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INVESTIGATION OF GRASSLAND/SHRUBLAND MIGRANTS ON THE LOWER DELMARVA PENINSULA

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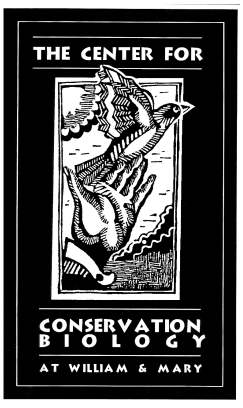

The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within todays social context. Our philosophy has been to use a general systems approach to locate critical information needs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

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INTRODUCTION

Concerns about declines in many North American bird populations have recently increased within both the scientific community and the general populous. To a large degree, this concern has been focused on neotropical migrants. In particular, neotropical migrant passerines that breed within forested habitats have received a great deal of attention from research and conservation organizations. However, results from the annual U.S. Fish and Wildlife Service's breeding bird survey suggest that species associated with grasslands and or shrublands have experienced annual population declines that in many cases are greater than those experienced by forest-dwelling birds (Robbins et al. 1986 Askins 1993). Declines of grassland species are particularly evident in northeastern North America where habitat loss due to secondary succession and urbanization has been dramatic. Results from two long-term studies have shown that several species that depend on early successional habitats have experienced marked declines over the past two decades (Hagan et al. 1992). Many of these declining species migrate either to the tropics or to the southeastern U.S. and depend on open habitats for rest and refueling. Open farmlands have declined by nearly 80% within the mid-Atlantic region since the 1940's (U.S. Dept. of Commerce 1981). Dramatic changes in land use practices over this same time period have left remaining open habitat less suitable for use by grassland species (Millenbath et al. 1996).

Each autumn large numbers migrant landbirds, reluctant to cross the Chesapeake Bay, are concentrated on the lower Delmarva Peninsula. To date, most of the research devoted to passerine migration on the lower Delmarva Peninsula has focused on neotropical migrants that depend on forested habitats (Watts and Mabey 1993, 1994). Relatively little attention has been given to species that require open habitats. The Eastern Shore of Virginia National Wildlife Refuge contains some of the most significant stopover habitat for open-habitat migrants within the mid-Atlantic region. Information is needed on the stopover ecology and habitat requirements of these species so that they may be incorporated into existing and developing management plans for the refuge and other landholders.

The objectives of this study were to investigate the use of grassland/shrubland habitats during the late period of fall migration. Information gathered will be used to determine the abundance and time of movement for open-habitat migrants on the lower Delmarva Peninsula.

METHODS

A study of open-habitat migrants was conducted at the Eastern Shore of Virginia National Wildlife Refuge during the late fall of 1999. Birds were surveyed within 5 different open habitats. Open habitats types included 1) monoculture forb – areas dominated primarily by horseweed (*Erigeron canadensis*), ragweed (*Ambrosia artemisiifolia*), and pigweed (*Amaranthus hybridus*), 2) grassland – areas dominated by a suite of grass species (e.g. crab grass (*Digitaria sanquinalis*), goose grass (*Eleusine indica*), panic grass (*Panicum lanuginosum*)), 3) mixed forb and grass – areas dominated by a suite of forb and grass species (e.g. goldenrod (*Salidago spp.*), common fennel (*Foeniculum vulgare*), pokeweed (*Phytolacca americana*), broomsedge (*Anrdopogon virginicus*), 4) fescue – areas dominated by tall fescue (*Festuca spp.*), and 5) honey suckle – areas with dense ground cover of Japanese honey suckle (*Lonicera japonica*). Three 150 m long transects were established within each habitat type (Table 1). Transects were positioned within the northern portion of the refuge to take advantage of habitat availability and to avoid areas open during controlled hunts (see Figure 1 for map of transect locations).

Transects were surveyed by two observers between 22 October and 20 December, 1999 (see Table 2 for summary of survey dates). In order to minimize the impact of temporal variation on habitat comparisons, all transects were surveyed every day. Transect assignments were alternated each survey day to disperse any observer bias. Surveys were conducted in 8-day time blocks where each transect was surveyed 4 times during each period. All surveys were conducted between 0.5 and 3 hrs after sunrise. Surveys were not conducted during heavy rains or when wind speed exceeded approximately 30 km/hr.

Birds were surveyed using the line transect method (Emlen 1971). An observer walked the length of each transect at a slow steady pace (approximately 30 m /minute) and recorded all individuals detected. To the extent possible, all individuals were identified to species. In addition to the species, the distance between the observer and the bird was recorded to the nearest 5 m at the time of detection. For those individuals that were observed prior to flushing, the type of substrate was recorded. Substrate categories used included 1) bare ground, 2) short native grass, 3) tall native grass, 4) fescue, 5) forbs, 6) blackberry (rubus), 7) woody/shrub, and 8) honesuckle (see Table 3 for substrate descriptions).

Table 1. Transect descriptions by habitat type.

