



Streamside Bird Monitoring Protocol for the Eastern Rivers and Mountains Network: Version 1.0

Natural Resource Report NPS/ERMN/NRR—2010/*DRAFT*



ON THE COVER

Louisiana Waterthrush (*Seiurus motacilla*) female feeding nestlings
Photograph by: James P. Mattsson

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Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.0	February 2010	Matt Marshall	Finalized as Version 1.0 - DRAFT	This protocol underwent peer review in February 2010 with all 3 peer reviewers recommending that the protocol be accepted after revision. Concurrently, the ERMN and ERMN member parks decided to discontinue the specialized Louisiana waterthrush surveys described herein. This decision led to a substantial revision of the protocol which is reflected in Version 2.0 (Marshall et al. 2012). All revisions suggested by the three peer reviewers were incorporated into Version 2.0 and are not reflected in this report. The primary purpose of finalizing this report (Version 1.0) in DRAFT form was to document the methods and SOPs for conducting the specialized “transect surveys” for Louisiana waterthrush between 2007 and 2010. Version 2.0 (Marshall et al. 2012) fully documents the rationale, methods, and SOPs for conducting avian point counts, hemlock condition scores, and other vegetation covariate data collection that occurred between 2007 and 2012.

Executive Summary

One of the primary objectives of the ecological monitoring (“vital signs”) program in the Eastern Rivers and Mountains Network (ERMN) is to evaluate status and trends in the condition of watersheds flowing into and through network parks. Louisiana Waterthrush (LOWA; *Seiurus motacilla*) monitoring was recognized as top priority at the network level during the vital signs prioritization process. This is the only bird species in the ERMN that depends on flowing waters for food and reproduction. LOWAs may respond to the composition of the benthic macroinvertebrate community given that they are more likely to occupy streams with a prey biomass containing a higher proportion of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera), many of which decline following human impacts such as sedimentation or acidification. LOWA are also more likely to occur along streams embedded within wide (e.g., > 80 m) tracts of older (e.g., > 50 years) deciduous or mixed deciduous-coniferous forest. Degradation of stream resources and/or fragmentation of forest resources may negatively impact LOWA. Thus, LOWA can serve as indicators of local riparian ecosystem integrity.

Monitoring other breeding bird species was identified initially as a lower priority vital sign for the ERMN. However, bird community monitoring can be efficiently and cost effectively incorporated into a LOWA monitoring protocol. Hence, the decision to develop a “streamside bird” protocol for both LOWA and other riparian breeding birds.

This protocol will provide the ERMN and park managers with comprehensive long-term data about the status and trends in the bird community along headwater streams including the possible effects of ecological and anthropogenic stressors. Permanent transects will be used to document changes in the bird community over time while accounting for species detectability. The justification, rationale, field methods, operational requirements, and data handling procedures are described herein and, in detail, in 10 standard operating procedures.

Availability of these monitoring data will increase manager knowledge, improve their ability to steward park resources, and allow them to adjust to and mitigate threats to the park’s riparian resources. The proposed monitoring strategy attempts to balance the immediate requirements of managers for current information against the necessity for insight into the changes occurring in bird communities and other watershed conditions over time.

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Faccio, S, and B. R. Mitchell. 2007. NETN breeding bird vital sign monitoring protocol. Version 2.00. Northeast Temperate Network, Woodstock, Vermont.

Gardali, T, D. Humple, M. Koenen, D. Press, W. Merkle, G. Geupel, G. Ballard, and S. Allen. 2006. San Francisco Bay Area Network Landbird Monitoring Protocol V3.0, Inventory and Monitoring Program. National Park Service and PRBO Conservation Science. Pacific West Region. San Francisco Bay Area Network.

McIntyre, C. L., R. Drum, K. L. Oakley, E. Debevec, T. L. McDonald, and N. Guldager. 2004. Passerine bird monitoring protocol for the Central Alaska Monitoring Network: Denali National Park and Preserve, Wrangel-St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve, Alaska. U.S. Department of the Interior, National Park Service, Denali Park, AK.

Route, B., T. J. Gostomski, M. Knutson, and N. Danz. 2007. Passerine Monitoring Protocol for National Parks of the Great Lakes Network (DRAFT). Internal working document, NPS-GLKN, Ashland, WI.

Background and Objectives

Background and History

Knowing the condition of natural resources in national parks is fundamental to the National Park Service's (NPS) mission to manage park resources "unimpaired for the enjoyment of future generations." Park managers are confronted with increasingly complex and challenging issues that require a broad-based understanding of the status and trends (see Appendix A for a glossary of key terms used in this protocol) of park resources as a basis for making decisions and working with other agencies and the public for the long-term protection of park ecosystems. The overall purpose of natural resource monitoring in parks is to develop scientifically sound information on the current status and long term trends in the composition, structure, and function of park ecosystems, and to determine how well current management practices are sustaining those ecosystems (Fancy et al. 2009). Use of monitoring information will increase confidence in manager's decisions and improve their ability to manage park resources, and will allow managers to confront and mitigate threats to the park and operate more effectively in legal and political arenas.

The NPS has initiated a long-term ecological monitoring program, known as "Vital Signs Monitoring", to provide the minimum infrastructure to allow more than 270 national park system units to identify and implement long-term monitoring of their highest-priority measurements of resource condition (Fancy et al. 2009). The term "vital signs" refers to a relatively small set of information-rich attributes that are used to track the overall condition or "health" of park natural resources and to provide early warning of situations that require intervention. Vital signs are defined as a subset of physical, chemical, and biological elements and processes of park ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values (Fancy et al. 2009). The broad-based, scientifically sound information obtained through this systems-based monitoring program will have multiple applications for management decision-making, research, education, and promoting public understanding of park resources.

NPS Vital Signs Monitoring is implemented programmatically through 32 ecoregional "networks" or groupings of parks linked by geography and shared natural resource characteristics. The network approach, through shared funding and professional staff, also facilitates collaboration, information sharing, and economies of scale.

To be relevant to current management issues and anticipate future issues, monitoring programs must be scientifically credible and produce quality data that is readily accessible and explicitly linked to management decision-making processes. To meet those criteria, explicitly stated goals and objectives are critical. The NPS established (Fancy et al. 2009) programmatic goals for all 32 networks as they plan, design, and implement integrated natural resource monitoring. 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.

The complex task of developing a monitoring program requires a front-end investment in planning and design to ensure that monitoring will meet the critical information needs of each park and produce scientifically credible data that are accessible to managers and other researchers in a timely manner. To that end, each network follows an explicit program development and implementation strategy (Fancy et al. 2009) that includes a peer reviewed monitoring plan (Marshall and Piekielek 2007) and a series of detailed, peer reviewed, monitoring protocols that describe how data are to be collected, managed, analyzed and reported (Oakley et al. 2003).

This protocol outlines the justification and procedures for long-term monitoring of Louisiana waterthrush and other streamside birds within the Eastern Rivers and Mountains Network (ERMN). The ERMN includes nine parks in New York, New Jersey, Pennsylvania, and West Virginia (Figure 1), which together encompass nearly 91,000 ha of land area and over 600 stream and river miles and within the parks' authorized boundaries. The network includes four smaller parks in central and southwestern Pennsylvania that have a primary cultural or historical focus. These cultural parks are Allegheny Portage Railroad National Historic Site (ALPO), Johnstown Flood National Memorial (JOFL), Fort Necessity National Battlefield (FONE), and Friendship Hill National Historic Site (FRHI). The remaining five larger parks preserve segments of large rivers and generally extend to the ridgetops surrounding the river section. These river parks are Upper Delaware Scenic and Recreational River (UPDE), Delaware Water Gap National Recreation Area (DEWA), New River Gorge National River (NERI), Gauley River National Recreation Area (GARI), and Bluestone National Scenic River (BLUE).

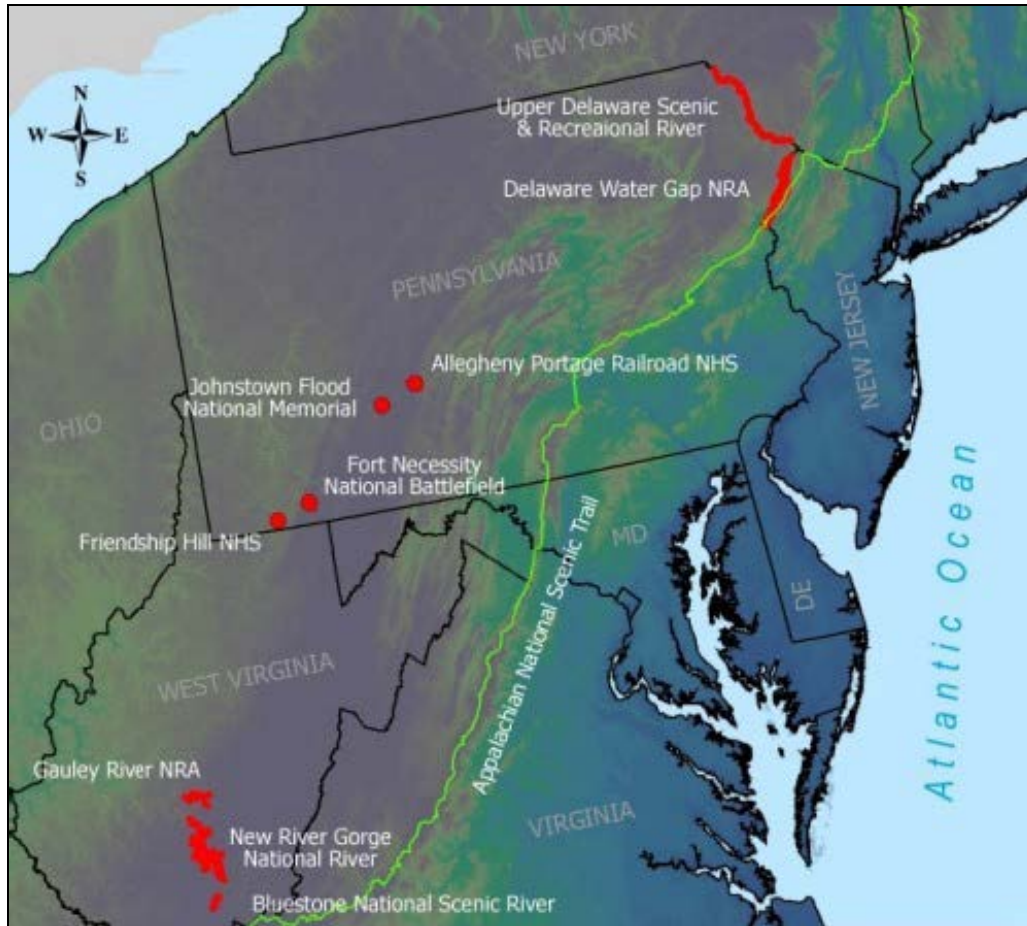


Figure 1. Location of parks in the Eastern Rivers and Mountains Network.

In addition to Louisiana waterthrush and other streamside birds, the ERMN is developing monitoring protocols for vegetation and soils (Perles et al. 2009), benthic macroinvertebrates (Tzilkowski et al. 2009), invasive species early detection (Keefer et al. 2009), surface water quality and flow, riparian plant communities, weather and climate, and air quality (Marshall and Piekielek 2007).

Target Users

This protocol will provide the ERMN and park managers with comprehensive long-term data about the status and trends in the bird community along tributary streams, including possible effects of ecological and anthropogenic stressors. Permanent transects will be used to document changes in the bird community over time while accounting for species detectability. Analyses of the bird monitoring data will eventually include landscape scale analyses (changes in landuse, cover types, patch size, fragmentation) and links to water quality, benthic macroinvertebrate community, climate and weather, and vegetation monitoring.

Availability of these monitoring data will increase manager knowledge, improve their ability to steward park resources, and allow them to adjust and mitigate threats to the park's aquatic resources. The proposed monitoring strategy attempts to balance the immediate requirements of managers for current information (i.e., data on how current values compare to regional status and

trends) against the necessity for insight into the changes occurring in bird communities and other watershed conditions over time.

Rationale for Monitoring Streamside Birds

One of the primary objectives of the ecological monitoring (“vital signs”) program in the ERMN is to evaluate status and trends in the condition of tributary watersheds flowing into and through these parks. Watershed condition is evaluated using measures of ecosystem integrity, including streamside bird species and communities, forest structure and composition, stream chemistry, and stream benthic macroinvertebrates. Currently, the primary stressors of interest across the ERMN include acid rain and nutrient deposition with concurrent changes in soil and water quality, habitat fragmentation and residential development outside park boundaries, over-browsing by white-tailed deer (*Odocoileus virginianus*) and invasions of non-native plants, pests and pathogens (Rentch 2005). Monitoring spatial and temporal patterns in the distribution (i.e., use, occupancy, and/or abundance) of select streamside bird species or guilds that are known to respond to landscape and patch-scale changes may serve as indicators of watershed conditions.

Louisiana Waterthrush (LOWA; *Seiurus motacilla*) monitoring was recognized as a top priority at the network level during the vital signs prioritization process by National Park Service (NPS) staff and other scientists (Marshall and Piekielek 2007). This is the only bird species in the ERMN that depends on flowing waters for food and reproduction (Robinson 1995). In particular, LOWAs may respond to the composition of the benthic macroinvertebrate community, as they are more likely to occupy streams with a prey biomass containing a higher proportion of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) (EPT; Mattsson et al. 2009). EPT taxa typically decline following human impacts such as sedimentation (Wood and Armitage 1997, Roy et al. 2003) or acidification (Mulholland et al. 1992, Griffith et al. 1995). Indeed, breeding density and pairing success of LOWAs is lower along acidified compared to circumneutral streams (Mulvihill et al. 2008). Furthermore, LOWAs are more likely to occur along streams embedded within wide (e.g., > 80 m) tracts of closed-canopy deciduous or mixed deciduous-coniferous forest (Mattsson 2006). Thus, LOWAs serve as indicators of local riparian ecosystem integrity. As such, standardized monitoring of LOWA population parameters is becoming widely accepted as a desirable component of an integrated long-term water quality and watershed condition monitoring program (Stucker 2000, Mattsson and Cooper 2006, Mulvihill et al. 2008).

Monitoring other breeding bird species was identified initially as a lower priority vital sign for the ERMN (Marshall and Piekielek 2007). However, bird community monitoring can be efficiently and cost effectively incorporated into a LOWA monitoring protocol. Hence, the decision to develop a “streamside bird” protocol for both LOWA and other riparian breeding birds. Birds can serve as cost-effective indicators of ecosystem condition due to their relative conspicuousness and responsiveness to ecological gradients (Roberge and Angelstam 2006). In particular, measuring the variation in spatial distributions of specific bird species or guilds can serve as a cost-effective means of assessing influences of landscape-scale conditions, including the extent of forest (O'Connell et al. 2000) and intensity of acidic deposition (Hames et al. 2002). Furthermore, individual species or guilds can serve as indicators of patch-scale conditions, such as forest structure, slope, and aspect (O'Connell et al. 2000).

Though all bird species expected to occur along tributary streams in the ERMN are included in the monitoring protocol (Appendix B), a subset of species generally referred to as songbirds (henceforth species; orders Columbiformes [doves and pigeons], Cuculiformes [cuckoos], Apodiformes [swifts and hummingbirds], Piciformes [woodpeckers], and Passeriformes [perching birds]) will primarily be used for monitoring watershed conditions in the ERMN due to their conspicuousness and demonstrated usefulness as indicators of ecological integrity (O'Connell et al. 2000). While collecting species-specific data across the songbird community can be efficient and cost-effective, analyzing status and trends separately for each species detected may be a poor use of resources. Instead, identifying individual species or guilds that reflect particular important elements of the ecosystem may be a more effective approach (e.g., O'Connell et al. 2000, Lussier et al. 2006).

Within the larger group of songbirds, for example, forest-interior obligate (FIO) species may be most sensitive to changes in forest condition (O'Connell et al. 2000). Following O'Connell et al. (1998, 2000), FIO species are defined as species that increase in density with increasing amount of forest in the landscape and are expected to be particularly responsive to ecosystem-level changes. The forest-interior guild can be further divided into patch-scale habitat, foraging, and nesting guilds. First, stream insectivores such as Acadian Flycatcher (*Empidonax virescens*) can capitalize on an abundance of emergent aquatic insects for food (Whitehead and Taylor 2002). Breeding density of Acadian flycatcher has also been shown to decrease with the amount of hemlock defoliation and may therefore reflect impacts by the hemlock wooly adelgid (Allen et al. 2009). Second, ground-nesters such as Ovenbird (*Seiurus aurocapillus*) are found most commonly in forest stands with a high degree of canopy closure (Van Horn and Donovan. 1994, Guenette and Villard 2005, but see Morton 2005, Betts et al. 2006). Third, shrub-nesters such as Hooded Warbler (*Wilsonia citrina*) (Greenberg and Lanham 2001, Heltzel and Leberg 2006) and Veery (*Catharus fuscescens*) (Kearns et al. 2006, Holmes and Pitt 2007) are found most often in older forests that include dense woody vegetation, and as such can serve as cost-effective indicators of vertical structure. Finally, conifer-associates such as Blue-headed Vireos are found more consistently in stands dominated by hemlock than those dominated by hardwoods (Ross et al. 2004). In contrast to forest-interior birds, synanthropic species (“associated with humans”) such as Brown-headed Cowbirds (*Molothrus ater*) are found more often in stands that are near lawns or other fields (Evans and Gates 1997, Howell et al. 2007). Therefore, monitoring spatial and temporal patterns in the distribution (i.e., use, occupancy, and/or abundance) of select streamside bird species or guilds (i.e., avian indicators) that are known to respond to landscape and patch-scale changes can serve as indicators of watershed conditions.

Measureable objectives

Monitoring objectives were established to meet the overarching vital signs programmatic goals and the rationale for monitoring the resource described above, while clearly articulating what will be measured and the desired outcome of the protocol. The monitoring objectives are coupled with sampling (or statistical) objectives (see Sampling Design section below) and, in time, with park management objectives (Elzinga et al. 1998) in an iterative process. In this way, monitoring will not be a stand alone activity, but instead an adaptive component of a larger process of natural resource management and decision making (Nichols and Williams 2006, Lovett et al.

2007). These objectives may also be refined at the park-specific level to fully integrate with management goals, possible management actions, and resource conditions.

The purpose of the streamside bird monitoring protocol is to quantify the spatiotemporal distribution of Louisiana waterthrush and other representative members of the bird community existing along ERMN tributaries to help maintain or improve condition of ERMN natural resources (i.e., flowing surface waters and the watersheds that they drain).

Primary monitoring objectives of the streamside bird protocol are to:

1. Estimate annual levels of stream reach-scale occupancy of focal bird species and guilds in selected ERMN watersheds.
2. Estimate trends among years in stream reach-scale occupancy of focal bird species and guilds in selected ERMN watersheds.
3. Calculate the Bird Community Index of biotic integrity for individual stream reaches in the ERMN.
4. Compare trends in occupancy of songbird species in selected ERMN watersheds to those of other studies in the region.

Secondary objectives are to relate changes in bird community metrics to conditions of the surrounding watershed in an effort to guide management actions in these parks. This can be accomplished by evaluating associations between bird metrics (described in Objectives 1-3 above) and other vital signs measuring watershed condition, including water quality, benthic macroinvertebrates, vegetation structure and composition, and landscape characteristics. These monitoring data will also allow comparisons of the status and trends in bird communities within the park/network to those within the region, based on results from the Breeding Bird Survey and Monitoring Avian Productivity and Survivorship programs.

Sampling Design

Rationale for selecting this sampling design

Many different survey methods have been used to quantify status or trends in bird populations, and many different monitoring programs are currently in place throughout North America to determine local, regional, or national trends in bird numbers (U.S. Geological Survey 2007). As the purpose of the streamside bird monitoring protocol is to quantify the spatiotemporal distribution of Louisiana waterthrush and other representative members of the bird community breeding along ERMN tributaries, the survey methods chosen for this protocol (described below) are designed to detect most of the forest breeding birds found along streams in the ERMN. Such detections allow quantification of a range metrics, including species or guild-specific use or occupancy, which at an appropriate scale can be interpreted as measures of relative abundance. In particular, streamside transects will be used to estimate relative abundance of Louisiana waterthrush. For the remaining species and guilds, variable-circular plot (VCP) point counts (henceforth, point counts) will be the primary method to estimate their spatiotemporal distribution (see below). Point counts are the mostly widely used and standardized methods to survey birds (Rosenstock et al. 2002). To account for imperfect detection of species during the surveys, the general approach described by MacKenzie and Royle (2005) to estimate occupancy at the scale of the point count station and of the streamside transect is employed.

A primary goal of the ERMN monitoring program is to provide information on the condition of watersheds and streams at a landscape or regional scale (i.e., park units). Given available resources and personnel, only a subset of the many ERMN tributary watersheds/streams will be sampled. Consequently, probabilistic designs are required to make unbiased and statistically rigorous inferences about watersheds/streams that were not sampled but meet the initial design conditions. A probabilistic sampling strategy was used to select most sites at DEWA and NERI (see below) but was not applicable at the other parks due to park characteristics (e.g., small parcel size, linear park shape, land ownership patterns). The criterion that was usually violated at the remaining parks was stream length, because stream sections at these parks were rarely ≥ 1 km long. For these remaining parks, a variety of factors were considered when choosing “targeted” sampling sites in consultation with park resource managers and the ERMN coordinator. Sampling effort is also expended at each park in proportion to the quantity (number and length) of streams within each park, and the process for choosing sampling locations was catered to each of these remaining parks due to the diverse characteristics (e.g., size, shape, ownership patterns) among parks throughout the network. The rationale for targeted sampling site selection is also described for the appropriate parks in the following sections.

The streamside bird monitoring protocol will not be implemented at two ERMN parks. One park, the Upper Delaware Scenic and Recreational River, is not included due to its limited area of publicly owned land. The authorized boundary of UPDE encompasses approximately 26,000 ha, however, only approximately 12 ha are owned by the National Park Service. Furthermore, only 5% of the land within the authorized boundary (approximately 1,225 ha in total) is held by public entities (i.e., federal government, Commonwealth of Pennsylvania, State of New York, or Sullivan County Parks). Establishing sampling sites on private lands involves some risk of lost

investment, as the National Park Service will have little control over the land use. In addition, data collected from plots on select publicly or privately owned parcels will not necessarily be representative of the park as a whole, making it difficult to draw inferences and guide management decisions (Urquhart et al. 1998). The second park, Johnstown Flood National Memorial, is also not included, because the South Fork of the Little Conemaugh River (SFLC), which flows through JOFL, is open canopy and will remain severely impaired due to acid mine drainage for the foreseeable future. Consequently, JOFL is not being sampled as part of the streamside bird monitoring program. The upstream-most tributary to the SFLCR is the only other perennial stream within NPS/JOFL property, which is also maintained as open canopy due to the cultural lakebed management and is also a prohibitively short stream segment.

Finally, collocation of streamside bird monitoring sites with sampling sites for other vital signs will provide multiple lines of evidence to better evaluate trends in ecosystem condition at a landscape scale with both terrestrial and aquatic components. For this reason, the sampling design and site selection scheme established for the streamside bird monitoring protocol is intended as a common design for the benthic macroinvertebrate sampling sites (Tzilkowski et al. 2009) and water quality sampling sites, along with providing the framework for estimating changing landscape characteristics (Marshall and Piekielek 2007). Watersheds were, therefore, selected to represent the range of underlying conditions in the ERMN while allowing evaluations of current stressors of interest (e.g., urbanization and acid precipitation). In particular, candidate watersheds at NERI and DEWA were stratified based on the following intrinsic conditions: 1) watershed area or size, 2) percent of watershed area preserved (i.e., within National Park Service or state park boundaries), 3) bedrock fertility, and 4) watershed topography. Each of these four intrinsic conditions, fully described below, have demonstrated direct or indirect effects on water quality parameters, benthic macroinvertebrate communities, and/or vegetation characteristics that could also ultimately drive the distribution of streamside bird communities.

Considerable discussion on these design considerations (and the field methods) occurred during two workshops in January 2007 among scientists and resource managers from the ERMN, NPS Water Resource Division, U.S. Geological Survey (USGS), The Pennsylvania State University, University of Georgia, Powdermill Nature Reserve, and Oklahoma State University (Mattsson 2007, NPS 2007).

The sections below describe in detail how these initial goals and considerations were incorporated into the sampling design. Components of this protocol sampling design are: (1) spatial design or site selection – sample locations and the area of statistical inference, (2) revisit design – frequency of site visits and replication, and (3) response design – what data are collected and the methods to do so (see “Field Methods” below).

Site selection

Site selection occurred in two stages: 1) candidate watersheds were identified and selected for sampling (see “Random-stratified site selection in NERI and DEWA” and “Targeted site selection in ALPO, FONE, FRHI, GARI, and BLUE” below), and 2) a “point transect” was established for bird monitoring in the selected watersheds.

The sampling unit for the streamside bird monitoring protocol is the “stream reach”, which for this protocol is defined as a 1-km length of stream along which a streamside transect is established on NPS property within the authorized boundary. This streamside transect is further divided into four 250-m intervals, within which use and occupancy by Louisiana waterthrush is estimated. Variable circular plot (VCP) point count stations are established along each streamside transect (5 point count stations spaced 250 m apart; henceforth, point-transect) to estimate the spatiotemporal distribution of the remaining bird species and guilds. Point-transects are synonymous with “sampling site” in this protocol (Figure 2), however individual count circles and transect intervals are considered sampling units in some analyses. See “Field Methods” and “Data Analysis” for how data will be collected and analyzed.

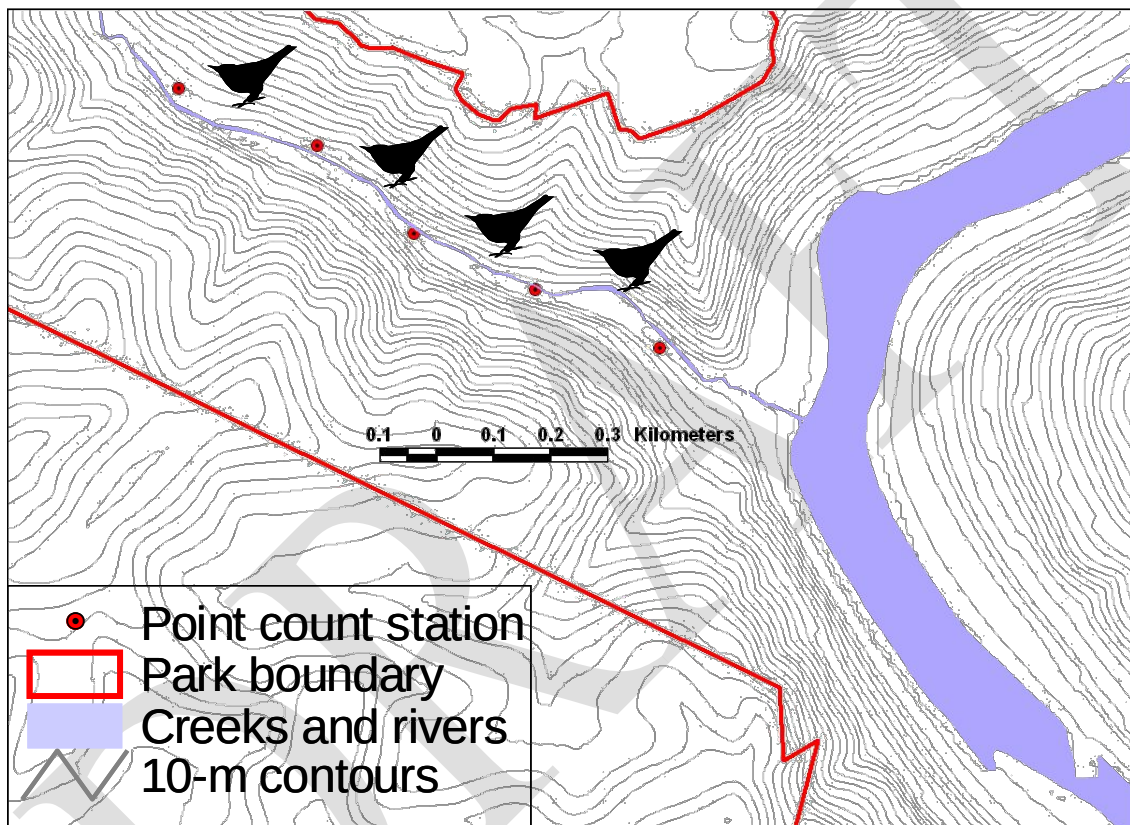


Figure 2. Example of a streamside bird monitoring sampling site, which consists of a 1-km streamside point transect with five point-count stations that delineate four 250-m intervals (indicated by LOWA silhouettes). This site depicted is Arbuckle Creek at NERI.

Random-stratified site selection in NERI and DEWA

Sampling Frame: The sampling frame (and, hence, the area to which inferences can be made) in the two largest parks of the ERMN, NERI and DEWA, consists of all tributary watersheds that meet the following criteria (henceforth, candidate watersheds): 1) ≥ 1 km of stream length within park boundaries, and 2) 1- 99.9 km² drainage area, which are expected to contain streams under closed canopy and are perennial throughout the spring and early summer.

Many watersheds contain short (i.e., < 1 km) segments of stream of particular size categories (see “Watershed Selection Process”) that flow through the ERMN parks. To allow sufficient

space for establishing streamside transects, watersheds with < 1 km of stream within the federally authorized boundary are excluded. In general, Digital Elevation Model (DEM) -based stream lines were used to measure stream length. In DEWA, however, lower-gradient streams were better represented by the National Hydrography Dataset (NHD; U.S. Geological Survey 2004b), which is based on digitized aerial photographs (1:24,000), when compared to the DEM-based stream map. Therefore, the NHD-derived stream was used when the NHD disagrees substantially (>20 m) from the DEM-based stream lines. In addition to 12 unnamed tributaries, the following tributaries were excluded from sampling in NERI due to the stream-length criterion alone: Sandylick Branch, Rush Run, Penfield Branch, Meadow Fork, Kates Branch (near Sandstone Falls), Craig Branch, and Big Stoney Creek. In addition to 7 unnamed tributaries, the following tributaries were excluded from sampling in DEWA due to the stream-length criterion alone: Crawford Branch, Mountain Run, Sawkill Creek, Shimers Brook, Tillman Brook.

Large, open-canopy creeks and rivers (catchment area $\geq 100 \text{ km}^2$) were excluded from the streamside bird monitoring effort, as these often host avian communities that are quite different than those found along closed-canopy tributaries (i.e., waterbirds and edge-associated species, as opposed to forest-interior songbirds). Furthermore, these larger, deeper waterways present great challenges for safe traversal on foot. In NERI, the excluded open-canopy creeks and rivers were Lick Creek, Piney Creek, Dunloup Creek, Glade Creek (downstream of Quinimont, WV), lower portion of Manns Creek, and New River. In DEWA, the excluded open-canopy creeks and rivers were Flat Brook, Bushkill Creek, and Delaware River.

These candidate watersheds were then stratified based on the four intrinsic conditions described below. In particular, criteria for site selection include only those watershed features that remain stable through time, allowing managers to more readily identify impacts from changes such as increases in acid rain and urbanization. A stratified random sampling design is required to make unbiased inferences about watersheds that were not sampled but meet the stratification conditions. Sampling a sufficient number of watersheds in each stratum will therefore allow managers to make inferences about entire strata.

Stratification Scheme: As watershed size increases, abiotic and biotic characteristics change in a predictable manner on a log-10 scale, including increased flow volume and extent of flooding, reduced size of sediment and other structures in the stream channel, increased abundance and species richness of benthic macroinvertebrate communities, and increased predominance of flood-tolerant vegetation along stream margins (Vannote et al. 1980, Church 2002, Klemm et al. 2002). Sizes of watersheds were estimated based on a 10-m DEM (DEM; U.S. Geological Survey 2004a). In particular, once watersheds were delineated, the number of cells that flow into any focal point within a watershed can be converted into a measure of catchment area for that point. These watershed boundaries were then used to generate watershed-specific statistics for site selection (Figures 3-8). For sampling, closed-canopy watersheds were defined initially on the log-10 scale as small (<1 km^2), medium (1.0-9.9 km^2), and large (10-99.9 km^2 ; Table 1). Based on current literature (Paybins 2003), small watersheds in the ERMN are expected to contain only ephemeral streams. Small watersheds, therefore, were also excluded from the streamside bird monitoring program.

