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A SIMPLE MODEL FOR PREDICTING NO. OF SPOTTED OWL TERRITORIES

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SUMMARY

A deterministic model is presented for predicting no. of spotted owl pairs (territories) in optimal habitat. The model uses four independent variables: total area (home range) occupied by one pair (A), proportion of overlap of occupied areas between two pairs (P), total acreage of area in question (T), and no. of acres of unsuitable habitat in T (U). Variation in any of these parameters will change the estimate of no. territories theoretically possible in an area. A general solution space is derived which suggests that predictions of greater than two or three territories are more sensitive to minor changes in A or P than changes in T or U.

THE BASIC MODEL

Let A represent the average area inhabited by a pair of spotted owls. A may represent total home range size in several different timber types, or a critical minimum area of dense, mature or old growth douglas fir for the nest grove. If such an area A is not shared, in total or in part, by another pair of spotted owls, then the maximum number N of pairs expected to be found in an area of T total acres is

$$N = \frac{T}{A}.$$

If each area occupied by a pair is not contiguous, then

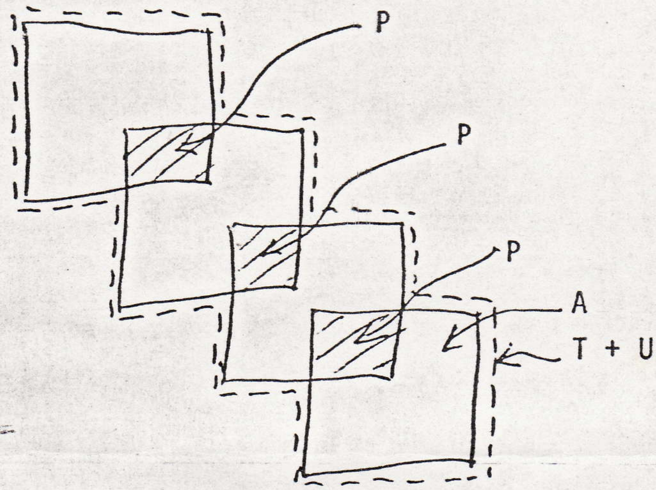
$$N < \frac{T}{A}.$$

If such discontinuous areas are U acres of unsuitable habitat, then

$$N = \frac{T - U}{A}.$$

If areas A overlap with proportions P between different pairs of owls (Fig. 1), then N may be estimated as

Fig. 1. Schematic of overlapping areas occupied by 4 pairs of spotted owls. Each square represents A acres per pair. Shaded regions represent P percentage of overlap. Dotted line represents entire area T acres in question, U acres of which may be unsuitable.



$$N = \frac{T - PA}{A - PA} ,$$

or, considering U acres of unsuitable habitat,

$$N = \frac{T - U - PA}{A - PA} . \qquad \text{Eq. 1}$$

Fig. 2 shows a solution A-P plane when T - U = 1000 ac of suitable habitat. The curves in the plane represent conditions allowing the existence of up to N pairs of spotted owls. For example, if spotted owl home ranges overlap by 25 percent (P = 0.25), and if the area occupied by one pair is 500 ac (A = 500), then up to 2 pairs of spotted owls might inhabit 1000 ac (T - U = 1000) of suitable habitat. Using these hypothetical data in Eq. 1,

$$N = \frac{T - U - PA}{A - PA} = \frac{1000 - (.25)(500)}{500 - (.25)(500)} = 2.3 \cong 2 \text{ pairs}$$

Note the convergence of the isopleth curves in Fig. 2 at (P = 1.00, A = 1000), which is a point on the line P = 1.00; this line is the set of all conditions of complete overlap of home ranges and represents a potentially infinite no. of pairs of spotted owls for any value of A.

Fig. 3 is the solution A-P plane when T - U = 2000 ac of suitable habitat. Here, with more suitable habitat available then represented in Fig. 1, if spotted owl home ranges overlap by 25 percent and if the area occupied by one pair is 500 ac (A = 0.25, P = 500) as above, then up to 4 pairs of spotted owls might inhabit the 200 suitable acres. The isopleth curves conjoin at P=1.00, A=2000.

