



Landbird Monitoring Protocol for the National Capital Region Network

Revision 2.0, 2023



Hooded Warbler (*Setophaga citrina*), a forest-breeding bird encountered in the National Capital Region Network.
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Landbird monitoring protocol for the National Capital Region Network: Revision 2.0, 2023

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Abstract

The National Park Service (NPS) Inventory and Monitoring (I&M) Program conducts long-term ecological monitoring of high-priority indicator resources, deemed “vital signs.” This protocol documents the justification and procedure for monitoring breeding landbirds, a vital sign, in one of the 32 ecoregional I&M networks, the National Capital Region Network (NCRN). “Landbird” refers to the many avian species that spend the majority of their lives in a terrestrial environment, including tree-dwelling birds, perching birds or songbirds, raptors, and ground-feeding birds. Landbird monitoring in the National Capital Region is conducted in both forest and grassland habitats throughout all 11 park units in the network.

The mission of the National Park Service is to preserve “unimpaired the natural and cultural resources” of the over 85 million acres of park land throughout the U.S. This management objective underlies the impetus behind implementing long-term monitoring within each I&M network. The NPS established five common programmatic goals for all 32 networks within the I&M program as they plan, design, and implement integrated natural resource monitoring (Fancy et al. 2009). These goals are to: 1) determine the status and trends of selected indicators of park ecosystem conditions to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources; 2) provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management; 3) provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments; 4) provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment; and 5) provide a means of measuring progress towards performance goals.

Landbird monitoring in the NCRN employs point count surveys to quantify the avian populations within each park. Point counts are a commonly used survey method that allows for both visual and auditory detections of individual birds and allows multiple surveys to be conducted in the same morning. For the NCRN Landbird Monitoring Protocol, point count surveys are conducted annually within forest and grassland habitats from mid-May through July.

The NCRN Landbird Monitoring Protocol consists of a Narrative (this document) and Standard Operating Procedures (SOPs) outlining in-depth instructions for: (1) field season preparation, (2) field methods/sampling, (3) data analyses, and (4) database management.

List of Acronyms

ANTI: Antietam National Battlefield

BCI: Bird Community Index

CATO: Catoctin Mountain Park

CBSD: Common Birds in Steep Decline

CHOH: Chesapeake and Ohio Canal National Historical Park

GOF: Goodness-of-Fit

GWMP: George Washington Memorial Parkway

HAFF: Harpers Ferry National Historical Park

I&M: Inventory and Monitoring

IUCN: International Union for Conservation of Nature

LC: Least Concern

MANA: Manassas National Battlefield Park

MONO: Monocacy National Battlefield

NACE: National Capital Parks-East

NCRN: National Capital Region Network

NPS: National Park Service

NT: Near Threatened

PIF: Partners in Flight

PRWI: Prince William Forest Park

ROCR: Rock Creek Park

VU: Vulnerable

WOTR: Wolf Trap National Park for the Performing Arts

Yel-d: Yellow Watch List–In decline

Yel-r: Yellow Watch List–Restricted range

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Background and Objectives

The national parks of the National Capital Region Network (NCRN) occur within and surrounding one of the largest urban areas in the United States, Washington, DC, and host a diverse array of bird species across varied habitats. The 11 park units in the NCRN include: Antietam National Battlefield (ANTI), Catocin Mountain Park (CATO), Chesapeake and Ohio Canal National Historical Park (CHOH), George Washington Memorial Parkway (GWMP), Harpers Ferry National Historical Park (HAFE), Manassas National Battlefield Park (MANA), Monocacy National Battlefield (MONO), National Capital Parks-East (NACE), Prince William Forest Park (PRWI), Rock Creek Park (ROCR), and Wolf Trap National Park for the Performing Arts (WOTR). Urban settings dominate a number of the park units in the NCRN including: the eastern portion of CHOH (which runs through suburban Montgomery County, MD, and Georgetown, DC), NACE (Anacostia Park, Baltimore Washington Parkway, Fort Washington Park, Greenbelt Park, Oxon Cove Park and Oxon Hill Farm, and Piscataway Park), ROCR, WOTR, and the GWMP. Alternatively, parks embedded in more rural areas include CATO, HAFE, PRWI, and sections of CHOH. The battlefield parks of ANTI, HAFE, MANA, and MONO provide suitable habitat for both grassland and forest species. Collectively, these varied parks, established to protect historical, cultural, and/or natural resources, support a diverse bird community. In total, these parks consist of more than 250 tracts of protected lands, ranging in area from < 1 ha to > 5,000 ha (total area is > 31,000 ha). The parks are located across four physiographic provinces (Valley and Ridge, Blue Ridge, Piedmont, and Coastal Plain; Fenneman and Johnson 1946), and three Bird Conservation Regions (Appalachian Mountains, Piedmont, and New England/Mid-Atlantic), as defined by the North American Bird Conservation Initiative (Bird Studies Canada and NABCI 2014). These Bird Conservation Regions (BCRs) define ecologically distinct zones where bird communities are similar, and species can be assigned a conservation priority for the region.