Transect Number	Habitat Type	Habit
1	Monoculture Forb	Dominated by one specie patches of native grass an
2	Monoculture Forb	Dominated by one specie
3	Monoculture Forb	Dominated by one specie ground cover.
4	Grassland	Dominated by short nativ and densities.
5	Grassland	Dominated by short nativ and densities
6	Grassland	Dominated by short nativ and densities.
7	Grassland	Dominated by short nativ and densities.
8	Fescue	Dominated by fescue gra native grass.
9	Fescue	Dominated by fescue gra dispersed throughout.
10	Fescue	Dominated by fescue gra grass and Rubus.
11	Mixed Forb	Dominated by two or mor native grass, bare earth a
12	Mixed Forb	Dominated by two or mor native grass, bare earth a
13	Mixed Forb	Dominated by two or mor native grass, bare earth a

Bird density estimates were calculated for each habitat using detection distances as outlined in Emlen (1971). The species-specific pattern of detection distances was used to derive a detection index. This detection index was then used to standardize density per 10 ha. A community-wide density estimate was also calculated by summing the peak estimates of all species observed by habitat type.

Figure 1. Map of survey transects.

Table 2. Summary of survey periods and dates.

Survey	Period 1	Period 2	Period 3	Period 4	Per
1	10-22-99	11-2-99	11-9-99	11-18-99	11-2
2	10-23-99	11-5-99	11-12-99	11-19-99	11-2
3	10-25-99	11-6-99	11-13-99	11-20-99	11-2
4	10-28-99	11-7-99	11-14-99	11-21-99	11-3

RESULTS

A total of 6,079 individual birds comprising 61 species were observed during the study period (see Appendix I for a list of species detected). Several species accounted for a large portion of the total observations. These species included the American Goldfinch (1,924 individuals), Savannah Sparrow (1,688), Swamp Sparrow (485), Song Sparrow (432), and Field Sparrow (295).

Table 3 Number of individuals and species observed by l

Number	Mono Forb	Grassland	Fescue	M
Individuals	2,622	1,575	278	
Species	28	21	29	

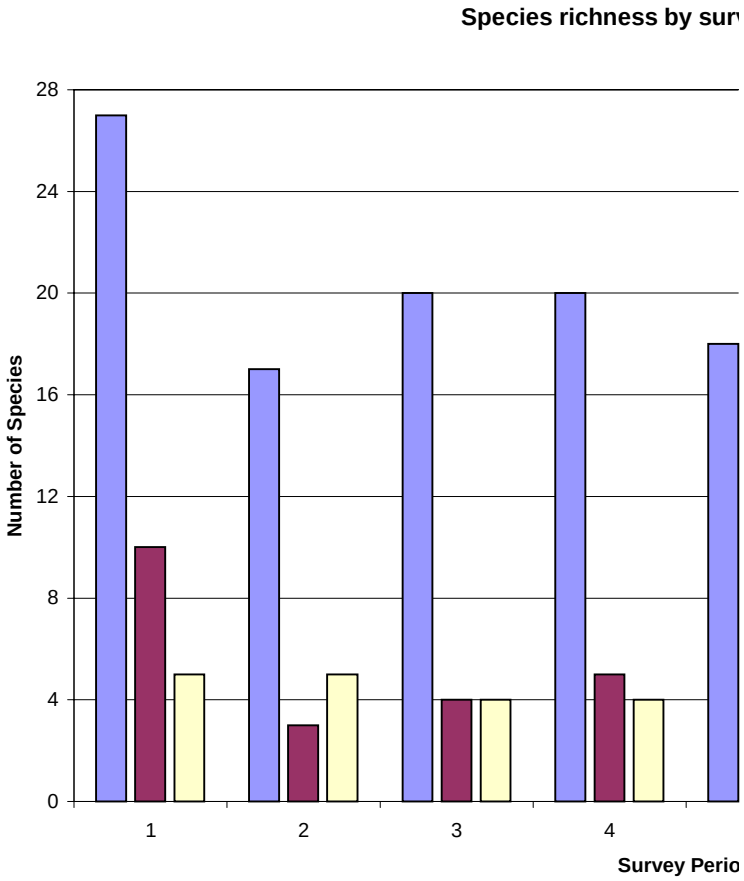
Several species worthy of note included Short-eared Owl, LeConte's Sparrow, Sharp-tailed Sparrow, Lark Sparrow, Clay-colored Sparrow, Connecticut Warbler, Marsh Wren, and 2 Sedge Wrens.

Temporal Patterns

The frequency of detection for all bird groups and many of the individual species varied with season. Figure 2 illustrates the seasonal patterns in species richness and abundance for the migration categories. For the two migration groups, the patterns indicate that neotropical migrants tend to move through the study area earlier in the season when compared to temperate migrants. This dichotomy in passage time between the two migration classes may be seen more clearly when the entire migration period (i.e. August through December) is examined (sensu Watts and Mabey 1994). However, even within this more focused study, differences between the two groups are apparent. For example, all of the species of warblers detected, except for the Yellow-rumped Warbler, and the Orange-crowned Warbler, were observed during the earliest survey periods. Both of these species are temperate migrants while all other warblers observed migrate to the tropics.

Species of temperate migrants showed considerable variation in the timing and pattern of passage (Appendix II presents peak detection dates for individual species by habitat type). Temperate migrants, showed 3 general patterns of migration. Several species were observed along transects during the early survey periods and were generally absent or present in reduced numbers during late-season surveys. Early temperate migrants include Common Snipe, Eastern Meadowlark, and Grasshopper Sparrow. Other species showed a peak in detection rate in the middle of the study period. Such species included American Goldfinches, White-throated Sparrow, White-crowned Sparrow, Chipping Sparrow, and Orange-crowned Warbler. Remaining species showed no discernable change in bird numbers throughout the season.

