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Implementing Avian Inventory and Monitoring Efforts on Corps of Engineers Project Lands

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PURPOSE: This technical note is a product of the Ecosystem Management and Restoration Research Program (EMRRP) work unit titled "Natural Resource Inventories for Special Status Species on Corps Operating Projects." The objective of the work unit is to provide guidelines for conducting Level I and II inventories on Corps projects (Martin et al. 2006). The emphasis is on methods that apply to a variety of animals rather than single species. The recent focus on ecosystem management and inclusion of nongame species in management plans has provided opportunities to improve the management of natural resources for many of the non-game forest, grassland, and aquatic birds. The purpose of this technical note is to: (1) provide an overview of the importance of monitoring avian communities on Corps projects (Figure 1), (2) identify important avian research and monitoring objectives that will benefit the management of Corps lands, (3) outline and describe specific methods for surveying terrestrial and open-water bird communities under a variety of habitat conditions, and (4) list examples of ongoing avian monitoring programs on Corps project lands.

Figure 1. Ecological monitoring of avian communities is an essential management element for Corps project lands.

BACKGROUND: Avian species are present in virtually every habitat type nationally and represent an important component of our nation's natural resources and overall biodiversity. Birds perform important ecological functions, including predatory and prey roles, seed dispersal, and pollination. Furthermore, birds represent an increasing economic resource; in 2001, people spent over $3.2 billion in equipment, bird seed, and travel expenditures, all for the purpose of observing birds (La Rouche 2003). Moreover, during the past century, birds have represented the primary focus of a majority of ecological and evolutionary research efforts, providing critical insights into our current understanding of natural processes at the individual, population, and community levels (Wiens 1989).

Currently, national and regional patterns of avian abundance and distribution for many species in North America have experienced long-term declines (Askins 1993, Rich et al. 2004). Evidence of these declines is derived from regional and national bird monitoring programs (e.g., the Breeding Bird Survey) (Sauer et al. 2000). Population declines are particularly acute for Neotropical migratory birds. These birds breed in temperate North America and migrate south to Central and South

America during the winter. Generally, species that winter south of the Tropic of Cancer are recognized as Neotropical migrants (DeGraaf and Rappole 1995). These represent nearly half of all breeding bird species in North America and include approximately 360 species of songbirds, shorebirds, waterfowl, and birds of prey. The remaining species include resident species that are non-migratory, and Nearctic migrants (sometimes called temperate migrants), that migrate between breeding and wintering grounds within North America, and many of these species are declining as well. Some of the sharpest declines in North American bird populations are occurring among grassland species (e.g., Dickcissel (*Spiza americana*), Grasshopper Sparrow (*Ammodramus savannarum*), Lark Sparrow (*Chondestes grammacus*), and Eastern Meadowlark (*Sternella magna*)) (Askins 1993, Herkert 1994, Vickery et al. 1999, Sauer et al. 2000), early-successional species (e.g., Yellow-breasted Chat (*Icteria virens*), White-eyed Vireo (*Vireo griseus*), and Loggerhead Shrike (*Lanius ludovicianus*)) (Askins 1993, Sauer et al. 2000, Hunter et al. 2001) and forest dependent species (e.g., Cerulean Warbler (*Dendroica cerulea*), Scarlet Tanager (*Piranga olivacea*), and Ovenbird (*Seiurus aurocapillus*)) (Askins 1993, Sauer et al. 2000).

Most terrestrial, large-scale monitoring efforts are insufficient to determine long-term trends for numerous wetland and open-water species, or nocturnal species. Such species include many gull (*Larus* spp.) and tern (*Sterna* spp.) species, and many owl (e.g., Great-horned Owl [*Bubo virginianus*]) or nightjars [*Caprimulgus* spp.]) species. Many of these species require a different monitoring methodology to assess long-term trends. While monitoring programs for these species have been developed and are ongoing, long-term data are either not available, or are too inconsistent to assess national or regional population trends.

INTRODUCTION: The Corps of Engineers manages over 450 man-made lakes within the continental United States. In addition, the Corps has jurisdiction over approximately 38,600 km of inland navigation rivers. Corps reservoir projects encompass approximately 4.7 million ha of land and open water habitat, with the total shoreline length exceeding the entire coastline of the United States (Fischer and Hamilton 1999, 2001). These areas support high quality riparian habitats along lakes and rivers, and constitute important year-round habitat for breeding, wintering, and migrating birds. The Corps was first authorized to manage these lands for wildlife, including bird communities, with the passage of Section 4 of the Flood Control Act of 1944 (U.S. Congress 1944). The Corps is also subject to Engineer Regulation (ER) 1130-2-540, Section 2.2c(1) (Headquarters, U.S. Army Corps of Engineers); the Department of Defense (DoD) Instructions (DODI 4715.3) (1996); and Executive Order 13186 (Presidential Documents 2001); where the need to protect and conserve migratory bird populations is mandated. Furthermore, in 1991, in response to the documented long-term population declines of many bird species, the DoD became a signatory member of the Partners in Flight (PIF) initiative that enlists the cooperation of over 300 federal and state agencies and nongovernmental organizations in the management and conservation of North American bird populations.

INVENTORY AND MONITORING: Inventory and monitoring efforts are essential elements in the management and conservation of natural resources on Corps projects. Natural resource inventories provide baseline information that permits managers to identify important habitats and determine the presence or absence of rare or sensitive species, including any species listed as endangered or threatened at the state or federal level. Monitoring efforts involve the repeated collection and analysis of population measures needed to evaluate current status or progress towards a stated goal. Data on population trends are critical if managers are to identify populations experiencing

significant changes in abundance or distribution. Avian population monitoring has a long history of success and was vital to the understanding of pesticide applications on numerous bird species (Carson 1962), long-term declines of grassland and riparian bird communities (Askins 1993), and forest fragmentation impacts on forest-dwelling landbirds in the eastern United States (Robbins et al. 1986). Similarly, avian population monitoring data also provided key evidence documenting the success of management efforts to restore populations of the Peregrine Falcon (*Falco peregrinus*) (White et al. 2002), Kirtland's Warbler (*Dendroica kirtlandii*) (Mayfield 1992), Willow Flycatcher (*Empidonax traillii extimus*) (Finch and Stoleson 2000), and numerous waterfowl species (Williams et al. 2002).

