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SUITABILITY STUDY FOR THE ALPINE MARMOT *(MARMOTA MARMOTA MARMOTA)* REINTRODUCTION ON THE GRIGNE MASSIF (COMO PROVINCE, LOMBARDIA, ITALY)

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ABSTRACT - The Alpine Marmot (*Marmota marmota marmota*) is widespread all over the eastern side of Como's province (NW Italy), with the exception of the Grigne massif, Mount Resegone and Mount Due Mani. These are three geographically isolated mountain ranges. For this reason the Faunal Service of the Provincial Administration of Como has undertake a project aimed at releasing individuals in the Grigne area. In this early stage a Suitability analysis was performed, using a Geographical Information System (GIS). Field data were collected concerning colonies distribution and spatial structure, inside a sample area where stable populations are present. This area is quite similar to the release area, and covers the whole part of Prealpi Cornasche between Sponda Biandino and the Artavaggio plains. Using GIS data analysis techniques a base thematic cartography was set up, which was based on informational strata such as altitude. slope and aspect. This information helped us to calculate optimum values of environmental ranges to look for within the release area. Finally, GIS siting operations highlighted zones suitable for releasing marmots. The use of a GIS instrument helped in the definition of colonisation-suitable sites on the basis of several parameters, optimising the costs-benefits ratio with the further advantage of being able to beep the topographical database up to date.

Key words: Marmota marmota, Reintroduction, Geographical Information Systems. Suitability analysis.

AIM OF THE PROJECT

This paper deals with the preliminary phase of a wider research project, co-ordinated by the Faunal Service of the Provincial Administration of Como, whose aim is to release individuals of the Alpine Marmot (*Marmota marmota marmota* L.. 1758) in some selected zones of the province's territory. As a preliminary study, environmental variables that significantly characterise Marmot's distribution were evaluated, considering geographical contexts similar to those of the release zone.

The sample area lies on the eastern sides of Valsassina, in the prealpine complex located south of the "linea Orobica". It is predominantly a limestone area and it has an extension of about 2800 ha, its lower boundary being defined by the superior limit of woods. to an height range from 1200 to

2500 m. Results from environmental-variables analysis have to be used as the key parameters to locate maximum suitability areas inside the Grignc massif. This is a geographically isolated mountain ridge that hosts only two colonies, which are the result of uncontrolled introductions carried out during the seventies. The Grigne area is mostly composed of sedimentary rocks. and has vegetational traits similar to those of the sample area, with a total area which covers 2015 ha.

SAMPLE AREA AND DATA COLLECTION

Data were collected from 34 direct surveys of the sample area: carried out by 2 to 4 field workers from June 1992 to September 1994. For each colonised spot (i.e. the minimum area that encloses a set of neighbouring burrows) an apposite form was filled. where the values of the fundamental environmental parameters were noted down and expressed as average or dominant values within the selected zone. Data on the animals observed in the sheltered zone were also recorded. Average measures were derived from a vari-

