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Analysis of Andean bear activity patterns and habitat use in páramo ecosystems in Southern Ecuador

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Declaration

I hereby declare that this thesis entitled “Analysis of Andean bear activity patterns and habitat use in páramo ecosystems in Southern Ecuador” is my own work and all the sources have been quoted and acknowledged by means of complete references.

In Prague 27.4.2018

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Anna Bernátková

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Abstract

Andean bear (*Treamarctos ornatus*) is the only species of the Ursidae family still present in South America and is considered to be a key species in its habitat. Andean bear is listed as vulnerable by The IUCN Red List of Threatened Species and is threatened by habitat loss and human-wildlife conflicts. Thus knowledge on activity patterns, diet preferences and availability of sources of feed is essential for further management of the species. The objective of this study was to improve the knowledge on the habitat use of Andean bear in Loja province, Southern Ecuador by combining research on all the factors above mentioned. First aim was to determine abundance of signs of Andean bear activity in two ecosystems: forest and páramo. Five plots were established in each of three study sites in forest and in three study sites in páramo. Secondly, the abundance of Bromeliads in the same study sites was determined. Third aim was to determine the correlations between abundance of Bromeliads, nutritional composition of Bromeliads and signs of activity of Andean bears in the three forest study sites. Finally, the percentage of Bromeliads in faeces collected during the sign survey was analyzed. Results showed that in forest ecosystem signs of Andean bear activity were significantly more abundant than in páramo ecosystems. No correlation was found between the abundance of Bromeliads, their nutritional composition (except for protein) and signs of activity of Andean bears in the forest ecosystem. There was a negative correlation between abundance of signs of Andean bear activity and protein content of Bromeliads, and positive correlation between percentage representation of *Tillandsia s*p. in faeces and protein content of Bromeliads in the forest. Interpretation of these results is complicated by an apparent homogeneity of the studied ecosystems, because no significant difference was found in the abundance of signs of Andean bear activity, and in the abundance of Bromeliads among forest study sites. Analysis in faecal samples of the use of Bromeliads by the species showed significantly higher amount of epiphytic *Tillandsia* sp. than ground páramo *Puya* sp. suggesting that forest Bromeliad species were favoured as a source of feed by the Andean bears. Further research on activity patterns, diet preferences, and availability and quality of feed sources of Andean bear is essential for comprehensive determination of Andean bear habitat use.

Key words: Bromeliads, diet preferences, habitat use, signs of activity, Spectacled bear

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1. Introduction and Literature Review

1.1. Introduction

Andean or Spectacled bear is the only species of the *Ursidae* family still present in South America. This bear is endemic to the area of Tropical Andes (The IUCN Red List of Threatened Species 2008). For the successful conservation of Andean bear, reports on the appropriateness and dispersion of the species environment are very essential. Several studies on the habitat use were already accomplished in South America (Ríos et al. 2006; Peyton 1980; Paisley 2006). Indicators of abundance offer affordable and relatively instantaneous methods for measuring occurrence of endangered carnivores crosswise broad environments (Gibbs et al. 1999). In South America Peyton (1980) mentions that the Andean bear performs a transference feeding behaviour, switching between seasonal use of mountain habitats, traversing long trails along the Andes, through which it traverses páramo and subandean forests and moors, in search of food sources.

Studies related to the species regarding their diet in the various habitats it occupies shows Andean bears prefer an omnivorous diet, in which they take advantage of all available resources of their environment, so that they feed mainly on plant matter but may also prey on animals (Peyton 1980; Suárez 1988; Paisley 2001). It is clear, that as most of other bear species, the Andean bears are omnivores (Braña et al. 1993; Wong et al. 2002; Hwang et al. 2002). Their diet is composed mainly of plant material: at least 305 species were described as potential source of food of the Andean bear (Davis 1995). Andean bears show preference for plants and fruits, from the fruits they feed intensively mainly when they are ripe. When the fruits are no longer available, the Andean bears feeding behaviour focuses exclusively on Bromeliads (Rodríguez et al. 1986; Peyton 1999). Due to this frugivorous tendency, Andean bears have been identified as a dispersers of some fruit species they consume (Rivadeneira 2001).

For survival of this species, ability of consumption and utilization of plants like Bromeliads is considered to be very important adaptation (Peyton 1980; Suárez 1988; Yerena 1999). It was confirmed that Bromeliaceae family is the most important source of food for the Andean bears as Bromeliads were present in all the faeces examined in the study accomplished in Southern Ecuador during one year time period (Cisneros 2012).

Various studies regarding Andean bear habitat use, activity patterns and diet preferences were already accomplished in South America. There is, however, noticeable deficiency of research combining all the aspects above mentioned. From the already known information on the species it is apparent that for the successful conservation of Andean bear it is essential to link several approaches of research and further management of the species.

1.2. Literature review

1.2.1. Andean bear (*Tremarctos ornatus*)

Andean or Spectacled bear is the only species of the *Ursidae* family still present in South America. This bear is endemic to the area of Tropical Andes and is listed as vulnerable by The IUCN Red List of Threatened Species (The IUCN Red List of Threatened Species 2008). Spectacled bear is found in Venezuela, Colombia, Ecuador, Peru and Bolivia and in these five countries its range covers approximately 26 000 km^2. Andean bears can vary in size from 140 to 175 kg in weight and in body length from 1.5 to 2.0 m in males. Females are approximately 1/3 smaller than males. Andean bear is usually black-coloured with typical face "mask" referring to the name spectacled. The mask is represented by lighter pelage that can be visible on the nose and around one or both eyes. Typical face mask of the species is presented in Figure 1. Andean bears have shorter hind limbs and longer front limbs and have plantigrade posture like other bear species. Andean bears are known to be great tree-climbers. They have short snout, relatively thick and short neck, short sloping ears and a very short tail. Andean Bears have some morphological characteristics that allow the species to have an efficient mastication of fibrous plant elements, such as the relatively larger *zygomatomandibularis* muscle and relatively smaller *masseterицus superficialis* than in strict carnivorous species (Davis 1955), and molars with rounded and wide cusps for grinding. This allows Andean bears to feed on very fibrous nourishment (Peyton 1999).

However, Spectacled bears have certain anatomical characteristics that still link them with a carnivorous diet, like a short small intestine and a simple, smooth and short colon (Servheen 1987). Still, the consumption of animal material by the Andean bears is very low, and it is presumed that, because of that, they must spend several hours a day feeding in order to complete their energy requirements with plant material. In this regard, in a study carried out in Ecuador, it was found that this species invests 20% of the day, exploring large areas suitable for feeding and 70% for feeding alone (Castellanos et al. 2005). On the other hand, because of their opportunistic feeding behaviour they have been also reported as detrimental due to the consumption of crops and farm animals (Peyton 1980; Poveda 1999; Figueroa & Stucchi, 2005; Castellanos et al. 2011).

A mechanism that can compensate the physiological characteristics of the digestive system of Andean bears, is the tendency to consume easily digestible vegetable parts as well as fruit, by comparative high energy content (lipids, carbohydrates and also proteins; Rogers 1987). For example, some fruits consumed by the Andean bear in the dry forest, tropical moist forest and premontane forest of Peru, such as *Capparis scabrida*, "guava Inga" sp. and "ungurahui" (*Oenocarpus bataua*), present low levels of fibre and high levels of energy: 73 kcal / 100g, 56 kcal / 100g and 307 kcal / 100g, respectively (INS 2009). Similarly, other species important in the diet of the Andean bear in the montane forest and the puna, such as *Gaultheria vaccinioides* and *Pernettya prostrata*, have a high protein content and low fibre content, resulting in a very high digestibility (Paisley 2001).

The species is diurnal and crepuscular (active during day and afternoon hours). Spectacled bears are not nocturnal, as was formerly believed. Although they rest at times or take short daytime naps, they are mostly active during the day and their activity declines as the night approaches. They sleep deeply before dawn and their activity increases again with the arrival of the day (Oso Andino 2016).

Despite being large animals, the Andean bears are agile climbers, they do not only climb trees (on whose branches they build platforms for resting or eating) but they climb rocks and mountains as well. They are also very good swimmers. The Andean bears construct structures similar to platforms on the high branches of the trees; for this, they break branches with leaves and lianas from above to form flat areas large enough and strong enough to provide them a place for resting comfortably and which are capable of supporting their weight during moments of sleep and daytime siesta. Bears use these tree platforms to eat, rest and take daytime naps. They also sometimes use them as lookouts to watch large areas during the day and find the right time to approach corn crops, and very occasionally livestock, which they may attack when natural food resources are lacking. These data contradict the traditional belief that animals are guided only by instincts at specific times and are completely lacking in coherent thinking or planning in advance (Figueroa & Stucchi 2005).

Andean bears are solitary animals that rarely establish direct contact with each other; however, they interact in other ways since they apparently leave messages for other individuals on various types of trees, especially the “cedrillo” family (*Brunelia* sp.). This behaviour is carried out by rubbing their backs with the trunks of trees or as leaving marks with their claws, and urinating or leaving hormonal secretions around them. Since the smell is the most developed sense of the bears, other individuals of this species can detect these signals at a distance and receive these messages, probably with courtship characteristics and mating objectives. Andean bears are very cautious and avoid contact with humans. Due to their excellent sense of smell, encounters between people and bears are very rare and if they happen the bears quickly run away and climb any nearby tree (Castellanos et al. 2011).

