

BREEDING BIRD POPULATIONS AND HABITAT ASSOCIATIONS
WITHIN THE SAVANNAH RIVER SITE (SRS)

A COOPERATIVE AGREEMENT

between the

USDA FOREST SERVICE – SAVANNAH RIVER

and the

DEPARTMENT OF BIOLOGICAL SCIENCES

CLEMSON UNIVERSITY

FINAL REPORT

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Introduction

During the 1970's and 1980's a dramatic decline occurred in the populations of Neotropical migratory birds, species that breed in North America and winter south of the border in Central and South America and in the Caribbean (Wilcove 1988, Treborgh 1989, Robbins et al. 1989, Hagan and Johnston 1992, Finch and Stangel 1993, Peterjohn and Sauer 1994). The debate on the causes of the decline has been intense (Faaborg 2002). Proposed causes range from deforestation in the tropics to increased cowbird parasitism on the breeding grounds because of forest fragmentation (Brittingham and Temple 1983, Faaborg and Arendt 1989, Hutto 1988, Morton and Greenberg 1989). Considerable research is underway or planned to determine the cause(s).

In 1991 an international initiative was mounted by U. S. governmental land management agencies, nongovernmental conservation agencies, and the academic and lay ornithological communities to understand the decline of Neotropical migratory birds in the Americas. The initiative is referred to as the Neotropical Migratory Bird Conservation Program (NMBCP) and is officially called Partners in Flight because of its international mission. For the last several years ornithologists and land managers have engaged in formal discussions about programs that would 1) inventory Neotropical migratory birds in various habitats, 2) begin studies that would measure the impact of various land management practices on Neotropical migratory bird populations, and 3) initiate a long-term monitoring program that would provide managers with information on the effectiveness of their practices to conserve Neotropical migrants.

In cooperation with the USDA Forest Service - Savannah River (FS – SR) we began 1992 a project directed to monitoring population densities of breeding birds using the Breeding Bird Census (BBC) methodology in selected habitats within the Savannah River Site SRS. In addition we related point count data on the occurrence of breeding Neotropical migrants and other bird species to the habitat data gathered by the Forest Inventory and Analysis (FIA) program of the USDA Forest Service (McClure et al. 1979, Sheffield 1981), and data on habitat treatments within forest stands.

Ultimately the monitoring data can be used to measure the impact of various forest management practices on the biodiversity of bird species in different landscapes not only within SRS, but throughout the state of South Carolina and the entire Southeast.

Kilgo et al. (2000) used data from the Breeding Bird Survey (BBS) and point count data from several studies (including ours) on SRS to compare breeding bird populations on and off the SRS property. They found that the SRS avifauna differed from the regional avifauna. Species that prefer forested habitats were more abundant and species that prefer agricultural and urban habitats were less abundant on SRS than in the surrounding region. These results are consistent with the differences between habitats on SRS and the surrounding area. When the site was established in 1951 a reforestation program began and forested land has increased from 48% to 89% of the total land cover on the site (White and Gaines 2000, Kilgo et al. 2000). The surrounding upper coastal plain of South Carolina consists of only 62% forested habitats (Kilgo et al. 2000).

In this report we summarize 10 years of Breeding Bird Census data collected from eight plots on SRS. Population trends on seven of these plots are compared with trend data from the Breeding Bird Survey and from two other study plots (mixed pine deciduous and bottomland)

located just south of the Savannah River Plant near Martin, SC. We also report on changes in bird numbers and species composition on another plot (clear-cut –longleaf pine regeneration) that has experienced successional vegetation changes.

Methods

Breeding Bird Censuses

The breeding bird census methodology follows Ralph et al. (1993). The vegetation classification on the breeding bird census plots follows the classification outlined in the Silviculture Examination and Prescription Field Book (1988).

During the breeding season of 1992, six Breeding Bird Census (BBC) plots were established and censused within the SRS. Each forested plot measured approximately 12.5 ha. Another plot of approximately 25 ha was established in a clear-cut/longleaf pine regeneration stand. The five forested plots included areas of mature longleaf pine, mature loblolly pine (Loblolly I), mature upland hardwood, mature bottomland hardwood, and mature swamp forest. Detailed plot descriptions are provided in the Journal of Field Ornithology, Vol. 64 Supplement and Appendix I. During the breeding season of 1993, two additional forested plots were established within the SRS, one in a mature loblolly pine stand (Loblolly II), the other in a stand of scrub oak with scattered longleaf pine. Detailed descriptions of these plots are provided in the Journal of Field Ornithology, Vol. 65 Supplement and Appendix I. In 1995 a new 11-20 year old loblolly pine plot was established to replace the original mature loblolly plot (Loblolly I). The original plot was abandoned after 1992 because of alteration of the surrounding landscape. The new plot is described in the Journal of Field Ornithology, Vol. 67 Supplement and Appendix I.

For each year through 1995, BBC results from the SRS plots were published in the Journal of Field Ornithology Supplements. Publication of the Supplements was discontinued after 1995. Table 1 summarizes the census history for the BBC plots. In 1993 four Breeding Bird Censuses were conducted in the following habitat types: longleaf pine, loblolly pine, scrub oak/longleaf pine, and clear-cut/longleaf pine regeneration (Journal of Field Ornithology, Vol. 65 Supplement: Pp. 75, 77-78, 94, 125-126). During the breeding season of 1994, four Breeding Bird Censuses were conducted in the following habitat types: upland hardwood, mature loblolly pine, bottomland hardwood, and clear-cut/longleaf pine regeneration (Journal of Field Ornithology, Vol. 66 Supplement: Pp. 61-63, 72, 116). The 1995 season included censuses in swamp forest, scrub oak, 11-20 year old loblolly pine, and clear-cut/longleaf pine regeneration (Journal of Field Ornithology, Vol. 67 Supplement: Pp. 58, 67-68, 89). Because of the rapid changes in the vegetation of the clear-cut/longleaf pine regeneration plot, the area that was censused in 1995 was reduced from the original 25 ha to 12.5 ha so that it could be covered thoroughly. The height and density of vegetation made a larger area difficult to census in the amount of time allotted.

The 1996 season included censuses in upland hardwood, longleaf pine, bottomland hardwood, and clear-cut/longleaf pine regeneration plots. The 1997 season included censuses in the 11-20 year old loblolly, mature loblolly, scrub oak, and clear-cut/longleaf pine regeneration plots. The 1998 season included censuses in swamp forest, upland hardwood, longleaf pine, and clear-cut/longleaf pine regeneration plots. In 1999, the bottomland hardwood, scrub oak, 11-20 year old loblolly, and clear-cut/longleaf pine regeneration plots were censused. The clear-cut/longleaf pine regeneration plot was the only plot censused in 2000 and 2001.

With the exception of the clear-cut/longleaf pine regeneration plot, we followed a schedule with two- to three-year intervals between censuses on each plot (Table 1). The clear-cut/longleaf pine regeneration plot was censused for 10 consecutive years while each of the other plots was censused only 3-4 times during those 10 years.

Table 1. History of Breeding Bird Censuses conducted on plots located on SRS

	Breeding Bird Census Plots							
	Upland	Clear-cut Regen.	Swamp	Longleaf Pine	Loblolly Pine I(a)	Bottomland	Loblolly Pine II	Scrub Oak
Year								
1992	X	X	X	X	X	X		
1993		X		X			X	X
1994	X	X				X	X	
1995		X	X		X			X
1996	X	X		X		X		
1997		X			X		X	X
1998	X	X	X	X				
1999		X			X	X		X
2000		X						
2001		X						

a - The original 40 year old plot was abandoned after 1992 because of alteration of the surrounding landscape. This plot was replaced in 1995 with a loblolly plot in the 11-20 year old condition class (see Appendix I).

Clariant Corporation (Sandoz, Inc.) Plots

From 1978 through 1993, S. A. Gauthreaux conducted limited area bird censuses at 22 sites (each 3 hectare) on property owned by the Clariant Corporation (formerly Sandoz, Inc.) south of the Savannah River Site and the settlement of Martin in Allendale County. The censuses of breeding birds were always conducted in late May and the time in a plot was always 45 minutes. The purpose of these censuses was to evaluate the environmental impact of a living filtration system (where industrial waste water was sprayed in pine forests) on bird populations. For the comparative analysis in this report, two control plots (Spray Control A and Lagoon Control A) were combined into a mixed pine/deciduous plot. The plots contained mixed woodland (approximately 50% pine and 50% deciduous), and the deciduous trees were mostly oaks (Quercus) and 30-50 feet in height. The soil was sandy and understory vegetation of shrubs and grasses occupied 60% of the ground area in the plot. The floodplain plot we discuss in this report is actually made up of four of the original Sandoz plots--Spray Drainage A, Spray Drainage B, Spray Drainage C, and Lagoon Drainage A. All of these plots were in the floodplain of the Savannah River and contained bottomland forest (tupelo, blackgum, sweetgum, oaks, and some cypress). The plots on the edge of the river also contained some cottonwood, willow, ash, elm, hackberry, and maple. The understory was generally thick and contained vines, shrubs, and cane and on a few occasions the plots close to the river were flooded or contained standing water.

