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Birds of Wetland Habitats in Delaware Water Gap National Recreation Area

Natural Resource Technical Report NPS/NER/ERMN/NRTR—2010/152

ON THE COVER
Photo description: Wetland 4051 near Park Headquarters; (Inset) swamp sparrow (*Melospiza georgiana*).
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Birds of Wetland Habitats in Delaware Water Gap National Recreation Area

Natural Resource Technical Report NPS/NER/ERMN/NRTR—2010/152

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Abstract

A two-year survey of wetland birds in the Delaware Water Gap National Recreation Area was conducted during 2004 and 2005. Bird species richness, diversity, frequency of occurrence by habitat, species, and guild wetland habitat preferences, and edge vs. interior habitat preferences were analyzed and compared in order to characterize the distribution and abundance of birds across wetland habitat types found within the recreation area. This information will be used to characterize wetland bird communities and comment on management strategies for continued protection of these habitats and their characteristic avian inhabitants.

Key Words: bird, guild, wetland, point count, detection rate, frequency, richness, diversity, edge, interior

Executive Summary

The explicit purpose of this project was to inventory wetland birds within the Delaware Water Gap National Recreation Area. Variable circular plot point counts were used to estimate the distribution and abundance patterns of wetland bird species and compare them across wetland habitat types within the park. Metrics used to describe these patterns included species richness, diversity, frequency of occurrence and detection-based measures of preference by species and guilds for wetland habitat types, and edge vs. interior habitats. A total of 104 points were surveyed twice each year during 2004 and 2005. Analyses characterized both individual survey point and wetland unit characteristics. Wetland units consisted of individual wetlands with single or multiple survey points and wetland complexes composed of individual wetlands connected spatially and/or hydrologically. This categorization resulted in 77 wetland units organized into 14 geographical groups based on their location in DEWA. It is at the wetland unit spatial scale that management activities would likely occur. Individual survey point habitats were categorized as open, shrub, open/shrub, forest, and shrub/forest wetlands. Wetland units, because of their larger size, typically consisted of a variety of wetland habitats and thus were more broadly described as open, shrub-open/shrub, and forest-shrub/forest habitats.

A total of 112 species of birds were detected in and around wetland habitats in the park. Twenty of 29 species of interest were observed, 19 of these species are listed as a species of concern, threatened, or endangered in one or both states. Three of the 20 species were detected using aural CD playback, primarily at night, including common moorhen (*Gallinula chloropus*), sora (*Porzana carolina*), and Virginia rail (*Rallus limicola*). The sora was only detected through the use of CD playback. The most rich and diverse survey points were generally open, shrub, and/or open/shrub sites in the New Jersey portion of the park, especially along the Flat Brook. Forest and shrub/forest wetlands generally exhibited the lowest richness and diversity values. The majority of species were detected in all wetland habitat types but were characteristically more frequent in specific types. No particular group of birds, e.g. warblers, dominated any of the habitats surveyed. Overall, the most frequently occurring species was the red-eyed vireo (*Vireo olivaceus*), followed by common yellowthroat (*Geothlypis trichas*), and gray catbird (*Dumetella carolinensis*). These species highlight the importance of edge habitat as well as shrub and shrub-open/shrub wetlands. Guilds of species - aerial, emergent/open/standing dead timber, forest, edge, shrub dominated - were detected in the wetland habitats where they would be expected. Thus, the forest guild was most prominent (e.g., had the highest detection sum) in forest-shrub/forest habitat; the emergent/open/dead timber guild was most prominent in open habitats, etc. Forested wetlands were most clearly dominated by their namesake guild with relatively low prominence for the other two guilds in this habitat type. Conversely, guilds within the shrub-open/shrub habitat were more equally prominent and, in fact, the forest guild was nearly as prominent as the namesake shrub-dominant guild in this habitat. From an individual species perspective, the red-winged blackbird (*Agelaius phoeniceus*) displayed the highest detection sum over all three wetland unit habitat types, but most detections occurred in open wetland habitat. Other species with generally high detection sums included common yellowthroat in shrub-open/shrub and red-eyed vireo in forested wetlands. Each of the three wetland unit habitat types was also characterized by its rare inhabitants. The latter included red-headed woodpecker (*Melanerpes erythrocephalus*) in open habitat (which includes standing dead timber swamps), golden-winged warbler (*Vermivora chrysoptera*), yellow-breasted chat (*Icteria virens*), and alder

flycatcher (*Empidonax alnorum*) in shrub-open/shrub wetlands and cerulean warbler (*Dendroica cerulea*) found primarily in forest-shrub/forest wetlands.

Introduction

The Definition of a Wetland

Numerous terms have been used to describe a variety of wetlands, including swamp, marsh, bog, fen, mire, peatland, pocosin, pothole, slough, playa, wet meadow, and muskeg (Tiner 1999). The official biological definition of the term “wetland” has evolved along with our knowledge of these important ecosystems. In 1953, the U.S. Fish and Wildlife Service published its first wetland classification system, “Classification of Wetlands of the United States” in which a wetland was simply defined as “lowland covered with shallow and sometimes temporary and intermittent waters.” The Fish and Wildlife Service established the National Wetlands Inventory Project (NWI) in the mid-1970s to collect, analyze, and disseminate scientific information on the characteristics and extent of wetlands in the United States. This resulted in a now well-known wetland classification system found in the “Classification of Wetlands and Deep Water Habitats of the United States” (Cowardin et al. 1979). The revised definition states that wetlands are “lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.” This was followed by a National Research Council definition between 1993 and 1995 stating that wetlands are “ecosystems that depend on constant and recurrent shallow inundation or saturation at or near the surface of the substrate.” This definition presumes that wetlands are often not recognizable because they sometimes lack obvious features such as standing water and hydrophytic vegetation (Tiner 1999). This remains the official scientific definition.

To be a jurisdictional or legally recognized wetland, three components of the environment - wetland hydrology, hydric soils, and hydrophytic vegetation - are considered. Two of the three must be indicative of wetland characteristics in order for an area to be legally considered a wetland. Hydrological factors include the presence, abundance, and source of water. It underlies the structure and function of a wetland and is responsible for the presence of the second characteristic, hydric soil. These are soils whose structure, primarily the ratio of ferric to ferrous iron and availability of oxygen, is altered by the persistent presence of water. Hydrophytic plants have characteristics allowing them to survive under saturated conditions including, root morphology (spongy, adventitious, growing on the surface), buttressing, and the presence of lenticels. The ability of plants to survive in wetlands varies, thus they are categorized along a continuum of dependence and are, in general, termed obligate (totally wetland dependent) or facultative (dependent to varying degrees) wetland plants. A preponderance of plants heavily dependent upon wetland conditions is necessary for vegetation to indicate the presence of a legally defined wetland (Dennison and Berry 1993).

Historical Context and the National Status of Wetlands

During the colonial period, it is estimated that there were 92 million ha (221 million ac) of wetlands in the coterminous United States (Dahl 1990). The Swampland Acts of 1849 and 1860 contributed significantly to loss of wetlands by granting 27 million ha (65 million ac) of wetlands to the states for conversion to other uses (Pavelis 1987). From 1940 to 1977 the federal government provided assistance in draining an additional 24 million ha (57 million ac) for agricultural purposes (Bryer et al. 2000). Florida has lost the most total acreage, 4 million ha (9 million ac) or 46% of its total acreage, California has lost the greatest percentage (91% [2 million ha {5 million ac}]) followed by Texas and a cluster of Midwestern states. New Jersey is in the 25–49.9% loss category, while Pennsylvania is in the 50–74.9% loss category (Figure 1).

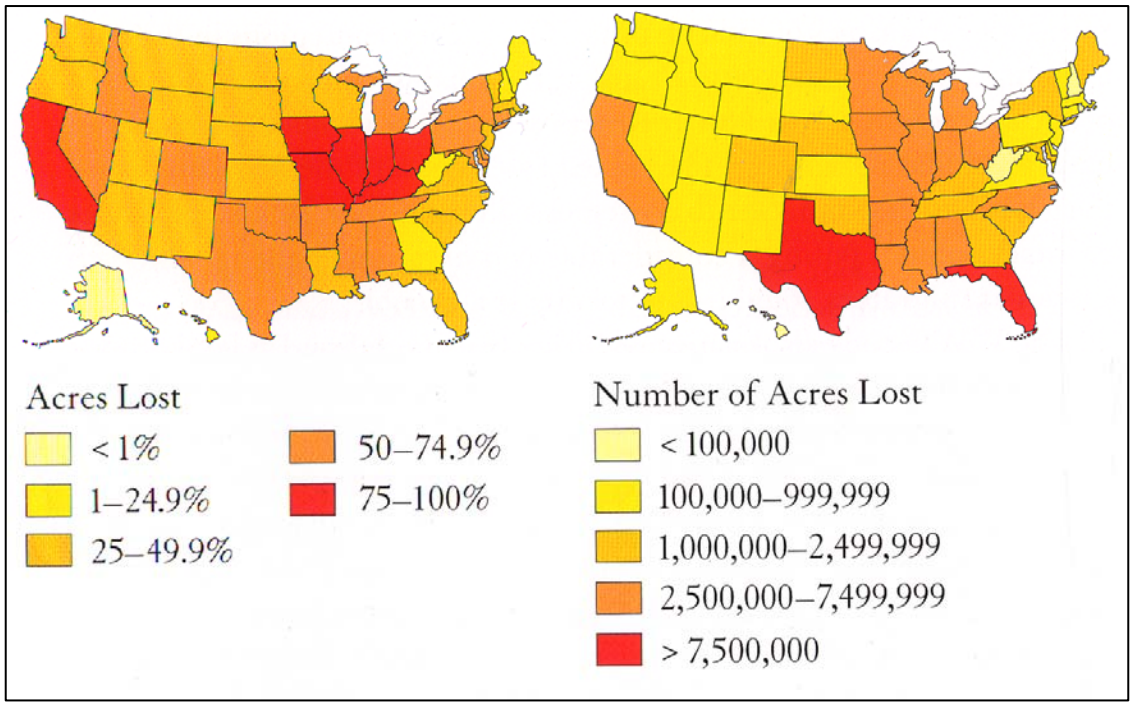

Figure 1. Wetland loss by percentage and total acreage (Bryer et al. 2000).

By 1997, only 42.7 million ha (105 million ac) remained; a decline of nearly 48% over a period of roughly 200 years. The earliest values of rate of loss derive from the period 1950 through the mid-1970s, when it is estimated that 185,400 ha (458,000 ac) were lost annually to various forms of human encroachment and development (Fryer et al. 1983). From the mid-1970s through the mid-1980s, the loss or conversion rate dropped to 117,400 ha (290,000 ac) per year. Losses continued to decline during the period from 1986–1997 when 260,700 ha (644,000 ac) were lost at an annual rate of only 23,700 ha (58,500 ac). Of these losses, 98% involved freshwater wetlands, primarily forested and freshwater emergent types, amounting to 256,500 ha (633,500 ac). Some of these losses were offset by an increase in freshwater scrub-shrub wetlands and freshwater ponds. The freshwater scrub-shrub category was the only wetland type to increase between 1986 and 1997. Losses during this period were attributed to urbanization (30%), agricultural activities (26%), silviculture (23%), and rural development (21%). Many factors have contributed to the steady decline in rate of wetland loss through 1997. The Army Corps of Engineers and the Environmental Protection Agency improved the effectiveness of regulations under Section 404 of the Clean Water Act, reducing losses incurred by use of general permits, addressing discharges of dredged material, and improving forestry practices in wetlands. Implementation of the "Swampbuster" regulations of 1985 and subsequent versions of the Food Security Act and agricultural set-aside and land retirement programs such as the Wetlands Reserve have also contributed significantly to the much-reduced rate of wetland loss. In 1986, the Emergency Wetlands Resources Act was passed in order to stem the loss of wetlands, increase conservation efforts, and mandate a summary report of wetland issues every 10 years, the last one representing the period from 1986–1997. It is from this source, unless otherwise referenced, that much of the information in this section derives (Dahl 2000). As of 1997, the wetlands of most interest with regard to the Delaware Water Gap National Recreation Area

(DEWA), inland freshwater wetlands, composed 95% of the nation's remaining total (20.5 million ha [50.7 million ac]), and most of these are forested wetlands.

Status of Pennsylvania's Wetlands

Pennsylvania's current loss rate per year is only 31.2 ha (75 ac), but since settlement, the state has lost over half of its original wetlands, primarily to agricultural conversion and suburbanization. The state currently has 303,973 ha (729,535 ac) of inland freshwater wetlands at more than 160,000 sites indicating that the majority of these are relatively small and isolated. Most are palustrine, and of these, forested wetlands compose 36% of the total acreage found in the state, while scrub-shrub swamps contribute 12% to the total. This is significant because of the 25,000 ha (60,000 ac) of wetlands lost across the country each year, the majority forested, a type that Pennsylvania contributes considerably to. Wetlands are concentrated in the northwestern and northeastern corners of the state. Pike and Monroe counties in the northeast, the location of the Pennsylvania portion of DEWA, have the highest proportion of their surface area composed of wetlands in the entire state at 6.7% and 6.4%, respectively. Most are located on the Pocono Plateau. (Pennsylvania State Wildlife Action Plan, http://www.pgc.state.pa.us, 2005).

Loss, fragmentation, and degradation of wetland habitats are the primary threats to wetlands and their dependent organisms in Pennsylvania. Loss and fragmentation occur as a result of residential, commercial, and industrial development, road construction, and detrimental agricultural practices. Of particular importance in Pennsylvania is urbanization; between 1982 and 1997, 1.58 ha (3.90 ac) of land were developed per Pennsylvania resident, ranking the state second behind Wyoming (U.S. Dept. of Agriculture, Natural Resources Inventory, U. S. Census Bureau 2006). Degradation occurs as a result of a variety of anthropogenic impacts including pollution (organochlorides, heavy metals, PCBs, acid mine drainage, acid deposition, storm water runoff), mowing and cutting of wetland vegetation by property owners (legal in Pennsylvania), surface and groundwater withdrawal, invasion by exotic plants and animals, and isolation of small, remnant wetlands and their inhabitants, resulting in increased predator pressure, higher organism death rates, and reduced genetic diversity (The Pennsylvania State Wildlife Action Plan, http://www.pgc.state.pa.us, 2005).

Status of New Jersey's Wetlands

New Jersey originally contained 625,000 ha (1,500,000 ac) of wetlands including extensive coastal saltwater marshes. The remaining total is 381,650 ha (915, 960 ac), for a net total loss of 39% since settlement. Like Pennsylvania, the majority of its freshwater wetlands are palustrine, primarily forested and scrub-shrub types (Association of State Wetland Managers, http://www.aswm.org/swp/newjersey9.htm). The Skylands ecological region of New Jersey, where the New Jersey portion of DEWA is located in the northwestern section of the state, has 14,608 ha (35,059 ac) of wetlands and, along with the Pinelands, contains most of New Jersey's freshwater wetlands (New Jersey Wildlife Action Plan, http://www.wildlifeactionplans.org/new_jersey.html, 2007). Loss and degradation of wetlands in New Jersey are caused by the same suite of factors impacting wetlands in neighboring Pennsylvania.

General Importance of Wetlands

The concern over wetland losses emanates from knowledge that wetlands are among the most biologically productive habitats; they provide major ecosystem services and they are biologically diverse.

Wetlands have very high primary productivity because wetland plants are unusually efficient at converting sunlight, water, and soil nutrients into plant biomass. (ACES [www.aces.edu]). Wetlands adjacent to major rivers are particularly important because they trap nutrients coming from upstream during floods and help regulate water flow (ACES [www.aces.edu]).

The term "Ecosystem Services" or "Ecosystem Economics" refers to the full range of services that society derives from nature (Armsworth and Roughgarten 2001). Ecosystems provide many benefits that are not extractive that economists can assign a dollar value to. Among the services provided by wetlands are flood control, erosion control, groundwater/aquifer recharge, and water filtration. Wetlands prevent flooding by spreading out excess water flow over floodplains and shallow depressions. They reduce erosion by decreasing floodwater velocity and volume and by filtering runoff. This also improves water quality by removal of nutrients and absorption of sediment loads. Their ability to collect water improves aquifer replenishment (Howard-Williams 1985, DeLaney 1995, Raisin and Mitchell 1995).

Conservation Status of Wetland Birds

Examples of the biological significance of wetlands for birds abound. On a worldwide basis, 146 species of wetland dependent birds are recognized by the International Union for the Conservation of Nature (IUCN) and Birdlife International as species of concern in different threat categories. Thirty percent of these are specifically dependent on bogs, marshes, and swamps (Stattersfield and Capper 2000). Approximately 50% of all federally listed endangered and threatened animals, 28% of plants, and 68% of birds are wetland dependent (Niering 1988). Other, more broadly based measures are also indicative of the importance of wetlands to bird diversity. The United States Geological Survey (USGS) Breeding Bird Survey (BBS) lists 41 wetland dependent species as either declining or significantly declining, which represents 34% of the 121waterbird species that the survey monitors (Figure 2).

The National Audubon Society conducts annual Christmas Bird Counts (CBC) across the nation and maintains is own conservation status database called the Watch List. Of the 212 wetland dependent bird species monitored by the CBC, 65 are listed as declining or significantly declining, representing 31% of the species. The Watch List program puts birds into three conservation status categories - green, yellow, and red - depending upon the degree to which a species is declining. The majority of wetland species appear to be secure (green); however, even though their population numbers remain relatively high, some of those species are declining (Figure 3).

The CBC Watch List and BBS surveys include wetland species associated with open water and coastal zones, but these indices are still broadly representative of what is happening to inland freshwater wetland species as well.

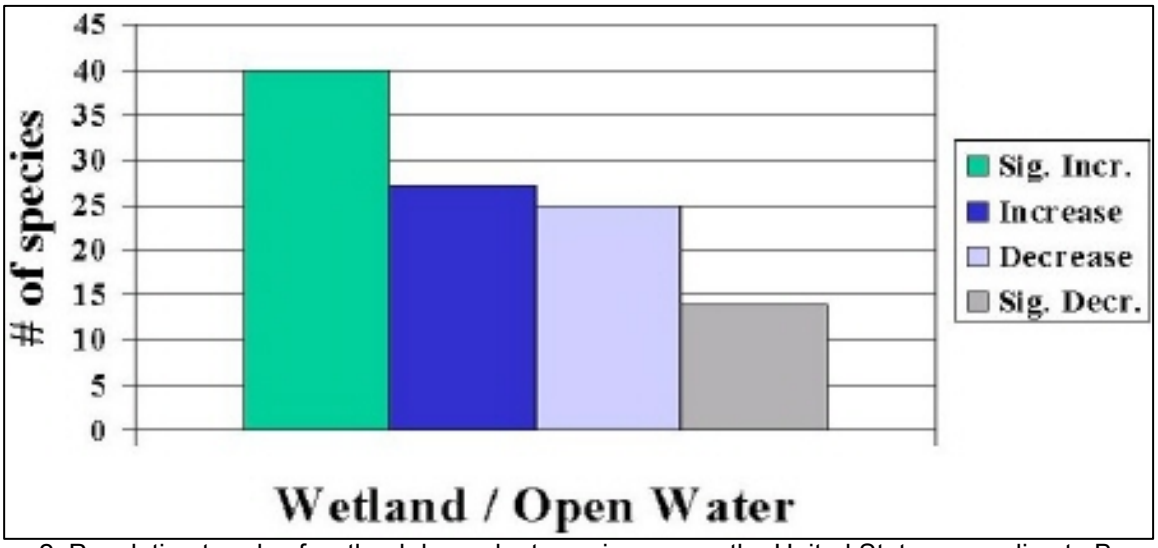

Figure 2. Population trends of wetland dependent species across the United States according to Breeding Bird Survey (BBS) data.

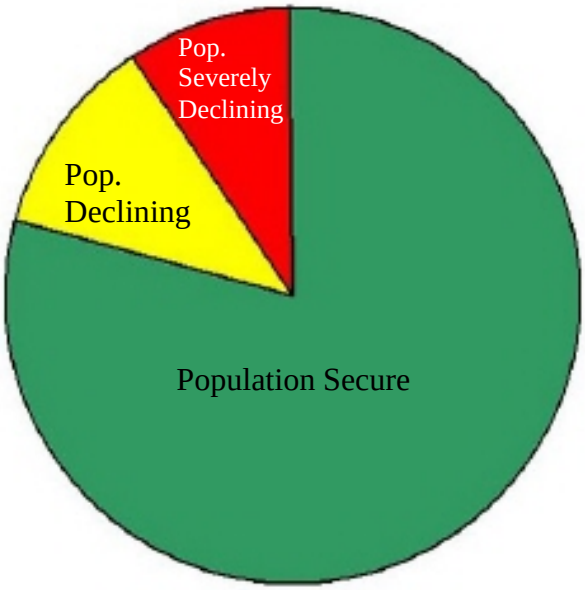

Figure 3. Proportion of wetland species in three Audubon Watch List population trend categories.

In Pennsylvania, there are roughly 297 species of breeding birds, and 60% of these species are at least partially associated with wetlands (Brooks and Croonquist 1990). Approximately 80% of the state's threatened and endangered bird species are at least partially dependent on these habitats. DEWA contains important habitats for some of these wetland species (Figure 4).

New Jersey has 202 species of birds (Walsh et al. 1999) with a slightly higher percent dependent upon wetlands, due to the presence of extensive coastal salt marshes, than in Pennsylvania. Fifty-five percent of New Jersey's threatened and endangered birds are at least somewhat wetland dependent and about half of these are dependent on freshwater wetlands to some extent.

Causes of Wetland Bird Population Declines

The specific factors driving the declines indicated by the various measures of conservation status mentioned above are habitat loss, fragmentation, invasive species, and global climate change. Loss and fragmentation of wetlands affect abundance, habitat use, reproduction, and survival (Dahl 1990, Brinson and Malvarez 2002). Some wetland species may not use small wetlands at all or will occur there in reduced density compared to larger wetlands (Naugle et al. 1999, Benoit and Askins 2002). Others will tend not to use individual wetlands unless they are a component of a larger wetland complex (Benoit and Askins 2002). Wetland loss exacerbates this tendency. Wetlands that are isolated from one another may harbor fewer species, just as many small wetlands do (Whited et al. 2000). The amount of interior vs. edge habitat is also an important factor influencing wetland habitat use by birds. In Iowa, one third of wetland species monitored

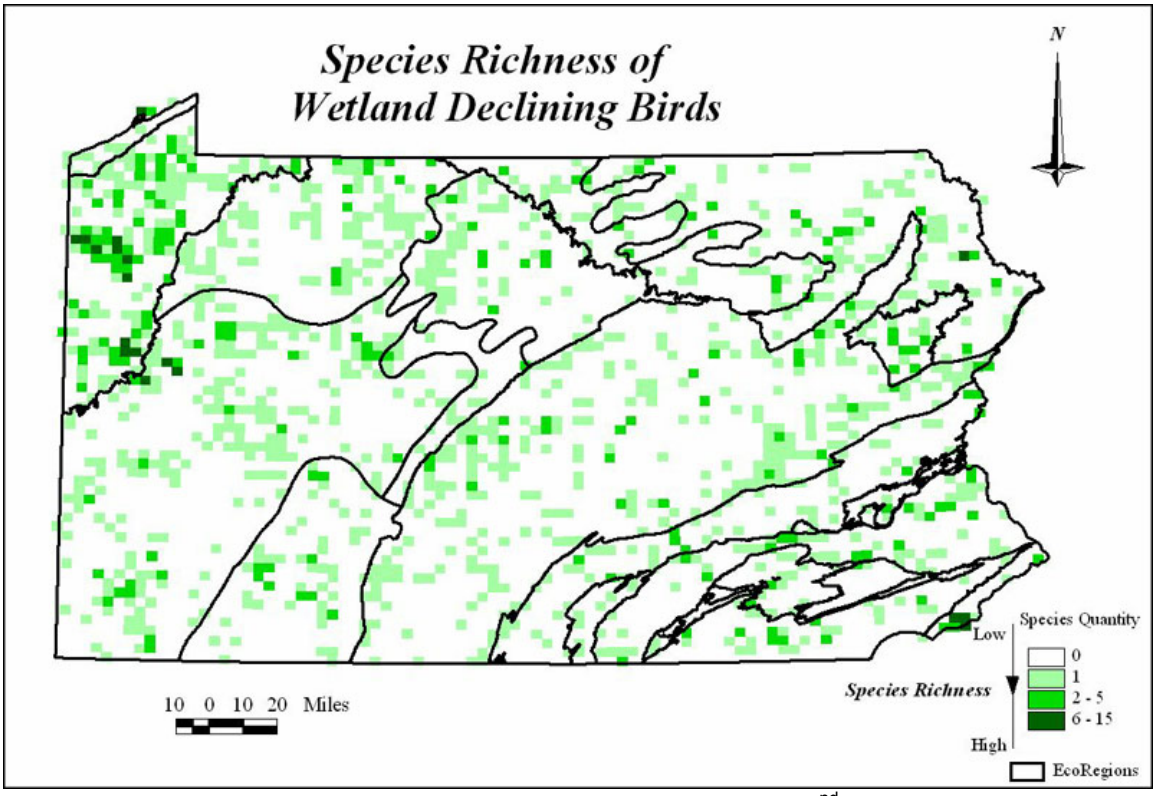

Figure 4. Wetland bird species richness across Pennsylvania (courtesy, 2nd Pennsylvania Breeding Bird Atlas 2010).

occurred in lower densities in wetlands with proportionally more edge than interior (Fairbairn and Dinsmore 2001). Breeding success in small wetlands with a high proportion of edge is often reduced because many generalized predators, such as the raccoon (*Procyon lotor*), prefer to hunt along edges (Weller 1999, Phillips et al. 2003). Variation in precipitation can reduce breeding success or even prevent species from breeding in dry years, a potentially more frequent scenario with the onset of global warming (Poiani and Johnson 1991).

