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A NUMERICAL APPROACH FOR THE EVALUATION OF BIOTOPES FOR CONSERVATIONAL PURPOSES

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Abstract. The non metric multi-dimensional scaling tecnique (NMDS) was used for ranking 6 natural areas in Italy to establish protection policy priorities. Each area was ranked for each of 8 factors: diversity, rarity, naturalness, size, representativeness, documentation, unicity and scientific value. Spearman's correlation coefficient was used to correlate each factor, with the ordination given by NMDS. Most factors were highly correlated, except unicity and representativeness, weekly correlated, and documentation, which is essentially uncorrelated.

Introduction

Generally the decision to protect areas of outstanding natural value is based mainly on political and managerial priorities and not on strictly scientific ecological criteria (Contoli, 1985). However in recent years, knowledge of the natural features of the less disturbed areas in the world is continually growing.

This knowledge can be used to develop ranking tools for quantitative evaluations on which to base conservation policy.

The planning of an efficient system of parks and natural reserves requires general scientific criteria to set priorities and to establish laws for each area.

Even though aesthetic and scenic values are important, the need for quantitative criteria has been defended in many recent papers (Bogliani and Fasola, 1985; Castelli, 1983; Castelli and Contoli, 1985; De Marchi, 1983; Gelbach, 1985; Kikkava, 1976; Klopatek et al., 1981; Lausi et al., 1978; Malcevschi and Fasola, 1983; Tubes and Blackwood, 1971). The method presented in this paper is a contribution to the methodology for developing conservation plans.

Quantification is a serious problem because available information is highly qualitative. To get consistent data for all the biotopes to be compared falls into the general problem of "measuring the unmeasurable" (Nijkamp et al., 1985). The use of ranks may be one solution.

Six biotopes are compared on eight criteria suggested by Margules and Usher (1981).

Nonmetric multidimensional scaling technique (Kruskal, 1964 a, b; Orlóci, 1978; Wish and Carrol, 1982) is used to order the biotopes as points in a onedimensional space in such a way that the 8 ranking factors are summarized as well as possible.

Data and methods

The 6 biotopes analyzed in the present study are regional parks or reserves active or proposed for Lazio (Central Italy): Castelli Romani (CR), Cimini (CIM), Lucretili (LUC), Tolfa (TOL), Palo (PAL); and a proposed national park in between Calabria and Basilicata (South Italy): Pollino (POL). They were selected for the present study because data were consistent for all of them.

The data for the biotopes are reported by Castelli (1983). The information sources may be classified into two groups:

- "Guide Works" (GW) describing the natural features of the biotopes under the perspective to support their status as Parks or Reserves (AA.VV., 1980; AA.VV., 1981; Contoli, Lombardi and Spada, 1980; C.N.R., 1971; De Angelis and Lanzara, 1983; W.W.F., 1972);
- "Reference Works" (RW) describing and comparing protected areas all over Italy, and published by qualified scientific organizations and/or associations (C.N.R. and M.LL.PP., 1971; Fanfani, Groppali and Pavan, 1977; Giunta Regionale Lazio, 1975; Groppali, Fanfani and Pavan, 1981; S.B.I., 1971; S.B.I., 1979).

The 8 factors used to rank biotopes in this study are among those suggested by Margules and Usher (1981). They are: Diversity, Rarity, Naturalness, Area, Representativeness, Documentation, Ecogeographic position, Unicity and Scientific value. For each factor the biotopes are ranked from 1 to 6:

1. *Diversity* (DIV) - Rank based on total number of species of the taxa consistently investigated in all the considered biotopes. The taxa are: Mammalia, Aves, Reptilia, Amphibia.
2. *Rarity* (RAR) - The biotopes with a largest number of species demanding protection according to international official lists were ranked 6 (max).
3. *Naturalness* (NAT) - Rank obtained by averaging the rank based on the number of "RW" quoting a given biotope for its natural importance (6 = max, 1 = min) with the rank based on the number of introduced (non native) species of the taxa used to determine Diversity

(1 = max, 6 = min).

4. *Area* (ARE) - Rank based on biotopes surface area (1 = small, 6 = large).

