GRANT APPLICATION
ZOOLOGICAL SOCIETY OF GENEVE

PROJECT TITLE

A habitat model for brown bear in the Polish Carpathians and Bieszczady mountains: implications for species conservation, forest management and land use planning

GENERAL INFORMATION

1. Organization where work will be performed
Institute of Nature Conservation (Polish Academy of Sciences)
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2. Funding period: ……**36**…..months

3. Number of personnel involved in the project: **6**

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4. Requested funding amount (in Polish zlotys - zł): **308 480 zł** (1 CHF = 2.4 PLN)

5. Project period: **1 February 2007- 31 January 2010**

6. Keywords: **conservation biology, diet, food availability, GIS, statistical modelling, habitat selection, home range, landscape, *Ursus arctos***

PROJECT SUMMARY

The Polish population of brown bears *Ursus arctos* is small (rough estimation of about 100 individuals) and its distribution is limited to the Carpathian mountains. Habitat loss and human access to bear habitat have been recently considered as the major threats for the species in Poland. The main goal of this project is to develop a model of habitat suitability for brown bear at a **landscape** (Polish Carpathians) and a **local scale** (Bieszczady mountains). We want to identify bear habitat requirements in a wide sense (food, escape cover and den sites) to determine the present state of the population, and to identify areas of high conservation value, conflictive areas, and areas with unoccupied potential habitat. We will analyse the influence of natural (landscape attributes, food availability) and human-related variables (human presence and activities) on the survival, reproduction and wintering of bears. The main methods will include satellite telemetry and GIS analysis. The seasonal use of habitat types within home ranges will be investigated in relation to changes in bear diet and the temporal availability and distribution of main food items. This project is very applied and aimed at developing a habitat-based management strategy for the conservation of bears. It will provide essential information for the design of conservation measures for the species, as well as for assessing the consequences of planned or ongoing changes in land use and minimising human-bear conflicts.

PROJECT DESCRIPTION, METHODOLOGY, AND EXPECTED RESULTS

1. General introduction and main objectives

Many large mammalian carnivore populations have decreased dramatically in size during the last century. Brown bears *Ursus arctos* formerly occurred throughout continental Europe, but later disappeared from most areas as the human population grew, being confined to remote or less accessible areas (Breitenmoser 1998, Jakubiec 1993, Swenson et al. 2000). Whereas the historic impact of man on bears was more related to the direct killing of animals, nowadays most important impacts are related to habitat loss. The remaining relict populations in southern, central and western Europe are small and highly fragmented (Servheen et al. 1998, Swenson et al. 2000). It has been necessary to conduct reintroduction programmes in the Italian and Austrian Alps and in the French Pyrenees (Kaczensky 2000). All European brown bear populations are classified as strictly protected and potentially endangered (Annex II) by the Bern and CITES Conventions, respectively. The northeastern European population, which covers parts of Finland, the Baltic states and Russia, and the population in the Carpathian mountains are the largest in Europe. The Carpathian population includes the brown bears in Slovakia, Poland, Ukraine and Romania and it has been estimated in c.a. 8,000 bears. The Polish population represents the northwestern range of the distribution of the Carpathian population (Swenson et al. 2000).

Brown bears, which were once present throughout the entire Poland, practically disappeared from the majority of the country by the XVII century (Jakubiec and Buchalczyk 1987). At the beginning of the XIX century, bear distribution was limited to the Carpathians, Białowieża Forest, Łodzka Forest and Kielce province. A century later, bear range was exclusively limited to the Carpathian mountains (Jakubiec and Buchalczyk 1987). After reaching minimum numbers in the 40s (10-14 individuals), the Polish bear population started a slow recovery from its two main refuges: the Tatra and Bieszczady mountains. The present Polish bear population is still small and it seems to have stabilised (Jakubiec & Buchalczyk 2001). Rough estimations yield a total of 100-128 individuals in the entire Polish Carpathians. For the bear population in Poland the most valuable area are the Bieszczady mountains, which are home for more than 70% of the population (Jakubiec 2001).