However, most Corps projects do not routinely inventory or monitor avian populations. Furthermore, monitoring efforts rarely last more than a few years or efforts are sporadic over many years, and these data are often insufficient to assess population trends. In addition, goals and objectives of monitoring efforts are often not thoroughly conceived and data from these efforts are rarely placed in national databases for regional and continental analyses (Bart et al. 2004, Bart 2005, Bart and Ralph 2005). Currently, many government agencies, and non-government organizations, including PIF, are working together to improve inventory and monitoring efforts on a continental scale. Referred to as Coordinated Bird Monitoring (CBM), this effort attempts to standardize bird monitoring in terms of methods and objectives, while maintaining the flexibility to meet local needs (Bart 2003, Bart and Ralph 2005). Overall, the CBM effort aims to improve efficiency and precision of current monitoring efforts (Bart 2003), and the initiative is supported by PIF (Rich et al. 2004) and other major bird conservation initiatives for landbirds, waterbirds and shorebirds. Specific survey methods have not been selected for standardization by CBM process, yet such efforts are currently under way (Bart 2003). However, numerous methods are available that are compatible with PIF recommendations and will likely be amendable to future CBM efforts (Rich et al. 2004, Bart and Ralph 2005).

Level I and II Inventories

Natural Resource Level I Inventories for Corps projects are defined as inventories of a general nature conducted to provide baseline information for Master Plan and Operational Management Plan development (Krause et al. 2004, Martin et al. 2006). Level II inventories involve the application of broad-based inventory methods to determine the occurrence and distributional status of selected species or species groups (e.g., songbirds, small mammals, bats, etc.). Level II inventories can then be followed by regular monitoring of selected species or species groups to determine population trends, or more specific methodologies can be selected for particular situations that require scientifically verifiable surveys of federally listed threatened and endangered species (Martin et al. 2006).

When establishing and implementing Level II inventories, particularly those involving avian monitoring programs on Corps project lands, it is recommended that managers incorporate goals, objectives, and methods consistent with the CBM and PIF approach. The remainder of this technical note summarizes these elements for application on Corps lands.

Setting Goals and Objectives: At the Corps project level, avian monitoring efforts will likely be used to support various local management objectives, including (from Bart 2003):

(1) Setting habitat protection targets.
(2) Determining whether a species or habitat needs special protection.

(3) Designing a strategy to reverse undesirable trends.
(4) Selecting specific habitats or areas to protect.
(5) Evaluating and improving existing projects as areas of bird habitat.

Birds are highly mobile with complex life histories, and numerous factors influencing population trends are likely to occur beyond the boundaries of Corps project lands. Determining whether specific trends are the result of project management or factors beyond the project boundaries is critical in devising adaptive management practices on Corps lands. Integrating Corps inventory and monitoring efforts with the CBM approach will permit Corps managers to meet local objectives while contributing to a larger regional effort that will provide critical information on factors influencing bird populations at the regional scale.

To integrate the CBM approach, specific Corps projects will need to identify current monitoring efforts occurring in the state or region by other government and non-government organizations. The integration of the CBM approach by the state of Montana (Young et al. 2005) provides an excellent example that could be modeled by other states and that provides suggestions on the monitoring approach that could be adopted by individual Corps projects.

Selection of Species: In general, survey efforts should focus on species of conservation concern, particularly any federal or state listed species or species regionally identified by PIF as Priority Species (Carter et al. 2000). Priority species have been identified by PIF using a prioritization process that applies concern scores for each species in 60 nationally recognized physiographic regions in the continental United States (Carter et al. 2000). Birds whose scores exceed a specific threshold are considered "Priority" species and are selected for concerted conservation and management efforts (Fitzgerald and Pashley 2000). Scores for each PIF Priority species in each physiographic region can be viewed at *www.rmbo.org/pif/pifdb.html*. Individual species or groups of species selected for monitoring efforts on individual Corps projects will likely depend on the regional location of specific projects. However, as part of a broader program of ecological monitoring and adaptive management (e.g., Bart 2005), entire bird communities should be monitored when logistics and funding permit. Monitoring bird communities will provide information on species that may experience population declines in the future but are not currently considered for special conservation attention. Furthermore, bird community monitoring can provide essential information on the status of numerous bird populations and permit managers to assess success or failure of current management efforts.

Nationally, bird communities in open grassland and riparian forest habitats are experiencing the most pronounced declines (Askins 1993, Herkert 1994, Vickery et al. 1999, Sauer et al. 2000, Hunter et al. 2001); therefore, monitoring efforts for terrestrial bird communities should focus on these habitats. However, certain Corps projects may need to focus on specific species, including threatened or endangered species (e.g., Least Tern [*Sterna antillarum*], Piping Plover [*Charadrius melodus*], Golden-cheeked Warbler [*Dendroica chrysoparia*]) (Figure 2), or other regional species of concern. These species may require monitoring methodologies different from terrestrial surveys with potential increases in costs and effort.

