Chapter 1

A Conservation Assessment Framework for Forest Carnivores

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BACKGROUND

Controversy over managing public lands is neither an unexpected nor recent development. In the 1970's, debate over land management began to focus on the effects of timber management practices on wildlife. This was most evident in the Pacific Northwest where the public was beginning to express strong concerns about the effects of timber harvest in late-successional forests on northern spotted owls and other vertebrates. The focus on all vertebrates and not just "game animals" distinguished these concerns from earlier wildlife-related issues. In 1976, Congress passed the National Forest Management Act, which mandated the maintenance of biological diversity on lands of the National Forest System. Regulations enacted pursuant to this law specified that viable populations of native and desirable non-native wildlife species would be maintained on planning units (i.e., National Forests) of the National Forest System. Thus, a statutory and regulatory basis was provided for appeals and litigation directed at what the public believed to be the negative effects of timber management practices on wildlife. The many legal challenges that ensued focused primarily on the harvesting of late-successional forests in the Pacific Northwest (see Meslow et al. 1981 for additional discussion).

The USDA Forest Service responded to this situation in 1981 by chartering a research and development program aimed at studying the role of old-growth forests as wildlife habitat (Ruggiero et al. 1991). Early research efforts of this program focused on the ecology of spotted owls, a species at the center of the most intense debate. Although research was underway, legal challenges disrupted forest management activities, and the controversy was played out in legal and political arenas. Science was not called on as part of the solution until nearly a decade later, *after* the development of a political impasse in one of the country's most important timber-producing regions. In 1989, in response to this impasse, an interagency agreement between the major land management agencies established the "Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl." The charter of this group was later incorporated into law (Section 318 of Public Law 101-121), and a conservation strategy for the northern spotted resulted (Thomas et al. 1990). In 1991, Congress intervened directly by commissioning the Scientific Panel on Late-Successional Forest Ecosystems, whose mission was to make broad recommendations about management of the remaining old-growth forests in the Pacific Northwest (Johnson et al. 1991). And, in 1993, President Bill Clinton intervened and appointed a task force of scientists to evaluate the effects of alternative management scenarios for old-growth forests on all wildlife in the Pacific Northwest (Thomas et al. 1993a). This intervention included an unprecedented visit by a U.S. president to the site of a regional forest management/ wildlife controversy for the purpose of facilitating its end (the Forest Conference convened in Portland, Oregon, on April 2, 1993).

It is clear from these events that public concern over the effects of land management on wildlife is enormously important politically, economically, and scientifically. It is also clear that the conservation strategy for the northern spotted owl came too late. Nearly two decades passed from the first concerns over the conservation status of this subspecies until scientists were asked to develop a "scientifically credible" conservation strategy. The necessary commitment to scientific research, which is essential as the basis for any defensible conservation plan, was made too slowly. The resultant socio-political turmoil was likely avoidable, at least in part, and the controversy would not have been so intractable if better scientific information had been available earlier.

Concerns about wildlife conservation in relation to forest management are limited neither to the Pacific Northwest nor to spotted owls. Appeals and legal challenges of timber management activities, relative to effects on wildlife, are now common throughout the country. The potential for re-enactment of the Pacific Northwest/old-growth. scenario exists throughout the western United States. And there is growing public sentiment that serious attention to the conservation of biological diversity is long overdue outside the Pacific Northwest.

PURPOSE

To address this situation, the USDA Forest Service decided in 1993 to evaluate what is known about the biology and ecology of several species or groups of species that are potentially sensitive to the effects of forest management, including the harvest of late-successional forests. This so-called *conservation assessment* process is directed at interior cutthroat trout, bull trout, Pacific salmon, forest owls (flammulated, boreal and great-gray), marbled murrelet, northern goshawk, and forest carnivores (marten, fisher, lynx, and wolverine). The forest carnivores are included in this group because of their relatively large area requirements, their association with late-successional forests, and the relative lack of information available for conservation planning. In addition, most of the geographic ranges of forest carnivores (about 65% for the marten and fisher) are found on public lands, and the marten, fisher, and lynx have been judged to be at medium to high-viability risk due to the reduction of old-growth forests in the Pacific Northwest (Thomas et al. 1993a, 1993b).

The conservation assessment process is intended to produce three specific products for each of the species in question: an overview of the existing state of knowledge with regard to species biology and ecology; a discussion of the management considerations stemming from this knowledge; and recommendations for research needed to fill voids in existing knowledge. Our mandate did not include the development of specific management recommendations and none appear here. The conservation assessment process is intended to lay the foundation for developing conservation strategies for species of concern. Thus, knowledge voids are assessed in this context, and the research recommendations are intended to address the information needed for developing scientifically defensible conservation strategies. Conservation strategies build on conservation assessments by incorporating new information that results from assessment recommendations and by prescribing specific conservation measures needed to ensure population viability and species persistence. Research designed to fulfill assessment recommendations will result in an understanding of the ecology of each species. Only then can we determine whether particular silvicultural practices are consistent with forest carnivore population persistence and whether they may be used to manage each species' habitat.

