SILVICULTURAL OPTIONS FOR MANAGING BIRDS IN NORTHERN HARDWOODS FORESTS IN EXTENSIVELY FORESTED LANDSCAPES

by David I. King and Richard M. DeGraaf

Developing silvicultural guidelines that consider the biological, aesthetic, and commercial values of forests can be a delicate balancing act. Because forests in the United States are to some degree under public control, either through the management review process in the case of public lands, or through legislative avenues in the case of private lands, the perceptions and opinions of the public are important factors shaping approaches to forest management. It is our opinion that much of the public debate on forest management issues suffers from a lack of good information on the effect of different management practices on the biological integrity of the forest. Without this information, efforts at a constructive dialogue are hampered by personal biases and uninformed emotional reactions. Our goal in this paper is to review and summarize the results of research we have conducted on the effects of silviculture on forest birds in the White Mountains of New Hampshire in an attempt to provide the building blocks for a constructive exchange on the appropriate manner in which to manage our forests.

Definition of Terms

First, we must define the silvicultural treatments we will consider. Our terminology differs in some cases from that of a silviculturalist, primarily because the silviculturalist is interested in what will eventually regenerate on the site, whereas we are interested in the structure of the forest at the time the management activity is carried out, or for a relatively short period of time thereafter. The management practices we will consider are the following:

- clearcutting, a practice in which all trees in the treated area are removed. In some cases, scattered trees are left standing to provide a seed source. Because this method results in trees beginning to grow at the same time, it belongs to a category of silvicultural techniques referred to as "even-aged management."
- partial cutting, in which as much as three-quarters of the trees are removed ("partial cutting" corresponds to methods the silviculturalist's lexicon refers to as the initial stages of a shelterwood cut, or to single tree selection).
- group selection, a specialized form of selective cutting in which small (half-acre or so) clearcuts are dispersed throughout a stand.

We have conducted research on all of the treatments mentioned above from 1979 to the present (DeGraaf 1991, DeGraaf 1995, DeGraaf et al. 1991, 1998, King et al. 1996, 1997, 1998a, 1998b, King and DeGraaf In Press). During the

course of our studies, we were fortunate to have the benefit of numerous studies on the effect of these treatments on the distribution of different bird species (e.g., Franzreb 1977, Webb et al. 1977, Franzreb and Ohmart 1978, Titterington et al. 1979, Crawford et al. 1981, Freedman et al. 1981, DeGraaf et al. 1991, Tobalske et al. 1991, Hagan et al. 1997, Norton and Hannon 1997). In some of these studies, bird distribution was described using the point-count method (Ralph et al. 1995), in which the researcher makes 1-3 visits to each survey point and records all the species seen or heard within a prescribed radius, which yields a measure of the relative abundance of each species, but not the actual number or position of bird territories. Alternatively, some researchers use the spot-mapping method to describe bird distribution (Robbins 1979). This is a more intensive method in which a greater number of visits are made to each site (generally more than ten). At each visit, the researcher records the location of all birds seen or heard. Using this information in combination with records of counter-singing individuals, the observer can describe the number, size, and location of bird territories. This information permits an analysis of the response of birds to silvicultural treatments that is far more detailed than a description of relative abundance (which is all that is yielded by the point-count technique); for example, spot mapping allows researchers to describe the positions of bird territories relative to clearcut edges (as in King et al. 1997).

Although studies employing these bird-survey techniques have yielded important information about the effect of silvicultural practices on the distribution of birds, at the inception of our studies very little was known about the effect of these treatments on avian reproductive success. This is an important omission, because birds often occupy habitat which is too marginal to support successful breeding (Gibbs and Faaborg 1990). Although in some cases we based our evaluation of a silvicultural system on its effect on bird community composition, we used reproductive success as the standard by which the quality of habitat must ultimately be measured. To accomplish this, we located bird nests in each study area by following individuals carrying nesting material or food. Once nests were found, we monitored their success by visiting them every 3-5 days. This allowed us to calculate a nest survival rate, which could then be compared with survival rates observed in areas subjected to other silvicultural treatments. However, the actual productivity of individual pairs is the ultimate indication of the success of individual pairs, and because birds often renest after initial failure, nest success is not necessarily an accurate indication of productivity. Therefore, we also mark birds with unique combinations of colored leg-bands, which allows us to assign renesting attempts, as well as periodic attempts at polygamy, to individual pairs. This allows us to quantify and compare the net reproductive success of individual birds living in different habitats.