5. *Representativeness* (REP) - Rank obtained by averaging the ranks given by: 1) the distance from nearest conservation area (6 = max, 1 = min); 2) the vegetation afinity value, calculated by Renkonen index (Renkonen, 1983) by comparing the percentages of surface occupied by mediterranean vegetation, mixed broad leaved forests, beech forests, coniferous forests and antropogenic vegetation in the biotope, with those in a reference country (the Region for regional parks and reserves, the State for national park) (6 = max, 1 = min); and 3) the geological affinity value computed using the same index by comparing the percentages of surface occupied by the geological formations of Quaternary, Tertiary, Secondary and Primary geological eras and the metamorphic and effusive rocks in the biotope and in reference country (6 = max, 1 = min).

6. *Documentation* (DOC) - Rank obtained by averaging the rank given by the number of publications based on the biotope, with the rank given by the number of citations of these publications in RW (both with 6 = max, 1 = min).

7. *Unicity* (UNI) - Rank based on the number of strictly endemic species (6 = max, 1 = min).

8. *Scientific value* (SVA) - Rank based on the number of scientific quotations of papers in the scientific literature (6 = max, 1 = min).

The ranks for each character in each biotope are presented in Table 1.

Table 1. Ranks given to each biotope for the 8 selected factors.

	DIV	RAR	NAT	ARE	REP	DOC	UNI	SVA	Sranks
CR	4	3	4	4	2	4.5	3	3	27.5
CIM	3	4	4	2	5	1.5	3	4	26.5
LUC	2	2	2	3	1	6	3	1	20.0
PAL	1	1	1	1	4	4.5	3	2	17.5
TOL	6	6	6	6	6	1.5	3	6	40.5
POL	5	5	4	5	3	3	6	5	36.0

Nonmetric multidimensional scaling (NMDS) as programmed by Brambilla and Salzano (1981) was applied to order the biotopes described in Table 1. One dimensional solution was selected. Spearman's rank correlation coefficient was used to measure the correlation between the NMDS ordination axis and the 8 factors in Table 1.

Results

The sequence of the biotopes given by the axis of one dimensional solution of NMDS is the following: PAL, LUC, CR, CIM, POL and TOL, with PAL, LUC and CR.

Table 2 presents the Spearman rank order correlation coefficients between the 8 factors in Table 1, the sum of ranks (Sranks) and the axis given by NMDS.

Table 2. The Spearman rank order correlation coefficients between the 8 factors, the sum of ranks (Sranks) and the axis given by NMDS.

	Sranks	NMDS
DIV	0.936	0.943
RAR	0.936	1.000
NAT	0.907	0.943
ARE	0.786	0.830
REP	0.640	0.543
DOC	0.640	0.140
UNI	0.560	0.543
SVAA	0.986	0.943
Sranks	1.000	0.957
NMDS	0.957	1.000

The scaling ranking has a high positive correlation with most of the ranking expressing natural value. The only small correlation value is for DOC, which represents only indirectly natural value. Also highly correlated is the sum of the ranks with the order of biotopes given by NMDS.

Discussion and conclusion

Quantitative criteria help to set priorities for biotopes conservation. However available information is mainly qualitative, which makes it difficult to quantify (Nijkamp et al. 1985). Another difficulty is that consistent information for all the variables used to describe biotopes is often missing.

Table 2 shows very high correlation between some variables and the rank order given by the one-dimensional scaling. If our purpose is to rank biotopes this technique would seem appropriate. The ranking we present here is the same as the one Castelli and Contoli (1985) produced by a different quantitative procedure.

A one-dimensional scaling that gives a good fit to the several ranking factors may not necessarily produce a ranking in which one extreme has biotopes more valuable than those at the other extreme. In cases where high ranks (6) are given to biotopes with high conservation values, the sum of the ranks may provide a more reliable criterion. When Spearman correlations between the scaling and the ranking factors are high, one would expect a high correlation between the scaling and the sum of the ranks as well. This last case is exemplified with the data presented here. It may be useful to include several areas with high impact, biological degradation or landscapes highly modified by human activity, to provide a non-biotope standard for evaluation and to help give the final rankings a direction from less to more deserving areas.

Unfortunately, as Castelli and Contoli (1985), Napoleone and Contoli (1985) have shown, it is impossible to use all the criteria that would be theoretically desirable. Additional factors would include biotic diversity, not only species richness, but also environmental heterogeneity, equitability (or evenness) among species, the level and complexity of trophic chains and so on (Margules and Usher, 1981; Everett, 1978; Gelbach, 1975; Goldsmith, 1975; Kikkawa, 1976; Klopatek et al., 1981; Tubes and Blackwood, 1971, Van der Ploeg and Vlijm, 1978; Wright, 1977).

Good documentation is very important for assessing the special protection of biotopes.

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