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Birds of Early Successional Habitats in the Delaware Water Gap National Recreation Area: Distribution, Abundance, and Management

Technical Report NPS/NER/NRTR--2006/039



ON THE COVER

Delaware Water Gap National Recreation Area Grass View; Field Sparrow; Prairie Warbler.

Photographs by: Project Team; Powdermill Avian Research Center; Powdermill Avian Research Center, respectively.

Birds of Early Successional Habitats in the Delaware Water Gap National Recreation Area; Distribution, Abundance, and Management

Technical Report NPS/NER/NRTR--2006/039

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U.S. Department of the Interior
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Abstract

A two-year survey of the early successional habitat avian community was conducted during the breeding seasons of 2002 and 2003 in the Delaware Water Gap National Recreation Area. Bird species richness, diversity, density, detection rates, and occurrence were determined and compared between years, among fields, and with vegetative parameters to elucidate the distribution and abundance of birds characteristic of open field habitats within the park. This information was used to develop management suggestions regarding the enhancement of habitat for these species.

Key Words: bird, guild, grassland, shrubland, point count, structure, composition.

Executive Summary

The explicit purpose of this project was to inventory grassland birds within the Delaware Water Gap National Recreation Area. Variable circular plot point counts were used to determine distribution and abundance patterns of early successional bird species, in general, and species occurrence, detection rates, species richness, diversity, and density, in particular, in open field habitat (<15% shrub cover) of the Delaware Water Gap National Recreation Area. All open fields (32) ranging in size from 4–36 ha (10–89 ac) were surveyed and comparisons made between years and among survey sites in order to characterize the early successional bird community. A listing of the ten species with the highest values for any of the above mentioned parameters is composed of a slight majority of shrubland species, including common yellowthroat and song sparrow, compared to typical grassland species. This may have occurred because of detections from the often shrubby perimeter of relatively small fields which compose most of the open habitat within the park. Thus, shrubland birds play a larger role than expected in project results even though predominantly shrubby fields were expressly eliminated from the sampling regime.

Grassland species richness, diversity, and density values were generally higher in larger fields and those with relatively sparse vegetation where grass dominated. Shrubland species did not exhibit evidence of area sensitivity. Association with shrubs was not specifically investigated since most shrubby habitat existed around field borders well away from vegetation sampling transects.

Suggested management options focus on a community-based approach for grassland birds, with a predominantly species-level approach for shrubland birds, paying attention to sensitivities (e.g., area requirements, vegetation composition, landscape habitat patterns) and implementation within a management decision hierarchy.

Introduction

Most birds associated with early successional habitats have declined in eastern North America since the 1950s and many are now on state threatened and endangered species lists (Hunter et al. 2001). These habitats are among those most severely reduced in area within the United States (Noss et al. 1995). Species dependent on open areas were originally associated with naturally occurring early successional habitats, including grasslands, shrublands, beaver meadows, and various types of barrens and glades. Today, they are characteristic of human induced habitats such as abandoned farmland, restored coalfields, pastures, roadsides, and utility rights-of-way. The thread uniting all of these habitats is disturbance, either natural or anthropogenic, upon which these species depend (Hunter et al. 2001). Structure and extent of such habitats is influenced by the type, severity, and frequency of the disturbance.

Grassland Species

Populations of many grassland birds have declined significantly during the last 30 years (Knopf 1994; Peterjohn and Sauer 1999). Mayfield (1988) referred to this as the “quiet decline” because of the relative lack of attention devoted to it until relatively recently. Unlike forest neotropical migrants whose population trends often vary among regions, the decline in grassland birds has been consistent, dramatic, and often more puzzling than that of forest-dwelling species (Bollinger and Gavin 1992; James et al. 1992; Askins 1993; Herkert 1995; Sauer et al. 1997; Peterjohn and Sauer 1999). Declining trends and small original populations have led to concern regarding the status of grassland birds in the Northeast (Shriver et al. 1997). By the early 1990s, birds of open habitats were the species most frequently listed as threatened, endangered, or of concern, with 13 species listed by three or more states (Vickery 1992). There are six grassland/shrubland species on Pennsylvania’s Breeding Birds of Special Concern list and ten listed in New Jersey (Table 1). In addition to those officially listed, other grassland species such as the field sparrow (*Spizella pusilla*) are also in rapid decline in Pennsylvania (boblinks are an exception) (Figure 1) and New Jersey (Figure 2) according to the U. S. Fish and Wildlife Service (USFWS) Breeding Bird Survey (BBS) trend analysis.

The smaller Pennsylvania Threatened and Endangered list is at least partially due to the planting of extensive grasslands on reclaimed strip mines in the western part of the state, primarily Clearfield County. Pennsylvania now has the largest population of Henslow’s sparrow in the Northeast as a result of these reclamation projects (Brauning 2001).

The reasons for declines in grassland bird populations include succession of abandoned farmland into shrub and forest habitats, reduction of hayfield acreage and more frequent haycropping on remaining hayfields (Vickery et al. 1994). It is estimated that 55% of the habitats whose area has declined most in the United States are grasslands (Noss et al. 1995). The area sensitivity exhibited by many of these species exacerbates the detrimental effects of these losses (Herkert 1994; Vickery et al. 1994). Grassland area has declined by 60% since the 1930s in New England and New York (Vickery et al. 1994).

Table 1. Endangered and threatened grassland birds of Pennsylvania and New Jersey.

State	Common Name	Scientific Name	Status
PA	Short-eared owl	<i>Asio flammeus</i>	Endangered
PA	Sedge wren	<i>Cistothorus platensis</i>	Endangered (proposed)
PA	Loggerhead shrike	<i>Lanius ludovicianus</i>	Endangered
PA	Dickcissel	<i>Spiza Americana</i>	Endangered
PA	Upland sandpiper	<i>Bartramia longicauda</i>	Threatened
PA	Northern bobwhite	<i>Colinus virginianus</i>	Candidate – at risk
NJ	Northern harrier	<i>Circus cyaneus</i>	Endangered
NJ	Short-eared owl	<i>Asio flammeus</i>	Endangered
NJ	Upland sandpiper	<i>Bartramia longicauda</i>	Endangered
NJ	Sedge wren	<i>Cistothorus platensis</i>	Endangered
NJ	Loggerhead shrike	<i>Lanius ludovicianus</i>	Endangered
NJ	Henslow's sparrow	<i>Ammodramus henslowii</i>	Endangered
NJ	Vesper sparrow	<i>Pooecetes gramineus</i>	Endangered
NJ	Bobolink	<i>Dolichonyx oryzivorus</i>	Threatened
NJ	Grasshopper sparrow	<i>Ammodramus savannarum</i>	Threatened
NJ	Savannah sparrow	<i>Passerculus sandwichensis</i>	Threatened

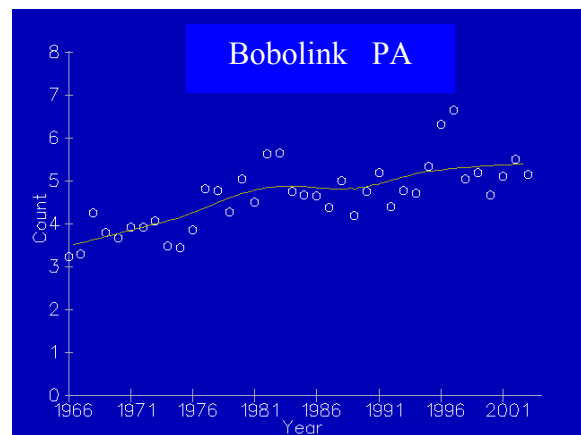
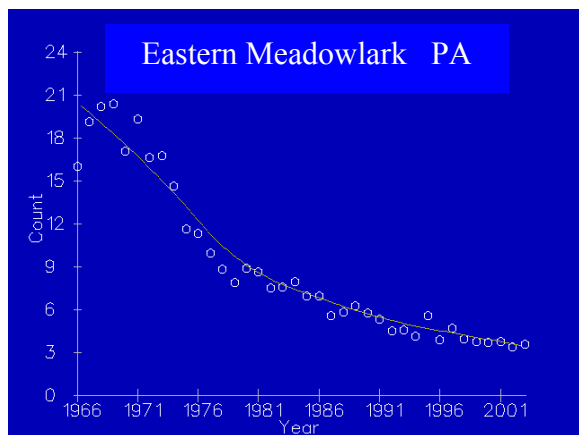
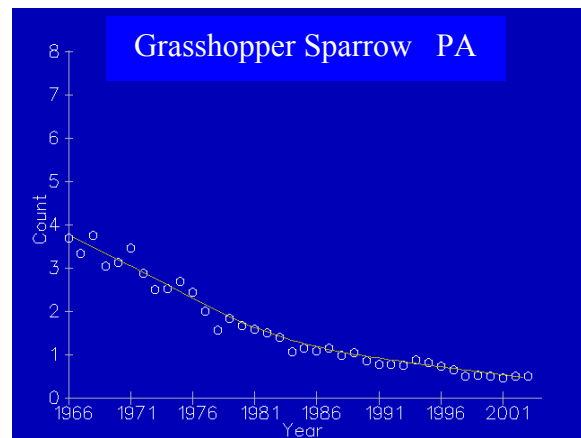
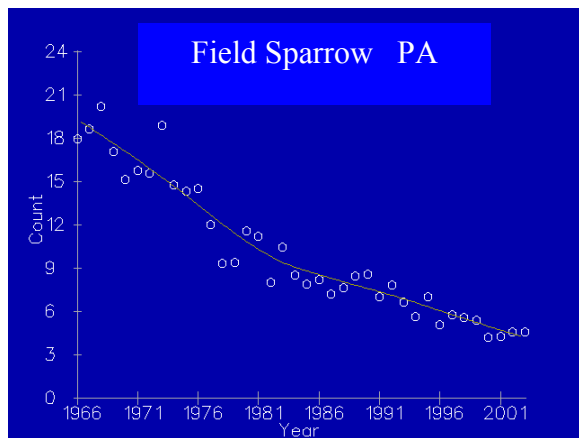


Figure 1. BBS population trends for selected Pennsylvania grassland birds showing declines in three species (courtesy USFWS BBS).

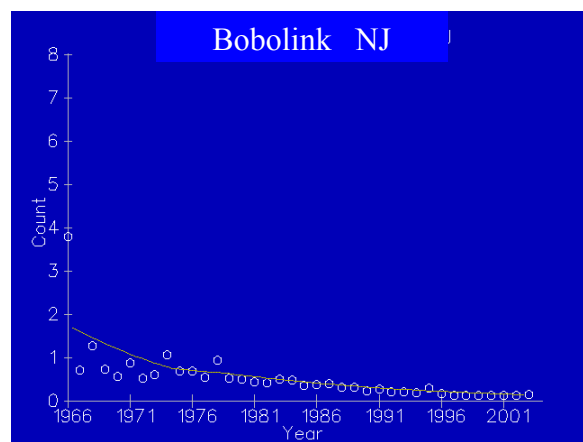
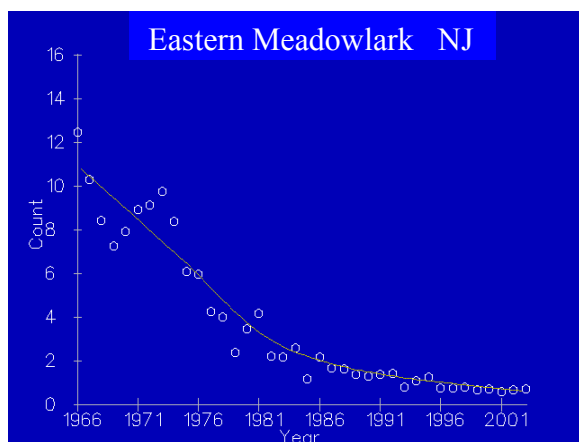
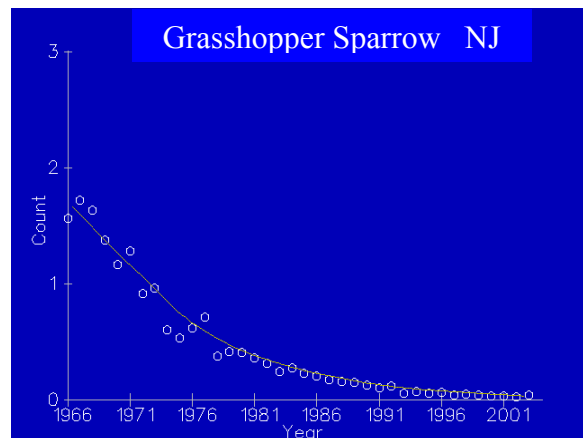
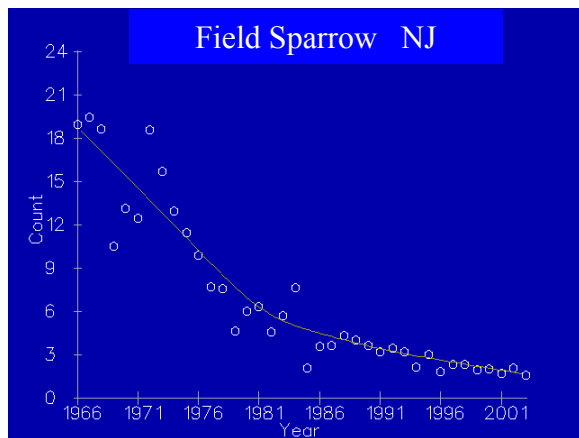


Figure 2. BBS population trends for selected New Jersey grassland birds showing declines (courtesy USFWS BBS).

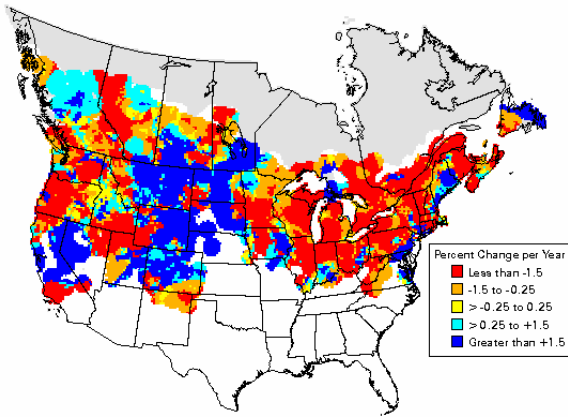
Concern for the welfare of grassland birds (Hunter et al. 2001) caused this group to rise to the top of the priority list of avian studies in the Delaware Water Gap National Recreation Area (DEWA) and Upper Delaware Scenic and Recreational River Biological Inventories Scoping Workshop held on October 24 and 25, 2000. This meeting was derived from a National Park Service Inventory and Monitoring directive initiated in 1991 (Williams 1999).

Logically, historical perspective is required in order to develop a management rationale and establish goals for restoration of grassland bird populations (Askins 2000). Prior to European settlement there were scattered large grasslands in the northeastern U. S. resulting from climate, soil, fire, and Native American influences (Askins 1997, 2000; Winne 1997). The Hempstead Plains on Long Island covered an estimated area of 20,000 ha (49,421 ac), and the 2,400 ha (5,930 ac) Montauk Downs existed farther east on the island (Harper 1911; Stalter and Lamont 1987). The Blueberry Barrens of eastern Maine are currently one of the largest open habitats utilized by grassland birds in the East (Vickery et al. 1994). They are maintained using fire in order to enhance blueberry (*Vaccinium* spp.) production.

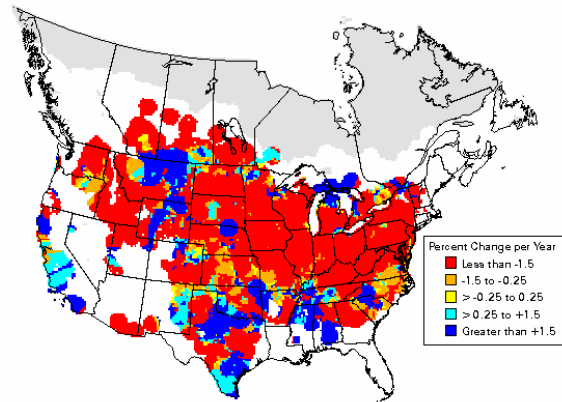
However, land survey records and palynological data suggest that most of northeastern North America was forested in Precolumbian times (Russell 1981; Burden et al. 1986; McAndrews 1988; Patterson and Sassaman 1988; Markes and Gardescu 1992; Foster 1995; Dieffenbacker-Krall 1997). The historical presence of species, such as the heath hen (*Tympanuchus cupido cupido*), the eastern subspecies of Henslow's sparrow (*Ammodramus henslowii susurrans*) and the "Ipswich" subspecies of savannah sparrow (*Passerculus sandwichensis princeps*) often are used as proof that grassland habitat existed prior to European colonization and land clearing by Native Americans. However, each of these species has some aspect of its natural history that dictates against using it to bolster the notion that extensive grasslands once existed in the Northeast. Heath hens also were found in scrub oak (*Quercus ilicifolia*) barrens, there is debate about validity of a Henslow's sparrow subspecies in the East, and the Ipswich sparrow currently breeds only on an island off Nova Scotia (Parks 1952; Schroeder and Robb 1993; Askins 1997).

A major impetus for promoting grassland bird management in the Northeast, regardless of the past prevalence of grassland birds in this region, is population declines in their traditional midwestern stronghold which can be seen in the BBS continent-wide population trend maps (Figure 3). Declines are evident across the continent as well, based on BBS grassland group trends (Table 2) and the National Audubon Society's Watchlist for grassland birds (Figure 4).

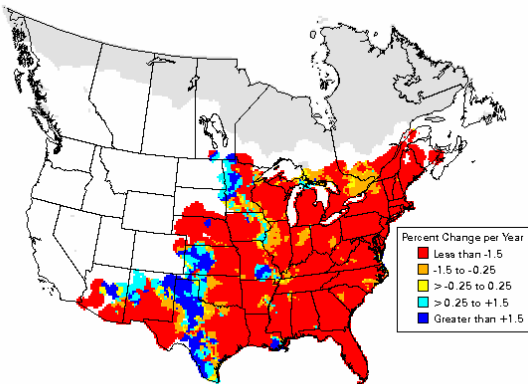
Approximately 80% of native Midwestern habitat in general and 99% of tallgrass prairie east of the Missouri River, in particular, have been altered or destroyed by agriculture, range management, and urbanization (Samson and Knopf 1994; Vickery et al. 1999). Thus, establishment and enhancement of northeastern grassland bird populations may serve as breeding population reservoirs for species rapidly declining within their original, native range (Herkert 1997; Wells and Rosenberg 1999).



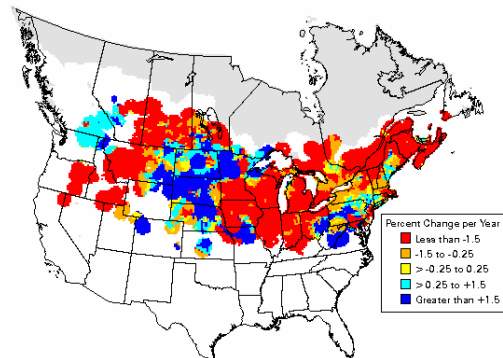
Savannah Sparrow



Grasshopper Sparrow



Eastern Meadowlark

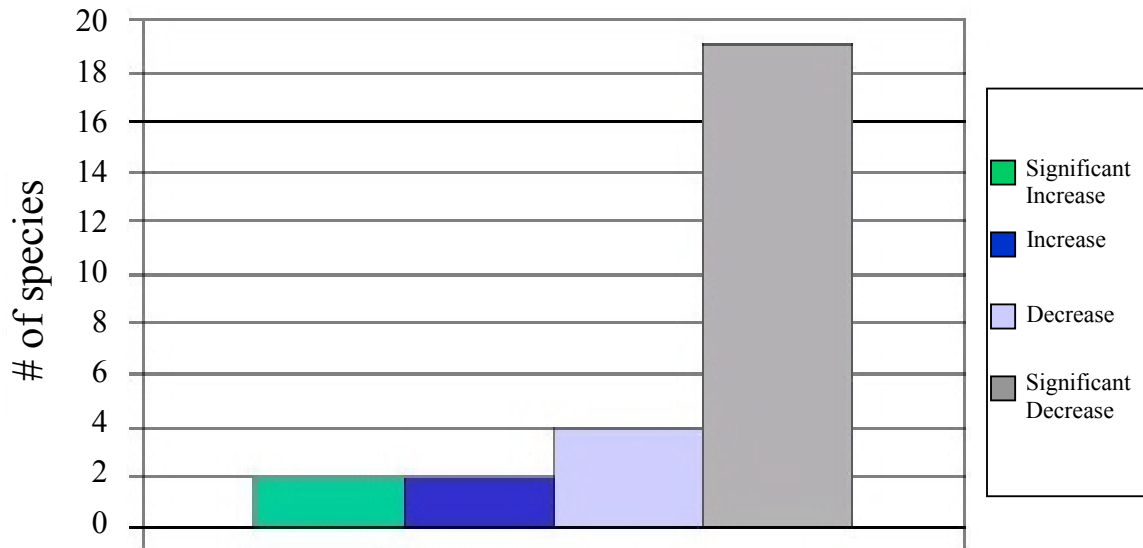


Bobolink

Figure 3. BBS continent-wide population trends for selected grassland species. Red color indicates an average decline of $>1.5\%$ per year (courtesy USFWS BBS).

Table 2. BBS continent-wide proportion of grassland species showing significant negative and positive trends (courtesy USFWS BBS).

Population Trend	Proportion of Species (%)
Significant negative trend	0.68
Significant positive trend	0.07



Population Status Categories for Grassland Birds

Figure 4. Number of grassland bird species in four National Audubon Society Watchlist status categories for grassland habitat.

Shrublands Species

Shrublands are defined as habitat patches with woody plants that are <3 m (10 ft) tall (Hunter et al. 2001). Lorimer (2001) makes a distinction between “successional habitat,” dominated by pioneer species, and “young forest habitat,” dominated by young stands of late successional species. Successional habitat occurs where pioneer plants colonize treeless areas that have been disturbed. Young forest habitat also develops in disturbed areas (gaps), but within forested landscapes. Both types of habitat are dominated by low, woody vegetation, but they vary in structure. Young forest habitats are typically more transitory than shrublands because tree saplings grow relatively quickly, produce a canopy, and shade out herb and shrub layers to some extent (Thompson and DeGraaf 2001).

Regardless of how they are formed, all are maintained by regular, but less frequent, forms of disturbance (e.g., fire) than are grasslands (Hunter et al. 2001). Historically, such habitats were always successional in the eastern United States, with the exception of xeric sites, including various types of barrens, and hydric sites, primarily shrub-scrub wetlands. The latter are presently the most prevalent natural shrubland type in DEWA (Thompson and DeGraaf 2001).

In the absence of disturbance, abandoned farmland succeeds into shrubland, a process that is occurring in many locations within DEWA. As succession proceeds in the eastern United States the number of bird species rapidly levels off at around 30 during years 1–2 following abandonment (Thompson et al. 1996). For continued existence of some of these species, both size and distribution of shrubland patches are equally important (Thompson and DeGraaf 2001). For example, prairie warblers (*Dendroica discolor*) tend to avoid small, isolated clearcuts (Annand and Thompson 1997). However, size is generally of less importance than with grassland species because many shrubland birds are adapted to colonizing relatively small patches of disturbance within a forested landscape (Rudnicki and Hunter 1993; Krementz and Christie 2000; Litvatis 2001). Regeneration habitats are often more ephemeral than the naturally occurring ones (Thompson and DeGraaf 2001). Maintenance of these habitats is dependent on planned anthropogenic disturbance regimes utilizing prescribed burns, chaining, cabling, scalping tillages, or felling with chainsaws (Yoakum et al. 1980).

Noss et al. (1995) used numerous sources to assess the degree to which ecosystems in the United States have shrunk in area. They identified 48 ecosystem types that have declined by more than 98%; of those, 24% were shrublands. Reduction in the extent of this habitat type is caused, primarily, by succession of abandoned farmland beyond the shrubland stage due to a lack of management effort. The lack is at least partially due to a perception that these habitats are uninteresting, uniform, and monotonous compared to lofty forests and fields blooming with wildflower displays in the spring (Gobster 2001). As a result, approximately 70% of birds characteristic of this habitat type in the eastern United States are experiencing population declines, one of the highest figures for any region of the United States (Witham and Hunter 1992; Hunter et al. 2001). Such trends are characteristic of several species of typical shrubland birds in Pennsylvania and New Jersey (Figure 5), and generally across the country, according to BBS continent-wide group trends and the National Audubon Society Watchlist for shrubland birds (Figures 6 and 7; Table 3).

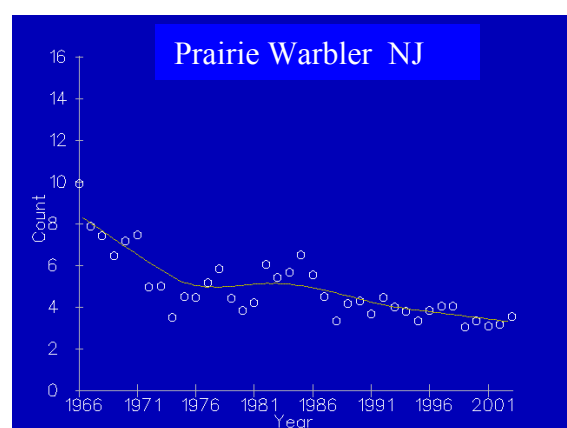
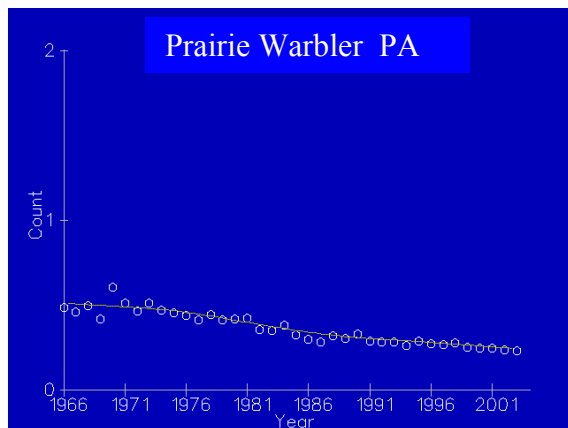
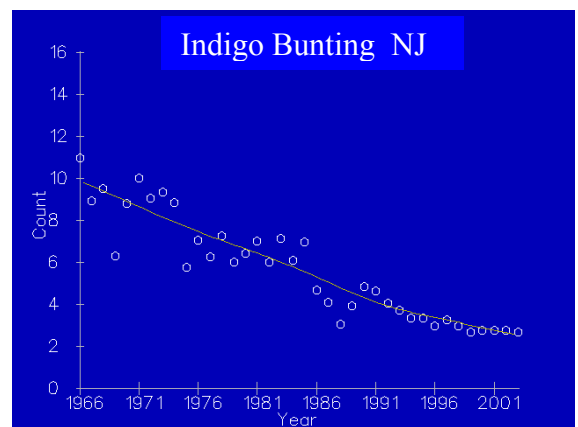
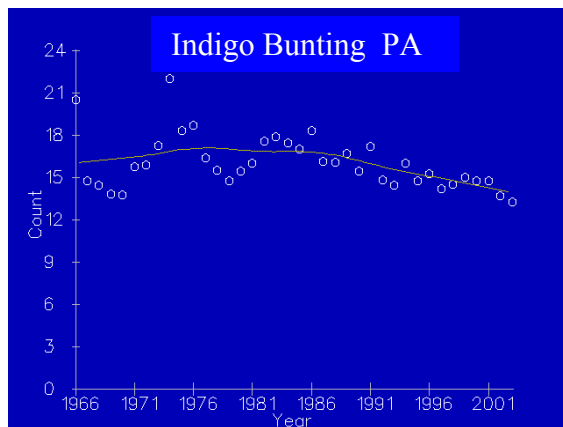


Figure 5. BBS population trends for selected Pennsylvania and New Jersey shrubland birds showing steady declines (courtesy USFWS BBS).

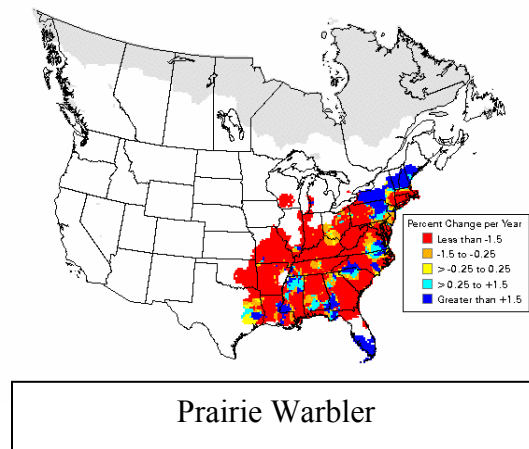
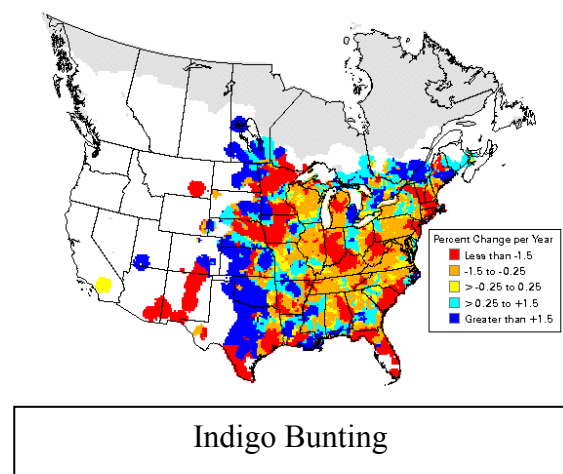


Figure 6. BBS continent-wide population trends for selected shrubland species. Red color indicates an average decline of $>1.5\%$ per year (courtesy USFWS BBS).

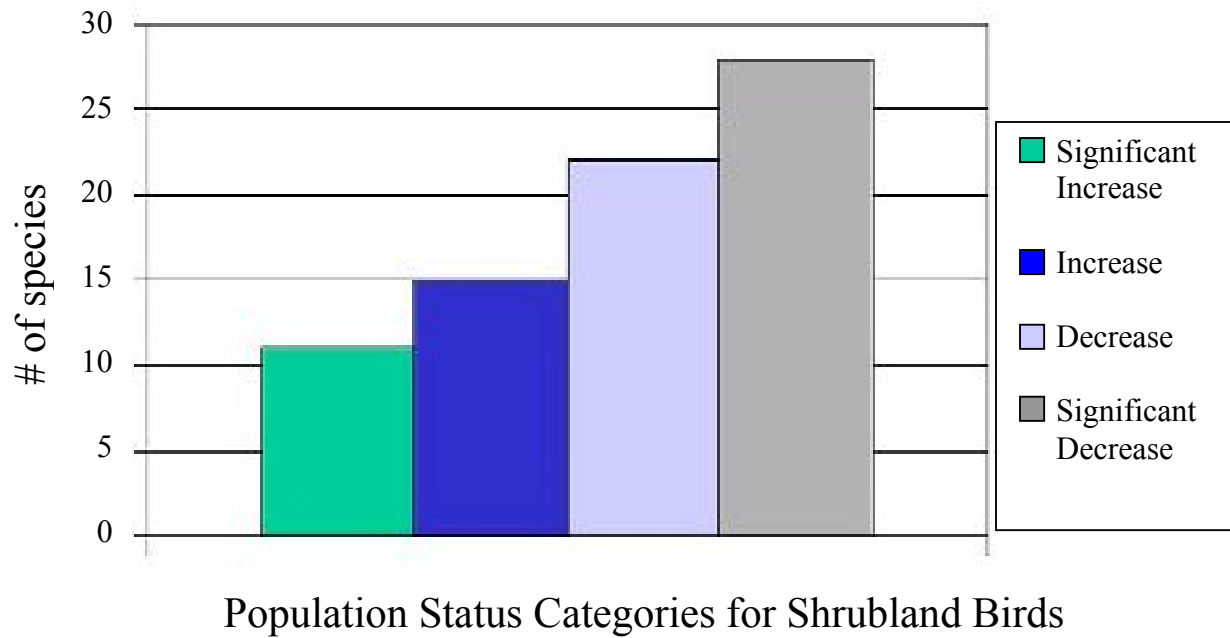


Figure 7. Number of bird species in four National Audubon Society Watchlist status categories.

Table 3. BBS continent-wide proportion of shrubland species with significant negative and positive trends (courtesy USFWS BBS).

Population Trend	Proportion of Species (%)
Significant negative trend	0.36
Significant positive trend	0.14

Summary

The general perspective presented above indicates that early successional habitats, whether natural or anthropogenic in nature, have declined from peaks in abundance earlier in this century. They now occupy <1% of their original distribution in the eastern United States (Noss et al. 1995). The reasons for the decline in extent have been well documented. Loss of habitat has led to widespread and consistent reductions in both grassland and shrubland bird populations. These declines can only be reversed if existing habitat is maintained at an early successional level by human intervention.

Project Goals

There are three major goals that this project will address:

- 1) Evaluate distribution and abundance of early successional birds.
- 2) Relate patterns of distribution and abundance to physical/vegetative characteristics of open habitats.
- 3) Develop a management rationale for maintaining/enhancing populations of grassland/shrubland birds.

Study Area

The Delaware Water Gap National Recreation Area contains 29,012 ha (69,629 ac) of forests, shrublands, wetlands, grasslands, and agricultural fields and extends for 66 km (41 mi) along the Delaware River where it forms the boundary between Pennsylvania and New Jersey.

Outstanding natural features include the Delaware River floodplain, the eastern-most edge of the Appalachian Plateau which borders the river to the west in Pennsylvania, Kittatinny Ridge, the southernmost extension of the Shawangunks which borders the river to the east in New Jersey, and the Delaware Water Gap itself where the river has cut through Kittatinny Ridge forming one of the best examples of a water gap in the world.

Vegetation in the narrow river valley reflects land use history. As it was under previous ownership, 1,214 ha (3,000 ac) are leased to farmers and maintained in agriculture. Abandoned fields and home sites are in various stages of ecological succession, including the old fields and shrub thickets of interest in this study. Older, larger trees are found mainly in wooded strips along the banks of the Delaware River and its tributaries, including many steep, hemlock-dominated ravines. Many miles of old dirt and gravel roads criss-cross the valley, having been used for access to homes, farm fields, and the river itself.

The park's 1987 General Management Plan states that the current mix of open lands and forest be maintained (General Management Plan 1987). Management activities to achieve this goal are permitted in the park's Resource Management Subzone, consisting of approximately 56% of the park's total area. Within this subzone, 20% of the landscape is to be maintained as open habitat, much of which is currently in agricultural use. The portion of this 20% not planted in crops can be managed to provide various stages of successional habitat, thus fulfilling goal #3 mentioned above.

Methods

Target Species

The first goal of this project was determining patterns of distribution and abundance of grassland birds in DEWA. Relatively little was known about this group of birds beforehand, although anecdotal sightings and the presence of a few large fields, some actively managed, led us to assume that an emphasis on grassland birds was warranted. As fieldwork progressed and preliminary analyses were completed it was realized that a much broader spectrum of species, including many shrubland birds, would be the focus of the study.

All species observed at sampling points were recorded, but the initial emphasis on grassland species led to the development of a list of target species designed to focus our attention on this group of birds. They were selected primarily based on range overlap with DEWA (Table 4).

Survey Site Selection

A major consideration in selecting sites for grassland bird surveys was the area requirement of target species. There is a considerable amount of evidence suggesting that area requirements exist, but some conjecture remains concerning the magnitude of area required by various grassland species (Winter and Faaborg 1999). Vickery et al. (1994) give specific area requirements for grassland birds in Maine based on a "50% incidence" index (e.g., a 50% likelihood that a species would be found in proper habitat of a given size). Requirements ranged from 200 ha (480 ac) for 50% incidence of upland sandpipers to 10 ha (24 ac) for 50% incidence of savannah sparrows. Field sparrows exhibited no specific area requirement. Whether or not an area requirement exists may depend on the surrounding landscape scale habitat matrix (Bakker et al. 2002). Some grassland species were found breeding in large patches, but they also utilized small patches if the surrounding landscape contained large expanses of grassland. Area importance as a determining factor increases if grassland sites are surrounded by forest from which predators can gain access to grassland ground nesters (Winter and Faaborg 1999).

