Nota lepid. Suppl. No. 2 : 4-12 ; 31.I.1991 ISSN 0342-7536

Ranking species and sites for butterfly conservation using presence-absence data in Central Spain

Arturo Baz

Dpt. de Biologia Animal., Universidad de Alcalá de Henares, 28871 Alcalá de Henares, Madrid, Spain

Summary

Rareness or percent occurrences of species is derived from presence-absence matrices (sites x species) and used to calculate a set of indices for ranking sites and species. The indices are designed to weight for sites with greater species richness and presence of rare species. UTM-grid squares with high index values are identified. The advantages and disadvantages of the method are discussed.

Introduction

Conservation efforts are often focussed on species that are rare numerically or have limited distributions, and/or sites that contain a high species richness in a relatively undisturbed state.

These two criteria (species richness and rarity) are the most used in wildlife conservation evaluation (Margules & Usher, 1981) and it is often only possible to obtain species presence-absence data for a series of potential conservation sites. The biotic data may be augmented with data on site characteristics such as area, superficial geology, vegetation, etc. Reserve planners and others must then decide which sites, if protected, would most achieve their conservation objectives.

Here I present an application of the numerical method of ranking species and sites (using species presence-absence data) used by Dony & Denholm (1985) and, more recently, by Minns (1987). The method is applied to the assemblage of native butterflies in Madrid province (Central Spain). Many native butterflies have limited distributions that have doubtless been reduced by human colonisation. There is a need to recognise species and sites requiring protection to conserve the native assemblage.

Methods

For ranking, the species assemblage and the total set of sites must first be defined.

In the application presented, the species assemblage is all the native butterflies in Madrid province (140 species) and the set of sites is the 109 UTM 100 km^2 squares of the same province (Fig. 1). The distributional data of the butterfly species in the UTM squares are extracted from the work of Gomez de Aizpurua (1987).

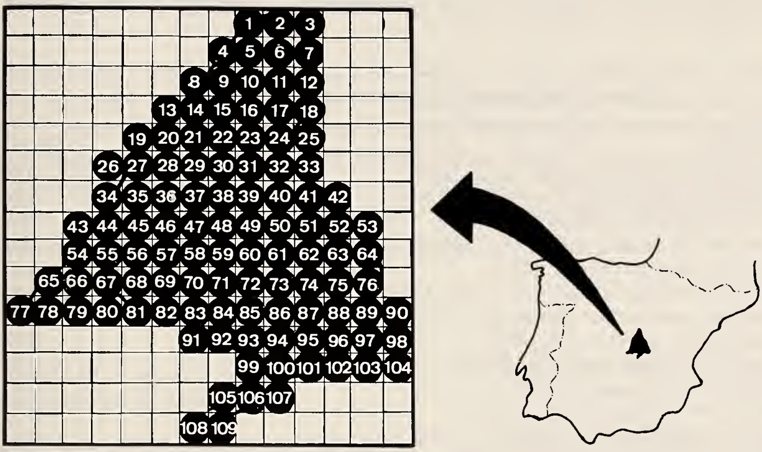

Fig. 1. Map representing the 109 UTM Km^2 squares of the Madrid province.

The required input data may be described as follows (see Minns, 1987).

Sites				Species assemblage					
i	1	2	3	.	.	.	.	m
1	S_{11}	S_{12}	S_{13}					S_{1m}
2	S_{21}	S_{22}	S_{23}					S_{2m}
3	S_{31}	S_{32}	S_{33}					S_{3m}
.	. .	.	.	S_{ij}	.	.	.	.
.	. .	.	.	.	.	.	.	.
.	. .	.	.	.	.	.	.	.
n	S_{n1}	S_{n2}	S_{n3}	.	.	.	.	S_{nm}

where n = number of sites ; m = number of species and S_{ij} presence (1)/ absence (o) of species j at site i.