Bird monitoring began in 2007 with the implementation of the forest bird monitoring protocol (Dawson and Efford 2014) by the University of Delaware. Beginning in 2014, grassland bird monitoring was implemented in MANA, and subsequently expanded to three additional battlefield parks (ANTI and MONO in 2015, and HAFE in 2016). This version of the protocol represents the current NCRN monitoring program, which spans forest and grassland habitats; as such the protocol name has been updated to “Landbird Monitoring Protocol for the National Capital Region Network.”

Rationale for Monitoring Landbirds

Birds are indispensable parts of our world. Birds function as ecosystem engineers, through construction of structures such as nests and tree holes that are then used by other organisms after being abandoned by the birds. Ecosystem condition or integrity can be estimated using avian community information, as birds are responsive to changes in the environment (O’Connell et al. 1998, Bryce et al. 2002, Chin et al. 2015, Ladin et al. 2016, Rempel et al. 2016). For example, changes detected in bird community metrics may be used to assess forest restoration or management success, when a degraded habitat is restored or when early successional habitat transitions into forest. Birds also provide benefits to humans through ecosystem services (Whelan et al. 2008). Examples of

ecosystem services provided by birds in the NCRN include carcass disposal by black (*Coragyps atratus*) and turkey vultures (*Cathartes aura*) and pest control by insectivores such as downy woodpecker (*Picoides pubescens*) on the invasive emerald ash borer (*Agrilus planipennis*; Sekercioglu 2006, Flower et al. 2014).

Long-term monitoring is essential for understanding changes in bird populations over time (Robbins et al. 1989) and garnering enough information to detect meaningful population changes often requires numerous years of continuous data. Long-term bird monitoring data coupled with explanatory covariates provide the opportunity to estimate the occupancy and/or abundance of a species and determine the factors that influence these population parameters.

The majority of parks in the NCRN are located in the greater Washington, DC, metro area, where some of the most rapid development in the U.S. occurs. As the areas surrounding National Parks are subsumed for human activity, these protected parks are increasingly important for local and regional bird conservation. Parks in urban areas have been shown to act as refuge for species, especially more specialized species unable to adapt to a completely human-dominated landscape (Carbó-Ramírez and Zuria 2011, Goodwin and Shriver 2014, Ladin et al. 2016). The associated loss, fragmentation, and degradation of natural habitats have led to regional or local declines in breeding bird populations (Sauer et al. 2017, Rosenberg et al. 2019), and the habitats in NCRN parks are becoming increasingly important to the preservation of the region's avifauna (Miller et al. 2016, 2018). Specifically, NCRN parks are dominated by deciduous forests supporting breeding forest birds, as well as managed grassland habitats that support breeding grassland birds.

Grasslands in North America are under threat, experiencing losses of over 95% due to agricultural and urban development (Askins 1999). In the eastern United States, grasslands occur in patchy remnants associated with pastures, airports, and hay or fallow fields (Zuckerberg et al. 2018). A suite of bird species is dependent on grassland ecosystems during the annual cycle, and as a group, these species have experienced steeper, more consistent, and widespread declines than any behavioral or ecological guild in the past 40 years (Vickery et al. 1999, Rosenberg et al. 2019). In eastern North America, 14 of 19 species of grassland and savanna birds have declined in the past 30+ years, with grasshopper sparrow (*Ammodramus savannarum*) declining at an estimated rate of 6% annually (Askins 1999). Better understanding how breeding grassland birds use specific habitats within the NCRN parks enables managers to make informed decisions about how best to manage grassland habitats to maximize their contribution to local and regional biodiversity conservation. For example, grassland habitats managed for agriculture in the mid-Atlantic can be coordinated to maximize yields while limiting impacts to breeding birds (Peterjohn 2006, Askins et al. 2007, Johnson et al. 2019). Staggering disturbance regimes such that not all grassland units are mowed or burned at the same time could provide a heterogeneous mix of 'time-since-disturbance' grasslands on the landscape.

Forests in the mid-Atlantic are also facing several threats, including heavy browsing pressure from white-tailed deer (*Odocoileus virginianus*; Schmit et al. 2020, Miller et al. 2023), tree diseases or insect pests (McConnell and Balci 2014, Jennings et al. 2017), and invasive exotic plants (Trammell et al. 2020, Miller et al. 2021), that affect their structure, condition, and composition, potentially

reducing their quality as habitat for some breeding bird species. Habitat loss from urbanization and urban sprawl are coupled with fragmentation (Irwin and Bockstael 2007), converting areas of once contiguous habitat into many smaller and often isolated patches, with over 70% of the Earth's forests now found to be within 1 km of the forest edge (Haddad et al. 2015). Positioned in the urban-suburban matrix, forests in the National Capital Region also experience loss and fragmentation from further human development. This fragmenting of the landscape increases proximity to edge habitat, leaving species more vulnerable to predation and nest parasitism (Wilcove 1985, Askins 1995, Donovan et al. 1997, Weinberg and Roth 1998) and local species extinction (Newmark 1991). With the increase in urbanization occurring worldwide, the protection of large tracts of forest provides an important service to species conservation.

