GEOGRAPHIC INFORMATION SYSTEM APLIED TO THE RESEARCH OF SPECIES IN DANGER OF EXTINCTION. THE BROWN BEAR CASE

Javier Naves Cienfuegos
Pilar García Manteca
Pilar Alvarez -Uria Tejero
Arturo Ruano Alvarez

INDUROT-Universidad de Oviedo
E-33004 Oviedo (Asturias)

Abstract

The brown bear (*Ursus arctos*) is one of the Spanish mammals in danger of extinction. Due to its high mobility and behaviour it is extremely difficult to keep sign of each individual of the population. For this reason, a set of seasonal maps of the available trophic resources has been developed to allocate bear activity. These maps are the product of data base developed with a Geographical Information System. Our study area (176 km^2) is located in the Somiedo Natural Park (Asturias, NW Spain). The map set has allowed to restriet the sampling bear activity to the selected environmental units. These selected areas constitute 54.58% of the total of the area of study during Spring, 12.17% during Summer and 28.23% during Autumn. These maps have allowed a selective sampling (trails) of key areas with a remarkable increase in the number of bear signs: an average of one point with sings of bear activity every 2.73 km covered. This result has been supposed to increase by six the effectiveness of proposed sampling approach over conventional methods.

1 Introduction

The brown bear (*Ursus arctos*) population has decreased dramatically worldwide, particularly in Europe and the USA [1]. In the case of the Iberian Peninsula, the brown bear population has been reduced to two relict nucleus, both of which are located in the Cantabrian Range [2]. The brown bear is now one of the four mammals in danger of extinction in Spain, according to the list of the National Catalogue of Threatened Species (1990). Therefore, it is a critical to have a clear understanding of the present state and evolution of the brown bear population.

The present study forms part of a wide project entitled "Influence of Human Activities on the Brown Bear", which is being currently carried out over an area of 176 km^2 in the Natural Park of Somiedo (Asturias, NW of Spain). The information in this project is managed by means of a Geographic Information System (GIS). In the GIS an environmental data base which is part of different types of subject maps (vegetation, bedrock geology, quaternary superficial formations, human infrastructures, etc.) is included. This cartography has been performed, at a working scale of 1:25.000 based on field data taken by specialists since 1989 [3,4].

Even under the best conditions, the brown bear, exhibit very low densities. Brown bear are highly mobile, often secretive behaviour, and occupy extremely large home ranges. An alternative method of keeping signs of the population is been developed in order to increase the success of the field sampling.

2 Methodology

A set of maps has been developed and they reflect the seasonal (Spring, Summer and Autumn) presence and location of plants that are an important part of the bear's food chain. These maps have allowed assement of the areas with the highest potential of having sings of bear activity.

2.1 Brown bear seasonal diet

The brown bear diet in the Cantabrian Mountains is well know [5]. An important part of this diet consist of herbaceous plants (78% of the total diet) in Spring, berries during Summer (52%) and nuts during Autumn (63%). In order to ellaborate the maps of the bear trophic resources 25 vegetable taxa of the mentioned food types have been chosen.

2.2 Cartography of trophic resources

The different trophic resources have been located using three layers of the environmental data base (vegetation, bedrock geology and quaternary superficial formations) included in the GIS and additional information related with this cartography.

Seven hundred thirty inventories of plants (phytosociological inventories) have been used to allocate the vegetarian trophic resources. These inventories have been obtained in the area of study or in surrounding[1]. They consist of a complete list of the plants present in each sampling location and its coverage value (% of surface area) [6]. Out of this list of plants, this study has been focused in the relative abundance of 25 taxa wich constitute most of the bear's diet. Finally, these inventoires have been associated to different cartographic units of vegetation layer [7]. Table 1 is an example and shows the results of the use of the inventories for the trophic resources consumed by the bear in Autumn.

From the total of 51 units which are cartographied in the study area, there was no related registered information available about 14. Nevertheless, the area occupied by said units only represents about 3.60% (6.31 km^2) of the total area. In some cases, some of these vegetations units without inventorial information have been included in the results.

The plant inventories and the vegetation map provide enough information to locate most of the bear seasonal trophic resources, but in some cases, the combination of different layers of information of the GIS has allowed greater accuracy in the location of some of important resources.

The blueberries, *Vaccinium,* and the *Luzula sylvatica* (eaten by the bear in Summer and Spring respectively), are plants related to oligotrophic substrates. Therefore, it is necessary to separate in some vegetation units (specifically in the beech forests) the siliceous areas from the calcareous ones.