Figure 2.



Patterns of Habitat Use

Species diversity was greatest in the mixed forb habitat where 37 species were observed followed by fescue (29), monoculture forb (28), honeysuckle (23), and grassland (21) (Table 3). The greatest number of species (42) were observed during the first survey period, 22 October – 28 October, this diversity is undoubtedly due to the observation of several neotropical migrants during the latter part of their fall migration. Species that were observed early in the season that would not typically be expected later into the fall and winter include Indigo Bunting, Nashville Warbler, Tennessee Warbler, Blackpoll Warbler, Connecticut Warbler, and Common Yellowthroat. Subsequent survey periods produced 16 to 29 species along the transects during each survey period. Overall bird numbers peaked during period 4 when 1,584 individuals were counted. This peak resulted from large numbers of migrating American Goldfinches using monoculture forb transects 1 and 2. The fewest number of birds counted coincided with the fewest number of species during period 7 (Table 4).

Table 3 Number of individuals and species observed by l

Number	Mono Forb	Grassland	Fescue	M
Individuals	2,622	1,575	278	
Species	28	21	29	

Table 4 Number of individuals and species by survey per

Number	Period 1	Period 2	Period 3	Period 4	Perio 5
Individuals	902	933	685	1584	613
Specie	42	25	28	29	23

Estimated minimum density for all birds combined was greatest along monoculture forb transects with a minimum of 259.15 birds expected per 10 hectares. The lowest overall minimum density occurred along the fescue transects with a minimum of 35.83 birds expected per 10 hectares (Appendix III). Peak density estimates for individual species ranged from a high of 2355.56 American Goldfinches per hectare on 19 November 1999 in monoculture forb, to a low of 4.17 birds per hectare for several species in the grassland habitat for which only one individual was observed (Appendix III).

There were 70 instances of no birds being counted on individual transects. This was most common on the fescue transects with 48 occurrences of no birds counted. Honeysuckle transects accounted for 8 surveys of "no birds", while monoculture forb and mixed forb transects each produced 6. Surveys of grassland transects resulted in only 2 instances of no birds being counted.

Birds observed along transects during surveys were not always using the designated transect habitat, this was especially true for transects in the fescue and honeysuckle habitats. Of 816 birds counted along transects in the honeysuckle habitat, only 96 or 11.8 % of these birds were actually observed in or flushed from honeysuckle. This trend is even more evident in the fescue habitat. Observations of birds along fescue transects totaled 278, however only 6 or 2.2% of these observations were of birds in or being flushed from fescue. The majority of birds counted within

these two habitat types were using small patches of grass, forbs, or *Rubus* present within larger patches of honeysuckle or fescue (Table 5).

While the greatest number of birds were counted along monoculture forb transects and the greatest species diversity was observed along mixed forb transects, transects in the different habitat types seemed to support somewhat distinct suites of species nearly unique unto them.

Monoculture Forb

This habitat type supported the greatest number of birds, with 2,622 individuals. Of these 2,622 birds 1,840 were American Goldfinches. Monoculture forb was the primary habitat for Red-winged Blackbirds, Vesper Sparrows, and Chipping Sparrows. Species that were found only in this habitat include Common Redpoll, Sharp-tailed Sparrow, Lark Sparrow, Indigo Bunting, Blackpoll Warbler, American Pipit, and Winter Wren.

Grassland.

While this habitat supported the fewest numbers of species, it was found to contain the second highest number of birds. Species that were found to use the open grassland as a primary

Table 5. Summary of bird use by habitat type and transect.

		Habitats Within T				
	Transec	Bare Ground	Short Grass	Tall Grass	Fescue	Forbs
Monoculture Forb	1	6	31	39	0	1603
	2	0	5	24	0	775
	3	0	4	37	0	98
Grassland	4	0	167	258	0	66
	5	0	243	20	0	1
	6	0	304	78	0	24
	7	0	363	10	0	41
Fescue	8	0	0	2	1	3
	9	0	0	8	0	65
	10	0	3	33	5	38
Mixed Forb	11	0	3	6	0	93
	12	0	23	65	0	196
	13	0	20	8	0	124
Honeysuckle	14	0	0	37	0	83
	15	0	5	77	0	135
	16	0	1	136	0	102
	All	6	1172	838	6	3447

habitat include the Common Snipe, Northern Harrier, Eastern Meadowlark, Lapland Longspur, Savannah Sparrow, and Grasshopper Sparrow. In addition the only Marsh Wren and Short-eared Owl observed were found in grassland habitat.

Fescue

The fewest numbers of birds (278) were found in this habitat type. Species found either primarily or exclusively along fescue transects include Blue Jay, Pine Siskin, LeConte's Sparrow, White-crowned Sparrow, and Hermit Thrush. However birds observed along fescue transects were not always using the designated transect habitat (Table 5). The majority of birds counted along fescue transects were using small patches of grass, forbs, and especially *Rubus* found within the fescue habitat.

Mixed Forb

Mixed forb habitats supported the greatest species diversity with 37 different species observed. Species that utilized this as a primary habitat include Virginia Rail, Sharp-shinned Hawk, Common Flicker, Northern Cardinal, Nashville Warbler, Northern Mockingbird, Gray Catbird, American Robin, and Eastern Bluebird. Mixed forb habitats were also used heavily by several species such as Field Sparrow, Song Sparrow, Swamp Sparrow, Yellow-rumped Warbler, Palm Warbler, and House Wren.