Over 150 bird species have been detected during landbird monitoring since 2007. Included in the list of species detected within the NCRN are twenty-two landbird species of both regional and continental conservation concern (Table 1), as designated by Partners in Flight (Partners in Flight 2021). These conservation designations highlight species which should be focal species for monitoring efforts, to the extent possible. Multiple reasons for concern exist across their ranges, and management or other on-the-ground conservation actions are considered necessary to reverse long-term population declines or sustain vulnerable populations (Rosenberg et al. 2016). Two NCRN parks, CATO and CHOH, likely host a high proportion of the regional population of the Cerulean Warbler. Thirteen additional species have been designated as Stewardship Species for the Eastern Deciduous Forest Biome (Rosenberg et al. 2016), due to a high proportion of their global population nesting within the biome. Of these, management action is recommended to maintain populations of brown thrasher (*Toxostoma rufum*) and eastern towhee (*Pipilo erythrophthalmus*), both of which need or use shrub/successional habitats or disturbed areas within forests or along forest edges. Some of the priority species are relatively common at present, and distributed throughout the NCRN parks (e.g., wood thrush, red-bellied woodpecker, Acadian flycatcher, Carolina wren). Others are patchily distributed, in part because they have more specific habitat requirements. Prothonotary warblers, for example, are associated with swamps or river margins, and occur only in the parks bordering the Potomac or Anacostia Rivers (i.e., CHOH, GWMP, NACE). In contrast, worm-eating warblers are associated with dry slopes on ridges or in ravines and are more commonly found in CHOH, HAFE, and PRWI.

Table 1. List of 27 Partners in Flight (PIF) species of continental concern (Partners in Flight 2021) detected within the National Capital Region Network of national parks. PIF categories include Common Birds in Steep Decline (CBSD), and for Watch List species: declining (Yel-d) and restricted range (Yel-r). IUCN Red List Categories shown: Least Concern (LC), Near Threatened (NT), Vulnerable (VU).

Common Name	4-letter Alpha Code	Scientific Name	PIF Category	IUCN Red List Category
Bank Swallow	BANS	<i>Riparia riparia</i>	CBSD	LC
Black-billed Cuckoo	BBCU	<i>Coccyzus erythrophthalmus</i>	Watch List - Yel-d	LC
Blackpoll Warbler	BLPW	<i>Setophaga striata</i>	CBSD	NT
Bobolink	BOBO	<i>Dolichonyx oryzivorus</i>	Watch List - Yel-d	LC
Canada Warbler	CAWA	<i>Cardellina canadensis</i>	Watch List - Yel-d	LC
Cerulean Warbler	CERW	<i>Setophaga cerulea</i>	Watch List - Yel-d	VU
Chimney Swift	CHSW	<i>Chaetura pelagica</i>	Watch List - Yel-d	VU
Chuck-will's-widow	CWWI	<i>Antrostomus carolinensis</i>	CBSD	NT
Common Grackle	COGR	<i>Quiscalus quiscula</i>	CBSD	NT
Common Nighthawk	CONI	<i>Chordeiles minor</i>	CBSD	LC
Eastern Meadowlark	EAME	<i>Sturnella magna</i>	CBSD	NT
Field Sparrow	FISP	<i>Spizella pusilla</i>	CBSD	LC
Grasshopper Sparrow	GRSP	<i>Ammodramus savannarum</i>	CBSD	LC
Green Heron	GRHE	<i>Butorides virescens</i>	CBSD	LC
Henslow's Sparrow	HESP	<i>Centronyx henslowii</i>	Watch List - Yel-d	LC
Herring Gull	HERG	<i>Larus argentatus</i>	CBSD	LC
Horned Lark	HOLA	<i>Eremophila alpestris</i>	CBSD	LC
Kentucky Warbler	KEWA	<i>Geothlypis formosa</i>	Watch List - Yel-d	LC
Least Flycatcher	LEFL	<i>Empidonax minimus</i>	CBSD	LC
Northern Bobwhite	NOBO	<i>Colinus virginianus</i>	CBSD	NT
Olive-sided Flycatcher	OSFL	<i>Contopus cooperi</i>	Watch List - Yel-d	NT
Prairie Warbler	PRAW	<i>Setophaga discolor</i>	Watch List - Yel-d	LC
Prothonotary Warbler	PROW	<i>Protonotaria citrea</i>	Watch List - Yel-d	LC
Red-headed Woodpecker	RHOW	<i>Melanerpes erythrocephalus</i>	Watch List - Yel-d	LC
Rusty Blackbird	RUBL	<i>Euphagus carolinus</i>	CBSD	VU
Wood Thrush	WOTH	<i>Hylocichla mustelina</i>	Watch List - Yel-d	NT
Yellow-billed Cuckoo	YBCU	<i>Coccyzus americanus</i>	CBSD	LC

Measurable Objectives

The long-term goal of landbird monitoring in the NCRN is to track the status and trends of breeding landbirds within forest and grassland habitats throughout the network. Estimates of trends include density, occupancy, and abundance across parks and within the network as a whole. Through long-

term bird monitoring, we also aim to inform park management of the status of breeding birds within their respective parks and to advise management decisions that may impact avian populations.