Many factors are threatening the future persistence of the bear population in Poland. Brown bears are a protected species classified as Near Threatened in the Polish Red Data Book of Animals (Jakubiec & Buchalczyk 2001), and The Action Plan for the Conservation of the Brown Bear in Europe (Swensson et al. 2000) has identified habitat fragmentation and human access to bear habitat as the major threats for the species in Poland. These threats are also important in Slovakia and Ukraine, countries sharing the bear population with Poland. It has been suggested that the area of brown bear occurrence in Poland is contracting due to exploitation and fragmentation of forest and to an increasing human pressure (Jakubiec 2001). On the other hand, the increasing artificial supply of food resources, as dumps, has created the additional problem of conditioned bears, frequently documented in the Tatra mountains. Thus, the risk of conflicts between bears and people has considerably increased in the last decade. More than half of the documented bear deaths in the Polish Carpathian mountains were human-caused (Jakubiec 2001). Future economical development may have important consequences for the persistence of the population if adequate conservation measures and land planning are not implemented.

The components of bear habitat can be grouped into three main categories: food, escape cover and den sites. In this sense, the habitat requirements of bears may be different for survival, reproduction and hibernation. Bear movements and habitat use, as well as survival and reproduction are strongly affected by the availability of food. Topography and human disturbance may also influence bear survival, as well as den choice (Kaczensky 2000, Swensson et al. 2000). On the other hand, human activities may also affect habitat quality by altering food abundance. Patches of critical bear foods may disappeared or be reduced, thus affecting bear densities and reproductive rates (Dahle & Swenson 2003a,b). The identification of such high-quality areas for brown bears represents a priority for the conservation of the species. Bears have large home ranges (e.g. Dahle and Swensson 2003a, b), which stresses the need of large suitable habitat to support a viable population, but also involve a great potential for conflicts with humans.

In spite of those threats and being one of the most important in Europe, the Carpathian bear population has been little studied and reliable field data is extremely scarce. The lack of means and the difficulties of the study area have contributed substantially to the gap in our knowledge about the ecology of Carpathian brown bears. Nowadays, satellite telemetry and GIS analysis offer the possibility of gathering precisely the necessary data. We propose to develop a first model to assess habitat suitability for brown bear at a landscape (Polish Carpathians) and a local scale (Bieszczady mountains).

Our main aim is to identify the quality and spatial arrangement of bear habitat in the Polish Carpathians, specifically in the Bieszczady mountains to (1) analyse the present conditions of the population, (2) determine bear habitat requirements, and (3) facilitate identification of core areas of high conservation value, conflictive areas, and areas with unoccupied potential habitat. This habitat model will provide essential information for the design of management strategies and conservation measures for the species. Specific goals of the project are:

(1) To determine the actual state of the brown bear population and its trend (expanding, stable or decreasing) in the Bieszczady mountains, in particular to obtain an accurate estimation of the bear numbers, densities, home ranges and distribution.

(2) To produce a model of bear-habitat relationship to identify the habitat variables (sensu Hall et al. 1997) affecting bear presence and reproduction, and thus to assess the habitat quality of the area. We will analyse the influence of natural (landscape attributes, food availability) and human-related variables (human presence and activities) on the (1) occurrence, (2) movements, and (3) reproduction of brown bears. The human and natural factors affecting the selection on wintering dens will be also investigated.

(3) To identify the key food resources for brown bear, specially during critical periods (inmediately after and before hibernation) and to investigate the relationship between habitat selection and food supply. Specifically, we will analyse (1) the seasonal changes in the diet, (2) the temporal availability and distribution of main food items, and (3) the seasonal use of habitat types within home ranges.

(4) To identify critical and conflictive areas for the species, as well as high-quality habitats that may deserve protection, totally or seasonally. This will help developing a habitat-based management strategy for the conservation of

bears. The impact of human activities on bears will be quantified, and may be extremely useful for decision-makers and future environmental impact assessment procedures.

2. Background and state of current knowledge

The loss and fragmentation of habitat is a major threat to the continued survival of many species in the world (e.g. Huxel and Hasting 1999, Brooks et al. 2002, Fernández et al. 2003). On the other hand, human activities has also a tremendous effect on the distribution and abundance of large carnivores (Woodroffe 2000). For long-lived species with low reproductive rates, as brown bears, it is well known that deaths are mainly caused by humans (review in Woodroffe & Ginsberg 1998), whereas nutritional condition, mainly determined by habitat quality, affects reproductive rates (e.g. Bunnell & Tait 1981, Rogers 1987). Understanding the potential impacts of both habitat loss and human activities on rare or threatened species is a primary topic in conservation biology.

