

Chapter 8

Summary

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Most ornithological studies in Southwestern ponderosa pine forests have yielded results that are applicable only to the specific location and particular conditions of the study areas (for example, Green 1979 and Hurlbert 1984). In addition, varying interpretation of similar study results by investigators has limited our ability to extend or synthesize research results from Southwestern ponderosa pine forests beyond the scope of any individual study. In studies that address similar questions and have similar results, broader inferences are possible.

Isolated studies of selected aspects of songbird ecology will not provide the level of resolution required to answer complex research questions and management problems. Therefore, decision makers should review our research recommendations and commit adequate financial and institutional support to incorporate them into a coordinated research program that systematically addresses these research needs. Developing management approaches to research needs that also meet societal demands will only occur when the USDA Forest Service, USDI Fish and Wildlife Service, state resource agencies, public advocacy groups, and other organizations agree that a more comprehensive understanding of ponderosa pine forest ecology is mandatory for management of Southwestern ponderosa pine forests and their avifauna.

Ponderosa Pine Forest Ecology

Ponderosa pine forests today differ drastically from those before European settlement of the Southwest (Covington and Wagner 1996; Moir et al., this volume). Many of these changes resulted from past land-use activities, primarily since European settlement (Raish et al., this volume; Scurlock and Finch, this volume). The foremost activities leading to forest change include logging, fuelwood harvest, fire suppression, livestock grazing, and urban development (Finch et al., this volume; Raish et al., this volume; Scurlock and Finch, this volume). The singular, synergistic, and cumulative impacts of these land uses have resulted in overstocked forests that exhibit 1) size-class distributions skewed toward smaller trees, 2) unnaturally high levels of disease and pathogens, 3) high susceptibility to catastrophic crown fires, 4) depleted woody and herbaceous understories, and 5) altered ecological relationships and ecosystem processes (Moir et al., this volume).

If we hope to evaluate population changes of birds inhabiting ponderosa pine forests, we must understand how their habitats have changed. Our knowledge of presettlement or reference ponderosa pine forests is limited to the results of retrospective studies, archaeological records, and exploration narratives (for example, Covington and Wagner 1996; and Scurlock and Finch, this volume). Although these descriptions provide useful models of presettlement forest patterns, the models are general, lacking detail about the range of variation that existed before intensive forest management (Reynolds et al. 1996). Presettlement or reference states for Southwestern forests are typically inferred from conditions existing in the late 1800s (Covington and Moore 1994). This assumes that historical conditions recorded during this time period are representative of prehistoric and Mexican periods, but as Scurlock and Finch (this volume) described, American Indians and Spanish people used Southwestern forests and wildlife to varying degrees before Anglo-American colonization of the Southwest through the 1800s. Therefore, we question the reliance on the late 1800s as the appropriate period for inferring reference forest conditions demonstrating minimal human impact.

Ponderosa pine occupies a gradient from the upper elevation of the pinyon-juniper woodland to mixed-conifer forests. Most knowledge of presettlement conditions is derived from studies conducted within the mid-elevation zone (between pinyon-juniper and mixed-conifer) where ponderosa occurs as a climax species. Researchers generally agree that xerophytic ponderosa pine forests were more open with clumps of pine trees interspersed among grassy openings. These conditions were maintained by low-intensity ground fires every 2 to 12 years that limited tree regeneration and dense forests (Moir et al., this volume). Given these conditions and disturbance regimes, much of the presettlement xerophytic pine forest probably tended toward older, mature conditions (Covington and Moore 1994). Descriptions of mesophytic forests (for example, mixed conifer) where ponderosa pine is a seral species are less available, but many of these forests were more open before 1880 (Moir et al., this volume).

Our ability to characterize existing ponderosa pine forests is also somewhat limited. We have detailed information on forest structure and composition for some areas, but information is limited for most. From what we do know, much of the existing ponderosa pine forests are relatively dense because small, relatively young (<100 years old) trees have proliferated in response to human use of forested lands. Logging, fuelwood harvest, and cata-

strophic fire have reduced the numbers of large, mature ponderosa pine trees and snags over time (Raish et al., this volume). Areas where the forest was originally a mosaic of tree clumps and grassy openings have become continuous tree canopies as trees have invaded these openings. Fire regimes and disease pathways have been altered, rendering these forests at far more risk than they were historically. Where fire, insects, and disease once played key roles in maintaining forests, they can now devastate forests.