All non-cropland open field sites of 4 ha (10 ac) or larger were considered for inclusion in this study based on suggested minimum size requirements for many grassland species (Herkert 1994). Forty-nine fields in the 4–8 ha (10–19 ac) category, 13 in the 9–21 ha (20–49 ac) category, and only three larger than 22 ha (>50 ac) were identified from leaf-off digital aerial photography flown in 1999. Site visits to all of these fields were conducted during April 2002 to confirm suitability. Twenty-nine sites met the minimum size and openness requirements. The remaining 36 fields were rejected, either because they were agricultural fields not in production when the aerial photos were taken, or they had since succeeded into shrubby fields (>15% shrub coverage). Three additional New Jersey fields that were cleared of shrubs were added in 2003. One suitable site located on the northwestern tip of Poxono Island in the Delaware River was not included due to access difficulties resulting from flooding during both years.

Table 4. List of target grassland species.

Common Name	Scientific Name
Northern harrier	<i>Circus cyaneus</i>
Northern bobwhite	<i>Colinus virginianus</i>
Killdeer	<i>Charadrius vociferus</i>
Upland sandpiper	<i>Bartramia longicauda</i>
Short-eared owl	<i>Asio flammeus</i>
Eastern kingbird	<i>Tyrannus tyrannus</i>
Horned lark	<i>Eremophila alpestris</i>
Sedge wren	<i>Cistothorus platensis</i>
Loggerhead shrike	<i>Lanius ludovicianus</i>
Field sparrow	<i>Spizella pusilla</i>
Lark sparrow	<i>Chondestes grammacus</i>
Clay-colored sparrow	<i>Spizella pallida</i>
Grasshopper sparrow	<i>Ammodramus savannarum</i>
Vesper sparrow	<i>Pooecetes gramineus</i>
Lincoln's sparrow	<i>Melospiza lincolnii</i>
Savannah sparrow	<i>Passerculus sandwichensis</i>
Henslow's sparrow	<i>Ammodramus henslowii</i>
Nelson's sharp-tailed sparrow	<i>Ammodramus nelsoni</i>
Bobolink	<i>Dolichonyx oryzivorus</i>
Eastern meadowlark	<i>Sturnella magna</i>

Variable Circular Plot Point Counts

Locating Points

A variable circular plot (vcp) is essentially a circle of undefined diameter within which all birds seen and heard are recorded along with their horizontal distance from the observer. A detection function is determined based on the distance to which a particular species can be reliably detected, and from this density estimates can be derived (Reynolds et al. 1980). Survey points for vcp point counts were located within survey fields using a Garmin III[®] GPS connected to an NBX-3 2-channel automatic differential beacon receiver backpack to improve accuracy. They were positioned to maximize the number of points per field, maintaining a minimum distance of 250 m (820 ft) between points and surrounding ecotones, although thorough coverage dictated closer proximity to edges in a few instances (Reynolds 1980; Ralph et al. 1995). Seven of 32 fields were large enough to accommodate multiple survey points within the minimum separation requirement of 250 m (820 ft). A total of 40 points was surveyed in 2002 and 43 in 2003 due to the addition of new fields that year.

Survey Chronology and Number of Rounds

Counts were conducted from sunrise to 1000 hr (Ralph et al. 1993), mostly on sunny days with little wind, from the last week in May until the first week of July. Survey periods thus coincided with the period of greatest daily avian activity and the height of the breeding season. Although two survey rounds were planned in each year, a slight extension of the survey period into the first week in July permitted completion of three rounds in both 2002 and 2003. Efficacy of point counts is enhanced by establishing more points rather than visiting fewer points more often (Savard and Hooper 1995). However, because all appropriate fields were sampled, e.g., no random or stratified selection procedure was required, we were afforded the luxury of increasing the number of rounds conducted at each point. Replication of counts at single points does improve accuracy of species abundance estimates and bird community composition (Petit et al. 1995; Ralph et al. 1995; Smith et al. 1995).

Inclusion of Species and Observers

All birds heard or seen at vcp points and their estimated distance from the observer were recorded (Reynolds 1980; Fancy and Sauer 2000). This method permits determination of population densities because data can be corrected for variability in the detection of different species (Scott et al 1981; Bibby et al. 1992). Birds flying overhead (aerial guild – see Data Entry and Organization section below) were included in all analyses, except density and diversity calculations (see Bird Species Density Estimation and Power Analysis section below), if engaged in foraging activity above the fields. Prior to the initiation of surveys, markers were set up at 10, 25, 50 and 100 m (33, 82, 164, and 328 ft) in a practice field to test, refine, and coordinate observer bird identification and distance estimation. Three observers were used in 2002, only two of which continued in 2003, providing a degree of continuity and consistency among observers through the two years of the field study (Bibby et al. 1992; Ralph et al. 1995).

Survey Duration

Survey duration was five minutes, a length of time considered reasonable in open habitat (Bibby et al. 1992). It reduces the potential of counting individuals more than once, an inherent problem in longer counts, and prevents detection of birds making long movements, which invalidates a standard assumption of point count protocol (Bibby et al. 1992). A sample data sheet can be found in Appendix A.

Vegetation Measurements

Sampling Procedure

Vegetation composition and structure were measured at 10 m (33 ft) intervals along a 100 m (328 ft) transect oriented randomly with its center on the survey point (Bibby et al. 1992). Sampling was done in late June and early July of 2002 and simultaneously with point counts in June of 2003. Only the data from 2003 were used for analysis, since it was done concurrently with the point counts at the height of the breeding season. The vegetation data sheet is attached as Appendix B.

Vegetation Composition

Composition was characterized by estimating the percent coverage and percent occurrence of major plant groups and bare ground. Percent coverage is the percent of a field of view occupied by the plant. It can exceed 100% because of layering. Percent occurrence is a measure of the proportion of various plant groups and bare ground occupying a given area, it always equals 100%. The area for both coverage and occurrence was delimited using an ocular tube, a simple sighting device 5 cm (2 in) in diameter, that allows an observer to focus attention on a defined area by reducing peripheral vision. Plants were grouped into grass/sedge, forb, shrub, sapling, and tree categories. Because very few shrubs, saplings, or trees were recorded, only grasses/sedges and forbs were used in analyzing relationships between vegetation and grassland bird communities.

Vegetation Structure

Vegetative structure was measured using a Robel Pole with alternating 0.25 dm (1 in) black and white bars for the first 2 dm (8 in), and 0.50 dm (2 in) intervals thereafter. All heights at which vegetation touched the pole were recorded, providing a measure of vegetative structure—foliage height distribution (FHD) (Willson 1974; Bibby et al. 1992).

Litter Depth

Litter depth was measured with a ruler at each sampling point along the vegetative sampling transect to the nearest millimeter.

Geographic Information System (GIS) Products

Following the completion of the collection of field data, three ArcView[®] 8.3 shapefiles were created; a polygon shapefile representing each field, a polyline shapefile delineating the habitat

edges each field contains, and a point shapefile locating the survey points placed within them. Complete, individual shapefile descriptions and their respective creation process are contained in HTML metadata files included with the shapefiles and printed out in Appendix C. The GPS data supplied the coordinates for the survey points, while the field extent and habitat edge were defined by examining the latest 2002 DEWA aerial photography in conjunction with a draft vegetation classification shapefile developed from the same imagery. As noted in the metadata, depiction of field boundaries and habitat edges could be subjective and was subject to potential limitations of the source data. For some fields with indistinct boundaries we used the location of survey point(s) within continuous-seeming habitat as observed on the aerial photo in conjunction with observations of field personnel. The same process was useful in determining the boundaries of fields present as an apparent member of a large complex of fields. For these fields boundaries were often defined by distinct hedgerows or other barriers. Despite these potential limitations, we feel the shapefiles represent field spatial data accurately enough for our purposes. For data analysis the field and habitat edge shapefiles allowed the calculation of field area and amount of edge categorized according to whether it was hard edge (an extensive habitat differing from that of the field, usually consisting of shrubs and/or forest) or a soft edge (primarily indistinct hedgerows and grassland-agricultural transitions). This distinction in edge type was made because woody edges are avoided by nesting grassland species, and thus have a greater influence on the bird community than relatively indistinct edges (O’Leary and Nyberg 2000).

Digital Photography

Digital photographs were taken at each survey point with a Kodak[®] DC290 Zoom Camera from three positions, a straight down view from shoulder height, a vegetation profile from ground level and a distant shot taken across the widest expanse of the field. A listing of photos can be found in Appendix D.

Data Entry and Organization

All avian and vegetation data was proofed once for errors and omissions after being entered into a Microsoft Access[®] database (field forms that data were recorded on are presented in Appendixes A and B). This database and the output used in the analysis and presentation of data are described in detail in the data dictionary (Appendix E). In the database, bird species were assigned to guilds based on their life-history characteristics. The five designations used were grassland, shrub, edge, aerial, and forest guilds. The forest guild, a minor component of the total data, is not considered further here. The other four guilds were used in field characterizations and interpretation of results. These guilds were pooled into one group, an open habitat guild, and used in the calculations of indices for DEWA’s open habitat bird community.

Data Analysis

Avian Occurrence, Detection Rates, and Community Indices

General indices of species occurrence, detection rates, species diversity, and species richness were obtained from the vcp point counts. Detection rates provide an index of abundance of each species calculated as a mean of the maximum number of detections per visit per field. For these indices all data was used, regardless of distance to the observer, making them analogous to unlimited distance point counts. All indices are calculated with the field as the sampling unit since this unit is of most interest to DEWA land managers. Occurrence and species richness are simply the function of the number of fields where a species was present, and the number of species present in a field, respectively. Detection rates and species diversity, however, were calculated according to maximum numbers detected from within-year repeat visits. This approach was chosen because we felt that the maximum number of detections of a particular species was a better approximation of the actual numbers present than the average of repeat visits for the majority of species. This was indicated by a high percentage of zero counts (~ 40%) during repeat visits for a species, given that it was detected on at least one visit to a point and substantial variability in the numbers detected (data on singing males only). Preliminary analysis also indicated that using maximum detections reduced variance in detection rate means.

Detection rates and species diversity calculations for sexually dimorphic species, and/or species where only males sing, were calculated using maximum numbers detected, based only on observations of singing males that we presume to be territorial, in order to reduce the potential that inclusion of data from all cues could bias results if different cues vary in their detectability and this detectability is not constant across survey factors, such as habitat and observers. With non-dimorphic species all detections were used because, depending upon the species, we could not discern territorial male from female visual and/or song/call detections. Species recorded as aerial foragers (the aerial guild) that are not amenable to distance analyses (see below) are also included for detection rate, occurrence, and species richness because they are an important component of DEWA's open habitats, with fields likely producing important food resources for these species. Detections of this guild, and of red-winged blackbirds, however, were excluded from the diversity calculations because these detections were particularly sporadic, often with relatively large numbers detected, and had undue influence on diversity values.

For species diversity, the Shannon-Weaver Index was used because it emphasizes the distribution of individuals among species (Shannon and Weaver 1949). We chose to pool data in the larger fields with multiple points (7 of the 32 total fields), recognizing that the species-area effect (Pielou 1977) should cause these fields to have high diversity values outside of any potential field area relationship to field quality. Species richness is also not calculated as a mean of individual point values for these fields, instead being simply a species list, so the effect should be noted here as well. Thus, diversity as we calculate it should evaluate distribution of individuals within species richness for all fields.

Bird Species Density Estimation

Distance data provided by vcp point counts was imported into the program DISTANCE[®] (Thomas et al. 2004) to produce density estimates. This is achieved through the calculation of a detection function of the distance data for a species (Figure 8), which attempts to model how the probability of detection declines as distance from the observer increases. This detection function allows the estimation of the proportion of individuals missed within the radius of detections for a species, thus a true assessment of the number of individuals per unit area is produced.

Buckland et al. (2001) provide a thorough and technical presentation of the theory and application of distance-based sampling procedures and is the source of the following data guidelines. Firstly, a key requirement for analysis is having sufficient numbers of detections in order to accurately depict the detection function; in general, at least 75–100 are recommended for point-count sampling and considerably more are preferable in order to reduce variance in density and detectability parameters. In addition, these detections should be of the same type since different types of detections (e.g., aural vs. visual) likely differ in their respective detectabilities. Secondly, individuals should be relatively stationary, at least over the count period; thus, species encountered primarily as aerial foragers (e.g., tree swallows) are not appropriately analyzed with this technique. Finally, pooling of data is considered robust with respect to individual factors that may influence detection probabilities such as habitat, observers, and survey year, as long as their influence is not unduly severe. While including the modeling of individual factors in the analysis is preferable, sample sizes seldom permit this—as in this study. Per these data guidelines, detections of singing males, by far the most frequent type of detection, were chosen, and eight species had sufficient pooled observations from the multiple visits to each point across both years for analysis (Table 5).

Following recommendations in Buckland et al. (2001) and using the graphical interface and data manipulation capabilities of the program, the pooled data for each species was explored in DISTANCE[®] for appropriate truncation and binning into distance intervals in order to improve the fit of the data to the model. A final detection function model was selected based on graphically and quantitatively (via Akaike's Information Criterion; AIC) observing the fit of the data to various models and selecting the best one (see Appendix F for graphs of detection functions and analysis details). Within DISTANCE[®], this model was used to produce density estimates per point and per year via the dataset stratification options of the program. Along with the density estimates, the program computes the standard error and 95% confidence intervals about the estimate. Other associated parameters include an estimate of the probability of detection, the likelihood of detecting a species at a point within its detection radius (see Appendix F).

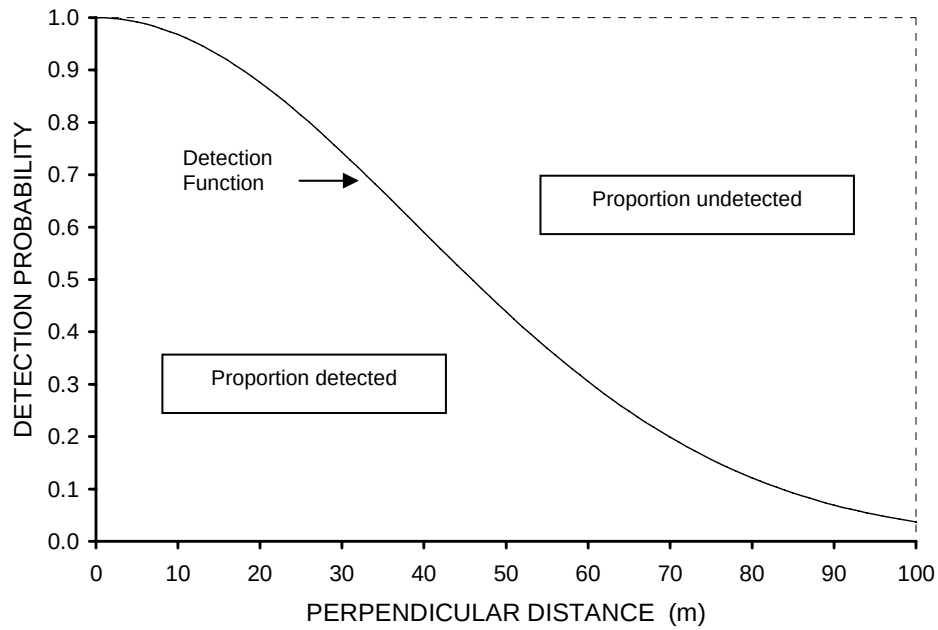


Figure 8. Graph of hypothetical detection function showing decline in detections of a bird species as distance increases from 0 (position of observer). The detection function allows the estimation of the number of undetected individuals within the entire survey radius.

Table 5. Number of pooled detections for the eight distance analysis species.

Species	Year		Total
	2002	2003	
Common yellowthroat	123	151	274
Red-winged blackbird	128	128	256
Field sparrow	113	117	230
Song sparrow	114	115	229
Prairie warbler	93	60	153
Indigo bunting	49	51	100
Yellow warbler	41	52	93
Gray catbird	48	44	92

The densities as calculated above are derived from the average of multiple visits to a point within a year (hereafter referred to as the mean of visits density). Because numbers of singing males of a particular species per visit were often quite variable and frequently included zero counts (see above), we felt that this density estimate could be biased low. In addition to the mean of visits density estimate, a further manipulation to the dataset prior to importing it into the program was employed in order to derive a density estimate based on which of the multiple visits to a point produced the maximum number of singing males for each of the species within a year (hereafter referred to as the maximum visit density). Both maximum and mean of visits density estimates are shown in this report to illustrate the differences between the calculation methods and test their effectiveness for population monitoring. However, we feel the maximum visit density is the more accurate of the methods. Statistical testing of paired differences with the probability of incorrectly rejecting the null hypothesis of no difference (Type I error) set at 5% was performed via z-tests (Buckland et al 2001).

Power Analysis of Sampling Design

The statistical power of a null hypothesis test is the probability of rejecting the null hypothesis when in fact it is false (Sokal and Rohlf 1981). However, retrospective power analysis (performed after a study has been completed) is commonly misapplied in order to interpret non-significant results as simply being due to lack of sample size or significant results with corresponding high power as being important (Baguley 2004). Retrospective power analyses such as these use observed effect sizes (i.e., the size of the difference between means) in order to calculate power and are not valid because both the p-value and power are dependent on the effect size, causing power to be generally low when the null hypothesis is not rejected and high when it is (Thomas 1997). Instead, the statistical power calculated here is used in a baseline study context, evaluating if the sampling scheme we used is likely to detect meaningful changes in populations of species between two sampling periods, similar to the Simons et al. (1995) report characterizing breeding bird communities in the Great Smoky Mountains National Park. The power of both types of density estimates (maximum visit and mean of visits) was calculated.

The free power analysis and sample size determination program DSTPLAN 4.2 (Brown et al. 2000) was used to perform power analyses using parameters of the between-year density estimates of the eight distance analysis species. The analysis option specified was for detecting differences between year-means obtained from paired sampling units, the 40 points sampled in both years. With a power level of 80% probability of detecting the change as a goal, we evaluated the power of a test to detect a 20% change in density between sampling periods (increase or decrease; e.g., 2-tailed test). If this was not achieved we determined what percent change would have to occur in order to have an 80% probability of detecting it. While many studies evaluate the sample size necessary in order to increase power, we chose not to do so since the number of points is strongly constrained by habitat availability (see Methods). Type I error probability was set at 10%, ($\alpha = 0.10$) instead of the commonly used 5%, since managers are usually more willing to make this type of statistical error when dealing with species of concern (i.e., they err on the side of caution).

Within the framework of a null hypothesis of no difference between paired sampling points the program can calculate any one of four parameters when supplied with three of them. These parameters are the effect size, the number of sampling points, the standard deviation of the

sample, and power. For the first analysis, the effect size was set at 20% of the highest year value, as specified in the manual. The number of sampling points was held constant at 40 for both analyses. While an additional three points were sampled in 2003, and were included in that year's density estimates, this discrepancy had little effect on parameter values and subsequent analysis results. The standard deviation of the sample is most easily calculated over a multi-year sampling effort. However, with just two years of data we had to estimate the standard deviation using the standard deviation of the set of differences between the paired points, as in Simons et al. (1995).

Multivariate Analysis of Vegetation Data

The vegetation sampling resulted in numerous compositional and structural variables that could be used to characterize each field (see variables in tables of Appendix E). We used the multivariate statistical method Principal Components Analysis (PCA) as a data reduction technique in order to define a reduced number of dimensions or axes (referred to as principal components or PC's) that explain the maximum amount of variance in the multidimensional data matrix of these variables. In essence, the method attempts to show pattern from the simultaneous consideration of numerous and likely correlated variables. The goal of the PCA was to examine how the fields might array or classify along these new axes, interpret the axes in terms of potential vegetative gradients, and show how they might relate to the bird results. Due to sample size considerations with PCA, however, bird variables and vegetation variables could not be considered within the same multivariate space. However, the new axes computed from the PCA were included with bird results in the correlation analysis described below.

We caution that this application of PCA must be considered as highly exploratory in nature, since the sampling effort (32 fields) falls well below the minimum recommended sample size of 100 needed for reliable use of the method (Gorsuch 1983). However, PCA appeared to produce meaningful axes for a grassland bird study in New York with a sample size of 43 fields (Norment et al. 1999). Following recommendations by Grimm and Yarnold (1995), our sample size restricted the number of variables selected for the PCA analysis to no more than six. Therefore, since preliminary analysis suggested that percent coverage and percent occurrence were practically synonymous, we used percent coverage variables, and of these only used three that showed the most variation between fields: grass/sedge, forb, and bare ground cover. The three structural variables included in the analysis were foliage height distribution, pooled into two height categories of 0–5 dm (0–20 in) and 5–10 dm (20–40 in), and litter depth.

Correlation Analysis

PCA analysis produces values for individual data points (the fields in our context) as they “score” according to the principal components produced. These scores can then be used in subsequent statistical analyses incorporating additional variables in order to test for relationships between principal component interpretations and the new variables. Correlation analysis using the Spearman rank correlation procedure was performed between scores for the first three principal components extracted, 2003 bird density estimates, and spatial data on the fields obtained from the project created GIS shapefiles (see Methods and Appendix C). This non-parametric procedure was chosen because most variables (with the exception of principal component scores) exhibited substantial departure from normality based on examination of data

skewness and kurtosis. The GIS-derived data were field area and amount of edge within 100 m (328 ft) buffers of point count stations. The buffer size was chosen because most bird detections occurred within 100 m (328 ft) of points. We examined how bird densities, species richness, and species diversity correlate to field area, amount of habitat edge, and interpretation of the principal components from the PCA. While correlation simply measures the degree of association between two variables, not whether one variable “causes” the other, we use it to suggest where causative relationships may exist and suggest how these correlations may indicate potential management issues. Advanced statistical procedures performed on multivariable or multivariate models (i.e., stepwise or multivariate regression) are beyond the scope of this report.

Results

General Inventory Results

A total of 49 open habitat guild species were observed during point counts for both years. A list of the common and scientific names of these species can be found in Appendix G. The project CD contains various inventory-produced products in addition to a digital copy of this report (see Appendix H). These include the GIS shapefiles and digital photographs noted previously, the database which contains all field data collected and queries that consolidate and filter this data for the analyses described below, and a Microsoft PowerPoint presentation that assembles various inventory results along with aerial photographs of the fields with overlays of the GIS products. A printout of this presentation, along with a description of its components and its intent, is contained in Appendix I. The ArcMap project used in the creation of the PowerPoint presentation has also been added to the CD, along with instructions on how to link the various layers it contains to tables and queries in the database to produce an interactive application analogous to the presentation.

Frequency of Occurrence

In both years, the majority of the species that occurred in more than 50% of the fields were those most closely tied to shrubby or edge habitat (nine species in 2002 and eight species in 2003), followed by three grassland birds species including field sparrow, American goldfinch and red-winged blackbird (Table 6). The most widespread species amongst fields in 2002 (all occurring at 86% of fields) were the common yellowthroat and gray catbird, both shrubland inhabitants, and the edge-associated cedar waxwing. In 2003, the common yellowthroat (93%) and field sparrow (83%) were the most widespread, but cedar waxwing occurrence dropped considerably (45%) versus 2002. The field sparrow was the grassland species (facultative) with the widest occurrence in both years (83% for both years) followed by the American goldfinch (79% in 2002; 62% in 2003) and red-winged blackbird (62% in 2002; 66% in 2003). The tree swallow was the most frequently occurring Aerial Guild species during both years (52% in 2002; 38% in 2003). Considering the entire list of species, most declined in occurrence from 2002 to 2003. This trend is evaluated and analyzed statistically in the species richness section below.

Targeted grassland species were observed at locations shown in Table 7. All of these species were detected only once among the three vcp survey rounds completed each year, usually the earliest one.

Table 6. Species occurrence over the 29 fields surveyed in both 2002 and 2003 and three additional fields in 2003. Percent occurrence is restricted to only fields surveyed in both years (% = # fields/29 x 100).

Species	Year		2003 additional	Guild
	2002 # fields (%)	2003 # fields (%)		
Cedar waxwing	25 (86)	13 (45)	1/3	Edge
Common yellowthroat*	25 (86)	27 (93)	1/3	Shrub
Gray catbird*	25 (86)	19 (66)	2/3	Shrub
Field sparrow*	24 (83)	24 (83)	2/3	Grass
American goldfinch	23 (79)	18 (62)	1/3	Grass
Indigo bunting*	23 (79)	21 (72)	3/3	Shrub
Prairie warbler*	21 (72)	18 (62)	1/3	Shrub
Song sparrow*	21 (72)	20 (69)	0/3	Shrub
Yellow warbler*	20 (69)	22 (76)	2/3	Shrub
Red-winged blackbird*	18 (62)	19 (66)	2/3	Grass
Blue-winged warbler	16 (55)	13 (45)	1/3	Shrub
Tree swallow	15 (52)	11 (38)	0/3	Aerial
American crow	14 (48)	11 (38)	2/3	Edge
Eastern towhee	14 (48)	14 (48)	2/3	Shrub
Chipping sparrow	13 (45)	12 (41)	1/3	Grass
Eastern bluebird	13 (41)	4 (14)	0/3	Edge
Eastern kingbird	12 (38)	12 (41)	0/3	Grass
Barn swallow	11 (38)	8 (28)	0/3	Aerial
Mourning dove	11 (38)	8 (28)	3/3	Edge
Northern cardinal	11 (38)	4 (14)	0/3	Shrub
Northern flicker	10 (34)	4 (14)	0/3	Edge
Eastern phoebe	9 (31)	5 (17)	1/3	Edge
Least flycatcher	8 (28)	9 (31)	0/3	Edge
Red-tailed hawk	8 (28)	4 (14)	0/3	Aerial
Willow flycatcher	8 (28)	10 (34)	1/3	Shrub
Baltimore oriole	6 (21)	15 (52)	1/3	Edge
Brown-headed cowbird	6 (21)	5 (17)	0/3	Edge
American robin	5 (17)	5 (17)	1/3	Edge
Chestnut-sided warbler	5 (17)	2 (7)	0/3	Shrub
Common grackle	5 (17)	2 (7)	1/3	Edge
Rough-winged swallow	5 (17)	3 (10)	0/3	Aerial
Turkey vulture	5 (17)	2 (7)	0/3	Aerial
Blue jay	3 (10)	6 (21)	0/3	Edge
Brown thrasher	3 (10)	1 (3)	0/3	Shrub
Cliff swallow	3 (10)	3 (10)	0/3	Aerial
European starling	3 (10)	2 (7)	0/3	Edge
Grasshopper sparrow	3 (10)	0 (0)	0/3	Grass
Northern mockingbird	3 (10)	1 (3)	0/3	Edge
Bobolink	2 (7)	0 (0)	0/3	Grass

Table 6. Species occurrence over the 29 fields surveyed in both 2002 and 2003 and three additional fields in 2003. Percent occurrence is restricted to only fields surveyed in both years (% = # fields/29 x 100) (continued).

Species	Year		2003 additional	Guild
	2002 # fields (%)	2003 # fields (%)		
Grasshopper sparrow	3 (10)	0 (0)	0/3	Grass
Northern mockingbird	3 (10)	1 (3)	0/3	Edge
Bobolink	2 (7)	0 (0)	0/3	Grass
Eastern meadowlark	2 (7)	3 (10)	0/3	Grass
House wren	2 (7)	1 (3)	0/3	Shrub
Orchard oriole	2 (7)	0 (0)	0/3	Edge
Warbling vireo	2 (7)	5 (17)	0/3	Edge
Bank swallow	1 (3)	4 (14)	0/3	Aerial
Chimney swift	1 (3)	0 (0)	1/3	Aerial
Savannah sparrow	1 (3)	0 (0)	0/3	Grass
Yellow-breasted chat	1 (3)	0 (0)	0/3	Shrub
Downy woodpecker	0 (0)	1 (3)	0/3	Edge
Ruby-throated hummingbird	0 (0)	2 (7)	0/3	Edge

* indicates density calculated for species

Table 7. Occurrence of targeted grassland species during both years of the study.

Species	Field	NPS #	Field Name	# Sightings/yr.
Grasshopper sparrow	PA01/1-3	5	Independence	2/2002
	PA02/1	3	Independence	1/2002
	PA04/1-3	----	Airfield South	1/2002
Savannah sparrow	NJ11/1&2	10	Silver Spray	1/2002
Bobolink	PA01/1-3	5	Independence	1/2002
	PA02/1	3	Independence	1/2002
Eastern meadowlark	PA03/1-3	----	Airfield South	1/2002
	PA13/2	4	Egypt Mills	1/2002 / 1/2003
	NJ10/1	9	Walpack Center	1/2002 / 1/2003

Detection Rates

Detection rates were calculated for each species as means of the maximum number of detections per visit, based on singing males. While a ranking of the species according to detection rates as an index of their abundance (Table 8) differs from the ranking according to frequency of occurrence, in general, the species with a high index are also those that are the most frequently occurring. Tree swallow had the highest detection rate in 2002 while Red-winged Blackbird had the highest detection rate in 2003. The magnitude of the standard error of these rates is particularly high relative to other species rates, however, indicative of relatively high variability in numbers detected for these species in these years. Two grassland species, the Field Sparrow and Red-winged Blackbird, supplanted shrubland species based on the index rankings for 2002. The most abundant shrubland birds according to the index were the Common Yellowthroat and Song Sparrow during both years. The most abundant Edge Guild species during both years was the Cedar Waxwing. Abundance levels for targeted grassland species were all very low ranging from 0.01–0.04 mean detections.

Species Richness

Species richness values were produced per field by counting all species detected during surveys (pooling data from multiple points if necessary, see Data Analysis section above). Most of the multiple point fields had amongst the highest species richness values in both years, the exception being field PA11/1&2 which had a value slightly below the mean number of species per field in each year (16.1 species/field - 2002, 13.6 species/field - 2003). Fields with 20 or more species in 2002 included PA01/1-3, NJ11/1&2, NJ10/2-4, PA13/2 and PA03/1-3. Included in this group are some of the largest fields as well as one moderately sized field (PA13/2). In 2002, fields PA09/2&3 and PA04/1-3 had 19 species but had the highest richness values for 2003 of 25 and 22 species, respectively; substantially higher than the mean number of species for that year. Species richness was often considerably reduced from 2002 to 2003 on a field-by-field basis. This trend is reflected statistically by a significant ($P < 0.05$) decrease in mean species richness between 2002 and 2003 (Table 9).

Species Diversity

Species diversity calculations were based on the maximum number of detections (pooling data from multiple points if necessary) for all species, excluding aerial foragers and red-winged blackbirds (see Data Analysis section above). Rankings of diversity values (Table 10) generally follow those observed for species richness. Eight of the 10 most species-rich fields in 2002 were ranked amongst the top 10 fields according to diversity values for that year. For 2002, seven of the fields with the highest richness also had the highest diversity and the highest diversity values were recorded at PA01/1-3, NJ11/1&2 and NJ10/2-4, the same fields with the highest overall richness values. Three of the 10 most diverse fields were relatively small, however, ranging in size from 2.33–2.95 ha (5.75–7.29 ac). One of the most species rich fields in both years, PA04/1-3, had a low diversity value for 2002. The diversity value for this field was among the top 10 for 2003, however. As with species richness, diversity also usually declined from 2002 to 2003 considered on a field-by-field basis. The comparison of means indicated the decline was not quite statistically significant, however ($p = 0.06$).

Table 8. Detection rates as an index of species abundance over the 29 fields surveyed in both 2002 and 2003. The three new fields surveyed in 2003 were not included in order to facilitate between year comparisons. Means were calculated from maximum number of detections/visit.

Species	Year				Guild
	2002		2003		
	mean (SE)		mean (SE)		
Tree swallow	2.07	(0.74)	1.44	(0.45)	Aerial
Cedar waxwing	1.95	(0.30)	1.21	(0.37)	Edge
Field sparrow*	1.90	(0.28)	1.68	(0.24)	Grass
Red-winged blackbird*	1.84	(0.38)	2.86	(0.89)	Grass
Common yellowthroat*	1.74	(0.23)	1.97	(0.24)	Shrub
Song sparrow*	1.48	(0.27)	1.59	(0.30)	Shrub
Prairie warbler*	1.29	(0.22)	1.10	(0.20)	Shrub
American goldfinch	1.08	(0.19)	1.05	(0.27)	Grass
Indigo bunting*	1.00	(0.15)	0.86	(0.13)	Shrub
Gray catbird*	0.98	(0.13)	0.72	(0.14)	Shrub
American crow	0.86	(0.22)	0.44	(0.13)	Edge
Yellow warbler*	0.84	(0.15)	0.87	(0.12)	Shrub
Mourning dove	0.75	(0.36)	0.34	(0.12)	Edge
Eastern towhee	0.61	(0.15)	0.50	(0.11)	Shrub
Blue-winged warbler	0.57	(0.11)	0.58	(0.16)	Shrub
Chipping sparrow	0.56	(0.14)	0.39	(0.09)	Grass
European starling	0.50	(0.37)	0.05	(0.04)	Edge
Barn swallow	0.48	(0.17)	1.93	(0.92)	Aerial
Eastern kingbird	0.44	(0.11)	0.33	(0.08)	Grass
Brown-headed cowbird	0.42	(0.21)	0.17	(0.07)	Edge
Turkey vulture	0.40	(0.20)	0.17	(0.16)	Aerial
Common grackle	0.37	(0.25)	0.06	(0.04)	Edge
Cliff swallow	0.36	(0.28)	0.41	(0.30)	Aerial
Eastern bluebird	0.36	(0.09)	0.08	(0.04)	Edge
Northern cardinal	0.35	(0.10)	0.11	(0.06)	Shrub
Northern flicker	0.30	(0.08)	0.09	(0.05)	Edge
Eastern phoebe	0.29	(0.09)	0.16	(0.07)	Edge
Least flycatcher	0.29	(0.11)	0.21	(0.07)	Edge
Red-tailed hawk	0.28	(0.10)	0.11	(0.06)	Aerial
American robin	0.24	(0.13)	0.18	(0.09)	Edge
Chestnut-sided warbler	0.21	(0.09)	0.03	(0.02)	Shrub
Willow flycatcher	0.21	(0.07)	0.28	(0.08)	Shrub
Rough-winged swallow	0.16	(0.08)	0.07	(0.04)	Aerial
Northern mockingbird	0.14	(0.08)	0.03	(0.03)	Edge
Baltimore oriole	0.12	(0.05)	0.44	(0.09)	Edge
Chimney swift	0.10	(0.10)			Aerial
Grasshopper sparrow	0.09	(0.06)			Grass
Brown thrasher	0.08	(0.05)	0.03	(0.03)	Shrub

Table 8. Detection rates as an index of species abundance over the 29 fields surveyed in both 2002 and 2003. The three new fields surveyed in 2003 were not included in order to facilitate between year comparisons. Means were calculated from maximum number of detections/visit (continued).

Species	Year				Guild
	2002		2003		
	mean (SE)		mean (SE)		
Orchard oriole	0.08	(0.07)			Edge
Blue jay	0.06	(0.04)	0.18	(0.08)	Edge
Bobolink	0.05	(0.04)			Grass
Eastern meadowlark	0.05	(0.04)	0.06	(0.04)	Grass
House wren	0.05	(0.04)	0.07	(0.07)	Shrub
Warbling vireo	0.05	(0.04)	0.12	(0.05)	Edge
Yellow-breasted chat	0.03	(0.03)			Shrub
Savannah sparrow	0.02	(0.02)			Grass
Bank swallow	0.01	(0.01)	0.29	(0.15)	Aerial
Downy woodpecker			0.03	(0.03)	Edge
Ruby-throated hummingbird			0.05	(0.04)	Edge

* indicates density calculated for species

Table 9. Species richness per field in 2002 and 2003, mean species richness per year (calculated for 29 fields surveyed in both years only), and results of statistical test of difference between means.

Field	No. points	Size (ha)	No. species		2002 mean	2003 mean
			2002	2003		
PA01/1-3	3	20.71	26	18	16.1	13.6
NJ11/1&2	2	15.66	24	21	t-test of means: $t = 2.259, 56 df,$ $p = 0.0278$	
NJ10/2-4	2	26.45	23	20		
PA13/2	1	9.20	21	16		
PA03/1-3	3	13.19	20	19		
PA04/1-3	2	35.91	19	22		
PA09/2&3	2	11.69	19	25		
NJ18/1	1	5.29	18	10		
PA14/1	1	4.67	18	11		
NJ09/1	1	8.05	17	15		
PA14/2	1	5.06	17	13		
NJ01/1	1	11.08	16	14		
NJ07/1	1	2.95	16	14		
PA02/1	1	2.46	16	9		
PA07/1	1	4.63	16	14		
PA09/1	1	11.60	16	14		
NJ02/1	1	4.20	15	13		
NJ12/1	1	4.65	15	11		
PA11/1&2	2	30.39	15	13		
PA05/1	1	4.77	14	9		
PA18/1	1	2.33	14	8		
NJ10/1	1	2.78	13	11		
NJ04/2	1	4.62	12	12		
NJ15/1	1	6.38	12	10		
PA13/1	1	3.78	12	10		
PA19/1	1	2.08	12	6		
NJ04/1	1	10.77	11	12		
NJ16/1	1	5.21	11	14		
NJ05/1	1	6.89	9	9		
NJ19/1	1	6.91	n/a	10		
NJ20/1	1	4.25	n/a	13		
NJ20/2	1	3.52	n/a	7		

Table 10. Species diversity per field in 2002 and 2003, mean diversity per year (calculated for 29 fields surveyed in both years only), and results of statistical test of difference between means.