Many nonnative plant species have invaded U.S. wetlands in recent years, sometimes making wetland habitat unsuitable for particular species. Purple loosestrife (*Lythrum salicaria*) is a classic example. This Eurasian plant produces extremely large quantities of seeds, spreads vegetatively, and replaces native wetland vegetation; thus, reducing food availability for bird species, resulting in abandonment and lowered bird species diversity (Thompson et al. 1987, Whitt et al. 1999). Global warming, with its greater and sometimes unpredictable influence on precipitation patterns, and increased evaporation will undoubtedly affect wetland species negatively (Poiani and Johnson 1991, Weller 1999).

The conservation status declines of wetland birds mentioned above reflect wetland losses of the past and continuing loss and anthropogenic alteration of those still in existence. Recognition of negative impacts on wetlands affecting bird populations affords the opportunity to correct and/or prevent these impacts through enlightened protection and management practices. Thus, wetland birds are important organisms to inventory because they are barometers of wetland condition and embody the notion that wetlands are diverse and productive biotic habitats that are worth protecting for a variety of reasons.

Project Goals

The objectives of this wetland bird survey were to: (1) categorize wetlands into specific habitat types by broadly characterizing wetland vegetation composition; (2) determine the richness and diversity of bird species utilizing wetlands in DEWA during the breeding season using variable circular plot point counts and CD call playback when appropriate; (3) confirm the presence of previously documented species of special interest (DEWA records, Pocono Environmental Education Center [PEEC] records, Pennsylvania and New Jersey Breeding Bird Atlas surveys); (4) calculate measures of abundance and distribution for breeding species; (5) compare the avifauna among different wetland habitat types, and; (6) compare the avifauna of wetland edges vs. interior habitat.

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, easternmost 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. One thousand two hundred and fourteen kilometers (3,000 ac) are leased to farmers and maintained in agriculture, as it was under previous ownership. Abandoned fields and home sites are in various stages of ecological succession. 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 crisscross the valley, having been used for access to homes, farm fields, and the river itself.

There are 6.66 million ha (16 million ac) of wetlands contained within the National Park System. The total wetland area in DEWA is estimated to be 2,267 ha (6,400 ac) according to the DEWA ArcGIS data layer developed in 1992 from 1991 aerial photography.

Methods

Species of Interest

An initial list of 14 wetland species of interest was compiled for the project proposal based on Pennsylvania and New Jersey threatened, endangered, and species of concern lists, existing sightings, preference for wetland habitat types, and range overlap with DEWA. This list included all priority wetland species recommended for inclusion in wetland studies by Ribic et. al (1999). Fifteen additional species were added to this original list as a result of observations in the field (Table 1). The final composition of the list reflects characteristic obligate wetland species, e.g., Virginia rail (*Rallus limicola*), species of concern not always found in wetlands that were, nevertheless, detected at several survey points, e.g., cerulean warbler (*Dendroica cerulea*), relatively rare species for this area, preferring shrubby, successional habitats, e.g., yellow-breasted chat *(Icteria virens*), relatively common species observed frequently and thus representative of DEWA wetlands, e.g., swamp sparrow (*Melospiza georgiana*), and species to be looked for given their range overlap with DEWA, but not observed, e.g., green-winged teal (*Anas crecca*).

Point Count Survey Site Selection

Selection of wetlands was done by examination of GIS wetland shapefiles and digital aerial photos provided by DEWA (Division of Research and Resource Planning office, ArcGIS data layer developed in 1992 from 1991 aerial photography), USGS topographic maps, and field verification. Considerable discrepancy was found between the number of wetlands shown on the shapefiles and actual wetland presence, especially for small and/or forested wetlands that accounted for 506/892 designated wetlands. Many large wetlands, here considered as wetland units, were composed of smaller components, shown as separate wetlands on the shapefiles. These factors largely account for the discrepancy between the large number of wetlands on the shapefiles (892) and the relatively small number actually sampled as described below.

To organize our sampling/selection effort, wetlands were clustered into 14 wetland groups from which individual wetland units were selected on the basis of access, an important consideration, regarding the total number of points that could be surveyed, wetland composition/shape, and the need to include the most prominent, large, distinct wetlands, less prominent, smaller wetlands proximal to the larger ones, areas of high wetland concentration, and as many smaller, forested wetlands as possible. From south to north, the wetland groups were labeled according to prominent DEWA locations including Totts Gap, Park Headquarters, Tom's Creek, PEEC, Dingman's and Conashaugh on the Pennsylvania side, and Sunfish Pond, Catfish Pond, Crater Lake, Flat Brook South, Flat Brook North, Thunder Mountain, Township Ballfield, and Shimer's Brook on the New Jersey side (Figure 5, Appendix A and Wetland Power Point program on the accompanying CD**)**. From these groups, 77 individual wetland units were selected. A wetland unit is a single wetland containing a single survey point, a large single wetland covered by multiple points, or individual wetlands that were physically/hydrologically interconnected to such an extent they were effectively a single large wetland requiring multiple survey points. A total of 104 survey points were distributed among the 77 wetland units. Points were selected based on the number required for complete coverage, access, and the required minimum 250 m separation to prevent overlap of detections (Reynolds et al. 1980, Ralph et al. 1995, Ribic et al. 1999).

Table 1. Bird species of interest and their 2009 conservation status in Pennsylvania and New Jersey.

Common Name	Scientific Name	Pennsylvania Status	New Jersey Status
American black duck	*Anas rubripes*	not listed	not listed
green-winged teal	*Anas crecca*	candidate - rare	not listed
wood duck	*Aix sponsa*	not listed	not listed
pied-billed grebe	*Podylimbus podiceps*	candidate – rare	endangered
least bittern	*Ixobrychus exilis*	endangered	special concern
American bittern	*Botarus lentiginosus*	endangered	endangered
green heron	*Butorides virescens*	not listed	not listed
great blue heron	*Ardea herodias*	not listed	special concern
red-shouldered hawk	*Buteo lineatus*	not listed	endangered
Virginia rail	*Rallus limicola*	status undetermined	special concern
sora	*Porzana carolina*	status undetermined	special concern
king rail	*Rallus elegans*	endangered	special concern
black rail	*Lateralus jamaicensis*	listed as (accidental)	threatened
common moorhen	*Gallinula chloropus*	not listed	not listed
Wilson's snipe	*Gallinago gallinago*	threatened	not listed
American woodcock	*Scolopax minor*	not listed	not listed
barred owl	*Strix varia*	not listed	threatened
red-headed woodpecker	*Melanerpes erythrocephalus*	not listed	threatened
alder flycatcher	*Empidonax alnorum*	not listed	not listed
fish crow	*Corvus ossifragus*	not listed	not listed
sedge wren	*Cistothorus platensis*	endangered	endangered
golden-winged warbler	*Vermivora chrysoptera*	not listed	special concern+
cerulean warbler	*Dendroica cerulea*	not listed	special concern
Kentucky warbler	*Oporornis formosus*	not listed	special concern
Canada warbler	*Wilsonia canadensis*	not listed	special concern
yellow-breasted chat	*Icteria virens*	not listed	special concern
swamp sparrow	*Melospiza georgiana*	not listed	not listed
orchard oriole	*Icterus spurious*	not listed	not listed
common grackle	*Quiscalus quiscula*	not listed	not listed

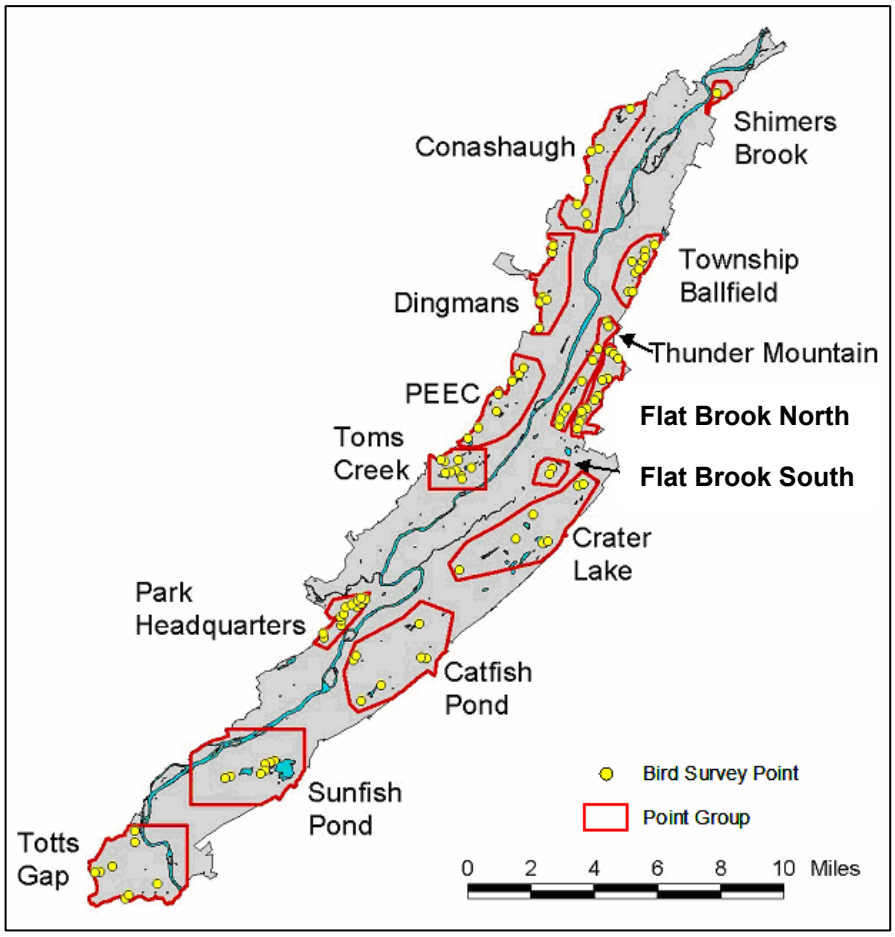

Figure 5. Location and name of wetland groups and 104 survey points in DEWA.

Thus, all 44 wetlands in the park 4.58 ha (11 ac) or larger and a majority of smaller wetlands, including many forested ones, were included. Four-digit numbers beginning with 4 were used to denote wetlands with low 4000s and most 4100s designating Pennsylvania survey points, from south to north, and higher 4100s and 4200s designating New Jersey survey points.

GPS coordinates for survey points were recorded using a Garmin III© GPS connected to an NBX-3 2-channel automatic differential beacon receiver backpack to improve accuracy and downloaded onto ArcGIS 9.1© projected orthophotographs. Fluorescent zip ties were used to assist in the location of points, especially for nocturnal CD playback surveys.

Variable Circular Plot Point Count Survey Protocol

The majority of variable circular plot point count (vcp) survey points were located along wetland edges, with the exception of some forested sites where access permitted location of points within the interior. Count duration was five minutes, which reduces the potential of counting individuals more than once and prevents detection of birds making long movements, which invalidates a standard assumption of point count protocol (Bibby et al. 1992). A sample vcp point count data sheet can be found in Appendix B. A period of one minute was allowed to acclimate birds to the observer during which time environmental data, including sky condition and precipitation (determined subjectively by observer), wind speed and temperature (measured using a Kestrel©

4000 hand held weather station), and noise level (using a subjective scale from 1–5) were recorded to characterize survey conditions. Surveys were not conducted at sustained wind speeds above 15 mph, on heavily overcast or cloudy mornings, or during precipitation events. Surveys were conducted from the bearing at each wetland that allowed the observer to directly face the main axis of the wetland. During the five minute survey period, species were recorded using American Ornithologists' Union (AOU) codes (Appendix C for a total list of species observed), distance from the point was estimated, direction was determined (behind, behind left or right, front, front left or front right), detection type categorized (song, call, drumming, visual), sex determined, if possible, and number of individuals noted.

All detections within 100 m (109 yd) of the survey point were included in analyses. Birds flying overhead were recorded as "flyovers;" those utilizing the airspace above wetlands for foraging, e.g. tree swallows, were recorded as "aerial" species. The general location of detections was recorded and categorized as being within the wetland, along the edge, or beyond wetland habitat. Two survey rounds were conducted each year beginning the last week in May and extending through the first week of July during the height of the breeding season. Counts were conducted from sunrise to 10:00 AM during this period of most intense singing activity (Ralph et al. 1993). An attempt was made to sample wetlands during each round in opposite order. Approximately 75% of the point counts over both years were conducted by a single individual, Jim Sheehan, while the other 25% were done by Terry Master, thus reducing observer bias. Concurrent test surveys by both observers in open, shrub, and forested wetlands produced very similar results.

Nocturnal Call Playback for Secretive Marsh Birds

Many characteristic marsh birds are difficult to see, thus, aural surveys are often used to detect these species (Conway and Gibbs 2005). Surveys using call playbacks pre-recorded on a CD were used at 12 survey points in 2004 and 16 points in 2005 (Table 2). Points were initially located on the most extensive emergent wetlands in 2004, the most appropriate sites for most of these species (Monahan and Faulk 1999). Additional promising sites in the Thunder Mountain Wetland Group were added in 2005. Experience from 2004 with time and driving route efficiency allowed for these additional surveys in 2005. Nocturnal surveys were conducted once during late May/early June and late July of 2004 and in early/late June of 2005, all prime periods for vocalization for most of these species (Ribic et al. 1999). Sites where nocturnal surveys were conducted are noted in Table 2 and on the Power Point program (Appendix D and Wetland Power Point Program on accompanying CD).

The Laboratory of Natural Sounds at Cornell University compiled the playback CD according to North American Continental Marsh Bird Monitoring protocol (Ribic et al. 1999). Important considerations when composing the CD included: (1) the order of species – generally, species are arranged from smallest to largest due to dominance considerations; (2) the order and variations of calls to present; (3) the length of time to present each call, and; (4) the length of pause between species and between the various calls for a specific species (Legare et al. 1999, Skoloda and Ribic 1999) (Table 3 and playback CD included with this report).

The major calls of each wetland species were broadcast consecutively with a 30 second break between each one. The length of time devoted to each call varied. The total length of time during which calls were broadcast for each nocturnal survey was 12.47 minutes, not including the 30 second breaks between calls and species. Sedge wren and barred owl songs/calls, respectively,

Table 2. Secretive marsh bird playback locations showing wetland group and specific wetlands surveyed within groups denoted by wetland code and survey dates.

Points Surveyed	**2004 Dates**	**2005 Dates**
Crater Lake Group 4251/1 (sedge marsh)	July 28	June 7
Headquarters Group 4053/1 (Community Drive behind the barn)	July 28	June 16
Headquarters Group 4053/2 (Community Drive sedge meadow)	June 2 July 28	June 16
Township Ballfield Group 4170/1 (north of Old Dingman's Road)	June 25	June 7 June 14
Township Ballfield Group 4171/1 (north of Old Dingman's Road)	May 25 June 14	June 16
Township Ballfield Group 4174/1,2,3 (East of Camp Kittatinny ball field)	June 14	June 7 June 16
Thunder Mountain Group 4190/1,2,3,4 (Off Thunder Mountain trail)		June 17
Thunder Mountain Group 4192/1 (road into Thunder Mountain trail)	July 28	June 17
Thunder Mountain Group 4193/1 (road into Thunder Mountain trail)	July 28	June 17
Thunder Mountain Group 4194/1,2 (between Old Mine & Peters Valley Rds.)	July 28	June 16

Table 3. Playback protocol for secretive marsh birds in the order played.

Common Name	**Genus**	**Species**	**Sound Type**
black rail	*Laterallus*	*jamaicensis*	kikky-doo grr-grr-grr
least bittern	*Ixobrychus*	*exilis*	coo coo kak kak
sora	*Porzana*	*carolina*	whinny kerwee
Virginia rail	*Rallus*	*limicola*	grunts tick-it kicker
king rail	*Rallus*	*elegans*	chac chac kik kik kik
American bittern	*Botaurus*	*lentiginosus*	pump-er-lunk
pied-billed grebe	*Podilymbus*	*podiceps*	donkey
common moorhen	*Gallinula*	*chloropus*	many call types
sedge wren	*Cistothorus*	*platensis*	chap chatata chadt krrt
barred owl	*Strix*	*varia*	who cooks for you all

were added onto the end of the CD by us because the wrens are often, but not necessarily, found in some types of emergent wetlands (e.g. sedge, wet meadow wetlands), and barred owls are often associated with forested wetlands. They were broadcast following the marsh bird sequence with the wren first. On several occasions, playback was used to further investigate or confirm calls heard following normal diurnal point count surveys.

Habitat Composition

Habitat/vegetative composition was qualitatively assessed by the observer, emphasizing dominant types/structure/plant groups, but, when possible, including more descriptive detail. Survey points were categorized into five major wetland types, including open, shrub, open/shrub, forest, and shrub/forest, that highlight vegetative composition and structure and are used in some of the avian analyses described below. The combined categories, e.g., open/shrub and shrub/forest, were necessary to characterize, as succinctly as possible, larger wetland units consisting of a mixture of habitat types. On the accompanying Wetland Power Point CD, the Habitat Group designation was used to emphasize specific wetland type and dominance/location of plant groups, such as shrubs, that are particularly important components of many wetlands and which avian community structure responds to. Donut graphs, separated into four quadrants surrounding the observer, are used to describe vegetation encircling the survey point, including quadrants behind the observer (since survey points were typically situated along the edge of wetland units) with upland vegetation. Habitats were described as open habitat (non-vegetated/ developed), open water (ponds, lakes), deciduous forest, mixed forest, coniferous forest, deciduous forest wetland, scrub-shrub wetland, emergent wetland, wet meadow, bog, and standing dead timber swamp. Habitats were further defined if a single plant dominated the wetland, e.g., sedge, rhododendron, etc. The abundance of snags was estimated in each quadrant and density is shown at three subjective levels (sparse, moderate, abundant), with the heaviest stippling representing highest numbers of snags. The descriptive terminology used in the detailed habitat descriptions follows the classification used in “Wetlands and Deepwater Habitats of the United States” (Cowardin et al. 1979) with regard to Palustrine System classes (emergent, scrub-shrub, forested) and, to some extent, subclasses (deciduous forest). Other, often more specific, terms used (wet meadow, mixed forest), we find descriptive of conditions in DEWA wetlands (Appendix E for habitat data sheet and the Wetland Power Point program on the accompanying CD)

Geographic Information System (GIS) Products

Two ArcGIS shapefiles were created to map the locations of wetland groups and survey points. The shapefile “dewa_wbi_wetlands” consists of 218 polygons depicting survey groups and wetland units. The shapefile “dewa_wbi_points” maps each of the 104 survey points.

To create these shapefiles, three existing shapefiles mapping DEWA wetlands — the parkwide wetlands map (wetlands.shp, 1992, originated by Markhurd, Inc.) and two versions of the park’s vegetation map (DEWA_vegetation_2006.shp and veg_draft_formation.shp, originated by the Pennsylvania Natural Heritage Program/The Nature Conservancy) — were overlaid on 2002 DEWA orthophotography (dewa_all_orthos_match.sid) using ArcGIS 9.1©. Polygons from each source were selected on the basis of how well they appeared to represent the wetlands surveyed by the inventory. If sources provided identical boundaries (or nearly so), the default was to select the polygon DEWA_vegetation_2006 (TNC II) (Appendix A). The other two wetland maps were used to supplement the TNC II polygon if they provided additional features within or associated

with the polygon. In a few cases, the TNC II polygon was deemed inaccurate in delineating boundaries or classifying the habitat, and one or both of the other sources were used. Field-truthing of the accuracy of the vegetation classification from any of the three sources was beyond the scope of this project. Contiguous polygons were joined to create many of the wetland units depicted in the wbi wetlands shapefile (see Appendix D and Wetland Power Point program on accompanying CD). Field derived GPS coordinates were employed to locate the survey points on the assembled wetland map. Shapefile descriptions and their respective creation process are contained in HTML metadata files and included in Appendix F.

Digital Photography

Digital photographs were taken at each survey point with a Kodak© DC290 zoom camera in three or four directions, e.g. front, back, left, and right, with the photo taken from the front corresponding to the observers compass bearing when conducting point counts. This front-facing photo was chosen for inclusion in the Wetland Power Point program (Appendix D). A catalog of digital images listing photo name, survey point, photo number (filename), date and time the photo was taken, compass bearing, and camera direction of the photo is presented in Appendix G.

Data Entry and Organization

All avian and vegetation data was proofed once for errors and omissions after being entered into a Microsoft Access© database (both point count and habitat composition field data forms are presented in Appendixes B and E, respectively). This database and the output used in the analysis and presentation of data are described in detail in the data dictionary (Appendix H).

Wetland Power Point Program

A Power Point program was created to present key results of the study. A sample slide from this program is shown in Appendix D. Slides show the 104 survey points and 77 wetland units organized into Open and Shrub, Mixed, Flat Brook, and Forested categories, with each category prefaced by a summary slide showing wetland group, unit, the survey points within each unit, and the slide number they can be seen on. The location of the wetland unit within DEWA is also shown in a small inset map. Wetland groups, survey points, area, and the Power Point slide on which the wetland can be seen are shown in Appendix A. A digital aerial orthophotograph showing wetland scale attributes, including the boundary, source shapefile (mostly TNC II, see GIS section above) survey point(s) surrounded by a 100-m buffer, general wetland habitat type, habitat composition surrounding the survey point, and a subjective description of the prevalence of standing dead timber (sparse, moderate, abundant) are presented on each slide, along with whether a CD playback was done there and if the point was included in the edge vs. open habitat analysis. A digital photo of the wetland taken along the bearing used by the observer during point counts is also included for each survey point. Specific point scale attributes shown include a species list by habitat guild, compiled across both survey years, the maximum number of detections for each species by year, highlighted species of interest (Table 1, conservation and/or management interest or migrants), and the presence of species observed at wetlands but not during official point count periods. Richness and diversity values based on both survey years and a quartile ranking of the wetland using both of these parameters are shown. Slide composition is described in more detail at the beginning of the Power Point Program (Appendix D and the Wetland Power Point program on accompanying CD).

Data Analysis

Data Analysis Perspective

Many of the surveyed wetlands were composed of a variety of wetland types, typically vegetated with emergent plants (e.g., sedges) or a mixture of emergent species and isolated shrubs, surrounded by a shrub-scrub and/or forested wetland fringe. Thus, birds detected at survey points were often recorded from a variety of habitat types. Habitat may influence the distance over which a bird may be detected aurally or visually, such as limiting the distance a singing bird may be detected by an observer in a densely vegetated forested swamp vs. an open water wetland. When homogeneous habitat units are surveyed, distance analysis techniques (Thomas et al. 2010) can be used to account for habitat influences on species detectability in order to estimate density. If heterogeneous habitat units are surveyed, distance analysis is still appropriate if survey points are located randomly with respect to habitat patches so that influence of habitat on detection functions is also random. The logistics of point locations, primarily access and associated time to get to the point, necessarily meant that points were not randomly positioned but were usually located along wetland edges. Distance analysis was not attempted for this reason, as potential vocal or visual effects on detectability by the placement of survey points in edge habitat would likely skew detection functions. Instead, we categorized detections as being in the interior or edge habitat of a wetland and studied species tendencies to occur in these locations within the wetland classes. Detections were also used to determine frequency of occurrence and calculate indices of abundance for species and avian community measures (e.g., species richness).

Much consideration was given to whether metrics used to describe wetland bird communities be analyzed according to survey point, wetland unit, or a combination of both depending upon the specific metric. Species richness and diversity varied considerably from point to point in wetland units with multiple points, and habitat could be more distinctly classified at the point scale. This provided an opportunity to explore metrics in conjunction with a finer resolution of habitat. Point scale metrics were calculated by combining species data over both years. The survey points were categorized using five habitat designations (open, shrub, open/shrub, forest, shrub/forest) based on the dominant vegetation type/structure.

Metrics involving habitat preferences (frequency of occurrence, habitat guild, habitat preference, and edge vs. interior preference) were more appropriately analyzed at the wetland unit spatial scale because it is at this scale, whole wetlands and physically/hydrographically connected wetland complexes, that ecological interactions and management activities occur. Due to having multiple points within larger wetland units, often with a variety of habitat types, combining the five point-scale habitat designations into fewer and broader unit-scale habitat designations was necessary. Three broader categories (open, shrub-open/shrub, and forest-shrub/forest) were found to effectively characterize the more extensive and mixed habitats in the larger and interconnected wetlands along with the smaller, more homogeneous wetlands.

Point Scale Attributes

Species Richness and Diversity

Species richness for each survey point was determined by pooling data across both years for a complete list of all species detected at the point. The Shannon-Weaver index of diversity was calculated for each survey point using the maximum number of a species detected across the four total visits to the point from both years. This index was selected because it emphasizes the distribution of individuals among species (Shannon and Weaver 1949). Survey points were ranked into species richness and diversity quartile categories (e.g., 1, 2, 3, and 4) based on the relative values for each parameter. Thus, survey points with a ranking of 1 were those whose richness and diversity values fell within the top 25% of values for all points, those with a ranking of 2 fell within the top 50–75% of values for all points, and so on.

Wetland Scale Attributes

Frequency of Occurrence

Frequency of occurrence was calculated for all species as the proportion of the number of wetland units a species was found in partitioned by wetland unit habitat type (open, shrub-open/shrub, and forest-shrub/forest) over both years. An overall frequency of occurrence value was derived along with separate values for each of the three habitat types.

Species/Guild Habitat Preferences

The number of detections (essentially used as an index of abundance) was used to indicate preference by individual species/guilds for habitat types. Values for each species were calculated by determining the maximum number of a species detected within a wetland unit across the four total visits (considering data separately if a unit contained multiple points) from both years.

Values for avian habitat guilds (e.g., aerial, emergent/open/standing dead timber, forested, edge, shrub dominated) were calculated by adding values for species within each guild for each wetland unit and averaging guild abundances for the wetland units grouped by habitat type (open, shrub-open/shrub, and forest-shrub/forest). Representative species of the guild or guilds dominating each habitat type were then determined as those with a minimum of 0.5 mean detections/wetland unit.

