictory and ambiguous legal framework hinders opportunities for experimentation. Tolerance varied by valley; it was lower amongst people more dependent on livestock husbandry, and tended to be higher amongst people over fifty. Although it was not possible to test statistically the correlation between the level of traditional beliefs and tolerance, or between the level of conflict and tolerance, two strong trends appear in the data: first, valleys with low levels of conflict were also those more tolerant of bears and second, they were the same valleys with higher levels of traditional beliefs. Causality would be difficult to determine. Bear populations were viewed as increasing in most of the wider study area, probably due largely to protection. Finally, because of the problems caused by bears, the majority of people would be glad if they disappeared.

9.4.1 *Attitudes towards wildlife protection*

The first objective in this enquiry into management and conservation in Apolobamba was to determine the differences in attitudes between people living inside and outside the protected area. As explored in previous chapters, many deep differences existed between the people in the north and south, which certainly long pre-date the establishment of the protected area. However, certain possible effects of the restrictions of living inside a protected area can be discerned amongst the people in the north. People in the south did not yet feel as actively thwarted by the park authority in their attempts to defend themselves against crop pests. Their frustration about crop pests came instead from the real practical difficulties in this battle, in that these animals are wary and hard to kill. Although, to a lesser extent, they too were indignant that they are not permitted to protect their crops and livestock from wild animals. This was not altogether surprising – negative attitudes towards protected areas held by reserve adjacent dwellers have been documented in multiple studies (Gillingham and Lee 1999; Infield 1988; Ite 1996; Mishra 1997; Newmark et al. 1993).

Nearly everyone who could be convinced to answer questions about the wildlife laws knew about the prohibition against killing wild animals and resented it, whether they lived inside or outside of the protected area (Figure 9-1). It seems fair to conclude that the scare tactics being employed by the protected area have been having a positive effect on bear populations. It also seems fair to conclude that these restrictions have had a negative effect on people's attitudes towards bears.

Grievances about large carnivores and other vertebrate pests have begun to be voiced and documented in the last few years and are escalating in Apolobamba (Section 234). This issue is becoming a focus for feelings about the protected area. It is worth asking what community conservation models have to offer in this system. Community-based conservation is centred on the coexistence of people and nature, rather than the protection of nature from people (Ghimire and Pimbert 1997; IIED 1994). Much of the experience in community-based conservation has unfolded in Africa and Asia (IIED 1994) but these ideas are gaining influence in Latin America, primarily in Amazonia (Molina Barrios 1996). Before the practical community-based management options can be considered, the legal issues associated with ownership of wildlife must be addressed.

9.4.2 Legal issues

As described in section 9.1.2, laws regarding the killing of bears are contradictory. In practice, as far as I could ascertain from interviews with the national wildlife authorities, no one in Bolivia has been prosecuted for killing bears. Hunting of Andean bears occurs both inside and outside protected areas in Bolivia, as in the rest of the bear's range and has been described as opportunistic (Yerena 1999), taking place in response to crop raiding, and as planned in response to suspected predation events (Goldstein 1991; Rumiz and Salazar 1999). The lack of compliance and enforcement of the Law of Total Ban has been described as "blatant" (Eulert 1995; Rumiz and Salazar 1999). However, it seems, from the results of this study, that compliance and enforcement in the UUNFR have been high, although resultant frustration is growing and may at some point force a re-examination of the contradictory legal situation.

9.4.3 Management alternatives

Few non-lethal deterrents of bears were deemed useful (Table 9-3). The aural, visual and olfactory deterrents were all employed, as was the clearing of undergrowth around fields. However, other than flags, tape, and scarecrows dressed in farmers' clothing, these methods require human presence. The preferred methods of using smoke and slingshots, and the possibility of using dogs, all require the presence of a crop guard. Time is the limiting resource in a season when other agricultural chores await attention (see Figures 8.2 and 8.3). To deter Andean bears from raiding crops, crop guards and plastic flagging have been used in Peru. Clearing of vegetation around the field's periphery and burning of tires on the entry trails have also been attempted but these methods were not effective (Peyton 1984). In this study, non-lethal methods for deterring bears and other predators from killing livestock were practically non-existent.

As mentioned in the previous chapter, the killing of problem large carnivores is judged to be an appropriate and necessary management tool in many countries (Mishra 1997) (Sillero-Zubiri and Laurenson 2001). Indeed, the protection of problem grizzly bears has led to the destruction of more animals than would have died if individuals were removed as soon as they were identified as problem animals (Meagher and Fowler 1989). When problems involving just a few individuals are not resolved, animosity from the local community may increase and expand to the entire species and the protected area itself (Tilson and Nyhus 1998), as appears to be the case in Apolobamba. In Minnesota, although electric fencing, scarecrows, exploders, and dogs were used by a minority of maize farmers, the management measures favoured by most landowners were lethal (either the shooting of crop-raiding individuals or unrestricted harvesting of bears during the hunting season) (Garshelis et al. 1999).

Compensation was one of the options solicited by the people of Queara in their letter to the UUNFR (9.3.2). In situations where the pest animal is endangered, such as the brown or grizzly bear, *Ursus arctos*, reimbursement for losses, and translocation of problem animals are common management techniques (Linnell et al. 1999; Mishra 1997; Sillero-Zubiri and Laurenson 2001). These techniques can be extremely expensive and often tend to escalate in cost (Garshelis et al. 1999). It is hard to imagine where funds would come from to underwrite such a programme, and it would be hard to overcome the difficulties of verifying cause of death of livestock in such extensive herding systems. However, compensation for livestock losses has also been recommended in the case of Andean bears in Venezuela (Yerena 1999).

If killing problem bears were made legal and a compensation programme judged desirable, the model of selling hunting licences to tourist hunters and allowing them to kill the problem animals may be of relevance (Garshelis et al. 1999). In theory, the revenues can be high enough to fund compensation for losses and to underwrite many other community projects. Individual problem animals can be removed from the population, while the community develops a commitment to the continued survival of the population as a whole. The possibility of tourist hunting is viewed as a Pandora's box by many Latin American conservationists (Paisley, in prep). Various concerns about this idea were voiced at a workshop about the Andean bear in Bolivia in 1999. Concerns include the potentially dramatic impact of increased mortality on populations of unknown densities and dynamics, and the difficulty of preventing private individuals from earning extra money by guiding hunters who are not sanctioned by the community (Sillero-Zubiri and Laurenson 2001).

Another alternative is bear-centred eco-tourism. Local people could earn money as guides and tourists, and in some areas could even be used as temporary crop guards during the heaviest raiding season. This happens to coincide with the dry season, the months in which most tourists visit (May-August). The opportunity to see an Andean bear, and to contribute to their continued survival in a spectacular setting, may be enough to convince tourists to spend a week patrolling the areas worst hit by raiding bears. If the benefits to the community from tourist hunting or viewing were sufficient, those communities could undertake to augment the diets of local bears with enriched wild food sources as a part of such a programme.

This sort of system would only work in limited areas, where there was coincidence of access, infrastructure and willingness of the community to participate. Furthermore, work thus far with tourists has been limited to a handful of individuals, and few benefits have been distributed to other members of the communities (RNFUU 1997). A perhaps more immediate difficulty with this idea is that bears are cryptic and no tourist or hunter could be guaranteed of seeing, photographing or shooting a bear. Radio collaring and habituation could be attempted to increase the chances of seeing bears. However, if such an initiative were backed up with enthusiasm from the communities concerned, and permissions were given, such is the appetite for novelty and rarity among the voracious wildlife consumers that this is an option to be considered.

