Studies in Avian Biology No. 21:144–147, 2000.

COORDINATING SHORT-TERM PROJECTS INTO AN EFFECTIVE RESEARCH PROGRAM: EFFECTS OF SITE PREPARATION METHODS ON BIRD COMMUNITIES IN PINE PLANTATIONS

JOHN C. KILGO, KARL V. MILLER, AND WILLIAM F. MOORE

Abstract. Several short-term projects conducted at the Savannah River Site have focused on the effects on avian populations of different techniques of preparing a site for tree planting in young pine plantations. The purpose of this paper is to provide an overview of these studies, to summarize the information they provide regarding the effects of pine management on avian communities, and to demonstrate how multiple short-term projects can be used to address pressing management issues. O'Connell (1993), Sparling (1996), and Branch (1998) examined breeding and wintering bird use of areas treated with several mechanical and chemical site preparation methods. Overall, there were few treatment-related effects on bird populations. Both O'Connell and Sparling believed that the few differences in bird use of treatment plots were associated with minor differences in the structural diversity of the vegetation. Each of these short-term studies provided timely information on an issue of management importance and, taken together, they provide a more comprehensive picture of the effects of site preparation methods on bird communities in pine plantations than a single long-term study.

Key Words: abundance, evenness, diversity, herbicides, richness, short-term research, Savannah River Site, site preparation, South Carolina.

Demand for softwood products from the southern United States has resulted in conversion of many natural pine and pine-hardwood forests to even-aged pine plantations. Pine plantations in the Southeast annually produce about 17% of the country's total softwood supply. Because of increased demand, pine plantations may furnish almost half of the nation's softwood by the year 2000, and possibly two-thirds by 2030 (U.S. Forest Service 1988).

Early stages of pine plantations provide excellent habitat for a number of early successional species of birds (Noble and Hamilton 1975, Meyers and Johnson 1978). However, within these early stages we know little about the influences of vegetative composition and structure on avian communities, which may vary considerably. For example, before seedling trees are planted, the plantation site must be prepared such that seedling survival will be maximized. Site preparation often involves elimination or reduction of vegetative competition, either through chemical (i.e., herbicide) or mechanical (e.g., shearing of residual plant material from the previous stand, raking and piling roots, etc.) means. Different site preparation techniques provide variable plant communities and vegetative structures (presence or absence of snags, hardwood sprouts, coarse woody debris, etc).

Production and environmental concerns over the loss of site productivity, soil erosion, increased costs, and variable efficacy has resulted in shifts from mechanical site preparation methods to use of forest herbicides over the past two to three decades. Although herbicides are not toxic to wildlife when used at labeled rates, they may affect wildlife indirectly by altering vegetative composition and structure (McComb and Hurst 1987). The herbicides currently used by forest industries have different selectivities and therefore redeveloping plant communities often vary among herbicide treatments. Additionally, the development of new, more selective herbicides, along with changes in the timing of applications, negate the establishment of long-term studies to document the influence of a particular site-preparation treatment on avian communities.

The ephemeral nature of these early successional communities and the rapid changes in forest regeneration technologies necessitate application of a series of short-term research projects. During the past seven years, three graduate research projects conducted at the Savannah River Site (SRS) under the direction of K. V. Miller have examined the effects of chemical and mechanical site preparation on songbird populations. O'Connell (1993) and O'Connell and Miller (1994) examined breeding bird abundances at two, three, and five years post-treatment on areas treated with mechanical versus hexazinone site preparation. Sparling (1996) studied breeding and wintering bird populations at one to two years post-treatment on areas receiving various site preparation treatments: mechanical, hexazinone, imazapyr, and picloram + triclopyr. Branch (1998) studied post-treatment years three and four on Sparling's plots. The purpose of this paper is to provide an overview of these studies and summarize the information they provide on the effects of pine plantation site preparation on avian populations. In so doing, we hope to demonstrate how multiple short-term projects can be used, indeed sometimes must be used, to address pressing management issues.

STUDY DESIGNS

The study design of O'Connell (1993) consisted of three replications of two treatments in age classes two, three, and five years post-treatment on areas ranging from 11–24 ha. Areas were chosen from historically planted loblolly pine (*Pinus taeda*) plantations on similar soil types. The chemical treatment included a broadcast of Pronone 10G® (hexazinone) at rates from 1.4 to 2.3 kg active ingredient/ha. Mechanical treatment consisted of shearing residual standing vegetation with a V-blade and windrowing residual plant material with a root rake. Comparisons between treatments were made for the following bird community parameters: Shannon diversity, Shannon evenness, Margalef richness, total abundance, and species-specific abundance.