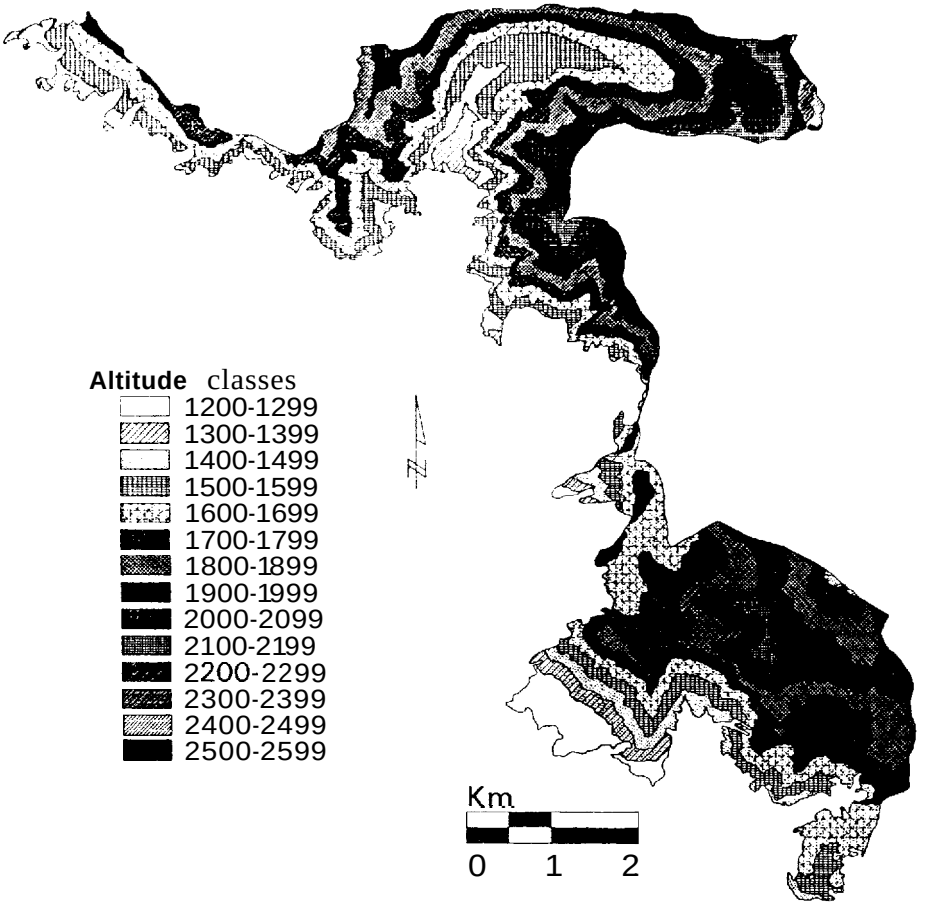

Figure 1: an example of a GIS thematic map. The one in the figure represents altitude. in 100m-wide classes. for the sample area.

Table 1 - Optimal. medium and low suitability ranges derived by frequency distribution analysis on the factors altitude, slope, aspect and solar radiation. These intervals were calculated only for variables for which the Alpine Marmot showed a clear preference. Space use preference test results are reported in the first column.

	Preference significance of resource selection	Maximum suitability		Medium suitability		Low suitability	
		lower	upper	lower	upper	lower	upper
Altitude (m a.s.l.)	p<0.05	1750	1850	1700	1900	1650	1950
.Aspect (degrees)	p<0.0001	118	231	110	250	110	250
Slope (degrees)	p<0.05	7	48	7	60	7	70
Solar radiation (hn/year)	p<0.0001	1500	2550	1200	2550	1100	2550

able number of measures, never less than 5, depending on the extension of each colonised spot. The following variables were measured, **in** accorrlance with Tosi *et al.* (1986):

- average altitude, rating it on a 100m-range;
- dominant aspect, considering only eight discrete classes **(S,** SE, E, NE, N, NW, W, SW);
- average terrain slope. measured using a clinometer. and rated on a four-grade slope scale;
- relative coverage of the colony area, taking into consideration rock. stones, grass. shrubs and trees;
- human disturbance, evaluated on a three-grade scale (low, medium. high) based on both intensity and duration over the year.

The next steps involved data storage. organization and the construction of a map. For this purpose a GIS based on ESRI's Arc/CAD program was used by Como Provincial Administration as a support system in wildlife management activities.

Topographic data inherent to both release and sample areas were digitised and analysed, to obtain thematic maps relative to altitude. aspect and slope (Pig. 1). Secondary information was calculated from this data. using polygon overlaying methods (Fig. 2. This included for example solar irradiation which was estimated as "normal sun hours per year", using the tables by Bartorelli (1967). or using the colony aspect map. For the sample area, map data were integrated with data from field surveys, whereas release area data were only collected from a 1:10000 Technical Regional Map.

Dimensional information (areas, perimeters etc.) was directly derived from GIS topological data structure. The integration of the maps of the colonies with the field information made cross-checking of the data possible, with the restilt that field information could be corrected, e.g. in the case of an approximate slope or aspect estimate (Fig. 3).

Results obtained from spatial analysis techniques completed the necessary information on the *sam*ple area with derived informational strata such as the one regarding solar radiation intensity. expressed in hours of sun per year. obtained from the union of aspect and slope statistics.