Selection of Seasons: Conservation of avian communities typically focuses on promoting sustainable populations. Therefore, most monitoring efforts focus on surveying breeding birds. However, the breeding season only represents a small portion of a bird's annual life-cycle, and other

Figure 2. The Golden-cheeked Warbler (*Dendroica chryosparia*) is an endangered species endemic to central Texas and has breeding populations on several Corps projects. Photo credit: Mr. Kelly R. Barr.

seasons may play an equally important role in the conservation of bird populations. For example, Neotropical migrant species are often dependent on available stopover habitat during the fall and spring migratory seasons. Loss and degradation of quality stopover habitat, particularly along the Gulf Coast, may be a primary cause of notable declines of eastern Neotropical migrant bird populations (Moore et al. 1995). Similarly, the over-wintering season is often a period of resource limitation, and may play an essential role in regulating populations (Fretwell 1972). Habitat availability during the winter has been shown to limit populations of the Golden-cheeked Warbler (Rappole et al. 2003), and grasslands in the Southeast constitute critical wintering habitat for the long-term management and conservation of Henslow's Sparrow (*Ammodramus henslowii*) populations (Herkert et al. 2002). Decisions on specific seasons to focus monitoring efforts will depend on the location of individual Corps projects and associated avian species of concern for the specific region. Often, monitoring efforts focused on a specific season or species may not need to be performed annually; sometimes surveys can be performed every 2 to 5 years (e.g., Hutto and Young (2002), International Piping Plover Census (U.S. Geological Survey 2006)). Therefore, for Corps projects that support species of concern during all seasons, a potential approach would be to alternate seasonal survey efforts annually (e.g., breeding season in year 1, winter season in year 2, spring/fall migration year 3, and back to breeding season in year 4). Such monitoring efforts could be coordinated with similar regional efforts, and cost-share agreements with the U.S. Geological Survey, National Audubon Society, and other organizations would permit completion of necessary monitoring while reducing costs for individual Corps projects.

Selection of Methods: Specific survey methods to be used for the CBM approach have not been established (Bart 2003); however, numerous common standardized methods are under consideration and application of any of these methods will likely fit into future CBM planning. Specific methods for the CBM approach will focus on estimating abundance, distribution, population trends, and population fitness using standardized methodologies. The continuity of the CBM approach will permit better data management and ease of combining data from multiple locations into a centralized database for regional assessment of priority bird species (Bart 2003). Common survey methodologies for terrestrial and riparian/open water bird communities are described below.

SURVEY METHODS

Terrestrial Surveys:

Point-count Surveys: Point-counts represent one of the most common and well-studied survey methods for terrestrial bird communities (Ralph and Scott 1981; Ralph et al. 1993, 1995; Hamel

et al. 1996; Huff et al. 2000). The basic procedure involves establishing survey stations randomly or systematically random throughout an area of interest. Survey stations can be stratified by habitat (e.g., Huff et al. 2000) and stations are generally 250 m apart to minimize double-counting of birds among stations and to maintain independence of data collected at each station. Once a surveyor reaches a survey station, he/she will record all birds and species detected aurally and visually onto a data sheet. Generally, standardized point-count surveys last for 5 to 10 min.; however, modifications are occasionally used. For example, the Breeding Bird Survey uses a modified 3-min. point-count survey along roads (Robbins et al. 1986, Sauer et al. 2000), and other researchers have extended the survey length to 20 min. to detect rare or secretive birds (Smith et al. 1993), especially during the non-breeding season. Often, birds are detected by song or call rather than visual sightings; therefore, point-counts are considered best for monitoring during the spring when breeding males are most vocal. Standardized protocols emphasize the timing of surveys to occur during the peak breeding season (start dates will vary with latitude and altitude) and that surveys should be conducted within 4 hr after sunrise (Ralph et al. 1993, 1995; Hamel et al. 1996). Survey methods strongly suggest that counts not be conducted during periods of rain or strong winds (>15-20 mph). Point-counts are typically conducted as 'fixed-radius' (e.g., all birds $\leq$50 m are recorded] or 'unlimited distance' (e.g., all birds detected are recorded). Birds are typically recorded at various distance categories (e.g., $\leq$25 m, 25-50 m, and $\geq$50 m), such that each count can be analyzed as an unlimited distance survey, or truncated to include birds $\leq$50 m, and be analyzed as a fixed-radius count (see Appendix A for sample data sheet).

The following step-by-step procedures are commonly used for conducting point-counts (after Hamel et al. (1996)):

(1) Approach the sampling point, noting any birds within 50 m of the counting station that are flushed, fly away, or retreat. These birds are marked on the data sheet at the appropriate distance from the point.
(2) Record wind and sky conditions, date, time, and observer.
(3) Start count as soon as possible.
(4) Record each bird seen or heard, spending part of the time facing in each cardinal direction to better detect all birds.
(5) Mark birds on data sheet in appropriate distance band (e.g., within 25 m, 25 to 50 m, and > 50 m).
(6) Mark each bird once, using the mapped location to judge whether subsequent songs were from new or already mapped individuals. All "flyovers" are recorded separately.
(7) Record birds observed/heard during the first 3 min, and next 2-min intervals separately.
(8) Do not count any birds believed to have been counted at previous stations.
(9) At the end of each count, recordings of bird detection are stopped. Do not record any new birds seen or heard after the sampling period was over (incidental observations can be recorded, but should not be entered or included in analyses).
(10) Move to next station.

Depending upon objectives, it is often statistically more powerful to survey as many different habitats and areas as possible, rather than making repeated visits to survey stations in a single season (Ralph et al. 1993, Smith et al. 1993). For population trend estimation in long-term monitoring programs, conducting biennial surveys may suffice (Hutto and Young 2002, 2003), and depending on

objectives, longer intervals between breeding season surveys may be acceptable (e.g., every 5 years for the National Piping Plover Census; Haig et al. 2005). Since many point-counts can be conducted over a large area within a relatively short period of time, this methodology is considered advantageous over most other survey techniques. Point-counts are useful for obtaining relative abundance estimates for most terrestrial bird populations, and the abundance estimates are then used for trend estimation over time (Hutto and Young 2002, Rosenstock et al. 2002, Thompson 2002, Novell et al. 2003).