The proportional occurrence (Pj) of species j across n sites is :

$$Pj = \sum_{i=1}^{n} Sij/n$$

the conservation priority (Qj) of each species is assumed to be the complement of its rareness, *Pj*.

$$Qj = 1 - Pj$$

Species which occur at all sites have a priority (*Qj*) of zero while species only occurring at one site have a *Qj* = (n — 1)/n. As the distribution of a species diminishes, so its conservation priority increases. The species in the assemblage can be ranked by their *Qj* values (see Table I).

Table I. Species with priorities values (*Qj*) ≥ mean + SD

Species	Qj values
Carcharodus flocciferus (Zeller, 1847)	0.99
Agrodiaetus amanda (Schneider, 1791)	0.99
Charaxes jasius (Linnaeus, 1766)	0.99
Carcharodus lavatherae (Esper, 1780)	0.98
Pyrgus fritillarius (Poda, 1761)	0.98
Aphantopus hyperantus (Linnaeus, 1758)	0.98
Clossiana euphrosyne (Linnaeus, 1758)	0.98
Clossiana dia (Linnaeus, 1767)	0.98
Brenthis ino (Rottemburg, 1775)	0.98
Pyrgus cirsii (Rambur, 1839	0.97
Aricia morronensis (Ribbe, 1910)	0.97
Cupido osiris (Meigen, 1829)	0.97
Hamearis lucina (Linnaeus, 1758)	0.97
Plebicula nivescens (Keferstein, 1851)	0.96
Euchloe belemia (Esper, 1799)	0.96
Artogeia mannii (Mayer, 1851)	0.96
Erynnis tages (Linnaeus, 1758)	0.95
Iolana iolas (Ochsenheimer, 1816)	0.95
Chazara prieuri (Pierret, 1837)	0.95
Apatura iris (Linnaeus, 1758)	0.95
Lycaeides idas (Linnaeus, 1761)	0.94
Gegenes nostrodamus (Fabricius, 1793)	0.93
Plebicula dorylas (D. & S., 1775)	0.93
Coenonympha glycerion (Borkhausen, 1788)	0.93
Erebia meolans (Prunner, 1798)	0.92
Pyrgus serratulae (Rambur, 1839)	0.91
Pyrgus armoricanus (Oberthür, 1910)	0.91
Pyrgus alveus (Hübner, 1810)	0.91
Aricia agestis (D. & S., 1775)	0.91
Satyrium acaciae (Fabricius, 1787)	0.91
Brenthis hecate (D. & S., 1775)	0.91
Libythea celtis (Laicharting, 1782)	0.91
Pseudophilotes abencerragus (Pierret, 1837)	0.90
Zizeeria knysna (Trimen, 1862)	0.90
Nymphalis antiopa (Linaeus, 1758)	0.90

The relative importance (*Ii*) of a site is defined as the sum of priorities of species present divided by the sum of priorities for all assemblage species.

$$Ii = \sum_{j=1}^{m} Sij\ Qj / \sum_{j=1}^{m} Qj$$

Of course this index is sensitive to the richness of the site. To compensate for that, a second site index is calculated which is the average priority (*Qi*) of species present.

$$Qi = \sum_{j=1}^{m} Sij\ Qj / \sum_{j=1}^{m} Sij$$

The importance index (*Ii*) can vary between 0 and 1 whereas the average priority (*Qi*) can vary in the range of species priorities (*Qj*) roughly between 0 and 1. Sites with a large portion of assemblage species present will tend to have high *I* and intermediate *Q* values. Sites with a few rare species will have intermediate *I* and high *Q* values. Sites with a few common species will have low *I* and *Q* values, or if both species richness and rarity are to be ranked the indices can be combined $(I + Q)/2$.

Results

The values of *I, Qi,* $I + Q/2$ and the number of species for each UTM square are summarized in Table II.

These values cover similar ranges and have similar means and standard deviations (Table III). Squares with index values greater than the mean plus standard deviation were selected (Figs. 2-5).

Fig. 6 represents the squares selected by all four indices and represents the definitive square selection for conservation.

