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Winter use of early successional habitats by birds within the Alligator River, NWR and Pocosin Lakes, NWR: Evaluating the benefit of management scenarios

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Cover Photo by Bryan Watts

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The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within todays social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

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EXECUTIVE SUMMARY

Many bird species that require early successional habitats have declined dramatically throughout the Northeastern United States during the past four decades. Several of these species are temperate migrants that spend the winter months in the southeastern United States. Refuge lands that contain early successional habitats may play an important role in the life cycle of these species. Understanding the requirements of target species is a critical first step toward integrating these species into future conservation plans. The primary objective of this study was to investigate the community of avian species utilizing early successional habitats within Alligator River, NWR and Pocosin Lakes, NWR during the winter months. A secondary objective was to evaluate the benefit of alternative management scenarios.

Fifty-four 500 m transects were established and surveyed three times for birds from January through March of 2002. Survey results were used to derive habitat-specific density estimates for 9 cover types. Density estimates were used along with a habitat inventory of Alligator River, NWR to generate population projections. The influence of various management scenarios on the number of birds supported was evaluated by shifting the allocation of cover types and recalculating population projections based on the new conditions.

The farm unit within Alligator River, NWR currently supports an estimated 24,000 birds. The establishment of fallow filter strips under the Conservation Reserve Program appears to be a benchmark event for the winter bird community. The community has two dominant divisions including species that utilize grasslands and species that require bare ground. Population projections suggest that a shift in management to discourage the formation of dense forb stands within filter strips could more than double the number of birds supported within upland areas. More modest gains could also be achieved by altering management of active agricultural areas and moist soil units. For the latter, prioritization of target species will be required to allow for the develop a goal-oriented management program.

Study areas within Pocosin Lakes, NWR supported a community of birds that was dominated by frugivores. The large standing crop of fruit supported by the vast tall pocosins across the refuge and broader peninsula likely has regional significance to temperate migrants that depend on fruit for the winter. These habitats may support very large portions of populations from throughout the Northeast. The strategic value of these habitats to birds during both migration and winter requires further evaluation.

BACKGROUND

Context

Populations of many bird species that require early successional habitats have experienced significant declines across North America over the past four decades (Robbins et al. 1986, Robbins et al. 1989, Herkert 1991, Knopf 1994, Peterjohn and Sauer 1999). Declines have been particularly dramatic throughout the northeastern United States (Askins 1993, Peterjohn and Sauer 1999, Norment 2002) leading to increasing conservation concerns within this region. Currently 17 early successional species are listed within at least one northeastern state as endangered, threatened, or of special concern. Many of these species have consistently received high conservation scores within partners-in-flight physiographic area plans throughout the region (http://www.blm.gov/wildlife/pifplans.htm).

Proposed reasons for population declines of early successional species throughout the Northeast include loss of grasslands due to secondary succession on abandoned farmland (Litvaitis 1993, Foster 1995, Askins 1997) and intensification of agricultural practices (Bollinger et al. 1990, Askins 1997). Several species experienced range expansions into the Northeast following a wave of small farm abandonment that occurred from the late 1800s through the early 1900's. These species have declined precipitously over the past four decades as these lands have proceeded through secondary succession. Because many of these species are area-sensitive, they are susceptible to habitat loss and fragmentation (Herkert 1994, Vickery et al. 1994).

The majority of early successional species experiencing declines in the Northeast are temperate migrants. These species breed in the north and migrate south to spend the winter months in the southeastern United States. This pattern implies that habitats within the south play a role in the life cycle of these species and that their management may influence population health. Numerous federal lands within the Southeast support early successional habitats. Alligator River, NWR and Pocosin Lakes, NWR located in coastal North Carolina both have substantial holdings of early successional habitats. Alligator River, NWR has recently enrolled in the conservation reserve program and removed approximately 700 ha of agricultural land from active production. The extent to which these and other early successional habitats support avian species during the winter is not completely known.

Objectives

Documenting the potential importance of land to target populations is a critical first step toward integrating species into future conservation plans. Understanding the requirements of target species is a prerequisite for designing management plans to provide for those requirements. The primary objective of this study was to investigate the community of avian species utilizing early successional habitats within Alligator River, NWR and Pocosin Lakes, NWR during the winter months. A secondary objective was to evaluate the benefit of alternative management scenarios.

METHODS

Study Area

This study was conducted within the "farm unit" of Alligator River, NWR and the early successional habitat located just south of Lake Phelps on Pocosin Lakes, NWR (Figures 1 and 2). Both of these areas are located on the peninsula of land bounded to the north by the Albemarle Sound and to the south by the Pamlico River. The farm unit and Lake Phelps sites are located within Tyrrell and Washington Counties, North Carolina respectively.

Alligator River, NWR Farm Unit

The farm unit includes nearly 1,800 ha of open land that is actively farmed and/or managed for wildlife. Prior to the 1980's this land supported tall pocosin habitat. The land was drained by establishing a network of feeder ditches and canals and cleared for cultivation. The upland portion of the unit that is available for farming represents approximately 75% of the open area. This land is highly compartmentalized by the system of feeder ditches. In 2000 approximately 50% of the uplands were taken out of agricultural production under the CRP program by establishing vegetated filter strips along either side of feeder ditches. The remainder of the open land is managed as a series of moist-soil units. These units are enclosed by earthen dykes such that they may be flooded in late winter for use by migrant waterfowl. A network of roads is maintained throughout the unit that follow the system of collection ditches. These roads permit access to all open lands.

Pocosin Lakes, NWR

The field site within Pocosin Lakes lies south of Lake Phelps and near or along the boundary of the Pungo Unit. The Pungo Unit was established in 1963 primarily for waterfowl management. The remainder of Pocosin Lakes was established in 1990 to provide habitat for migratory waterfowl and other wildlife. Lands within and around the vicinity of the study area were drained for agriculture using a system of feeder ditches, collection ditches, and canals similar to the farm unit of Alligator River, NWR. The agricultural ventures failed in the 1980's and the land has been undergoing reversion back to pocosin vegetation. These fields likely supported early successional grasslands in the years just following cultivation. Plants characteristic of this successional sere have now been replaced and the dominant ground cover is bracken fern. The area is increasingly dominated by woody vegetation such as gallberry (*Ilex coriacea*), wax myrtle (*Myrica cerifera*), and sweetbay (*Magnolia virginiana*) that are characteristic of pocosin habitat.

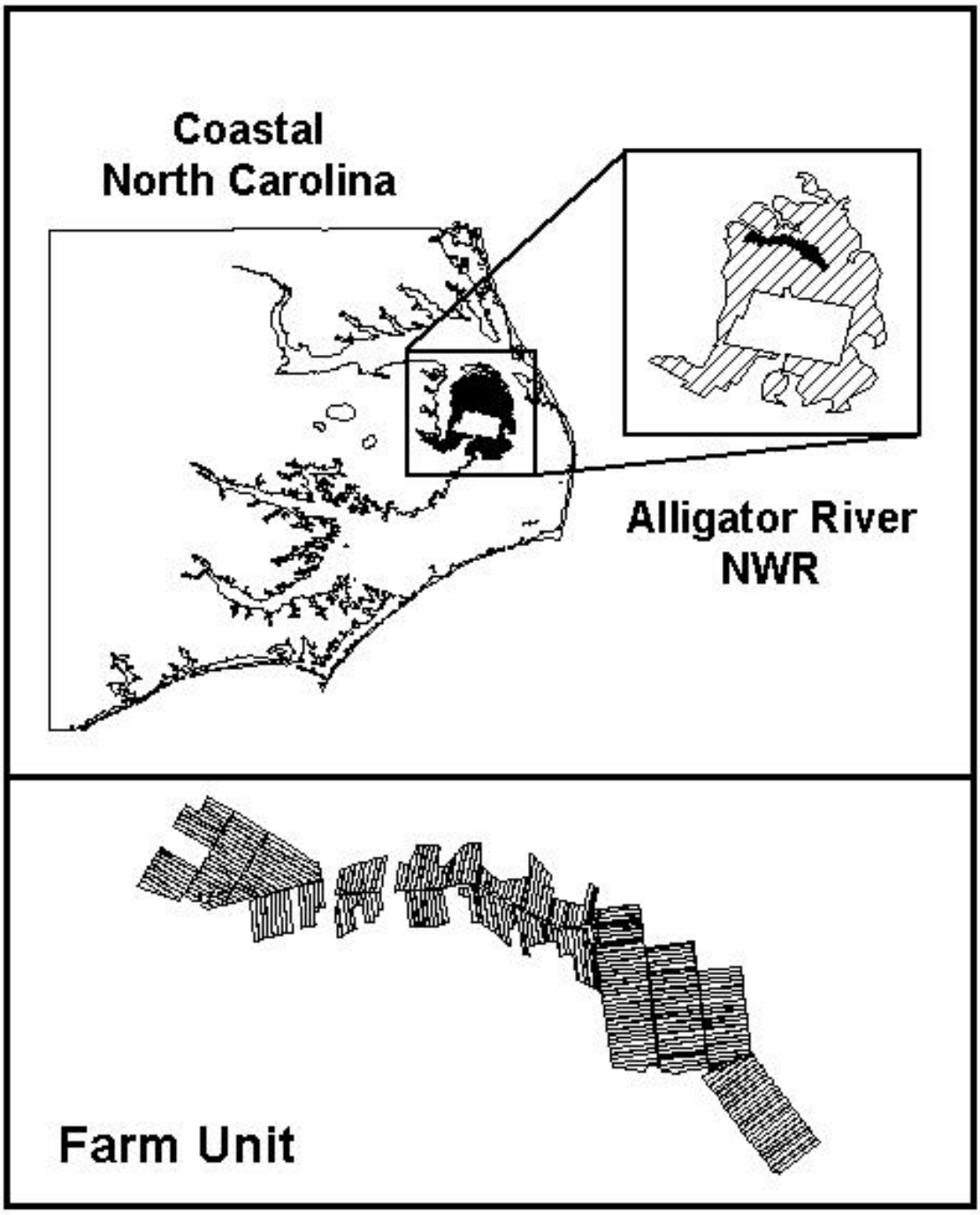

Figure 1. *Map of study area within Alligator River, NWR. Farm unit shown above is indicated as black area within map of Alligator River, NWR.*

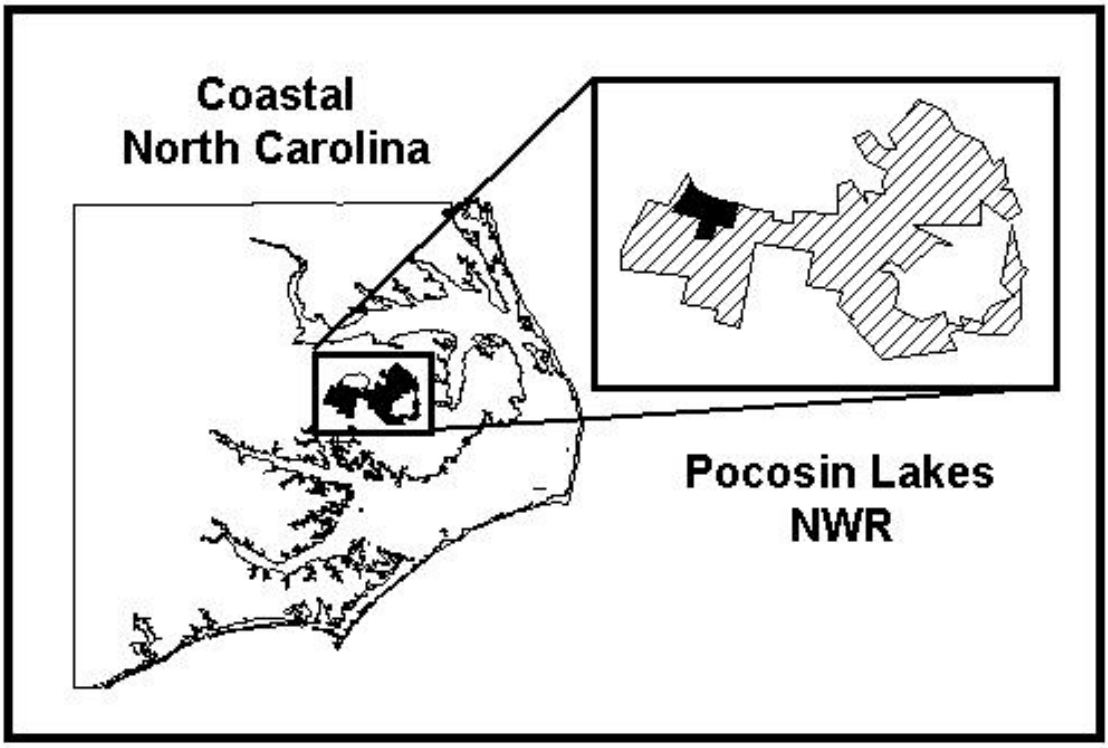

Figure 2. *Map of study area within Pocosin Lakes, NWR. Study site is indicated as black area within map of Pocosin Lakes, NWR.*

Transect Surveys

Alligator River, NWR

Forty-two linear habitat plots were chosen within the farm unit of Alligator River, NWR in early January of 2002. Plots were chosen based on the condition of vegetative cover. Seven cover treatments were used including 4 within the upland agriculture areas and 3 within the moist soil units. Treatments within the upland agriculture areas included 1) high forb density (HFD), 2) low forb density (LFD), 3) crop stubble (ACS), and 4) winter wheat (WW). Treatments within the moist soil units included 1) idle grass (IG), 2) mixed planting (MP), and 3) crop stubble (MCS) (see Table 1 for habitat descriptions).

Table 1. Description of land cover types surveyed within Alligator River, NWR and Pocosin Lakes, NWR (January – March, 2002).