Line Transects: Line-transect surveys are the next most common technique used to survey terrestrial bird populations. This technique involves establishing a transect through a desired habitat type or area; the transect is walked at a standardized pace and all birds detected visually or aurally are recorded. Most transects are at least 100 m in length, and may be several hundred meters in length or longer; therefore, it is often a labor-intensive technique and usually not as efficient as point-count surveys. Furthermore, this technique is often not tenable in highly variable habitats, sites with very dense vegetation, or areas with steep terrain. However, in the process of walking a transect, birds are typically flushed in front of the observer; so this method does not depend as heavily on singing cues by birds and is considered a better method for surveys conducted in the non-breeding seasons (Ralph and Scott 1981, Ralph et al. 1993). Like point-count surveys, birds are typically placed into various distance categories on either side of the observer. When assessing detectability indices or density, the distance to each bird detected is often estimated or measured directly (typically using a range finder), rather than placed into distance categories. Line-transect surveys are often used to estimate detectability differences among species and habitats, and this methodology is strongly recommended when density estimates are desired (Burnham et al. 1980, Rosenstock et al. 2002, Thompson 2002, Norvell et al. 2003, Buckland 2006). Standardized protocols for conducting line transects during the breeding season are similar to point-count survey protocols (e.g., time of day, no surveys in high winds, etc.), and often, since point-count stations are typically placed in a line through a study area, data from line-transects and point-counts provide very similar estimates of relative abundance (Ralph and Scott 1981, Verner 1985).

Area Searches: Area searches are typically conducted during the non-breeding season, and involve a surveyor walking through an area using a consistent pace. The surveyor is not limited to staying at a point or walking a specific trail, but is free to roam through the area and to detect as many bird species and individuals as possible. As long as effort is consistent among different areas or habitats (e.g., amount of time per unit area), statistical comparisons are possible; however, this method is generally used only to obtain a species list and presence/absence data for targeted locations (Ralph et al. 1993). This method is not as efficient as point-counts or line transect surveys, and generally not recommended for monitoring purposes. However, this method is useful for nest searches and may incorporate monitoring of nesting success of selected species if desired (Ralph et al. 1993, Bart 2003).

Spot Mapping: Spot mapping is the most labor-intensive technique for monitoring bird populations. This method involves repeated visits to a specific area, and systematically walking through the area (each area is typically laid out in a grid format), where all birds are identified and located on maps. Accumulations of locations for specific birds on the study area map are considered an index of a defended territory, and these territories are delineated at the end of the season. From a spot mapping effort, all birds breeding in an area are known; therefore, the spot mapping method yields the best

estimate of density of all the survey methods. However, this method is almost exclusively used for the breeding season, and has little utility during other times of the year. Because of the labor required, this method usually focuses on only a few species rather than the entire bird community. A more detailed description of spot mapping can be found in Ralph et al. (1993) and the International Bird Census Committee (IBCC) (1970).

Figure 3. The use of mist nets is a commonly used method to capture birds, like this White-eyed Vireo (*Vireo griseus*), to measure and monitor numerous demographic attributes of bird populations. Photo credit: Mr. Giri Athrey.

Constant-effort Mist Netting and Banding: Population demographics and physiological health of bird populations are best determined through the actual capture and handling of target bird species (Figure 3). The use of mist nets is a well-established technique to safely capture most of the small North American passerines (DeSante 1992, Ralph et al. 1993). From mist net operations, information on age demographics, sex ratios, physiological condition of individuals and reproductive success can be obtained. Mist net captures, plus the banding or marking of individuals, can provide insights into differential survivorship from the previous year, and the degree of dispersal among age/sex classes and between habitat types. However, mist net operations are labor intensive and only cover a small area. Also, unlike other methods, federal banding and marking permits are required, and individual states may also require additional permits. Despite the limitations, mist netting operations are frequently used for long-term monitoring of songbird populations (e.g., Monitoring Avian Productivity and Survivorship Program [MAPS]) (DeSante 1992).

Evening Surveys/Tape Play-Back Surveys: Numerous crepuscular species are rarely detected during morning point-count or line-transect surveys, and may require different techniques to determine presence/absence or to obtain an estimate of abundance. Such species include many owls and nightjars (e.g., Whip-poor-will [*Caprimulugus vociferus*], Common Poorwill [*Phalaenoptilus nuttallii*]). Evening roadside surveys may suffice for assessing presence/absence or estimating relative abundance of these species. Although roadside surveys may often bias measures of bird populations (Ellingson and Lukacs 2003), logistic difficulties, especially during periods of poor light, may make surveys of crepuscular species away from roads and trails difficult. Several owl species (e.g., Eastern Screech Owl [*Otus asio*]) often respond well to calls and songs broadcast from a tape or CD player; therefore, incorporating a tape playback during evening point-counts may be useful to detect these species, and may provide a better estimate of relative abundance (Takats et al. 2001). Since tape playback procedures are often loud, the calls and songs can carry for some distance. In order to prevent double counting of species, survey stations may need to be 1.6 km apart (Takats et al. 2001). Survey routes should include at least 10 survey stations, and stations should be surveyed at least once a year during a period of peak vocalizations for owls present at a locality. Survey routes should be selected at random from available routes in a locality or region, and all survey stations should be georeferenced for future analyses of habitat relationships. Most owl surveys last between 5 and

13 minutes, and should include a 2-minute quiet period before a playback recording is used (Takats et al. 2001). A detailed, standardized method for monitoring owls is provided by Takats et al. (2001), and this procedure should also be appropriate for other nocturnal birds, as well.

Wetland / Riparian / Open Water Surveys

Marsh Species: Marsh species (e.g., rails and bitterns) are secretive birds that live in wetlands and aquatic environments. They forage, nest, and roost in areas of dense, emergent vegetation, particularly grasses, sedges, reeds, and cattails (*Typha* spp.) along the water's edge. Many of the marsh species in North America are currently experiencing population declines (e.g., American Bittern [*Botaurus lentiginous*], King Rail [*Rallus elegans*]) (Sauer et al. 2000), or are already listed as species of conservation concern because of long-term declines (e.g., Black Rail [*Laterallus jamaicensis*], Yellow Rail [*Coturnicops noveboracensis*], Limpkin [*Aramus guarauna*], and several western races of Clapper Rail [*R. longirostris*]) (U.S. Fish and Wildlife Service 2002). These birds, along with species of open-water and coastal birds (e.g., herons, egrets, gulls, and terns) (see below), are already the subject of local, regional and continental efforts to protect, conserve, and monitor existing populations (Howe et al. 2000, Kushlan et al. 2002, Conway and Gibbs 2005, Conway and Nadeau 2006).

