VIABLE POPULATIONS OF SPOTTED OWLS FOR MANAGEMENT OF OLD GROWTH FORESTS IN THE PACIFIC NORTHWEST

M.S. Boyce
L.L. Irwin

1990
Bulletin WWRC-90-11

In

Ecosystem Management
Rare Species and Significant Habitats
New York State Museum Bulletin 471

Mark S. Boyce
Department of Zoology and Physiology
University of Wyoming
Laramie, Wyoming

Larry L. Irwin
National Council for Air and Stream Improvement
Corvallis, Oregon

Viable Populations of Spotted Owls for Management of Old Growth Forests in the Pacific Northwest

Mark S. Boyce
Department of Zoology and Physiology
University of Wyoming, Laramie, WY 82071

Larry L. Irwin
National Council for Air and Stream Improvement
P. O. Box 458, Corvallis, OR 97339

Abstract: The Northern Spotted Owl (*Strix occidentalis caurina* Xantus 1859) has become a surrogate for efforts to preserve remaining old growth forests in the Pacific Northwest. We review here a viability analysis prepared by the U. S. Forest Service which evaluates risks of extinction resulting separately from (a) stochastic demographic processes, (b) inbreeding and loss of genetic variability, and (c) habitat loss. Stochastic demography must include density dependence to be realistic, particularly for a territorial species. Because of high sampling variance, it is unlikely that adequate data can be accumulated for most rare species to provide demographic projections that differ significantly from a constant population. A model that integrates all components of the Forest Service viability analysis predicts a low probability that Spotted Owls will go extinct under the Forest Service's preferred management alternative. However, we emphasize that such a model is unrealistic because it does not incorporate spatial distribution of owls, and population fragmentation imposes the greatest risk of their extinction. A metapopulation model by Lande (1988) estimates acreage of old-growth forest necessary to preserve the Spotted Owl on Spotted Owl Habitat Areas (SOHAs). However, such estimates are dependent upon accurate determinations of the proportion of SOHAs and other habitats that are truly suitable for Spotted Owls. Habitat requirements of the owls must be carefully documented to justify management based upon the metapopulation model.

Pages 133 - 135. Ecosystem Management: Rare Species and Significant Habitats. New York State Museum Bulletin 471. 1990.

INTRODUCTION

The Northern Spotted Owl is currently the focus of the most heated conservation debate in the United States (Simberloff, 1987; Wilcove, 1987). The Spotted Owl is being used as a surrogate species for the preservation of remaining old-growth forests in the Pacific Northwest, where the timber industry depends largely on forests older than 200 years for its wood supply. Because most remaining old-growth habitats are on National Forest lands, the U.S.D.A. Forest Service is in the uncomfortable position of trying to compromise timber interests with those favoring preservation of old-growth forests and Spotted Owls.

The U.S. Forest Service (USDA, 1986; 1988) has recently attempted a viability analysis for Spotted Owls, using the three distinct approaches of (1) stochastic demography, (2) population genetics, and (3) habitat characterization, to forecast the probability of extinction under various management alternatives. We will review this viability analysis and suggest different approaches for future efforts.

VIABLE POPULATIONS OF SPOTTED OWLS

In its Draft Supplemental Environmental Impact Statement (USDA, 1986), the Forest Service concluded that stochastic demography is the modelling approach of greatest significance to Spotted Owls, because it yields the lowest prospects for their survival. In general, the greater the environmental and demographic variance the lower the long-run growth rate and the higher the probability of extinction for the population (Tuljapurkar and Orzack, 1980). The Forest Service's demographic projections were based on the Leslie matrix, however, which is an exponential growth model. A stochastic exponential model has essentially two possible outcomes: the population will increase to infinity or it will decline to extinction (Boyce, 1977). For a territorial species such as the Spotted Owl, we find such a model structure totally unrealistic, and insist that some form of density-dependence be incorporated into it.

Another common difficulty with demographic analysis is the inability of the user to estimate reliably for all of the parameters in the model. For example, a 15×15 Leslie Matrix for Spotted Owls requires that at least 28 parameters be estimated. As a consequence, projections based upon such models are statistically unreliable. A smaller model, *e.g.* a 3×3 stage projection matrix (Lefkovitch, 1965), will have almost identical dynamics; however, the smaller model requires that only three or four parameters be estimated, and will thus provide projections with substantially smaller confidence intervals, since the degrees of freedom associated with each parameter estimate will be larger. Bootstrapping and jackknifing procedures exist to evaluate the uncertainty in such population projections (Meyer *et al.*, 1986), but these have not been applied to Spotted Owl data.

Based upon meager data existing on the demography of Spotted Owls, Lande (1988) could not show that the population growth rate differed significantly from that of a constant population. Lande (1988) came to this conclusion despite the fact that he seriously underestimated the magnitude of variance in growth rate by calculating only the binomial component of sampling variance. Although the Final SEIS (USDA, 1988) claims that Spotted Owl populations are declining at 0.5% to 1.1% per annum, it offers no confidence intervals around these rates of decline. Although nest sites have been destroyed at a rate of 1.5% per year (Forsman *et al.*, 1984), the ultimate fate of the occupants is unknown. Because of inadequate population surveys and small sample sizes for demographic parameter estimates, there does not appear to be any reliable evidence that Spotted Owl populations are indeed declining in the Pacific Northwest.