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[1] Inventories references: Amigo, J., Guitian, J. and Fernández, J. A., 1987. Datos sobre los bosques ribereños de Aliso (*Alnus glutinosa)* cantabro-atlánticos ibéricos. Ser. Informes, Vol. 22, pp. 159-176. Secretariado de publicaciones. Univ.de la Laguna; Bueno, A. and Fernández, J. A., 1989. Unpublished inventories; Díaz, T. E., 1974. La vegetación del litoral occidental asturiano. Rev. Fac. Cienc. Vol.15-16(2), pp. 381-545, Oviedo; Díaz, T. E. and Fernández, J. A., 1994. La vegetación de Asturias. Itinera geobotanica, Vol.8, pp. 243-528. León; Fernández, J. A., 1981. Estudio de la flora y vegetación del concejo de Somiedo. Doctoral Thesis. Univ. de Oviedo; Marquínez, J. (ed.), 1986. Estudio ambiental del concejo de Somiedo. Univ. de Oviedo. Unpublished report; Martínez, G. and Mayor, M., 1974. Estudio fitosociológico y fitotopográfico de las vertientes septentrional y meridional del Puerto Ventana. Rev. Fac. Cienc., Vol. 15(1), pp.55-109. Oviedo; Puente, E., 1988. Flora y vegetación de la cuenca alta del río Sil (León). Diputación provincial de León; Rivas-Martínez, S., Díaz, T. E., Fernández, J. A., Loidi, J. and Penas, A., 1984. La vegetación de la alta montaña cantábrica. Los Picos de Europa. Ediciones leonesas, S. A. León; Romero, C. M. 1983. Flora y vegetación de la cuenca alta del río Luna. Icona ed. Monografías 29.

VEGETATION UNIT	n(1)	*Fagus sylvatica*	*Quercus*	*Castanea sativa*
FORESTS				
Beech forest	50	75.00	1.85	0.10
Quercus pyrenaica oligotrophic forest	29		59.20	0.17
Q. petraea oligotrophic forest	28		32.00	2.41
SHRUBS				
Evergreen oak shrubs	13		36.33	
SCRUBS				
Cytisus scoparius scrubs	18		14.40	

(1) Number of inventories used.

Table 1: Autumn trophic resources: mean coverage values (% of surface area) of the plants (food) of each vegetation cartographic units with inventorial information associated.

The fruit of the shrubs *Rhamnus alpina*, is part of the Summer diet. Althoug this shrubs can be abundant in certain areas, these areas usually is not registered through the vegetation map and the inventoires. The coverage of this shrubs in some vegetation units is greater than the estimated one, from the inventories, when the substrate is made up of calcareous rocks scree and blocks. Besides, in many occasions it is observed in small areas which are not cartographied as individual vegetation units at a scale of 1:25.000, but other layers of the data base (quaternary superficial formations) include information which may detect these details. Therefore, the *Rhamnus alpina* is seen in a map by means of the combination of some units of the vegetation map (shrubs and scrubs) with some units of the map of quaternary superficial formations (calcareous superficial formations without matrix or with very little matrix).

The cartographic data base has been handled by union and intersection operations in the GIS. These operations have allowed the creation of derived seasonal maps with selected environmental units (EUs). The GIS has also permitted the creation of associated numerical information (number of polygons, areas, etc.).

2.3 Bear activity sampling: trails.

The derived maps have been used to design seasonal sampling of bear activity. The samply proccess consist of the random selection of 100 geographic points within the selected EUs. These points have been joint through field trails. The trail lenght has been measure with the tools of the GIS.

3 Results

Three compilated seasonal maps of EUs have been produced. These mapas reflect the available trophic resources during spring, summer an autumn. The selected EUs constitute 54.58% of the total of the area of study during Spring, 12.17% during Summer and 28.23% during Autumn (Table 2). The Figure 1 saw, as a example, the selected EUs with available trophic resources during autumn.

These maps have been used to direct the sampling of bear activity (trails) to key zones, according to season, of the total area of study. 128 trails have been done with a total of 565.25 km covered. This sampling has resulted in the location of geographical points with sings of bear activity (scats, hair, beds, traces, etc.) every 2.73 km covered (mean for all season). The total points with sings of bear activity are 207 (Table 2).