Marsh species are difficult to detect either visually or aurally, and are therefore difficult to monitor. However, these species respond well to surveys that broadcast calls and songs, allowing researchers to obtain presence/absence information, estimate populations and assess detectability under different conditions (Conway and Nadeau 2006). Conway (2005) and Conway and Nadeau (2006) have developed a monitoring protocol that is currently under consideration as a standard protocol for international, national, regional, and local monitoring efforts for marsh bird populations. The monitoring protocol is consistent with CBM designs and objectives (Bart 2003), and is recommended for use by Corps managers with an interest in monitoring marsh birds on Corps projects. Key elements in the marsh bird monitoring protocol include:

(1) Surveys in freshwater, brackish, and saltwater marshes.
(2) Survey sites selected randomly out of a larger area context; ideally within the habitat, but edges and roads may be used if necessary.
(3) In most cases, survey areas will need 50 or more survey point stations to estimate population trends.
(4) Survey stations should be fixed and permanent, and surveyed at least three times annually during peak breeding period.
(5) Surveys can be conducted during the morning (30 min before sunrise until 10:00 am) or evening (4 hr before sunset) (timing will depend upon activity of species present).
(6) Each survey should be conducted during a 10-day window, and each window is separated by 7 days (e.g., in Washington, first surveys should be conducted between 1-10 May, second surveys between 17-27 May, and third surveys between 3-13 June).
(7) At each survey point, the survey begins with 5 min of passive (no call/song broadcast) count, followed by 30 sec of call/song broadcast of a primary species, followed by 30 sec of passive count, followed by 30 sec of call/song broadcast, and so forth, until all primary calls/songs of primary species at a specific location are broadcast.

(8) There are 13 primary species of continental importance that must be included in the survey protocol depending on the project locality: Black Rail, Least Bittern (*Ixobrychus exilis*), Yellow Rail, Sora (*Porzana carolina*), Virginia Rail (*R. limicola*), King Rail, Clapper Rail (*R. longirostris*), American Bittern, Common Moorhen (*Gallinula chloropus*), Purple Gallinule (*Porphyrio martinica*), American Coot (*Fulica americana*), Pied-billed Grebe (*Podilymbus podiceps*), and Limpkin.
(9) Specific species to be monitored will vary depending upon the region in which the monitoring effort is occurring.
(10) The chronological order of calls/songs will vary with survey area, but should be consistent among replicates and years of the monitoring effort.
(11) The order of the call/song broadcast should start with the least intrusive species (see Conway 2005).
(12) Additional species may be added according to the region being surveyed.
(13) Distance of species to observer should be recorded ($\leq$20 m, $\leq$60 m, and $\leq$100 m), so that detectability and density estimates can be calculated.
(14) During broadcast, placement and direction of broadcast should be consistent during each survey and replicate (direct broadcast over the emergent vegetation of the marsh; speaker should not be rotated during survey), and sound pressure should be 80-90 dB.

For further information and a detailed description of this standardized method, along with sample data sheets, refer to Conway (2005).

Open Water or Coastal Surveys: Numerous species use open water or coastal habitat, including many seabirds (e.g., shearwaters and petrels) and many colonial waterbirds (e.g., terns, gulls, herons, and pelicans). Many of these species utilize habitats along shoreline areas around coasts and harbors, lakes, reservoirs, and riverine areas, and are often a concern for interior and coastal Corps projects. On interior Corps projects, monitoring the breeding success of the endangered Interior Least Tern is often a priority (Lott 2006). Along coastal areas, numerous colonial waterbirds and seabirds may also be of importance to some Corps projects, and may need to be monitored. Similar to terrestrial and marsh birds, populations of seabirds and colonial waterbirds are also thought to be experiencing declines. However, little or no information is available on population trends for many of these species because of a lack of accurate, scientifically defensible data (Steinkamp et al. 2003). In an effort to establish standardized monitoring protocols for these birds, the U.S. Geological Survey (USGS) has established the Waterbird Monitoring Partnership (*http://www.pwrc.usgs.gov/cwb/manual/*). In addition, numerous national and international government agencies and private organizations have formed collaborative partnerships to establish the Waterbird Conservation Plan for the Americas (Kushlan et al. 2002).

Steinkamp et al. (2003) developed a series of standardized approaches to monitoring many of the waterbirds during the breeding season under a variety of conditions and habitats. These protocols call for data collection to create an index of abundance. Although these protocols focus on the breeding season, additional efforts are currently under way to establish methods appropriate for wintering and migratory seasons (Steinkamp et al. 2003). Furthermore, these methods are consistent with the CBM approach (e.g., Bart 2003), and should be adopted by Corps projects interested in monitoring these birds. Key elements in the seabird and colonial waterbird monitoring protocols include:

(1) Consideration of potential errors caused by variability, temporal variability, and detection probability.
(2) Development of monitoring methods based on nesting behavior and nesting habitats, with detailed standardized methods for various groups (groups include cliff nesting species, burrow nesting species, ground nesting species [whole colony counts and index counts], crevice nesting species, colonies in trees and shrubs, marsh nesting species, and pelagic species.
(3) Protocols provided for special circumstances involving specific species including the Pigeon Guillemot (*Cepphus columba*), Crested Auklet (*Aethia cristatella*), Least Auklet (*A. pusilla*), Horned Puffin (*Fratercula corniculata*), Marbled Murrelet (*Brachyramphus marmoratus*), Franklin's Gull (*Larus pipixcan*), Little Gull (*L. minutus*), Forster's Tern (*S. forsteri*), and Black Tern (*Childonias niger*).
(4) Recommendations for specific parameters to be measured for each species and species group to be monitored, including total individual adult counts, sub-sampling of adults, total nest counts, and indices based on samples of occupied nests.
(5) Recommendations on the best survey approach, plus pros and cons of each survey method; survey methods include counts by boat, counts by fixed-wing aircraft, counts by foot, and counts of nest sites using aerial photography.