In addition to comparing the effects of mechanical and chemical treatments, Sparling (1996) and Branch (1998) examined the effects of 3 different herbicides on redeveloping plant and animal communities. The study design of Sparling (1996) and Branch (1998) included three replications of each of the following: Arsenal® (imazapyr), Velpar® ULW (hexazinone), Tordon K®+Garlon 3A® (picloram+triclopyr), and a mechanical treatment (root-raking and windrowing). Hexazinone was applied using a backpack sprayer in April 1992, while imazapyr and picloram+triclopyr were applied with a boom sprayer mounted on a tractor in May 1992. Mechanically prepared areas were treated in October 1992. Longleaf pine (*Pinus palustris*) was planted on a 1.3 × 3.1 m spacing in February 1993. Comparisons among treatments were made for the following bird community parameters: Shannon diversity, Shannon evenness, species richness, and total abundance.

All three studies used 25-m fixed-radius point counts to census birds from April–June. O'Connell (1993) sampled at five point count stations on each of his 18 treatment plots and visited each station twice during the breeding season. Sparling (1996) and Branch (1998) sampled at six stations on each of 12 treatment plots and visited each station three times during the breeding season and three times during winter (December). Counts were conducted within three hours of sunrise and were not conducted on rainy or excessively windy days. Each station was sampled for five minutes, and all birds seen or heard within the plot, but not flying overhead, were recorded. See O'Connell (1993) and Sparling (1996) for detailed descriptions of vegetation sampling techniques.

TABLE 1. AVIAN SPECIES DIVERSITY AND ABUNDANCE (MEAN NUMBER PER TREATMENT AREA ± SE) TWO, THREE, AND FIVE YEARS POST-TREATMENT ON CHEMICALLY AND MECHANICALLY PREPARED SITES IN BARNWELL COUNTY, S.C., 1991–1992 (ADAPTED FROM O'CONNELL 1993)

Bird community parameter[a]	Hexazinone	Mechanical
2 years post-treatment		
H'	2.47 (0.08)A[b]	2.15 (0.05)B
J'	0.95 (0.01)	0.92 (0.02)
R	3.92 (0.38)	3.24 (0.20)
Abundance	31.70 (13.4)	24.70 (6.7)
Brown-headed Cowbird	3.66 (0.33)A	1.66 (0.33)B
Eastern Bluebird	1.67 (0.33)A	0.00 (0.00)B
Mourning Dove	3.00 (0.00)A	1.00 (1.00)B
Yellow-breasted Chat	1.33 (0.67)B	3.33 (0.33)A
3 years post-treatment		
H'	2.39 (0.07)A	2.10 (0.03)B
J'	0.92 (0.01)	0.92 (0.03)
R	3.80 (0.21)	3.03 (0.41)
Abundance	25.30 (10.3)	22.00 (9.0)
Carolina Wren	0.00 (0.00)B	1.33 (0.33)A
Chipping Sparrow	2.00 (0.00)A	0.00 (0.00)B
Yellow-breasted Chat	0.67 (0.33)B	2.67 (0.67)A
5 years post-treatment		
H'	2.04 (0.08)	1.91 (0.05)
J'	0.91 (0.02)	0.92 (0.01)
R	3.07 (0.22)	2.70 (0.17)
Abundance	12.03 (6.6)	11.70 (5.9)

[a] H' = Shannon diversity; J' = Shannon evenness; R = Margalef richness.
[b] Within a row, means followed by different letters are significantly different at $P \leq 0.10$.

FINDINGS

O'CONNELL (1993)

Totals of 29, 26, and 21 avian species were recorded at two, three, and five years post-treatment, respectively. Total bird abundances did not differ between treatments in any age class (Table 1). Indigo Buntings (*Passerina cyanea*) were the most commonly observed species on all sites. At two years post-treatment, Brown-headed Cowbirds (*Molothrus ater*) and Mourning Doves (*Zenaida macroura*) also were recorded commonly. Mourning Doves and Eastern Bluebirds (*Sialia sialis*) were more abundant on hexazinone sites, whereas Yellow-breasted Chats (*Icteria virens*) were more abundant on mechanical treatments. At three years post-treatment, common species were Indigo Buntings, Brown-headed Cowbirds, and Prairie Warblers (*Dendroica discolor*). Chipping Sparrows (*Spizella passerina*) were more abundant on hexazinone treatments, whereas Yellow-breasted Chats and Carolina Wrens (*Thryothorus ludovicianus*) were more abundant on the mechanically treated areas. Bird species diversity was greater on the hexazinone plots at two and three years post-treatment. At five years post-treatment, commonly recorded species included Prairie Warblers, Indigo Buntings, and Carolina Wrens, but no differences in diversity, evenness, richness, or the abundance of any species were detected between treatments. Total bird abundance was correlated with herbaceous species diversi-

