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FINAL REPORT

Submitted by:

Virginia Department of Conservation and Recreation
Division of Natural Heritage

Virginia Department of Game and Inland Fisheries
Nongame and Endangered Species Program

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ABSTRACT

Reported declines of neotropical migratory songbird populations have drawn the attention of the scientific community and the general public. While researchers and conservationists have focused their energies on understanding the behavioral and ecological dynamics of these population during the breeding and wintering season, migration ecology has remained largely neglected. Migration must be endured twice annually and is a particularly stressful event for birds. Comprehensive conservation efforts on behalf of migratory birds must include this critical phase of life if they are to succeed in protecting whole populations.

The two-year Northampton Migratory Bird Habitat Utilization Study was initiated under Northampton County's Special Area Management Plan (SAMP) to provide this rural, coastal county with sound scientific data to guide the development of enforceable policies that will protect and enhance migratory songbird habitat. Conserving migratory birds and their habitat in lower Northampton County will serve to generate the basis of a burgeoning nature tourism industry, help to protect water quality and moderate secondary impacts of coastal development.

In summary, results from the first year of the study (1992) demonstrated that:

1. Long-distance migrants are most abundant during the first half of the migratory period while short-distance migrants are most abundant during the last half of the season.
2. Bird activity was greater in the morning compared to the afternoon.
3. If birds spatially redistribute during the course of a day, they do so very early in the morning.
4. Many long- and short-distance migrants concentrate along the bayside and near the tip of the peninsula. Resident species tend to be least abundant near the peninsula tip.
5. In general, there is no clear relationship between bird abundance and forest patch size.
6. The majority of birds from both migrant groups were more abundant close to the forest edge than in the interior.
7. Most species over-utilized plots with relatively high vegetation density.
8. Individual species were associated with particular vertical strata within the forest.

The vertical distribution of species is in general agreement with associations known for the breeding and wintering seasons.

Results from 1992 were used to refine our research questions and modify data collection efforts for the second field season. Specifically, we chose to increase sampling within the forested bayside corridor and collect data on the physiological condition and foraging behavior of birds during stopover. We also repeated the broad survey coverage of lower Northampton County at sites established in 1992. A descriptive summary of new data from studies conducted in the fall of 1993 are presented in tables and graphs accompanying this report.

STUDY BACKGROUND AND JUSTIFICATION

Bounded by the Chesapeake Bay to the west and undeveloped Atlantic barrier islands to the east, the lower Delmarva Peninsula has long been recognized as a significant stop-over area for migrating birds of all kinds (Rusling 1936). This area is included in the Western Hemisphere Shorebird Reserve Network and is home to the Kiptopeke songbird banding and hawk observation station established by the Virginia Society of Ornithology 29 years ago. Giving further confirmation of the ecological value of the lower Delmarva for fall migrants, the U.S. Fish and Wildlife Service established the Eastern Shore National Wildlife Refuge at the peninsula tip specifically for the conservation of migratory birds.

Unlike the Cape May Peninsula to the north, intensive study of fall migrants on the lower Delmarva did not begin until 1991. A regional study of the geographic distribution of fall migrants on the Cape May and Delmarva peninsulas was initiated in that year (Mabey et al. 1993). While some general regional patterns of migrant abundance were identified in that study, local landscape and habitat associations were obscured by the study's large scale geographic approach.

Stop-over concentrations on the lower Delmarva differ from other coastal concentration areas such as the northern Gulf Coast and the Cape May Peninsula for at least two reasons. First, neotropical migrants that stop on the Delmarva do not appear to face any immediate major ecological barriers that would necessitate extremely long non-stop flights. Second, relatively more short-distance migrants (those birds that winter in southern U.S.) appear to use the Delmarva as a stop-over site than use the Cape May peninsula or the Gulf Coast (P. Kerlinger *pers. comm.*, M. Woodrey *pers. comm.*). Although this is likely to be a result of simple geography, the large numbers of short distance migrants add a unique dimension to stop-over ecology on the lower Delmarva. The presence of short-distance migrants increases the overall ecological value of Eastern Shore habitat and may provide more potential prey for raptor species.

Further studies of stop-over ecology on the lower Delmarva will not only be important to a broader understanding of migration but will play a significant role in

Northampton County's conservation initiatives. With the adoption of their comprehensive plan in 1990, Northampton officially recognized the value of the area's unique natural resources as the current and historical base of the county's economy and culture (Northampton County Joint Local Planning Commission 1990). Agriculture is the county's leading industry; in 1987, the county's 119 commercial farms generated $43,085,703 (Northampton Co. Planning and Zoning Dept. 1989). Shell and finfishing are also critical to the local economy, representing an estimated 10-20% of Virginia's bay region industry. In 1988, the bay region brought in $62,096,849 worth of seafood. Forestry has the potential for being the third most important economic base in the county but provided only $500,000 directly to the community in 1988, although the estimated "value" of timber sales for that year is over fourteen million dollars (Northampton Co. Planning and Zoning Dept. 1989). There is also growth potential the nature- and historic-based tourism.

Land use patterns in Northampton County have remained relatively stable over the past century. In 1986 about 35% of land area was in cropland, 20% in forest, 39% in marsh/wetland, and only 5% was classified as urban, industrial, or other (Northampton Co. Planning and Zoning Dept. 1989). Agricultural lands do not appear to be increasing because the best soils are already in cultivation. Forestlands are decreasing slowly as they are transferred into "alternate uses", mostly home sites.