Analyses

We compare the BBC data with census data from two other sources, the Breeding Bird Survey (BBS) and two nearby census plots (mixed pine deciduous and bottomland) located on property managed by Clariant Corporation (formerly Sandoz, Inc.) in Allendale county.

The raw data (territories/40 ha) for each of the forested BBC plots are presented in Appendix II. The data for the Clear-cut/Longleaf Pine Regeneration plot are presented in Table 4. Population trends on the BBC plots were examined using linear regression (Tables 2-4). We used the route-regression method for estimation of population trends in the BBS data (Sauer 2003). We performed two sets of analyses using BBS data, one for USFWS Region 4 (southeastern U. S.) and the other for the physiographic region Upper Coastal Plain. Both analyses cover the time period of 1978-2002 which incorporates the years that censuses were conducted on the Clariant (Sandoz) property and on our BBC plots at SRS.

Results and Discussion

Forested BBC Plots

Results of the BBS, Clariant (Sandoz), and BBC population trend analyses are presented in Table 2 for permanent resident species and in Table 3 for migrant species. Among permanent resident species, only two species showed significant changes on the forested BBC plots. Carolina Chickadees declined on the Bottomland Hardwood plot and Pine Warblers declined on the Longleaf plot. Carolina Chickadees also showed significant declines in both BBS analyses and on the Floodplain census plot at Clariant (Sandoz). Pine Warblers showed significant

increases in both BBS analyses and a significant decline in the Floodplain plot at Clariant (Sandoz).

Among migrant species, Yellow-billed Cuckoos showed a significant increase on the BBC Bottomland Hardwood plot. Both regional BBS analyses reported significant declines for this species. On the Upland Hardwood plot, Wood Thrush, Hooded Warbler, and Summer Tanager all had significant declines. Summer Tanagers also declined significantly on the Loblolly II plot. There were also significant declines for Wood Thrushes in both sets of BBS analyses and in the Clariant (Sandoz) Floodplain plot. Hooded Warblers had significant declines in both of the Clariant (Sandoz) plots but not in the BBS analyses. There were no significant changes in Summer Tanager numbers in the BBS data or on the Clariant (Sandoz) plots.

Only six species had significant changes in numbers on the SRS BBC plots. The BBS data set had 31 species with significant changes in the southeastern region analysis and 20 species with significant changes in the upper coastal plain analysis (Tables 2 and 3). Twelve of the species with significant changes in the BBS data did not occur on the BBC plots frequently enough to allow analysis (e.g. Northern Bobwhite, Northern Mockingbird, Common Grackle, and Painted Bunting). Even if these twelve species are excluded from consideration, there appears to be a difference between the numbers of species showing significant population trends in the regional data when compared to the SRS BBC data. The results indicate that populations are more stable on the SRS BBC plots. However, the BBC data may not be adequate to detect changes in bird populations. The forested BBC plots have been censused only 3 or 4 times during the study period (Table 1). The ability of statistical tests, such as linear regression, to detect significant population trends is probably limited by this small number of censuses. Another potentially confounding factor is the number of different observers who have conducted

these censuses. Observer effects have been cited as a confounding variable in many studies involving census data (Sauer et al. 1994).

Table 2. Population trend analyses for permanent resident species on BBS routes, Sandoz property, and BBC plots at SRS.

Species	BBS (1978-2002)				Sandoz (1978-1993)			
	Southeast		Upper Coastal Plain		Floodplain		Mixed	
	trend	p value	trend	p value	trend	p value	trend	p value
Northern Bobwhite								
Mourning Dove	-0.63	0.02017	-1.87	0.00000	0.06	0.7494	-0.38	0.0494
Common Ground-Dove								
Red-headed woodpecker								
Red-bellied Woodpecker	0.25	0.22058	-0.16	0.55224	0.17	0.3996	-0.1	0.6259
Downy Woodpecker	-0.46	0.22138	-1.24	0.04100	-0.1	0.6074	-0.15	0.459
Blue Jay	-1.33	0.00000	-1.70	0.00000	-0.32	0.0987	-0.44	0.0245
American Crow	1.48	0.00000	1.63	0.00000	-0.06	0.7491	-0.2	0.3068
Fish Crow	0.44	0.53363	0.42	0.58394	-0.06	0.7426	-0.62	0.0012
Carolina Chickadee	-1.28	0.00008	-2.12	0.00001	-0.4	0.0359	-0.15	0.4376
Tufted Titmouse	1.04	0.00001	0.74	0.01738	-0.34	0.0805	0.13	0.4904
White-breasted Nuthatch	1.94	0.00288	3.30	0.16308				
Brown-headed Nuthatch	-0.83	0.34550	-2.24	0.12402	-0.17	0.4229	-0.38	0.049
Carolina Wren	0.85	0.00010	0.63	0.04593	-0.54	0.0047	-0.27	0.1628
Eastern Bluebird	3.30	0.00000	3.33	0.00000	0.04	0.8676	0.12	0.548
Northern Mockingbird								
Brown Thrasher	-0.15	0.57637	-0.08	0.85479				
Pine Warbler	0.67	0.04805	1.59	0.00389	-0.56	0.0041	-0.07	0.74
Eastern Towhee	-1.14	0.00000	-0.65	0.06397	-0.25	0.2112	-0.31	0.1011
Bachman's Sparrow	-0.53	0.84528	5.67	0.57624	-0.31	0.1585	-0.07	0.7313
Chipping Sparrow	1.71	0.00020	1.00	0.06077				
Field Sparrow	-1.49	0.00004	-1.25	0.05179				
Northern Cardinal	0.11	0.45424	-0.14	0.50796	-0.39	0.0433	-0.52	0.0075
Eastern Meadowlark	-3.86	0.00000	-4.82	0.00000				
Common Grackle	-2.67	0.00000	-2.22	0.00000				
Brown-headed Cowbird	-1.38	0.00001	-1.87	0.00002	0.06	0.7437	0.06	0.7469

Table 2. (cont.)

Species	Savannah River Site (1992-2001)													
	Bottomland Hardwood		Swamp		Upland Hardwood		Scrub Oak		Longleaf		Loblolly II		Loblolly I	
	trend	p value	trend	p value	trend	p value	trend	p value	trend	p value	trend	p value	trend	p value
Northern Bobwhite														
Mourning Dove							-0.66	0.3675						
Common Ground-Dove														
Red-headed woodpecker														
Red-bellied Woodpecker	-0.88	0.2789	-0.3	0.3333	-0.49	0.5955	-0.66	0.1056	0.08	0.8316	-0.12	0.8211		
Downy Woodpecker	-0.84	0.1908	-0.61	0.3333	0.08	0.8607			0.39	0.3342				
Blue Jay							-1.55	0.0561						
American Crow														
Fish Crow														
Carolina Chickadee	-0.85	0.042	-1.21	0.1719	-1.22	0.2971	0.1952	0.66	-0.13	0.7238	0.76	0.1678	0	1
Tufted Titmouse	-0.03	0.9615	0.9	0.121	0.56	0.4746	0	1	-0.07	0.9383	-1.01	0.3619	-0.82	0.3333
White-breasted Nuthatch														
Brown-headed Nuthatch			-1.2	0.1789	-0.07	0.8771								
Carolina Wren	-0.43	0.575	-0.3	0.9164	-1.15	0.1294					-1.51	0.6413		
Eastern Bluebird									-0.86	0.3252	0.26	0.9169		
Northern Mockingbird									-0.55	0.2883				
Brown Thrasher							-0.57	0.0577						
Pine Warbler							-1.87	0.2483	-2.81	0.0083	0.38	0.8211	-0.4	0.3333
Eastern Towhee									-0.82	0.5852	0.51	0.7197		
Bachman's Sparrow									-1.89	0.0659				
Chipping Sparrow									0.08	0.9657				
Field Sparrow														
Northern Cardinal	-1.81	0.1837			-1.56	0.2579	0.24	0.7476			0.33	0.9341	-0.8	0.3333
Eastern Meadowlark														
Common Grackle														
Brown-headed Cowbird														

Table 3. Population trend analyses for migrant species on BBS routes, Sandoz property, and BBC plots at SRS.