Field	No. points	Size (ha)	Diversity		2002 mean	2003 mean
			2002	2003		
PA01/1-3	3	20.71	2.95	2.55	2.42	2.28
NJ11/1&2	2	15.66	2.91	2.72	t-test of means: $t = 1.921$, 56 df , $P = 0.0599$	
NJ10/2-4	2	26.45	2.76	2.59		
PA09/2&3	2	11.69	2.70	2.92		
PA13/2	1	9.20	2.66	2.45		
NJ09/1	1	8.05	2.60	2.48		
PA03/1-3	3	13.19	2.55	2.67		
NJ07/1	1	2.95	2.53	2.58		
PA02/1	1	2.46	2.49	1.86		
PA18/1	1	2.33	2.49	1.69		
PA14/2	1	5.06	2.48	2.35		
PA14/1	1	4.67	2.47	2.15		
NJ01/1	1	11.08	2.46	2.48		
PA11/1&2	2	30.39	2.46	2.04		
PA07/1	1	4.63	2.43	2.23		
NJ18/1	1	5.29	2.43	1.91		
NJ15/1	1	6.38	2.43	2.25		
NJ02/1	1	4.20	2.41	2.40		
PA09/1	1	11.60	2.34	2.39		
PA13/1	1	3.78	2.32	2.15		
PA19/1	1	2.08	2.32	1.73		
NJ16/1	1	5.21	2.31	2.31		
PA05/1	1	4.77	2.30	1.73		
NJ10/1	1	2.78	2.30	2.21		
PA04/1-3	2	35.91	2.26	2.51		
NJ04/1	1	10.77	2.21	2.27		
NJ12/1	1	4.65	2.12	2.04		
NJ04/2	1	4.62	1.78	2.30		
NJ05/1	1	6.89	1.75	2.06		
NJ19/1	1	6.91	n/a	2.04		
NJ20/1	1	4.25	n/a	2.25		
NJ20/2	1	3.52	n/a	1.83		

Density by Field

Examining maximum-visit density values on an individual field basis (Table 11), several observations are of interest. Few fields contained all eight species, this occurred at only two fields and only in 2002 (PA01/1-3 and PA03/1-3). Most fields had between five and seven of these species, but, as evidenced by presence/absence indications between years within the table, there was considerable species turnover between years in some fields (e.g., NJ01/1) although others remained stable (PA14/1). The summary of gains and losses at the bottom of Table 11 show that yellow warbler and gray catbird, in particular, exhibit relative instability in occupation of specific fields. Fields with maximum values per species per year are summarized in Table 12. Fifteen fields were represented with PA14/1 included for five species and PA2/1 and PA18/1 each included for three species.

Density Estimates

Density Comparison Between Years and Calculation Methods

Density estimates were calculated for eight species as the mean number of territorial (singing) males per hectare for all sites. Separate estimates were prepared based on either the mean or maximum number of detections per visit (Table 13). No significant ($P < 0.05$) between-year differences were found based on analysis of the maximum visit density or mean of visits density estimates, in fact, p-values were high and substantial overlap exists between 95% confidence intervals for the two years (Figure 9). Density values were considerably higher for all species when using the maximum visit method. The difference between the methods for a species within a year was not statistically tested. However, comparing confidence intervals between methods does suggest that some density estimates differ based on method, such as the Yellow Warbler's 2003 estimates.

Density Comparison Among Species

Because no significant differences were found within species between years, a mean of the two density estimates (one mean for each method) was calculated and the maximum-visit density was compared statistically between species (Figure 10). Song sparrow and common yellowthroat maximum-visit densities (gray bars in Figure 10) were significantly higher than the densities for the other six species, and effect-size differences were large (roughly 50% greater than the density for the next highest species). The next highest density, that of the field sparrow, was significantly higher than the next four species except for the red-winged blackbird and again differences between means were large. This ordering of species and the magnitude of differences between them is substantially different from the index of abundance rankings reported previously and shown in Table 8. The mean-of-visits density estimate is shown (Figure 10) in order to emphasize the difference in the density estimates derived from the two procedures; this density estimate is generally about 50% of the size of the maximum visit density estimate.

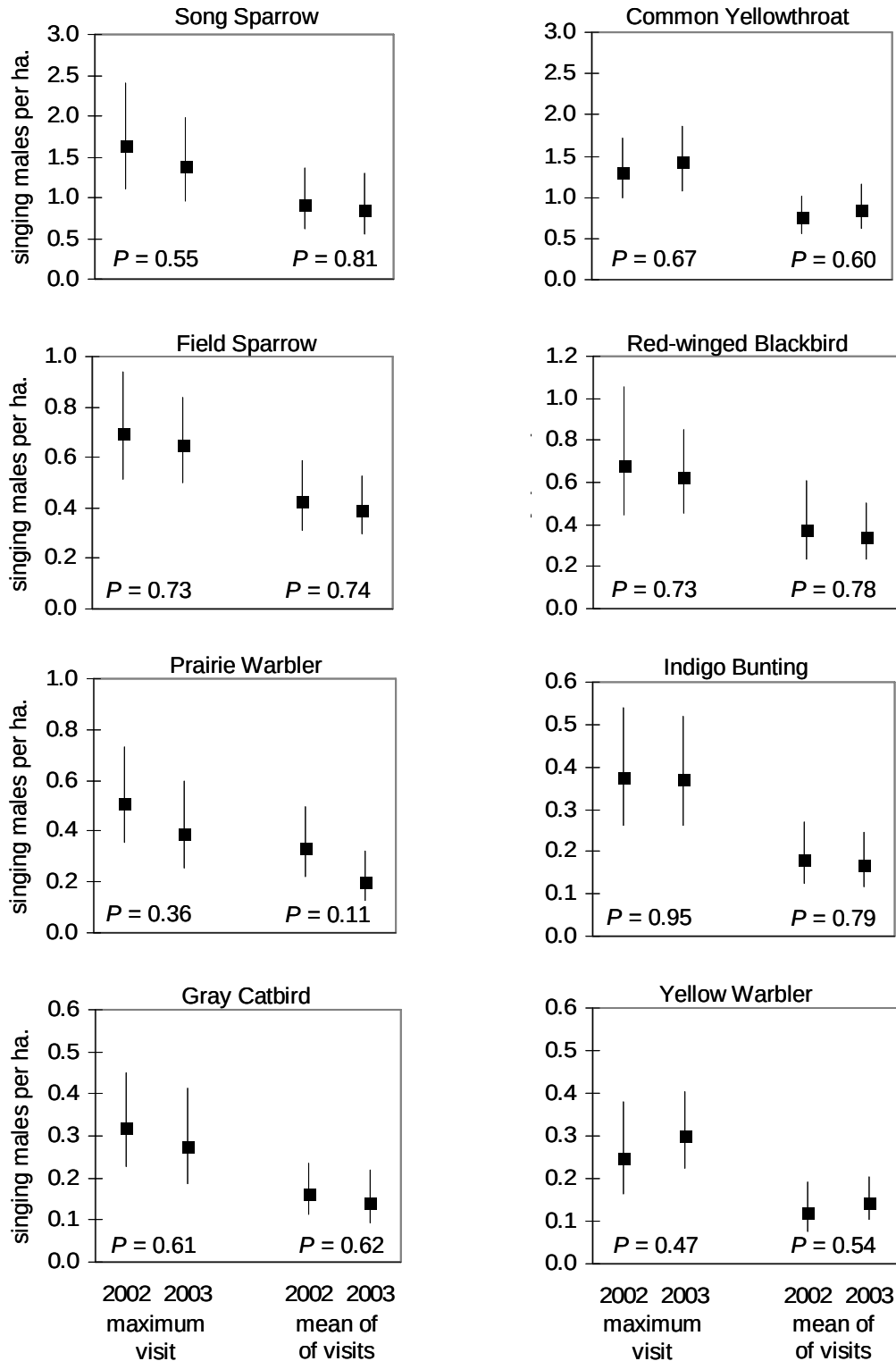


Figure 9. Species density compared between years and between calculations of density based on maximum visit and mean of visits method. Means shown with 95% confidence limits obtained from program DISTANCE[®], P-values indicate statistical testing of between-year differences within calculation method (z-test approximation of t-test).

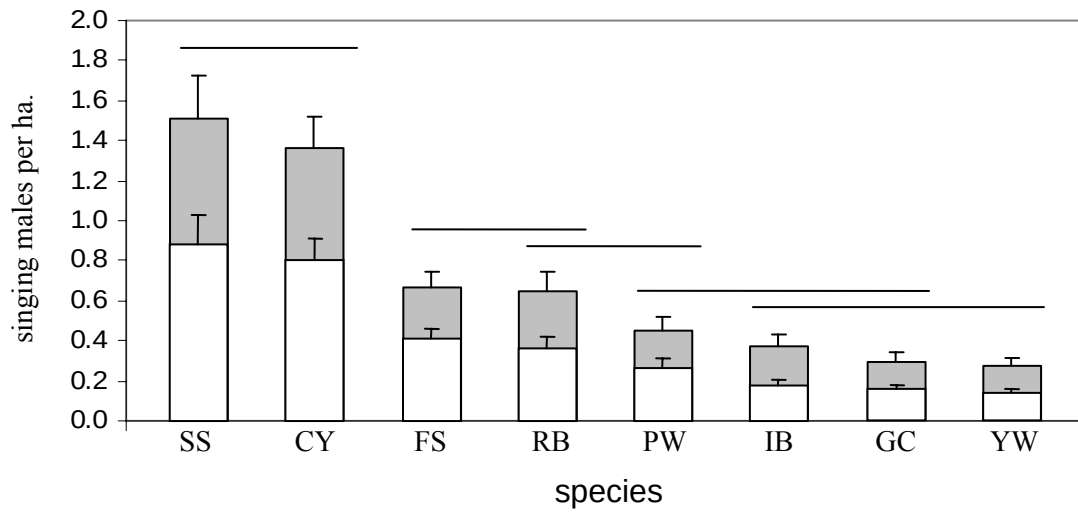


Figure 10. Among species comparison of density estimates following averaging of 2002 and 2003 values. Within a species the maximum visit density is the shaded gray bar and the mean of visits density is the white bar. Densities are shown +1 standard error and significant differences ($p \leq 0.05$) between species are indicated by bars that do not share a horizontal line (z-test of maximum visit densities only). Codes for species are SS = song sparrow, CY = common yellowthroat, FS = Field Sparrow, RB = Red-winged Blackbird, PW = Prairie Warbler, IB = Indigo Bunting, GC = Gray Catbird, and YW = Yellow Warbler.

Table 11. Individual species maximum-visit density values (singing males/ha) per field for both years (2002 values shown with 2003 values in parenthesis) and counts of these species per year. Fields are arranged in descending number of 2002 species, asterisks represent species density estimate gains = * and losses (*) between years, and n/a signifies fields not surveyed in 2002. Sums of the gains and losses between years for each species across fields are also shown (29 between-year fields only).

Field	Common Yellowthroat	Field Sparrow	Gray Catbird	Indigo Bunting	Prairie Warbler	Red-winged Blackbird	Song Sparrow	Yellow Warbler	#spp 2002	#spp 2003
PA01/1-3	1.49 (1.24)	0.46 (0.46)	0.14 (0.14)	0.44 (0.59)	0.29 (*)	1.15 (1.04)	2.56 (2.56)	0.37 (0.37)	8	7
PA03/1-3	2.48 (2.98)	0.61 (0.91)	0.69 (0.41)	0.15 (*)	0.58 (0.43)	0.46 (0.35)	3.52 (3.52)	0.49 (0.49)	8	7
NJ04/1	1.49 (0.74)	0.91 (0.91)	0.41 (*)	0.44 (0.44)	* (0.43)	0.35 (0.35)	2.88 (0.96)	0.37 (0.37)	7	7
NJ07/1	* (0.74)	1.37 (0.91)	0.41 (0.41)	1.32 (0.44)	0.86 (*)	0.35 (*)	0.96 (1.92)	0.37 (0.37)	7	6
NJ09/1	2.23 (1.49)	0.91 (0.91)	0.41 (0.41)	0.44 (0.88)	0.43 (0.43)	1.39 (1.04)	0.96 (*)	* (0.37)	7	7
NJ12/1	0.74 (2.23)	1.82 (1.82)	0.41 (0.41)	0.44 (0.88)	0.86 (0.86)	1.73 (*)		0.37 (*)	7	5
PA05/1	0.74 (2.23)	0.46 (0.91)	0.41 (*)	0.44 (0.44)	0.43 (*)	* (0.69)	2.88 (4.81)	0.74 (0.37)	7	6
PA09/2&3	1.49 (2.98)	0.68 (0.68)	0.21 (*)	0.22 (0.44)	0.86 (0.65)	0.17 (0.52)	1.44 (1.44)	* (0.55)	7	7
NJ01/1	0.74 (0.74)	1.82 (0.46)	0.41 (1.23)	* (0.44)	0.86 (0.86)		0.96 (0.96)	0.37 (*)	6	6
NJ02/1	2.23 (*)	0.46 (*)	0.41 (0.41)	0.44 (*)	* (0.43)	0.35 (*)	2.88 (1.92)	* (0.37)	6	4
NJ10/2-4	0.25 (0.99)	0.30 (1.06)	* (0.14)	0.44 (0.15)	0.72 (0.58)	2.08 (1.04)	0.64 (0.32)		6	7
NJ11/1&2	0.37 (0.74)	0.23 (0.23)	* (0.41)	0.22 (0.88)	0.22 (*)	0.69 (0.87)	0.48 (0.48)	* (0.37)	6	7
NJ15/1	1.49 (1.49)	0.91 (*)	0.41 (0.41)	0.44 (0.44)	0.43 (0.86)		1.92 (*)	* (0.37)	6	5
PA13/2	* (0.74)	0.46 (0.46)	0.41 (0.41)	0.88 (*)	0.43 (0.86)	1.04 (1.39)	0.96 (1.92)	* (0.37)	6	7
PA14/1	3.72 (2.23)	1.82 (1.82)		1.32 (0.88)	0.43 (0.43)		1.92 (2.88)	1.10 (0.37)	6	6
PA14/2	1.49 (1.49)	1.37 (0.91)	0.41 (*)	0.44 (0.44)	0.43 (0.43)	* (0.35)	0.96 (*)	* (0.37)	6	6
NJ04/2	0.74 (0.74)	0.91 (0.46)	* (0.41)			1.73 (1.73)	0.96 (*)	0.37 (0.37)	5	5
NJ05/1	1.49 (2.23)	2.28 (1.37)	0.41 (0.41)	0.88 (0.44)	1.73 (1.3)		* (0.96)		5	6
PA02/1	2.98 (2.23)			0.44 (0.88)		0.69 (0.35)	4.81 (4.81)	0.37 (*)	5	4
PA04/1-3	2.23 (1.98)	* (0.15)		0.15 (*)		1.50 (0.92)	4.49 (1.28)	0.25 (0.37)	5	5
PA07/1	1.49 (1.49)	0.46 (1.37)	0.41 (*)	* (0.44)	0.86 (1.3)		* (0.96)	0.37 (0.37)	5	6
PA09/1	0.74 (0.74)	1.82 (1.37)	0.41 (0.82)	0.44 (*)	1.30 (1.73)			* (0.37)	5	5
PA11/1&2	0.74 (2.23)		0.21 (*)	0.44 (0.22)		0.52 (1.04)	0.96 (1.92)	* (0.18)	5	5
PA13/1	0.74 (*)	0.46 (0.46)	0.82 (0.41)		1.73 (0.86)	* (0.35)	0.96 (1.92)		5	5
PA18/1	1.49 (3.72)		1.23 (0.41)	0.88 (0.44)		* (0.35)	1.92 (4.81)	0.74 (1.1)	5	6
PA19/1	1.49 (0.74)	0.46 (0.46)	0.82 (0.82)		0.43 (*)			1.10 (0.74)	5	4
NJ16/1	1.49 (0.74)	1.37 (0.91)	0.82 (*)	* (0.44)	0.86 (0.86)			* (0.37)	4	5
NJ18/1		1.82 (0.46)	0.41 (0.41)	0.44 (0.44)		0.69 (0.69)			4	4
NJ10/1		* (1.37)			1.30 (0.43)	0.69 (1.04)		0.37 (*)	3	3

Table 11. Individual species maximum-visit density values (singing males/ha) per field for both years (2002 values shown with 2003 values in parenthesis) and counts of these species per year. Fields are arranged in descending number of 2002 species, asterisks represent species density estimate gains = * and losses (*) between years, and n/a signifies fields not surveyed in 2002. Sums of the gains and losses between years for each species across fields are also shown (29 between-year fields only) (continued).

Field	Common Yellowthroat	Field Sparrow	Gray Catbird	Indigo Bunting	Prairie Warbler	Red-winged Blackbird	Song Sparrow	Yellow Warbler	#spp 2002	#spp 2003
NJ19/1	n/a (0.74)	n/a	n/a (0.41)	n/a (0.88)	n/a (0.43)	n/a (2.08)	n/a	n/a	n/a	5
NJ20/1	n/a	n/a (0.46)	n/a	n/a (0.44)	n/a	n/a (1.39)	n/a	n/a (0.37)	n/a	4
NJ20/2	n/a	n/a (0.46)	n/a (1.23)	n/a (0.88)	n/a	n/a	n/a	n/a	n/a	3
gains/ losses (# fields)	2/2	2/2	3/7	3/5	2/5	4/3	1/4	10/4		

Table 12. Fields with the highest density values for the eight species.

Species	2002 Field #	NPS Name/#	2002 Density	2003 Field #	NPS Name/#	2003 Density
Common yellowthroat	PA14/1	Bushkill, 5	3.72	PA18/1	Michaels, 30	3.72
Field sparrow	NJ5/1	Roberts/Ennis 8, 23	2.28	PA14/1 NJ12/1	Bushkill, 5 Walpack Ctr., 18	1.82
Gray catbird	PA18/1	Michaels, 30	1.23	NJ01/1 NJ20/2	Shimers, 7 Lennington, 4	1.23
Indigo bunting	PA14/1 NJ07/1	Bushkill, 5 Flatbrook WMA	1.32	PA02/1 PA14/1 NJ09/1 NJ11/1&2 NJ12/1 NJ19/1 NJ20/2	Independence, 3 Bushkill, 5 Walpack Inn Sil. Spray, 10,8 Walpack Ctr., 18 B&H Spur, 8 Lennington, 10	0.88
Prairie warbler	NJ5/1	Roberts/Ennis 8, 23	1.73	PA09/1	Loch Lomond	1.73
Red-winged blackbird	NJ10/2-4	Walpack Ctr., 9, 6	2.08	NJ19/1	B&H Spur, 8	2.08
Song sparrow	PA02/1	Independence, 3	4.81	PA02/1 PA05/1 PA18/1	Independence, 3 Airfield Rd., 11 Michaels, 30	4.81
Yellow warbler	PA14/1 PA19/1	Bushkill, 5 Michaels, 18	1.10	PA19/1	Michaels, 18	0.74

Power Analysis Results

The power to detect a 20% change in species density between two sampling periods under the current sampling design was uniformly low for all species and differed little between the maximum visit and the mean of visits density estimate within species (Table 13.). Small differences in this power value within some species are apparent depending on the type of density estimate, but between species these differences are not consistently in one direction or another. The largest improvement in power is seen with the common yellowthroat's maximum density estimate, an increase of 0.12. However, the next largest increase in power (0.08) is with the field sparrow's average density estimate. The lack of power is also evident in the relatively large changes (range 32–44%) estimated as necessary to occur in order for this sampling procedure to detect them with a reasonable amount of certainty (power constrained at 0.80; i.e., 80% of the time).

Principle Components Analysis

The first three principal components together explained most of the variance of the data matrix (89%; Table 14). Of these, PC 1 explained more of the variance (42%) than PC 2 (28%), which was followed by PC 3 (16%). Looking at the loadings of the variables for these factors, PC 1 was interpreted to represent a field's vegetative structure based on the foliage height distribution variables (FHD 0–5 dm [0–20 in] and FHD 5–10 dm [20–40 in]) at one end of the spectrum and bare ground cover at the other. PC 2 appeared to represent vegetative composition with cover of Grass/Sedge and Forb having strong, opposite loadings. Another structural measure, Litter Depth, alone appeared to account for most of PC 3. The presence of relatively high factor loadings for Forb Cover in both PC 1 and PC 2 may indicate some instability in the analysis, cross loadings such as this can be due to a small sample size (Osbourne et al. 2004). Alternatively, Forb Cover could also be correlated to field vegetative structure. Although not necessarily the case in PCA analysis, the sign of the factor loading is positively associated with the value of the actual variables; thus, for instance, the PC 1 score for a field with high Grass/Sedge Cover is also high. This relationship is explored further in Figure 11, which plots individual fields based on their scores for PC 1 and PC 2, presumably the most important of the three PC's based on their percent variance explained. While Figure 11. shows a cloud of points with little definition, there does appear to be some grouping along the PC 2 (compositional) gradient. The majority of the largest fields (>20 ha [>50 ac]) tend toward grass dominance, while fields in the middle size class (10–20 ha [25–50 ac]) have increased forb cover. Fields in the smallest size category show no obvious compositional tendencies. No such grouping is apparent along PC 1, the fields array along this structural gradient.

Correlation Analysis

Few significant correlations were produced from the Spearman rank correlation analysis, and the strength of these correlations was low to moderate, ranging from -0.37 to 0.59 (Table 15.). Thus, none of the significant correlations could be said to represent strong associations between variables. The strongest (and positive) correlation was between two bird species density values, the common yellowthroat and the song sparrow. Common yellowthroat densities were also positively correlated with those of the yellow warbler. Other species density correlations

Table 13. Components and results of power calculations for the eight density species.

Species	Density estimate type ^a	Density per year ^b		SD ^c	20% change power ^d	Detectable % change with power = 0.80 ^e
		2002	2003			
Song sparrow	max	<i>1.63</i>	1.39	1.622	0.34	40
	mean	<i>0.91</i>	0.85	0.972	0.32	43
Common yellowthroat	max	1.30	<i>1.42</i>	1.130	0.47	32
	mean	0.76	<i>0.85</i>	0.844	0.35	40
Field sparrow	max	<i>0.69</i>	0.65	0.601	0.42	35
	mean	<i>0.42</i>	0.39	0.322	0.50	30
Red-winged blackbird	max	<i>0.68</i>	0.62	0.662	0.35	39
	mean	<i>0.38</i>	0.34	0.387	0.33	41
Prairie warbler	max	<i>0.51</i>	0.39	0.464	0.39	37
	mean	<i>0.33</i>	0.20	0.273	0.45	33
Indigo bunting	max	<i>0.38</i>	0.37	0.392	0.32	42
	mean	<i>0.18</i>	0.17	0.198	0.31	43
Gray catbird	max	<i>0.32</i>	0.28	0.343	0.31	43
	mean	<i>0.16</i>	0.14	0.178	0.31	43
Yellow warbler	max	0.25	<i>0.30</i>	0.311	0.33	42
	mean	0.12	<i>0.14</i>	0.160	0.30	44

a. max = distance analysis results using maximum visit density, mean = distance analysis results using mean of visits density.

b. Highest year-value is in italics and this value was used to compute effect size (% change).

c. Standard deviation of the set of between-year differences of 40 sampling points.

d. Power to detect a change of 20% in density between years using the highest year-value and alpha = .10.

e. Percent change of the highest year-value required in order to detect the change with a power of .80 and alpha = 0.10.

Table 14. Principal Components Analysis (PCA) results: cumulative variance of the data matrix explained by the first three principal components and factor loadings of the variables for each component.

Principal component (PC)	Eigenvalue	Proportion of Variance Explained	Cumulative Proportion
1	2.50	0.42	0.42
2	1.69	0.28	0.70
3	0.97	0.16	0.86

Variables	Factor Loadings		
	PC 1	PC 2	PC 3
Litter Depth	0.06	0.32	0.88
FHD 0-5dm	0.50	0.36	-0.04
FHD 5-10dm	0.45	0.08	-0.37
Grass/Sedge Cover	-0.21	0.70	-0.22
Forb Cover	0.49	-0.46	0.18
Bare Ground Cover	-0.51	-0.26	-0.01

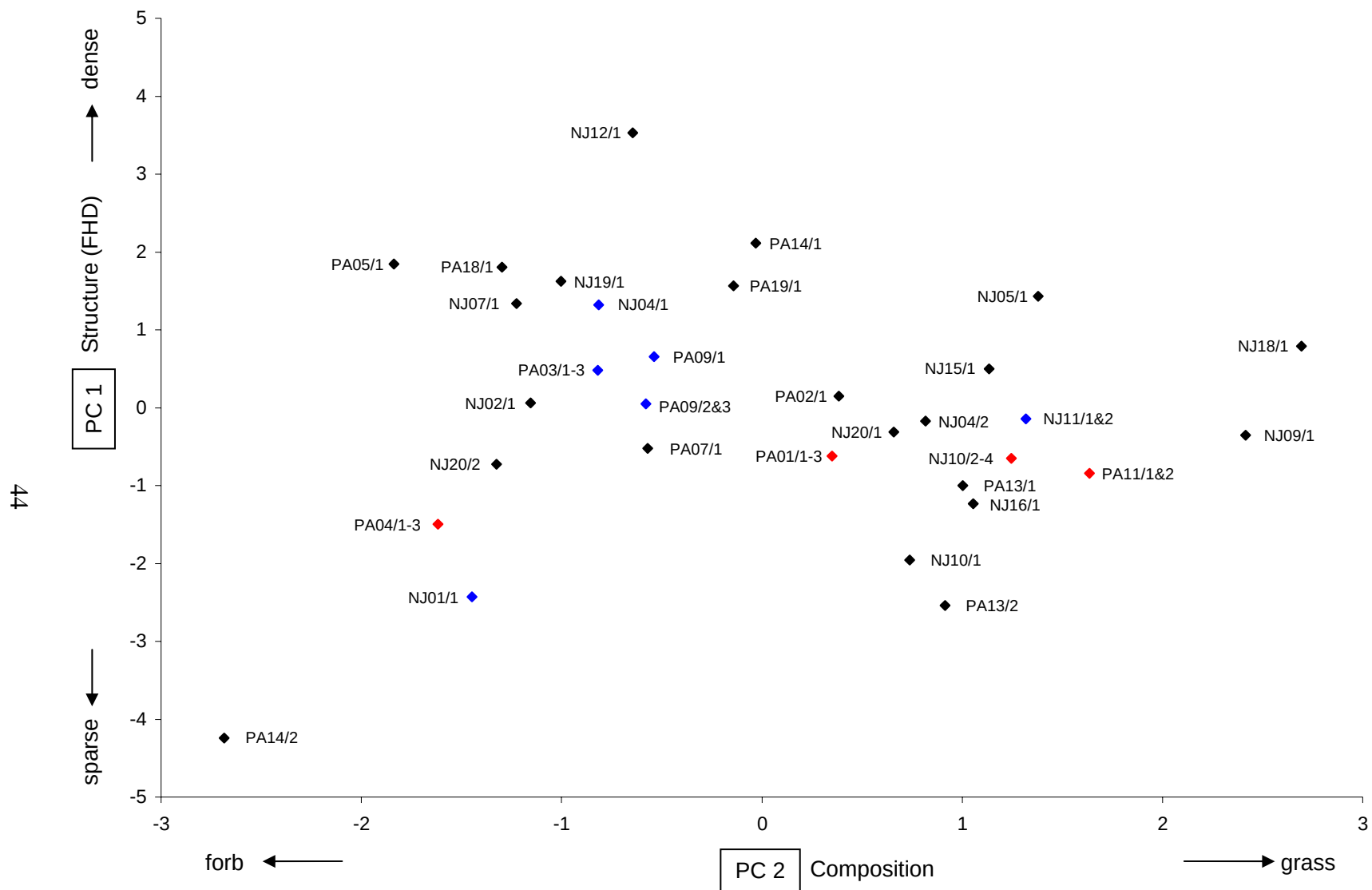


Figure 11. Principal component 1 plotted against principal component 2. Field area indicated by color: <10 ha = black, 10–20 ha = blue, >20 ha = red.

Table 15. Selected results of Spearman rank correlation analysis of GIS, PCA, and 2003 avian data. Bold values indicate significant correlations at p=0.05 and italicized correlations are marginally significant at p=0.10.

Variable	Field sparrow	Gray catbird	Indigo bunting	Prairie warbler	Red- winged blackbird	Song sparrow	Yellow warbler	PC 1	PC 2	PC 3	Area (ha)	Survey point edge
Common yellowthroat	0.10	<i>-0.30</i>	0.18	-0.01	-0.16	0.59	0.42	0.31	-0.22	0.20	0.19	-0.09
Field sparrow		-0.14	0.08	0.50	-0.33	-0.17	-0.16	0.21	-0.04	0.33	-0.19	0.13
Gray catbird			0.00	0.15	-0.27	-0.25	-0.11	0.05	-0.11	-0.10	-0.21	0.12
Indigo bunting				-0.16	-0.06	0.02	-0.20	0.31	0.01	0.00	-0.22	0.03
Prairie warbler					-0.37	-0.28	-0.19	-0.05	0.04	0.14	-0.11	-0.13
Red-winged blackbird						-0.12	-0.11	-0.20	0.28	-0.07	<i>0.30</i>	<i>-0.30</i>
Song sparrow							0.31	0.22	-0.27	0.06	0.00	0.21
Yellow warbler								0.15	-0.26	0.23	-0.06	0.19
Area (ha)								-0.26	0.09	0.09		
Richness ^a								-0.45	0.08	0.28	0.52	-0.28
Diversity ^a								-0.46	0.07	0.14	0.50	-0.38

a. correlation analysis using 1-survey point fields only (n=25).

indicate some positive association between field sparrows and prairie warblers, and a small negative association between prairie warblers and red-winged blackbirds. The principal component that reflected a gradient in field structural characteristics (PC 1) showed a significant negative correlation with species richness and diversity values, while field area was significantly and positively correlated with these two avian indices. These correlations were based on a reduced subset of the fields, only those containing one survey point to attempt to remove the effect of differential sampling bias from the correlation.

Species Richness and Diversity vs. Field Area

As a final means of assessing which fields may be most important to DEWA, the relationships suggested by the correlations are explored further graphically. Open guild species richness and diversity are plotted against field area in Figures 12 and 13, respectively. Area is plotted on the z-axis to facilitate reference to fields of specific size on the correlation line, to disperse fields horizontally across the graph permitting easier viewing of species richness/diversity vs. area relationships and to allow for clear labeling of individual fields. As suggested by the correlations, the plot indicates that species richness and diversity are positively associated with field size. This relationship appears to increase in a non-linear manner judging by the field values previous to and following the point where field area increases dramatically (at approximately 10 ha [25 ac]). It is also primarily the fields above this area that contain more than one sampling point. Abundant spread in the data is evident as well suggesting the influence of other factors on these indices. The difference between years in species richness and diversity noted previously is also quite apparent.

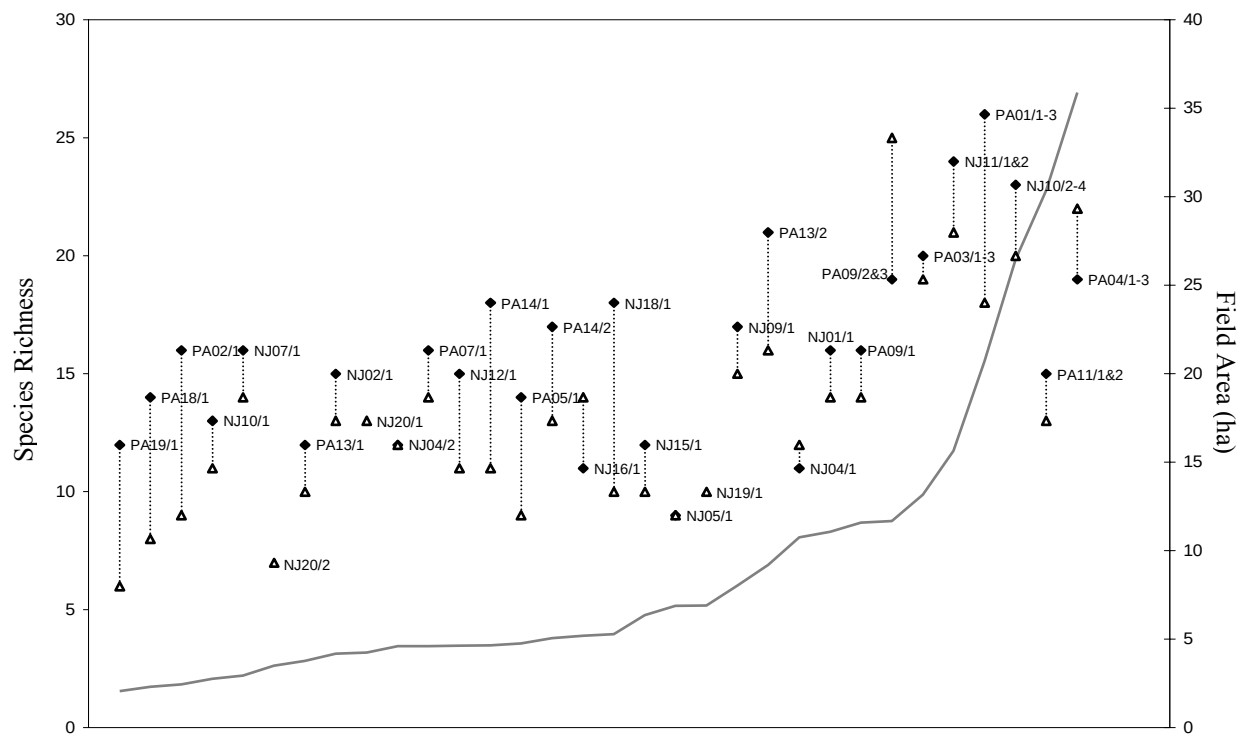


Figure 12. Open guild species richness in 2002 (closed diamonds) and 2003 (open triangles) arranged along an increasing gradient of field size (ha).

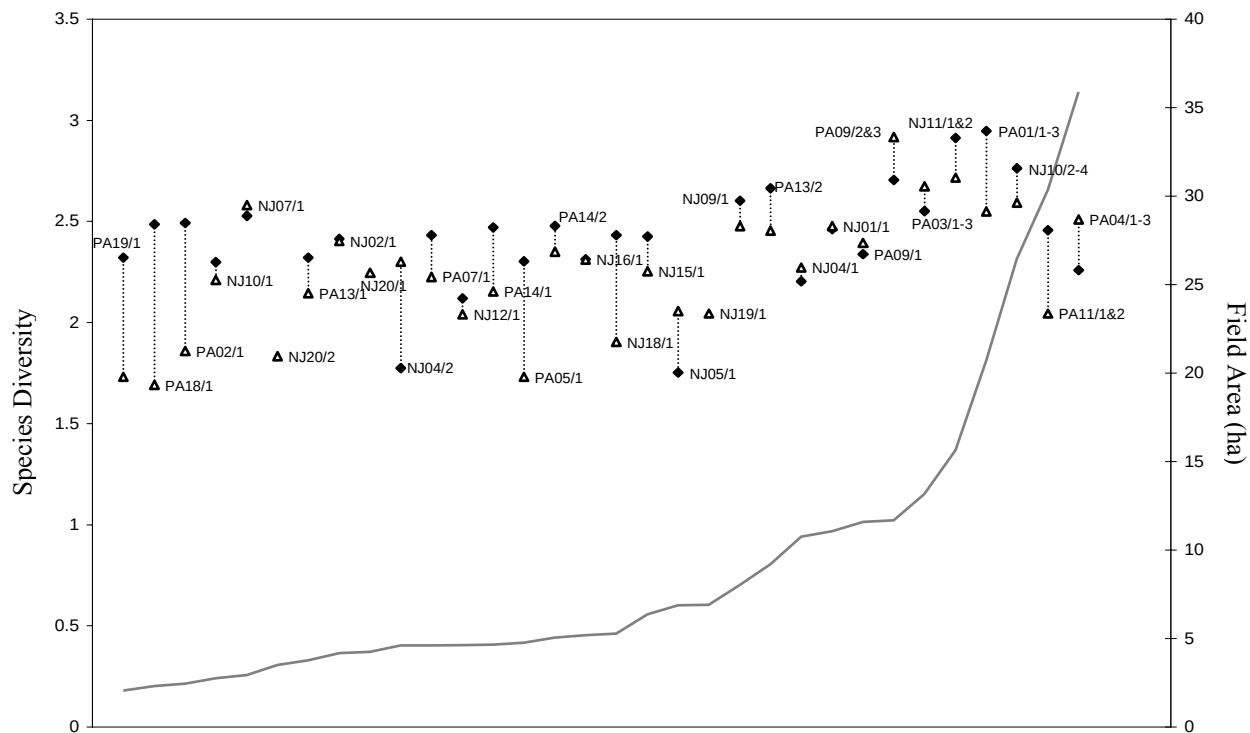


Figure 13. Open guild species diversity in 2002 (closed diamonds) and 2003 (open triangles) arranged along an increasing gradient of field size (ha).