Each method is presented with backing literature and detailed tables of average degree of error associated with each method (Steinkamp et al. 2003). For a recent approach to monitoring the national breeding population of the Interior Least Tern, refer to Lott (2006).

Shorebirds: As with other groups of birds, many shorebird species are experiencing population declines (Howe et al. 2000, Bart et al. 2005). Approximately 72 species of shorebirds are known to migrate, winter, or breed in North America. During the 1970s and 1980s, data from both the United States and Canada indicated declines for 16 of 26 species surveyed (Howe et al. 1989). Several breeding species of importance include the Snowy Plover (*C. alexandrinus*) and federally endangered Piping Plover. The Red Knot (*Calidris canutus*) is a species that depends upon available high-quality stop-over habitat during migration. Sharp declines of this species at migratory stop-over areas on the Delaware Bay have drawn attention to the importance of protecting and conserving habitat for migratory shorebirds (Harrington 2006). Wintering areas along the Gulf Coast are critical for many shorebirds, including the Piping Plover. Thus, monitoring shorebird populations may require numerous survey efforts during multiple seasons each year. Currently, shorebirds are monitored in North America through two continental survey efforts, the Maritimes Shorebird Survey (MSS) and the International Shorebird Survey (ISS). Both of these efforts use volunteers to systematically survey migration movement during the spring and fall. The Pacific Flyway Project in the western United States conducted surveys between 1988 and 1993, and focused on counting all birds in all wetlands simultaneously (e.g., on one weekend) (Howe et al. 2000). Also, the International Piping Plover Census is a single species survey effort that estimates the entire Piping Plover population every 5 years by surveying all known breeding locations of the species (U.S. Geological Survey 2006). While these efforts yield important information on the status of many shorebird species, many other species are poorly censused or missed altogether (Howe et al. 2000, Bart et al. 2005). In an effort to standardize and improve methods for monitoring shorebirds throughout the year, Bart et al. (2005) developed a comprehensive monitoring program for shorebirds at the regional and national levels. This program, "Program for Regional and International Shorebird Monitoring" (PRISM) has

developed a protocol for monitoring shorebirds in Canada and the United States (Bart et al. 2005). Information about PRISM and shorebird monitoring (see also Howe et al. 2000) can be found at *http://www.shorebirdworld.org/fromthefield/PRISM/PRISM1.htm*. Key elements of PRISM include:

(1) Methods for censusing shorebirds including by foot, boat, and aerial surveys.
(2) Methods for estimating population sizes from breeding season and migratory stop-over counts.
(3) Tabulation and discussion of difficulties of monitoring shorebirds during different seasons.
(4) Methods for determining detectability.
(5) Satisfaction of three goals of the Shorebird Monitoring Committee, and determination of species requiring more information on population size and trends.
(6) Recommended surveys of major migration staging areas and wintering areas to provide population estimates for some species.
(7) Methods that can be applied to single species, species groups, or multiple species surveys.

For further information on detailed shorebird monitoring protocols, refer to Howe et al. (2000) or Bart et al. (2005).

Abundance Indices or Density Estimates: Methods that estimate abundance through direct counts of detected birds assume that counts reflect a constant proportion of the total number of birds present during all habitats, seasons, and years (Ralph et al. 1993, Hutto and Young 2002, Rosenstock et al. 2002, Thompson 2002, Norvell et al. 2003, Bart 2005, Buckland 2006, Toms et al. 2006). For example, if bird counts within a particular area increase 50 percent during a monitoring period, it is assumed that this increase reflects an actual increase in the true population (Rosenstock et al. 2002, Thompson 2002, Norvell et al. 2003). However, since such an increase could reflect one of numerous factors, including an improvement in detection abilities of the surveyors, increased detectability of birds due to habitat changes (e.g., tree-thinning operations), or changes in weather patterns (e.g., increased frequency of frontal movements during migration counts), this assumption is probably rarely valid (Rosenstock et al. 2002, Thompson 2002, Norvell et al. 2003, Buckland 2006). Controversy has risen in scientific circles ranging from researchers who view abundance indices as inaccurate and potentially misleading measures of bird population trends (Rosenstock et al. 2002, Thompson 2002, Ellingson and Lukacs 2003, Norvell et al. 2003), to others who view such indices as the best approach for monitoring bird populations (Ralph et al. 1993; Huff et al. 2000; Hutto and Young 2002, 2003; Toms et al. 2006).

The best solution for correcting potential biases inherent in methods that create abundance indices is to calculate detectability estimates that can be applied to counts made by different observers, in different habitats, and at different times (Burnham et al. 1980, Rosenstock et al. 2002, Thompson 2002, Norvell et al. 2003, Ellingson and Lukacs 2003). These detectability estimates can then be used to adjust density estimates, reducing variability and increasing precision of population estimates (Burnham et al. 1980, Rosenstock et al. 2002, Norvell et al. 2003). However, distance sampling techniques often contain numerous assumptions that may also be invalid (e.g., that all birds within $\leq$ 20 m are detected), and variability in distance estimates by field personnel may increase potential biases (see Hutto and Young (2003) and Ellingson and Lukacs (2003) for contrasting discussions of these issues). Furthermore, distance sampling techniques require large sample sizes, which often are not possible for many rare species in large multi-species monitoring efforts (e.g.,

Hutto and Young 2002). Currently, there is no easy way to address all the concerns inherent in existing monitoring programs and available methods. The CBM approach advocates standardized methods that create abundance indices, yet these methods also include the option to incorporate distance sampling to allow calculations of detectability estimates if desired (Bart 2003, 2005). For selected species with suitable sample sizes, abundance indices and density estimates through detectability corrections can be compared and contrasted to ensure that meaningful data are being collected. Additionally, other approaches can be used, including the double sampling approach (e.g., using both spot-mapping and point counts to verify bird population trends) (Bart and Earnst 2002), or utilizing a double-observer approach to minimize biases of direct counts (Nichols et al. 2000).