Cover Treatment	Description
Alligator River, NWR	
Agriculture	
High Forb Density (HFD)	HFD was restricted to the filter strips along feeder ditches that were established under the CRP program. HFD filter strips were those that supported dense stands of forbs (e.g. Erigeron canadensis, Solidago spp.) with woody stems.
Low Forb Density (LFD)	LFD was restricted to the filter strips along feeder ditches that were established under the CRP program. LFD filter strips were those that supported sparse stands of forbs. Ground cover within these strips was dominated by short grasses (e.g. Setaria spp., Panicum spp.).
Crop Stubble (ACS)	ACS were areas in active agriculture that had been harvested but not replanted in winter wheat. Stubble within most of these compartments appeared to be from soy beans.
Winter Wheat (WW)	WW were areas in active agriculture that had been planted in winter wheat.
Moist Soil	
Idle Grass (IG)	IG blocks were areas within the moist soil units that had been left idle for 2-4 years and that supported dense stands of grasses (e.g. Setaria spp., Panicum spp.) often with scattered forb clumps.
Mixed Planting (MP)	MP blocks were areas within the moist soil units that had been planted with a mixture of wildlife food plants such as millet for the benefit of wildlife.
Crop Stubble (MCS)	MCS blocks were areas that had supported crops but had been harvested and not replanted. Stubble within most of these compartments appeared to be from soy beans.
Pocosin Lakes, NWR	
Early Successional (ES)	ES included the large field that was previously cultivated and that was progressing through the early stages of oldfield succession. Ground cover was dominated by bracken fern and scattered broom sedge (Andropogon virginicus).
Tall Pocosin (TP)	TP included several areas that were previously cultivated but had passed through the early stages of oldfield succession and were now reverting back to tall pocosin. These areas supported dense stands of woody shrubs (e.g. Ilex coriacea, Myrica cerifera, Rubus spp.) and trees (e.g. Magnolia virginiana)

High forb density filter strip (dark brown to left) and upland agricultural crop stubble (light area on right) photo by Bryan Watts.

Low forb density filter strip. photo by Bryan Watts.

Winter Wheat. photo by Bryan Watts.

Idle Grass plot. photo by Bryan Watts.

Mixed Planting plot. photo by Bryan Watts.

Moist Soil Crop Stubble plot. photo by Bryan Watts.

Transects were laid out such that they began near the road edge and ran parallel to feeder ditches. Six spatial replicates were chosen and laid out for each cover treatment (see Table 2 for transect dimensions). Exact plot locations were chosen by first mapping cover types and numbering habitat blocks. Study plots were chosen randomly from numbered blocks until the number of replicates was filled. Random choices were stratified so that replicates were dispersed among subunits to the extent possible. In order to improve independence, transect positions were discarded unless they were at least 200 m from other selected sites. Due to the small number of idle grass and mixed planting blocks, separation to this degree was not possible for these habitat types. Transects were established between 8 and 21 January 2002.

After plots were established, the density of forb plants was measured within filter strips to test perceived differences between high and low density plots (high and low plots were initially chosen by eye). Plant density was measured for ten points along each transect using a collapsible wooden frame measuring 1 x 1 m. Sample points were chosen by subdividing each transect into 10 sections. Samples were taken near the mid-point of each section and 3 m to the left or right. Direction of sample was determined by the toss of a coin. All plants taller than 20 cm were counted. Plan density represents a conservative estimate of stem density because most plants encountered were of species with multiple stems.

Pocosin Lakes, NWR

Twelve habitat plots were chosen within the study area of Pocosin Lakes, NWR in late January of 2002. Plots were chosen based on the condition of vegetative cover. Two cover treatments were used including 1) early successional (ES) and 2) tall pocosin (TP) (see Table 1 for habitat descriptions). Six spatial replicates were chosen for each cover treatment (see table 2 for transect dimensions). All early successional transects were established within the large open patch along the southeastern edge of the study area. Transects were separated by 200 m and ran north and south. Transects began near the edge of roadways running east-west through the patch. After a thorough assessment of this area, transects were placed within the most open areas available (this patch is rapidly filling in with woody vegetation). Rather than cutting trails into the tall pocosin habitat, transects were established along fire breaks and narrow roads that penetrated into this habitat. No more than one transect was established within each roadway. Transects were established between 1 January and 4 February, 2002.

Surveys

Birds were censused between 8 January and 31 March, 2002. To reduce the effects of seasonal bias, censuses were conducted within rounds such that all transects were censused before the beginning of the subsequent round. Each transect was censused three times during the study period. All censuses were completed within 5 h of sunrise.

Table 2. Dimensions of transects established within Alligator River, NWR and Pocosin Lakes, NWR in 2002.

Treatment	Transect	Length (m)	Area (ha)
HFD	1	500	0.40
HFD	2	500	0.40
HFD	3	500	0.40
HFD	4	500	0.40
HFD	5	500	0.40
HFD	6	500	0.40
LFD	1	500	0.40
LFD	2	500	0.40
LFD	3	500	0.40
LFD	4	500	0.40
LFD	5	500	0.40
LFD	6	500	0.40
ACS	1	500	0.75
ACS	2	500	0.75
ACS	3	500	0.75
ACS	4	500	0.75
ACS	5	500	0.75
ACS	6	500	0.75
WW	1	500	0.75
WW	2	500	0.75
WW	3	500	0.75
WW	4	500	0.75
WW	5	500	0.75
WW	6	500	0.75
IG	1	465	1.40
IG	2	465	1.40
IG	3	500	1.50
IG	4	465	1.40
IG	5	465	1.40
IG	6	480	1.44
MP	1	320	0.96
MP	2	420	1.26
MP	3	500	1.50
MP	4	500	1.50
MP	5	500	1.50
MP	6	410	1.23
MCS	1	500	1.50
MCS	2	500	1.50
MCS	3	500	1.50
MCS	4	500	1.50

Table 2. –continued-

Treatment	Transect	Length (m)	Area (ha)
MCS	5	500	1.50
MCS	6	500	1.50
ES	1	500	1.50
ES	2	500	1.50
ES	3	500	1.50
ES	4	500	1.50
ES	5	500	1.50
ES	6	500	1.50
TP	1	500	1.50
TP	2	500	1.50
TP	3	500	1.50
TP	4	500	1.50
TP	5	500	1.50
TP	6	500	1.50

Early successional plot within Pocosin Lakes, NWR. photo by Bryan Watts.

Tall pocosin plot within Pocosin Lakes, NWR. photo by Bryan Watts.

Birds were censused along marked transects using a standard, variable-width transect technique (Emlen 1974). The observer moved along the transect at a constant speed and searched for birds within the habitat block. All individuals encountered were identified to species and recorded. In addition to the species, how the bird was initially detected was also recorded. Detection types included aural, visual, and flushed. Distances between the observer and the birds detected (detection distance) and the distance between the bird and transect (transect distance) were also recorded in order to facilitate density estimation. Because of the inherent difficulties with unreferenced distance estimation, a stratified approach was used. For birds believed to be within 10 m of the observer, distances were estimated to 1-m resolution. For birds believed to be within 10 and 50 m away, distances were estimated to the nearest 5 m. For birds between 10 and 100 m away, distances were estimated to the nearest 10 m, and for birds greater than 100 m away distances were estimated to the nearest 50 m.

Diurnal Raptor Survey

An attempt was made to systematically survey diurnal raptors by automobile throughout the farm unit on Alligator River, NWR. A survey route was designed that 1) allowed for visual access to all compartments of the farm unit and 2) reduced the possibility of recounting individuals (Figure 3). Surveys were conducted in the early afternoon (after completion of transect surveys). No surveys were conducted during rain days or when wind speed exceeded approximately 24 kph (15 mph). Four surveys were conducted. Survey dates included 10 and 16 January and 4 and 25 February, 2002.

Birds were surveyed by driving along the route and stopping between each adjacent set of feeder ditches to scan the ground surface for raptors with 10 X 40 binoculars. The forest edge adjacent to the farm unit was also scanned for perching birds. All raptors perched or flying over each compartment were identified to species and recorded. No attempt was made to estimate detection or transect distances. The survey took approximately 4 hrs to complete.

Data Analysis

To compare plant densities between high and low forb filter strips, an average density (stems m^{-2}) was calculated for each plot based on the ten vegetation measurements taken. A one-way ANOVA was then performed to determine differences between the two treatments.

In order to compute bird densities for each transect, a correction factor was computed for each cover type independently (Emlen 1974). Habitat-specific correction factors were derived for all birds collectively and for individual species with adequate sample sizes. Correction factors were used to compute densities for each transect and round combination. To avoid pseudoreplication, an average density value was computed for each transect based on the three census rounds. Treatment effects were evaluated using a

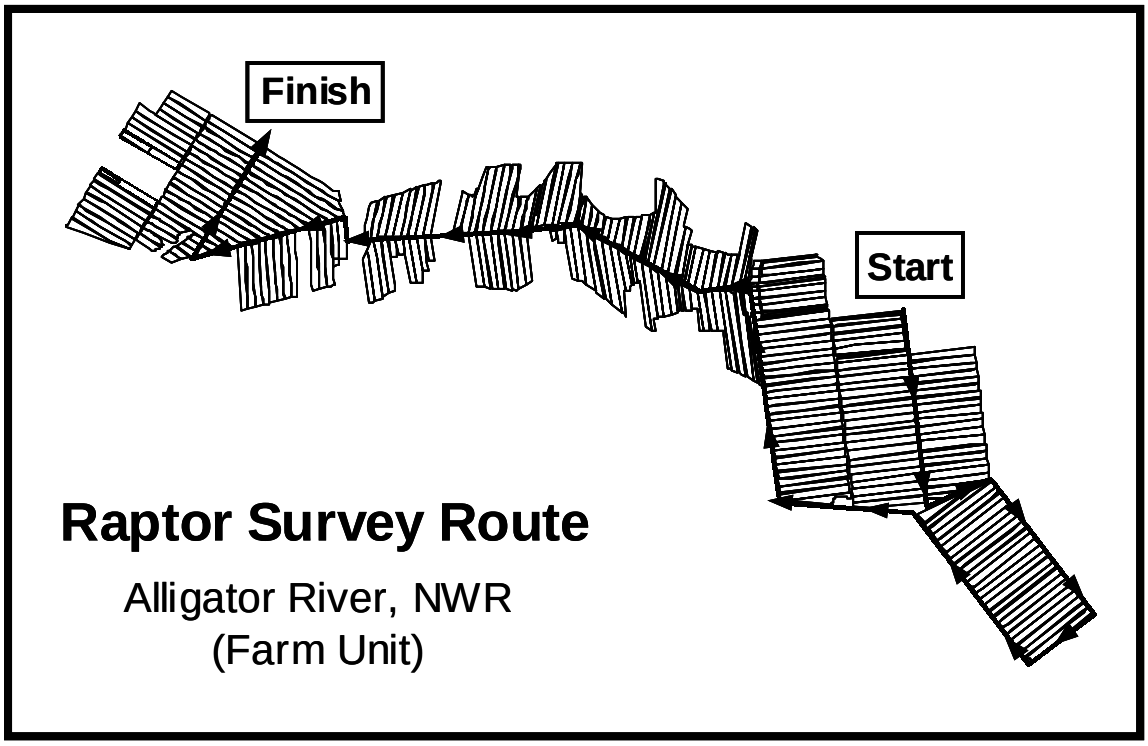

Figure 3. *Map of Alligator River, NWR farm unit with raptor survey route indicated.*

one-way ANOVA. This approach was used for community-wide parameters, as well as, individual species with adequate sample sizes. Post-hoc comparisons were conducted using Tukey's Honestly Significant Difference to determine the specific structure of differences in responses to cover type (Sokal and Rohlf 1981).

Evaluating Management Scenarios

An assessment of cover types was conducted within the farm unit to determine the availability of habitats. This was done by driving all roadways and mapping cover within each farm section (area between feeder ditches or dykes). Mapping was done on a detailed GIS map of the study area that included all field sections. A GIS layer was then produced for cover types across the farm unit. Habitat availability was then calculated by summing the acreage for each cover type.

Population projections were computed for all birds collectively and common species independently by multiplying the mean, habitat-specific densities of birds by habitat availability. This resulted in an estimate of the number of individuals supported by each cover type. Estimates could then be summed to provide an estimate for the entire farm unit or for upland agricultural areas and moist soil units separately.

The influence of various management scenarios on the number of birds supported was evaluated by shifting the allocation of cover types and recalculating population projections based on the new conditions. The range of potential management scenarios was limited to those that would logically be pursued based on the current "foot print" of the land.

RESULTS

Alligator River, NWR

Forb Density

Forb density was approximately six times higher within HFD compared to LFD filter strips (Figure 4). Differences were statistically significant (df = 1, F-statistic = 63.61, $p < 0.001$). The result of this difference is that HFD had greater screening cover but much lower ground cover of grasses. Most LFD transects supported dense stands of seed-producing grasses.