Discussion

Grassland Species

There are many factors that influence the distribution and abundance of grassland species, including area sensitivity, plant composition, plant structure, and the surrounding landscape just to mention a few. Our results implicate some of the factors that might be playing a role in DEWA.

Area sensitivity may be among the influencing factors (Herkert 1994; Vickery et al. 1994, Clawson and Rotella 1996; Walk and Warner 1999; Douglas and Lawrence 2001). It is the most important variable that grassland birds appeared to respond to in a New York study (Norment et al. 1999). Two-thirds of the survey fields were less than 10 ha (25 ac) (see Table 9), the suggested minimum size for many grassland species (Herkert et al. 1994). Species richness and diversity rose with field size of 10 ha (25 ac) or more, although this could be due to a species-area, sampling effort effect because most large fields had more than one survey point placed in them (see Figures 12 and 13).

Many of the largest fields are dissected by hedgerows which reduces their effective size (O'Leary and Nyberg 2000), but several exhibited the highest species richness, diversity, and density values (see Tables 9–12). It is from these fields that the few sightings of targeted grassland species have come (see Table 7). Correlation values between area and diversity/richness indices were moderate (see Table 15) suggesting some association between these variables. A notable exception, the field sparrow, was the most abundant grassland bird (facultative) found in the park, it is not area sensitive (Vickery et al. 1994), preferring small habitat patches (Horn et al. 2002.).

Vegetation structure, as indicated by the principal components analysis and measured by foliage height distribution (FHD) and amount of bare ground, may have some influence on distribution of grassland birds in DEWA (see Table 15) and other locations (Kobal et al. 1999; Norment et al. 1999). The majority of large fields characterized by high richness, diversity and density values, and at least fleeting glimpses of target species, all fall in the less dense structural range (see Table 15). Fields with these vegetative characteristics contained the most abundant and diverse assemblage of grassland birds in New York (Norment et al. 1999), and this pattern has management implications.

Composition of the surrounding landscape also influences the presence of grassland species. There is a greater tendency to inhabit smaller patches if surrounding habitat consists of large, open expanses of grassland (Bakker et al. 2002).

Shrubland Species

Shrubland birds were not intended to be a primary focus of this project and shrub dominated fields were intentionally eliminated from our sampling protocol. However, shrubland birds compose the majority of the top ranking species in occurrence, detection frequency, and density analyses. They constitute six of the eight species whose level of detection frequency was sufficient for density calculations (see Table 5). This is probably due to the mosaic of grassland,

shrubby borders, and hedgerows that characterize many DEWA fields. There are virtually no fields, even the largest ones, that don't have a mixture of these habitat types and are divided in some manner by hedgerows (see Appendix I). Consequently, some focus on shrubland species is warranted.

Patterns of distribution and abundance among shrubland birds generally suggest no relationship with area (Rudnický and Hunter 1993; Krementz and Christie 2000; Litvatis 2001). For example, the common yellowthroat, the most abundant shrubland species, is considered to be area independent (Douglas and Lawrence 2001). In contrast, the prairie warbler does demonstrate some degree of area sensitivity (Annand and Thompson 1997) and prefers to nest >20 m (65 ft) from edge habitat (Woodward et al. 2001).

Because shrubs were only rarely encountered on vegetation transects, and contributed very little to an understanding of bird distribution and abundance, they were dropped from further vegetative analyses. They were characteristically associated with hedgerows and as a fringe between woodland and grassland. Thus, they did not appear on vegetation transects which were centered on the survey points in the middle of grassland for the most part. Therefore, we did not demonstrate significant differences in preference between grassland species and shrubland species for vegetation characteristics. Nevertheless, shrubland species were obviously detected often, probably because the small size of many fields allowed observers to record them from isolated shrubs within fields and the woodland-grassland fringe during point counts. Because shrubland birds are generally less area sensitive, they probably do not respond as much to surrounding landscape factors.

Management Approach

Management activities can be applied at differing spatial scales (see Figures 14 and 15). Ecosystem approaches attempt to conserve biological diversity and thus are generalized in their effect and referred to as a "coarse filter" approach (Hunter 1990; Probst and Crow 1991; Noss et al. 1995). At this scale, management activities are directed at conserving assemblages, suites, guilds, and/or relatively large groups of species. Current management activities in the park exemplify this approach and have resulted in a mix of early successional habitats suitable for a range of characteristic species. A species level or "fine filter" approach is more narrowly focused toward specific habitats and/or species and can be extremely important for managing threatened and endangered species (Thompson and DeGraaf 2001).

Application of management activities based on spatial scale considerations involves three subsequent concerns including size, proximity of edges, and the spatial arrangement of habitat patches within the surrounding landscape. Habitat concerns include prioritization of management activities for grassland or shrubland birds, and depending on the choice, consideration of whether existing habitat is vegetated by native vs. exotic plants and if planting is necessary, what species/groups of plants to use. Implementation, the third consideration, could involve planting and/or introducing forms of disturbance to existing vegetative communities. Plantings may be done once or may have to be repeated. Both the type of disturbance (e.g., mowing/burning for grasslands) and frequency (e.g., short or long term) have to be considered. With the approach determined and concerns considered, a decision hierarchy can be

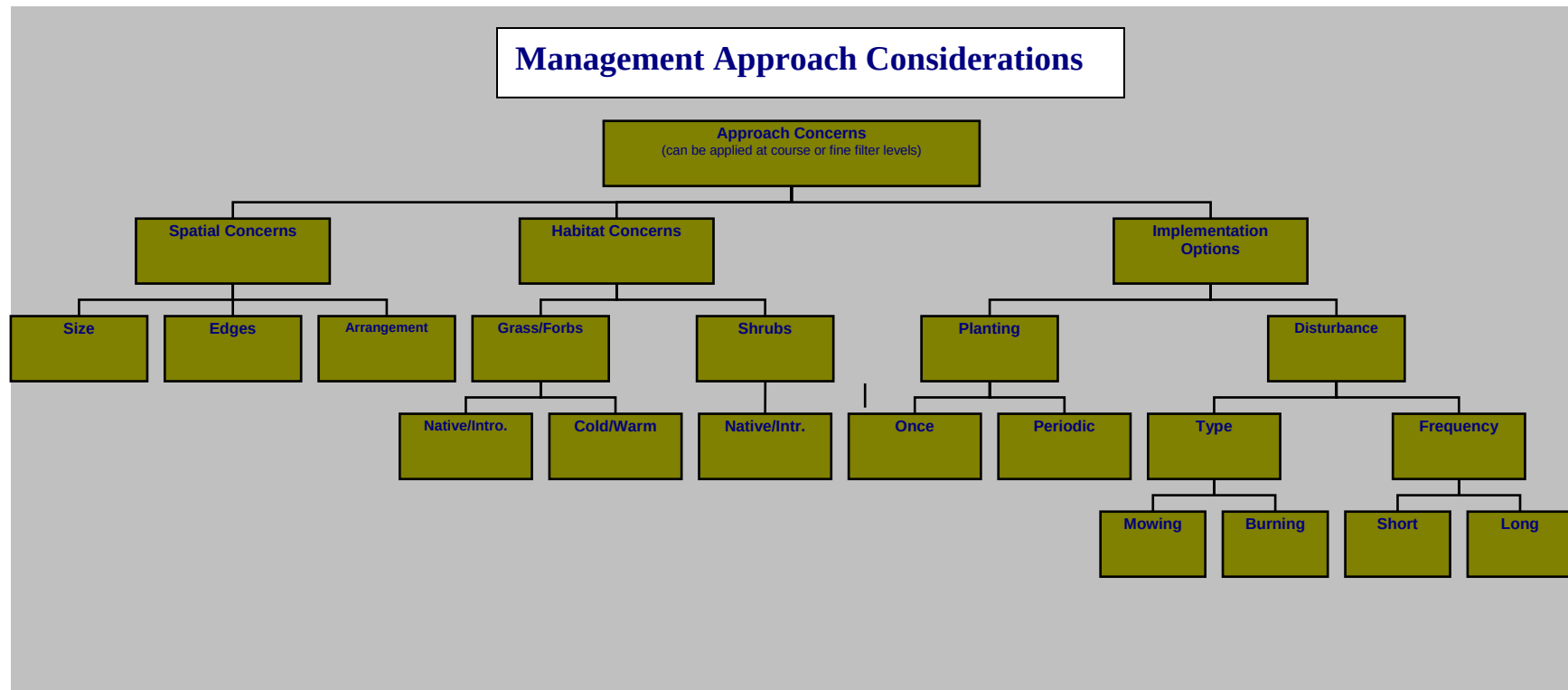


Figure 14. Management approach.

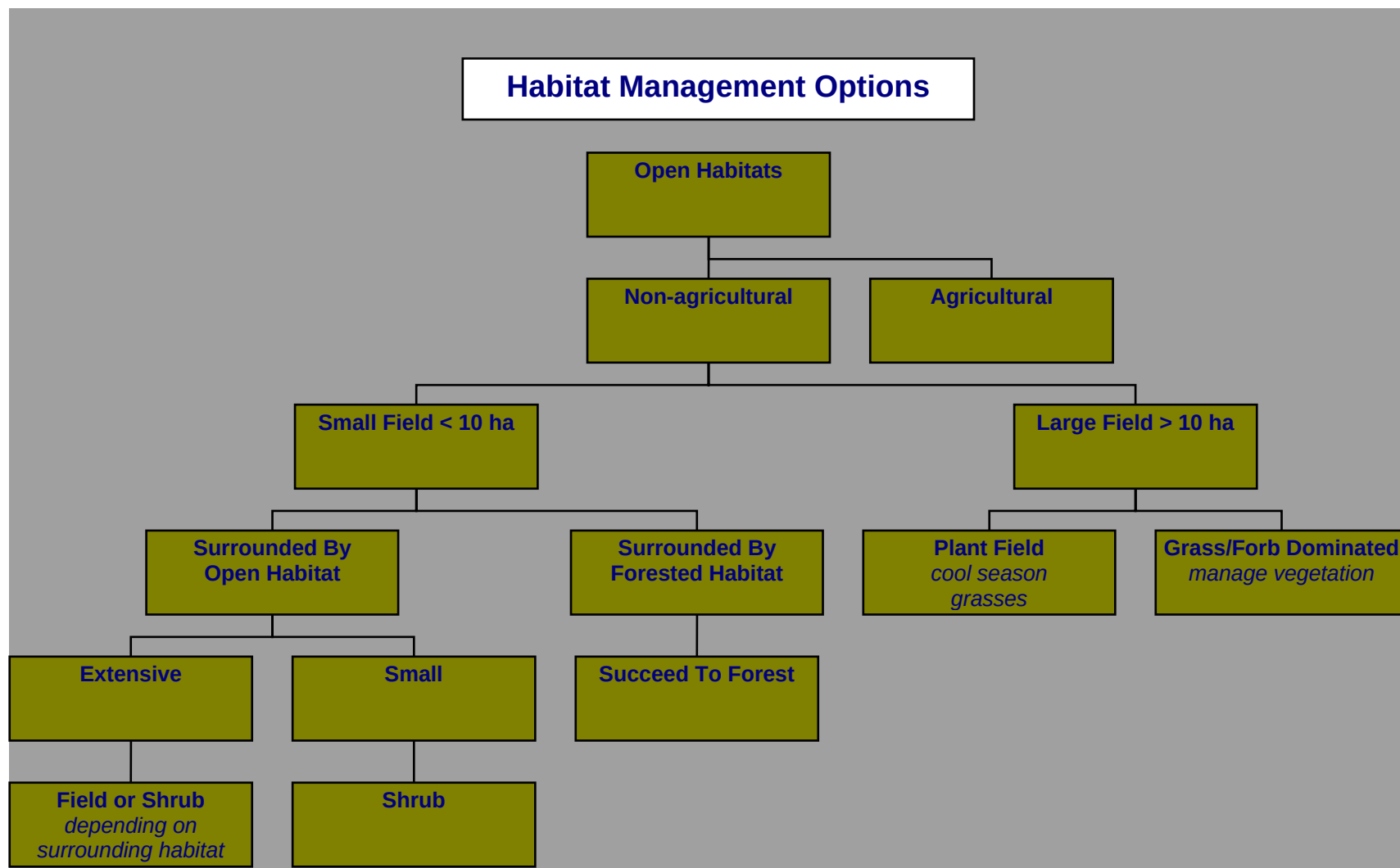


Figure 15. Habitat management options for existing herbaceous landscapes.

implemented to determine how best to apply management activities on a habitat and landscape scale.

The overall goals of the proposed habitat management scenario presented below (see Figure 15) are to:

1. maintain a mix of early successional habitat types
 - a. maximize overall avian diversity
2. direct management only to grasslands of adequate size
 - a. existing large grasslands
 - b. grasslands enlarged by consolidation of smaller fields where appropriate
3. enhance habitat for grassland species by manipulating plant structure and species
 - a. composition

The goals are to be achieved with overriding concern for enhancing the size and contiguous nature of all major habitat types within the park.

Habitat Management Options

The survey suggests, even given its limitations, that the DEWA grassland bird community is not a major component of the park's overall biodiversity. However, 20% of the park is designated to remain as open habitat and thus should be managed for grassland birds where appropriate. Management efforts might be most efficiently directed towards existing fields of adequate size and/or consolidation of smaller fields into contiguous blocks.

Proposed habitat management options (see Figure 15) are most straightforward for large fields (>10 ha [25 ac]). The 10 ha (25 ac) value appears to be the threshold size at or above which minimally area sensitive species, such as the eastern meadowlark and grasshopper sparrow, begin to appear (Swanson 1996).

The plan is more complicated for small fields (<10 ha [<25 ac]). If a small field is grass/forb dominated and surrounded by extensive grass or shrubland, it should be managed according to the surrounding dominant habitat type (e.g., either grassland or shrubland). If the surrounding open habitat type is small in extent it should be allowed to revert to shrubland with no field option, since small fields are not conducive to grassland species, but small shrublands are sufficient for many characteristic species (Rudnicki and Hunter 1993; Krementz and Christie 2000; Litvatis 2001). Those small fields surrounded by forest, no matter how extensive, should be allowed to succeed into forest, as this is the dominant habitat within the park. This would eliminate fragmentation and thus increase the size of forested blocks, an important consideration for forest birds, many of which are also area sensitive.

All extensive grasslands, either currently existing or created as a result of consolidation of small fields proximal to each other, should be planted in native grasses (e.g., cool-season grasses) and have all hedgerows removed. Norment et al. (1999), in a New York study, and McCoy et al., (2001) in a northern Missouri investigation, recommended that cool-season grasses, including a combination of timothy (*Phleum pratense*), brome-grass (*Bromus inermis*), orchard grass (*Dactylis glomerata*), redtop (*Agrostis gigantea*), alfalfa (*Medicago sativa*), clover (*Trifolium*

spp.), and birds-foot trefoil (*Lotus corniculatus*), be planted rather than warm-season varieties because of reduced vegetation height and density that grassland birds may have responded to in DEWA. Warm-season grasses are dominated by switchgrass (*Panicum virgatum*) which grows too high and dense for typical grassland species such as bobolinks or savannah sparrows, which display lower densities in such habitat (Volkert 1992; Prescott and Murphy 1995; McCoy et al. 2001).

There appears to be considerable variation in recommendations regarding mowing and burning as methods to maintain grasslands. In part, this reflects differences in species' preferences for vegetation structure and composition. For example, Henslow's Sparrow prefers unmowed grasslands while the savannah sparrow likes mowed patches on reclaimed strip mine sites in Clearfield County, Pennsylvania (Brauning et al. 2001). Sedge wrens preferred unmowed sites in North Dakota (Horn and Koford 2000). Brauning et al. (2001) suggested creating patches of mowed and unmowed sites in grasslands, assuming they are large enough, and that mowing should be done sparingly on a biannual or triennial schedule. Conversely, McCoy et al. (2001) states that mowing did little to reverse succession or increase diversity in grasslands in Missouri, although it seems obvious that some mowing is necessary to maintain grasslands at the appropriate level of succession. Swengel and Swengel (2001) indicate that mowing is preferable to burning as a management tool and that mowed fields showed a significantly higher abundance of all grassland species in Missouri. To summarize, it appears that mowing is preferable to burning as a management tool, that it should be done sparingly, and that when done, it should occur after the safe nesting dates of the grassland species present, usually mid-July, but even extending into August for northern harriers (Beardslee and Mitchell 1965; Andrie and Carroll 1988; Norment et al. 1999).

Management Scenarios

DEWA fields can be divided into four major categories based on how best to manage them given their current characteristics. See Appendix I for field examples.

- 1) Large existing fields (PA01/1-3; Independence and Santos fields)
 - a) manage intensively for grassland birds
- 2) Large existing fields with hedgerows (NJ 20/1; Lennington)
 - a) remove all hedgerows
 - b) manage intensively for grassland birds
- 3) Field complexes composed of a habitat mosaic (NJ 18/1; Depew)
 - a) if mostly grassland, remove hedgerows to make parcels contiguous
 - b) if a mosaic of habitats exists with no successional stage dominating the area, leave in current condition to foster avian diversity
- 4) Small isolated fields <10 ha in area (PA 5/1; Airfield Road)
 - a) management options depend on surrounding landscape
 - i) if surrounded by forest, allow to succeed to forest
 - ii) if surrounded by shrubland, allow to succeed to shrubland

Monitoring Issues

Ideally, management should include effort to monitor its effectiveness. Unfortunately, the power analysis indicates the current sampling scheme is not likely to detect between-year density changes unless changes are large. Due to limited habitat in DEWA, improving power by increasing sample size is not an option. Another way to increase power is to try different sampling procedures. Spot-mapping or distance sampling using line transects, both of which produce density estimates, may have improved precision over the sampling scheme used in this inventory. Alternatively, multi-year sampling using the current scheme would increase the likelihood of detecting a trend and allow the application of more sophisticated trend analysis techniques (see Nur et al. 1999) utilizing observed variation about the trend line instead of the current procedure which requires an estimate of this variation. Of course, if the management goal is to focus on a particular species or species group (e.g. prairie warblers or grassland birds), then simple presence data may be sufficient.

Management Conclusions

In conclusion, management in DEWA should focus primarily on a coarse filter approach for the grassland bird community since few rare, threatened, or endangered grassland birds were observed. This would provide habitat for the general grassland bird community present and may enhance the attractiveness of grassland habitat in the park for future colonization by targeted species such as eastern meadowlarks, bobolinks, and various sparrow species. A fine filter approach might be applied selectively, perhaps regarding the field sparrow, which, although not officially included on federal and/or state conservation lists, is rapidly declining throughout most of its range (Audubon Society Watchlist), but is still abundant in the park.

For shrubland birds, a fine filter approach should be the primary management approach because this community of birds is less area sensitive and thus perhaps less responsive to coarse filter, large scale management activities, and because several species of rare shrubland dependent birds are present in the park, including golden-winged warbler and yellow-breasted chat.

From a habitat perspective, the multi-scale management suggestions offered concentrate on grasslands of adequate size to provide habitat for that community of birds, increase the contiguous size of all habitat types, and provide for a rich habitat mosaic within the park. Since population viability is the result of an interaction between local habitat factors and the landscape context of habitats, an approach that combines both spatial scales should be most effective (Thompson and DeGraaf 2001).

Literature Cited

- Andrle, R. E., and J. R. Carroll. 1988. The atlas of breeding birds in New York state. Cornell University Press. Ithaca, NY.
- Annand, E. M., and F. R. Thompson, III. 1997. Forest bird response to regeneration practices in central hardwood forests. *Journal of Wildlife Management* 61:159–171.
- Askins, R. A. 1993. Population trends in grassland, shrubland and forest birds in eastern North America. *Current Ornithology* 11:1–34.
- Askins, R. A. 1997. History of grasslands in the northeastern United States: Implications for bird conservation. Pp. 119–136 in *Grasslands of Northeastern North America* (P. D. Vickery and P. W. Dunwiddie, Eds.). Massachusetts Audubon Society. Lincoln, MA.
- Askins, R. A. 2000. *Restoring North America's Birds: Lessons from Landscape Ecology*. Yale University Press, New Haven, CT.
- Baguley, T. 2004. Understanding statistical power in the context of applied research. *Applied Ergonomics* 35:73–80.
- Bakker, K. K., D. E. Naugle, and K. F. Higgins. 2002. Incorporating landscape attributes into models for migratory grassland bird conservation. *Conservation Biology* 16:1638–1646.
- Beardsley, C. S., and H. D. Mitchell. 1965. Birds of the Niagara Frontier region. *Bull. Buffalo Society of Natural History* 22:1–478.
- Bibby, C. J., N. D. Burgess, and D. A. Hill. 1992. *Bird census techniques*. The British Trust for Ornithology. Academic Press. New York, NY. 257 pp.
- Bollinger, E. K., and T. A. Gavin. 1992. Eastern bobolink populations: Ecology and conservation in an agricultural landscape. Pp. 497–506 in *Ecology and Conservation of Neotropical Migrant Landbirds* (J. M. Hagan III and D. W. Johnson, Eds.) Smithsonian Institution Press. Washington, D. C.
- Brauning, D., M. Grishaver, and C. Grainer. 2001. Nesting season responses of three grassland sparrow species to previous-year mowing on reclaimed surface mines in Clarion County, Pennsylvania. *J. Pennsylvania Academy of Science* 75:23–26.
- Brown, B. W., C. Brauner, A. Chan, D. Gutierrez, J. Herson, J. Lovato, J. Polsley, K. Russell, and J. Venier. 2000. DSTPLAN, Version 4.2. Houston, TX: University of Texas, M. D. Anderson Cancer Center, Department of Biomathematics.
ftp://odin.mdacc.tmc.edu/pub/win32/dstplan_4.2_se.exe
- Buckland, S. T., D. R. Anderson, J. L. Burnham, D. L. Borchers, and L. Thomas. 2001. *Introduction to distance sampling: Estimating abundance of biological populations*. Oxford University Press. Oxford, UK.

- Burden, E. T., J. H. McAndrews, and G. Norris. 1986. Palynology of Indian and European forest clearances and farming in lake sediment cores from Awenda Provincial Park, Ontario. *Canadian Journal of Earth Science* 23:43–54.
- Clawson, M. R., and J. J. Rotella. 1996. The success of artificial nests in CRP fields, native vegetation and field borders in southwestern Montana. *J. Field Ornithology* 69:180–191.
- Diffenbacher-Krall. 1997. Paleoecology and historical ecology of an extensive bluejoint reedgrass grassland in coastal eastern Maine. Pp. 53–67 *in* Grasslands of Northeastern North America (P. D. Vickery and P. W. Dunwiddie, Eds.). Massachusetts Audubon Society. Lincoln, MA.
- Douglas, J. H., and D. Lawrence. 2001. Area requirements of grassland birds: A regional perspective. *Auk* 118:24–34.
- Fancy, S. G., and J. R. Sauer. 2000. Recommended methods for inventorying and monitoring landbirds in National Parks. Unpublished report.
- Foster, D. 1995. Land-use history and 400 years of vegetation change in New England. Pp. 253–319 *in* Global Land Use Change: A Perspective from the Columbian Encounter (B. L. Turner II, A. G. Sal, F. G. Bernaldez, and F. di Castri, Eds.). Consejo Superior de Investigaciones Cientificas. Madrid, Spain.
- General Management Plan. 1987. General Management Plan - Delaware Water Gap National Recreation Area / Pennsylvania - New Jersey. United States Department of the Interior / National Park Service.
- Gobster, P. H. 2001. Human dimensions of early successional landscapes in the eastern United States. *Wildlife Society Bulletin* 29:474–482.
- Gorsuch, R. L. (1983). Factor analysis (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Grimm, L., and P. Yarnold, P. 1995. Reading and Understanding Multivariate Statistics. American Psychological Association. Washington, D.C.
- Harper, R. M. 1911. The Hempstead Plains: A natural prairie on Long Island. *Bull. of the American Geographical Society* 43:351–360.
- Herkert, J. R. 1994. The effects of habitat fragmentation on Midwestern grassland bird communities. *Ecological Applications* 4:461–471.
- Herkert, J. R. 1995. Ann analysis of midwestern breeding bird population trends.: 1966-1993. *American Midland Naturalist* 134:41–50.
- Herkert, J. R. 1997. Bobolink *Dolichonyx oryzivorus* population decline in agricultural landscapes in the midwestern USA. *Biological Conservation* 80: 107–112.

- Horn, D. J., and R. R. Koford. 2000. Relation of grassland bird abundance to mowing of Conservation Reserve Program fields in North Dakota. *Wildlife Society Bulletin* 28:653–659.
- Horn, D. J., R. R. Koford, and B. Malinda. 2002. Effects of field size and landscape composition on grassland birds in south-central Iowa. *J. Iowa Academy of Natural Science* 109:1–7.
- Hunter, W. C., D. A. Buehler, R. A. Canterbury, J. L. Confer, and P. B. Hamel. 2001. *Wildlife Society Bulletin* 29: 440–455.
- James, F. C., D. A. Wiedenfield, and C. E. McCulloch. 1992. Trends in breeding populations of warblers : declines in the southern highlands and increases in the lowlands. Pp. 43–46, in *Ecology and Conservation of Neotropical Migrant Landbirds* (J. M. Hagan III, and D. W. Johnson, Eds.). Smithsonian Institution Press. Washington, D. C.
- Knopf, F. L. 1994. Avian assemblages on altered grasslands. *Studies in Avian Biology* 15:247–257.
- Kobal, S. N., N. F. Payne, and D. R. Ludwig. 1999. Habitat/area relationships. Abundance and composition of bird communities in 3 grassland types. *Trans. of the Illinois Academy of Science* 92:109–131.
- Krementz, D. G., and J. S. Christie. 2000. Clearcut size and scrub-successional bird assemblages. *Auk* 117:913–924.
- Litvatis, J. A. 2001. Importance of early-successional habitats to mammals in eastern North American forests. *Wildlife Society Bulletin* 29:503–510.
- Lorimer, C. G. 2001. Historical and ecological roles of disturbance in eastern North American forests: 9,000 years of change. *Wildlife Society Bulletin* 29:425–439.
- McAndrews, J. H. 1988. Human disturbance of North American forests and grasslands: The fossil pollen record. Pp. 673–697 in *Vegetation History* (B. Huntley and T. Webb III, Eds.). Kluwer Academic Publishers. New York.
- McCoy, T. D., E. W. Kurzejeski, L. W. Burger, and M. R. Ryan, Jr. 2001. The effects of conservation practice, mowing, and temporal changes on vegetation structure on CRP fields in northern Missouri. *Wildlife Society Bulletin* 29:979–987.
- Marks, P. L., and S. Gardescu. 1992. Vegetation of the central Finger Lakes region of New York in the 1790's. *New York State Museum Bulletin* no. 484. Albany, NY.
- Mayfield, H. F. 1988. Changes in bird life at the western end of Lake Erie. Part 1. *American Birds* 42: 393–398.
- Norment, C. J., C. D. Ardizzone, and K. Hartman. 1999. Habitat relationships and breeding biology of grassland birds in New York. *Studies in Avian Biology* 19: 112–121.

- Noss, R. F., E. T. LaRoe, III, and J. M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. United States Department of the Interior, National Biological Service. Biological Report 28. Washington, D. C.
- Nur, N., S. L. Jones, and G. R. Guepel. 1999. A statistical guide to data analysis of avian monitoring programs. U.S. Department of the Interior, Fish and Wildlife Service. BTP-R6001-1999. Washington, D.C.
- O'Leary, C. H., and D. W. Nyberg. 2000. Treelines between fields reduces the density of grassland birds. *Natural Areas Journal* 20:243–249.
- Osborne, J. W., and A. B. Costello. 2004. Sample size and subject to item ratio in principal components analysis. *Practical Assessment, Research & Evaluation*, 9(11). Electronic peer-reviewed journal. Retrieved April 17, 2005 from <http://PAREonline.net/getvn.asp?v=9&n=11>.
- Parkes, K. C. 1952. The birds of New York and their taxonomy. Ph.D. dissertation. Cornell University. Ithaca, NY.
- Patterson, W. A., and K. E. Sassman. 1988. Indian fires in the prehistory of New England. Pp. 107–135 in *Holocene Human Ecology in Northeastern North America* (G. P. Nicholas, Ed.). Plenum Publishing. NY.
- Peterjohn, B. G., and J. R. Sauer. 1999. Population status of North American grassland birds from the North American Breeding Bird Survey. 1966–1996. *Studies in Avian Biology* 19:27–44.
- Petit, D. R., L. J. Petit, V. A. Saab, and T. E. Martin. 1995. Fixed-radius point counts in forests: factors influencing effectiveness and efficiency. In *Monitoring Bird Populations by Point Counts* (C. J. Ralph, J. R. Sauer and S. Droege, eds.). USDA Forest Service Technical Report PSW-GTR-149. Pacific Southwest Research Station. Albany, CA. Pp. 49–57.
- Prescott, D. R. C., and A. J. Murphy. 1995. Bird populations and vegetation structure of tame dense nesting cover (DNC) in Alberta's aspen parkland. Alberta North American Waterfowl Management Plan Centre. Edmonton, Alberta. Canada.
- Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. United States Department of Agriculture. Pacific Southwest Research Station General Technical Report PSW-GTR-144.
- Ralph, C. J., S. Droege, and J. R. Sauer. 1995. Managing and monitoring birds using point counts: standards and applications. In *Monitoring Bird Populations by Point Counts* (C. J. Ralph, J. R. Sauer, and S. Droege, eds.). USDA Forest Service Technical Report PSW-GTR-149. Pacific Southwest Research Station. Albany, CA. Pp. 161–168.
- Reynolds, R. T., J. M. Scott, and R. A. Nussbaum. 1980. A variable circular plot method for estimating bird numbers. *Condor* 82:309–313.

- Rudnický, T. C., and M. L. Hunter, Jr. 1993. Reversing the fragmentation perspective: effects of clearcut size on bird species richness in Maine. *Ecological Applications* 3:357–366.
- Russell, E. W. B. 1981. Vegetation of Northern New Jersey before European settlement. *American Midland Naturalist* 105:1–12.
- Samson, F., and F. Knopf. 1994. Prairie conservation in North America. *BioScience* 44: 418–421.
- Sauer, J. R., J. E. Hines, G. Gough, I. Thomas, and B. J. Peterjohn. 1997. The North American Breeding Bird Survey, v. 96.1 [online] Patuxent Wildlife Research Center. Laurel, MD. Available at <http://www.mbr.nbs.gov/bbs/bbs.html>.
- Savard, J. L., and T. D. Hooper. 1995. Influence of survey length and radius size on grassland bird surveys by point counts at Williams Lake, British Columbia. In *Monitoring Bird Populations by Point Counts* (C. J. Ralph, J. R. Sauer, and S. Droege, eds.). USDA Forest Service General Technical Report PSW-GTR-149. Pacific Southwest Research Station. Albany, CA. Pp. 57–62.
- Schoeber, M. A., and L. A. Robb. 1993. Greater Prairie Chicken (*Tympanuchus cupido*). In *The Birds of North America*. No. 36 (A. Poole, P. Stettenheim and F. Gill, Eds.). Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union. Washington, D. C.
- Scott, M. J., F. L. Ramsay, and C. B. Kepler. 1981. Distance estimation as a variable in estimating bird numbers. *Studies in Avian Biology* 6. Cooper Ornithological Society. 334–341.
- Shannon, C. E., and W. Weaver. 1949. The mathematical theory of communication. University of Illinois Press. Urbana, IL.
- Shriver, W. G., A. L. Jones, and P. D. Vickery. 1997. Northeast Grassland Bird Survey. Massachusetts Audubon Society. Lincoln, MA.
- Simons, T. R., K. Rabenold, and G. L. Farnsworth. 1995. Characterization of deciduous forest breeding bird communities of Great Smoky Mountains National Park. Final report to the National Park Service. 84 pp.
- Smith, W. P., D. J. Twedt, R. J. Cooper, D. A. Wiedenfeld, P. B. Hamel, and R. P. Ford. 1995. Sample size and allocation of effort in point count sampling of birds in bottomland hardwood forests. In *Monitoring Bird Populations by Point Counts* (C. J. Ralph, J. R. Sauer and S. Droege, eds.). USDA Forest Service Technical Report PSW-GTR-149. Pacific Southwest Research Station. Albany, CA. Pp. 7–19.
- Sokal, R. R., and F. J. Rohlf. 1981. *Biometry*, 2nd ed. Freeman, NY.
- Stalter, R., and E. E. Lamont. 1987. Vegetation of the Hempstead Plains, Mitchell Field, Long Island. *NY Bull. of the Torrey Botanical Club* 114:330–335.

- Swengel, S. R., and A. B. Swengel. 2001. Relative effects of litter and management on grassland bird abundance in Missouri, USA. *Conservation International* 11:113–128.
- Thomas, L. 1997. Retrospective power analysis. *Conservation Biology* 11(1):276–280.
- Thomas, L., J. L. Laake, S. Strindberg, F. F. C. Marques, S. T. Buckland, D. L. Borchers, D. R. Anderson, K. P. Burnham, S. L. Hedley, J. H. Pollard, and J. R. B. Bishop. 2004. Distance 4.1. Release 2. Research Unit for Wildlife Population Assessment, University of St. Andrews. UK. <http://www.ruwpa.st-and.ac.uk/distance/>.
- Thompson, F. R., III, and R. M. DeGraaf. 2001. Conservation approaches for woody, early successional communities in the eastern United States. *Wildlife Society Bulletin* 29:483–494.
- Thompson, F. R., III, S. K. Robinson, D. R. Whitehead, and J. D. Brawn. 1996. Management of central hardwood landscapes for conservation of migratory birds. In F. R. Thompson, III, (ed.). *Management of Midwestern Landscapes for the Conservation of Neotropical Migratory Birds*. United States Department Agriculture, Forest Service. General Technical Report NC-187. St. Paul, MN.
- Vickery, P. D. 1992. A regional analysis of endangered, threatened and special-concern birds in the northeastern United States. *Transactions of the Northeast Section of the Wildlife Society* 48:1–10.
- Vickery, P. D., M. L. Hunter, Jr., and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. *Conservation Biology* 8:1087–1097.
- Vickery, P. D., P. L. Tubaro, J. M. Cardoso, B. G. da Silva, J. Peterjohn, J. R. Herkert, and R. B. Cavalcanti. 1999. Conservation of grassland birds in the Western Hemisphere. *Studies in Avian Biology* 19:2–26.
- Volkert, W. K. 1992. Response of grassland birds to a large-scale prairie planting project. *Passenger Pigeon* 54:191–196.
- Walk, J. W., and R. E. Warner. 1999. Effects of habitat area on the occurrence of grassland birds in Illinois. *American Midland Naturalist* 141:339–344.
- Wells, J. V., and K. V. Rosenberg. 1999. Grassland bird conservation in eastern North America. *Studies in Avian Biology* 19:72–80.
- Williams, G. L. 1999. The National Park Service I & M Program: Current status and new initiatives. *Proceedings of the 10th Conference on Research and Resource Management in Parks and on Public Land*. The 1999 GWS Biennial Conference. The George Wright Society. Pp. 245–250.
- Willson, M. F. 1974. Avian community organization and habitat structure. *Ecology* 55:1017–1029.