Less radical management possibilities are difficult to come by. The deterrence methods already employed in Apolobamba, that could provide the basis for future research, are the use of smoke, and the clearing of swathes around cultivated areas. African experience has shown that highly palatable crops such as maize are best planted more than 500m away from the forest edge (Naughton-Treves 1998). This is not an option in the Andean environment because of the limited areas with a slope flat enough to be cultivated. The extensive destruction of surrounding forest would certainly not be desirable. Reserve guards, of which there are now more than thirty in Apolobamba, could be asked to help as crop guards during the height of the raiding reason. Exploders are of some utility in scaring away crop raiding animals, and their provision by the Reserve improves the general feeling about how seriously the problems are being taken (Lewis and Alpert 1997). The most promising management alternative overall is learning from the considerable successes in the Bolivian lowlands of wildlife co-management with rural communities (Townsend 1999).

9.4.4 Determinants of tolerance

The median factor scores for tolerance of bears were negative in all but two valley/zones, both of which were in the south (Figure 9-7). However, it is worth noting that the total range of factor scores for tolerance includes positive scores in all but two valley/zones. The lowest tolerance was in valley/zone 2, Pelechuco, where livestock losses are taken to be a serious problem and where frustration is high with regard to prohibitions about killing bears. Livestock herding was a significant predictor of level of tolerance. Even though bears cause problems and economic losses to people by raiding their maize crops, the perceived losses suffered by cattlemen provoke comparatively greater frustration and intolerance. Interview data from southern Bolivia echoed this sentiment, in that 74% of interviewees viewed the bear as a crop and livestock pest and, of those, 97% gave livestock predation as the principal conflict issue (Eulert 1995). People for whom livestock husbandry and maize farming is important had greater conflicts with bears, but, interestingly, it was only livestock husbandry that correlated negatively with tolerance.

People over fifty tended to be more tolerant of bears and had higher levels of traditional beliefs than people under fifty. Language also tended towards significance in explaining variation of tolerance of bears. Language serves as another surrogate variable for traditionalism, as monolingual Quechua speakers exhibit a lower degree of acculturation (Allen 1992). This lends support to the idea that traditional positive views of bears are losing ground to a more antagonistic attitude.

One of the initial aims of the thesis was to document geographic variation in attitudes and beliefs about bears in Apolobamba as a whole. One of the questions posed in the introduction was whether or not it is true that in one valley bears are looked upon as allies while in the next they are seen as enemies. I had formed this impression during an initial visit to the study site in 1997, when I spoke to people from Chiata who described the bear as protective of people and as man's friend. I also talked at that time to people from Queara who had an extremely antagonistic relationship with bears. This turned out to be an oversimplification of the variation present – many other complex factors are involved in predicting a person's attitude towards bears, more than simply the valley/zone in which they live.

Traditional beliefs about bears were stronger in the southern valley/zones where, simultaneously, tolerance was relatively higher and conflict with bears was lower. Outside of the south, the valley/zone with the most traditional and reverential beliefs about bears was at the northernmost extreme of Apolobamba – in Queara and Puina, illustrating geographic variation between valleys/zones. However, generally, in the north, traditional values and tolerance are exhausted in the face of the prohibition about killing problem bears. These people directly suffer both crop raiding and livestock losses that they blame, to a large degree, on bears. In the south, traditional and reverential attitudes toward bears are no longer so directly linked with interaction with real bears. The larger human population in the south, for example nearly 2000 in Amarete last census, as compared with around 400 in Queara and Puina combined, means that bears are less in evidence. In some places in the south bears are thought of as more a historical or even mythic creature.

Three underlying variables in the interview data were distinguished by the factor analysis, and because these variables came from the same data set, it was not possible to test the correlation between these factors statistically. It is difficult to disentangle the complex interplay of traditional beliefs, management and conflict in determining tolerance of bears. Cumulatively, these findings suggest that intolerance of bears is highest when coincident with conflict, particularly with regard to perceived livestock predation. They also suggest that traditional beliefs, often held more firmly by the elderly, go some way to increasing tolerance.

9.4.5 Conservation prospects

Bear populations were almost unanimously considered to be healthy and increasing inside the RNFUU. If this were the case, it would be attributable to four main factors. First, many people have had their firearms "decommissioned" by the RNFUU and they are too poor to buy new ones. Second, bears are difficult to kill without a lot of interest. People rarely have sufficient time, as their activities are spilt between farming (primarily in the puna life zone), tending livestock and mining. Third, mining is increasing in importance and the agricultural frontiers are, perhaps temporarily, shrinking. Fourth, people are scared of punishment for breaking the law. Finally, because of the terrain in the cloud forests of Apolobamba, many areas are real strongholds for bears, without human threat or traffic. It is debatable as to whether or not these areas hold all of the resources that bears need. However, these forested ravines do nonetheless provide safe refuge for many bears during much of the year.

Attitudes about bear conservation in its purest form (i.e. should there be bears in the future?) elicited interesting and worrying results. The majority of people in both the north and south responded neutrally or positively to the idea of no more bears. This can perhaps be best explained by imagining responses in our society to the inquiry, 'How it be if there were no more criminals?' Despite the innumerable stories venerating crime in our popular and classical culture, we could not, in good conscience, say that there should be criminals in the future. Although we are fascinated by crime we know that criminals steal from and threaten people. Bears are valued abstractly and practically, and they are of great conceptual importance to people, but given a choice, life would simply be easier without them.

Clearly, the implementation of any novel approaches to the resolution of conflicts between bears and people must be guided by local people. Community based conservation initiatives are undermined by the failure to understand the goals, needs and aspirations of different groups of local people, and by the assumption that they make up a uniform group (IIED 1994). Development interventions provide opportunities for the wealthy and influential to consolidate their advantage, at the expense of the poor and less powerful and conservation-oriented interventions are no exception to this problem (Homewood et al. 1997). They are commonly initiated and managed by outsiders with a natural sciences background but limited understanding of social issues, processes and pitfalls. The UUNFR has in place a guiding committee made up of members from the communities inside its boundaries. As stated in Chapter 2, the southernmost extent of the study area was not included in any protected area but has, since the termination of fieldwork, been included in the new Apolobamba Natural Area of Integrated Management, which is a reorganisation and expansion of the RNFUU (from 240,000 hectares to 483,744 hectares). This category of use aims to strike a balance between biodiversity conservation and development of local people (Molina Barrios 1996). It will be the challenge of the new expanded protected area, particularly in its new status, to build upon this participation in trying to resolve large carnivore-related animosity.

9.5 SUMMARY

1. Frustration about problem animals is widespread and attitudes to laws protecting pest animals are negative. People inside, and increasingly outside, of the protected area are afraid of punishment for killing bears or for using or selling bear parts.

2. The Ulla Ulla National Fauna Reserve has been very successful in fulfilling its mandate to protect wild fauna – 92% of interviewees in the PA said that fear of punishment would stop them from killing bears. Only one of the six bears known to have been killed in the last ten years in Apolobamba was killed inside the protected area.

3. Bear populations are generally perceived to be increasing in both the north and south, with the few reports of decreasing populations coming only from the south.