The convergence of the isopleth curves in both Figs. 2 and 3 reflects a condition of this model: that as the amount of suitable habitat available approaches the home range size of one pair of spotted owls, then the degree of uncertainty or variation in the estimate of N becomes greater, at higher values of P, for a given variance in the value of P. In other words, as T-U approaches A, and for a given mean deviation in the value of P (i.e., P is estimated as some value plus or minus a mean deviation, or $\overline{P} \pm MD$), then the range in estimates of N corresponding to the range in values of P ($\overline{P}$ - MD to $\overline{P}$ + MD) is greater at higher values of $\overline{P}$. This condition may be graphically represented, as in Fig. 4.

A general solution space (A-P-T space) is presented in Fig. 5, which shows the solution of N = 5 territories. The surface and the half-space below the surface in the figure represent conditions sufficient for at least five territories; the half-space above the surface represents conditions of less than five territories. The solution space also indicates the relationship in the model between area occupied by one pair of owls, and total area of suitable habitat, for various values of P and a given value of N (see Fig. 6).

Fig. 2. Solution plane for T - U = 1000 acres of suitable habitat. See text for explanation of equation which generated this figure. Note convergence of curves at P = 1.00, A = 1000.

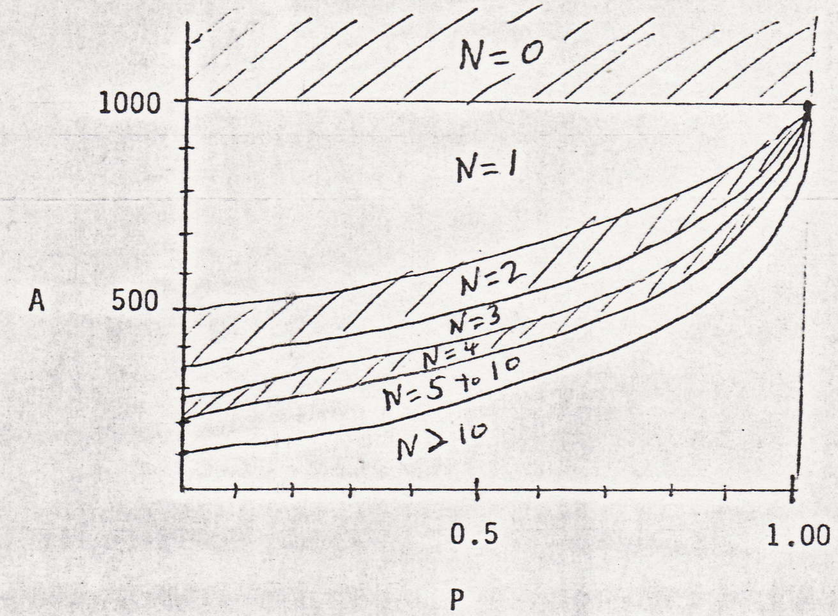


Fig. 3. Solution plane for T - U = 2000 acres of suitable habitat. See text for explanation of equation which generated this figure. Curves converge at P = 1.00, A = 2000.