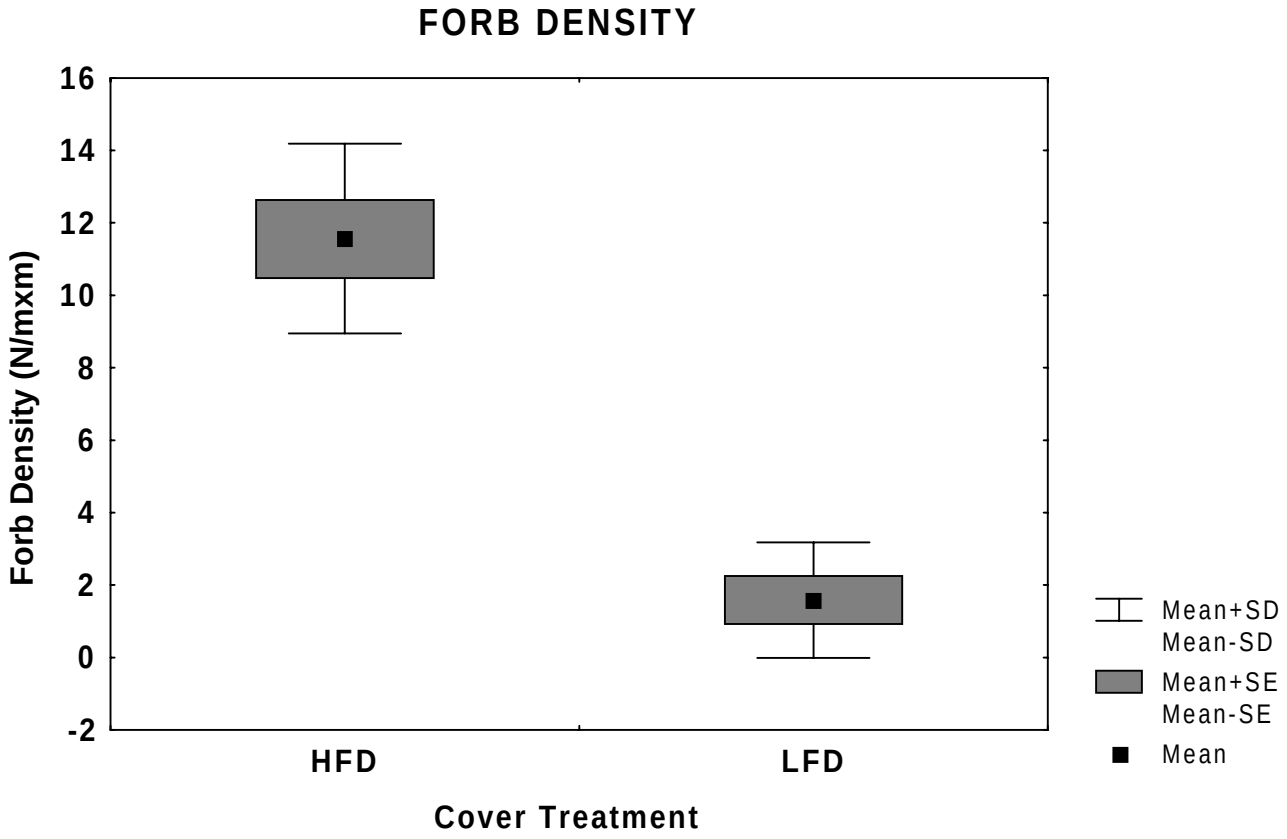

Figure 4. *Comparison of forb density between high forb density and low forb density filter strips.*

Transect Surveys

Nearly 1,650 observations of birds were made along survey routes during the study period. Observations included 24 species (Appendix I). However, three species including Savannah Sparrow (see Appendix II for species names), Common Snipe, and Eastern Meadowlark accounted for nearly 80% of all observations. Savannah Sparrows alone accounted for 53% of bird detections. Other frequently detected species included Killdeer, Swamp Sparrow, and Sedge Wren.

Cover treatment had a significant influence on the density of birds detected (Table 3, Figure 5). All species combined, as well as, all common species individually, exhibited distributions that were not expected by chance (One-way ANOVA, $p < 0.001$ for all comparisons). Post-hoc comparisons revealed that several of the most common species showed a significant positive response to grass cover (Table 4). These species were often associated with both the idle grass cover within the moist soil unit and the low forb density filter strips that supported dense stands of grasses within the upland agricultural areas (Figure 6a and 6b). The remainder of the common species showed significant positive responses to bare ground. Most of these species were associated with areas of bare ground that were frequently wet. There was relatively little use of high forb density filter strips even though this was the most abundant cover type throughout the farm unit.

Table 3. Results of one-way ANOVAs comparing mean densities across cover types within the farm unit of Alligator River, NWR.

Bird Group	SS	MS	MSE	F	P
All Birds	4360.2	726.7	55.04	13.20	<0.001
Common Snipe	341.2	56.9	9.71	5.86	<0.001
Killdeer	28.1	4.7	0.19	24.31	<0.001
Northern Harrier	9.2	1.5	0.28	5.41	<0.001
Eastern Meadowlark	193.2	32.2	4.19	7.69	<0.001
Savannah Sparrow	4036.0	672.7	30.86	21.80	<0.001
Swamp Sparrow	159.8	26.6	2.85	9.33	<0.001
Sedge Wren	102.7	17.1	1.33	12.83	<0.001

Table 4. Results of post-hoc comparisons of density by treatment. Treatment types with the same letter were not significantly ($p > 0.05$) different using Tukey's Honestly Significant Difference.

Bird Group	HFD	LFD	ACS	WW	IG	MP	MCS
All Birds	A	B	A	A	B	A	A
Common Snipe	A	A	A	A	A	B	A
Killdeer	A	A	A	A	A	A	B
Northern Harrier	A	B	A	A	A	A	A
Eastern Meadowlark	A	A	B	A	A	B	A
Savannah Sparrow	A	B	A	A	B	A	A
Swamp Sparrow	A	A	A	A	B	A	A
Sedge Wren	A	B	A	A	B	A	A

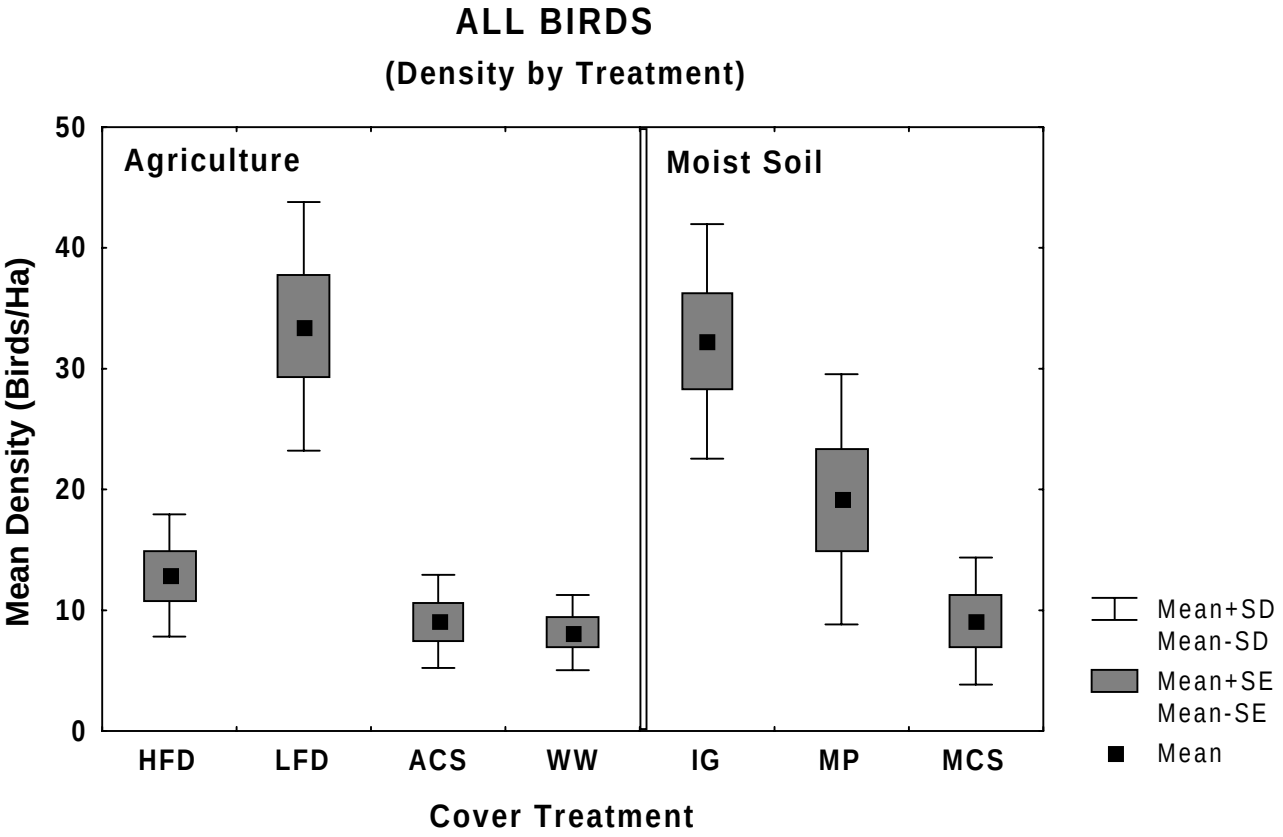

Figure 5. *Response of all birds collectively to cover type.*

Upland Agriculture – Eleven species were detected along transects within upland agricultural lands. Overall bird density was significantly higher (One-way ANOVA, $F = 9.6$, $p < 0.001$) within filter strips compared to areas within active agriculture (Figure 7). Of the species most commonly recorded, only the Eastern Meadowlark showed the opposite pattern and was observed in higher densities within the areas that were actively cultivated. Within the actively cultivated areas, meadowlarks were found in higher densities within the crop stubble compared to the areas planted in winter wheat. This difference was more pronounced in the later survey rounds as the winter wheat grew and completely covered the bare ground. As indicated previously, the density of most species utilizing filter strips was significantly higher within low forb density strips compared to high forb density strips.

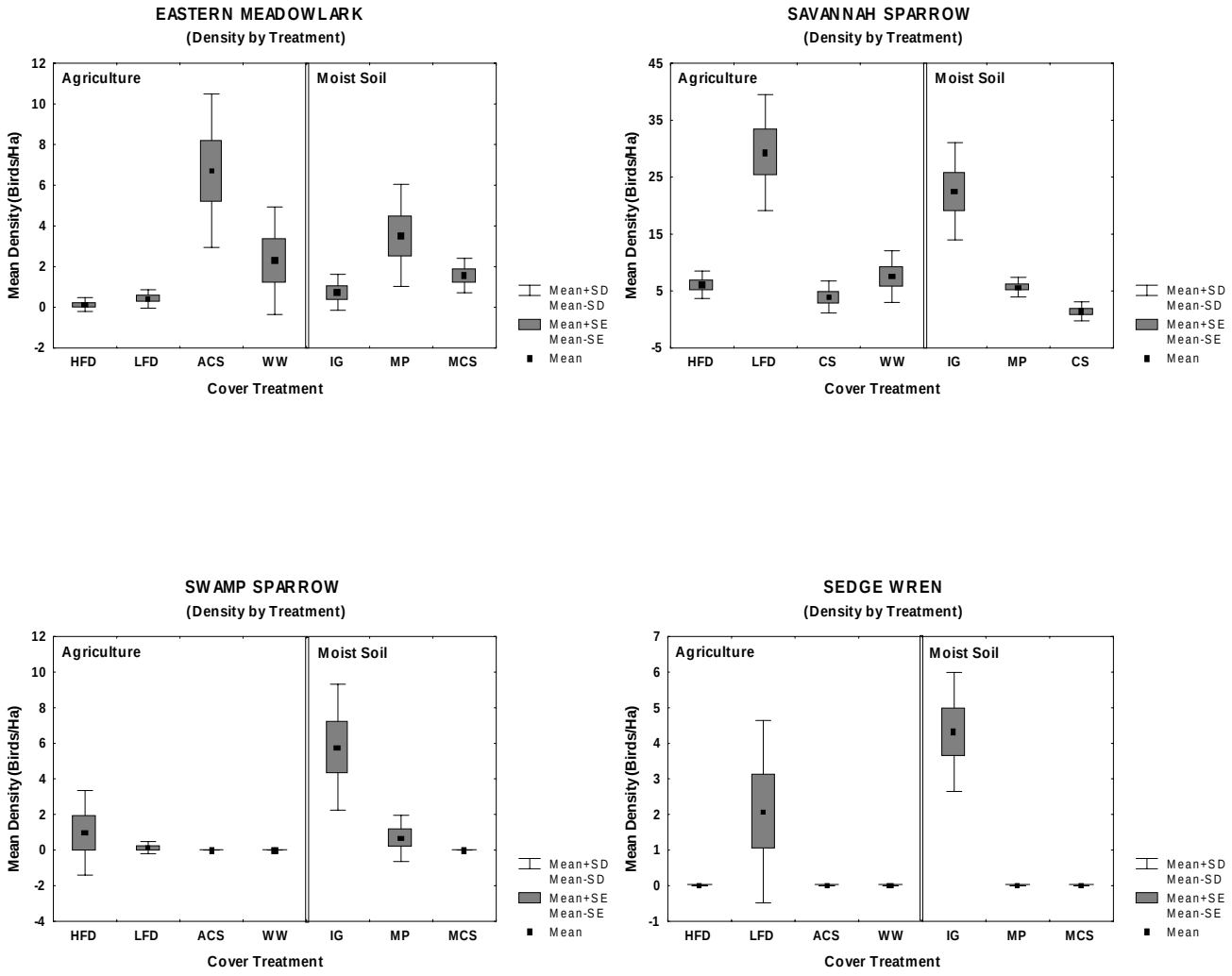

Figure 6a. *Response of common species to cover treatments.*

Moist Soil Units – Twenty-one species were detected along transects within the moist soil units. Overall bird density was significantly higher (One-way ANOVA, $F = 14.5$, $p < 0.01$) within idle grass compared to the actively cultivated areas (Figure 8). However, this result reflects the dominant influence of Savannah Sparrows on the overall pattern of bird distribution. Of the species frequently recorded within the most soil units, only 4 showed a significant positive association with idle grass. These included Savannah Sparrow, Swamp Sparrow, Sedge Wren, and Short-eared Owl. Virtually all of the remaining species were associated with bare ground that had been inundated due to the overflow of feeder ditches. This included all of the shorebirds such as Killdeer, Least Sandpiper, and Greater Yellowlegs. Common Snipes were also associated with bare wet ground but appeared to have the additional requirement of standing cover. More than 90% of all snipes detected along transects were within mixed plantings that were inundated with water.