4. Differences in attitudes were not as simple as north versus south. A finer-scale clustering of attitudes by valley/zone was demonstrated using generalised linear models.

5. Older people, and people who speak no Spanish tended to have more traditional beliefs about bears. People less reliant on livestock were more tolerant of bears, in terms of thinking of them as good or neutral animals and responding negatively to the idea of their extinction.

6. The majority of people in both the north and south would be glad if there were no more bears in Apolobamba.

Chapter 10

GENERAL DISCUSSION

Bugmancia, a flower common in bear habitat, also featured in Bolivian myths (Paredes Candia 1968).

10.1 ANDEAN BEARS AS CULTURALLY SALIENT ANIMALS

This study has had three main aims: to characterise the interaction between Andean bears and people and quantify the extent of conflict; to collect new ecological data about the home range and habits of Andean bears; and to analyse the implication of these findings for management and conservation.

The pursuit of these aims has led to one primary conclusion: the prominence of the *jucumari* as evidenced in interviews, myths, rituals, letters to the protected area, and conversation in the town square, is more than can be explained empirically. The local people are agitated about conflicts with bears, but attacks on people are almost unheard of, no predation of livestock could be documented and crop raiding observed in the study was minimal. The conservation authorities are concerned about the status of the species, but bear populations were perceived to be increasing throughout most of the study area.

This research was not conceived as an evaluation of the relative prominence of different species of animals in local perception. Such an investigation would ask which animals live in the area, which figure in stories, and with which species people interact. Interviewees in this study knew that the researchers were interested particularly in their interaction with bears, and as such, their responses focussed on this species. Despite the bias towards bears inherent in this approach, this thesis has presented varied evidence that Andean bears do figure prominently in the Apolobamban worldview. This prominence – or salience – may have important implications for conservation. The following section will define terms in order to discuss this issue.

10.1.1 Flagships, charisma and cultural salience

Andean bears have been described using the full range of jargon associated with single species conservation: 'umbrella species'(Peyton 1999), 'indicator species' (Yañez 1990), 'landscape species' (Goldstein 2001; Yerena 1998) and even, due to their role as dispersers of large seeds, 'keystone' species (Peyton 1988; Rivadeneira 2000). While the applicability of these terms to Andean bears may be debatable, these animals are certainly considered to be charismatic for many people and as such are used as 'flagships' for many Andean conservation initiatives (Peyton 1999; Yerena 1998).

The authors of a recent analysis of the value of 'flagship species' ask two questions of relevance to this issue: 'What makes certain species charismatic?' and 'To whom are they charismatic?' (Leader-Williams and Dublin 2000). They make the point that a species perceived as charismatic by, say, the British public may not be looked upon in the same way by "people who live amongst wild species in remote areas, lacking the basic necessities of life, often competing with wildlife over limited resources and which may threaten their lives or livelihoods".

Charisma has been defined as "the ability to inspire followers with devotion or enthusiasm" (OED 1999). Because of this uniformly positive connotation, it is not relevant to species in conflict with local people. However, if the concept of charisma is rejected on this basis, another term is needed to refer to the prominence and predominance of certain species in the myths, perceptions, complaints, pharmacopoeias, etc. of local people. "Cultural salience" may be a better term, because it allows for the ambivalent attitudes that large carnivores provoke amongst the people who coexist with them. Salience is defined as "the quality of jutting out, being prominent, conspicuous, or noticeable and, in heraldry, standing on its hind legs with forepaws raised" (Pearsall and Trimble 1996). The term cultural salience is used in anthropology to describe animals that are viewed with particular interest and that are invested with particular meanings (Morris 2000). For some cultures there may be a single salient animal (Reichel-Dolmatoff 1975; Willis 1974), while for others, several animals may have high levels of cultural salience (Morris 2000). This concept, and the complexity and ambivalence it encompasses, may be of use in conservation. Cultural salience and charisma are distinct from one another, but may be different manifestations of the same human predisposition to focus on certain animals. This discussion will review the findings of the present study in relation to the concept of cultural salience, and the implications thereof for conservation, following the order of the questions set out in section 1.7.

10.1.2 Early and deep impressions of bears through myths and rituals

A diverse corpus of traditional stories featuring bears was collected in Apolobamba. Far beyond the well-known Bear's Son, stories told of conflict, of bears as jesters, monsters, and super-heroes. Support for the hypothesis that the bear mythic theme pre-dates the arrival of the Spanish was found through this diversity, particularly in other stories related to human-bear couples. Further evidence was found in Chavin, where images of the Andean bear emerge as possible origins of the modern bear costume, in which people dance in festivals throughout Bolivia. The ritual and sacramental treatment of bear parts was also documented. Symbolic mentions of bears occur in speech, and discussion of bears is relished. Bears are closely associated with three other animals that might also be referred to culturally salient megavertebrates: pumas, foxes and condors.

10.1.3 Variation in beliefs and attitudes about bears

People in Apolobamba expressed a wide range of beliefs and attitudes about bears. To some people a bear is merely a pest animal: it is of no utility to people; it is bad, vengeful, and dangerous. To others a bear is God-like, possessing the equivalent of seven human souls; its parts must never be sold but must be treated according to certain rituals. The majority of people knew of medicinal uses of bear parts.

Many attitudes differ significantly between the north (inside the protected area), and the south (outside the protected area). In the north, bears were encountered more often and a more negativistic and dominionistic attitude was prevalent. Due to awareness of wildlife laws, people were afraid of punishment for killing bears, or for using or selling bear parts. In the south, a more respectful and mystical (or moralistic and symbolic) attitude prevailed – they were more afraid of bears, but thought of them in more positive terms.

10.1.4 Food resources relied upon by Andean bears

Details of bear ecology were described by interviewees in both the north and south, although in more detail in the north where people have greater contact with bears. The feeding ecology, as determined by this research, tallies closely with what was described during the interviews. Flowering and fruiting was staggered throughout the year for ten species of plants monitored at the study site. However, scats indicated that berries were eaten from March to June, and tree fruits were consumed from June to October.

Evidence of feeding on animals occurred primarily during the rainy season. Bromeliads were eaten throughout the year and comprised more than half of the diet, even when only one scat was collected per feeding bout (in order not to overestimate their importance).

10.1.5 The activity and movement patterns of Andean bears

Andean bears often have been assumed to be largely or entirely nocturnal due to their cryptic and secretive habits. However, bears in this study were diurnally active. In addition, they did not hibernate. The bears had a bimodal activity rhythm, with peaks on either side of a midday lull, and little activity during hours of darkness. The daily time budgets of two males averaged 53% activity. This percent activity was central to the range of activity exhibited by the non-denning panda, and by three other species in non-denning months: the American black and brown bears, and the Asiatic black bears. Overall, bears were more active during the dry season than the rainy season. This relationship may have been related to weather and food availability; bears tended to be less active during rainy weather in both seasons.

The bears had core home ranges of approximately 8 km^2 in which they were located roughly two thirds of the time. Within this area, the two bears showed a high degree of home range overlap. Both bears had larger home ranges and made longer daily movements in the rainy season. They also displayed a clear pattern of varying seasonal use of three habitat types. Use of the grassland was greatest at the beginning of the rainy season, diminishing thereafter through the year. Use of the ecotone was greatest in the late rainy until early dry season. The forest was used most during the dry season. The two bears spent at least four days in close company, including feeding together at the carcass of a cow during the rainy season.