When a female is in heat there may be a number of males following her and they may even fight to gain their attention. The female usually has one or two cubs. It is not known exactly how long the cubs stay with their mother, but it is believed to be about a year. Little is known about the reproduction of Andean bears in the wild, but some captive bears in zoos have reproduced successfully.

Andean bears do not hibernate. Its habitat within the neotropical zone is characterized by high biodiversity and the absence of the four seasons in this area allows food to be accessible throughout the year (Oso Andino 2016).

Figure 1. Andean bear cubs with typical face masks (photo credit: Oso Andino 2016)

1.2.2. Conflicts and conservation

The Andean bear is an enigmatic figure of the mythical tales of the humid forests and adjacent Andean grasslands of the tropical Andes. However, habitat loss and human-animal conflicts, place it in a situation of threat throughout its whole range (Wallace et al. 2014).

Andean bears are a key species with a fundamental role in the dynamics of the ecosystems in which they live. It is known, for example, that in the Intag area, within the cloud forest and páramo of the Ecuador, the bears tear off the bark of certain trees, causing these individuals to die prematurely which allows the formation of clearings within the cloud forest, spaces in which the solar rays reach the ground so that the small trees can grow, promoting the regeneration of the life inside the forest. As said before, Andean bears are very agile and often climb trees and move among them in search of bromeliads and fruits. This activity also contributes to the formation of small illuminated spaces suitable for the growth of new vegetation. By feeding on berries, bears are also important seed dispersers within cloud forest and moorland ecosystems, vital planetary lungs, freshwater sources, and essential elements of the natural water cycle (Oso Andino 2016).

In addition, this mammal is considered an umbrella species because its protection and that of the ecosystems in which it lives, means the conservation of other species of flora and fauna that are highly strategic for the life of the Andean forests and the moors. And these ecosystems also provide us with a large number of environmental goods and services. The Andean bear, due to its characteristics of landscape species and its conservation needs, should be selected as an object of conservation in the national parks system, making it a key element of biodiversity, which implies generating management measures and seeking inter-institutional coordination for its conservation (Parques Nacionales Naturales de Colombia 2017).

There are many reasons why the Andean bear should be protected. Its ecology continues to be investigated, but the significant decrease of its habitat makes its survival only possible through integral conservation programs that continue with the investigation of this species, the rescue and rehabilitation of captive individuals and sustainable development projects with the local and regional inclusion of human communities that are now close to this species, so that they understand its importance and the ecosystem to which it belongs (Oso Andino 2016).

Conflicts between people and Andean bears occur mainly in the Andean region, where the bears cause damages on grazing cattle and crops, especially on corn. In the last decade the reports of conflicts between bears and people have increased. The main causes of the increase are:

1) The expansion of the agriculture activities to the areas that represent natural habitat of the Andean bear;

2) The reduction, fragmentation and isolation of habitat, and the consequent search for resources by bears in areas outside their natural range;

3) The type of agricultural production near the areas of presence of the Andean bear, farming and breeding of animals which is vulnerable to attacks of the bear or with the presence of attractants for the bears.

The conservation of wild species associated with conflicts and protected by law, such as the Andean bear, presents particular difficulties for the environmental and administrative authorities. This is due to the confrontation between the interests of the people affected, represented by the owners of livestock and crops, with the interests of society as a whole, represented by institutions, such as corporations and autonomous regions or the Ministry of the Environment. Some want to preserve their goods and production; others, a wild species of value to society. It is so that there is currently an increasing number of conservation efforts that try to find balance of needs of people with wildlife preservation (Marchini & Luciano 2009). It is important to understand that the conflict between people and wildlife creates problems for local communities and that solutions must be considered with regard to them (Le Bel & Czudek 2010). The resolution of conflicts between people and the bears requires both an institutional and operational framework manuals and guides that facilitate the application of conflict management tools and techniques. A first fundamental step for the resolution of the conflict, is the diagnosis of the risk of conflict, which is determined by the ecology of the species, people affected by the conflict, the type of agricultural activities carried out in the area of the conflict as well as by the possibilities of management (Márquez & Goldstein 2014).

Andean bears require large tracts of land that include different ecosystems, so that their conservation has different levels of complexity that are being approached by means of a methodological proposal, taking into account the needs of this species, as well as those of the human populations that share the same area for living. This approach is known as the living landscapes approach. This means that the conservation of key animal species goes beyond political boundaries, to construct what is called the biological landscape of this particular species. It also identifies human activities in the same area, providing information on this so-called human landscape. The conjunction of both types of information, the human landscape and the biological landscape, is a tool that facilitates the decisions to know where to focus the conservation and management efforts more efficiently (WCS 2014).

Considering the importance of bear conservation in the tropical Andes, and regarding the scarce systematized information on its distribution and ecology, at the beginning of this millennium, efforts to concentrate and analyze collectively available data on the species in the North of the Andes were made. Led by World Wildlife Fund (WWF), with the support of other institutions, particularly Wildlife Conservation Society (WCS) and Ecociencia, this operation covered all existing knowledge of the area of Andean bear distribution, in Colombia, Ecuador and Venezuela, as the Northern part of Peru (Rodríguez et al. 2003). At the same time, the analysis of these results was also published in an international journal (Kattan et al. 2004). All the findings and recommendations have been widely cited (García-Rangel 2012) and incorporated in the conservation plans of the Andean bear over its natural range as a result in 2007, the Andean Bean Expert Group of IUCN convened the II International Symposium of the Andean Bear, held in November 2008, in Lima, Peru. From that time, many conferences focused on bear species took place around the world. The last one, 25th International Conference on Bear Research and Management, from 12th to 17th of November in Quito, Ecuador Quito Land of Bears 2017).

1.2.3. Cultural importance of Andean bear

In addition to its ecological relevance, the Andean bear has a deep rooted cultural value in the Andean and Amazonian worldviews. In the Andes, the species has been conceptualized as the *Ukuku* – a mediator between the stages or states of life, between the world of the living and dead, between nature and culture or between life and death. One of the most spectacular ceremonies of the Andean cultural heritage, the *Qoyllur Rit'i*, has as one of its protagonists as a humanized bear, the *Ukuku*. With the arrival of Europeans, popular myths, traditions, perceptions and beliefs on the bears were shared and a mystical creature - *Ukumari*, a being half bear and half man was created. With the qualities of both this creature was admired and feared at the same time. Ethnicities such as *Matsiguenga*, who live in the foothills of the Andean mountain, sharing habitat with Speclacled bears call them *Maeni*, the supreme creator of life (WCS 2014).

1.2.4. South Ecuador – Andean bear habitat description

Ecuador has a very high floristic diversity, which represents, in ecological terms, the primary production of an ecosystem; particularly, the Andean region has the highest floristic diversity in the country, with 9865 species that are equivalent to approximately 64% of the total (Jorgensen & León 1999). Within this diversity, the South of Ecuador stands out for its unique characteristics, belonging to the region of Amotape-Huancabamba, where the Andean depression is found. Peaks here are lower than 3788 m a.s.l.., which is why the páramos here can be found at the altitude between 2800 and 3000 m a.s.l. (Valencia et al. 1999). Typical páramos of South Ecuador are shown in Figure 2.

Figure 2. Páramos of Southern Ecuador with typical vegetation cover; establishment of plots for the sign survey (photo credit: author)

The habitat, the geological history along with the landscape and a high speciation rate due to the rapid genetic radiation of some species, contribute to a high degree of diversification, as well as various climatic features, orographic heterogeneity, geological and soil conditions, as well as the human impact are the causes which have increased plant diversity in the Southern Ecuador (Richter et al. 2009). Between 3000 and 4000 of vascular plant species are present in the Podocarpus area. In this cloud forest there are the most species of trees from all over Ecuador (Lozano et al. 2002). The composition of the cloud forests and moors of the South is very particular and different from the formations in the North of the country (Jorgensen & Ulloa 1996; Lozano et al. 2002). Podocarpus area is presented in Figure 3. This high diversity of primary producers of Andean ecosystems, and particularly in the Podocarpus, may be interesting if we consider the diversity of the diet of the Andean bear. More than 130 species of plants and animals are recorded in diet studies reported in its range (Stucchi et al. 2003). The species apparently performs seasonal use of the available food (Cuesta et al. 2003). Wide range of the Andean bear diet is represented by an important group of fibrous species such as bromeliads, bamboos, palms, etc. It is assumed, that in this particular case of the páramo, special values of floristic diversity could have an effect on the herbivore populations (Jiménez & Novaro 2004).

Figure 3. Area of Podocarpus National Park (photo credit: author)

The Andean bear (*Tremarctos ornatus*) has very wide ecological requirements and due to this the key to preserve this species is a successful management and conservation of Andean ecosystems such as páramos and cloud forests (Yerena & Torres 1994). Thus, the Andean bear can be used as an umbrella species for the conservation of ecosystems where it inhabits, associated biological diversity and ecological functions that this biodiversity provides (water, landscape). In fact the Andean bear has been considered a main central point of conservation in multiple conservation plans of the Ecuadorian and regional biodiversity (for example, the Andean Ecoregional Complex of the North, Condor Biorreserva, Sangay National Park, among others). In Ecuador there are 57,825 km^2 of habitat available for the Andean bear. Of these 8,230 km^2 are within the National System of Protected Areas (SNAP). This surface is fragmented into 24 units forming a possible metapopulation structure, so the viability of the population in the long term depends on the degree of isolation and the viability of subpopulations (Kattan et al. 2004).