Lower amounts of protected area in a watershed provide more opportunities for urbanization. Such disturbances can lead to increased sedimentation or eutrophication and reduced macroinvertebrate community integrity of downstream ecosystems, and these impacts become most evident beyond 10% urban development (Roy et al. 2003, King et al. 2005, Lussier et al. 2006). Percent of watershed preserved is estimated by dividing the watershed area within federal or state park ownership by the total area of that watershed. For sampling, watersheds were classified as having high ($\geq 90\%$) or low ($< 90\%$) amount of preserved land (Table 1).

Certain geologic formations affect acid-neutralizing capacity and other physical and chemical aspects of surface waters. The degree to which surface waters that drain across these formations are sensitive to acid precipitation is known as bedrock fertility (Williard et al. 2005, Snyder et al. 2006). More fertile bedrock has lower buffering capacity and therefore streams that drain from such bedrock are more susceptible to acidification. In NERI, three geological types have been mapped at the 1:250 000 scale, including shale, sandstone, and shale/sandstone (Figure 5; Nicholson et al. 2005). Sandstone has approximately half the bedrock fertility of shale, and so areas within watersheds receive bedrock fertility scores as follows: shale = 1, sandstone/shale = 0.5, and sandstone = 0. In DEWA, however, 22 geology types occur based on a map for Pennsylvania at the 1:250 000 scale (Pennsylvania Bureau of Topographic and Geologic Survey 2001) and a map for New Jersey at the 1:100 000 scale (New Jersey Department of Environmental Protection 2007). These maps were combined and each geology type within DEWA was assigned a score from 1 to 5, representing increasing levels of bedrock fertility (Figure 6; Table 2). Bedrock fertility for watersheds in these parks is therefore estimated by calculating the area-weighted mean bedrock fertility (AWMBF) value for each watershed. As there were no a priori reasons to differentially weight certain geology types, watersheds were classified for sampling based on this AWMBF as having high ($\geq$ AWMBF) or low ($<$ AWMBF) bedrock fertility (Table 1).

Watershed topography largely regulates flows and resultant stream morphology, including channel length/width ratios and distribution of sediment sizes (Church 2002). Such topography can be quantified from a 10-m DEM (U.S. Geological Survey 2004a) by calculating the means and standard deviations of watershed elevation and of watershed slope. Area-weighted standard deviation of elevation (AWSDE; termed “relief”) is the most representative of watershed topography in both NERI and DEWA (Figures 7 and 8), as it has the highest Pearson’s correlation statistic in a cross-correlation matrix of these four metrics (Table 3; SAS Institute Inc 2004). Topography was therefore estimated by calculating the area-weighted mean relief. As there were no a priori reasons to do otherwise, watersheds were classified for sampling based on AWSDE as having low ($<$ AWSDE) or high ($\geq$ AWSDE) relief (Table 1).

Table 1. Stratification system for watersheds in New River Gorge National River (NERI) and Delaware Water Gap National Recreation Area (DEWA) of the Eastern Rivers and Mountains Network.

Classification criteria	Data Source/GIS layers	Literature support	Strata	
			Low	High
Tributary watershed area (km ²)	10-m DEM	Klemm et al. 2002	1.0-9.9	10-99.9
% Watershed preserved	NPS authorized boundary, state park/forest lands	Roy et al. 2003 King et al. 2005 Lussier et al. 2006	<90	≥90
Bedrock fertility ^{a,b}	Bedrock geology	Williard et al. 2005 Snyder et al. 2006	< 2.37; < 0.138	≥ 2.37; ≥ 0.138
Relief ^a	10-m DEM	Church 2002	< 54.9; < 81.3	≥ 54.9; ≥ 81.3

^a Values reported separately as standard deviation of elevation (m) for each park unit: DEWA; NERI

^b Area-weighted mean scores based on two classification systems : 5 classes for DEWA and 3 classes for NERI.

Table 2. Bedrock fertility scores based on geological formations in DEWA (Pennsylvania Bureau of Topographic and Geologic Survey 2001, New Jersey Department of Environmental Protection 2007, Perles pers. comm.).

Rank	Bedrock formation
1	Shawangunk Formation, Sandstone
2	Trimmers Rock Formation, siltstone
2	Martinsburg Formation, shale, Graywacke
2	Bloomsburg Red Beds, shale, siltstone
2	Ramseyburg Member, graywacke sandstone
3	Mahantango Formation, shale
3	Marcellus Shale
3	Esopus Formation, shaly to sandy siltstone
3	Oriskany Group, calcareous siltstone
3	Port Ewen Shale, calcareous siltstone
4	Buttermilk Falls Limestone through Esopus Formation, undivided, siliceous sandstone
4	Ridgeley Formation through Coeymans Formation, undivided, sandstone
4	Decker Formation through Poxono Island Formation, undivided, calcareous sandstone
4	Rondout and Decker Formations, undivided, limestone
4	Schoharie Formation, calcareous siltstone
5	Bossardville Limestone
5	Buttermilk Falls Limestone
5	Kalkberg Limestone, Coeymans Limestone, Manlius Limestone, undivided
5	Minisink Limestone and New Scotland Formation, undivided, argillaceous limestone
5	Poxono Island Formation, dolomite

Table 3. Pearson correlation matrix of summary statistics describing topography of candidate watersheds, based on a 10-m digital elevation model in two national parks of the ERMN.

	Slope			Elevation				
Statistic	Mean	SD ^a	CV ^b	Mean	SD	CV	Park mean	Global mean
New River Gorge National River (NERI)								
Slope								
Mean	1	0.24	-0.79	-0.16	0.58	0.75	0.27	0.41
SD	0.24	1	0.34	0.31	0.36	0.26	0.42	0.49
CV	-0.79	0.34	1	0.27	-0.34	-0.52	-0.01	0.14
Elevation								
Mean	-0.16	0.31	0.27	1	0.36	-0.01	0.3	0.27
SD	0.58	0.36	-0.34	0.36	1	0.91	0.48	0.52
CV	0.75	0.26	-0.52	-0.01	0.91	1	0.4	0.47
Delaware Water Gap National Recreation Area (DEWA)								
Slope								
Mean	1	0.86	0.1	0.13	0.56	0.62	0.54	0.41
SD	0.86	1	0.57	-0.06	0.42	0.62	0.57	0.49
CV	0.1	0.57	1	-0.21	0.02	0.25	0.29	0.14
Elevation								
Mean	0.13	-0.06	-0.21	1	0.59	-0.03	0.24	0.27
SD	0.56	0.42	0.02	0.59	1	0.77	0.56	0.52
CV	0.62	0.62	0.25	-0.03	0.77	1	0.54	0.47

^a Standard deviation.

^b Coefficient of variation = SD/mean.

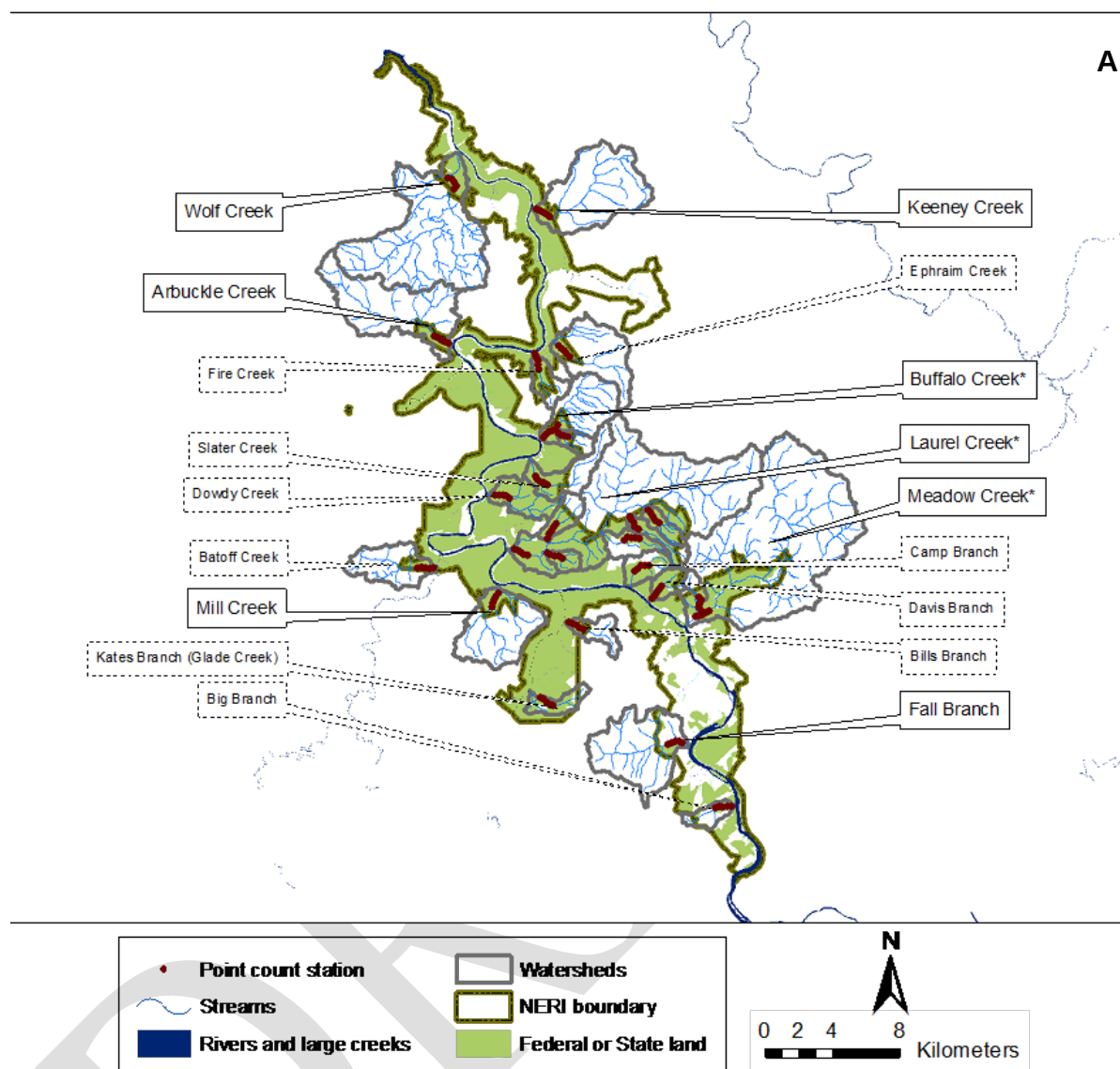
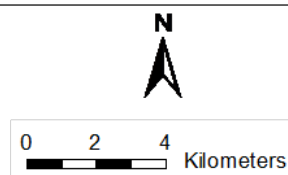
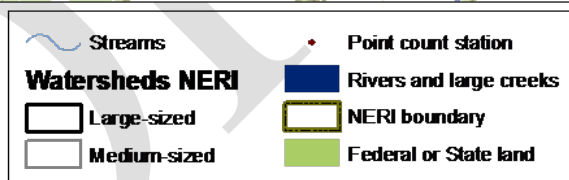
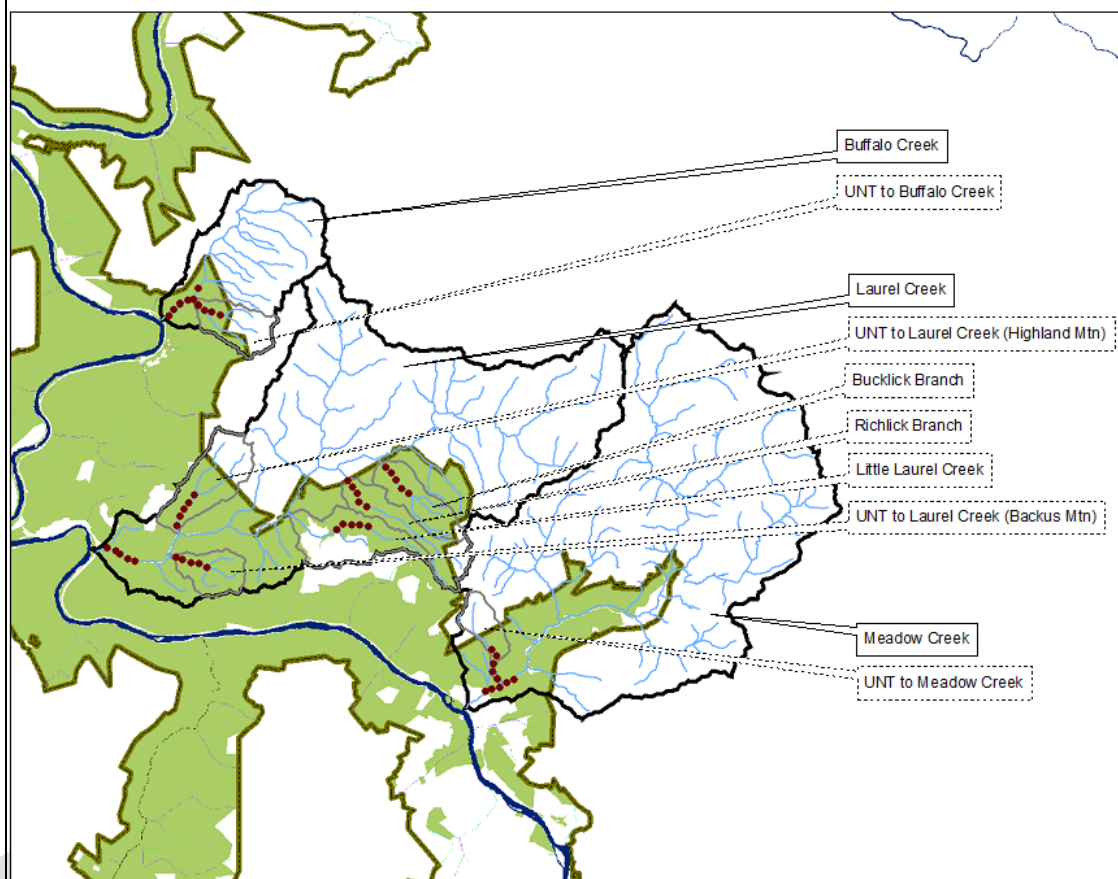


Figure 3. Point transects established along tributary watersheds of NERI (A), including those that are nested within one another (B). Solid and dashed borders around labels represent large- (10-99.9 km²) and medium-sized (1-9.99 km²) watersheds, respectively. * = Large-sized watershed contains at least one sampled medium-sized watershed (shown in B).

B



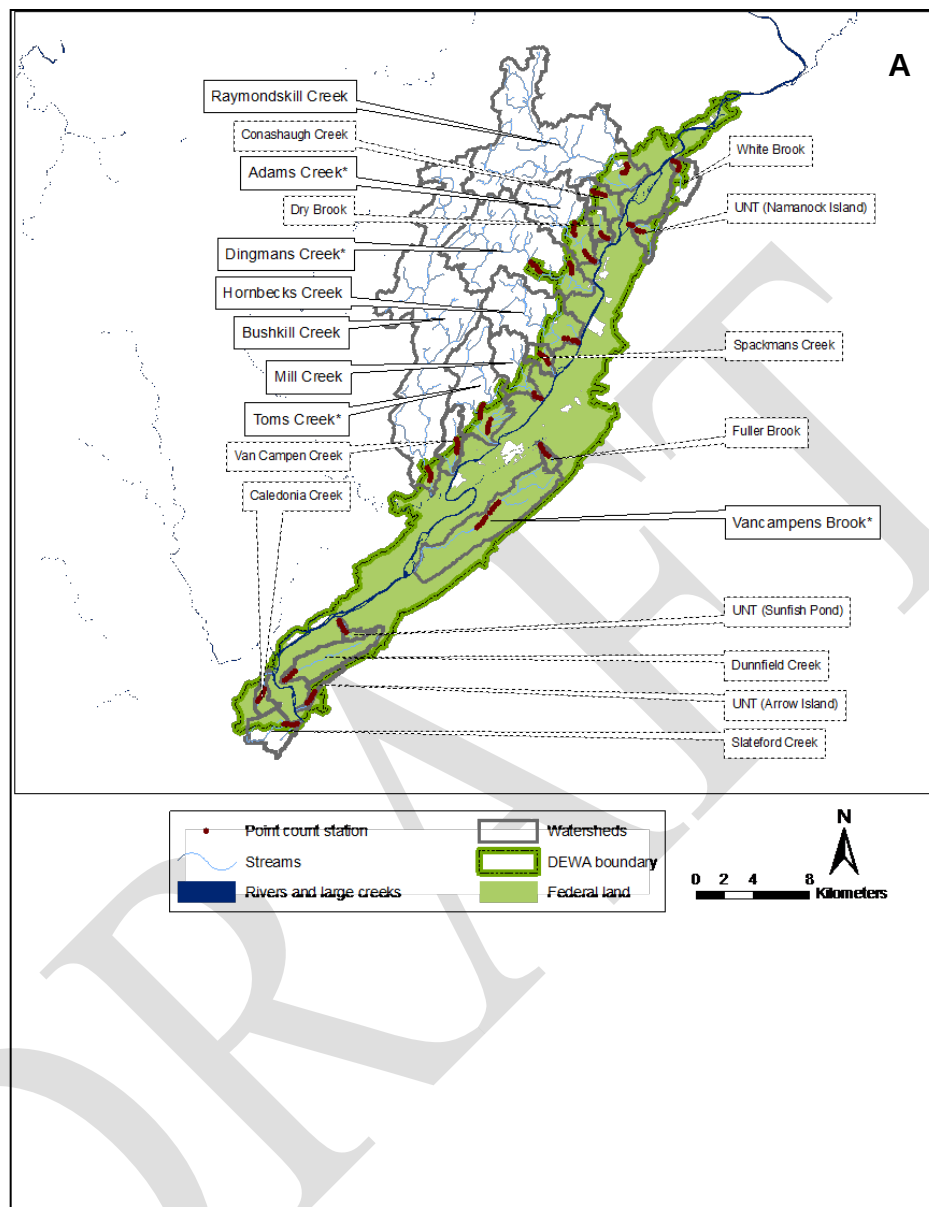
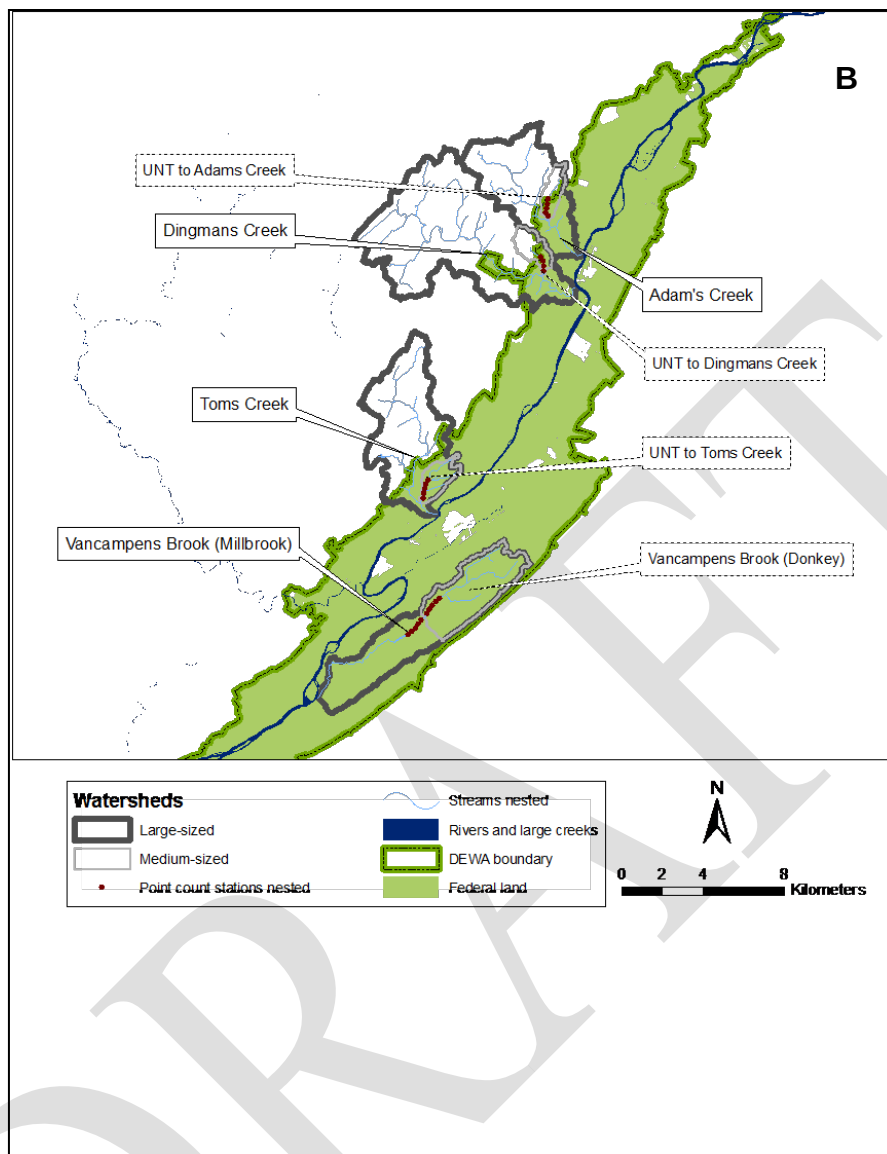


Figure 4. Point transects established along tributary watersheds of DEWA. Solid and dashed borders represent large- (10-99.9 km²) and medium-sized (1-9.99 km²) watersheds, respectively. * = Large-sized watershed contains at least one sampled medium-sized watershed (shown in B).



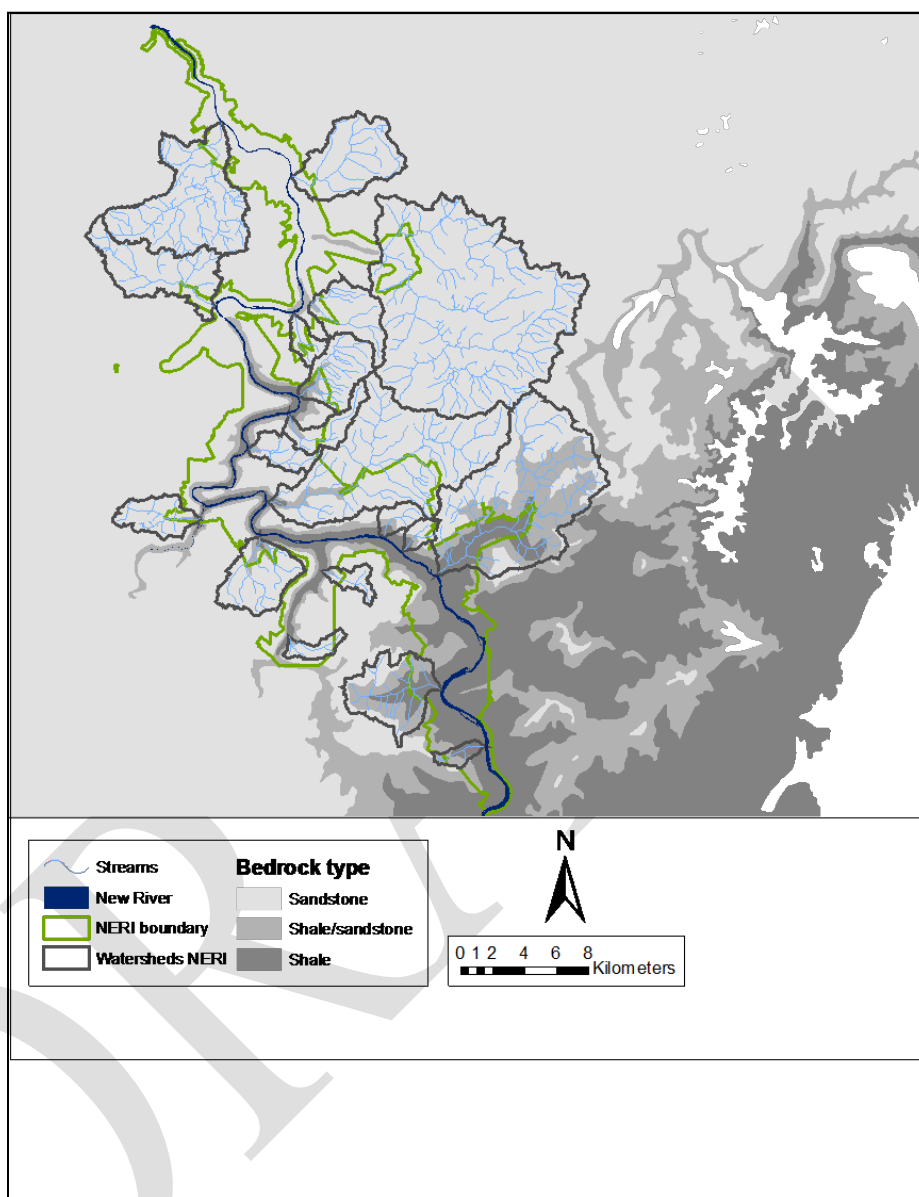


Figure 5. Bedrock geology types and sampled watersheds shown for reference in New River Gorge National River. Hollow areas in graph represent alluvium, which is not found within park watersheds. See Figure 3 for watershed names.

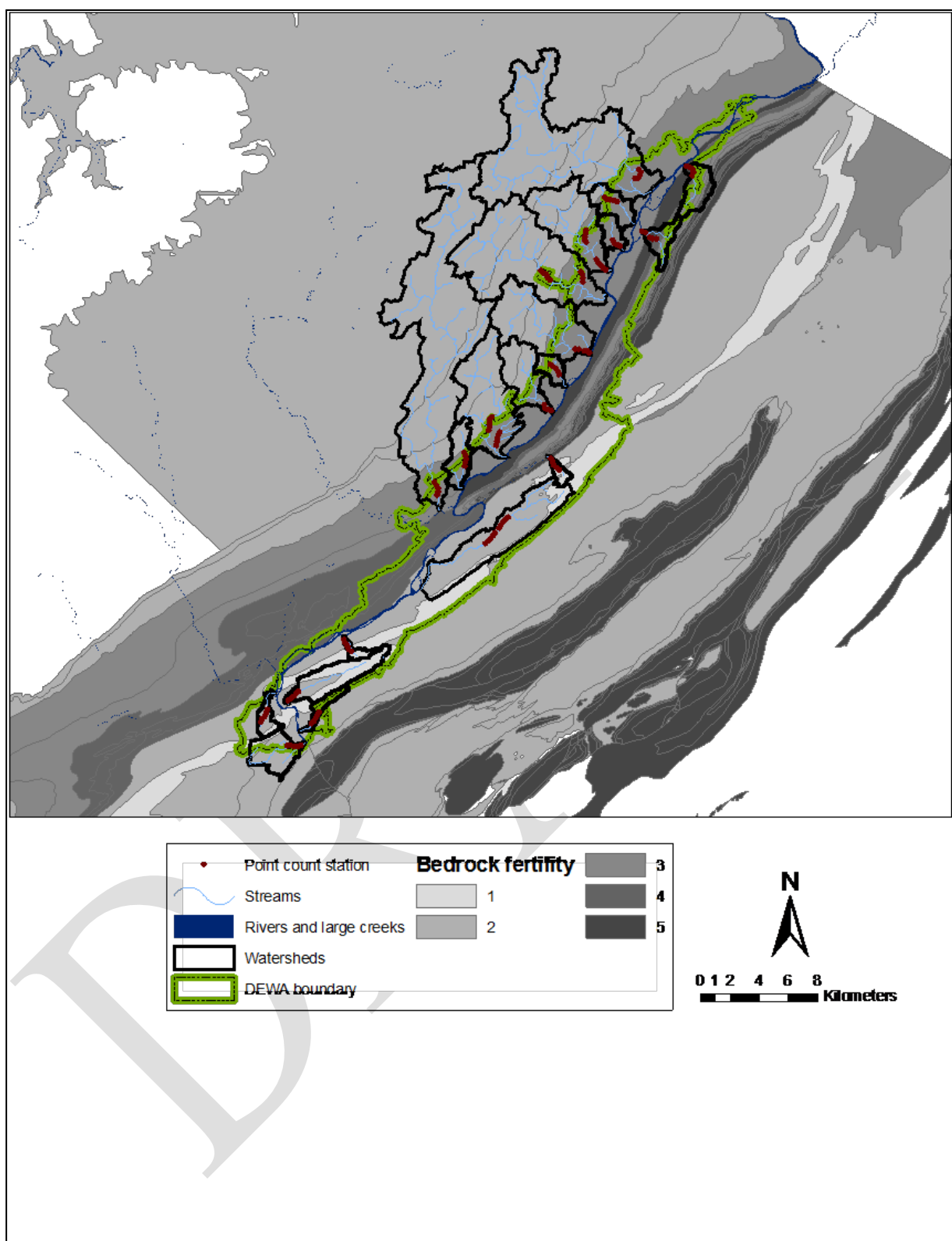


Figure 6. Bedrock geology types and sampled watersheds shown for reference in Delaware Water Gap National Recreation Area ordered from 1 = lowest bedrock fertility to 5 = highest bedrock fertility. See Figure 4 for watershed names.

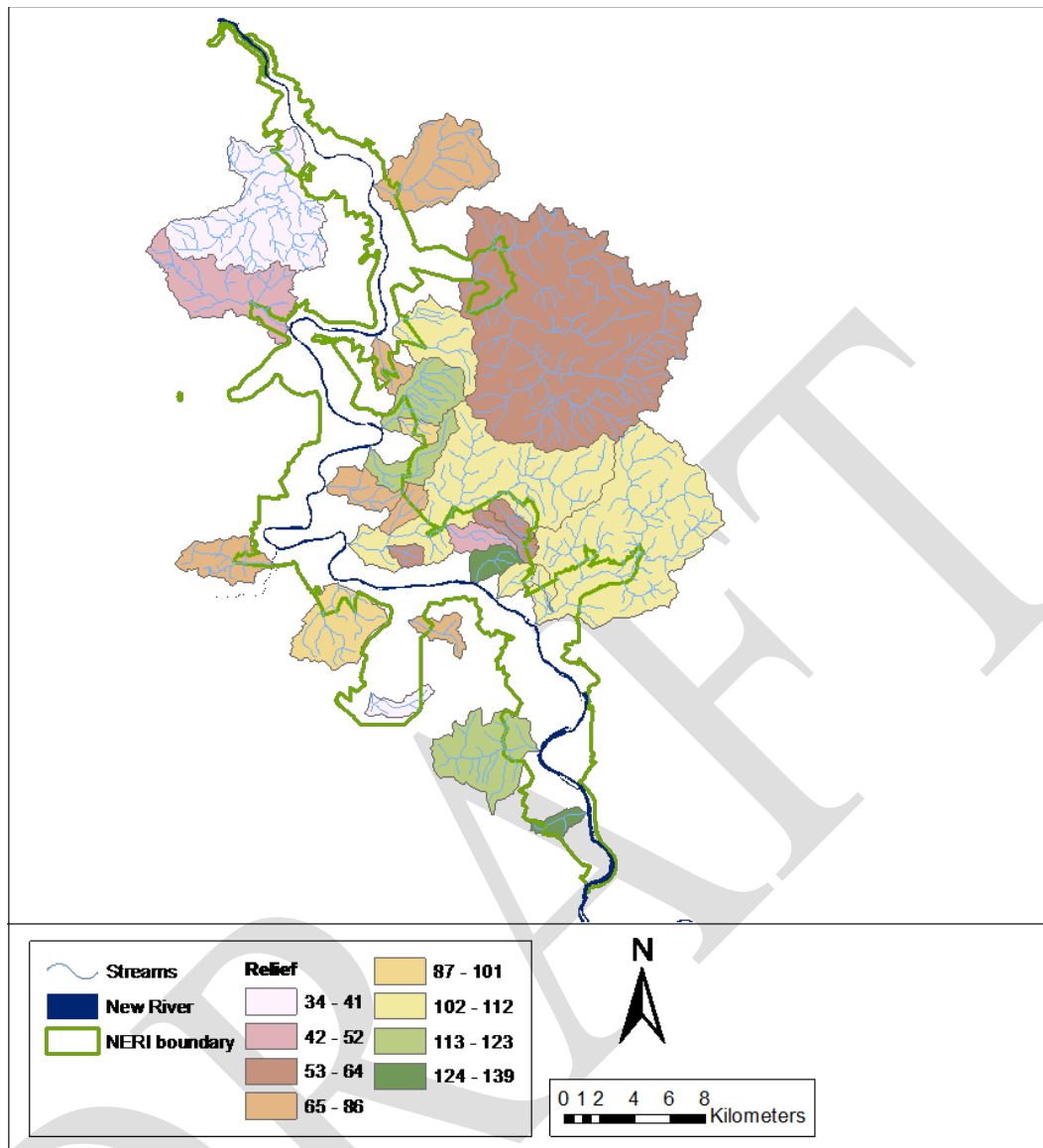


Figure 7. Relief (i.e., standard deviation of elevation) within sampled watersheds in New River Gorge National River. See Figure 3 for watershed names.