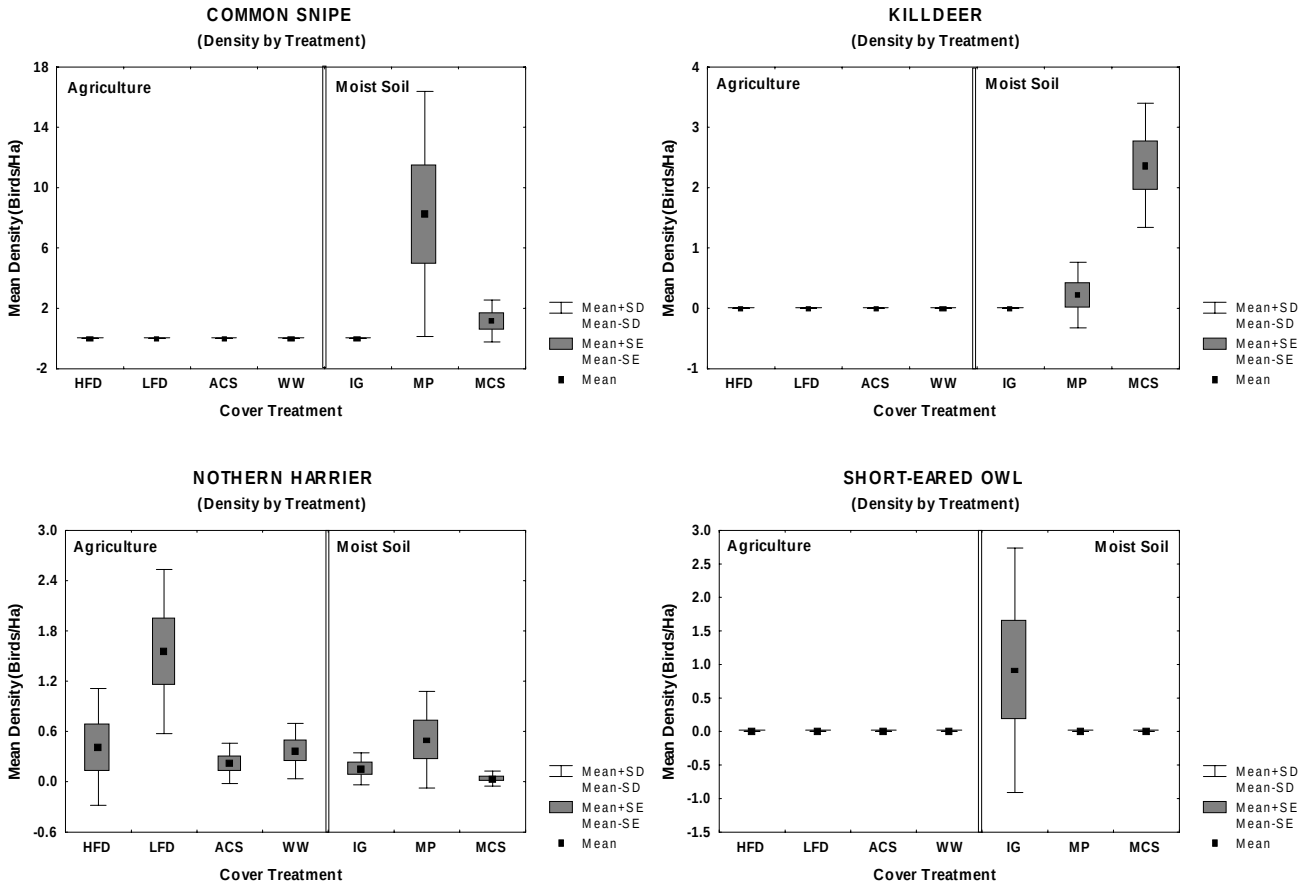

Figure 6b. *Response of common species to cover treatments.*

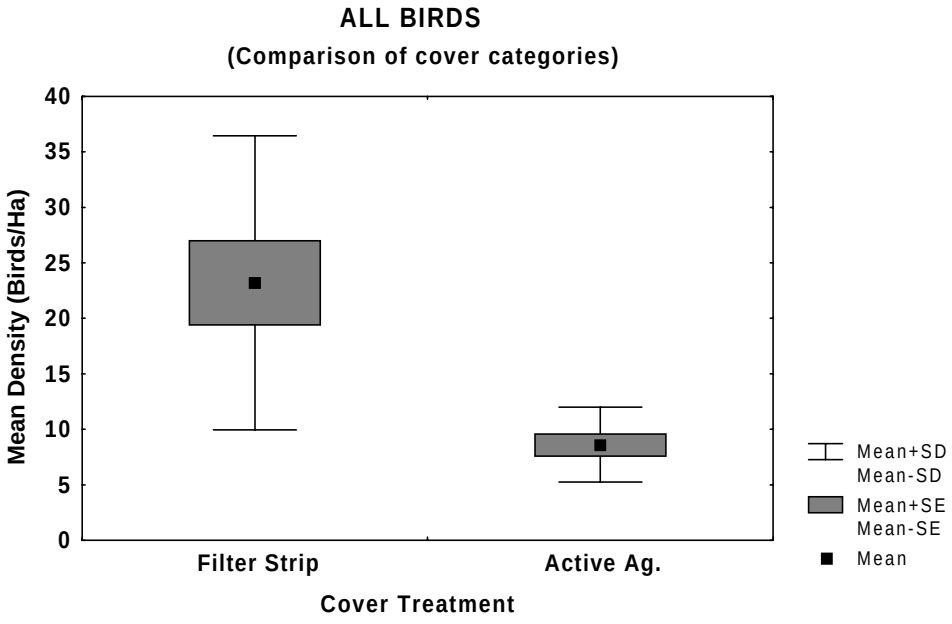

Figure 7. *Comparison of bird densities between cover categories within upland agriculture..*

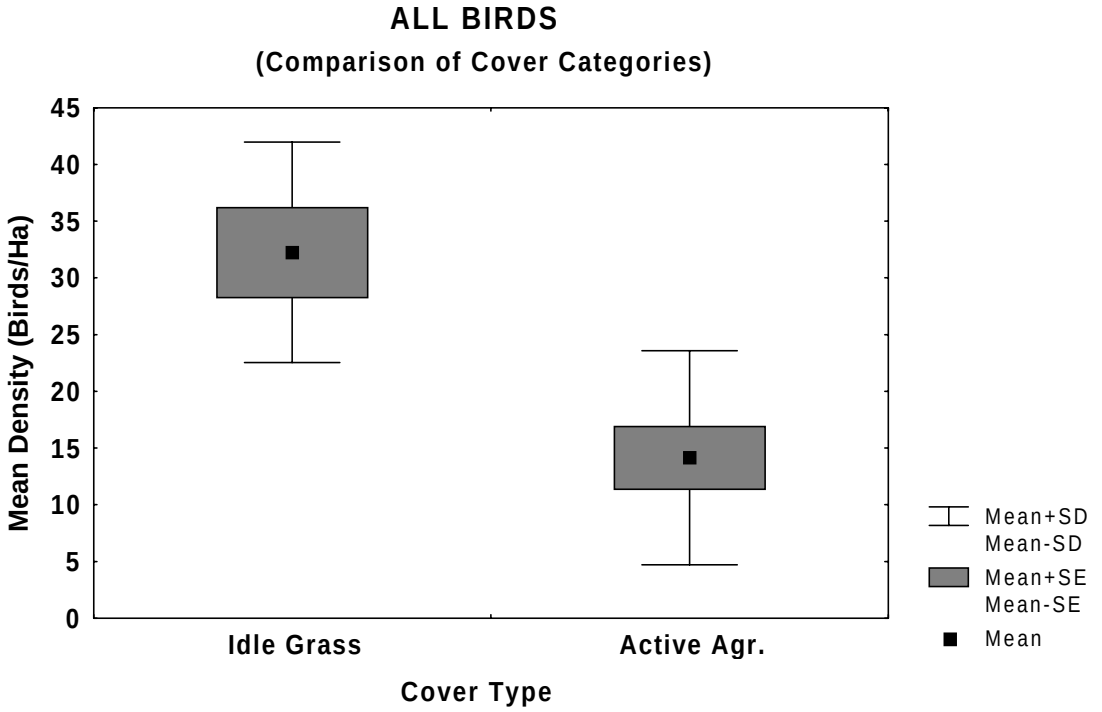

Figure 8. *Comparison of bird density between cover categories within moist soil units.*

Evaluation of Management Scenarios

Inventory of Cover Types - The farm unit contains approximately 1,764 ha of open land. This includes 1,324 ha within the upland agricultural units and 440 ha managed as moist soil units. During the study period, cover types within the upland areas were dominated by HFD filter strips and winter wheat (Table 5). Moist soil units were dominated by crop stubble. The distribution of cover types reflect the large management blocks across the site (Figure 9a-d).

Bird Projections - Based on the inventory of cover types and the density of birds estimated from transect surveys, the farm unit supported approximately 23,930 birds (Table 6). Nearly 70% of these birds were supported within the upland agricultural areas. Projections of selected common species were lead by Savannah Sparrow (60%), Eastern Meadowlark (12%), Sedge Wren (3%), and Common Snipe (3%).

Upland Agriculture – Lands contained within the upland agricultural areas are currently of two types. These include areas that are currently under active cultivation and fallow filter strips established along feeder ditches. Currently there are no plans to alter these land cover footprints. This implies that consideration of shifts in management to improve habitat availability should focus on these divisions.

Table 5. Summary of land area accounted for by cover types within the farm unit (Alligator River, NWR

Cover Type	Situation	Area (Ha)
High Forb Density	Agriculture	602
Winter Wheat	Agriculture	463
Crop Stubble	Agriculture	154
Low Forb Density	Agriculture	105
Subtotal	**Agriculture**	**1,324**
Crop Stubble	Moist Soil	260
Idle Grass	Moist Soil	127
Mixed Planting	Moist Soil	53
Subtotal	**Moist Soil**	**440**
Total	**-----**	**1,764**

Table 6. Projection of birds (rounded to the nearest 10) supported during the study period within the farm unit of Alligator River, NWR. Projection based on habitat-specific density estimates and habitat availability.

Bird Group	Agriculture	Moist Soil	Total
All Birds	16,450	7,480	23,930
Common Snipe	0	740	740
Killdeer	0	630	630
Eastern Meadowlark	2,230	690	2,920
Savannah Sparrow	10,870	3,540	14,410
Sedge Wren	220	550	770

Filter strips established within upland agricultural areas are currently projected to support an estimated 11,280 birds. As indicated above, bird densities were more than three fold higher within LFD filter strips compared to HFD filter strips. In order to examine the possible benefit of management alternatives, projections were performed across the range of possible alternatives (Figure 10). The number of birds supported by filter strips could be more than doubled by shifting management from HFD to LFD. Because the same bird species are using both filter types, a shift in management would not result in a shift in the bird community.