Clearcutting

Clearcutting is perhaps the most reviled technique in the silviculturalist's repertoire. This is largely because clearcutting is too often employed not as a silvicultural technique, which implies attention to the effect of the treatment on the health of the regenerating stand, but as a resource extraction technique, in which it is simply the most efficient way to remove the maximum amount of wood fiber from a site.

Clearcutting has a dramatic effect on the forest bird community. Nearly all bird species present at the inception of clearcutting are no longer present at its completion (Conner and Adkisson 1977, Titterington et al. 1979, Costello 1995, DeGraaf 1991, King and DeGraaf In Press). However, clearcutting represents the initial stages in the development of a bird community as ecologically important as the mature forest bird community: the early-successional shrubland bird community (DeGraaf 1991, Schulte and Neimi 1998, King and DeGraaf In Press). The species diversity of the early-successional shrubland bird community is as high as the diversity found in mature forest (DeGraaf 1991, King and DeGraaf In Press). Furthermore, a large proportion of mature-forest birds that exhibit territorial behavior (for example, singing behavior) in early successional stands (such as 5-10 year old clearcuts) actually build nests in these habitats (King et al. In Prep). These include Red-eyed Vireo (*Vireo olivaceus*), Rose-breasted Grosbeak (*Pheucticus ludovicianus*), Black-and-white Warbler (*Mniotilta varia*), American Redstart (*Setophaga ruticilla*), and Swainson's Thrush (*Catharus ustulatus*). In contrast, few early-successional shrubland bird species, such as Common Yellowthroat (*Geothlypis trichas*), Chestnut-sided Warbler (*Dendroica pensylvanica*), and Alder Flycatcher (*Empidonax alnorum*), nest in mature forest (King and DeGraaf, unpublished data). Finally, in the northeast, early-successional shrubland birds are declining at a greater rate than mature forest birds, a fact that is attributed to their relatively narrow habitat requirements and the loss of early-successional habitats due to forest maturation over the past century (Askins 1993).

We mentioned earlier that reproductive success is the gold standard of habitat quality; how do nest predation rates compare between mature forest and early-successional shrubland habitat? Nest survival (the probability of the average nest surviving to fledge at least one young) of Ovenbird nests was 50-60 percent in mature northern hardwoods forest (King et al. 1996), a figure similar to that cited for a variety of forest-nesting passerines (Martin 1992). In comparison, nest survival at our sites in 4-8 year old clearcuts of about 10 hectares (twenty-five acres) in size averaged 80 percent, and ranged as high as 100 percent (King and DeGraaf In Press). High nest survival rates in clearcuts are probably due to high levels of nest concealment (Rudnicky and Hunter 1993) and low predator abundance (King et al. 1998a) in recently harvested areas.

Although clearcutting is beneficial to birds in some ways, clearcutting may negatively affect birds in adjacent forest. In one year of a two-year study, Ovenbird nests within mature forest that were 200 meters or less from clearcut borders were twice as likely to be depredated as nests farther than 200 meters from clearcut borders (King et al. 1996). Furthermore, nest predation rates on artificial nests (salvaged bird nests baited with domestic finch eggs designed to simulate actual nests) near clearcut borders were twice as likely to be depredated than nests farther away (King at al. 1998a). Although the use of artificial nests has been widely criticized (DeGraaf and Maier 1996), the use of salvaged bird nests baited with small-sized eggs may avoid many of the biases associated with egg size and nest appearance that are inherent in artificial nest studies that have employed *Coturnix* quail eggs and artificial wicker nests (King et al. 1999). Higher predation rates near clearcut borders are probably the result of the concentration of predator species near edges (King et al. 1997), a behavior that may enable them to utilize food resources within the clearcut yet also benefit from the cover provided by the mature forest. Increases in edge-related nest predation can potentially have serious consequences for mature-forest birds if the habitat becomes too fragmented (Thompson 1993). However, in heavily forested ecosystems, such as the White Mountain National Forest, where less than ten percent of the landscape is in the shrub/sapling stage (U.S. Forest Service 1986, page III-30), there is enough forest interior habitat to ensure the viability of mature-forest bird communities (DeGraaf and Angelstam 1993). Further, the species composition of mature-forest bird communities (Welsh and Healy 1993) and predation rates on artificial nests (DeGraaf 1995) do not differ between managed and unmanaged areas of the White Mountain National Forest.