Habitat models have become an important tool in conservation biology because they improve our understanding of the factors that determine the distribution and abundance of species and the human factors leading to habitat change. They are particularly useful to investigate conservation problems of animals highly sensible to habitat alteration and with large spatial requirements, like the brown bear (Carroll et al. 2001). Habitat models are commonly based on the association of species' presence-absence data with quantitative patterns of the landscape. On a finer scale, habitat quality may be also linked with demographic features such as reproduction and mortality (e.g. Fernández et al. 2003, Naves et al. 2003, Nielsen et al. 2004a). Their basic idea is to predict the probability of occupancy (or breeding, dying) from a set of landscape-scale explanatory variables (Manly et al. 2002). Their outcomes are interpreted in terms of habitat suitability, and they have been proven to be very useful in the design of conservation plans for many species (Boyce & McDonald 1999, Merrill et al. 1999, Schadt et al. 2002, Posillico et al. 2004).

In Europe, recently developed habitat models for brown bear have provided essential information. In the central Apennines, Posillico et al. (2004) identified the potential habitat for a low-density bear population, which allowed (1) to assess the overlap between the suitable habitat and the system of protected areas, (2) to define the areas of high-quality habitat where the detrimental human activities should be critically considered, and (3) to provide guidelines for the preservation of suitable areas where the population could expand and recover. Suitable habitat for bears was positively related with deciduous woodlands, mainly of masting species as oak *Quercus robur* and beech *Fagus sylvatica*, and with ecotones where forest fruits were abundant. At low altitudes and with higher proportion of shrubland, the probability of bear presence decreased. Interestingly, the same relations were found in northern Spain (Naves et al. 2003). But as a difference, the model by Naves et al. (2003) included also human variables, which appeared to be the most important factors affecting bear mortality. In this model, habitats were classified within the source-sink theory (Pulliam 1988) which allowed, for example, the identification of good habitats where human-caused mortality was high (attractive sinks), as well as of low-quality habitats where the population could persist because a lower risk of human-induced mortality (refuge).

Up to now, models of habitat suitability for bear population in Europe have exclusively focused on small isolated and endangered populations, as the previous ones. Although the Carpathian bear population in not under such a critical situation at present, the identification of bear habitat requirements and the building of a habitat model is a priority and a basic starting point for further investigations. As shown for Yellowstone grizzly population, very small amounts of habitat degradation can lead to dramatic changes in population growth rate (Doak 1995). For example, the additional conversion of 15% of an area from good habitat to bad can shift a population from stability to a 4% annual decline. Thus, even what is seen as very mild degradation (e.g. the building of roads or selective forestry) must be viewed with caution. On the other hand, there is a time lag between the crucial point in degradation from which population decline will begin and when degradation effects might first be detected (Doak 1995). Additionally, the detection of population declines from simple monitoring or census data is very unlikely (Taylor & Gerrodette 1993), and by the time declines are detected, it will probably be too late to prevent critical amounts of habitat degradation (Doak 1995). So, a priori analyses of the probable consequences of development before habitat degradation reach a critical point are strongly necessary.

Bears are negatively affected by the density of roads, as shown by studies carried out in Europe (Clevenger et al. 1997) and North America (Mace et al. 1999, Wielgus et al. 2002). Generally, high-quality bear habitats are considered roadless areas with a mosaic of forests and natural openings, in proximity to a secure forest stands providing day beds and hiding cover (Blanchard 1980, Hamer & Herrero 1987, Apps et al. 2004). Forestry activities (e.g. clearcuts, coniferous plantations) can have both negative and positive effects on the quality of bear habitat (Wielgus & Vernier 2003, Nielsen et al. 2004b, c). Logging in itself may be not necessarily destructive to bear habitat (Swensson et al. 2000). Unplanned tourism can have adverse effects on bears. Human recreational activities may actually displace bears from good habitats; change their patterns of habitat use by reducing the time available for a bear to use an area; change their activity patterns to more nocturnal; and increase the risk of conflict with humans (Mattson 1990, Kaczensky 2000, Swensson et al. 2000). Those human disturbances can lead to nutritional stress, especially in lactating females. Recreational activities close to crucial food resources make represent “black holes” for bears. On the other hand, the increase of human food, garbage, dumps and other attractants represent a serious problem because they lead again to human-bear conflicts. Besides being dangerous for people, these conflicts may end up with the bear being shot or becoming “habituated” to people. Unfortunately, such situations become more and more common in the Polish Carpathians (Jakubiec 2001, Jakubiec unpubl.).

