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AN EXAMINATION OF THE EFFECTS OF SIZE AND ISOLATION ON THE WILDLIFE CONSERVATION VALUE OF WOODED SITES

I Birds

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Introduction

MacArthur (1972) has summarised much of the available information on species numbers and diversity in relation to geographical isolation of islands, mountain tops, etc., and the size of the areas involved.

In this context, it would be of interest to know whether isolated woodlands behave as "islands" as far as plant or bird species are concerned, or whether, in an area such as the south of England, the distances between such woods are small enough to be insignificant. It would also be interesting to know what effect the size of a wood has on the number of species present and on their "conservation value".

Background

The effect of the isolation of an area of habitat on its value for wildlife conservation is usually difficult to determine, as aspects of the past history of the site, which are difficult to quantify, may be of over-riding importance for some species of plants and animals. A theoretical value for isolated areas of different sizes has been calculated previously (Helliwell, 1973a), on the assumption that there were equal numbers of areas in each size category. In practice, there are usually fewer areas of habitat in the larger size classes. For example, the Forestry Commission census of woodlands under 5 acres (Forestry Commission, 1953) shows a decrease in the number of woods as the size increases:-

Woods of 1 to 2 acres (0.4 to 0.8 hectares)	16,350
Woods of 2 to 3 acres (0.8 to 1.2 hectares)	14,800
Woods of 3 to 4 acres (1.2 to 1.6 hectares)	9,000
Woods of 4 to 5 acres (1.6 to 2.0 hectares)	6,000

Using the method used previously (Helliwell, 1973a) the value of an isolated woodland area in each of these four size categories is likely to be:-

Size of wood	Relative no. of species	Relative value of each additional species	Relative value of site	Relative value per unit area
0.4-0.8 hectare	100	1.00	100	100
0.8-1.2 hectare	117	1.35	144	86
1.2-1.6 hectare	129	2.10	222	95
1.6-2.0 hectare	139	3.75	371	123

In this case, the larger woodland areas are likely to be worth more per acre than the smaller areas, owing to their greater scarcity.

Given a slightly different number of woods in each size class, the value per unit area would, using this method of evaluation, remain constant (Fig. 1).

In a situation where an area of habitat is not isolated, but is merely a sample of a larger continuous area, the number of species recorded is likely to be greater (Preston 1962, Kilburn 1966, Brown, 1971), but the increase in number with increasing sizes of sample will be correspondingly less, and the additional species which are included at the larger sample sizes will be recorded on a more-or-less random basis and not because they can only be found in large samples. Nevertheless, the species which are recorded in the larger samples tend to be species which are less ubiquitous and have, therefore, a higher priority for conservation. For example, in a sample of 50 hedgerows in Shropshire (Helliwell, 1973b), the mean "value" of the additional species recorded with successive increments of sample size more than doubled between the smallest (2 m length) and the largest (256 m length) sample sizes, (Fig. 2). The relative "value" of samples of different sizes is shown in Fig. 3, and a similar curve has been obtained in a number of other cases where sample areas of increasing size have been surveyed.

In this case, the value of 2 hectares of habitat will not be twice a great as the value of 1 hectare, as long as it remains part of a larger continuous area of habitat. However, if the area were to be reduced in size, by the destruction of part of it, to 1 hectare, the value of the hectare remaining would fall, over a period of time, as it would be affected by the reduction in size. It would, in fact, fall in value to the corresponding level on the area/value curve for isolated sites. Thus, in Fig. 4, an evaluation of a sample (A) of a large woodland area would give a higher value than a similar area of isolated woodland (B), and the value of A would fall eventually to the level of B if the sample were to become isolated.

The larger the area of habitat one examines, the closer will it be in species content and "value" to a sample of a continuous area of habitat, until, at some point, it will equal this value. The isolated area of habitat may, in fact, exceed the value (though not the species content) of a continuous area at some stage, as it may be more valuable to have several types of habitat in a region than to have a complete cover of only one type. This point will, however, rarely be reached in a country such as Britain which has relatively small amounts of semi-natural habitat.