Rapid change in the landscape is, however, on the horizon. In eleven miles of bayside shoreline from the tip of the peninsula north, almost seven have already been subdivided for development. The majority of this land is forested and may be one of the most important areas for migrating landbirds on the entire Delmarva Peninsula (Mabey et al. 1993). Northampton County will face a radical population shift as vacation and retirement homes are built over the next 5-10 years.

In keeping with the Northampton County comprehensive plan's commitment to managed growth, a Special Area Management Plan (SAMP) was initiated in 1992 with funding from the National Oceanic and Atmospheric Administration's (NOAA) Office of Coastal Resource Management. In the context of the SAMP, Northampton County has acknowledged migratory landbirds and their habitats to be of significant conservation value. By including neotropical migrants as a resource to protect and enhance through new,

enforceable policies, Northampton County is recognizing the international importance of the Delmarva Peninsula as a stop-over concentration area as well as the integral role birds and their habitat play in the ecological health of the region. The SAMP seeks to control the cumulative and secondary impacts of coastal development by "maintaining maximum vegetation cover for wildlife habitat and nutrient removal from non-point runoff" and by steering development away from "sensitive wildlife habitat and groundwater recharge areas and toward areas with greatest carrying capacity" (Virginia Coastal Resources Management Program: Coastal Zone Management Act Section 309 Final Strategy, VACOE, Grant No. NA17OZ0359-01). The SAMP effort will also be directed toward increasing public access and promoting appropriate nature tourism for the area. To achieve its goals, Northampton County has identified the need for detailed scientific data that will classify sensitive wildlife areas and assess the value of native vegetation in relation to wildlife. The migratory bird habitat study was initiated under the SAMP to fill that need. This report outlines the design refinement and accomplishments of the study during our second season of data collection (Fall migration, 1993).

SUMMARY OF FIRST YEAR RESULTS

During the fall of 1992, we conducted 10,800 point counts at 264 sites established within forested habitat patches in lower Northampton County. We counted over 22,500 birds of 119 species. Analyses of those data indicate:

1. Long-distance migrants are most abundant during the first half of the migratory period while short-distance migrants are most abundant during the last half of the season.
2. Bird activity was greater in the morning compared to the afternoon.
3. If birds spatially redistribute during the course of a day, they do so very early in the morning.
4. Many long- and short-distance migrants concentrate along the bayside and near the tip of the peninsula. Resident species tend to be least abundant near the peninsula tip.
5. In general, there is no clear relationship between bird abundance and forest patch size.
6. The majority of birds from both migrant groups were more abundant close to the forest edge than in the interior.
7. Most species over-utilized plots with relatively high vegetation density.

8. Individual species were associated with particular vertical strata within the forest. The vertical distribution of species is in general agreement with associations known for the breeding and wintering seasons.

For further details of these results, see Watts and Mabey, 1993.

OVERVIEW OF SECOND YEAR STUDY

The comprehensive design employed during the first field season provided much insight into the broad-scale distribution patterns and habitat needs of fall migrants on the lower Delmarva Peninsula. In general, migrants seem to concentrate within 10 km of the peninsula tip, particularly within the forested corridors that line the bayside shoreline. These findings confirm long-standing beliefs (based on a considerable body of anecdotal evidence) held by the local ornithological community regarding migrant distribution patterns. In addition, bird distribution patterns relative to the structure of vegetation suggest that most migrant species settled in areas with dense understory vegetation.

These preliminary results combined with direct observations of bird movements suggest a tentative scenario for how migrants distribute themselves upon arrival. Incoming migrants appear to move south until reaching the mouth of the Chesapeake Bay where they fall out into the scrub vegetation near the peninsula tip. Birds then move west and north along the Bay shoreline for some undetermined distance seeking out appropriate vegetation where they may settle to forage and roost. This scenario is in keeping with anecdotal observations made at Kiptopeake Beach over the past 30 years.

The general concentration of migrants along the bayside of the peninsula appears to be an accident of geography, consistent with coastal peninsular effects documented in other locations around the world. However, how birds distribute themselves along the lower bayside (south to north and west to east) and what role specific areas and habitats play as stopover sites remains unclear. Because virtually all of the proposed land use changes, are to occur within the bayside stopover area, answers to these questions are fundamental to the construction of any conservation plan. In order to further clarify the distribution and activity patterns of migrants on the lower bayside, we initiated three new research programs during

the 1993 field season. These initiatives included a bayside transect study (to examine distribution and habitat use within the bayside), a banding study at Kiptopeake banding station (to investigate the physical condition and residency time of migrants), and a bayside foraging study (to investigate resource and vegetation use along the bayside). These studies were conducted in addition to continuing the large-scale, geographic distribution/habitat use study begun during the first field season (see Watts and Mabey 1993). Below is a description of these new initiatives, as well as a brief summary of 1993 activities.