Abundance of food is a prime factor determining habitat selection by animals (e.g. Newton 1998), and influencing spatial organization and population density in bears (McLoughlin et al. 2000). Recent studies has shown that the selection of habitats by bears correspond well with the spatial and temporal availability of food on both a landscape and local scale (McLoughlin et al. 2002, Lyons et al. 2003). Temporally preferred habitats are those which provide bigger amounts and more types of bear foods in a certain period. Lack of these habitats, and consequently of bear food, may be related to increased bear damage to livestock and beehives. According to studies in other areas (Servheen 1983, Mattson et al. 1991, Clevenger et al. 1992, Green et al. 1997, Mattson 1997, Persson et al. 2001, Nielsen et al. 2004c) and preliminary data from the Polish Carpathians (Frąckowiak 1997, Jakubiec 2001), we hypothesized that 3 food resources may be highly important for bears in the Bieszczady mountains: ungulates (both as prey and carrion), forest fruits and beechnut. Ungulate carcasses appeared to be essential food after emerging from the den (Green et al. 1997, Mattson 1997, Persson et al. 2001). Berries and hard mast seems to be extremely important before hibernation (Clevenger et al. 1992, Jakubiec 2001, Persson et al. 2001). These key food resources become available in crucial moments in the life of the bears, thus they can significantly affect the seasonal habitat use.

Not only foraging habitats (containing food), but also security places may play an important role in habitat selection. Bears often use daily bed sites under close canopies where they take refuge (Herrero 1985). In areas with high human disturbance the presence of protective shrub or forest cover will be an indispensable part of bears home area. During the reproductive season, females with cubs restrict their home ranges in order to avoid infanticidal males (Swensson et al. 1997, Dahle and Swensson 2003a). Thus, it may be expected that certain landscape structures and terrain of difficult access may be selected by these females. Suitable winter dens are also an important component of bear habitat. Winter dens shelter bears from unfavorable weather conditions, help to save vital energy and provides protection (Folk et al. 1976, Schoen et al. 1987). Specially during the denning period, brown bears are very sensitive to human disturbance (Swenson et al. 1997, Linnell et al. 2000). Such disturbances may be critical for pregnant females and females with cubs. Human influence was shown to be the main factor determining bear choice of dens in Slovenia (Petram et al. 2004). In the Polish Carpathians, bear winter dens seem to be located on the ground surface rather than underground or caves (Jakubiec 2001). Surprise encounters of humans with denning bears not only disturb the bears but may also result in a serious human injury.

The selection of habitats by animals is a multi-level, hierarchical process, and different factors may determine the second-order (home range selection) and third-order (within home ranges) habitat selection (Johnson 1980, Rondinini and Boitani 2002, McLoughlin et al. 2002). We expect different habitat attributes affecting survival, reproduction and wintering of brown bear at both a local (Bieszczady) and a landscape (Polish Carpathians) scale. We want to study to what extent the availability of food resources, human activities and landscape structure determine habitat selection. We hypothesized that the importance of these factors varies temporally and spatially. Outside the mating season (May-July), bears may track within their home ranges the pulses of key food resources. Therefore, seasonal home ranges will vary in response to food availability. In the reproductive season, habitat use may be affected by other factors, such as reproductive status of the individuals and recreational activities, which partly overlap with bear mating season. We expect those factors related to topography and human activities to be the most important during the denning season.

Bieszczady mountains are representative of a typical bear habitat in temperate latitudes. Their productive beech forests contribute to higher bear densities than in the northern coniferous forests (Swensson et al. 2000, Dahle and Swensson 2003b).The area is low-human populated (15 people/km²) and the ecosystem well preserved. Therefore, this will be the first study in Europe on a high-density bear population in a productive and relatively undisturbed habitat. These natural conditions will allow us to obtain unique data on bear spatial and trophic requirements. It will also provide the first accurate data for the Carpathian bear population, little studied, which could be extrapolated to the neighbouring countries and give some insight for bear conservation there. Presumably arising conflicts in future, as well as increasing threats for the bear population in Poland, remark the need of this type of studies.