In the Southern part of Ecuador there is one of the largest patches of Andean bear habitat in the region - the Podocarpus National Park, the only protected area in Ecuador that conserves habitat large enough for the successful preservation of the species. As said before, the Andean bear main threats are the destruction and alteration of its habitat. It is estimated that páramos and cloud forests, important ecosystems for the Andean bear, have suffered a reduction of 38% of its original surface. There are two main causes of decreasing trend of the Andean bear population: one is the conflict that is generated when the bear feeds on the fields of maize or livestock of human populations; less common is the hunt associated with the traffic of animals or parts thereof, which are used as ornament, food or medicine. The models of Andean bear habitat, based on geographic information systems (GIS), are a suitable tool to predict the presence and habitat use of a species in a relatively large area. These models are suitable for generalist species and can identify areas of importance for conservation (Cuesta et al. 2001).

In Ecuador, several studies have been carried out on the availability of Andean bear habitat. These studies have made it possible to zonify a community territory (Oyacachi) and to select priority conservation areas in two protected areas (Ecological Reserve Cayambe Coca and Sangay National Park). This methodological experience is now applied to provide preliminary inputs to assess the functionality and biological feasibility of conservation corridors Yacuambi - Podocarpus and Podocarpus - Sabanilla. The proposals of these corridors are initiatives of the Fundación Arcoiris, of the Working Group in Páramos de Loja with the support of Conservation International (Remache et al. 2004).

1.2.5. Habitat use of Adean bear

Habitat can be defined as the total sum of environmental factors in an area that any population needs to survive and reproduce. An animal may use the habitat in different ways. The use of habitat implies the occupation of a given habitat without any connotation of preference, while the selection of habitat refers to the selection made among those that are available.

Habitat selection has been defined as the process in which the animal chooses which components of a habitat to use. In this context habitat selection occurs at four levels:

1) Geographic scale and behaviour, which is genetically determined.

2) At the population scale, where animals regulate their activities and its area of life or territory is taken as its spatial unit.

3) Scale of specific sites or specific components within the area of life (microhabitats) and occurs at the scale of individuals or populations.

4) At the scale of individuals and how they obtain or access the resources of each microsite (Litvaitis et al. 1994; Cuesta et al. 2001; Johnson 1980).

However, habitat should be considered in a broader context that takes into regard possible transformation of natural habitats by human activities such as agriculture, livestock, hunting, selective logging, construction of roads, etc. This makes habitat loss the main threat of Andean bear. That is, the extent of the Andean bear area is affected by the distribution of human resources and therefore, the capacity of an area to meet the needs of the species (Peyton 1984). As a result, in recent years, Andean Bear has become restricted to poor quality habitats, causing them to move outside their boundaries to the fields of crops for feed on maize, sugar cane, potatoes and even domestic livestock (Perico & García, 2001). Andean bear in its natural habitat (in Madrigal private reserve) is presented in Figure 4.

Studies on resource availability of the Andean bear, selection and use of habitat have been developed a little more than 35 years ago with the research carried out by Peyton (1980) in Peru. In South America, Peyton (1980) mentions that the Andean bear performs a transference feeding behaviour, switching between seasonal use of mountain habitats, traversing long trails along the Andes, through which it traverses páramo and subandean forests and moors, in search of bromeliad plants (Bromeliaceae) and fruits of trees and shrubs of *Ericacea*. The eating habits of the Andean bear have been described as omnivorous, but much of that food material corresponds to plants (Cabrera & Yepes 1960; Peyton 1980) although 14 other authors claim to have found parts of insects, birds and mammals in the analysis of their faecal material (Goldstein & Yerena 1986).

Figure 4. Photo of Andean bear from camera trap placed in Madrigal private reserve in 2016 (photo credit: Hugo Tapia)

The components of a habitat are defined as the unique vegetation, topography and other important characteristics for the survival of the species of bears (high diversity, abundance of food plants, rest sites, plus an abundant coverage (Jonkel 1983). Andean bears spend great deal of the time in the forest habitat, where they are able to find food and coverage (Peyton 1980), while páramo habitats, where dense formation of bromeliad plants can be found, are used seasonally (Peyton 1980; Suárez 1985; Goldstein & Yerena 1986; Rodríguez 1991). For example, Bargali et al. (2004) mentioned that the use of habitat by Sloth bear (*Melursus ursinus*) in central India is determined by seasonal variation in the food, the shelter and the coverage of the place. The availability of fruit trees, density of shrubs, water, and insects influence the habitat use in the grizzly bear (*Ursus arctos*) as well (Jonkel 1983; Mattson 2004). The spatial use of the domestic environment of the Black bear (*Ursus americanus*) can vary over a year, in response to concentrations and the seasonal availability of food (Jonkel et al. 1971). The black bear uses a habitat according to the climatic conditions and food availability (Lindsey et al. 1977). The dynamics of the pattern of use of a habitat is probably a reflection of interspecific relationships and response of black bears to locate areas with food and trees that are important in the daily existence of the black bear, particularly in regard to having safety features for climbing trees (Herrero 1972; Lindsey et al. 1977).

The movement of the Andean bear in the páramo has been described as seasonal. Andean bears climb to the páramo when the rain increase in the forest and the food supply is restricted (Peyton 1980; Mondolfi 1989). It is suggested that the Andean bear does not stay in the páramos the whole time because it is more vulnerable to the climatic conditions and possibly hunters, because the vegetation in páramo is very low and sparse (Peyton 1980). Plants that predominate in this type of habitat are mainly grasses, Bromeliaceae, Gramineae, small trees - primarily Ericacea, and *Espeletya* sp. (Suárez 1988).

1.2.6. Abundance of bears – signs of the activity

Indicators of profusion offer affordable and relatively instantaneous methods for measuring occurrence of endangered carnivores crosswise broad environments (Gibbs et al. 1999). Determination of the abundance of wide ranging, low density species is very challenging, time-consuming and demanding in view of money. If there are no reliable clues on species abundance, decisions on protection of endangered species may be established on guessing, estimations and assumptions. This may lead to bad choices that can be disadvantageous for wildlife preservation (Blake & Hedges 2004).

In these times, fortunately, there are more and more people and experts showing interest in preservation of wildlife, including large carnivores. But still, we are witnessing huge drop in abundance of these species (Check 2006; Dinerstein et al. 2007). Abundance of large carnivores in their environment can be assessed by revelation signs of the species in the form of footprints, faeces, hairs, scrape marks and vocalization (Karanth et al. 2003). Number of marks and signs in particular landscape are usually linked to the occurrence of the species (Stander 1998). Examples of signs of activity are shown in Figure 5.

Figure 5. Signs of Andean bear activity - faeces (left) and sratch marks (right) (photo credit: author)

For the successful conservation of Andean bear, reports on the appropriateness and dispersion of the species environment are very essential. Several studies on the habitat use were already accomplished in South America. For instance in the Oyacachi River Basin in the eastern Andes Mountains, bimonthly sign surveys along 1.6-km transects were used to conclude habitat preferences of Andean bear. During 2000 and 2001, 549 and 202 locations of the species activity were documented. Recorded signs of the activity were: feeding signs that were recorded with the highest frequency (53.3%), followed by scats (19.6%), footprints (13.4%), hair (6.9%), tree marks (4.8%), trails (1.2%), and ground nests (0.8%) (Cuesta et al. 2003). Another study was held in Bolivia in two different areas of protection – Madidi National Park and Apolobamba Natural Area of Integrated Management. Researchers analyzed habitat use of Andean bear in different environments. The investigation took place in páramo, elfin forest, upper montane humid forest, middle montane humid forest, lover montane humid forest, foot-hill humid forest and dry montane forest. 28 sites (84%) of total 33 sampled locations showed signs of bear activity. The team documented evidences of bear abundance as paths, feeding signs, beds, scratches, faeces, nets and hairs. Occurrence of the species differed in particular habitats. Andean bears favoured forest vegetation in higher altitudes and avoided habitats below 1000 m a.s.l. (Ríos et al. 2006).

1.2.7. Bromeliads – important food source of Andean bear

Andean bears inhabit extreme Andean environments such as the páramos, which together with the montane forests have an offer of little useful resources for carnivores. For survival and structuring of niches of this species, ability of consumption and utilization of plants like Bromeliads, bamboo and palms is considered to be very important adaptation (Peyton 1980; Suárez 1988; Yerena 1999). Andean bear feeding on *Tillandsia* sp. (Bromeliaceae) is presented in Figure 6.

Figure 6. Andean bear feeding on Bromeliads (*Tillandsia* sp.) (photo credit: Oso Andino 2016)

In determining the diet of herbivores, one of the most accurate methods used for the identification and quantification of plants consumed, is based on microhistological techniques (Castellanos 2005). By these methods it was confirmed that Bromeliaceae family is the most important source of food for the Andean bears during the whole year as Bromeliads were present in all the faeces examined in the study accomplished in Southern Ecuador (Cisneros 2012). From the Bromeliaceae family, Andean bears consume mainly *Puya* sp. (in páramo ecosystems) and *Tillandsia* sp. (in forest ecosystems) (Peyton 1980; Goldstein 2004; Cisneros 2012). The importance of this family is not only immersed in the richness of Bromeliad species of which the Andean bears feed but also in the amount of these plants that is consumed by the Andean bear. It is marked that in diet of Andean bear family Bromeliaceae predominates through the whole year (Cisneros 2012). Representatives of family Bromeliaceae are shown in Figure 7.