Honeysuckle

Birds observed along honeysuckle transects were not always using the designated transect habitat. The majority of birds counted in honeysuckle habitat were using small patches of grass, forbs, or *Rubus*, in larger patches of honeysuckle. Species found only along honeysuckle transects include Eastern Phoebe, and Tennessee Warbler. Species such as Field Sparrow, Song Sparrow, and Swamp Sparrow also utilized honeysuckle patches.

Observations of Individual Species

Individual species varied considerably in terms of abundance and habitat use. See Appendix IV for a summary of distribution information by species.

Virginia Rail – Only one individual was observed on the surveys. This bird was flushed from forbs along transect 12 on 12 December 1999.

Common Snipe – Fairy common in short grass habitat especially along grassland transects during the first three survey periods. All individuals except one were observed from 22 October 1999 to 13 November 1999.

Northern Bobwhite – Very common throughout survey along monoculture forb and honeysuckle transects, less common on grassland and mixed forb transects, and none encountered on fescue transects.

Mourning Dove – Only two individuals observed. One flushed from tall grass along transect 16 on 25 October 1999, and one flushed from short grass along transect 5 on 6 November 1999.

Northern Harrier – Regularly flushed from short and tall grass along grassland transects throughout surveys.

Sharp-shinned Hawk – One observed perched in shrub/sapling on transect 12 on 18 November 1999.

Cooper's Hawk – Three individuals observed, one flushed from tall grass along transect 13 on 25 October 1999, one flushed from forbs on transect 2 on 12 November 1999, and one perched in shrub/sapling along transect 10 on 4 December 1999.

Short-eared Owl – One individual flushed from tall grass on transect 6 on 20 December 1999.

Common Flicker – One individual was observed in a shrub/sapling on 7 November 1999 along transect 11.

Eastern Phoebe – One phoebe was observed perched in a shrub/sapling on 28 October 1999 on transect 16.

Blue Jay – A single individual was flushed from shrubs/saplings along transect 10 on 29 November 1999.

Brown-headed Cowbird – Cowbirds were observed on two occasions during the survey, a large flock of 70 birds was seen foraging in short grass along transect 7 on 28 October 1999 and another 2 individuals were flushed from forbs along transect 1 on 21 November 1999.

Red-winged Blackbird – This species was fairly common especially along monoculture forb transect where it was observed on 13 survey days. It was typically flushed from forbs mixed in with flocks of goldfinches. Red-winged Blackbirds reached their peak density on monoculture forb

transects on 7 November 1999, when 44.4 bird per 10 hectares were estimated. An additional 12 individuals were counted in short grass along transect 6 on 22 October 1999.

Eastern Meadowlark – Meadowlarks were regularly encountered along grassland transects during the first 5 survey periods when 197 individuals were counted. This species reached its peak density of 45 birds per 10 hectares on 25 October 1999. Most meadowlarks had seemed to have migrated by the end of November. Only 4 individuals were encountered within these habitats during the last 3 survey periods. Only one meadowlark was observed along transects in other habitat types, this individual was flushed from forbs on transect 11 during the 28 October 1999 survey.

House Finch – This species was observed frequently after the first survey period, especially along monoculture forb transects. It was also observed on grassland, mixed forb, and fescue transects.

Common Redpoll – A single redpoll was counted on three occasions. Surveys on November 2, 19, and 29 each produced a single bird utilizing forb habitat on monoculture forb transects 1 and 2.

American Goldfinch – This was the most abundant species observed on the surveys with 1924 individuals counted. Goldfinches were observed along transects in all habitat types, however the were most abundant along monoculture forb transects where they reached a peak density of an estimated 2355.5 birds per 10 hectares on 19 November 1999. Most goldfinches (80%) were counted within the study area between 5 November and 21 November 1999.

Pine Siskin – A total of 6 siskins were counted along the transects, three individuals were observed in shrubs/saplings along transect 10 on both 28 October 1999 and 14 November 1999.

Lapland Longspur – This species was observed on 3 occasions along grassland transects and twice on monoculture forb transects. A maximum of 3 individuals were counted in short grass on 13 November 1999 along transect 7.

Vesper Sparrow – This species occurred regularly throughout the survey at low densities. Vesper Sparrows were found along honeysuckle, grassland, and especially monoculture forb transects. They were observed on 12 occasions during every survey period though no more that 2 individual were counted on any survey day.

Savannah Sparrow – Savannah sparrows were the second most abundant species counted during the survey. They were observed along all transects, and were found along grassland transects every survey day. While numbers of savannah sparrow were found using grass or forb habitats along all transects, 70% of the individuals counted occurred along transects in the grassland habitat. They reached a peak density of an estimated 366.67 birds per 10 hectares within the grassland habitat on 20 November 1999.

Grasshopper Sparrow – Only eight individuals were observed throughout the surveys. One individual was found on both the monoculture forb and mixed forb transects, while the remaining 6 birds occurred along grassland transects. Due to the secretive nature, refusal to flush and infrequent calls, of this genera of sparrow actual numbers may be higher than that reported.

LeConte's Sparrow – One individual was observed in small patch of tall grass along transect 10 on 21 November 1999.

Sharp-tailed Sparrow – One individual was observed in forbs along transect 1 on 25 October 1999.