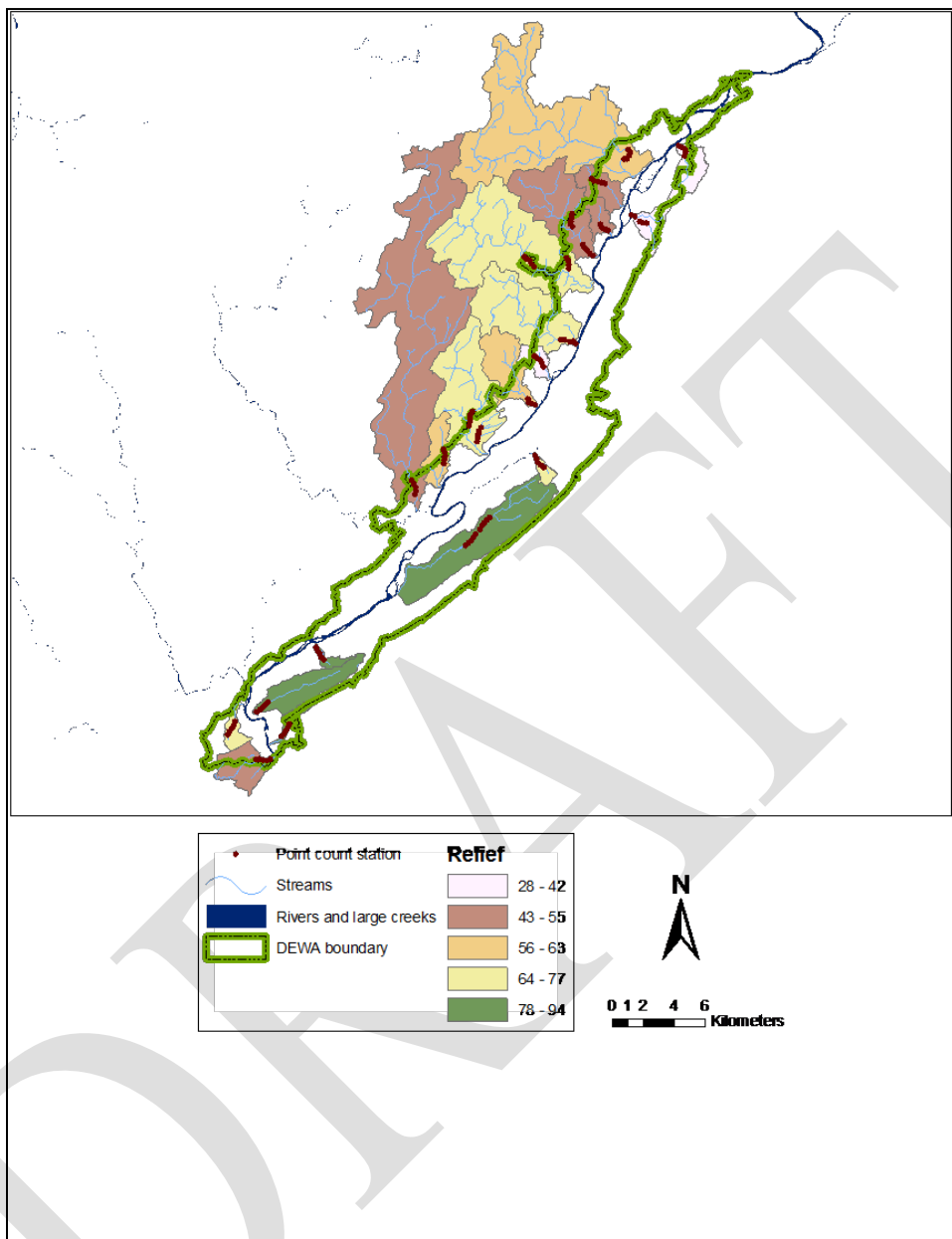


Figure 8. Relief (i.e., standard deviation of elevation) within sampled watersheds in Delaware Water Gap National Recreation Area. See Figure 4 for watershed names.

Watershed selection process: Variation in underlying watershed features may relate to variation in the status and trends of the streamside bird community and other vital signs chosen for the ERMN. By stratifying site selection by these factors, this variation can be taken into account when making inferences about variation in these vital signs. Each stratification variable was therefore divided into ecologically-meaningful strata for site selection separately for each of the two major park units (See “Sampling Scheme” above; Table 1). Collectively, the strata represent the diversity of watershed types in each park unit (Tables 4 and 5; Figures 9-12).

Watersheds were selected in a stepwise fashion. First, a substratum was defined as a particular combination of stratification categories (e.g., low values for watershed area, percent watershed preserved, topography, and bedrock fertility; Table 4). Based on the four stratification variables and two categories per variable, there was a possibility of 16 substrata (Table 4). A substratum was excluded if there are no candidate watersheds in that stratum. Second, watersheds were assigned a number between 0 and 1 with 4 decimal places, drawn from a random, continuous uniform distribution (SAS Institute Inc 2004). Third, watersheds with the highest random number within each substratum were selected for round 1 of sampling and removed from the candidate pool (i.e., random sampling without replacement). This process was repeated to generate a list of watersheds by the a priori substratum and by the randomly assigned round for NERI (Appendix C) and for DEWA (Appendix D). The list for each park serves as a guide for watershed selection and, if necessary, replacement due to problems with site access or safety. In particular, if a watershed must be replaced, then the next watershed in that substratum is selected for the bird surveys. Through this process, the inclusion probability of each watershed in a given stratum is inversely proportional to the number of other watersheds in that stratum. Thus, if a particular stratum has very few candidate watersheds, then these would likely all be chosen for inclusion in the monitoring program. This approach ensured sampling within all substrata with at least one candidate watershed, and therefore the sample included the widest possible range of watershed types. This stratified random sampling was conducted once for NERI and once for DEWA.

In spring of 2007, watersheds were selected in NERI and DEWA using the selection process just described. While some watersheds were replaced in 2008 due to site access or noise issues, the number and proportion of candidates sampled remained quite similar between years. Of the total candidates during 2008, 28-100% were sampled from substrata in NERI, and 43-100% of the candidates were sampled from substrata in DEWA (Table 5). Except for the two most common substrata of NERI, at least half of the candidates were sampled in each substratum, totaling 25 sampled watersheds (Table 5). Aside from eight watersheds that contain intermittent streams, all candidate watersheds were sampled in DEWA, totaling 24 sampled watersheds (Table 5). In addition to sampling broadly across watershed types, selected watersheds spanned the parks geographically (Figures 3 and 4).

While the underlying characteristics are best represented by continuous variables (e.g., watershed size in km²), strata are delineated in a binary fashion (e.g., medium vs. large) to facilitate the selection process. Consequently, the stratified random sampling design that aims to select a wide variety of watershed types may, in actuality, become compromised by inadvertently selecting a large proportion of watersheds near the binary threshold (e.g., medium-large), therefore obscuring actual variation across the park. Furthermore, eliminating candidate watersheds based

on ground-based attributes (e.g., surface flow levels or access) may also limit the representativeness of the sample. Strata metrics (e.g., watershed size) must therefore be compared between the candidate and sampled watersheds to ensure a representative sample of the park. With the possible exception of bedrock fertility in NERI, the distribution of criterion values for selected watersheds represent those of candidate watersheds in NERI and DEWA (Figures 13 and 14). Despite categories of 0-13.7% and 13.8-100% shale (Table 1), the random stratified sampling procedure in NERI tended to exclude by chance candidate watersheds with >36% shale (Figure 13), and therefore the sampled watersheds may not represent some of the highest fertility watersheds in NERI.

Table 4. Numbers and proportions of watersheds in New River Gorge National River (NERI) and Delaware Water Gap National Recreation Area (DEWA) sampled for streamside bird monitoring from a set of candidate watersheds stratified by watershed size and percent protected strata. See Table 1 for definition of each stratification variable.

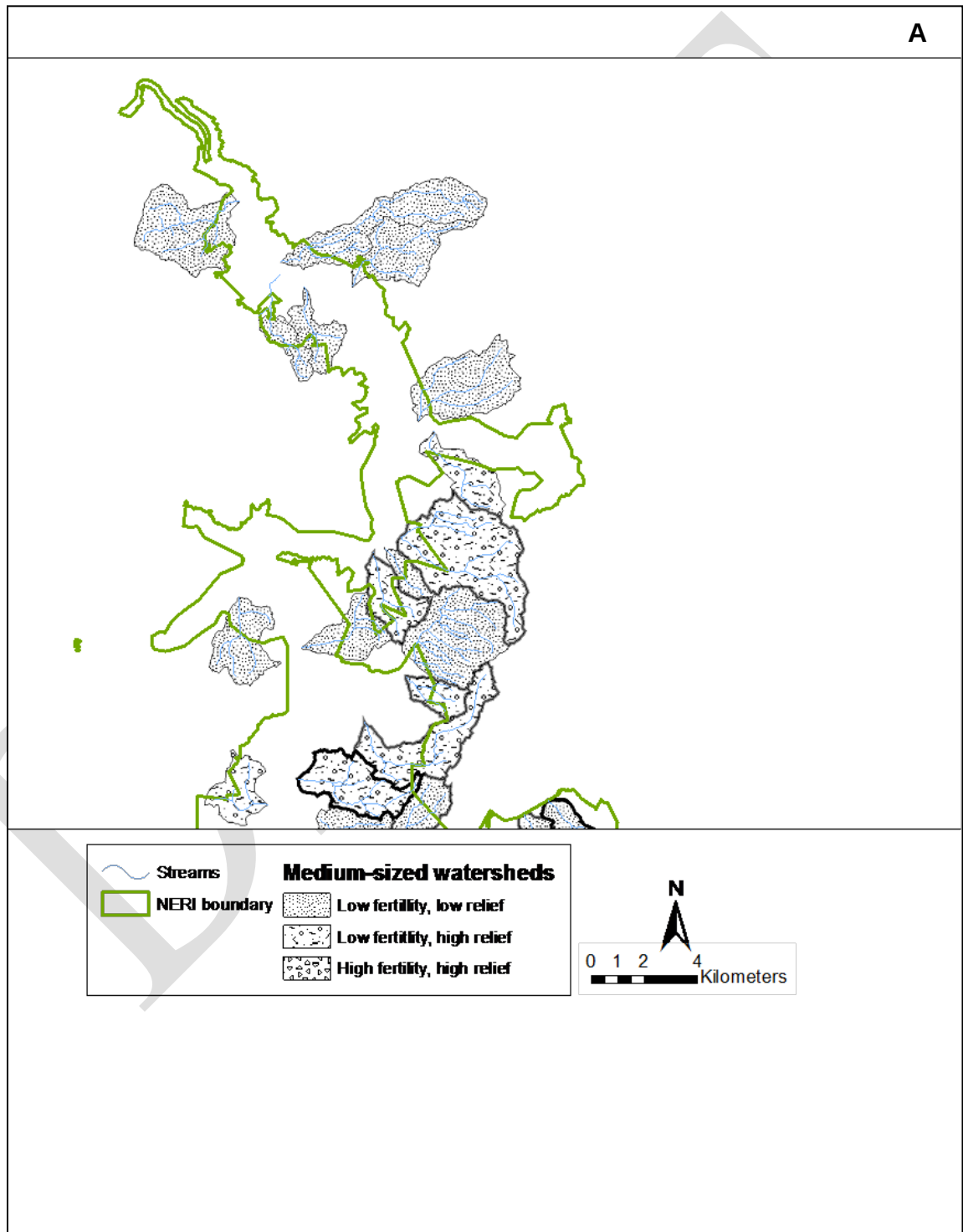
Park	Number of candidates				Number sampled				Proportion sampled			
	Watershed size		% Protection		Watershed size		% Protection		Watershed size		% Protection	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
NERI	41	12	50	3	17	10	25	2	0.415	0.833	0.500	0.667
DEWA	24	8	17	13	16	8	15	9	0.640	1.000	0.789	0.643
Total	65	20	67	16	33	18	40	11				

Table 5. Number and percentages of watersheds sampled from a set of candidate watersheds in 16 substrata for New River Gorge National River (NERI) and Delaware Water Gap National Recreation Area (DEWA). Unless otherwise noted, at least half of candidate watersheds surveyed in each substratum. Dash indicates that no candidate watersheds exist in that substratum. See Table 1 for definition of each stratification variable.

Stratification variable / park unit										Substrata											
Tributary watershed area:										Low					High						
% Watershed preserved:										Low					High						
Bedrock fertility:										Low		High		Low		High		Low		High	
Relief:		Low		High		Low		High		Low		High		Low		High		Total			
Number of candidates																					
NERI		18	9	-	11	1	2	-	-	5	3	-	4	-	-	-	-	-	53		
DEWA		2	1	7	-	4	3	7	-	6	-	1	-	-	1	-	-	-	32		
Total		20	10	7	11	5	5	7	-	11	3	1	4	-	1	-	-	-	85		
Number of candidates sampled																					
NERI		5 ^a	5	-	4 ^a	1	2	-	-	3	3	-	2	-	-	-	-	-	25		
DEWA		1	1	6	-	3	2	3	-	6	-	1	-	-	1	-	-	-	24		
Total		6	6	6	4	4	4	3	-	9	3	1	2	-	1	-	-	-	49		
Percentage of candidates sampled																					
NERI		0.28 ^a	0.56	-	0.36 ^a	1.00	1.00	-	-	0.60	1.00	-	0.50	-	-	-	-	-			
DEWA		0.50	1.00	0.86	-	0.75	0.67	0.43	-	1.00	-	1.00	-	-	1.00	-	-	-			

^a Less than half of candidate watersheds surveyed in these most common substrata.

Figure 9. Strata for medium-sized watersheds in the northern (A) and southern (B; next page) regions of New River Gorge National River based on bedrock fertility (i.e., percent shale) and relief (i.e., standard deviation of elevation). Sampled watersheds have thick gray or black borders, where border color represents the amount of area in protected lands (i.e., < 90% are gray and $\geq$ 90% are black). All watersheds with $\geq$ 90% of their area in protected lands were sampled. See Figure 3 for watershed names.



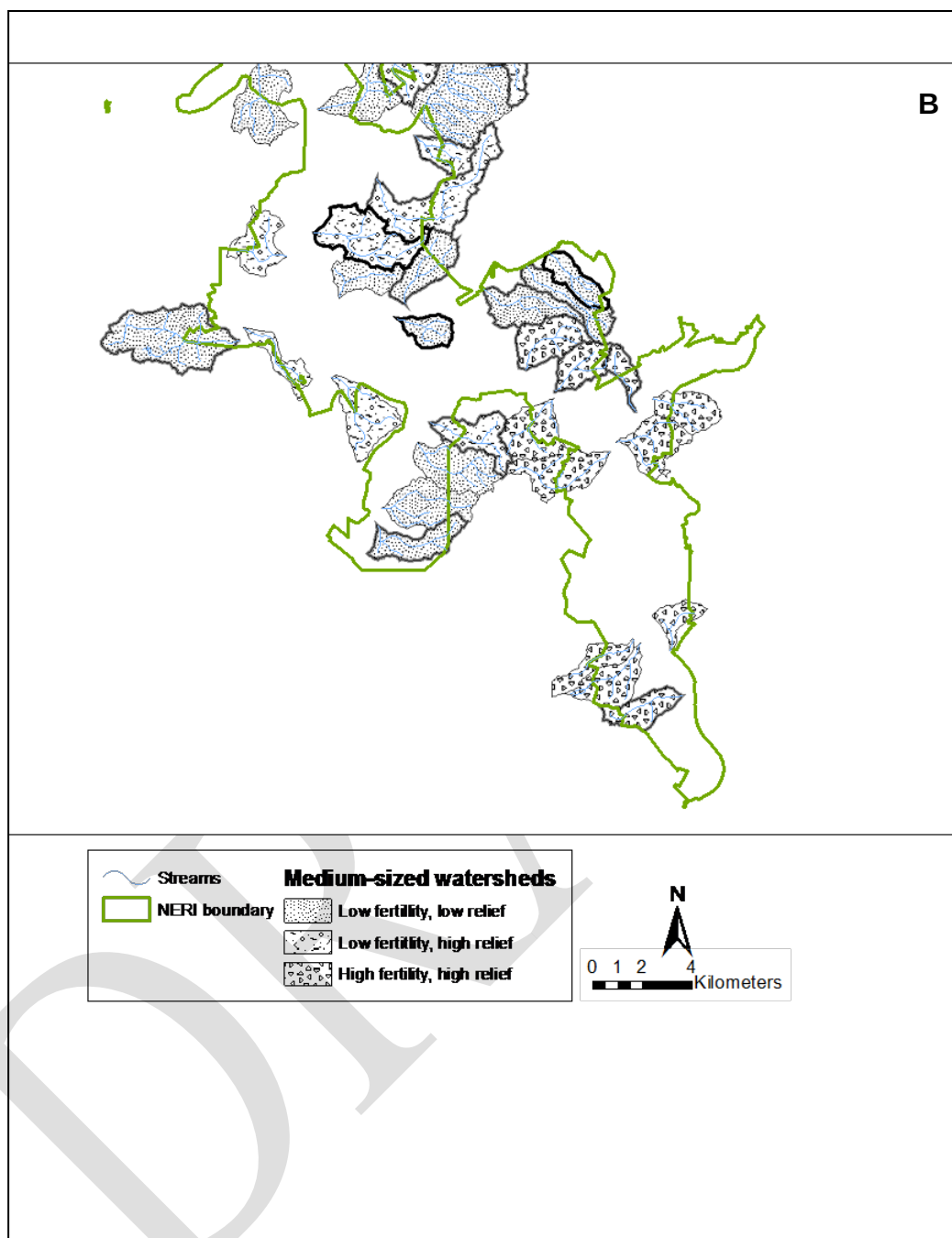


Figure 10. Strata for large-sized watersheds in New River Gorge National River based on bedrock fertility (i.e., percent shale) and relief (i.e., standard deviation of elevation). Sampled watersheds have thick gray borders. All large-sized watersheds have <90% of their area in protected lands. See Figure 3 for watershed names.

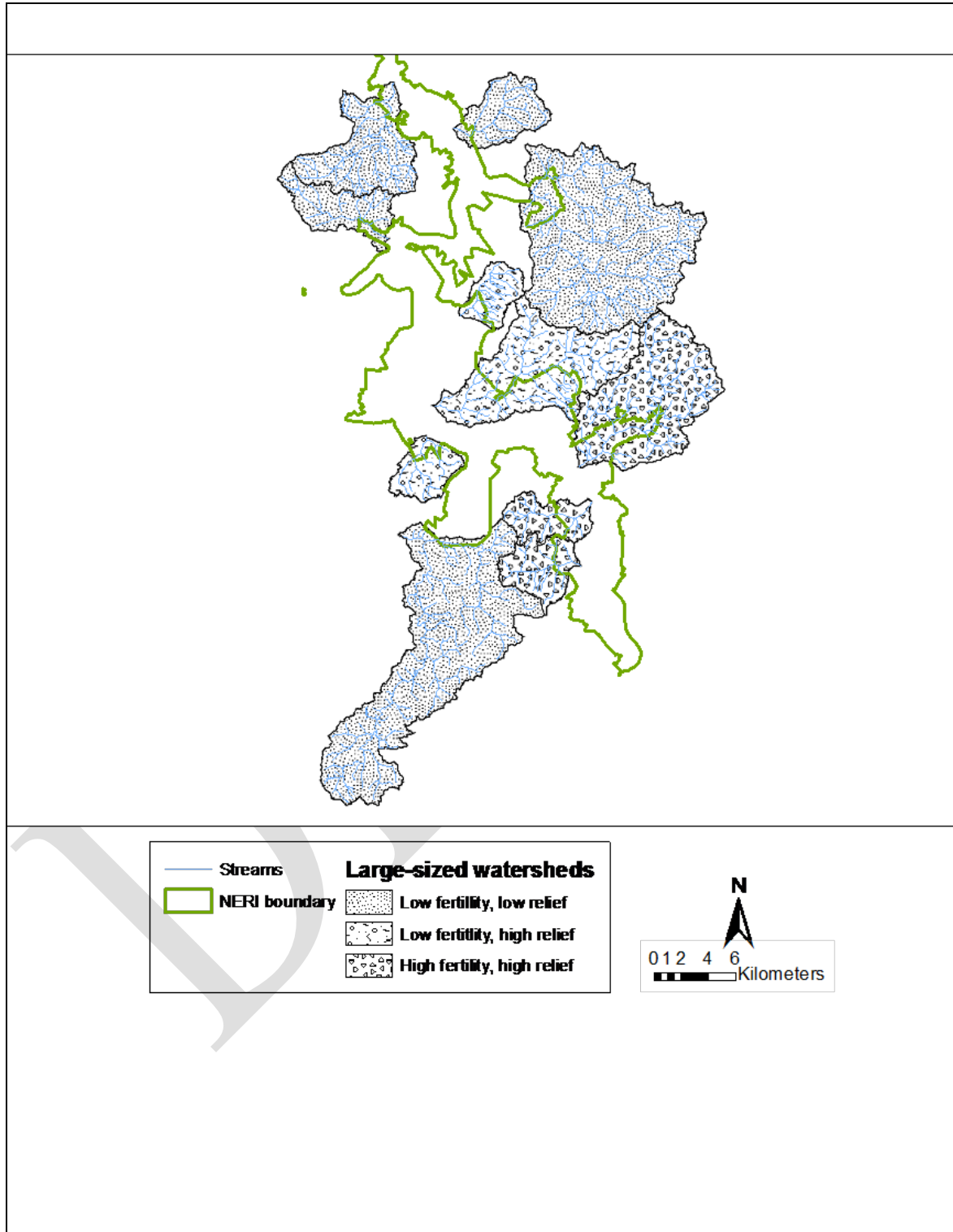
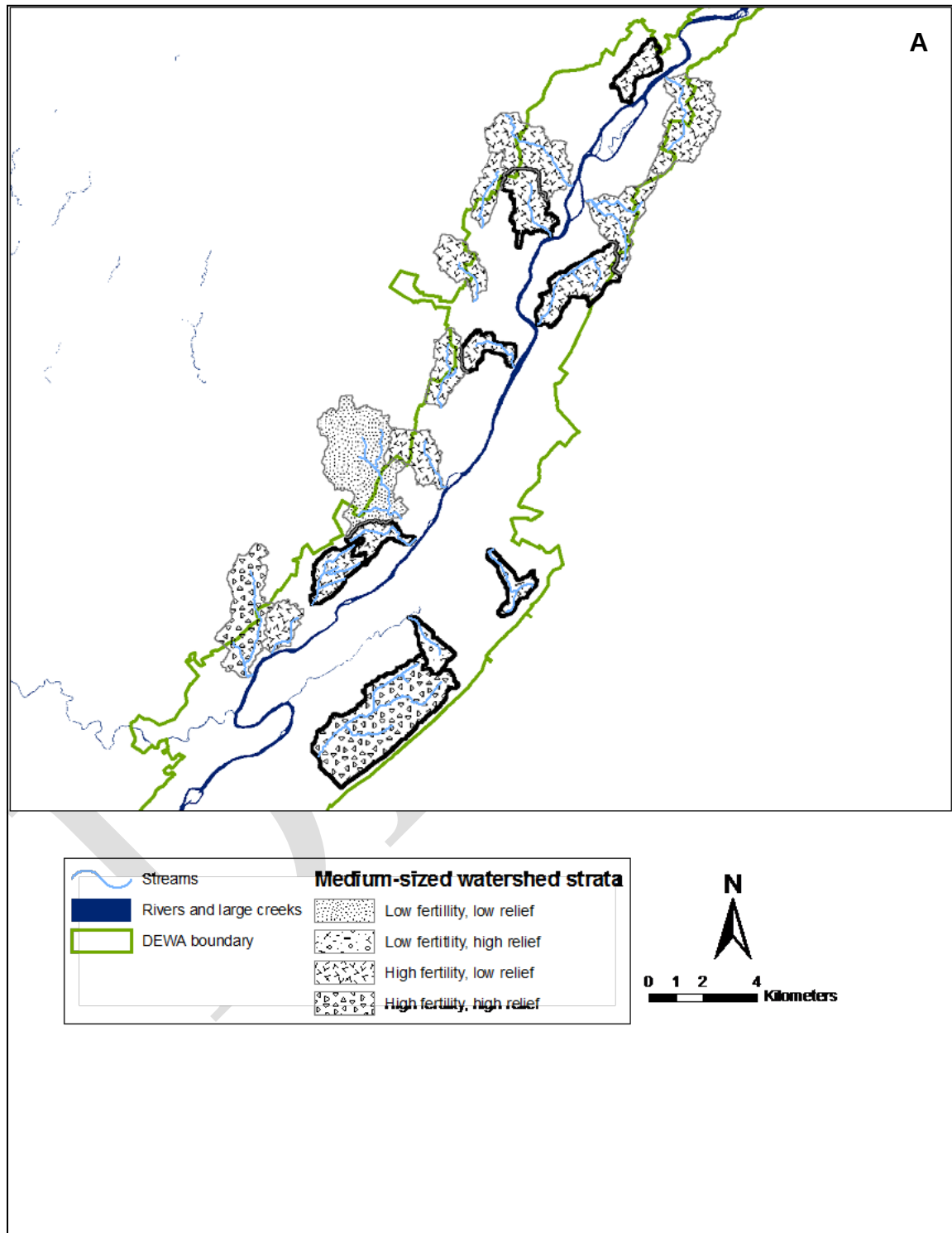


Figure 11. Strata for medium-sized watersheds in the northern (A) and southern (B; next page) regions of Delaware Water Gap National Recreation Area based on bedrock fertility (i.e., area-weighted mean score) and relief (i.e., area-weighted standard deviation of elevation). Watersheds with thick black borders have $\geq 90\%$ of their area in protected lands. See Figure 4 for watershed names.



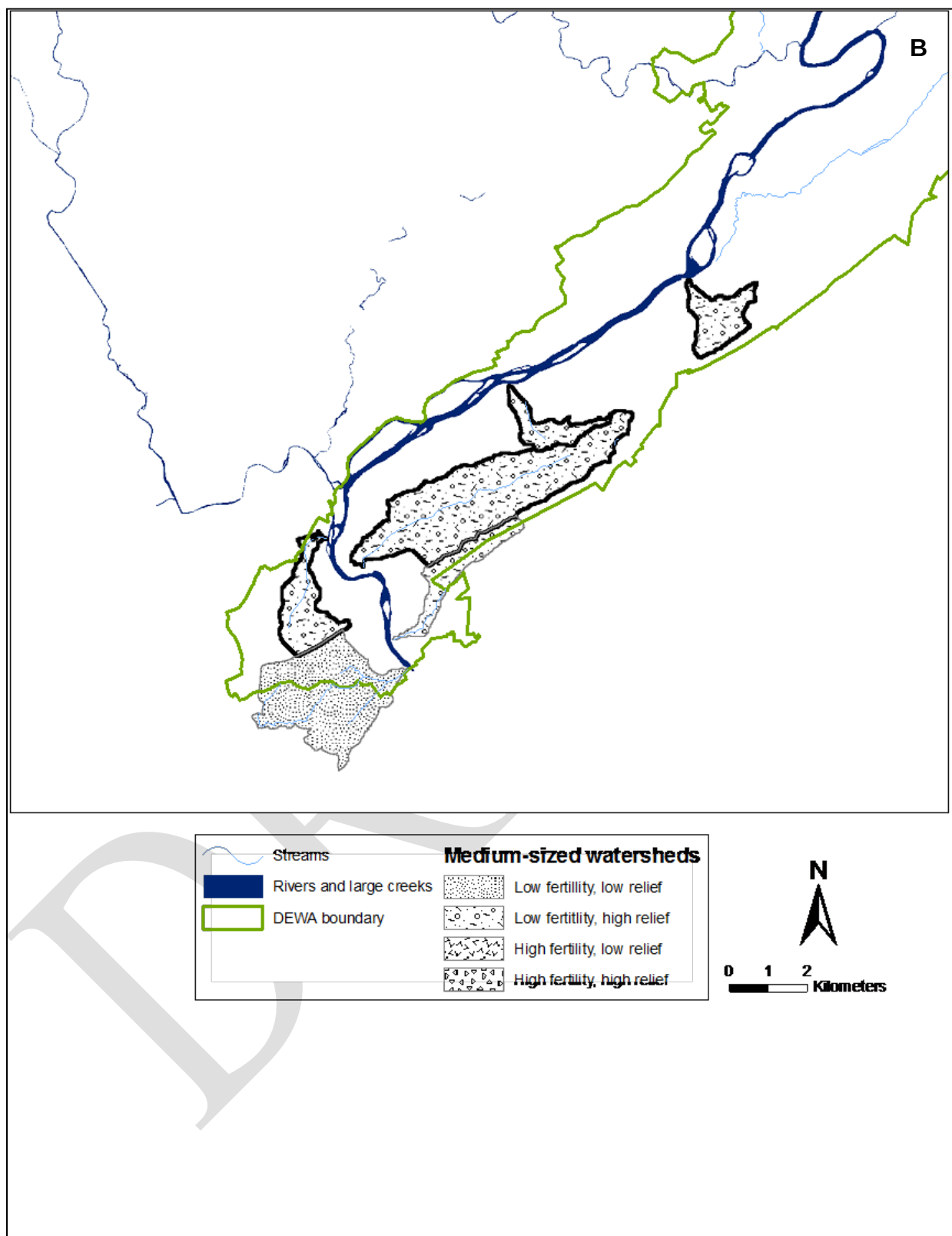


Figure 12. Strata for large-sized watersheds in Delaware Water Gap National Recreation Area based on bedrock fertility (i.e., area-weighted mean score) and relief (i.e., area-weighted standard deviation of elevation). Watershed with thick, black border has $\geq 90\%$ of its area in protected lands. See Figure 4 for watershed names.