The second approach used by the Forest Service in their viability analysis was to estimate the degree of inbreeding expected to occur in Spotted Owl populations. In general, inbreeding is not likely to be an important consideration for viability analysis of Spotted Owls, because inbreeding is unlikely to affect the birds until populations decline to approximately 120 individuals (USDA, 1986; 1988). This may present a very real risk for isolated populations, *e.g.*, those on the Olympic Peninsula, but, for the core distribution of Spotted Owls it is unlikely that inbreeding depression is an immediate threat.

The disjunct approaches employed by the Forest Service can be integrated into a single density-dependent age-structured model where the genetic inbreeding effects are incorporated as an Allee effect (Boyce, 1987). Our studies suggest that the critical parameter determining the probability of extinction in such an integrated model is the habitat's carrying capacity for Spotted Owls. Therefore, perhaps the most useful calculations performed by the Forest Service (USDA, 1988) were the estimates of a habitat capability index (HCI) and projected capacity of various areas to support owls under various management alternatives.

Estimates of the habitat's carrying capacity for Spotted Owls were assumed to represent equilibrium population sizes in a density-dependent model. As was true for the exponential growth model: as environmental and demographic stochasticity increases, the population growth rate declines, along with the average population size (Boyce and Daley, 1980). Nevertheless, even with stochastic variation, the probability of extinction is very low for Spotted Owls at carrying capacities projected for the Forest Service's preferred alternative (Boyce, 1987). This is because density dependence dampens population fluctuations and greatly reduces the probability of extinction (see Ludwig, 1975). There is a serious weakness in this approach, however, because it ignores the metapopulation structure, i.e., spatial variation, of the population (Lande, 1987).

Ultimately, we suspect the fate of the Spotted Owl will depend upon geometry of distribution of subpopulations and isolated mating pairs in the Pacific Northwest. Lande (1987, 1988) made a first attempt to model the spatial structure of the owls and estimated that at least 21% of the Spotted Owl habitat (in old-growth forests) in the Pacific Northwest must be preserved for persistence of Spotted Owls. This is in line with the preferred alternative of the Forest Service (except on the Olympic Peninsula), but there are a host of assumptions in Lande's modelling effort that require careful evaluation before accepting the 21% value proposed. The assumptions include (1) random spacing of habitat patches, (2) density dependence only based on juvenile dispersal and prospects for establishment in an unoccupied patch of habitat, (3) accurate characterization of Spotted Owl habitat, and (4) that the baseline population was in demographic equilibrium. Also, note that if old-growth habitat drops below 21%, Lande's model guarantees extinction. But, if old growth is maintained above 21% one can only conclude that the probability of extinction is something less than 1.0, i.e., the owls may still have a high probability of extinction.

It is perhaps too easy to be critical of these pioneering efforts at viability analysis, and it is even more difficult to offer alternatives. No clear guidelines exist for performing a viability analysis (Soule, 1987); therefore, one must view the Forest Service efforts as a commendable first attempt. Nevertheless, there is still much to be resolved both theoretically and empirically before much confidence can be placed in the management alternative for Spotted Owls promoted by the Forest Service.

PROPOSED ACTION BY THE FOREST SERVICE

The preferred alternative (Alternative F) offered by the U.S. Forest Service will maintain habitat for 2,180 pairs of Spotted Owls over the 15-year planning period (USDA, 1988). This constitutes 80% of the existing Spotted Owl habitat. The no-action alternative (Alternative A) with no restraint on old-growth forest harvest over current trends will allow habitat for 2,140 pairs or 79% of existing habitat. The 50-year projection predicts that habitat for only 60% of the pairs will remain under the preferred alternative whereas 62.5% of the pairs will be supported if the Forest Service were to invoke Alternative L (no further harvest of Spotted Owl habitats).

Although this appears at first to be only a token effort for Spotted Owl conservation by the Forest Service, the perceived costs to the timber industry are still a billion dollars, assuming that old-growth forests can be valued at $10,000 per hectare (Simberloff, 1987). If a moratorium on old-growth mining were instituted, the ultimate cost perceived by the timber industry may be as high as $10.4 billion.

To a conservationist, perhaps the most distressing part of the preferred alternative is the extent of risk accepted relative to persistence of the Spotted Owl population on the Olympic Peninsula of Washington. Even by the Forest Service's projections, there is a high probability that the small, apparently isolated population on the Olympic Peninsula will be extirpated as a consequence of habitat alteration within the planning period. If, in fact, this population is isolated, the proposed action would constitute a violation of the mandate given by the National Forest Management Act of 1976 that a viable population be maintained "which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is *well distributed* in the planning area" (USDA, 1988).

On the other hand, the validity of the assumption that the Olympic Peninsula population is isolated has not been established. Indeed, several pairs and scattered individuals have been found in developing forests south of the Olympic Peninsula (Irwin *et al.*, 1987). The value of the establishment of these individuals to a well-distributed population will only be significant if it is shown that they breed successfully and contribute to gene flow between subpopulations.