10.1.6 Behavioural and ecological factors influencing interaction with people

Bromeliads are abundant and plentiful, but of low nutritive value. Fruits are of higher nutritive value, but are a scarce and patchy resource consumed at low intake rates. In contrast, anthropogenic food sources such as maize and cattle are high in nutritive value and, once accessed, available in high concentrations. The attraction to these resources brings bears into contact with people. The activity patterns of Andean bears in the study closely echoed local human activity patterns, a factor which may contribute to their cultural salience. The home ranges of both bears, as well as overlapping with one another other, overlapped to some degree with areas used occasionally by local people.

10.1.7 The scale and nature of bear-people interaction

Inside the protected area, people had a more confident attitude towards encounters with bears, most people finding them potentially scary but only under certain circumstances. In contrast, outside of the protected area a more apprehensive and fearful attitude to bears prevails.

It was not possible to confirm predation of livestock by bears. Bears were documented to have fed on six cows, one newborn calf, and two horses during the study, but there was no certainty as to the cause of death. The species thought by interviewees to be the biggest killers of livestock were, in descending order of frequency of mention: puma, fox, bear and condor. Outside the protected area, condors and bears were rarely mentioned as livestock killers. Livestock losses were described as occurring more frequently in the rainy season. Most people who thought bears were livestock killers thought that certain animals became habituated to killing livestock.

When asked which animals raid crops, people said that bears were the most frequently mentioned animal (80% of maize farmers). However, only 15% described them as the worst crop-pest. When ranking animals based on the percentage of people who thought to mention an animal and who also described it as the worst, bears were ranked ninth (after less conspicuous animals, including insects, rodents and birds, particularly parrots). This suggests that though less conspicuous, the damage caused by these animals may actually be greater. The field most severely damaged by bears displayed 6% of the ears consumed. As in other studies, isolated fields and those on the edges of cultivated areas were the most vulnerable to crop depredation by bears.

10.1.8 Response to the restrictions of living inside a protected area

Frustration about problem animals was widespread and attitudes to laws protecting pest animals were almost unanimously negative. Bears are one of four predator species acting as a focus for animosity towards the protected area. People inside, and increasingly outside of the protected area were afraid of being punished for killing bears or for using or selling bear parts. The rumour existed that the animals were remotely monitored by the government computers.

One of six bears reported to have been killed in the last ten years in Apolobamba was killed inside the protected area. Bear populations are generally perceived to be increasing in both the north and south. Some people in the south had seen bears for the first time recently, suggesting that bear populations are indeed growing. One likely reason for this increase is that scare tactics and active "decommissioning" of firearms have been employed by the protected area. At the same time that these tactics may, at least in the short term, have been good for bears, they have had a negative effect on people's attitudes towards bears. Contemporary management strategies used throughout the world to help people coexist with large carnivores include three main elements: eliminating specific problem animals; improving anti-predator and general livestock management; and providing compensation for livestock losses (Mishra 1997). It is not surprising that attitudes inside the protected area were negative and worsening, given that none of these techniques have been employed. As the people of Queara declared in their letter to the Reserve, "In the case that you don't respond to the petitions and complaints that we make ... our necessities will oblige us to eliminate these pest animals." Taking them at their word, the outlook for Andean bears, pumas, foxes and condors, the four culturally salient predators, may deteriorate if this growing resentment is not taken seriously and if steps are not taken to address the situation.

10.1.9 Factors correlated with high tolerance of bears

Tolerance of bears varied between valleys, and was generally higher outside the protected area. The relationship between traditional beliefs, conflict and tolerance could not be tested statistically. However, in general, low tolerance coincided with low traditional beliefs, and high conflict. Multi-variate analysis showed that older people, and people who speak no Spanish tended to have more traditional beliefs about bears. People less reliant on livestock were more tolerant of bears. However, the majority of people in both the north and south would be glad if there were no more bears in Apolobamba.

In two valleys/zones, both of which are heavily involved in livestock husbandry, the mean and range of tolerance scores were negative. However, positive tolerance scores were found in the other five valley/zones. One source of interest in this data lies in the reasons given by 38% of interviewees who would not be glad if bears were exterminated. For some people the bear is a source of pride. For some people it is of great utility both to be able to kill a problem bear and be fortified by consuming its meat and blood. For other people, bears are important because they have always been a part of things, and because they are the powerful ruling chiefs in the animal hierarchy.

Conservationists have traditionally recognised two main types of relationships between people and large carnivores: devotion and enthusiasm *ex situ,* and conflict and persecution *in situ* (Jackson 1999). This dichotomy ignores the diverse and often contradictory attitudes towards and relationships with large carnivores (Morris 2000). Moreover, even when recognising the high price that local people have to pay in terms of loss of life and livelihood, many initiatives suggest that local people must be "taught" or "convinced" to support large carnivore conservation through environmental education (Jackson 1999; Sillero-Zubiri and Laurenson 2001). This attitude ignores the wealth of traditional environmental knowledge held by local people (Johnson 1992), and the rational response that people have to real practical issues (Mishra 1997).

Cultural salience is a double-edged sword – people in Apolobamba are fascinated by bears, but also blame them disproportionately for livestock predation and crop-raiding. Being big, diurnal, and attracted to anthropogenic food sources, all lead to being noticed. Being noticed, in turn, can easily lead to being killed. Levels of human-induced mortality might be higher for bears in Apolobamba, given the amount of people favouring extermination, were it not for certain factors in their favour: mining has provided increased employment away from bear habitat, with the result that lower altitude fields and trails have been abandoned; people have been scared to kill bears, and in some cases have had their weapons taken away; and the topography provides refuge for bears in many areas unused by people. Bears have utilitarian value for people in Apolobamba, but not so great as to justify actively poaching them.

10.1.10 Practical outputs of the present study

In the interest of future Andean bear management and conservation, it may be worth reviewing some of the practical outputs of the present study. Several people were employed under this project, all of whom have gained knowledge and training useful for research and conservation work. The very fact of carrying out a research project, particularly one including radio-collaring animals, awakened interest in the species locally. Community meetings and the Bear Day held for local students further increased this process. The investigation of crop-raiding and livestock depredation issues may have increased tolerance for bears by indicating to local people that those issues were being taken seriously. Finally, the collection of myths and rituals surrounding bears, and the identification of the Chavin bear as a likely ancient origin of this mythic them, provide rich material for the formulation of a culturally appropriate conservation symbol.

10.1.11 Cultural salience and large carnivore conservation

Large carnivores have a natural prominence in the human mind (Kellert et al, 1996). Although they are unlikely to be seen as charismatic by people who have to suffer the consequences of living with them (Leader-Williams and Dublin 2000), they are nonetheless often culturally salient animals. They may be the subjects of myth and ritual, prominent figures in popular culture and venerated by traditional people. Also, and even concurrently, they are likely to be vilified as pests (Clutton-Brock, 1996). They readily become the focus for frustrations and animosity towards protected areas (Sillero-Zubiri and Laurenson, 2001). Hence, the results of this study suggest a two-pronged approach to large carnivore conservation.