At point 1 on the area scale in Fig. 4, the difference in value between an isolated and a non-isolated area of habitat is in the order of 300% (points A and B), but at a point representing an area some four times this size the difference in value is only about 90% (points C and D). The units on the area scale have not been adequately defined, but if they were to represent areas of approximately 1 hectare in the case of woodlands, the two curves would appear to come near to meeting at a point somewhere around 10-15 hectares. At such a point, most of the British flora and fauna could exist in a wood, if conditions were otherwise suitable, and any further increase in size would not make the area very much more valuable, except for the fact that it would contain a larger population of many of the species present.

The hypothesis advanced above is based to a large extent on semi-theoretical factors which require further validation, particularly as regards animal, as opposed to plant, populations. Preston (1962) claims, however, that the same general considerations govern the numbers of species and their rarity in both plant and animal kingdoms; and it would be difficult to make any progress in the absence of some such hypothesis.

Bird census data

Data on bird populations is relatively difficult to obtain, requiring a large input of time and skill, compared to floristic survey work. To obtain data which would have been adequate for an analysis of the type required it would be necessary to employ at least four skilled ornithologists for a period of two to three months, in addition to a botanist. In the absence of such data, it was thought that an examination of some of the British Trust for Ornithology common bird census data might be useful. This covers a large number of sites, which have not been selected on any systematic basis; each of which has been censused for one or more years by a member of the B.T.O. As there is a larger number of members in south-east England than elsewhere, it was decided to look at all the available census data for woodland sites in that part of the country. 60 sites were included in this [illegible]. all of which had been censused during the period 1969-1972, which was a period of relative stability in bird populations in Britain*. No information was available on the structure of these woodlands or their floristic composition.

Table 1 lists the minimum, mean and maximum value for each of 12 variables which were examined.

* by 1969 most bird populations had recovered from the cold winter of 1962-1963 and the population changes after 1969 were less marked.

Table 1

Variable	Minimum	Mean	Maximum
1. Area of sample (acres)	0.3	42.4	154
2. Area of wood sampled	0.3	667	14,000
3. % woodland in 1 sq km	2.0	46.0	100
4. % woodland in 4 sq km	2.5	34.6	90
5. Distance from nearest wood (chains)	0.5	7.8	180
6. Distance from nearest larger wood	0.5	204	1,000**
7. Distance from nearest wood over 20 acres	0.5	23.4	372
8. No. of pairs per acre	0.89	5.0	12.4
9. Estimated biomass per acre	87.5	477	1,300
10. Deviation from expected no. of spp	-66%	2%	40%
11. Deviation from expected value of spp.	-76%	-20%	103%
12. Ratio of value exponential to biomass per acre	-50.8	8.0	149

** arbitrary maximum

The "value", was calculated on the basis of the scarcity of each species in the region and in the British Isles, and the number of pairs present (see Helliwell 1974 for details of the method), multiplied by the length of the bird in question (see Helliwell 1971).

The deviation from the expected value was calculated on the basis of the expected value being equal to the area of the sample raised to the power 0.36 and multiplied by a constant (150.0); and the deviation from the expected number of species was calculated on the basis of the expected number being equal to the area of the sample raised to the power 0.26 and multiplied by a constant (12.0).

Variable 9 was calculated on the basis of Kleiber's statement (Kleiber 1961) that the metabolic rate of mammals and birds is equal to their body weight raised to the power 0.75. Using length as an index of weight the metabolic rate will then be proportionate to the length of the species raised to the power 2.25. The length (in inches) of each species, raised to the power 2.25, was, therefore, multiplied by the number of pairs of that species. (This takes no account of the fact that some species raise more young than other species, and some account should, theoretically have been taken of that fact. Such a refinement was not thought to be necessary at such a preliminary stage, however).