Partial Cutting

The various forms of partial cutting are widely perceived as more benign forms of silviculture because the alteration of the structure of the stand is less dramatic than that resulting from clearcutting. However, this very feature of partial cutting — the fact that it results in a bird community that is intermediate between a clearcut and a mature forest (Freedman et al. 1981, Annand and Thompson 1997, King and DeGraaf In Press) — is the key to understanding its limitations in bird habitat management.

But because partial cutting creates forest conditions (basal area, canopy closure and shrub density) that are intermediate between clearcuts and mature forest (King and DeGraaf In Press), this treatment fails to provide habitat suitable for birds that are specialists of early-successional shrubland, such as the Alder Flycatcher, or mature forest, such as the Scarlet Tanager (*Piranga olivacea*) or the Brown Creeper (*Certhia americana*). Thus, partial cutting best accommodates bird species that have relatively wide habitat tolerances, and least accommodates bird species with specialized habitat requirements. As the result

of the overlap of relatively generalized early-successional shrubland and mature-forest bird species in partial-cut stands, species diversity is often greatest in these stands (King and DeGraaf In Press). However, it must be emphasized that when examined beyond the level of individual stands, species diversity is lower, because the most specialized early-successional shrubland and mature-forest birds are relatively scarce or absent from forests in which even-aged management is absent (Welsh and Healy 1993).

Group Selection

Group selection represents a special case of selective cutting in that the habitat conditions in terms of plant species composition and vegetation structure are similar to a clearcut. The primary difference is in habitat area: clearcuts on the White Mountain National Forest are by definition larger than 2-3 acres (about one hectare), whereas groupcuts are generally a fraction of an acre in size. Thus, although several early-successional shrubland bird species — such as Alder Flycatcher, White-throated Sparrow (*Zonotrichia albicollis*), and American Goldfinch (*Carduelis tristis*) — characteristic of clearcuts are less abundant or absent in groupcuts, it is because these species exhibit area sensitivity and avoid smaller habitat patches (Rudnicky and Hunter 1993, Costello 1995, Annand and Thompson 1997).

Although there are differences between clearcuts and groupcuts in bird species composition, many species characteristic of clearcuts do occur in groupcuts (Costello 1995, Annand and Thompson 1997). However, it is important to know whether these birds are actually breeding successfully in clearcuts. In a three year study, we found that the nesting success of birds nesting in early-successional habitat, which included Chestnut-sided Warbler, American Redstart, Swainson's Thrush, Veery (*Catharus fuscescens*), Rose-breasted Grosbeak, Alder Flycatcher, Black-throated Blue Warbler (*Dendroica caerulescens*), Magnolia Warbler (*Dendroica magnolia*), White-throated Sparrow, Common Yellowthroat, Indigo Bunting (*Passerina cyanea*), Red-eyed Vireo, Gray Catbird (*Dumetella carolinensis*), Hermit Thrush (*Catharus guttatus*), American Goldfinch, and Cedar Waxwing (*Bombycilla cedrorum*), did not differ between clearcuts of about ten hectares (twenty-five acres) and groupcuts 0.2-0.7 hectares (about 0.5 to 1.7 acres) in size (King et al. In Prep). Furthermore, the fledging success of color-banded Chestnut-sided Warblers did not differ between clearcuts and groupcuts (King et al. In Prep).

This is good news for the subset of species that are characteristic of clearcuts but that occur in groupcuts, as well. However, groupcuts create more edge per unit area than clearcuts, and nest predation on birds nesting within forest adjacent to groupcuts is higher than in forest interior (King et al. 1998b), which could potentially compromise the viability of mature-forest birds nesting in stands managed by groupcutting (Thompson 1993). Thus, groupcutting

appears to present a similar condition to that of partial cutting: the resulting habitat conditions created are an unhappy compromise between the needs of early-successional and mature-forest birds.

In conclusion, both mature forest and early-successional habitat created by clearcutting have unique bird communities. The bird communities in stands of intermediate conditions, such as those treated with partial-cutting techniques, do not fully represent either mature-forest or early-successional bird communities as the result of the paucity of specialist species. We predict that reliance on partial-cutting techniques exclusively in the White Mountain National Forest would result in decreases of populations of mature-forest and early-successional shrubland specialist bird species. We believe that the purposes of bird conservation in forested landscapes can best be served by employing a variety of silvicultural techniques, including even-aged management.