SELECTED EXAMPLES OF CORPS AVIAN INVENTORY/MONITORING PROJECTS

New England District. Basic inventories using standardized point-count methods have been completed on lands surrounding several reservoir projects in the Connecticut River basin. In 2004, the District hired several college students under the Student Conservation Association (SCA) to assist with a variety of natural resources inventories. The U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory, conducted a three-day training workshop in May 2004 to teach SCA personnel how to perform avian sampling techniques.

Walla Walla District. In 2004, ERDC began conducting basic inventories and implementing a long-term monitoring program on numerous Habitat Management Units along the Snake and Columbia Rivers in southeastern Washington and Northeastern Oregon. The objectives of these surveys are to provide baseline information on seasonal bird communities in different habitats, better understand the potential impacts of an increasingly invasive shrub species (Russian Olive [*Elaeagnus angustifolia*]) on seasonal bird communities, and to provide management recommendations for these sites (POC: Dr. Richard A. Fischer, CEERD-EE-E).

Interior Least Tern Inventory and Monitoring. During the last two weeks of June and the first week of July 2005, numerous Corps Districts contributed to the first complete range-wide survey for the Federally endangered Interior Least Tern (Lott 2006). The primary objectives of this survey were to: 1) provide a minimum count of the number of adult Least Terns occurring on inland waterways and other suitable habitats during the breeding season, 2) document the range-wide distribution of nesting colonies, and 3) describe the types of habitats that are being used for nesting. Several of these same Districts have been conducting inventory and monitoring efforts on this species for several years to remain in compliance with a variety of biological opinions by the U.S. Fish and Wildlife Service (USFWS) on such systems as the Missouri and Arkansas Rivers (POC: Dr. Richard A. Fischer, CEERD-EE-E).

Bald Eagle Monitoring. The Corps has played a significant role in recovery efforts of the Bald Eagle (Fischer 2000). Bald Eagles breed, nest, migrate through, and winter on numerous Corps lakes and reservoirs throughout the United States. In cooperation with the USFWS, other federal and state agencies, and nongovernmental organizations, the Corps has been involved in a variety of activities in support of eagle conservation, including breeding season and mid-winter eagle surveys, management of breeding and wintering habitat, and education and outreach. For example, the Kansas City District (POC: Mike Watkins – CENWK-OD-TR) has been conducting mid-winter and nesting Bald Eagle surveys on Corps lakes within the District for over 10 years (Watkins and

Mulhern 1999). This work had led to a greater understanding of the importance of Corps lands in promoting sustainable populations of the Bald Eagle and has resulted in a multitude of publications on Bald Eagle recovery efforts in the Kansas City District (Watkins 1998).

Each January, the U.S. Geological Survey coordinates the Midwinter Bald Eagle Survey, in which several hundred individuals count eagles along standard, non-overlapping survey routes throughout the United States to establish an index to the total wintering Bald Eagle population in the lower 48 states, to determine eagle distribution during a standardized survey period, and to identify previously unrecognized areas of important winter habitat. Beginning in 2007, the Corps will take over the coordination and administration of the Midwinter Bald Eagle surveys (POC: Mr. Wade Eakle, CESPD-PDS-O).

Pittsburgh District. Winter bird surveys were conducted at 33 Corps facilities, including 16 reservoirs and 17 locks and dams on the Allegheny, Monongahela, and Ohio Rivers in 2003. Corps personnel collected data for wintering birds concurrent with the Midwinter Bald Eagle Surveys at 112 fixed points and continuous route stations. Corps personnel in the Pittsburgh District have been participating in the Winter Bird Survey since 1989 to inventory bird species and document trends in winter bird use at facilities within the District (Piehler 2003).

Coastal Bird Surveys. During the 1970s, extensive research on avian use of dredged material islands was conducted under the Corps' Dredged Material Research Program (DMRP) along significant portions of the Atlantic and Gulf coasts. More than 600,000 nesting colonial waterbirds of 35 species were detected (Soots and Landin 1978). Since then, numerous Corps Districts have been directly or indirectly involved in inventory and monitoring efforts of coastal birds. The Wilmington District has funded extensive surveys of colonial waterbirds at numerous dredged-material deposition sites along the coast. Annual surveys are conducted by Steve Calver (CESAS-PD-E) at the Savannah River Site, which is a large dredged-material disposal site in South Carolina. This site has been designated as an Important Bird Area by the Audubon Society. Dr. Ruth Beck (College of William and Mary) has conducted extensive seasonal avian inventories at the Corps' Craney Island disposal site since the 1970's. Craney Island is a dredged material confined disposal facility (CDF) located near the James and Elizabeth Rivers near Portsmouth, Virginia. In Florida, the Jacksonville District has taken a proactive approach to monitoring and managing dredged material operations to benefit migratory birds. The District has conducted frequent avian monitoring on dredged material islands to decrease conflicts between the presence of breeding birds and the disposal of dredged material. Several Corps Districts are involved in inventory and monitoring of Piping Plovers and other coastal shorebirds and waterbirds at and near large coastal engineering projects.