Many of these variables were significantly correlated with other variables, and it was obvious that larger samples had been taken in woods with fewer pairs per acre.

There were smaller, but still significant, negative correlations between the size of the whole wood and the number of pairs per acre, and between the density of woodland in 1 or 4 sq km and the number of pairs per acre or the deviation from the expected number of species (Table 2). Isolated woods had a significantly larger number of pairs and species than expected, which may be due to less intensive commercial management of such woods, to the increased "edge effect" or to biased sampling. (Where territory of a breeding pair was recorded as overlapping the edge of a wood, it was counted as half a pair). There was no significant correlation between the isolation of the wood, as measured by the distance to the nearest adjacent wood, and the size of the sample area, so the larger numbers of pairs and species are unlikely to be due to a bias in the <u>size</u> of sample taken.

Using multiple regression, the multiple correlation coefficient for the deviation from the expected numbers of species was only 0.13, and the coefficient for the deviation from the expected "value" was only 0.12, when regressed against variables 2-7. This would appear to indicate that, within the 60 woodland areas sampled, the variation in numbers of species and pairs of birds is dependent to only a minor degree on the overall size of the wood, the density of woodlands in the locality, or the distance from other woodland areas. Variation is, therefore, more likely to be due to the structure and floristic composition of the woodland, or to some other factor not measured.

Table 2 Correlation matrix for B.T.O. data

	1	2	3	4	5	6	7	8	9	10	11	12
1. Area of sample	1	.42**	.25	.22	-.08	.17	-.13	-.55**	-.24	-.18	.16	.03
2. Area of wood		1	.24	.42**	-.09	.57**	-.11	-.29*	-.27*	-.16	-.10	.05
3. Woodland in 1 sq km			1	.91**	-.29*	.46**	-.41**	-.44**	-.30*	-.29*	-.17	-.10
4. Woodland in 4 sq km				1	-.32*	.61**	-.43**	-.47**	-.43**	-.35**	-.27*	-.07
5. Distance nearest wood					1	-.05	.51**	.32*	.35**	.35**	.32*	-.01
6. Distance nearest larger wood						1	-.01	-.23	-.25	-.18	-.15	.02
7. Distance nearest wood over 20 ac.							1	.45**	.45**	.20	.19	.00
8. No. of pairs per acre								1	.75**	.57**	.39**	.10
9. Biomass per acre									1	.72**	.72**	-.21
10. Deviation from expected no. of spp.										1	.74**	-.30**
11. Deviation from expected value of spp.											1	-.12
12. Ratio of value exponential to biomass per acre												1

* significant at 0.05 probability level
** significant at 0.01 probability level

N.B. This sample of woodlands may not have been representative of woodlands in general, and the sample included only 7 woods of less than 5 hectares (12.4 acres). These conclusions cannot, therefore, be applied to woodlands in general without further testing.

Floristic data

A brief survey of hedgerows in part of West Shropshire (Helliwell 1973b) indicated that new hedges were unlikely to be a very significant factor in the dispersal of woodland plants, but some old hedgerows contain a number of woodland plants and may provide sources of seed for the colonization of newly planted woodlands.

Woodlands of predominantly native tree species are currently being examined in the same part of Shropshire, and it is expected that the results of this work will be published in six to twelve months' time.