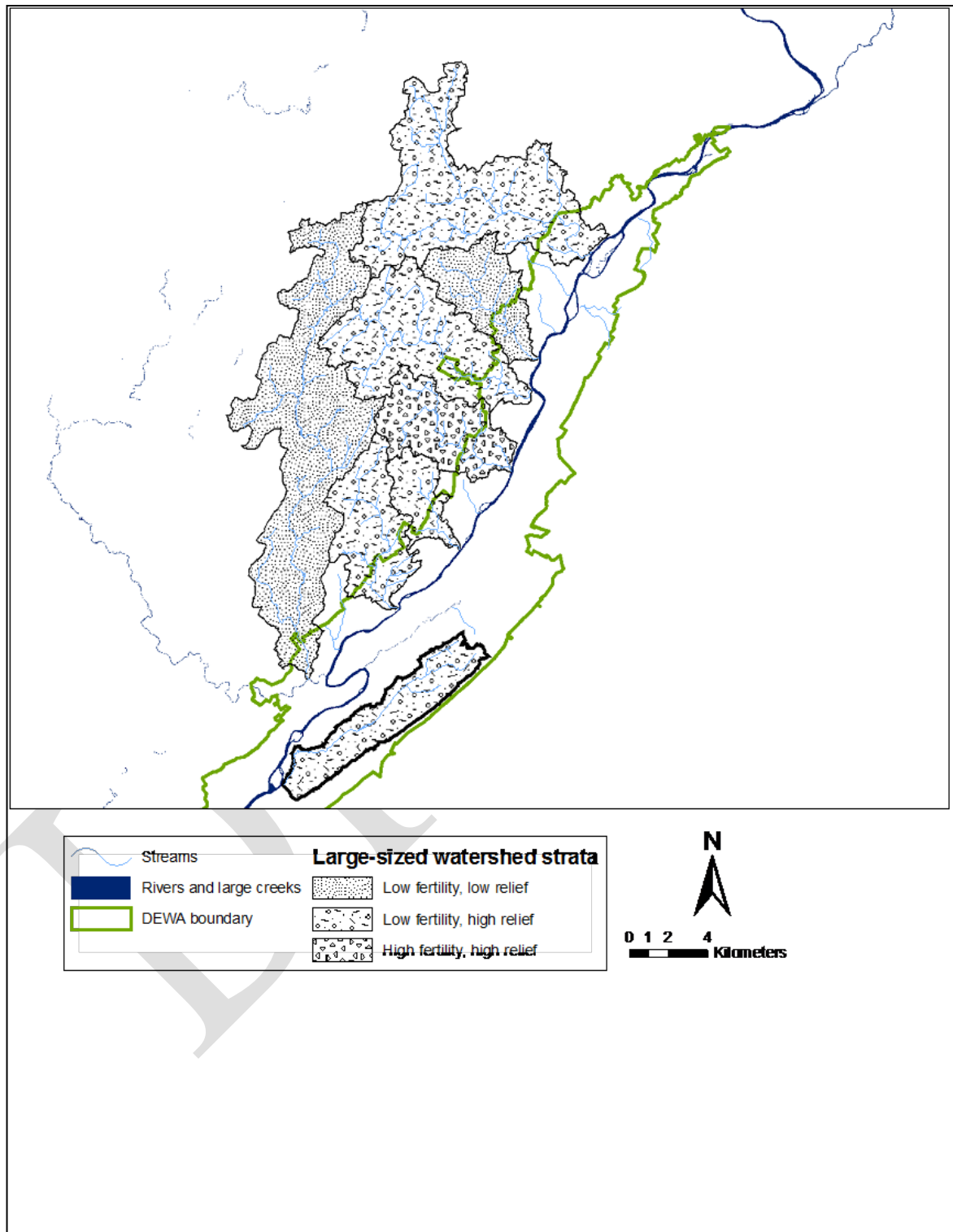


Figure 13. Comparison of continuous variables for all (candidate) watersheds and the sampled subset of watersheds in New River Gorge National River. Dashed horizontal line across each graph indicates cut-off value for low and high strata (see Table 1 for definitions). Solid horizontal line in center of each box represents the median, edges of the box represent the interquartile range, whiskers represent the 5th and 95th percentiles, and x's represent extreme values.

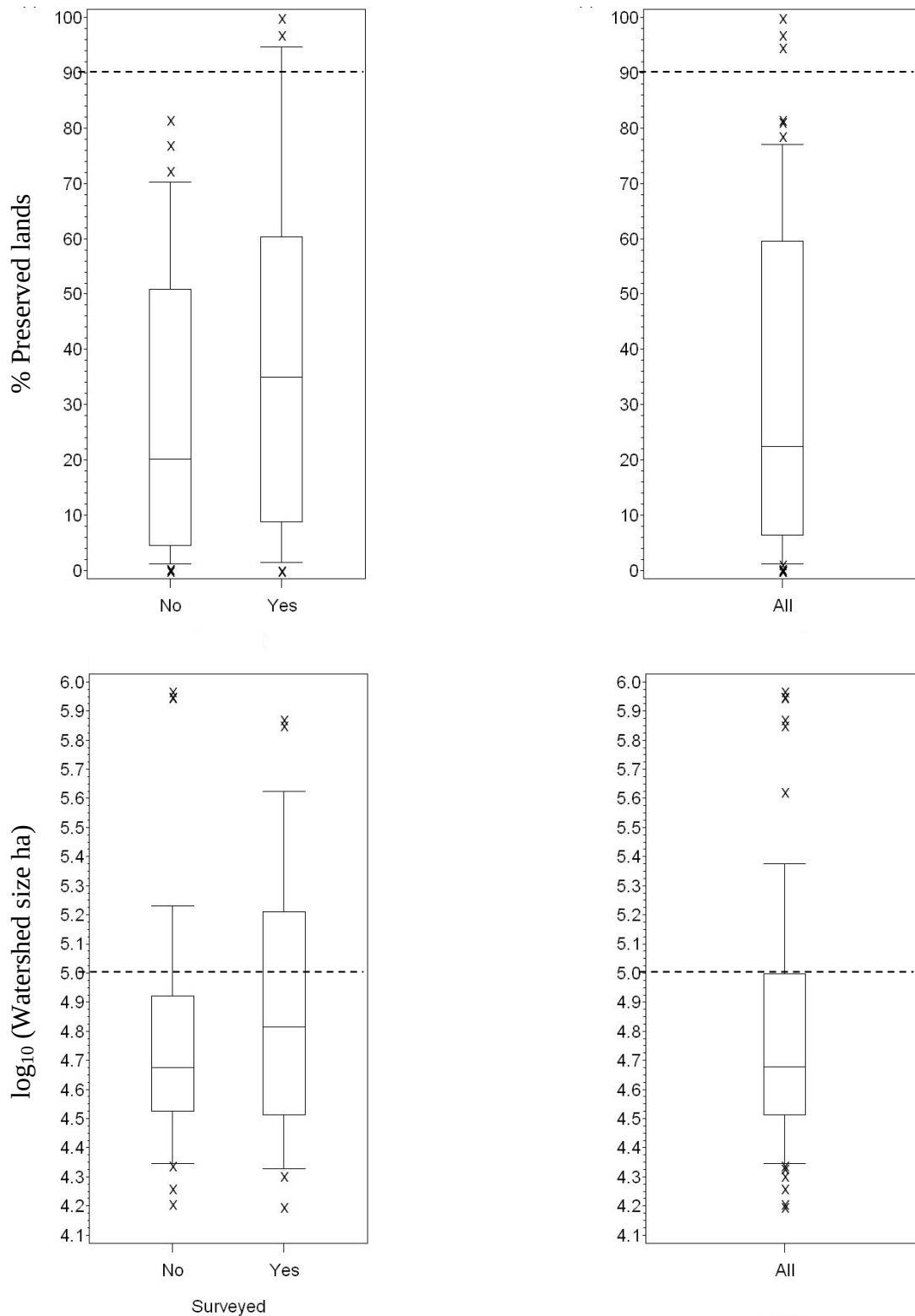


Figure 13. Continued.

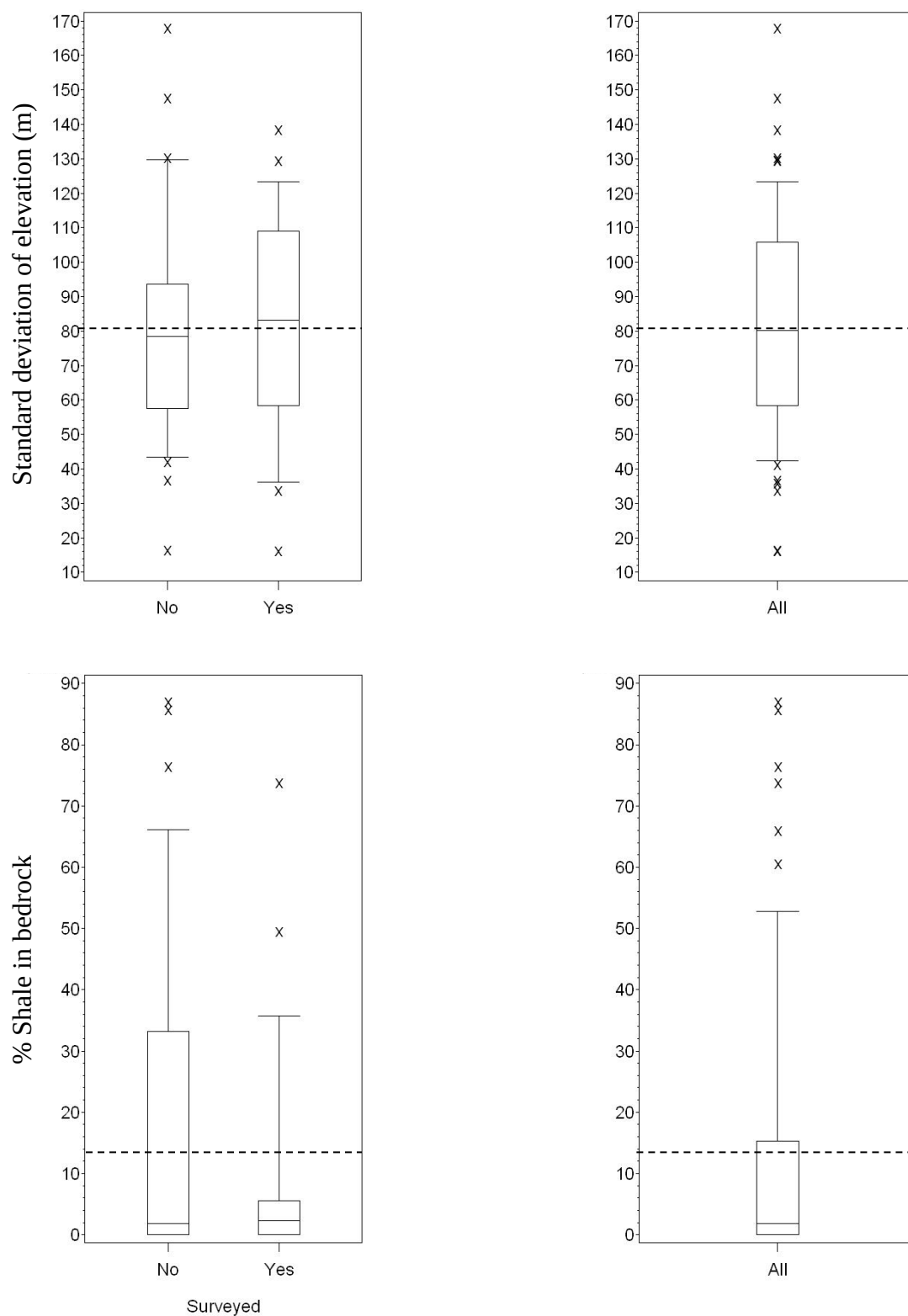


Figure 14. Site-selection characteristics for candidate and sampled watersheds in Delaware Water Gap National Recreation Area. Dashed horizontal line across each graph indicates cut-off value for low and high strata (see Table 1 for definitions). Solid horizontal line in center of each box represents the median, edges of the box represent the interquartile range, whiskers represent the 5th and 95th percentiles, and x's represent extreme values.

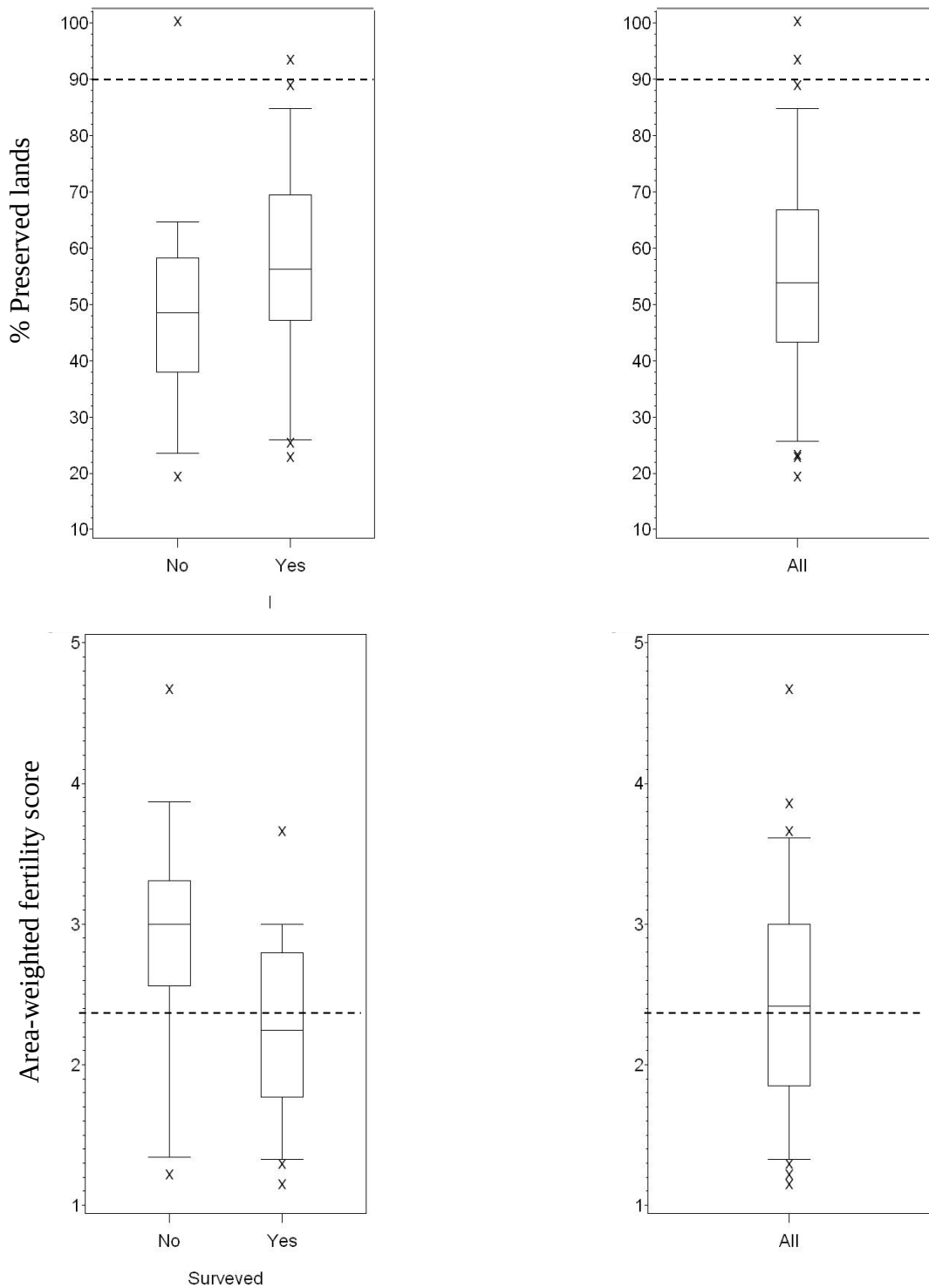
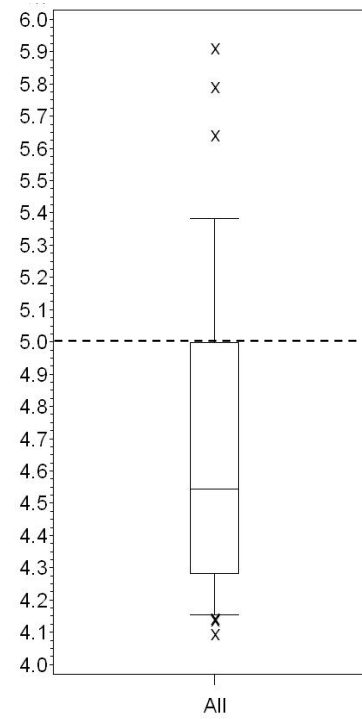
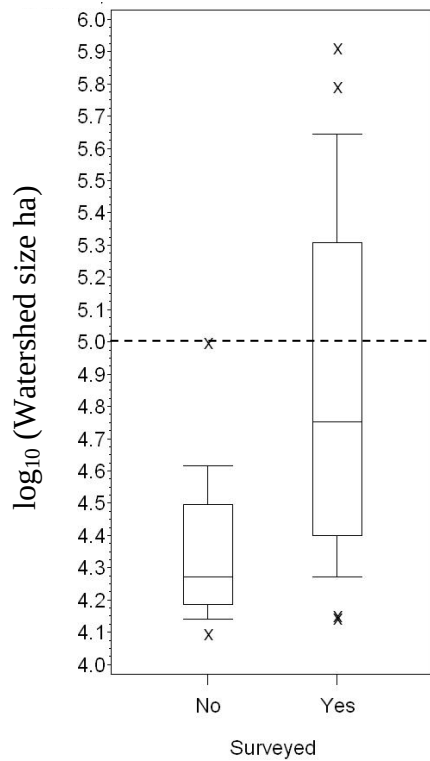
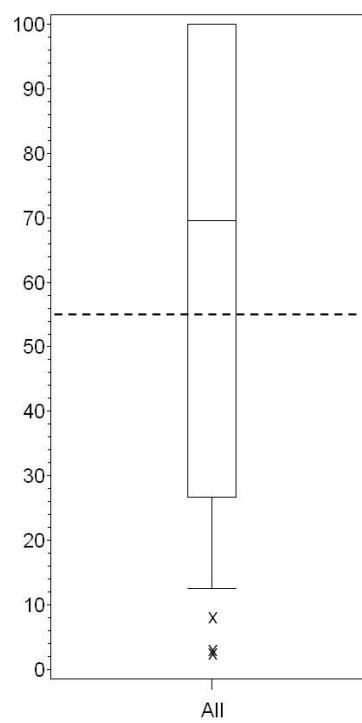
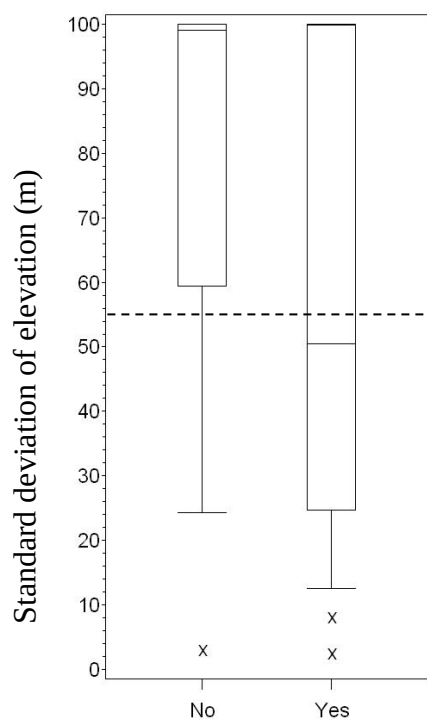


Figure 14. Continued.



Point-transect establishment in NERI and DEWA

Once a watershed was selected for inclusion in the monitoring program, a point-transect was established (Figures 2-4) using the following procedures. First, if a selected stream network contained >5 candidate points, then an endpoint (upstream or downstream) was chosen at random, and the adjacent string of 5 points was selected for monitoring. Some candidate networks include multiple tributaries and therefore contained >2 candidate endpoints. Second, along the selected string of 5 points separated by 250 m, a 1-km streamside transect was established for monitoring streamside birds. In some cases, transects were modified to accommodate unusual circumstances. For example, a selected transect along Buffalo Creek in NERI was expanded and a gap is created in the middle to avoid overlap with a second selected transect beginning at the confluence with a tributary of Buffalo Creek. Another example is, in DEWA, streamside transects were adjusted accordingly when the NHD disagreed substantially (>20 m) from the DEM-based stream lines.

If possible, transects along flowing channels were shifted when some of the randomly-selected points could not be accessed due to safety (n = 2 in NERI) or property ownership (n = 4 in NERI). Otherwise, the stream network was excluded from monitoring (n = 2 in NERI due to safety) and replaced by another stream based on the stratified-random sampling scheme. Finally, some transects were excluded if the stream channel was dry or exhibited intermittent flow during expected baseflow conditions in early spring (n = 9 in DEWA). While some surveyed stream channels were intermittent along transects in NERI during the late spring sampling period, none of the selected transects should be intermittent during the early spring sampling period while LOWAs are establishing nests. All transects selected for the long-term monitoring program in NERI and DEWA were surveyed annually starting in 2007, with the following exceptions that were surveyed annually starting in 2008: 1) NERI -- Davis Branch; and 2) DEWA -- Toms Creek, Raymondskill Creek, and UNT at Dingmans Creek.

Targeted Site selection at GARI and BLUE, ALPO, FONE, and FRHI

Although the probabilistic strategy defined the majority of sampling sites at the largest parks (i.e., DEWA, NERI), that approach was not widely applicable at the other parks, primarily because they did not contain many (or any) streams with > 1 km of their length within the park boundaries. Also, in several cases, too few streams were available for a logical random approach. To maximize coverage of candidate streams in these parks, transects were established wherever possible in these parks, and transect lengths ranged from 0.25-1 km. In these cases, a variety of factors were considered when choosing “targeted” sampling sites in consultation with park resource managers and the ERMN coordinator. The rationale for targeted sampling site selection is described for each park in the following sections.

Gauley River National Recreation Area

GARI hosts six candidate streams with ≥ 1 km inside federally authorized park boundaries, but none of these are entirely on federal land. These streams, rather, cross private inholdings, and therefore require special permissions from existing landowners. In the event that landownership changes, new permissions must be sought to continue monitoring these streams. In 2007, three GARI streams were selected for long-term monitoring, and this was part of the larger site selection procedure that included the NERI watersheds (see “Random-stratified site selection in NERI and DEWA” above). By chance, all three selected watersheds are large-sized, and so the

three medium-sized watersheds in GARI were not selected. Unless sampling priorities shift or permissions are revoked, then only the three currently selected streams will be included in the long-term monitoring (Figure 15).

Bluestone National Scenic River

BLUE has only two candidate streams with ≥ 1 km inside park boundaries. Indian Branch traverses four ≥ 6 -m waterfalls and is bordered by rock cliffs that prevent observers from surveying the entire 1-km stretch safely within a suitable time frame. Indian Branch was surveyed in 2007 but has since been discontinued due for safety reasons. Little Bluestone River, however, is very traversable. In addition, this park hosts two other medium to large watersheds with ≥ 750 m (Mountain Creek and unnamed creek) and another unnamed creek with ≥ 500 m of stream within the federally authorized boundary. Each of these creeks could therefore provide space for 3-4 point count stations within this boundary. During 2009, it was determined that the two unnamed creeks were too difficult to access. Furthermore, NERI personnel regularly monitor water quality on the Little Bluestone River and Mountain Creek. Streamside bird transects were therefore established along Little Bluestone River and Mountain Creek in 2009, which will represent this park in the long-term monitoring program (Figure 16).

Allegheny Portage Railroad National Historic Site

Blair Gap Run (BGR) is the largest stream at ALPO and serves as a municipal water supply for the cities of Altoona and Hollidaysburg, Pennsylvania. Due to the linear, winding nature of ALPO and BGR, there are only short sections of BGR and its tributaries that flow through NPS property. As such, targeted sites were selected in consultation with Kathy Penrod (ALPO Natural Resource Specialist). ALPO has three point-transects in the streamside bird monitoring program (Figure 17). The first, sampled since 2007, is a 1-km transect along Millstone Run. The second is a 500-m transect established along the downstream section of an unnamed stream near Foot of Ten above its confluence with Blair Gap Run. The third is also a 500-m transect along a stretch of BGR that is within park boundaries near the Hollidaysburg (Muleshoe) reservoir.

Fort Necessity National Battlefield

There are three targeted sites at FONE (Figure 18) that were selected in consultation with Connie Ranson (FONE/FRHI Natural Resource Specialist). In general, candidate stream sections that flow through portions of the park managed for historical preservation and/or visitor access are excluded from the monitoring program. The first site is a 1-km transect located on an unnamed tributary to Great Meadows Run, which is FONE's largest stream. The second site is a 250m-transect located on the unnamed tributary to Scotts Run west of the "picnic loop" drive. The third site is a 500m transect established on an unnamed tributary to Scotts Run near Rankin Road (Figure 18).

Friendship Hill National Historic Site

FRHI has two targeted sites that were selected in consultation with Connie Ranson (FONE/FRHI Natural Resource Specialist). A 1-km transect and 750-m transect, respectively, were established along FRHI's two main tributaries, both unnamed but traditionally referred to as Ice Pond Run and Dublin Run (Figure 19).

Figure 15. Candidate watersheds and point transects established along tributary watersheds of GARI. Solid and dashed borders represent large- (10-99.9 km²) and medium-sized (1-9.99 km²) watersheds, respectively. All large-sized watersheds were sampled in 2007 and 2008.

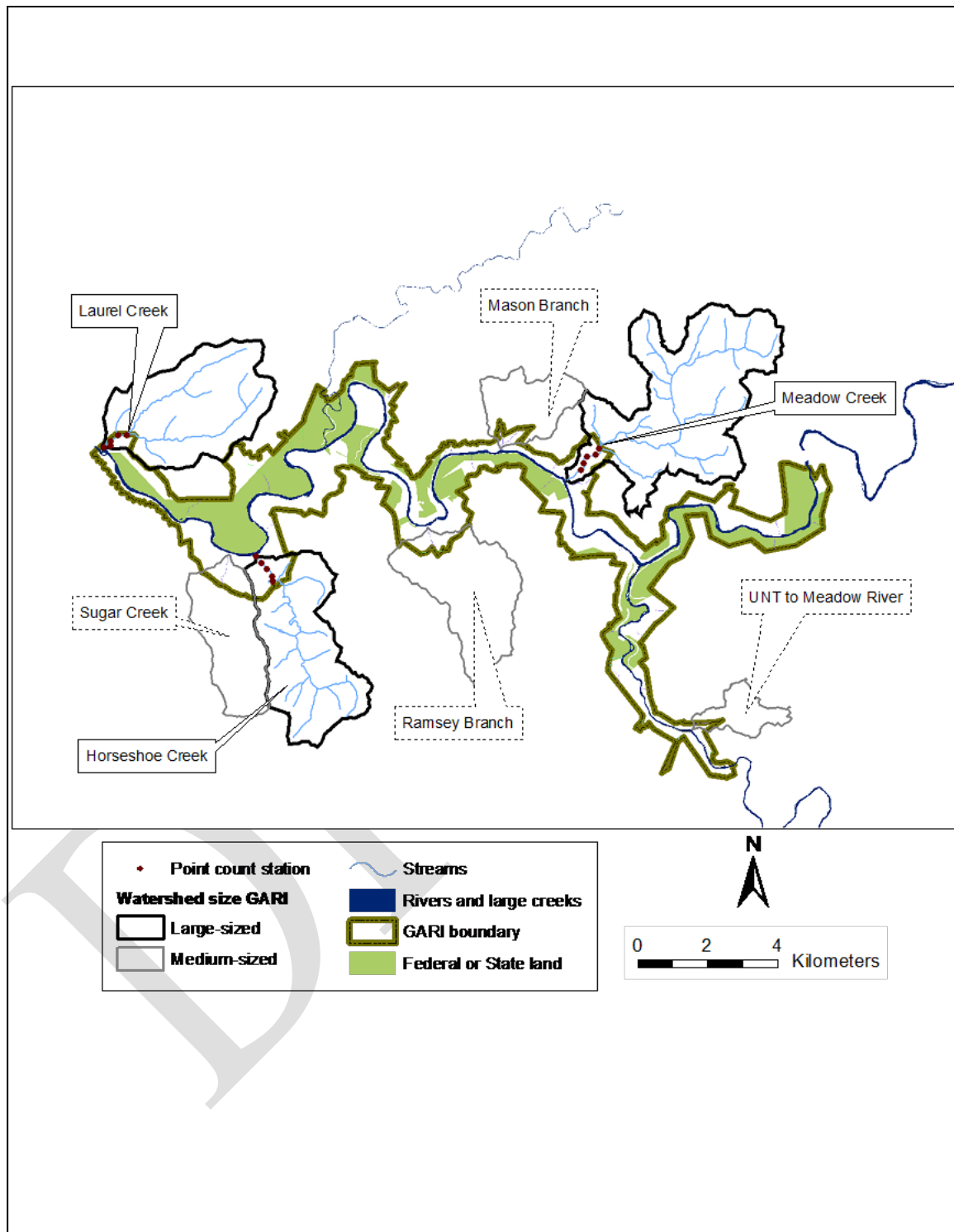


Figure 16. Candidate watersheds and point transects established along tributary watersheds in BLUE. Solid and dashed borders represent large- (10-99.9 km²) and medium-sized (1-9.99 km²) watersheds, respectively. All land within BLUE border is in public ownership; the top transect point for Mountain Creek is just outside park boundary, with permission from landowner.

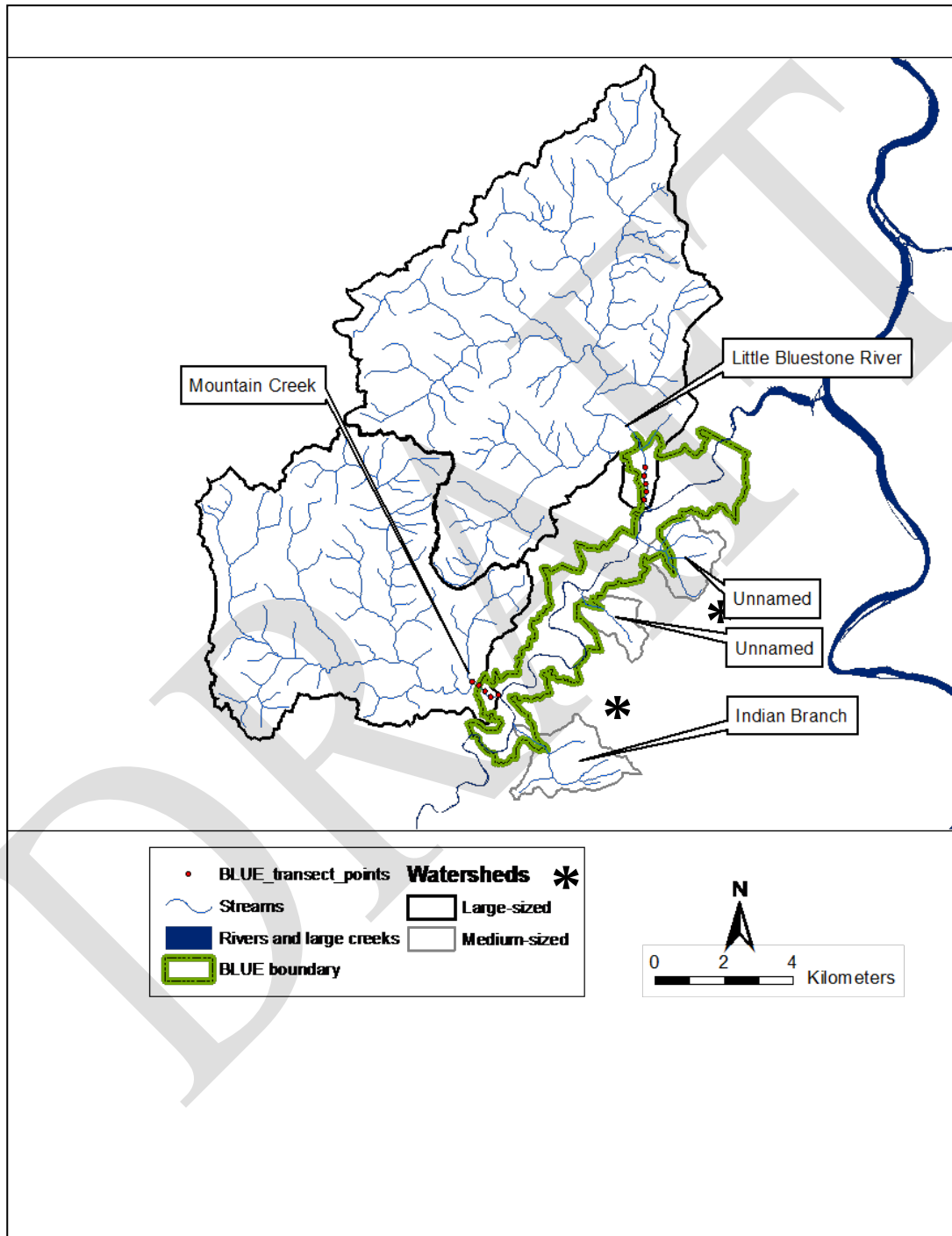


Figure 17. Point transects and watersheds selected for streamside bird monitoring in ALPO.