Detections for each species were used to calculate mean values for the three-wetland unit habitat types in order to examine habitat preferences by species. As with frequency of occurrence, an overall mean index of abundance across habitat types was calculated and used to rank species preferences for habitat type. Relative abundance was often a value less than one, since most species were not detected in all of the wetlands of a particular habitat type, and, if detected, the number of detections was typically low, perhaps one or two individuals for a given 5-minute survey. A few pervasive species, such as the red-eyed vireo, were represented by values greater than one, at least in some habitats, since they were detected at most points and sometimes in greater numbers than typical of other species.

Edge vs. Interior Habitat Preference

The bearing of the observers conducting point counts ensured that detections would be recorded from the interior of wetlands. The position of survey points along the edges of wetlands and the

size of many wetlands in relation to the 100-m detection distance surrounding points meant that detections were frequently recorded from wetland edges also. It was therefore important to measure edge vs. interior preference for species with a sufficient number of detections. The difficulty was to separate edge vs. interior preference from habitat influences.

To test how species are distributed with respect to edge habitat for survey points located along the edges of wetlands with interiors that were open versus shrub-dominated (from open and shrub-open/shrub wetland units), the detections for each species were summed according to location (wetland interior or wetland edge) across visits to points over both years. Forested wetlands were not included because of their relative vegetative homogeneity from interior to edge.

Two complementary null hypotheses can be envisioned to test whether wetland interior or wetland edge in these two habitat types influence bird detections for a hypothetical well-distributed species. In the first hypothesis, if the species uses wetland edge versus interior randomly, regardless of whether the interior is open or shrub-dominated, then expected frequencies of individuals should be approximately equal between the two locations (Figure 6, part a). In the second hypothesis, if the species occurs approximately equally between wetlands with interiors that are open or shrub-dominated, but the species favors one location over the other, regardless of wetland interior habitat type, expected frequencies of individuals by location across the wetland interior habitat types should be roughly similar (Figure 6, parts b and c).

Goodness of fit (Pearson's Chi-Square) and Fishers Exact Test were used on 2×2 contingency tables of the observed number of detections for each species arranged as in Figure 6 to see if there was an association between wetland interior habitat type and the distribution of the observed locations. Species with 30 or more total detections were analyzed, and Fishers Exact Test was used in situations where one or more expected cell frequencies was less than five. This analysis, along with species showing obvious tendencies toward the edge or interior of wetlands regardless of habitat type, are presented as a means to indicate the relative importance of edge and interior habitat to maintaining diversity of DEWA's wetland-associated species.

a.

	Edge	Interior
Open-Interior	50	50
Shrub-Interior	50	50

b.

	Edge	Interior
Open-Interior	25	75
Shrub-Interior	25	75

c.

	Edge	Interior
Open-Interior	75	25
Shrub-Interior	75	25

Figure 6. Hypothetical distribution of the number of detections of a species according to location in open-interior and shrub-interior wetlands. (a) randomly distributed – no preference for edge or interior regardless of habitat type; (b) prefers the interior with no apparent habitat influence and; (c) prefers the edge equally with no apparent habitat influence.

Results

A total of 112 species were detected during the course of this study, including 111 species detected during vcp point counts and 1 species (sora) detected only during CD playbacks (Appendix C). A total of 6,023 individual birds (records) were observed during the vcp point counts. All individual bird records (n=1,632) in which the location of the detection was recorded as "outside of the wetland" were removed (filtered through a database query) prior to all analyses for this report. These data were collected in the field, but given the focus of the report, all analyses were restricted to observations that occurred "in" the wetlands of interest. The original, unfiltered data are available in the accompanying database in addition to the "filtered" data used for analyses (Appendix H).

A total of 107 species of birds were observed "in" wetlands during the course of vcp point counts, including species heard just prior to or after the official five minute point count period (Appendix C). This total represents 40% (107/264) of species found on the DEWA bird checklist (Pocono Environmental Education Center). Putting this total in context, it contains 23 more species than the total found during two years of vcp point counts in DEWA's early successional habitats (Master et al. 2006). The number of points surveyed during that project was 43, considerably lower than the 104 points included in the wetland project, but those points did cover virtually all of the park's open, early successional habitats. Of those 107 species observed, 20/29 species of interest were observed, (Table 1) including; (1) American black duck, (2) wood duck, (3) green heron, (4) great blue heron, (5) red-shouldered hawk, (6) Virginia rail, (7) sora, (8) common moorhen, (9) American woodcock, (10) red-headed woodpecker, (11) alder flycatcher, (12) fish crow, (13) golden-winged warbler, (14) cerulean warbler, (15) Kentucky warbler, (16) Canada warbler, (17) yellow-breasted chat, (18) swamp sparrow, (19) orchard oriole, and (20) common grackle.

The five species detected during the course of the study but "outside" of wetlands were wild turkey, whip-poor-will, common raven, magnolia warbler, and black-throated blue warbler.

CD Playback for Secretive Marsh Birds

Aural broadcasts were used to detect various species of nocturnally active marsh birds and confirm some detections during daylight hours at survey points with proper habitat for these species. All of the detections were recorded in 2004; there were none in 2005 in spite of expanded coverage during that year. Most detections came from the Township Ballfield group of wetlands (Table 4). Virginia rail also responded to the CD playback at a survey point in the Headquarters Group of wetlands where a pair was heard on 2 June 2004. Virginia rail has been seen at this same site prior to this project (Jeff Shreiner, DEWA Biologist, pers. comm. 2004).

Point Scale Attributes

Species Richness

Species richness values were calculated for the 104 survey points by pooling species detected over both years (Appendix I). The top 20 survey points, ranked by richness, are presented in Table 5. The majority of these points are located in shrub or open/shrub wetlands (14) found mostly on the New Jersey side of DEWA. The Flat Brook North (FN) wetland group was represented by four survey points in the listing. Overall, NJ-4174/3 in the Township Ballfield

Table 4. Species detected using marsh bird CD playback.

Wetland Group	Survey Point	Species Detected	Date	Time
Township Ballfield	4174/1	common moorhen*	14 June 2004	0422
Township Ballfield	4171/1	sora	25 May 2004	1948
			14 June 2004	0715
Township Ballfield	4170/1	Virginia rail*	25 May 2004	0431
Headquarters	4053/2	Virginia rail (pair)	2 June 2004	2040
			28 July 2004	2130

*These species also detected during vcp surveys at the same site and day.

Table 5. The twenty most species rich survey points and their habitat types.

Wetland Unit	Survey Point	Habitat Type	Species Richness
Township Ballfield 5	NJ-4174/3	open/shrub	30
Flat Brook North 1	NJ-4210/1	shrub	29
Flat Brook North 1	NJ-4210/2	shrub	28
Flat Brook South 1	NJ-4230/1	open	28
Catfish Pond 1	NJ-4270/1	shrub	27
Thunder Mountain 2	NJ-4191/1	shrub	26
Park Headquarters 2	PA-4051/2	shrub	26
PEEC 4	PA-4093/1	open	26
Flat Brook North 3	NJ-4213/1	forest	26
Catfish Pond 3	NJ-4272/1	shrub	25
Shimers 1	NJ-4150/1	open	25
Thunder Mountain 5	NJ-4194/1	open/shrub	25
Flat Brook South 1	NJ-4230/2	forest	25
Flat Brook North 1	NJ-4210/4	shrub	24
Township Ballfield 2	NJ-4171/1	shrub	24
PEEC 2	PA-4091/1	open	23
Park Headquarters 2	PA-4051-1	shrub	23
Crater Lake 5	NJ-4254/1	open/shrub	23
Catfish Pond 5	NJ-4274/1	open	23
Thunder Mountain 5	NJ-4194/2	open/shrub	23

group was the richest survey point with 30 species. There were only two forested sites in the 20 survey points with the highest richness. Fourteen of the 20 survey points with the lowest richness values (Appendix I, not shown in Table 5) were forested or shrub/forest sites. The survey point with the lowest richness value of all 104 survey points was 4071/1 in the Toms Creek group with just seven species, although it is a very small (0.567 ha [1.400 ac]) forested wetland.

Species Diversity

Species diversity values for the 104 survey points were calculated by pooling data over both years (Appendix J). The top 20 survey points, ranked by diversity, are presented in Table 6. All but four of these survey points overlap with the top 20 richest points. The majority of these points are located on shrub and open/shrub wetlands (13) found mostly on the New Jersey side of DEWA. The Flat Brook North (FN) wetland group was represented by six survey points in the listing. Overall, NJ-4210/1 in the Flat Brook North group had the highest diversity index (3.28) and was ranked second in richness. There are only two forested sites in the 20 survey points with the highest diversity and they are the same as those in the richness listing in Table 5. Twelve of

Table 6. The twenty most diverse survey points and their habitat types.

Wetland Unit	Survey Point	Habitat	Diversity
Flat Brook North 1	NJ-4210/1	shrub	3.28
Flat Brook North 1	NJ-4210/2	shrub	3.24
Catfish Pond 1	NJ-4270/1	shrub	3.21
Flat Brook South 1	NJ-4230/1	open	3.21
Township Ballfield 5	NJ-4174/3	open/shrub	3.20
Flat Brook South 1	NJ-4230/2	forest	3.19
Flat Brook North 3	NJ-4213/1	forest	3.19
Catfish Pond 3	NJ-4272/1	shrub	3.15
Flat Brook North 1	NJ-4210/4	shrub	3.13
Thunder Mountain 2	NJ-4191/1	shrub	3.13
Crater Lake 5	NJ-4254/1	open/shrub	3.08
Shimers 1	NJ-4150/1	open	3.07
Township Ballfield 2	NJ-4171/1	shrub	3.04
Thunder Mountain 5	NJ-4194/1	open/shrub	3.03
Conashaugh 6	PA-4136/1	open	3.01
Park Headquarters 2	PA-4051/2	shrub	3.01
Flat Brook North 1	NJ-4210/3	shrub	3.00
PEEC 2	PA-4091/1	open	3.00
Toms Creek 4	PA-4073/1	open	2.99
Flat Brook North 5	NJ-4215/1	shrub	2.98

the 20 survey points with the lowest diversity values were either forested or shrub/forest sites (Appendix I, not shown in Table 6). The survey point with the lowest diversity value (1.83) of all 104 survey points was 4071/1 in the Toms Creek group, also the survey point with the lowest richness.

Wetland Scale Attributes

Frequency of Occurrence

Frequency of occurrence values for each species are shown by habitat and overall ranking in Table 7. Values were calculated across both years based on the frequency of occurrence of a species in wetland units composing each major habitat type. Values for the three habitat types were summed to derive an overall frequency of occurrence for the 77 wetland units. The majority of species were found in all habitat types but typically occurred more frequently in a specific habitat. The red-eyed vireo was the most frequently occurring species overall and was found in nearly all wetlands, especially those with forest and forest/shrub components. Common yellowthroat was the most frequently occurring species in open habitats; red-eyed vireo and gray catbird were most prevalent in shrub-open/shrub habitat; and red-eyed vireo was most frequently occurring in forest-shrub/forest habitat followed closely by the ovenbird. The swamp sparrow was the most frequently occurring, characteristic wetland species; in general; and in open and shrub-open/shrub habitats; in particular. Most of the 20 species of interest detected had frequency of occurrence values of 32% or less (the majority much less than that); with the highest values most often in the open habitat category that also included standing dead timber swamps. For the most part, frequency of occurrence values for all species are roughly proportional to the degree that they are characteristic of a particular habitat.

Table 7. Frequency of occurrence (proportion of the number of wetland units a species was found in) by habitat type. Species listed in descending order based on overall mean frequency. Species of interest are in bold print.

	Frequency of Occurrence by Habitat Type (# of wetland units in type)			
Species	**Open (22)**	**Shrub/Open-Shrub (26)**	**Forest/Shrub-Forest (29)**	**Overall Mean Frequency**
red-eyed vireo	0.86	0.88	0.97	0.91
common yellowthroat	0.95	0.85	0.52	0.75
gray catbird	0.82	0.88	0.59	0.75
ovenbird	0.36	0.46	0.93	0.61
song sparrow	0.86	0.69	0.21	0.56
blue-gray gnatcatcher	0.64	0.50	0.52	0.55
scarlet tanager	0.64	0.38	0.52	0.51
American redstart	0.27	0.62	0.55	0.49
red-winged blackbird	0.86	0.54	0.10	0.47
veery	0.18	0.58	0.59	0.47
yellow warbler	0.45	0.62	0.28	0.44
black-and-white warbler	0.36	0.54	0.41	0.44
black-capped chickadee	0.36	0.50	0.45	0.44
cedar waxwing	0.55	0.46	0.31	0.43
American goldfinch	0.50	0.50	0.31	0.43
great-crested flycatcher	0.45	0.46	0.38	0.43
hairy woodpecker	0.27	0.58	0.34	0.40
tree swallow	0.77	0.42	0.03	0.38
Baltimore oriole	0.59	0.42	0.14	0.36
brown-headed cowbird	0.23	0.46	0.38	0.36
wood thrush	0.23	0.31	0.48	0.35
tufted titmouse	0.32	0.19	0.45	0.32
blue jay	0.27	0.27	0.38	0.31
northern cardinal	0.18	0.38	0.31	0.30
northern flicker	0.50	0.15	0.24	0.29
swamp sparrow	**0.32**	**0.42**	**0.14**	**0.29**
eastern wood-pewee	0.23	0.23	0.38	0.29
downy woodpecker	0.27	0.23	0.28	0.26
eastern kingbird	0.45	0.31	0.03	0.25
wood duck	**0.45**	**0.31**	**0.03**	**0.25**
eastern towhee	0.27	0.42	0.07	0.25
common grackle	**0.55**	**0.23**		**0.23**
white-breasted nuthatch	0.23	0.19	0.28	0.23
chestnut-sided warbler		0.54	0.14	0.23
yellow-throated vireo	0.32	0.19	0.17	0.22
prairie warbler	0.23	0.38	0.07	0.22
red-bellied woodpecker	0.18	0.27	0.21	0.22
blue-winged warbler	0.14	0.35	0.14	0.21
Louisiana waterthrush	0.18	0.08	0.34	0.21
indigo bunting	0.36	0.27		0.19
green heron	**0.32**	**0.27**	**0.03**	**0.19**
American crow	0.18	0.23	0.17	0.19
mourning dove		0.38	0.17	0.19
pine warbler	0.18	0.15	0.21	0.18
great blue heron	**0.41**	**0.15**		**0.17**
Eastern bluebird	0.23	0.27	0.03	0.17
hooded warbler	0.09	0.19	0.21	0.17
pileated woodpecker	0.23	0.19	0.07	0.16
chipping sparrow	0.23	0.19	0.03	0.14
Eastern phoebe	0.18	0.15	0.10	0.14
least flycatcher	0.18	0.19	0.03	0.13

Species	Frequency of Occurrence by Habitat Type (# of wetland units in type) Open (22)	Shrub/Open-Shrub (26)	Forest/Shrub-Forest (29)	Overall Mean Frequency
rose-breasted grosbeak	0.09	0.12	0.17	0.13
warbling vireo	0.18	0.12	0.07	0.12
blackburnian warbler	0.09	0.04	0.21	0.12
American robin	0.23	0.08	0.03	0.10
black-billed cuckoo	0.05	0.12	0.14	0.10
mallard	0.18	0.12		0.09
brown creeper	0.18	0.08	0.03	0.09
willow flycatcher	0.14	0.12		0.08
alder flycatcher	**0.05**	**0.19**		**0.08**
blue-headed vireo		0.12	0.10	0.08
Canada goose	0.14	0.04	0.03	0.06
house wren	0.09	0.08	0.03	0.06
black-throated green warbler	0.09	0.04	0.07	0.06
ruby-throated hummingbird	0.09	0.04	0.07	0.06
cerulean warbler		**0.08**	**0.10**	**0.06**
belted kingfisher	0.14	0.04		0.05
red-tailed hawk	0.14	0.04		0.05
Carolina wren	0.05	0.12		0.05
yellow-billed cuckoo	0.05	0.08	0.03	0.05
worm-eating warbler	0.05	0.04	0.07	0.05
red-headed woodpecker	**0.09**	**0.04**		**0.04**
northern parula	0.05	0.04	0.03	0.04
field sparrow		0.08	0.03	0.04
orchard oriole		**0.08**	**0.03**	**0.04**
hermit thrush			0.10	0.04
rough-winged swallow	0.09			0.03
American black duck	**0.05**	**0.04**		**0.03**
barn swallow	0.05	0.04		0.03
blackpoll warbler	0.05	0.04		0.03
chimney swift	0.05	0.04		0.03
Canada warbler		**0.04**	**0.03**	**0.03**
northern waterthrush		0.04	0.03	0.03
Acadian flycatcher	0.05			0.01
cliff swallow	0.05			0.01
mute swan	0.05			0.01
red-shouldered hawk	**0.05**			**0.01**
sharp-shinned hawk	0.05			0.01
Virginia rail	**0.05**			**0.01**
sora	**0.05**			**0.01**
common moorhen		**0.04**		**0.01**
golden-winged warbler		**0.04**		**0.01**
Kentucky warbler		**0.04**		**0.01**
yellow-breasted chat		**0.04**		**0.01**
broad-winged hawk			0.03	0.01
brown thrasher			0.03	0.01
yellow-rumped warbler			0.03	0.01

Habitat/Guild Analysis

The detections for all species were summed in order to determine which guilds were most prevalent in the three major habitat groupings (Table 8). For the most part, those guilds of species most closely associated with their typical habitat type (e.g., the forested avian guild in the forest-shrub/forest wetland unit habitat type) displayed the highest detection sum in that habitat. The open habitat had the highest overall detection sum, probably because that type includes standing dead timber swamps and their characteristic species and there were more visual detections from this habitat type. The shrub-open/shrub habitat was a close second and the forest-shrub/forest type was a distant third in overall detection sum magnitude. Forested wetlands were relatively low in diversity and species richness (Tables 5, 6; Appendix I) and visual detections were relatively few. The shrub-open/shrub habitat displayed the most evenly distributed guild detection sums, indicating that this is a transitional habitat suitable for a variety of species.

Species Habitat Preference Analysis

Table 9 shows the sum of detections by species across both years for the wetland unit habitat types. All species with high detection sums in at least one of the habitat types are highlighted in bold, as are sums in its less preferred habitats. The high sums for most species occur in their preferred habitat. However, some interesting, perhaps unexpected, patterns emerged, including black-and-white warbler with a high shrub-open/shrub detection sum (its forest value was only slightly higher) and blue-gray gnatcatcher, common yellowthroat, and red-eyed vireo with comparable values across all habitat types. The high wood duck value for the open habitat is explained by the inclusion of standing dead timber swamps in that habitat type. The highest detection sum was for the red-winged blackbird in open habitats. Other species with detection sums >1 include common yellowthroat in open and shrub-open/shrub, gray catbird in shrub-open/shrub, great blue heron in open (due to nesting colonies located in standing dead timber swamps), red-eyed vireo in forest-shrub/forest, song sparrow and tree swallow in open, and yellow warbler in shrub-open/shrub habitat. Of the targeted wetland species, the swamp sparrow displayed the highest detection sum, which was similar in both open and shrub-open/shrub habitats.

Edge vs. Interior Analysis

Of the species statistically tested with the contingency table analysis, several trends are evident that show that edge and interior habitat appear to influence bird detections differently in open and shrub-open/shrub wetland habitats. Gray Catbird, with a significant difference in the frequency of location between the habitats (P = 0.0000) and a relatively high sample size of 160 detections, had the most observations in edge vs. interior (45 vs. 19) in the open-interior wetlands in contrast to the opposite case for observations of edge vs. interior in the shrub-interior wetlands (27 vs. 69). Thus, gray catbirds likely select habitat type (the relatively shrubby edges of open-interior wetlands and the shrubby interior of shrub-interior wetlands) over position (edge vs. interior). If they preferred position over habitat, then they would have shown a preference for the interior of open-interior wetlands. While not contrasting as greatly or with rather lower sample sizes, eastern towhee (P = 0.0086) and black-capped chickadee (P = 0.0027) show a tendency to be retained in the edge habitat of open-interior wetlands and to occupy the interior of shrub-interior wetlands. Three other species with relatively high detection sample sizes and significant results, common yellowthroat (N = 217; P = 0.0002), song sparrow (N = 153; P = 0.0422), and yellow warbler (N = 128; P = 0.0000), share a tendency to predominantly occupy

Table 8. Sum of mean detections by avian habitat guild over both years for wetland unit habitat types. Representative species (having mean detections ≥0.5) are determined for the species habitat guilds in each type. Guilds in each type where the sum of the mean detections is ≥ 20% of the total sum for the habitat type are in bold italics (as are totals).

Wetland Unit Habitat Type	**Avian Habitat Guild**	**Index - sum of guild species means**	**Representative Species - scoring high within the habitat guild (≥ 0.5 mean detections)**
Forest-Shrub/Forest	Aerial		
	Emergent/Open/Dead timber	1.00	
	Forested	***11.96***	Ovenbird, red-eyed vireo, American redstart, veery, scarlet tanager, tufted titmouse, blue-gray gnatcatcher, wood thrush, black-and-white warbler, great crested flycatcher
	Edge	3.32	cedar waxwing
	Shrub-dominant	3.25	common yellowthroat, gray catbird
Forest-Shrub/Forest Total		***19.54***	
Open	Aerial	0.44	
	Emergent/Open/Dead timber	***13.96***	red-winged blackbird, tree swallow, Canada goose, wood duck, common grackle, great blue heron, American goldfinch, swamp sparrow
	Forested	***8.81***	red-eyed vireo, black-capped chickadee, scarlet tanager, blue-gray gnatcatcher, ovenbird
	Edge	5.30	cedar waxwing, Baltimore oriole, eastern kingbird
	Shrub-dominant	6.11	common yellowthroat, song sparrow, gray catbird, yellow warbler
Open Total		***34.63***	
Shrub-Open/Shrub	Aerial	0.14	
	Emergent/Open/Dead timber	***6.41***	red-winged blackbird, tree swallow, American goldfinch, wood duck, common grackle, swamp sparrow
	Forested	***9.36***	red-eyed vireo, American redstart, black-and-white warbler,black-capped chickadee, great crested flycatcher, veery, blue-gray gnatcatcher, ovenbird, hairy woodpecker
	Edge	6.18	cedar waxwing, brown-headed cowbird, Baltimore oriole, blue jay
	Shrub-dominant	***9.68***	common yellowthroat, yellow warbler, gray catbird, song sparrow, chestnut-sided warbler, eastern towhee, prairie warbler
Shrub-Open/Shrub Total		***31.77***	

Table 9. Sum of species detections across both years for habitat types. Species in bold print show relatively high detection sums in at least one habitat type.

Species	Open (less shrub edge)	Shrub-Open/Shrub	Forest-Shrub/Forest
Acadian flycatcher	0.037		
alder flycatcher	**0.074**	**0.273**	
American black duck	0.074		
American crow	0.222	0.227	0.214
American goldfinch	**0.815**	**0.818**	**0.393**
American redstart	**0.333**	**0.818**	**0.893**
American robin	0.185	0.136	0.071
Baltimore oriole	**0.593**	**0.500**	**0.143**
barn swallow	0.074		
belted kingfisher	0.111	0.045	
black-and-white warbler	**0.444**	**0.727**	**0.500**
black-billed cuckoo	0.074	0.091	0.143
blackburnian warbler	0.111	0.045	0.179
black-capped chickadee	0.667	0.636	0.464
blackpoll warbler	0.037	0.045	
black-throated green warbler	0.111		0.071
blue jay	0.259	0.500	0.464
blue-gray gnatcatcher	**0.556**	**0.545**	**0.536**
blue-headed vireo	0.037	0.091	0.107
blue-winged warbler	**0.259**	**0.364**	**0.143**
broad-winged hawk			0.036
brown creeper	0.185	0.045	0.036
brown thrasher			0.036
brown-headed cowbird	0.259	0.636	0.429
Canada goose	**1.593**		**0.036**
Canada warbler		0.045	0.036
Carolina wren	0.037	0.136	
cedar waxwing	1.185	1.409	0.571
cerulean warbler		0.091	0.107
chestnut-sided warbler		**0.864**	**0.143**
chimney swift	0.037	0.091	
chipping sparrow	0.222	0.182	0.036
cliff swallow	0.074		
common grackle	1.259	0.545	
common moorhen		0.045	
common yellowthroat	**1.593**	**2.000**	**0.857**
downy woodpecker	0.259	0.364	0.286
eastern bluebird	0.259	0.273	0.036
eastern kingbird	0.519	0.318	0.036
eastern phoebe	0.185	0.182	0.107
eastern towhee	**0.333**	**0.682**	**0.071**
eastern wood-pewee	0.222	0.227	0.393
field sparrow	0.037	0.045	0.036
golden-winged warbler		0.091	
gray catbird	**0.963**	**1.318**	**0.821**
great blue heron	**1.259**	**0.136**	
great-crested flycatcher	**0.444**	**0.636**	**0.500**
green heron	0.370	0.364	0.036

Species	Open (less shrub edge)	Shrub-Open/Shrub	Forest-Shrub/Forest
hairy woodpecker	0.407	0.500	0.321
hermit thrush			0.179
hooded warbler	0.111	0.273	0.214
house wren	0.222		0.036
indigo bunting	**0.296**	**0.409**	
Kentucky warbler		0.045	
least flycatcher	0.148	0.273	0.036
Louisiana waterthrush	0.185	0.091	0.357
mallard	0.370	0.091	
mourning dove	0.111	0.455	0.214
mute swan	0.074		
northern cardinal	0.222	0.364	0.393
northern flicker	0.481	0.227	0.250
northern parula	0.037	0.045	0.036
northern waterthrush		0.045	0.036
orchard oriole		0.136	0.036
ovenbird	**0.519**	**0.545**	**1.821**
pileated woodpecker	0.222	0.182	0.071
pine warbler	0.222	0.136	0.179
prairie warbler	**0.185**	**0.545**	**0.107**
red-bellied woodpecker	0.148	0.318	0.214
red-eyed vireo	**1.333**	**1.182**	**1.464**
red-headed woodpecker	0.074	0.136	
red-shouldered hawk	0.037		
red-tailed hawk	0.148	0.045	
red-winged blackbird	**3.407**	**1.455**	**0.214**
rose-breasted grosbeak	0.074	0.136	0.179
rough-winged swallow	0.111		
ruby-throated hummingbird	0.074	0.045	0.071
scarlet tanager	**0.630**	**0.455**	**0.571**
sharp-shinned hawk	0.037		
song sparrow	**1.111**	**1.136**	**0.286**
swamp sparrow	**0.519**	**0.545**	**0.179**
tree swallow	**2.370**	**1.273**	**0.036**
tufted titmouse	**0.370**	**0.227**	**0.571**
veery	**0.370**	**0.591**	**0.786**
Virginia rail	0.037		
sora	0.037		
warbling vireo	0.185	0.136	0.107
white-breasted nuthatch	0.296	0.227	0.321
willow flycatcher	0.185	0.182	
wood duck	**1.333**	**0.636**	**0.036**
wood thrush	**0.296**	**0.318**	**0.536**
worm-eating warbler	0.037	0.045	0.071
yellow warbler	**0.889**	**1.409**	**0.393**
yellow-billed cuckoo	0.037	0.091	0.036
yellow-breasted chat		0.045	
yellow-rumped warbler			0.036
yellow-throated vireo	0.333	0.182	0.179
Grand Total	**34.630**	**31.773**	**19.536**

the interior of shrub-interior habitat (e.g. 16 edge vs. 101 interior detections for Common Yellowthroat). While these species appear to be more abundant in the edges of open-interior vs. shrub-interior wetlands, they also have approximately equal or even higher numbers of detections in the interior relative to the edge of open-interior wetlands (e.g. 35 edge vs. 65 interior detections for common yellowthroat).