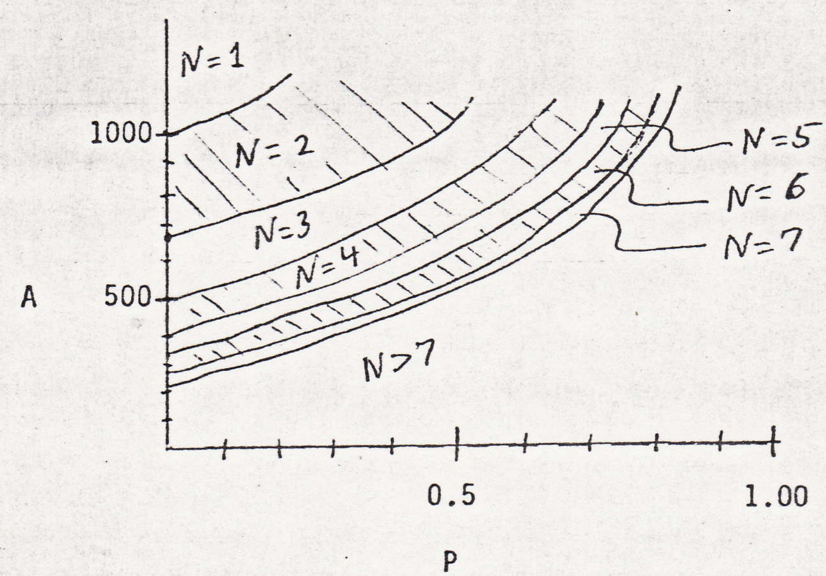


Fig. 4. Realms of confidence in the estimate of no. of spotted owl territories (N), for average values of the proportion of overlap between adjacent territories ($\overline{P}$) and the difference between area of suitable habitat (T-U) and the area occupied by one pair of owls (A), for a given mean deviation of $\overline{P}$. The implication of this curve is that as suitable habitat decreases in size, e.g. to small islands of old growth, then the degree of confidence in values of N generated by the model (Eq. 1, text) is at best high, if the average proportion of overlap of adjacent pairs of spotted owls is low. Likewise, confidence in N is lower when considering larger areas of suitable habitat.

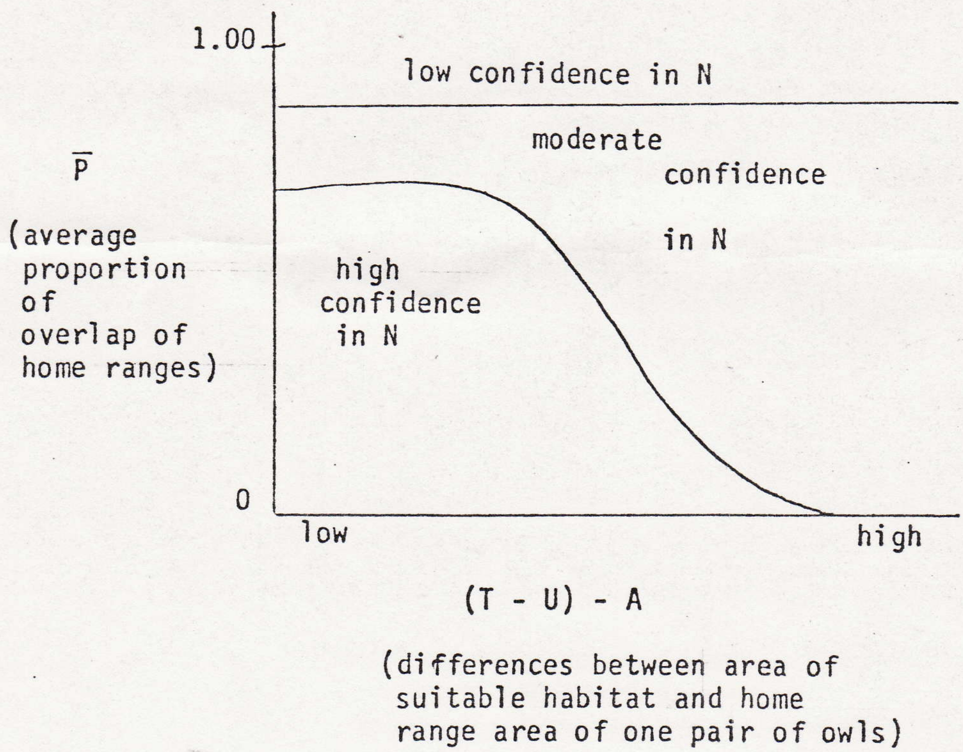


Fig. 5. Solution space of Eq. 1 in text, for N = 5 territories. All curves on the A-P plane will rise for $N<5$, and drop for $N>5$. All points falling on or below this curve surface represent conditions sufficient for the existence of at least five pairs of owls. Points above the surface represent insufficient conditions.