3. Methodology

Three main methods will be used simultaneously in the proposed project: (1) satellite radio-telemetry, (2) spatial analysis with Geographical Information Systems, and (3) analysis of bear diet and food availability.

Tracking of radio-equipped bears will be conducted in the Bieszczady mountains, specifically within an area that will ensure the tracked animals stay inside the country (Forestry Districts of Lutowiska, Wetlina and Cisna). This is an area of high diversity of biotopes, including the San river valley, large mixed and beech forests in the mountain ranges of Otryt, Połonin, Moczarnego and Łopiennika, as well as in the highest parts of the mountains, where bear winter dens are usually located.

3.1. Satellite telemetry

Earlier research on brown bear in the study area has evidenced the difficulties of gathering accurate data using traditional VHF telemetry due to the large home ranges of bears (up to 260 km^2 for males and up to 190 km^2 for females) and the working difficulties of the study area (e.g. few roads, deep snow cover). Building a habitat suitability model requires high quality data, i.e. very exact bear positions, frequent locations (up to 25,000 fixes collected by one transmitter), and a regular time interval between locations. In the study area, these data can be only collected by satellite telemetry. Traditional telemetry in such difficult conditions involves also an enormous costs in terms of personnel, time and logistics (field equipment, car use, fuel), and cannot provide the high-quality data needed. Previous experience shows that in Bieszczady mountains a maximum of 35 locations per animal and year could be gathered, whereas in Tatra a habituated bear was located 160 times within a year. In Croatia and Sweden, GPS telemetry via GSM network allowed a permanent monitoring of the animals and the number of locations obtained per year were several hundreds (Huber 2004, Swenson 2005).

Satellite transmitters are fitted with a GPS that will take exact position of the animal following a programmed schedule. The data will be stored in the memory and will be remotely send via GSM. The collars will be fitted with a hibernation sensor, so the GPS engine stops taking fixes during bear hibernation, and with a drop-off mechanism. This drop-off mechanisms allows the remote release of the collar from the animal once the battery is going to be finished, without having to trap the animal once again, which is not always possible. GPS collars have another advantage, and it is that they can be used several times; just the battery itself can be changed in the collars recovered in the field. Collars will be additionally equipped with a VHF beacon to facilitate their retrieval and to permit direct field locations of the animal in necessary cases.

Bears will be captured in specially designed box traps and immobilized with the help of tranquiliser darts. Box traps will be fitted with alarm systems to minimize the time until the bear is released. Bears will be captured mainly in the end of winter. The minimum sample required for proper statistical analysis and a balanced experimental design is 8 adult bears, including 4 males and 4 females. Bears will be immobilized with Domator (0.8 ml per 10 kg body mass) and will receive Antisedan (0,4 ml per 10 kg body mass) as a reversal agent. Animals will be fitted with GPS-GSM collars (Vectronic Aerospace). Ear tags with numbers will allow the identification of the animals. The age, measurements and weight of the animals will be also taken.

Radio-collared animals will be located every 2 hours. Based on these data we will estimate annual and seasonal home ranges of males and females (Minimum Convex Poligon and kernel estimation), and provide accurate data on population density and structure in the study area. These data can be compared with the data traditionally gathered by hunters and foresters. Precise locations of the wintering dens, and eventually day beds, will allow their characterization. Telemetry locations will be mapped in GIS for the analysis of habitat use by bears at a local scale.

3.2. GIS analysis and spatial use

We will adopt a two-scale design to investigate habitat selection in bears, based on the comparison of used and unused habitats (Johnson 1980, Manly et al. 2002). First, the landscape scale, which corresponds to the Polish Carpathian mountains, includes the range of bear distribution and adjacent areas. This landscape analysis will allow us to determine the second-order habitat selection or home range selection (Johnson 1980, McLoughlin et al. 2002, Rondinini and Boitani 2002), i.e., determine the factors affecting bear distribution in Poland. The habitat model will be built based on a data set on bear presence and reproduction and the habitat variables derived from GIS, following similar procedures to Naves et al. (2003) and Posillico et al (2004). The bear data set includes about 4,000 bear records collected since 1945 by researchers (Jakubiec 2001, Jakubiec unpubl.), based on observations made by foresters, rangers and local people. The set includes not only direct observations, but also other bear signs such as wintering dens, day beds, tracks, scats and marked trees. Additional records of bear observations during the study period will be obtained through questionnaires distributed among foresters and hunters. We will apply different statistical modelling procedures to derive the probabilistic resource functions (Manly et al. 2002). This resource selection function classifies the study area according to the habitat quality and/or probabilities of bear use, and will be mapped using a GIS.