OVERVIEW

The developing paradigm of conservation biology forms the basis for the forest carnivore conservation assessment. And, as outlined in the contents, we have attempted to address those biological and ecological topics that are central to the issue of maintaining viable populations of the species in question. Each species account (Chapters 2-5) addresses what is known about population ecology and demography, behavioral ecology, habitat requirements, movement ecology, and community interactions. These classes of information are fundamental to conservation planning. Knowledge of habitat requirements is essential for understanding the resources needed for species persistence. Community interactions mediate the use of these resources and hence must be understood for reliable conservation planning. Community interactions in the form of predator-prey relationships also can have a direct effect on population persistence. The vital rates of natality and mortality, along with an understanding of how the environment influences these rates, constitutes basic information for developing models of population persistence. And an understanding of how movement ecology relates to the potential connectedness of populations within metapopulation structures is equally basic to understanding population dynamics and estimating persistence probabilities. Finally, because behavior mediates all interactions between organisms and their environment, understanding fundamental behavioral patterns is important to understanding species' ecology. In each of these broad categories, we have also tried to identify areas where information basic to conservation planning is currently lacking.

It would be ecologically naive to assume that knowledge in any of the above areas could be extrapolated with equal validity to all populations across the geographic ranges of each forest carnivore species. Rather, we assume that ecotypic variation exists within these species. Although the amount of this variation is unknown, we stress its potential significance in formulating of conservation strategies. Accordingly, we have adopted an ecological stratification scheme (Appendix A) that we believe represents the major physiographic and ecological influences likely to effect ecotypic variation. Species distribution patterns are superimposed on this ecological stratification in Appendix B. For reasons presented above (see Chapter 7 for additional discussion), we have also used this framework to make geographically explicit research recommendations in Chapter 7. By doing this, we are stressing that important ecological differences may exist among species populations and we are also cautioning against overextrapolation of research results.

An important feature of our ecological stratification is the explicit delineation of important ecoprovinces that span the Canada-U.S. border. Forest carnivore populations in the United States represent the southern portions of species' ranges that are centered in Canada. This distribution pattern has important implications for conservation planning, and international cooperation in developing conservation strategies seems appropriate. The ecological framework provided here should facilitate such cooperation.

We have focused on the western U.S., exclusive of Alaska. The Tongass National Forest in Alaska is currently involved in important analyses of long-term species viability for marten and other species (Interagency Viable Population Committee-Iverson, pers. comm.). We have focused on the western conterminous United States because concerns about habitat reduction and landscape modification through management appear to be most urgent in this area. Moreover, all four forest carnivore species are sympatric in portions of this area, thus affording the opportunity for ecosystem studies that examine the common elements of their ecologies, including a common prey base.

THE QUANTITY AND QUALITY OF EXISTING INFORMATION

Research findings like those reviewed in this book must be evaluated in terms of the quantity and quality of information available on any given topic and for any given location. Such an evaluation should form the basis for judgments about the reliability and salience of information relative to decision-making or conservation planning (see Romesburg 1981 for a pertinent discussion). We have taken steps throughout this assessment to help the reader evaluate the quantity and quality of the information presented. There are at least six ways in which research results can be misleading or misinterpreted and thus misapplied in a conservation assessment. These are discussed below.

Geographic Limitations

Existing information may be the result of research conducted at only one or a few geographic locations. Research results from a specific geographic area may be unreliable or even misleading when applied to other locations. The risks associated with such extrapolations generally increase as distances increase and ecological conditions become increasingly dissimilar. This is equally true when numerous studies have been conducted in the same geographic location. Although numerous studies may add to the reliability or breadth of knowledge as it applies to the geographic area of investigation, multiple studies from the same or very similar study areas do little to increase the value of the resultant information relative to other geographic areas with different ecological conditions.

Extensive Information From Few Studies

While single studies may provide important knowledge, insight, or even understanding, multiple studies provide scientific corroboration of these results. Accordingly, reliable bodies of knowledge are usually based on well-documented concordance among results of independent investigations. It follows that a literature review based on 10 studies does not reveal as strong an information base as the same review based on 20 or more studies. This is equally true when one or a few studies cover many topics, as is the case in many natural history studies (especially of the thesis or dissertation genre). This situation leads to copious citations and the documentation of findings across a broad array of topics, sometimes creating the false impression of an extensive body of information.