Other species show clear tendencies towards the edge or the interior regardless of wetland habitat, often to the point of precluding statistical testing (Table 10). Great blue heron, swamp sparrow, tree swallow, and wood duck were only detected in the interior; while common grackle, eastern bluebird, green heron, and red-winged blackbird were predominately detected in the interior. Although less clearly seen across both wetland habitats, species such as Baltimore oriole and scarlet tanager favor the edges; especially of open-interior wetlands. Red-eyed vireo also appears to strongly favor edge habitat, although the significant test statistic ($P = 0.000$) indicates an influence of habitat with a substantial number of detections in the interior of shrub-interior wetlands.

Table 10. Frequencies of edge and interior detections summed across point count surveys for species at open-interior and shrub-interior wetlands and contingency table analysis.

Species	Wetland Habitat	Pt N	Location Frequency		Contingency Table test[b]	
			Edge	Interior	N[a]	Test Statistic[c]
American goldfinch	open-interior	10	6	12	33	1.0000
	shrub-interior	7	5	10		
American redstart	open-interior	10	11	6	52	0.4756
	shrub-interior	18	19	16		
Baltimore oriole	open-interior	16	22	3	43	0.1328
	shrub-interior	10	12	6		
black-and-white warbler	open-interior	11	14	4	43	0.2197
	shrub-interior	17	15	10		
black-capped chickadee	open-interior	10	13	4	36	**0.0027**
	shrub-interior	10	5	14		
blue-gray gnatcatcher	open-interior	17	19	13	53	0.5922
	shrub-interior	12	14	7		
brown-headed cowbird	open-interior	4	4	2	27*	
	shrub-interior	11	5	16		
blue jay	open-interior	6	6	1	18*	
	shrub-interior	6	7	4		
blue-winged warbler	open-interior	4	4	2	32	0.1937
	shrub-interior	10	9	17		
cedar waxwing	open-interior	10	8	11	40	0.7263
	shrub-interior	9	10	11		
common grackle	open-interior	15	5	51	72	0.5800
	shrub-interior	7	0	16		
common yellowthroat	open-interior	32	35	65	217	**0.0002**
	shrub-interior	27	16	101		
chestnut-sided warbler	open-interior	1	0	1	36	1.0000
	shrub-interior	16	7	28		
downy woodpecker	open-interior	6	2	4	14*	
	shrub-interior	6	2	6		
eastern bluebird	open-interior	6	0	10	26*	
	shrub-interior	7	2	14		
eastern kingbird	open-interior	14	10	33	56	0.7112
	shrub-interior	7	2	11		
eastern phoebe	open-interior	6	4	4	13*	
	shrub-interior	5	3	2		
eastern towhee	open-interior	11	15	3	51	**0.0086**
	shrub-interior	13	15	18		
eastern wood-pewee	open-interior	7	6	3	17*	
	shrub-interior	6	5	3		
great blue heron	open-interior	11	0	67	69**	
	shrub-interior	2	0	2		
great-crested flycatcher	open-interior	14	14	9	52	0.3656
	shrub-interior	16	14	15		
gray catbird	open-interior	27	45	19	160	0.000
	shrub-interior	28	27	69		
green heron	open-interior	10	0	15	23*	
	shrub-interior	5	2	6		

Species	Wetland Habitat	Pt N	Location Frequency		Contingency Table test[b]	
			Edge	Interior	N[a]	Test Statistic[c]
hairy woodpecker	open-interior	9	2	7	20*	
	shrub-interior	10	4	7		
indigo bunting	open-interior	9	12	7	30	0.4539
	shrub-interior	6	5	6		
northern cardinal	open-interior	7	6	2	19*	
	shrub-interior	10	6	5		
northern flicker	open-interior	13	5	16	30	1.000
	shrub-interior	4	2	7		
ovenbird	open-interior	9	12	1	46	0.0717
	shrub-interior	14	20	13		
prairie warbler	open-interior	6	8	4	26*	
	shrub-interior	10	5	9		
red-bellied woodpecker	open-interior	4	1	3	15*	
	shrub-interior	7	4	7		
red-eyed vireo	open-interior	28	65	3	129	**0.0000**
	shrub-interior	28	41	20		
red-winged blackbird	open-interior	29	7	150	215	0.6855
	shrub-interior	14	1	57		
scarlet tanager	open-interior	17	20	0	34	
	shrub-interior	9	9	5		
song sparrow	open-interior	29	30	67	153	**0.0422**
	shrub-interior	17	9	47		
swamp sparrow	open-interior	10	0	27	50**	
	shrub-interior	11	0	23		
tree swallow	open-interior	10	0	38	45**	
	shrub-interior	6	0	7		
tufted titmouse	open-interior	8	7	3	15*	
	shrub-interior	4	2	3		
veery	open-interior	5	5	0	30	
	shrub-interior	14	12	13		
white-breasted nuthatch	open-interior	6	2	7	15*	
	shrub-interior	5	4	2		
wood duck	open-interior	13	0	40	65**	
	shrub-interior	8	0	25		
wood thrush	open-interior	4	5	0	13*	
	shrub-interior	7	4	4		
yellow-throated vireo	open-interior	9	12	2	21*	
	shrub-interior	5	7	0		
yellow warbler	open-interior	16	31	32	128	**0.0000**
	shrub-interior	18	7	58		

a. excluded from contingency table analysis due to *sample size < 30, **presence in one location only
b. bold values deemed statistically significant
c. Fisher's Exact Test underlined, otherwise Pearson Chi-Square goodness of fit test

Discussion

Overview

General Wetland Characteristics

The results, analyses, and summary presented above describe DEWA's wetlands in terms of habitat characteristics, avian community parameters, species preferences, and interrelationships among these factors. Having defined DEWA's wetlands using these metrics, individual wetland types can be discussed and compared. An observer traveling through the park would notice that, physically, most of DEWA's wetlands are relatively small. Size is an important consideration with respect to management/conservation options because it helps define wetland avian communities (Brown and Dinsmore 1986, Gibbs 1993, Semlitsch and Bodie 1998). Open wetlands, classed as open or shrub - open/shrub wetlands in the Results section, represent most of the larger wetlands in the park and would typically consist of a mosaic of habitat types, often arranged with an emergent core, shrubby interior patches and/or fringe, and a forested edge. A small number of open wetlands are dominated by a few plant groups, mostly sedges/grasses or standing dead timber (snags), the latter typically created by beaver activity. Less obvious would be the park's shrub-dominated wetlands; although shrubs infiltrate many of the park's wetlands to some extent. Least obvious would be the park's forested wetlands that are numerous, small, and often located in relatively remote areas. Many of these wetland types occur in complexes connected physically and/or hydrologically. No matter what the characteristics, a tally of birds heard while standing at the core of DEWA wetlands would reveal many edge species not associated specifically with wetland habitat. Thus, the important characteristics of DEWA's wetlands from a management/ conservation perspective include size, vegetative composition, presence of snags/influence of beaver activity, association into complexes, and the prevalence of edge habitat. These characteristics, in large part, dictate the avifauna of DEWA's wetlands, which consists of five general groups of birds, including: (1) species characteristic of edges; (2) those typical of general wetland habitats; (3) those associated with specific wetland characteristics; (4) shrubland birds; and (5) a miscellaneous group with general habitat preferences. These groups are reflected in the species of interest listed in Table 1. In the following narrative, individual wetlands, wetland complexes, and wetland groupings used as examples can be viewed using the Wetland Power Point Program (WPPP) on the accompanying CD.

Importance of Wetland Size and Connectivity

Evidence suggests that small wetlands play a proportionally greater role in metapopulation dynamics than is suggested by the area they cover (Gibbs 1993). In a study conducted in Maine, Gibbs (1993) found that loss of small wetlands within a 600-km^2 area reduced total wetland area by 19% but reduced the overall number of wetlands by 62%, suggesting that most wetlands were relatively small. The numerical loss would, of course, diminish the probability of having wetlands proximal to each other in wetland complexes, which has demonstrated benefits with regard to species richness and diversity (Brown and Dinsmore 1986). They found that 10 of 25 wetland bird species disappeared from marshes <5 ha in size in Iowa and that species richness was often greater in wetland complexes than in larger, isolated wetlands. Another benefit of having relatively large numbers of small wetlands is that they harbor a greater number of demes or subpopulations of wetland organisms and thus contribute disproportionately to both the biodiversity and genetic diversity of wetland populations when compared to isolated, large

wetlands (Semlitsch and Bodie 1998). Loss of such wetlands leads to a reduction in the number and/or density of individuals available to disperse and an increase in dispersal distance to the next available wetland. This applies more to less mobile organisms, such as amphibians, but could also apply to bird species, like rails, that may not disperse as well as most bird species.

In DEWA, wetland complexes, composed of a mosaic of small wetlands and exemplified by the Flat Brook North (FN) and South (FS) wetland groups, were among the most species rich and diverse of all wetlands in the park. Six of the 20 wetlands with the highest species richness were in these complexes as were eight of the 20 most diverse wetlands, and most were at or near the top of the respective lists (Tables 5 and 6). Conversely, some of the largest wetlands in the park, e.g., survey points 4194/1 and 4194/2 in the Thunder Mountain Group (WPPP #39), are included in the top 20 wetlands for both richness and diversity but are positioned in the lower half of each list. Thus, the effect of size on bird richness and diversity is difficult to determine and depends on wetland type (even the largest forested wetlands were relatively low in richness and diversity), the degree to which wetlands are arranged into hydrologically connected complexes, and the number of wetland habitat types composing such complexes. The highly rich and diverse Flat Brook Wetland Group complexes mentioned above were composed of a variety of wetland types, mostly shrub-open/shrub wetlands mixed with forested and open types. Survey points 4053/1 and 4053/2 in the Headquarters Group (PPPW #17), consisting of mostly a single habitat type, open wetland, were not listed in the top 20 wetlands for either richness or diversity (Appendixes I, J).

Species of Interest

Twenty of the 29 species of interest (Table 1) were observed during the two years of field surveys. Three of these species responded to CD playback (Table 4). The mean frequency of occurrence for the 20 species was only 5%, or approximately equivalent to being detected in 4/77 wetland units. If the three most frequently observed species of interest are not considered (swamp sparrow – 29%, wood duck – 25%, and common grackle – 23%), the mean frequency of occurrence for species of interest was approximately 1%, or equivalent to being observed in only 1/77 wetland units. Of the three most frequently observed species, the swamp sparrow and wood duck were the only obligate wetland species. The prevalence of common grackle, certainly not a wetland obligate, and the third most frequently detected species, was unexpected.

Wetland Habitat Types

Open Wetlands

Thirty-one of 104 survey points were categorized as open wetlands. Twenty-two of 77 wetland units were considered open wetlands. All were generally emergent wetlands, specifically, wet meadows (less hydric) or true emergent wetlands, some were primarily vegetated with grasses/sedges, and a few with portions of open water. All standing dead timber (snags) wetlands were included in this category and some had isolated interior shrubs and/or a shrubby fringe. Some of these wetlands were among the largest in the park. Thunder Mountain survey points NJ-4190/1–4 (WPPP #s 34, 35) were located in an open wetland with standing dead timber consisting of nearly 14 ha (34.5 ac), but most were smaller in size.

Five of the twenty most species rich and diverse wetlands were open but, in general, were not in the top tier of these lists (Tables 5 and 6). The Flat Brook South 1 survey point NJ-4230/1

(WPPP #48) was the highest-ranking open wetland for richness and diversity, ranking fourth for both measures. These wetlands were dominated (based on guild habitat preferences and species detections, Tables 8 and 9) by the open guild of species, including red-winged blackbird, tree swallow, Canada goose, wood duck, common grackle, great blue heron, American goldfinch, and swamp sparrow. Forest species were the second most prevalent guild, including red-eyed vireo, black-capped chickadee, scarlet tanager, blue-gray gnatcatcher, and ovenbird**.** This reflects detections from the shrubby and wooded edges of wetlands (Table 8).

All of the marsh bird playback survey points were on open wetlands (Table 2). Species that respond to playbacks, e.g., grebes, moorhens, coots, rails, and bitterns, are found primarily in emergent wetlands (Conway and Gibbs 2005, NatureServe 2010). Virginia rail and sora are particularly fond of emergent wetlands dominated by grasses and/or sedges (Conway and Gibbs 2005, NatureServe 2010). Both of these species and common moorhen were detected during the first year of the survey, but there were no marsh bird detections using playback during the second year (Table 4). All three species were observed in various wetlands in the Township Ballfield Group. Of the three species, only the Virginia rail was observed in another wetland (Headquarters Group, PA-4053/2, WPPP #17), and it was the only one of these species observed prior to this study (Jeff Shreiner, DEWA Biologist, pers. comm. 2004) in this same wetland. Stable populations of these species, perhaps with the exception of Virginia rail, probably do not exist in DEWA, but the potential is there and preservation of these sites provides important migratory stop-over habitat. Recent surveys of the Township Ballfield wetlands in New Jersey indicate the continuing presence of Virginia rail and sora in these wetlands (Jeff Shreiner, DEWA Biologist, pers. comm. 2004). Of the open wetlands surveyed where marsh birds were not detected using playback, Crater Lake Group survey point NJ-4251/1 (WPPP #4) and Thunder Mountain Group survey point PA-4192/1 (WPPP #37) would be particularly appropriate for continued monitoring for these species based on their size and extensive emergent vegetation dominated by grasses and sedges.

Standing dead timber was prevalent in some open wetlands, many concentrated within the Park Headquarters, Tom's Creek, PEEC, and Thunder Mountain Wetland Groups (Figure 5). These wetlands were included in the open category because emergent vegetation dominated at ground level. They are very important habitats for three groups of birds within DEWA, including woodpeckers, secondary cavity nesters, and great blue herons. It is estimated that 85 species of North American birds utilize snags for nesting and/or roosting sites (Scott et al. 1977). Beaver activity was important in the formation of most, if not all, of the standing dead timber wetlands in the park. They also create expanses of open water habitat that reverse typical wetland plant succession (Tiner 1999). Thus, beaver activity creates two habitat types, with their associated species, which raises the park's total biodiversity. The distribution of beavers (*Castor canadensis*) within the park and how they are managed will play a major role in the dynamics of park wetlands in the future.

Although not observed frequently, red-headed woodpecker, officially threatened in New Jersey, was confined to standing dead timber and was observed in the Headquarters Group of wetlands at survey points PA-4051/1, PA-4051/2 (WPPP #15 and 16), and 4052/1 (WPPP #15 and 16) adjacent to the DEWA headquarters where they have been seen for many years (Larry Rymon, Professor of Biology, East Stroudsburg University, pers. comm., 2004). An individual was also observed at nearby survey point PA-4057/2 (WPPP #18 and 19). This is one of the few, perhaps

the only, regularly occurring population of this species in northeastern Pennsylvania (Second Pennsylvania Breeding Bird Atlas 2010). This species, never common in Pennsylvania, was observed in approximately half of the survey blocks in the current Pennsylvania Breeding Bird Atlas (2004–2008) compared to the first atlas conducted from 1984–1989 (Shutsky 1992, Second Pennsylvania Breeding Bird Atlas 2010). Declines are also shown in BBS state trends (BBS 2010). Many of these wetlands contained 6/7 possible woodpecker species, the exception being yellow-bellied sapsucker (*Sphyrapicus varius*).

The primary representative of the aerial guild and a secondary cavity nester, the tree swallow, was observed most often in wetlands dominated by snags, as was the wood duck, another secondary cavity nester. Interestingly, other secondary cavity nesters, like great-crested flycatcher and black-capped chickadee, showed relatively equal frequencies of occurrence across all wetland types.

All of the park's great blue heron nesting colonies were located in standing dead timber wetlands including survey points PA-4054/2 and 4057/2, both in the Headquarters Group (WPPP #s 18 and 19), PA-4093/1 in the PEEC Group (WPPP #22), and PA-4073/1 in the Tom's Creek Group (WPPP #s 30 and 31). Great blue herons were considered to be declining through the mid-1980s but have rebounded and now compose over half of Pennsylvania's total colonially nesting bird population, with about 1,500 pairs scattered across the state (Ross 2010). They are listed as a species of concern in New Jersey (Table 1).

Interestingly, common grackle was noticeably attracted to this wetland type, although the reason(s) are not readily apparent. The overall frequency of occurrence for this typically open habitat species among surveyed open wetlands units was higher (55%) than among 29 vcp surveyed successional fields in DEWA (17% in 2002, 7% in 2003) (Master et al. 2006).

Shrub and Open/Shrub Wetlands

Shrub and open/shrub wetlands were the most species rich and diverse wetland types in DEWA. Thirteen of the 20 most species rich and diverse wetlands were shrub and open/shrub wetlands, including the top three wetlands for each parameter (Tables 5 and 6). Overall, survey point PA-4174/3 in the Township Ballfield Group (WPPP #s 28 and 29) had the highest species richness of all points, while NJ-4210/1 in the Flat Brook North Group was the most diverse (WPPP #49).

These categories merge into one another and so are discussed together in this section. There are 29/104 survey points categorized as shrub habitat. The larger wetland units always contain a variety of habitat types and thus are categorized as shrub-open/shrub wetlands. In DEWA, shrubs occur in four specific situations including: (1) as a fringe vegetating relatively xeric wetland edges (Dingman's Group, PA-4114/1, PPPW #14); (2) as invaders of wetland interiors that are less hydric, e.g., wet meadow sites (Headquarters Group, PA-4053/1, PPPW #17); (3) as a major vegetation component within hydric wetlands (Catfish Pond Group, NJ-4271/1, PPPW #11) ; and (4) as the dominant vegetation type in a hydric wetland (Conashaugh Group, PA-4131/1, PPPW #8). There are 26 wetland units categorized as shrub-open/shrub wetlands. Under very hydric conditions, shrublands often do not progress to later successional stages (Thompson and DeGraaf 2001, DeGraaf and Yamasaki 2003); thus, no active management is required to maintain this wetland habitat.

Shrubs are the transitional vegetation type in these wetlands and their presence and extent has a major influence on avian community structure. The most frequently detected species (Table 7), in order, were red-eyed vireo, gray catbird, common yellowthroat, song sparrow, and yellow warbler. All are typical shrub species except the red-eyed vireo, the most frequently observed species. This is partially due to the very common status of this species but also to the influence of detections from the wooded edges of wetlands. The forest guild of species was nearly as prevalent, based on detection sums (Table 8), as typical shrub species in this wetland type because of edge effects. Individual species with the highest detection sums (Table 9), in order, included common yellowthroat, red-winged blackbird, yellow warbler, and gray catbird.

The swamp sparrow, a species of interest (Table 1), was, by all measures, the most prevalent obligate wetland dependent species in the park. Their frequency of occurrence and detection sum (Tables 7 and 9, respectively) were highest in shrub habitat but were nearly as high in open wetlands. They were observed in 42% of all shrub-open/shrub wetlands and 32% of all open wetlands. Their population remains stable in Pennsylvania but is declining in New Jersey (Breeding Bird Survey 2010). Comparison of breeding bird atlas data shows a considerable increase in distribution from the first to the second atlas (Second Pennsylvania Breeding Bird Atlas 2010).

Many of these species are typical shrubland species in xeric sites as well (Confer and Pascoe 2003). For such species, there is the question of whether their prevalence in this habitat type is due to a preference for shrubs, edge habitat, or both. For example, gray catbird was observed, based on detection sums, significantly more often along the wetland edge in open interior wetlands, e.g., no interior shrubs, and within the interior of wetlands dominated by shrubs (Table 10). Conversely, common yellowthroat, song sparrow, and yellow warbler show a significant tendency to occupy the interior of wetlands whether or not shrubs dominate there. These patterns suggest the importance of edges and shrub dominance and location in determining avian community structure in these wetlands.

Shrub and open/shrub wetlands harbor several relatively rare species of interest (Table 1) in DEWA, including yellow-breasted chat, golden-winged warbler, Canada warbler, and Kentucky warbler. Each was observed in only one northeastern DEWA New Jersey wetland. The yellow-breasted chat was detected at NJ-4210/4, Flat Brook North Group, WPPP #50; the golden-winged warbler was observed at NJ-4172/1, Township Ballfield Group, WPPP #27; Canada warbler at NJ-4213/1,2, Flat Brook North Group, WPPP #53; and the Kentucky warbler at NJ-4272/1, Catfish Pond Group, WPPP #42. The yellow-breasted chat, golden-winged warbler, and Kentucky warbler are all declining in Pennsylvania and to a greater extent in New Jersey where they are all species of concern (Gill 1992, Leberman 1992, Master 1992, Breeding Bird Survey 2010, Second Pennsylvania Breeding Bird Atlas 2010). In fact, the Kentucky warbler is nearly extirpated in New Jersey. It is interesting that all three species were observed at New Jersey survey points in the northeastern quadrant of DEWA. There is national concern over the conservation status of the golden-winged warbler, in particular (Confer 1992). Several individuals were also observed in xeric successional habitats in the northeastern portion of DEWA; thus, this region remains the only area of New Jersey where this species, albeit tenuously, can still be found (Master et al. 2006).

Forest and Shrub/Forest Wetlands

Forested wetlands are common throughout the Northeastern United States and are the most common type of wetland in Pennsylvania, occupying 36% of all wetland acreage in the state (Swift et al. 1984, Pennsylvania State Wildlife Action Plan, http://www.pgc.state.pa.us, 2005). They are, at least numerically, the most abundant wetland type found in DEWA, as well. DEWA's wetland shapefile indicates that there are 506 Palustrine Forested Wetlands in the park, although ground surveys prior to the establishment of survey points indicate that they are not that numerous. Thirty-seven survey points were located in forest-shrub/forest wetlands and 29/77 wetland units were categorized as such. There are two basic vegetative structures associated with forested wetlands in the park, those with an open understory (mostly forested wetlands - survey point PA-4133/1, Conashaugh Group, WPPP #58) and those with a dense understory (forest - shrub/forest wetlands), often composed of rhododendron (survey points PA-4002/1 and 2, Totts Gap Group, WPPP #68). Generally, forested wetlands, as a group, had the lowest species richness and diversity values of all wetland types. Fourteen of 20 wetland units with the lowest species richness were either forested or forest-shrub/forest sites (Appendix I). Twelve of those with the lowest diversity values were also forest or forest-shrub/forest wetlands (Appenidx J). Survey point PA-4071/1, Toms Creek Group, WPPP #65, was the forested wetland with both the lowest richness and diversity values of all survey points. Swift et al. (1984) found that the addition of a shrub understory increased species richness in forested wetlands in Massachusetts.

The red-eyed vireo and ovenbird occurred most frequently in forested wetlands (Table 7) and their detection sums were highest for forest - shrub/forest wetlands along with American redstart, whose detection sum was also high for the shrub-open/shrub habitat (Table 9). The latter value is probably the result of detections along forested edges of wetlands with shrubs where the majority of them occurred (Table 10). Veery was the only other species observed in more than 50% of the forested wetlands, while wood thrush was observed in 48% of these wetland units. As a guild, forest birds dominated the forest - shrub/forest habitat to a greater degree than did either the emergent/open/dead timber guild in open wetland habitats or the shrub-dominant guild in shrub-open/shrub wetlands. Thus, forest birds appear less flexible in their habitat requirements and are not subject to the edge effects observed with the other two guilds (Table 8).

The cerulean warbler was observed at six survey points, located on WPPP #s 3, 12, 36, 53, 59, and 70, half of them forested. This species prefers forest, but with gaps, and thus was observed in some shrub and even open wetlands. Among neotropical migrants, it is one of the most rapidly declining species in North America (Breeding Bird Survey 2010, Second Pennsylvania Breeding Bird Atlas 2010) but is expanding its range in the northeast. DEWA is part of that expansion and the population distribution of this species in DEWA is currently being investigated (Terry Master and Shannon Curley, personal observation).