Secondly, the third-order habitat selection or habitat selection within home ranges will be investigated in the Bieszczady mountains using GPS locations of the bears equipped with satellite transmitters. We will compare the habitat characteristics of a buffer area centered at bear locations (as determined by satellite telemetry) with those of random locations within each home range (Manly et al. 2002). From the statistical analysis of these data we will also obtain the resource selection function within home ranges. The same procedure will be followed to analyze the seasonal patterns of habitat selection within home ranges. Similarly, the selection of wintering dens will include additional habitat data collected directly in the field and it will be analyzed in comparison with those of random locations within home ranges (Manly et al. 2002). The sample will also include dens found during previous studies (Jakubiec 2001, Jakubiec unpubl.).

Habitat analyses have mostly involved traditional multivariate methods such as multiple linear regression, Principal Component Analysis, discriminant function analysis and Mahalanobis distance. However, generalized linear models (GLM) have gained in popularity, because they allow for some nonlinear responses. In addition, they are amenable to novel habitat modelling techniques based on the confrontation of several plausible hypotheses designed a priori, such as Information-Theory approaches (e.g. Johnson and Omland 2004). The difficulty here is to define real absence data to contrast the presence data with. Environmental niche factor analysis (ENFA) is an alternative method that has the advantage of using only presence data, but it is sometimes difficult to interpret the results in a biological way and less useful for hypothesis testing. Thus, we will apply different statistical modelling procedures.

The habitat variables included in the GIS analysis will describe characteristics of the terrain or topography, landscape structure, human footprint and forest/vegetation types. Habitat data will be derived from Landsat satellite images (NASA), forest cover in Europe (European Forest Institute EFI), CORINE Landcover (forest types), SRTM digital elevation model and available digital and cartographic maps of roads, urban settlements and watersheds. Habitat data at a smaller scale will be also obtained from detailed digital maps of the forest and vegetation types from the Forest Inventory and Management Plan.

3.3. Diet and food supply

Within home ranges, habitat selection patterns may vary primarily in response to food availability, although non-food related factors (e.g. risk of predation) may be also important (McLoughlin and Ferguson 2000). To investigate changes in bear diet and whether bear habitat use reflects their temporal food requirements, bear scats will be systematically collected on a monthly basis. GPS-telemetry locations will allow us to collect scats of marked individuals and will facilitate to get a good sample from all periods. Diet analysis will be conducted following standard methods (Putman 1984, Reynolds & Aebischer 1991, Dahle et al. 1998) and using identification keys (e.g. Pucek 1981, Teerink 1991) and reference material.

The availability of main bear food in critical periods (ungulate carcasses, forest fruits and beechnut) will be surveyed in the main habitat types, classified according to basic vegetation types (Zarzycki 1963) and altitude: (1) the foreland level (up to 500 m a.s.l.), including mixed forest and mainly patches of dry grasses (class *Festuco-Brometea*); (2) the lower subalpine forest (between 500 and 1,150 m a.s.l.) dominated by the Carpathian beechwood *Fagetum carpaticum* where beech *Fagus sylvatica* is the main tree stand with admixtures of fir *Abies alba*, sycamore *Acer pseudoplatanus* and spruce *Picea excelsa*, and (3) the alpine meadows (above 1,150 m a.s.l.), characterized by large mountain pastures and dominated by grass communities. Their annual abundance will be estimated in a total of 18 plots of 0.5 km² each (1 x 0.5 km). The plots will be spatially separated and randomly distributed. Six plots will be located in each main habitat type; three of them on the southern slope and three on the northern slope.