Figure 7. Bromeliaceae - *Puya* sp. in páramo (left) and *Tillandsia* sp. in forest (right) (photo credit: author)

2. Aims of the Thesis

This thesis is a part of a more complex research project focused not only on habitat use and activity patterns of Andean bears, but also on influence of nutrient composition of Bromeliads on the habitat use of Andean bears. For better understanding, a scheme of all the factors and aims of this broader research is presented in Figure 8: aims of this thesis are highlighted in red colour, while aims of other parts of the research project are presented in blue colour. Main objective of this study was to assess the relationship between nutrient composition and abundance of Bromeliads, important feed source of Andean bear, and signs of activity of Andean bears. For that reason, specific aims were stated. Following fundamental aims describing habitat use and activity patterns of Andean bears were examined:

1) Differences in abundance of signs of Andean bears activity in two distinct ecosystems
2) Differences in abundance of signs of Andean bears activity in three distinct forest study sites
3) Differences in abundance of Bromeliads in three distinct forest study sites
4) Percentage representation of *Puya* sp. (Bromeliaceae) and *Tillandsia* sp. (Bromeliaceae) in collected faeces samples
5) Correlation between abundance of Bromeliads and signs of activity of Andean bears
6) Correlation between nutritional composition of Bromeliads and signs of activity of Andean bears
7) Correlation between percentage composition of Bromeliads in the faeces and nutritional composition of Bromeliads

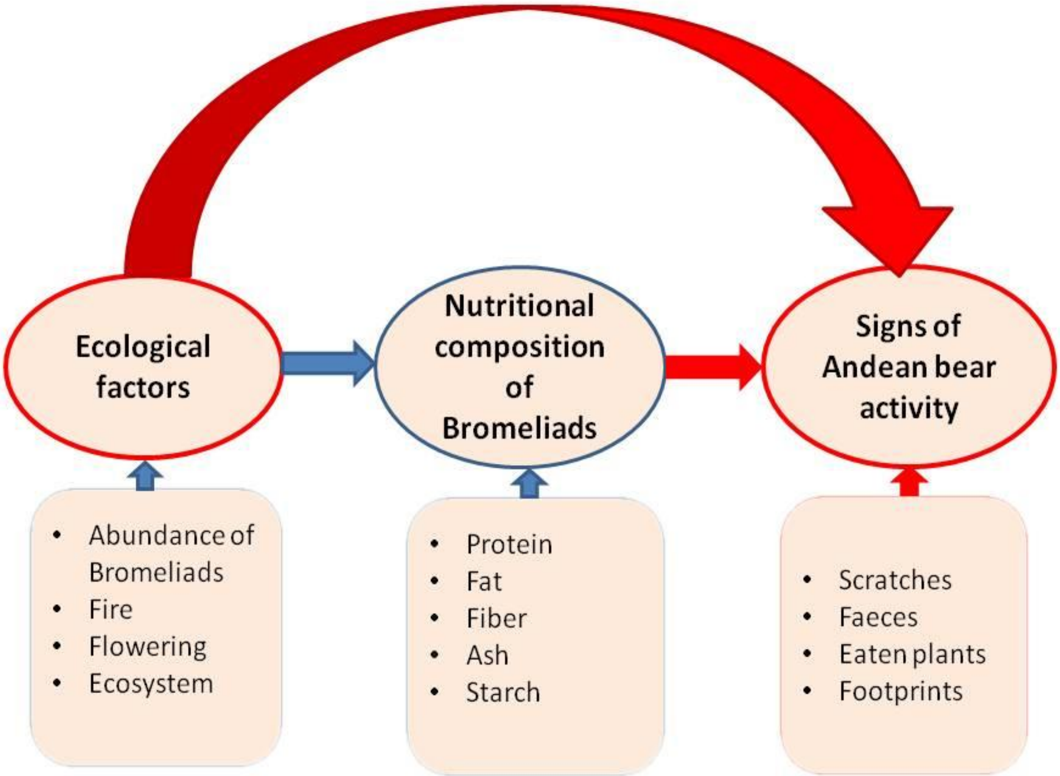

Figure 8. Scheme of aims of the full research project. Aims of this thesis are presented in red colour, aims of the second part of the research are presented in blue colour.

3. Methods

3.1. Study sites

Data collection was performed in six study sites – three in páramo ecosystem and three in montane forest ecosystem in Loja province, Southern Ecuador from June to July 2017 (Figure 9) These months were chosen for the reason that according to Cisneros (2013) Andean bears are normally active in both páramo and forest ecosystems in this period of the year.

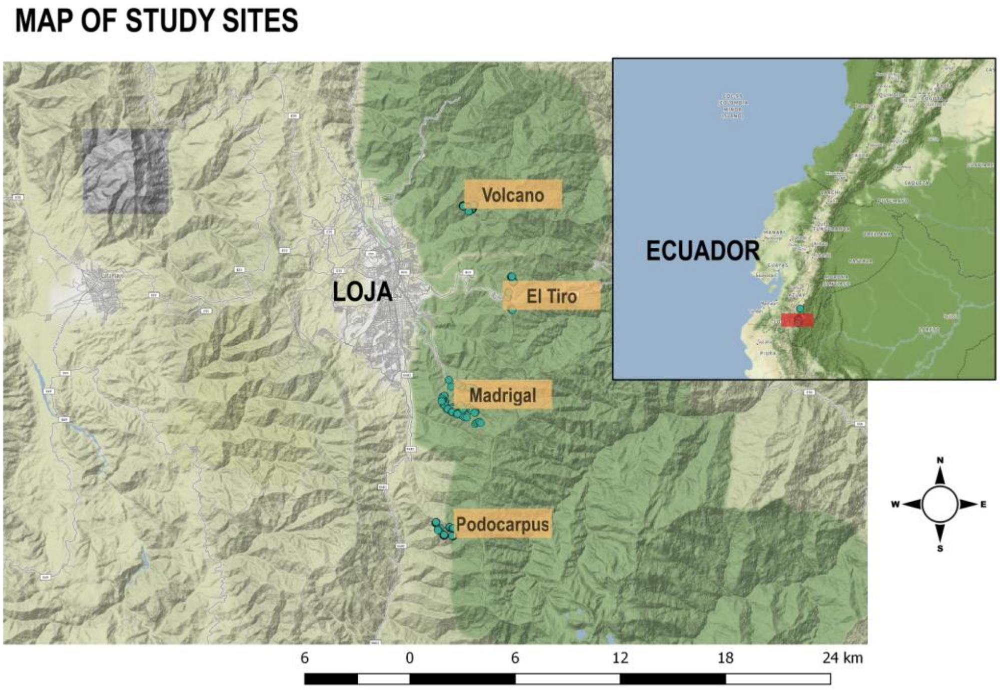

Figure 9. Research area. Created using QGIS 2.14.21 and OSM data model map

Podocarpus National Park – montane forest

Podocarpus National Park is located above 2800 m a.s.l. between the provinces of Loja and Zamora Chinchipe. In this area, the centres of endemism of the Northern and Southern Andes overlap: it is an area of confluence of the coastal dry vegetation and the more humid regions of the high Andes and the Amazon, with a great diversity of species, many of them unique (Narvaez 2013). The area of Podocarpus National Park is approximately 1,460 km^2. Podocarpus possesses an exceptional flora. It is said to be an immense botanical garden located in an area of confluence between the humid Andes of the North and the drier forests of the Southern Tumbesian area. In this area, more than 3,000 species of plants are found. In the sector of San Francisco, several species of orchids stand out, many of them endemic and of great ornamental importance. Podocarpus is a place of very high bird diversity, with more than 622 registered species. Various species of mammals can be found in Podocarpus National Park such as dwarf deers (*Mazama rufina*), cougars (*Puma concolor*), South american coatis (*Nasua nasua*) and mountain foxes (*Lycalopex culpaeus*), Andean bears (*Tremarctos ornatus*), spider monkeys (*Atelidae* sp.) and Mountain tapirs (*Tapirus pinchaque*), as well as innumerable species of amphibians and reptiles (Ministerio del Ambiente 2015). In the Podocarpus National Park, both páramo and montane forest ecosystems are found. The poor accessibility led us to stratify the study area following the central touristic pathways and roads.

El Volcano – montane forest

El Volcano is our working title for a montane forest located above 2000 m a.s.l., west of the Universidad Técnica Particular de Loja. It is an open non limited area (bounded only by meadows) with no or insignificant human disturbance. This forest is very similar to forests in Podocarpus National Park and Madrigal in its plant composition, but there are no pathways and roads, so it makes this area a perfect place for documentation of Andean bear activity in an area free of human influence. The Marginal parts of El Volcano forest are not very dense and there is a high abundance of Bromeliads. Closer to centre section the vegetation is almost impenetrable and thus less suitable for the bear activity.

Madrigal del Podocarpus – montane forest and páramo

Madrigal is a private reserve of 800 ha owned by family Tapia. Located seven kilometres from the city of Loja, the Madrigal reserve is part of a micro-basin located North of the Podocarpus National Park, at elevation from 2,200 m to 3,300 m a.s.l., it is a living laboratory, where 80 species of orchids and many other plant species have been identified, open to university students and researchers. Every year from 2012 camera traps placed in the reserve detect many mammals, not only Andean bear, but also other species such as the Andean fox (*Lycalopex culpaeus*), Mountain tapir (*Tapirus pinchaque*), Jaguar (*Panthera onca),* South American coati *(Nasua nasua)* and others. Madrigal del Podocarpus is also home to countless bird species, many of them endangered, such as Bearded Guan (*Penelope barbata*). For this reason, the site is ideal to carry out the study of the habitat and biological aspects of the Andean bear, with the aim of serving as a reference for the implementation of management measures and conservation at local and regional level (Family Tapia, personal communication, August 2017).