Acknowledgments

We wish to thank the following for their valuable help in the field: B. Banks, K. Ellison, D, Godek, F. Kieth, M. LeConte, J. Milam, J. Neely, S. Schmidt, M. Stoddard and A. Workman. Additional logistical support and advice was provided by C. Costello of the USDA Forest Service Bartlett Experimental Forest, and the staff of the Saco, Androscoggin, and Ammonusic Districts of the White Mountain National Forest. J. Kirn and T. Maier supplied eggs used in artificial nest experiments. Our research has benefitted by comments from or discussion with the following people: D. Albano, C. Costello, T. Donovan, R. Holmes, P. Houlihan, P. Hunt, D. Kroodsma, T. Maier, W. McComb, J. Milam, S. Robinson, R. Schauffler, and R. Yahner.

REFERENCES

Annand, E., and F.R. Thompson, III. 1997. Forest bird response to regeneration practices in central hardwood forests. *Journal of Wildlife Management* 61:159-171.

Askins R.A. 1993. Population trends in grassland, shrubland, and forest birds in eastern North America. *Current Ornithology* 11:1-34.

Conner, R.N., and C.S. Adkisson. 1977. Effects of clearcutting on the diversity of breeding birds. *Journal of Forestry* 73:781-785.

Costello, C. 1995. Songbird response to group selection harvests and clearcuts in the White Mountains National Forest. M.S. Thesis, University New Hampshire, Durham. 94 pp.

Crawford, H.S., R.G. Hooper, and R.W. Titterington. 1981. Songbird population response to silvicultural practices in central Appalachian hardwoods. *Journal of Wildlife Management* 45:680-692.

DeGraaf, R.M. 1991. Breeding bird assemblages in managed northern hardwoods forests in New England. Pages 154-171 in *Wildlife and Habitats in Managed Landscapes* (J. E. Rodiek and E. G. Bolen, Eds.). Washington, D.C. Island Press.

DeGraaf, R.M. 1995. Nest predation in managed and reserved extensive northern hardwood forests. *Forest Ecology and Management* 79:227-234.

DeGraaf, R.M., and P. Angelstam. 1993. Effects of timber size-class on predation of artificial nests in extensive forest. *Forest Ecology and Management* 61:127-136.

DeGraaf, R.M., W.M. Healy, and R. Brooks. 1991. Effects of thinning and deer browsing on breeding birds in New England oak woodlands. *Forest Ecology and Management* 41:179-191.

DeGraaf, R.M., J.B. Hestbeck, and M. Yamasaki. 1998. Associations between breeding bird abundance and stand structure in the White Mountains, New Hampshire and Maine, USA. *Forest Ecology and Management* 103:217-233.

DeGraaf, R.M., and T.J. Maier. 1996. Effect of egg size on predation by white-footed mice. *Wilson Bulletin* 108:535-539.

Franzreb, K.E. 1977. Bird population changes after timber harvesting of a mixed conifer forest in Arizona. USDA Forest Service Research Paper RM-184. 26 pp.

Franzreb, K.E., and R.D. Ohmart. 1978. The effects of timber harvesting on breeding birds in a mixed-conifer forest. *Condor* 80:431-441.

Freedman, B., C. Beauchamp, I.A. McLaren, and S.I. Tingly. 1981. Forestry practices and populations of breeding birds in a hardwood forest in Nova Scotia. *Canadian Field Naturalist* 95:307-311.

Gibbs, J.P., and J. Faaborg. 1990. Estimating the viability of Ovenbird and Kentucky Warbler populations in forest fragments. *Conservation Biology* 24:193-196.

Hagan, J.M., P.S. McKinley, A.L. Meehan, and S.L. Grove. 1997. Diversity and abundance of landbirds in a northeastern industrial forest. *Journal of Wildlife Management* 61:718-735.

Hansen, A.J., W.C. McComb, R. Vega, M.G. Raphael, and M. Hunter. 1995. Bird habitat relationships in natural and managed forests in the West Cascades of Oregon. *Ecological Applications* 5:555-569.

Kilgore, B.M. Response of breeding bird populations to habitat changes in a giant sequoia forest. *American Midland Naturalist* 85:135-152.

King, D.I., C.R. Griffin, and R.M. DeGraaf. 1996. Effect of clearcutting on habitat use and reproductive success of the Ovenbird in forested landscapes. *Conservation Biology* 10:1380-1386.

King, D.I., C.R. Griffin, and R.M. DeGraaf. 1997. Effect of clearcut borders on distribution and abundance of forest birds in northern New Hampshire. *Wilson Bulletin* 102:239-245.