Ungulate carcasses will be censused every year at the end of the winter, following methods described by Selva (2004). Seed traps (type Klawitter & Stubb's modified) placed in the plots in the beechwood habitat will be used to estimate the annual production of beechnuts (Sutherland 1996). Ten seed traps will be randomly placed and separated at least 200 m in each of the six beechwood plots. The frequency of bilberries *Vaccinium myrtillus* in each habitat type will be estimated in line transects of 50 m length (Sutherland 1996). Five line transects will be randomly located in each plot. To estimate the annual production of bilberries, the fruits will be counted every year in frame quadrats of 0.5 m² established at 10 m intervals adjacent to the line transect. A subsample of fruits will be weighed to estimate the fresh weight productivity per unit area (Nielsen et al. 2004c).

The research team has a strong background in large predator ecology and conservation biology. Z. Jakubiec, H. Okarma and W. Śmietana have conducted research projects on wolves *Canis lupus*, European lynx *Lynx lynx* and brown bear in the Carpathian mountains. N. Selva have been involved in research projects on wolves and scavenging birds and mammals in Białowieża Forest. They have gained big experience with animal capturing and telemetry, as well as with home range, habitat and diet analysis. The cooperation with the Dept. Ecological Modelling- UFZ Centre for Environmental Research (Leipizg, Germany) is a guarantee for the successful development of the project. It represents one of the top European research institutions in modelling techniques and possesses a high scientific level. N. Selva gained experience there during a 6-months Marie Curie training fellowship. S. Kramer-Schadt and N. Fernández have a strong background on GIS analysis and habitat and statistical modelling. They have developed different habitat models for European and Iberian lynx *Lynx pardinus*, clearly orientated towards conservation and sensible management strategies. The propose project combine our different fields of expertise.

4. Outputs and dissemination of results

The proposed project will enable the characterization of bear habitat (in a wide sense), which is essential to assess the risks associated with landscape alterations, to design conservation strategies for the species and to avoid future and present conflicts. This is a very applied conservation project that will fulfil many of the actions required to be taken in Poland by the European Action Plan for brown bear conservation (Actions 4.3.1., 4.3.2. and 4.3.3., Swensson et al. 2000). Its results can be extrapolated to other areas in the Carpathians and basic ecological data on bears which is currently lacking will be obtained. The results will substantially contribute to the preparation of a brown bear conservation plan for Poland, and also for the Carpathian bear population.

The results will be potentially publishable in international recognized journals (e.g. Conservation Biology, Journal of Animal Ecology, Ecography), and spread also in popular articles. They will be also presented in scientific conferences on ecology and conservation of large predators. Special attention will be put into the dissemination of the main results among the general public in cooperation with the media, and among related professionals (foresters, hunters) via informative talks and presentations.

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PROJECT SCHEDULE

No.	Task description	Expected completion date	Expected cost
1	Capture of bears and monitoring of GPS-collared individuals	february 2007- november 2009	150 500 zł
2	GIS spatial analysis	june 2007- december 2010	61 000 zł
3	Collection of bear scats, diet analysis and estimation of bear food availability	february 2007- november 2009	70 480 zł
4	Building of the models of habitat suitability for brown bear at a landscape and local scales	february 2007- january 2010	21 000 zł
5	Preparation of the protection and management plan for brown bear in Poland, based on the habitat models	may 2009- januray 2010	5 500 zł
		TOTAL	**308 480 zł**

PROPOSED BUDGET

No.	Item	Funds for each budget year (zł)				
		2007	**2008**	**2009**	**2010**	**TOTAL**
1	Direct costs, including:	209 930	37 000	26 000	7 800	280 730
	1/ Salaries and benefits	4 200	6 000	6 000	-	16 200
	2/ Equipment	169 730	-	-	-	169 730
	3/ Other direct costs	36 000	31 000	20 000	7 800	94 800
2	Indirect costs	10 050	9 250	6 500	1 950	27 750
3	Total costs (1+2)	**219 980**	**46 250**	**32 500**	**9 750**	**308 480**

DETAILS OF DIRECT COST ITEMS

1) Salaries and benefits

Technical worker (half-part time) 27 person-months x 600 zł = **16 200 zł**

2) Tracking equipment

2.1. Satellite transmitters

GPS-GSM Plus Collar (Vectronic Aerospace) – 8 units

Total costs = 8 x 18 560 zł = **148 480 zł**

Weight: 800-950 gr.; operating temperature: -40ºC to 80ºC; options selected: temperature logging, activity logging, hibernator sensor; VHF beacon transmitter; drop-off mechanism (time-controller).