Family Tapia acquired El Madrigal in 2003. Their aim was to preserve the 180 ha of native montane forest that remained pristine and to reforest another 120 hectares that had been used by farmers as a pasture for livestock. The rest of the area is composed by a non natural or man-made páramo, it is a páramo placed on a lower elevation than on which natural páramo ecosystems are found. On 19th of November, 2016 there was a fire in the páramo because of a long period without rain. The fire was set by one of the neighbours, who wanted to clear his pasture, and spread quickly due to strong wind. It took four days to stop the fire and 60 ha mainly of páramo but also of forest were damaged (Family Tapia, personal communication, July 2017).

Unburnt páramo

Unburnt páramo is our working title for a páramo located close to El Carmen, Loja on the west slope of the Madrigal del Podocarpus border. It is a non natural páramo placed on a lower elevation than on which natural páramo ecosystems are found. This area is bounded by the farm land and meadows on the South and by forest on other sides. As many other páramos in Ecuador, this place was once a forest which was later burnt and used as a pasture for cattle. According to local people, it was abandoned decades ago left to its fade. At this time, typical flora of páramos of Southern Ecuador can be found there. On the Southern boundary slopes are covered by shrubby vegetation, on the uppermost part many bromeliad species are abundant in large numbers. The plant composition, elevation, climate conditions and slope compositions are very similar to Madrigal del Podocarpus, but as there was no influence of fire for dozens of years, more bromeliad species can be found in this páramo. Unlike in Madrigal, in this “Unburnt páramo”, *Puya eringioides* and different (ground) species of *Tillandsia* can be found.

El Tiro - páramo

El Tiro is a páramo ecosystem located close to the Northern part of the Podocarpus National Park. The composition of the plants can be described as herbaceous and shrubby vegetation, which is characteristic for these specific páramos that start at an altitude atypical for these ecosystems - lower than 2,900 m s.n.m (Cisneros 2013). There is a high diversity and endemism of plants in these ecosystems (Lozano 2002) that differentiate these páramos from the rest of the country. The study area can be accessed by road Loja - Zamora, which separates the North end of the Podocarpus Park and other areas. This road was enlarged in 2009, setting up a base of operations and processing of materials right in the páramo. These industrial changes have generated a great disturbance of the natural ecosystem. To date, no restoration work has been observed in the area.

However even after the construction of the road and continuation of the industrial management the activity of Andean bears has been observed in El Tiro (Cisneros 2013).

3.2. Data collection

3.2.1. Survey of the signs of activity of Andean bears

Many successful studies focused on the habitat use of Andean bear were based on evaluation of the signs of abundance of the species in its environment (Cuesta et al. 2003), thus for our research we decided to adopt this exact method. Because there are many challenges in accessibility of the terrain, for our sign sampling we selected areas close to the main pathways in each of the study sites and we preferred to carry out our analysis in the manner of plot survey.

Indications of bear activities were collected in six study sites. Three sites were located in the páramo ecosystem and three were located in the upper montane humid forest. In each of the study sites five plots in size of 50 m x 50 m were placed. All the plots were placed in an aspect to different features of microhabitat (slopes, vegetation types etc.). To avoid replications all of the plots in each site were at least 250 m apart. Once the start of the plot was detected, we marked the starting point with a red tape and followed a straight line according to GPS up to the other corner of the plot (everything was repeated again for the whole plot). Red tapes were placed along the whole plot at 10 m intervals to assure that during the examination the whole plot was investigated. After completion, the whole plot was investigated through by a team of two to three people. For each plot we collected GPS (global positioning system) coordinates of the location and the type of the sign. Types of signs that were collected included: faeces, ground nests, party eaten plants, scratch marks, hairs and footprints. For better comparability, the data were further counted per hectare. Collected GPS data were thereafter used for creation of maps of study sites in QGIS 2.14.21 and OSM data model map.

3.2.2. Abundance of Bromeliads

Abundance of bromeliads was evaluated in six study sites. Three sites were located in the páramo ecosystem and three were located in the upper montane humid forest. In each of the study sites five plots in size of 50 m x 50 m were placed for the collection of signs of bear activity. In each of these 50 m x 50 m plots two plots in size of 10 m x 10 m were placed randomly. This method was chosen on account of high diversity, density and elevation of the plant cover. Assessment of the plant abundance in tropical montane forest would be beyond the bounds of possibility in the plots of 50 m x 50 m. In view of reasons above mentioned, only the most abundant bromeliad species of each plot was evaluated. In every small plot the most plentiful bromeliad species was chosen and exact number of this species was counted. For better comparability, the data were further counted per hectare.

3.2.3. Faeces samples

In the plots used for the sign survey all detected faeces were collected, gathered into plastic Ziploc bags and afterwards stored in a freezer. Before the filtration all collected stool samples were unfrozen and separately, filtered through laboratory test sieve in diameter of 1.5 mm so only the largest particles were obtained. Particles of the required size of the each sample were immediately placed into plastic vessels and preserved in alcohol. Every sample was afterwards placed into large plastic dish and all the particles were equally spread out. Using two measuring sticks every tenth particle was selected and placed in a dish so the percentage representation was met. The fragments in the faeces were measured by orderly locating 10 non-overlapping fields in which undigested particles were identified on 10 slides (100 fields per sample). These particles were further divided into bromeliad origin and unknown by microhistological analysis - a technique widely used in studies of animal food habits (Carriere 2002). Bromeliad particles were distinguished into *Puya* sp. and *Tillandsia* sp. by microscopical comparison to a reference collection of bromeliads found in the study area, which was made in order to identify the unique characteristics of the plant species (the reference collection was made by mashing *Puya* sp. and *Tillandsia* sp. in a blender into small particles, so it would resemble plants digested by Andean bears, the reference collection was preserved in alcohol). Percentage representation of the bromeliad species in every stool samples was counted.

3.2.4. Nutritional composition of Bromeliads

For the thesis of my colleague Adéla Paříková, entitled: "Ecological factors affecting nutrient composition of Bromeliads used by the Andean bear (Tremarctos ornatus)", samples of the most abundant species in the 10 m x 10 m plots were collected and nutrient composition of those samples was analysed. From the *Pitcairnioideae* subfamily three species of *Puya* genus were collected – *Puya eryngioides, Puya nitida* and *Puya parviflora* and from subfamily *Tillandsioideae Tillandsia* sp. was collected. For the evaluation of the nutrients (protein, fat, fibre, ash, starch), Near Infrared Spectroscopy method (NIRS) was used. Analysis was done in a NIRS™ DS2500 F from FOSS. Part of these nutritional analyses were thereafter used in this thesis for the investigation of factors influencing habitat use of the Andean bear in Southern Ecuador.

3.3. Data analysis

For the statistical analysis of the data, IBM® SPSS® Statistics 20 software was used. Normality was evaluated by Shapiro-Wilk test. For the analysis of different distribution of bear activity between two ecosystems, Mann-Whitney U test was used.

Differences in frequency of bear activity in forest study sites were analyzed by Kruskal-Wallis test. Occurrence of Bromeliads in three forest study sites was tested by Kruskal-Wallis test. Sperman´s correlation was used to detect correlation between signs of activity of Andean bears and nutrient composition of Bromeliads, and between signs of activity of Andean bears and abundance of Bromeliads. For evaluation of correlation between percentage representation of Bromeliads in faeces and nutrient composition of Bromeliads, Sperman´s correlation was used. For the comparison of percentage representation of Bromeliads in forest, paired T-test was used. Graphs were prepared in SPSS and Microsoft Excel 97-2003.

4. Results

Normality of all the variables used in the following analyses was measured by Shapiro-Wilk test: abundance of Bromeliads ($W=0.801$; $df = 36$; $p<0.001$), total activity ($W=0.561$; $df = 30$; $p<0.001$), signs of Andean bear activity ($W=0.561$; $df = 30$; $p<0.001$), percentage representation of Bromeliads in faeces – *Puya* sp. ($W=0.334$; $df = 23$; $p<0.001$) and *Tillandsia* sp. ($W=0.914$; $df = 23$; $p=0.049$). All them revealed a not normal distribution.

Normality of nutritional composition of Bromeliads evaluated by Shapiro-Wilk test showed the following results: protein ($W=0.969$; $df=15$; $p=0.848$), fat ($W=0.966$; $df=15$; $p=0.795$), fibre ($W=0.932$; $df=15$; $p=0.288$), ash ($W=0.859$; $df=15$; $p=0.024$), starch ($W=0.957$; $df=15$; $p=0.636$). The distribution was normal for all these variables.

4.1. Sign survey

To discover habitat preference of Andean bear, signs of activity were analyzed for differences between the two studied ecosystems. As shown in Figure 10, there was a significant difference ($U=12.5$; $N=30$; $p<0.001$) between abundance of signs of Bear activity per hectare in two different ecosystems – forest ($n=15$) and páramo ($n=15$).

As shown in figure 11, there was no significant difference in sign abundance per hectare among three different forest study sites ($H = 2.784$; $df=2$; $p=0.249$) – Madrigal ($n=5$), Podocarpus ($n=5$), Volcano ($n=5$).