The areas selected are the Central part of the Guadarrama mountains, the Ayllon massif, the Casa de Campo and monte del Pardo near Madrid, and the localities of Loeches and Campo Real in the south-eastern Plateau. Each zone is included in some of the faunistic units recognized by Viejo *et al.* (1988) using the same data.

Discussion

The importance (*I*) and average priority (*Q*) indices offer an objective means of ranking sites for identifying areas with greater species richness and concentration of rare species.

Rankings obtained with the numerical method were compared with selections made by experts (i.e. Gomez Bustillo & Fernandez Rubio, 1974 ; Viedma *et al.*, 1985). There is a very good correlation between the UTM squares selected by experts and those with $(I + Q)/2$ values greater than $\bar{x} + s$. These results suggest that the indices *I* and *Q* reasonably approximate the subjective selection process.

Table II. Values of *I*, *Qi*, $(I + Q)/2$ and number of species for each UTM square

Sites	I	Q_i	$I + Q/2$	No. sp.
1	0.54	0.55	0.545	87
2	0.55	0.55	0.550	90
3	0.27	0.46	0.365	53
4	0.32	0.47	0.395	62
5	0.28	0.44	0.360	58
6	0.45	0.47	0.460	85
7	0.38	0.45	0.415	75
8	0.16	0.45	0.305	32
9	0.32	0.48	0.400	59
10	0.41	0.49	0.450	74
11	0.30	0.40	0.350	67
12	0.27	0.40	0.335	61
13	0.45	0.51	0.480	78
14	0.40	0.51	0.455	70
15	0.25	0.45	0.350	50
16	0.34	0.45	0.395	67
17	0.19	0.34	0.265	50
18	0.25	0.39	0.320	58
19	0.52	0.52	0.520	89
20	0.59	0.56	0.575	94
21	0.25	0.45	0.350	49
22	0.14	0.36	0.250	36
23	0.12	0.30	0.210	34
24	0.22	0.36	0.290	55
25	0.22	0.38	0.300	52
26	0.58	0.53	0.555	97
27	0.61	0.55	0.580	99
28	0.55	0.52	0.535	94
29	0.18	0.36	0.270	45
30	0.24	0.41	0.325	52
31	0.21	0.37	0.290	52
32	0.20	0.36	0.280	51
33	0.27	0.41	0.340	58
34	0.44	0.47	0.455	82
35	0.59	0.52	0.555	100
36	0.35	0.43	0.390	73
37	0.25	0.40	0.325	57
38	0.17	0.32	0.245	47
39	0.03	0.18	0.105	17
40	0.07	0.26	0.165	24
41	0.06	0.22	0.140	23
42	0.07	0.35	0.210	18
43	0.24	0.38	0.310	57
44	0.26	0.38	0.320	61
45	0.31	0.41	0.360	66
46	0.16	0.32	0.240	46
47	0.18	0.35	0.265	45
48	0.34	0.42	0.380	72
49	0.19	0.33	0.260	51
50	0.04	0.23	0.135	18
51	0.15	0.35	0.250	39
52	0.21	0.38	0.295	49
53	0.15	0.34	0.245	40
54	0.25	0.37	0.310	60