Lark Sparrow – One individual was observed in forbs along transect 2 on 25 October 1999.

White-crowned Sparrow – This species was observed infrequently along mixed forb transects and in patches of *Rubus* along transect 10. A total of 7 individuals were observed from 23 October to 21 November 1999.

White-throated Sparrow – Observed along transects in all habitat types except grassland. Most abundant in forbs along monoculture and mixed forb transects, and in *Rubus* along transect 10.

Chipping Sparrow – Small numbers of this species were observed in all habitat types. However, 27 individuals (69% of total observed) were observed on November 21 and 28 primarily along monoculture forb transects.

Clay-colored Sparrow – One individual was observed in a small patch of tall grass on transect 10 during the 21 November 1999 survey.

Field Sparrow – This species was observed in all habitat types throughout the survey, but was found to be most abundant in forbs and *Rubus* along mixed forb and honeysuckle transects.

Dark-eyed Junco – Juncos were encountered infrequently during surveys. Seven individuals were counted along grassland transects on November 7 and 11, one bird was observed perched in a shrub on transect 16 on 9 November, and one bird was flushed from forbs along transect 12 on 30 November 1999.

Song Sparrow – Common, observed all habitat types, and recorded on all survey days. Least abundant in grassland where only 2 individuals were observed. Greatest number occurred along monoculture and mixed forb transects.

Swamp Sparrow – As with Song Sparrow, Swamp Sparrow were observed in all habitat types, and recorded on all survey days. This species was also least abundant along grassland transect where only one was observed. Transects in honeysuckle habitat produced the most observations.

Fox Sparrow – A total of 4 individuals were encountered. One bird was observed in a *Rubus* patch on transect 10 on 19 November, and 3 bird were observed on transects 10 and 16 on 29 November 1999.

Eastern Towhee – One individual was observed in forbs along transect 12 on 23 October 1999.

Northern Cardinal – A total of 10 individuals was observed from 25 October to 4 December 1999. Of these 10 birds, 8 were observed along mixed forb transects and the remaining 2 birds were observed in *Rubus* on transect 10.

Indigo Bunting – Two individuals were observed in forbs along monoculture forb transects throughout the survey, one bird was observed on 25 October and one was found on 19 November 1999.

Dickcissle – From November 12 to November 21 1999, 4 Dickcissle were detected on surveys. One was observed in *Rubus* on transect 13, 2 were observed in a patch of tall grass along transect 10, and 1 was seen perched in a shrub/sapling on transect 11.

Nashville Warbler – One individual was observed in *Rubus* along transect 12 on 28 October 1999.

Orange-crowned Warbler – A total of 8 individual were observed from 12 November to 16

December 1999. This species was observed in low numbers, 1-3 individuals, in all habitat types except grassland.

Tennessee Warbler – One individual was observed in tall grass/forbs along transect 16 on 23 October 1999.

Yellow-rumped Warbler – Common, this species was counted throughout the survey in all habitat types, especially, mixed and monoculture forb.

Blackpoll Warbler – Two individuals were observed in forbs on transect 1 during the October 22 1999 survey.

Palm Warbler - This species moved through the study area from 25 October to 13 November 1999. During this period 29 individuals were observed, primarily along mixed and monoculture forb transects.

Connecticut Warbler – One individual was observed in a patch of *Rubus* on transect 10 on 28 October 1999.

Common Yellowthroat – Six individuals were observed during the first survey period, and an additional bird was detected on 18 November 1999. Yellowthroats were counted in all habitat types except grassland.

Yellow-breasted Chat – One individual was observed in a shrub/sapling along transect 12 on 5 November 1999.

American Pipit – One individual was observed on a patch of bare earth along transect 1 on 5 December 1999.

Northern Mockingbird – Throughout the survey 15 Mockingbirds were detected. Transects in mixed forb habitats produced 11 birds, the remaining 4 birds were observed in a patch of *Rubus* along transect 10.

Gray Catbird – Two Catbirds were observed in shrub/saplings along mixed forb transects. One individual was observed on 22 October while the other was found on 29 November 1999.

Brown Thrasher – Two individuals were observed during the survey. One was observed in *Rubus* on transect 10 on 23 October, the other was detected in forbs along transect 16 on 25 October 1999.

Carolina Wren – This species was detected in all habitat types except grassland, however

only 13 individuals were recorded throughout the survey.

House Wren – As with the Carolina wren this Wren was observed in all habitat types except grassland. Throughout the survey 23 individuals were counted, most of the birds detected were found on either mixed forb or honeysuckle transects.

Winter Wren – One individual was flushed from tall grass along transect 3 on 22 October 1999.

Sedge Wren – Two individuals were observed, one in forbs on transect 13 on 22 October, and one in tall grass along transect 16 on 28 October 1999.

Marsh Wren – One Marsh Wren was detected in forbs along transect 6 on 25 October 1999.

Golden-crowned Kinglet – This species was observed in the study area between October 23 and 28. During this period 5 individuals were counted along fescue and mixed forb transects.

Ruby-crowned Kinglet – As with Golden-crowned kinglets, 6 Ruby-crowned Kinglets were observed along mixed forb transects between October 23 and 28. An additional 5 individuals were counted along transects in fescue, mixed forb, and honeysuckle later in the survey.

Hermit Thrush – One individual was observed in a patch of forbs on transect 10 on 4 December 1999.