Bayside Transect Study

In order to clarify distribution and habitat use patterns within the forested corridor (on the lower bayside), we established a network of 30 transects for bird surveys. Transects were laid out in 5 "bundles" of 6 with bundles being positioned within the remaining large forested tracts (bundle 1 located on the Eastern Shore Wildlife Refuge, bundle 5 located just south of Elliot's Creek). Individual transects ran 100 - 120 m due east from the bayside forest edge and were marked off at 10 m intervals with individually numbered wire flags. Transects within bundles were spaced a minimum of 100 m apart. All transects were surveyed twice per week with the starting point and direction of survey, as well as, the observer randomly determined.

Transects were surveyed by stopping within each 10 m segment for a period of 1 min and recording all birds within 20 m north or south of the center line. All birds were identified to species and placed in vertical strata in accordance with the 1992 protocol. This survey network allows for the assessment of bird distribution patterns in both a north/south (both within and between transect bundles) and east/west (moving inland from the forest edge to 10 m resolution) direction. In addition, vegetation was quantified for each 10 m section to a height of 8 m. This allows for the assessment of vegetation effects on bird distribution along the bayside.

Banding Study

In order to better understand the relative significance of the bayside as a stopover area for migrants we initiated a collaborative banding study with the Virginia Society of

Ornithology at the Kiptopeake banding station. This banding station is one of the oldest, continuously run migration stations in the country and typically captures several thousand migrants per year between early September and late October. We were specifically interested in determining the physiological condition of incoming migrants, the duration of residency within the bayside area, and any changes in fat stores that might give some indication as to the quality of foraging habitat within the area. One field technician (rotating position) was assigned each day to the banding station to assist the banding staff and to collect physiological data.

Each bird captured was first processed by the bander in charge and then by one or more of the field staff. Banders measured wing cord and determined species, sex, and age where possible. Field technicians then measured weight using a pesola spring scale to the nearest 0.5 g and then classified subcutaneous fat deposits in the furcular fossa. Fat was classed by visual inspection on a 6 class scale. Fat and weight data collected on all birds captured is intended to give a description of physiological condition. Data collected on birds captured twice or more provide a coarse estimate of residency times for birds stopping over along the bayside, and trends in fat changes during residency gives some evidence of habitat quality.

Bayside Foraging Study

In order to establish the functional relationship between birds and their habitats, we initiated a study to link foraging rate, foraging tactics and success to vertical strata and vegetational substrate. Twice per week, just prior to or after transect surveys (see above), field staff conducted focal bird observations for two-hour time periods. Observers walked along bayside transects until encountering birds, selected a focal individual and followed that individual for successive 15 sec bouts. Individual birds were observed at close range to quantify their behavior and location. Time spent in foraging behavior, foraging tactics used, vegetational substrate used, strata occupied and success rates were all coded and recorded. Compilation of this data is intended to give an indication of direct bird/substrate/strata relationships, as well as, indicate habitat profitability.

SUMMARY OF ACTIVITIES

Overall, the 1993 fall migration on the lower Delmarva was considerably stronger than that of the previous year. While the total number of species observed remained relatively constant over the two falls, the numbers of birds detected in the zone study (conducted in both years) were higher in 1993 for residents, long-distance migrants, and short-distance migrants (Appendix I). There is general agreement in the patterns of peak activity for each of these groups with 1992 peaks appearing earlier and somewhat weaker. The addition of the larger 1993 data set will substantially strengthen the conclusions of this study.

Zone/Forest Patch Study

Point counts were conducted at a selection of sites established in 1992. We included two small and two large forest patches in each of six zones and remarked all twenty-four during the first week of August. We initiated point counts on August 9 and continued to conduct counts two mornings a week through November 13. During this time, we counted a total of 16,800 birds of 115 species in nearly 4,032 point counts (Appendix II).

Bayside Transect Study

Thirty transects were delineated and established in the field during the first week of August. Observers visited all transects two mornings a week from August 11 to November 13. A total of 6683 birds of 109 species were detected over almost 840 transect surveys (Appendix III).

Banding Study

Kiptopeke Banding Station opened on September 5, and collection of fat, weight and recapture data began at that time. Daily operation of the station continued through October 31. During the first two weeks of November the station was open for 8 days. We collected fat and weight data from 4,412 birds of 90 species. 346 birds (37 species) were recaptured

during the 1993 season. We have both first capture and recapture fat/weight data for approximately 80% of those birds.

Bayside Foraging Study

The bayside foraging study was conducted along the thirty transects established early in the 1993 season. We began foraging observations on August 11 and continued two mornings a week through November 13. Nearly 280 hours were spent recording 3,204 foraging events.

OVERVIEW OF FINAL PROJECT PHASE AND PLANNED ANALYSIS

We have completed two seasons of data collection and are now ready to begin a comprehensive analysis of our data. Within the zone/forest patch study, the combination of data from both 1992 and 1993 will likely strengthen the patterns established by analysis of 1992 data. We anticipate that the studies initiated this year will help better define the relative importance of the bayside habitats.

We have prioritized our analyses with policy development considerations in mind. We will begin with an analysis of geographic distribution patterns, first systemwide and then within the bayside corridor. The second level of analysis will address habitat associations of migrants within the entire system and the bayside alone. The last level of analysis will specifically examine habitat value factors employing data related to foraging behavior and the migrants' physiological condition (fat/weight).