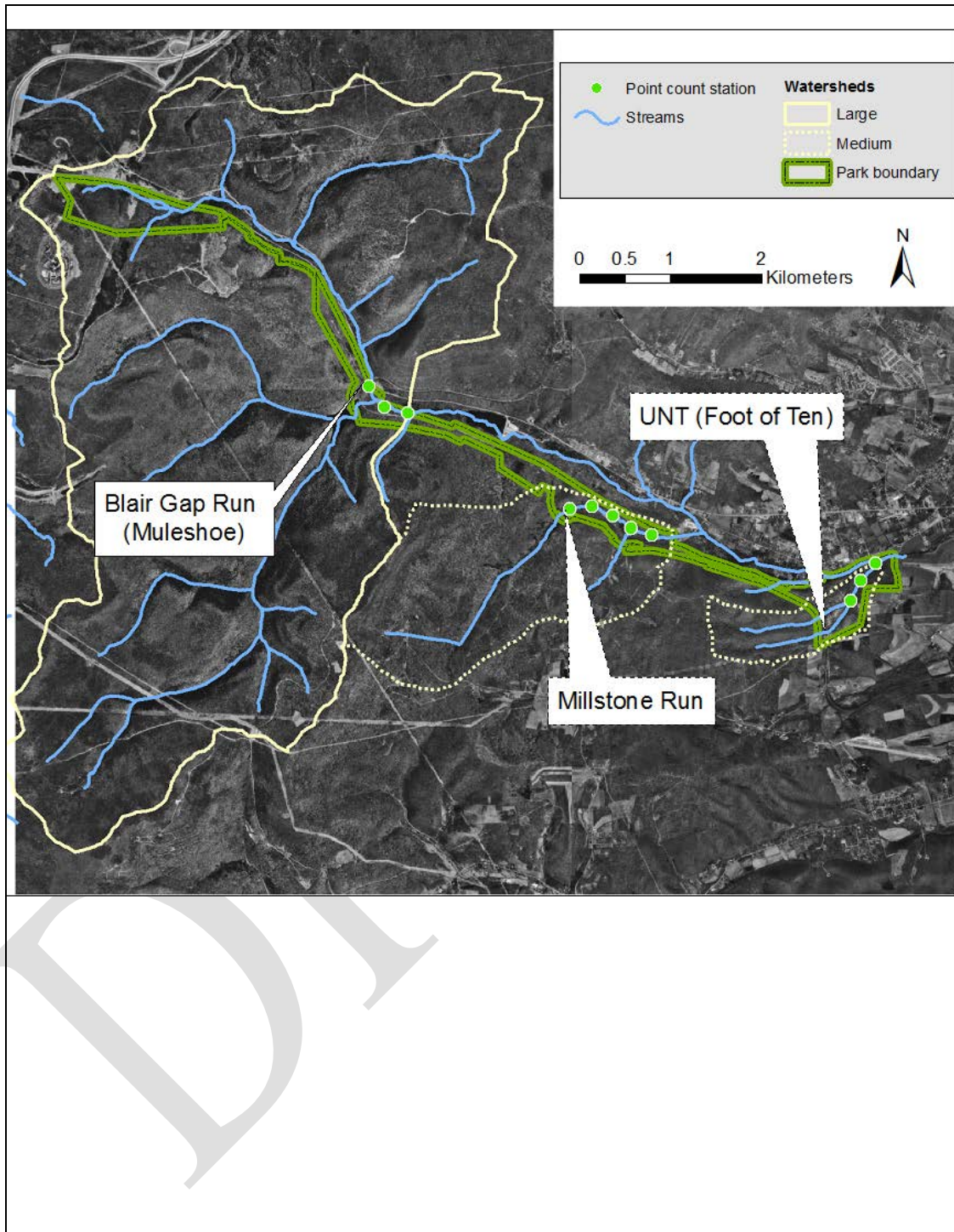


Figure 18. Point transects and watersheds selected for streamside bird monitoring in FONE, which are all small-sized (0.1-0.9 km²).

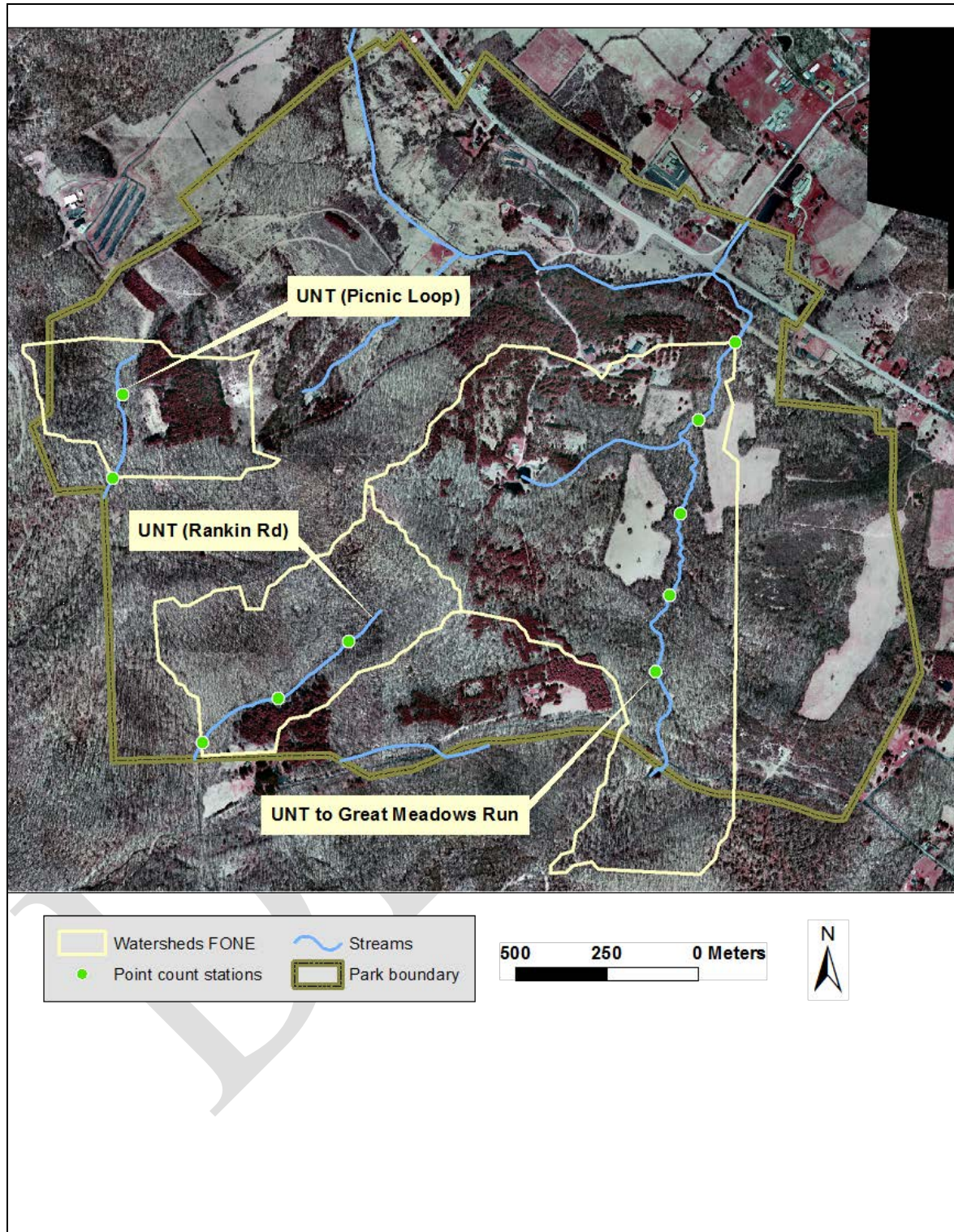
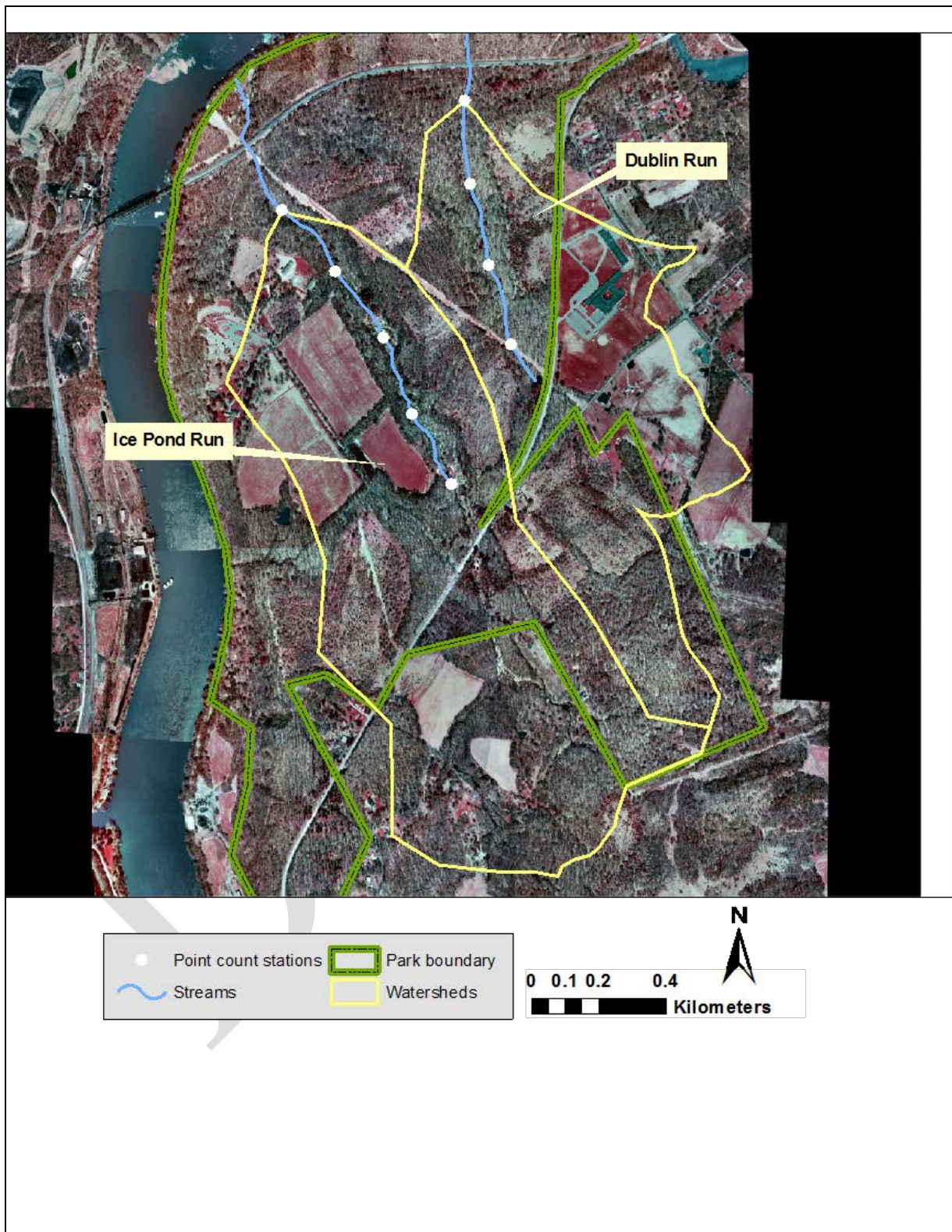


Figure 19. Point transects and medium-sized (1-9.99 km²) watersheds in FRHI.



Sampling frequency and replication

To meet the measureable objectives (see “Background and Objectives”), streamside bird surveys will occur annually along each selected transect. Explanation and justification for the level of spatial and temporal replication within years follows.

Modeling Approach, Estimation Problem, and Background

Failure to account for detection biases has been shown to generate biased interpretations of bird community metrics (Alldredge et al. 2007b). To take into account imperfect detection of species during the surveys, the general approach described by MacKenzie and Royle (2005) is employed to estimate occupancy at the scale of the point count station and of the streamside transect (henceforth, occupancy approach). Extensions to this general approach (i.e., Royle and Dorazio 2006, Royle and Kéry 2007) are applied to account for the nested nature of the data collection (i.e., points or 250-m intervals within transects). Alternative approaches may also be considered to account for imperfect detection while estimating abundance at the point-count scale, including repeat counts (Kéry et al. 2005), time-of-detection (Alldredge et al. 2007a) and distance methods (Thomas et al. 2005). The specific modeling approach may vary by species and guild, depending on the number of detections of individuals in each sample unit. The chosen approach(es) will enable estimation of bird community metrics (i.e., use, occupancy, abundance, species richness, and local extinction and colonization), while accounting for variation in detection probabilities among survey points, visits, observers, watersheds, and years

Replication

Replicate samples for each transect can be utilized to account for biases in detection rates. In addition to accurate parameter estimates (e.g., bird community metrics), a goal of the monitoring program is to obtain precise estimates that is achieved, in part, through such replication. In particular, replication may be optimized within and across transects with a fixed budget to obtain the greatest precision in parameter estimates.

Replication within transects

The finest spatial sampling unit within a particular watershed is a point-count circle (i.e., 50-m or 75-m radius) or a streamside transect interval (i.e., 250 m). Likewise, the finest temporal sampling unit is a single minute during a 5-minute point count or a single pass along a transect interval. Depending on specific goals for estimation, estimates can be summarized across sampling units for coarser-scale analyses.

When applying this modeling approach to estimating patterns of spatial distribution, at least two replicates per spatial sampling unit are needed, and these can be spatial and/or temporal replicates. Immediate goals of this monitoring program are to estimate annual occupancy and interannual changes in occupancy of focal songbird species in 75-m radius point-count circles and LOWA in 250-m transect intervals (see “Data Analysis”). Such estimates should represent relative abundances of these species, as the sampling areas correspond with estimates of their territory sizes (Poole 2005).

As many songbirds sing in bouts rather than continuously throughout a morning (Poole 2005), temporal replicates are used to account for this detection bias. In particular, conducting repeat

visits at survey locations provides a means by which to account for birds that were unavailable during a particular visit. The optimal number of such repeat visits (assuming a fixed budget) depends on the levels of availability for detection and detectability given occupancy for focal species or ecological guilds. In particular, the optimal number is highest for species that are the most common or that are the most difficult to detect at locations, given that they occupy those locations. This makes intuitive sense, because many samples are required to confirm that a common or cryptic species is absent. Based on results from an analysis of streamside bird monitoring data from two of the WV parks (i.e., NERI, GARI) in 2007, at least one species from every forest-interior songbird guild except cavity-nesting species required < 5 visits to ensure an accurate estimate of transect-scale occupancy for that species. After combining species into guilds, four visits would ensure accurate estimates of occupancy for each guild, except dead-wood nesters (Mattsson and Marshall 2009). Though conceptually cavity-nesting species would be good indicators of forest conditions, their low detectability may preclude them from being a reliable indicator.

The actual timing of the surveys is also important to ensure that the assumption of closure among temporal replicates is met. LOWAs are expected to complete their spring migration approximately 7 weeks before the remaining migratory focal species. Based on the timing of migration for LOWA and the remaining migratory focal species, the annual monitoring effort is divided into two 4-week sampling periods (see SOP 5 “Streamside Bird Surveys”). To ensure four temporal samples per streamside transect in a 4-week season, observers must conduct two passes along each transect per morning during each of two 2-week blocks within the 4-week sampling period

Replication among watersheds in NERI

Due to the great number of candidate watersheds in NERI (n=53; Table 5) and funding constraints for hiring and housing field technicians, only a subset of these watersheds are included in the monitoring program. The number of watersheds that can physically be sampled in each sampling period in NERI can be defined as:

$$W = V^{-1} * \Sigma(O * D)$$

where W is number of watersheds surveyed across survey period, O is number of observers, D is number of days each observer is available to conduct surveys, and V is number of visits per watershed across survey period. Given that in each survey period there are O=3 observers who each work D=20 days and visit a watershed each of these days, and each watershed is visited on V=2 separate days, $W = 30 = 2^{-1} * 3 * 20$.

Optimizing sampling effort

Based on some preliminary simulations, greater precision of estimates is gained by surveying more watersheds (i.e., higher W) than by increasing the number of replicate samples per watershed (i.e., higher R). This claim is based on equal effort (i.e., R/W) and constant parameter values across transects. If detection rates vary among years, then more replication within watersheds would be warranted (i.e., higher R/W). As abundances and rates of occupancy and detection are poorly known for the focal species, this proposed design may need to be adjusted to

achieve optimization. Therefore, watersheds and/or samples within watersheds may be added or dropped as more data become available.

Detectable Levels of Change

Thresholds for meaningful changes in distribution of sentinel species must be determined to define detectable levels of change. In the context of structured decision making for conservation and resource management, thresholds come in three forms, including ecological, utility, and decision (or management) thresholds (Martin et al. 2009). For this monitoring protocol, utility thresholds should be based on quantitative management values of alternative future ecosystem conditions. With a very simple example, managers wish to maintain sentinel species occupancy $\geq 30\%$. Utility values would then be assigned using the following conditional: if sentinel species occupancy $\geq 30\%$, then continue urbanizing; else, stop urbanizing. Ecological thresholds, in contrast, should be based on empirical model predictions of how sentinel species respond to system conditions. An ecological threshold for this example might be determined based on a model of interannual occupancy dynamics. Using the incidence function by Hanski (1994), and assuming constant interannual occupancy dynamics, projected stable occupancy (PSO) can be calculated using the following formula: $PSO = I / (I + E)$, where I = immigration and E = emigration. Consider the following conditional: if landscape contains $<10\%$ urban, then sentinel species $I = E = 20\%$ and $PSO = 50\%$; else $I = 10\%$, $E = 30\%$, and $PSO = 25\%$. Following with this very simple example, the action threshold would be 10% urban land cover. In reality, continuous relationships between occupancy dynamics and system conditions would need to be modeled, but this example suffices to demonstrate the use of thresholds for making management decisions.

Ideally, definitions of utility thresholds for sentinel species distribution should be provided by park managers and/or public input. In lieu of such definitions, such thresholds can be based on initial estimates in the park, published estimates of spatiotemporal distribution in pristine systems of the MAH, trends from long-term monitoring programs in the MAH, or theoretical thresholds of extinction. Using initial conditions would assume that current conditions are optimal for management and conservation in the park.

Based on literature review, the only available estimates of distribution from pristine systems in the MAH are based on a one-year study of songbirds in eleven 10 to 18-ha old-growth mixed deciduous forest census plots in northwestern PA (Haney 1999). As presented, these results may not be comparable with results from the streamside monitoring program due to differences in spatial resolution of sampling, lack of correction for detectability, and the lack of trend information. Published results from long-term studies in the MAH (DeSante et al. 2008, Sauer et al. 2008) also present challenges for comparison due to differing sampling approaches.

Given these uncertainties, using initial conditions as a benchmark in conjunction with theoretical models for extinction risk may be the best option. Ovaskainen and Hanski (2003) presented a formula for deterministic threshold for persistence of a metapopulation: $e/c > (n-1)/n$, where e = probability of patch extinction or emigration, c = probability of patch colonization or immigration, and n = number of patches. As n increases, $(n-1)/n$ (i.e., the proportion of colonizable habitat) approaches 1. Thus, for a large n , if immigration probability exceeds emigration probability (i.e., gains exceed losses; $PSO > 50\%$), then the metapopulation is

expected to persist. Otherwise, the metapopulation is expected to become extinct ($PSO \leq 50\%$). This is a rather conservative approach, as some might argue that, for example, a PSO of 30% is acceptable for species conservation. A 50% threshold, therefore, should be considered a placeholder until input from park managers and/or the public becomes available.

The goal for monitoring and analysis, then, will be to detect, with a high degree of confidence or credibility (e.g., 90%), a decline in sentinel species occupancy estimates below initial occupancy estimates or below thresholds for extinction. Such criteria for detecting declines will be evaluated every 5-10 years to account for lagging effects of large-scale phenomena such as climate change.

Personnel Requirements

Successfully coordinating environmental monitoring projects requires coordination, communication and cooperation among all those involved. Therefore, the responsibility for tasks cannot be placed on a single individual and instead must be distributed and shared among many involved in the project. The primary responsibility for certain tasks will reside with certain individuals more than others, but all will share responsibility to ensure that each task is completed properly.

Roles and Responsibilities

See SOP 1 “Roles and Responsibilities” for concise descriptions of personnel and tasks to be completed as part of the monitoring protocol. Some of the most important roles and responsibilities are provided here.

The crew supervisors are responsible for implementing this monitoring protocol. Each crew supervisor must be proficient at training observers to do the following: (1) identify streamside birds of their assigned park unit by sight and sound, (2) safely traverse rugged terrain, (3) estimate distance accurately for birds detected aurally, and (4) enter and proof data in a MS Access database. Each supervisor supervises one field crew at their assigned park unit. Crew supervisors will oversee the hiring and training of the field crews and provide crews with field supplies and computers that have Microsoft Access and associated files. In some cases, a supervisor may be required or opt to conduct a portion of the streamside surveys. Crew supervisors are responsible for providing all field gear and data collection equipment, supplies, and data forms for the field season. Crew supervisors must also ensure that field crews enter and proof all field data according to schedule. Finally, crew supervisors ensure that all field equipment is clean, stored, and will remain in good working order for the following field season.

The data management aspect of the monitoring effort is the shared responsibility of the crew supervisors, field crews, and the data manager. Typically, the crew supervisors are responsible for ensuring proper data collection, data entry, data verification and validation, and data transfer to the data manager. The data manager is responsible for data archiving, data security, dissemination and database design. The data manager, in collaboration with the crew supervisors and the avian ecologist, also develops data entry forms and other database features as part of quality assurance and automates report generation. The data manager is ultimately responsible that adequate QA/QC procedures are built into the database management system and appropriate data handling procedures are followed.

The avian ecologist, together with the Network Coordinator, is responsible for ensuring continuance of project funding. Independent roles of the avian ecologist include formatting data collected for this monitoring effort and analysis and reporting of these data. Another responsibility is to revise the protocol based on input from the Network Coordinator and from crew supervisors. Depending on funding, the avian ecologist may also be responsible for supervising field crews and data management.

Qualifications and Training

See SOP 4 “Hiring and Training Observers” for details on hiring and training all personnel associated with the streamside bird monitoring program. The most essential component for the collection of credible, high-quality data on birds is a competent observer. This cannot be overemphasized. During the course of a five-year Hawaiian Forest Bird Survey, the importance of carefully selecting and training observers became increasingly apparent (Kepler and Scott 1981). Carefully screening initial applicants can eliminate the more obvious visual, aural, and psychological factors that increase observer variability (Kepler and Scott 1981); proficient bird observers obtain species estimates within 90% and abundance estimates within 80% accuracy (Ralph et al. 1993).

Various studies have shown that observer bias is one of the most noteworthy bias factors in trend analysis of songbird populations (Scott and Pratt 1986, Sauer et al. 1994, Kendall et al. 1996). In addition to being able to visually identify birds, field observers must be proficient at identifying species by their songs and calls, and using distance estimation. Therefore, recordings of birds in the study area, especially for the less common or unexpected species will be provided for surveyors. Observers will be tested frequently on their ability to identify bird calls. Good hearing ability is essential because many birds, particularly in forested habitats, are detected by sound only. While differences in hearing ability between observers may strongly affect survey results (Ramsey and Scott 1981), training has been shown to improve the ability of observers to detect birds (McLaren and Cadman 1999). Furthermore, the use of variable circular plots theoretically adjusts for variations in hearing ability, to an extent, so that two observers with different hearing abilities may still produce unbiased density estimates (Kepler and Scott 1981, Ramsey and Scott 1981). A week-long training session covering distance estimation and identification of all focal species by sound will therefore be required for all observers before surveys begin.

The quality of the observer will determine the quality of the data. Therefore, each observer is required to participate in a one-week training course before each of the two study periods (see SOP # 3 “Hiring and Training Observers” for details). The first training period occurs during late March, and the second occurs in mid June. All members of the bird survey crew will complete these mandatory training sessions before collecting data in the respective study periods.

Species known or expected to occur in specific parks will be emphasized when training observers, but observers will be urged to familiarize themselves with the remaining species as well. Inferences from the analysis will focus on species or guilds (henceforth, sentinels) that have sufficient precision in estimates of their occupancy or abundance to monitor changes among years.

Operational Requirements

Annual Workload and Field Schedule

Bird surveys, data analyses, and reporting must be completed every year. The first training period for the bird survey crews will include 5 days of instruction before the sampling period begins and will focus on LOWA identification, GPS navigation, and marking/remarking of transects and point count stations. The first sampling period will vary by region within the ERMN: 1) March 25 – April 24 in West Virginia (i.e., NERI, GARI, BLUE), 2) April 5 – May 4 in DEWA, and 3) March 30 – April 29 in ALPO, FONE and FRHI. Observers will begin to familiarize themselves with bird species other than LOWA during the first sampling period. The second training period for the bird survey crews will include 7 days of instruction before the second sampling period begins and will focus on focal species identification, distance estimation, and measurements of vegetation and stream noise. The second sampling period will again vary by region within the ERMN: 1) May 24 – June 23 in NERI, GARI and BLUE, 2) June 1 – June 29 in DEWA, and 3) May 27 – June 26 in ALPO, FONE, and FRHI. These periods may be delayed due to inclement weather. Both periods coincide with the peak breeding activities for LOWAs, and the second period commences with completion of spring passerine migration.

The following timeline outlines the annual schedule and personnel for implementing the ERMN streamside bird protocol:

- 1) January-February (Avian ecologist and supervisors)
 - a) Hire field crews
 - b) Prepare for field season
- 2) March-July (Avian ecologist, supervisors, and field crews)
 - a) Travel to field house and field sites
 - b) Train and supervise field crews (DEWA, NERI, GARI, BLUE)
 - c) Conduct point-transect surveys
 - d) Enter and proof data
- 3) August-December (Avian ecologist)
 - a) Analyze data
 - b) Prepare and submit manuscripts and annual report
 - c) Present results at professional meeting
 - d) Discuss results with park resource managers

Facility and Equipment Needs

The nature of bird survey work does not require special facilities beyond normal office space, field housing, appropriate vehicles, and equipment storage needs. SOP 2 “Before the Field Season” contains a list of the equipment needed by survey crews.

Startup Costs and Budget

This protocol was developed through a cooperative agreement with The University of Georgia’s Warnell School of Forestry and Natural Resources. The agreement covered protocol research and development, field personnel, and data collection at NERI, GARI and BLUE for the first four years of the program (FY2007-2010). The total budget for this agreement and its modifications was approximately \$375,000. An additional cooperative agreement with a budget of approximately \$57,000 with East Stroudsburg University covered protocol development and data collection at DEWA from 2009 through 2010. Beginning in 2010 (and the 2011 field season) the protocol will be managed by the network coordinator with the field season (data collection) likely implemented through cooperative agreements with universities. Data collection will require crew leaders and 2 technicians at DEWA and NERI, respectively. However, the crew leader at DEWA is not involved with daily data collection tasks. The network coordinator will travel to ALPO for data collection and a contractor will travel to FONE and FRHI.

Costs associated with implementing the annual field sampling portion of the streamside bird monitoring protocol are approximately \$75,000 with details provided in Table 6. This estimate includes salaries for field crew leaders, crew members, transportation, housing, travel costs, and supplies that are used every year. Costs not shown include approximately 30% of the ERMN network coordinators time to assist with overall protocol management and to write annual summary reports. Periodic funding for detailed and thorough trend and other analyses beyond what the network coordinator is capable (skills and/or time) may also be required.

Table 6. Estimated annual costs of conducting field work for the streamside bird monitoring protocol in seven park units of the Eastern Rivers and Mountains Network.

Budget category	NERI, GARI, BLUE	DEWA	ALPO	FONE, FRHI
Salaries, contracts, fringe	\$ 28,600	\$ 17,550	\$ 0	\$ 1,800
Travel	\$ 5,000	\$ 5,000	\$ 350	\$ 600
Supplies	\$ 1,000	\$ 1,000	\$ 100	\$ 100
Indirect if Univ. (17.5%)	\$ 6,000	\$ 4,100	\$ 0	\$ 0
Park housing	\$ 1,000	\$ 2,500	\$ 0	\$ 0
Total	\$ 41,600	\$ 30,150	\$ 450	\$ 2,500

Field Methods

Detailed descriptions of site establishment, conducting the streamside bird surveys including vegetation and stream noise measurements, example field forms, and details regarding the sequence of events during the field season are described in SOP 4 “Establishing, Marking and Relocating Sites”, SOP 5 “Conducting the Streamside Bird Transect”, and Appendix E “Field Forms”. For maps and directions to selected transects, contact the Data Manager (see SOP 1 “Roles and Responsibilities”). Important aspects of data collection are highlighted below.

Field season preparation

The monitoring described in the protocol occurs annually in late March through the end of June. However, the ability to successfully complete the field portion of the protocol will hinge upon thorough advance planning. This planning includes preparation of equipment, maps, field forms, and databases; advertising, hiring, and training observers; securing housing and vehicles; among other responsibilities. Details on each of these activities are described in SOP 2 “Before the Field Season” and SOP 3 “Hiring and Training Observers.”

Conducting streamside bird surveys

Each 1-km streamside transect will be visited on four days per year during spring/early summer. Transect surveys to document LOWAs (see below) are conducted on all four visits. Point count surveys to document all other streamside breeding birds (see below) are conducted only during the third and fourth visits (Table 7). During each visit, an observer traverses the transect twice (i.e., upstream and downstream) collecting data on LOWA and, during the third and fourth visits, also conducts a 5-minute point count at each of the (typically) 5 point count stations on both passes along the transect. Each transect, therefore, has two subsamples (passes) within each visit day, for a total of 8 transect-visit occasions and 4 point-count visit occasions per year. Each visit begins at sunrise and ends 4.5 hr after sunrise. Ideally, repeat transect visits are rotated among 2-3 observers within each year to account for observer biases, however single observers conduct the surveys due to logistical constraints at ALPO, FONE, and FRHI.

Table 7. Sampling schedule for streamside bird surveys in the Eastern Rivers and Mountains Network.

Sampling period	Visit number	Transect	Stream noise	Vegetation	Point count	Range of dates for surveys		
						NERI GARI BLUE	ALPO FONE FRHI	DEWA
First	1	X		X		March 25 April 24	March 30 April 29	April 5 May 4
	2	X		X ^a				
Second	3	X	X	X	X	May 24 June 23	May 27 June 26	June 1 June 29
	4	X	X	X ^a	X			

^a Vegetation is only sampled a second time in a sampling period if a different field observer is available.

LOWA transect surveys

Observers walk each transect in a slow and methodical manner to detect LOWAs. Each detection is documented on field datasheets by recording the location, pairing status, age, height relative to ground or stream, distance and direction (i.e., left or right) from the main channel, and ancillary information to support location and pairing status assignment (e.g., interactions with other LOWAs).

The first two visits occur during early spring (roughly March 30 through May 15 depending on park), which corresponds with LOWA spring migratory arrival to the parks, territory establishment, pairing, and nest building. The period ends when most paired females begin incubating a clutch of eggs. Males are very vocal during this period, and they spend much of their time guarding their mate, foraging, and inspecting potential nest sites. The timing of, and bird behavior during, this period maximizes the potential of detecting LOWAs and LOWA pairs if they are present. The two transect visits during this period are separated by approximately two weeks.

The third and fourth visits to each transect occur during late spring / early summer (roughly May 20 through June 30 depending on park), which corresponds with the peak LOWA fledging period. LOWA pairs are therefore very active during this period while tending young. These two transect visits are also separated by approximately two weeks.

Point count surveys

Point counts surveys are conducted concurrent with LOWA transect surveys during the third and fourth visits to each transect. This period (roughly May 20 through June 30) corresponds to the period when the majority of streamside birds have completed spring migration and commenced breeding activities, which includes frequent singing by males (which, again, increases the chances the bird will be detected given that it is present). While walking each transect, observers

stop at each point count station and conduct the 5-minute point count. During point counts, observers record the following information for each individual bird detected: 1) species identity, 2) type of detection (e.g., singing, calling, drumming, or visual), and 3) whether it was first detected within < 50 m, 50 – 75 m, or > 75 m of the point count station. Observers pause for 5 minutes at the upstream or downstream end of each transect before conducting the point counts of the second pass.

Vegetation and stream noise measurements

Wind-generated tree-fall gaps and, to a lesser extent, landslides, lightning, drought, and insect-defoliations play important roles in shaping the structure and composition of vegetation communities along streams in the ERMN (Rentch 2005). By governing the composition and successional stages of plant communities, these natural disturbances are important in structuring the composition of associated streamside bird assemblages (Greenberg and Lanham 2001, Saunders et al. 2006, Bowen et al. 2007). An important component of any bird monitoring program, therefore, is measuring the response of bird species to changes in vegetation. Rapid visual assessments of vegetation structure and composition surrounding each point count station will therefore be conducted.