We question the proposal in the Final SEIS (USDA, 1988) to allocate smaller areas of old growth to SOHAs in core portions of the Spotted Owl range in central and southwestern Oregon. The justification for large SOHAs in Washington is that home ranges of pairs of birds are substantially larger than those in Oregon (Allen and Brewer, 1985; USDA, 1988). However, populations in the central Cascades of Washington have also been much less productive than those in central and southwestern Oregon. To maximize the chances of persistence for the Northern Spotted Owl, we suggest that SOHAs in Oregon should be at least as large as those set for Washington.

Finally, the U.S. Fish and Wildlife Service has recently recommended listing for the Northern Spotted Owl as a threatened species, affording it protection under the Endangered Species Act. At this time, there are a number of active and pending court cases involving Spotted Owls. It seems likely that federal courts and U.S. Congress will determine the ultimate fate of the Spotted Owl and old-growth forests in the Pacific Northwest.

CONCLUSIONS

1. It is essential that statistical reliability be evaluated in viability analyses for rare species.
2. Reliable projections of the probability of extinction using demographic models require enormous sample sizes; therefore, demographic projections cannot be justified in most viability analyses.
3. Exponential growth models such as the Euler equation or the Leslie matrix are inappropriate for projecting the probability of extinction in territorial species where density dependence stabilizes numbers.

4. Habitat fragmentation is an essential component of any realistic model of Spotted Owl viability. It appears that the greatest threats to extinction for Spotted Owls exist because of the potential for population fragmentation.
5. The Forest Service's preferred alternative in the Final SEIS (USDA, 1988) accepts considerable risk of extinction for the Spotted Owl population on the Olympic Peninsula. Furthermore we are concerned that the Forest Service is making the greatest efforts to preserve populations in Washington while allocating less habitat for productive populations in core areas of central and southwestern Oregon.

ACKNOWLEDGMENTS

We benefited from discussions and correspondence with Rollie Lamberson, Charles Biles, Barry Noon, David Wilcove, Gordon Orians, Andy Stahl, Harriet Allen, Bruce Marcot, H. Holthausen, K. Johnson, David Ligon, Jim Nichols, K. O'Halloran, Mark Shaffer, and members of the Northwest Forest Resource Council. Thanks to E. H. Merrill for reviewing the manuscript. We received support from the National Council of the Paper Industry for Air and Stream Improvement and the Wyoming Water Research Center.

LITERATURE CITED

Allen, H. L. & L. W. Brewer. 1985. A review of current northern Spotted Owl (*Strix occidentalis caurina*) research in Washington state. *In*: R. J. Gutierrez and A. B. Carey (eds.) Ecology and management of the spotted owl in the Pacific Northwest. pp. 55-57. USDA-Forest Service Gen. Tech. Rep. PNW-185.

Boyce, M. S. 1977. Population growth with stochastic fluctuations in the life table. Theor. Popul. Biol. 12: 366-373.

__________. 1987. A review of the U. S. Forest Service's viability analysis for the spotted owl. National Council for Air and Stream Improvement, Corvallis, OR.

__________. & D. J. Daley. 1980. Population tracking of fluctuating environments and natural selection for tracking ability. Am. Nat. 115: 480-491.

Forsman, E. D., E. C. Meslow & H. M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildl. Monogr. no. 87.

Irwin, L. L., T. L. Fleming & S. M. Speich. 1987. Spotted owl presence and habitat components in younger forests: A progress report. National Council for Air and Stream Improvement, Corvallis, OR.

Lande, R. 1987. Extinction thresholds in demographic models of territorial populations. Am. Nat. 130: 624-635.

________. 1988. Demographic models of the northern spotted owl (*Strix occidentalis caurina*). Oecologia 75: 601-607.

Lefkovitch, L. P. 1965. The study of population growth in organisms grouped by stages. Biometrics 21: 1-18.

Ludwig, D. 1975. Persistence of dynamical systems under random perturbation. S.I.A.M. Review 17: 605-640.

Meyer, J. S., C. G. Ingersoll, L. L. McDonald & M. S. Boyce. 1986. Estimating uncertainty in population growth rates: Jackknife vs. bootstrap techniques. Ecology 67: 1156-1166.

Simberloff, D. 1987. The spotted owl fracas: Mixing academic, applied, and political ecology. Ecology 68: 766-772.

Soule, M. E. 1987. Viable populations for conservation. Cambridge University Press, Cambridge.

Tuljapurkar, S. D. & S. H. Orzack. 1980. Population dynamics in variable environments. I. Long run growth rates and extinction. Theor. Popul. Biol. 18: 314-342.

USDA. 1986. Draft supplement to the environmental impact statement for an amendment to the Pacific Northwest Regional Guide. 2 Volumes. U. S. Forest Service, Portland, OR.

____. 1988. Final supplement to the environmental impact statement for an amendment to the pacific northwest regional guide. 2 Volumes. U. S. Forest Service, Portland, OR.

Wilcove, D. S. 1987. Public lands management and the fate of the spotted owl. Am. Birds 41: 361-367.