As we analyze our data, we will continue to work closely with Northampton County, the SAMP coordinator, and other SAMP partners to interpret our results and help guide the development of the policy changes outlined in the SAMP strategy

ACKNOWLEDGEMENTS

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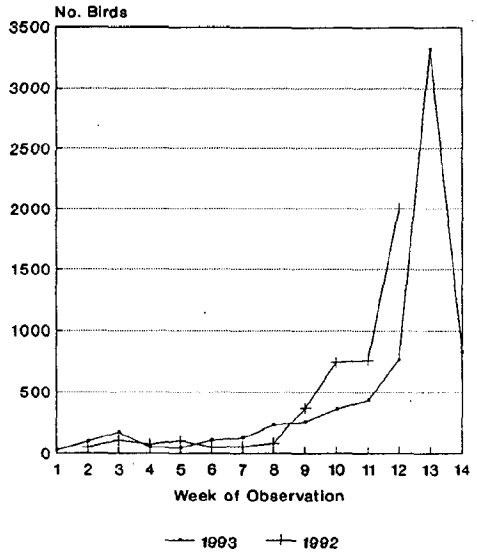
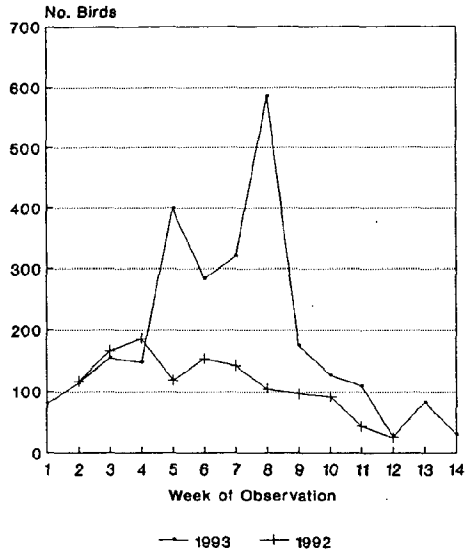
APPENDIX I. A comparison of 1992 and 1993 zone abundance data for three categories of birds.

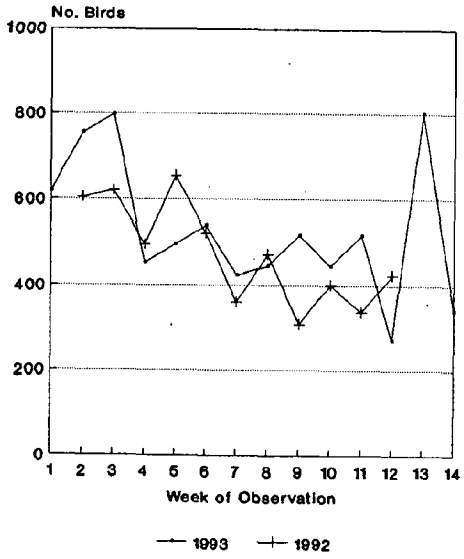
SHORT-DISTANCE MIGRANT SPECIES



LONG-DISTANCE MIGRANT SPECIES



RESIDENT SPECIES



APPENDIX II. Point Count Data 1993: species abundance by week.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
Green-backed Heron	--	2	1	--	--	--	--	1	--	--	--	--	--	--	4
Great Blue Heron	--	--	3	--	--	--	--	2	--	--	--	--	--	1	6
American Woodcock	--	--	--	--	--	--	--	--	--	--	--	--	6	3	9
Common Bobwhite	13	--	16	--	3	20	3	--	--	--	--	--	1	--	56
Sharp-shinned Hawk	--	--	--	--	--	--	1	2	3	5	2	1	2	1	17
Red-tailed Hawk	--	--	--	--	1	--	--	--	1	--	1	--	1	--	4
Broad-winged Hawk	--	--	--	--	--	--	--	--	2	--	--	--	--	--	2
Red-shouldered Hawk	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1
Bald Eagle	--	--	--	--	--	1	--	--	--	--	--	1	--	--	2
American Kestrel	--	--	--	--	--	--	--	--	--	--	--	1	--	--	1
Merlin	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1
Great-horned Owl	1	1	--	1	--	4	1	--	--	2	--	1	1	--	12
Screech Owl	--	--	--	--	--	--	--	--	--	--	--	1	--	--	1
Mourning Dove	7	5	9	14	4	7	10	5	1	17	2	--	--	18	99
Yellow-billed Cuckoo	10	10	8	6	3	2	2	1	--	--	--	--	--	--	42
Black-billed Cuckoo	--	1	--	1	--	--	--	--	--	--	--	--	--	--	2
Chuck-will's Widow	--	--	--	1	--	--	--	--	--	--	--	--	--	--	1
Ruby-throated Hummingbird	4	3	1	1	--	2	--	--	--	--	--	--	--	--	11
Red-headed Woodpecker	--	6	5	1	13	3	3	2	--	--	--	--	2	--	35
Red-bellied Woodpecker	11	15	18	10	11	12	20	22	14	15	7	17	12	17	201
Yellow-bellied Sapsucker	--	--	--	--	--	--	--	--	3	2	1	1	2	3	12
Downey Woodpecker	20	22	14	13	16	9	18	20	10	13	6	12	4	14	191
Hairy Woodpecker	3	1	1	4	--	3	--	2	2	1	--	1	4	4	26
Pileated Woodpecker	--	--	1	--	--	--	--	--	1	1	--	--	--	1	4
Norther Flicker	2	14	5	4	12	21	27	67	55	30	36	52	26	30	381
Eastern Wood Pewee	3	6	2	--	--	2	1	5	1	1	--	--	--	--	21
Acadian Flycatcher	--	--	--	--	2	--	--	1	--	--	--	--	--	--	3

