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INVITED ESSAY

DATA NEEDS FOR AVIAN CONSERVATION BIOLOGY: HAVE WE AVOIDED CRITICAL RESEARCH?[1]

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As ornithologists, birds are our stock in trade. Many of us have built our professional careers on a foundation of research and teaching about birds. Most of us spend considerable leisure time observing them. We lament the passing of species that have not managed to cope with changes in their environment. And we worry about dwindling populations of the many species now threatened with extinction. It is obvious, however, that the rate of extinction of bird species will accelerate in spite of a growing movement to counter this trend. Here I contend that conservation planning for many endangered bird species will be seriously (maybe hopelessly) hampered by a lack of critical information, and that this situation results in part from the reward systems associated with research.

This thesis is based on my recent participation in development of a proposed conservation strategy for the Northern Spotted Owl (*Strix occidentalis caurina*) (Thomas et al. 1990), so points raised here would not necessarily apply to all species for which conservation plans may be needed. The owl strategy was built around five simple, seemingly self-evident concepts of conservation biology (e.g., see Diamond 1975, den Boer 1981, Harris 1984, Noss and Harris 1986, Wilcove et al. 1986, Thomas et al. 1990:23, 285–286).

THE CONCEPTS

(1) *The probability of extinction is inversely related to the extent of a species' geographic distribution.* The Heath Hen (*Tympanuchus cupido cupido*) is a classic example, as its original distribution from New England to Virginia was eventually reduced to Martha's Vineyard Island, off the coast of Massachusetts. There, in the early decades of this century, it experienced a series of detrimental events that finally led to its extinction (Simon and Geroudet 1970, Shaffer 1981). The status of Hawaii's bird fauna is also instructive. Most of Hawaii's endangered species occupy < 10% of their former range, even though some have populations estimated between 1,000 and 10,000 birds. On the other hand, most of Hawaii's nonendangered forest species occupy > 10% of their former range and some have populations estimated between 100 and 1,000 birds (Scott et al. 1988). Obviously, a conservation strategy should seek to maintain a species' distribution throughout its existing range. This is den Boer's (1981) concept of spreading the risk; it is the "key hedge against major catastophes that could otherwise extinguish the sole remaining population of a once widespread species" (Thomas et al. 1990:285). Lack of available information would not likely be a significant deterrent to following this guideline for most bird species, although additional details about a species' distribution within its range would undoubtedly be needed to map a proposed conservation strategy.

(2) *Large blocks of habitat capable of supporting subpopulations of many breeding pairs are better than smaller blocks capable of supporting only one to a few breeding pairs.* Knowing that bigger is better, however, still begs the ultimate question of "How big is big enough?" We used two approaches to find an answer for the Northern Spotted Owl—computer simulations and empirical studies (Thomas et al. 1990:239–267; 286–291). Both approaches led independently to a conclusion that blocks of habitat large enough to support 15–20 breeding pairs, given a moderate level of dispersal among blocks, would result in reasonably stable subpopulations.

Simulation models are necessarily simplifications of the real world; the validity of their assumptions can be critical to model outcomes. Vital rates used to parameterize demographic models for the Northern Spotted Owl were based on the best available information. This owl easily ranks among the most intensively studied bird species in the world. Even so, only a couple studies were of sufficiently long duration and large enough in scale to provide statistically reliable estimates of age-specific reproductive and survival rates, turnover rates, dispersal rates, and so on. If this is the case for one of the world's most-studied bird species, the situation is undoubtedly worse for most of the others—including most endangered species.

Empirical data available for reaching a judgment on this point were also meagre and included none from studies of Spotted Owls. Results of only two field studies (Jones and Diamond 1976, Pimm et al. 1988) allowed estimates of extinction rates in relation to time and initial population sizes of birds, and both studies were based on true island populations (i.e., surrounded by water). More studies of this sort are urgently needed for a wide variety of situations, especially in terrestrial landscapes where stands of suitable habitat of various sizes are scattered at varying distances from one another.

Two additional factors—floaters and vocal communication—were prominent in our contention that blocks of habitat large enough for multiple breeding pairs are superior to blocks large enough for only one to a few pairs (Thomas et al. 1990:292–296). If the dynamics of the floater segment of a population, in relation to territory holders, is anything like that revealed by Smith (1978) for the Rufous-collared Spar-

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row (*Zonotrichia capensis*), very small blocks of suitable habitat are unlikely to include areas where floaters could persist and be in a position to rapidly replace a territorial bird that disappears. The number of studies documenting relations of floaters to an associated territorial population can be tallied on one hand. Indeed, this may be the most neglected area of study in avian ecology, but one vitally important to our overall understanding of population dynamics.

The connection between vocal communication and a conservation strategy relates to the fact that vocal, territorial signals should be much more frequent in a block of habitat with many territorial pairs than in a block with one to a few pairs. This is true not only because more birds are present, but also because their song rate tends to be higher when stimulated by singing neighbors (e.g., Gochfield 1978, Kroodsma and Verner 1978). The increased signalling rate from larger blocks of habitat probably leads dispersing birds to find them more often than expected on the basis of block size alone. For example, Boag (1976) concluded that the establishment of territories by Ruffed Grouse (*Bonasa umbellus*) was "not entirely in response to availability of potentially acceptable vegetation." Increasing densities led to more recruitment through yet higher drumming rates. To my knowledge, this effect has not been carefully studied in relation to recruitment rates in small vs. large blocks of suitable habitat for any species.