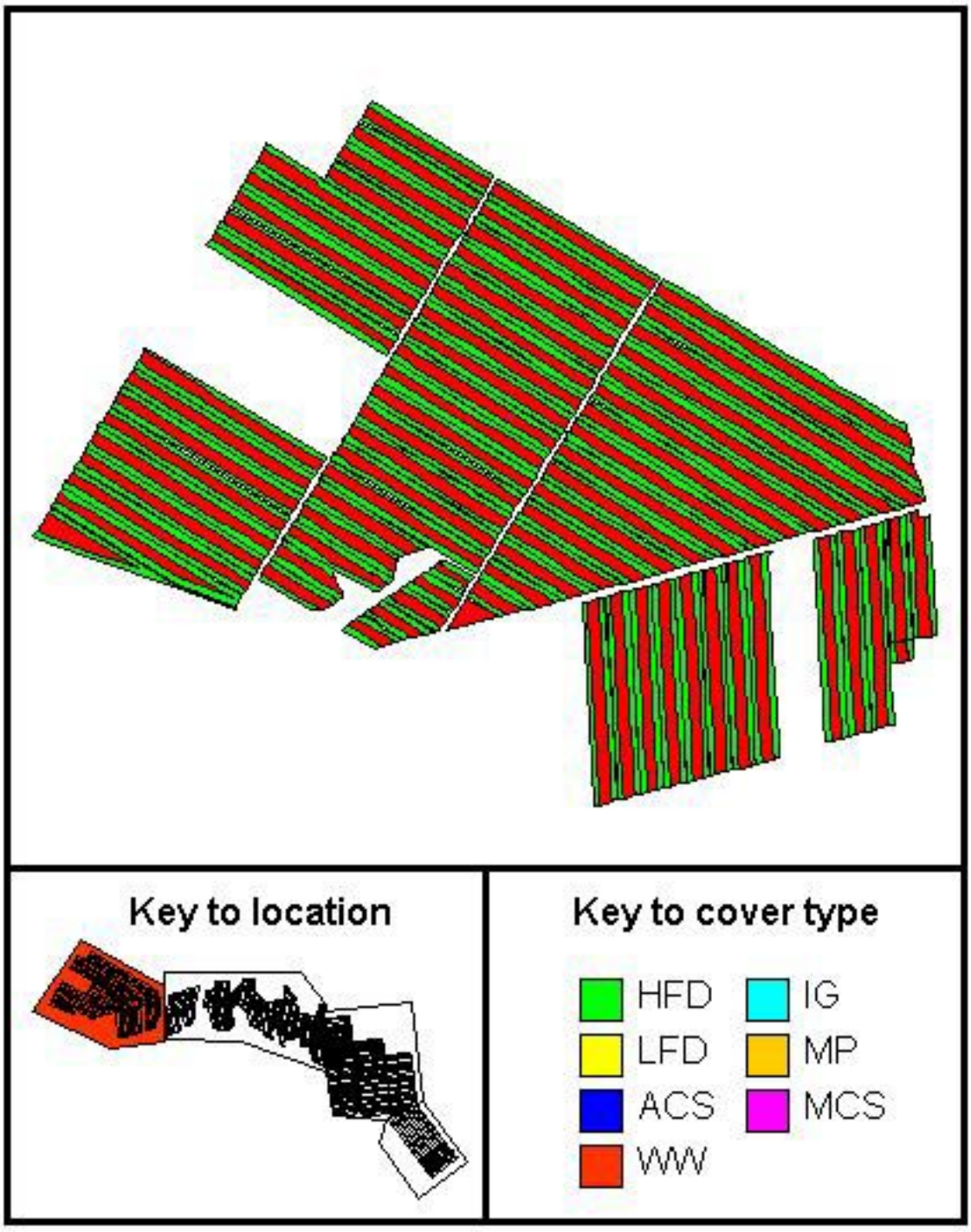

Figure 9a. *Map of cover types within the Alligator River, NWR farm unit.*

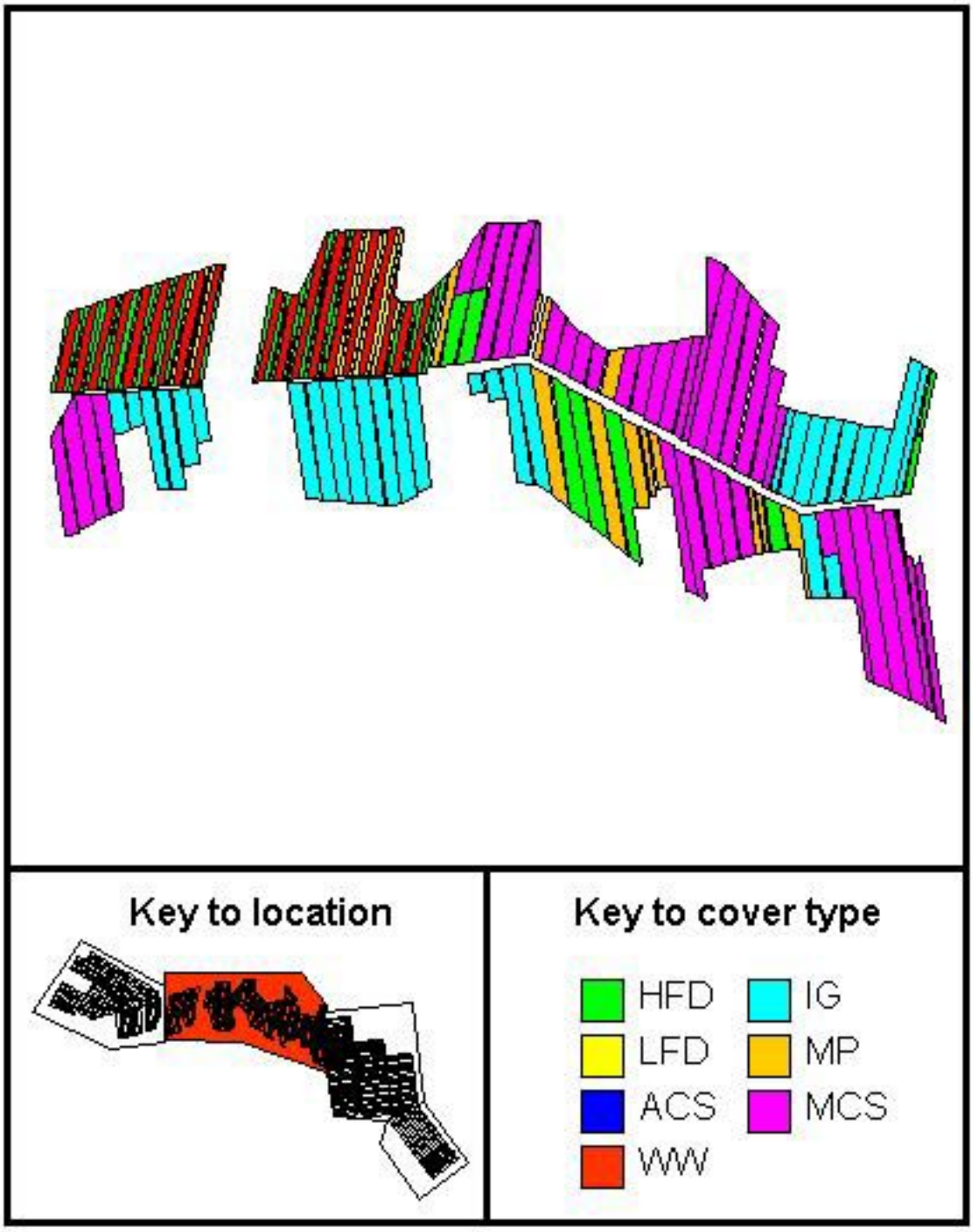

Figure 9b. *Map of cover types within the Alligator River, NWR farm unit.*

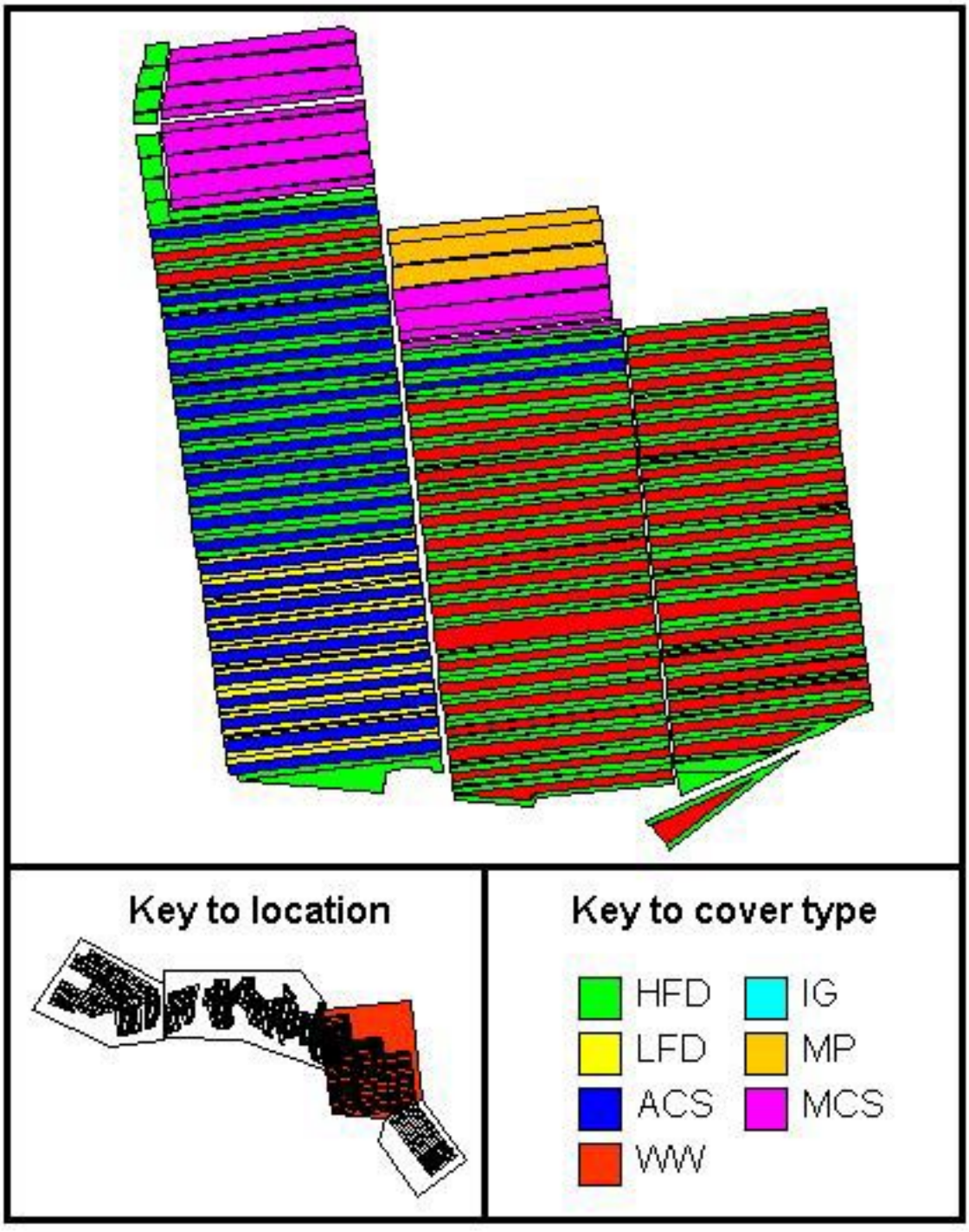

Figure 9c. *Map of cover types within the Alligator River, NWR farm unit.*

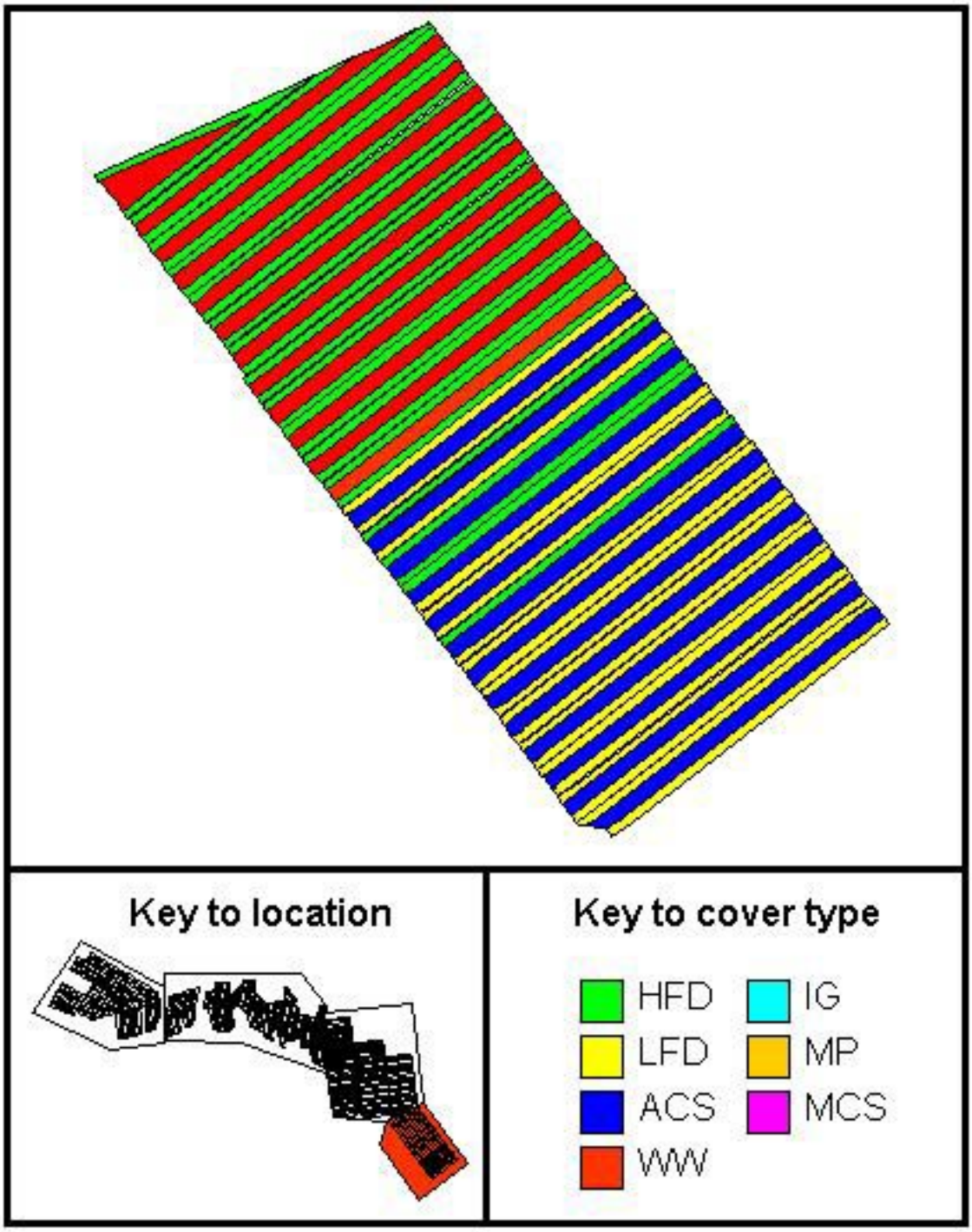

Figure 9d. *Map of cover types within the Alligator River, NWR farm unit.*

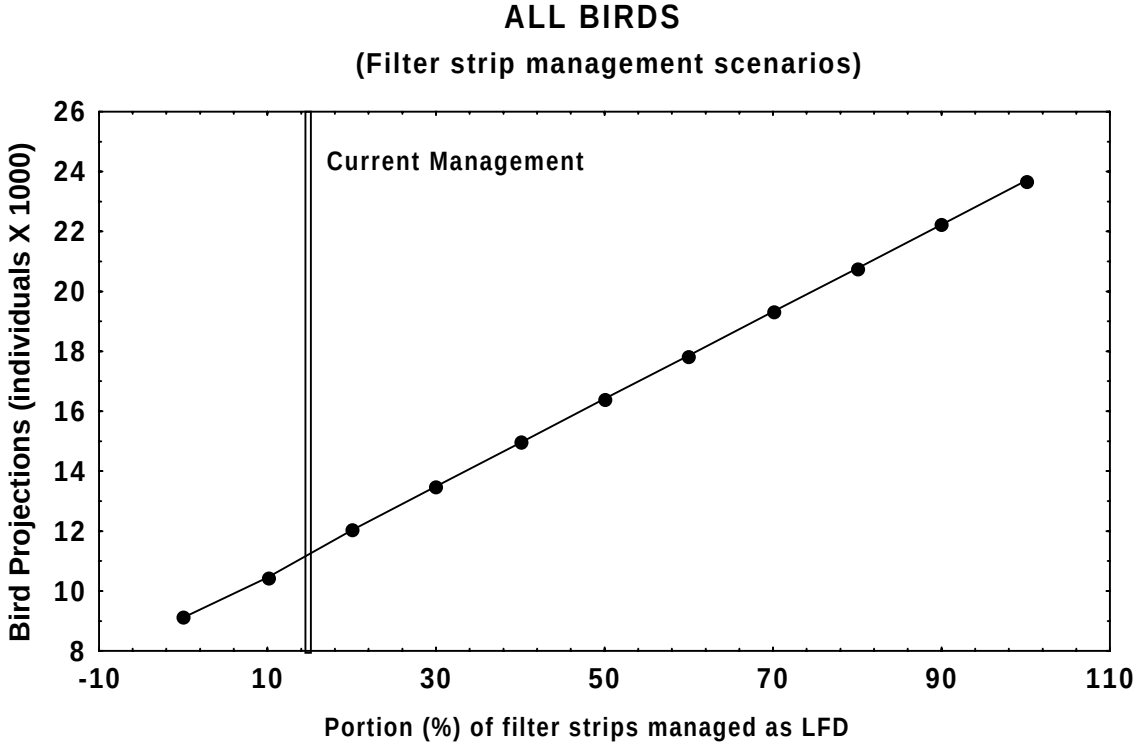

Figure 10. *Results of population projections for filter strips across the rull range of possible allocations. Current population estimate is indicated by the double vertical line.*

Field blocks currently under cultivation within the upland areas are projected to support an estimated 5,170 birds. Blocks that contained crop stubble through the winter were found to support marginally higher bird densities compared to blocks planted in winter wheat (9.1 vs 8.2 birds/ha). In order to examine the possible benefit of shifts in management, projections were performed across the range of possible alternatives (Figure 11). This projection illustrates that within this limited set of land uses, shifts in management will result in modest gains. Across the entire range of alternatives, bird projections vary by less than 10%.