The objectives of the NCRN Landbird Monitoring Protocol are to:

1. estimate network-wide and, when possible, park-wide status and trends in occupancy and abundance for breeding landbird species;
2. estimate network- and park-wide Forest Bird Community Integrity Indices.

Sampling Design

Background and History of Protocol Development

After a series of scoping meetings and workshops in the early 2000s, a suite of indicators representing the state of natural resources in the NCRN parks (called “vital signs”) were identified and prioritized, including forest breeding birds (NPS 2005). Dawson and Efford (2014) designed the initial NCRN forest bird monitoring protocol, which employs point count surveys at monitoring sites distributed throughout NCRN to estimate the forest bird species composition and abundance, and to track changes in these metrics over time. The forest bird monitoring protocol was first implemented in 2007 by the University of Delaware, which has overseen the implementation and revisions of the forest bird monitoring protocol since. Initially all bird monitoring points were in forest habitat and were designed to be co-located with NCRN's long-term forest vegetation monitoring plots (Schmit et al. 2014).

In response to park interests in gaining a better understanding of the breeding grassland bird populations, grassland points were added at four parks (initiated at MANA in 2014, ANTI and MONO in 2015, and HAFE in 2016) and have been included in the annual monitoring protocol since. As part of the 2023 protocol revision, we are formally including the grassland bird component into all aspects of the forest bird protocol and changing the name to “Landbird Monitoring Protocol for the National Capital Region Network.”

Sample Site Selection

Populations of forest and grassland-nesting birds are sampled and monitored at points on a grid developed for sampling terrestrial vital signs in NCRN parks (Koenen 2005). The grid of points, spaced at 250-m intervals, was generated and clipped with park boundaries in ArcGIS (Environmental Systems Research Institute, Redlands, CA).

For forest bird sample site selection, a Generalized Random-Tessellation Stratified (GRTS) design was applied to the network-wide grid, producing a spatially balanced, ordered list of randomly selected points (Stevens and Olsen 2004). Sites were ground-truthed to ensure they were appropriate for forest bird monitoring. Points were rejected if they were considered to be within incorrect habitat, unsafe for monitoring (e.g., steep slopes), or too difficult to access. This GRTS plot selection method was also used for forest vegetation monitoring, and many forest bird monitoring locations are co-located with vegetation monitoring points (Schmit et al. 2014). Occasionally, some plots were suitable for monitoring birds, but not vegetation, and in those cases, there is no overlap. In 2014, after eight years of sampling forest birds, additional points were added to ANTI, MONO, and WOTR as these parks had insufficient data for most analyses. For regional analysis (NCRN level) these additional points should be excluded, or the analysis should take into account the varying sampling intensity.

The sampling design for forest-nesting birds is informed not only by the GRTS design, but by the desire to obtain network-wide measures of abundance or density for a wide variety of bird species, some of which are sparsely or patchily distributed. Because of the inherent heterogeneity of the

NCRN parks, we believe that sampling at a large number of points from the GRTS frame is necessary to provide adequate coverage of particular habitats used by priority species. More intensive sampling at a smaller number of points risks missing some species altogether. Efficiently accomplishing this necessitates adopting a count-based sampling method, rather than using territory mapping or a capture-mark-recapture approach (e.g., Efford 2004, Efford et al. 2004) to estimate species' densities. As of 2023, there are 411 forest sampling points (Table 2).

Table 2. Count of monitoring points sampled within each park in the National Capital Region Network.

Park Name	Code	Forest Points	Grassland Points
Antietam National Battlefield	ANTI	14	100
Catoctin Mountain Park	CATO	45	0
Chesapeake and Ohio Canal National Historical Park	CHOH	85	0
George Washington Memorial Parkway	GWMP	27	0
Harpers Ferry National Historical Park	HAFE	20	29
Manassas National Battlefield Park	MANA	24	44
Monocacy National Battlefield	MONO	15	70
National Capital Parks-East	NACE	29	0
Prince William Forest Park	PRWI	132	0
Rock Creek Park	ROCR	14	0
Wolf Trap National Park for the Performing Arts	WOTR	6	0
National Capital Region Network (Total)	NCRN	411	243

For grassland bird sample site selection, we included all points in the grid that occurred in grassland habitat within each park. In MANA, points were randomly selected using the GRTS method due to logistical constraints. Points located on easement or other non-federal lands within park boundaries were excluded from the sample. As of 2023, there are 243 grassland sampling points (Table 2).

Note that due to differences in site selection methods, grassland birds are generally more intensely monitored than forest birds. As a result, the data from these two monitoring efforts should not be indiscriminately combined for analysis as this will result in a biased outcome.