APPENDIX II continued.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
Great-crested Flycatcher	5	2	1	3	6	3	--	1	--	--	--	--	--	--	21
Least Flycatcher	--	--	--	--	--	--	1	--	--	--	--	--	--	--	1
Eastern Phoebe	--	--	--	--	--	--	--	5	8	6	1	--	1	11	32
Eastern Kingbird	--	--	2	1	6	--	--	--	--	--	--	--	--	--	9
Blue Jay	12	21	9	8	13	20	27	71	67	54	15	49	12	17	385
American Crow	4	19	1	6	9	18	12	7	1	14	6	--	6	4	107
Fish Crow	2	5	5	26	9	3	--	--	--	1	--	--	--	1	52
Carolina Chickadee	109	113	103	93	63	85	85	126	83	150	92	68	72	83	1325
Brown Creeper	--	--	--	--	--	--	--	2	2	16	7	8	6	17	58
Tufted Titmouse	5	16	18	6	16	20	20	14	18	27	19	32	27	27	265
White-breasted Nuthatch	--	--	--	--	--	--	1	1	--	--	--	--	--	--	2
Red-breasted Nuthatch	--	--	--	--	--	--	10	31	25	13	11	46	7	10	153
Brown-headed Nuthatch	2	--	--	--	--	--	--	--	--	--	--	--	--	--	2
House Wren	--	--	--	--	--	1	--	5	3	1	--	--	--	--	10
Winter Wren	--	--	--	--	--	--	--	2	8	12	1	11	17	28	79
Carolina Wren	184	202	142	100	153	129	143	121	106	87	63	85	90	126	1732
Ruby-crowned Kinglet	--	--	--	--	--	--	--	2	5	12	22	25	30	11	107
Golden-crowned Kinglet	--	--	--	--	--	--	--	1	5	65	85	168	213	122	659
Blue-gray Gnatcatcher	2	7	6	5	1	--	--	1	--	--	--	--	--	--	22
Eastern Bluebird	--	--	--	--	--	--	1	1	--	--	--	--	--	--	2
Wood Thrush	--	--	--	--	--	1	--	6	2	--	--	1	--	--	10
Swainson's Thrush	--	--	--	--	1	1	--	5	--	--	--	--	--	--	7
Gray-cheeked Thrush	--	--	--	--	--	--	--	2	5	1	--	--	--	--	8
Hermit Thrush	--	--	--	--	--	--	--	--	1	3	17	28	28	49	126
Veery	--	--	--	3	25	7	5	3	--	--	--	--	--	--	43
American Robin	--	22	111	7	1	22	5	2	16	1	7	141	2639	191	3165
Gray Catbird	--	--	1	--	2	--	4	58	27	23	7	8	2	2	134

APPENDIX II continued.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
Mockingbird	2	1	3	--	7	5	1	3	2	1	1	1	--	--	27
Brown Thrasher	--	--	--	--	--	1	4	20	7	--	--	1	--	--	33
Cedar Waxwing	--	--	--	--	--	1	--	17	--	6	--	6	47	2	79
European Starling	--	22	51	36	29	34	16	5	2	41	28	3	90	1	358
White-eyed Vireo	2	5	4	3	1	--	--	--	--	--	--	--	--	--	15
Solitary Vireo	--	--	--	--	--	--	1	--	--	2	--	1	1	--	5
Red-eyed Vireo	10	10	19	9	16	18	6	8	--	--	--	--	--	--	96
Warbling Vireo	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1
Blue-winged Warbler	1	--	2	1	--	--	--	--	--	--	--	--	--	--	4
Tennessee Warbler	--	--	--	--	--	--	--	2	--	--	--	--	--	--	2
Nashville Warbler	--	--	--	--	--	--	2	1	--	1	--	--	--	--	4
Northern Parula	--	--	--	--	--	--	11	58	9	5	--	--	--	--	83
Black-and-white Warbler	8	17	24	25	55	20	23	40	4	4	1	--	--	--	221
Black-throated Blue Warbler	--	--	5	6	7	7	22	82	35	24	--	--	--	--	188
Blackburnian Warbler	--	--	--	--	--	1	--	4	--	--	--	--	--	--	5
Chestnut-sided Warbler	--	--	2	4	--	1	3	--	--	--	1	--	--	--	11
Cape May Warbler	--	--	--	--	--	--	--	1	11	1	2	--	--	--	15
Magnolia Warbler	--	--	1	1	--	1	5	20	2	--	--	--	--	--	30
Yellow-rumped Warbler	--	--	--	--	--	--	--	5	56	138	212	167	186	177	941
Black-throated Green Warbler	--	--	--	--	--	--	6	6	5	2	2	--	--	--	21
Yellow-throated Warbler	--	2	1	--	2	1	1	1	--	--	--	--	--	--	8
Prairie Warbler	--	1	--	1	--	--	1	--	--	--	--	--	--	--	3
Bay-breasted Warbler	--	--	--	--	--	--	1	--	2	--	--	--	--	1	4
Blackpoll Warbler	--	--	--	--	--	--	--	3	6	3	1	2	--	--	15
Pine Warbler	12	35	42	28	19	45	57	18	8	8	2	2	--	1	277
Palm Warbler	--	--	--	--	--	--	--	9	6	14	2	--	2	1	34
Connecticut Warbler	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1