As indicated in the separate analyses presented above, the greatest potential for improving upland agricultural areas for birds during winter is in changing the character of filter strips. Taken together, a shift in management of both filter strips and active agricultural areas could result in a two-fold increase in the number of birds supported on these lands (Figure 12).

Moist Soil Units – The moist soil units surveyed are managed primarily for winter waterfowl. During the study period, cover within the units was either in active agriculture or within idle grass. Active agricultural areas were either left in crop stubble for the winter or left with a standing crop of mixed planting. Presumably, all three of these cover types are interchangeable. However, because of recent management, crop stubble and mixed planting would likely be the easiest to interchange.

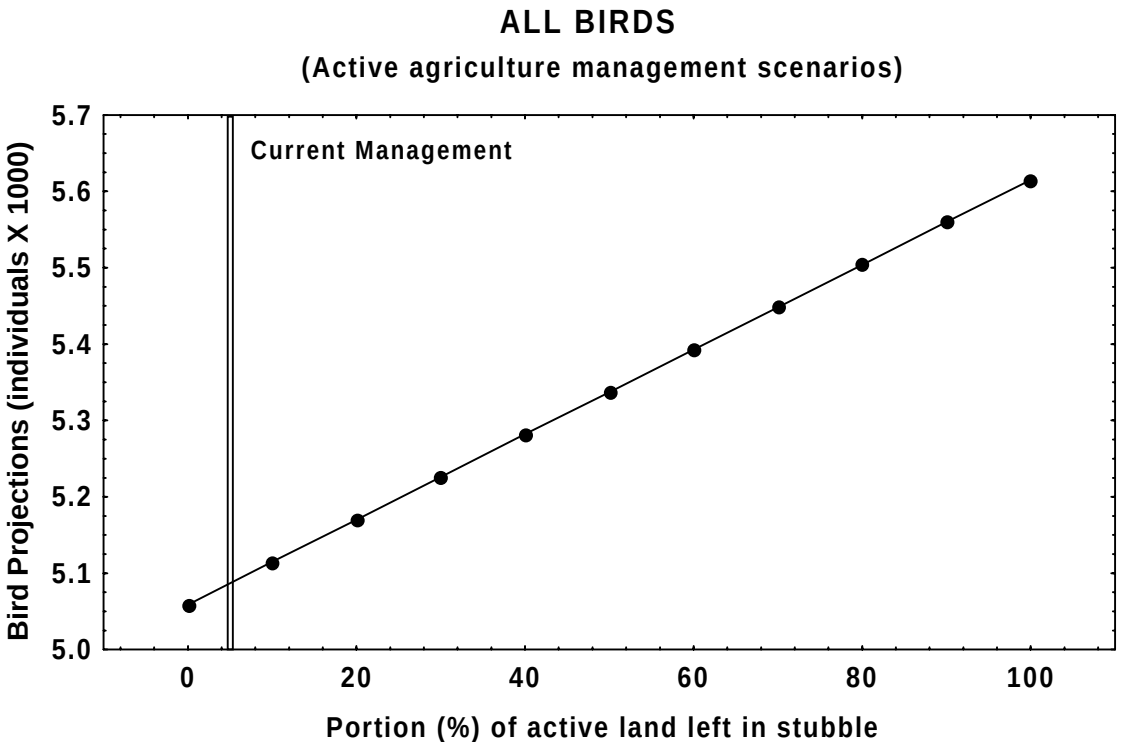

Figure 11. *Results of population projections for upland agricultural areas across the rull range of possible allocations. Current population estimate is indicated by the double vertical line.*

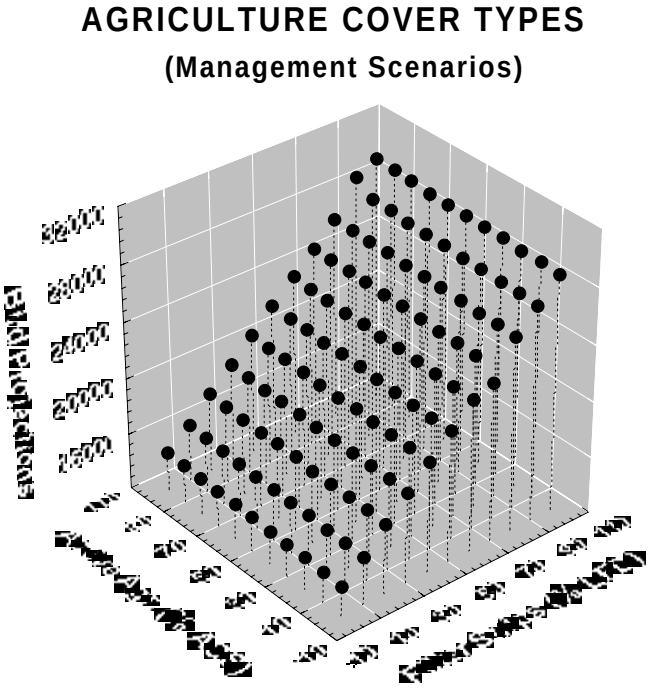

Figure 12. *Results of population projections for upland areas across the rull range of possible allocations of both filter strips and active agriculture.*

Based on the current cover footprint, active agriculture covers 313 ha or 71% of the land within moist soil units. In order to examine the possible benefits of changes in the management of active agriculture, projections were performed across the range of possible alternatives (Figure 13). The number of total birds supported could be increased by more than 100% by shifting management of agricultural areas toward mixed plantings. However, unlike upland agricultural areas, mixed plantings and crop stubble supported different species. Because of this pattern, changes in the composition of cover types will also shift the composition of the bird community. For example, increasing the proportion of land allocated to mixed planting from 0-100% could increase the number of Common Snipe supported from approximately 380 to 2,600. This shift would reduce the number of Killdeer expected from 750 to 0. For this reason, prioritization of target species would be required to make management decisions.

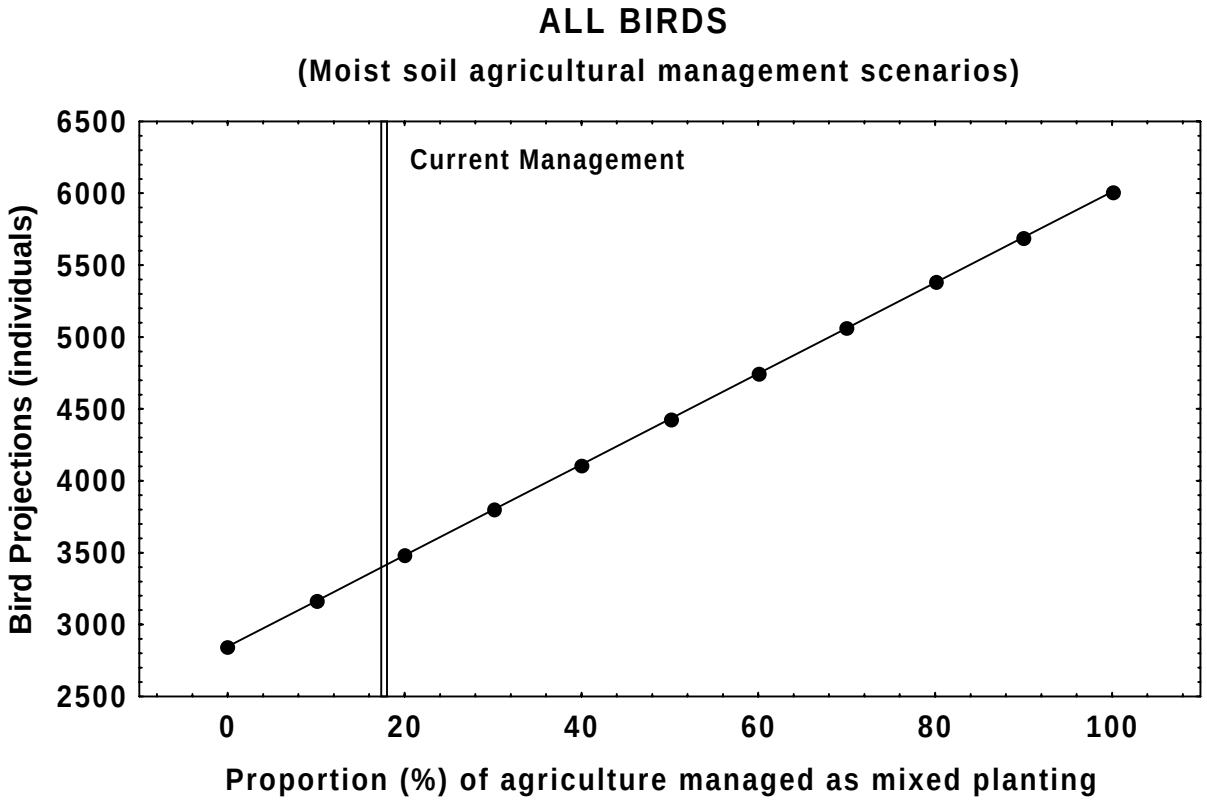

Figure 13. *Results of population projections for agricultural areas within moist soil units across the rull range of possible allocations. Current population estimate is indicated by the double vertical line.*

Moist soil units currently support approximately 127 ha of idle grass. This cover type supported some of the highest densities of birds of all those examined within the farm unit. Increases in the amount of idle grass available within the moist soil units would come at the expense of areas currently managed as active agriculture. Such shifts would alter the composition of the bird community within the moist soil units. As with changes between mixed plantings and crop stubble, prioritization of target species would be required to make management decisions.

Diurnal Raptor Surveys

Seven species of diurnal raptors (and Turkey Vulture) were detected during 4 driving surveys of the farm unit (Table 7). Northern Harriers and Red-tailed Hawks accounted for more than 88% of all observations with harriers accounting for 68% alone. In addition to the birds detected during surveys, Red-shouldered Hawks and Sharp-shinned Hawks were observed within or around the farm unit during the study period.

Table 7. Summary of diurnal raptor surveys within the farm unit of Alligator River, NWR.

Species	1/10/02	1/16/02	2/4/02	2/25/02
Northern Harrier	166	153	181	162
Red-tailed Hawk	48	43	60	51
Turkey Vulture	11	9	17	14
American Kestrel	12	9	10	8
Bald Eagle	3	1	3	2
Rough-legged Hawk	2	2	1	1
Merlin	1	0	1	0
Cooper's Hawk	1	0	0	2
Total	244	217	273	240

Northern Harrier – An extraordinary population of harriers was supported by the farm unit during the study period. The average density recorded is approximately 1 bird/11 ha of open land. The number of adult males (gray birds) was stable between 10 and 12 across surveys. This represents approximately 6.5% of the birds recorded. Due to the long distance over which many of these birds were observed, no attempt was made to separate adult females from juvenal-plumaged birds (brown birds). Half (49.3%) of the birds detected were foraging over filter strips within the upland agriculture areas or over idle grass within the moist soil units. The other large portion (44.2%) of the birds were perched on the ground in either crop stubble or winter wheat. Less than 7% of the birds detected were observed perched in filter strips or flying over crop stubble/winter wheat. However, detection of birds perched within HFD filter strips was difficult due to poor visibility. Birds perched on the ground in open areas were often in groups of 4 or 5.

Four communal roosts were located within the eastern portion of the farm unit (Figure 14). These sites were located incidentally while conducting transect surveys or were located by observing birds moving into roosts in the evening. It is likely that other roosts occur. For example, there almost certainly is a roost within the western portion of the unit since a considerable number of birds utilize this habitat and birds were not observed to move out of this area into the eastern portion during the evening hours. Roosts were characterized by a large number of depressions in the vegetation and a high concentration of cast pellets. From a limited number of evening surveys it was determined that approximately 15-20 birds used roost A, 70-80 birds used roost B, 20-30 birds used roost C, and 20-30 birds used roost D. Roost B also contained 6-10 Short-eared Owls roosting during the day. Consistency in the use of these roosts is not known and there may be considerable movement between sites. More than 1,000 pellets were collected from communal roosts to evaluate diet (these pellets have been dried and await further analysis). Prey observed to be captured or consumed were overwhelmingly cotton rats. Remains of cotton rats (*Sigmodon hispidis*) consumed by raptors were observed throughout the farm unit.

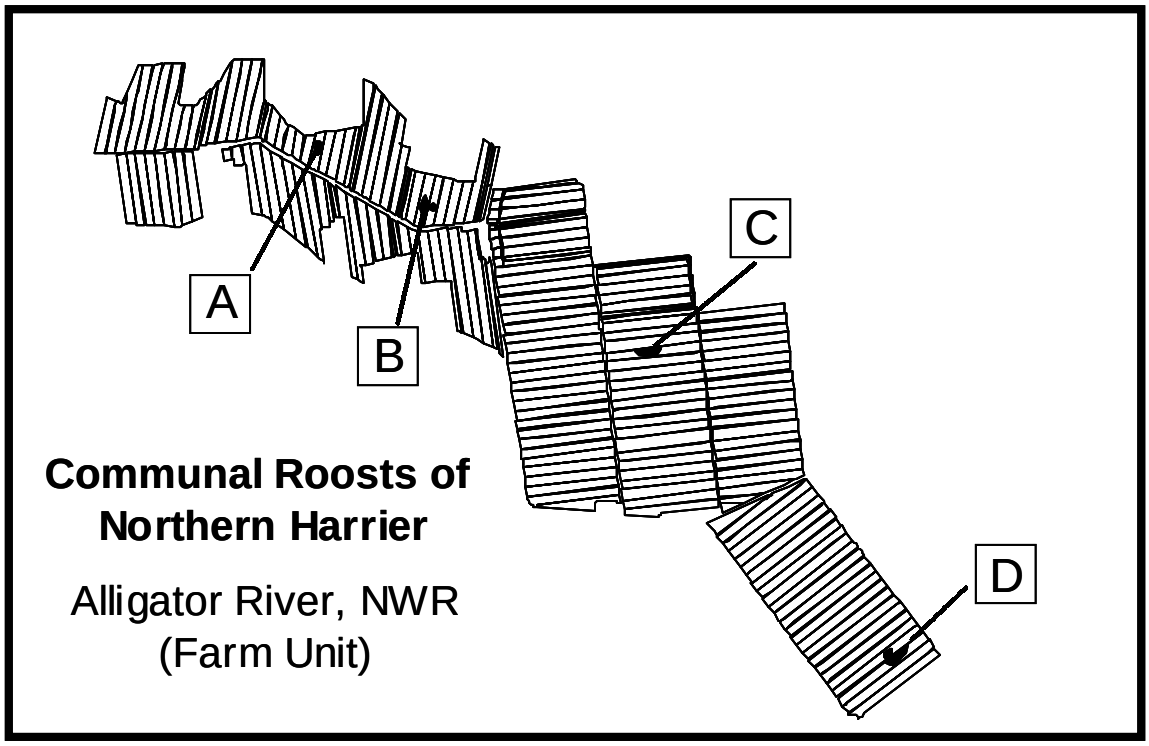

Figure 14. *Location of areas supporting nocturnal, communal roosts of Northern Harriers.*

Red-tailed Hawk – The farm unit supported a very large population of Red-tailed Hawks. Average density recorded was 1 bird/33 ha of open land. Most birds observed were soaring over fields, perching on the ground within open areas (i.e. crop stubble or winter wheat) or perched along the forest edge. Age ratio of birds identified to age was relatively even between hatching-year and adults. Several nests were located along the forest edge that were either old or under construction. No attempt was made to determine the size of the breeding population.