GIS-derived information was then used in subsequent statistical analysis, to obtain information on the frequency distribution of altitude, aspect, slope and solar radiation classes.

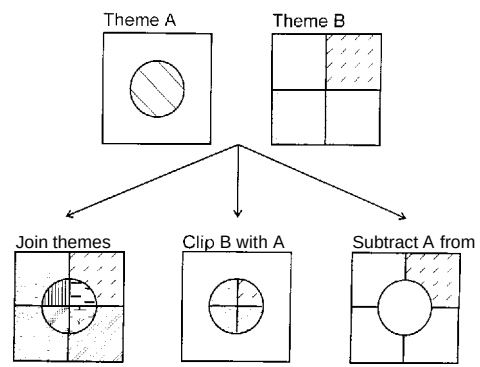

Figure 2: polygon overlay between two themes yielding a derived theme.

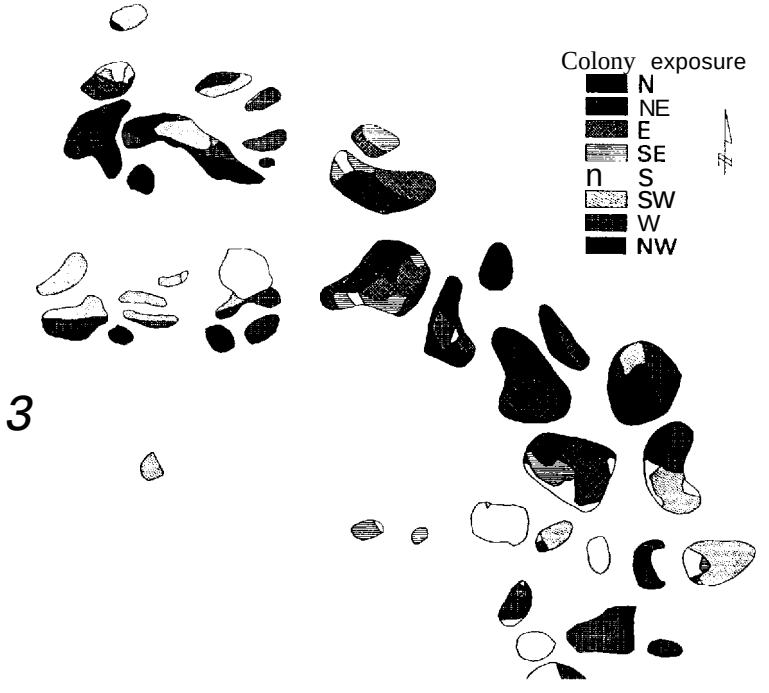

Figure 3: field data correction/integration: each polygon represents a colonised area, inside of which are noticeable several different exposures, due to the clipping of GIS "exposure" theme with "colonies" theme.

RELEASE AREA AND SITING

Relative and absolute frequencies of the principal environmental parameters measured for each colony. to obtain suitability ranges based on 95% confidence intervals of the means (Armitage. 1991), assuming that variables are normally distributed. This estimation was carried out only on the environmental variables for which the species showed a clear preference (Table 1) and was evaluated by the compositional analysis MANOVA technique (Aebischer *et al.*, 1993).

Assuming that data were related to a spatial context, each associated surface value was taken into account, using it as a weight, that is, frequency values for each variable discrete classes were weighted by the surface amount (expressed as a fraction of the total study area surface) belonging to each class. Then, some spatial queries performed with the GIS evidenced the zones in the release area that were characterised by what resulted to be the optimal parameters for the Alpine Marmot (Fig. 4). A maximum suitability area of about 6.35 ha was delineated. Medium and low suitability areas were also individuated by means of GIS siting technique, but starling from a different set of "optimal parameters" as the base for a spatial query. In fact, for the "medium suitability" zone we considered the outstanding values of the above mentioned environmental parameters measured over an area enclosing the colonised surface itself, plus a 100 m strip surrounding each