(3) *Unfragmented blocks of relatively homogeneous habitat suitable for a species are generally better than loose aggregations of smaller blocks of suitable habitat.* Fragmentation, and its accompanying edge effects, are matters of concern for species faced with large-scale removal of suitable habitat (e.g., Thomas et al. 1990: 274, 293). Recently exposed edges in forested habitats, for example, are vulnerable to blow-down of trees. The remaining forest interior is subject to wind- and sun-induced desiccation to some distance inside the edges. And edges tend to attract an assemblage of other species that may be detrimental to a species well-adapted to forest interior conditions. Finally, when fragment sizes are smaller than needed by a bird to satisfy all life functions, it must pass through intervening patches of relatively unsuitable (and potentially hostile) habitat when moving among patches of suitable habitat. The result may be higher mortality rates, lower reproductive rates, or both. Documenting these effects, however, is particularly difficult and time-consuming for species with very large home ranges, long life spans, and relatively low reproductive rates. And this problem is exacerbated by the fact that fragmentation always occurs together with loss of habitat, usually in ways that make it difficult to isolate the separate effects of the two factors.

(4) *Blocks of suitable habitat that are close together are better than blocks far apart.* This concept addresses the need for successful dispersal from one block to another, but the statement is only relative. It does not answer the question of "How near should blocks be to one another to assure dispersal between them?" We had data on distances dispersed from natal territories by 56 radio-tagged, juvenile spotted owls. We had no objective criteria, however, for setting an appropriate distance between habitat blocks. That decision was reached by consensus among Team members using a Delphi approach (Thomas et al. 1990:305–308). An objective protocol for making such a decision may be unattainable, but it certainly deserves careful study. In any case, setting a distance between blocks of suitable habitat is among the most critical parts of a conservation strategy, and it obviously depends on having a reliable estimate of the distribution of dispersal distances. I suspect that such data exist for fewer than 1% of all bird species for which we may be called upon in the near future to devise a conservation strategy.

(5) *Habitat separating blocks of suitable breeding habitat should allow dispersal by members of the species in question, and especially by juveniles.* Much recent literature supports the concept of corridors of suitable habitat connecting population centers, but conflicting viewpoints have been expressed (review in Thomas et al. 1990:303). Careful studies of corridor use by dispersing animals are scarce. The two studies of dispersing juvenile Northern Spotted Owls (Gutiérrez et al. 1985, Miller 1989) led us to believe that they would not confine their dispersal to corridors of habitat suitable for breeding. Instead, we proposed a landscape approach to dispersal based on habitat conditions consistent with observed use for foraging and resting by Spotted Owls. The owl strategy calls for 50% of the forested area surrounding blocks of suitable breeding habitat to be in stands of trees averaging at least 11 inches (27.9 cm) in diameter at breast height and averaging at least 40% canopy cover (the "50-11-40 rule"). Operationally, we believe this distribution of suitable foraging habitat will allow more successful dispersal than narrow corridors of better habitat connecting blocks of breeding habitat, but with most of the surrounding forest matrix in a condition less than suitable even for foraging by the owls.

Assuring successful dispersal is another highly critical aspect of a conservation strategy, but we know little or nothing for most species about the general directions chosen by dispersing birds, the nature of the movement patterns followed, or what sorts of habitats they select and how they use them as they disperse.

CONCLUSIONS

In broad outline, the owl strategy (Thomas et al. 1990) proposes relatively large blocks of habitat suitable for all life functions for multiple pairs of Northern Spotted Owls. These should be distributed throughout the current range of the subspecies. They should be separated by distances consistent with observed dispersal distances of juvenile owls. And they should be embedded in a landscape of habitat that allows foraging, resting, and cover by birds dispersing between blocks.

The key pieces of information needed to map this strategy include vital demographic rates, density estimates at a landscape scale, a suitable size for habitat blocks to assure a reasonably stable subpopulation of breeding pairs, the role of floaters in population dynamics, the extent to which fragmentation is tolerable within habitat blocks, the role of social facilitation of territorial songs/calls that may serve to attract dispersing birds to a block of suitable habitat, and the dispersal distances and behaviors of the birds (especially juveniles). Even though these data needs were brought out by conservation planning for the Northern

Spotted Owl, most or all of them should apply to most other bird species as well.

This brings me to my final point. Most information vitally needed for conservation planning requires intensive and extensive field studies, usually of long duration (e.g., at least 7–10 years for a single, large-scale demographic study). And it is usually labor-intensive. Our "reward" systems for research tend to discourage such studies. Graduate studies tend to be limited to a period of 2–3 years (M.S. degrees) or 4–6 years (Ph.D. degrees), and graduate students typically lack resources to undertake the large-scale field operations needed to implement very labor-intensive studies. Their rewards are graduate degrees, which, they hope, will propel them into positions in academia, public agencies, consulting firms, and the like. If successfully planted in a career position that includes research, they are again faced with a general lack of funding and a frustrating failure of their funding sources to understand the importance of long-term studies. Their rewards are promotions, salary increases, tenure, acclaim, and so on. And the usual yardstick is publication—not so much the quality as the quantity, although quality does count for something. The result is a tendency to emphasize studies on topics with a high likelihood of yielding publishable results in a relatively short time, generally five years or less. This is not to say that long-term studies are not done, just that they are exceptional.

I believe this reward system has contributed to the fact that researchers have almost totally avoided studies of some of the most important questions needing answers for conservation planning. I hope the current trend of increasing numbers of endangered species, throughout the world, may stimulate some researchers to break with the historic pattern.

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