Conclusions

A total of 106 species of birds were recorded during the two years of field surveys conducted for this inventory. The mean frequency of occurrence of designated wetland species of interest among the 77 wetland units surveyed in DEWA was very low. The most frequently observed obligate wetland species were the swamp sparrow and wood duck, observed in 29% and 25% of wetland units, respectively. Detection sums indicated that both species were common at the wetland units where they were observed. Shrub and shrub-open/shrub wetlands, especially those in the Flat Brook area of DEWA in northeastern New Jersey, were the most species rich and

diverse, while forested wetlands had the fewest species and lowest diversity. The presence of shrubby wetlands, coupled with habitat diversity enhanced by beaver activity which creates open water and standing dead timber, were largely responsible for the observed level of wetland species richness and diversity. In spite of the relative paucity of obligate wetland species of interest, DEWA wetlands provide habitat for many species, including some rare species, and are an integral contributor to the park's overall biodiversity.

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Appendix A. Survey points within each wetland group referenced to Power Point program slides (Appendix D). Wetland areas based on TNC II shapefile unless otherwise noted.

Wetland Group	Survey Point Number*,**,***	Habitat Type	Area		Power Point Slide #
			Hectares	Acres	
Catfish Pond	NJ-4270/1	Shrub	4.292	10.607	10
	NJ-4271/1	Shrub	12.493	30.87	11
	NJ-4272/1*	Shrub	7.14	18.52	42
	NJ-4272/2*	Forest	7.14	18.52	42
	NJ-4273/1	Shrub	6.564	16.221	12
	NJ-4274/1	Open	2.302	5.687	43
	NJ-4275/1	Forest	6.878	17.399	43
Conashaugh	PA-4130/1**	Forest	1.064	2.631	56
	PA-4131/1	Shrub	4.319	10.675	8
	PA-4132/1**	Forest	2.850	7.042	57
	PA-4132/1**	Forest	0.984	2.432	57
	PA-4133/1**	Forest	2.040	5.04	58
	PA-4133/1**	Forest	2.001	4.943	58
	PA-4134/1**	Forest	2.989	7.387	41
	PA-4134/1**	Forest	2.17	5.364	41
	PA-4135/1**	Shrub	0.511	1.262	41
	PA-4135/1**	Shrub	2.212	5.465	41
	PA-4136/1**	Open	1.679	4.151	9
	PA-4136/1**	Open	2.37	5.856	9
Crater Lake	NJ-4250/1	Open	1.818	4.492	3
	NJ-4251/1	Open	2.098	6.643	4
	NJ-4252/1	Shrub	3.639	8.994	5
	NJ-4253/1	Open	3.496	8.639	6
	NJ-4254/1	Shrub	2.432	5.786	7
	NJ-4255/1	Shrub	5.204	12.859	7
	NJ-4256/1	Open	2.420	5.980	4
Dingman's	PA-4110/1**	Open	2.233	5.518	13
	PA-4110/1**	Open	1.280	3.163	13
	PA-4111/1	Shrub	1.204	2.975	44
	PA-4112/1	Forest	1.490	3.682	44
	PA-4113/1	Shrub	0.876	2.165	44
	PA-4114/1**	Shrub	0.272	0.671	14
	PA-4114/1**	Shrub	0.915	2.261	14
	PA-4115/1	Open	0.546	1.350	14
Flat Brook North	NJ-4210/1	Shrub	8.276	20.450	49
	NJ-4210/2	Shrub	9.455	23.361	49
	NJ-4210/3	Shrub	2.848	7.037	50,51
	NJ-4210/4	Shrub	5.338	13.188	50,51
	NJ-4210/5	Forest	7.204	17.800	50,51
	NJ-4211/1*	Forest	9.840	24.314	52
	NJ-4212/1*	Forest	9.840	24.314	52
	NJ-4213/1*	Forest	21.444	53.25	53
	NJ-4213/2*	Shrub	21.444	53.25	53
	NJ-4214/1*	Shrub	5.726	14.148	54
	NJ-4214/2*	Shrub	5.726	14.148	54
	NJ-4215/1	Shrub	3.355	8.288	54

Wetland Group	Survey Point Number*,**,***	Habitat Type	Area		Power Point Slide #
			Hectares	Acres	
Flat Brook South	NJ-4230/1	Open	12.240	30.247	48
	NJ-4230/2	Forest	20.502	50.662	48
Park Headquarters	PA-4050/1*	Forest	6.028	14.895	59
	PA-4050/2*	Forest	6.028	14.895	59
	PA-4051/1*	Shrub	5.716	14.124	15,16
	PA-4051/2*	Shrub	5.716	14.124	15,16
	PA-4052/1*	Open	5.299	13.094	15,16
	PA-4052/2*	Open	5.299	13.094	15,16
	PA-4053/1*	Open	6.222	15.373	17
	PA-4053/2*	Open	6.222	15.373	17
	PA-4054/1*	Open	3.030	7.487	18,19
	PA-4054/2*	Open	3.030	7.487	18,19
	PA-4056/1	Shrub	2.556	6.315	18,19
	PA-4057/1*	Open	4.239	10.477	18,19
	PA-4057/2*	Open	4.239	10.477	18,19
PEEC	PA-4090/1*	Forest	1.263	3.121	60
	PA-4090/1*	Forest	1.162	2.873	60
	PA-4091/1	Shrub	0.644	1.591	20
	PA-4092/1	Shrub	1.907	4.713	21
	PA-4093/1	Open	2.562	6.329	22
	PA-4094/1	Open	1.044	2.579	23
	PA-4095/1	Forest	1.992	4.923	61
	PA-4096/1**	Forest	0.641	1.585	61
Shimers	NJ-4150/1**	Shrub	5.562	13.745	24
	NJ-4150/1**	Shrub	10.063	26.57	24
Sunfish Pond	NJ-4030/1*	Shrub/Forest	7.146	17.658	45
	NJ-4030/2*	Shrub/Forest	7.146	17.658	45
	NJ-4031/1*	Shrub	5.808	14.354	25
	NJ-4031/2*	Shrub	5.808	14.354	25
	NJ-4032/1	Shrub/Forest	5.138	12.698	46
	NJ-4032/2*,**	Shrub/Forest	5.138	12.698	46
	NJ-4032/2*,**	Shrub/Forest	3.523	8.706	46
	NJ-4032/3*,**	Shrub/Forest	5.138	12.698	46
	NJ-4032/3*,**	Shrub/Forest	3.523	8.706	46
Thunder Mountain	NJ-4190/1**	Open	2.613	6.457	34,35
	NJ-4190/1**	Open	13.959	34.491	34,35
	NJ-4190/2*	Open	13.959	34.491	34,35
	NJ-4190/3*	Open	13.959	34.491	34,35
	NJ-4190/4*	Open	13.959	34.491	34,35
	NJ-4191/1	Shrub	3.305	8.168	36
	NJ-4192/1	Open	5.162	12.756	37
	NJ-4193/1	Open	3.700	9.144	38
	NJ-4194/1*,***	Open/Shrub	6.712	16.585	39
	NJ-4194/2*,***	Open/Shrub	6.712	16.585	39
Tom's Creek	PA-4070/1	Forest	0.567	1.400	64
	PA-4071/1**	Forest	5.526	13.654	65
	PA-4071/1**	Forest	3.821	9.442	65
	PA-4072/1	Forest	0.839	2.146	65
	PA-4073/1	Open	1.428	3.528	30,31

Wetland Group	Survey Point Number*,**,***	Habitat Type	Area		Power Point Slide #
			Hectares	Acres	
	PA-4074/1	Open	2.156	5.327	30,31
Tom's Creek (cont)	PA-4078/1	Open	1.161	2.868	30,31
	PA-4075/1**	Forest	1.924	4.754	66
	PA-4075/1**	Forest	1.210	2.991	66
	PA-4076/1	Forest	1.062	2.652	66
	PA-4077/1	Forest	1.664	4.111	67
Tott's Gap	PA-4002/1**	Forest	1.789	4.421	68
	PA-4002/1**	Forest	0.698	1.724	68
	PA-4002/2	Forest	1.789	4.421	68
	PA-4003/1*	Forest	3.906	9.652	69
	PA-4003/2*	Forest	3.906	9.652	69
	PA-4004/1***	Forest	4.695	11.601	70
	PA-4005/1	Open	1.028	2.540	32
	PA-4006/1	Shrub	0.403	0.997	33
	PA-4007/1**	Forest	7.089	17.518	71
Township Ballfield	NJ-4170/1	Open	1.967	4.859	26
	NJ-4171/1	Shrub	3.412	8.433	26
	NJ-4172/1***	Shrub	13.000	32.124	27
	NJ-4172/1***	Shrub	3.049	7.534	27
	NJ-4173/1*	Forest	9.159	22.634	62
	NJ-4173/2*	Forest	9.159	23.634	62
	NJ-4174/1*	Open/Shrub	16.782	41.468	28,29
	NJ-4174/2*,**	Open/Shrub	16.782	41.468	28,29
	NJ-4174/2*,**	Open/Shrub	3.922	9.69	28,29
	NJ-4174/3*,**	Open/Shrub	16.782	41.468	28,29
	NJ-4174/3*,**	Open/Shrub	3.922	9.69	28,29
	NJ-4175/1**	Forest	1.329	3.284	63
	NJ-4175/1**	Forest	0.926	2.289	63

*multiple points in same wetland
**either DEWA Wetland and/or TNC II shapefile used
***either DEWA Wetland and/or TNC I shapefile used

Appendix B. Variable circular plot point count field data sheet.

VARIABLE CIRCULAR PLOT POINT COUNT DATA SHEET
WETLAND BIRD INVENTORY – DELAWARE WATER GAP NATIONAL RECREATION AREA

National Park Service/
East Stroudsburg University

Observers:	JS	Park Code:	DEWA	Wetland #	4095	Type:	FS
Date:	5/23/05	Proj. Code:	WBIVCP	Point #	1	Visit:	1

Start Time: (24hh EST)	EST 0548	*Comments:*							260°
Weather:	Precip: (0-5)	0	Wind: (0-5):	0	Noise (0-5):	0	Temp: (C.)	70	Sky (% cld *or* oc/fog)	50

Inter -val	Spp. Code	Dist. (m.) *or* AR/FO	Det. Type (s/c/v)	Sex (m/f/u)	#	Comments	Location *In*	*Hab*	*Edge*	*Out*	*dir*
0-3	REVI	35	S	m	1	R			✓		
	OVEN	30	S	m	1	B				✓	
	OVEN	40	S	m	1	LF	✓				
	WOTH	45	S	m	1	RF	✓				
	CHSP	30	S	M	1	B				✓	
	SCTA	75	S	m	1	RB				✓	
	REVI	40	S	m	1	L			✓		
	EAPH	90	C	u	1	RF			✓		
3-5	BCCH	25	C/S	m	1	B				✓	
3-5	PIWA	50	S	m	1	B				✓	
	BTGN	40	S	m	1	R				✓	

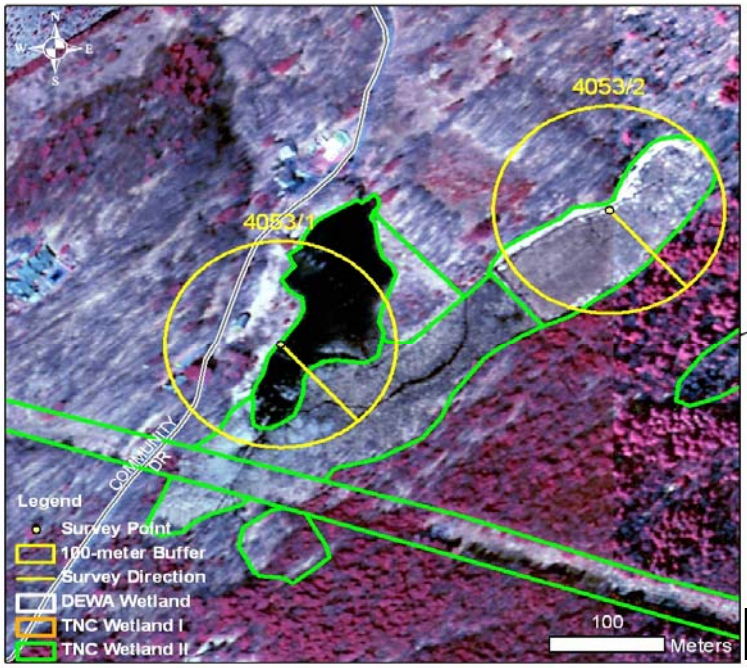
Appendix C. List of species observed.

Number	Common Name	Scientific Name
1	Acadian flycatcher	*Empidonax virescens*
2	alder flycatcher	*Empidonax alnorum*
3	American black duck	*Anas rubripes*
4	American crow	*Corvus brachyrhynchos*
5	American goldfinch	*Carduelis tristis*
6	American redstart	*Setophaga ruticilla*
7	American robin	*Turdus migratorius*
8	American woodcock	*Scolopax minor*
9	Baltimore oriole	*Icterus galbula*
10	barn swallow	*Hirundo rustica*
11	belted kingfisher	*Megaceryle alcyon*
12	black-and-white warbler	*Mniotilta varia*
13	black-billed cuckoo	*Coccyzus erythropthalmus*
14	blackburnian warbler	*Dendroica fusca*
15	black-capped chickadee	*Poecile atricapillus*
16	blackpoll warbler	*Dendroica striata*
17	black-throated green warbler	*Dendroica virens*
18	blue jay	*Cyanocitta cristata*
19	blue-gray gnatcatcher	*Polioptila caerulea*
20	blue-headed vireo	*Vireo solitarius*
21	blue-winged warbler	*Vermivora pinus*
22	broad-winged hawk	*Buteo platypterus*
23	brown creeper	*Certhia americana*
24	brown thrasher	*Toxostoma rufum*
25	brown-headed cowbird	*Molothrus ater*
26	Canada goose	*Branta canadensis*
27	Canada warbler	*Wilsonia canadensis*
28	Carolina wren	*Thryothorus ludovicianus*
29	cedar waxwing	*Bombycilla cedrorum*
30	cerulean warbler	*Dendroica cerulea*
31	chestnut-sided warbler	*Dendroica pensylvanica*
32	chimney swift	*Chaetura pelagica*
33	chipping sparrow	*Spizella passerina*
34	cliff swallow	*Petrochelidon pyrrhonota*
35	common grackle	*Quiscalus quiscula*
36	common merganser	*Mergus merganser*
37	common moorhen	*Gallinula chloropus*
38	common yellowthroat	*Geothlypis trichas*
39	dark-eyed junco	*Junco hyemalis*
40	downy woodpecker	*Picoides pubescens*
41	eastern bluebird	*Sialia sialis*
42	eastern kingbird	*Tyrannus tyrannus*
43	eastern phoebe	*Sayornis phoebe*
44	eastern towhee	*Pipilo erythrophthalmus*
45	eastern wood-pewee	*Contopus virens*
46	field sparrow	*Spizella pusilla*
47	fish crow	*Corvus ossifragus*
48	golden-winged warbler	*Vermivora chrysoptera*
49	gray catbird	*Dumetella carolinensis*

Number	Common Name	Scientific Name
50	great blue heron	*Ardea herodias*
51	great-crested flycatcher	*Myiarchus crinitus*
52	great horned owl	*Bubo virginianus*
53	green heron	*Butorides virescens*
54	hairy woodpecker	*Picoides villosus*
55	hermit thrush	*Catharus guttatus*
56	hooded warbler	*Wilsonia citrina*
57	house wren	*Troglodytes aedon*
58	indigo bunting	*Passerina cyanea*
59	Kentucky warbler	*Oporornis formosus*
60	killdeer	*Charadrius vociferus*
61	least flycatcher	*Empidonax minimus*
62	Louisiana waterthrush	*Seiurus motacilla*
63	mallard	*Anas platyrhynchos*
64	mourning dove	*Zenaida macroura*
65	mute swan	*Cygnus olor*
66	northern cardinal	*Cardinalis cardinalis*
67	northern flicker	*Colaptes auratus*
68	northern parula	*Parula americana*
69	northern waterthrush	*Seiurus noveboracensis*
70	orchard oriole	*Icterus spurius*
71	ovenbird	*Seiurus aurocapilla*
72	pileated woodpecker	*Dryocopus pileatus*
73	pine warbler	*Dendroica pinus*
74	prairie warbler	*Dendroica discolor*
75	purple finch	*Carpodacus purpureus*
76	red-bellied woodpecker	*Melanerpes carolinus*
77	red-breasted nuthatch	*Sitta canadensis*
78	red-eyed vireo	*Vireo olivaceus*
79	red-headed woodpecker	*Melanerpes erythrocephalus*
80	red-shouldered hawk	*Buteo lineatus*
81	red-tailed hawk	*Buteo jamaicensis*
82	red-winged blackbird	*Agelaius phoeniceus*
83	rose-breasted grosbeak	*Pheucticus ludovicianus*
84	northern rough-winged swallow	*Stelgidopteryx serripennis*
85	ruby-throated hummingbird	*Archilochus colubris*
86	ruffed grouse	*Bonasa umbellus*
87	scarlet tanager	*Piranga olivacea*
88	sharp-shinned hawk	*Accipiter striatus*
89	song sparrow	*Melospiza melodia*
90	swamp sparrow	*Melospiza georgiana*
91	tree swallow	*Tachycineta bicolor*
92	tufted titmouse	*Baeolophus bicolor*
93	veery	*Catharus fuscescens*
94	Virginia rail	*Rallus limicola*
95	warbling vireo	*Vireo gilvus*
96	white-breasted nuthatch	*Sitta carolinensis*
97	willow flycatcher	*Empidonax traillii*
98	wood duck	*Aix sponsa*
99	wood thrush	*Hylocichla mustelina*
100	worm-eating warbler	*Helmitheros vermivorum*

Number	Common Name	Scientific Name
102	yellow warbler	*Dendroica petechia*
103	yellow-billed cuckoo	*Coccyzus americanus*
104	yellow-breasted chat	*Icteria virens*
105	yellow-rumped warbler	*Dendroica coronata*
106	yellow-throated vireo	*Vireo flavifrons*
	Wetland Species Detected Only with CD Playback	
107	sora	*Porzana carolina*
	Species Detected Beyond Surveyed Wetlands	
108	wild turkey	*Meleagris gallopavo*
109	whip-poor-will	*Caprimulgus vociferous*
110	common raven	*Corvus corax*
111	magnolia warbler	*Dendroica magnolia*
112	black-throated blue warbler	*Dendroica caerulescens*

Appendix D. Sample slide from Wetland Power Point Program.



Group: Headquarters Wetland HQ 4

Point-scale Attributes

	Point no.* 4053/1	4053/2
Richness	19 (3)	19 (3)
Diversity	2.81 (3)	2.87 (3)

*Value (Quartile rank)

both Marsh Bird CD playback points

both points used in edge analysis

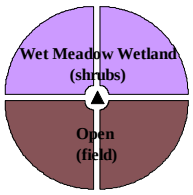
Wetland-scale Attributes

Unit	Wetland Type	Standing Dead Timber	Habitat Group
HQ4	Open	Absent	multipoint: 4053/1 emergent, little interior shrub; 4053/2 emergent, little interior shrub, portion dense shrub-scrub

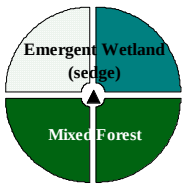
Guild	Species	# detections[1] Point number: 4053/1	4053/2
Aerial	Barn Swallow	1	
Edge	Baltimore Oriole	1	
	Cedar Waxwing	3	
	Chipping Sparrow	1	
	Eastern Kingbird	P	
	Eastern Phoebe	P	
	Least Flycatcher		1
	Mourning Dove	P	
	Northern Flicker	1	
	Warbling Vireo	1	
Forest	American Redstart		1
	Black-and-white Warbler		1
	Black-billed Cuckoo	1	
	Blackburnian Warbler		1
	Blue-gray Gnatcatcher	1	
	Great Crested Flycatcher		1
	Northern Parula	P	
	Ovenbird		1
	Red-eyed Vireo	1	2
	Scarlet Tanager		1
	Veery		1
	Yellow-throated Vireo		1
Open[2]	Common Grackle	2	1
	Red-winged Blackbird	4	3
	Swamp Sparrow	2	2
	Tree Swallow	3	
	Virginia Rail		P
Shrub	Alder Flycatcher	1	
	Common Yellowthroat	2	1
	Gray Catbird		1
	Indigo Bunting	1	
	Northern Cardinal		1
	Song Sparrow	2	1
	Willow Flycatcher	1	1
	Yellow Warbler	3	1

[1] Max detected for both years; P = present after count.
[2] Wet meadows, marshes, and standing dead timber swamps.
Species of interest.

Habitat Composition



Habitat Composition



DEWA_WBI_photos\Park Headquarters\HQ4

Appendix E. Habitat composition field data sheet.

Date	Wetland	Point
7/7/05	4070	1

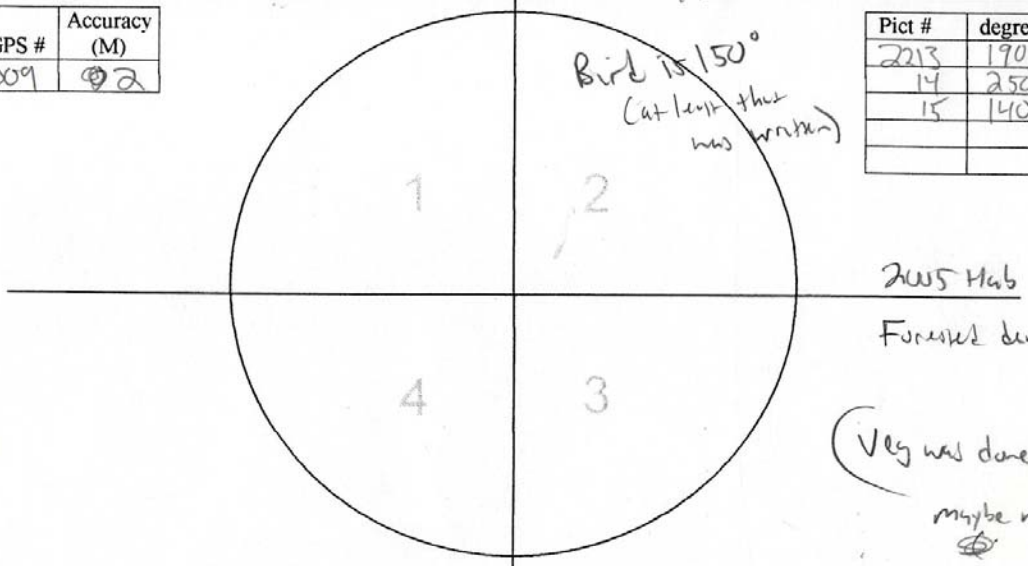
Bearing: 150° – should be 190°

Observer(s): JS

DGPS #	Accuracy (M)
009	2

Pict #	degree
2213	190
14	250
15	140

Bird is 150° (at least that was written)



2005 Hab

Forested dense shrub

(Veg was done w/ 190°)

maybe not

Quad 1 (left front)		Quad 2 (right front)		Quad 3 (right back)		Quad 4 (left back)	
Habitat	%	Habitat	%	Habitat	%	Habitat	%
DFSS	20	DFSS	40	DF dry	100	DF dry	100
DF dry	80	DF dry	60				
DF in SS simp	20%	DF in SS simp	40	DF	100%	DF	100%
DF	80%	DF	60				

Appendix F. Metadata.

dewa_wbi_points

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: J. Sheehan
Originator: T. Master
Publication_Date: 20100201
Title:
dewa_wbi_points
Geospatial_Data_Presentation_Form: vector digital data
Publication_Information:
Publication_Place: East Stroudsburg, PA
Publisher: Dept. of Biological Sciences, East Stroudsburg University
Online_Linkage:
Description:
Abstract:
This point shapefile was created by collecting with a global positioning system (GPS) device the coordinates of the point count stations surveyed for wetland birds of the Delaware Water Gap National Recreation Area (DEWA).
Purpose:
To represent the point count stations located in the
wetlands of DEWA surveyed by the 2004-2005 wetland bird inventory.
Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 2004
Ending_Date: 2005
Currentness_Reference:
ground condition
Status:
Progress: Complete
Maintenance_and_Update_Frequency: None planned
Spatial_Domain:

Bounding_Coordinates:
West_Bounding_Coordinate: -75.165440
East_Bounding_Coordinate: -74.787633
North_Bounding_Coordinate: 41.313359
South_Bounding_Coordinate: 40.944290
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: birds (Aves)
Theme_Keyword: wetland
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: Terry L. Master
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:
Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 2; ESRI ArcCatalog 9.2.2.1350

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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:

All of the avian point count stations surveyed by the wetland bird inventory are represented in this dataset.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
Using a differentially corrected GPS device, all point count station locations are deemed to be accurate to within 10 meters of the true location.
Lineage:
Process_Step:
Process_Description:
Following GPS data collection, coordinates were downloaded and within a Geographic Information System were mapped and attributes related to the wetland bird inventory added.
Process_Date: 2006

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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: 104

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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: 0.000000
Ordinate_Resolution: 0.000000
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

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Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: dewa_wbi_points
Entity_Type_Definition:
Shapefile Attribute 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: GROUP
Attribute_Definition:
Which of the 14 survey groups the point is located in.
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: WETLAND
Attribute_Definition:
Which of the 77 wetland units the point is contained in.
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: PTYPE
Attribute_Definition:

Whether the point is located in a wetland containing a single or multiple survey points (up to 4 to a wetland).
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: WETLPT_NO
Attribute_Definition:
Unique point identifier created by concatenating WETL_NO and PT_NO that can be linked to TBL_WetlandPoints in DEWA_WBI.mdb.
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: WETL_NO
Attribute_Definition:
Numerical wetland identifier initially determined during project set up
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: PT_NO
Attribute_Definition:
Numerical point identifier initially determined within a wetland during project set up
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: MODEL
Attribute_Definition:
Garmin GPS device model used.
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: GPS_TIME
Attribute_Definition:
Time of GPS data collection.
Attribute_Definition_Source:
GPS supplied
Attribute:
Attribute_Label: GPS_DATE
Attribute_Definition:
Date of GPS data collection.
Attribute_Definition_Source:
GPS supplied
Attribute:
Attribute_Label: X
Attribute_Definition:
UTM NAD 83 x-coordinate
Attribute_Definition_Source:

