# Conservation Planning for US National Forests: Conducting Comprehensive Biodiversity Assessments

BARRY R. NOON, DENNIS D. MURPHY, STEVEN R. BEISSINGER, MARK L. SHAFFER, AND DOMINICK DELLASALA

*The US Forest Service has proposed new regulations under the National Forest Management Act that would replace a long-standing requirement that the agency manage its lands "to maintain viable populations of existing native and desired non-native vertebrate species." In its place, the Forest Service would be obligated merely to assess ecosystem and species diversity. A landscape assessment process would rely on ecosystem-level surrogate measures, such as maps of vegetation communities and soils, to estimate species diversity. Reliance on such "coarse-filter" assessment techniques is problematic because there tends to be poor concordance between species distributions predicted by vegetation models and observations from species surveys. The proposed changes would increase the likelihood of continued declines in biodiversity and fail to address the original intent of the act. We contend that responsible stewardship requires a comprehensive strategy that includes not only coarse-filter, ecosystem-level assessment but also fine-filter, species-level assessments and viability assessments for at-risk species.*

*Keywords: forestry, forests, management, policy, conservation*

**The US National Forest Management Act (NFMA) is** an essential statute for maintaining biotic diversity on 192 million acres of national forests and national grasslands. It was enacted in 1976 as reform legislation in response to environmental impacts from timber harvest, grazing, and mining on national forest lands, which the public and Congress found increasingly unacceptable (Wilkinson and Anderson 1987). Among many provisions for resource protection, a primary emphasis was the protection of individual species. The statutory language of NFMA requires management of the national forests and grasslands to "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives" (16 US Code 1604[g][3][B]). Since 1982, the regulations governing implementation of NFMA have addressed this diversity provision by requiring that "fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area" (36 Code of Federal Regulations, sec. 219.19, app. 13). Revisions to NFMA regulations adopted in 2000 retained the requirement for viable populations and expanded it to include all plant and animal species (Federal Register 65 [218]: 67514–67581).

Although NFMA has remained essentially unchanged since its enactment, the US Forest Service has now proposed regulations that eliminate an explicit population viability requirement and that restrict management responsibility to vertebrates and vascular plants (Federal Register 67 [235]: 72770–72816). The proposed regulations require only a "hierarchical, sequential approach to consider and assess both ecosystem diversity and species diversity" and that the Forest Service "identify species for which substantive evidence exists that continued persistence in the planning or assessment area is at risk, specific risks or threats to these species, and measures required for their conservation or restoration" (Federal Register 67 [235]: 72801). No specific language to compel species-level analyses of viability has been proposed. Moreover, the proposed regulations would subsume the existing species conservation requirement into a landscape assessment process that would use a variety of unproven

*Barry R. Noon (e-mail: brnoon@cnr.colostate.edu) is a professor in the Department of Fishery and Wildlife Biology, Graduate Degree Program in Ecology, at Colorado State University, Fort Collins, CO 80523. Dennis D. Murphy is director of the graduate program in Ecology, Evolution, and Conservation Biology at the University of Nevada, Reno, NV 89557. Steven R. Beissinger holds the A. Starker Leopold Chair of Wildlife Biology and is chair of the Department of Environmental Science, Policy, and Management at the University of California, Berkeley, CA 94720. Mark L. Shaffer is senior vice president for Programs at Defenders of Wildlife in Washington, DC 20005. Dominick DellaSala is director of the Klamath-Siskiyou Program for the World Wildlife Fund in Ashland, OR 97520.* 

ecosystem-level surrogates to estimate species diversity without necessarily examining the condition or status of individual species. Although not explicitly stated, the substance of these proposed regulations hinges on two underlying assumptions: (1) Land-use planning that relies solely on such "coarse-filter" (Hunter et al. 1988) approaches to assess the distributions and status of ecological communities is adequate to assess how well the needs of all their constituent species will be met, and (2) the uncertainty that accompanies indirect assessments of species status provided by coarse-filter tools is acceptable because species-level assessments are too difficult or too expensive to implement. These assumptions are not only counter to current understanding of the role and dynamics of specific species in sustaining ecosystem processes (e.g., Kinzig et al. 2002), they also negate the nature and appropriate role of population viability analyses in land-use planning.

## Inadequacies of assessments employing only a coarse-filter approach

To understand the functioning of any complex system, it is necessary to identify and attempt to elucidate the parts that it comprises. For ecological systems, the most fundamental "parts" are species. Sir Arthur Tansley originally defined ecosystems as biotic communities or assemblages of species and their physical environment in specific places (Tansley 1935). Directly contradicting this view of ecosystems as collections of interacting species, the proposed regulations focus resource assessments almost entirely on vegetation types and successional stages, geology, landforms, and soils. The logic behind this coarse-filter approach is that the majority of species can be protected by conserving examples of natural vegetation communities, obviating the need to evaluate the status of each species individually (Noss 1987, Noss and Cooperrider 1994).