Background noise can have dramatic effects on the spatial distribution, singing behavior, and detectability of birds (Lengagne and Slater 2002, Slabbekoorn and Smith 2002). While these effects have been demonstrated in response to anthropogenically generated noise (e.g., Patricelli and Blickley 2006), natural noise effects remain less understood. In mountainous regions such as the ERMN, noise generated by waterfalls and rapids is sufficient to affect bird behavior and detectability and, as such, hand-held sound (decibel) meters will be used to quantify noise generated by streams (henceforth, stream noise).

Vegetation measurements will be taken at each point count station during all four visits to each transect if different observers are available (to account for observer variability in these estimates). If different observers are not available, vegetation measurements will only be taken during the first and third visit (Table 7). Stream noise is measured prior to each point count during the second period (third and fourth visits).

Data Handling, Analysis, and Reporting

One of the most important goals of the Inventory and Monitoring (I&M) Program is to integrate natural resource inventory and monitoring information into park planning, management, and decision-making. Collecting data on specific natural resource parameters such as vital signs is the first step toward improving our understanding of park ecosystems. Sound data management practices enable us to analyze, synthesize, and model the data, transforming them into useful information.

This section gives a brief overview of the ERMN Data Management Plan (Piekielek 2009). The full network plan, in conjunction with the national-level plan, Data Management Guidelines for Inventory and Monitoring Networks (NPS 2008), describes strategies that have been and will be adopted by the ERMN.

Database Design

The ERMN Streamside Bird Monitoring Database is a custom relational database developed in Microsoft Access to store all the data collected for the streamside bird monitoring protocol. The database consists of tables, queries, data-entry forms, and built-in reporting tools. The database builds on the Natural Resource Database Template, which is a set of core database tables and is the standard for the Inventory and Monitoring Program. The database structure, relationships, and dictionary will be fully documented in Appendix F (to be developed).

Data Entry, Verification, and Editing

Accurate collection and stewardship of data are critical to the success of the streamside bird monitoring program. Ensuring data quality must be a priority during crew training and throughout the data handling process. Data handling typically involves the following steps: data entry, data verification, data processing and storage/backups. Data entry consists of transferring raw data from field data forms into a database. Data verification immediately follows data entry and involves checking the database records and the original data entry forms for accuracy. Validation procedures seek to identify generic errors (i.e. missing, mismatched, or duplicate records) as well as logical errors specific to the protocol.

Details of the data handling process, quality control, storage, and archiving are described in detail in SOP 7 “Data Management”.

Metadata Procedures

Metadata will be developed for all datasets developed by the network. This includes both spatial and non-spatial datasets. Executive Order 12906 mandates that every federal agency document all new geospatial data it collects or produces using the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata (CSDGM; www.fgdc.gov/metadata/constan.html).

Recommended Reporting Schedule and Format

Three types of reports will be produced for the ERMN streamside bird monitoring protocol. Annual summary reports will be produced each year. Park resource managers are the primary

audience for the annual summary reports. These summaries will document the efforts of the streamside bird monitoring protocol and convey findings of the previous field season. They will typically follow the Natural Resource Data Series format, content, and level of peer review per guidelines provided by the NPS Natural Resource Program Center (NRPC). In many instances, the purpose of these reports is to get summary information to park resource managers in a timely manner, and, as such, some of the data and conclusions will still be regarded as provisional. A second type of informational report, termed a Resource Brief, will also be produced in concert with the annual summary report. The intended audiences for this shorter, executive summary-style, brief are park superintendents, planners, and interpreters, among others.

In addition to these annual summary reports, detailed reports in which data are analyzed and synthesized will be produced on a periodic basis, typically every 3 to 5 years. They will follow a format appropriate for an NPS Technical Report and/or scientific journal and will contain in-depth analyses and undergo extensive peer review. Further, these comprehensive reports will place the observed results in both a regional and historical context by relating them to published literature, discussing the significance of the results relative to changing environmental factors, and providing management recommendations based on these findings when appropriate. The target audience will be park natural resource managers of the ERMN, other I&M Networks, the broader scientific community, state departments of natural resources and local municipalities.

These three reports will form the core reporting requirements and schedule for this protocol. Additional reports, data summaries, and presentations for a variety of purposes will be performed as appropriate.

Recommendations for Routine Data Summaries and Analysis

The data analysis for the streamside bird monitoring program has one overarching objective: to evaluate bird communities as indicators of biotic integrity in the parks and provide this information to resource managers in a timely manner. See “Rationale for Monitoring Streamside Birds” for explanation of focal species and guilds and SOP 8 “Data Analysis” for detailed recommendations on analytical methods. The data collected for this protocol allow for a wide range of analyses, and the recommendations below represent example analyses that may be conducted.

Specific objectives of data summaries and analysis:

1. Estimate stream-reach scale occupancy and relative abundance of songbird species in selected watersheds of the ERMN.
2. Estimate and provide hypotheses to explain trends among years in stream reach-scale occupancy probabilities for songbird species in selected ERMN watersheds.
3. Calculate the Bird Community Index of biotic integrity for individual stream reaches in the ERMN.
4. Compare trends in occupancy of songbird species in selected ERMN watersheds to those of other studies in the region.

5. Based on results from data analyses, provide ERMN scientists and resource managers with recommendations for adapting monitoring and management to ensure high biotic integrity in the parks.

Relative Abundance and Trends

Of the ERMN parks, NERI and DEWA offer sufficient numbers of selected tributaries for modeling the spatiotemporal distribution of streamside songbirds while accounting for detection biases. The remaining parks (GARI, BLUE, ALPO, FONE, FRHI), in contrast, have few (2-3 each) selected tributaries and therefore only raw detections (henceforth, naïve occupancy) will be summarized for these parks.

Occupancy modeling approach: Detections of birds during consecutive years will enable estimation of point, interval, and/or watershed-level occupancy, which could be interpreted as a measure of relative abundance. To account for the nestedness of spatial samples (i.e., points or intervals within streamside transects), a hierarchical model of occupancy dynamics will be used (Royle and Kery 2007). The model will be fit to the data using a Markov-chain Monte Carlo (MCMC) procedure that enables estimation of the latent occupancy process based on species detections. The procedure also allows consideration of alternative model structures to address particular assumptions, including whether occupancy indeed changes between years, whether a hierarchical model is used, whether species have unique levels of detectability or unique levels occupancy, and whether particular covariates are included for detectability (e.g., observer) or for occupancy (e.g., watershed size).

This MCMC modeling procedure will be conducted using WinBUGS 4.1 (Spiegelhalter et al. 2003) and may include, for example: 1) transect-interval occupancy by LOWAs, and 3) count-circle occupancy by forest-interior songbirds representing specific guilds (e.g., migratory status, nest placement, habitat). The existence of constancy of interannual transitions in occupancy (henceforth, occupancy dynamics) may be examined by comparing models with and without such dynamics. Support for constant dynamics would justify defining ending occupancy as the projected stable occupancy probability (PSO) estimate from Hanski (1994): $PSO = I / (I + E)$, where I and E are probabilities of immigration and emigration, respectively. Otherwise, ending occupancy would be defined as the occupancy probability from the last year analyzed. More complete descriptions of the occupancy modeling approach and assumptions are available elsewhere (MacKenzie et al. 2003, Mattsson and Marshall 2009).

LOWA transect survey analyses: Distribution and density of LOWA and LOWA breeding pairs have been shown to be indicators of spatial variation in stream ecosystem integrity (Mattsson and Cooper 2006, Mulvihill et al. 2008). Though not yet examined, changes over time in distribution and abundance of LOWA and LOWA pairs likely reflect changes in stream ecosystem integrity. Because LOWA territories extend 250 m of stream in at least portions of the ERMN (Mattsson et al. 2009), occupancy of all LOWAs and of LOWA pairs within each 250-m transect interval may be considered as an index of the spatiotemporal distribution of LOWA along selected tributaries in the ERMN.

Point-count survey analysis: Fluctuations in distribution of neotropical migratory forest-interior songbird species likely reflect ecosystem changes on their breeding grounds, migratory routes,

and/or wintering grounds (Jones et al. 2003). Species-specific patterns could indicate particular changes, such as frequency of tree fall gaps, tree species composition, and stream ecosystem integrity. As an example of the type of analyses possible, occupancy of particular songbird species or guilds (e.g., canopy-nesting forest-interior obligate species) within 75-m count circles may be considered in the analysis. This “guild” approach is amenable to many other similar analyses depending on the question of interest.

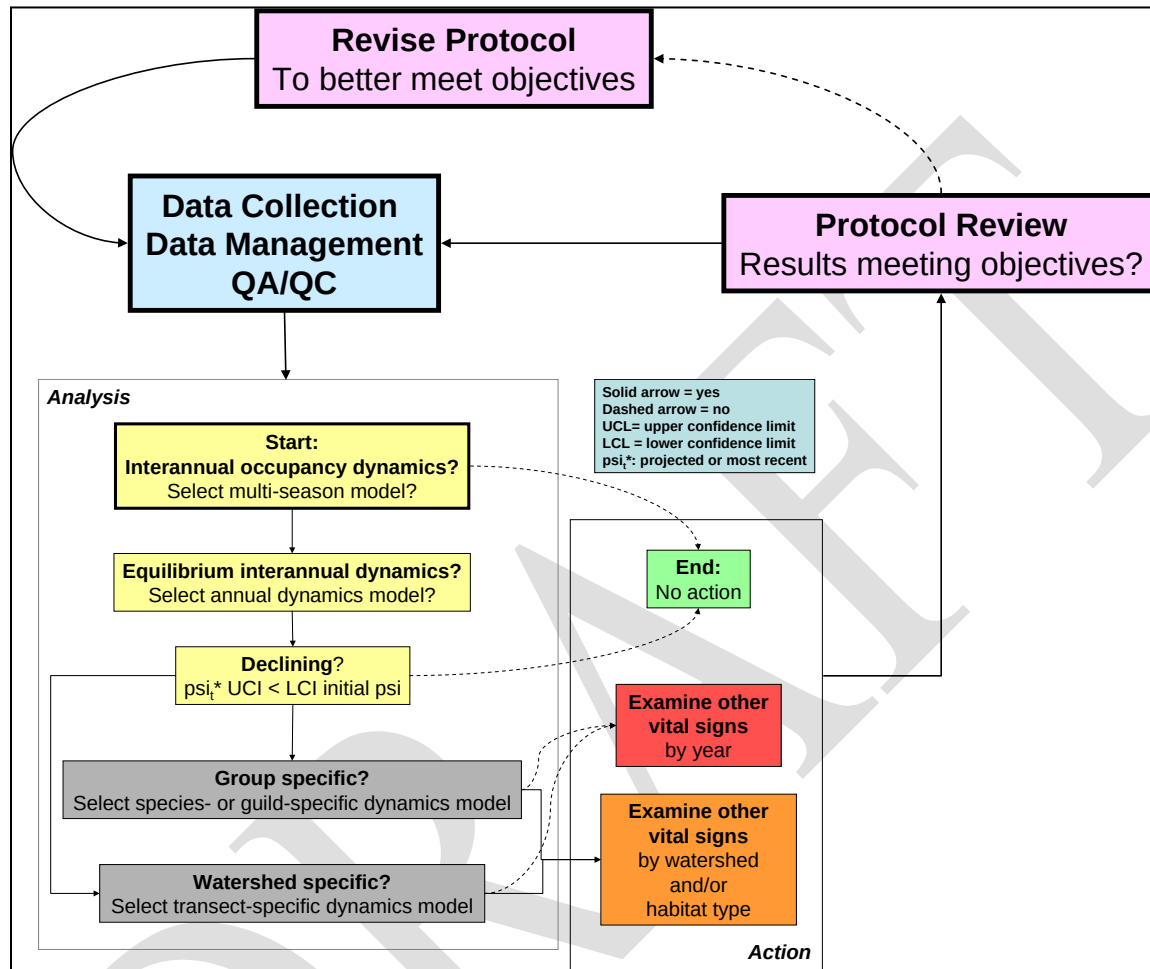
Bird Community Index of Biotic Integrity

In addition to the guild and species-specific analysis above, the point-count survey data are amenable to an application of a recently developed Bird Community Index (BCI) of biotic integrity in the Mid-Atlantic Highlands (MAH; O'Connell et al. 2000). The BCI is applicable to the ERMN, as nearly all of the parks are entirely contained by the MAH. The MAH boundary falls along the Delaware River, and so the New Jersey portion of DEWA falls just outside the MAH. In particular, relative proportions of species belonging to predefined sets of behavioral and physiological response guilds determine the BCI score for a 1-km transect (See SOP 8 “Data Analysis”). Such an index provides a coarse assessment and potentially reveals ecosystem-level status and changes along a disturbance gradient from “pristine” or “natural” (i.e., forested) to “highly disturbed” or “urban.” This assessment is based on species life history attributes rather than species vulnerability *per se* and therefore aims to provide a snapshot of ecological condition at a landscape scale.

Integration across vital signs and adaptive management

Adapting monitoring of vital signs and management of park resources in accordance with analytical results is an important aspect of an effective long-term monitoring program (Martin et al. 2009). Triggers for actions typically relate to a priori decision thresholds (see “Detectable Levels of Change” in Sampling Design). If, for example, declines in community integrity or occupancy for any of the forest-interior assemblages become evident and consistent over multiple years, then further analyses may be recommended to identify the spatiotemporal and ecological extent of the changes. In particular, transect or strata-specific models of bird community metrics could be analyzed to determine if certain species, guilds, transects, watersheds, types of watersheds, or regions within the park exhibit particularly sharp declines. Once these changes have been described, then relevant vital signs (e.g., benthic macroinvertebrates, land cover, climate, and vegetation) could be evaluated in areas of sharp declines to develop more specific hypotheses for the changes (Figure 20). These hypotheses provide guidance for further monitoring and targeted management actions aimed at reversing such declines. Using Bayesian methods, for example (see “Occupancy modeling approach” above), monitoring data can be used to update levels of belief, or weights of evidence, in favor of competing hypotheses about how specific management alternatives relate to desired patterns of streamside bird occupancy.

Figure 20. Flow chart linking streamside bird monitoring protocol and results with more detailed analyses and integration with other vital signs. If interannual dynamics are evident and remain constant among years, then projected occupancy (ψ_i^*) is used. If interannual dynamics are evident and fluctuate among years, then most recent annual estimate of occupancy (ψ_{it}) is used.



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Standard Operating Procedure (SOP) #1

Roles and Responsibilities

Version 0.5 Draft

Revision History Log:

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This SOP provides cooperators, field crews and network staff with information on who is responsible for performing project tasks. This SOP applies to all personnel involved in the monitoring protocol, including the Principal Investigator, field crews, network staff, and any cooperators.

Successfully coordinating environmental monitoring projects requires coordination, communication and cooperation among all those involved. Therefore, the responsibility for tasks can not be placed on a single individual but distributed and shared among many involved in the project. The primary responsibility for certain tasks will reside with certain individuals more than others, but all will share responsibility to ensure that each task is completed properly. For instance, network staff will not be directly involved with field season preparation but should be aware of the need for cooperators to take necessary steps to prepare for the upcoming field season.

I. Personnel

See list of names, titles, and contact information in Table 1.1.

A. **Coordinator** – The coordinator is responsible for overseeing the entire project. This does not mean that he/she plays active roles in each task but knows the rationale and requirements for each task and the responsible party for completing each task. Note that the coordinator is also responsible for overseeing other vital signs monitoring efforts in the ERMN, including vegetation and water quality. Pending availability of collaborators, the coordinator may take over the role of the avian ecologist (see below).

B. Avian Ecologist – Plays an integral role in maintaining project funds on an annual basis, protocol review/revision, sampling design, and data analysis. He/she is also responsible for handling requests for data collected using this protocol. He/she can assist in other areas but these are the primary areas of responsibility. A collaborator from an outside agency or institution may serve as the avian ecologist, and funds may be available to compensate them for their time.

C. Crew supervisors– Responsible for managing project funds in preparation for and during the field season, hiring and training field technicians, and ensuring that the data is collected properly. Must be able to provide the field team with a vehicle and provide them with guidance throughout the field season. Also must ensure that the data is properly entered into the project database, thoroughly checked and validated and transferred to NPS offices in accordance with data transfer guidance. Must work closely with coordinator, ecologist, and data manager regarding the budget, protocol review and revision, and data management, analysis, and reporting. Depending on the availability of collaborators, the avian ecologist may take over the role of crew supervisor in one or more parks.

D. Data Manager – Responsible for coordinating data management throughout the lifespan of the project. Develops data management guidance for the project, develops the proper database application for data storage and ensures that the crew supervisors and field crew are properly trained on using the application. Provides GIS needs during site selection and GPS software/hardware support during remainder of project.

E. Field Crews – Responsible for field data collection, data entry and data QA/QC for the WV parks and DEWA. Supervised directly by crew supervisors.

I. Tasks

The following are listed in chronological order. See Table 1.2 for a chart showing the personnel responsible for each task.

A. Budget Tracking: Review project budget to make sure that the project has not exceeded cost expectations. Cooperators must work together to agree on a reasonable and sustainable annual project budget.

B. Database development: Create a project database based on the I&M database template that meets the needs of the project. Ensure that the database functions properly and meets requirements for analysis while ensuring a user-friendly interface for data entry/proofing. Though the ecologist, crew supervisors, and field crews are not directly involved with this task, the data manager should consult these individuals during the development process. See SOP 8 “Data Management.”

C. Field season preparation: Hire and train field crews, and ensure that field equipment is obtained and ready for use. Ensure that housing, vehicles, and park radios are made available to the field crew. Crew supervisors will be responsible for these tasks. See SOP 2 “Before the Field Season,” and SOP 3 “Hiring and Training Observers.”

D. Field work: Conduct streamside surveys (SOP 5), and relocate sampling points (SOP 4) in accordance with the protocol. This task primarily falls on the field crew but crew supervisors must ensure that field crews are properly trained.

E. Data Entry/Proofing: Data are entered into the project database in accordance with the specific project data entry requirements. This task primarily falls on the field crew, but crew supervisors must ensure that the field crews are properly trained in using the project database. See SOP 8 “Data Management”.

F. Data Transfer and Archiving: After entering and proofing their data, each field crew transfers the database to the respective crew supervisor. After ensuring the data are complete and free of errors, the principal investigator transfers the database to the data manager for archiving. Once the data manager ensures agreement with I&M standards, the database is finally transferred to the ecologist for analysis and reporting. See SOP 8 “Data Management.”

G. Data Analysis: Prepare summaries and conduct the necessary analyses as described in the protocol (SOP 9). Though the coordinator is not directly responsible for this task, he/she should be consulted during the design and acquisition of results from preliminary analyses. The avian ecologist will be responsible for this task but may coordinate with the data manager for simple database summaries.

H. Reporting: Prepare and provide annual reports summarizing the results of field work from the previous field season and illustrating interesting findings and analysis results (SOP 20). Though the coordinator is not primarily responsible for this task, he/she should assist by reviewing draft reports. The avian ecologist will be responsible for this task but may coordinate with the data manager for simple database summaries.

I. Protocol revision and review: This is an on-going task that should take place at least annually. Review should involve input from all of those involved in the project. Depending on the revisions needed, the coordinator will delegate this task between the avian ecologist and data manager. See SOP 20 “Revising the Protocol.”

Table 1.1 List of personnel involved with streamside bird monitoring in the ERMN as of January 2010.

Title	Name	Affiliation	Phone	E-mail
Network Coordinator	Matt Marshall	National Park Service	814-863-0134	matt_marshall@nps.gov
Avian Ecologist	Brady Mattsson	U.S. Geological Survey	706-534-0896	bmattsson@usgs.gov
Crew Supervisor - NERI, GARI, BLUE	Kirk Stodola	University of Georgia	706-542-1403	stodolak@warnell.uga.edu
Crew Supervisor - DEWA	Terry Master	East Stroudsburg Univ.	570-422-3709	TMaster@po-box.esu.edu
Contractor - FONE, FRHI	Brad Ross	Contractor	814-404-1714	bdr102@verizon.net
Database Manager	Kris Callahan	National Park Service	814-863-2320	kristina_callahan@nps.gov

Table 1.2. Personnel responsible for each task in streamside bird monitoring in the ERMN.

Task	Personnel				
	Coordinator	Avian Ecologist	Crew Supervisor	Data Manager	Field Crews
Budget tracking	X	X	X		
Database development	X	X		X	
Field season preparation	X		X	X	X
Field work	X		X		X
Data entry/proofing	X		X		X
Data transfer and archiving	X		X	X	X
Data Analysis	X	X		X	
Reporting	X	X		X	
Protocol revision and review	X	X	X	X	X

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Standard Operating Procedure (SOP) #2

Before the Field Season

Version 0.5 Draft

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP provides cooperators and network staff with information on preparations for the field season. The crew supervisors and field crew will review the entire protocol, including the protocol narrative all the SOPs, several months before surveys begin. All crew members will be issued a copy of this protocol during the pre-survey training. Several weeks will be required for crew leaders to prepare for each one-week training session and organize field gear. Crew supervisors will pay particular attention to hiring and training observers for this project. Bird identification and distance estimation is extremely important; accurate identification of birds by sound is essential. While misidentification is much more serious than errors in estimating distances or double-counting a bird, special attention must be placed on distance estimation due to variation in creek noise, topography, and vegetation structure. The training sessions will prepare observers to accurately estimate distances to all forest-interior songbird species. An adequate training program requires a significant amount of preparation time.

Procedures:

I. General Preparation and Review:

- 1. Review “Background and Objectives” of the Protocol Narrative and all SOPs.** Understand the goals and procedures of the monitoring program and begin preparations for the training period and field season.

2. Develop timeline and field schedule and outline responsibilities of individual crew members.

3. Review field notes, maps, and trip reports from past sampling events. Identify any unique conditions (private land access, hazardous routes, missing markers, etc.) that may be encountered en route to or along each transect.

4. Provide and review the streamside bird species list for the park unit. See Appendix B. Review the species most likely to be encountered in the West Virginia parks (i.e., NERI, GARI, BLUE), DEWA, or the western Pennsylvania parks (i.e., ALPO, FONE and FRHI). Species lists from sampled transects and other sources for each park unit will be incorporated into training and studied before surveys begin. Also, review species that have not been recorded but that may be detected on a particular transect or habitat type. Each crew member will carry a copy of the species list in their field notebook, printed on Rite-in-the-Rain[®] loose leaf, to use as a quick reference for identification. *[Note: The taxonomy of families, genera, and species as well as common and scientific names used follow the 7th edition (1998) of the American Ornithologists' Union (AOU) Checklist of North American Birds, including changes made in the 42nd, 43rd, 44th, 45th, 46th, 47th, and 48th Supplements to the Check-list, as published in The Auk 117: 847-858 (2000); 119:897-906 (2002); 120:923-932 (2003); 121:985-995 (2004); 122:1026-1031 (2005); 123:926-936 (2006); 124:1109-1115 (2007)].*

5. Provide map and directions for each transect (one house copy and one field copy). In addition to a description of the transect itself, maps include driving directions, labeled roads and other landmarks. Maps are stored with the Network Coordinator and Data Manager. Crew leaders will provide to technicians.

6. Print blank field data forms. The field data forms are included as appendices in SOP 5 “Conducting Streamside Surveys”. Print these onto Rite-in-the-Rain[®] looseleaf paper. For each transect, print 1+ double-sided copies of the Transect Data Form, and, for the late spring / early summer surveys, 2+ double-sided copies of the Point Count Data Form.

7. Upload waypoints and MapSource[®] maps onto the GPS units. Ensure that customized MapSource[®] maps and all point count stations and navigation markers are uploaded from ArcView[®] or ArcGIS[®] onto each Garmin[®] GPS unit before the start of the field season. See SOP 6 “Using Global Positioning System (GPS) Units” for instructions.

II. Scheduling Field Work:

1. Devise the daily survey schedule. Review “Field Methods” in the Protocol Narrative, and see Tables 5.1 – 5.4 in SOP 5 “Conducting Streamside Surveys”. The exact field schedule may shift slightly by year and will depend primarily on weather. Monitoring efforts in the West Virginia Parks will require three full-time crew members, while DEWA will require two full-time crew members. Each 1-km transect is surveyed

by one observer in a morning, but crews may travel to sites in pairs depending on driving logistics. Each observer will sample one transect per morning, as time to travel between and/or traverse most transects precludes sampling two transects in a 4.5 hr period. Crews must attend one week of training before the start of each sampling period (see SOP # 3 “Hiring and Training Observers” for details).

2. Provide flexibility to account for bad weather days. Crew members must be flexible, because sampling schedules often change due to weather events. Survey efforts are inherently intense due to the rugged terrain and brief periods of peak breeding activities by Louisiana Waterthrush, which is the main focal species of the monitoring program. Crews will generally work five days out of every seven, but this ratio may vary depending on weather conditions. Crew leaders should have a realistic understanding of goals (number of transects and visits per transect) for each sampling period. The physical condition of the crew is also a factor for consideration in survey scheduling, especially for stream transects that are very steep and/or deep. It is wise to plan for weather days throughout the month and always have a backup plan.

3. Produce a tentative survey schedule. A tentative survey schedule should be constructed for the entire field season to ensure efficiency, taking into account all logistical considerations, including travel time, availability/need of a vehicle with high clearance, private land access, relative difficulty of transects, and pairing of neighboring sites. Ultimately, survey scheduling should provide a detailed plan, but remain somewhat flexible to account for weather.

III. Organizing Supplies and Equipment:

1. Review equipment inventory before the field season.

2. Organize and prepare all field equipment several weeks before commencing field work. Table 2.1 summarizes the field equipment needs for each crew member for each point-transect survey; Table 2.2 summarizes the equipment required for making permanent plots; Table 2.3 summarizes suggested personal equipment. All equipment should be examined for functionality and completeness before field work begins.

3. Update equipment inventory at end of field season.

Table 2.1 List of field equipment needed for each transect survey in the ERMN. Items should be provided to each field crew member unless otherwise noted.

Number Required	Item Description
1	Water-resistant binoculars (8 x 40)
1	Compass (with declination) ^a
1	Handheld Garmin GPS 60csx (or newer) for navigation
1+	Bird Field Guide(s) (Recommended: Sibley Guide to Eastern Birds) ^b
1	Rite-In-the-Rain [®] spiral field notebook
1+	Field Data Form- VCP point count datasheet (printed on Rite-in-the-Rain [®] paper)
3+	Field Data Form- Transect datasheet (printed on Rite-in-the-Rain [®] paper)
1	Field Data Form- Stream noise & vegetation datasheet (printed on Rite-in-the-Rain [®] paper)
1	Streamside bird species list for particular park unit (printed on Rite-in-the-Rain [®] paper)
1	High-resolution road map with sites clearly marked (stays in vehicle)
1	Driving and hiking directions to transect and points (printed on Rite-in-the-Rain [®] paper)
1	CD Player ^b
1	Bird song CD(s) (Recommended: Stokes Field Guide to Bird Songs: Eastern Region) ^b
1	Radioshack [®] Sound Level Meter (Model# 33-2055 or newer)
1	Hand-held NPS radio (for communication with crew and emergency law enforcement)
1	First Aid Kit
1+	Extra mechanical pencils and lead (7mm)
Many	Extra batteries (for radio and GPS unit)
1+	Roll of bright pink flagging and black sharpies (for marking points, gear that might be lost, etc.)

^a Declinations: NERI = GARI = BLUE = -7.5; FONE = FRHI = -9.5; ALPO = -10; DEWA = -13.

^b Provide one per field crew

Table 2.2 List of additional field equipment required for marking or remarking permanent survey points on each transect in the ERMN.

Number Required	Item Description
1	Small hammer or mallet
5+	1" Aluminum nails
5	Replacement aluminum tree tags (engraved with station numbers 1-5)

Table 2.3 List of recommended personal equipment for each transect survey in the ERMN.

Number Required	Item Description
1	Breathable, sturdy, packable rain jacket and pants
1	Quick-dry pants with closeable, 6" x 8" pocket(s) to store field notebook
1	Quick-dry, long-sleeve shirt
1	Day pack with food or snacks and 1+ liter of water
1	Good pair of water-ready boots ^a
1	Water-ready socks (e.g., Neoprene) ^a
1	Digital wristwatch and small stopwatch attached to field notebook
1	Water-ready gloves (e.g., Neoprene)
1	Warm hat
Optional	Additional clothing as necessary (e.g., field vest, blaze orange)
Optional	Personal first aid supplies and toiletries

^a Simms® Rivershed™ Wading Boots and Neoprene socks provided by NPS.

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Standard Operating Procedure (SOP) #3

Hiring and Training Observers

Version 0.5 Draft

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This SOP explains the procedures and goals of the hiring and training process for field crews. This SOP applies directly to the crew supervisors. Achieving the goal of accurate, reliable, and consistent data begins with the hiring process, followed by a rigorous training program. Field crews must be prepared both mentally and physically for the extreme conditions associated with field work in the ERMN. Training should ensure that all observers are able to identify, by sight and especially by sound, 100% of the focal bird species expected to be encountered in the focal park unit(s) and > 90% of bird species that have reasonable potential to occur in that park unit. It is also essential that observers are able to accurately and consistently estimate distances to unseen singing individuals of the focal species and follow standard operating procedures to assure consistency among observers.

This SOP is one of the most important SOPs of this protocol and contains two subsections: 1) Hiring Observers and 2) Training Observers. Accurate measurement of distances and correct identification of species is critical for reliable estimates of bird densities (Fancy 1997). The “Hiring Observers” subsection summarizes the essential skills that observers must possess for this project and provides guidance on selecting and hiring observers. The “Training Observers” subsection summarizes the training that field crews will receive before the field season and describes the training program.

From 2007-2009, the avian ecologist for the ERMN stream bird monitoring project (Brady Mattsson, University of Georgia [UGA]) worked cooperatively with Terry Master at East Stroudsburg University (ESU) to hire and train observers for the monitoring program in the WV parks (i.e., NERI and GARI) and DEWA, respectively. During this time period, the network coordinator and a private contractor surveyed streams in ALPO and FONE/FRHI, respectively. Surveying streams annually in the ERMN requires the following personnel: one crew supervisor and two technicians in DEWA, one crew supervisor and three technicians in the WV parks, one

technician for ALPO, and one technician for FONE and FRHI. The partnership between the NPS, UGA, and ESU ensured the hiring of qualified field observers for the project in addition to high-quality and consistent training in bird identification (by sight and sound) and distance estimation. This model has helped maintain consistency in data collection and field methods, and has provided outstanding opportunities for training new personnel to become primary observers for this project.

I. Hiring Observers:

1. Qualifications

One of the essential components for the collection of accurate data is a competent observer. Potential observers should preferably have at least one year of experience conducting point counts in eastern forests, but must at least demonstrate enthusiasm, good physical condition, and willingness to devote their time and energy to the 12-week monitoring program. In addition to visual identification of LOWA, observers should ideally already be proficient at identifying many of the focal species by their vocalizations. It is also preferable that observers are skilled at distance estimation. Observers must have excellent hearing ability, because many birds are detected by sound only. Ideally, though, hearing abilities among observers should be equal. Good hearing ability is essential for the collection of accurate data. Field experience is an important variable to consider when evaluating potential observers, because experienced observers may be able to identify birds by only a brief glimpse, a portion of a song, or a single call note. Regardless of experience, however, potential team members with serious hearing loss (> 20 dB) within the range of bird vocalizations should be excluded from consideration for these positions, unless they have their hearing corrected to 10 dB using hearing aids.

The essential skills and experience necessary for technicians and biologists working as observers include: identifying birds by sight and sound (songs, drumming, and call notes), using distance estimation techniques, good eyesight and good hearing ability, excellent physical condition, and backcountry experience. The physical and psychological demands of remote field work in the ERMN should not be underestimated. Even the most skilled observer is of no use if they are unable to cope with adverse field conditions. Bird surveys in the ERMN demand a capacity for adjusting to waking well before dawn, navigating to remote field sites, and hiking through rugged, steep terrain with dense understory, deep creeks, and treacherous waterfalls. The terrain in the WV parks is especially difficult to traverse. Crews must endure extended periods of light precipitation and near-freezing temperatures during the first sampling period, then poison ivy, stinging nettle, and ticks in the PA parks during the second sampling period. The remote nature of the work requires wise judgment, and crew members should preferably have at least two seasons of experience working in remote backcountry situations.