American Kestrel – The study area appeared to support approximately one dozen American Kestrels. These birds were primarily males and seemed to have a stable distribution throughout the study period. A few individuals, in particular, were observed repeatedly in the same location. Birds were observed taking over wintering grasshoppers and pursuing passerines.

Bald Eagle – At least 5 Bald Eagles were detected during the study period. This included 3 juvenal-plumaged birds that were observed on the same day and a resident pair of adults that was seen repeatedly during the course of the study. Young birds were typically encountered within the eastern portion of the unit either on the county landfill property or around the inundated areas that supported the bulk of the waterfowl. The adult pair was observed frequently perched or hunting waterfowl north of the maintenance shed in the moist soil units. One of these birds was observed to stoop on a young harrier and follow the bird into the tree line. In early January a partially completed nest was found along the northern tree line behind the maintenance shed. This nest was completed and an incubating bird was observed for the first time on 23 February.

Rough-legged Hawk – Two Rough-legged Hawks were observed on more than one occasion within the farm unit. One of these individuals roosted behind the maintenance shed next to an old combine and was seen regularly. A second bird was observed infrequently at locations across the entire unit.

Merlin – A single Merlin was observed within the farm unit. This individual was an adult male that seemed to hunt primarily within the moist soil unit west of the maintenance shed.

Cooper's Hawk – Cooper's Hawks were seen infrequently within the farm unit. Both juvenal and adult-plumaged birds were observed indicating at least 2 birds. These birds were observed along forest edges.

Red-shouldered Hawk – Several observations of Red-shouldered Hawks were made in the vicinity of the farm unit. These birds were never observed foraging within the farm unit but appeared occasionally from the surrounding forests and pocosins.

Sharp-shinned Hawk – Sharp-shins were observed both along the forest edge and within the farm unit on several occasions.

Pocosin Lakes, NWR

Transect Surveys

A total of 636 observations of birds were made along survey routes during the study period. Observations included 23 species (Appendix III). Two species including American Robin and Yellow-rumped warbler (see Appendix II for species names) accounted for 63% of all observations. Other commonly encountered species included White-throated Sparrow, Cedar Waxwing, Short-eared Owl, Eastern Towhee, and Common Yellowthroat.

Cover treatment had a significant influence on the overall density and number of species detected (Table 8). On average, bird density was nearly 5 times higher within the tall pocosin compared to the early successional habitat (Figure 15). Species richness was approximately 3 times higher within tall pocosin (Figure 16). All species combined and most of the common species individually utilized one of the two cover types more than expected by chance (One-way ANOVA, $p<0.05$). Cover associations were split between species (Figure 17a and 17b). Some species such as Short-eared Owl, Northern Harrier, Savannah Sparrow, and Eastern Meadowlark were associated with the early successional cover type. Other species such as the Gray Catbird, Cedar Waxwing, Yellow-rumped Warbler, and Common Yellowthroat were associated with the woody vegetation that was more abundant within the tall pocosin cover type.

Table 8. Results of one-way ANOVAs comparing mean density or species richness across cover types within Pocosin Lakes, NWR.

Bird Group	SS	MS	MSE	F	P
All Birds (abundance)	1579.2	1579.2	57.81	27.32	<0.001
All Birds (richness)	62.2	62.2	0.89	69.64	<0.001
Short-eared Owl	3.0	3.0	0.50	5.97	<0.05
Eastern Meadowlark	0.5	0.5	0.06	7.80	<0.05
Savannah Sparrow	2.1	2.1	0.31	6.88	<0.05
Eastern Towhee	1.5	1.5	0.09	15.94	<0.01
Northern Cardinal	3.6	3.6	0.21	16.72	<0.01
Cedar Waxwing	2.4	2.4	0.28	8.57	<0.01
Yellow-rumped warbler	101.5	101.5	4.74	21.40	<0.001
Common Yellowthroat	1.3	1.3	0.01	132.3	<0.001
American Robin	3.7	3.7	15.04	0.25	>0.05

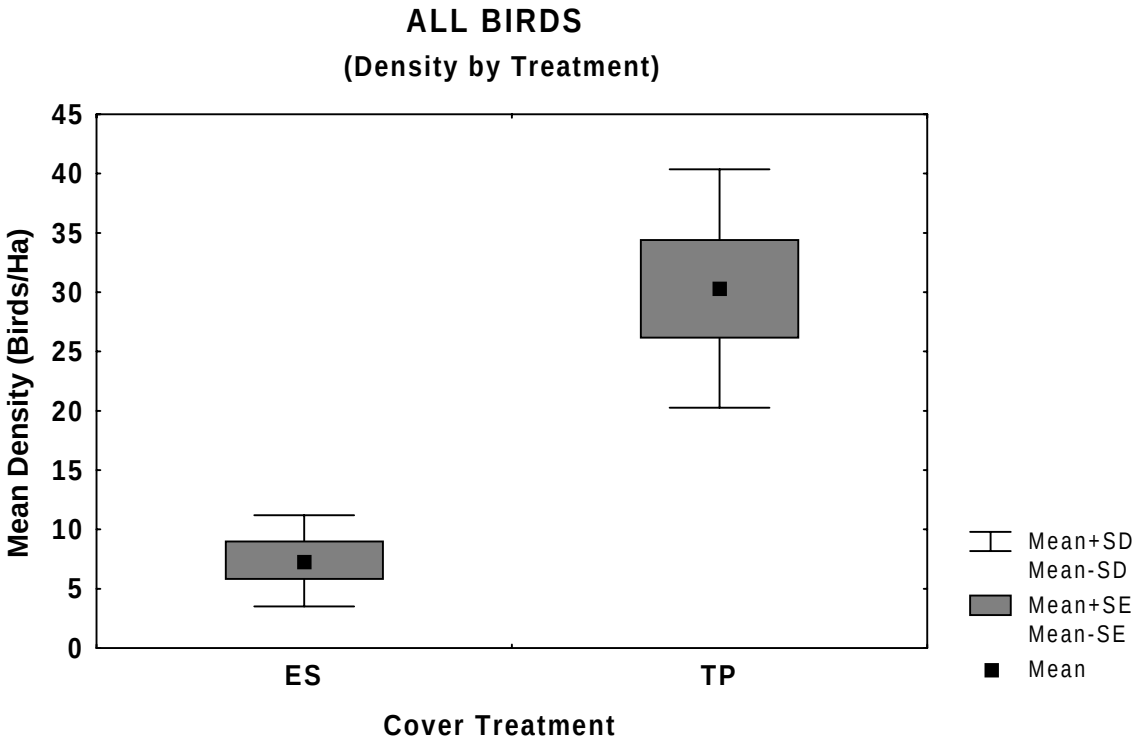

Figure 15. *Comparison of mean bird density between early successional and tall pocosin habitats within Pocosin Lakes, NWR.*

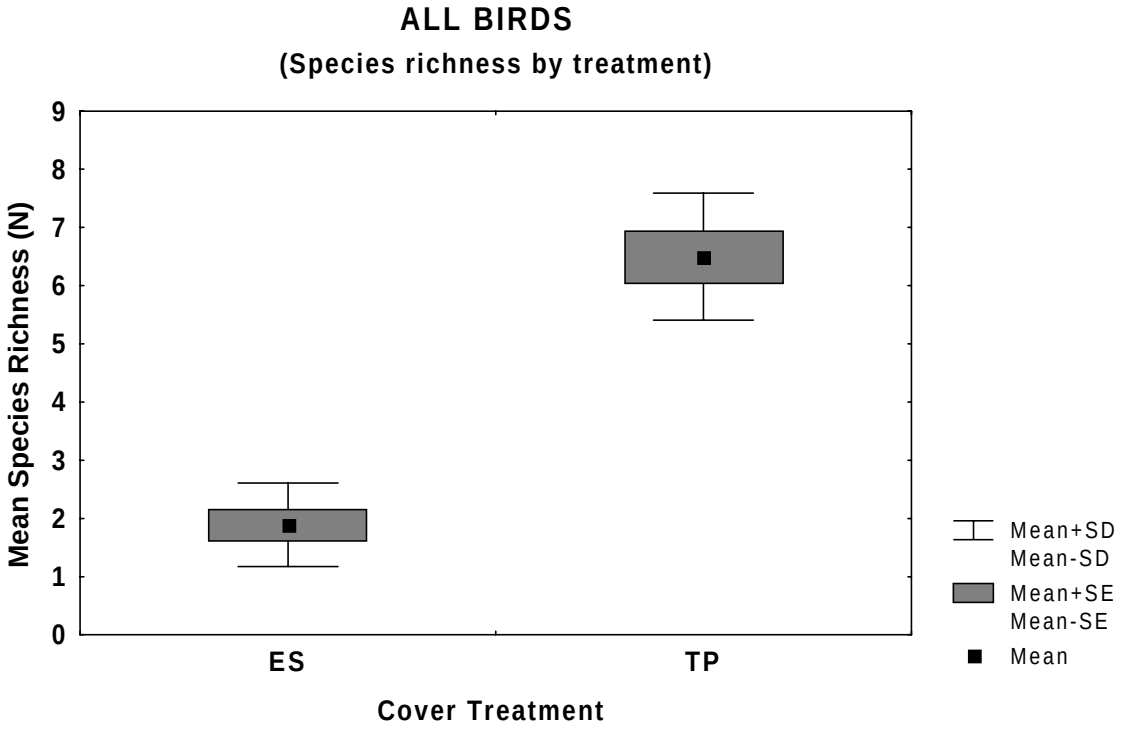

Figure 15. *Comparison of mean species richness between early successional and tall pocosin habitats within Pocosin Lakes, NWR.*

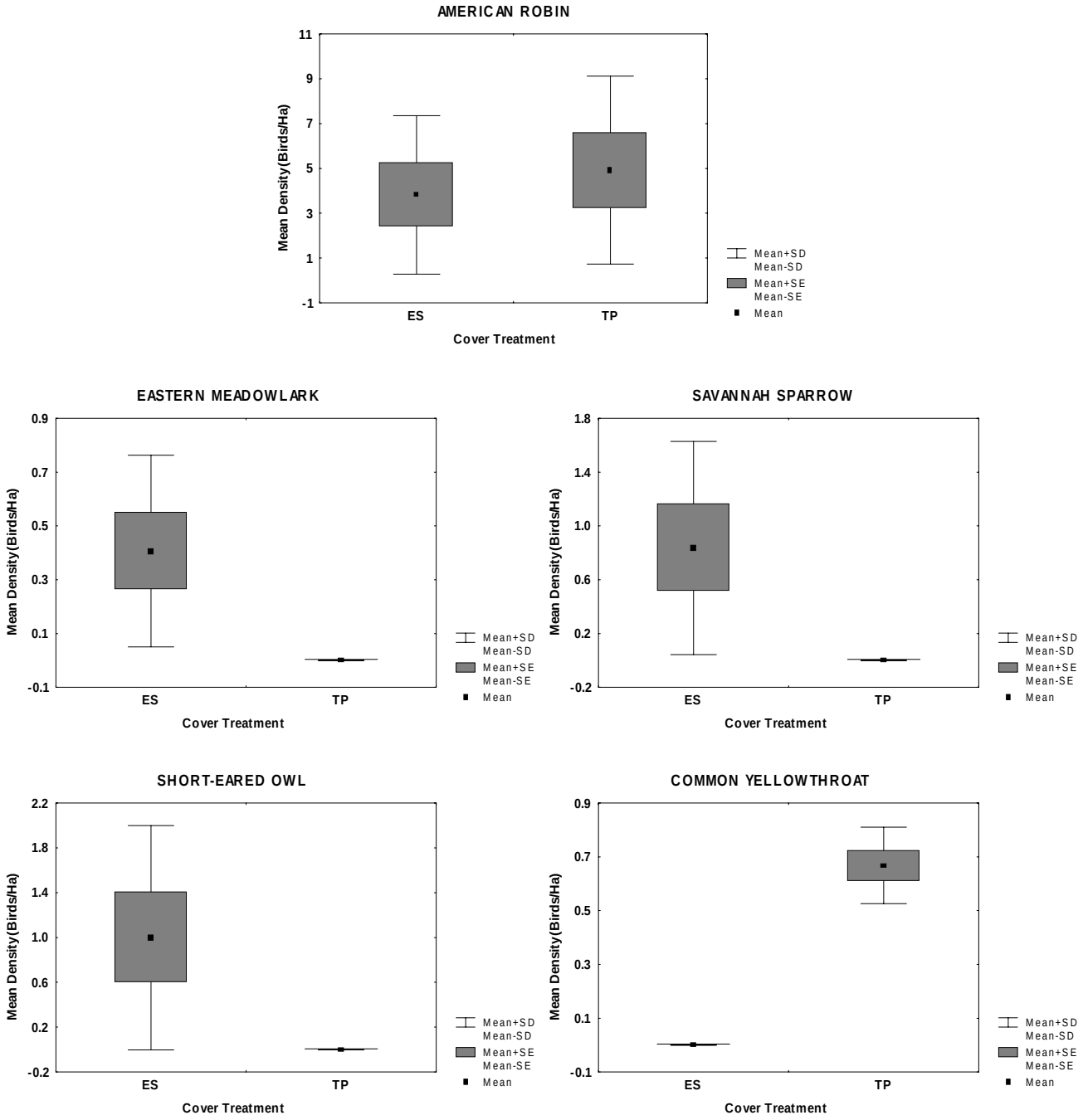

Figure 17a. *Comparison of mean bird density for selected species between early successional and tall pocosin habitats within Pocosin Lakes, NWR.*