First, in many parts of the world there may be benefits from blowing on the embers of traditional beliefs and thereby increasing tolerance of bears from inside the culture. The Nez Perce of central Idaho offer one example of an indigenous group with strong traditional beliefs, who have become central to carnivore conservation efforts. The United States federal government has contracted the Nez Perce to manage the recovery of the wolf, which is listed in the United States as an endangered species. Responsibilities include environmental education, as well as tracking and studying the wolves (Cheater 1998). Likewise, the cultural salience of the tiger in Asian consciousness has been suggested to have potential to fortify conservation efforts (Jackson 1999).

Second, the ambivalence towards large carnivores can take a negative turn if people are excluded from resources and not given the right to defend themselves. Few conservation policies provide long-term incentives for coexistence with large carnivores (Gibson and Marks 1995). When local people have all of the costs and none of the benefits of living with these animals, no amount of myths or environmental education can convince people not to kill a marauding predator, however charismatic or culturally salient it may be. And, arguably, nor should they. The peace that must be sought between large carnivores and people involves compromise. Individuals of both parties will inevitably continue to suffer some losses. However, at least this stronghold of intact habitat, Andean bear populations seem to be healthy. Bears are highly culturally salient and have utilitarian, symbolic, and moralistic value to people as well as dominionistic and negativistic value. If local people are given the right to co-manage the Andean bear population it seems likely that coexistence equitable for both species is attainable in Apolobamba.

PAGE NUMBERING AS FOUND IN THE ORIGINAL THESIS

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Evidence of feeding on animals occurred primarily during the rainy season. Bromeliads were eaten throughout the year and comprised more than half of the diet, even when only one scat was collected per feeding bout (in order not to overestimate their importance).

10.1.5 The activity and movement patterns of Andean bears

Andean bears often have been assumed to be largely or entirely nocturnal due to their cryptic and secretive habits. However, bears in this study were diurnally active. In addition, they did not hibernate. The bears had a bimodal activity rhythm, with peaks on either side of a midday lull, and little activity during hours of darkness. The daily time budgets of two males averaged 53% activity. This percent activity was central to the range of activity exhibited by the non-denning panda, and by three other species in non-denning months: the American black and brown bears, and the Asiatic black bears. Overall, bears were more active during the dry season than the rainy season. This relationship may have been related to weather and food availability; bears tended to be less active during rainy weather in both seasons.

The bears had core home ranges of approximately 8 km^2 in which they were located roughly two thirds of the time. Within this area, the two bears showed a high degree of home range overlap. Both bears had larger home ranges and made longer daily movements in the rainy season. They also displayed a clear pattern of varying seasonal use of three habitat types. Use of the grassland was greatest at the beginning of the rainy season, diminishing thereafter through the year. Use of the ecotone was greatest in the late rainy until early dry season. The forest was used most during the dry season. The two bears spent at least four days in close company, including feeding together at the carcass of a cow during the rainy season.

10.1.6 Behavioural and ecological factors influencing interaction with people

Bromeliads are abundant and plentiful, but of low nutritive value. Fruits are of higher nutritive value, but are a scarce and patchy resource consumed at low intake rates. In contrast, anthropogenic food sources such as maize and cattle are high in nutritive value and, once accessed, available in high concentrations. The attraction to these resources brings bears into contact with people. The activity patterns of Andean bears in the study closely echoed local human activity patterns, a factor which may contribute to their cultural salience. The home ranges of both bears, as well as overlapping with one another other, overlapped to some degree with areas used occasionally by local people.

10.1.7 The scale and nature of bear-people interaction

Inside the protected area, people had a more confident attitude towards encounters with bears, most people finding them potentially scary but only under certain circumstances. In contrast, outside of the protected area a more apprehensive and fearful attitude to bears prevails.

It was not possible to confirm predation of livestock by bears. Bears were documented to have fed on six cows, one newborn calf, and two horses during the study, but there was no certainty as to the cause of death. The species thought by interviewees to be the biggest killers of livestock were, in descending order of frequency of mention: puma, fox, bear and condor. Outside the protected area, condors and bears were rarely mentioned as livestock killers. Livestock losses were described as occurring more frequently in the rainy season. Most people who thought bears were livestock killers thought that certain animals became habituated to killing livestock.

When asked which animals raid crops, people said that bears were the most frequently mentioned animal (80% of maize farmers). However, only 15% described them as the worst crop-pest. When ranking animals based on the percentage of people who thought to mention an animal and who also described it as the worst, bears were ranked ninth (after less conspicuous animals, including insects, rodents and birds, particularly parrots). This suggests that though less conspicuous, the damage caused by these animals may actually be greater. The field most severely damaged by bears displayed 6% of the ears consumed. As in other studies, isolated fields and those on the edges of cultivated areas were the most vulnerable to crop depredation by bears.

10.1.8 Response to the restrictions of living inside a protected area

Frustration about problem animals was widespread and attitudes to laws protecting pest animals were almost unanimously negative. Bears are one of four predator species acting as a focus for animosity towards the protected area. People inside, and increasingly outside of the protected area were afraid of being punished for killing bears or for using or selling bear parts. The rumour existed that the animals were remotely monitored by the government computers.

One of six bears reported to have been killed in the last ten years in Apolobamba was killed inside the protected area. Bear populations are generally perceived to be increasing in both the north and south. Some people in the south had seen bears for the first time recently, suggesting that bear populations are indeed growing. One likely reason for this increase is that scare tactics and active "decommissioning" of firearms have been employed by the protected area. At the same time that these tactics may, at least in the short term, have been good for bears, they have had a negative effect on people's attitudes towards bears. Contemporary management strategies used throughout the world to help people coexist with large carnivores include three main elements: eliminating specific problem animals; improving anti-predator and general livestock management; and providing compensation for livestock losses (Mishra 1997). It is not surprising that attitudes inside the protected area were negative and worsening, given that none of these techniques have been employed. As the people of Queara declared in their letter to the Reserve, "In the case that you don't respond to the petitions and complaints that we make ... our necessities will oblige us to eliminate these pest animals." Taking them at their word, the outlook for Andean bears, pumas, foxes and condors, the four culturally salient predators, may deteriorate if this growing resentment is not taken seriously and if steps are not taken to address the situation.

10.1.9 Factors correlated with high tolerance of bears

Tolerance of bears varied between valleys, and was generally higher outside the protected area. The relationship between traditional beliefs, conflict and tolerance could not be tested statistically. However, in general, low tolerance coincided with low traditional beliefs, and high conflict. Multi-variate analysis showed that older people, and people who speak no Spanish tended to have more traditional beliefs about bears. People less reliant on livestock were more tolerant of bears. However, the majority of people in both the north and south would be glad if there were no more bears in Apolobamba.

In two valleys/zones, both of which are heavily involved in livestock husbandry, the mean and range of tolerance scores were negative. However, positive tolerance scores were found in the other five valley/zones. One source of interest in this data lies in the reasons given by 38% of interviewees who would not be glad if bears were exterminated. For some people the bear is a source of pride. For some people it is of great utility both to be able to kill a problem bear and be fortified by consuming its meat and blood. For other people, bears are important because they have always been a part of things, and because they are the powerful ruling chiefs in the animal hierarchy.

Conservationists have traditionally recognised two main types of relationships between people and large carnivores: devotion and enthusiasm *ex situ,* and conflict and persecution *in situ* (Jackson 1999). This dichotomy ignores the diverse and often contradictory attitudes towards and relationships with large carnivores (Morris 2000). Moreover, even when recognising the high price that local people have to pay in terms of loss of life and livelihood, many initiatives suggest that local people must be "taught" or "convinced" to support large carnivore conservation through environmental education (Jackson 1999; Sillero-Zubiri and Laurenson 2001). This attitude ignores the wealth of traditional environmental knowledge held by local people (Johnson 1992), and the rational response that people have to real practical issues (Mishra 1997).