We are also observing shifts in the composition of these forests as a result of past forest management. In some ponderosa pine stands, the number of shade-tolerant conifers is increasing, moving the classification of some stands from ponderosa pine to mixed-conifer (Johnson 1994a). In existing mixed-conifer forests, an emphasis on harvesting mature ponderosa pine trees over other conifer species may be altering both stand structure and composition in favor of more shade-tolerant conifers such as Douglas-fir and white fir (USDI 1995).

A cornerstone to conserving avian populations in ponderosa pine forests is acquiring more detailed information about past and current forest conditions. Published research and existing knowledge (this volume) provide a good foundation from which we can proceed, but significant information gaps remain. In particular, we must understand the range of variation in key forest attributes both in reference ponderosa pine forests and in the forests that exist today. Managing ponderosa pine forests for one ecological condition may not provide the variation in conditions needed to support the variety of birds native to Southwestern pine forests (Miller 1996). Also required is the information and technology needed to evaluate forest conditions over large geographic areas. The ability to quantify and model spatial relationships of vegetative conditions, especially at the landscape and regional scales, is critical to understanding the dynamics of ponderosa pine ecosystems and evaluating areas in greatest need of remedial management actions.

Songbird Ecology

Most insightful studies of the ecology of ponderosa pine birds have been conducted within the past 40 years. These studies have been largely descriptive, although some small-scale experiments have been conducted. The most extensive descriptive study examined bird-habitat relationships within 23 stands representing gradients of ecological conditions in ponderosa pine and pine-oak forests of northern Arizona (Rosenstock 1996). This work with major studies by Szaro, Brawn, Blake, Balda, and others (for example, T. Martin's study in progress through the

Montana Cooperative Wildlife Research Unit, University of Montana) provides the basis for much of our current knowledge of songbird community ecology in Southwestern ponderosa pine forests (Finch et al., this volume; Hall et al., this volume). Knowledge gaps not addressed by community-level studies are captured to some extent by single-species studies conducted by investigators such as Marzluff and Martin (Marzluff, this volume; Finch et al., this volume; Hall et al., this volume).

Because most published studies of passerines are relatively recent, their results largely reflect ecological relationships in forests altered by human activities over the past century. Although archaeological records from prehistoric periods and historical ornithological accounts from expeditions and collections exist for the Southwest (Scurlock and Finch, this volume), these records document mostly presence and absence of bird species rather than avian abundances. Therefore, bird use of ponderosa pine forests reported in contemporary studies cannot be readily compared to historical accounts or archaeological finds. Consequently, we do not know if patterns of abundance and species composition of birds that we see today are similar to those of presettlement forests. Because the Southwest has undergone extensive climatic changes such as warming over geologic time, contemporary avifaunas in Southwestern ponderosa pine forests likely differ from prehistoric or historical avifaunas in response to natural forest changes alone (Johnson 1994b). That the Southwest was settled by different cultural groups at different periods of time, each group using forest and avian resources to different extents (Scurlock and Finch, this volume), further confounds interpretation of temporal and spatial changes in avifaunas.

If we assume, however, that the strongest or most consistent relationships that we detect in contemporary studies also existed in the past, then it could be instructive to evaluate whether habitat resources essential for specific bird species were available in presettlement forests. We could then speculate whether temporal changes in resource distributions or quantities would have been beneficial or detrimental to species' populations. For example, species that rely on large trees for an important aspect of their life history (such as nesting) may have been more abundant in the past when large trees were more abundant, whereas species that favor dense stands may have been less abundant historically.

Cavity-nesting species are perhaps the most studied group of birds in the Southwest (Balda 1975; Cunningham et al. 1980; Ffolliot 1983; Brawn and Balda 1983; Rosenstock 1996). Collectively, these studies emphasize the importance of snags, particularly large snags, as potential nesting substrates for these species. Results of Brawn's (1985) experimental research on secondary cavity-nesting birds and Rosenstock's (1996) observational research on both primary and secondary cavity nesters concur that snags

and nest substrates are limiting factors for many of these species. Miller's (1992) analysis of Breeding Bird Survey (BBS) data suggests that populations of the hairy woodpecker, acorn woodpecker, violet-green swallow, white-breasted nuthatch, pygmy nuthatch, mountain chickadee, and mountain bluebird are declining in the Southwest. If these declines are indeed real, then loss of snags that provide nest, foraging, and perch sites could be a contributing or even a primary factor explaining declining populations.