The original intent of coarse-filter approaches to landscape planning was to provide distribution maps of land cover that could be used to inform the conservation of entire species assemblages, including communities of interacting or potentially interacting species (Jennings 2000, Groves et al. 2002). Broadscale applications of coarse-filter methods have relied on ecoregional classifications determined by a variety of measures of climate, substrate, and plant composition. However, they commonly and often exclusively default to dominant vegetation, because vegetation types can be assessed by remote-sensing technologies and have been linked, using general habitat models, to the distributions of many vertebrate species (Scott et al. 1993). For example, recent planning efforts by the Forest Service for 4.4 million hectares of public forests and grasslands in the Sierra Nevada of California assessed the effects of various management alternatives on vertebrate species using wildlife–habitat relationship models (Mayer and Laudenslayer 1988) to classify habitats based on three attributes—dominant vegetation type, successional stage, and canopy closure. When these models were coupled with a vegetation growth and yield model (Davis and Johnson 1987), they allowed a comparison of how competing forest management scenarios would be likely to affect future wildlife populations (Forest Service 2001).

Coarse-filter approaches to assess the viability of species for land-use planning purposes can provide cost-efficient, indirect methods of assessing species distributions, but to assess the viability of species, at least three assumptions must hold true: (1) Attributes that define the coarse filter (i.e., dominant vegetation types) are sufficient and reliable surrogates for habitat and can effectively predict the occurrence of a given species; (2) managing coarse-filter attributes will address the factor(s) currently limiting abundance, density, and persistence of each species; and (3) the spatial resolution of the coarse filter matches the scale at which given species respond to environmental heterogeneity. Although these assumptions may be valid for some species in many circumstances, especially species that are small-bodied, abundant, and tightly linked to a particular vegetation community, the likelihood that the assumptions are met for all, or even most, species in an assemblage is low. For that reason, landscape planning employs "fine-filter" assessments, which are based on direct measures of the status and trends of individual species or on models of population viability to evaluate the needs of species at risk of decline.

The utility of the coarse-filter approach has been tested for many individual species with equivocal success (see Scott et al. [2002]). In general, there has been poor concordance between predicted and observed distributions. Commission errors (false positives, or predictions that a species is present when it is absent) have been shown to be more common than omission errors (false negatives, or predictions that a species is absent when it is present) at spatial scales appropriate to regional conservation planning—for example, vertebrates in the state of Maine and in national parks in Utah and breeding birds in California (Edwards et al. 1996, Boone and Krohn 1999, 2000, Garrison et al. 2000, Garrison and Lupo 2002, Robertson et al. 2002). Thus, coarse-filter assessments often overestimate the presence and, presumably, the viability of species on the planning landscape.

Only by increasing the resolution of the coarse filter (which reduces the area predicted to be suitable habitat for the species), as well as the number of land-cover types (usually by stratifying the vegetation communities more finely), can commission and omission errors be simultaneously reduced (Karl et al. 2000). Prediction errors are also related to ecological attributes of a species: Species that are rare, colonial, or habitat specialists, or that have small home ranges, are most likely to be misclassified (Karl et al. 2000, Scott et al. 2002). The misclassified groups of species usually include those most likely to be at risk of population declines or extirpation—that is, those that should be targets of conservation planning efforts (McKinney 1997). In sum, these prediction errors suggest that employing a coarse-filter approach alone is inadequate to meet NFMA requirements to provide for the diversity and viability of plant and animal communities.

### Integrating the fine filter with population viability analysis

Coarse- and fine-filter approaches to conservation planning differ in both the extent and resolution of measurement employed and the targeted level of biological organization. In general, mapped coarse-filter attributes reflect higher-level processes and patterns that arise, for example, from disturbance processes that operate across entire landscapes. For pragmatic reasons, coarse-filter attributes considered during the planning process are often those that can be measured inexpensively using remote imagery. Coarse filters rarely will accurately reflect the complex and dynamic habitat requirements of any individual species. In contrast, a fine filter makes measurements directly at the species level for the subset of species whose habitat requirements were not captured by the attributes that define the coarse filter.

Neither coarse- nor fine-filter assessments alone can prescribe the extent or area of habitat necessary to maintain viable populations of plant and animal species on the landscape. Many rare and declining species are limited primarily by the availability of suitable habitat (Wilcove et al. 1998), and the viability of such species depends to a great extent on how much of their habitat is conserved. Population viability analysis (PVA) is an in-depth method of fine-filter assessment used to evaluate habitat loss or similar risk factors for specific species (Boyce 2002, Shaffer et al. 2002).