King, D.I., R.M. DeGraaf, and C.R. Griffin. 1998a. Edge-related nest predation in clearcut and groupcut stands. *Conservation Biology* 12:1412-1415.

King, D.I., R.M. DeGraaf, and C.R. Griffin. 1998b. Nest predator distribution among clearcut forest, forest edge and forest interior in an extensively forested landscape. *Forest Ecology and Management* 104:151-156.

King, D.I., R.M. DeGraaf, C.R. Griffin, and T.J. Maier. 1999. Do predation rates on artificial nests accurately reflect predation rates on natural bird nests? *Journal of Field Ornithology* 70:257-262.

King, D.I., and R.M. DeGraaf. In press, *Forest Ecology and Management*. Bird species diversity and nesting-success in partial-cut forests in northern New Hampshire.

Martin T.E. 1992. Breeding productivity considerations: What are the appropriate habitat features for management? Pages 455-473 in *Ecology and Conservation of Neotropical Migrant Landbirds* (J.M. Hagan III and D.W. Johnston, Eds.). Washington, D.C. Smithsonian Institution Press.

Maurer, B.A., L.B. McArthur, and R.C. Whitmore. 1981. Effects of logging on guild structure of a forest bird community in West Virginia. *American Birds* 35:11-13.

Morrison, M., B.G. Marcot, and R.W. Mannan. 1992. *Wildlife-habitat Relationships: Concepts and Applications*. Madison, Wisconsin: University of Wisconsin Press.

Norton, M.R. and S.J. Hannon. 1997. Songbird response to partial-cut logging in the boreal mixedwood forest of Alberta. *Canadian Journal of Forest Research* 27:44-53.

Probst, J.R. 1979. Oak forest bird communities. Pages 80-88 in *Management of Northcentral and Northeastern Forests for Nongame Birds* (R.M. DeGraaf and K.E. Evans, Eds.). US Forest Service General Technical Report NC-51, Minneapolis, Minnesota, USA.

Ralph, C.J., J.R. Sauer, and S. Dreoge. 1995. Monitoring birds by point counts. USDA Forest Service General Technical Report PSW-149.

Robbins, C.S. 1970. Recommendations for an international standard for a mapping method in bird census work. *Audubon Field Notes* 24:723-726.

Robbins, C.S. 1979. Effect of forest fragmentation on bird populations. Pages 198-213 in *Management of Northcentral and Northeastern Forests for Nongame Birds* (R.M. DeGraaf and K.E. Evans, Eds.). US Forest Service General Technical Report NC-51, Minneapolis, Minnesota, USA.

Rudnicky, T.C., and M.L. Hunter, Jr. 1993. Reversing the fragmentation perspective: effects of clearcut size on bird species richness in Maine. *Ecological Applications* 3:357-366.

Schulte, L. A., and G. J. Neimi. 1998. Bird communities of early-successional burned and logged forest. *Journal of Wildlife Management* 62:1418-1429.

Thompson, F. R., III. 1993. Simulated responses of a forest-interior bird population to forest management options in central hardwood forests of the United States. *Conservation Biology* 7:325-333.

Thompson, F.R., III, J.R. Probst, and M.G. Raphael. 1995. Impacts of silviculture: Overview and management recommendations. Pages 201-209 in *Ecology and Management of Neotropical Migrant Birds* (T.E. Martin and D.M. Finch, Eds.). New York: Oxford University Press.

Titterington, R.W., H.S. Crawford, and B.N. Burgason. 1979. Songbird responses to commercial clear-cutting in Maine spruce-fir forests. *Journal of Wildlife Management* 43:602-609.

Tobalske, B.W., R.C. Shearer, and R.L. Hutto. 1991. Bird populations in logged and unlogged western larch/Douglas-fir forest in western Montana. USDA Forest Service Research Paper INT-442. 12 pp.

U.S. Forest Service, 1986. Land and Resource Management Plan: White Mountain National Forest, Eastern Region. Laconia, New Hampshire.

Webb, D.L., D.F. Behrend, and B. Saisorn. 1977. Effect of logging on songbird populations in a northern hardwood forest. *Wildlife Monographs* 55:1-35.

Welsh, C.W., and W.M. Healy. 1993. Effect of even-aged timber management on bird species diversity and composition in northern hardwoods of New Hampshire. *Wildlife Society Bulletin* 21:143-154.

David I. King and **Richard M. DeGraaf** are researchers with the United States Department of Agriculture's Forest Service Northeastern Research Station at the University of Massachusetts at Amherst.