- Winne, J. C. 1997. History of vegetation and fire on the Pineo Ridge pine grassland barrens of Washington County, Maine. Pp. 25–52 in *Grasslands of Northeastern North America* (P. D. Vickery and P. W. Dunwiddie, Eds.). Massachusetts Audubon Society. Lincoln, MA.
- Winter, M., and J. Faaborg. 1999. Patterns of area sensitivity in grassland-nesting birds. *Conservation Biology* 13:1424–1436.
- Witham, J. W., and M. L. Hunter, Jr. 1992. Population trends of Neotropical migrant landbirds in southern coastal New England. *In* J. M. Hagen, III, and D. W. Johnson (eds.). *Ecology and Conservation of Neotropical Migrant Landbirds*. Smithsonian Institution. Washington, D. C.
- Woodward, A. A., A. D. Fink, and F. R. Thompson, III. 2001. Edge effects and ecological traps: effects on shrubland birds in Missouri. *Journal of Wildlife Management* 65:668–675.
- Yoakum, J. W., W. P. Dasmann, H. R. Sanderson, C. M. Nixon, and H. S. Crawford. 1980. Habitat improvement techniques. *In* S. Schmnitz (ed.). *Wildlife Management Techniques Manual*, The Wildlife Society. Washington, D. C.

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Appendix B. Variable point count vegetation data sheet.

APPENDIX B -- GRASSLAND BIRD SURVEY -- VPC VEGETATION DATA												
Observers:							Park Code:		DEWA			
Date:	Time:						Proj. Code:		GBIVCP			
Edge Distance (m):	1-	2-	3-	4-			Loc. Code:					
Transect Orient. (°):	Digital Photo #s:						(st./fd.#-pt.#)(wypt.#)					
TRANSECT DISTANCE (m)	0	10	20	30	40	50	60	70	80	90	100	
% Coverage - bare grd												
grass/sedge												
forbs												
shrubs												
saplings (< 10 cm DBH)												
trees (> 10 cm DBH)												
% Occurrence - bare grd												
grass/sedge												
forbs												
shrubs												
saplings (< 10 cm DBH)												
trees (> 10 cm DBH)												
Litter Depth (mm)												
Height-Density (dm)	0	10	20	30	40	50	60	70	80	90	100	
1												
1.25												
1.5												
1.75												
2												
2.25												
2.5												
2.75												
3												
3.5												
4												
4.5												
5												
5.5												
6												
6.5												
7												
7.5												
8												
8.5												
9												
9.5												
10												
>10												



Appendix C. Metadata for the project created GIS shapefiles.

A Grassland Bird Inventory of the Delaware Water Gap National Recreation Area: Grassland Fields

Metadata also available as

Metadata:

- [Identification Information](#)
- [Data Quality Information](#)
- [Spatial Data Organization Information](#)
- [Spatial Reference Information](#)
- [Entity and Attribute Information](#)
- [Distribution Information](#)
- [Metadata Reference Information](#)

Identification Information:

Citation:

Citation Information:

Originator: Sheehan Jr., James

Publication Date: 20041105

Title:

A Grassland Bird Inventory of the Delaware Water Gap National Recreation Area:
Grassland Fields

Geospatial Data Presentation Form: vector digital data

Publication Information:

Publication Place: East Stroudsburg, PA

Publisher: Dept. of Biological Sciences, East Stroudsburg University

Description:

Abstract:

This dataset displays the 32 grassland fields of DEWA used by the inventory of grassland birds. The grassland field attribute "GNAME" may be linked with appropriate tables or queries in the Microsoft Access 2000 database DEWA_GBI.mdb that contain the field "GrasslandName" to display collected bird and habitat data or provide a means to explore these data in relation to spatial and classification variables in the dataset.

Purpose:

To represent, classify and obtain spatial data on the grasslands of DEWA.

Time Period of Content:

Time Period Information:

Range of Dates/Times:

Beginning Date: 2002

Ending Date: 2003

Currentness Reference: ground condition

Status:

Progress: Complete

Maintenance and Update Frequency: None planned

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -75.061768
East_Bounding_Coordinate: -74.768600
North_Bounding_Coordinate: 41.332025
South_Bounding_Coordinate: 41.033875
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: birds (Aves)
Theme_Keyword: grassland
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: National Park Service
Place_Keyword: DEWA
Place_Keyword: Delaware Water Gap National Recreation Area
Access_Constraints: none
Use_Constraints: none
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Master, Terry L.
Contact_Organization: Dept. of Biological Sciences, East Stroudsburg University
Contact_Position: Professor
Contact_Address:
Address_Type: mailing and physical
Address: 200 Prospect St.
City: East Stroudsburg
State_or_Province: PA
Postal_Code: 18301
Country: USA
Contact_Voice_Telephone: 570-422-3709
Contact_Electronic_Mail_Address: Terry.Master@po-box.esu.edu
Native_Data_Set_Environment: ESRI ArcGIS 8.3 shapefile

Data_Quality_Information:

Attribute_Accuracy:

Attribute_Accuracy_Report:

No formal tests were used. Attributes are believed to be accurate.

Logical_Consistency_Report:

No formal tests were used. Data is believed to be logically consistent.

Completeness_Report:

The grassland fields in this dataset do not comprise all of the grassland habitat within DEWA. However, the most significant (largest, most grassland-like) fields are believed to be represented here. Additionally, grassland fields may change as habitat changes and polygon boundaries may need to be redefined as more data becomes available.

Positional_Accuracy:

Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:

No formal test was used to determine accuracy. As drawn, the polygon boundaries appear to reasonably represent field perimeters apparent on available orthophotography, however.

Lineage:

Source_Information:

Source_Citation:

Citation_Information:

Originator: Craig Thompson

Publication_Date: 2003

Title:

Unpublished dataset: a mosaic of orthophotographs from a recent aerial flight.

Geospatial_Data_Presentation_Form: raster digital data

Publication_Information:

Publication_Place: Milford, PA

Publisher: Delaware Water Gap National Recreation Area

Other_Citation_Details: File name: dewa_all_orthos_match.sid

Source_Scale_Denominator: 2500

Type_of_Source_Media: CD-ROM

Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 2003

Source_Currentness_Reference: ground condition

Source_Citation_Abbreviation: orthophotography

Source_Contribution:

Provided a basis for selecting and creating grassland field polygons and providing attribute information about them.

Source_Information:

Source_Citation:

Citation_Information:

Originator: Craig Thompson

Publication_Date: 2003

Title:

Unpublished dataset: a land use classification based on orthophotography.

Geospatial_Data_Presentation_Form: vector digital data

Publication_Information:

Publication_Place: Milford, PA

Publisher: Delaware Water Gap National Recreation Area

Other_Citation_Details: File name: veg_draft_formation.shp

Type_of_Source_Media: CD-ROM

Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 2003

Source_Currentness_Reference: ground condition

Source_Citation_Abbreviation: land use classification

Source_Contribution:

Provided a basis for selecting and creating grassland field polygons and providing attribute information about them.

Process_Step:

Process_Description:

Individual polygons representing the 32 grassland fields were drawn by using an overlay of the latest available land use classification of DEWA on the latest available DEWA orthophotography. Existing polygons of the land use dataset that encompassed established sampling points located within grassland habitat were selected and extracted to a new shapefile. The boundaries of these polygons were then edited as necessary to conform to obvious habitat edges apparent on the orthophoto, edges that were subjectively chosen to represent the perimeter of the field. Area and perimeter for these polygons were calculated, and attribute data supplied for habitat type, a project identifier, and field name and number according to DEWA if available.

Process_Date: 20040903

Spatial_Data_Organization_Information:

Direct_Spatial_Reference_Method: Vector

Point_and_Vector_Object_Information:

SDTS_Terms_Description:

SDTS_Point_and_Vector_Object_Type: G-polygon

Point_and_Vector_Object_Count: 32

Spatial_Reference_Information:

Horizontal_Coordinate_System_Definition:

Planar:

Grid_Coordinate_System:

Grid_Coordinate_System_Name: Universal Transverse Mercator

Universal_Transverse_Mercator:

UTM_Zone_Number: 18

Transverse_Mercator:

Scale_Factor_at_Central_Meridian: 0.999600

Longitude_of_Central_Meridian: -75.000000

Latitude_of_Projection_Origin: 0.000000

False_Easting: 500000.000000

False_Northing: 0.000000

Planar_Coordinate_Information:

Planar_Coordinate_Encoding_Method: coordinate pair

Coordinate_Representation:

Abcissa_Resolution: 0.000064

Ordinate_Resolution: 0.000064

Planar_Distance_Units: meters

Geodetic_Model:

Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257222

Entity_and_Attribute_Information:

Detailed_Description:

Entity_Type:

Entity_Type_Label: dewa_gbi_grasslands

Entity_Type_Definition: dbase (.dbf) table

Entity_Type_Definition_Source: ESRI

Attribute:

Attribute_Label: FID

Attribute_Definition: Internal feature number.

Attribute_Definition_Source: ESRI

Attribute_Domain_Values:

Unrepresentable_Domain:

Sequential unique whole numbers that are automatically generated.

Attribute:

Attribute_Label: Shape

Attribute_Definition: Feature geometry.

Attribute_Definition_Source: ESRI

Attribute_Domain_Values:

Unrepresentable_Domain: Coordinates defining the features.

Attribute:

Attribute_Label: GNAME

Attribute_Definition: Unique name given to each grassland field.

Attribute_Definition_Source: Project supplied

Attribute:

Attribute_Label: RECNO

Attribute_Definition:

Numeric identifier of original polygon(s) from the land use classification used as a basis for the new grassland field polygon.

Attribute_Definition_Source: Project supplied

Attribute:

Attribute_Label: AREA

Attribute_Definition: Grassland field area in square meters.

Attribute_Definition_Source: Software generated

Attribute:

Attribute_Label: HECTARES

Attribute_Definition: Grassland field area in hectares.

Attribute_Definition_Source: Software generated

Attribute:

Attribute_Label: PERIMETER

Attribute_Definition: Grassland field perimeter in meters.

Attribute_Definition_Source: Software generated

Attribute:

Attribute_Label: NPS_FNAME

Attribute_Definition: National Park Service name(s) for identification purposes.

Attribute_Definition_Source: Delaware Water Gap National Recreation Area

Attribute:

Attribute_Label: NPS_FNUM

Attribute_Definition: National Park Service number(s) for identification purposes.

Attribute_Definition_Source: Delaware Water Gap National Recreation Area

Distribution_Information:

Distributor:

Contact_Information:

Contact_Person_Primary:

Contact_Person:

Contact_Organization:

Contact_Address:

Address_Type:

Address:

City:

State_or_Province:

Postal_Code:

Contact_Voice_Telephone:

Distribution_Liability:

Metadata_Reference_Information:

Metadata_Date: 20041105

Metadata_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Sheehan Jr., James

Contact_Organization: Dept. of Biological Sciences, East Stroudsburg University

Contact_Address:

Address_Type: mailing and physical

Address: 200 Prospect St.

City: East Stroudsburg

State_or_Province: PA

Postal_Code: 18301

Contact_Voice_Telephone: 570-856-0453

Contact_Electronic_Mail_Address: jf_sheehan@hotmail.com

Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata

Metadata_Standard_Version: FGDC-STD-001-1998

Generated by [mp](#) version 2.8.17 on Sat Nov 06 10:35:33 2004

A Grassland Bird Inventory of the Delaware Water Gap National Recreation Area: Grassland Point Count Stations

Metadata also available as

Metadata:

- [Identification Information](#)
- [Data Quality Information](#)
- [Spatial Data Organization Information](#)
- [Spatial Reference Information](#)
- [Entity and Attribute Information](#)
- [Distribution Information](#)
- [Metadata Reference Information](#)

Identification_Information:

Citation:

Citation_Information:

Originator: Sheehan Jr., James

Publication_Date: 20041105

Title:

A Grassland Bird Inventory of the Delaware Water Gap National Recreation Area:
Grassland Point Count Stations

Geospatial_Data_Presentation_Form: vector digital data

Publication_Information:

Publication_Place: East Stroudsburg, PA

Publisher: Dept. of Biological Sciences, East Stroudsburg University

Description:

Abstract:

This point shapefile displays the 42 point count stations located in grassland habitat of DEWA used by the inventory of grassland birds. The point count station attribute "PNAME" may be linked with appropriate tables or queries in the Microsoft Access 2000 database DEWA_GBI.mdb that contain the field "PointName" to display collected bird and habitat data or provide a means to explore these data in relation to spatial and classification variables in the dataset.

Purpose:

To represent, classify and obtain spatial data on the point count stations located within DEWA grasslands.

Time_Period_of_Content:

Time_Period_Information:

Range_of_Dates/Times:

Beginning_Date: 2002

Ending_Date: 2003

Currentness_Reference: ground condition

Status:

Progress: Complete

Maintenance_and_Update_Frequency: None planned

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -75.060457
East_Bounding_Coordinate: -74.771294
North_Bounding_Coordinate: 41.331232
South_Bounding_Coordinate: 41.034690
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: birds (Aves)
Theme_Keyword: grassland
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: National Park Service
Place_Keyword: DEWA
Place_Keyword: Delaware Water Gap National Recreation Area
Access_Constraints: none
Use_Constraints: none
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Master, Terry L.
Contact_Organization: Dept. of Biological Sciences, East Stroudsburg University
Contact_Position: Professor
Contact_Address:
Address_Type: mailing and physical
Address: 200 Prospect St.
City: East Stroudsburg
State_or_Province: PA
Postal_Code: 18301
Country: USA
Contact_Voice_Telephone: 570-422-3709
Contact_Electronic_Mail_Address: Terry.Master@po-box.esu.edu
Native_Data_Set_Environment: ESRI ArcGIS 8.3 shapefile

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
No formal tests were used. Attributes are believed to be accurate.
Logical_Consistency_Report:
No formal tests were used. Data is believed to be logically consistent.
Completeness_Report:
The number of available point count stations was determined by sampling considerations, the amount and size of grassland habitat, and logistics.
Positional_Accuracy:
Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:

The GPS unit was used in conjunction with a differential beacon receiver and point averaging was used to gain an accuracy of less than or equal to 5 meters.

Lineage:

Process_Step:

Process_Description:

Coordinates were obtained with a global positioning system device. Attribute data was supplied for point X and Y coordinates in UTM Zone 18 NAD83 units, point elevation, and a project identifier.

Process_Date: 20040903

Spatial_Data_Organization_Information:

Direct_Spatial_Reference_Method: Vector

Point_and_Vector_Object_Information:

SDTS_Terms_Description:

SDTS_Point_and_Vector_Object_Type: Entity point

Point_and_Vector_Object_Count: 43

Spatial_Reference_Information:

Horizontal_Coordinate_System_Definition:

Planar:

Grid_Coordinate_System:

Grid_Coordinate_System_Name: Universal Transverse Mercator

Universal_Transverse_Mercator:

UTM_Zone_Number: 18

Transverse_Mercator:

Scale_Factor_at_Central_Meridian: 0.999600

Longitude_of_Central_Meridian: -75.000000

Latitude_of_Projection_Origin: 0.000000

False_Easting: 500000.000000

False_Northing: 0.000000

Planar_Coordinate_Information:

Planar_Coordinate_Encoding_Method: coordinate pair

Coordinate_Representation:

Abscissa_Resolution: 0.000064

Ordinate_Resolution: 0.000064

Planar_Distance_Units: meters

Geodetic_Model:

Horizontal_Datum_Name: North American Datum of 1983

Ellipsoid_Name: Geodetic Reference System 80

Semi-major_Axis: 6378137.000000

Denominator_of_Flattening_Ratio: 298.257222

Entity_and_Attribute_Information:

Detailed_Description:

Entity_Type:

Entity_Type_Label: dewa_gbi_grasslandpoints
Entity_Type_Definition: dbase (.dbf) table
Entity_Type_Definition_Source: ESRI
Attribute:
Attribute_Label: FID
Attribute_Definition: Internal feature number.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain:
 Sequential unique whole numbers that are automatically generated.
Attribute:
Attribute_Label: Shape
Attribute_Definition: Feature geometry.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain: Coordinates defining the features.
Attribute:
Attribute_Label: PNAME
Attribute_Definition: Unique name given to each grassland field point count station.
Attribute_Definition_Source: Project supplied
Attribute:
Attribute_Label: DATE_TIME
Attribute_Definition: Date waypoint recorded.
Attribute_Definition_Source: Global positioning sytem device
Attribute:
Attribute_Label: POSITION
Attribute_Definition: Geographic projection and datum.
Attribute_Definition_Source: Global positioning sytem device
Attribute:
Attribute_Label: X
Attribute_Definition: Easting
Attribute_Definition_Source: Global positioning sytem device
Attribute:
Attribute_Label: Y
Attribute_Definition: Northing
Attribute_Definition_Source: Global positioning sytem device
Attribute:
Attribute_Label: ALTITUDE
Attribute_Definition: Elevation in meters.
Attribute_Definition_Source: Global positioning sytem device.

Distribution_Information:

Distributor:
Contact_Information:
Contact_Person_Primary:
Contact_Person:

Contact_Organization:
Contact_Address:
Address_Type:
Address:
City:
State_or_Province:
Postal_Code:
Contact_Voice_Telephone:
Distribution_Liability:

Metadata_Reference_Information:
Metadata_Date: 20041105
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Sheehan Jr., James
Contact_Organization: Dept. of Biological Sciences, East Stroudsburg University
Contact_Address:
Address_Type: mailing and physical
Address: 200 Prospect St.
City: East Stroudsburg
State_or_Province: PA
Postal_Code: 18301
Contact_Voice_Telephone: 570-856-0453
Contact_Electronic_Mail_Address: jf_sheehan@hotmail.com
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998

Generated by [mp](#) version 2.8.17 on Sat Nov 06 10:35:29 2004

A Grassland Bird Inventory of the Delaware Water Gap National Recreation Area: Grassland Field Habitat Edges

Metadata also available as

Metadata:

- [Identification Information](#)
- [Data Quality Information](#)
- [Spatial Data Organization Information](#)
- [Spatial Reference Information](#)
- [Entity and Attribute Information](#)
- [Distribution Information](#)
- [Metadata Reference Information](#)

Identification_Information:

Citation:

Citation_Information:

Originator: Sheehan Jr., James

Publication_Date: 20041105

Title:

A Grassland Bird Inventory of the Delaware Water Gap National Recreation Area:
Grassland Field Habitat Edges

Geospatial_Data_Presentation_Form: vector digital data

Publication_Information:

Publication_Place: East Stroudsburg, PA

Publisher: Dept. of Biological Sciences, East Stroudsburg University

Description:

Abstract:

This dataset displays the habitat edges of the 32 grassland fields of DEWA used by the inventory of grassland birds. The grassland field attribute "GNAME" may be linked with appropriate tables or queries in the Microsoft Access 2000 database DEWA_GBI.mdb that contain the field "GrasslandName" to display collected bird and habitat data or provide a means to explore these data in relation to spatial and classification variables in the dataset.

Purpose:

To represent, classify and obtain spatial data on the grassland field habitat edges of DEWA.

Time_Period_of_Content:

Time_Period_Information:

Range_of_Dates/Times:

Beginning_Date: 2002

Ending_Date: 2003

Currentness_Reference: ground condition

Status:

Progress: Complete

Maintenance_and_Update_Frequency: None planned

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -75.062409
East_Bounding_Coordinate: -74.768600
North_Bounding_Coordinate: 41.332025
South_Bounding_Coordinate: 41.032859
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: birds (Aves)
Theme_Keyword: grassland
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: National Park Service
Place_Keyword: DEWA
Place_Keyword: Delaware Water Gap National Recreation Area
Access_Constraints: none
Use_Constraints: none
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Master, Terry L.
Contact_Organization: Dept. Biological Sciences, East Stroudsburg University
Contact_Position: Professor
Contact_Address:
Address_Type: mailing and physical
Address: 200 Prospect St.
City: East Stroudsburg
State_or_Province: PA
Postal_Code: 18301
Country: USA
Contact_Voice_Telephone: 570-422-3709
Contact_Electronic_Mail_Address: Terry.Master@po-box.esu.edu
Native_Data_Set_Environment: ESRI ArcGIS 8.3 shapefile

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
No formal tests were used. Attributes are believed to be accurate.
Logical_Consistency_Report:
No formal tests were used. Data is believed to be logically consistent.
Completeness_Report:
Polylines were created for all grassland field polygons. However, polylines may be subjective, and may change as habitat changes and more data becomes available.
Positional_Accuracy:
Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:

The polyline boundaries appear to conform to habitat edges apparent on the orthophoto, however, no formal test was used to determine the accuracy of the boundaries in the field.

Lineage:

Source_Information:

Source_Citation:

Citation_Information:

Originator: Sheehan Jr., James

Publication_Date: 20041105

Title:

A Grassland Bird Inventory of the Delaware Water Gap National Recreation Area:

Grassland Fields

Geospatial_Data_Presentation_Form: vector digital data

Publication_Information:

Publication_Place: East Stroudsburg, PA

Publisher: Dept. of Biological Sciences, East Stroudsburg University

Type_of_Source_Media: CD-ROM

Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 2003

Source_Currentness_Reference: ground condition

Source_Citation_Abbreviation: dewa_gbi_grasslands.shp

Source_Contribution:

Provided grassland field polygons that were used to create grassland field polylines.

Source_Information:

Source_Citation:

Citation_Information:

Originator: Craig Thompson

Publication_Date: 2003

Title:

Unpublished dataset: a mosaic of orthophotographs from a recent aerial flight.

Geospatial_Data_Presentation_Form: raster digital data

Publication_Information:

Publication_Place: Milford, PA

Publisher: Delaware Water Gap National Recreation Area

Other_Citation_Details: File name: dewa_all_orthos_match.sid

Source_Scale_Denominator: 2500

Type_of_Source_Media: CD-ROM

Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 2003

Source_Currentness_Reference: ground condition

Source_Citation_Abbreviation: orthophotography

Source_Contribution:

Provided a basis for creating and classifying grassland field polylines and providing attribute information about them.

Source_Information:

Source_Citation:

Citation_Information:

Originator: Craig Thompson

Publication_Date: 2003

Title:

Unpublished dataset: a land use classification based on orthophotography.

Geospatial_Data_Presentation_Form: vector digital data

Publication_Information:

Publication_Place: Milford, PA

Publisher: Delaware Water Gap National Recreation Area

Other_Citation_Details: File name: veg_draft_formation.shp

Type_of_Source_Media: CD-ROM

Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 2003

Source_Currentness_Reference: ground condition

Source_Citation_Abbreviation: land use classification

Source_Contribution:

Provided a basis for creating and classifying grassland field polylines and providing attribute information about them.

Process_Step:

Process_Description:

The completed dataset dewa_gbi_grasslands.shp was converted from a polygon to a polyline shapefile. For each grassland field, that field's polyline was clipped according to various habitat edge categories based on the overlay of the latest available land use classification of DEWA on the latest available DEWA orthophotography. Additional edges inside and outside each field's perimeter were also added using this process. Polyline lengths were calculated and attribute data supplied according to grassland field identity, and classification by habitat type, structural characteristic, and location relative to grassland field perimeter.

Process_Date: 20040903

Spatial_Data_Organization_Information:

Direct_Spatial_Reference_Method: Vector

Point_and_Vector_Object_Information:

SDTS_Terms_Description:

SDTS_Point_and_Vector_Object_Type: String

Point_and_Vector_Object_Count: 185

Spatial_Reference_Information:

Horizontal_Coordinate_System_Definition:

Planar:

Grid_Coordinate_System:
Grid_Coordinate_System_Name: Universal Transverse Mercator
Universal_Transverse_Mercator:
UTM_Zone_Number: 18
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.999600
Longitude_of_Central_Meridian: -75.000000
Latitude_of_Projection_Origin: 0.000000
False_Easting: 500000.000000
False_Northing: 0.000000
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: 0.000064
Ordinate_Resolution: 0.000064
Planar_Distance_Units: meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257222

Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: dewa_gbi_grasslandedges
Entity_Type_Definition: dbase (.dbf) table
Entity_Type_Definition_Source: ESRI
Attribute:
Attribute_Label: FID
Attribute_Definition: Internal feature number.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain:
Sequential unique whole numbers that are automatically generated.
Attribute:
Attribute_Label: Shape
Attribute_Definition: Feature geometry.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain: Coordinates defining the features.
Attribute:
Attribute_Label: GNAME
Attribute_Definition: Unique name given to each grassland field.
Attribute_Definition_Source: Project supplied
Attribute:

Attribute_Label: EDGE_LOC

Attribute_Definition: Location of habitat edge respective to field.

Attribute_Definition_Source: Project supplied

Attribute_Domain_Values:

Enumerated_Domain:

Enumerated_Domain_Value: Perimeter

Enumerated_Domain_Value_Definition: Edge is along the field perimeter

Enumerated_Domain:

Enumerated_Domain_Value: External

Enumerated_Domain_Value_Definition: Edge is outside the field perimeter

Enumerated_Domain:

Enumerated_Domain_Value: Internal

Enumerated_Domain_Value_Definition: Edge is within the field perimeter

Attribute:

Attribute_Label: EDGE_CAT

Attribute_Definition: The habitat the edge is comprised of.

Attribute_Definition_Source: Project supplied

Attribute_Domain_Values:

Enumerated_Domain:

Enumerated_Domain_Value: cropland

Enumerated_Domain_Value_Definition: Edge is along an agricultural field.

Enumerated_Domain:

Enumerated_Domain_Value: developed

Enumerated_Domain_Value_Definition:

Edge is along buildings or other structures and surrounding grounds.

Enumerated_Domain:

Enumerated_Domain_Value: forest

Enumerated_Domain_Value_Definition: Edge is a along a forest.

Enumerated_Domain:

Enumerated_Domain_Value: grassland

Enumerated_Domain_Value_Definition: Edge is a along another grassland.

Enumerated_Domain:

Enumerated_Domain_Value: hedgerow

Enumerated_Domain_Value_Definition: Edge is a along a narrow strip of shrubs or tree.

Enumerated_Domain:

Enumerated_Domain_Value: water

Enumerated_Domain_Value_Definition: Edge is along ponds, lakes, or rivers.

Enumerated_Domain:

Enumerated_Domain_Value: road

Enumerated_Domain_Value_Definition: Edge is along a road.

Enumerated_Domain:

Enumerated_Domain_Value: shrubland

Enumerated_Domain_Value_Definition: Edge is along a shrubland.

Enumerated_Domain:

Enumerated_Domain_Value: wet_perenforb

Enumerated_Domain_Value_Definition:

Edge is along temporarily flooded temperate perennial forb vegetation.

Attribute:

Attribute_Label: SHRUB_EDGE

Attribute_Definition: Classifies edge according to structure.

Attribute_Definition_Source: Project supplied

Attribute_Domain_Values:

Enumerated_Domain:

Enumerated_Domain_Value: Yes

Enumerated_Domain_Value_Definition:

Edge likely represents a substantial structural transition from the grassland field habitat, containing shrubs, saplings, or small trees.

Enumerated_Domain:

Enumerated_Domain_Value: No

Enumerated_Domain_Value_Definition:

Edge likely does not represent a substantial structural transition from the grassland field habitat, such as a transition to an agricultural field.

Attribute:

Attribute_Label: LENGTH

Attribute_Definition: Length of edge in meters

Attribute_Definition_Source: Software generated

Attribute:

Attribute_Label: COMMENTS

Attribute_Definition: Optional comments about edge

Attribute_Definition_Source: Project supplied

Distribution_Information:

Distributor:

Contact_Information:

Contact_Person_Primary:

Contact_Person:

Contact_Organization:

Contact_Address:

Address_Type:

Address:

City:

State_or_Province:

Postal_Code:

Contact_Voice_Telephone:

Distribution_Liability:

Metadata_Reference_Information:

Metadata_Date: 20041105

Metadata_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Sheehan Jr., James

Contact_Organization: Dept. of Biological Sciences, East Stroudsburg University
Contact_Address:
Address_Type: mailing and physical
Address: 200 Prospect St.
City: East Stroudsburg
State_or_Province: PA
Postal_Code: 18301
Contact_Voice_Telephone: 570-856-0453
Contact_Electronic_Mail_Address: jf_sheehan@hotmail.com
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998

Generated by [mp](#) version 2.8.17 on Sat Nov 06 10:35:23 2004

Appendix D. Digital photo file listing.

Folder	File Name	Size (kb)	Tag Date/Time	Photo Date/Time	Grassland Field Name	Grassland Point Name
long_view	nj1-1_tag.jpg	72.3	10/2/04 5:56 PM	8/1/04 2:28 PM	NJ01/1	NJ01/1
	nj2-1_tag.jpg	83.0	10/2/04 5:56 PM	8/24/04 9:26 AM	NJ02/1	NJ02/1
	nj4-1_tag.jpg	69.1	10/2/04 5:56 PM	6/17/03 8:44 AM	NJ04/1	NJ04/1
	nj4-2_tag.jpg	84.0	10/2/04 5:56 PM	8/24/04 9:42 AM	NJ04/2	NJ04/2
	nj5-1_tag.jpg	83.2	10/2/04 5:56 PM	6/17/03 7:46 AM	NJ05/1	NJ05/1
	nj7-1_tag.jpg	73.5	10/2/04 5:56 PM	6/27/03 9:56 AM	NJ07/1	NJ07/1
	nj9-1_tag.jpg	50.9	10/2/04 5:56 PM	6/25/03 9:17 AM	NJ09/1	NJ09/1
	nj10-1_tag.jpg	95.1	10/2/04 5:56 PM	6/25/03 11:19 AM	NJ10/1	NJ10/1
	nj10-2_tag.jpg	72.8	10/2/04 5:56 PM	6/25/03 11:05 AM	NJ10/2-4	NJ10/2
	nj10-3_tag.jpg	70.6	10/2/04 5:56 PM	6/25/03 10:13 AM	NJ10/2-4	NJ10/3
	nj10-4_tag.jpg	78.4	10/2/04 5:56 PM	6/25/03 10:36 AM	NJ10/2-4	NJ10/4
	nj11-1_tag.jpg	78.7	10/2/04 5:56 PM	6/25/03 8:27 AM	NJ11/1&2	NJ11/1
	nj11-2_tag.jpg	64.3	10/2/04 5:56 PM	6/25/03 8:08 AM	NJ11/1&2	NJ11/2
	nj12-1_tag.jpg	82.4	10/2/04 5:56 PM	8/1/04 12:58 PM	NJ12/1	NJ12/1
	nj15-1_tag.jpg	77.5	10/2/04 5:56 PM	6/27/03 8:42 AM	NJ15/1	NJ15/1
	nj16-1_tag.jpg	38.2	10/2/04 5:56 PM	6/27/03 8:13 AM	NJ16/1	NJ16/1
	nj18-1_tag.jpg	63.2	10/2/04 5:56 PM	6/27/03 9:08 AM	NJ18/1	NJ18/1
	nj19-1_tag.jpg	68.1	10/2/04 5:56 PM	6/16/03 11:13 AM	NJ19/1	NJ19/1
	nj20-1_tag.jpg	89.1	10/2/04 5:56 PM	6/16/03 12:51 PM	NJ20/1	NJ20/1
	nj20-2_tag.jpg	93.4	10/2/04 5:56 PM	6/16/03 12:08 PM	NJ20/2	NJ20/2
	pa1-1_tag.jpg	66.3	10/2/04 5:56 PM	6/23/03 11:30 AM	PA01/1-3	PA01/1
	pa1-2_tag.jpg	53.9	10/2/04 5:56 PM	6/23/03 9:43 AM	PA01/1-3	PA01/2
	pa1-3_tag.jpg	52.9	10/2/04 5:56 PM	6/23/03 10:25 AM	PA01/1-3	PA01/3
	pa2-1_tag.jpg	101.7	10/2/04 5:56 PM	6/23/03 10:58 AM	PA02/1	PA02/1
	pa3-1_tag.jpg	90.6	10/2/04 5:56 PM	8/24/04 10:09 AM	PA03/1-3	PA03/1
	pa3-2_tag.jpg	93.6	10/2/04 5:56 PM	8/24/04 10:20 AM	PA03/1-3	PA03/2
	pa3-3_tag.jpg	80.4	10/2/04 5:56 PM	6/16/03 4:20 PM	PA03/1-3	PA03/3
	pa4-1_tag.jpg	68.8	10/2/04 5:56 PM	6/16/03 4:59 PM	PA04/1-3	PA04/1
	pa4-2_tag.jpg	63.9	10/2/04 5:56 PM	6/16/03 5:22 PM	PA04/1-3	PA04/2
	pa4-3_tag.jpg	73.1	10/2/04 5:56 PM	6/16/03 5:42 PM	PA04/1-3	PA04/3
	pa5-1_tag.jpg	72.6	10/2/04 5:56 PM	6/25/03 5:17 PM	PA05/1	PA05/1
	pa7-1_tag.jpg	73.0	10/2/04 5:56 PM	6/25/03 4:54 PM	PA07/1	PA07/1
	pa9-1_tag.jpg	38.4	10/2/04 5:56 PM	6/27/03 7:17 AM	PA09/1	PA09/1
	pa9-2_tag.jpg	48.7	10/2/04 5:56 PM	8/24/04 10:58 AM	PA09/2&3	PA09/2
	pa9-3_tag.jpg	71.0	10/2/04 5:56 PM	8/24/04 11:06 AM	PA09/2&3	PA09/3
	pa11-1_tag.jpg	45.9	10/2/04 5:56 PM	6/19/03 9:23 AM	PA11/1&2	PA11/1
	pa11-2_tag.jpg	53.2	10/2/04 5:56 PM	6/19/03 9:01 AM	PA11/1&2	PA11/2
	pa13-1_tag.jpg	65.7	10/2/04 5:56 PM	6/19/03 8:19 AM	PA13/1	PA13/1
	pa13-2_tag.jpg	27.8	10/2/04 5:56 PM	6/19/03 7:57 AM	PA13/2	PA13/2
	pa14-1_tag.jpg	48.1	10/2/04 5:56 PM	6/27/03 11:17 AM	PA14/1	PA14/1
	pa14-2_tag.jpg	70.8	10/2/04 5:56 PM	6/27/03 10:53 AM	PA14/2	PA14/2
	pa18-1_tag.jpg	88.4	10/2/04 5:56 PM	8/24/04 11:48 AM	PA18/1	PA18/1
	pa19-1_tag.jpg	43.2	10/2/04 5:56 PM	6/27/03 12:16 PM	PA19/1	PA19/1
	<u>GPS-Photo Link hyperlink ESRI shapefile</u>					
	longview.shp					