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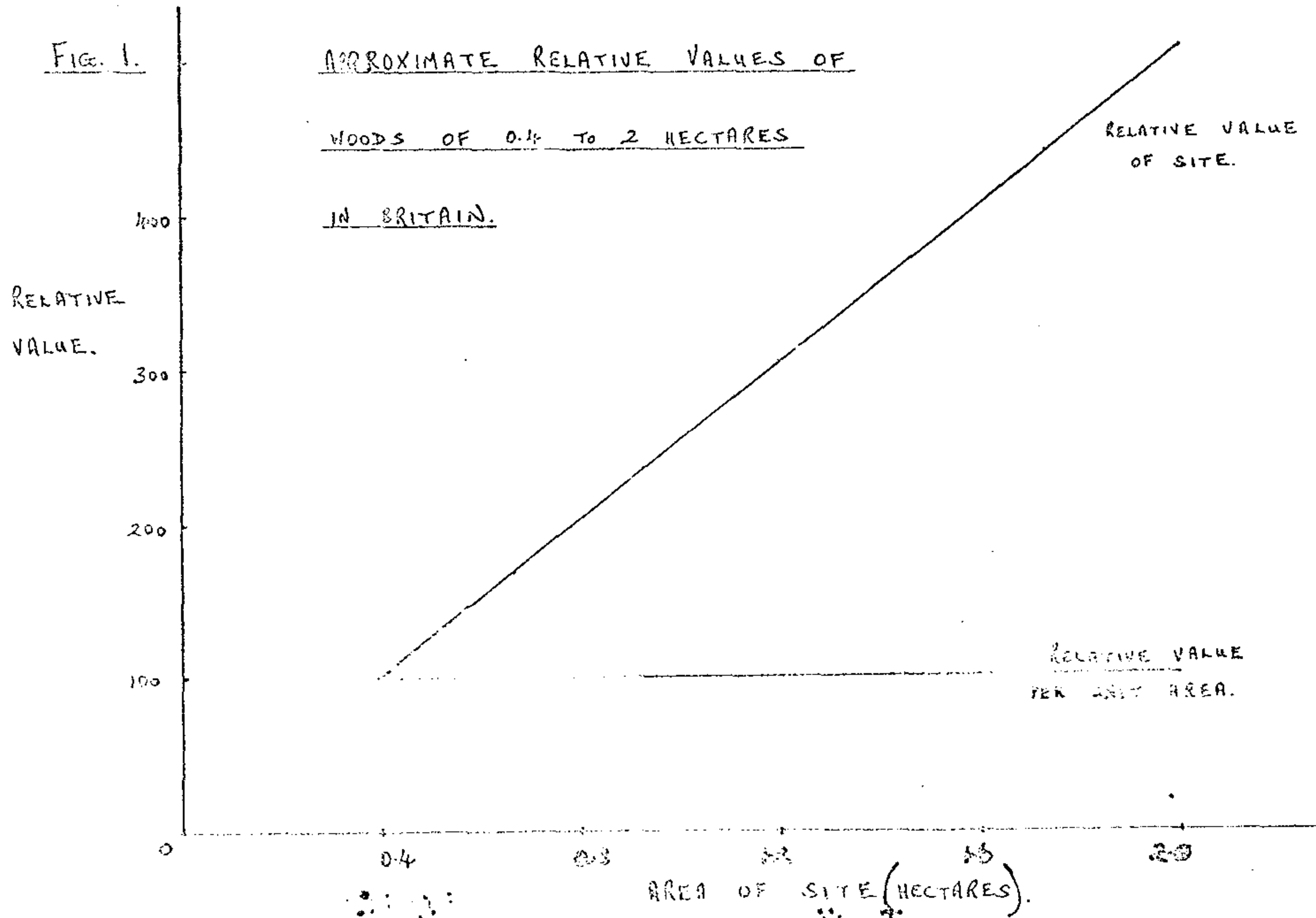
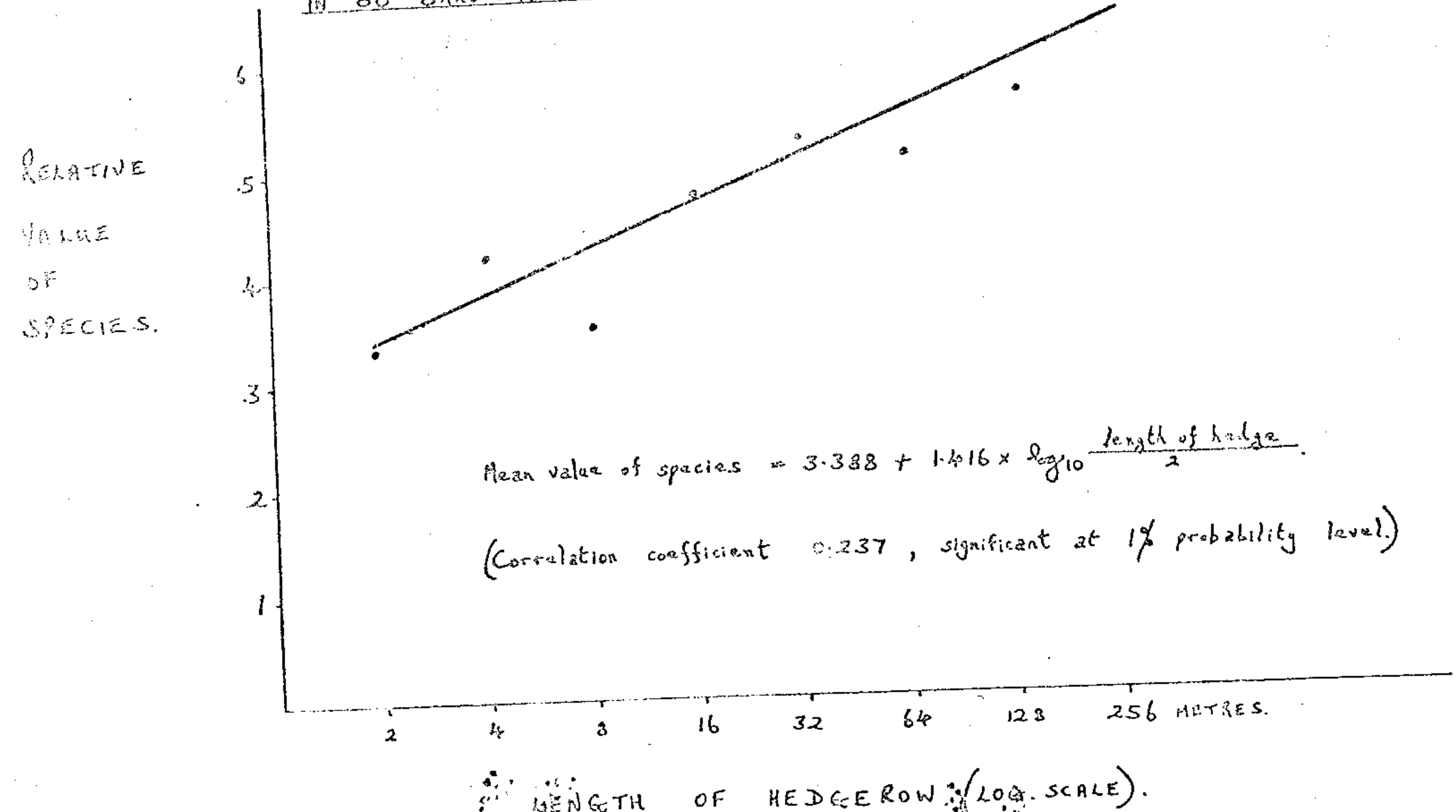