American Robin – Two individuals were observed in short grass along mixed forb transects on 7 November and 29 November 1999.

Eastern Bluebird – Five Bluebirds were observed perched in a sapling along transect 13 on 29 November 1999.

DISCUSSION

The Eastern Shore of Virginia National Wildlife Refuge currently supports a diverse gradient of open habitats that range from open grasslands to woody shrublands. The results of this study suggest that these habitats support a diverse assemblage of birds that require open habitats during fall migration. Due to their geographic position, the fields contained within the refuge may represent some of the most important patches of open stopover habitat within the region.

The results of this study show that habitat type has a strong influence on the use of space by open-habitat migrants. Species richness was highest in mixed forb patches that contained the

greatest structural complexity of the habitats examined. Species richness was lowest in grassland patches that contained the lowest structural complexity of the habitats examined. In general, systematic changes in bird communities are common across gradients of habitat structure (e.g. Johnston and Odum 1956, Karr 1971). It is generally believed that structural complexity is related to resource diversity such that highly structured habitats provide more opportunity for species packing compared to structurally simple habitats. Both vertical and horizontal complexity are generally greater (due to vertical layering and horizontal patchiness of woody vegetation) in later successional mixed patches compared to earlier successional grassland patches. Both of these factors have been shown to contribute to bird species diversity (e.g. MacArthur and MacArthur 1961, Roth 1976, Karr 1971, May 1982).

Vegetative structure is one of the primary habitat dimensions that determine community structure in early successional bird communities during the nonbreeding season (e.g. Wiens 1973, Pulliam and Mills 1977, Lima and Valone 1991). This is true to a large extent because predation is one of the principal sources of mortality and many of the early successional passerines use vegetative cover as a means to reduce susceptibility to predators. Within early successional fields, vegetation influences predation risk in two functionally different ways. The first is that dense stands of tall stems (grasses and forbs) provide a “visual refuge” for birds by making it more difficult for predators to detect them. The second is that dense stands of woody vegetation provide a “protective refuge” by making it more difficult for predators to access and extract prey once detected. Dependency on woody vegetation as a protective refuge varies considerably between species (Pulliam and Mills 1977). The influence of this single habitat element is so strong that the addition of even small amounts of woody vegetation has been shown to cause substantial shifts in community composition (Lima and Valone 1991).

In addition to vegetative structure, a second habitat dimension that has a dominant influence on bird distribution is food availability. Monoculture forb and grassland habitats supported the majority (70%) of birds observed. These two habitat types contained dense stands of plants that produce large amounts of seeds. Open-habitat migrants depend on seed crops to replenish energy reserves during migration.

The two habitat types containing extensive coverage of fescue and honesuckle supported some of the lowest densities of birds. The majority (>90%) of birds detected within these habitats were associated with the interstitial patches of native plants rather than the dominant cover type. Neither fescue or honesuckle appear to provide adequate cover or food for open-habitat migrants. Areas containing these plant types reduce the capacity of the refuge to support migrants.

MANAGEMENT CONSIDERATIONS/RECOMMENDATIONS

The results of this study provide insights into the habitat requirements of open-habitat migrants that are important to the development of appropriate management guidelines. The most significant finding in this regard is that the areas currently covered with fescue and honeysuckle support relatively few late-season migrants. An effort should be made to convert these lands into habitats that provide more value to migrants.

A second consideration important for the development of management guidelines is that many open-habitat migrants exist within specific disturbance/successional niches. Some species occur only within open grassland patches while others occur only within patches that contain patches of woody vegetation. This pattern implies that in order to support the entire suite of open-habitat species, a gradient of habitats must be provided. An effort should be made to set aside specific areas that will be managed to provide needed conditions.

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Appendix I: List of species observed during transect surv
as follows: T = Temperate Migrants, N = Neotropical Migra

Species	Scientific Name
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatu*
Cooper's Hawk	*Accipiter cooperii*
Northern Bobwhite	*Colinus virginianus*
Virginia Rail	*Rallus limicola*
Common Snipe	*Gallinago gallinago*
Mourning Dove	*Zenaida marcroura*
Short-eared Owl	*Asio flammeus*
Common Flicker	*Colaptes auratus*
Eastern Pheobe	*Sayornis phoebe*
Blue Jay	*Cyanocitta cristata*
Carolina Wren	*Thryothorus ludovicianus*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*
Golden-Crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Eastern Bluebird	*Sialia sialis*
Hermit Thrush	*Catharus guttatus*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Northern Mockingbird	*Mimus polyglottos*
Brown Thrashe	*Toxostoma rufum*

Appendix I. *cont.*

Species	Scientific Name	Mi
White-throated Sparrow	Zonotrichia albicollis	
White-crowned Sparro	Zonotrichia leucophrys	
Dark-eyed Junco	Junco hyemalis	
Lapland Longspur	Calcarius lapponicus	
Northern Cardinal	Cardinalis cardinalis	
Indigo Bunting	Passerina cyanea	
Dickcissle	Spiza americana	
Red-winged Blackbird	Agelaius phoeniceus	
Eastern Meadowlark	Sturnella magna	
Brown-headed Cowbird	Molothrus ater	
House Finch	Carpodacus mexicanus	
Common Redpoll	Carduelis flammea	
Pine Siskin	Carduelis pinus	
American Goldfinch	Carduelis tristus	

Appendix II. Peak density estimates and date for selected
Days refers to the number of days that species was detecte