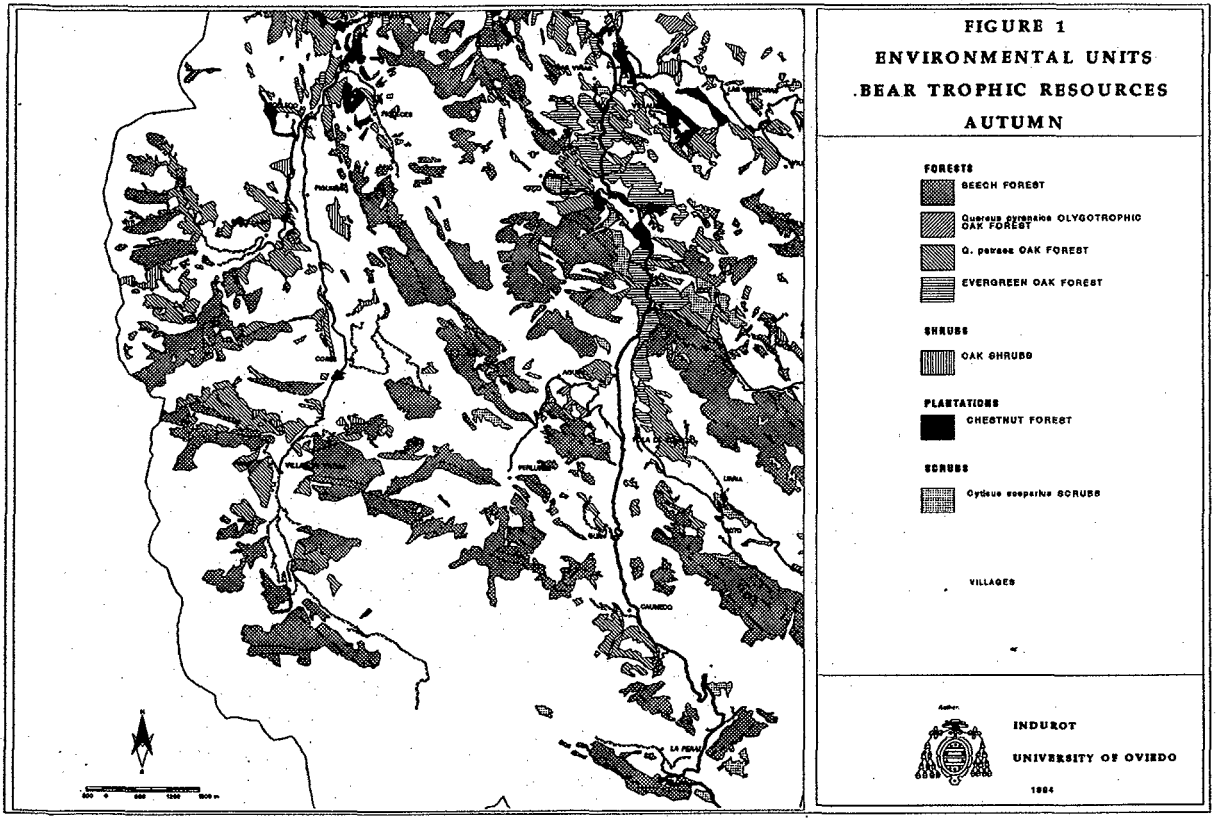
FIGURE 1
ENVIRONMENTAL UNITS
.BEAR TROPHIC RESOURCES
AUTUMN
FORESTS
BEECH FOREST
Quercus pyrenaica OLYGOTROPHIC OAK FOREST
Q. pyrenaica OAK FOREST
EVERGREEN OAK FOREST
SHRUBS
OAK SHRUBS
PLANTATIONS
CHESTNUT FOREST
SCRUBS
Cytisus scoparius SCRUBS
VILLAGES
INDUROT
UNIVERSITY OF OVIEDO
1984

Previous sampling carried out (May, 1990) in the Natural Park of Somiedo, produced an average of 1 point with bear sign every 11 km for a total of 153 km covered [8]. This demostrates effectiveness of proposed sampling approach over conventional methods.

Season	EUs area (%)	trails (n)	distance (km)	signs (n)	km. per one signs
Spring	54.58	35	172.07	107	1.61
Summer	12.17	49	183.34	45	4.07
Autumn	28.23	44	209.84	55	3.80

Table 2: Results of the 1994 bear activity sampling campaign

References

[1] Servheen, C. 1990. The status and Conservation of the bears of the World. 8th Int. Conf. Bear Res. and Manage., Monongr. Series nº 2, 32 pp.

[2] Naves, J. and G. Palomero, 1993. El oso pardo (*Ursus arctos*) en España. ICONA, Colección Técnica, Madrid. 384 pp.

[3] Marquinez, J.; P. García-Manteca and A.M. Felicisimo. 1991. Metodología para una cartografía básica ambiental en zonas no urbanas. Second International Congress on Regional Planing, Valencia, pp. 1941-1946.

[4] García Manteca, P. and A. Menendez Duarte. 1995. Geographical Information System for Natural Resources in Asturias. 17th Int. Cartogr. Conf. Barcelona.

[5] Braña, F. ; Naves, J. and G. Palomero. 1988. Hábitos alimenticios y configuración de la dieta del oso pardo (*Ursus arctos* L.) en la Cordillera Cantábrica. Acta Biol. Mont., Ser. Doc. Trav., Vol 2, pp. 27-38.

[6] Braun-Blanquet, J., 1979. Fitosociología. Bases para el estudio de las comunidades vegetales. Blume ed.. Barcelona.

[7] Fernández Prieto, J. A., 1987. Bases y criterios para una futura cartografía de la vegetación asturiana. Oviedo.

[8] Purroy, F.J. (1991). Distribución y número. In A.P. Clevenger y F.J. Purroy (Eds). Ecología del oso pardo en España. Monografías Museo Nacional de Ciencias Naturales. Madrid. pp: 9-16.

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