TABLE 2. AVIAN SPECIES DIVERSITY AND ABUNDANCE (MEAN NUMBER PER CENSUS PLOT ± SE) ON CHEMICALLY AND MECHANICALLY PREPARED SITES AT ONE, TWO, AND THREE YEARS POST-TREATMENT IN BARNWELL COUNTY, S.C., 1993–1996 (ADAPTED FROM SPARLING 1996 AND BRANCH 1998)

Season	Bird community parameter[a]	Treatment			
		Hexazinone	Imazapyr	Picloram+ triclopyr	Mechanical
1993					
June	H′	1.79 (0.35)	2.30 (0.20)	1.96 (0.40)	2.10 (0.05)
	J′	0.93 (0.01)	0.92 (0.02)	0.87 (0.02)	0.94 (0.01)
	N	7.67 (2.73)	12.67 (2.67)	11.00 (3.51)	9.33 (0.33)
	Abundance	2.22 (0.48)	4.33 (0.70)	5.56 (1.08)	3.00 (0.52)
December	H′	1.32 (0.39)	1.68 (0.38)	1.62 (0.18)	1.35 (0.20)
	J′	0.63 (0.15)	0.80 (0.06)	0.85 (0.06)	0.77 (0.10)
	N	7.67 (1.33)	9.33 (3.84)	8.00 (2.65)	5.67 (0.33)
	Abundance	7.39 (2.39)	10.67 (2.05)	6.17 (2.54)	4.39 (1.26)
1994					
June	H′	2.05 (0.20)	2.22 (0.16)	2.08 (0.31)	1.47 (0.25)
	J′	0.88 (0.03)	0.89 (0.03)	0.93 (0.01)	0.76 (0.09)
	N	10.67 (2.03)	13.33 (3.84)	10.33 (2.91)	7.00 (1.15)
	Abundance	4.44 (0.93)	7.44 (1.51)	4.39 (0.81)	3.06 (0.49)
December	H′	1.25 (0.07)B[b]	1.38 (0.05)AB	1.63 (0.13)A	1.65 (0.08)A
	J′	0.82 (0.01)	0.80 (0.03)	0.82 (0.05)	0.77 (0.08)
	N	4.67 (0.33)B	5.67 (0.67)B	7.33 (0.33)A	9.00 (1.15)A
	Abundance	5.61 (1.77)	8.11 (1.88)	11.89 (2.27)	11.17 (2.51)
1995					
June	H′	2.27 (0.06)	2.45 (0.16)	2.46 (0.16)	2.14 (0.13)
	J′	0.86 (0.02)	0.89 (0.02)	0.89 (0.02)	0.84 (0.05)
	N	14.00 (1.53)	16.67 (3.53)	16.67 (3.38)	13.00 (1.53)
	Abundance	7.83 (1.17)	10.22 (1.47)	9.33 (1.32)	7.39 (0.91)
December	H′	1.56 (0.13)	1.83 (0.25)	1.86 (0.15)	1.84 (0.15)
	J′	0.71 (0.11)	0.77 (0.03)	0.78 (0.02)	0.77 (0.05)
	N	9.33 (1.53)	10.67 (2.51)	11.00 (1.73)	11.00 (1.00)
	Abundance	11.17 (2.17)	10.94 (0.67)	9.50 (0.88)	10.94 (4.79)
1996					
June	H′	2.47 (0.33)	2.69 (0.04)	275 (0.28)	2.66 (0.34)
	J′	0.87 (0.07)	0.87 (0.04)	0.91 (0.78)	0.93 (0.02)
	N	17.33 (2.89)	22.33 (2.31)	12.00 (3.61)	17.33 (0.58)
	Abundance	6.56 (1.02)	9.50 (3.56)	7.78 (2.22)	6.39 (2.02)
December	H′	1.80 (0.26)	1.80 (0.04)	1.90 (0.09)	1.86 (0.20)
	J′	0.84 (0.01)	0.82 (0.02)	0.82 (0.07)	0.87 (0.05)
	N	8.67 (2.31)	9.00 (0.00)	10.33 (1.15)	8.67 (1.15)
	Abundance	6.39 (1.84)	7.14 (1.19)	7.72 (1.92)	5.56 (0.25)

[a] H′ = Shannon diversity; J′ = Shannon evenness; N = mean number of species per plot.
[b] Within a row, means followed by different letters are significantly different at $P \leq 0.05$.

ty, herbaceous species richness, and woody species diversity.

SPARLING (1996)

Forty-seven breeding and 27 wintering bird species were recorded. Bird abundance did not differ among the treatments during any sample period (Table 2). In winter of 1994 (i.e., 2 years post-treatment), diversity was greater on picloram + triclopyr and mechanical plots than on hexazinone-treated plots. Also, species richness was lower on hexazinone and imazapyr plots than on mechanically treated plots. No other treatment-related differences in avian community measures were detected.