GIS calculation
Attribute:
Attribute_Label: Y
Attribute_Definition:
UTM NAD 83 y-coordinate
Attribute_Definition_Source:
GIS calculation
Attribute:
Attribute_Label: LON_DD
Attribute_Definition:
Longitude in decimal degrees
Attribute_Definition_Source:
GIS calculation
Attribute:
Attribute_Label: LAT_DD
Attribute_Definition:
Latitude in decimal degrees
Attribute_Definition_Source:
GIS calculation
Attribute:
Attribute_Label: AZ_TRUE
Attribute_Definition:
Bearing (true) that observer faced when collecting bird observations.
Attribute_Definition_Source:
Project supplied

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Distribution_Information:
Distributor:
Contact_Information:
Contact_Person_Primary:
Contact_Person:
Contact_Organization:
Contact_Address:
Address_Type:
Address:
City:
State_or_Province:
Postal_Code:
Country:
Contact_Voice_Telephone:
Resource_Description: Downloadable Data
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Transfer_Size: 0.223

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Metadata_Reference_Information:
Metadata_Date: 20100201
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: T. Master
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
Country: USA
Contact_Voice_Telephone: 570-422-3709
Contact_Electronic_Mail_Address: Terry.Master@po-box.esu.edu
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Extensions:
Online_Linkage: http://www.esri.com/metadata/esriprof80.html
Profile_Name: ESRI Metadata Profile

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dewa_wbi_wetlands

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: J. Sheehan
Originator: T. Master
Publication_Date: 20100201
Title:

dewa_wbi_wetlands
Geospatial_Data_Presentation_Form: vector digital data
Publication_Information:
Publication_Place: East Stroudsburg, PA
Publisher: Dept. of Biological Sciences, East Stroudsburg University
Online_Linkage:
Description:
Abstract:
This polygon shapefile was created by overlay of three separate vector sources of wetlands of the Delaware Water Gap National Recreation Area (DEWA) on the latest DEWA orthophotography and selecting features from them as necessary to best represent the wetlands surveyed by the inventory of wetland birds. This should be considered an initial representation requiring field verification or additional spatial data sources as the overlay resulted in gaps and overlaps in the polygons representing these wetlands; therefore area calculations would be inaccurate and were not performed. For each polygon the attribute table contains the vector source and associated information, and identifies which of the 77 wetland units it is a part of and the associated wetland unit information: the number of bird survey points it contains and which of the fourteen survey groups it was assigned to for conducting the bird surveys.
Purpose:
To represent, classify and obtain spatial data on thewetlands of DEWA surveyed by the 2004-2005 wetland bird inventory
Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 2004
Ending_Date: 2005
Currentness_Reference:
ground condition
Status:
Progress: Complete
Maintenance_and_Update_Frequency: None planned
Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -75.166201
East_Bounding_Coordinate: -74.778388
North_Bounding_Coordinate: 41.324222
South_Bounding_Coordinate: 40.943934
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: birds (Aves)
Theme_Keyword: wetland
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: Terry L. Master
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:
Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 2; ESRI ArcCatalog 9.2.2.1350

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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 wetlands in this dataset do not comprise all of the current wetland habitat within DEWA. However, the most significant wetlands and wetland complexes are believed to be represented here along with a subsample of smaller isolated ones.
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 wetlands boundaries apparent on the orthophotography when wetlands are distinctly visible. For these and other wetlands not so easily visible (i.e. forested wetlands within upland forest), field observations can also support boundary determination in most cases.
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 wetland boundaries.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Markhurd, Inc.
Publication_Date: 1992
Title:
Unpublished dataset: original digitized wetland boundaries of DEWA
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: wetlands.shp
Type_of_Source_Media: CD-ROM
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1992
Source_Currentness_Reference:
ground condition
Source_Citation_Abbreviation:
wetland boundary delineation, pre_tnc

Source_Contribution:
Original wetland shapefile used to select wetlands for inventory. Provided polygons and associated attribute information for wetlands surveyed in part; that were combined with the two other wetland vector sources as needed to create this shapefile.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Pennsylvania Natural Heritage Program/The Nature Conservancy
Publication_Date: 2003
Title:
Unpublished dataset: draft 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:
draft land use classification, tnc_I
Source_Contribution:
Initial classification of dewa_all_orthos_match.sid. Provided polygons and associated attribute information for wetlands surveyed in part; that were combined with the two other wetland vector sources as needed to create this shapefile.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Pennsylvania Natural Heritage Program/The Nature Conservancy
Publication_Date: 2006
Title:
Unpublished dataset: final 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: dewa_veg_assoc_0609.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:
final land use classification, tnc_II
Source_Contribution:
Final classification of dewa_all_orthos_match.sid. Provided polygons and associated attribute information for wetlands surveyed in part; that were combined with the two other wetland vector sources as needed to create this shapefile.
Process_Step:
Process_Description:
Three sources of polygons representing the wetlands of DEWA were overlaid on the latest available DEWA orthophotography. Polygons from each source were selected on the basis of how well they appeared to represent the wetlands surveyed by the inventory. If sources provided identical boundaries (or nearly so), the default was to select the polygon from the final land use classification (tnc_II). The additional wetland boundary sources were used to supplement the tnc II polygon if they provided additional features within or associated with the polygon. In a few cases, the tnc_II polygon was deemed inaccurate in delineating boundaries or classifying the habitat and one or both of the other sources were used. No attempt was made to individually field-truth the accuracy of the habitat classification per polygon from any of the sources, however.

Multiple polygons were selected to represent many of the wetlands surveyed. If obtained from different sources, this could result in overlapping features with attendant difficulties in representing spatial variables (e.g. area, perimeter, shape) on a per wetland basis. Also, in the case of wetland complexes comprised of multiple habitat types, it was not always possible to discretely separate wetlands into the units named by the inventory as surveyed wetlands. Due to these difficulties and the lack of field verification of the selected polygon's habitat classifications, this shapefile should be considered as an initial representation of the wetlands surveyed by the inventory. It does provide an important look into the complexity of DEWA wetlands, however, and when considered in the context of the bird information collected at these wetlands should serve an important management and research function.
Process_Date: 2006
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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: 218
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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: 0.000000
Ordinate_Resolution: 0.000000
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

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Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: dewa_wbi_wetlands
Entity_Type_Definition:
Shapefile Attribute 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: GROUP
Attribute_Definition:
Which of the 14 survey groups the feature is a part of.
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: WETLAND
Attribute_Definition:
Which of the 77 wetland units the feature is a part of.
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: UNIQID
Attribute_Definition:
Unique row identifier created by concatenating WETLAND, DATA_SRC, and SRCID.
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: PTYPE
Attribute_Definition:
Whether wetland contains single or multiple bird survey points (up to 4 to a wetland)
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: WETCMT
Attribute_Definition:
Miscellaneous comments about the feature's spatial relationship to other features (e.g., connectivity).
Attribute_Definition_Source:
Project supplied
Attribute:
Attribute_Label: DATA_SRC
Attribute_Definition:
Which of the three vector sources of digitized wetland boundaries the feature was derived from.
Attribute_Definition_Source:
Project supplied
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: pre_tnc

Enumerated_Domain_Value_Definition:
original DEWA wetland shapefile
Enumerated_Domain:
Enumerated_Domain_Value: tnc_I
Enumerated_Domain_Value_Definition:
draft habitat classification of latest DEWA orthophoto
Enumerated_Domain:
Enumerated_Domain_Value: tnc_II
Enumerated_Domain_Value_Definition:
final habitat classification of latest DEWA orthophoto
Attribute:
Attribute_Label: LOCAL_NAME
Attribute_Definition:
tnc_II feature description
Attribute_Definition_Source:
dewa_veg_assoc_0609.shp
Attribute:
Attribute_Label: FORMATION
Attribute_Definition:
tnc_II and I detailed feature description
Attribute_Definition_Source:
dewa_veg_assoc_0609.shp, veg_draft_formation.shp
Attribute:
Attribute_Label: LABEL
Attribute_Definition:
pre-tnc wetland shapefile feature description
Attribute_Definition_Source:
wetlands.shp
Attribute:
Attribute_Label: SRCID
Attribute_Definition:
Identifier for shapefile feature extracted from the vector source.
Attribute_Definition_Source:
dewa_veg_assoc_0609.shp, veg_draft_formation.shp, wetlands.shp
Attribute:
Attribute_Label: WETL_N
Attribute_Definition:
Link to TBL_Wetlands in DEWA_WBI.mdb.
Attribute_Definition_Source:
Project supplied

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Distribution_Information:
Distributor:
Contact_Information:
Contact_Person_Primary:

Contact_Person:
Contact_Organization:
Contact_Address:
Address_Type:
Address:
City:
State_or_Province:
Postal_Code:
Country:
Contact_Voice_Telephone:
Resource_Description: Downloadable Data
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Transfer_Size: 0.223

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Metadata_Reference_Information:
Metadata_Date: 20100201
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: T. Master
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
Country: USA
Contact_Voice_Telephone: 570-422-3709
Contact_Electronic_Mail_Address: Terry.Master@po-box.esu.edu
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Extensions:
Online_Linkage: http://www.esri.com/metadata/esriprof80.html
Profile_Name: ESRI Metadata Profile
Metadata_Extensions:
Online_Linkage: http://www.esri.com/metadata/esriprof80.html
Profile_Name: ESRI Metadata Profile

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Appendix G. Digital photo listing.

Photo Name	Point	Photo Number	Date/Time	Bearing	Direction
Catfish Pond					
CP_4270_1_f45.jpg	4270/1	P0001829.jpg	7/8/04 10:36	45	f
CP_4270_1_lb280.jpg	4270/1	P0001830.jpg	7/8/04 10:37	280	lb
CP_4270_1_r90.jpg	4270/1	P0001831.jpg	7/8/04 10:37	90	r
CP_4271_1_f330.jpg	4271/1	P0001826.jpg	7/8/04 10:03	330	f
CP_4271_1_l240.jpg	4271/1	P0001828.jpg	7/8/04 10:04	240	l
CP_4271_1_r40.jpg	4271/1	P0001827.jpg	7/8/04 10:04	40	r
CP_4272_2_f30.jpg	4272/2	P0001820.jpg	7/8/04 9:03	30	f
CP_4272_2_l280.jpg	4272/2	P0001822.jpg	7/8/04 9:03	280	l
CP_4272_2_r90.jpg	4272/2	P0001821.jpg	7/8/04 9:03	90	r
CP_4272_1_f350.jpg	4272/1	P0001823.jpg	7/8/04 9:14	350	f
CP_4272_1_l270.jpg	4272/1	P0001824.jpg	7/8/04 9:14	270	l
CP_4272_1_r90.jpg	4272/1	P0001825.jpg	7/8/04 9:14	90	r
CP_4273_1_f160.jpg	4273/1	P0001940.jpg	8/1/04 11:12	160	f
CP_4273_1_l70.jpg	4273/1	P0001942.jpg	8/1/04 11:13	70	l
CP_4273_1_r250.jpg	4273/1	P0001941.jpg	8/1/04 11:13	250	r
CP_4275_1_b190.jpg	4275/1	P0001816.jpg	7/8/04 8:03	190	b
CP_4275_1_f350.jpg	4275/1	P0001813.jpg	7/8/04 8:02	350	f
CP_4275_1_l270.jpg	4275/1	P0001815.jpg	7/8/04 8:03	270	l
CP_4275_1_r70.jpg	4275/1	P0001814.jpg	7/8/04 8:02	70	r
CP_4274_1_f290.jpg	4274/1	P0001817.jpg	7/8/04 8:20	290	f
CP_4274_1_l220.jpg	4274/1	P0001818.jpg	7/8/04 8:20	220	l
CP_4274_1_r10.jpg	4274/1	P0001819.jpg	7/8/04 8:21	10	r
Conashaugh					
CO_4130_1_b.jpg	4130/1	P0002164.jpg	6/18/05 7:37	140	b
CO_4130_1_f40.jpg	4130/1	P0002163.jpg	6/18/05 7:37	40	f
CO_4130_1_l.jpg	4130/1	P0002166.jpg	6/18/05 7:38	320	l
CO_4130_1_r.jpg	4130/1	P0002165.jpg	6/18/05 7:37	230	r
CO_4131_1_f250.jpg	4131/1	P0002160.jpg	6/18/05 7:09	250	f
CO_4131_1_l.jpg	4131/1	P0002162.jpg	6/18/05 7:10	170	l
CO_4131_1_r.jpg	4131/1	P0002161.jpg	6/18/05 7:09	350	r
CO_4132_1_b.jpg	4132/1	P0002189.jpg	6/27/05 14:42	310	b
CO_4132_1_f120.jpg	4132/1	P0002186.jpg	6/27/05 14:41	120	f
CO_4132_1_l.jpg	4132/1	P0002188.jpg	6/27/05 14:41	40	l
CO_4132_1_r.jpg	4132/1	P0002187.jpg	6/27/05 14:41	230	r
CO_4133_1_b.jpg	4133/1	P0002184.jpg	6/27/05 14:22	280	b
CO_4133_1_f40.jpg	4133/1	P0002182.jpg	6/27/05 14:22	40	f
CO_4133_1_l.jpg	4133/1	P0002183.jpg	6/27/05 14:22	130	l
CO_4133_1_r.jpg	4133/1	P0002185.jpg	6/27/05 14:22	310	r

Photo Name	Point	Photo Number	Date/Time	Bearing	Direction
CO_4135_1_f300.jpg	4135/1	P0002176.jpg	6/27/05 13:43	300	f
CO_4135_1_l.jpg	4135/1	P0002177.jpg	6/27/05 13:43	30	l
CO_4135_1_r.jpg	4135/1	P0002178.jpg	6/27/05 13:43	250	r
CO_4134_1_f120.jpg	4134/1	P0002181.jpg	6/27/05 14:05	120	f
CO_4134_1_l.jpg	4134/1	P0002180.jpg	6/27/05 14:04	50	l
CO_4134_1_r.jpg	4134/1	P0002179.jpg	6/27/05 14:04	210	r
CO_4136_1_f330.jpg	4136/1	P0002173.jpg	6/27/05 13:21	330	f
CO_4136_1_l.jpg	4136/1	P0002175.jpg	6/27/05 13:22	240	l
CO_4136_1_r.jpg	4136/1	P0002174.jpg	6/27/05 13:22	60	r
Crater Lake					
CL_4250_1_f150.jpg	4250/1	P0001754.jpg	7/1/04 6:14	150	f
CL_4250_1_l60.jpg	4250/1	P0001755.jpg	7/1/04 6:14	60	l
CL_4250_1_r240.jpg	4250/1	P0001756.jpg	7/1/04 6:15	240	r
CL_4251_1_b40.jpg	4251/1	P0001753.jpg	7/1/04 5:37	40	b
CL_4251_1_f180.jpg	4251/1	P0001750.jpg	7/1/04 5:35	180	f
CL_4251_1_l90.jpg	4251/1	P0001751.jpg	7/1/04 5:36	90	l
CL_4251_1_r230.jpg	4251/1	P0001752.jpg	7/1/04 5:36	230	r
CL_4256_1_f160.jpg	4256/1	P0002259.jpg	9/1/05 11:40	160	f
CL_4256_1_l.jpg	4256/1	P0002261.jpg	9/1/05 11:40	70	l
CL_4256_1_r.jpg	4256/1	P0002260.jpg	9/1/05 11:40	240	r
CL_4252_1_f340.jpg	4252/1	P0001757.jpg	7/1/04 7:10	340	f
CL_4252_1_l270.jpg	4252/1	P0001758.jpg	7/1/04 7:11	270	l
CL_4252_1_r60.jpg	4252/1	P0001759.jpg	7/1/04 7:11	60	r
CL_4253_1_f190.jpg	4253/1	P0001760.jpg	7/1/04 8:03	190	f
CL_4253_1_l120.jpg	4253/1	P0001763.jpg	7/1/04 8:04	120	l
CL_4253_1_lf150.jpg	4253/1	P0001764.jpg	7/1/04 8:06	150	lf
CL_4253_1_r310.jpg	4253/1	P0001762.jpg	7/1/04 8:04	310	r
CL_4253_1_rf240.jpg	4253/1	P0001761.jpg	7/1/04 8:04	240	rf
CL_4254_1_f30.jpg	4254/1	P0001767.jpg	7/2/04 6:42	30	f
CL_4254_1_l320.jpg	4254/1	P0001769.jpg	7/2/04 6:42	320	l
CL_4254_1_r120.jpg	4254/1	P0001768.jpg	7/2/04 6:42	120	r
CL_4255_1_f130.jpg	4255/1	P0001770.jpg	7/2/04 7:15	130	f
CL_4255_1_l65.jpg	4255/1	P0001774.jpg	7/2/04 7:17	65	l
CL_4255_1_lf105.jpg	4255/1	P0001773.jpg	7/2/04 7:17	105	lf
CL_4255_1_r220.jpg	4255/1	P0001772.jpg	7/2/04 7:16	220	r
CL_4255_1_rf180.jpg	4255/1	P0001771.jpg	7/2/04 7:16	180	rf
Dingmans					
DG_4110_1_b.jpg	4110/1	P0002121.jpg	5/27/05 15:44	180	b
DG_4110_1_f360.jpg	4110/1	P0002119.jpg	5/27/05 15:43	360	f
DG_4110_1_l.jpg	4110/1	P0002122.jpg	5/27/05 15:44	280	l
DG_4110_1_r.jpg	4110/1	P0002120.jpg	5/27/05 15:43	110	r

Photo Name	Point	Photo Number	Date/Time	Bearing	Direction
DG_4111_1_f230.jpg	4111/1	P0002108.jpg	5/27/05 13:34	230	f
DG_4111_1_l.jpg	4111/1	P0002109.jpg	5/27/05 13:34	170	l
DG_4111_1_r.jpg	4111/1	P0002110.jpg	5/27/05 13:34	320	r
DG_4112_1_f105.jpg	4112/1	P0002111.jpg	5/27/05 13:53	105	f
DG_4112_1_l.jpg	4112/1	P0002112.jpg	5/27/05 13:53	210	l
DG_4112_1_r.jpg	4112/1	P0002113.jpg	5/27/05 13:53	20	r
DG_4113_1_f290.jpg	4113/1	P0002105.jpg	5/27/05 13:14	290	f
DG_4113_1_l.jpg	4113/1	P0002106.jpg	5/27/05 13:14	220	l
DG_4113_1_r.jpg	4113/1	P0002107.jpg	5/27/05 13:14	40	r
DG_4114_1_f330.jpg	4114/1	P0002116.jpg	5/27/05 14:25	330	f
DG_4114_1_l.jpg	4114/1	P0002114.jpg	5/27/05 14:25	240	l
DG_4114_1_r.jpg	4114/1	P0002115.jpg	5/27/05 14:25	60	r
DG_4115_1_b.jpg	4115/1	P0002118.jpg	5/27/05 14:48	40	b
DG_4115_1_f220.jpg	4115/1	P0002117.jpg	5/27/05 14:48	220	f
Flat Brook North					
FN_4210_1_b140.jpg	4210/1	P0001929.jpg	7/30/04 15:10	140	b
FN_4210_1_f300.jpg	4210/1	P0001927.jpg	7/30/04 15:09	300	f
FN_4210_1_l200.jpg	4210/1	P0001928.jpg	7/30/04 15:10	200	l
FN_4210_1_r30.jpg	4210/1	P0001930.jpg	7/30/04 15:11	30	r
FN_4210_2_b110.jpg	4210/2	P0001925.jpg	7/30/04 14:43	110	b
FN_4210_2_f300.jpg	4210/2	P0001923.jpg	7/30/04 14:43	300	f
FN_4210_2_l180.jpg	4210/2	P0001924.jpg	7/30/04 14:43	180	l
FN_4210_2_r10.jpg	4210/2	P0001926.jpg	7/30/04 14:44	10	r
FN_4210_3_b70.jpg	4210/3	P0001915.jpg	7/30/04 13:12	70	b
FN_4210_3_f260.jpg	4210/3	P0001912.jpg	7/30/04 13:11	260	f
FN_4210_3_l170.jpg	4210/3	P0001914.jpg	7/30/04 13:12	170	l
FN_4210_3_r350.jpg	4210/3	P0001913.jpg	7/30/04 13:11	350	r
FN_4210_4_f130.jpg	4210/4	P0001920.jpg	7/30/04 14:00	130	f
FN_4210_4_l40.jpg	4210/4	P0001922.jpg	7/30/04 14:01	40	l
FN_4210_4_r180.jpg	4210/4	P0001921.jpg	7/30/04 14:01	180	r
FN_4210_5_b150.jpg	4210/5	P0001918.jpg	7/30/04 13:37	150	b
FN_4210_5_f320.jpg	4210/5	P0001916.jpg	7/30/04 13:36	320	f
FN_4210_5_l250.jpg	4210/5	P0001919.jpg	7/30/04 13:37	250	l
FN_4210_5_r60.jpg	4210/5	P0001917.jpg	7/30/04 13:37	60	r
FN_4211_1_f130.jpg	4211/1	P0001909.jpg	7/30/04 12:16	130	f
FN_4211_1_l60.jpg	4211/1	P0001910.jpg	7/30/04 12:17	60	l
FN_4211_1_r190.jpg	4211/1	P0001911.jpg	7/30/04 12:17	190	r
FN_4212_1_f140.jpg	4212/1	P0001906.jpg	7/30/04 12:03	140	f
FN_4212_1_l50.jpg	4212/1	P0001907.jpg	7/30/04 12:04	50	l
FN_4212_1_r230.jpg	4212/1	P0001908.jpg	7/30/04 12:04	230	r
FN_4213_1_b160.jpg	4213/1	P0001902.jpg	7/30/04 11:24	160	b
FN_4213_1_f330.jpg	4213/1	P0001904.jpg	7/30/04 11:26	330	f
FN_4213_1_l270.jpg	4213/1	P0001903.jpg	7/30/04 11:25	270	l

Photo Name	Point	Photo Number	Date/Time	Bearing	Direction
FN_4213_1_r60.jpg	4213/1	P0001905.jpg	7/30/04 11:26	60	r
FN_4213_2_b165.jpg	4213/2	P0001898.jpg	7/30/04 11:05	165	b
FN_4213_2_f340.jpg	4213/2	P0001896.jpg	7/30/04 11:04	340	f
FN_4213_2_l240.jpg	4213/2	P0001897.jpg	7/30/04 11:05	240	l
FN_4213_2_r45.jpg	4213/2	P0001899.jpg	7/30/04 11:05	45	r
FN_4214_1_f50.jpg	4214/1	P0001893.jpg	7/30/04 10:38	50	f
FN_4214_1_l330.jpg	4214/1	P0001894.jpg	7/30/04 10:39	330	l
FN_4214_1_r180.jpg	4214/1	P0001895.jpg	7/30/04 10:39	180	r
FN_4214_2_f200.jpg	4214/2	P0001890.jpg	7/30/04 10:20	200	f
FN_4214_2_l120.jpg	4214/2	P0001891.jpg	7/30/04 10:20	120	l
FN_4214_2_r280.jpg	4214/2	P0001892.jpg	7/30/04 10:21	280	r
FN_4215_1_f50.jpg	4215/1	P0001887.jpg	7/30/04 9:55	50	f
FN_4215_1_l315.jpg	4215/1	P0001888.jpg	7/30/04 9:56	315	l
FN_4215_1_r240.jpg	4215/1	P0001889.jpg	7/30/04 9:56	240	r
Flat Brook South					
FS_4230_2_b130.jpg	4230/2	P0001945.jpg	8/1/04 12:07	130	b
FS_4230_2_f300.jpg	4230/2	P0001943.jpg	8/1/04 12:06	300	f
FS_4230_2_l220.jpg	4230/2	P0001946.jpg	8/1/04 12:07	220	l
FS_4230_2_r40.jpg	4230/2	P0001944.jpg	8/1/04 12:06	40	r
FS_4230_1_f330.jpg	4230/1	P0001947.jpg	8/1/04 12:33	330	f
FS_4230_1_l260.jpg	4230/1	P0001949.jpg	8/1/04 12:33	260	l
FS_4230_1_r70.jpg	4230/1	P0001948.jpg	8/1/04 12:33	70	r
Park Headquarters					
HQ_4050_1_f0.jpg	4050/1	P0001866.jpg	7/26/04 8:56	0	f
HQ_4050_1_l300.jpg	4050/1	P0001867.jpg	7/26/04 8:56	300	l
HQ_4050_1_r60.jpg	4050/1	P0001868.jpg	7/26/04 8:57	60	r
HQ_4050_2_f150.jpg	4050/2	P0001869.jpg	7/26/04 9:19	150	f
HQ_4050_2_l90.jpg	4050/2	P0001870.jpg	7/26/04 9:20	90	l
HQ_4050_2_r270.jpg	4050/2	P0001871.jpg	7/26/04 9:20	270	r
HQ_4051_1_f0.jpg	4051/1	P0001832.jpg	7/22/04 8:19	0	f
HQ_4051_1_l270.jpg	4051/1	P0001833.jpg	7/22/04 8:19	270	l
HQ_4051_1_r90.jpg	4051/1	P0001834.jpg	7/22/04 8:20	90	r
HQ_4051_2_f230.jpg	4051/2	P0001835.jpg	7/22/04 8:49	230	f
HQ_4051_2_l100.jpg	4051/2	P0001836.jpg	7/22/04 8:50	100	l
HQ_4051_2_r245.jpg	4051/2	P0001837.jpg	7/22/04 8:51	245	r
HQ_4052_1_f160.jpg	4052/1	P0001838.jpg	7/22/04 9:21	160	f
HQ_4052_1_l59.jpg	4052/1	P0001839.jpg	7/22/04 9:22	59	l
HQ_4052_1_r235.jpg	4052/1	P0001841.jpg	7/22/04 9:24	235	r
HQ_4052_2_f200.jpg	4052/2	P0001842.jpg	7/22/04 9:46	200	f
HQ_4052_2_l95.jpg	4052/2	P0001843.jpg	7/22/04 9:46	95	l
HQ_4052_2_r260.jpg	4052/2	P0001844.jpg	7/22/04 9:46	260	r
HQ_4053_1_f150.jpg	4053/1	P0001845.jpg	7/22/04 10:12	150	f
HQ_4053_1_l75.jpg	4053/1	P0001846.jpg	7/22/04 10:12	75	l