2. Hiring procedures

The following procedures for hiring assume that technicians will be employed by a non-federal agency or institution. Furthermore, some institutions or agencies will require additional procedures for hiring employees that could delay employment, including background checks.

- a. **Prepare job announcement.** The following is a template, where START and END = start and end dates of employment (see Scheduling Transect Visits in SOP 5 “Conducting Streamside Bird Surveys”), YYYY = year of sampling, and # = number of technicians needed (see Replication section in Protocol Narrative), \$\$\$\$ = total stipend per technician (\$10-15 per hour, 6-8 hours per day, see job boards below for competitive rates), and PARK(S) = name(s) and location(s) of parks where technicians will work (portions in square brackets [] should be omitted if advertising for only one park), and SUPERVISOR = name, address, and email of crew supervisor in charge of hiring that year:

FIELD TECHNICIANS (3) needed START – END YYYY for study of bird communities along forested tributaries in the Appalachian Mountains. Study area[s] include(s) PARK(S). This project is part of a long-term monitoring program being developed for the National Park Service to investigate the impacts of acidification, over-browsing by white-tailed deer, and urbanization on park ecosystem integrity. Duties will include point-counts, and streamside transect surveys of bird species that are sensitive to ecosystem modifications, with special emphasis on Louisiana Waterthrush. Previous field research experience and ability to identify eastern forest songbirds by ear is required. Patience, humbleness, alertness, close attention to detail, making thorough field notes, and enthusiasm for hiking many kilometers of mountain streams are essential. Personal vehicle preferred, but not required. Reimbursement for mileage, housing, and a total stipend of \$\$\$\$ will be provided. Send a cover letter stating your interests [with your preference (if any) for working at PARK(S)], a resume that includes dates of relevant experience, and contact information for three references that can describe your abilities in the field to SUPERVISOR. Positions will be filled as soon as suitable applicants are found. Please write “NPS application” on the subject line of your email.

- b. **Post job announcement.** The job announcement should be distributed at local Universities and posted monthly until crews are hired, starting mid-October of each year at the following websites:
- Texas A&M University, Department of Wildlife and Fisheries Sciences Job Board, <http://wfsc.tamu.edu/jobboard/index.htm>
 - Society for Conservation Biology, Jobs in Conservation Biology, <http://www.conbio.org/jobs/input/>
 - Ornithological Societies of North America, Ornithological Jobs, <http://www.osnabirds.org/on/ornjobs.htm>
- c. **Select and interview job candidates.** See Qualifications above, and request references for applicants that meet most/all of these qualifications. Provided they have good references, schedule a phone interview. The initial interview should be quite casual, allowing room for questions from the applicant, but certain questions should be addressed:
- Why did you apply for this position?* Applicants should demonstrate enthusiasm for getting involved with the project.

- ii. *Describe your background and experience that you believe is relevant to this position.* Applicants should be able to explain clearly in their own words their experience in conducting bird surveys, identifying birds by sound, and distance estimation.
- iii. *Describe your ability to work closely with a supervisor or crew members and independently.* Applicants should demonstrate that they work well with others (training, scheduling transect visits, data management) and alone (in the field, keeping up communication while supervisor is away).
- iv. *How rugged were the field conditions during past projects?* All applicants should demonstrate their capacity to handle cold weather, early mornings, wet feet, and slippery footing. Applicants for DEWA should be able to handle ticks. Applicants for NERI & GARI should be prepared to handle tricky navigation to transects, steep climbs, crawling through rhododendron, stinging nettle, poison ivy, and cold and misty conditions.
- v. *During past projects, describe the procedure for data entry, data management, and data proofing.* Applicants should show that they are motivated to enter data on a daily basis and submit proofed data on a weekly basis, working with a crew member to proof the data.

d. Administer a bird sound quiz. For those applicants that perform well during the initial interview, they will schedule a time to take a quiz of bird sounds for the focal species in the park where they would work (see Appendix B). After receiving a list of species that will be included, applicants should be allowed at least two weeks to prepare for the quiz. The supervisor will inform the applicant before the quiz the number of species that will be included and that one sound file will include an assemblage of species to resemble an actual point count. The quiz may be administered over the phone or in person, depending on the applicant's preference. If over the phone, then the supervisor will email the applicant a password-protected zipped file containing the bird sounds. The supervisor provides the applicant with the password, and the applicant extracts the zipped file to their hard drive and plays the sound files that are named in such a way that the supervisor knows the identity of the species but the applicant does not. Applicants play each sound file once and tell the supervisor the species. The supervisor notes their answer, and the process is repeated until all species have been played. Applicants may replay sound files at the end of the quiz at the supervisor's discretion. Though ultimate decisions to hire applicants are at the supervisor's discretion, applicants must identify $\geq 75\%$ of the species correctly to pass.

e. Make job offers and hire technicians. The supervisor sends official job offers over email stating the salary and dates of employment. The applicant is allowed up to one week to respond to the email confirming their acceptance and terms of employment. This is not a legally-binding contract but may prevent some hires from accepting another position and essentially backing out on the project. Hiring should be completed as early as possible but no later than late February.

- f. **Hiring paperwork.** Immediately upon hiring, the supervisor provides each hire with the paperwork required for hiring seasonal employees at the respective agency or institution. Hires should also submit any paperwork necessary for them to be reimbursed for mileage on their personal vehicle and to be covered by the institution's insurance plan while operating a motor vehicle during the project. Hires should submit paperwork as early as possible but no later than March 1 to ensure sufficient time for processing.

II. Training Observers—General Guidelines:

A rigorous observer training program can reduce bias and variability among observers. The training session before the first sampling period focuses on transect survey procedures, which include identification of LOWA by sight and sound and estimating density of evergreen vegetation. The training session before the second sampling period emphasizes point-count survey procedures, which include 1) identification of all focal species by sound, 2) distance estimation, 3) stream noise measurements, and 4) estimating density of all vegetation. The goal of training is to ensure accuracy and consistency among observers. In particular, observers will be trained so that they have comparable skills in carrying out survey protocols and that they are recording data in a consistent format. The annual training sessions described in this section are mandatory for all observers.

The following section outlines the tasks to be completed during each 5 to 7-day training period.

1. **Prepare for the training program.** Crew supervisors (i.e., instructors) must prepare training materials, itineraries, and field gear before the training program begins. Along with the training program, there are a variety of other tasks that will have to be completed in preparation for field work. Thus, it is crucial that instructors prepare well in advance, budget their time appropriately, and coordinate with each other. Instructors should review

Kepler, C. B., and J. M. Scott. 1981. Reducing bird count variability by training observers. *Studies in Avian Biology* 6:366-371

for a detailed discussion of training observers to identify birds by sight and sound as well as training them to estimate distances. See Appendix B for a list of bird species likely to be encountered at each park unit. Suggested field guides for bird surveys in ERMN:

Dunn, Jon L., and Jonathan Alderfer. 2006. *National Geographic Field Guide to the Birds of North America, Fifth Edition*. National Geographic.

Sibley, David Allen. 2003. *The Sibley Field Guide to Birds of Eastern North America*. Alfred A. Knopf, New York, New York.

2. **Require all crewmembers to attend each day of training sessions.** Observers from previous seasons normally do not need as much annual training in bird identification

skills as new observers. However, all observers must attend the entire training course each year. Experienced observers can assist as additional teachers with less experienced trainees. Experienced observers will also continue practicing distance estimation, working on identification of birds by call notes and partial songs to generally improve their identification skills, and begin to familiarize themselves with the study area(s).

3. **Issue field gear and protocol before training begins.** See SOP 2, “Before the Field Season” for a list of field gear. Provide a copy of this protocol to all trainees, along with field gear and other training materials, before training begins. Ensure that crewmembers have all the appropriate equipment (listed in SOP 2 “Before the field season”), and that they have reviewed the SOPs relevant to conducting surveys and data entry/proofing (i.e., SOPs 3-6) by the time training starts. Ensure that trainees are informed and prepared for the training and survey events; everyone should bring binoculars, raingear, water-ready boots, appropriate clothing, field guides, and any other appropriate for equipment each day of training. Finally, Park or Network staff will ensure that field crews are provided with, and are comfortable with using, emergency communication equipment (e.g., park radios or cell phones) and a park service vehicle for the WV parks.
6. **Start training days early and continue until accomplishments have been made.** Problems enumerating individual birds during the “dawn chorus” can lead to erroneous survey results. Thus, adjust the training time to best prepare observers, incorporating the peak singing time for most species. After day one, begin training one half hour after sunrise, then at sunrise on the following days. This early training time also allows crew members to become accustomed to waking up early, which will be crucial when the real surveys begin. Training sessions will end at the discretion of the supervisor, based on the accomplishments for that day.
7. **Crew supervisors lead training sessions before sampling periods.** During the week preceding each sampling period, crew supervisors must spend 5-7 mornings with all members of the field crew (0 - 4 hours after sunrise), pointing out focal species, providing learning tips, and answering questions.
8. **First field training session**
 - a. *Goals* -- By the end of the 5-day training session, each crew member should be able to navigate to and along many of the selected transects with the GPS unit, and locate and install permanent markers. Crew members must also accurately identify and visually estimate distances to LOWAs without the aid of binoculars, the crew supervisor, measuring devices (other than pacing or GPS unit), or any reference materials.
 - b. *Overview*
 - i. During each day of training, the crew supervisor takes the field crew to one of the more accessible transects, starting with the southern-most areas (see Tables 5.2 and 5.3 in SOP 5 “Conducting Streamside Surveys”). Presumably, none of the transects has been visited since the previous year, and so training sessions can be used to locate, reestablish, or establish

permanent markers along transects. This will simplify some of the actual surveys during the first week of the sampling period.

- ii. Each crew member will learn how to operate their assigned GPS unit while navigating as a group to the first transect marker (see SOP 6 “Using Global Positioning System (GPS) Units”).
- iii. If LOWAs are observed en route to the marker, then see 8c-e.
- iv. After the LOWA observations (if any), each crew member will learn how to locate and/or install a permanent marker (see SOP 4 “Establishing, Marking and Relocating Sampling Points”).
- v. Return to step iii until all point count stations and transect markers have been located or established, or until the crew has received sufficient training for the day.

c. *Visual and aural identification*

- i. As the emphasis of the first sampling period is on transect surveys for LOWA, other species and point count surveys should receive lower priority during the first training session. This is, however, a good time of year to see songbirds before leaves emerge.
- ii. In particular, field crew members should be able to identify LOWAs that are perched, flying, chipping, or singing. The crew supervisor should provide tips on visually distinguishing LOWAs from other birds found often in or near the stream channel, including Winter Wren and Eastern Phoebe. Crew members should also be able to distinguish chip notes of LOWA and similar species, such as Northern Cardinal.

d. *Distance estimation*

- i. Crewmembers should learn how to accurately estimate distances by sight from transect interval markers for the purposes of mapping locations of LOWAs.
- ii. If a LOWA is within 50 m of the marker, then their distance should be estimated visually. As practice, observers should stand at varying distances from transect markers (e.g., 10, 20, 30, 40, 50 m) while estimating distances to rocks, branches, or other notable landmarks in the stream channel to simulate LOWA mapping.
- iii. If a LOWA is beyond 50 m of the marker, then the GPS unit will be used to map their location (see SOP 6 “Using Global Positioning System (GPS) Units”).

e. *Density of evergreen vegetation*

- i. Crew supervisors should demonstrate estimating density of evergreen vegetation within 50 m of point count stations in four quadrats within three height categories (see SOP 5 “Conducting Streamside Surveys”).
- ii. Crew members should independently report their estimates to calibrate and provide consistency among observers.

f. *Data recording*

- i. Crew supervisors should instruct the field crew on use of the Transect Form and the Vegetation Survey Form (see Appendix E).

- ii. In particular, they should become familiar with the codes entered on the form and how these will be entered in a database on a weekly or, ideally, daily basis.

9. Second field training session

a. Goals

- i. By the end of this 7-day training session, each crewmember will be able to estimate distances accurately to each focal species while taking into account topography, understory density, and ambient noise, without the aid of measuring devices.
- ii. Crewmembers will also be able to identify all focal species by sight and especially sound without the aid of binoculars, the crew supervisor, or any reference materials.

b. Overview

- i. During each day of training, the crew supervisor takes the field crew to a birding location of their choice (Table 3.1).
- ii. Each birding location should provide crewmembers ample opportunities for completing the tasks outlined in 9c-d.

c. Visual and aural identification

- i. Though field crewmembers began to familiarize themselves with identification of focal species and with point-count methods during the first sampling period, these skills must be honed during the organized training session.
- ii. As most species will be detected aurally rather than visually, the training should emphasize learning vocalizations of all focal species.
- iii. Crew supervisors should be cognizant of focal species that are challenging for field crews to distinguish (e.g., REVI - BHVI, LOWA – SWWA - HOWA, NOPA - CERW - BTBW). Field crews should also be alerted to the possibility of mistaking certain focal species for non-focal species (e.g., KEWA - CARW, RBGR - BAOR, SCTA – SUTA, LOWA – YTWA, HAWO - DOWO). Whenever possible, the training effort should focus on these challenging species.
- iv. Watching a bird sing can be particularly helpful for learning their vocalization more permanently. At the very least, field crews should be within 50 m of a vocalizing bird, unobstructed by background noise or hillside, to learn their song.

d. Calibrating distances to singing birds using hide-and-seek game

- i. One crewmember (i.e., hider) approaches a consistently singing bird of a focal species near a trail (< 50 m), while the others (i.e., seekers) remain standing on the trail, at least 100 m away from the hider.
- ii. Once the hider is within 10 m of such a bird, they inform the seekers via two-way radio of the species that they have located (i.e., target bird). If multiple individuals of that species are vocalizing, then the hider presses the “Talk” button briefly whenever the bird sings.
- iii. The seekers then discuss their distance estimate while creating a GPS waypoint for their current location. They proceed to where they believe to

be 75 m and 50 m from the target bird, creating a waypoint at each location. The hider may reveal themselves at the 50-m mark to enable the seekers to visualize their proximity to the bird. A rangefinder may be used to measure the distance as well.

- iv. Upon arrival at the location of the bird, the seekers compare their estimates with the actual distances. To do so, they use the GPS unit to navigate from the location of the bird to the waypoints they created en route to the bird. See SOP 6 “Using Global Positioning System (GPS) Units”.
- v. Crewmembers will likely underestimate distances, as several species (e.g., Ovenbird, Swainson’s Warbler, Louisiana Waterthrush) “throw their voices” by singing loudly. Other reasons for underestimation include amphitheater-like topography in valleys.
- vi. Overestimation, on the other hand, can be caused by quietly singing birds (e.g., Worm-eating Warbler), stream noise, hill blockage, and/or dense understory vegetation.
- vii. Therefore, this procedure must be repeated until each crewmember consistently achieves $\pm 10\%$ accuracy, or better, in estimating distances to birds in representative topographies and habitats.
- e. *Stream noise and vegetation density*
 - i. Crewmembers should learn the protocol for taking stream noise measurements and calibrating estimation of density for all vegetation (see SOP 5 “Conducting Streamside Surveys”).
 - ii. Special attention should be noted for any sound meters that are consistently above or below the other meters to ensure consistency.
- f. *Data recording*
 - i. Crew supervisors should instruct the field crew on use of the Point Count, Stream Noise, and Vegetation Survey Forms (see Appendix E).
 - ii. In particular, they should become familiar with the codes entered on the forms and how these will be entered in a database on a weekly or, ideally, daily basis.
 - iii. Discuss potential problems that hinder data recording, including soft songs, distant songs, stream noise, high bird densities, fly-overs, moving birds, and inclement weather.

10. Data entry, proofing and management

- a. Following the last few days of training, crew supervisors instruct field crews on entering and proofing data in the designated Access database (See SOP 7 “Data Management”).
- b. The crew supervisor will instruct each crewmember while entering observations recorded earlier that day. In the absence of such observations, fictional observations will suffice.
- c. Next, crewmembers will work in pairs to practice proofing the data.
- d. Crew supervisors should inform field crew that data should be entered daily, and proofed data must be submitted within a week of collection. Without a sufficient

explanation for a delay (e.g., technical problems, family emergency), failure to do so may result in probationary action.

- e. Database records created during training should be discarded, as they should be excluded from the final database.

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Table 3.1. Focal bird species detected along maintained roads or trails in or near NERI, GARI and BLUE, 2007-2009. No reliable locations known for KEWA or VEER. See Appendix B for species codes.

Location	Species														
	ACFL	SCTA	REVI	BHVI	BAWW	SWWA	WEWA	BTBW	CERW	BTNW	OVEN	LOWA	HOWA	CAWA	AMRE
Babcock SP ^a	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Endless Wall ^b	X	X	X	X	X	X				X	X	X	X	X	X
Irish Mtn Rd ^c		X	X	X	X		X		X		X		X		X
Fall Branch ^d	X	X	X						X		X	X			X
Glade Creek ^e	X	X	X							X	X	X			

^a Walk from Grist Mill along Old Sewell Rd -- becomes Narrow Gauge trail: <http://www.babcocksp.com/babcock.pdf> ;
http://maps.google.com/maps?f=q&source=s_q&hl=en&geocode=&q=37.979519,-80.945984

^b Walk from Fern Creek trail head: http://www.nps.gov/neri/planyourvisit/upload/crtrails_2004.pdf ;
http://maps.google.com/maps?f=q&source=s_q&hl=en&geocode=&q=38.062406,-81.05608

^c Driving route: <http://maps.google.com/maps?q=Irish+Mountain+Rd,+25918>

^d http://maps.google.com/maps?f=q&source=s_q&hl=en&geocode=&q=37.746314,-80.925272

^e Walk from New River trail head: http://www.nps.gov/neri/planyourvisit/upload/NERI_gladetrails.pdf ;
http://maps.google.com/maps?f=q&source=s_q&hl=en&geocode=&q=37.827146,-81.010322

**Streamside Bird Monitoring Protocol for the
Eastern Rivers and Mountains Network
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Standard Operating Procedure (SOP) #4

Establishing, Marking and Relocating Sampling Points

Version 0.5 Draft

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP explains the procedure for (1) locating existing point count stations along streamside transects, and (2) establishing, modifying and marking point count stations. This SOP applies to field crews and crew supervisors. Directions to sampling sites are provided in appendices of SOP 2 “Before the Field Season”.

Procedures:

I. Locating Existing Markers

- 1. Obtain driving and hiking directions to the streamside transect (see appendices in SOP 2 “Before the Field Season”).**
- 2. Ensure that the designated Garmin GPS unit contains waypoints representing these point count stations (See SOP 6 “Using Global Positioning System (GPS) Units”).**
- 3. Due to GPS error, the Garmin unit should allow observers to navigate within approximately 7 m of marked stations.**
- 4. Look for bright (perhaps faded) pink zipties (DEWA only) or flagging tape (all other parks) tied to a branch or trunk of a live tree or shrub.** There should be one flag or ziptie at stream edge and one uphill at the point count station. Often, rodents or deer chew knots in the flagging, so these markers may be on the ground. Next, look for

an aluminum tree tag on the main trunk of a tree facing the stream ~1.5 m high (i.e., permanent marker). If necessary, consult the printed map for any notes about specific locations of individual points. Note any missing/replaced markers on the Point Count or Transect Form.

II. Marking Permanent Monitoring Points

- 1. Install permanent markers only during the first sampling period.** This avoids unnecessary disturbance (i.e., altering behaviors of local birds) while conducting point count surveys during the second sampling period.
- 2. Locate a suitable place for conducting the point count.** The point count station itself should be 1) directly uphill from the waypoint for the respective 250-transect interval, 2) buffered from stream noise but ca. 20 m from stream, and 3) allow a comfortable standing position with the ability to turn and listen to birds in all directions,
- 3. Install permanent marker(s) within 1 m of the point count station.** Pound an aluminum nail to affix the aluminum tree tag on a tree ca. 1.5 m from the ground on the side facing the stream (i.e., downhill). The tags are pre-engraved with the number representing the number for that point count station. At DEWA only, tie a neon ziptie to the trunk or prominent branch of the same tree with the tag.
- 4. Attach a fresh, 1-m strip of bright pink flagging tape to a prominent, live tree trunk or branch 2 m high and within 2 m of the following: 1) streamside transect interval, and 2) point count station.** Each flag should have “NPS #” where # is the point count station ID ranging from 1 through 5, where 1 is the upstream end and 5 is the downstream end. The point count station flag should have a zero or bulls-eye preceding the ID # to distinguish this location from the streamside interval. At DEWA only, remove flagging after conducting final point count for that season. At other parks, if flagging persisted from previous year, then fresh flagging will supplement the existing flagging when needed. Old flagging on the ground, however, should be shipped to the landfill.

**Streamside Bird Monitoring Protocol for the
Eastern Rivers and Mountains Network
DRAFT**

Standard Operating Procedure (SOP) #5

Conducting Streamside Surveys

Version 0.5 Draft

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP provides instructions for conducting 1-km streamside transect surveys focused on LOWA and 5-minute Variable Circular Plot (VCP) avian point counts every 250 m along the transect, including endpoints. For an overview, see “Field Methods” in the Protocol Narrative. This SOP describes in detail the procedure for collecting data and completing the “Field Data Form—Transect Datasheet”, “Field Data Form—Point Count Survey Datasheet”, and “Field Data Form—Stream Noise and Vegetation Datasheet” (included in Appendix E). This SOP applies to all personnel involved in data collection and training, including the crew supervisors and field crews.

Procedures:

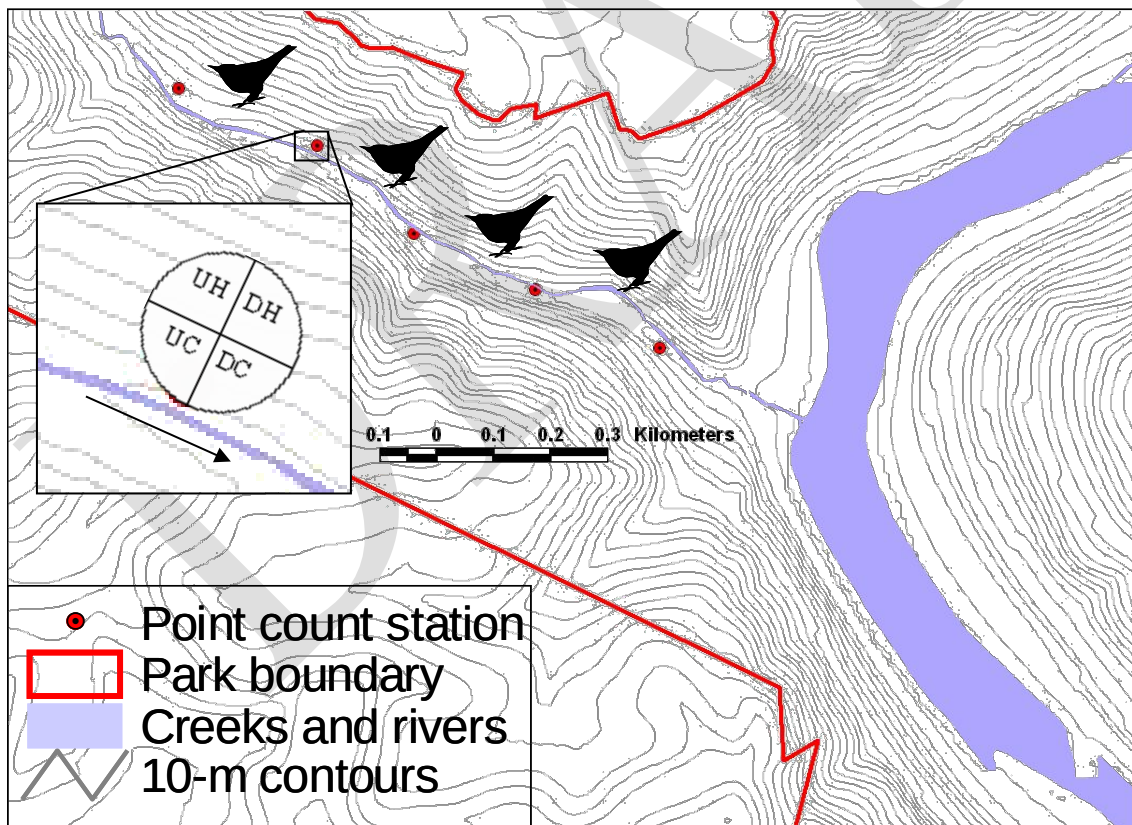
I. **Before Surveys Begin:** See SOP 2 “Before the Field Season” for required equipment, scheduling crews, training, and preparing for surveys.

II. **Terminology for sampling sites (Figure 5.1)**

A. **Transect:** 1-km streamside transects along which surveys are conducted. There are 3-25 transects per park.

- B. **Transect marker:** Found every 250 m along transect and placed on a tree along streambank. Typically, a stream has 5 transect markers, but depending on the length of the stream within the park boundary, each transect may have only 3 or 4 transect markers.
- C. **Transect interval:** 250-m stream reaches between successive transect markers, typically 4 but as few as 2 per transect.
- D. **Point-count station:** center of variable-circle survey center placed 0-20 m uphill from each transect marker, typically 5 but as few as 3 per transect.

Figure 5.1. Example of a streamside bird monitoring sampling site, which consists of a 1-km streamside point transect with five point-count stations that delineate four 250-m intervals (indicated by LOWA silhouettes). Each count circle is divided into four quadrats (UC = upstream creek, UH = upstream hill, DH = downstream hill, DC = downstream creek; example shown here NOT to scale), whose order varies depending on which side of the stream the point count is located. The site depicted is Arbuckle Creek at NERI.



E. **Quadrat:** 50-m diameter pie slice radiating from a point-count station, four per station oriented according to topography (Figure 5.1):

1. Upstream-creek (**UC**): one quadrat edge along contour of hill going upstream and the other toward creek.
2. Upstream-hill (**UH**): one quadrat edge along contour of hill going upstream and the other away from creek.
3. Downstream-hill (**DH**): one quadrat edge along contour hill going downstream and the other away from creek.
4. Downstream-creek (**DC**): one quadrat edge along contour of hill going downstream and the other toward creek.

III. Terminology for sampling intensity (Table 5.1)

A. **Sampling period:** Roughly. 4-week interval during which transect surveys are conducted each year, dates vary by park (for dates see “Scheduling site visits” below), but two per year:

1. **First sampling period:** late winter through mid-spring, corresponds with arrival and onset of incubation by LOWA females.
2. **Second sampling period:** late spring through early summer, corresponds with two critical periods:
 - a) Arrival and fledging of young by neotropical-migratory songbirds.
 - b) Fledging and departure of young LOWAs.

B. **Visit:** ≤ 4.5 hour period during which a transect survey is conducted starting near sunrise, two per sampling period.

C. **Pass:** single traversal from one end of a transect to the other, two per visit, one walking upstream and the other walking downstream, direction varies by transect.

Table 5.1. Sampling schedule for streamside bird surveys in the Eastern Rivers and Mountains Network.

Sampling period	Visit number	Transect	Stream noise	Vegetation	Point count	Range of dates for surveys		
						NERI GARI BLUE	ALPO FONE FRHI	DEWA
First	1	X		X		March 25 April 24	March 30 April 29	April 5 May 4
	2	X		X ^a				
Second	3	X	X	X	X	May 24 June 23	May 27 June 26	June 1 June 29
	4	X	X	X ^a	X			

^a Vegetation is only sampled a second time in a sampling period if a different field observer is available.

IV. Scheduling site visits

A. Conduct four visits per season along each transect, with two visits in each of two sampling periods. Weather permitting, each visit should be 7-10 days apart. Visits are conducted twice between late March and the beginning of May (depending on park) and twice between late May and the end of June (again, depending on park; see below and Table 5.1).

1. Surveys during visits 1 and 2 (first sampling period) include:
 - a) Vegetation surveys (evergreen only; see “Conducting vegetation surveys” below)
 - b) Transect surveys (See “Conducting transect surveys” below)
2. Surveys during visits 3 and 4 (second sampling period) include:
 - a) Stream noise surveys (see “Conducting stream noise surveys” below)
 - b) Vegetation surveys (evergreen only; see “Conducting vegetation surveys” below)
 - c) Point count surveys (see “Conducting point count surveys” below)
 - d) Transect surveys (see “Conducting transect surveys” below)

B. Dates for sampling periods will vary by region within the ERMN (Table 5.1)

1. First sampling period: transect surveys only
 - a) March 25 – April 24 at NERI, GARI, BLUE
 - b) April 5 – May 4 at DEWA
 - c) March 30 – April 29 at ALPO, FONE, FRHI
2. Second sampling period: point-count and transect surveys
 - a) May 24 – June 23 at NERI, GARI, BLUE
 - b) June 1 – June 29 at DEWA

c) May 27 – June 26 at ALPO, FONE, FRHI

C. Whenever possible, rotate observers among visits to each transect. This will enable the Avian Ecologist to account for observer bias in the analyses.

D. Keep the survey schedule similar among years and among sampling periods.

The actual survey dates may vary, but transects surveyed early in the sampling period should be surveyed early in the following sampling periods. The sequence of transects sampled should also be kept as consistent as possible across years. See Tables 5.2-5.4 for site directions and suggested ordering of site visits and clusters of sites in NERI and DEWA.

E. Prepare up to a week ahead to acquire permission to access certain transects (Tables 5.2 – 5.3).

Table 5.2. Approximate order (south to north) for visiting transects in BLUE, NERI, and GARI, with notes about traversal difficulty and access. Transects near the same city ammenable for carpooling. Transects located in NERI unless otherwise noted. Contact Data Manager for maps and directions to transects.

Site name	Traversal difficulty	Access notes
Week 1		
Near Nimitz, WV		
Mountain Creek ^{a,b,c}	Easy	Car parking; need permission and gate key
Little Bluestone River ^a	Easy	Car parking
Near Hinton, WV		
Fall Branch	Moderate-easy	Easy 380-m hike along trail from car parking
Big Branch	Moderate	Moderate 260-m hike from car parking
Near Bragg, WV		
Bills Branch ^d	Moderate-difficult	Moderate-difficult 420-m hike from car parking; need permission
Kates Branch (Glade Creek) ^e	Moderate	Moderate 300-m hike from NPS truck parking; notify park ranger
Near Sandstone, WV		
Little Meadow Creek	Moderate-easy	Moderate-easy 160-m hike along creek from car parking
Meadow Creek	Moderate	Easy 70-m hike from car parking
Near Beury, WV		
Davis Branch	Moderate-difficult	Moderate-difficult 07-mi hike along trails from car parking
Camp Branch	Moderate-difficult	Easy 200-m hike through woods from car parking
Little Laurel Creek	Easy	Car parking by culvert in transect
Richlick Creek	Moderate-easy	Moderate 1-km hike from Little Laurel Creek parking
Bucklick Creek ^e	Moderate-easy	Truck parking; need gate key, maybe waders to cross Laurel Cr
Near Prince, WV		
Mill Creek	Easy-moderate	Easy 0.2-mi hike on trail from car parking
Batoff Creek	Easy-moderate	Easy 450-m hike along trail from car parking
Week 2		
Near Prince, WV		

Table 5.2. Approximate order (south to north) for visiting transects in BLUE, NERI, and GARI, with notes about traversal difficulty and access. Transects near the same city ammenable for carpooling. Transects located in NERI unless otherwise noted. Contact Data Manager for maps and directions to transects.

Site name	Traversal difficulty	Access notes
Laurel Creek	Easy-moderate	Easy 250-m hike along creek from car parking
UNT at Laurel Creek (Highland Mtn)	Difficult	Car parking; may need waders to cross Laurel Cr
UNT at Laurel Creek (Backus Mtn)	Moderate-difficult	Moderate 150-m hike along creek from car parking
Near Thurmond, WV		
Dowdy Creek	Moderate-difficult	Truck parking at bridge just below transect
Slater Creek	Moderate-difficult	Moderate 500-m hike along creek from truck parking
Buffalo Creek	Moderate-easy	Car parking at bridge across transect
UNT to Buffalo Creek	Moderate-difficult	15-minute hillside trail hike from Buffalo Creek parking
Arbuckle Creek	Moderate-easy	Flat 1-mi hike along river from Dun Glen
Fire Creek ^c	Moderate	Moderate 70-m hike from truck parking; need CSX gate key
Ephraim Creek ^c	Moderate	Moderate 750-m hike from truck parking; need CSX gate key
Near Fayetteville, WV		
Wolf Creek	Difficult	Moderate-easy 860-m hike from car parking
Near Edmond, WV		
Keeney Creek	Moderate-difficult	Car parking
Near Kessler's Cross Lanes, WV		
Meadow Creek ^f	Moderate	Easy 220-m hike along ATV trail from truck parking
Near Marvel, WV		
Horseshoe Creek ^f	Moderate-difficult	Easy 380-m walk from truck parking; need gate key; call day before
Near Swiss, WV		
Laurel Creek ^f	Moderate-easy	Truck parking within a few meters of transect

^a BLUE

^b Call Dennis Richmond for permission 304-787-4511 (home) -- contact network coordinator beforehand for talking points

^c For gate keys, contact NPS resource manager Jesse Purvis at his office: 304-465-6513.