Species	BBS (1978-2002)				Sandoz (1978-1993)			
	Southeast		Upper Coastal Plain		Floodplain		Mixed	
	trend	p value	trend	p value	trend	p value	trend	p value
Yellow-billed Cuckoo	-2.25	0.00000	-3.00	0.00000	-0.31	0.1137	-0.01	0.9627
Ruby-throated Hummingbird	0.26	0.68723	-0.75	0.44339	-0.28	0.1523	-0.19	0.3645
Eastern Wood-Pewee	-1.45	0.00000	-1.60	0.00112	-0.07	0.7508	0.08	0.6992
Acadian Flycatcher	0.27	0.47739	0.82	0.15512	-0.53	0.0054	0.69	0.0004
Great Crested Flycatcher	1.02	0.00014	0.48	0.30292	-0.04	0.8193	-0.23	0.2439
Eastern Kingbird	-0.50	0.14291	-0.15	0.76676	0.26	0.2328	-0.24	0.246
White-eyed Vireo	0.33	0.13705	0.64	0.02694	-0.68	0.0003	0.15	0.4331
Yellow-throated Vireo	1.60	0.01824	2.05	0.07013	0.06	0.7469	0.08	0.717
Red-eyed Vireo	0.74	0.00548	0.21	0.55127	0.08	0.6781	-0.42	0.0328
Blue-gray Gnatcatcher	0.63	0.12387	0.90	0.20767	-0.21	0.2723	0.43	0.0207
Wood Thrush	-1.09	0.00343	-0.92	0.03315	-0.58	0.0027	0.25	0.2209
Gray Catbird	-2.22	0.00016	-0.49	0.53214				
Northern Parula	-0.06	0.9015	0.43	0.53502	-0.62	0.001	-0.28	0.1503
Yellow-throated Warbler	0.17	0.83503	-2.17	0.26077	0.08	0.6781	0.13	0.5384
Prairie Warbler	-1.46	0.00924	-0.89	0.22860	0.03	0.8745	-0.12	0.5617
Black-and-white Warbler	-1.70	0.01134	-4.16	0.00085				
American Redstart	3.26	0.00927	0.26	0.87115				
Prothonotary Warbler	-1.39	0.15392	-1.67	0.37532	0.03	0.8901		
Swainson's Warbler	1.62	0.51245	5.25	0.21048	-0.81	0.0001		
Ovenbird	0.46	0.43448	-0.18	0.76254				
Louisiana Waterthrush	0.41	0.64399	-1.37	0.19561	0.12	0.5575		
Kentucky Warbler	-1.55	0.00116	-2.39	0.00004	-0.26	0.1812	0.21	0.3408
Common Yellowthroat	-1.31	0.00000	-0.32	0.56215				
Hooded Warbler	0.30	0.50462	0.89	0.09773	-0.7	0.0002	-0.45	0.039
Yellow-breasted Chat	0.77	0.00435	1.51	0.00003	0.4	0.0589	-0.01	0.9587
Summer Tanager	-0.11	0.79427	-0.41	0.42867	-0.17	0.3996	0.02	0.9262
Blue Grosbeak	0.87	0.00674	0.67	0.09422	0.13	0.5449	-0.19	0.3411
Indigo Bunting	-0.22	0.24466	0.11	0.66801	0.61	0.0021	0.23	0.26
Painted Bunting	-3.63	0.00031	-0.41	0.76688	0.07	0.7449	0.18	0.3661
Orchard Oriole	-0.44	0.30799	0.84	0.21183	0.5	0.0212	-0.07	0.7313

Table 3. (cont.)

Species	Savannah River Site (1992-2001)													
	Bottomland Hardwood		Swamp		Upland Hardwood		Scrub Oak		Longleaf		Loblolly II		Loblolly I	
	trend	p value	trend	p value	trend	p value	trend	p value	trend	p value	trend	p value	trend	p value
Yellow-billed Cuckoo	0.89	0.0381	0.30	0.6766	0.17	0.5528	-0.66	0.3675						
Ruby-throated Hummingbird														
Eastern Wood-Pewee									1.51	0.1231	-1.01	0.3619		
Acadian Flycatcher	1.43	0.0971	-3.33	0.1618	-0.49	0.8471								
Great Crested Flycatcher	-0.72	0.3124	-0.61	0.3333			-1.15	0.1597	-0.7	0.3785	-0.99	0.3764	-0.82	0.3333
Eastern Kingbird														
White-eyed Vireo	-2.05	0.2899			-0.57	0.0577								
Yellow-throated Vireo					-0.4	0.7128								
Red-eyed Vireo	-1.06	0.5538	0.60	0.5542	-0.83	0.6833								
Blue-gray Gnatcatcher	1.85	0.1048	0.00	1	0.49	0.4467	1.8	0.4118						
Wood Thrush	-1.26	0.2622			-1.71	0.0159	-0.81	0.089						
Gray Catbird														
Northern Parula	0.26	0.9374	-1.82	0.2349	1.14	0.8384								
Yellow-throated Warbler					0.57	0.8407								
Prairie Warbler									-3.31	0.2783				
Black-and-white Warbler	-0.39	0.2649			-0.65	0.4108	-0.16	0.7418						
American Redstart	0.16	0.9543			-0.16	0.8652								
Prothonotary Warbler			-1.22	0.6151										
Swainson's Warbler	0.71	0.3296												
Ovenbird							-0.41	0.3318						
Louisiana Waterthrush					0.165	0.8652								
Kentucky Warbler	-0.56	0.7574			-2.71	0.0972								
Common Yellowthroat														
Hooded Warbler	-1.67	0.6802			-2.38	0.0087								
Yellow-breasted Chat														
Summer Tanager	-0.21	0.7959	-0.62	0.6616	-0.82	0.0001	-1.15	0.1597	-0.97	0.0565	-2.08	0.0366		
Blue Grosbeak									-0.43	0.5552				
Indigo Bunting											1.95	0.1075		
Painted Bunting														
Orchard Oriole														

Clear-cut/Longleaf pine Regeneration Plot

The raw data and analysis results for the Clear-cut/Longleaf Pine Regeneration plot are presented in Table 4. As the plot has matured Northern Bobwhite, Common Ground-dove, Red-headed Woodpecker, Red-bellied Woodpecker, Eastern Kingbird, Eastern Bluebird, Northern Mockingbird, Bachman's Sparrow, and Orchard Oriole have all shown significant declines. None of these species were encountered on the plot after 1998. Two species, White-eyed Vireo and Pine Warbler, have shown significant increases.

The population trends observed on the plot are not surprising given the successional changes taking place as the plot has matured. Most of the species showing significant declines are species typical of more open or edge habitats (Hamel 1992). The two woodpecker species are an exception. However, their decline is primarily the result of the 1995 reduction in the area being censused. This eliminated a small stand (0.5 ha) of hardwoods and several snags where these species were typically found. White-eyed Vireos showed a significant increase as understory vegetation matured in several areas of the plot and along its edges. Pine Warblers were first counted in the plot in 1999 when the plot was 9 years old and the Longleaf pines had reached 4-8 m in height. A nest and fledglings were found on the plot in 2001 when the pines had reached 10 m in height in some areas and produced a more or less continuous canopy in part of the eastern end of the plot.

There has also been a significant decline in species diversity on the plot (Table 4). The number of species recorded dropped from 30 to 14. Part of this decline may be attributable to the 1995 reduction in the area being censused which reduced some of the heterogeneity of the plot.

Table 4. Clear-cut-longleaf pine regeneration plot data (territories/40 ha) and analyses.

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001		
Observer	DD	SW	CI	CI	MG	MG	SW	SW	SW	SW		
Plot area (ha)	25	25	25	12.5	12.5	12.5	12.5	12.5	12.5	12.5		
Census Trips	8	8	10	10	10	10	10	10	10	10		
Stand Age (years)	2	3	4	5	6	7	8	9	10	11		
											<u>trend</u>	<u>p value</u>
Northern Bobwhite	20	4.8	9.6	9.6	0	0	8	0	0	0	-1.61	0.016
Mourning Dove	12.8	0	11.2	12.8	0	0	0	3.2	3.2	3.2	-0.86	0.162
Common Ground-dove	3.2	4	4.8	3.2	6.4	3.2	4.8	0	0	0	-0.48	0.045
Yellow-billed Cuckoo	0.8	0	0	0	0	0	0	0	0	0		
Red-headed Woodpecker	3.2	4	4.8	4.8	0	0	0	0	0	0	-0.58	0.007
Red-bellied Woodpecker	2.4	2.4	4.8	3.2	3.2	0	0	0	0	0	-0.45	0.01
Downy Woodpecker	0	0	0	1.6	0	0	0	0	0	0		
Northern Flicker	3.2	1.6	2.4	3.2	0	0	0	0	0	0		
Great Crested Flycatcher	3.2	2.4	4	3.2	6.4	3.2	0	0	3.2	0	-0.34	0.142
Eastern Kingbird	4.8	2.4	4	6.4	4.8	0	0	0	0	0	-0.63	0.013
White-eyed Vireo	4.8	0.8	3.2	3.2	0	4.8	11.2	11.2	9.6	6.4	0.88	0.038
Blue Jay	1.6	0	0	1.6	0	0	0	0.8	0	1.6	-0.01	0.958
Carolina Chickadee	0	0.8	0	0	9.6	6.4	3.2	1.6	3.2	3.2	0.36	0.32
Tufted Titmouse	0.8	0	0	0	0	0	0	0	3.2	0		
Brown-headed Nuthatch	0.8	0	0	3.2	0	0	0	0	0	0		
Carolina Wren	9.6	4.8	6.4	3.2	12.8	8	6.4	1.6	1.6	4.8	-0.51	0.204
Blue-gray Gnatcatcher	0	0	0	0	0	0	0	0	0.8	0		
Eastern Bluebird	6.4	9.6	9.6	6.4	3.2	0	0	0	0	0	-1.18	0.001
Gray Catbird	0	1.6	0	9.6	12.8	9.6	8	4.8	0.8	0	0.06	0.915
Northern Mockingbird	7.2	9.6	4.8	4.8	14.4	0	0	0	0	0	-1.12	0.034
Brown Thrasher	2.4	2.4	2.4	8	6.4	9.6	6.4	3.2	0	4.8	0.04	0.904
Pine Warbler	0	0	0	0	0	0	0	1.6	3.2	4.8	0.45	0.007
Prairie Warbler	23.2	14.4	12	19.2	30.4	32	17.6	12.8	12.8	3.2	-1.15	0.257
Common Yellowthroat	0.8	4	0	8	0	6.4	8	0	0	0	-0.17	0.679
Yellow-breasted Chat	10.4	14.4	20.8	12.8	14.4	12.8	20.8	16	9.6	6.4	-0.43	0.425
Summer Tanager	4	1.6	4	0	0	0	0	0	0.8	0		
Eastern Towhee	16	8.8	8.8	24	30.4	16	24	16	14.4	6.4	-0.15	0.867
Bachman's Sparrow	19.2	10.4	8	6.4	19.2	12.8	0	0	0	0	-1.89	0.014
Chipping Sparrow	3.2	0	0	0	0	0	0	0	0	0		
Field Sparrow	0	0	0	0	0	0	14.4	6.4	6.4	0	0.42	0.439
Northern Cardinal	6.4	2.4	4.8	6.4	6.4	12.8	6.4	4.8	8	8	0.36	0.246
Blue Grosbeak	16.8	4	11.2	8	16	6.4	12.8	6.4	6.4	6.4	-0.58	0.26
Indigo Bunting	24	14.4	13.6	9.6	54.4	38.4	16	6.4	6.4	12.8	-1.15	0.532
Brown-headed Cowbird	0	4.8	0	0	0	0	0	0	0	3.2		
Orchard Oriole	19.2	8	4.8	6.4	11.2	0	0	0	0	0	-1.71	0.005
Total Species	30	27	23	27	19	20	15	15	17	14	-1.75	0.001