Sampling Frequency and Methodology

Each year there are two monitoring visits to each sampling location during the breeding season (mid-May through July), each consisting of a 10-minute single-observer point count. This level of effort was determined to be sufficient to have 80% power to detect a 50% decline in 10 years for 52 forest-nesting bird species, including 14 of 19 priority species, if trend analyses are based on unadjusted count data, or for 30 species (six priority species) if based on density estimates (Dawson and Efford 2014). Following guidance from the initial NCRN bird monitoring protocol (Dawson and Efford 2014) we conducted a power analysis on the initial years of implementation (2007–2011) which indicated adequate power for species of conservation concern at the network level (Ladin and Shriver

2013). During initial years of grassland sampling (2014–2019), grassland sites were sampled three times annually. Following these six years of sampling, we conducted a power analysis to determine if the grassland bird sampling effort could detect changes in abundance over time with two annual visits. Results indicated that this level of sampling was appropriate and beginning in 2021 grassland sites were sampled twice per season.

Limitations of point count sampling include incomplete or imperfect detection, as often a species will not be detected at a site when present. Imperfect detection of birds creates a potential for artifactual variation due to variation in the detection probability rather than in population size or density. Consequently, field methods that allow for estimation of detection probabilities are strongly recommended (Royle et al. 2005, Schmidt et al. 2013) so that counts can be adjusted to obtain detection adjusted estimates of bird density or abundance; these include distance sampling (Buckland et al. 2009), double-observer counts (Nichols et al. 2000), and removal or time of detection sampling (Farnsworth et al. 2005, Alldredge et al. 2007). However, these methods each have a set of assumptions that can be difficult to meet, and require more complex data collection procedures, putting additional burdens upon (and requiring additional skills of) observers. Therefore, methodology was included in the NCRN Landbird Monitoring Protocol (i.e., distance classes and time intervals where first detected) which allow for the use of hierarchical models to estimate detection adjusted occupancy and abundance (MacKenzie et al. 2002, 2003, Royle et al. 2005).

Parks and Sampling Locations

The following sections provide a summary of sampling sites in the 11 park units where the NCRN Landbird Monitoring Protocol is implemented.

Antietam National Battlefield (ANTI)

Established in 1890 to commemorate the single bloodiest day of the American Civil War (23,110 casualties), Antietam National Battlefield, located in the Great Valley region of the Appalachian Ridge and Valley province, encompasses over 1,315 ha of farmland, pastures, woodlots and limestone forests and attracts approximately 205,000 visitors annually. Landbird monitoring occurs in 114 points within the park.

Catoctin Mountain Park (CATO)

Established in 1954, Catoctin Mountain Park is a 2,384 ha hardwood forest park located within the mountains of the Blue Ridge Province. The landbird sampling locations (n = 45) at Catoctin Mountain Park are all located in forest habitat as 95% of CATO is forested. Catoctin Mountain Park is part of a larger forested public lands complex that includes Cunningham Falls State Park, Frederick and Thurmont Watersheds, and Gambrill State Park.

Chesapeake and Ohio Canal National Historical Park (CHOH)

Established in 1961, the approximately 8,100 ha Chesapeake and Ohio Canal National Historical Park extends 296.9 kilometers (184.5 miles) along the Potomac River from Washington, DC, to Cumberland, MD. The Chesapeake and Ohio Canal National Historical Park supports a variety of habitats including forests, rocky outcrops, bluffs, floodplains, and wetlands with 85 forest bird sampling points located throughout.

George Washington Memorial Parkway (GWMP)

Established in 1933, the George Washington Memorial Parkway is a 25-mile-long (40 km) parkway that runs along the south bank of the Potomac River from Mount Vernon, Virginia, northwest to McLean, Virginia where 27 forest landbird sampling points are located.

Harpers Ferry National Historical Park (HAFE)

Established in 1944, Harpers Ferry National Historical Park (NHP) is a 1,481-ha park located at the confluence of the Potomac and Shenandoah rivers in and around Harpers Ferry, West Virginia. Harpers Ferry NHP is comprised of approximately 70% of eastern deciduous forest while the majority of the remaining habitat is agricultural leases or grasslands. Landbird monitoring occurs in 49 points within the park.

Manassas National Battlefield Park (MANA)

Established in 1936, Manassas National Battlefield Park encompasses approximately 1,600 ha of forest and grassland habitats. Landbird monitoring occurs in 68 points within the park.

Monocacy National Battlefield (MONO)

Established in 1934, Monocacy National Battlefield encompasses approximately 600 ha of forest and grassland habitats with landbird monitoring occurring in 85 points within the park.

National Capital Parks—East (NACE)

Established in 1965, is an administrative grouping of multiple National Park Service sites encompassing approximately 3,200 ha of land. Landbird monitoring occurs in 29 forest points within the administrative units of the park.

Prince William Forest Park (PRWI)

Established in 1936, Prince William Forest Park encompasses approximately 6,000 ha of forest habitat and is the largest protected natural area in the Washington, DC, metropolitan region. Landbird monitoring occurs in 132 forest points within the park.