Sites	I	Q_i	I + Q/2	No. sp.
55	0.22	0.35	0.285	57
56	0.17	0.32	0.245	49
57	0.23	0.35	0.290	58
58	0.21	0.35	0.280	54
59	0.34	0.43	0.385	70
60	0.10	0.37	0.235	26
61	0.11	0.36	0.230	27
62	0.31	0.48	0.395	59
63	0.13	0.32	0.225	35
64	0.25	0.38	0.315	57
65	0.17	0.32	0.245	48
66	0.18	0.33	0.255	50
67	0.22	0.35	0.285	55
68	0.20	0.35	0.275	51
69	0.20	0.34	0.270	54
70	0.21	0.34	0.275	56
71	0.10	0.28	0.190	32
72	0.14	0.34	0.240	36
73	0.27	0.40	0.335	60
74	0.35	0.44	0.395	70
75	0.20	0.40	0.300	46
76	0.30	0.40	0.350	64
77	0.12	0.28	0.200	37
78	0.18	0.33	0.255	49
79	0.18	0.31	0.245	50
80	0.15	0.31	0.230	42
81	0.14	0.30	0.220	42
82	0.16	0.31	0.235	46
83	0.13	0.29	0.210	41
84	0.09	0.26	0.175	31
85	0.07	0.29	0.180	22
86	0.13	0.37	0.250	31
87	0.15	0.36	0.255	38
88	0.27	0.41	0.340	59
89	0.24	0.37	0.305	56
90	0.20	0.37	0.285	50
91	0.14	0.30	0.220	40
92	0.11	0.29	0.200	34
93	0.12	0.32	0.220	34
94	0.12	0.36	0.240	31
95	0.21	0.38	0.295	49
96	0.24	0.38	0.310	56
97	0.22	0.37	0.295	53
98	0.26	0.43	0.345	54
99	0.24	0.37	0.305	57
100	0.23	0.39	0.310	53
101	0.09	0.29	0.190	29
102	0.12	0.32	0.220	34
103	0.11	0.34	0.225	29
104	0.12	0.34	0.230	32
105	0.05	0.26	0.155	19
106	0.27	0.42	0.350	59
107	0.28	0.43	0.355	58
108	0.28	0.43	0.355	58
109	0.02	0.21	0.117	11

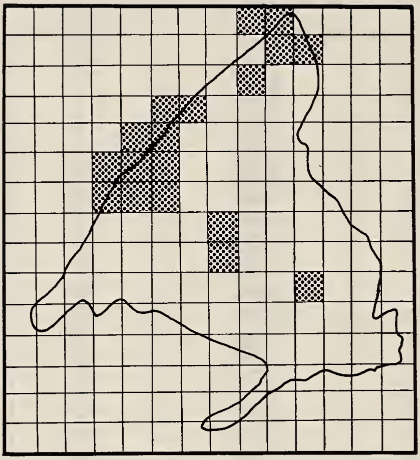

Fig. 2.

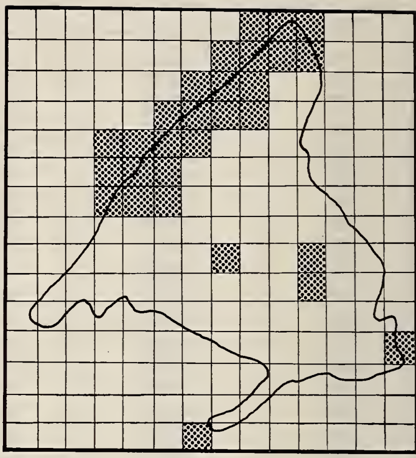

Fig. 3.

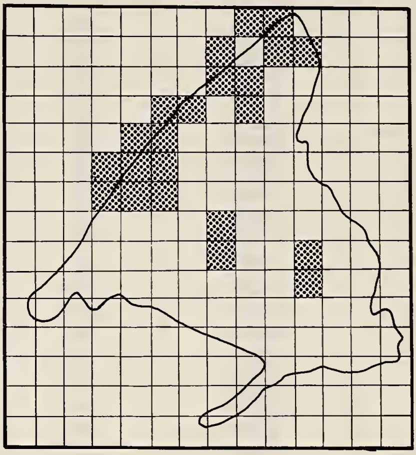

Fig. 4.

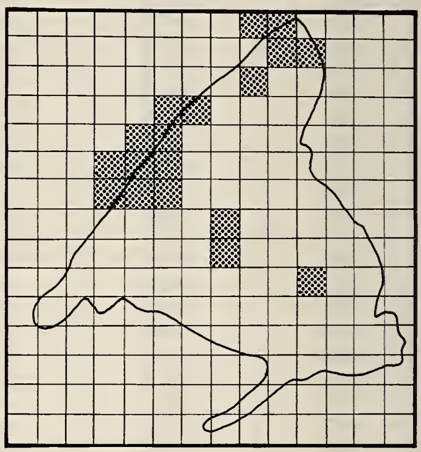

Fig. 5.