Folder	File Name	Size (kb)	Tag Date/Time	Photo Date/Time	Grassland Field Name	Grassland Point Name
horiz_view	nj1-1horiz_tag.jpg	116.7	10/3/04 9:06 AM	8/1/04 2:29 PM	NJ01/1	NJ01/1
	nj2-1horiz_tag.jpg	97.4	10/3/04 9:06 AM	8/24/04 9:26 AM	NJ02/1	NJ02/1
	nj4-2horiz_tag.jpg	97.3	10/3/04 9:06 AM	8/24/04 9:42 AM	NJ04/1	NJ04/2
	nj5-1horiz_tag.jpg	62.8	10/3/04 9:06 AM	6/17/03 7:46 AM	NJ05/1	NJ05/1
	nj7-1horiz_tag.jpg	105.5	10/3/04 9:06 AM	6/27/03 9:56 AM	NJ07/1	NJ07/1
	nj9-1horiz_tag.jpg	113.3	10/3/04 9:06 AM	6/25/03 9:17 AM	NJ09/1	NJ09/1
	nj10-1horiz_tag.jpg	86.0	10/3/04 9:06 AM	6/25/03 11:19 AM	NJ10/1	NJ10/1
	nj10-2horiz_tag.jpg	87.8	10/3/04 9:06 AM	6/25/03 11:05 AM	NJ10/2-4	NJ10/2
	nj10-3horiz_tag.jpg	78.4	10/3/04 9:06 AM	6/25/03 10:13 AM	NJ10/2-4	NJ10/3
	nj10-4horiz_tag.jpg	72.1	10/3/04 9:06 AM	6/25/03 10:36 AM	NJ10/2-4	NJ10/4
	nj11-1horiz_tag.jpg	87.1	10/3/04 9:06 AM	6/25/03 8:27 AM	NJ11/1&2	NJ11/1
	nj11-2horiz_tag.jpg	73.8	10/3/04 9:06 AM	6/25/03 8:08 AM	NJ11/1&2	NJ11/2
	nj12-1horiz_tag.jpg	107.2	10/3/04 9:06 AM	8/1/04 1:01 PM	NJ12/1	NJ12/1
	nj15-1horiz_tag.jpg	86.2	10/3/04 9:06 AM	6/27/03 8:42 AM	NJ15/1	NJ15/1
	nj16-1horiz_tag.jpg	100.3	10/3/04 9:06 AM	6/27/03 8:13 AM	NJ16/1	NJ16/1
	nj18-1horiz_tag.jpg	51.1	10/3/04 9:06 AM	6/27/03 9:08 AM	NJ18/1	NJ18/1
	nj19-1horiz_tag.jpg	114.3	10/3/04 9:06 AM	6/16/03 11:13 AM	NJ19/1	NJ19/1
	nj20-1horiz_tag.jpg	118.0	10/3/04 9:06 AM	6/16/03 12:51 PM	NJ20/1	NJ20/1
	nj20-2horiz_tag.jpg	106.8	10/3/04 9:06 AM	6/16/03 12:07 PM	NJ20/2	NJ20/2
	pa1-1horiz_tag.jpg	115.2	10/3/04 9:06 AM	6/23/03 11:30 AM	PA01/1-3	PA01/1
	pa1-2horiz_tag.jpg	118.4	10/3/04 9:06 AM	6/23/03 9:43 AM	PA01/1-3	PA01/2
	pa1-3horiz_tag.jpg	91.4	10/3/04 9:06 AM	6/23/03 10:25 AM	PA01/1-3	PA01/3
	pa2-1horiz_tag.jpg	97.7	10/3/04 9:06 AM	6/23/03 10:58 AM	PA02/1	PA02/1
	pa3-1horiz_tag.jpg	115.0	10/3/04 9:06 AM	8/24/04 10:10 AM	PA03/1-3	PA03/1
	pa3-2horiz_tag.jpg	115.0	10/3/04 9:06 AM	8/24/04 10:20 AM	PA03/1-3	PA03/2
	pa3-3horiz_tag.jpg	129.5	10/3/04 9:06 AM	6/16/03 4:20 PM	PA03/1-3	PA03/3
	pa4-1horiz_tag.jpg	82.7	10/3/04 9:06 AM	6/16/03 4:59 PM	PA04/1-3	PA04/1
	pa4-2horiz_tag.jpg	137.1	10/3/04 9:06 AM	6/16/03 5:21 PM	PA04/1-3	PA04/2
	pa4-3horiz_tag.jpg	92.0	10/3/04 9:06 AM	6/16/03 5:42 PM	PA04/1-3	PA04/3
	pa5-1horiz_tag.jpg	67.9	10/3/04 9:06 AM	6/25/03 5:17 PM	PA05/1	PA05/1
	pa7-1horiz_tag.jpg	129.1	10/3/04 9:06 AM	6/25/03 4:54 PM	PA07/1	PA07/1
	pa9-1horiz_tag.jpg	91.8	10/3/04 9:06 AM	6/27/03 7:17 AM	PA09/1	PA09/1
	pa9-2horiz_tag.jpg	120.0	10/3/04 9:06 AM	8/24/04 10:58 AM	PA09/2&3	PA09/2
	pa9-3horiz_tag.jpg	118.0	10/3/04 9:06 AM	8/24/04 11:06 AM	PA09/2&3	PA09/3
	pa11-1horiz_tag.jpg	78.1	10/3/04 9:06 AM	6/19/03 9:23 AM	PA11/1&2	PA11/1
	pa11-2horiz_tag.jpg	61.9	10/3/04 9:06 AM	6/19/03 9:00 AM	PA11/1&2	PA11/2
	pa13-1horiz_tag.jpg	68.5	10/3/04 9:06 AM	6/19/03 8:19 AM	PA13/1	PA13/1
	pa13-2horiz_tag.jpg	82.5	10/3/04 9:06 AM	6/19/03 7:56 AM	PA13/2	PA13/2
	pa14-1horiz_tag.jpg	94.2	10/3/04 9:06 AM	6/27/03 11:17 AM	PA14/1	PA14/1
	pa14-2horiz_tag.jpg	82.3	10/3/04 9:06 AM	6/27/03 10:52 AM	PA14/2	PA14/2
	pa18-1horiz_tag.jpg	127.8	10/3/04 9:06 AM	8/24/04 11:48 AM	PA18/1	PA18/1
	pa19-1horiz_tag.jpg	93.6	10/3/04 9:06 AM	6/27/03 12:16 PM	PA19/1	PA19/1
	<u>GPS-Photo Link hyperlink ESRI shapefile</u>					
	horizview.shp					

Folder	File Name	Size (kb)	Tag Date/Time	Photo Date/Time	Grassland Field Name	Grassland Point Name
vert_view	nj1-1vert_tag.jpg	153.9	10/3/04 9:12 AM	8/1/04 2:28 PM	NJ01/1	NJ01/1
	nj2-1vert_tag.jpg	140.6	10/3/04 9:12 AM	8/24/04 9:26 AM	NJ02/1	NJ02/1
	nj4-1vert_tag.jpg	115.4	10/3/04 9:12 AM	6/17/03 8:43 AM	NJ04/1	NJ04/1
	nj4-2vert_tag.jpg	148.6	10/3/04 9:12 AM	8/24/04 9:41 AM	NJ04/2	NJ04/2
	nj5-1vert_tag.jpg	115.0	10/3/04 9:12 AM	6/17/03 7:46 AM	NJ05/1	NJ05/1
	nj7-1vert_tag.jpg	133.7	10/3/04 9:12 AM	6/27/03 9:56 AM	NJ07/1	NJ07/1
	nj9-1vert_tag.jpg	156.4	10/3/04 9:12 AM	6/25/03 9:17 AM	NJ09/1	NJ09/1
	nj10-1vert_tag.jpg	146.0	10/3/04 9:12 AM	6/25/03 11:19 AM	NJ10/1	NJ10/1
	nj10-2vert_tag.jpg	153.9	10/3/04 9:12 AM	6/25/03 11:05 AM	NJ10/2-4	NJ10/2
	nj10-3vert_tag.jpg	152.8	10/3/04 9:12 AM	6/25/03 10:12 AM	NJ10/2-4	NJ10/3
	nj10-4vert_tag.jpg	153.0	10/3/04 9:12 AM	6/25/03 10:35 AM	NJ10/2-4	NJ10/4
	nj11-1vert_tag.jpg	148.0	10/3/04 9:12 AM	6/25/03 8:27 AM	NJ11/1&2	NJ11/1
	nj11-2vert_tag.jpg	123.7	10/3/04 9:12 AM	6/25/03 8:08 AM	NJ11/1&2	NJ11/2
	nj12-1vert_tag.jpg	119.6	10/3/04 9:12 AM	8/1/04 1:01 PM	NJ12/1	NJ12/1
	nj15-1vert_tag.jpg	124.1	10/3/04 9:12 AM	6/27/03 8:42 AM	NJ15/1	NJ15/1
	nj16-1vert_tag.jpg	130.9	10/3/04 9:12 AM	6/27/03 8:13 AM	NJ16/1	NJ16/1
	nj18-1vert_tag.jpg	141.6	10/3/04 9:12 AM	6/27/03 9:08 AM	NJ18/1	NJ18/1
	nj19-1vert_tag.jpg	114.1	10/3/04 9:12 AM	6/16/03 11:12 AM	NJ19/1	NJ19/1
	nj20-1vert_tag.jpg	139.7	10/3/04 9:12 AM	6/16/03 12:51 PM	NJ20/1	NJ20/1
	nj20-2vert_tag.jpg	142.4	10/3/04 9:12 AM	6/16/03 12:07 PM	NJ20/2	NJ20/2
	pa1-1vert_tag.jpg	119.2	10/3/04 9:12 AM	6/23/03 11:29 AM	PA01/1-3	PA01/1
	pa1-2vert_tag.jpg	135.8	10/3/04 9:12 AM	6/23/03 9:43 AM	PA01/1-3	PA01/2
	pa1-3vert_tag.jpg	149.5	10/3/04 9:12 AM	6/23/03 10:25 AM	PA01/1-3	PA01/3
	pa2-1vert_tag.jpg	125.8	10/3/04 9:12 AM	6/23/03 10:58 AM	PA02/1	PA02/1
	pa3-1vert_tag.jpg	105.0	10/3/04 9:12 AM	8/24/04 10:09 AM	PA03/1-3	PA03/1
	pa3-2vert_tag.jpg	100.9	10/3/04 9:12 AM	8/24/04 10:19 AM	PA03/1-3	PA03/2
	pa3-3vert_tag.jpg	140.1	10/3/04 9:12 AM	6/16/03 4:20 PM	PA03/1-3	PA03/3
	pa4-1vert_tag.jpg	109.3	10/3/04 9:12 AM	6/16/03 4:59 PM	PA04/1-3	PA04/1
	pa4-2vert_tag.jpg	149.6	10/3/04 9:12 AM	6/16/03 5:21 PM	PA04/1-3	PA04/2
	pa4-3vert_tag.jpg	126.4	10/3/04 9:12 AM	6/16/03 5:41 PM	PA04/1-3	PA04/3
	pa5-1vert_tag.jpg	80.1	10/3/04 9:12 AM	6/25/03 5:17 PM	PA05/1	PA05/1
	pa7-1vert_tag.jpg	134.8	10/3/04 9:12 AM	6/25/03 4:54 PM	PA07/1	PA07/1
	pa9-1vert_tag.jpg	134.4	10/3/04 9:12 AM	6/27/03 7:17 AM	PA09/1	PA09/1
	pa9-2vert_tag.jpg	133.6	10/3/04 9:12 AM	8/24/04 10:58 AM	PA09/2&3	PA09/2
	pa9-3vert_tag.jpg	134.9	10/3/04 9:12 AM	8/24/04 11:06 AM	PA09/2&3	PA09/3
	pa11-1vert_tag.jpg	108.3	10/3/04 9:12 AM	6/19/03 9:23 AM	PA11/1&2	PA11/1
	pa11-2vert_tag.jpg	109.0	10/3/04 9:12 AM	6/19/03 9:00 AM	PA11/1&2	PA11/2
	pa13-1vert_tag.jpg	70.1	10/3/04 9:12 AM	6/19/03 8:19 AM	PA13/1	PA13/1
	pa13-2vert_tag.jpg	100.7	10/3/04 9:12 AM	6/19/03 7:56 AM	PA13/2	PA13/2
	pa14-1vert_tag.jpg	92.5	10/3/04 9:12 AM	6/27/03 11:17 AM	PA14/1	PA14/1
	pa14-2vert_tag.jpg	116.8	10/3/04 9:12 AM	6/27/03 10:52 AM	PA14/2	PA14/2
	pa18-1vert_tag.jpg	121.2	10/3/04 9:12 AM	8/24/04 11:47 AM	PA18/1	PA18/1
	pa19-1vert_tag.jpg	126.5	10/3/04 9:12 AM	6/27/03 12:16 PM	PA19/1	PA19/1
	<u>GPS-Photo Link hyperlink ESRI shapefile</u>					
	vertview.shp					

Appendix E. Data dictionary.

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Primary Tables

The database contains 10 primary tables of inventory data (Figure 1). They are arranged according to Phase II specifications of the Natural Resource Database Template (NRDT) as (1) a GIS component: TBL_Grasslands, which contains attributes of the inventoried grassland fields; (2) the core structure of TBL_GrasslandPoints (analogous to the NRDT table Tbl_Locations), supplying attribute data for the points located within grassland fields where surveys of grassland birds and grassland habitat occur, TBL_PointSurveys (analogous to NRDT table Tbl_Events), containing attributes of the visits to points to conduct surveys, and TBL_Observers, providing a listing of the personnel conducting surveys; and (3) component tables of data from surveys of grassland birds and grassland habitat. Component tables are TBL_VCPsurveyBirds: the birds detected on VCP (Variable Circular Plot) point counts, TBL_VCPconditions: the weather and noise conditions during VCP counts, TBL_VegCovOcc: the percent cover and occurrence of vegetation, TBL_FHD: the density of foliage as measured along the Robel pole, TBL_RobelPole: the height of vegetation as measured on four sides of the Robel pole, and TBL_PointParameters: the distance and direction of habitat edge from four directions to the point.

The GIS component TBL_Grasslands contains the size of the grassland field in hectares, a value obtained from the ArcGIS 8.3 polygon shapefile dewa_gbi_grasslands.shp. This and other attribute data from this shapefile and dewa_gbi_grasslandedges.shp may also be obtained by linking TBL_Grasslands[GrasslandName] with the GNAME field in the shapefiles. Data fields within TBL_GrasslandPoints contain the spatial coordinates of the points obtained from the ArcGIS 8.3 point shapefile dewa_gbi_grasslandpoints.shp and may be linked via TBL_GrasslandPoints[PointName] with the PNAME field in the shapefile. These linkages are also shown in individual table descriptions below and described in the GIS metadata.

Secondary Tables

The database contains five secondary tables that supply data "looked up" by attribute fields in the primary tables (Figure 2). These are: tlu_Observer, which contains codes looked up by TBL_Observers for the observers conducting the grassland bird and grassland habitat surveys and supplies additional attribute data about them; tlu_Species, which contains species codes looked up by TBL_VCPsurveyBirds for the birds detected during VCP point counts and contains additional attribute data about the species; and tlu_NoiseCode, tlu_WindCode, and tlu_RainCode containing codes looked up by TBL_VCPconditions for the noise, wind and precipitation conditions, respectively, present during VCP point counts and an attribute field in each explaining the codes.

Table Relationships

The relationship structure (Figures 3 and 4) of the database deviates in part from the NRDT but can be readily converted if necessary. This may be done by re-establishing relationships between the tables using the NRDT required fields contained as candidate primary and foreign keys within appropriate tables. We chose not to use the composite keys LocationID and EventID of the NRDT relationship structure since the components are readily available to be re-assembled as necessary. This provides a reduction in data redundancy and simplifies filtering or sorting in forms and queries by eliminating the need for string extraction. Also, for our purposes, the relationships simplified the creation of forms for data entry and validation, and queries providing data for analyses.

The current structure creates a relationship between the core and component tables such that: Locations *have* Events *have* birds and habitat as opposed to: Locations *have* birds and habitat and Events *have* birds and habitat of the NRDT structure. An additional difference is the use of auto-increment primary keys for the tables below the level of the NRDT Tbl_Locations analogue: TBL_GrasslandPoints. The relationships established in this database may still be used to supply the identity of each row in the core and component tables identical to the NRDT via query, and this method was used to create the NRDT required fields. The NRDT field EventID has been modified, however, due to the presence of multiple events occurring at the same date and time, thus EventID now has an additional component of a unique row identifier.

Result Queries and Externally Generated Tables

The database contains output from the primary and secondary tables used in data analysis and summary as result queries within the database and tables imported from Excel spreadsheets that perform components of data analysis and summary. Individual table and query descriptions summarize calculations and queried fields.

I. Distance Analysis

RSQ_DistanceData (Figure 5) provides the detection data used by the program DISTANCE for the eight species chosen for density estimates. The data filter field [datatype] in TBL_VCPsurveyBirds was used to select data appropriate for distance analysis (see table and query descriptions below). The data was first analyzed by DISTANCE in order to select truncation distances for each species beyond which data were excluded, and this information was used in an Excel pivot table summary of RSQ_DistanceData determining which visit to a particular point contained the maximum number of detections for a species within a year. The pivot table summary was then converted to a raw dataset and imported into the database as EXT_MaxVisitData. This externally derived dataset was used to calculate densities and associated standard errors and 95% confidence limits for each species as well as calculations of statistical power.

II. Diversity and Species Richness Data & Index of Abundance

RSQ_Max_byfield (Figure 6) provides the data used calculate Shannon-Wiener species diversity and species richness values for open-guild species in the grassland fields within each inventory year. It also provides a tabular summary of these species that is incorporated into the DEWA_GBI.ppt Microsoft PowerPoint presentation. The query sbq_SumByVisit was first used to generate the number of detections per species per visit to grassland points within years. The data filter fields [datatype] and [diversitycat] in TBL_VCPsurveyBirds were used to select data appropriate for summation (see table and query descriptions below). RSQ_Max_byfield was created by using sbq_SumByVisit in conjunction with tlu_Species to select the maximum detection value for open-guild species at grassland fields within a year. For grassland fields with multiple points, whichever point had the maximum detection value for a species was selected. The procedure to create RSQ_Max_bypoint was identical except that the maximum detection value is obtained per grassland point, not grassland field. These data were then exported to Excel and spreadsheet functions were used to calculate diversity and richness. For the grassland field dataset, the 25% quartiles of these data were calculated and used in the diversity and richness rankings of DEWA_GBI.ppt. The grassland field dataset and the grassland point dataset were imported into the database as external tables EXT_RichDiversity_byfield and EXT_RichDiversity_bypoint, respectively. The query sbq_SumByVisit was used to calculate an index of abundance from the maximum detection values.

III. Vegetation Data

RSQ_VegCovOcc_bypoint and RSQVegStructure_bypoint (Figure 7) average the percent cover and occurrence and foliage height distribution data, respectively, measured along the 100 meter vegetation transect per grassland point. These queries are used to create RSQ_VegCovOcc_byfield and RSQVegStructure_byfield by averaging across points to produce mean values per grassland field. Grassland field data were incorporated into the DEWA_GBI.ppt presentation.

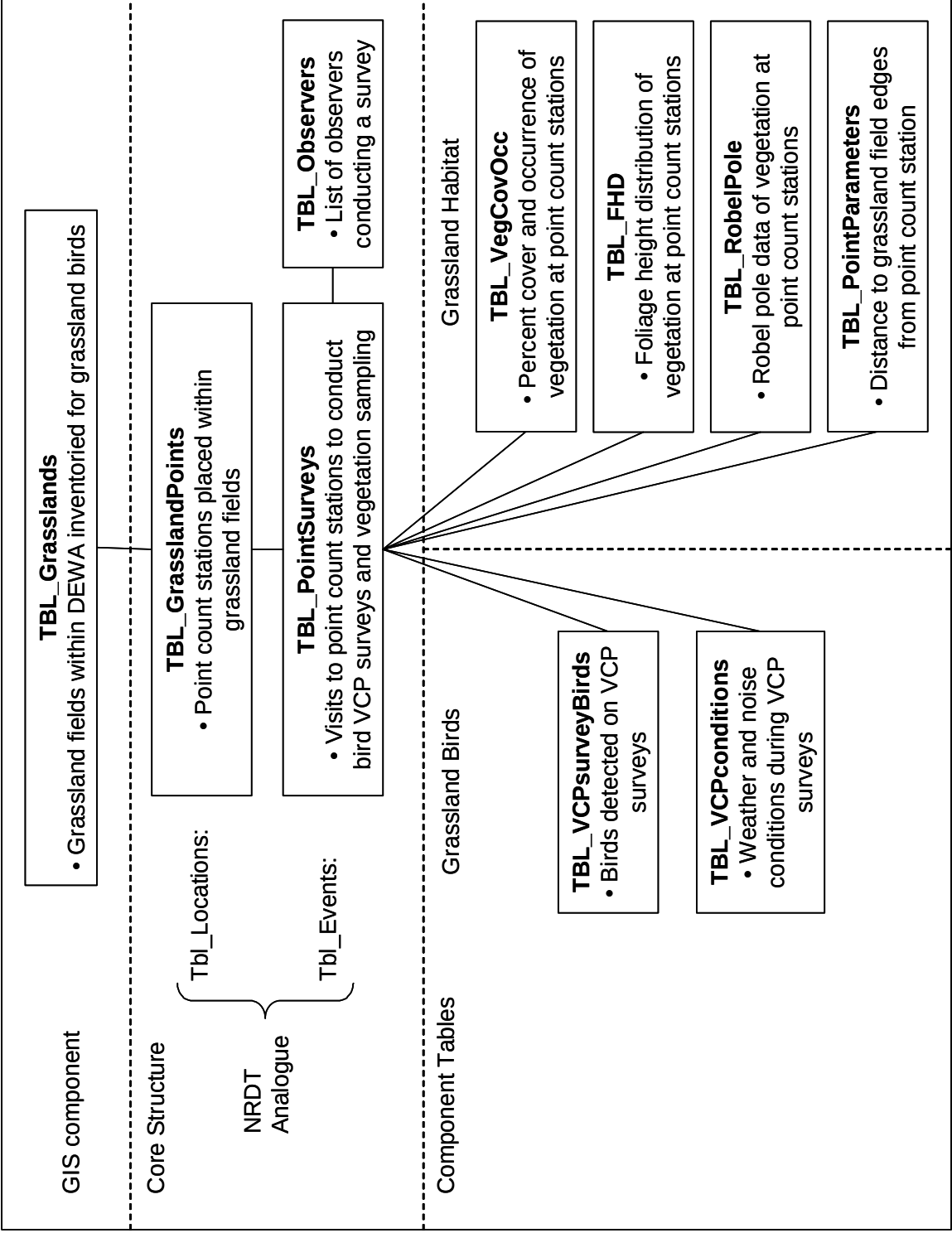


Figure 1. Primary tables in DEWA_GBI.mdb showing relationships and arranged according to NRDT specifications.

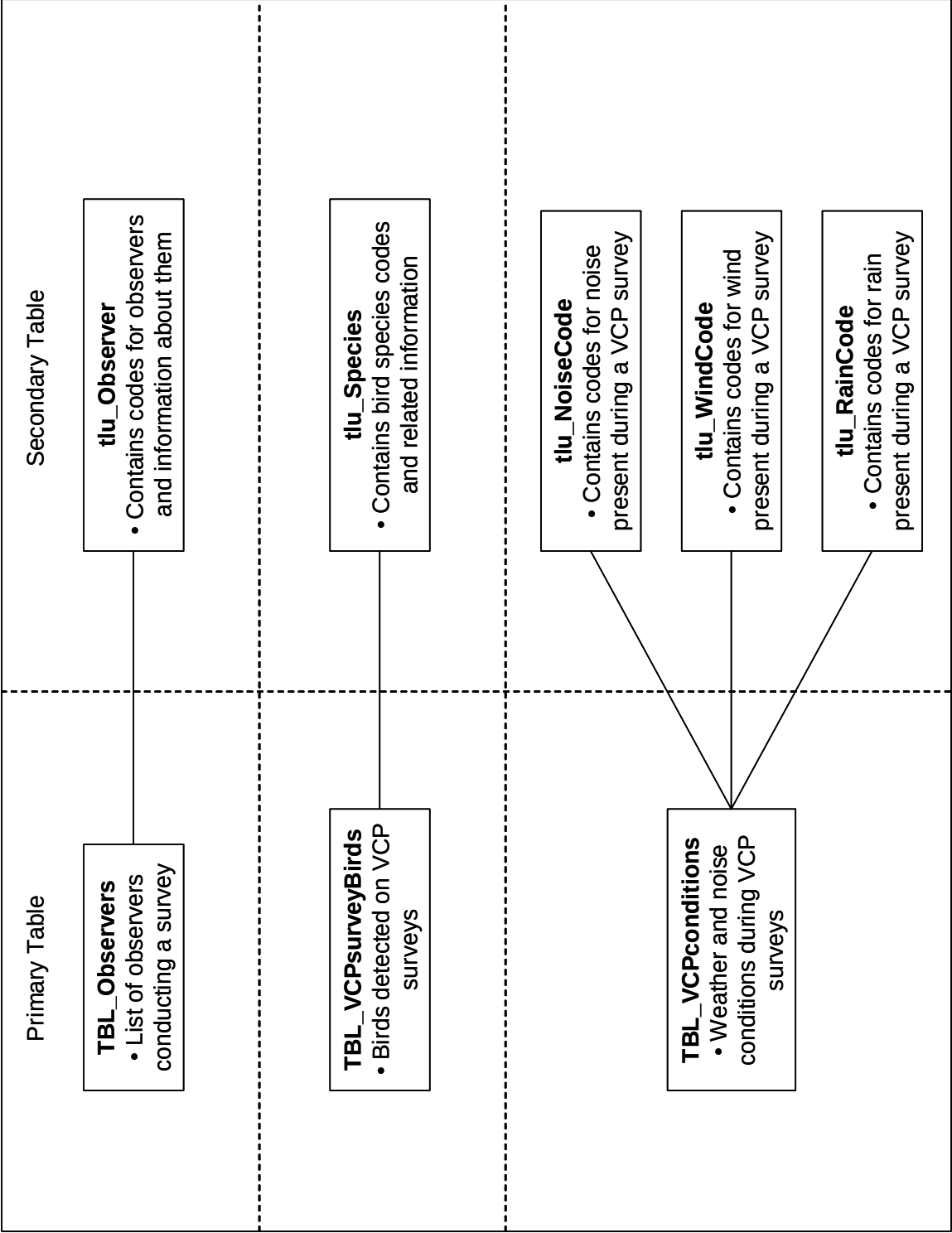


Figure 2. Secondary Tables (right) showing relationship to their respective Primary Table (left) in DEWA_GBI.mdb.

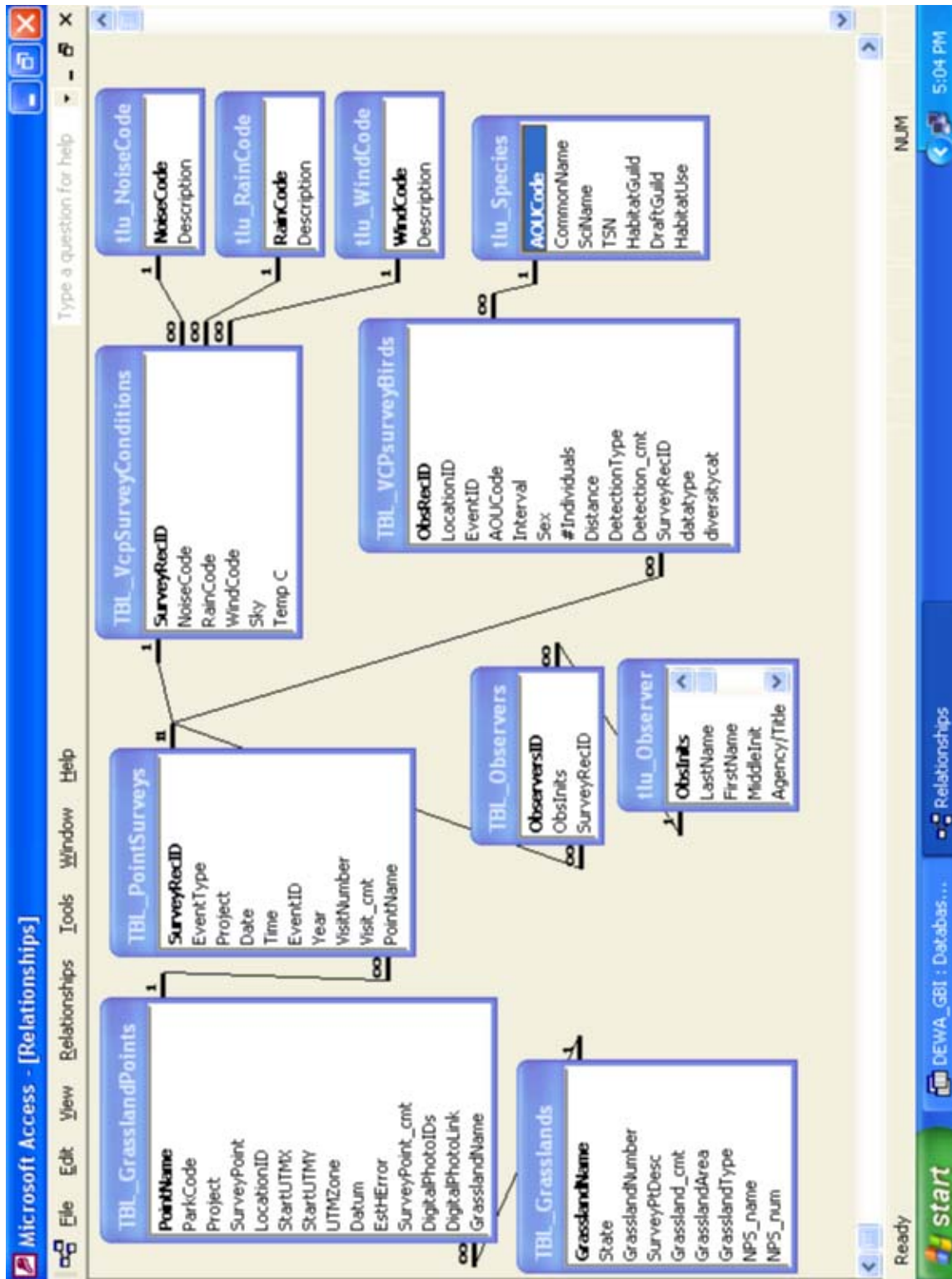


Figure 3. Microsoft Access relationship structure for grassland bird component.

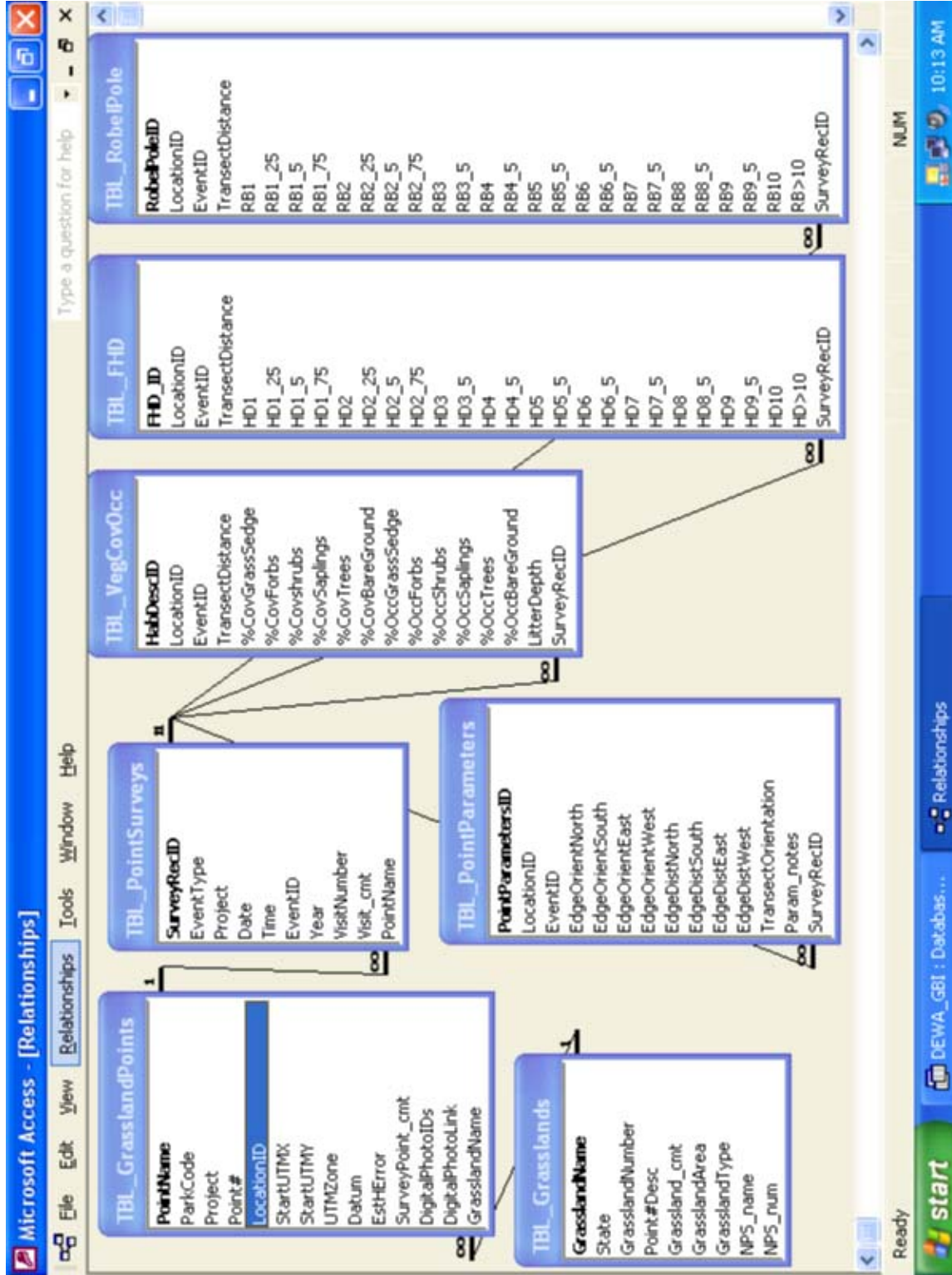


Figure 4. Microsoft Access relationship structure for grassland habitat component.

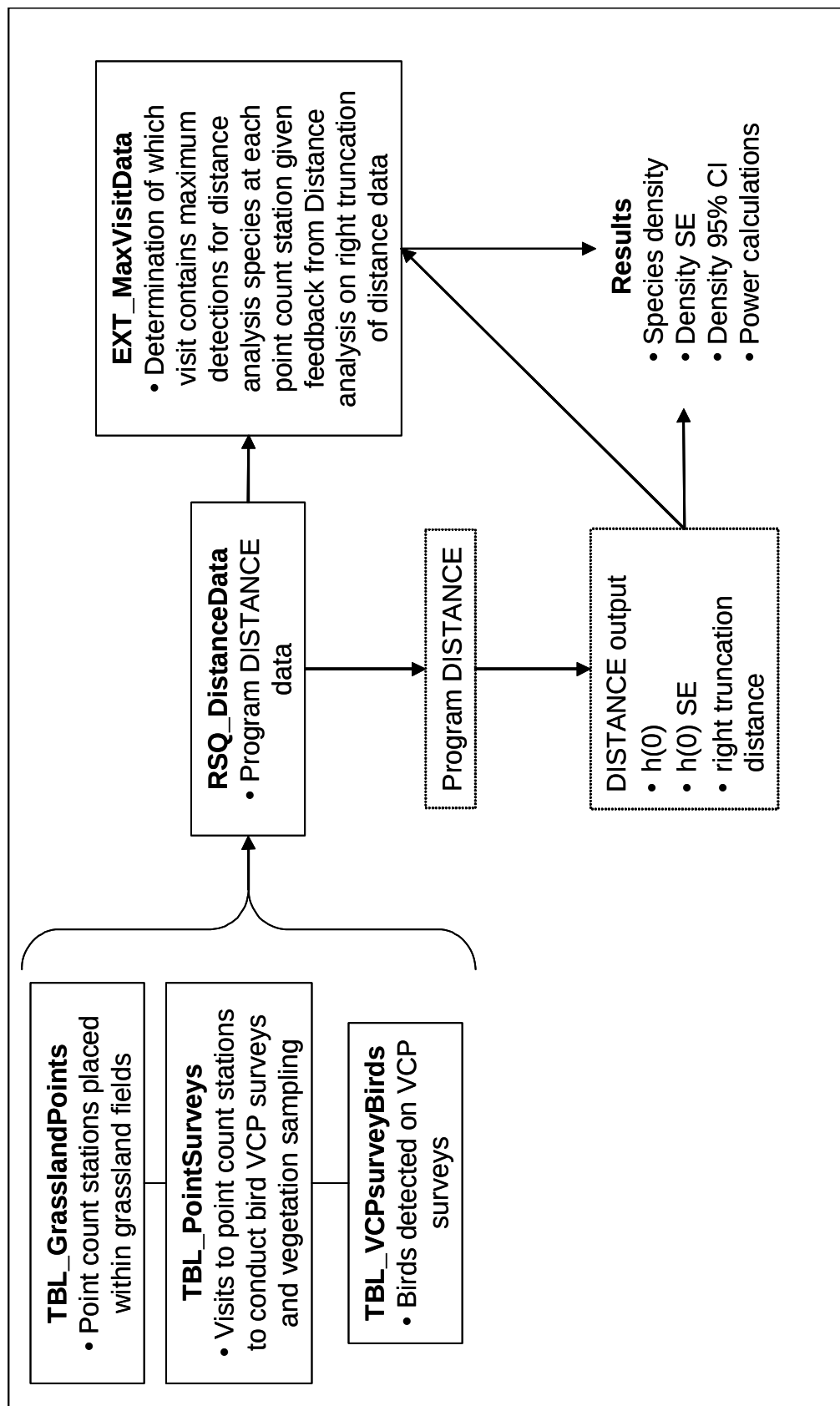


Figure 5. Query RSQ_DistanceData and its primary table components (to left of brace), and flow diagram leading to the externally derived table EXT_MaxVisitData and program DISTANCE analysis and results.