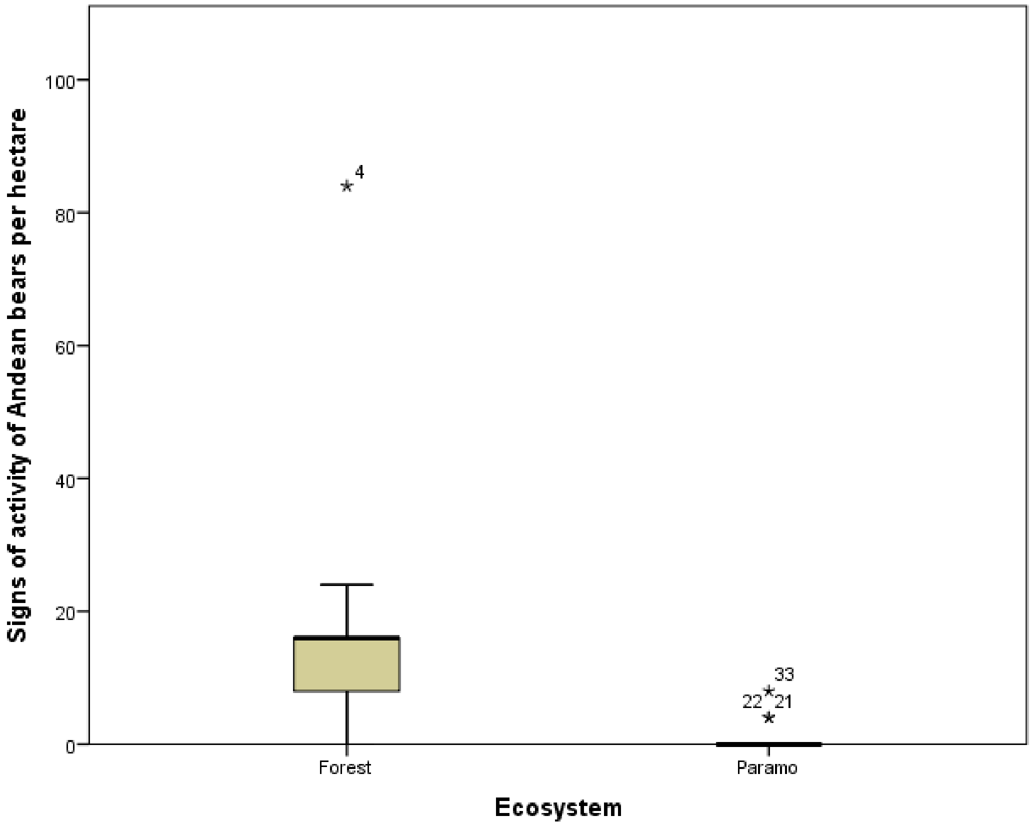

Figure 10. Signs of Andean bear activity per hectare in forest and in páramo

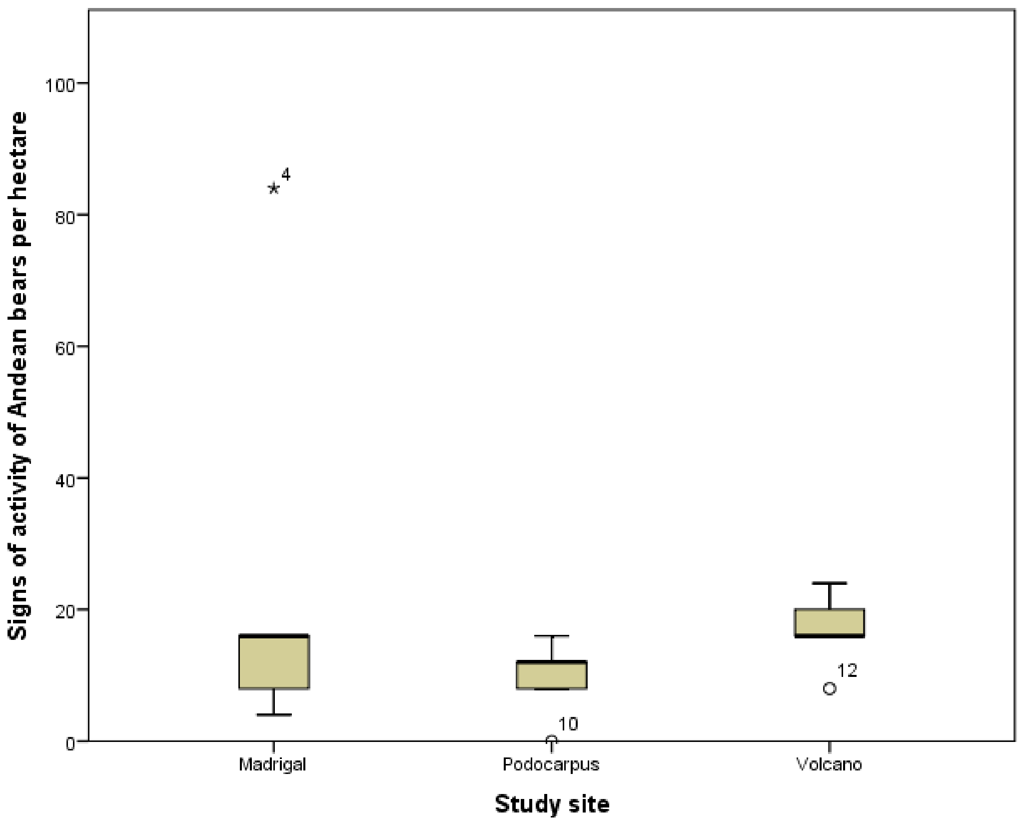

Figure 11. Signs of Andean bear activity per hectare in forest study sites

4.2. Abundance of Bromeliads

To discover differences in abundance of sources of feed, the abundance of Bromeliads was compared among three forest study sites. As shown in Figure 12, there was no significant difference (H=2.215; df=2; p=0.330) in abundance of Bromeliads per hectare in three different forest study sites – Madrigal (n=5), Podocarpus (n=5), Volcano (n=5).

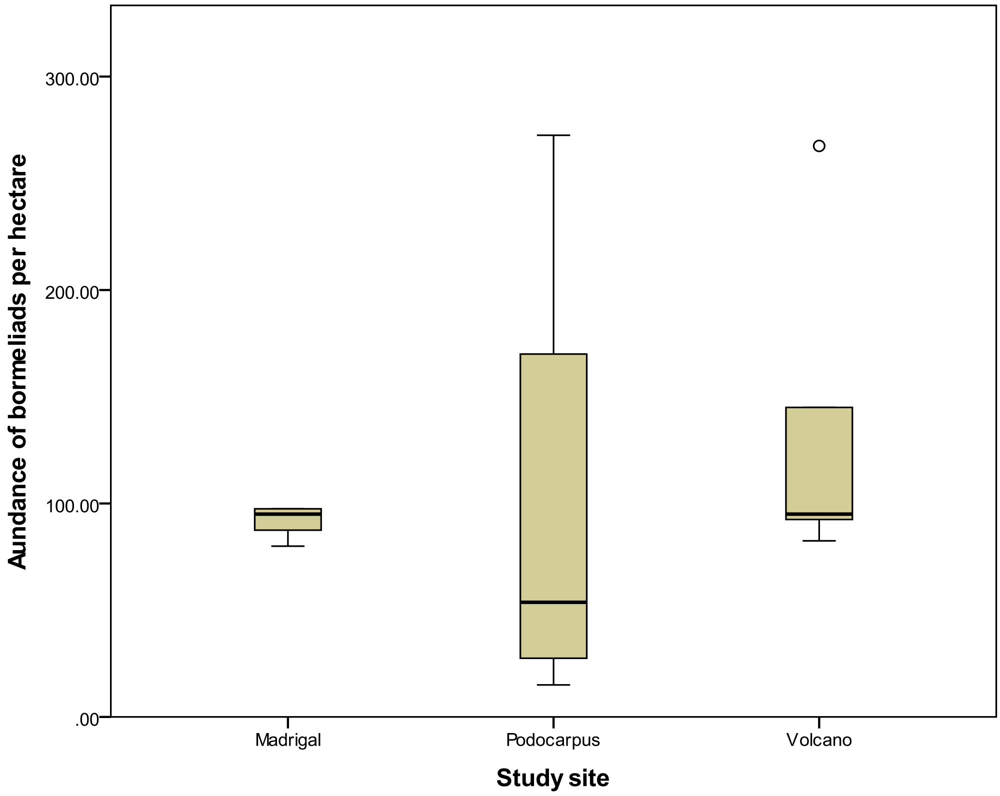

Figure 12. Abundance of Bromeliads per hectare in forest study sites

4.3. Faeces samples

To discover feeding preferences of Andean bear, representation of Bromeliads in faeces was analyzed. The average percentage representation of Bromeliads in faeces samples differed between two tested ecosystems (Figure 13). In forest there was 1.38% [SD=4.29] of *Puya* sp. and 26.62% [SD=13.59] of *Tillandsia* sp. on average. In páramo there was 0% [SD=0.00] of *Puya* sp. and 8% [SD=8.00] of *Tillandsia* sp. on average.