In the study area, the only method to obtain the high-quality data required to build a habitat model is satellite telemetry. Thus, it is an indispensable method for the present project. Traditional telemetry has not yielded satisfactory results for the species in difficult areas and all current studies on bear ecology tend to use it. The GPS location data will be directly transmitted to our computer via mobile phone system. **We will try to find sponsors to cover the cost of other additional 4 satellite transmitters from other sources in order to have a sample of 12 bears.** The Institute of Nature Conservation has VHF tracking receivers in necessary case. The drop-off mechanism minimises the possible disturbance to animals and allows recovering the collars. The GPS-GSM collars can be used again in other projects after changing the batteries.

2.2. GSM Groundstation

Vectronic Aerospace
Total cost = **4 800 zł**
The groundstation receives GPS position information from the GPS GSM Plus collar via the GSM service. Additional new GPS and beacon schedules can be transmitted via GSM to the collar, which gives flexibility and security for the data. The groundstation is further connected to a PC for receiving the data.

2.3. Data transmission

2 846 SMS per collar x 0.30 zł = 850 zł per bear
Total cost = 850 x 8 bears = **6 800 zł**
The GPS-collar will be programmed to take the bear position every 2 hours. On an average scenario and in our study area, a GPS-GSM collar can work 830 days, which means a total of 9 960 fixes taken per collar (830 days x 12 daily fixes). These data will be transmitted via SMS to the groundstation, and up to 7 positions can be sent in one SMS. However, due to the bad GSM-SMS cover of the study area, it is recommend to transmit the data twice as the most secure option. This sums up 2 846 SMS transmitted per collar.

3) Computer equipment

GEO-PC Prostation P-220; Monitor LCD 19" Iiyama ProLite E480S-W and printer HP DeskJet 9300
Computer PC = 3 800 zł

Monitor = 1 750 zł

Printer = 1700 zł

Total cost = **7 250 zł**

For the GIS spatial analysis we need a computer with certain technical parameters to work and process the big amount of data from digital maps. It is also necessary a high-quality monitor of bigger dimensions to classify the satellite images and work on the maps. The selected printer can reproduce quite good quality maps in colour. The Institute of Nature Conservation can provide the GIS programme ArcView, but lacks the computer equipment required.

4) Construction of box traps for bears

Total cost = 2 traps x 1 600 zł = 3 200 zł

We will use a third bear trap and trap alarm systems from the Institute of Nature Conservation.

5) Construction of seed traps

Total cost = 60 units x 100 zł = **6 000 zł**

We will use modified Klawitter & Stubb's seed traps, specially designed for collecting heavy seed as beechnuts, and to minimize losses from seed-eating animals. They are durable, so they can be used in future studies.

Once the project is finished, all the equipment which is owned by the Institute of Nature Conservation can be used in other research projects related to animal ecology and conservation.

6) Other direct costs

6.1. Travel expenses – 60 000 zł

It is planned a monthly visit per year to the Dept. Ecological Modelling- Centre for Environmental Research in Leipzig (Germany) for joint work with the other project executors. Trapping bears, collection of bear scats and estimation of food availability will require frequent visits of the researchers to the study area, on average a week-stay 8 times per year for 2-3 researchers.

6.2. Tranquilizers and dart equipment – 8 000 zł

We will use the tranquiliser Domitor and the antidotum Antisedan as a reversal agent. They will be applied with the help of a darting blow-pipe and special gun. The cost includes syringes and pharmaceutical products and sums up to 1000 zl per bear. Institute of Nature Conservation has the necessary equipment to tranquillize the animals.

6.3. Field and laboratory supplies – 3 500 zł

Torches, batteries, bags for scat collection, boxes for sample storage, gloves, detergent, microscope material for diet analysis.

6.4. Office materials – 3 000 zł

CDs, floppy discs, printer toner, paper, notebooks, envelopes.

6.5. Participation in conferences – 6 000 zł

We plan to present the first results of the project in the 5th European Congress of Mammalogy to be held in 2007 in Italy.

6.6. Publication fees – 4 500 zł

Some of the journals where we plan to publish require the payment of a publication fee.

6.7. Purchase of literature – 2 000 zł

Recent books and monographs on spatial and statistical analysis and on modelling techniques are needed.