Photo Name	Point	Photo Number	Date/Time	Bearing	Direction
HQ_4053_1_r215.jpg	4053/1	P0001847.jpg	7/22/04 10:13	215	r
HQ_4053_2_f180.jpg	4053/2	P0001848.jpg	7/22/04 10:33	180	f
HQ_4053_2_l90.jpg	4053/2	P0001849.jpg	7/22/04 10:33	90	l
HQ_4053_2_r250.jpg	4053/2	P0001850.jpg	7/22/04 10:34	250	r
HQ_4054_1_f175.jpg	4054/1	P0001851.jpg	7/22/04 10:51	175	f
HQ_4054_1_l90.jpg	4054/1	P0001852.jpg	7/22/04 10:51	90	l
HQ_4054_1_r265.jpg	4054/1	P0001853.jpg	7/22/04 10:52	265	r
HQ_4054_2_f150.jpg	4054/2	P0001854.jpg	7/22/04 11:10	150	f
HQ_4054_2_l80.jpg	4054/2	P0001855.jpg	7/22/04 11:11	80	l
HQ_4054_2_r260.jpg	4054/2	P0001856.jpg	7/22/04 11:11	260	r
HQ_4056_1_f0.jpg	4056/1	P0001857.jpg	7/23/04 10:50	0	f
HQ_4056_1_l250.jpg	4056/1	P0001858.jpg	7/23/04 10:51	250	l
HQ_4056_1_r60.jpg	4056/1	P0001859.jpg	7/23/04 10:51	60	r
HQ_4057_1_f160.jpg	4057/1	P0001860.jpg	7/23/04 11:12	160	f
HQ_4057_1_l90.jpg	4057/1	P0001861.jpg	7/23/04 11:13	90	l
HQ_4057_1_r240.jpg	4057/1	P0001862.jpg	7/23/04 11:13	240	r
HQ_4057_2_f150.jpg	4057/2	P0001863.jpg	7/23/04 11:27	150	f
HQ_4057_2_l70.jpg	4057/2	P0001864.jpg	7/23/04 11:27	70	l
HQ_4057_2_r240.jpg	4057/2	P0001865.jpg	7/23/04 11:28	240	r
PEEC					
PC_4090_1_f340.jpg	4090/1	P0002294.jpg	9/2/05 8:26	340	f
PC_4090_1_l.jpg	4090/1	P0002296.jpg	9/2/05 8:27	240	l
PC_4090_1_r.jpg	4090/1	P0002295.jpg	9/2/05 8:27	60	r
PC_4091_1_b.jpg	4091/1	P0002292.jpg	9/2/05 8:04	270	b
PC_4091_1_f90.jpg	4091/1	P0002290.jpg	9/2/05 8:04	90	f
PC_4091_1_l.jpg	4091/1	P0002293.jpg	9/2/05 8:04	15	l
PC_4091_1_r.jpg	4091/1	P0002291.jpg	9/2/05 8:04	180	r
PC_4092_1_f140.jpg	4092/1	P0002286.jpg	9/2/05 7:34	140	f
PC_4092_1_l.jpg	4092/1	P0002289.jpg	9/2/05 7:35	70	l
PC_4092_1_misc.jpg	4092/1	P0002288.jpg	9/2/05 7:35	270	misc
PC_4092_1_r.jpg	4092/1	P0002287.jpg	9/2/05 7:34	210	r
PC_4093_1_f200.jpg	4093/1	P0002283.jpg	9/2/05 7:16	200	f
PC_4093_1_l.jpg	4093/1	P0002285.jpg	9/2/05 7:17	120	l
PC_4093_1_r.jpg	4093/1	P0002284.jpg	9/2/05 7:17	270	r
PC_4094_1_f280.jpg	4094/1	P0002251.jpg	8/19/05 9:26	10	f
PC_4094_1_l.jpg	4094/1	P0002250.jpg	8/19/05 9:26	200	l
PC_4094_1_r.jpg	4094/1	P0002249.jpg	8/19/05 9:26	280	r
PC_4095_1_b.jpg	4095/1	P0002252.jpg	8/19/05 9:46	260	f
PC_4095_1_f260.jpg	4095/1	P0002253.jpg	8/19/05 9:46	260	f
PC_4095_1_l.jpg	4095/1	P0002255.jpg	8/19/05 9:46	180	l
PC_4095_1_r.jpg	4095/1	P0002254.jpg	8/19/05 9:46	0	r

Photo Name	Point	Photo Number	Date/Time	Bearing	Direction
PC_4096_1_f225.jpg	4096/1	P0002256.jpg	8/19/05 10:04	225	f
PC_4096_1_l.jpg	4096/1	P0002258.jpg	8/19/05 10:04	135	l
PC_4096_1_r.jpg	4096/1	P0002257.jpg	8/19/05 10:04	330	r
Shimers					
SH_4150_1_b60.jpg	4150/1	P0001741.jpg	6/29/04 6:10	60	b
SH_4150_1_f240.jpg	4150/1	P0001739.jpg	6/29/04 6:09	240	f
SH_4150_1_l150.jpg	4150/1	P0001742.jpg	6/29/04 6:10	150	l
SH_4150_1_r330.jpg	4150/1	P0001740.jpg	6/29/04 6:10	330	r
Sunfish Pond					
SP_4030_1_b260.jpg	4030/1	P0001722.jpg	6/23/04 10:09	260	b
SP_4030_1_f150.jpg	4030/1	P0001720.jpg	6/23/04 10:08	150	f
SP_4030_1_l60.jpg	4030/1	P0001719.jpg	6/23/04 10:08	60	l
SP_4030_1_r210.jpg	4030/1	P0001721.jpg	6/23/04 10:09	210	r
SP_4030_2_f150.jpg	4030/2	P0001717.jpg	6/23/04 9:40	150	f
SP_4030_2_l90.jpg	4030/2	P0001716.jpg	6/23/04 9:40	90	l
SP_4030_2_r240.jpg	4030/2	P0001718.jpg	6/23/04 9:41	240	r
SP_4031_1_l350.jpg	4031/1	P0001712.jpg	6/23/04 8:33	350	l
SP_4031_1_lf50.jpg	4031/1	P0001713.jpg	6/23/04 8:34	50	lf
SP_4031_1_r160.jpg	4031/1	P0001715.jpg	6/23/04 8:35	160	r
SP_4031_1_rf110.jpg	4031/1	P0001714.jpg	6/23/04 8:35	110	rf
SP_4031_2_f160.jpg	4031/2	P0001710.jpg	6/23/04 8:00	160	f
SP_4031_2_l90.jpg	4031/2	P0001709.jpg	6/23/04 8:00	90	l
SP_4031_2_r270.jpg	4031/2	P0001711.jpg	6/23/04 8:00	270	r
SP_4032_1_f160.jpg	4032/1	P0001707.jpg	6/23/04 7:19	160	f
SP_4032_1_l110.jpg	4032/1	P0001706.jpg	6/23/04 7:18	110	l
SP_4032_1_r240.jpg	4032/1	P0001708.jpg	6/23/04 7:19	240	r
SP_4032_2_f180.jpg	4032/2	P0001704.jpg	6/23/04 6:43	180	f
SP_4032_2_r270.jpg	4032/2	P0001705.jpg	6/23/04 6:43	270	r
SP_4032_3_lf120.jpg	4032/3	P0001702.jpg	6/23/04 5:50	120	lf
SP_4032_3_rf190.jpg	4032/3	P0001703.jpg	6/23/04 5:50	190	rf
Thunder Mountain					
TM_4190_1_f0.jpg	4190/1	P0001806.jpg	7/7/04 10:03	0	f
TM_4190_1_l280.jpg	4190/1	P0001808.jpg	7/7/04 10:04	280	l
TM_4190_1_r90.jpg	4190/1	P0001807.jpg	7/7/04 10:03	90	r
TM_4190_2_f150.jpg	4190/2	P0001809.jpg	7/7/04 10:29	150	f
TM_4190_2_l55.jpg	4190/2	P0001810.jpg	7/7/04 10:30	55	l
TM_4190_2_r240.jpg	4190/2	P0001811.jpg	7/7/04 10:31	240	r
TM_4190_3_f120.jpg	4190/3	P0001803.jpg	7/7/04 9:25	120	f
TM_4190_3_l35.jpg	4190/3	P0001805.jpg	7/7/04 9:29	35	l
TM_4190_3_r200.jpg	4190/3	P0001804.jpg	7/7/04 9:25	200	r
TM_4190_4_f140.jpg	4190/4	P0001800.jpg	7/7/04 9:04	140	f
TM_4190_4_l60.jpg	4190/4	P0001801.jpg	7/7/04 9:04	60	l
TM_4190_4_r220.jpg	4190/4	P0001802.jpg	7/7/04 9:05	220	r
TM_4191_1_f160.jpg	4191/1	P0001878.jpg	7/30/04 8:51	160	f
TM_4191_1_l60.jpg	4191/1	P0001879.jpg	7/30/04 8:52	60	l

Photo Name	Point	Photo Number	Date/Time	Bearing	Direction
TM_4191_1_r240.jpg	4191/1	P0001880.jpg	7/30/04 8:52	240	r
TM_4192_1_f320.jpg	4192/1	P0001881.jpg	7/30/04 9:11	320	f
TM_4192_1_l240.jpg	4192/1	P0001882.jpg	7/30/04 9:12	240	l
TM_4192_1_r40.jpg	4192/1	P0001883.jpg	7/30/04 9:12	40	r
TM_4193_1_f180.jpg	4193/1	P0001884.jpg	7/30/04 9:36	180	f
TM_4193_1_l90.jpg	4193/1	P0001886.jpg	7/30/04 9:36	90	l
TM_4193_1_r250.jpg	4193/1	P0001885.jpg	7/30/04 9:36	250	r
TM_4194_1_b210.jpg	4194/1	P0001962.jpg	8/1/04 13:44	210	b
TM_4194_1_f30.jpg	4194/1	P0001959.jpg	8/1/04 13:43	30	f
TM_4194_1_l300.jpg	4194/1	P0001961.jpg	8/1/04 13:44	300	l
TM_4194_1_r120.jpg	4194/1	P0001960.jpg	8/1/04 13:44	120	r
TM_4194_2_f120.jpg	4194/2	P0001956.jpg	8/1/04 13:22	120	f
TM_4194_2_l40.jpg	4194/2	P0001958.jpg	8/1/04 13:22	40	l
TM_4194_2_r190.jpg	4194/2	P0001957.jpg	8/1/04 13:22	190	r
Toms Creek					
TC_4070_1_f150.jpg	4070/1	P0002213.jpg	7/7/05 13:53	190	f
TC_4070_1_l.jpg	4070/1	P0002215.jpg	7/7/05 13:54	250	l
TC_4070_1_r.jpg	4070/1	P0002214.jpg	7/7/05 13:53	140	r
TC_4071_1_f130.jpg	4071/1	P0002207.jpg	7/7/05 13:12	130	f
TC_4071_1_l.jpg	4071/1	P0002209.jpg	7/7/05 13:13	60	l
TC_4071_1_r.jpg	4071/1	P0002208.jpg	7/7/05 13:13	240	r
TC_4072_1_f230.jpg	4072/1	P0002210.jpg	7/7/05 13:29	230	f
TC_4072_1_l.jpg	4072/1	P0002212.jpg	7/7/05 13:30	360	l
TC_4072_1_r.jpg	4072/1	P0002211.jpg	7/7/05 13:30	180	r
TC_4074_1_b.jpg	4074/1	P0002206.jpg	7/7/05 12:50	150	b
TC_4074_1_f240.jpg	4074/1	P0002205.jpg	7/7/05 12:50	270	f
TC_4074_1_l.jpg	4074/1	P0002203.jpg	7/7/05 12:50	240	l
TC_4074_1_r.jpg	4074/1	P0002204.jpg	7/7/05 12:50	330	r
TC_4078_1_f180.jpg	4078/1	P0002216.jpg	7/7/05 14:11	180	f
TC_4078_1_l.jpg	4078/1	P0002218.jpg	7/7/05 14:12	90	l
TC_4078_1_r.jpg	4078/1	P0002217.jpg	7/7/05 14:11	270	r
TC_4073_1_f40.jpg	4073/1	P0002219.jpg	7/7/05 14:22	40	f
TC_4073_1_l.jpg	4073/1	P0002221.jpg	7/7/05 14:22	320	l
TC_4073_1_r.jpg	4073/1	P0002220.jpg	7/7/05 14:22	90	r
TC_4075_1_f330.jpg	4075/1	P0002197.jpg	7/7/05 12:01	330	f
TC_4075_1_l.jpg	4075/1	P0002199.jpg	7/7/05 12:01	270	l
TC_4075_1_r.jpg	4075/1	P0002198.jpg	7/7/05 12:01	40	r
TC_4076_1_f150.jpg	4076/1	P0002200.jpg	7/7/05 12:18	150	f
TC_4076_1_l.jpg	4076/1	P0002201.jpg	7/7/05 12:18	80	l
TC_4076_1_r.jpg	4076/1	P0002202.jpg	7/7/05 12:18	220	r

Photo Name	Point	Photo Number	Date/Time	Bearing	Direction
TC_4077_1_f130.jpg	4077/1	P0002194.jpg	7/7/05 11:36	130	f
TC_4077_1_l.jpg	4077/1	P0002196.jpg	7/7/05 11:36	70	l
TC_4077_1_r.jpg	4077/1	P0002195.jpg	7/7/05 11:36	210	r
Totts Gap					
TG_4002_1_f100.jpg	4002/1	P0001872.jpg	7/29/04 10:50	100	f
TG_4002_1_l30.jpg	4002/1	P0001873.jpg	7/29/04 10:50	30	l
TG_4002_1_r150.jpg	4002/1	P0001874.jpg	7/29/04 10:51	150	r
TG_4002_2_f300.jpg	4002/2	P0001875.jpg	7/29/04 11:11	300	f
TG_4002_2_l240.jpg	4002/2	P0001876.jpg	7/29/04 11:11	240	l
TG_4002_2_r60.jpg	4002/2	P0001877.jpg	7/29/04 11:11	60	r
TG_4003_1_b.jpg	4003/1	P0002238.jpg	8/5/05 10:44	260	b
TG_4003_1_f110.jpg	4003/1	P0002235.jpg	8/5/05 10:43	330	f
TG_4003_1_l.jpg	4003/1	P0002236.jpg	8/5/05 10:44	65	l
TG_4003_1_misc.jpg	4003/1	P0002239.jpg	8/5/05 10:45	not rec.	misc
TG_4003_1_r.jpg	4003/1	P0002237.jpg	8/5/05 10:44	160	r
TG_4003_2_b.jpg	4003/2	P0002244.jpg	8/5/05 11:17	60	b
TG_4003_2_f150.jpg	4003/2	P0002242.jpg	8/5/05 11:16	230	f
TG_4003_2_l.jpg	4003/2	P0002241.jpg	8/5/05 11:16	150	l
TG_4003_2_r.jpg	4003/2	P0002243.jpg	8/5/05 11:16	300	r
TG_4004_1_b.jpg	4004/1	P0002247.jpg	8/5/05 11:37	300	b
TG_4004_1_f330.jpg	4004/1	P0002246.jpg	8/5/05 11:37	210	f
TG_4004_1_l.jpg	4004/1	P0002245.jpg	8/5/05 11:37	110	l
TG_4004_1_r.jpg	4004/1	P0002248.jpg	8/5/05 11:37	30	r
TG_4005_1_f180.jpg	4005/1	P0001934.jpg	7/31/04 9:26	180	f
TG_4005_1_l120.jpg	4005/1	P0001935.jpg	7/31/04 9:27	120	l
TG_4005_1_r240.jpg	4005/1	P0001936.jpg	7/31/04 9:27	240	r
TG_4006_1_f330.jpg	4006/1	P0001937.jpg	7/31/04 9:47	330	f
TG_4006_1_l240.jpg	4006/1	P0001938.jpg	7/31/04 9:48	240	l
TG_4006_1_r30.jpg	4006/1	P0001939.jpg	7/31/04 9:48	30	r
TG_4007_1_b190.jpg	4007/1	P0001933.jpg	7/31/04 8:18	190	b
TG_4007_1_f0.jpg	4007/1	P0001932.jpg	7/31/04 8:17	0	f
TG_4007_1_r120.jpg	4007/1	P0001931.jpg	7/31/04 8:16	120	r
Township Ballfield					
TB_4170_1_f300.jpg	4170/1	P0001793.jpg	7/6/04 12:36	300	f
TB_4170_1_l230.jpg	4170/1	P0001794.jpg	7/6/04 12:36	230	l
TB_4170_1_r30.jpg	4170/1	P0001795.jpg	7/6/04 12:37	30	r
TB_4171_1_f105.jpg	4171/1	P0001796.jpg	7/6/04 12:54	105	f
TB_4171_1_l45.jpg	4171/1	P0001797.jpg	7/6/04 12:55	45	l
TB_4171_1_r215.jpg	4171/1	P0001798.jpg	7/6/04 12:55	215	r
TB_4172_1_f225.jpg	4172/1	P0001782.jpg	7/6/04 11:11	225	f
TB_4172_1_l140.jpg	4172/1	P0001783.jpg	7/6/04 11:11	140	l
TB_4172_1_r310.jpg	4172/1	P0001784.jpg	7/6/04 11:12	310	r

Photo Name	Point	Photo Number	Date/Time	Bearing	Direction
TB_4173_1_f300.jpg	4173/1	P0001785.jpg	7/6/04 11:36	300	f
TB_4173_1_l220.jpg	4173/1	P0001786.jpg	7/6/04 11:37	220	l
TB_4173_1_r60.jpg	4173/1	P0001788.jpg	7/6/04 11:42	60	r
TB_4173_2_b140.jpg	4173/2	P0001791.jpg	7/6/04 12:00	140	b
TB_4173_2_f310.jpg	4173/2	P0001789.jpg	7/6/04 11:59	310	f
TB_4173_2_l220.jpg	4173/2	P0001792.jpg	7/6/04 12:00	220	l
TB_4173_2_r50.jpg	4173/2	P0001790.jpg	7/6/04 12:00	50	r
TB_4174_1_f130.jpg	4174/1	P0001775.jpg	7/6/04 10:01	130	f
TB_4174_1_l50.jpg	4174/1	P0001777.jpg	7/6/04 10:02	50	l
TB_4174_1_r210.jpg	4174/1	P0001776.jpg	7/6/04 10:02	210	r
TB_4174_2_b180.jpg	4174/2	P0001780.jpg	7/6/04 10:30	180	b
TB_4174_2_f300.jpg	4174/2	P0001778.jpg	7/6/04 10:30	300	f
TB_4174_2_l240.jpg	4174/2	P0001779.jpg	7/6/04 10:30	240	l
TB_4174_2_r15.jpg	4174/2	P0001781.jpg	7/6/04 10:31	15	r
TB_4174_3_b100.jpg	4174/3	P0001749.jpg	6/29/04 8:32	100	b
TB_4174_3_f260.jpg	4174/3	P0001746.jpg	6/29/04 8:25	260	f
TB_4174_3_l200.jpg	4174/3	P0001748.jpg	6/29/04 8:25	200	l
TB_4174_3_r0.jpg	4174/3	P0001747.jpg	6/29/04 8:25	0	r
TB_4175_1_f100.jpg	4175/1	P0001743.jpg	6/29/04 7:29	100	f
TB_4175_1_l30.jpg	4175/1	P0001744.jpg	6/29/04 7:30	30	l
TB_4175_1_r180.jpg	4175/1	P0001745.jpg	6/29/04 7:30	180	r

Appendix H. Data dictionary.

Species Inventory Database
Data Dictionary for: Birds of Wetland Habitats in the Delaware Water Gap National Recreation Area - Distribution, Abundance & Management

File Name: DEWA_WBI.mdb (Microsoft Access 2000)

Database Tables

This relational database (Figure H1., Table H1.) has four primary tables of data organizing the bird surveys of wetlands for the project. TBL_Wetlands contains the original 77 wetlands that were selected for the survey and TBL_WetlandPoints contains the 104 survey points allocated to these wetlands; locations at which bird surveys took place. TBL_PointSurveys contains the 414 visits to the survey points over two breeding seasons in 2004 and 2005 to conduct the bird surveys while TBL_VCPsurveyBirds contains the over 6,000 bird detections recorded during the surveys. TBL_WetlandPoints also provides the post-survey designation of the dominant habitat at each point into broad categories of Open, Shrub, and Forest. Within this table, these coarse habitats on a point by point basis are further assigned into the final designations of the habitat that is considered to dominate the final wetland (i.e., the management or analysis unit) each point or points is located in (see below).

The additional six tables contain information "looked up" by the two of the primary tables. TLU_Birds contains the 114 bird species considered by the project and relates back to TBL_VCPsurveyBirds while TLU_SppGuildClass adds further information to each species regarding its biology and habitat preferences obtained from species accounts in The Birds of North America Online (http://bna.birds.cornell.edu/bna) used in grouping data for analyses or examining the species and survey results. TLU_Observer, TLU_NoiseCode, TLU_RainCode, and TLU_WindCode contain information behind the values recorded during the visits to points to conduct bird surveys contained in TBL_PointSurveys.

Result Queries

Three queries have been created in order to organize the data, show results, and reproduce the basic datasets that were used to produce results for the final report. The sum of the number of individuals of bird species detected per survey point and visit # for the two inventory years are produced by Query1_SppDetections, which is the basis for the species occurrence tables, richness and diversity metrics, and point- and wetland-based analyses in the report. In order to show how points are ultimately combined into wetland units, Query2_WetlandUnits contains the units and their habitat designations as they are derived from the point or points they contain as well as a subdatasheet linked to TBL_WetlandPoints within Microsoft Access to view the individual point attributes (Figure H2.). Query3_LocationAnalysisDataset sums the detections by location per survey point for the edge versus interior detections analysis dataset. An additional query, Query4_DEWA_WBI_VCPdata, provides potential users with the raw Variable Circular Plot point count dataset that was not used due to bias introduced by non-random point placement and apparent preferences of some species for edge and interior habitat locations (see report).

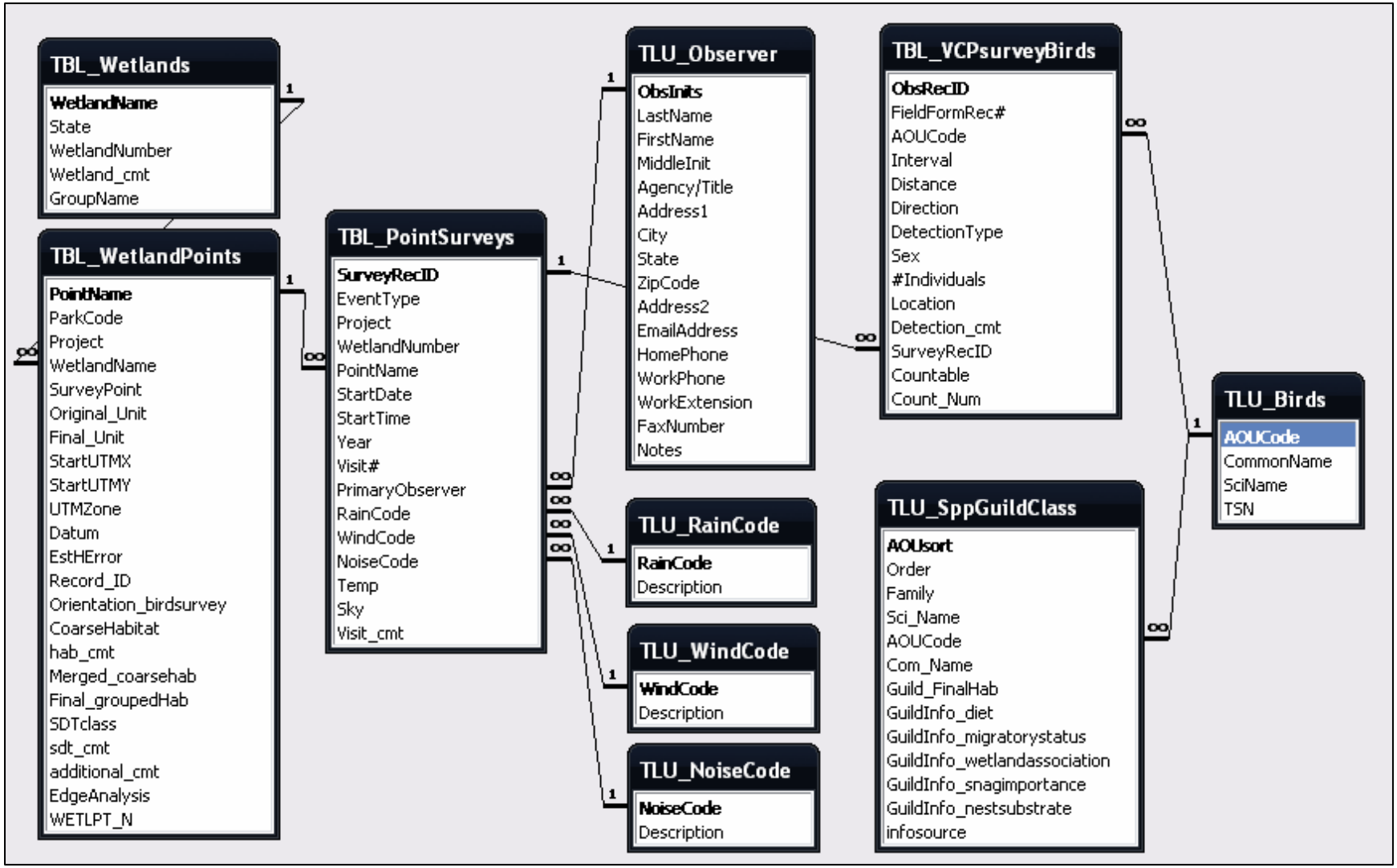

Figure H1. Table relationships in Microsoft Access.