An assessment approach that includes both coarse and fine filters and PVA was recommended by the Committee of Scientists to the US Forest Service and incorporated into the 2000 NFMA regulations (COS 1999). In addition to rare and at-risk species, the committee recommended that two groups of species be evaluated using fine filters—those that provide comprehensive information on the state of a given ecosystem (indicator species) and those that play significant functional roles in ecosystems (focal species). The latter category includes species that contribute disproportionately to the transfer of matter and energy (e.g., keystone species), structure the environment and create opportunities for additional species (e.g., ecological engineers), or exercise control over competitive dominants, thereby promoting increased biotic diversity (e.g., strong interactors). Thus, fine-filter assessments might be needed for 10 to 50 of the 200 to 1100 species typically evaluated in regional planning efforts carried out by the Forest Service and may need to include select invertebrates as well as vertebrates and plants.

Formal PVAs are needed only for species in decline or at high risk or for species with such functional significance that their loss might have unacceptable ecological effects. Many methods of viability assessment exist to accommodate diverse sources and amounts of data (Beissinger and Westphal 1998, Andelman et al. 2001). All methods explicitly or implicitly require some sort of model that relates population dynamics to environmental variables, including variables affected by management. The range of available methods offers a tradeoff between complexity of analysis and generality of results.

Population viability analysis is neither inherently difficult nor expensive, but it does require thoughtful model choice and construction and good judgment in the implementation of analyses. Perhaps the most demanding aspect of building realistic PVA models for assessment of alternative management scenarios is acquisition of sufficient data to yield accurate and precise parameter estimates (Beissinger and Westphal 1998). These models then permit reliable assessments of alternative management scenarios (Noon and McKelvey 1996). The choice of models and data collection methods depends in part on the life history characteristics of the species to be assessed, the quality and quantity of existing data, the time and money available for additional data acquisition, and the resolution and extent of analysis (Beissinger and Westphal 1998, Andelman et al. 2001). A method that uses a formal mathematical model of analysis is often preferable to less quantitative methods for analyzing viability when there is sufficient knowledge of demography, dispersal, habitat use, and threats.

Currently, population viability analyses are required to address the viability requirements of NFMA. In the context of the act, viable populations consist of "self-sustaining and interacting populations that are well distributed through the species' range. Self-sustaining populations are those that are sufficiently abundant and have sufficient diversity to display the array of life history strategies and forms to provide for their long-term persistence and adaptability over time" (Federal Register 65 [218]: 67580–67581). Many population attributes included in this definition can be evaluated using population viability analyses, but they cannot be addressed solely through the application of coarse-filter analyses.

### A scientifically credible approach to national forest planning

An expert panel convened by the National Center for Ecological Analysis and Synthesis, at the request of the Forest Service, concluded that "viability assessment is an essential component of ongoing forest management and forest planning processes. A variety of methods can and should be incorporated into viability assessments" (Andelman et al. 2001, p. 136). A scientifically credible approach to management of a diversity of plant and animal communities in US national forests and national grasslands combines coarse-filter and fine-filter approaches to identify conservation targets, including the judicious use of PVA for focal species and species at risk. Scientifically valid and pragmatic management does not require that the status of all species be directly assessed. But failure to detect declining species and to address the putative threats to their persistence leaves only the prohibitive provisions of the Endangered Species Act to serve as a safety net.

Although coarse-filter, fine-filter, and PVA assessment tools are imperfect, their weaknesses are sufficiently understood that the information they provide is, on balance, useful, and the Forest Service's failure to require their use is irresponsible. Insights provided by the use of these tools will inform managers about the condition of the ecosystems they are charged with protecting and the likely consequences of the management decisions they are empowered to make. Acting on these insights to change management practices when needed will aid biodiversity conservation and enable the Forest Service to meet its stewardship responsibilities.

## References cited


Andelman SJ, et al. 2001. Scientific Standards for Conducting Viability Assessments under the National Forest Management Act: Report and Recommendations of the NCEAS Working Group. Santa Barbara: National Center for Ecological Analysis and Synthesis, University of California. (2 November 2003; *www.fs.fed.us/psw/rsl/projects/wild/lee/lee3.pdf*)

Beissinger SR, Westphal MI. 1998. On the use of demographic models of population viability in endangered species management. Journal of Wildlife Management 62: 821–841.

Boone RB, Krohn WB. 1999. Modeling the occurrence of bird species: Are the errors predictable? Ecological Applications 9: 835–848.

———. 2000. Predicting broad-scale occurrences of vertebrates in patchy landscapes. Landscape Ecology 15: 63–74.