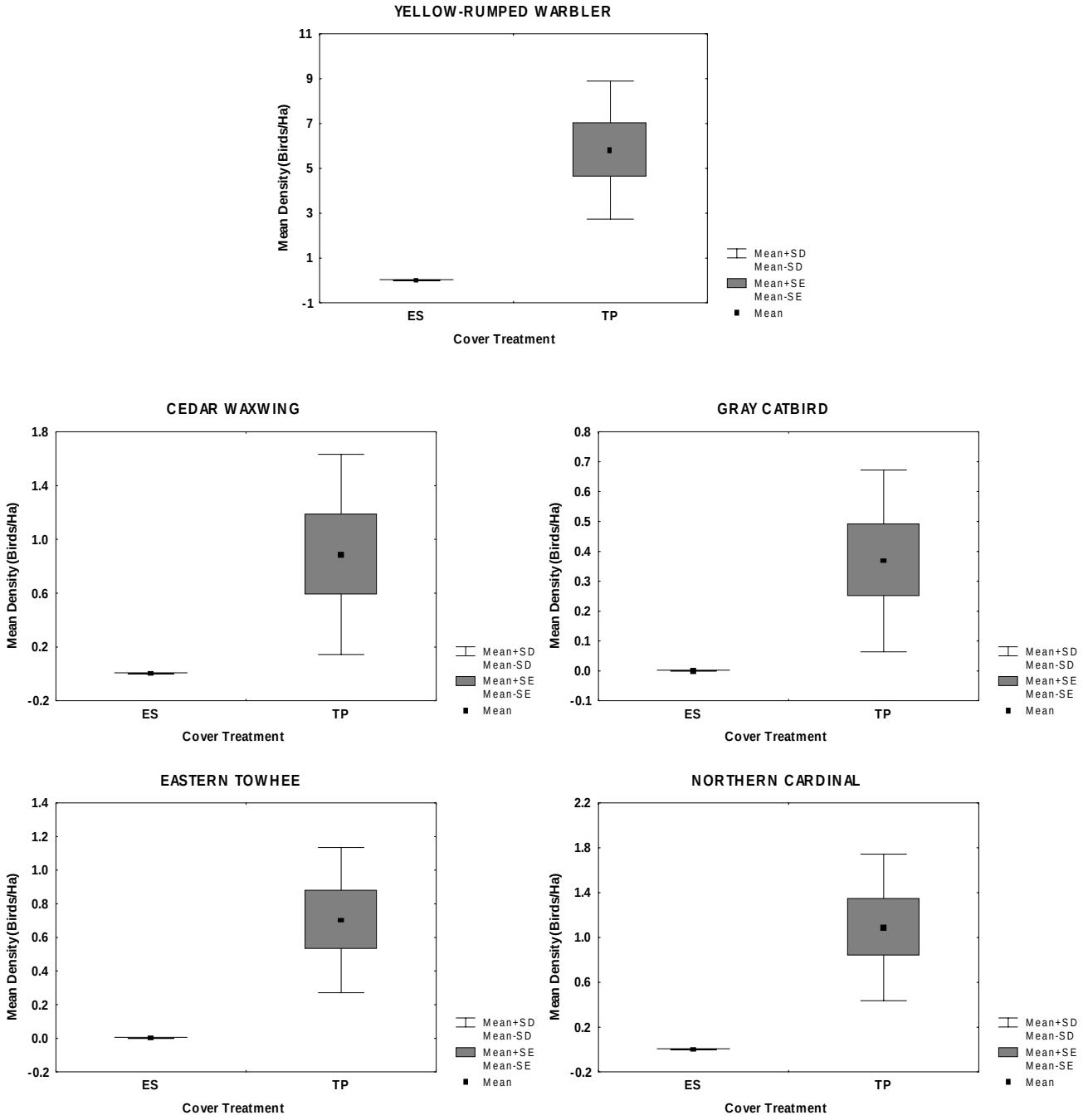

Figure 17b. *Comparison of mean bird density for selected species between early successional and tall pocosin habitats within Pocosin Lakes, NWR.*

DISCUSSION

Open lands within Alligator River, NWR and Pocosin Lakes, NWR appear to provide winter habitat for a dense community of birds during the winter months. The most prominent divisions of this community are composed of species that require grasslands, bare wet ground, or woody vegetation. Some portions of these lands are under direct management control providing the flexibility to develop goal-oriented management programs to benefit high-priority species.

Within the farm unit of Alligator River, NWR, the establishment of fallow filter strips under the Conservation Reserve Program appears to have been a benchmark event for birds using the upland agricultural areas during the winter. More than 75% of the birds estimated to use upland areas were associated with filter strips. This result is consistent with the general finding in other parts of the country (e.g. Johnson and Schwartz 1993, Granfors et al. 1996, Millenbah et al. 1996, Delisle and Savidge 1997) that the CRP program has been beneficial to declining birds.

Filter strips with low densities of forbs supported approximately three times higher bird densities compared to filter strips with high densities of forbs. Evaluation of the full range of management options suggests that the number of birds supported within upland areas could be more than doubled by converting high forb filter strips to low forb filter strips. The density of birds and character of the community within low-density strips is very similar to those observed within the idle grass plots. During the winter months, grassland bird communities are influenced by the availability and distribution of seeds used as food (e.g. Pulliam and Parker 1979, Dunning and Brown 1982, Beck and Watts 1997). The apparent difference between HFD and LFD filter strips is the production of seed used as food by many species. Many of the tall forb species within the study site produce small seeds that are not used as a food source by birds. These same forbs form a continuous cover that shades the ground surface and prevents growth of grasses that produce important seed crops. The use of fire, mechanical or other management techniques to discourage the formation of dense forb stands within filter strips would benefit wintering birds.

The two cover types within active agricultural areas supported comparable bird communities. Species such as Savannah Sparrows venture out into these open areas from adjacent filter strips and were observed in moderate densities. Eastern Meadowlarks are associated with bare ground where they probe for invertebrates. Meadowlarks used active agricultural areas significantly more than adjacent filter strips. Evaluation of management scenarios within active agricultural areas suggested that there would be only minor gains anticipated from shifting management to favor crop stubble over winter wheat. Given the likely economic considerations, this does not appear to be a viable strategy to improve habitat availability.

The moist soil units supported a diverse bird community. The idle grasslands supported the highest overall density of birds and were very similar to LFD filter strips. The active agricultural areas supported a component of the bird community that was not shared with any other cover types within the farm unit. Shorebirds including primarily Killdeer and Common Snipe were associated with inundated areas of bare ground. Killdeer numbers were relatively stable over the study period. Common Snipe numbers increased substantially over the study period suggesting that there was recruitment into the site either due to observed increases in inundation over the study period or to early migration movements. Small numbers of yellowlegs were also observed throughout the study period. Other shorebird species such as Least Sandpipers and Short-billed Dowitchers were just beginning to arrive during the final survey round. These patches likely play a much larger role for shorebirds as stopover habitats later during spring migration.

The density of diurnal raptors within the farm unit was extraordinary. The number of Northern Harriers and Red-tailed Hawks, in particular, was very high. These birds were clearly responding to an extremely high density of hispid cotton rats. Other predators such as the red wolfe (*Canis niger*) and bobcat (*Lynx rufus*) were also observed to exploit cotton rats within the same fields. Without a population monitoring program in place, it is not clear whether or not the number of rats available is related to the establishment of filter strips. However, most of the rats observed and the foraging activity of predators were focused on filter strips and patches of idle grass. It is also not possible to know if the rat population has reached some type of peak or has been sustained at this level for a period of time. It is easily possible that the population will decline in the near term resulting in fewer predators. Clearly, understanding the factors that influence the cotton rat population is essential to future management of the predator populations.

Study areas within Pocosin Lakes, NWR supported a community of birds that was dominated by frugivores (i.e. American Robin, Gray Catbird, Cedar Waxwing, Yellow-rumped Warblers). The early successional transects did support sparse populations of Eastern Meadowlarks, Savannah Sparrows, and Northern Harriers. Seed-eating birds were conspicuously absent from the interior of the early successional patch. Most of the sparrows observed were along the raised roadway where narrow strips of grasses were present. The interior of the patch was dominated by bracken ferns and food availability was likely very low. As has been indicated elsewhere (Fussell), this patch likely supported a dense community of grassland birds in the years following agricultural abandonment when drainage and nutrient levels would have produced large seed crops. The site is now undergoing rapid succession to tall pocosin.

A surprise within the early successional habitat was the large number of Short-eared Owls. Six to eight birds were flushed together from several locations within the overall patch (some of these sites were not along formal transects). These birds were primarily within large patches of broomsedge. Birds observed at the point of flushing were often roosting under small shrubs or beside logs although some were in more open areas. No attempt was made to observe birds emerging from roosts so it is not known whether or not birds are using the early successional habitat for foraging or just roosting there.

Several pellets were collected from roost sites but have not been examined to determine prey. Based on the observed use of vegetation and the direction of succession, these birds will not be present within this site for very many more years.

The large standing crop of fruit supported by the vast tall pocosins across the peninsula likely has regional significance to temperate migrants that depend on fruit for the winter. These habitats may support very large portions of populations throughout the Northeast. Numbers of American Robins supported by the peninsula likely reach into the millions. These birds gather in tremendous nocturnal roosts within the interior of these habitats. Large numbers of Yellow-rumped Warblers and Cedar Waxwings are also present. Gray Catbirds and other species occur in lower numbers that are still impressive at this latitude. The strategic value of these habitats to birds during both migration and winter needs further evaluation.

ACKNOWLEDGEMENTS

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APPENDIX I: List of bird species detected along transects within the farm unit of Alligator River, NWR. Numbers indicated the sum of all detections within each survey round.

Common Name	Round 1	Round 2	Round 3	Total
Ring-billed Gull	6	8	0	14
Common Snipe	25	38	164	227
Least Sandpiper	0	0	43	43
Greater Yellowlegs	0	0	12	12
Lesser Yellowlegs	0	3	0	3
Killdeer	24	29	17	70
Northern Bobwhite	0	1	0	1
Mourning Dove	0	0	1	1
Northern Harrier	17	13	10	40
Merlin	1	0	0	1
American Kestrel	4	0	0	4
Short-eared Owl	8	3	2	13
American Crow	10	2	0	12
Fish Crow	0	2	0	2
Red-winged Blackbird	1	3	0	4
Eastern Meadowlark	69	74	60	203
Savannah Sparrow	409	255	219	883
Grasshopper Sparrow	1	1	2	4
Song Sparrow	10	0	0	10
Swamp Sparrow	38	8	8	54
Tree Swallow	0	0	3	3
Common Yellowthroat	1	0	1	2
Sedge Wren	14	11	7	32
American Robbin	0	6	0	6

APPENDIX II: List of species detected during winter surveys within Alligator River, NWR and Pocosin Lakes, NWR.

Common Name	Scientific Name
Ring-billed Gull	*Larus delawarensis*
Common Snipe	*Gallinago gallinago*
Least Sandpiper	*Calidris minutilla*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Killdeer	*Charadrius vociferous*
Northern Bobwhite	*Colinus virginianus*
Mourning Dove	*Zenaida macroura*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Red-tailed Hawk	*Buteo janaicensis*
Rough-legged Hawk	*Buteo lagopus*
Merlin	*Falco columbarius*
American Kestrel	*Falco sparverius*
Short-eared Owl	*Asio flammeus*
Downy Woodpecker	*Picoides pubescens*
Common Flicker	*Colaptes auratus*
American Crow	*Corvus brachyrhynchos*
Fish Crow	*Corvus ossifragus*
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Common Grackle	*Quiscalus quiscula*
Savannah Sparrow	*Passerculus sandwichensis*
Grasshopper Sparrow	*Ammodramus savannarum*
White-throated Sparrow	*Zonotrichia albicollis*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
Eastern Towhee	*Pipilo erythrophthalmus*
Northern Cardinal	*Cardinalis cardinalis*
Tree Swallow	*Tachycineta bicolor*
Cedar Waxwing	*Bombycilla cedrorum*
White-eyed Vireo	*Vireo griseus*
Yellow-rumped Warbler	*Dendroica coronata*
Common Yellowthroat	*Geothlypis trichas*
Gray Catbird	*Dumetella carolinensis*
Brown Thrasher	*Toxostoma rufum*
Carolina Wren	*Thryothorus ludovicianus*
House Wren	*Troglodytes aedon*
Sedge Wren	*Cistothorus platensis*
Ruby-crowned Kinglet	*Regulus calendula*
American Robbin	*Turdus migratorius*

APPENDIX III: List of bird species detected along transects within the study area of Pocosin Lakes, NWR. Numbers indicated the sum of all detections within each survey round.

Common Name	Round 1	Round 2	Round 3	Total
Mourning Dove	4	5	3	12
Northern Harrier	2	2	2	6
Short-eared Owl	22	5	0	27
Downy Woodpecker	0	0	1	1
Common Flicker	4	3	3	10
American Crow	0	0	1	1
Eastern Meadowlark	2	0	9	11
Common Grackle	5	0	5	10
Savannah Sparrow	4	4	4	12
White-throated Sparrow	0	8	32	40
Song Sparrow	1	0	0	1
Eastern Towhee	8	6	5	19
Northern Cardinal	5	9	4	18
Cedar Waxwing	8	3	13	24
White-eyed Vireo	2	0	1	3
Yellow-rumped Warbler	49	57	57	163
Common Yellowthroat	7	5	7	19
Gray Catbird	4	3	3	10
Brown Thrasher	0	1	2	3
House Wren	0	1	0	1
Carolina Wren	1	0	0	1
Ruby-crowned Kinglet	0	0	8	8
American Robin	78	130	28	236
All Birds	**206**	**242**	**188**	**636**