Table H1. Database tables and their attributes.

Table Name:	**TBL_Wetlands**			
Table Description:	**T1. Contains wetlands where data is collected; has validation rule for [WetlandName]**			
Field Name	**Type**	**Size**	**Property**	**Value**
WetlandName	Text	50	Description:	Unique wetland name obtained from State and WetlandNumber; Link to GIS wetland shapefile
State	Text	2	Description:	2-letter state code where wetland is located
WetlandNumber	Long Integer	4	Description:	Unique 4-digit code (4001–4999) representing wetland, project supplied
Wetland_cmt	Memo	-	Description:	Optional comment about wetland
GroupName	Text	255	Description:	Name of survey group, project supplied
Table Name:	**TBL_WetlandPoints**			
Table Description:	**T2. Contains points located in wetlands where surveys are performed; has validation rule for [PointName]**			
Field Name	**Type**	**Size**	**Property**	**Value**
PointName	Text	50	Description:	Unique combination of SurveyPoint with WetlandName
ParkCode	Text	50	Description:	for compatibility with NPS specs; code for Delaware Water Gap National Recreational Area
Project	Text	50	Description:	for compatibility with NPS specs; code for Wetland Bird Inventory
WetlandName	Text	50	Description:	Foreign Key that relates a SurveyPoint to a wetland contained in TBL_Wetlands
SurveyPoint	Byte	1	Description:	Survey point number within wetland (1 - i)
Original_Unit	Text	50	Description:	Original designation of wetland that survey point is located in
Final_Unit	Text	50	Description:	Final management unit designation for wetland that survey point is located in
StartUTMX	Double	8	Description:	UTM X (easting) coordinate for the center of the plot or location OR starting point of a line or polygon (double precision to15 significant digits)
StartUTMY	Double	8	Description:	UTM Y (northing) coordinate for the center of the plot or location OR starting point of a line or polygon (double precision to15 significant digits)
UTMZone	Text	4	Description:	UTM zone
Datum	Text	5	Description:	Datum of mapping ellipsoid
			RowSource:	"NAD27";"NAD83"
			RowSourceType:	Value List
EstHError	Single	4	Description:	Estimated horizontal accuracy error in METERS--see users guide for complete details and examples
Record_ID	Long Integer	4	Description:	Unique numeric row identifier (candidate primary key)
Orientation_birdsurvey	Integer	2	Description:	True compass direction in degree's faced for recording bird locations
CoarseHabitat	Text	50	Description:	Point-based classification of dominant habitat
hab_cmt	Text	255	Description:	Text description of habitat at point
Merged_coarsehab	Text	50	Description:	Habitat classification from CourseHabitat merged as necessary for wetland-based analyses
Final_groupedHab	Text	50	Description:	Grouping of Merged_coursehab for analysis of general bird guild/habitat data
SDTclass	Text	50	Description:	Classification of the amount of standing dead timber present at a point (only applies to non-forest CourseHabitat points)
sdt_cmt	Text	255	Description:	Text description of standing dead timber at point
additional_cmt	Text	255	Description:	Miscellaneous comments about point habitat
EdgeAnalysis	Text	10	Description:	Point used in analysis of birds detected in edge habitat
WETLPT_N	Text	50	Description:	Link to GIS wetland survey point shapefile
Table Name:	**TBL_PointSurveys**			
Table Description:	**T3. Contains visits to wetland points to conduct bird surveys**			
Field Name	**Type**	**Size**	**Property**	**Value**
SurveyRecID	Long Integer	4	Description:	Unique row identifier
EventType	Text	50	Description:	Type of sampling taking place at this time and date
			RowSource:	"VCP Survey"
			RowSourceType:	Value List
Project	Text	50	Description:	for compatibility with NPS specs; code for Wetland Bird Inventory
WetlandNumber	Long	4	Description:	Unique 4-digit code (4001–4999) representing wetland

	Integer			
PointName	Text	50	Description:	Unique combination of SurveyPoint with WetlandName
StartDate	Date/Time	8	Description:	Date of survey
			Format:	yyyy-mmm-dd
StartTime	Date/Time	8	Description:	Time survey started (a.m.)
			Format:	Short Time
Year	Long Integer	4	Description:	Inventory year
Visit#	Byte	1	Description:	Sequential visit number to point within inventory year
PrimaryObserver	Text	3	Description:	3-character initials of observer performing the survey
			RowSource:	SELECT TLU_Observer.ObsInits, TLU_Observer.LastName, TLU_Observer.FirstName FROM TLU_Observer;
			RowSourceType:	Table/Query
RainCode	Byte	1	Description:	Code used to record precipitation conditions during count
			RowSource:	SELECT TLU_RainCode.RainCode, TLU_RainCode.Description FROM TLU_RainCode;
			RowSourceType:	Table/Query
WindCode	Byte	1	Description:	Code used to record wind strength (Beaufort Scale)
			RowSource:	SELECT TLU_WindCode.WindCode, TLU_WindCode.Description FROM TLU_WindCode;
			RowSourceType:	Table/Query
NoiseCode	Byte	1	Description:	Code used to record background noise as it affects observer's ability to hear birds
			RowSource:	SELECT TLU_NoiseCode.NoiseCode, TLU_NoiseCode.Description FROM TLU_NoiseCode;
			RowSourceType:	Table/Query
Temp	Text	50	Description:	Fahrenheit
Sky	Text	50	Description:	% cloud or oc (overcast)/fog
Visit_cmt	Memo	-	Description:	Optional comment about visit
Table Name:	**TBL_VCPsurveyBirds**			
Table Description:	**T4. Contains birds detected during VCP surveys**			
Field Name	**Type**	**Size**	**Property**	**Value**
ObsRecID	Long Integer	4	Description:	Unique row identifier
AOUCode	Text	50	Description:	4-letter code of species detected
			RowSource:	SELECT TLU_Birds.AOUCode, TLU_Birds.CommonName FROM TLU_Birds
			RowSourceType:	Table/Query
Interval	Text	50	Description:	Time interval (0–3 min, 3–5 min, extraneous observations: before count, after count)
			RowSource:	"0–3";"3–5"; “bc”; “ac”
			RowSourceType:	Value List
Distance	Text	5	Description:	Distance to individual estimated in meters (Null=no data)
Direction	Text	50	Description:	Direction of detection relative to direction observer faces (F -front, B -back, L -left, R- right)
			RowSource:	F;B;L;R;RF;LF;RB;LB (Null=no data)
			RowSourceType:	Value List
DetectionType	Text	50	Description:	Type of audio or visual detection
			RowSource:	Song;Call;Visual;Drum (Null=no data)
			RowSourceType:	Value List
Sex	Text	50	Description:	Sex of individual detected if known, also if a pair or group
			RowSource:	Male;Female;Unknown;Pair;Group (Null=no data)
			RowSourceType:	Value List
#Individuals	Long Integer	4	Description:	Number of individuals detected
Location	Text	50	Description:	Where within surrounding habitat detection took place
			RowSource:	Inside wetland;Outside wetland;Edge;FO-Flyover;AR-Sally;NoData (AR-Sally = aerial, likely foraging)
			RowSourceType:	Value List
Detection_cmt	Memo	-	Description:	Optional comment about detection
SurveyRecID	Long Integer	4	Description:	Foreign Key that relates detection back to its survey
Countable	Text	50	Description:	How #Individuals were processed for specific analyses (count all, count in wetland, count both, count one, count only occurrence, count singing male, don’t count one of pair, don’t count species already counted, dont

				count unknown species ID)
			RowSource:	count_all;count_because_in;count_both;count_one; count_onlyocc;count_sgmale;dc_ofpair;dc_onecounted; dontcount
			RowSourceType:	Value List
Count_Num	Long Integer	4	Description:	Number of individuals to count or sum for analyses based on Countable field value
Table Name:	**TLU_Birds**			
Table Description:	**T90. Contains bird species codes looked up by TBL_VCPsurveyBirds**			
Field Name	**Type**	**Size**	**Property**	**Value**
AOUCode	Text	50	Description:	Primary Key Field: unique identifier of 4-character AOU code for bird species
CommonName	Text	50	Description:	Common or vernacular name for the species
SciName	Text	50	Description:	Scientific name for the species
TSN	Double	8	Description:	Taxonomic Serial Number for the species as assigned by ITIS (Integrated Taxonomic Info System)
Table Name:	**TLU_SppGuildClass**			
Table Description:	**T91. Contains guild information for bird species**			
Field Name	**Type**	**Size**	**Property**	**Value**
AOUsort	Double	8	Description:	Taxonomic sort order; Primary Key field
Order	Text	50	Description:	Taxonomic Order species is in
Family	Text	50	Description:	Taxonomic Family species is in
Sci_Name	Text	50	Description:	Scientific name for the species
AOUCode	Text	50	Description:	Unique identifier of 4-character AOU code for bird species
Com_Name	Text	50	Description:	Common or vernacular name for the species
Guild_FinalHab	Text	50	Description:	A - aerial; E/D - emergent/open/dead timber; F - forested habitat; G - edge habitat; S - shrub-dominated
GuildInfo_diet	Text	50	Description:	A - aquatic inverts.; F - fruit; H - fish; I - terrest. inverts.; N - nectar; O - broad diet; P - herbivorous; S - seeds; V - terrest. verts.
GuildInfo_migratorystatus	Text	50	Description:	M - migratory, not neo-trop; MW - mig. but here in winter; N - non-migratory; T - neo-tropical migrant
GuildInfo_wetlandassociation	Text	50	Description:	N - no; Y - yes
GuildInfo_snagimportance	Text	50	Description:	B - breeds mainly; F - feeding; H - high (both B&F); L - low (no B or F); O - other use; S - breeds sometimes
GuildInfo_nestsubstrate	Text	50	Description:	B - burrow; C - cavity; G - ground; M - man-made; P - nest parasite; S - shrub; T - tree
infosource	Text	50	Description:	BNA - obtained from Birds of North America Species Account
Table Name:	**TLU_Observer**			
Table Description:	**T92. Contains observer codes looked up by TBL_VCPsurveyVisits**			
Field Name	**Type**	**Size**	**Property**	**Value**
ObsInits	Text	3	Description:	Observer initials (max. 3 characters)
LastName	Text	50	Description:	Last name of observer
FirstName	Text	50	Description:	First name of observer
MiddleInit	Text	4	Description:	Middle initial of observer
Agency/Title	Text	255	Description:	Observer title and employer
Address1	Text	255	Description:	Primary address of observer
City	Text	50	Description:	City/Town of primary address
State	Text	2	Description:	State of primary address
ZipCode	Text	10	Description:	Zip Code of primary address
Address2	Text	255	Description:	Secondary address of observer if applicable
EmailAddress	Text	50	Description:	Email address of observer
HomePhone	Text	20	Description:	Home phone number of observer
WorkPhone	Text	20	Description:	Work phone number of observer
WorkExtension	Text	5	Description:	Extension of work phone number if applicable
FaxNumber	Text	20	Description:	Observer's fax number if applicable
Notes	Memo	-	Description:	Comments about observer
Table Name:	**TLU_NoiseCode**			
Table Description:	**T93. Contains noise codes looked up by TBL_VCPsurveyVisits**			
Field Name	**Type**	**Size**	**Property**	**Value**
NoiseCode	Byte	1	Description:	Code used to record background noise as it affects observer's ability to hear birds
Description	Text	250	Description:	Explanation of background noise code

Table Name:	**TLU_RainCode**			
Table Description:	**T94. Contains rain codes looked up by TBL_VCPsurveyVisits**			
Field Name	**Type**	**Size**	**Property**	**Value**
RainCode	Byte	1	Description:	Code used to record precipitation conditions during count
Description	Text	250	Description:	Explanation of rain code
Table Name:	**TLU_WindCode**			
Table Description:	**T95. Contains wind codes looked up by TBL_VCPsurveyVisits**			
Field Name	**Type**	**Size**	**Property**	**Value**
WindCode	Byte	1	Description:	Code used to record wind strength (Beaufort Scale)
Description	Text	250	Description:	Explanation of wind code

Query2_WetlandUnits : Select Query

GroupName	Unit	SurveyPoint_count	Merged_coarsehab	Final_groupedHab
Crater Lake	CL4	1	Shrub	Shrub/OpenShrub
Crater Lake	CL5	1	Open	Open
Crater Lake	CL6_7	2	OpenShrub	Shrub/OpenShrub

PointName	CoarseHabitat	hab_cmt	Merged_coarsehab	Final_groupedHab	SDTclass	EdgeAnalysis
NJ_4254/1	Open	emergent, little interior shrub	OpenShrub	Shrub/OpenShrub	moderate	yes
NJ_4255/1	Shrub	emergent dominated some interior shrub	OpenShrub	Shrub/OpenShrub	moderate	yes

GroupName	Unit	SurveyPoint_count	Merged_coarsehab	Final_groupedHab
Dingmans	DG1	1	Open	Open
Dingmans	DG2	1	Shrub	Shrub/OpenShrub
Dingmans	DG3	1	Forest	Forest/ShrubForest
Dingmans	DG4	1	Shrub	Shrub/OpenShrub
Dingmans	DG5	1	Shrub	Shrub

Record: 19 of 77

Figure H2. Query2_WetlandUnits showing linked subdatasheet of TBL_WetlandPoints (select fields shown).

Form

The database contains a form displaying the birds detected per visit to each survey point (Figure H3.). Survey point attributes are shown as well as all variables recorded on field forms.

FRM_PointSurveys : Form

Observer:	JSJ	PointName:	NJ_4080/1	Visit#:	1	Rain:	0	Visit_cmt:	whip-poor will detected near AT on walk in between pt# 1-2, also deju song
Date:	6/2/2004	GroupName:	Sunfish Pond			Wind:	3	Temp:	
Time:	4:25	CoarseHabitat:	Shrub			Noise:	0	14	
Year:	2004	Unit:	SP1			Sky:	10		

Species:	Interval:	Dist.:	Dir.:	Det. Type:	Sex:	#:	Count	Countable	Location:	Detection_cmt:
VEER	0-3	45	LF	Song	Male	1	1	count_sgmale	Inside wetland	
REVI	0-3	45	LF	Song	Male	1	1	count_sgmale	Inside wetland	
AMRE	0-3	35	LF	Song	Male	1	1	count_sgmale	Inside wetland	
BHCO	0-3			Call	Unknown	2	2	count_all	FO-Flyover	
GRCA	0-3	30	L	Song	Male	1	1	count_sgmale	Inside wetland	
GRCA	0-3	30	R	Call	Male	1	1	count_both	Inside wetland	sang earlier
COYE	0-3	60	R	Song	Male	1	1	count_sgmale	Inside wetland	
EATO	0-3	50	RF	Call	Unknown	1	0	dc_onecounted	Inside wetland	
EAWP	0-3	50	RB	Song	Male	1	1	count_sgmale	Outside wetland	
OVEN	0-3	60	B	Song	Male	1	1	count_sgmale	Outside wetland	
YWAR	0-3	60	RF	Song	Male	1	1	count_sgmale	Inside wetland	
FISP	0-3	85	RF	Song	Male	1	1	count_sgmale	Inside wetland	
COYE	0-3	70	RF	Song	Male	1	1	count_sgmale	Inside wetland	
GCFL	0-3	150	R	Call	Unknown	1	1	count_all	Outside wetland	
EATO	3-5	35	L	Song	Male	1	1	count_sgmale	Inside wetland	

Record: 1 of 15

Record: 1 of 414

Figure H3. Form displaying birds detected at survey points.

Appendix I. Wetland unit species richness rankings.

Wetland Unit	Survey Point	Habitat Type	Species Richness
TB5	NJ-4174/3	Open/shrub	30
FN1	NJ-4210/1	shrub	29
FN1	NJ-4210/2	shrub	28
FS1	NJ-4230/1	open	28
CP1	NJ-4270/1	shrub	27
TM2	NJ-4191/1	shrub	26
HQ2	PA-4051/2	shrub	26
PC4	PA-4093/1	open	26
FN3	NJ-4213/1	forest	26
CP3	NJ-4272/1	shrub	25
SH1	NJ-4150/1	open	25
TM5	NJ-4194/1	open/shrub	25
FS1	NJ-4230/2	forest	25
FN1	NJ-4210/4	shrub	24
TB2	NJ-4171/1	shrub	24
PC2	PA-4091/1	open	23
HQ2	PA-4051/1	shrub	23
CL5	NJ-4254/1	open/shrub	23
CP5	NJ-4274/1	open	23
TM5	NJ-4194/2	open/shrub	23
FN1	NJ-4210/3	shrub	22
FN5	NJ-4215/1	shrub	22
TB5	NJ-4174/2	open/shrub	22
CO6	PA-4136/1	open	22
TC4	PA-4073/1	open	22
TC4	PA-4074/1	open	22
CL3	NJ-4252/1	shrub	21
HQ3	PA-4052/1	open	21
TB5	NJ-4174/1	open/shrub	21
CL6	NJ-4255/1	open/shrub	20
TB3	NJ-4172/1	shrub	20
TM1	NJ-4190/3	open	20
HQ5	PA-4054/1	open	20
TM3	NJ-4192/1	open	20
SP1	NJ-4030/1	shrub/forest	19
TC4	PA-4078/1	open	19
HQ7	PA-4057/1	open	19
HQ4	PA-4053/2	open	19
TM4	NJ-4193/1	open	19
HQ4	PA-4053/1	open	19
HQ3	PA-4052/2	open	19
TB1	NJ-4170/1	open	19
TM1	NJ-4190/4	open	19
TB4	NJ-4173/2	forest	19
FN1	NJ-4210/5	forest	19
CP5	NJ-4275/1	forest	19
FN4	NJ-4214/2	shrub	18
CL4	NJ-4253/1	open	18
PC3	PA-4092/1	shrub	18
TM1	NJ-4190/2	open	18
HQ1	PA-4050/2	forest	18
FN3	NJ-4213/2	shrub	17
DG5	PA-4114/1	shrub	17
HQ1	PA-4050/1	forest	17
SP1	NJ-4030/2	shrub/forest	17
FN2	NJ-4211/1	forest	17
FN2	NJ-4212/1	forest	17
SP2	NJ-4031/2	shrub	16
CP4	NJ-4273/1	shrub	16
TM1	NJ-4190/1	open	16
HQ5	PA-4054/2	open	16
DG1	PA-4110/1	open	16
HQ7	PA-4057/2	open	16
CP3	NJ-4272/2	forest	16
TB4	NJ-4173/1	forest	16
CP2	NJ-4271/1	shrub	15
SP3	NJ-4032/1	shrub/forest	14
CO5	PA-4134/1	forest	14
TG3	PA-4004/1	forest	14
CO5	PA-4135/1	shrub	13
FN4	NJ-4214/1	shrub	13
SP2	NJ-4031/1	shrub	13
PC5	PA-4094/1	open	13
CO3	PA-4132/1	forest	13
TC6	PA-4076/1	forest	13
TG1	PA-4002/1	forest	13
TG2	PA-4003/1	forest	13
HQ6	PA-4056/1	shrub	12
CO2	PA-4131/1	shrub	12
CL1	NJ-4250/1	open	12
DG2	PA-4111/1	shrub	12
PC7	PA-4096/1	forest	12
TC7	PA-4077/1	forest	12
TG2	PA-4003/2	forest	12
SP3	NJ-4032/3	shrub/forest	12
TG5	PA-4006/1	shrub	11
DG4	PA-4113/1	shrub	11
CL7	NJ-4256/1	open	11
TG1	PA-4002/2	forest	11
TC5	PA-4075/1	forest	11
CO4	PA-4133/1	forest	11
TG6	PA-4007/1	forest	11
SP3	NJ-4032/2	shrub/forest	10
CO1	PA-4130/1	forest	10
CL2	NJ-4251/1	open	10
TB6	NJ-4175/1	forest	10
TC3	PA-4072/1	forest	10
PC6	PA-4095/1	forest	10
DG3	PA-4112/1	forest	10
TG4	PA-4005/1	open	9
DG6	PA-4115/1	open	9
PC1	PA-4090/1	forest	9
TC1	PA-4070/1	forest	8
TC2	PA-4071/1	forest	7

Appendix J. Wetland unit species diversity rankings.

Wetland Unit	Survey Point	Habitat Type	Species Diversity
FN1	NJ-4210/1	Shrub	3.28
FN1	NJ-4210/2	shrub	3.24
CP1	NJ-4270/1	shrub	3.21
FS1	NJ-4230/1	open	3.21
TB5	NJ-4174/3	open/shrub	3.20
FS1	NJ-4230/2	forest	3.19
FN3	NJ-4213/1	forest	3.19
CP3	NJ-4272/1	shrub	3.15
FN1	NJ-4210/4	shrub	3.13
TM2	NJ-4191/1	shrub	3.13
CL5	NJ-4254/1	open/shrub	3.08
SH1	NJ-4150/1	open	3.07
TB2	NJ-4171/1	shrub	3.04
TM5	NJ-4194/1	open/shrub	3.03
CO6	PA-4136/1	open	3.01
HQ2	PA-4051/2	shrub	3.01
FN1	NJ-4210/3	shrub	3.00
PC2	PA-4091/1	open	3.00
TC4	PA-4073/1	open	2.99
FN5	NJ-4215/1	shrub	2.98
TC4	PA-4074/1	open	2.97
HQ3	PA-4052/1	open	2.95
CL3	NJ-4252/1	shrub	2.95
PC4	PA-4093/1	open	2.92
TM1	NJ-4190/3	open	2.92
TC4	PA-4078/1	open	2.91
HQ7	PA-4057/1	open	2.90
HQ5	PA-4054/1	open	2.90
TB5	NJ-4174/1	open/shrub	2.89
SP1	NJ-4030/1	shrub/forest	2.89
TM3	NJ-4192/1	open	2.89
CL6	NJ-4255/1	open/shrub	2.88
TB3	NJ-4172/1	shrub	2.88
TB5	NJ-4174/2	open/shrub	2.88
HQ4	PA-4053/2	open	2.87
TM4	NJ-4193/1	open	2.87
CP5	NJ-4274/1	open	2.87
TB4	NJ-4173/2	forest	2.87
FN1	NJ-4210/5	forest	2.87
CP5	NJ-4275/1	forest	2.85
HQ1	PA-4050/2	forest	2.84
FN4	NJ-4214/2	shrub	2.84
HQ2	PA-4051/1	shrub	2.84
HQ4	PA-4053/1	open	2.81
FN3	NJ-4213/2	shrub	2.80
CL4	NJ-4253/1	open	2.79
DG5	PA-4114/1	shrub	2.79
HQ1	PA-4050/1	forest	2.79
PC3	PA-4092/1	shrub	2.77
TM5	NJ-4194/2	open/shrub	2.77
HQ3	PA-4052/2	open	2.77
TM1	NJ-4190/2	open	2.74
TB1	NJ-4170/1	open	2.73
CP3	NJ-4272/2	forest	2.72
TB4	NJ-4173/1	forest	2.71
SP1	NJ-4030/2	shrub/forest	2.71
FN2	NJ-4211/1	forest	2.71
FN2	NJ-4212/1	forest	2.71
SP2	NJ-4031/2	shrub	2.69
CP4	NJ-4273/1	shrub	2.69
TM1	NJ-4190/1	open	2.68
SP3	NJ-4032/1	shrub/forest	2.62
HQ5	PA-4054/2	open	2.61
CO5	PA-4134/1	forest	2.59
CO3	PA-4132/1	forest	2.56
TG3	PA-4004/1	forest	2.55
CO5	PA-4135/1	shrub	2.54
TC6	PA-4076/1	forest	2.54
CP2	NJ-4271/1	shrub	2.54
PC5	PA-4094/1	open	2.51
TG1	PA-4002/1	forest	2.51
PC7	PA-4096/1	forest	2.48
FN4	NJ-4214/1	shrub	2.48
TG2	PA-4003/1	forest	2.48
CO2	PA-4131/1	shrub	2.44
TC7	PA-4077/1	forest	2.44
CL1	NJ-4250/1	open	2.43
DG1	PA-4110/1	open	2.41
TG2	PA-4003/2	forest	2.40
DG2	PA-4111/1	shrub	2.40
SP2	NJ-4031/1	shrub	2.38
DG4	PA-4113/1	shrub	2.37
TG1	PA-4002/2	forest	2.37
TC5	PA-4075/1	forest	2.37
CL7	NJ-4256/1	open	2.35
TG5	PA-4006/1	shrub	2.34
SP3	NJ-4032/3	shrub/forest	2.34
CO4	PA-4133/1	forest	2.30
HQ6	PA-4056/1	shrub	2.28
TB6	NJ-4175/1	forest	2.27
SP3	NJ-4032/2	shrub/forest	2.25
TC3	PA-4072/1	forest	2.25
CO1	PA-4130/1	forest	2.25
PC6	PA-4095/1	forest	2.25
CL2	NJ-4251/1	open	2.22
DG3	PA-4112/1	forest	2.20
HQ7	PA-4057/2	open	2.20
TG6	PA-4007/1	forest	2.20
TG4	PA-4005/1	open	2.16
DG6	PA-4115/1	open	2.16
PC1	PA-4090/1	forest	2.16
TC1	PA-4070/1	forest	2.04
TM1	NJ-4190/4	open	2.02
TC2	PA-4071/1	forest	1.83

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