Boyce MS. 2002. Population viability analysis and conservation policy. Pages 41–49 in Beissinger SR, McCullough DR, eds. Population Viability Analysis. Chicago: University of Chicago Press.

[COS] Committee of Scientists. 1999. Sustaining the People's Lands: Recommendations for Stewardship of the National Forests and Grasslands into the Next Century. Washington (DC): US Department of Agriculture, Forest Service. (27 October 2003; *www.fs.fed.us/forum/nepa/rule/cosreport.shtml*)

Davis LS, Johnson KN. 1987. Forest Management. 3rd ed. New York: McGraw-Hill.

Edwards TC Jr, Deshler ET, Foster D, Moisen GG. 1996. Adequacy of wildlife habitat relation models for estimating spatial distributions of terrestrial vertebrates. Conservation Biology 10: 263–270.

Forest Service. 2001. Sierra Nevada Framework Forest Plan Amendment and Final Environmental Impact Statement. Sacramento (CA): US Department of Agriculture, Forest Service, Pacific Southwest Region.

Garrison BA, Lupo T. 2002. Accuracy of bird range maps based on habitat maps and habitat relationship models. Pages 367–375 in Scott JM, Heglund PJ, Morrison ML, Haufler JB, Raphael MG, Wall WA, Samson FB, eds. Predicting Species Occurrences: Issues of Accuracy and Scale. Washington (DC): Island Press.

Garrison BA, Erickson RA, Patten MA, Tomossi IC. 2000. Accuracy of wildlife model predictions for bird species occurrences in California counties. Wildlife Society Bulletin 28: 667–674.

Groves CR, Jensen DB, Valutis LL, Redford KH, Shaffer ML, Scott JM, Baumgartner JV, Higgins JV, Beck MW, Anderson MG. 2002. Planning for biodiversity conservation: Putting conservation science into practice. BioScience 52: 499–512.

Hunter ML Jr, Jacobson GL Jr, Webb T III. 1988. Paleoecology and the coarse-filter approach to maintaining biological diversity. Conservation Biology 2: 375–385.

Jennings MD. 2000. Gap analysis: Concepts, methods, and recent results. Landscape Ecology 15: 5–20.

Karl JW, Wright NM, Heglund PJ, Garton EO, Scott JM, Hutto RL. 2000. Sensitivity of species habitat relationship model performance to factors of scale. Ecological Applications 10: 1690–1705.

Kinzig AP, Pacala SW, Tilman D. 2002. The Functional Consequences of Biodiversity: Empirical Progress and Theoretical Expectations. Princeton (NJ): Princeton University Press.

Mayer KE, Laudenslayer WF Jr, eds. 1988. A Guide to the Wildlife Habitats of California. Sacramento: California Department of Forestry and Fire Protection.

McKinney ML. 1997. Extinction vulnerability and selectivity: Combining ecological and paleontological views. Annual Review of Ecology and Systematics 28: 495–516.

Noon BR, McKelvey KS. 1996. Management of the spotted owl: A case history in conservation biology. Annual Review of Ecology and Systematics 27: 135–162.

Noss R. 1987. From plant communities to landscapes in conservation inventories: A look at The Nature Conservancy (USA). Biological Conservation 41: 11–37.

Noss R, Cooperrider AY. 1994. Saving Nature's Legacy. Washington (DC): Island Press.

Robertsen MJ, Temple SA, Coleman J. 2002. Pages 399–410 in Scott JM, Heglund PJ, Morrison ML, Haufler JB, Raphael MG, Wall WA, Samson FB, eds. Predicting Species Occurrences: Issues of Accuracy and Scale. Washington (DC): Island Press.

Scott JM, et al. 1993. Gap analysis: A geographic approach to protection of biological diversity. Wildlife Monographs 123: 1–41.

Scott JM, Heglund PJ, Morrison ML, Haufler JB, Raphael MG, Wall WA, Samson FB, eds. 2002. Predicting Species Occurrences: Issues of Accuracy and Scale. Washington (DC): Island Press.

Shaffer M, Hood-Watchman L, Snape WJ III, Latchis IK. 2002. Population viability analysis and conservation policy. Pages 123–146 in Beissinger SR, McCullough DR, eds. Population Viability Analysis. Chicago: University of Chicago Press.

Tansley AG. 1935. The use and abuse of vegetational concepts and terms. Ecology 16: 284–307.

Wilcove DS, Rothstein D, Dubow J, Phillips A, Losos E. 1998. Quantifying threats to imperiled species in the United States. BioScience 48: 607–615.

Wilkinson CF, Anderson HM. 1987. Land and Resource Planning in the National Forests. Washington (DC): Island Press.