Cultural salience is a double-edged sword – people in Apolobamba are fascinated by bears, but also blame them disproportionately for livestock predation and crop-raiding. Being big, diurnal, and attracted to anthropogenic food sources, all lead to being noticed. Being noticed, in turn, can easily lead to being killed. Levels of human-induced mortality might be higher for bears in Apolobamba, given the amount of people favouring extermination, were it not for certain factors in their favour: mining has provided increased employment away from bear habitat, with the result that lower altitude fields and trails have been abandoned; people have been scared to kill bears, and in some cases have had their weapons taken away; and the topography provides refuge for bears in many areas unused by people. Bears have utilitarian value for people in Apolobamba, but not so great as to justify actively poaching them.

10.1.10 Practical outputs of the present study

In the interest of future Andean bear management and conservation, it may be worth reviewing some of the practical outputs of the present study. Several people were employed under this project, all of whom have gained knowledge and training useful for research and conservation work. The very fact of carrying out a research project, particularly one including radio-collaring animals, awakened interest in the species locally. Community meetings and the Bear Day held for local students further increased this process. The investigation of crop-raiding and livestock depredation issues may have increased tolerance for bears by indicating to local people that those issues were being taken seriously. Finally, the collection of myths and rituals surrounding bears, and the identification of the Chavin bear as a likely ancient origin of this mythic them, provide rich material for the formulation of a culturally appropriate conservation symbol.

10.1.11 Cultural salience and large carnivore conservation

Large carnivores have a natural prominence in the human mind (Kellert et al, 1996). Although they are unlikely to be seen as charismatic by people who have to suffer the consequences of living with them (Leader-Williams and Dublin 2000), they are nonetheless often culturally salient animals. They may be the subjects of myth and ritual, prominent figures in popular culture and venerated by traditional people. Also, and even concurrently, they are likely to be vilified as pests (Clutton-Brock, 1996). They readily become the focus for frustrations and animosity towards protected areas (Sillero-Zubiri and Laurenson, 2001). Hence, the results of this study suggest a two-pronged approach to large carnivore conservation.

First, in many parts of the world there may be benefits from blowing on the embers of traditional beliefs and thereby increasing tolerance of bears from inside the culture. The Nez Perce of central Idaho offer one example of an indigenous group with strong traditional beliefs, who have become central to carnivore conservation efforts. The United States federal government has contracted the Nez Perce to manage the recovery of the wolf, which is listed in the United States as an endangered species. Responsibilities include environmental education, as well as tracking and studying the wolves (Cheater 1998). Likewise, the cultural salience of the tiger in Asian consciousness has been suggested to have potential to fortify conservation efforts (Jackson 1999).

Second, the ambivalence towards large carnivores can take a negative turn if people are excluded from resources and not given the right to defend themselves. Few conservation policies provide long-term incentives for coexistence with large carnivores (Gibson and Marks 1995). When local people have all of the costs and none of the benefits of living with these animals, no amount of myths or environmental education can convince people not to kill a marauding predator, however charismatic or culturally salient it may be. And, arguably, nor should they. The peace that must be sought between large carnivores and people involves compromise. Individuals of both parties will inevitably continue to suffer some losses. However, at least this stronghold of intact habitat, Andean bear populations seem to be healthy. Bears are highly culturally salient and have utilitarian, symbolic, and moralistic value to people as well as dominionistic and negativistic value. If local people are given the right to co-manage the Andean bear population it seems likely that coexistence equitable for both species is attainable in Apolobamba.

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Appendix I - Interview guide

This following is used as a guide, but flow of the interview is directed by the interviewee. Skipped sections are returned too later in the interview. Further insight on any point of interest is sought using questions like how? when? where? who?

I. Basic background
1. What is your name?
2. What languages do you speak? In which are you most comfortable?
3. How old are you?
4. What is your main occupation? Do you engage in mining, livestock husbandry and maize cultivation? What is their relative importance to you and your family?

II. Encounter / tolerance
1. Have you ever seen a bear? How many times?
2. When is the last time you saw a bear?
3. Are you afraid of meeting a bear when you go out (in the *campo*, or countryside)?
4. How do you feel if you see a bear? Are they scary?
5. What would the bear do?
6. What would you do?
7. Would a bear attack a person? Have you ever heard of it happening?
8. Why would a bear attack a person?

III. Crop raiding
1. Are there animals which damage crops in the valley?
2. Which animal causes most damage?
3. Do bears raid crops in this valley?
4. Have you had direct experience of crop-raiding?
5. Has crop-raiding intensified or decreased in severity?
6. Does crop-raiding vary in intensity according to year?
7. Do other animals damage the crops?
8. Which crops get hit the hardest by bear-raiding? Other animals?
9. Which fields get hit the hardest? Why? Who owns them?
10. Which fields of which crop are ignored? Why?
11. Is it possible to keep bears or other animals from raiding? How?
12. Do bears raid when a person is present? How far away?

IV. Livestock depredation
1. Do any wild animals kill livestock in this valley?
2. Do bears kill livestock in this valley?
3. Which species/sex/age/condition kill? Which animals do they kill?
4. How do you know which predator has killed an animal?
5. Have you noticed any pattern to the kills (location, time of year, repeat kills)?
6. Do any deterrent methods work?

V. Use of parts
1. Do bears provide medicine for people? What is it for?
2. Do you use it?
3. Is bear meat eaten?
4. Are bears good to eat? Have you eaten the meat? How often? When?
5. Do you have any bear parts in your house? Do other people?
6. Are bear parts sold? Who sells and who buys? Why?
7. Which bear parts are sold? What other uses are there of bear parts?

VI. Beliefs
1. Do you believe that jucumaris have powers?
2. What does it mean if a person sees jucumari?
3. Are jucumaris good or bad or both?
4. What sort of being is a jucumari?

VII. Myths
1. Can you tell me any stories, myths or folktales about jucumaris?
2. Do you dream about bears? If so, what does it signify?
3. Does the character of the bear dance in festivals? What is the costume like? What does it signify?

VIII. Ecology
1. Are there different kinds of bears? What do they look like?
2. What hours of the day are bears most active?
3. Do bears live and travel alone or in groups?
4. How many cubs does a mother bear have?
5. How long do the cubs stay with the mother?
6. What do bears eat?
7. Do bears eat different things in different seasons?
8. Where do bears live?
9. Do bears live in different places in different seasons?
10. Have you ever found a dead bear? Did you know why it died?
11. Have you ever seen a sick bear?
12. What else do you know about bears' lives and habits?

IX. Management and conservation laws

1. How do people kill bears?
2. Can you tell me about how to make a bear trap? How does it work?
3. What do you use as bait?
4. Can you tell me about any other kind of management of bears?
5. Do you use any techniques to manage other animals?
6. Would you kill a bear under extreme circumstances (if it threatened you/if it ate *n*% of crops/if it killed one of your animals)?
7. Would there be any consequences? Would you tell people?
8. How many bears have been killed in the last ten years? Where, when, how?
9. What do you know about any laws relating to wildlife?
10. Have you heard of the RNFUU or Madidi?
11. What are your opinions about the park authorities and the wildlife laws?