	MONOCULTURE FORB			GRASSLAND		
SPEC	**DAYS**	**PEAK DATE**	**DENSITY**	**DAYS**	**PEAK DATE**	
Common Snipe	-----	-----	-----	6	10-25	
Northern Bobwhite	8	12-4	222.22	2	10-23	
Mourning Dove	-----	-----	-----	1	11-6	
Yellow-shafted Flicker	-----	-----	-----	-----	-----	
Eastern Phoebe	-----	-----	-----	-----	-----	
Blue Jay	-----	-----	-----	-----	-----	
Brown-headed Cowbird	1	11-21	11.1	1	10-28	
Red-winged Blackbird	13	11-7	44.4	1	10-22	
Eastern Meadowlark	-----	-----	-----	19	10-25	
House Finch	7	11-5	44.4	1	12-11	
Common Redpoll	3	11-2,19,29	5.56	-----	-----	
American Goldfinch	25	11-19	2355.56	3	12-8	
Pine Siskin	-----	-----	-----	-----	-----	
Lapland Longspur	2	12-16,20	5.56	3	11-13	
Vesper Sparrow	12	11-5 12-18	11.1	3	11-12,13,28	
Savannah Sparrow	29	11-5	111.1	32	11-20	
Grasshopper Sparrow	1	11-13	11.1	4	10-25	

Appendix II. Continued.

	MONOCULTURE FORB			GRASSLAND		
Species	**DAYS**	**PEAK DATE**	**DENSITY**	**DAYS**	**PEAK DATE**	
Lark Sparrow	1	10-25	11.1	-----	-----	
White-crowned Sparrow	-----	-----	-----	-----	-----	
White-throated Sparrow	13	11-30	122.22	-----	-----	
Shipping Sparrow	4	11-28	77.78	1	11-19	
Clay-colored Sparrow	-----	-----	-----	-----	-----	
Field Sparrow	-----	-----	-----	4	10-28	
Dark-eyed Junco	-----	-----	-----	2	11-7	
Song Sparrow	30	12-13	50	2	10-25 11-18	
Swamp Sparrow	15	10-25	27.78	1	11-29	
Fox Sparrow	-----	-----	-----	-----	-----	
Rufous-sided Towhee	-----	-----	-----	-----	-----	
Northern Cardinal	-----	-----	-----	-----	-----	
Indigo Bunting	2	10-25 11-19	5.56	-----	-----	
Dickcissle	-----	-----	-----	-----	-----	
Nashville Warbler	-----	-----	-----	-----	-----	
Orange-crowned Warbler	1	11-18	5.56	-----	-----	
Tennessee Warbler	-----	-----	-----	-----	-----	

Appendix II. Continued.

	MONOCULTURE FORB			GRASSLAND		
Species	**DAYS**	**PEAK DATE**	**DENSITY**	**DAYS**	**PEAK DATE**	
Common Yellowthroat	2	10-22 11-18	5.56	-----	-----	
Yellow-breasted Chat	-----	-----	-----	-----	-----	
American Pipit	-----	-----	-----	1	12-5	
Northern Mockingbird	-----	-----	-----	-----	-----	
Gray Catbird	-----	-----	-----	-----	-----	
Brown Thrasher	-----	-----	-----	-----	-----	
Carolina Wren	3	11-19	11.1	-----	-----	
House Wren	3	MANY	11.1	-----	-----	
Winter Wren	1	10-22	11.1	-----	-----	
Sedge Wren	-----	-----	-----	-----	-----	
Marsh Wren	-----	-----	-----	1	10-25	
Golden-crowned Kinglet	-----	-----	-----	-----	-----	
Ruby-crowned Kinglet	-----	-----	-----	-----	-----	
American Robin	-----	-----	-----	-----	-----	
Eastern Blubird	-----	-----	-----	-----	-----	

Appendix III: Minimum estimated densities for species

Species	Monoculture Forb			Grassland		
	Max. Detection Distance	No. of Birds Observed	Min. expected density	Max. Detection Distance	No. of Birds Observed	Min. expecte density
Virginia Rail	--	--	--	--	--	--
Common Snipe	--	--	--	25	12	1.25
Northern Bobwhite	20	88	15.28	35	2	0.15
Mourning Dove	--	--	--	15	1	0.17
Northern Harrier	--	--	--	80	9	0.29
Sharp-shinned Hawk	--	--	--	--	--	--
Cooper's Hawk	15	1	0.23	--	--	--
Short-eared Owl	--	--	--	5	1	0.52
Yellow-shafted Flicke	--	--	--	--	--	--
Eastern Pheobe	--	--	--	--	--	--
Blue Jay	--	--	--	--	--	--
Brown-headed Cowbird	15	2	0.46	45	70	4.05
Red-winged Blackbird	20	36	6.25	40	12	0.78
Eastern Meadowlark	--	--	--	80	200	6.51
House Finch	25	33	4.58	20	14	1.82
Common Redpoll	20	3	0.52	--	--	--
American Goldfinch	40	1840	159.72	20	39	5.08
Pine Siskin	--	--	--	--	--	--
Lapland Longspur	10	2	0.69	60	6	0.26
Vesper Sparrow	15	14	3.24	20	3	0.39
Savannah	30	250	28.94	50	1180	61.46

Appendix III (continued):