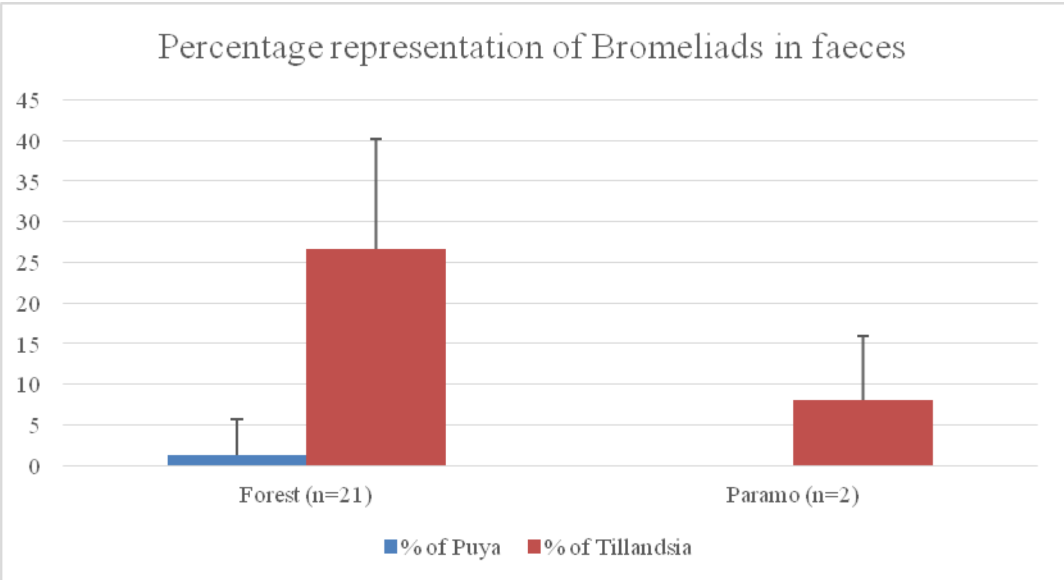

Figure 13. Percentage representation of Bromeliads in faeces

4.4. Correlation between signs of activity of Andean bears per hectare and number of Bromeliads per hectare

Spearman´s correlation between abundance of signs of Andean bear activity and abundance of Bromeliads was performed to discover if activity of Andean bears is affected by abundance of feed, but no correlation was found (ρ=-0.070; N=15; p=0.811). The result is shown in Figure 14.

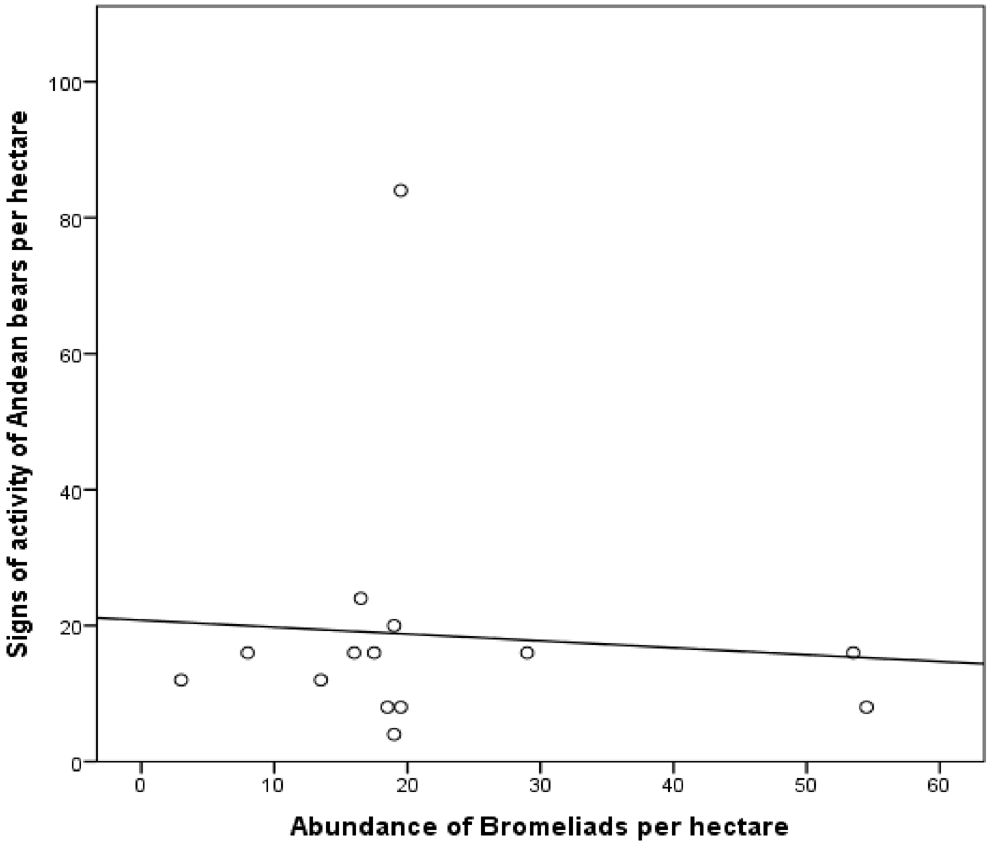

Figure 14. Correlation between signs of activity of Andean bears per hectare and number of Bromeliads per hectare

4.5. Correlation between signs of activity of Andean bears and nutritional composition of Bromeliads

Spearman´s correlation between abundance of signs of Andean bear activity and nutritional composition of Bromeliads (protein; fat; fibre; ash; starch) was performed to discover if activity of Andean bears is affected by quality of feed in that area. No correlation was found between signs of Andean bear activity and fat; fibre; ash; starch. However, there was a negative correlation between signs of Andean bear activity and protein content of Bromeliads in the forest (ρ= -0.535; N=15; p=0.040). The result is shown in Figure 15.

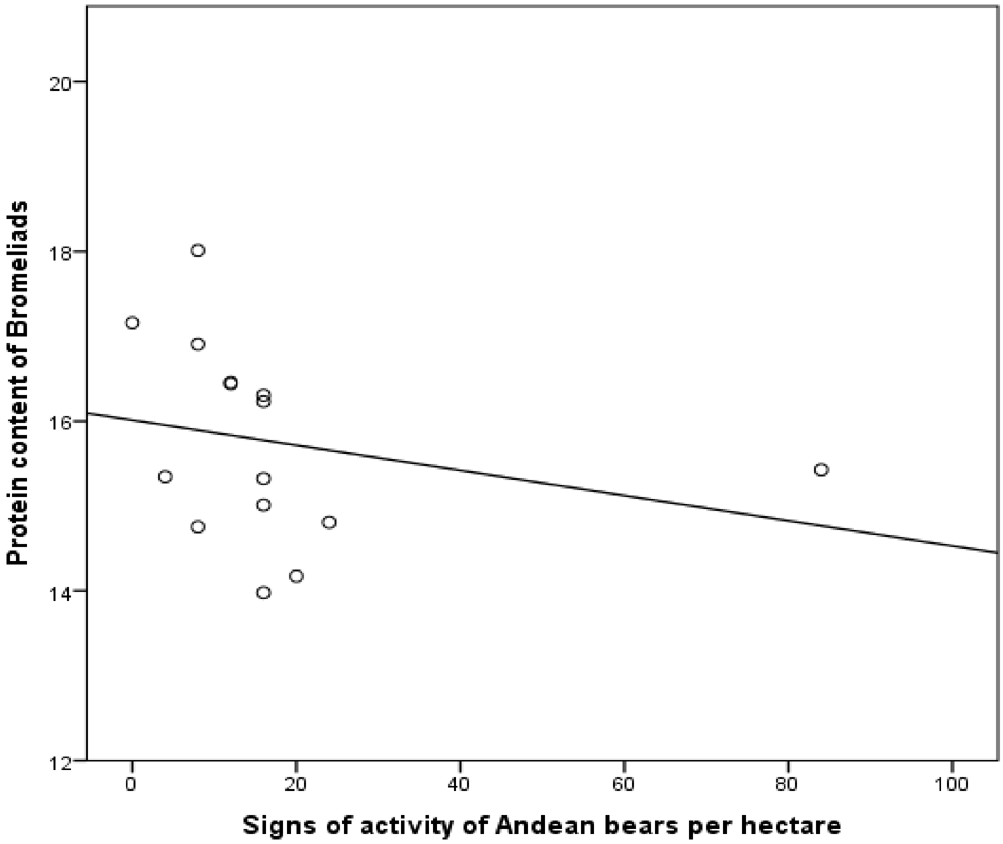

Figure 15. Correlation between signs of activity of Andean bears and protein content of Bromeliads

4.6. Correlation between Percentage representation of Bromeliads in faeces samples and nutritional composition of Bromeliads

Spearman´s correlation between percentage representation of Bromeliads in faeces samples and nutritional composition of Bromeliads (protein; fat; fibre; ash; starch) was performed to discover if consumption of Bromeliads by Andean bears is affected by quality of feed – Bromeliads. No correlation was found between percentage representation of Bromeliads in analyzed faeces and fat; fibre; ash; starch. There was a positive correlation found between percentage representation of *Tillandsia* sp. in faeces and protein content of Bromeliads in the forest (ρ=0.786; N=7; p=0.036). The result is shown in Figure 16.