Mobile District — Carter's Lake, GA. Carters Lake provides a wide array of habitats that contribute to a diverse bird community. The lake impounds about 1300 ha of water on the Coosawatte River and the Reregulation Pool impounds 400 ha. Approximately 2000 ha of project land surround the lake. These habitats range from early successional, pine stands, mixed hardwoods, upland hardwoods, cove hardwoods, beaver ponds, rivers, streams, and lakes. Twenty-one point counts have been conducted in various habitats on the project each year since 1996. Approximately 45 species are recorded each year with over half being neotropical migrants. The project site is now

recognized as an Important Bird Area for the state of Georgia by the Audubon Society (POC: Paul Jastram, CESAM-OP-CA).

SUMMARY: Bird populations perform numerous important ecological functions and constitute a vital feature of our nation's biodiversity. Concern for many bird populations has risen over the course of several decades because of documented declines of many bird species. The U.S. Army Corps of Engineers manages over 450 lakes and reservoirs and over 38,600 km of shoreline and adjacent riparian habitats and these areas support many terrestrial, riparian, and aquatic birds during the breeding, wintering, and migratory seasons. The Corps is subject to U.S. Department of Defense and U.S. Army Regulations to protect and conserve bird populations. Moreover, the Corps is subject to terms of the DoD agreement with Partners In Flight to protect migratory bird species. A national effort, Coordinated Bird Monitoring (CBM), has been formed to improve monitoring and management of bird populations nationwide. This technical note summarizes the goals and objectives of the CBM approach and numerous field methods for inventorying and monitoring terrestrial, riparian, and aquatic bird populations. Corps projects are encouraged to incorporate the CBM approach to inventorying and monitoring bird populations on Corps lands. The CBM approach encompasses numerous standardized techniques to be utilized nationally to permit analyses of bird populations at the local, regional, and national scales. All the field methods presented provide techniques that estimate relative abundance, plus means for estimating detectability for density estimates to reduce sources of variability inherent in many monitoring methods. Efforts to inventory and monitor bird populations on Corps lands will enable the Corps to meet compliance requirements while providing information on population trends and the impacts of management operations on bird species and multi-species communities. Examples of current avian monitoring efforts in selected Corps Districts are provided.

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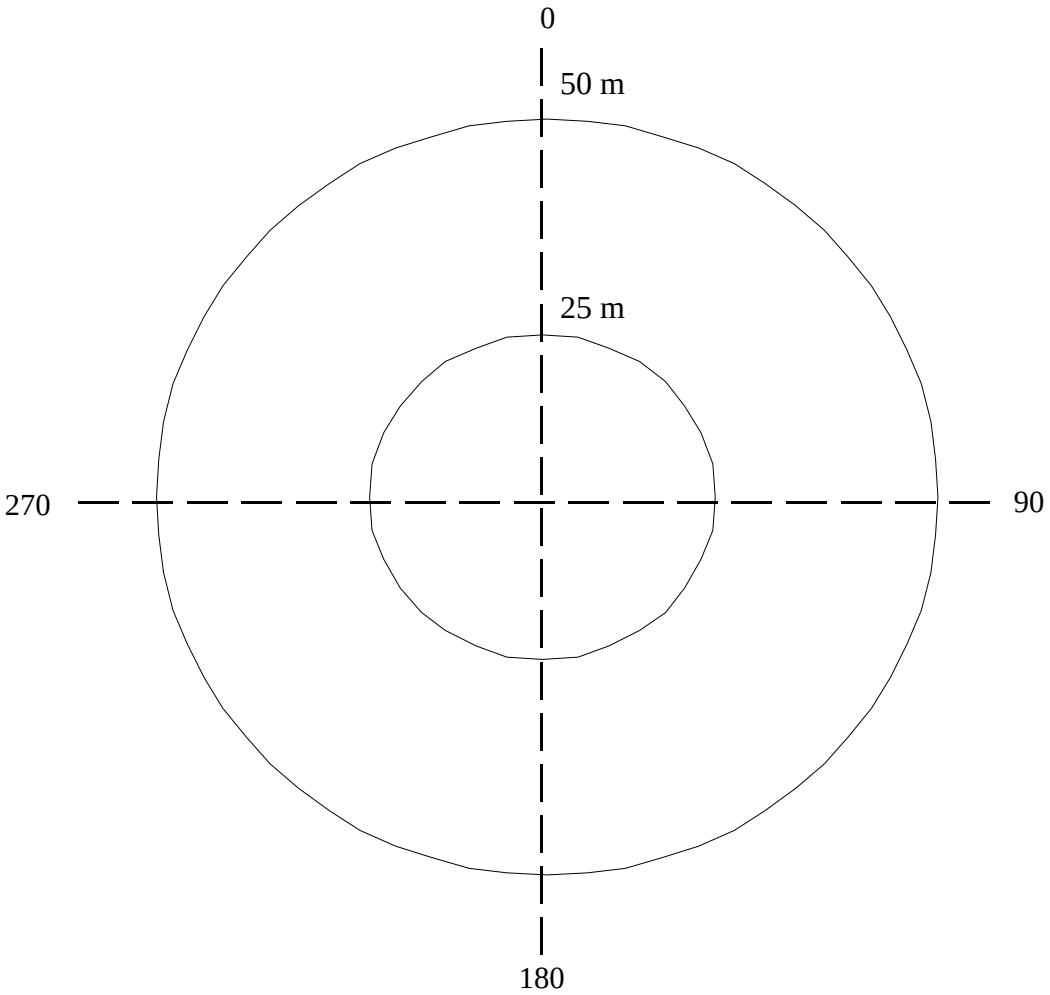
Appendix A. Sample Point-count Data Sheet for Avian Community Inventory and Monitoring.

POINT COUNT SURVEYS
SUMMER BREEDING

Observer _____

Area ☐☐☐☐ Habitat ☐☐☐☐☐☐☐☐ Month ☐☐ Day ☐☐ Year ☐☐☐☐ Time ☐☐☐☐ Point ☐☐☐ Visit ☐

Temp ☐☐ Wind ☐☐ Sky ☐☐ UTM Northing ☐☐☐☐☐☐☐ UTM Easting ☐☐☐☐☐☐☐



FLYOVERS: _____

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