Winter bird abundance was correlated with vine abundance at one year post-treatment. Woody vegetation was correlated with summer and winter bird abundance at two years post-treatment. Breeding bird abundance was positively correlated with vegetation volume at lower heights (0.5–1.0 m).

BRANCH (1998)

During the third and fourth years post-treatment on Sparling's (1996) plots, Branch (1998) detected no differences in either breeding or wintering bird community variables. Analyses relating bird community variables to vegetation structural variables were unavailable. Apparently, by three to four years post-treatment, the few effects that the various herbicides had produced in the bird communities one to two years post-treatment had disappeared.

CONCLUSIONS

Both O'Connell (1993) and Sparling (1996) reported greater vertical structure on chemically treated sites than mechanically treated sites. O'Connell (1993) attributed the greater bird abundance and diversity of chemically treated sites at two and three years post-treatment to differences in vegetation components, particularly vertical structure associated with residual snags. He also noted that the greater numbers of snags present on the hexazinone treatments likely accounted for the greater numbers of cavity-nesting species such as Eastern Bluebird and species that utilize perches such as Brown-headed Cowbird and Mourning Dove. The positive relationship between bird communities and vertical vegetation structure long has been recognized (MacArthur and MacArthur 1961, James 1971, Willson 1974). Johnson and Landers (1982) attributed higher bird diversity in two year-old plantations compared to 6–15 year-old plantations to the presence of residual snags, and winter bird numbers in Texas were higher on areas with snags than on snagless areas (Dickson and Conner 1982). Similarly, in Mississippi, bird species diversity in pine stands is related directly to the number of residual snags and cavities (Darden et al. 1990). Because most forms of intensive mechanical site preparation remove the majority of standing stems from a site whereas chemical site preparation techniques leave residual snags, chemical site preparation likely is more beneficial to bird species that utilize snags, either for nesting, roosting, or as song perches.

Some species were more abundant on mechanically treated sites (O'Connell 1993). Mechanical site preparation involves collection of woody debris into windrows. These windrows and the vegetation associated with them apparently resulted in superior habitat conditions on mechanically treated sites, as compared to chemically treated sites, for shrub-scrub birds such as Carolina Wren and Yellow-breasted Chat.

The herbicides tested by Sparling (1996) and Branch (1998) differ in the suites of plants species that they control, and therefore in the re-developing plant communities. However, these differences in the vegetative communities do not result in significant effects on avian habitat. Sparling (1996) reported few differences in vertical structure among the different herbicides one to two years post-treatment, and Branch (1998) detected no differences three to four years post-treatment. Similarly, study areas in Georgia treated with hexazinone, imazapyr, and picloram+triclopyr had similar amounts of snags and residual hardwoods at four and five years post-treatment (Moore 1996) and, consequently, the associated bird communities did not differ.

Overall, few treatment-related differences in avian abundance and diversity were detected in any of the studies, suggesting that changes in silvicultural prescriptions from mechanical to chemical site preparation may have few impacts on avian communities. The only apparent exceptions to this pattern are species that utilize the windrows associated with mechanical site preparation (i.e., Carolina Wren, Yellow-breasted Chat). Similarly, since Sparling (1996) and Branch (1998) found no differences in avian abundance and species richness among various site preparation herbicides, choice of herbicide may not be important to avian communities either. Different results may occur with other herbicides, application rates, or application timing. Additionally, the use of herbicide tank mixtures (i.e., simultaneous application of two or more of the herbicides tested in the reported studies) likely will result in greater vegetation control and could impact songbird communities, at least in the initial years post-treatment. Therefore, further research is needed to establish the generality of the results reported herein. Yet, because of their spatial and temporal similarities, these three studies provide a foundation for continued studies on the effects of various site preparation methods on breeding and wintering songbird populations.

The burgeoning use of herbicides in forestry is resulting in rapidly changing technologies. Herbicides are being employed with increasing frequency for site preparation, crop tree release, and mid-rotation stand management. Developing technologies such as more selective herbicides, changes in the timing and method of applications, and use of herbicide mixtures preclude the establishment of long-term studies to document the influence of one particular site-preparation treatment on avian communities. Additionally, early successional communities in re-establishing pine plantations are ephemeral in nature and thus necessitate application of a series of short-term research projects.

ACKNOWLEDGMENTS

This work was supported through programs of the U.S. Department of Energy's Savannah River Site National Environmental Research Park, the Savannah River Natural Resource Management and Research Institute, and the U.S. Forest Service Southern Research Station.