FIG. 1. APPROXIMATE RELATIVE VALUES OF WOODS OF 0.4 TO 2 HECTARES IN BRITAIN.

FIG. 2. MEAN RELATIVE VALUES OF ADDITIONAL PLANT SPECIES AT INCREASING SAMPLE SIZES IN 50 SHROPSHIRE HEDGES.



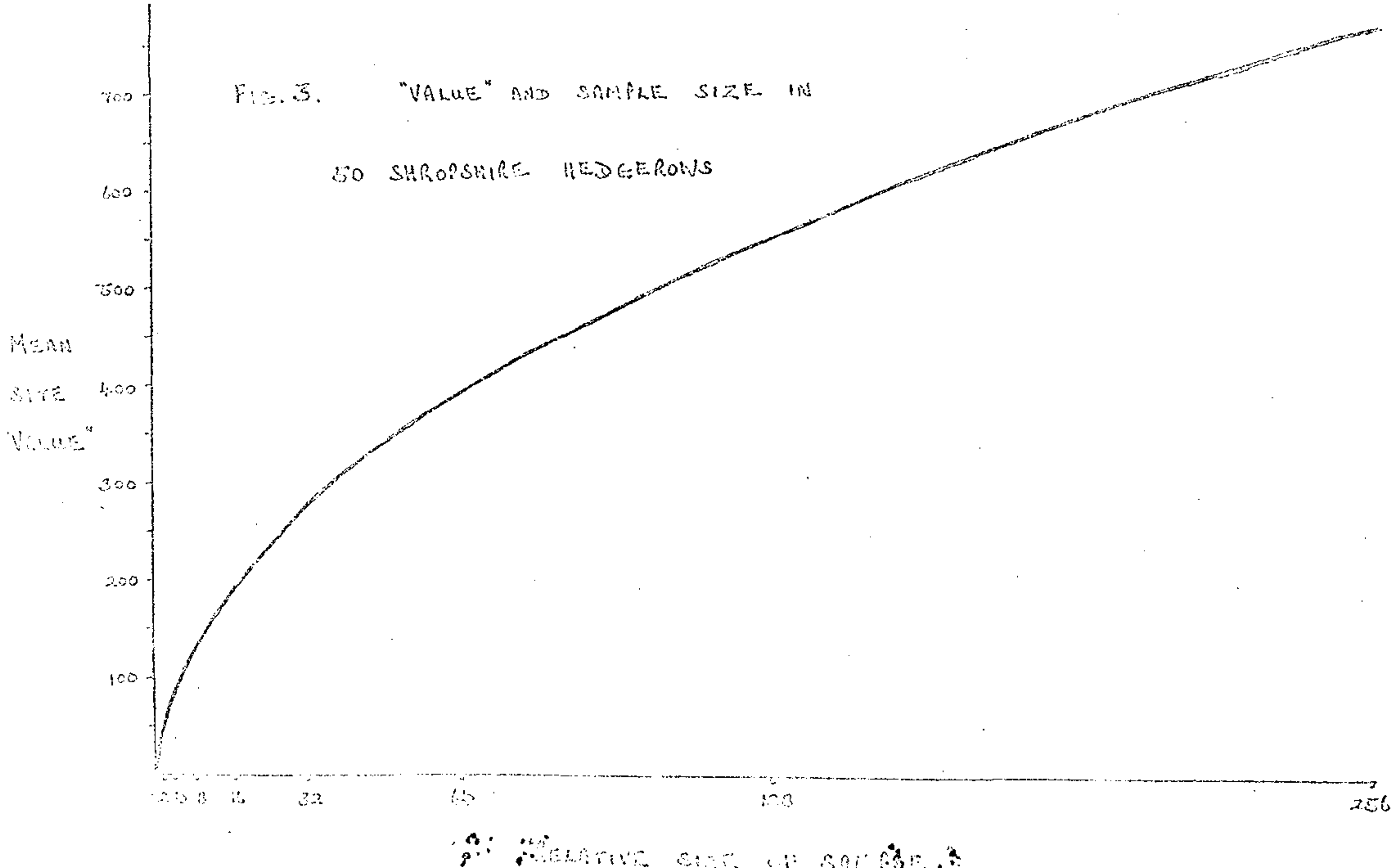


FIG. 3. "VALUE" AND SAMPLE SIZE IN 50 SHROPSHIRE HEDGEROWS

FIG. 4. RELATIVE VALUES OF ISOLATED AND NON-ISOLATED AREAS OF HABITAT