X. Status

1. What changes have you observed in the number of bears in this area in your lifetime?
2. Has there been a particular time when there were fewer bears than there are now? Why?
3. How would it be if there were no more bears in Apolobamba?

Information to be found out from a few people in each town.

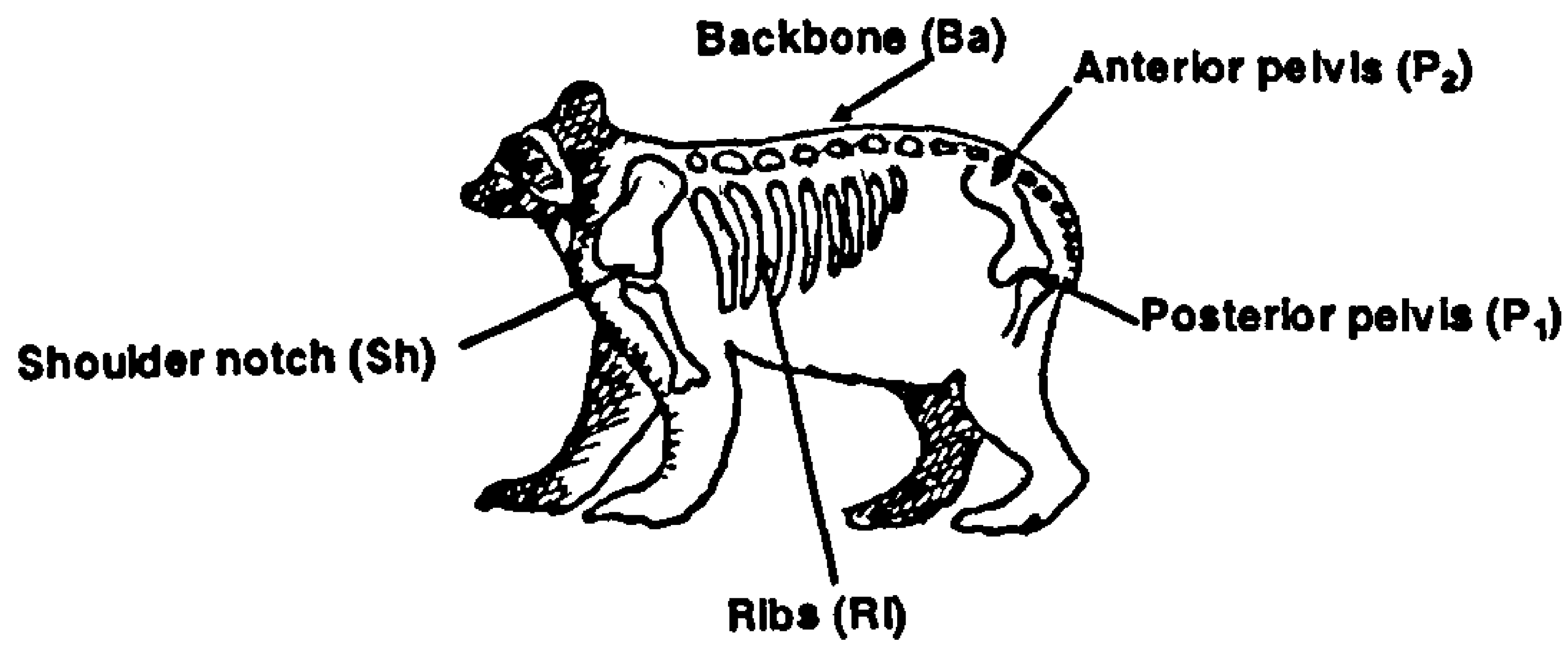
General context

Has the size of the village changed?
What are the biggest changes in the history of the town?
Has farming changed in this valley in the last ten years? Since your grandparents were young? Have animal herding practices changed? The numbers and types of animals kept?

Appendix II Capture and handling reports

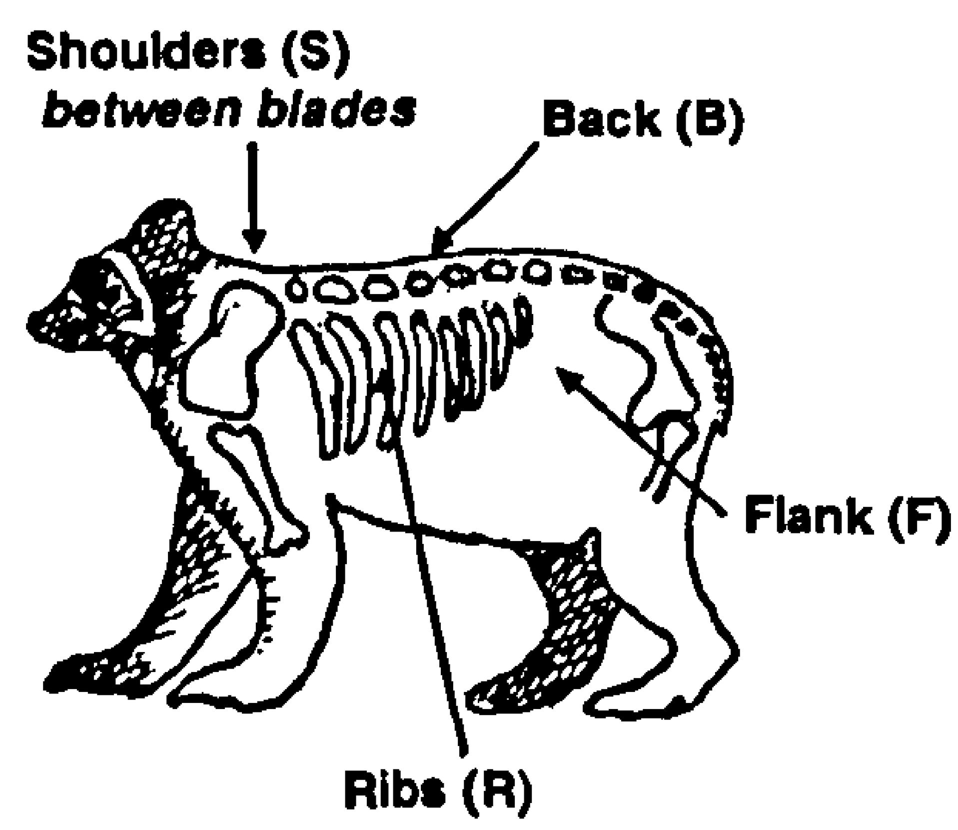
First handling, bear M1

Date: April 30, 1998
Present: Susy Paisley and Augusto Cuila
Estimated weight: 125 lbs, 56 Kg
Drug used: Telazol 4.5mg
Time/amount of drugging: 8:40am/2.0mg 9:20am/2.5mg
Time head down: 8:25am
Beginning handling: 8:30am
Time head up: 9:35am
Recovery: After the head was raised for the first time, recovery was slow: the bear attempting to get up, and rolling down the hill, rubbing its face with paws. Clear anterior to posterior recovery. There was some tremor in the head from 10:25 for two minutes, then from 10:30 for about seven minutes, the left paw shook slightly. Ambulant by 11:00. Slept a lot for rest of day. Had an active period at 3:00, travelling to a nearby cave where he stayed, moving little, for 14 hours.
Collar #14044, frequency 151.034 (with whip) on fourth hole, 17 cm extra cut off
Sex Male ♂
Weight (gasp) 73lbs (34Kg)
Samples: hair blood tooth did not take as bear was so young
Total length 88cm
Neck girth 33cm
Head girth 40cm
Head length 27cm
Chest girth 54?cm
Humerus length 25cm
Ulna length 29cm
Upper canine: length 25mm anterior-posterior 14mm width 8mm
Lower canine: length 22mm anterior-posterior 13mm width 8mm
Tooth eruption: top: 3 incisors, 1 canine, 4 premolars, 2 molars;
bottom, 3 in, 1 c, 3 p, 2 m