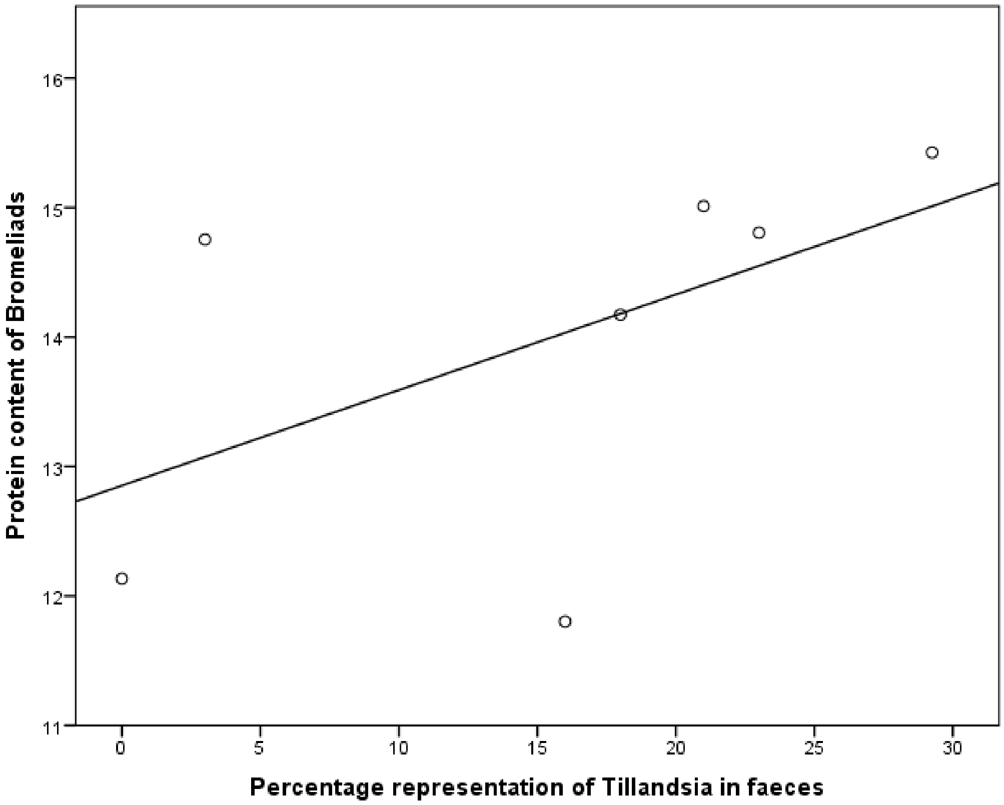

Figure 16. Correlation between Percentage representation of Bromeliads in faeces samples and protein content of Bromeliads

5. Discussion

In this study we found that in the time period from June to July 2017 activity of Andean bears in páramo ecosystems was negligible while montane humid forests were highly favoured by the species. Analysis of the faeces supported this fact as the average percentage representation of *Tillandsia* sp. in the collected faeces was significantly higher than the average percentage representation of *Puya* sp. There was no correlation between the Andean bear activity and the abundance of Bromeliads in the forest ecosystem. No correlation was found between the Andean bear activity and the nutritional composition of Bromeliads – (fat; fibre; ash; starch) except for protein content: there was a negative correlation between signs of Andean bear activity and protein content of Bromeliads in the forest. This suggests that bears were using different sites in the forests independently on the abundance and nutritional composition of the possible sources of food. No correlation was found between percentage representation of Bromeliads in analyzed faeces and nutritional composition of Bromeliads – (fat; fibre; ash; starch). However, there was a positive correlation between percentage representation of *Tillandsia* sp. in faeces and their protein content. The results also higlight certain homogeneity of the forest habitat – amount of Bromeliads, their nutritional composition, and signs of Andean bear activity did not vary among forest study sites.

In the previous studies, it was found that all the members of family *Ursidae* favour habitats with the most productive conditions (Schoen 1990). This may explain the detected fluctuation in utilization of different vegetation types within the suitable habitats in Southern Ecuador shown in our results. Cuesta et al (2003) detected a noticeable pattern of periodic change of sources of feed and thus also in favoured ecosystems in the areas of Andean bear distribution. Although the pilot study on the habitat use of Andean bear in páramos in the area of Podocarpus National Park carried out by Cisneros (2013) showed that Andean bears were active in páramo ecosystems in each month from April 2009 to March 2010 (from June – July the amount of registered signs represented 12.32% of all the signs found during one year time period). However our results presented different tendency – in the time of data collection from June to July 2017 there were only three signals (from two plots in two different study sites – two signs in El tiro and one sign in burnt páramo in Madrigal, representing only 1.95% of all the signs registered during our research) detected in páramos.

Avoidance of páramo ecosystem of El Tiro may be explained by presence of industrial disturbances in the area. Avoidance of burnt páramo area of Madrigal may be explained by the fire and damage of the vegetation, which took place on 19th of November 2016. On the other hand, páramos of unburnt side of Madrigal and El Tiro showed the same bears´ activity pattern even if no fire was present in these areas for dozens of years. Flowering phase of most of the Bromeliads, and so possible changes of nutrient compositions of these plants in all of the páramo ecosystems, may be the reason for lack of bear signals and activity in these places (Pařiková 2018). About forest study sites, which were clearly favoured over páramo, there were no significant differences in the number of signs in the three studied areas. Goldstein (2014) found that Andean bears tend to select *Tillandsia* feeding sites with larger trees and great canopies. However, we found no significant difference in the abundance of signs of Andean bear activity among Madrigal, Volcano and Podocarpus forest, even if there were larger trees in Podocarpus National Park.

No correlation between the abundance of signs of Andean bear activity and nutritional composition of Bromeliads (fat; fibre; ash; starch) may mean that activity of Andean bears is not affected by quality of feed (Bromeliads). However, negative correlation between signs of Andean bear activity and protein content of Bromeliads in the forest was found. This discovery may suggest that activity of Andean bears is either driven by another macronutrient (other carbohydrates not studied here) or is not influenced by the nutritional composition and quality of feed at any rate, and that Andean bears may base their forage decision rather on quantity than quality. Paisley (2001) and Rivadeneria-Canedo (2008) stated that Andean bears are aimed at large amounts of feed in their foraging habits, because meristems (part of plant consumed by Andean bears) in general have low nutritional value – and in Bromeliads it is lower than in most of plants. Previously published studies indicated that carbohydrate content of Bromeliads is low (Galasso 2002, Castellanos et al. 2005) It ranges from 2.6% to 6.0% of total dry mass (Zotz & Richter 2006). However, from the study by Paříková (2018) it is clear that the starch content of Bromeliads growing in the areas, where our research took place, is on average 15.26% of the total dry mass (of the parts preferably consumed by Andean bears).

The lack of correlation detected between the percentage representation of Bromeliads in analyzed faeces and the nutritional composition of Bromeliads (fat; fibre; ash; starch) may mean that consumption of Bromeliads by Andean bears is not affected by quality of feed (Bromeliads). Nevertheless there was a positive correlation found between percentage representation of *Tillandsia* sp. in faeces and protein content of Bromeliads in the forest. These findings, contradicting the result of negative correlation between activity of bears and protein composition of Bromeliads, may once more indicate that foraging of Andean bears is either driven by another macronutrient (carbohydrate), or is not driven by the quality of feed at all, or that bears were foraging and defecating in distinct places. Andean bears may seek the most abundant food – Paisley and Garshelis (2006) described, that Andean bears, like Giant pandas, are non-caecal monogastrics and are consequently inefficient at fibre (and thus plant matter) digestion. They, nonetheless, have several morpohological specialisations allowing effective mastication if fibrous feed. And most importantly they are recompensating this handicap by quick consumption of large quantities of food. Another option of explaining our contradicting results is the possibility that bears might have been less active on the ground than in the places where they were feeding (canopy). Signs of activity were investigated only on the ground level, but as reported by Figueroa and Stucchi (2005) Andean bears often use tree platforms to eat, rest and take daytime naps. In this case our result may suggest that general activity of Andean bears in areas with higher bromeliads content was lower, but bears favoured those places as feeding sites. Positive correlation between percentage representation of *Tillandsia* sp. in faeces and protein content of Bromeliads in the forest might be a proof for this theory.

In the previous studies it was found, that preferred feed of Andean bears depends on the abundance of the types of sources of food within habitat (Peyton 1986; Goldstein & Salas 1993). Our results confirm this fact because homogeneity of Bromeliad cover in the forest ecosystems was followed by the homogeneity in the signs of Andean bear activity.

Previous research on the diet preferences of Andean bear based on faeces analysis discovered that the frequency of bromeliads in the faeces did not vary among sampling periods and that bears fed mostly on terrestrial species of Bromeliads growing in the páramo (Troya et al. 2004). From our sampling, it is clear that in the time and place of our research, Andean bears fed almost exclusively on epiphytic Bromeliads – *Tillandsia* sp. However, our results are, unfortunately, limited by small sample size.

6. Conclusions

Because of the previous research on Andean bear activity, we assumed that bears are active in both ecosystems – forest and páramo during the whole year. However, our results showed that Andean bears were active almost exclusively in forest ecosystem during our study period. This outcome may be explained by human-caused disturbance in the páramo study sites. Even if there was a negative correlation between abundance of signs of Andean bear activity and protein content of Bromeliads, and positive correlation between protein content of Bromeliads and percentage representation of *Tillandsia s*p. in faeces, interpretation of the results is complicated by apparent homogeneity of examined forest study sites (there were no differences in abundance of signs of Andean bear activity among forest study sites, nor differences in Abundance of Bromeliads among these areas). On account of outcome of this research we recommend, that further research focused on correlation between protein content of Bromeliads and activity patterns of Andean bears should be performed for more comprehensive determination of Andean bear habitat use.

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