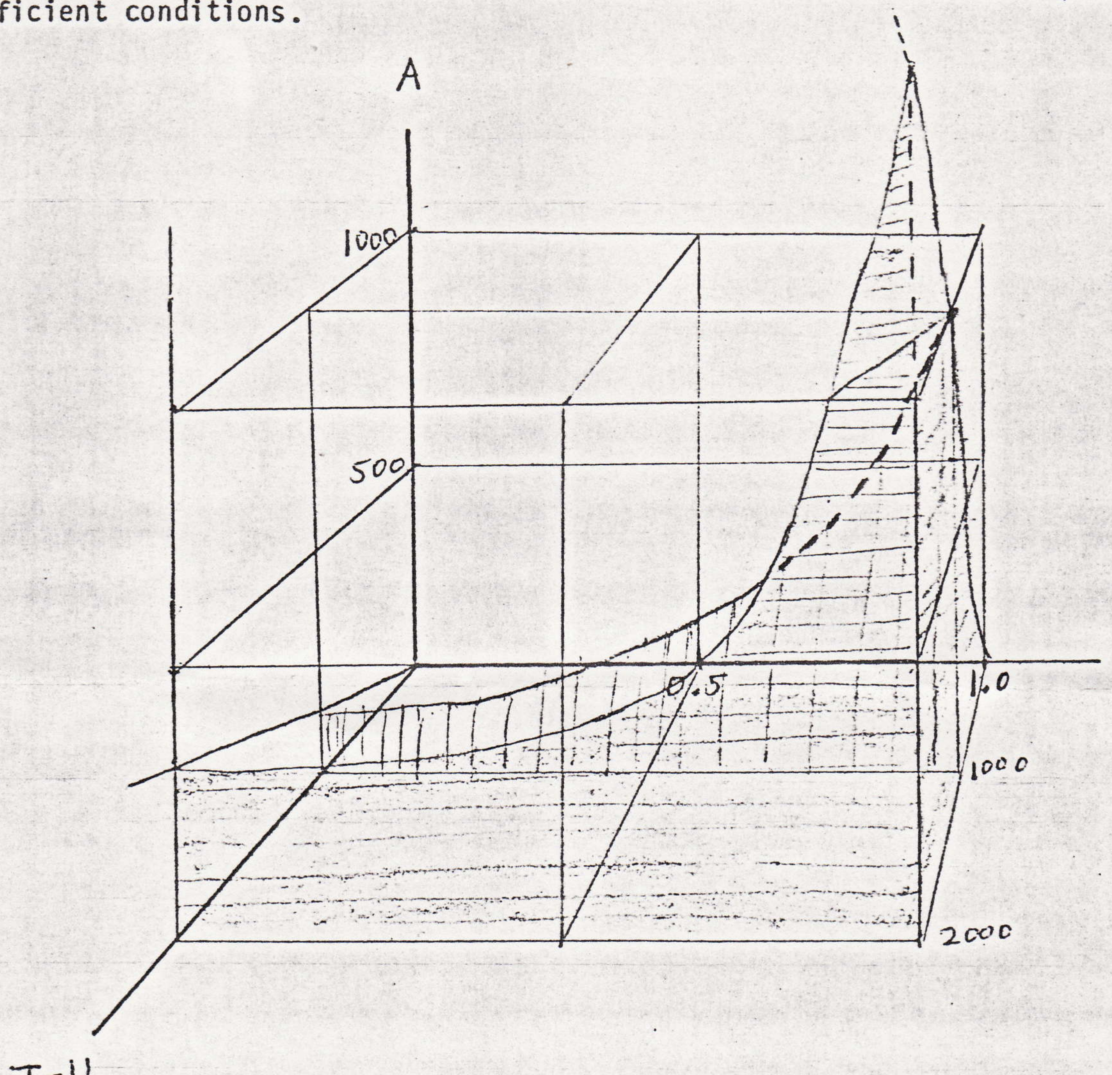


Fig. 6. Relation of home range size of spotted owls (A) and area of suitable habitat (T-U). The curves are drawn under the condition of five territories present, at various degrees of overlap of adjacent home ranges (P), as per Eq. 1 (see text).