Conclusions

Compared to the BBS and Clariant (Sandoz) data, there have been very few changes in the breeding bird populations on the forested BBC plots at SRS. Other than periodic burning on some of these plots, there has been very little change in the habitat characteristics of the plots over the years. Given this relative habitat stability, one might expect few changes in breeding bird populations. However, the limited number of census years and the use of different observers over the years probably limit the ability of the statistical tests to detect differences. Additional censuses will be required to improve sample sizes for future analyses.

The Clear-cut/Longleaf Pine Regeneration plot experienced significant habitat change over the years as the pines have matured. The population changes on the plot are consistent with the successional changes that have occurred. The data set for the plot consists of 10 years of continuous data, which probably also improves the ability of the statistical analyses to detect changes. Compared to the forested BBC plots, this larger data set produced a greater number of significant population changes than were observed on all of the forested plots combined. Additional censuses of this plot should be conducted to continue monitoring changes in breeding populations as the plot continues to mature.

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Appendix I

Breeding Bird Census Plot Descriptions

Bottomland Hardwood Forest – Established in 1992. (J. Field Ornithol. Vol. 64, No.1
(Supplement): 55-56)

Description of Plot: A square plot (350 x 350 m) with a closed canopy dominated by Red Maple, Sweetgum, and Laurel Oak, estimated to be between 31 and 60 years of age. Mean canopy height, 20 m (range 15-20 m). The E three-quarters of the plot is dominated by a thick Cane understory. Other understory plants include Sweetgum and Red Maple. Three small (<20 m diameter) openings in the canopy are scattered in the N half of the plot and are dominated by a thick ground cover of grape vines. Other ground cover plants include Cat Brier and Sphagnum. Approximately 50% of the plot was inundated during three visits, while < 2% was under water during the other six visits. The E 10-40 m of the plot is located above a 1.5 m embankment and contains vegetation more characteristic of drier hardwood forests. **Edge:** Up to 75% of the plot's perimeter is bordered by the same habitat, and the plot lies within a tract of similar habitat 51-100 ha in size. The narrow strip of drier hardwoods on the E edge is bordered by mature and regenerative pine plantations. **Topography and Elevation:** The plot is nearly level with a W-facing slope of < 5%. Minimum elevation 38 m, maximum 43 m.

Clear-cut-Longleaf Pine Regeneration – Established in 1992. (J. Field Ornithol. Vol. 64, No. 1 (Supplement): 68-69)

Description of Plot: A rectangular plot (300 x 700 m). The plot was cleared in 1990 and Longleaf Pine seedlings were planted. There is no canopy except for a 0.5 ha area where a Hackberry and Southern Red Oak copse was left standing. A number of snags occur throughout the plot (2-3 per ha with several dense clumps). The limited understory is dominated by Black Cherry and Southern Red Oak. About 30% of the plot consists of a dense growth of blackberry. Little Bluestem and Switchgrass make up much of the rest of the relatively sparse ground cover.

Edge: Less than 25% of the plot's perimeter is bordered by the same habitat, and more than 200 ha of similar habitat border on or are within a short distance of the plot. The NE and NW sections of the plot are bordered by Loblolly Pine forest. Isolated stands of mixed hardwoods border much of the N boundary. A Forest Service road runs along the S boundary and the roadside opposite the plot consists of a narrow band of dense young pines and cedars. A power line with steel towers runs along the W edge. **Topography and Elevation:** The plot is nearly level with a slope of < 5%. Minimum elevation 85 m, maximum 92 m.

1995 Census (J. Field Ornithol. Vol. 67, No. 4 (Supplement): 89-90)

Description of Plot: Because the site was initially clear-cut and replanted, the vegetation demonstrates growth and infilling each year. Planted longleaf pines are now approximately 1.2-1.5 m tall. Clumps of naturally-occurring trees, such as sweetgum, and various shrubs have become dense in some areas. Vertical structure of the vegetation has significantly increased since plot organization. Because vegetation presently inhibits identification of bird species to 100 m,

plot size was reduced from 25 to 12.5 ha. Grid intersections were likewise reduced from 100 m to 50 m.

2001 Census

Description of Plot: Because the site was initially clearcut and replanted, the vegetation demonstrates growth and infilling each year. Planted longleaf pines are now approximately 4-10 m tall. Over most of the plot the ground cover is sparse. Blackberry (Rubus sp.) is common throughout the plot. There are also isolated clumps of dense vegetation (sweetgum, privet, and other shrubs). The largest of these is approximately 0.25 ha. The plot was burned since the 2000 census, reducing the amount of shrub and ground cover compared to 1999 and 2000.

Loblolly Pine Forest (Loblolly II) – Established in 1993. (J. Field Ornithol. Vol. 65, No.2 (Supplement): 75)

Description of Plot: A rectangular plot (350 x 400 m) in a 34-yr-old stand located in the SE section of the Savannah River Site. The closed canopy is dominated by loblolly pine. There are also 2-3 clumps of water oaks with maximum heights below the canopy of loblolly pine, and some sweetgum. Mean canopy height, 18 m (range 6-20 m). The minimal understory is dominated by sweetgum, wax myrtle, and red maple. The sparse ground cover is dominated by muscadine, yellow jessamine, and gooseberry. **Edge:** At least 60% of the plot's perimeter is bordered by the same habitat, and the plot is part of a stand 48.2 ha in size. The SE edge is bordered by a Forest Service road on an old railroad bed with similar habitat across the road. The SW corner is bordered by a road and hardwoods, with a small stream located across the road.

Topography and Elevation: The plot is nearly level with a slope of < 5%. Minimum elevation 73 m, maximum 82m.

Loblolly Pine Plantation (cut in 1981, Loblolly I) -- Established in 1995. (J. Field Ornithol. Vol. 67 (Supplement): 58)

Description of Plot: A square plot (350 X 350 m) located in the SW section of the Savannah River Site. A seed-tree cut was performed in 1981. Scattered remnant loblolly pine trees were left standing for reseeding the site. The forest has regenerated with loblolly trees of approximately uniform size (7.6-9.1 m tall with the exception of the larger seed trees which are up to 17 m tall). The young trees currently form a low, thick canopy. A hardwood inclusion, dominated by understory-sized water oaks, is located in the N section of the plot. Clumps of water oak saplings are scattered throughout the N section. The ground cover is sparse and dominated by poison oak, wax myrtle, and yellow jessamine. **Edge:** More than 75% of the plot's perimeter is bordered by the same habitat, and the plot lies within a tract of similar habitat < 25 ha in size. The N border of the plot parallels a train track and a dirt access road. The plot boundary is set back approximately 10 m from the dirt road to avoid inclusion of edge habitat. North of the train track is a clear-cut. The young loblolly plantation extends to the S and W of the plot. However, the stand is not much larger than the plot itself. A small, depressional, mature hardwood forest borders part of the E edge of the plot. Main roads border the mature hardwoods to the E and the loblolly pine plantation to the S. **Topography and Elevation:** The plot is nearly level with a SE-facing slope of < 5% grade. Minimum elevation 62 m, maximum 71 m.