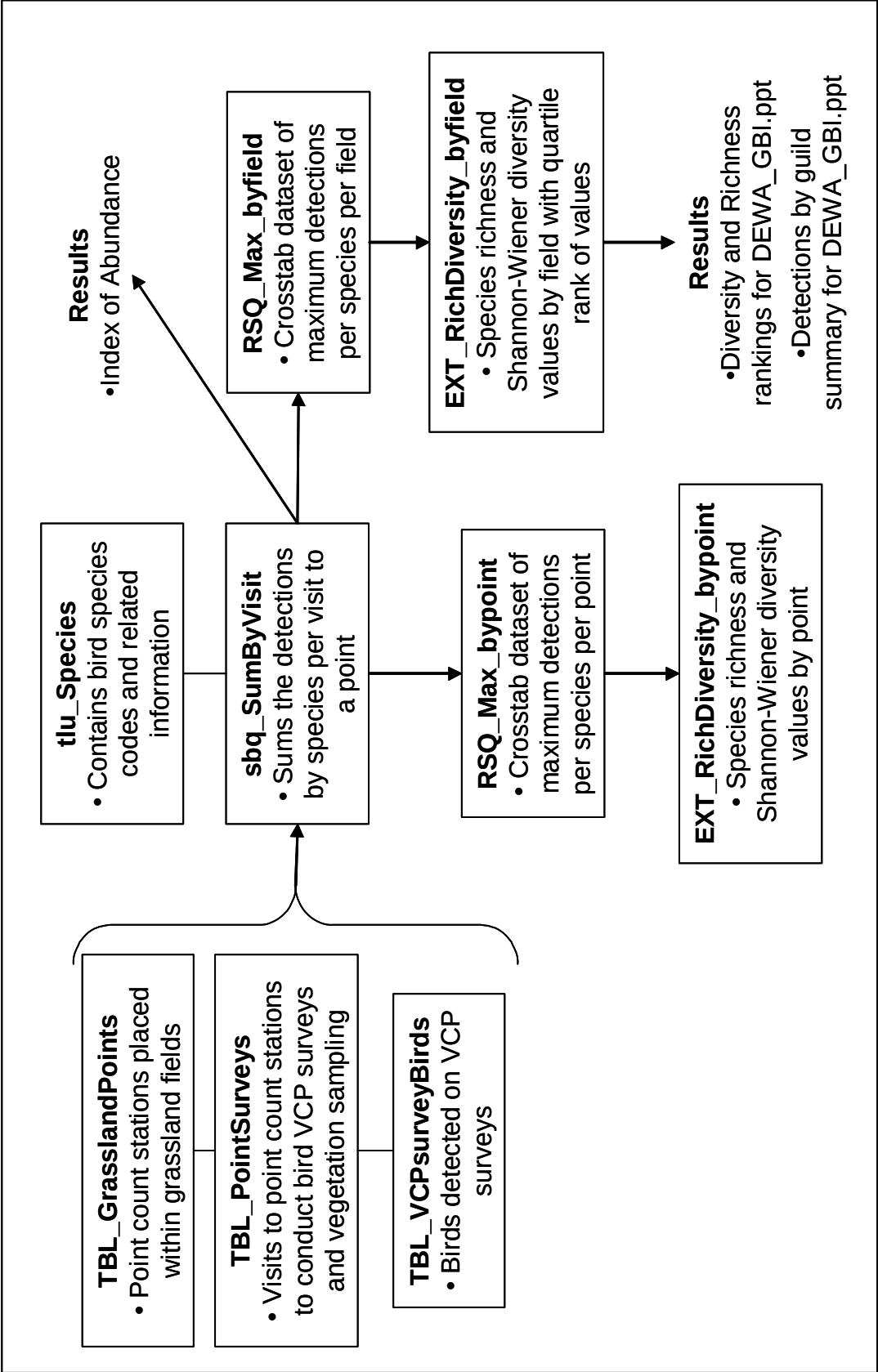


Figure 6. Table and query components of the crosstab queries RSQ_Max_byfield and RSQ_Max_bypoint leading to the externally derived tables EXT_RichDiversity_byfield, EXT_RichDiversity_bypoint and associated results.

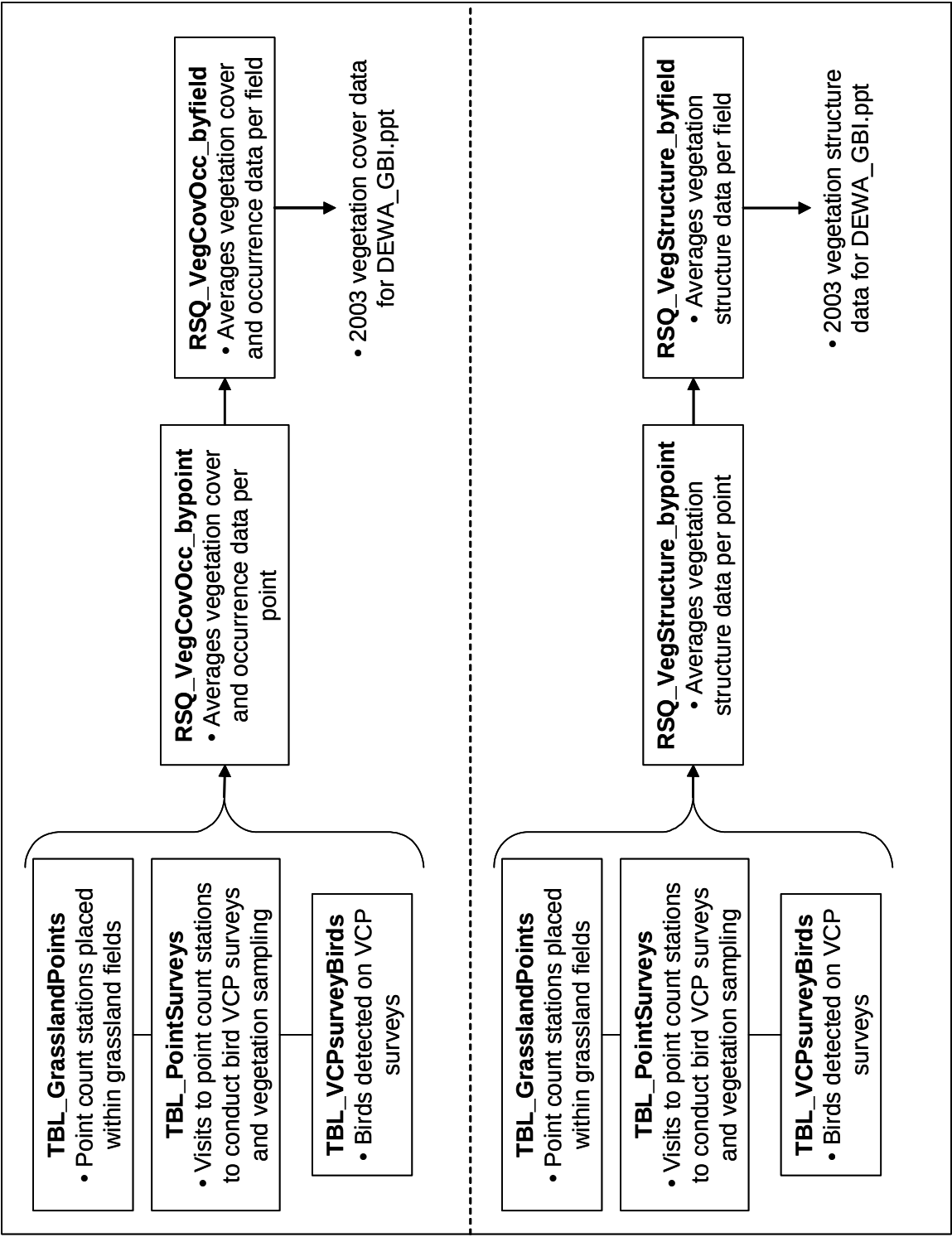


Figure 7. Queries of vegetation cover and occurrence and vegetation structure data by grassland point and grassland field.

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_Grasslands

T1. Grassland fields within DEWA inventoried for grassland birds

FieldName	Type	Description
GrasslandName	Text	Primary Key Field: unique identifier for grassland field surveyed; GIS link to dewa_gbi_grasslands.shp and gbi_grasslandedges.shp polygon shapefiles
State	Text	2-letter state code where grassland is located; used in GrasslandName
GrasslandNumber	Long Integer	2-digit code (01-99) representing grassland within NJ or PA; used in GrasslandName
Point#Desc	Text	Description of number of point count stations contained within grassland; used in GrasslandName
Grassland_cmt	Memo	Optional comment about grassland
GrasslandArea	Double	Size of grassland field in hectares
GrasslandType	Text	Management intensity classification: old field; modified; unknown
NPS_name	Text	Field name according to DEWA for identification purposes
NPS_num	Text	Field number(s) according to DEWA for identification purposes

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_GrasslandPoints

T2. Point count stations placed within grassland fields (NRDT = Tbl_Locations)

FieldName	Type	Description
PointName	Text	Primary Key Field: unique identifier for point count station located within grassland field; GIS link to dewa_gbi_grasslandpoints.shp point shapefile
ParkCode	Text	NPS code for Delaware Water Gap National Recreational Area
Project	Text	NPS code for Grassland Bird Inventory
SurveyPoint	Byte	Point count station number within grassland (1 - i); used in PointName
LocationID	Text	NRDT required field: Location ID code
UTMX	Double	UTM X (easting) coordinate for SurveyPoint
UTMY	Double	UTM Y (northing) coordinate for SurveyPoint
UTMZone	Text	UTM zone
Datum	Text	Datum of mapping ellipsoid
EstHError	Single	Estimated horizontal accuracy error (meters)
SurveyPoint_cmt	Memo	Optional comment about survey point
DigitalPhotoIDs	Text	File name of digital photographs for identification purposes
DigitalPhotoLink	Hyperlink	Link to file containing digital photographs
GrasslandName	Text	Foreign Key Field: relates to TBL_Grasslands; used in PointName

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_PointSurveys

T3. Visits to point count stations to conduct bird VCP surveys and vegetation sampling (NRDT = Tbl_Events)

FieldName	Type	Description
SurveyRecID	Long Integer	Primary Key Field: auto-increment number, unique identifier for sampling event
EventType	Text	Type of sampling taking place at this time and date; VCP Survey or Veg Sampling
Project	Text	NPS code for Grassland Bird Inventory
Date	Date/Time	Date of survey
Time	Date/Time	Time survey started
EventID	Text	NRDT required field: Sampling event ID code
Year	Long Integer	Inventory year
tYear	Text	Inventory year as text field workaround for ArcGIS crosstab import problem
VisitNumber	Long Integer	Sequential visit number within inventory year
Visit_cmt	Memo	Optional comment about visit
PointName	Text	Foreign Key Field: relates to TBL_GrasslandPoints

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_Observers

T31. List of observers conducting a survey

FieldName	Type	Description
ObserversID	Long Integer	Primary Key Field: auto-increment number, unique identifier for observer at survey
ObsInits	Text	Initials of observer conducting survey, values obtained from tlu_Observers.ObsInits
SurveyRecID	Long Integer	Foreign Key Field: relates to TBL_PointSurveys

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_VCPsurveyBirds

T4. Birds detected on VCP surveys

FieldName	Type	Description
ObsRecID	Long Integer	Primary Key Field: auto-increment number, unique identifier for birds detected during VCP counts
LocationID	Text	NRDT required field: LocationID code
EventID	Text	NRDT required field: Sampling event ID code
AOUCode	Text	4-letter code of species detected, values obtained from tlu_Species.AOUCode
Interval	Text	Time interval (0-3 min, 3-5 min)
Sex	Text	Male, Female or Unknown
#Individuals	Double	Number of individuals detected
Distance	Integer	Distance to individual estimated in meters
DetectionType	Text	How detected: Call, Song, Visual, Call/Visual, Song/Visual
Detection_cmt	Text	Optional comment about individual/group detected
Datatype	Text	Field used to filter data suitable for distance analysis {dist_data = distance analysis data, fo = flyover don't use; fo_use = flyover use; non_dist_data = non distance data, non_use = species not using habitat, xx = no distance recorded}
Diversitycat	Text	Field used to filter data suitable for diversity and richness analysis, {n = don't use, y = use, fo_use = flyover use, **** = (select species codes), flock* = flocking species}
SurveyRecID	Long Integer	Foreign Key Field: relates to TBL_PointSurveys

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_VCPconditions

T41. Weather and noise conditions during VCP surveys

FieldName	Type	Description
SurveyRecID	Long Integer	Primary Key/Foreign Key Field: auto-increment number, unique identifier for weather and noise conditions during VCP surveys, relates toTBL_PointSurveys
NoiseCode	Byte	Code used to record background noise as it affects observer's ability to hear birds, values obtained from tlu_NoiseCode.NoiseCode
RainCode	Byte	Code used to record precipitation conditions during count, values obtained from tlu_RainCode.RainCode
WindCode	Byte	Code used to record wind strength (Beaufort Scale), values obtained from tlu_WindCode.WindCode
Sky	Text	estimated % cloud cover or overcast/fog sky
Temp C	Long Integer	temperature (degrees Celsius) during survey

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_VegCovOcc

T5. Percent cover and occurrence of vegetation at point count stations

FieldName	Type	Description
HabDescID	Long Integer	Primary Key Field: auto-increment number, unique identifier for vegetation measurements along transects
LocationID	Text	NRDT required field: LocationID code
EventID	Text	NRDT required field: Sampling event ID code
TransectDistance	Text	Distance along transect in 10-meter intervals (0-100), where vegetation measurements were collected.
CovGrassSedge	Long Integer	% Coverage of Grasses and Sedges
CovForbs	Long Integer	% Coverage of Forbs
Covshrubs	Long Integer	% Coverage of Shrubs
CovSaplings	Long Integer	% Coverage of Saplings (<10 cm DBH)
CovTrees	Long Integer	% Coverage of Trees (>10 cm DBH)
CovBareGround	Long Integer	% Coverage of Bare Ground
OccGrassSedge	Long Integer	% Occurrence of Grasses and Sedges
OccForbs	Long Integer	% Occurrence of Forbs
OccShrubs	Long Integer	% Occurrence of Shrubs
OccSaplings	Long Integer	% Occurrence of Saplings (<10 cm DBH)
OccTrees	Long Integer	% Occurrence of Trees (>10 cm DBH)
OccBareGround	Long Integer	% Occurrence of Bare Ground
LitterDepth	Long Integer	Depth of leaf litter (mm)
SurveyRecID	Long Integer	Foreign Key Field: relates to TBL_PointSurveys

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_FHD

T51. Foliage height distribution of vegetation at point count stations

FieldName	Type	Description
FHD_ID	Long Integer	Primary Key Field: auto-increment number, unique identifier for vegetation structure measurements along transects
LocationID	Text	NRDT required field: LocationID code
EventID	Text	NRDT required field: Sampling event ID code
TransectDistance	Text	Distance along transect in 10-meter intervals (0-100), where vegetation measurements were collected.
HD1	Yes/No	Yes indicates leaf touching Robel Pole at 1dm. No indicates no leaves touching.
HD1_25	Yes/No	Yes indicates leaf touching Robel Pole at 1.25dm. No indicates no leaves touching.
HD1_5	Yes/No	Yes indicates leaf touching Robel Pole at 1.5dm. No indicates no leaves touching.
HD1_75	Yes/No	Yes indicates leaf touching Robel Pole at 1.75dm. No indicates no leaves touching.
HD2	Yes/No	Yes indicates leaf touching Robel Pole at 2dm. No indicates no leaves touching.
HD2_25	Yes/No	Yes indicates leaf touching Robel Pole at 2.25dm. No indicates no leaves touching.
HD2_5	Yes/No	Yes indicates leaf touching Robel Pole at 2.5dm. No indicates no leaves touching.
HD2_75	Yes/No	Yes indicates leaf touching Robel Pole at 2.75dm. No indicates no leaves touching.
HD3	Yes/No	Yes indicates leaf touching Robel Pole at 3dm. No indicates no leaves touching.
HD3_5	Yes/No	Yes indicates leaf touching Robel Pole at 3.5dm. No indicates no leaves touching.
HD4	Yes/No	Yes indicates leaf touching Robel Pole at 4dm. No indicates no leaves touching.
HD4_5	Yes/No	Yes indicates leaf touching Robel Pole at 4.5dm. No indicates no leaves touching.
HD5	Yes/No	Yes indicates leaf touching Robel Pole at 5dm. No indicates no leaves touching.
HD5_5	Yes/No	Yes indicates leaf touching Robel Pole at 5.5dm. No indicates no leaves touching.
HD6	Yes/No	Yes indicates leaf touching Robel Pole at 6dm. No indicates no leaves touching.

HD6_5	Yes/No	Yes indicates leaf touching Robel Pole at 6.5dm. No indicates no leaves touching.
HD7	Yes/No	Yes indicates leaf touching Robel Pole at 7dm. No indicates no leaves touching.
HD7_5	Yes/No	Yes indicates leaf touching Robel Pole at 7.5dm. No indicates no leaves touching.
HD8	Yes/No	Yes indicates leaf touching Robel Pole at 8dm. No indicates no leaves touching.
HD8_5	Yes/No	Yes indicates leaf touching Robel Pole at 8.5dm. No indicates no leaves touching.
HD9	Yes/No	Yes indicates leaf touching Robel Pole at 9dm. No indicates no leaves touching.
HD9_5	Yes/No	Yes indicates leaf touching Robel Pole at 9.5dm. No indicates no leaves touching.
HD10	Yes/No	Yes indicates leaf touching Robel Pole at 10dm. No indicates no leaves touching.
HD>10	Yes/No	Yes indicates leaf touching Robel Pole at >10dm. No indicates no leaves touching.
SurveyRecID	Long Integer	Foreign Key Field: relates to TBL_PointSurveys

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_RobelPole

T52. Robel pole data of vegetation at point count stations

FieldName	Type	Description
RobelPoleID	Long Integer	Primary Key Field: auto-increment number, unique identifier for vegetation height measurements along transects
LocationID	Text	NRDT required field: LocationID code
EventID	Text	NRDT required field: Sampling event ID code
TransectDistance	Text	Distance along transect in 10-meter intervals (0-100), where vegetation measurements were collected.
RB1	Text	Number (1-4) indicates vegetation height is 1dm on the robel pole in up to 4 directions.
RB1_25	Text	Number (1-4) indicates vegetation height is 1.25dm on the robel pole in up to 4 directions.
RB1_5	Text	Number (1-4) indicates vegetation height is 1.5dm on the robel pole in up to 4 directions.
RB1_75	Text	Number (1-4) indicates vegetation height is 1.75dm on the robel pole in up to 4 directions.
RB2	Text	Number (1-4) indicates vegetation height is 2dm on the robel pole in up to 4 directions.
RB2_25	Text	Number (1-4) indicates vegetation height is 2.25dm on the robel pole in up to 4 directions.
RB2_5	Text	Number (1-4) indicates vegetation height is 2.5dm on the robel pole in up to 4 directions.
RB2_75	Text	Number (1-4) indicates vegetation height is 2.75dm on the robel pole in up to 4 directions.
RB3	Text	Number (1-4) indicates vegetation height is 3dm on the robel pole in up to 4 directions.
RB3_5	Text	Number (1-4) indicates vegetation height is 3.5dm on the robel pole in up to 4 directions.
RB4	Text	Number (1-4) indicates vegetation height is 4dm on the robel pole in up to 4 directions.
RB4_5	Text	Number (1-4) indicates vegetation height is 4.5dm on the robel pole in up to 4 directions.
RB5	Text	Number (1-4) indicates vegetation height is 5dm on the robel pole in up to 4 directions.
RB5_5	Text	Number (1-4) indicates vegetation height is 5.5dm on the robel pole in up to 4 directions.
RB6	Text	Number (1-4) indicates vegetation height is 6dm on the robel pole in up to 4 directions.

RB6_5	Text	Number (1-4) indicates vegetation height is 6.5dm on the robel pole in up to 4 directions.
RB7	Text	Number (1-4) indicates vegetation height is 7dm on the robel pole in up to 4 directions.
RB7_5	Text	Number (1-4) indicates vegetation height is 7.5dm on the robel pole in up to 4 directions.
RB8	Text	Number (1-4) indicates vegetation height is 8dm on the robel pole in up to 4 directions.
RB8_5	Text	Number (1-4) indicates vegetation height is 8.5dm on the robel pole in up to 4 directions.
RB9	Text	Number (1-4) indicates vegetation height is 9dm on the robel pole in up to 4 directions.
RB9_5	Text	Number (1-4) indicates vegetation height is 9.5dm on the robel pole in up to 4 directions.
RB10	Text	Number (1-4) indicates vegetation height is 10dm on the robel pole in up to 4 directions.
RB>10	Text	Number (1-4) indicates vegetation height is >10dm on the robel pole in up to 4 directions.
SurveyRecID	Long Integer	Foreign Key Field: relates to TBL_PointSurveys

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: TBL_PointParameters

T53. Distance to grassland field edges from point count station

FieldName	Type	Description
PointParametersID	Long Integer	Primary Key Field: auto-increment number, unique identifier for distance to edge measurements from point count stations
LocationID	Text	NRDT required field: LocationID code
EventID	Text	NRDT required field: Sampling event ID code
EdgeOrientNorth	Text	Compass bearing to 1 of 4 closest edges from point count station
EdgeOrientSouth	Text	Compass bearing to 2 of 4 closest edges from point count station
EdgeOrientEast	Text	Compass bearing to 3 of 4 closest edges from point count station
EdgeOrientWest	Text	Compass bearing to 4 of 4 closest edges from point count station
EdgeDistNorth	Double	Distance to the nearest meter to 1 of 4 closest edges from point count station measured with a laser rangefinder
EdgeDistSouth	Double	Distance to the nearest meter to 2 of 4 closest edges from point count station measured with a laser rangefinder
EdgeDistEast	Double	Distance to the nearest meter to 3 of 4 closest edges from point count station measured with a laser rangefinder
EdgeDistWest	Double	Distance to the nearest meter to 4 of 4 closest edges from point count station measured with a laser rangefinder
TransectOrientation	Text	Compass bearing(s) of vegetation survey 100 meter transect
Param_notes	Memo	Optional comments about parameters
SurveyRecID	Long Integer	Foreign Key Field: relates to TBL_PointSurveys

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: tlu_Observer

T90. Contains codes for observers and information about them

FieldName	Type	Description
ObsInits	Text	Primary Key Field: observer initials (max. 3 characters), unique identifier for the field personnel of the project
LastName	Text	Last name of observer
FirstName	Text	First name of observer
MiddleInit	Text	Middle initial of observer
Agency/Title	Text	Observer title and employer
Address	Text	Primary address of observer
Address2	Text	Secondary address of observer if applicable
City	Text	City/Town of primary address
State	Text	State of primary address
ZipCode	Text	Zip Code of primary address
EmailAddress	Text	Email address of observer
HomePhone	Text	Home phone number of observer
WorkPhone	Text	Work phone number of observer
WorkExtension	Text	Extension of work phone number if applicable
FaxNumber	Text	Observer's fax number if applicable
Notes	Memo	Comments about observer

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: tlu_Species

T91. Contains bird species codes and related information

FieldName	Type	Description
AOUCode	Text	Primary Key Field: unique identifier of 4-character AOU code for bird species
CommonName	Text	Common or vernacular name for the species
SciName	Text	Scientific name for the species
TSN	Double	Taxonomic Serial Number for the species as assigned by ITIS (Integrated Taxonomic Info System)
HabitatGuild	Text	Guild of primary habitat type of species: Forest, Edge, Grass, Shrub

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: tlu_NoiseCode

T92. Contains codes for noise present during a VCP survey

FieldName	Type	Description
NoiseCode	Byte	Primary Key Field: unique identifier of code used to record background noise as it affects observer's ability to hear birds
Description	Text	Explanation of background noise code

Table: tlu_WindCode

T93. Contains codes for wind present during a VCP survey

FieldName	Type	Description
WindCode	Byte	Primary Key Field: unique identifier of code used to record wind strength (Beaufort Scale)
Description	Text	Explanation of wind code

Table: tlu_RainCode

T94. Contains codes for rain present during a VCP survey

FieldName	Type	Description
RainCode	Byte	Primary Key Field: unique identifier of code used to record precipitation conditions during count (rain)
Description	Text	Explanation of rain code

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: EXT_MaxVisitData

X1. Determination of which visit contains maximum detections for distance analysis species at each point count station given feedback from distance analysis on right truncation of distance data

FieldName	Type	Description
RecordID	Long Integer	Primary Key Field: unique identifier of sum of detections per species per VCP survey visit
Year	Double	Inventory year
AOUCode	Text	4-letter code of species detected
PointName	Text	Point count station located within grassland field
VisitNumber	Double	Sequential visit number within inventory year
Total	Double	Sum of the number of individuals detected within truncation distance obtained by program DISTANCE
MaxCode	Text	Filter: {= "max"} used to select visit with maximum number of detections

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: EXT_RichDiversity_byfield

X2. Species richness and Shannon-Wiener diversity values by field with quartile rank of values

FieldName	Type	Description
RecordID	Long Integer	Primary Key Field: unique identifier of diversity and richness analysis results per grassland field
Year	Double	Inventory year
GrasslandName	Text	Grassland field surveyed
Open_diversity	Double	Shannon-Wiener diversity value for open-guild species excluding Aerial subguild and RWBL detections
OpenD_rank	Double	Quartile ranking of within-year diversity values
Open_richness	Double	Species richness value for open-guild species
OpenR_rank	Double	Quartile ranking of within-year species richness values

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Table: EXT_RichDiversity_bypoint

X2a. Species richness and Shannon-Wiener diversity values by point count station

FieldName	Type	Description
RecordID	Long Integer	Primary Key Field: unique identifier of diversity and richness analysis results per point count station
Year	Double	Inventory year
PointName	Text	Point count station located within grassland field
Open_diversity	Double	Shannon-Wiener diversity value for open-guild species excluding Aerial subguild and RWBL detections
Open_richness	Double	Species richness value for open-guild species

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Query: RSQ_DistanceData

Q1. Program DISTANCE data

FieldName	Description
Year	Parent Table: TBL_PointSurveys
PointName	Parent Table: TBL_GrasslandPoints
VisitNumber	Parent Table: TBL_PointSurveys
AOUCode	Parent Table: TBL_VCPsurveyBirds
Distance	Parent Table: TBL_VCPsurveyBirds
#Individuals	Parent Table: TBL_VCPsurveyBirds
datatype	Filter {= "distdata"} used to select appropriate DISTANCE detection data; Parent Table: TBL_VCPsurveyBirds

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Query: sbq_SumbyVisit

Q2. Sums the detections by species per visit to a point

FieldName	Description
Year	Parent Table: TBL_PointSurveys
GrasslandName	Parent Table: TBL_GrasslandPoint
PointName	Parent Table: TBL_GrasslandPoint
VisitNumber	Parent Table: TBL_PointSurveys
AOUCode	Parent Table: TBL_VCPsurveyBirds
SumOf#Individuals	Parent Table: TBL_VCPsurveyBirds; Value: Sum of [#Individuals] Where [distdata] <> "fo" And <> "non_use" And [diversitycat] <> "n"

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Query: RSQ_Max_byfield

Q2a. Crosstab dataset of maximum detections per species per field within a year

FieldName	Description
GrasslandName	Parent Query: sbq_SumByVisit; Crosstab: Row Variable
HabitatGuild	Parent Table: tlu_Species; Filter <> "forest"; Crosstab: Row Variable
CommonName	Parent Table: tlu_Species; Crosstab: Row Variable
y2002	Parent Query: sbq_SumByVisit; Crosstab: Column Variable; Value: max value of detections in 2002
y2003	Parent Query: sbq_SumByVisit; Crosstab: Column Variable; Value: max value of detections in 2003

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Query: RSQ_Max_bypoint

Q2b. Crosstab dataset of maximum detections per species per point within a year

FieldName	Description
PointName	Parent Query: sbq_SumByVisit; Crosstab: Row Variable
HabitatGuild	Parent Table: tlu_Species; Filter <> "forest"; Crosstab: Row Variable
CommonName	Parent Table: tlu_Species; Crosstab: Row Variable
y2002	Parent Query: sbq_SumByVisit; Crosstab: Column Variable; Value: max value of detections in 2002
y2003	Parent Query: sbq_SumByVisit; Crosstab: Column Variable; Value: max value of detections in 2003

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Query: RSQ_VegCovOcc_bypoint

Q3. Averages vegetation cover and occurrence data per grassland point

FieldName	Description
Year	Parent Table: TBL_PointSurveys
PointName	Parent Table: TBL_GrasslandPoints
GrasslandName	Parent Table: TBL_GrasslandPoints
TransectDistance_n	Count of TBL_VegCovOcc.TransectDistance
AvgOfCovGrassSedge	Average of TBL_VegCovOcc.CovGrassSedge
AvgOfCovForbs	Average of TBL_VegCovOcc.CovForbs
AvgOfCovshrubs	Average of TBL_VegCovOcc.Covshrubs
AvgOfCovSaplings	Average of TBL_VegCovOcc.CovSaplings
AvgOfCovTrees	Average of TBL_VegCovOcc.CovTrees
AvgOfCovBareGround	Average of TBL_VegCovOcc.CovBareGround
AvgOfOccGrassSedge	Average of TBL_VegCovOcc.OccGrassSedge
AvgOfOccForbs	Average of TBL_VegCovOcc.OccForbs
AvgOfOccShrubs	Average of TBL_VegCovOcc.OccShrubs
AvgOfOccSaplings	Average of TBL_VegCovOcc.OccSaplings
AvgOfOccTrees	Average of TBL_VegCovOcc.OccTrees
AvgOfOccBareGround	Average of TBL_VegCovOcc.OccBareGround
AvgOfLitterDepth	Average of TBL_VegCovOcc.LitterDepth

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Query: RSQ_VegCovOcc_byfield

Q3. Averages vegetation cover and occurrence data per grassland field

FieldName	Description
Year	Parent Query: RSQ_VegCovOcc_bypoint
GrasslandName	Parent Query: RSQ_VegCovOcc_bypoint
Point_n	Count of RSQ_VegCovOcc_bypoint.PointName
AvgOfCovGrassSedge	Average of RSQ_VegCovOcc_bypoint.CovGrassSedge
AvgOfCovForbs	Average of RSQ_VegCovOcc_bypoint.CovForbs
AvgOfCovshrubs	Average of RSQ_VegCovOcc_bypoint.Covshrubs
AvgOfCovSaplings	Average of RSQ_VegCovOcc_bypoint.CovSaplings
AvgOfCovTrees	Average of RSQ_VegCovOcc_bypoint.CovTrees
AvgOfCovBareGround	Average of RSQ_VegCovOcc_bypoint.CovBareGround
AvgOfOccGrassSedge	Average of RSQ_VegCovOcc_bypoint.OccGrassSedge
AvgOfOccForbs	Average of RSQ_VegCovOcc_bypoint.OccForbs
AvgOfOccShrubs	Average of RSQ_VegCovOcc_bypoint.OccShrubs
AvgOfOccSaplings	Average of RSQ_VegCovOcc_bypoint.OccSaplings
AvgOfOccTrees	Average of RSQ_VegCovOcc_bypoint.OccTrees
AvgOfOccBareGround	Average of RSQ_VegCovOcc_bypoint.OccBareGround
AvgOfLitterDepth	Average of RSQ_VegCovOcc_bypoint.LitterDepth

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Query: RSQ_VegStructure_bypoint

Q4. Averages vegetation structure data per grassland point

FieldName	Description
Year	Parent Table: TBL_PointSurveys
PointName	Parent Table: TBL_GrasslandPoints
GrasslandName	Parent Table: TBL_GrasslandPoints
TransectDistance_n	Count of TBL_VegStructure.TransectDistance
hd_0to2dm	Sum of (TBL_FHD.HD1 + HD1_25 + HD1_5 + HD1_75 + HD2) / TransectDistance_n*5
hd_2to4dm	Sum of (TBL_FHD.HD2_25 + HD2_5 + HD2_75 + HD3 + HD3_5 + HD4) / TransectDistance_n*6
hd_4to6dm	Sum of (TBL_FHD.HD4_5 + HD5 + HD5_5 + HD6) / TransectDistance_n*4
hd_6to8dm	Sum of (TBL_FHD.HD6_5 + HD7 + HD7_5 + HD8) / TransectDistance_n*4
hd_8to10dm	Sum of (TBL_FHD.HD8_5 + HD9 + HD9_5 + HD10 + HD>10) / TransectDistance_n*5
hd_0to5dm	Sum of (TBL_FHD.HD1 + HD1_25 + HD1_5 + HD1_75 + HD2 + HD2_25 + HD2_5 + HD2_75 + HD3 + HD3_5 + HD4 + HD4.5 + HD5) / TransectDistance_n*13
hd_5to10dm	Sum of (TBL_FHD.HD6_5 + HD7 + HD7_5 + HD8 + HD8_5 + HD9 + HD9_5 + HD10 + HD>10) / TransectDistance_n*9

Species Inventory Database

Data Dictionary for: A Point Count Survey of Grassland Birds in the Delaware Water Gap
National Recreation Area

File Name: DEWA_GBI.mdb (Microsoft Access 2000)

Query: RSQ_VegStructure_byfield

Q4a. Averages vegetation structure data per grassland field

FieldName	Description
Year	Parent Query: RSQ_VegCovOcc_bypoint
GrasslandName	Parent Query: RSQ_VegCovOcc_bypoint
Point_n	Count of RSQ_VegCovOcc_bypoint.PointName
hd_0to2dm	Average of RSQ_VegCovOcc_bypoint.hd_0to2dm
hd_2to4dm	Average of RSQ_VegCovOcc_bypoint.hd_2to4dm
hd_4to6dm	Average of RSQ_VegCovOcc_bypoint.hd_4to6dm
hd_6to8dm	Average of RSQ_VegCovOcc_bypoint.hd_6to8dm
hd_8to10dm	Average of RSQ_VegCovOcc_bypoint.hd_8to10dm
hd_0to5dm	Average of RSQ_VegCovOcc_bypoint.hd_0to5dm
hd_5to10dm	Average of RSQ_VegCovOcc_bypoint.hd_5to10dm

Appendix F. DISTANCE[®] analysis detection function graphs and selected analysis details.

The purpose of this document is to 1) show a graphical representation of the detection function model selection effort for each of the eight density-estimate species, a process which results in the selected model being used to calculate density; and 2) to present selected analysis details representing key parameters from the final model selected. This discussion is largely guided by Buckland et al. (2001) and extensive use of the DISTANCE[®] program and its documentation, as well as much exploration of the archives of the distance-sampling e-mail list (<http://www.jiscmail.ac.uk/lists/distance-sampling.html>). Distance analysis is undoubtedly a complex effort, and substantial variability in results is possible, dependent upon how the analyst chooses the model and handles the data. Diefenbach et al. (2003) also show how strongly observer variability can affect detectability, a factor that we chose not to model in our analysis of the distance data. In consideration of these caveats, our interpretation of the data is open to question, although we believe the results we obtained are an improvement over no use of techniques to account for differential detectability among species. While not an exhaustive presentation of the complete analysis, the graphs and details contained herein should allow others to evaluate, in part, our application of this technique.

Graphs were produced with GxHisto.xls – An excel macro for creating detection probability plots by Tim Gerrodette, Southwest Fisheries Science Center, NMFS (available from <http://www.ruwpa.st-and.ac.uk/distance/distancesupport.html>). Two graphs are presented for each species, the one on the left, using default model specifications and a large number of even-width bins (continuous detection distances grouped into discrete intervals) in order to evaluate potential heaping (where the observer has a tendency to round continuous distances up or down to convenient values) and avoidance/attraction behavior of the bird to the observer. Both factors can make model selection problematic, and alleviating their influence is usually done by selectively binning the data (pooling the continuous data into discrete intervals). This graph also shows the data with no truncation in recorded distances, so that the pooled sample size (n) equals all detections of singing males. Model fit is also usually improved by right-truncating a certain portion of the furthest distances where fitting the model is difficult. The graph on the right shows the model of the final detection function chosen with bins and truncation distance applied, the name of the model, and the pooled sample size (n) following truncation. Note that heaping and avoidance appear to be present for some species (e.g. indigo bunting, red-winged blackbird).