APPENDIX II continued.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
Hooded Warbler	--	3	--	--	1	--	--	1	--	--	--	--	--	--	5
Canada Warbler	--	--	2	1	--	--	1	--	--	--	--	--	--	--	4
Worm-eating Warbler	2	4	6	6	--	--	--	--	--	--	--	--	--	--	18
Ovenbird	2	6	15	10	18	10	8	13	--	--	--	--	1	--	83
Louisiana Waterthrush	--	--	--	1	--	--	--	--	--	--	--	--	--	--	1
Northern Waterthrush	2	--	1	--	1	1	--	2	--	--	--	--	--	--	7
Common Yellowthroat	--	--	--	1	--	--	--	6	2	1	1	--	1	--	12
American Redstart	13	36	45	59	226	151	207	221	35	17	--	1	--	--	1011
Prothonotary Warbler	--	1	--	--	--	--	--	--	--	--	--	--	--	--	1
Blue Grosbeak	2	1	1	--	--	1	--	--	--	--	3	--	--	--	8
Rose-breasted Grosbeak	--	--	--	--	--	--	2	10	--	--	--	--	--	--	12
Evening Grosbeak	--	--	--	--	--	--	--	--	--	--	5	--	3	--	8
Northern Cardinal	114	138	113	90	83	70	71	82	59	59	27	31	15	29	991
Indigo Bunting	9	--	--	--	--	1	--	2	8	1	1	--	--	--	22
Rufous-sided Towhee	--	--	--	--	--	--	--	3	5	8	3	10	5	5	39
Fox Sparrow	--	--	--	--	--	--	--	--	--	--	--	--	1	1	2
Song Sparrow	--	--	--	--	--	--	--	--	--	--	--	3	3	7	13
Field Sparrow	--	--	--	3	--	--	--	--	--	4	--	2	--	--	9
Chipping Sparrow	--	--	--	--	--	--	--	--	1	2	7	--	6	6	22
White-throated Sparrow	--	--	--	--	--	--	--	1	2	3	11	55	80	100	262
Swamp Sparrow	--	--	--	--	--	--	--	--	--	--	--	2	--	5	7
Dark-eyed Junco	--	--	--	--	--	--	--	--	--	1	1	1	9	36	48
Red-winged Blackbird	--	--	1	--	--	--	--	--	--	--	--	--	1	--	2
Rusty Blackbird	--	--	--	--	--	--	--	--	--	--	--	--	51	4	55
Brown-headed Cowbird	2	--	--	--	1	--	--	--	--	--	--	--	--	--	3
Common Grackle	138	189	298	50	77	120	15	1	207	3	50	3	463	1	1615
Boat-tailed Grackle	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1

APPENDIX II continued.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
Northern Oriole	--	--	4	2	22	46	5	4	--	--	--	--	--	--	83
Scarlet Tanager	--	--	--	--	2	--	--	--	--	--	--	--	--	--	2
Summer Tanager	5	7	6	1	2	4	4	1	--	1	--	--	--	--	31
Purple Finch	--	--	--	--	--	--	--	--	2	2	1	2	14	3	24
House Finch	2	--	--	--	--	--	--	--	4	1	1	--	--	--	8
Pine Siskin	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1
American Goldfinch	1	1	--	--	--	--	--	8	--	4	--	3	1	9	27
UID Flycatcher	--	--	--	1	4	--	2	2	--	--	--	1	--	--	10
UID Crow	--	2	--	2	3	--	--	--	--	--	--	--	--	--	7
UID Thrush	--	--	--	--	2	--	--	2	--	--	--	--	--	--	4
UID Vireo	--	--	--	--	--	--	1	--	--	--	--	--	--	--	1
UID Warbler	5	7	4	3	6	3	13	20	24	7	10	--	--	--	102
UID Sparrow	--	--	--	--	--	--	--	--	--	--	1	1	1	--	1
UID Hawk	--	1	--	--	--	1	--	--	--	--	--	--	--	3	5
UID Kinglet	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1
UID Woodpecker	--	1	1	1	1	1	1	2	1	2	--	--	--	--	11
UID Bird	3	3	4	7	2	8	5	3	6	10	2	2	--	2	57
Total	734	987	1139	667	956	952	892	1290	978	951	782	1063	4202	1197	16800