Longleaf Pine Forest – Established in 1992. (J. Field Ornithol. Vol. 64, No.1 (Supplement): 68-69)

Description of Plot: A square plot (350 x 350 m). A canopy dominated by mature Longleaf Pine, estimated to be between 31 and 60 years of age, covers 80% of the plot. Mean canopy height, 22 m (range 15-25 m). Where there is no canopy the understory is dominated by Sassafras, Laurel Oak, and Common Persimmon, and the ground cover is dominated by Poison Oak, Deer Berry, Camphor Weed, Little Bluestem, and *Aristida* grasses. The U. S. Forest Service uses a fire rotation schedule to manage the habitat. **Edge:** Up to 75% of the plot's perimeter is bordered by the same habitat, and the plot lies within a tract of similar habitat 51-100 ha in size. A lightly traveled Forest Service road runs along the N boundary. **Topography and Elevation:** The plot is nearly level with a slope of < 5%. Minimum elevation 79 m, maximum 82m.

Scrub Oak Forest with Scattered Longleaf Pine – Established in 1993. (J. Field Ornithol. Vol. 65, No.2 (Supplement): 94)

Description of Plot: A square plot (350 x 350 m) located in the NE corner of the Savannah River Site and maintained by the U. S. Forest Service. The open canopy is dominated by turkey oak, longleaf pine, and bluejack oak, estimated to be between 31 and 60 years of age. The mature longleaf pines are scattered throughout, rising well above the oak canopy. Mean canopy height, 7 m (range 5-15 m). The uniformly dense understory is dominated by turkey oak, sparkleberry, and dwarf post oak. The variable ground cover is dominated by gooseberry and dwarf huckleberry in the S and W portions of the plot, and by patches of bracken fern in the E half. Ground cover is sparsely distributed in much of the N section. The substrate is xeric and sandy, with no streams or standing water present. **Edge:** The plot is bordered on all sides by similar habitat, although a clear-cut area is present across a woods road running tangential to the SW corner. An 18-ha Department of Energy set aside area borders the W edge. The plot lies within a tract of similar habitat 26-50 ha in size. **Topography and Elevation:** The plot is nearly level with a S-facing slope of < 5%. Minimum elevation 93 m, maximum 108 m.

Tupelo-Cypress Swamp – Established in 1992. (J. Field Ornithol. Vol. 64, No.1 (Supplement): 80-81)

Description of Plot: A rectangular plot (200 x 550 m) with a closed canopy dominated by Water Tupelo and Bald Cypress, estimated to be between 61 and 100 years of age. Mean canopy height, 25 m (range 18-35 m). The limited understory is also dominated by Water Tupelo and Bald Cypress. Most of the patchily distributed ground cover consists of emergent vegetation such as Slender Arrowhead and beak rush. Other plants, such as Virginia-willow, Poison Ivy, and various briars, sprout along fallen logs. The plot is completely inundated throughout the year and is homogeneous in both vegetative composition and structure. No channels exist, but there is a constant ESE flow of water. Three small (< 25 m) “ponds” are present where the canopy is open, one of which contains vegetation (water lilies) not located elsewhere on the plot. Remnant cypress stumps measuring > 2 m in diameter are scattered throughout, but no living trees exceed 1.2 m dbh. **Edge:** Up to 75% of the plot’s perimeter is bordered by the same habitat, and the plot lies within a tract of similar habitat > 500 ha in size. The NNE border of the plot is located along the edge of the swamp and consists of a strip of upland hardwood forest 15-200 m wide. Managed pine woodlands and clear-cut areas are located beyond the hardwoods. The swamp extends 1-1.5 km beyond the SSW border of the plot to the Savannah River and continues both upstream (WNW) and downstream (ESE) for several km. **Topography and Elevation:** The plot is level. Minimum elevation 26 m, maximum 26 m.

Upland Hardwood Forest – Established in 1992. (J. Field Ornithol. Vol. 64, No.1 (Supplement): 57)

Description of Plot: A square plot (350 x 350 m). A closed canopy dominated by Southern Red Oak, Mockernut Hickory, and White Oak, estimated to be between 61 and 100 years of age, covers 80% of the plot. Mean canopy height, 25 m (range 18-30 m). The understory is dominated by Flowering Dogwood, American Holly, and Sweetgum. The ground cover is dominated by grape, Cane, and Butterfly-Pea. A small spring runs the length of the plot, 100 m from the south edge. The more hydric soils along the streams support vegetation such as Cane, which is not found in other areas of the plot. **Edge:** Less than 25% of the plot's border perimeter is bordered by the same habitat, and the plot lies within a tract of similar habitat 26-50 ha in size. A large stream (4-8 m wide) borders the W and half of the N edges. The S border is 3-15 m from the edge of a grass-forb-dominated power line corridor. **Topography and Elevation:** Most of the land slopes 20-40° toward the spring that runs through the plot. A similar slope is located along the W 50 m of the plot, facing the stream. Within 50 m of two-thirds of the N edge, the land drops 18-20 m along a wooded 45-60° slope. Minimum elevation 49 m, maximum 76 m.

Appendix II

Breeding Bird Census Plot Census Data

Bottomland Hardwood Plot Census Data. Numbers are territories/40 ha.

* = < 0.5 territory on plot, v = visitor

Year	1992	1993	1994	1995	1996	1997	1998	1999
Observer	JP		CI		MG			SW
Plot area (ha)	12.2		12.2		12.2			12.2
Census Trips	9		10		10			10
Cooper's Hawk								
Red-shouldered Hawk	1.6		v		0.0			0.0
Red-tailed Hawk	0.0		0.0		v			0.0
Wild Turkey	0.0		0.0		v			0.0
Northern Bobwhite								
Mourning Dove	0.0		4.9		0.0			0.0
Common Ground-dove								
Yellow-billed Cuckoo	3.3		6.6		8.2			9.8
Eastern Screech-owl	0.0		0.0		v			0.0
Barred Owl	0.0		0.0		v			v
Barn Owl	0.0		v		0.0			0.0
Common Nighthawk								
Chuck-will's-widow								
Whip-poor-will								
Chimney Swift								
Ruby-throated Hummingbird	0.0		0.0		3.3			3.3
Red-headed Woodpecker								
Red-bellied Woodpecker	6.6		6.6		8.2			*
Downy Woodpecker	6.6		4.9		6.6			*
Northern Flicker	0.0		0.0		v			0.0
Pileated Woodpecker	3.3		1.6		3.3			*
Eastern Wood-Pewee	0.0		v		0.0			0.0
Acadian Flycatcher	18.0		23.0		27.9			27.9
Great Crested Flycatcher	4.9		6.6		6.6			0.0
Eastern Kingbird	0.0		0.0		0.0			0.0
White-eyed Vireo	13.1		19.7		16.4			v
Yellow-throated Vireo	3.3		v		0.0			v
Red-eyed Vireo	29.5		37.7		37.7			23.0
Blue Jay	v		v		v			v
American Crow	0.0		0.0		0.0			v
Fish Crow	0.0		0.0		v			0.0
Purple Martin	0		0.0		0.0			v
Barn Swallow								
Carolina Chickadee	9.8		6.6		6.6			3.3
Tufted Titmouse	9.8		6.6		11.5			8.2
White-breasted Nuthatch	0.0		v		0.0			v
Brown-headed Nuthatch								
Carolina Wren	19.7		13.1		18.0			14.8
Blue-gray Gnatcatcher	9.8		11.5		21.3			21.3
Eastern Bluebird								

Bottomland Hardwood Plot Census Data (cont.)

Wood Thrush	11.5	9.8	13.1	1.6
Gray Catbird				
Northern Mockingbird				
Brown Thrasher				
Northern Parula	14.8	13.1	37.7	11.5
Yellow-throated Warbler				
Pine Warbler	1.6	0.0	v	0.0
Prairie Warbler				
Black-and-white Warbler	8.2	6.6	8.2	4.9
American Redstart	16.4	14.8	36.1	13.1
Prothonotary Warbler				
Worm-eating Warbler	1.6	0.0	0.0	0.0
Swainson's Warbler	3.3	*	6.6	6.6
Ovenbird				
Louisiana Waterthrush				
Kentucky Warbler	9.8	8.2	19.7	3.3
Common Yellowthroat	0.0	0.0	v	0.0
Hooded Warbler	23.0	52.5	37.7	18.0
Yellow-breasted Chat				
Summer Tanager	3.3	*	6.6	*
Eastern Towhee	0.0	v	0.0	0.0
Bachman's Sparrow				
Chipping Sparrow				
Field Sparrow				
Northern Cardinal	14.8	8.2	13.1	0.0
Blue Grosbeak				
Indigo Bunting	0.0	v	v	0.0
Eastern Meadowlark				
Common Grackle		0.0	0.0	v
Brown-headed Cowbird	0.0	v	v	v
Orchard Oriole				
American Goldfinch	0	0.0	0.0	v
Visitors				
Black Vulture	*	0.0	v	0.0
total species	25	22	22	19

Clear-cut-Longleaf Pine Regeneration Plot Census Data. Numbers are territories/40 ha.