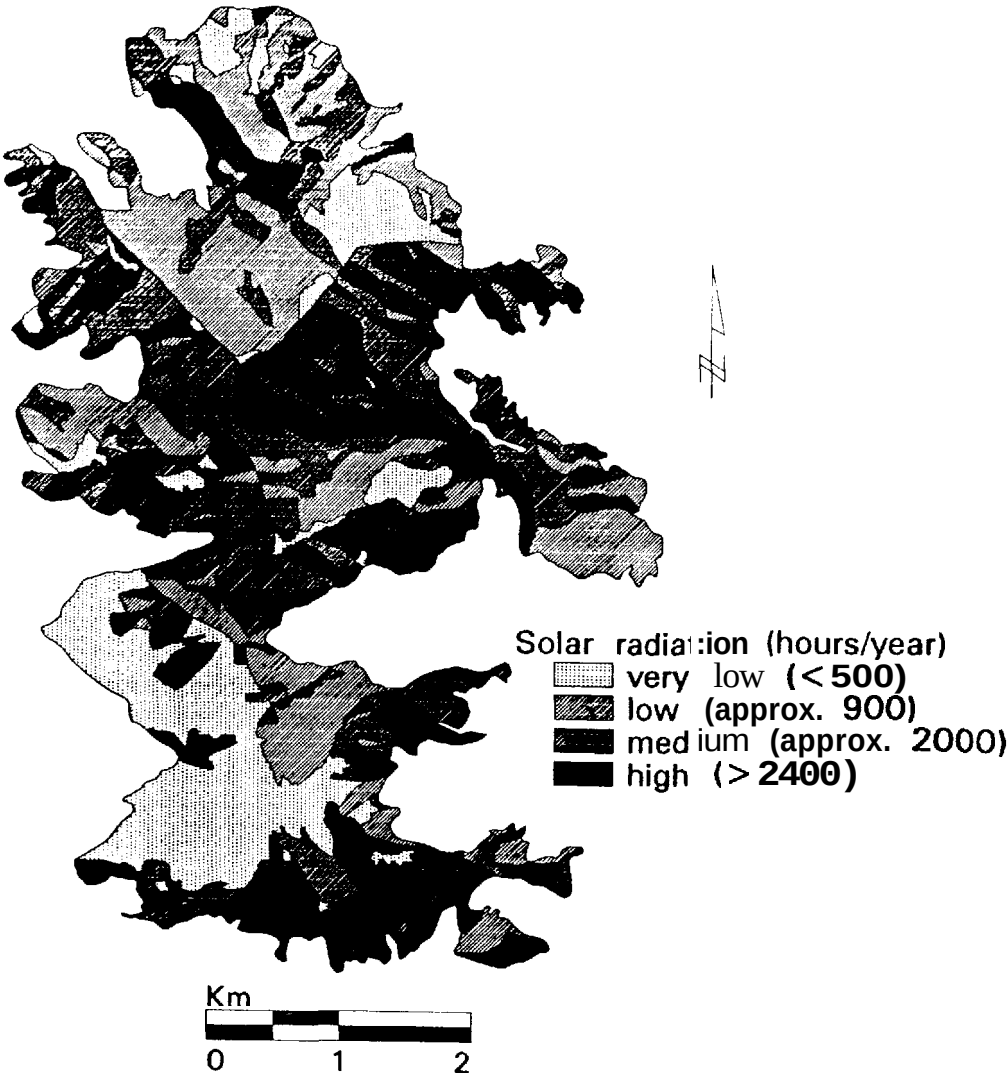

Figure 4: Suitability map derived from the superimposition of three independent siting operations. The three different suitability zones are evidenced.

colony (in GIS terminology, a *buffer*), and for the "low suitability" zone we considered values evaluated for a zone equal to the colonised area plus a 500 m buffer. These operations led to the individuation of two areas of 289.34 ha and 1132.67 ha.

Future plans and release

The next steps of the project will involve creating a more precise suitability model, based on traditional mathematical logistic modelling, in order to obtain a detailed suitability map to correct the one obtained from siting, and to provide a more generai

model for Marmot suitability evaluation. Release operations will take place in late spring. in the high and middle suitability sites identified by the methods described here. Furthermore, a constant monitoring phase is scheduled immediately after release. Other analogous release operations will be carried out, after careful localisation of suitable areas, in the remaining mountain areas near Lecco (Mount Resegone, Mount Due Mani), where the species is not present.

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