APPENDIX III. Transect Survey Data 1993: species abundance by week.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
Great Blue Heron	--	--	--	--	1	--	--	--	--	--	--	--	--	--	1
American Woodcock	--	--	--	--	--	--	--	--	--	--	--	--	3	--	3
Sharp-shinned Hawk	--	--	--	--	--	1	2	--	1	6	5	--	2	3	20
Cooper's Hawk	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1
Red-tailed Hawk	--	--	--	--	--	--	--	--	--	--	1	--	--	--	1
Broad-winged Hawk	--	--	--	--	--	1	--	---	--	--	--	--	--	--	1
Bald Eagle	--	--	--	--	1	1	2	--	--	--	--	--	--	--	4
Osprey	1	--	--	1	1	--	--	--	--	--	1	--	--	--	4
Merlin	--	--	--	--	--	--	1	--	--	--	--	--	--	--	1
Peregrine Falcon	--	--	--	--	--	--	--	--	--	--	--	1	--	--	1
Great-horned Owl	--	--	--	--	--	--	--	1	--	--	1	--	--	--	1
Barred Owl	--	1	--	--	--	--	--	--	--	--	--	--	--	--	1
Mourning Dove	13	10	9	1	5	2	2	1	--	6	9	2	--	--	60
Yellow-billed Cuckoo	4	3	--	--	2	1	1	--	--	--	--	--	--	--	11
Black-billed Cuckoo	1	--	--	--	--	--	--	1	--	--	--	--	--	--	2
Chuck-will's Widow	1	--	--	--	1	--	--	--	--	--	--	--	--	--	2
Ruby-throated Hummingbird	5	2	11	--	1	--	--	--	--	--	--	--	--	--	19
Red-headed Woodpecker	--	1	1	--	--	--	--	--	--	--	--	--	--	--	2
Red-bellied Woodpecker	4	5	4	2	2	3	2	5	1	--	1	6	3	4	42
Yellow-bellied Sapsucker	--	--	--	--	--	--	--	--	--	1	2	--	--	--	3
Downey Woodpecker	6	1	5	2	5	6	1	2	1	4	1	4	4	--	42
Hairy Woodpecker	--	--	--	2	--	--	--	--	--	--	--	--	--	--	2
Pileated Woodpecker	--	--	1	2	--	--	--	2	--	--	--	--	--	--	5
Norther Flicker	2	6	3	6	--	3	8	12	26	6	8	9	5	5	99
Eastern Wood Pewee	--	1	--	--	3	--	3	1	--	--	1	--	--	--	9
Acadian Flycatcher	--	--	--	--	1	1	--	--	--	--	--	--	--	--	2
Great-crested Flycatcher	--	--	1	--	4	--	--	--	--	--	--	--	--	--	5

APPENDIX III continued.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
Willow Flycatcher	--	--	--	--	--	2	--	--	--	--	--	--	--	--	2
Yellow-bellied Flycatcher	--	--	--	--	1	1	--	--	--	--	--	--	--	-	2
Eastern Phoebe	--	--	--	--	--	--	--	2	1	--	--	--	--	--	3
Eastern Kingbird	--	11	201	57	20	16	--	--	--	--	--	--	--	--	305
Barn Swallow	2	--	--	--	--	--	--	--	--	--	--	--	--	--	2
Blue Jay	1	5	2	3	3	8	12	33	40	10	29	11	21	7	185
American Crow	--	--	--	--	--	10	--	--	--	--	--	--	--	--	10
Fish Crow	4	--	--	1	33	--	--	--	--	1	--	--	--	--	39
Carolina Chickadee	82	54	44	14	30	26	8	36	31	30	35	41	39	25	495
Brown Creeper	--	--	--	--	--	--	--	--	2	6	4	5	3	--	20
Tufted Titmouse	1	2	2	4	1	4	1	6	3	3	11	20	11	58	127
White-breasted Nuthatch	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1
Red-breasted Nuthatch	--	--	--	--	--	6	9	25	48	18	27	20	50	17	220
House Wren	--	--	--	--	--	--	1	--	--	1	--	--	1	--	3
Winter Wren	--	--	--	--	--	--	--	--	2	3	14	--	18	4	40
Carolina Wren	103	84	70	28	25	30	34	27	25	13	30	22	31	23	545
Ruby-crowned Kinglet	--	--	--	--	--	--	--	--	10	9	48	14	104	11	196
Golden-crowned Kinglet	--	--	--	--	--	--	--	--	8	17	44	58	323	49	499
Blue-gray Gnatcatcher	45	5	21	4	6	11	--	--	--	--	--	--	--	--	92
Wood Thrush	--	--	--	--	--	1	--	--	2	1	1	--	--	--	5
Swainson's Thrush	--	--	--	--	1	--	--	--	--	--	1	--	--	--	2
Gray-cheeked Thrush	--	--	--	--	--	--	1	1	1	1	1	--	--	--	5
Hermit Thrush	--	--	--	--	--	--	--	--	--	2	27	16	41	20	106
Veery	--	--	2	--	12	15	2	--	1	--	--	--	--	--	32
American Robin	9	--	1	2	8	1	--	--	2	--	2	30	116	15	186
Gray Catbird	--	--	--	--	--	1	--	15	14	6	8	--	2	--	46
Mockingbird	3	--	--	--	4	--	1	--	--	--	--	--	--	1	9