Small Sample Sizes and/or Highly Variable Results

Small sample sizes are related to anecdotal information in that the resultant information may fail to represent a meaningful or common natural condition or event. And, when little is known about a species, this type of inherently unreliable information tends to be repeated and applied without the necessary qualifiers. For example, our knowledge about the denning habitat requirements for lynx is based on very few actual den sites. In spite of this, some authors will cite the studies involved and portray our knowledge on this topic as much more solid than it actually is. In many cases, this kind. of situation goes undetected by decision-makers or readers of review articles or management-oriented overviews. Similar problems occur when larger sample sizes reveal highly variable findings, which are! then reported as a simple mean value without appropriate statistical qualifiers and professional interpretation.

Ambiguous Parameters and Problems of Scale

Some parameters are inherently ambiguous, and conclusions based on data resulting from the measurement of such parameters can be misleading. For example, simple occurrence of animals in some habitat says little about habitat requirements, and even intensive measures of parameters like density can sometimes be misleading (Van Horne 1983). In spite of this understanding, observations of animals occurring in particular environments are sometimes incorrectly reported as indicative of specific habitat requirements or a lack thereof (see Chapter 7 for additional discussion). Similarly, a species may conduct different activities in different habitats, as in the case of foraging and denning habitats. These habitats may be strikingly different but both are essential. A general description of the habitat requirements of the species should consider the availability of each type and their spatial juxtapositions.

Problems of scale arise when individuals within populations are sampled and the resultant parameter estimates are applied to the entire species. This seemingly obvious and easily avoidable problem is quite common, especially when ecological results are applied or interpreted in a management context (Ruggiero et al. 1994).

Definition of Terms and Inappropriate Inference

The issue of old-growth forest as important habitat for forest carnivores is laden with philosophical and semantic problems that can hinder communication about habitat requirements. "Old-growth" is a stage of forest development characterized by large components (e.g., logs, snags, live trees) and structural complexity (e.g., vertical and horizontal). These attributes vary as a function of vegetation type, site conditions, and disturbance history. Thus, in general, old growth is a concept rather than a specific set of conditions. Old-growth characteristics develop gradually as forests mature, so that there is no specific threshold where mature stands become old growth. Thus, the characteristics of late-successional forests (including the oldest forests) are what interest us as habitat for forest carnivores. In order to focus on the structural and compositional features of forest habitats, we have chosen to use the term *late-successional* forests when referring to mature and older forests that possess the attributes listed above.

Our work requires the definition of three additional terms: fragmentation, dispersal, and den site. "Fragmentation" occurs when a large expanse of habitat is transformed into a number of smaller patches of smaller total area, isolated from each other by a matrix of habitats unlike the original (Wilcove et al. 1986:237). The process of fragmentation includes loss of stand area, loss of stand interior area, changes in relative or absolute amounts of stand edge, and changes in insularity (Turner 1989). "Dispersal" is important because it connotes the successful establishment (usually by juvenile animals) of a breeding territory in an area distant from the natal area. "Natal den sites" are important because they play a key role in recruitment by providing parturition sites. Inappropriate inferences about dispersal are made when authors confuse the long-distance movement capability of animals with their ability to successfully disperse. Inappropriate inferences about habitat requirements for denning are made when authors use the term "den" in reference to resting sites that are not associated with parturition or rearing of young. Similarly, there are important ecological differences between natal den sites (used for parturition) and other den sites that are used subsequent to parturition.

Inappropriate Methods

Using the wrong method to address the right question can result in inaccurate or incomplete answers. Questions about population structure and area requirements, for example, are germane to conservation planning. Information about area requirements is best obtained by well-designed (i.e., sufficient data over appropriately long time-periods) radio-telemetry studies. However, telemetry studies are expensive, and much information about the area requirements of forest carnivores has been derived from relocations of marked animals. There is an important distinction here with regard to the quality of resulting information. Similarly, questions about population structure have often been addressed by examining the carcasses of trapped animals. The quality of inferences from such data is questionable because the structure and dynamics of exploited populations differ from unexploited populations in ways that are poorly understood.

For the reasons discussed in this section, we have tried to provide a realistic view of the actual scientific knowledge base that forms the foundation of the species-account narratives. We have done this in each species account by including a tabular summary of existing studies by topic and including information on study location, duration, methodology, and sample size. Similarly, in Chapter 7 (table 1) we have represented the geographic distribution of existing knowledge for all 4 species in 10 topical areas of special importance to conservation planning. We have also asked the authors of each species account to provide their thoughts about management considerations that follow from the state of knowledge and to provide their recommendations about information still needed for develoment of conservation strategies for each species. In addition, we present a synthesis of these management considerations and information needs in Chapters 6 and 7, thus giving the reader two perspectives on these important aspects of the assessment.

MANAGEMENT CONSIDERATIONS AND INFORMATION NEEDS

As alluded to above, the state of scientific knowledge on forest carnivores carries with it certain implications for land management. Because the quantity and quality of information available for the western United States is limited, one such implication is that the conservation status of forest carnivores is itself uncertain. Thus, empirically based management strategies for species conservation cannot now be developed, and a significant commitment to research is needed.