We show the following parameters and their associated measures of variance obtained from the program output of the final detection function chosen:

(1) $h(0)$ - the slope of the probability density function (PDF) of detection distances at distance zero. The PDF as estimated at zero is viewed as a convenient density estimator with much support in the statistical literature (Buckland et al. 2001), and may be used to calculate density (per hectare) via the formula $D = \sum_{i=1}^k Spp_{\#} \left(\frac{h(0)}{2\pi k} \right) 10^4$

where $Spp_{\#}$ is the number of singing males of a species at a point, π is 3.14..., and k is the number of points sampled.

(2) p - the probability of observing a singing male in the defined area for that species.

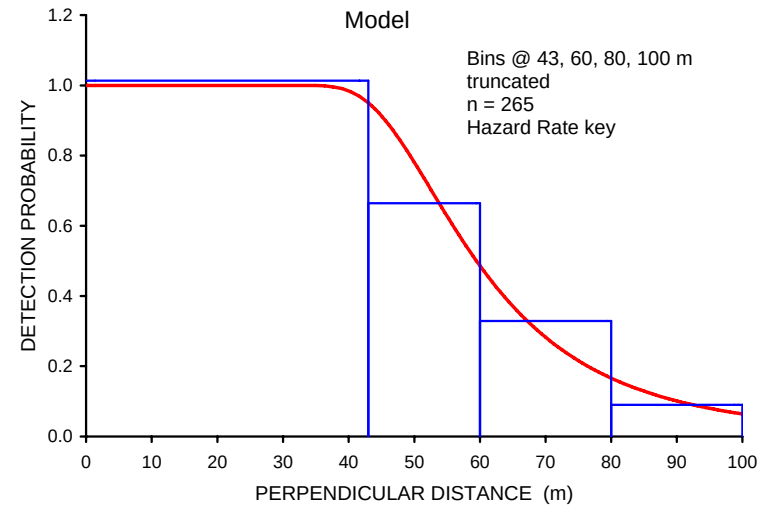
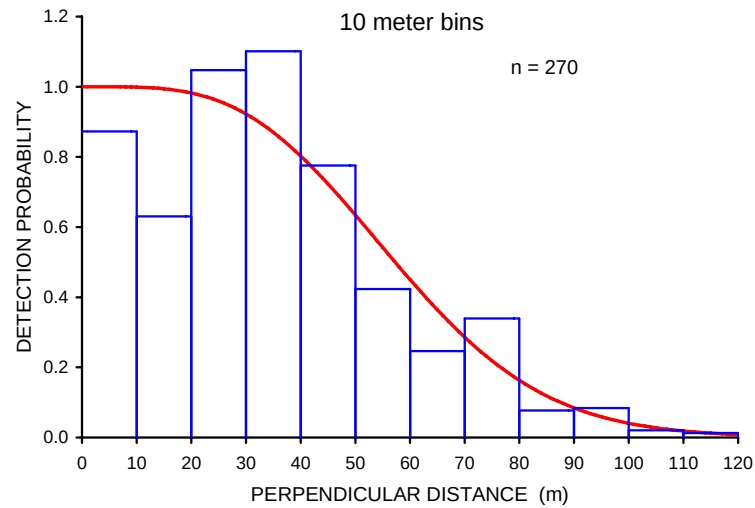
(3) EDR - the effective detection radius, the radius at which the same proportion of individuals are missed as are detected.

And for each year, based on the maximum visit data, the following, with their associated measures of variance:

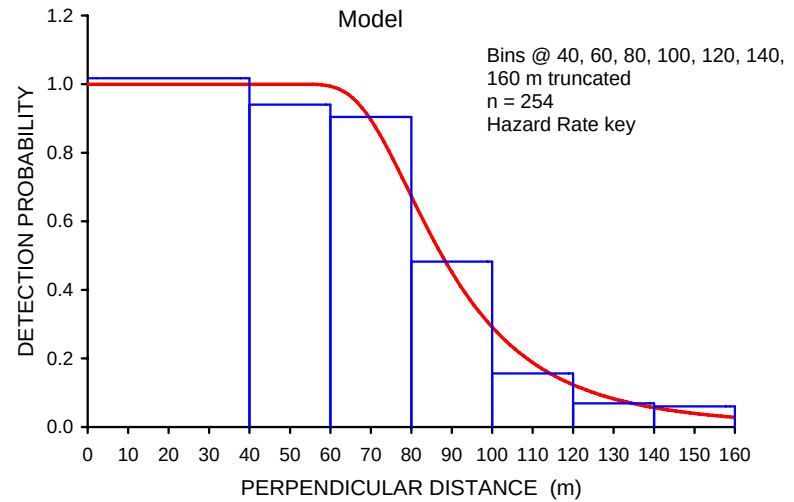
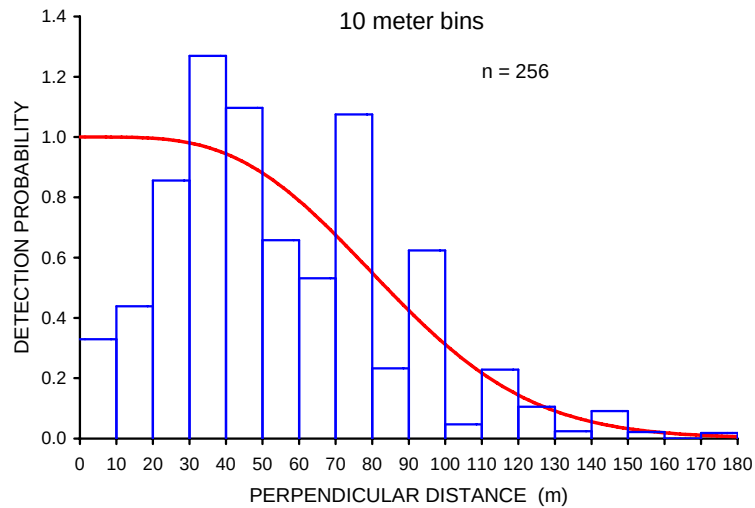
(4) n/K - encounter rate (# individuals detected/#points).

(5) D - density in birds per hectare.

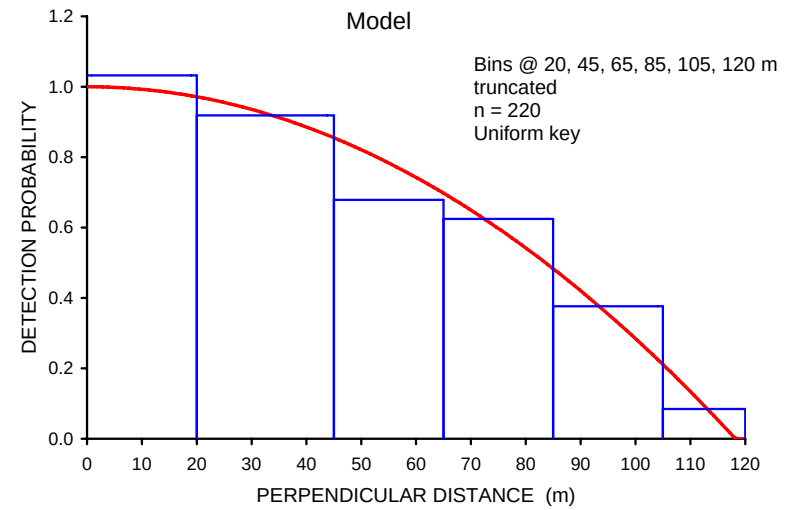
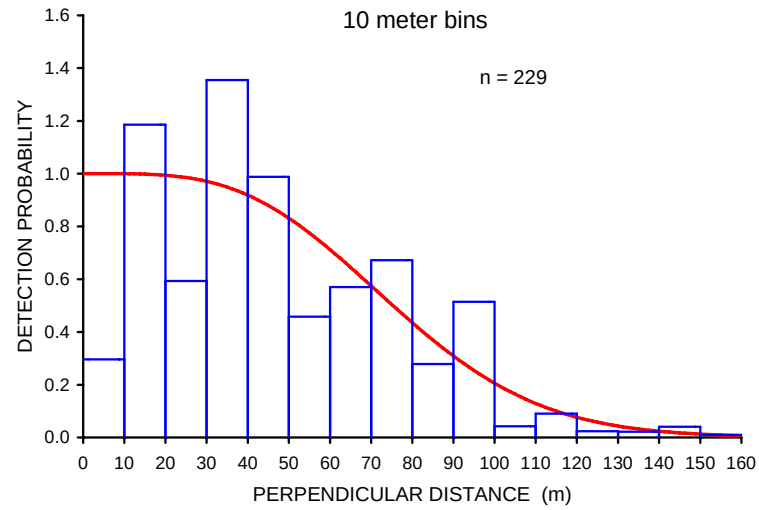
a. Common Yellowthroat



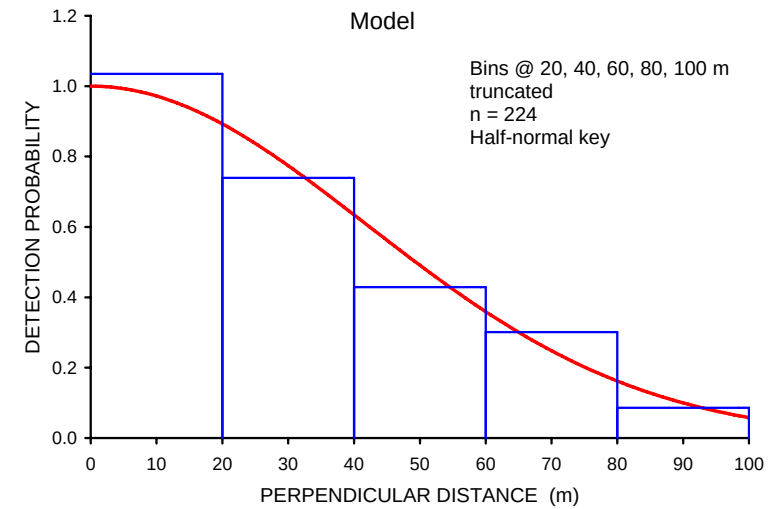
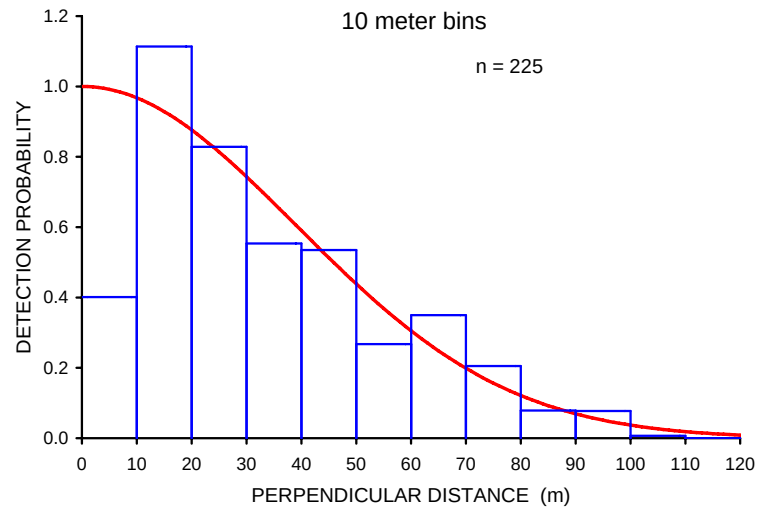
b. Red-winged Blackbird



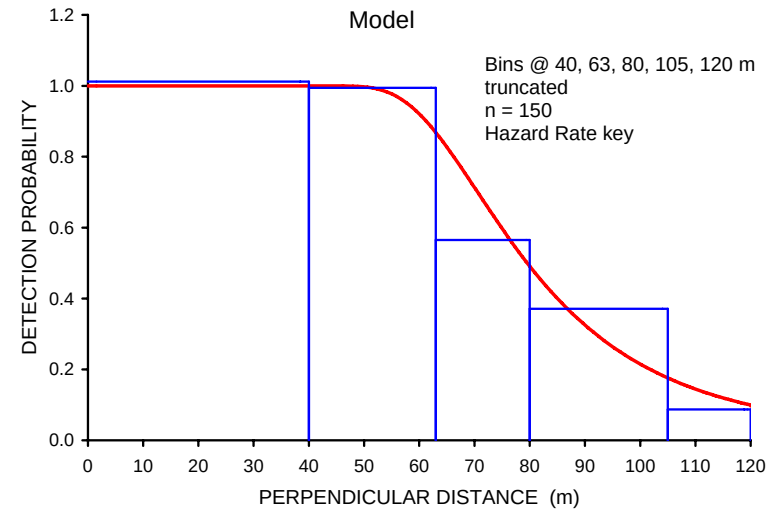
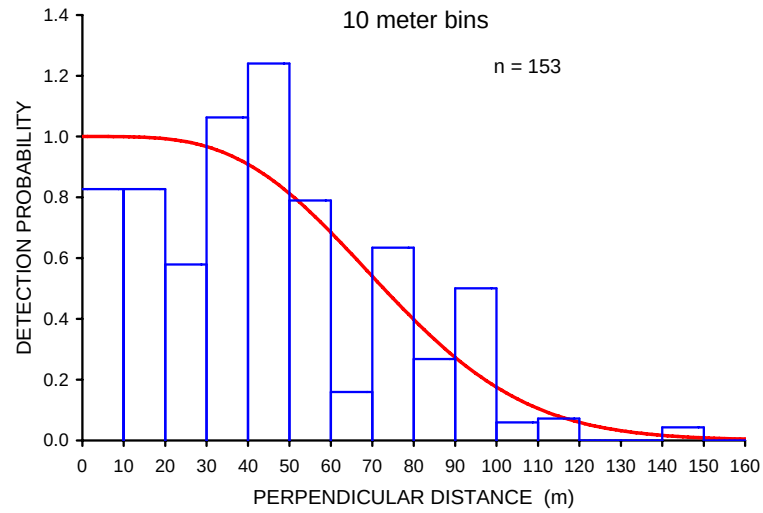
c. Field Sparrow



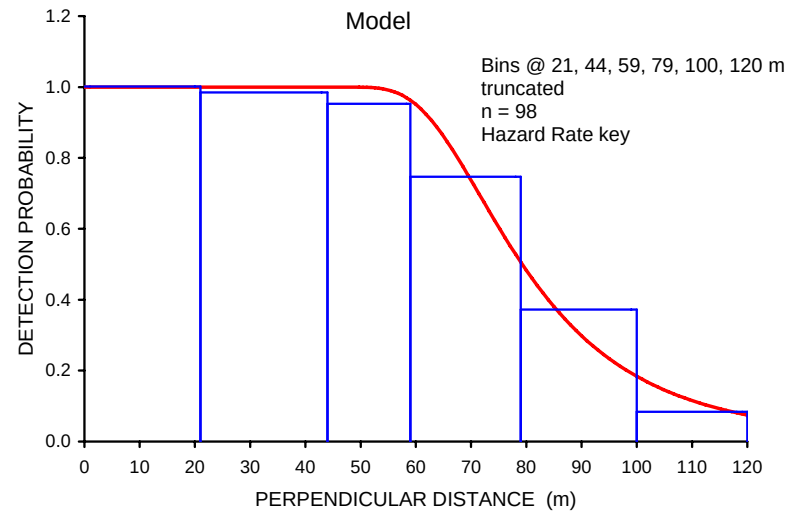
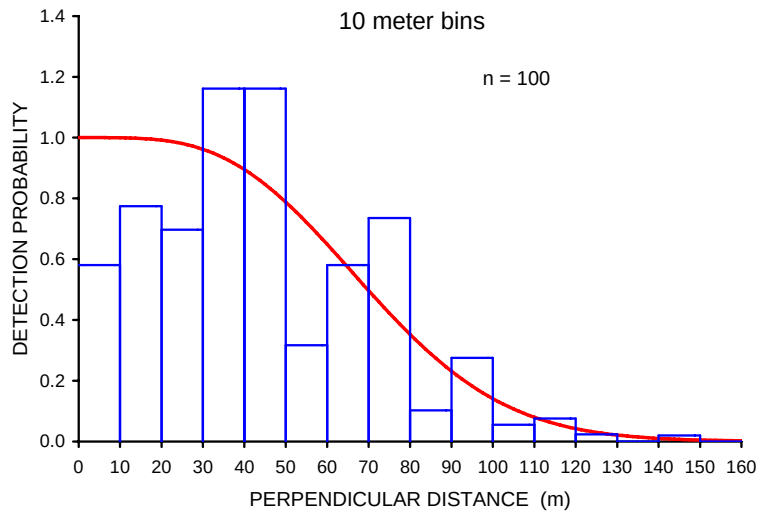
d. Song Sparrow



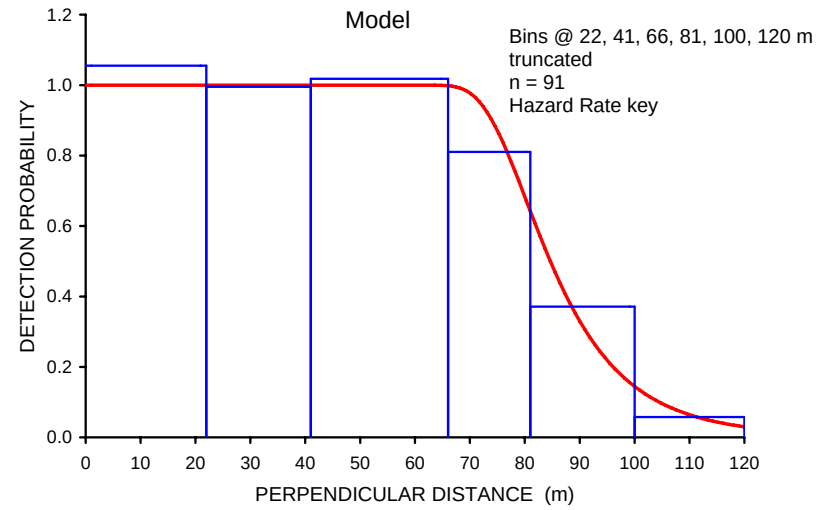
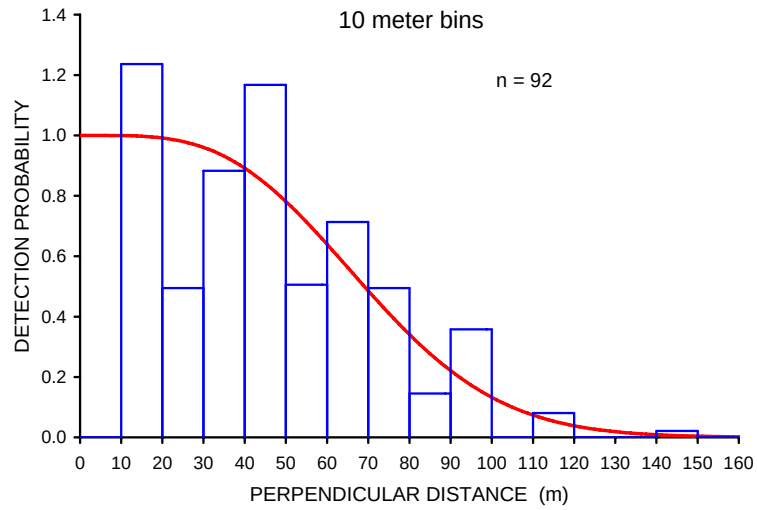
e. Prairie Warbler



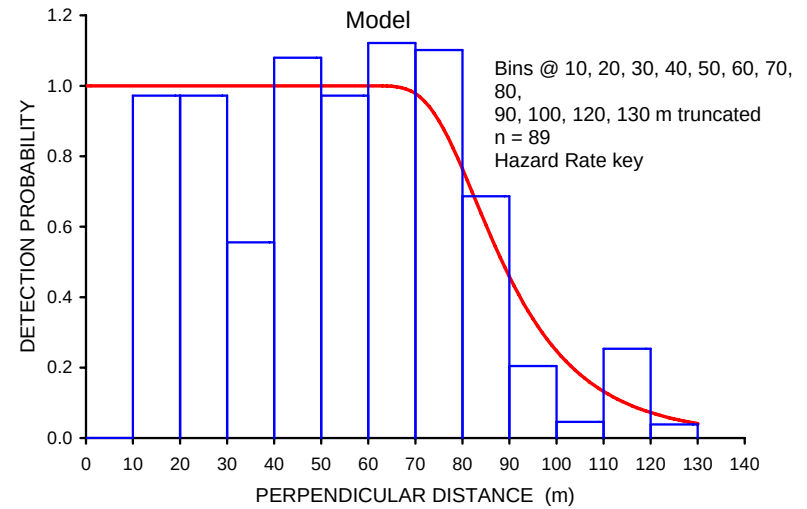
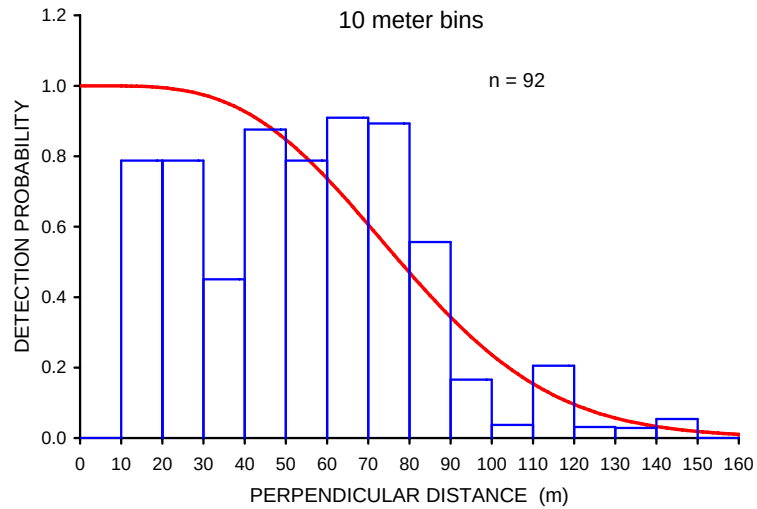
f. Indigo Bunting



g. Gray Catbird



h. Yellow Warbler



Selected DISTANCE output

$h(0)$ = slope of probability density function of detection distances at distance 0.
 p = probability of observing an object in defined area.
EDR = effective detection radius.
 n/K = encounter rate.
 D = density.

A. Common Yellowthroat

Model Selected
Hazard Rate key

Parameter	Point Estimate	Standard Error	Percent Coef. of Variation	95% Percent Confidence Interval	
h	0.46733E-03	0.35411E-04	7.58	0.40265E-03	0.54241E-03
p	0.42796	0.32427E-01	7.58	0.36872	0.49671
EDR	65.419	2.4784	3.79	60.718	70.483
2002					
n/K	1.7500	0.20801	11.89	1.3772	2.2238
D	1.3016	0.18348	14.10	0.98433	1.7212
2003					
n/K	1.9070	0.22277	11.68	1.5077	2.4120
D	1.4184	0.19750	13.92	1.0767	1.868

B. Red-winged Blackbird

Model Selected
Hazard Rate key

Parameter	Point Estimate	Standard Error	Percent Coef. of Variation	95% Percent Confidence Interval	
h(0)	0.21766E-03	0.15128E-04	6.95	0.18985E-03	0.24955E-03
p	0.35893	0.24947E-01	6.95	0.31307	0.41152
EDR	95.858	3.3312	3.48	89.518	102.65
2002					
n/K	1.9750	0.42136	21.33	1.2889	3.0262
D	0.68417	0.15352	22.44	0.43812	1.0684
2003					
n/K	1.7907	0.26738	14.93	1.3270	2.4164
D	0.62033	0.10217	16.47	0.44728	0.86032

C. Field Sparrow

Model Selected
Uniform key
Simple polynomial adjustments of order(s) : 2

Parameter	Point Estimate	Standard Error	Percent Coef. of Variation	95% Percent Confidence Interval	
h(0)	0.28626E-03	0.10956E-04	3.83	0.26547E-03	0.30867E-03
p	0.48519	0.18569E-01	3.83	0.44995	0.52319
EDR	83.587	1.5995	1.91	80.493	86.799
2002					
n/K	1.5250	0.22642	14.85	1.1312	2.0558
D	0.69477	0.10653	15.33	0.51103	0.94458
2003					
n/K	1.4186	0.18298	12.90	1.0947	1.8384
D	0.64630	0.86954E-01	13.45	0.49383	0.84585

D. Song Sparrow

Model Selected
Half-normal key

Parameter	Point Estimate	Standard Error	Percent Coef. of Variation	95% Percent Confidence Interval	
h(0)	0.60399E-03	0.50200E-04	8.31	0.51288E-03	0.71127E-03
p	0.33113	0.27522E-01	8.31	0.28119	0.38995
EDR	57.544	2.3914	4.16	53.021	62.453
2002					
n/K	1.7000	0.30424	17.90	1.1871	2.4346
D	1.6342	0.32246	19.73	1.1049	2.4169
2003					
n/K	1.4419	0.23836	16.53	1.0352	2.0083
D	1.3860	0.25645	18.50	0.96082	1.9994

E. Prairie Warbler

Model Selected
Hazard Rate key

Parameter	Point Estimate	Standard Error	Percent Coef. of Variation	95% Percent Confidence Interval	
h(0)	0.27167E-03	0.26667E-04	9.82	0.22387E-03	0.32967E-03
p	0.51124	0.50183E-01	9.82	0.42129	0.62039
EDR	85.801	4.2111	4.91	77.875	94.534
2002					
n/K	1.1750	0.18566	15.80	0.85524	1.6143
D	0.50805	0.94506E-01	18.60	0.35175	0.73380
2003					
n/K	0.90698	0.17550	19.35	0.61597	1.3355
D	0.39216	0.85089E-01	21.70	0.25553	0.60185

F. Indigo Bunting

Model Selected
Hazard Rate key

Parameter	Point Estimate	Standard Error	Percent Coef. of Variation	95% Percent Confidence Interval	
h(0)	0.27721E-03	0.30477E-04	10.99	0.22301E-03	0.34459E-03
p	0.50102	0.55084E-01	10.99	0.40306	0.62281
EDR	84.940	4.6692	5.50	76.165	94.725
2002					
n/K	0.85000	0.12685	14.92	0.62958	1.1476
D	0.37501	0.69511E-01	18.54	0.26019	0.54052
2003					
n/K	0.83721	0.11494	13.73	0.63543	1.1031
D	0.36937	0.64968E-01	17.59	0.26121	0.52232

G. Gray Catbird

Model Selected
Hazard Rate key

Parameter	Point Estimate	Standard Error	Percent Coef. of Variation	95% Percent Confidence Interval	
h(0)	0.25829E-03	0.21360E-04	8.27	0.21921E-03	0.30433E-03
p	0.53773	0.44469E-01	8.27	0.45637	0.63358
EDR	87.996	3.6385	4.13	81.058	95.527
2002					
n/K	0.77500	0.12136	15.66	0.56569	1.0618
D	0.31859	0.56417E-01	17.71	0.22421	0.45268
2003					
n/K	0.67442	0.12768	18.93	0.46181	0.98491
D	0.27724	0.57276E-01	20.66	0.18415	0.41739

H. Yellow Warbler

Model Selected
Hazard Rate key

Parameter	Point Estimate	Standard Error	Percent Coef. of Variation	95% Percent Confidence Interval	
h(0)	0.23118E-03	0.20661E-04	8.94	0.19362E-03	0.27602E-03
p	0.51191	0.45750E-01	8.94	0.42875	0.61120
EDR	93.012	4.1563	4.47	85.111	101.65
2002					
n/K	0.67500	0.13581	20.12	0.45113	1.0100
D	0.24836	0.54678E-01	22.02	0.16059	0.38409
2003					
n/K	0.81395	0.10124	12.44	0.63387	1.0452
D	0.29948	0.45869E-01	15.32	0.22125	0.40536

Appendix G. List of all species observed during vcp counts in 2002 and 2003.

Common Name	Scientific Name
American crow	<i>Corvus brachyrhynchos</i>
American goldfinch	<i>Carduelis tristis</i>
American redstart	<i>Setophaga ruticilla</i>
American robin	<i>Turdus migratorius</i>
Baltimore oriole	<i>Icterus galbula</i>
bank swallow	<i>Riparia riparia</i>
barn swallow	<i>Hirundo rustica</i>
black-and-white warbler	<i>Mniotilta varia</i>
black-billed cuckoo	<i>Coccyzus erythrophthalmus</i>
black-capped chickadee	<i>Poecile atricapillus</i>
black-throated green warbler	<i>Dendroica virens</i>
blue jay	<i>Cyanocitta cristata</i>
blue-headed vireo	<i>Vireo solitarius</i>
blue-winged warbler	<i>Vermivora pinus</i>
bobolink	<i>Dolichonyx oryzivorus</i>
broad-winged hawk	<i>Buteo platypterus</i>
brown thrasher	<i>Toxostoma rufum</i>
brown-headed cowbird	<i>Molothrus ater</i>
cedar waxwing	<i>Bombycilla cedrorum</i>
chestnut-sided warbler	<i>Dendroica pensylvanica</i>
chimney swift	<i>Chaetura pelagica</i>
chipping sparrow	<i>Spizella passerina</i>
cliff swallow	<i>Petrochelidon pyrrhonota</i>
common grackle	<i>Quiscalus quiscula</i>
common yellowthroat	<i>Geothlypis trichas</i>
downy woodpecker	<i>Picoides pubescens</i>
eastern bluebird	<i>Sialia sialis</i>
eastern kingbird	<i>Tyrannus tyrannus</i>
eastern meadowlark	<i>Sturnella magna</i>
eastern phoebe	<i>Sayornis phoebe</i>
eastern towhee	<i>Pipilo erythrophthalmus</i>
eastern wood-pewee	<i>Contopus virens</i>
European starling	<i>Sturnus vulgaris</i>
field sparrow	<i>Spizella pusilla</i>
fish crow	<i>Corvus ossifragus</i>
grasshopper sparrow	<i>Ammodramus savannarum</i>
gray catbird	<i>Dumetella carolinensis</i>
great blue heron	<i>Ardea herodias</i>
great crested flycatcher	<i>Myiarchus crinitus</i>
hooded warbler	<i>Wilsonia citrina</i>
house wren	<i>Troglodytes aedon</i>
indigo bunting	<i>Passerina cyanea</i>
killdeer	<i>Charadrius vociferus</i>

Common Name	Scientific Name
least flycatcher	<i>Empidonax minimus</i>
Louisiana waterthrush	<i>Seiurus motacilla</i>
mallard	<i>Anas platyrhynchos</i>
mourning dove	<i>Zenaida macroura</i>
northern cardinal	<i>Cardinalis cardinalis</i>
northern flicker	<i>Colaptes auratus</i>
northern mockingbird	<i>Mimus polyglottos</i>
northern parula	<i>Parula americana</i>
orchard oriole	<i>Icterus spurius</i>
ovenbird	<i>Seiurus aurocapillus</i>
pileated woodpecker	<i>Dryocopus pileatus</i>
prairie warbler	<i>Dendroica discolor</i>
purple finch	<i>Carpodacus purpureus</i>
red-bellied woodpecker	<i>Melanerpes carolinus</i>
red-eyed vireo	<i>Vireo olivaceus</i>
red-tailed hawk	<i>Buteo jamaicensis</i>
red-winged blackbird	<i>Agelaius phoeniceus</i>
rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>
rough-winged swallow	<i>Stelgidopteryx</i>
ruby-throated hummingbird	<i>Archilochus colubris</i>
savannah sparrow	<i>Passerculus sandwichensis</i>
scarlet tanager	<i>Piranga olivacea</i>
sharp-shinned hawk	<i>Accipiter striatus</i>
song sparrow	<i>Melospiza melodia</i>
tree swallow	<i>Tachycineta bicolor</i>
tufted titmouse	<i>Parus bicolor</i>
turkey vulture	<i>Cathartes aura</i>
veery	<i>Catharus fuscescens</i>
warbling vireo	<i>Vireo gilvus</i>
white-breasted nuthatch	<i>Sitta carolinensis</i>
wild turkey	<i>Meleagris gallopavo</i>
willow flycatcher	<i>Empidonax traillii</i>
wood thrush	<i>Hylocichla mustelina</i>
worm-eating warbler	<i>Helmitheros vermivorus</i>
yellow warbler	<i>Dendroica petechia</i>
yellow-billed cuckoo	<i>Coccyzus americanus</i>
yellow-breasted chat	<i>Icteria virens</i>
yellow-rumped warbler	<i>Dendroica coronata</i>
yellow-throated vireo	<i>Vireo flavifrons</i>

Appendix H. CD table of contents.

File Name:	Description:
1. DEWA_GBI_final_report.doc	Final Report
2. DEWA_GBI.mdb	Species Inventory Database (Microsoft Access 2000)
3. DEWA_GBI_photos (folder)	Folder for digital photos
3a. horiz_view (folder)	Folder for digital photos of horizontal view of vegetation
3b. long_view (folder)	Folder for digital photos of long view across field
3c. vert_view (folder)	Folder for digital photos of vertical view of vegetation
3d. FileList.doc	Lists of digital photos
4. DEWA_GBI.ppt	PowerPoint presentation of grassland fields
5. ESRI_shapefiles (folder)	Grassland field, grassland field edges, and grassland points GIS data products and associated metadata
6. DEWA_GBI.mxd	GIS ArcMap project
7. ArcMap_project (folder)	Additional ArcMap project files
7a. ArcMap_projectlayers (folder)	Additional layers used by ArcMap project
7b. ArcMap_project_information.doc	Document describing how to use ArcMap project

Appendix I. DEWA_GBI.ppt Microsoft PowerPoint presentation of grassland fields.

Overview

This is a printout of DEWA_GBI.ppt, the Microsoft PowerPoint presentation of digital aerial photographs depicting the 32 grassland fields surveyed, as well as select inventory information associated with them. The data sources of this information are the inventory's GIS data products and the inventory database, and its primary purpose is to provide one example of how information from both sources may be related for a useful summary of results and to give a "face to a name" for DEWA's grassland fields and specific ones referenced in the report text. The creation of the PowerPoint presentation was a laborious process of exporting individual ESRI ArcMap layouts containing a digital orthophoto of the field and overlays of ESRI shapefiles representing the field's survey point(s), point buffers, and field edges and pasting these images along with tables of data from the database and shapefiles as modified within Excel spreadsheets. This presentation may also be viewed as a potential template for a dynamic ArcMap interface that would provide a much more flexible, interactive tool for DEWA land managers.

Product components

Photo: The inventory-produced shapefiles `dewa_gbi_grasslandedges.shp` and `dewa_gbi_grasslandpoints.shp` (see report text and Appendix C) demarcate each field's edges (including the boundary and internal edges, such as hedgerows, if present) and survey point(s) contained within the field, respectively, on the photograph. The photograph's source is an unpublished raster dataset, `dewa_all_orthos_match.sid`, a mosaic of orthophotographs from a recent aerial flight obtained from DEWA. A 50 m (164 ft) and a 100 m (328 ft) buffer surrounding each point is included to represent, respectively, the radius within which the vegetation data was measured and the radius within which the bulk (90%) of bird detections occurred.

Inset: The inset provides the approximate location of the grassland field within the park.

Vegetation Cover and Structure Data: This box summarizes vegetation cover of grasses and sedges, forbs, woody plants (shrub, sapling, and tree cover combined), and bare ground as measured along the 100-m (328-ft) transect centered on a point. Depth of litter in centimeters and density of vegetation in two height categories, 0–5 and 5–10 dc (0–20 in and 20–40 in), are also given. Data was obtained via queries contained in the Access database `DEWA_GBI.mdb` that average vegetation structure and composition data across field points as necessary.

GIS Size and Edge Data: This box contains field area in hectares as calculated from the polygons contained in the inventory-produced shapefile `dewa_gbi_grasslands.shp` and a quartile ranking from largest (4) to smallest (1) of the field's area. The total amount of edge in meters, and a breakdown of this amount as forest, hedgerow, road, and another category are also given and were calculated from `dewa_gbi_grasslandedges.shp`.

Field Identification: For identification purposes, the name the inventory used for the field is given as well as the NPS field name and number as supplied by DEWA personnel.

Bird Species List: This box contains detection data for the aerial, edge, grass, and shrub species guilds. The detection data is contained as a query in the Access database DEWA_GBI.mdb that supplies, for each year, the maximum number of a species detected at any one point within a field. Occurrences of rare or high-priority species are also highlighted.

Diversity and Richness Measures: This box contains field diversity and richness values of the open guild (the aerial, edge, grass, and shrub guilds, pooled) calculated from the bird species list. Quartile rankings (1 = least and 4 = most diverse or species rich) of these values are also supplied. Fields with high rankings in both categories have this box highlighted.

As the nation's primary conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

National Park Service
U.S. Department of the Interior



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