The loss of large trees in many ponderosa pine forests has also likely impacted populations and habitats of numerous species. Rosenstock (1996) found positive relationships between the relative abundance of large trees and breeding populations of violet-green swallows, brown creepers, house wrens, chipping sparrows, pygmy nuthatches, and northern flickers. All of these species except the chipping sparrow are bark-foraging species or require snags for nesting. Large trees may provide habitat for many arthropod prey of bark-foraging birds, and these bark-foraging birds may be morphologically adapted to forage more efficiently on the bark furrows of larger trees (Richardson 1942). For species such as the chipping sparrow and perhaps Grace's warbler, large trees provide elevated song posts and substrates for their open-cup nests. Thus, the loss of large trees not only curtails the sustained supply of large snags and nest cavities but may also reduce foraging substrates, song perches, and substrates for open-cup nests.

Changes to the forest understory, mainly the loss of structural and floristic diversity, have also altered habitats of a number of species. Gambel oak is an important understory component in pine-oak forests (Rosenstock 1996), and aspen is an important component of some early successional ponderosa pine forests. Unlike pines, large oaks and aspens often have natural or excavated cavities while still live. Characteristics of these cavities appear to be favored by some bird species over cavities in pine snags (Finch et al., this volume). Gambel oak provides acorn mast, and arthropods found on oaks add to the diversity of prey for insectivorous birds. We are observing loss of large Gambel oaks to fuelwood harvest and loss of aspen to pine succession in fire-excluded forests. Increased competition with pines for light as forest canopy cover increases may also explain declines of these deciduous trees. Further, heavy browsing by wildlife and livestock may be limiting regeneration of oak, aspen, and shrubs to replace those lost by natural or human causes (USDI 1995).

Grasses, forbs, and shrubs provide cover for ground-foraging and ground-nesting species. They also provide a variety of seeds, fruits, and nectar for granivorous (such as juncos, towhees, sparrows), frugivorous (such as thrushes), and nectivorous (such as hummingbirds) species. Since 1880, these herbaceous understories have been heavily impacted by livestock, elk, increased tree densities, and altered fire regimes. Undoubtedly, these changes

have affected the avifauna. Reductions in the amounts of seeds and fruits may be particularly important during the winter, when these foods are generally more available than arthropods.

Studies should continue to emphasize habitat and population ecology but must provide greater consideration of geographic variation, seasonality, spatial scale, and population demographics. Past management activities have reduced the amount of mature/old-growth ponderosa pine forest in the Southwest and the openness of stands. Older forests and open forests provide unique conditions used by various species (Siegel 1989, Finch et al. this volume). Researchers have identified some general habitat correlates for birds in late-successional forests, but additional research—especially experimental—that details the ultimate and proximate factors underlying avian selection of different ponderosa pine habitats could help to identify key forest attributes that might be emphasized in future forest management. New research should examine bird-habitat relationships in different ponderosa pine types, successional stages, and patch sizes across a gradient of spatial scales and management situations (commercial forests, wilderness areas, research natural areas, experimental forests). Research should also identify key site-level characteristics. At larger landscape scales, for example, bird-habitat relationships should consider patch size and shape, distance between patches, number of patches, and landscape mosaic patterns (Rich and Mehlhop, this volume).

Published information on bird-habitat relationships is limited both spatially and temporally. As noted by Rich and Mehlhop (this volume), knowledge of habitat relationships and population characteristics of ponderosa pine birds at the landscape level is virtually nonexistent for the Southwest. Many earlier studies suffer from little or no replication (number of sample plots within a similar condition or treatment), restricting the level of inference possible from the results. Also, most studies were relatively short-term (1–4 years) and were typically restricted to the breeding season. In addition, most breeding bird studies did not evaluate reproductive success or survival rates in relation to habitat elements. As a result, the full range of habitat use by resident species has not been sampled; habitat use by species that do not occupy Southwestern ponderosa pine forests during the breeding season (for example, most wintering and many migrating birds) has rarely been studied; temporal variation in bird communities is not well understood (Gaud et al. 1986; Hejl and Beedy 1986; Hall et al., this volume); and avian demographic responses to habitat variation need further study. Thus, our knowledge of habitat associations of birds in ponderosa pine is a credible start but is far from what we require to describe desired conditions to land managers.