Rock Creek Park (ROCR)

Established in 1890, Rock Creek Park is the third national park to be designated by the federal government and encompasses over 700 ha of protected land. Landbird monitoring occurs in 14 forest points within the park.

Wolf Trap National Park for the Performing Arts (WOTR)

Established in 1966, Wolf Trap National Park for the Performing Arts is the only national park dedicated to presenting the performing arts. Landbird monitoring occurs in six forest points within the park.

Field Methods

Field Season Schedule and Preparation

Monitoring described in this protocol occurs annually during the avian breeding season from mid-May through July. Successfully implementing data collection requires that planning begin in January, including: securing field housing and vehicles; advertising; interviewing and hiring field crews; preparing equipment; and ensuring the database is available for data entry during the field season. Details on each of these activities are described in SOP1: [Field Season Preparation](#).

Conducting Landbird Point Counts

Each point is surveyed twice each breeding season (15 May–30 July) by skilled and trained observers between 20-minutes before and five-hours after sunrise. Whenever possible, we avoid having the same observer visit the same site twice within a season. The basic procedure for conducting point counts is to first navigate to the site using maps and a GPS. Upon arrival at the point count station, the observer records a number of environmental conditions (see SOP2: [Field Data Collection](#)) and waits 1 minute before initiating the formal survey. After the 1-minute acclimation period, the observer conducts the 10-minute point count recording all species detected by sight and sound with the specified time and distance intervals. During point counts, the following information for each individual bird detected is recorded: 1) species identity; 2) type of detection (e.g., song, call, visual); 3) sex of the bird where discernible; 4) the distance band of first detection (0–25, 26–50, 51–100 m of the point count station); 5) time-interval of the first detection (0–2.5, 2.5–5, 5–7.5, 7.5–10 minutes); 6) whether the bird was identified in the first 3 minutes; and 7) if the bird is flying over the canopy at the time of detection. After the 10-minute count is complete, the observer navigates to the next station and repeats this process until the points for that morning have been surveyed. Note: in 2007, observers did not record whether individuals were detected within the first 3 minutes and from 2007–2018, observers only recorded two distance bands (0–50 and 51–100 m).

Details of conducting the point count survey as well as example data sheets are described in SOP2.

Data Management

Data management has evolved during the course of implementing the NCRN Landbird Monitoring Protocol and will continue to evolve as new data management and analytics tools are developed. Due to the COVID-19 pandemic, the 2020 field season was canceled, and no landbird data were collected during that year.

Database Design

From 2007 to 2022, we used a Microsoft Access database developed by the NCRN data manager using the NPS Database Template standard. The Microsoft Access database consisted of two files, a ‘front-end’ that included the data entry forms and a ‘back-end’ database where all of the data were stored. In 2023, a new database system was developed to move away from the MS Access ‘front-end’/‘back-end’ design and create a SQL online data entry/management system. The current SQL database system allows for multiple users to enter data simultaneously directly into the database hosted on a server which can be directly accessed by the data manager.

Data Entry, Verification, and Acceptance

Data are recorded on a physical data sheet by a single observer each survey. Data are entered into the database by a second technician, ideally on the same day it was collected. After entry, the data are then verified by a third technician. Following the field season, when all sampling events are entered and verified, data are then put through a QC process by the data manager (see SOP3: [Data Analysis](#)).

Metadata Procedures

Data documentation is an important step toward ensuring the value of long-term monitoring data as staff changes and cooperator changes are certain. Metadata is the structured information related to the content, quality, and explanation of the data fields. Metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata published for NCRN Landbird Protocol will conform to current IMD standards.

Data Dissemination

After all QC for a field season has been completed, an updated cumulative dataset will be published along with relevant metadata.

The majority of data analysis and reporting will be conducted by the Principal Investigator and network Ecologist. All completed reports and articles will be publicly available from multiple sources including the [NCRN website](#) and the [NPS DataStore](#).