* = < 0.5 territory on plot, v = visitor

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Observer	DD	SW	CI	CI	MG	MG	SW	SW	SW	SW
Plot area (ha)	25	25	25	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Census Trips	8	8	10	10	10	10	10	10	10	10
Stand Age (years)	2	3	4	5	6	7	8	9	10	11
Cooper's Hawk	0	0	0	0	v	0	0	0	0	0
Red-shouldered Hawk	0									
Red-tailed Hawk	0	0	0	0	v	0	0	0	0	0
Wild Turkey										
Northern Bobwhite	20	4.8	9.6	9.6	0	v	8	0	0	0
Rock Dove	0	0	0	0	v	0	0	0	0	0
Mourning Dove	12.8	0	11.2	12.8	v	v	0	3.2	3.2	3.2
Common Ground-dove	3.2	4	4.8	3.2	6.4	3.2	4.8	0	0	0
Yellow-billed Cuckoo	0.8	0	0	0	0	0	0	0	0	0
Eastern Screech-Owl										
Barred Owl										
Common Nighthawk	0	0	0	v	v	0	0	0	0	0
Chuck-will's-widow										
Whip-poor-will										
Chimney Swift	0	0	0	v	v	v	0	0	0	0
Ruby-throated Hummingbird										
Red-headed Woodpecker	3.2	4	4.8	4.8	v	0	0	0	0	0
Red-bellied Woodpecker	2.4	2.4	4.8	3.2	3.2	*	0	0	0	0
Downy Woodpecker	*	0	v	1.6	v	0	0	0	0	0
Northern Flicker	3.2	1.6	2.4	3.2	v	v	0	0	0	0
Pileated Woodpecker	0	0	v	0	0	v	0	0	0	0
Eastern Wood-Pewee	0	0	v	0	0	0	0	0	0	0
Acadian Flycatcher										
Eastern Phoebe	0	0	v	0	0	0	0	0	0	0
Great Crested Flycatcher	3.2	2.4	4	3.2	6.4	3.2	0	0	3.2	0
Eastern Kingbird	4.8	2.4	4	6.4	4.8	*	0	0	0	0
White-eyed Vireo	4.8	0.8	3.2	3.2	0	4.8	11.2	11.2	9.6	6.4
Yellow-throated Vireo										
Red-eyed Vireo										
Blue Jay	1.6	0	0	1.6	v	*	0	0.8	0	1.6
American Crow	0	0	0	v	v	v	0	0	0	0
Fish Crow	0	0	0	v	v	v	0	0	0	0
Purple Martin	0	0	0	v	0	0	0	0	0	0
Barn Swallow	0	0	0	0	0	v	0	0	0	0
Carolina Chickadee	0	0.8	v	0	9.6	6.4	3.2	1.6	3.2	3.2
Tufted Titmouse	0.8	0	v	0	v	0	0	0	3.2	0
White-breasted Nuthatch	0	0	0	v	0	0	0	0	0	0
Brown-headed Nuthatch	0.8	0	v	3.2	v	0	0	0	0	0
Carolina Wren	9.6	4.8	6.4	3.2	12.8	8	6.4	1.6	1.6	4.8

Clear-cut-Longleaf Pine Regeneration Plot Census Data (cont.)

Blue-gray Gnatcatcher	0	0	v	v	v	0	0	0	0.8	0
Eastern Bluebird	6.4	9.6	9.6	6.4	3.2	*	0	0	0	0
Wood Thrush										
Gray Catbird	0	1.6	v	9.6	12.8	9.6	8	4.8	0.8	0
Northern Mockingbird	7.2	9.6	4.8	4.8	14.4	v	0	0	0	0
Brown Thrasher	2.4	2.4	2.4	8	6.4	9.6	6.4	3.2	0	4.8
Northern Parula										
Yellow-throated Warbler										
Pine Warbler	0	0	0	0	0	0	0	1.6	3.2	4.8
Prairie Warbler	23.2	14.4	12	19.2	30.4	32	17.6	12.8	12.8	3.2
Black-and-white Warbler										
American Redstart										
Prothonotary Warbler										
Worm-eating Warbler										
Swainson's Warbler										
Ovenbird										
Louisiana Waterthrush										
Kentucky Warbler										
Common Yellowthroat	0.8	4	v	8	v	6.4	8	0	0	0
Hooded Warbler										
Yellow-breasted Chat	10.4	14.4	20.8	12.8	14.4	12.8	20.8	16	9.6	6.4
Summer Tanager	4	1.6	4	v	v	v	0	0	0.8	0
Eastern Towhee	16	8.8	8.8	24	30.4	16	24	16	14.4	6.4
Bachman's Sparrow	19.2	10.4	8	6.4	19.2	12.8	0	0	0	0
Chipping Sparrow	3.2	0	0	0	0	v	0	0	0	0
Field Sparrow	0	1.6	4	6.4	9.6	9.6	14.4	6.4	6.4	0
Northern Cardinal	6.4	2.4	4.8	6.4	6.4	12.8	6.4	4.8	8	8
Blue Grosbeak	16.8	4	11.2	8	16	6.4	12.8	6.4	6.4	6.4
Indigo Bunting	24	14.4	13.6	9.6	54.4	38.4	16	6.4	6.4	12.8
Eastern Meadowlark	4.8	1.6	v	0	0	0	0	0	0	0
Common Grackle	0	0	0	0	v	0	0	0	0	0
Brown-headed Cowbird	0	4.8	v	v	v	v	0	0	0	3.2
Orchard Oriole	19.2	8	4.8	6.4	11.2	0	0	0	0	0
American Goldfinch										
Visitors										
Double-crested Cormorant										
Great Blue Heron	0	0	0	0	v	0	0	0	0	0
Great Egret	0	0	0	0	v	0	0	0	0	0
Cattle Egret	0	0	0	0	v	v	0	0	0	0
Green Heron	0	0	0	0	v	0	0	0	0	0
White Ibis	0	0	0	0	v	0	0	0	0	0
Black Vulture	0	0	0	v	v	v	0	0	0	0
Turkey Vulture	0	0	0	v	v	0	0	0	0	0
total species	30	27	23	27	19	20	15	15	17	14

Loblolly II Plot Census Data. Numbers are territories/40 ha.

* = < 0.5 territory on plot, v = visitor

Year	1992	1993	1994	1995	1996	1997	1998	1999
Observer		SW	CI			MG		
Plot area (ha)		12.2	12.2			12.2		
Census Trips		10	10			10		
Cooper's Hawk								
Red-shouldered Hawk								
Red-tailed Hawk								
Wild Turkey								
Northern Bobwhite								
Mourning Dove		v	3.3			0.0		
Common Ground-dove								
Yellow-billed Cuckoo		0.0	1.6			0.0		
Eastern Screech-Owl								
Barred Owl								
Common Nighthawk								
Chuck-will's-widow								
Whip-poor-will								
Chimney Swift								
Ruby-throated Hummingbird								
Red-headed Woodpecker		3.3	6.6			*		
Red-bellied Woodpecker		3.3	4.9			3.3		
Downy Woodpecker		v	4.9			*		
Northern Flicker		*	3.3			*		
Pileated Woodpecker		0.0	1.6			v		
Eastern Wood-Pewee		6.6	8.2			3.3		
Acadian Flycatcher		v	v			v		
Great Crested Flycatcher		9.8	11.5			6.6		
Eastern Kingbird								
White-eyed Vireo		0.0	1.6			*		
Yellow-throated Vireo		0.0	1.6			0.0		
Red-eyed Vireo		v	v			0.0		
Blue Jay		v	v			v		
American Crow		0.0	0.0			v		
Fish Crow								
Purple Martin		v	0.0			0.0		
Barn Swallow								
Carolina Chickadee		v	1.6			3.3		
Tufted Titmouse		3.3	4.9			0.0		
White-breasted Nuthatch								
Brown-headed Nuthatch		3.3	11.5			*		
Carolina Wren		3.3	11.5			6.6		
Blue-gray Gnatcatcher		v	v			3.3		
Eastern Bluebird								

Loblolly II Plot Census Data (cont.)

Wood Thrush			
Gray Catbird			
Northern Mockingbird			
Brown Thrasher			
Northern Parula	0.0	v	*
Yellow-throated Warbler			
Pine Warbler	23.0	18.0	23.0
Prairie Warbler	0.0	0.0	3.3
Black-and-white Warbler			
American Redstart			
Prothonotary Warbler			
Worm-eating Warbler			
Swainson's Warbler			
Ovenbird	0.0	v	0.0
Louisiana Waterthrush			
Kentucky Warbler			
Common Yellowthroat			
Hooded Warbler			
Yellow-breasted Chat			
Summer Tanager	8.2	6.6	*
Eastern Towhee	3.3	8.2	6.6
Bachman's Sparrow			
Chipping Sparrow	0.0	0.0	v
Field Sparrow			
Northern Cardinal	1.6	14.8	6.6
Blue Grosbeak			
Indigo Bunting	*	3.3	8.2
Eastern Meadowlark			
Common Grackle			
Brown-headed Cowbird	*	v	v
Orchard Oriole			
American Goldfinch	v	0.0	v
Visitors			
Wood Duck	v	v	0.0
total species	14	20	18

Loblolly I Plot Census Data. Numbers are territories/40 ha.