Fig. 2. UTM squares with $I \geq$ mean + SD.
Fig. 3. UTM squares with $Qi \geq$ mean + SD.
Fig. 4. UTM squares with $(I + Q)/2 \geq$ mean + SD.
Fig. 5. UTM squares with no. of species $\geq$ mean + SD.

The method is based on the recognition that conservation is a relative process with arbitrary bounds on the sites and species to be considered. The use of such a method decreases reliance of reserve planners on limited expertise. Used in conjunction with an extensive database, species and sites can be ranked in terms of national importance.

Table III. Minimum, maximum, mean, standard deviation (SD) and mean + SD of date presented in Table II

Index	Minimum	Maximum	Mean	SD	Mean + SD	n
I	0.03	0.61	0.23	0.13	0.36	109
Q	0.18	0.56	0.38	0.05	0.43	109
(I + Q)/2	0.10	0.58	0.30	0.10	0.40	109
species number	11	100	51.62	19.28	71	109

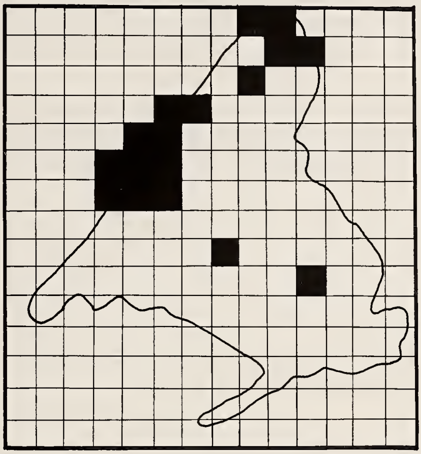

Fig. 6. UTM squares common to the four selection indices.

This method can be used more specifically. For instance, as Viejo & Viedma (1988) pointed out, the *Quercus* forests are the most important biotopes with regard to butterfly conservation. This method can be applied to the detection of forests which have a greater conservation priority in terms of national importance.

Basic presence-absence data for a particular site is often the only information readily available and in despite of its disadvantages (i.e. all species are not equally vulnerable to detection, all squares are not equally surveyed) this data must be utilised. Such methods must play an increasingly important role as the need for conservation grows.

References

Dony, J. G. & Denholm, I., 1985. Some quantitative methods of assessing the conservation value of ecologically similar sites. *Journal of Applied Ecology* 22 : 229-238.

Gomez Bustillo, M. R. & Fernandez Rubio, F., 1974. *Mariposas de la Península Ibérica*. Vol. I, Ropalóceros. ICONA. Madrid, 180 pp.

Gomez De Aizpurua, C., 1987. *Atlas provisional de los lepidópteros de Madrid* (Papilionoidea, Hesperioidea y Zygaenoidea). Comunidad de Madrid, 101 pp.

Margules, C. & Usher, M. B., 1981. Criteria used in assessing wildlife conservation potential : A review. *Biological Conservation* 21 : 79-109.

Minns, C. K., 1987. A method of ranking species and sites for conservation using presence-absence data and its application to native freshwater fish in New Zealand. *New Zealand Journal of Zoology* 14 : 43-49.

Viedma, M. G., Escribano, R., Gomez Bustillo, M. R. & Mattoni, R. H. T., 1985. The first attempt to establish a Nature Reserve for the conservation of Lepidoptera in Spain. *Biological Conservation* 32 : 255-276.

Viejo, J. L., Martin, J. & Silva, C., 1988. Patrones de distribución de las Mariposas de Madrid (Insecta, Lepidoptera, Papilionoidea et Hesperioidea). *Ecologia* 2 : 359-368.

Viejo, J. L. & Viedma, M. G., 1988. Los bosques y la conservación de las mariposas en el centro de la Península Ibérica (Lep : Papilionoidea et Hesperioidea). *Boletín de la Real Sociedad Española de Historia Natural (Biología)* 84 (1-2) : 153-164.