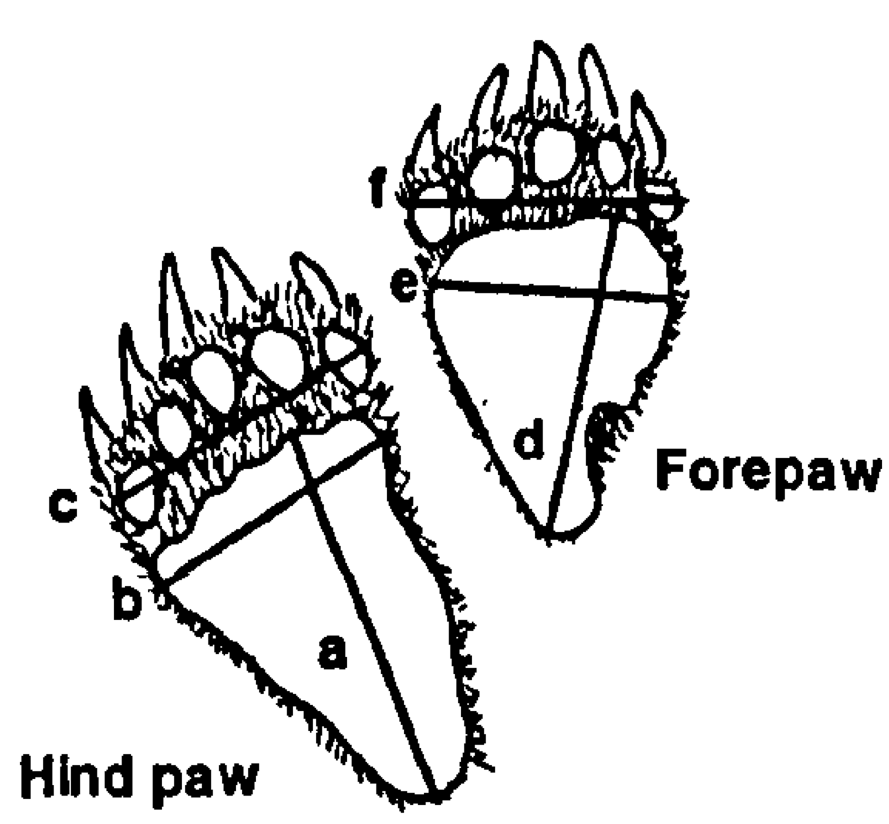


Bone prominence (see diagram above) (1=bones feel sharp, 2=bones easily felt and distinct, 3= bones can be felt but not beru distinct, 4=bones hard to feel or cannot be felt):

Sh 2, Ri 2, Ba 3, P_1 2, P_2 2



Fat thickness (see diagram above): S 10mm, R 8mm, B 13mm, F 10mm
Testicles (l x w) 25mm x 15mm



Paw measurements (see diagram above): a 97mm d 99mm
b 82mm e 82mm
c 90mm f 92mm

Notes: fur shiny and black, eye rings nearly complete (see sketch) , no visible external parasites, no scars, teeth white, left upper canine has small chip at end.

Second handling, bear M2

Date: June 29, 1998
Present: Susy Paisley and Natalia Trepp
Estimated weight: 30 Kg
Drug used: Telazol 3.25mg
Time/amount of drugging: 11:00/1.25mg 11:40/2.00mg 12:17/1.00mg
Time head down: 12:00
Beginning handling: 12:00
Time head up: 13:00
Recovery: It was extremely difficult to administrate the necessary dosage of Telazol because of the bears small size and quick reflexes. We administrated more of the drug at 12:17 because the bear started to recover. The recovery was without complications, except that the bear had a tremor in the head and paws during much of the handling. He also vomited twice at 13:30.
Collar frequency: 151.053 (with whip) on fourth hole, 17 cm extra cut off
Sex Male ♂
Weight 73lbs (34 kgs)
Samples: hair ___ blood ___ tooth ___
Total length 119 cm
Neck girth 36 cm
Head girth 43 cm
Head length 23.5 cm
Chest girth 58 cm
Humerus length 25cm
Ulna length 29 cm
Upper canine: length 18mm anterior-posterior 12mm width 7mm
Lower canine: length 22mm anterior-posterior 12mm width 7.5mm
Tooth eruption: top: 3 incisors, 1 canine, 4 premolars, 2 molars;
bottom, 3 in, 1 c, 3 p, 2 m
Bone prominence: Sh 2, Ri 2, Ba 3, P_1 2, P_2 2
Fat thickness: S 10mm, R 8mm, B 13mm, F 10mm
Testicles (l x w) 28.5mm x 26mm
Paw measurements: a 97mm d 45mm
b 85mm e 73mm
c 81mm f 78mm
Notes: fur shiny and black, eye rings under the eye (see sketch), no visible external parasites, no scars, teeth yellowish and worn.

Appendix III Crop raiding birds.

Gray-hooded parakeet, *Bolborhyncus aymara* A slim bright green parakeet with a dark grey cap to below eyes, with some yellowish grey on wings and pale grey cheeks, throat and breast. Usually in small groups of up to 40. When maize is ripening often present, crossing to nearby forest when not raiding.

Band-tailed pidgeon, *Columba fasciata albilinea* Similar though larger than a feral pigeon with a white collar above a dark shiny green hind-neck. A gregarious bird that sometimes forms large feeding flocks and gives heavy wing claps when startled. Settles on crops in great whirling groups.

Mitred conure, *Aratinga mitrata* 38 cm. Green above and yellowish below. Forehead is a deep purplish red grading to pale red on forecrown. Very limited distribution, and not known in this area until recently.

Red-winged tinamou, *Rhynchotus rufescens* 40 cm. Fat chicken-like bird with long, curved bill and surrounded by bristles (cilia). Cinnamon and buff with tiny black bars all over body, with dark barred cap and creamy throat. Apolobamba is northwesternmost portion of range, declining. Usually hidden in crop or vegetation- fly rarely but conspicuously with loud whirring motion.

Black-backed grosbeak, *Pheuticus auroventris* 20 cm. Black above and yellow on belly and flanks with strong black beak. Forages in corn fields alone, in pairs, or mixed species flocks. Uncommon in wide range through Bolivia.

Mountain casique, *Cacicus leucorhamphus crysonotus* 28cm. Black with yellow on rump and with a long strong yellowish beak. Solitary or in flocks of 6-7 birds, and sometimes mixed species flocks.

Oropendula, *Psarocoilus sp.* up to 45 cm. Highly distinctive birds that resemble black birds with long broad beaks and colourful tails. They make pendulous nests that hang down from branches. Local people informed us that they raided crops. Three species are found in the La Paz department. We were unable to confirm which in any species were involved in crop raiding.