* = < 0.5 territory on plot, v = visitor

Year	1992	1993	1994	1995	1996	1997	1998	1999
Observer				CI		MG		SW
Plot area (ha)				12.2		12.2		12.2
Census Trips				10		10		10
Cooper's Hawk								
Red-shouldered Hawk								
Red-tailed Hawk								
Wild Turkey								
Northern Bobwhite				v		0.0		0.0
Mourning Dove				v		3.3		0.0
Common Ground-dove								
Yellow-billed Cuckoo				v		0.0		3.3
Eastern Screech-Owl								
Barred Owl								
Common Nighthawk				0.0		0.0		v
Chuck-will's-widow								
Whip-poor-will								
Chimney Swift								
Ruby-throated Hummingbird								
Red-headed Woodpecker				0.0		v		0.0
Red-bellied Woodpecker				v		v		0.0
Downy Woodpecker				3.28		v		v
Northern Flicker				v		0.0		v
Pileated Woodpecker				0.0		0.0		v
Eastern Wood-Pewee				v		0.0		0.0
Acadian Flycatcher				*		v		0.0
Great Crested Flycatcher				6.56		3.3		3.3
Eastern Kingbird								
White-eyed Vireo				1.64		0.0		0.0
Yellow-throated Vireo				1.64		0.0		0.0
Red-eyed Vireo				0.0		v		v
Blue Jay				v		3.3		v
American Crow				v		v		0.0
Fish Crow				0.0		0.0		v
Purple Martin								
Barn Swallow								
Carolina Chickadee				3.28		v		3.3
Tufted Titmouse				8.2		8.2		4.9
White-breasted Nuthatch								
Brown-headed Nuthatch								
Carolina Wren				3.28		v		v
Blue-gray Gnatcatcher				4.92		v		v
Eastern Bluebird				0.0		v		0.0

Loblolly I Plot Census Data (cont.)

Wood Thrush	4.92	0.0	0.0
Gray Catbird			
Northern Mockingbird			
Brown Thrasher	v	v	0.0
Northern Parula	1.64	v	v
Yellow-throated Warbler			
Pine Warbler	4.92	3.3	3.3
Prairie Warbler			
Black-and-white Warbler			
American Redstart	0.0	v	0.0
Prothonotary Warbler			
Worm-eating Warbler			
Swainson's Warbler			
Ovenbird			
Louisiana Waterthrush			
Kentucky Warbler			
Common Yellowthroat			
Hooded Warbler			
Yellow-breasted Chat			
Summer Tanager	0.0	0.0	v
Eastern Towhee	v	*	v
Bachman's Sparrow			
Chipping Sparrow			
Field Sparrow			
Northern Cardinal	9.84	9.8	6.6
Blue Grosbeak	0.0	0.0	v
Indigo Bunting			
Eastern Meadowlark			
Common Grackle			
Brown-headed Cowbird	v	v	v
Orchard Oriole			
American Goldfinch			
Visitors			
Green Heron	0.0	*	v
total species	13	8	6

Longleaf Plot Census Data. Numbers are territories/40 ha.

* = < 0.5 territory on plot, v = visitor

Year	1992	1993	1994	1995	1996	1997	1998	1999
Observer	DD	JP			MG		SW	
Plot area (ha)	12.2	12.2			12.2		12.2	
Census Trips	8	11			10		10	
Cooper's Hawk								
Red-shouldered Hawk	0.0	0.0			0.0		v	
Red-tailed Hawk								
Wild Turkey								
Northern Bobwhite	0.0	v			0.0		0.0	
Mourning Dove	v	*			1.6		v	
Common Ground-dove								
Yellow-billed Cuckoo	v	4.9			0.0		v	
Eastern Screech-Owl								
Barred Owl								
Common Nighthawk	*	3.3			4.9		v	
Chuck-will's-widow								
Whip-poor-will	0.0	0.0			1.6		0.0	
Chimney Swift	0.0	0.0			v		0.0	
Ruby-throated Hummingbird								
Red-headed Woodpecker	1.6	3.3			4.9		v	
Red-bellied Woodpecker	1.6	4.9			3.3		3.3	
Downy Woodpecker	v	3.3			3.3		3.3	
Hairy Woodpecker	3.3	0.0			0.0		3.3	
Red-cockaded Woodpecker	3.3	3.3			3.3		3.3	
Northern Flicker	3.3	1.6			3.3		3.3	
Pileated Woodpecker	*	1.6			v		v	
Eastern Wood-Pewee	9.8	9.8			11.5		19.7	
Acadian Flycatcher								
Great Crested Flycatcher	11.5	4.9			6.6		4.9	
Eastern Kingbird								
White-eyed Vireo								
Yellow-throated Vireo	1.6	1.6			0.0		0.0	
Red-eyed Vireo								
Blue Jay	3.3	3.3			3.3		3.3	
American Crow	0.0	0.0			0.0		v	
Fish Crow	v	0.0			v		0.0	
Purple Martin	0.0	0.0			0.0		v	
Barn Swallow								
Carolina Chickadee	4.9	4.9			6.6		3.3	
Tufted Titmouse	4.9	3.3			9.8		1.6	
White-breasted Nuthatch	0.0	0.0			v		0.0	
Brown-headed Nuthatch	8.2	11.5			9.8		3.3	
Carolina Wren	6.6	3.3			v		0.0	

Longleaf Plot Census Data (cont.)

Blue-gray Gnatcatcher	*	3.3	v	0.0
Eastern Bluebird	6.6	8.2	3.3	4.9
Wood Thrush	0.0	0.0	0.0	0.0
Gray Catbird				
Northern Mockingbird				
Brown Thrasher	v	3.3	0.0	v
Northern Parula				
Yellow-throated Warbler				
Pine Warbler	32.8	29.5	19.7	16.4
Prairie Warbler	31.2	9.8	18.0	1.6
Black-and-white Warbler				
American Redstart				
Prothonotary Warbler				
Worm-eating Warbler				
Swainson's Warbler				
Ovenbird	v	0.0	0.0	0.0
Louisiana Waterthrush				
Kentucky Warbler				
Common Yellowthroat	1.6	v	0.0	0.0
Hooded Warbler				
Yellow-breasted Chat				
Summer Tanager	8.2	8.2	3.3	3.3
Eastern Towhee	14.8	8.2	16.4	4.9
Bachman's Sparrow	21.3	16.4	9.8	9.8
Chipping Sparrow	9.8	21.3	23.0	11.5
Field Sparrow	0.0	0.0	v	0.0
Northern Cardinal	*	1.6	6.6	v
Blue Grosbeak	3.3	6.6	v	3.3
Indigo Bunting	0.0	8.2	v	3.3
Eastern Meadowlark				
Common Grackle	0.0	0.0	v	0.0
Brown-headed Cowbird	v	v	v	0.0
Orchard Oriole				
American Goldfinch	0.0	0.0	0.0	v
Visitors				
American Robin	0.0	0.0	0.0	v
total species	26	29	22	20

Scrub Oak Plot Census Data. Numbers are territories/40 ha.

* = < 0.5 territory on plot, v = visitor

Year	1992	1993	1994	1995	1996	1997	1998	1999
Observer		JP		CI		MG		SW
Plot area (ha)		12.2		12.2		12.2		12.2
Census Trips		11		10		10		10
Cooper's Hawk								
Red-shouldered Hawk		v		v		*		v
Red-tailed Hawk		v		0.0		0.0		v
Wild Turkey		v		0.0		0.0		0.0
Northern Bobwhite		0.0		0.0		0.0		0.0
Mourning Dove		6.6		3.3		v		3.3
Common Ground-dove								
Yellow-billed Cuckoo		6.6		3.3		v		3.3
Eastern Screech-Owl								
Barred Owl		0.0		0.0		0.0		v
Common Nighthawk		0.0		v		0.0		0.0
Chuck-will's-widow								
Whip-poor-will								
Chimney Swift								
Ruby-throated Hummingbird		v		0.0		0.0		0.0
Red-headed Woodpecker								
Red-bellied Woodpecker		3.3		3.3		0.0		0.0
Downy Woodpecker		*		v		0.0		0.0
Northern Flicker		v		v		0.0		v
Pileated Woodpecker		4.9		v		v		*
Eastern Wood-Pewee		0.0		0.0		v		0.0
Acadian Flycatcher								
Eastern Phoebe								
Great Crested Flycatcher		11.5		6.6		3.3		4.9
Eastern Kingbird								
White-eyed Vireo								
Yellow-throated Vireo								
Red-eyed Vireo		*		0.0		0.0		0.0
Blue Jay		6.6		3.3		*		v
American Crow		v		v		0.0		*
Fish Crow		0.0		v		0.0		0.0
Purple Martin		0.0		v		0.0		0.0
Barn Swallow		0.0		v		0.0		0.0
Carolina Chickadee		4.9		3.3		6.6		8.2
Tufted Titmouse		6.6		3.3		3.3		6.6
White-breasted Nuthatch								
Brown-headed Nuthatch		v		3.3		*		v
Carolina Wren		0.0		v		v		0.0
Blue-gray Gnatcatcher		4.9		3.3		v		18.0
Eastern Bluebird		0.0		0.0		0.0		v

Scrub Oak Plot Census Data (cont.)