This need for much additional information through research leads to a practical dilemma. Conservation planning draws on information from all aspects of a species' ecology. Accordingly, for little-studied (and difficult-to-study) species like the forest carnivores, the list of information needs is long indeed. And the need to replicate some studies to generate regionally generalizable information only expands the list of needed research. The dilemma, then, is how to be scientifically rigorous in prescribing needed research while also recognizing the practical limits of available resources and acknowledging real questions about the feasibility of collecting certain crucial information (e.g., vital rates for wolverine populations). Long lists of needed studies for even a single species are difficult to prioritize and often lead to a piecemeal approach to research whereby knowledge gaps persist. Problems of consistency and comparability arise, and studies are conducted on an opportunistic rather than a comprehensive and well-integrated basis.

Our solution to this problem is to avoid long "laundry lists" of needed research (although detailed information needs are included in each species account) in favor of a comprehensive, programmatic approach to producing the information needed for developing conservation strategies for forest carnivores. In reality, most well-designed studies address multiple objectives or multiple information needs. Thus, we believe that for each species a few highly integrated and comprehensive studies replicated in the geographic areas of concern will satisfy existing information needs for conservation planning (see Chapter 7 for additional discussion). We believe this approach will result in high levels of consistency, a comprehensive body of knowledge, and optimal use of available resources. Unfortunately, it will also take considerable time, expense, and effort. This should not, however, deter managers from developing conservative interim guidelines that will maintain future options.

LITERATURE CITED

Johnson, K.N; Franklin, J.F.; Thomas, J.W. [et al.]. 1991. Alternatives for management of late-successional forests of the Pacific Northwest. A report to the Agriculture Committee and the Merchant Marine and Fisheries Committee of the U.S. House of Representatives; 1991 October 8. Corvallis, OR: College of Forestry, Oregon State University; Seattle, WA: College of Forest Resources, University of Washington; La Grande, OR: U.S. Department of Agriculture, Pacific Northwest Research Station; New Haven, CT: School of Forestry and Environmental Studies, Yale University: The Scientific Panel on Late-Successional Forest Ecosystems. 59 p.

Meslow, E.C.; Maser, C; Verner, J. 1981. Old-growth forests as wildlife habitat. In: Transactions of the 46th North American Wildlife Natural Resource Conference; 1981. Washington, DC: Wildlife Management Institute; 46: 329-335.

Romesburg, H.C. 1981. Wildlife science: gaining reliable knowledge. Journal of Wildlife Management. 45(2): 293-313.

Ruggiero, L.F.; Hayward, G.D.; Squires, J.R. 1994. Viability analysis in biological evaluations: concepts of population viability analysis, biological populations, and ecological scale. Conservation Biology. 8(2): 364-372.

Ruggiero, L.F.; Aubry, K.B.; Carey, A.B. [et al.]. 1991. Wildlife and vegetation of unmanaged Douglas-fir forests. Gen. Tech. Rep. PNW-285. Portland, OR: U.S. Department of Agriculture, Pacific Northwest Forest and Range Experiment Station. 533 p.

Thomas, J.W.; Forsman, E.D.; Lint, J.B. [et al.]. 1990. A conservation strategy for the northern spotted owl. Portland OR: A report prepared by the Interagency Scientific Committee to address the conservation of the northern spotted owl. U.S. Department of Agriculture, Forest Service; U.S. Department of Interior, Bureau of Land Management, Fish and Wildlife Service, National Park Service. Washington, DC: U.S. Government Printing Office. 427 p.

Thomas, J.W.; Raphael, M.G.; Meslow, E.C. [et al.]. 1993a. Forest ecosystem management: an ecological, economic, and social assessment. Portland, OR: A report prepared by the Forest Ecosystem Management Assessment Team. U.S. Department of Agriculture, Forest Service; U.S. Department of Commerce, National Marine Fisheries; U.S. Department of the Interior, Bureau of Land Management, Fish and Wildlife Service, National Park Service; Environmental Protection Agency. 794-478. Washington, DC: U.S. Government Printing Office.

Thomas, J.W.; Raphael, M.G.; Anthony, R.G. [et al.]. 1993b. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 523 p.

Turner, M.G. 1989. Landscape ecology: the effect of pattern on process. Annual Review of Ecological Systematics. 20: 171-197.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management. 47: 893-901.

Wilcove, D.S.; McLellan, C.H.; Dobson, A.P. 1986. Habitat fragmentation in the temperate zone. In: Soulé, M.E., ed. Conservation Biology: The Science of Scarcity and Diversity. Sunderland, MA: Sinauer Associates, Inc.: 237.