APPENDIX III continued.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
Brown Thrasher	--	--	--	--	--	--	3	4	2	--	--	1	--	1	11
European Starling	--	--	--	--	--	--	--	--	--	--	--	50	--	--	50
White-eyed Vireo	14	4	16	9	18	4	--	--	--	--	--	--	--	--	65
Red-eyed Vireo	5	7	10	3	31	4	1	5	--	--	--	--	--	--	66
Blue-winged Warbler	--	1	4	--	--	--	--	--	--	--	--	--	--	--	5
Lawrence's Warbler	--	1	--	--	--	--	--	--	--	--	--	--	--	--	1
Northern Parula	--	--	--	--	--	2	2	21	1	--	--	--	--	--	26
Yellow Warbler	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1
Black-and-white Warbler	7	11	12	7	77	15	1	19	3	1	--	--	--	--	154
Black-throated Blue Warbler	--	--	--	2	2	5	2	32	11	7	3	--	--	--	64
Blackburnian Warbler	--	--	--	--	1	--	--	2	--	--	--	--	--	--	3
Chestnut-sided Warbler	--	--	1	--	--	1	1	--	--	--	--	--	--	--	3
Cape May Warbler	--	--	--	--	--	--	2	18	5	2	1	1	--	--	29
Magnolia Warbler	--	--	--	--	1	7	1	4	2	--	--	--	--	--	15
Yellow-rumped Warbler	--	--	--	--	--	--	--	1	35	50	569	217	219	91	1182
Black-throated Green Warbler	--	--	--	--	--	2	1	7	1	--	3	3	--	--	17
Yellow-throated Warbler	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1
Prairie Warbler	10	1	3	3	2	7	--	5	--	--	--	--	--	--	31
Blackpoll Warbler	--	--	--	--	--	--	5	3	9	2	3	3	--	--	25
Pine Warbler	26	25	17	6	57	3	3	6	6	--	--	2	--	--	151
Palm Warbler	--	--	--	--	--	--	--	--	--	--	2	--	--	--	2
Mourning Warbler	--	--	--	--	--	5	--	--	--	--	--	--	--	--	5
Kentucky Warbler	--	--	--	1	--	--	--	--	--	--	--	--	--	--	1
Hooded Warbler	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1
Canada Warbler	--	2	--	--	--	--	--	--	--	--	--	--	--	--	2
Wilson's Warbler	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1
Worm-eating Warbler	--	--	5	--	--	--	--	--	--	--	--	--	--	--	5

APPENDIX III continued.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
Ovenbird	--	2	2	3	3	4	--	1	1	--	--	--	--	--	16
Northern Waterthrush	--	1	--	1	--	--	--	2	--	--	--	--	--	--	4
Common Yellowthroat	--	--	2	1	4	6	--	3	1	--	1	--	--	--	18
American Redstart	7	23	9	19	74	202	10	55	8	5	--	--	--	--	412
Prothonotary Warbler	--	2	--	1	--	--	--	--	--	--	--	--	--	--	3
Blue Grosbeak	--	--	3	1	--	1	--	--	--	--	--	--	--	--	5
Rose-breasted Grosbeak	--	--	2	--	1	--	1	--	--	--	--	--	--	--	4
Northern Cardinal	41	33	22	22	19	12	25	30	18	13	9	11	12	14	281
Indigo Bunting	1	--	--	--	--	1	--	8	1	--	--	--	--	--	11
Rufous-sided Towhee	--	--	--	--	--	--	--	--	1	1	17	--	8	3	30
Fox Sparrow	--	--	--	--	--	--	--	--	--	--	--	--	--	5	5
Song Sparrow	--	--	--	--	--	--	--	--	--	--	2	--	5	--	7
Field Sparrow	1	3	1	1	--	--	--	--	--	--	--	3	--	3	12
Chipping Sparrow	--	--	--	--	--	--	1	--	--	--	2	1	--	--	4
White-throated Sparrow	--	--	--	--	--	--	--	--	--	--	13	3	24	19	59
Swamp Sparrow	--	--	--	--	--	--	--	--	--	--	--	2	--	--	2
Dark-eyed Junco	--	--	--	--	--	--	--	--	--	1	8	2	20	27	58
Brown-headed Cowbird	1	--	2	--	--	--	--	--	--	--	--	--	--	--	3
Common Grackle	1	--	--	--	--	--	--	--	--	--	150	--	--	--	151
Boat-tailed Grackle	--	--	1	--	--	--	--	--	--	--	--	--	--	--	1
Northern Oriole	--	--	--	--	9	--	--	2	--	--	--	--	--	--	11
Orchard Oriole	1	--	1	--	--	--	--	--	--	--	--	--	--	--	2
Scarlet Tanager	--	--	--	1	--	--	--	--	--	--	--	--	--	--	1
Summer Tanager	3	2	2	1	4	1	--	--	--	--	--	--	--	--	13
Purple Finch	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1
House Finch	--	--	1	--	--	--	--	--	--	--	--	2	--	--	3
Pine Siskin	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1

APPENDIX III continued.

SPECIES	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	TOTAL
American Goldfinch	--	--	--	--	--	--	--	2	--	--	--	2	5	1	10
UID Flycatcher	1	--	--	--	--	3	1	--	--	--	--	--	--	--	5
UID Thrush	--	--	--	--	--	1	1	1	--	--	--	--	--	--	3
UID Warbler	2	2	2	6	13	19	3	24	10	6	3	3	3	--	80
UID Sparrow	--	--	--	--	--	--	--	--	--	--	--	--	1	--	1
UID Hawk	--	--	--	1	--	--	--	--	--	--	--	--	--	1	2
UID Woodpecker	--	--	--	--	1	--	--	--	--	--	--	--	--	--	1
UID Bird	2	--	1	1	3	2	2	3	1	5	4	--	--	--	24
Total	410	311	497	219	501	451	158	430	335	239	1154	515	1074	408	6683