Data Analysis

The primary goal of the analysis and reporting for the NCRN Landbird Monitoring Program is to provide status and trend estimates for breeding forest and grassland birds. Status and trend estimates are first calculated across all sampling locations within the NCRN (i.e., network-level status and trends). For some species and some parks, with adequate detections and sampling points within a park respectively, status and trends can be estimated at the park level. Given the inherent nature of long-term monitoring, the ability to estimate status and trends changes over time as more years of the protocol are implemented. The type of analyses also changes over time as the extent of data increases with each monitoring year. For example, when there were less than five years of NCRN Landbird Monitoring data available, we were able to ask questions regarding the effects of environmental noise on breeding bird occupancy (Goodwin and Shriver 2010). Goodwin and Shriver (2010) stratified a subset of monitoring locations into ‘loud’ and ‘quiet’ sites and found that bird species with low frequency songs were less likely to occupy ‘loud’ sites possibly due to song masking by traffic noise. Using the forest bird community integrity index, we compared the condition of the bird communities breeding within and outside of NCRN parks and showed that National Parks maintained higher integrity bird communities than outside the parks (Goodwin and Shriver 2014). As the NCRN Landbird Monitoring Program matured, we used nine years of data to describe patterns in the forest bird community integrity index and surrounding land cover (Ladin et al. 2016). Ladin et al. (2016) showed that the NCRN forest bird community was positively related to forest cover surrounding the sampling location. Estimates of population trends for the majority of breeding bird species across the NCRN and, when possible, within each park, have been summarized in technical reports after five and ten years of implementation (Ladin and Shriver 2013, 2021). These analyses, while the first of their kind for these parks, can be challenging to interpret given the number of species and varying patterns across parks and the network but do provide the foundation for initial status and trend estimates for birds breeding in NCRN parks. With the addition of grassland monitoring starting in 2014, we now have information related to the breeding grassland bird populations within these parks. Using five years of grassland survey data, we provided estimates of breeding grassland bird abundance and changes in abundance over time (Rickert 2021) and quantified the influence of grassland management and habitat type (i.e., row crop, pasture, meadow) on the occupancy and abundance of breeding grassland birds (Massa et al. 2024).

Estimating breeding bird status and trends is a primary objective of the NCRN Landbird Monitoring Protocol; however, determining the factors that are influencing those patterns can provide more compelling summaries and data interpretations. A first step in the process of attempting to explain the observed patterns in the NCRN breeding bird community was to compile co-variables that potentially influence breeding birds (Redmond 2023). Using NCRN Landbird Monitoring data from 2007–2019, Redmond (2023) estimated that wood thrush (*Hylocichla mustelina*) occupancy, colonization, and extinction rates were positively associated with the normalized difference vegetation index (NDVI) and forest cover. Using 13 years of data provided a novel opportunity to estimate the change in state (i.e., colonization/extinction) across the sampling locations over time and determine what co-variables influenced these state transitions. As the NCRN Landbird Monitoring

Protocol continues to mature, more analytical approaches can be applied to continue to elucidate patterns in the NCRN breeding bird community. See SOP3 for current data analyses approaches.

Data Reporting

Recommendations for Routine Reporting

Reporting has evolved over the course of implementing the NCRN Landbird Monitoring Protocol and includes Investigator Annual Reports (IARs), NPS technical reports (Ladin and Shriver 2013, 2021), resource briefs, and peer-reviewed publications in scientific journals (Goodwin and Shriver 2010, 2014, Ladin et al. 2016, Massa et al. 2024). IARs are produced annually as a requirement of park-issued permits for monitoring. IARs include a variety of data summaries meaningful for park managers, such as estimates of species richness, trend analyses for species with enough detections within a park to allow for park level trend estimation, and the forest bird community integrity index over time. IARs and annual summaries are re-run after each field season to provide a concise summary of the species richness, species trends at the network and park levels, and forest bird integrity on an annual basis.

Operational Requirements

Here we outline the roles, responsibilities, staff qualifications, schedule, and funding resources required to implement the NCRN Landbird Monitoring Protocol. Coordinating long-term ecological monitoring requires clear communication and cooperation among all parties involved. The NCRN staff and the co-operators communicate at least bi-monthly throughout the annual cycle to collaborate on data analyses and reporting as well as to plan for the implementation of each year landbird monitoring.

Tasks

See the IMD Science Information Lifecycle and IMD Reporting Guidance for an overview of regular, recurring activities related to protocol implementation. Key annual tasks associated with NCRN Landbird Monitoring Protocol implementation are summarized below.

- **Field Season Preparation:** Beginning early in the calendar year, the PM and PI ensure that field crews are hired and trained, housing is acquired, and that all field equipment are purchased, updated, or otherwise obtained. PI and network staff collaborate to review and finalize field season logistics (i.e., housing needs and travel routes). PI applies for park permits.
- **Prepare data management system for field season:** Data Manager (DM) ensures that the data management system is prepared for data entry. DM reviews data entry, QA (quality assurance) and verification procedure with the crew. DM also ensures that proper data backup will occur.
- **Field Crew Training:** PM ensures field crew are properly trained according to SOP2.
- **Data Collection:** Crew leader and field crew ensure that all field data is collected in sync with the most recent protocol and SOPs. Field data are collected on paper datasheets. Crew leader and field crew are responsible for regular communication with network and with parks to relay progress, safety concerns, and/or unanticipated challenges.
- **Data Entry:** Data is entered into the project database in accordance with the specific project data entry requirements. This task primarily falls on the field crew, but NCRN staff must ensure that the field crew is properly trained in using the project database.
- **Data QA/QC:** Data is verified and validated in accordance with NCRN QA/QC requirements.
- **Data Publication:** Ensure that data that have been completely verified and validated are stored safely and securely on NCRN servers. Responsible parties ensure that data is transferred from co-operators to NCRN office on the agreed upon transfer schedule. Co-operators must transfer deliverables in a timely manner and NCRN staff must ensure that deliverables are received and that they meet the required standards. Data archiving should take place at least annually once all the field data have been received. A data package should be published to the DataStore annually. The data package includes all data sets (both spatial and non-spatial) documented with Federal Geographic Data Committee (FGDC) metadata.