Existing information on population trends and the population ecology of ponderosa pine birds provides good

baseline information but leaves many questions unanswered. Results from analyses of BBS and Christmas Bird Count (CBC) data, despite their weaknesses, can be used as a starting point to focus future monitoring and research efforts (which is indeed their intent). A logical start would be to increase the number of samples in ponderosa pine forests for both BBS and CBC and to allocate samples throughout the range of conditions found in these forests. Further, results from BBS or CBC data could be used as a basis for more intensive sampling efforts (see also Manley et al. 1993). For example, Miller's (1992) preliminary analysis of BBS data suggests that more species have declined than have increased in abundance over the past 30 years. Greater effort should be devoted to monitoring bird populations exhibiting these perceived declines. This more intensive monitoring should not be restricted to measures of absolute or relative abundance, but should also include estimates of other population parameters such as survival, reproduction, or turnover rates. Likely, research will be needed to determine which population parameter is the most sensitive index of population status prior to initiating intensive monitoring efforts.

Effects of Land-Use Activities

Numerous types of land and natural resource use have the potential of altering bird habitats, leading to spatial and temporal changes in bird populations (Rotenberry et al. 1995; Saab et al. 1995; Thompson et al. 1995). The primary current land uses discussed in this volume include timber harvest, fire, fire suppression, grazing by wildlife and livestock, recreation, and urbanization. At least three major factors complicate a study addressing the effects of any of these factors. The first is that natural events such as climate, succession, and numerous stochastic disturbances occur simultaneously with human impacts. Separating effects of natural events from human activities is extremely difficult. Second, where human activities occur, more than one type of activity usually takes place. For example, many forests that have undergone timber harvest have also been subjected to fire suppression and livestock grazing. Thus, the real effects of land use are likely synergistic rather than the results of any one factor acting singly. Third, effects of activities can become additive or even multiplicative over time. These cumulative effects, coupled with synergistic effects and effects of natural events, create a difficult and complicated puzzle to solve. That has not prevented researchers from attempting to address these questions in the past, nor should it dissuade researchers from doing so in the future. Limiting the number of variables under study can help to reduce the complexity of a study, and developing coopera-

tive research partnerships to conduct studies that address interactions among land uses may be the key to interpreting complex bird-habitat relationships. Regardless of how studies might be approached, understanding interactive cause-effect relationships of land use is critical for future management of Southwestern ponderosa pine forests and the conservation of the associated avifauna.

Observational studies are basically correlative and may not elucidate cause-effect relationships. Although the studies reviewed in this book have provided useful information, the interpretations that we have drawn from them are limited. The effects of various land uses, singly and in combination, are best studied using well-designed experiments. The need for experiments to understand the effects of land management on specific ecosystem attributes (including birds) is not a new concept (see Eberhardt and Thomas 1991; James and McCulloch 1995; USDI 1995). Such studies are rarely conducted because costs and logistical obstacles associated with implementing large-scale forest manipulations limit their application.

We recognize that the design and implementation of experiments is a daunting challenge (Carpenter et al. 1995). Granted, we can develop educated guesses based on available evidence as to how particular land uses might affect bird habitats, populations, and perhaps community dynamics, but we can rarely assign levels of assurance that our guesses are correct. Given that such studies would need to be both well replicated and conducted at large spatial scales, success of implementing experiments requires commitment and collaboration by public participants, resource-management agencies, and researchers. Treatments such as logging, fire, and grazing manipulations would need to be implemented by management agencies, following experimental designs developed in cooperation with researchers. Numerous opportunities exist to plan and design management treatments that allow for the implementation of research experiments (Carpenter et al. 1995). Taking advantage of these opportunities would resolve many key issues on forest passerine ecology.

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