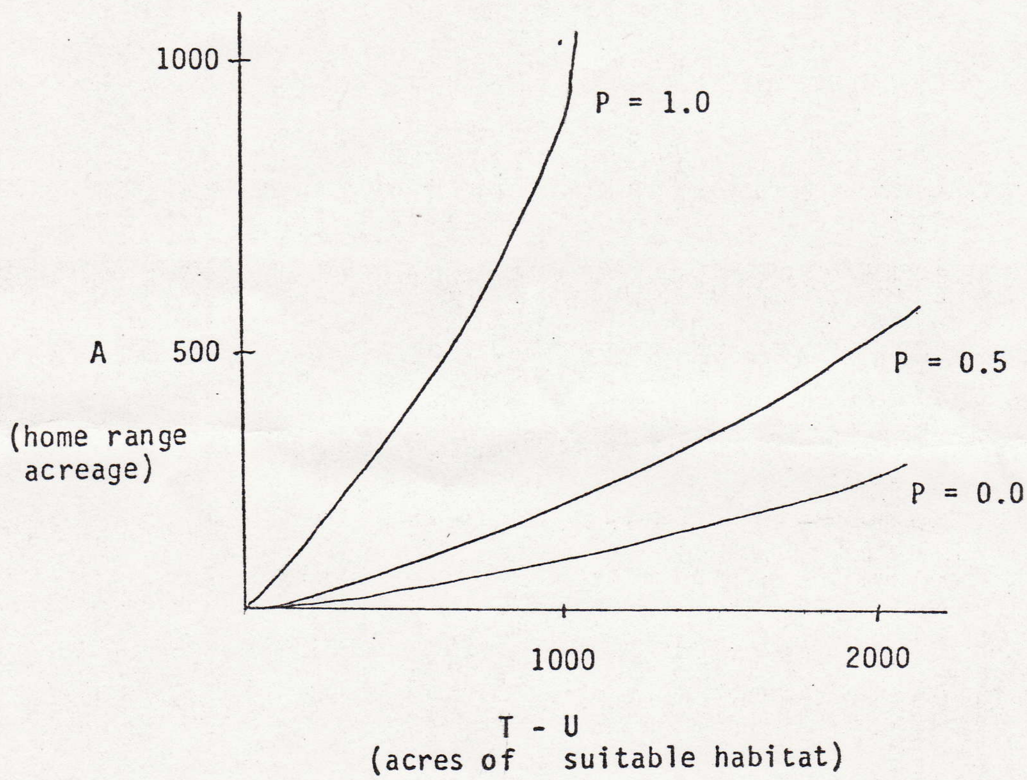


Fig. 5 as well suggests that the predictions of greater than two or three territories are, in general, more sensitive to minor changes in A or P than in T or U, as discussed above in relation to the solution planes.

DISCUSSION

The basic model is founded on the following assumptions:

1) The no. of territories in an area of suitable habitat is mainly a function of two aspects of the species' biology: its home range size and the degree of overlap of adjacent home ranges of different breeding pairs.

2) Home range size is positively correlated with degree of overlap of adjacent home ranges of different pairs.

The spotted owl's biological need for a given feeding area A are probably quite variable. A is probably lower in value in areas where the prey base is (i) close to the nesting grove, (ii) relatively dense (i.e., a high biomass of prey per unit area), or (iii) of high quality (e.g., small mammals vs. insects). Thus, as A varies according to these factors, the no. of territories in a given area of suitable habitat may vary as well.

The degree of overlap of adjacent home ranges of breeding pairs is virtually unknown. A small degree of overlap may be expected, as spotted owls are highly vocal during the breeding season, and respond territorially and vigorously to imitations of their own call within about one quarter mile of their assumed nest grove, inferring that most of their home range is defended.

Amount of overlap, though small, may vary as a function of such variables as habitat quality; juxtaposition and composition of different age classes, canopy closures, and compositions of timber stands within their home range; and genetic relationship between the adjacent pairs. Thus, as P varies as per these factors, the no. of territories in a given area of suitable habitat may vary as well.

Also, factors other than home range size and degree of overlap of adjacent home ranges may influence the no. of territories in an area of suitable habitat, such as presence of potential predators, degree of external disturbance (as from man), and travel corridors as influencing dispersal or immigration rates. All these factors may limit the usefulness of Assumption 1, above.

Assumption 2 may hold in habitats of limited size, such as old growth islands in a sea of young growth, and only where the prey base and adequate nesting and roosting substrates are not also limiting. Because of such mitigating and synergistic factors, the assumed positive correlation between home range size and degree of overlap of adjacent home ranges may be spurious.