Wood Thrush	4.9	1.6	0.0	0.0
Gray Catbird				
Northern Mockingbird				
Brown Thrasher	3.3	1.6	0.0	v
Northern Parula	0.0	0.0	0.0	v
Yellow-throated Warbler				
Pine Warbler	18.0	6.6	3.3	6.6
Prairie Warbler	0.0	v	0.0	0.0
Black-and-white Warbler	3.3	3.3	0.0	3.3
American Redstart				
Prothonotary Warbler				
Worm-eating Warbler				
Swainson's Warbler				
Ovenbird	8.2	4.9	6.6	4.9
Louisiana Waterthrush				
Kentucky Warbler				
Common Yellowthroat				
Hooded Warbler				
Yellow-breasted Chat				
Summer Tanager	11.5	6.6	3.3	4.9
Eastern Towhee				
Bachman's Sparrow				
Chipping Sparrow	0.0	v	0.0	0.0
Field Sparrow				
Northern Cardinal	3.3	v	v	4.9
Blue Grosbeak				
Indigo Bunting				
Eastern Meadowlark				
Common Grackle	0.0	0.0	v	0.0
Brown-headed Cowbird	v	v	v	0.0
Orchard Oriole	0.0	0.0	0.0	0.0
American Goldfinch	0.0	0.0	0.0	v

Visitors

total species	18	15	9	13
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Tupelo-Cypress Swamp Plot Census Data. Numbers are territories/40 ha.

* = < 0.5 territory on plot, v = visitor

Year	1992	1993	1994	1995	1996	1997	1998	1999
Observer	JP			CI			SW	
Plot area (ha)	11			11			11	
Census Trips	8			10			10	
Cooper's Hawk	0.0			v			0.0	
Red-shouldered Hawk	0.0			0.0			*	
Red-tailed Hawk								
Wild Turkey								
Northern Bobwhite								
Mourning Dove	0.0			3.6			v	
Common Ground-dove								
Yellow-billed Cuckoo	5.5			3.6			7.3	
Esatern Screech-Owl								
Barred Owl	3.6			0.0			v	
Common Nighthawk								
Chuck-will's-widow								
Whip-poor-will								
Chimney Swift	v			v			v	
Ruby-throated								
Hummingbird	v			0.0			0.0	
Red-headed Woodpecker								
Red-bellied Woodpecker	7.3			7.3			5.5	
Downy Woodpecker	7.3			3.6			3.6	
Hairy Woodpecker	v			v			v	
Northern Flicker	0.0			0.0			v	
Pileated Woodpecker	3.6			v			1.8	
Eastern Wood-Pewee								
Acadian Flycatcher	40.0			34.5			20.0	
Great Crested Flycatcher	7.3			3.6			3.6	
Eastern Kingbird								
White-eyed Vireo	*			3.6			0.0	
Yellow-throated Vireo	1.8			v			0.0	
Red-eyed Vireo	5.5			3.6			9.1	
Blue Jay	v			v			3.6	
American Crow	v			v			*	
Fish Crow	0.0			v			v	
Purple Martin	0.0			0.0			v	
Barn Swallow								
Carolina Chickadee	10.9			5.5			3.6	
Tufted Titmouse	5.5			7.3			10.9	
White-breasted Nuthatch	12.7			7.3			5.5	
Brown-headed Nuthatch	v			v			0.0	
Carolina Wren	9.1			20.0			7.3	
Blue-gray Gnatcatcher	5.5			7.3			5.5	
Eastern Bluebird								

Tupelo-Cypress Swamp Plot Census Data (cont.)

Wood Thrush			
Gray Catbird			
Northern Mockingbird			
Brown Thrasher			
Northern Parula	50.9	49.1	40.0
Yellow-throated Warbler	12.7	v	0.0
Pine Warbler			
Prairie Warbler			
Black-and-white Warbler			
American Redstart	1.8	0.0	0.0
Prothonotary Warbler	36.4	23.6	29.1
Worm-eating Warbler			
Swainson's Warbler			
Ovenbird			
Louisiana Waterthrush			
Kentucky Warbler			
Common Yellowthroat			
Hooded Warbler			
Yellow-breasted Chat			
Summer Tanager	7.3	*	3.6
Eastern Towhee			
Bachman's Sparrow			
Chipping Sparrow			
Field Sparrow			
Northern Cardinal	1.8	3.6	v
Blue Grosbeak			
Indigo Bunting			
Eastern Meadowlark			
Common Grackle	0.0	v	v
Brown-headed Cowbird	3.6	0.0	0.0
Orchard Oriole			
American Goldfinch			
Visitors			
Anhinga	0.0	0.0	v
Great Blue Heron	*	*	v
Great Egret	0.0	*	0.0
White Ibis	0.0	v	v
Wood Stork	0.0	v	0.0
Wood Duck	5.5	v	v
total species	24	19	18

Upland Hardwood Plot Census Data. Numbers are territories/40 ha.

* = < 0.5 territory on plot, v = visitor

Year	1992	1993	1994	1995	1996	1997	1998	1999
Observer	JP		CI		MG		SW	
Plot area (ha)	12.2		12.2		12.2		12.2	
Census Trips	8		10		10		10	
Cooper's Hawk								
Red-shouldered Hawk								
Red-tailed Hawk								
Wild Turkey	0.0		0.0		v		v	
Northern Bobwhite								
Mourning Dove	0.0		6.6		0.0		v	
Common Ground-dove								
Yellow-billed Cuckoo	4.9		6.6		4.9		6.6	
Eastern Screech-Owl								
Barred Owl	3.3		1.6		3.3		v	
Common Nighthawk								
Chuck-will's-widow								
Whip-poor-will	0.0		0.0		3.3		0.0	
Chimney Swift	0.0		0.0		0.0		v	
Ruby-throated								
Hummingbird	v		0.0		9.8		v	
Red-headed Woodpecker	0.0		0.0		v		0.0	
Red-bellied Woodpecker	3.3		6.6		6.6		*	
Downy Woodpecker	3.3		4.9		6.6		3.3	
Hairy Woodpecker	0.0		0.0		0.0		v	
Northern Flicker	0.0		0.0		4.9		0.0	
Pileated Woodpecker	1.6		v		3.3		3.3	
Eastern Wood-Pewee	0.0		v		0.0		0.0	
Acadian Flycatcher	18.0		14.8		29.5		9.8	
Great Crested Flycatcher	*		0.0		6.6		v	
Eastern Kingbird	0.0		0.0		0.0		0.0	
White-eyed Vireo	3.3		1.6		v		0.0	
Yellow-throated Vireo	4.9		11.5		8.2		3.3	
Red-eyed Vireo	23.0		13.1		26.2		13.1	
Blue Jay	0.0		0.0		v		v	
American Crow	0.0		0.0		0.0		v	
Fish Crow	0.0		0.0		0.0		v	
Purple Martin	0.0		0.0		0.0		v	
Barn Swallow								
Carolina Chickadee	13.1		6.6		11.5		3.3	
Tufted Titmouse	8.2		6.6		13.1		9.8	
White-breasted Nuthatch	1.6		0.0		3.3		v	
Brown-headed Nuthatch								
Carolina Wren	16.4		11.5		13.1		8.2	
Blue-gray Gnatcatcher	4.9		9.8		9.8		8.2	
Eastern Bluebird								

Upland Hardwood Plot Census Data (cont.)

Wood Thrush	16.4	13.1	8.2	6.6
Gray Catbird				
Northern Mockingbird				
Brown Thrasher				
Northern Parula	39.4	34.4	72.2	34.4
Yellow-throated Warbler	3.3	11.5	23.0	3.3
Pine Warbler	1.6	v	0.0	v
Prairie Warbler				
Black-and-white Warbler	4.9	4.9	6.6	v
American Redstart	3.3	v	6.6	0.0
Prothonotary Warbler	*	1.6	v	v
Worm-eating Warbler	v	0.0	6.6	v
Swainson's Warbler				
Ovenbird	v	v	0.0	0.0
Louisiana Waterthrush	v	3.3	6.6	*
Kentucky Warbler	16.4	4.9	v	0.0
Common Yellowthroat	0.0	0.0	v	0.0
Hooded Warbler	16.4	9.8	6.6	1.6
Yellow-breasted Chat				
Summer Tanager	13.1	11.5	9.8	8.2
Eastern Towhee				
Bachman's Sparrow				
Chipping Sparrow				
Field Sparrow				
Northern Cardinal	11.5	8.2	11.5	0.0
Blue Grosbeak	0.0	v	0.0	v
Indigo Bunting	0.0	0.0	v	v
Eastern Meadowlark				
Common Grackle				
Brown-headed Cowbird	0.0	v	v	v
Orchard Oriole				
American Goldfinch	0.0	0.0	0.0	v
Visitors				
total species	26	23	27	17