This requires completing the proper metadata forms in accordance with NCRN metadata standards. Co-operators must complete the metadata, but NCRN staff must review and ensure that metadata is received and completed properly.

- **Data Summary and Reporting:** PI will oversee routine data summaries and deliver these to network staff and parks in a variety of formats (IARs, Resource Briefs, ad-hoc analyses), to be identified by project team each implementation cycle.
- **Conduct annual Operational Review:** each IMD protocol must conduct an Operational Review annually (Mitchell et al. 2018).

Table 3 displays the annual tasks for each role in the Landbird Monitoring team.

Table 3. Tasks for landbird monitoring in the NCRN.

Role	Responsibilities
Protocol Lead - Principal Investigator (PI)/Project Manager (PM)	Implements protocol and provides oversight, administration, and budget tracking Protocol review/revision Prepares for field season including hiring and training field crew members/leaders Handles and coordinates data requests Assists data manager with data certification Data summary & analysis Reporting Leads annual Operational Review
Ecologist	Data summary & analysis Reporting Protocol review/revision
Data Manager (DM)	Advises on data and information management activities Develops and maintains compliant and functional data management systems Oversee annual data publication
Crew Lead	Plans and coordinates daily activities of the field crew, including communicating with park contacts to schedule visits Data collection Data entry, QA/QC, and quality control Recommend changes to protocol in terms of field operations as well as insight into database development during Operational Review
Field Crew	Data collection Data entry and QA/QC

Field Personnel: Requirements and Effort Distribution

At least three observers will be needed to conduct the required number of point-counts during the sampling period when nearly all forest and grassland breeding birds in the National Capital Region are settled on territories and actively vocalizing. The monitoring points are widely dispersed, and the limited time available for sampling (~8 weeks each year, mornings only) demands that they be sampled as efficiently as possible. Travel times can be greatly reduced by visiting points in close proximity in succession on one morning. To achieve balanced coverage of points by observers, the

two visits to points should be made by different observers, and all observers should conduct a similar number of 10-minute counts. The second visit to a point should occur at least two weeks after the first visit.

Field Personnel: Qualifications, Training, and Safety

Hiring qualified field technicians, providing appropriate training, and overseeing their data collection is critically important for the consistency and quality of the NCRN Landbird Monitoring Protocol (SOP1 and SOP2). Observer experience, attention to detail, training, and supervision are directly related to data quality. Hierarchical models used in the NCRN Landbird Monitoring Protocol data analyses can address some of the issues associated with observer variation, but the best practices dictate that field techs are screened prior to hiring, provided rigorous training, and evaluated periodically during the course of the field season for quality control.

Annual Workload and Schedule

Implementation of the NCRN Landbird Monitoring Protocol is a year-round responsibility. Data collection, management, analyses, and reporting must be completed every year along with budget and project management, and communications with parks and other interested parties. That said, the avian breeding season (May–July) of each year is the focal point for data collection and therefore dictates the annual schedule.

Beginning in January, the PI should ensure that field equipment is organized and ready for use; ensure that housing, vehicles, and park permits are arranged and available; and begin the hiring process. Training typically begins during the second or third week of May, with data collection beginning as soon as the PI determines that the crew is sufficiently trained and ready to begin. The field season, including training, is approximately eight weeks in length and is therefore typically completed by the first week of July. Table 4 outlines the annual schedule for implementing the NCRN Landbird Monitoring Protocol.

Table 4. Project timeline for implementing the NCRN Landbird Monitoring Protocol. A cell with an ‘X’ indicates a month when a given task takes place.

Tasks	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Field season preparation	X	X	–	–	–	–	–	–	–	–	–	–
Prepare DM system for field season	–	X	X	–	–	–	–	–	–	–	–	–
Field season training	–	–	–	–	X	–	–	–	–	–	–	–
Data collection, entry, and QA/QC	–	–	–	–	X	X	X	–	–	–	–	–
Operational Review	–	–	–	–	–	–	–	–	–	X	–	–
Data publication, summary, and reporting	X	X	X	X	X	X	X	X	X	X	X	X

Revising the Protocol

Protocol review and revision is a recurring task and includes input from all of those involved in the protocol implementation. See Inventory and Monitoring Division protocol review guidance for detailed guidance on protocol reviews and timelines (Mitchell et al. 2018). An annual Operational Review is held following each field season. A formal science review of the protocol should occur regularly, and include an evaluation of the narrative, SOPs, associated database, analyses and reports produced by the PI and external reviewers. The protocol narrative and each SOP contain a revision history log located at the beginning of each document that is completed for each change to explain reasons for changes, and to assign a new version number to the revised SOP or narrative. Careful documentation of changes to the protocol and a library of previous protocol versions are essential for maintaining consistency in data acquisition and for appropriate treatment of the data during data summary and analysis.

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