Species	Monoculture Forb			Grassland		
	Max. Detection Distance	No. of Birds Observed	Min. expected density	Max. Detection Distance	No. of Birds Observed	Min. expected density
White-throated Sparrow	30	89	10.3	--	--	--
Chipping Sparrow	25	28	3.98	20	1	0.13
Clay-colored Sparrow	--	--	--	--	--	--
Field Sparrow	25	1	0.14	20	7	0.91
Dark-eyed Junco	--	--	--	15	7	1.22
Song Sparrow	40	110	9.55	20	2	.026
Swamp Sparrow	20	29	5.03	15	1	0.17
Fox Sparrow	--	--	--	--	--	--
Eastern Towhee	15	1	0.23	--	--	--
Northern Cardinal	--	--	--	--	--	--
Indigo Bunting	30	2	0.23	--	--	--
Dickcissle	--	--	--	--	--	--
Nashville Warbler	--	--	--	--	--	--
Orange-crowned Warbler	10	1	0.35	--	--	--
Tennessee Warbler	--	--	--	--	--	--
Yellow-rumped Warbler	60	64	3.70	10	1	0.26
Blackpoll Warbler	15	2	0.46	--	--	--
Palm Warbler	30	12	1.39	--	--	--
Connecticut Warbler	--	--	--	--	--	--
Common	10	2	0.69	--	--	--

Appendix III (continued):

Species	Monoculture Forb			Grassland		
	Max. Detection Distance	No. of Birds Observed	Min. expected density	Max. Detection Distance	No. of Birds Observed	Min. expected density
Gray Catbird	--	--	--	--	--	--
Brown Thrasher	--	--	--	--	--	--
Carolina Wren	30	5	.058	--	--	--
House Wren	20	3	0.52	--	--	--
Winter Wren	5	1	0.69	--	--	--
Sedge Wren	--	--	--	--	--	--
Marsh Wren	--	--	--	20	1	0.13
Golden-Crowned Kinglet	--	--	--	--	--	--
Ruby-crowned Kinglet	--	--	--	--	--	--
Hermit Thrush	--	--	--	--	--	--
American Robin	--	--	--	--	--	--
Eastern Bluebird	--	--	--	--	--	--
TOTAL	--	2622	259.15	--	1575	87.36

Appendix IV: Summary of Bird observations by species a

	Monoculture Forb			Grassland		
Species	**1**	**2**	**3**	**4**	**5**	**6**
Virginia Rail	--	--	--	--	--	--
Common Snipe	--	--	--	2	--	5
Northern Bobwhite	57	31	--	1	--	--
Mourning Dove	--	--	--	--	1	--
Northern Harrier	--	--	--	4	2	3
Sharp-shinned Hawk	--	--	--	--	--	--
Cooper's Hawk	--	1	--	--	--	--
Short-eared Owl	--	--	--	--	--	1
Yellow-shafted Flicker	--	--	--	--	--	--
Eastern Pheobe	--	--	--	--	--	--
Blue Jay	--	--	--	--	--	--
Brown-headed Cowbird	2	--	--	--	--	--
Red-winged Blackbird	31	5	--	--	--	12
Eastern Meadowlark	--	--	--	32	22	86
House Finch	31	2	--	--	--	--
Common Redpoll	1	2	--	--	--	--
American Goldfinch	1308	509	23	3	--	--
Pine Siskin	--	--	--	--	--	--
Lapland Longspur	2	--	--	--	2	--
Vesper Sparrow	11	3	--	2	1	--
Savannah Sparrow	181	35	34	437	235	294
Grasshopper Sparrow	--	--	1	4	1	--
LeContes Sparrow	--	--	--	--	--	--
Sharp-tailed Sparrow	1	--	--	--	--	--
Lark Sparrow	--	1	--	--	--	--
White-crowned Sparrow	--	--	--	--	--	--
White-throated Sparrow	--	89	--	--	--	--
Chipping Sparrow	18	5	5	--	--	1
Clay-colored Sparrow	--	--	--	--	--	--
Field Sparrow	--	--	1	2	--	1
Dark-eyed Junco	--	--	--	1	--	1
Song Sparrow	18	38	54	1	--	1
Swamp Sparrow	4	21	4	1	--	--

Appendix IV (continued): Summary of Bird observations

Species	Monoculture Forb			Grassland		
	1	2	3	4	5	6
Yellow-rumped Warbler	3	57	4	1	--	--
Blackpoll Warbler	2	--	--	--	--	--
Palm Warbler	5	--	7	--	--	--
Connecticut Warbler	--	--	--	--	--	--
Common Yellowthroat	1	1	--	--	--	--
Yellow-breasted Chat	--	--	--	--	--	--
American Pipit	1	--	--	--	--	--
Northern Mockingbird	--	--	--	--	--	--
Gray Catbird	--	--	--	--	--	--
Brown Thrasher	--	--	--	--	--	--
Carolina Wren	--	--	5	--	--	--
House Wren	1	2	--	--	--	--
Winter Wren	--	--	1	--	--	--
Sedge Wren	--	--	--	--	--	--
Marsh Wren	--	--	--	--	--	1
Golden-Crowned Kinglet	--	--	--	--	--	--
Ruby-crowned Kinglet	--	--	--	--	--	--
Hermit Thrush	--	--	--	--	--	--
American Robin	--	--	--	--	--	--
Eastern Bluebird	--	--	--	--	--	--