^d Call Mike Peck at Grandview office: 304-763-3145 x29 or x10 for secretary. His father-in-law currently owns the car parking area.

Table 5.2. Approximate order (south to north) for visiting transects in BLUE, NERI, and GARI, with notes about traversal difficulty and access. Transects near the same city ammenable for carpooling. Transects located in NERI unless otherwise noted. Contact Data Manager for maps and directions to transects.

Site name	Traversal difficulty	Access notes
^e Call NPS Ranger Sandy Schuck on her cell phone: 304-640-8824.		
^f GARI		

Table 5.3. Approximate order (south to north) for visiting transects in DEWA, with notes about traversal difficulty and access. Contact Data Manager for maps and directions to transects.

Site name	Traversal difficulty	Access notes
Week 1		
Slateford Creek	Moderate-difficult	35-m hike very steep at first and vegetated
UNT to Delaware River (Arrow Island)	Easy	Long but moderately easy 1.7-km hike mostly along trails; 75 c toll upon return
Caledonia Creek	Moderate-difficult	Long but easy 1.2-km hike mostly along old, overgrown road
Dunnfield Creek	Easy	Easy 180-m hike along a trail; 75 c toll upon return
UNT to Delaware River (Sunfish Pond)	Difficult	Moderately difficult 285-m hike up steep trail; \$1 toll each way
Vancampens Brook (Millbrook Village)	Moderate-easy	Easy 0.8-km walk along roadside and up old gravel road; \$1 toll each way
Vancampens Brook (Donkey Hollow)	Moderate-easy	Easy 1.3-km hike mostly up old gravel road but vegetation can be very thick at end; \$1 toll each way
Little Bushkill Creek	Moderate-easy	Easy 350-m hike along creek, but trail is thin and overgrown
Fuller Brook	Difficult	0.6-km hike easy at first along gravel road, but ends with moderate hike along creek; \$1 toll each way
Van Campen Creek	Moderate	Easy 30-m walk along road
Week 2		
UNT to Toms Creek	Moderate-easy	Easy 50-m walk through woods
Toms Creek	Moderate-easy	Easy 0.4-km walk mostly along creek; call day before for parking permit from PMLE ^a
Mill Creek	Moderate	Moderately easy 0.4-km walk along the creek through some vegetation
Spackmans Creek	Moderate-easy	Moderately easy 65-m walk through some thick vegetation
Hornbecks Creek	Moderate-difficult	Easy 0.6-km hike along an old gravel road
UNT to Dingmans Creek	Moderate-difficult	Easy 35-m walk across the road and creek
Dingmans Creek	Easy	Easy 0.5-km walk along busy road
Adams Creek	Moderate	Easy 360-m hike on trails
Dry Brook	Moderate	Easy 170-m hike through a field where vegetation can get thick later in the season
UNT to Adams Creek	Moderate-easy	Moderately-easy 0.5-km hike through woods along property line and stone walls
Week 3		
UNT to Delaware River (Namanock Island)	Moderate-difficult	Moderately-easy 0.6-km hike up a trail alongside the creek; 75 c toll upon return
Conashaugh Creek	Moderate	Easy 75-m walk along the roadside
Raymondskill Creek	Easy	Moderate 415-m hike mostly along open trails
White Brook	Moderate	Moderate 375-m hike along a much overgrown trail and along side the creek; 75 c toll upon return

^a Pocono Mountain Lake Estates Visitor Office (570.588.6523)

Table 5.4. Suggested order for visiting sites in ALPO, FRHI, and FONE, with notes about traversal difficulty and access. Transects within each park should all be surveyed in a single morning. Contact Data Manager for maps and directions to transects.

Site name	Traversal difficulty	Access notes
ALPO -- 12 miles west of Altoona, PA off US Route 22		
Millstone Run	Easy	Park along Valley Forge Road at PA Game Commission gate and walk ~300 m downhill to stream.
UNT to Blair Gap Run (Foot of Ten)	Easy	Park at NPS gate along Mill Road and walk ~100 m into park to stream.
Blair Gap Run (Muleshoe)	Moderate	Park at PA Game Commission lot along "Old US Route 22" just downhill of "Muleshoe Bridge". Cross street and walk ~25m to stream and start of transect.
FRHI -- 3 miles north of Point Marion, PA on PA Route 166.		
Ice Pond Run	Moderate	1400-m hike from parking near park entrance; last 750 m in steep, banked stream gorge with waterfalls.
Dublin Run	Moderate	800-m hike from park trail; middle 300 m in steep, banked gorge with waterfalls.
FONE -- 11 miles east of Uniontown, PA on US Route 40 near Farmington, PA.		
UNT to Scotts Run (Rankin Rd)	Easy	900-m slightly upslope hike from southwest corner of FONE.
UNT to Great Meadows Run	Easy	1250-m flat hike from southeast corner of FONE.
UNT to Scotts Run (Picnic Loop)	Easy	450-m flat hike from FONE picnic loop parking lot.

V. Daily timing and conditions of count

A. **Consider weather conditions before leaving the house.** When survey conditions are questionable, the primary consideration is the crew's safety, followed by the observer's ability to hear birds. Harsh conditions (high winds, heavy rain/flooding, dense fog, freezing temperatures, or snow) may warrant delaying surveys until at least the following day. Certain inclement weather conditions may be tolerated during the first sampling period, as LOWAs can be readily detected during moderate rain (B. J. Mattsson personal observation). In some cases, National Oceanic & Atmospheric Administration forecast or overnight rainfall totals may be used to facilitate the decision whether or not to delay surveys. Current weather conditions and forecasts are available on the NPS radio weather channel and online at <http://www.erh.noaa.gov/rlx/>

B. **Counts begin within 15 minutes of local sunrise and must be completed within 4.5 hours.** Minimizing the duration of the survey will minimize bias induced by time of day on bird detections.

C. **Discontinue the survey if weather conditions hinder detectability of birds (e.g., high winds, rain, or very dense fog) or pose a significant risk of hypothermia (e.g., freezing temperatures).** Incomplete survey data due to inclement weather or injury should be discarded and the entire survey should be redone within 7 days from the first attempt.

VI. Conducting transect surveys (all visits; first and second sampling periods; for condensed version, see Appendix E)

A. **Navigate to the starting point (i.e., first transect marker) using a handheld GPS unit.** See SOP 6 "Using Global Positioning System (GPS) Units". If the survey point has not been permanently marked or the marker cannot be found, attach marker (see SOP 4 "Establishing, Marking and Relocating Sampling Points").

B. **Upon arrival at the first transect marker, fill out the top of the Transect Datasheet while resting for at least one minute.** See Appendix E. Record park, site, date, observer initials, page number, and weather. Start new row on datasheet with time and write "start" in notes. Record any LOWAs or focal species observed (see below). Resting for a minute also allows the heartbeat to calm after hiking and the observer to get oriented.

C. **Walk 0 - 20 meters uphill to the first point-count station.** Protocols conducted depend on the sampling period. If the survey point has not been permanently marked or the marker cannot be found after thorough search, attach marker (see SOP 4 "Establishing, Marking and Relocating Sampling Points"). Details for conducting vegetation, stream-noise and point count surveys are found below.

1. First sampling period.

- a) Conduct vegetation survey

2. **Second sampling period**

- a) Conduct vegetation survey
- b) Conduct stream-noise survey
- c) Conduct point-count survey

3. **Both sampling periods.** When finished at point-count station, return to stream and begin walking to next transect marker while paying close attention to detect any LOWAs en route.

D. For each LOWA detected (including members of pairs and fledged families), record the observation in a new row on the Transect Datasheet. This will enable the Avian Ecologist to enumerate individuals and to make inferences about their exact location(s) and breeding status. The attributes to be recorded in the appropriate fields on the Transect Datasheet (for detailed description see Appendix E) include:

- 1. Time of day (HH:MM).
- 2. Initial stream distance to nearest UPSTREAM transect marker (use GPS unit to estimate distance unless transect marker is in view).
- 3. Minimum horizontal distance and direction (left or right while facing UPSTREAM) from the bird to the main channel.
- 4. Minimum vertical distance from the bird to the ground.
- 5. Movements from original position, especially into/out of a 250-m transect interval.
- 6. Detection type -- whether the bird was seen or just heard chipping, singing extended song, and/or singing normal song.
- 7. Pairing status -- level of certainty about pairing status.
- 8. Notes -- use two rows if needed to record the following information:
 - a) Any behavioral interactions (e.g., countersinging, contact calls, courtship).
 - b) Minimum distance between birds if multiple LOWAs were detected.
 - c) Breeding activity and bird age -- whether bird carries nesting material, or if during second sampling period, tail length relative to body, carries food, or begs.

E. If there are multiple LOWAs in a cluster (i.e., within 10 m), then they will all usually receive the same pairing status. There may be exceptions in some clusters, for example, when two of the LOWAs chase each other and one of the LOWAs is heard buzzing, seen carrying nesting material or food, or two LOWAs are seen copulating. In

this case, some LOWAs may have a different pairing status than other members of the cluster.

F. One row per individual usually suffices to summarize an entire observation, but there may be instances where it is more efficient to use multiple rows for an individual. For instance, the LOWA may change its location from upland to stream or change its behavior from singing in the canopy to foraging with a female in the stream. In these cases, the individual retains the same pairing status for each row on the datasheet. When using multiple rows for an individual, indicate this by ensuring the start/stop times do not overlap among rows and write “Same as above” in the Notes field.

G. When possible, remain in visual contact with each LOWA for up to 5 minutes or until its age and breeding status are known. This will enable observers to record evidence of its age or reproductive status (e.g., mated, tending fledglings). See Description of Transect Datasheet (Appendix E) for further instructions on classifying breeding status and age. If the LOWA flies out of view and remains undetected for 1 minute, then proceed walking to next transect point. In general, avoid backtracking along the transect survey route beyond 50 m.

H. For LOWAs off the main channel, including side tributaries and upland habitat, record their horizontal distance to the main channel. LOWAs detected beyond 20 m from the nearest section of the main channel are a lower priority for gathering more detailed information, such as visual confirmation and breeding status. In some cases, it may be infeasible or unsafe to track such off-main-channel birds.

I. Observers should avoid pushing any LOWAs observed to maintain their natural movement patterns throughout their territory. Precautions include avoiding eye contact with the bird and making an effort to stay at least 20 m from the bird. An observer will move away from the bank edge upon observing a LOWA in the stream channel and will return after the LOWA is beyond view of the observer.

J. In turn, relocate, refresh, and/or install markers for each transect marker and point count station. To document sampling effort, record the arrival/departure time for each transect marker in a new row on the Transect Datasheet. For further instruction, see SOP 4 “Establishing, Marking and Relocating Sampling Points”.

K. After the first pass, record on one row of the Transect Datasheet the start and end times for a 5+minute rest period before the return pass along the transect. Record on the Transect Datasheet the waypoint and military time (HH:MM) when reaching the turnaround point, before and after a 5-minute rest period. The rest period is important for the observer to have a snack and recuperate, especially after an arduous hike. This will also create a distinct break between passes, which is an important assumption for an analysis based on detection histories.

L. While the priority is to record observations of LOWA, observers should record any focal species detected along transect intervals that were not detected

during point count surveys. For each individual, record detection type and location in new row on Transect Datasheet. This information takes little time to record and can be used to document breeding phenology and develop a more complete list of focal species detected along streamside transects.

VII. Conducting vegetation surveys (all visits; first and second sampling periods; for condensed version, see Appendix E)

A. Conduct the vegetation survey once per point per visit before conducting the survey at that point-count station. See “Conducting point count surveys” above.

B. At each point count station, estimate evergreen cover during first sampling period and total vegetation cover during second sampling period. Leaf out is normally completed after the first sampling period (i.e., after second round of surveys), which obscures evergreen cover during the second sampling period. When rotating observers between visits to transects during a sampling period is impractical, vegetation measurements are only taken once at those transects during that sampling period.

C. While standing at the point count station, estimate vegetation cover in three height categories (i.e., 0.5-2 m, 2-5 m, >5m) in each quadrat (i.e., upstream toward creek, downstream toward creek, upstream toward hill, downstream toward hill). Visualize each unit of measurement as a 3-dimensional pie slice with sides formed by quadrat boundaries, a bottom formed by contours of the ground, and a crust that encircles the point count station with a 50-m radius. Record percent vegetation cover in each pie slice on the Stream Noise and Vegetation Datasheet (Appendix E). This procedure should be completed in ≤ 4 minutes (i.e., ≤ 1 minute per quadrat).

D. While still standing at the point count station, record hemlock condition score. Individual hemlocks will be in conditions ranging from alive and healthy to fallen snags to absent. Record the predominant condition within 50 m of point-count station. See Appendix E for guidelines in assigning hemlock scores.

VIII. Conducting point count surveys (Second sampling period only; for condensed version, see Appendix E)

1. Point-count surveys are concurrent with transect surveys. See “Conducting transect surveys” above.

2. Upon arrival at a point count station, determine if weather conditions are suitable for continuing survey. Unsuitable conditions include continuous periods (>5 min) of rain that soaks paper or of winds that carry leaf litter and move tree crowns.

3. Upon arrival at a point count station, evaluate whether blank datasheets are needed to record stream noise, vegetation, or point count data. If so, fill out the top of each blank data sheet, including the date, time, observer initials, page number (e.g., 1 of __), and point count station ID (the latter is entered in a new row on the Point Count

Survey Datasheet). See Appendices 5.C and 5.D for datasheets. Preparing the datasheets includes a 1-min rest period that allows the heartbeat to calm after hiking and the observer to get oriented.

4. Complete the stream noise, vegetation, and point count surveys in sequence.

To ensure data quality, do not conduct stream noise or vegetation survey concurrently with the point count.

5. When ready to begin, find a comfortable position to stand at the point count station, become aware of any vocalizing birds, record the military time, and start the 5-minute stopwatch. Use the Point Count Survey Datasheet to record bird observations during the survey (Appendix E). If an episodic event interferes substantially with your ability to detect birds during the 5-minute count (e.g., approached by park visitor, loud train or plane passing nearby), then stop the count until the disturbance has passed and start over. Cross out the interrupted data and note what happened on your form.

6. Record one individual per row on the datasheet. Make every effort to avoid double counting individuals detected at a single point. Note any uncertainties for distinguishing individuals during the count, including movements of individuals. If an individual is known or suspected to have been counted at a previous point, record this individual during the current count and make note of the possible double-count.

7. Record several crucial attributes about each individual detected. The attributes to be recorded for each individual include the following (required unless otherwise noted; for detailed description see Appendix E):

- A. Species identity (4-letter code).
- B. Initial type of detection (e.g., singing, calling, drumming, quiet; note additional types in the notes column).
- C. Horizontal distance category of first detection (i.e., <50 m, 50-75 m, 75+ m);
- D. Age (adult, juvenile, or unknown).
- E. Quadrat of first detection (i.e., upstream toward creek, downstream toward creek, upstream toward hill, downstream toward hill).
- F. Minute of first detection (i.e., 1-5).
- G. Tally of minutes detected (i.e., standard pattern to illustrate the exact minute(s) of detection).

It is often easier to first record the minute of detection, the quadrat, followed by the distance band. An accurate estimation of location often requires multiple detections, whereas the observer can immediately record the minute(s) in which each bird was detected.

8. In addition to the crucial attributes, observers may record in the notes column ancillary data. Ancillary bird data may include movements among distance bands or quadrats, sex for silent, sexually-dimorphic species, and breeding activities such

as courtship or carrying nesting material or food (mating status/nesting stage). Ancillary point count data may include weather conditions or ambient noise levels.

9. **Ensure that all fields have been completed immediately after each 5-minute count.** For counts with many individuals, often it is necessary to fill in blank fields after the count for some individual birds based on memory.
10. **If no birds were detected during the survey, complete a row on the datasheet.** To document that the point was surveyed, record the time, any ancillary data, and write, “no birds” in the notes column.
11. **LOWAs detected only during the point count should only be recorded on the Point Count Survey Datasheet.** In other words, do not record such LOWAs on the Transect Datasheet. These will be kept separate in the analysis.
12. **Upon completion of the point-count survey, proceed along streamside transect to next point-count station.** See “Conducting transect surveys” above.

IX. Conducting stream-noise surveys (Second sampling period only; for condensed version, see Appendix E)

A. Conduct the stream noise survey once per point per visit before conducting the survey at that point-count station. See “Conducting point count surveys” above. Stream noise varies according to recent rainfall levels.

B. While standing at the point count station, take one stream noise reading averaged over 5 seconds in each quadrat (i.e., upstream toward creek, downstream toward creek, upstream toward hill, downstream toward hill). Hold Radioshack® sound meter 1 m from ground, and point microphone toward the center of the quadrat, and make sure dial is turned to 60 dB. If needed, press button labeled “WEIGHTING” until “A” appears on the display, and press button labeled “RESPONSE” until “SLOW” appears on the display. When ready to take the reading, press and hold the button labeled “DH” (i.e., data hold) until the display reads, “1.” Press MAX four times until the display reads, “5.” If needed, press MIN to decrease the number on the display. Press RESET to begin the reading. After 5 seconds, the meter displays the average sound level, and “MIN” and “MAX” begin flashing on the display. Record this sound level on the Stream Noise and Vegetation Datasheet (Appendix E), and press the button labeled “RESET” when ready to take the next reading. If meter displays “LO” for sound reading, then record 49 on the datasheet.

C. If interferences occur during a sound level reading (e.g., loud bird song, traffic, rain, wind), this can induce an upward bias in the estimate of stream noise. Therefore, make an effort to take a sound reading when the meter is unaffected by interferences. During a reading, watch the bar at the bottom of the display on the sound level meter to determine whether interferences bias the reading. It may be necessary to

wait and take readings during the return pass. This survey should be completed in ≤ 1 minute.

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**Streamside Bird Monitoring Protocol for the
Eastern Rivers and Mountains Network
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Standard Operating Procedure (SOP) #6

Using Global Positioning System (GPS) Units

Version 0.5 Draft

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP provides instructions on how to set up a Garmin GPS unit, upload and download waypoints, and use it for navigating to waypoints in the ERMN. GIS/GPS specialists should provide crew supervisors with the appropriate GPS units with background maps customized for the designated park unit. Crew supervisors are responsible for ensuring the appropriate settings on each GPS unit and that locations for all point count stations and transect markers have been uploaded from GIS software to each GPS unit. Field crews will complete a GPS training program before field work begins. Upon completion of the training, every crewmember is expected to be able to navigate to an existing waypoint. At the discretion of the supervisor, crews may also be expected to mark and download new waypoints from a Garmin GPS CSX (or similar) unit to an assigned computer. The following instructions are based on the Garmin CSX series, but should be similar for other Garmin units. Please refer to the user manual for specific instructions when using a different unit.

1) Uploading waypoints

- a) *This should be completed by the crew supervisor before field-crew training begins. See SOP 2 “Before the Field Season” for schedule.*
- b) *Required materials*
 - i) Windows 98 (or higher) software
 - ii) DNRGarmin v5.11 software – download for free at <http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html>

- iii) Garmin CSX (or similar) unit with data cable and custom background maps for navigation in the designated park unit. The crew supervisor should obtain such units from the designated GIS specialist (see SOP 1 “Roles and Responsibilities”).
 - iv) If needed, contact Data Manager (see Table 1.1 in SOP 1 “Roles and Responsibilities”) to request the GPS waypoint shapefile for designated park unit and formatted for uploading onto Garmin GPS units. In addition to waypoints that provide assistance while navigating transects, each GPS shapefile contains locations for all point count stations and transect parkers.
 - c) *Connect GPS unit:* Plug GPS unit into a USB port on the computer using the data cable, and turn on GPS unit. The GPS unit receives power from the computer, so no batteries are required.
 - d) *Clear existing waypoints*
 - i) To avoid confusion, any waypoints currently in the GPS unit should be erased before uploading the official set of waypoints. This will also ensure sufficient space in the GPS memory card for storing new waypoints.
 - ii) On the Garmin CSX unit, press FIND, then ENTER to view Waypoints. If there are any, then press MENU, select “Delete...”, press ENTER, select “All Symbols”, press ENTER, select “Yes”, and press ENTER.
 - e) *Open DNRGarmin*
 - i) If window pops up with the message “Garmin USB GPS device not found”, then click “Cancel”.
 - ii) Within the DNRGarmin menu, go to GPS, Set Port, and make sure “USB” is checked. Make sure the GPS unit is connected and turned on, then restart DNRGarmin.
 - iii) If the same window appears, consult the nearest IT support staff member for assistance.
 - f) *Set the projection:* Within DNRGarmin menu, go to File, Set Projection, and choose NAD_1983_UTM_Zone_17N for NERI, GARI, BLUE, ALPO, FONE and FRHI or NAD_1983_UTM_Zone_18N for DEWA.
 - g) *Import point count shapefile*
 - i) Within DNRGarmin menu, go to File, Load From, File... . Within the browse window, choose “ArcView Shapefile (*.shp)” under Files of Type.
 - ii) Browse to the point count shapefile, and click “Open”.
 - h) *Upload waypoints*
 - i) Within DNRGarmin menu, go to Waypoint, Upload.
 - ii) If successful, a window with the message, “Transfer Complete. x Waypoints uploaded.” appears, where x = the number of waypoints uploaded.
 - iii) To verify, scroll down while viewing the list on the Waypoint screen of the GPS unit.
- 2) **GPS set-up for navigation**
- a) *This should be completed by the crew supervisor before field-crew training begins.* See SOP 2 “Before the Field Season” for schedule.
 - b) *Set up Map screen*
 - i) Press PAGE or QUIT until the Map screen appears.
 - ii) If more than two data fields are displayed, then press MENU, select “Data Fields...”, and select “2 Data Fields”.

- iii) If data fields other than “Accuracy” and “Dist to Next” are displayed, then press MENU, select “Change Data Fields”, and select these fields from the respective pull-down menus. Press QUIT when done.
 - c) *Set up Compass screen*
 - i) Press PAGE or QUIT until the Compass screen appears.
 - ii) If less than four data fields are displayed, then press MENU, select “Data Fields...”, and select “4 Data Fields”.
 - iii) If data fields other than “Accuracy”, “Dst to Next”, “[Waypoint at] Next”, and “Sunrise” are displayed, then press MENU, select “Change Data Fields”, and select these fields from the respective pull-down menus. Press QUIT when done.
- 3) **Navigation and marking waypoints:**
 - a) *See SOP 2 “Before the Field Season” for required equipment and supplies and SOP 5 “Conducting Streamside Surveys” for general instructions on navigation.*
 - b) *Navigate to parking spot for designated transect*
 - i) Turn on GPS unit before entering vehicle in the morning, while standing in an open area to maximize satellite reception.
 - ii) Press FIND, select Waypoints, press MENU, go to “Select Symbol”, choose the symbol Ⓢ, and select the waypoint with the name of the designated transect. Select “Go To”.
 - iii) Once satellite reception is confirmed, follow the driving directions provided (SOP 2 “Before the Field Season”) while periodically checking the map screen on the GPS unit.
 - iv) For some driving routes, information waypoints (ⓘ) will be found on the map screen. Place cursor over a particular information waypoint to see specific directions en route to the parking spot.
 - v) The parking spot waypoint (Ⓢ) will be displayed on the map screen. Place cursor over the parking spot waypoint to confirm the name of the destination transect.
 - vi) In the event of a permanent (i.e., until at least the next visit to the transect) change to a driving route or to the parking spot itself, then mark a new waypoint with the appropriate symbol and name (See “Mark new waypoint” below). Note this change and later describe this change to the crew supervisor.
 - c) *Navigate to first transect interval marker*
 - i) Look up the waypoint ID for the designated transect on the list of hiking directions.
 - ii) On GPS unit, press FIND, and select Waypoints. If symbols are sorted by name rather than by location, then press MENU and select “Find Nearest”. Select the green pin with the designated waypoint ID, and select “Go To”.
 - iii) There may be variations between where the waypoint should be and where the marker actually is, due to poor satellite reception. In the case of poor accuracy (i.e., >10 m), try moving to a location with greater sky exposure and hold GPS unit as high as possible.
 - iv) If a marker cannot be relocated, then mark a new waypoint with the appropriate symbol and name (See “Mark new waypoint” below). Note this problem and later describe this problem to the crew supervisor.
 - d) *Navigate to point count station or subsequent transect interval marker*
 - i) Repeat steps 3ci-iii above, except select a blue flag symbol when navigating to a point count station.

- ii) When selecting a point count station, the waypoint ID (e.g., “NERI.ARCR.1R”) is formatted as the 4-letter code for the park, 4-letter code for the transect, then a digit and a character indicating the side of the stream where the point count station is located (i.e., left/right while looking UPSTREAM).
- e) *Mark new waypoint*
 - i) Stand at the location you wish to mark while holding the GPS unit away from the body such that the screen is still readable.
 - ii) On GPS unit, press MARK. The screen displays information for the new waypoint. By default, the waypoint is named with the next highest number not yet used in the list of stored waypoints. Press QUIT to cancel new waypoint – the waypoint will not be stored.
 - iii) Choose symbol -- Highlight the symbol at the top left corner, and press ENTER. Choose the appropriate symbol.
 - (1) Ⓟ = parking spot for transect
 - (2) Ⓛ = driving route information
 - (3) Green pin = 250-m transect interval
 - (4) Blue flag = point count station
 - iv) Rename waypoint -- Highlight the first line with the waypoint ID, and press ENTER. Provide an appropriate ID for the waypoint (no spaces, max. 14 characters), and select “OK” when done or press QUIT to cancel. All IDs must have two prefixes, including a 1-letter park code (N=NERI, G=GARI, B=BLUE, O=FOHE, H=FRHI, D=DEWA) and a 4-letter transect code.
 - (1) Parking spot – prefix + “_P” for parking. For example, “N.LACR_P” = parking for NERI Laurel Creek.
 - (2) Driving route information -- prefixes + directions. For example, “N.LACRgoNE” = turn northeast at this intersection to go toward NERI Laurel Creek.
 - (3) Transect interval -- prefixes + number 1-5, where 1 = upstream end waypoint and 5 = downstream end waypoint. For example, “N.LACR1” = upstream end of NERI Laurel Creek.
 - (4) Point count station -- prefixes + number 1-5, where 1 = upstream end point count station and 5 = downstream end point count station, + character L or R, indicating the side of the stream where the point count station is located (i.e., left/right while looking UPSTREAM). For example, “N.LACR1L” = point count station on left side of stream at upstream end of NERI Laurel Creek.
 - v) Waypoint averaging
 - (1) Highlight “Avg” at bottom left, and press ENTER. The GPS unit begins calculating an averaged location, updating every second.
 - (2) Continue averaging until accuracy goes below 7 m (less is even better) or the measurement count exceeds 100. Press ENTER when done.
 - (3) If the averaged accuracy remains above 10 m after 100 measurements, then press QUIT and restart waypoint averaging. After repeated failures during the first pass, consider retrying during second pass.
 - vi) Verify waypoint
 - (1) Press PAGE or QUIT until the map screen appears.

- (2) Check to make sure that the new waypoint is displayed and that its mapped location is within approximately 10 m of the true location, with respect to the mapped stream, contour lines, roads, trails, park boundaries, or other landmarks.
 - (3) Double-check the accuracy by navigating to the new waypoint from the true location. While standing at the same spot, press FIND, and select Waypoints. If symbols are sorted by name rather than by location, then press MENU and select "Find Nearest". Select new waypoint from top of list, select "Go To" at bottom right, and press ENTER.
 - (4) If the waypoint is >10 m from the true location and accuracy is <10 m, then press FIND, and select Waypoints. Select new waypoint from top of list, highlight "Delete" at bottom left, and press ENTER twice to confirm. Return to step 4ev.
- 4) Downloading waypoints from GPS unit to computer
- a) *This should be completed by the end of each sampling period by either the crew leader or field crewmember, depending on particular logistics.* This is only necessary for units that contain new waypoints.
 - b) *Required materials*
 - i) Windows 98 (or higher) software
 - ii) DNRGarmin v5.11 software – download for free at <http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html>
 - iii) Garmin CSX (or similar) unit with data cable and stored waypoints.
 - c) *Connect GPS unit:* Plug GPS unit into a USB port on the computer using the data cable, and turn on GPS unit. The GPS unit receives power from the computer, so no batteries are required.
 - d) *Open DNRGarmin*
 - i) If window pops up with the message "Garmin USB GPS device not found", then click "Cancel".
 - ii) Within the DNRGarmin menu, go to GPS, Set Port, and make sure "USB" is checked. Make sure the GPS unit is connected and turned on, then restart DNRGarmin.
 - iii) If the same window appears, consult the nearest IT support staff member for assistance.
 - e) *Set the projection:* Within DNRGarmin menu, go to File, Set Projection, and choose NAD_1983_UTM_Zone_17N for the NERI, GARI, BLUE, ALPO, FONE and FRHI or NAD_1983_UTM_Zone_18N for DEWA.
 - f) *Download waypoints*
 - i) Within DNRGarmin menu, go to Waypoint, Download.
 - ii) If successful, a window with the message, "Received x Waypoints" appears, where x = the number of waypoints downloaded.
 - iii) To verify, scroll down while viewing the list in DNRGarmin.
 - g) *Export and transfer shapefile*
 - i) Within DNRGarmin menu, go to File, Save To, File... .
 - ii) Within the browse window, choose "ArcView Shapefile (Projected) (*.shp)" under Files of Type. For file name, type "ERMN x thru MM/DD/YY", where x = the assigned number of the GPS unit, and MM/DD/YY = the date of the last waypoint created.
 - iii) Browse to a designated folder, and click "Save".

- iv) Open Windows Explorer, browse to designated folder, and highlight all 3 files with the name “ERMN x thru MM/DD/YY” (.shx, .shp, .dbf).
- v) Right-mouse click on selected files, Send to, Compressed (zipped) Folder, and transfer this zipped folder to the designated GIS Specialist.

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**Streamside Bird Monitoring Protocol for the
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Standard Operating Procedure (SOP) #7

Data Management

Version 0.5 Draft

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP addresses data management topics specific to the streamside bird monitoring protocol. For additional information about data management within the Eastern Rivers and Mountains Network (ERMN) please reference the ERMN Data Management Plan (Piekielek 2009).

All data collected is entered into the Streamside Bird Monitoring Protocol database which is fully documented in Appendix F (to be developed) of the Streamside Bird Monitoring Protocol Narrative.

Workspace

At the minimum, field crews need to have an office space and/or access to the following items:

1. Computer with Microsoft Office 2007 and DNR Garmin
2. Hard drive for backup
3. Appropriate cables for GPS units and backup hard drive.
4. Internet access
5. Laser printer (printing field forms) and extra ink cartridges
6. Refer to SOP “Before the Field Season” for a list of additional workspace supplies, including Rite-in-rain (R) paper for printing field forms and pencils.

Data Entry

All data collected as part of the ERMN streamside bird monitoring program (transect, stream noise, vegetation, and point count) is either entered directly by the observer who collected the data, or the actual observer reads their data to someone else who enters the data. All data is then proofed in a similar fashion, with the observer who collected the data reading to someone else

inspecting the entered data. Ideally, data is entered and proofed the day of collection. If this is not feasible, then this must be accomplished within one week of data collection. Each crew supervisor should provide the field crew with a weekly schedule showing the deadlines for data entry, proofing, and transfer.

Quality Control and Assurance

Data verification is necessary to ensure that values recorded on the field form and keyed into the database are correctly entered (i.e., the entered value is the “correct” value). Evaluating post-acquisition data is a potentially difficult but necessary task, regardless of the data source.

Several steps are taken prior to, during, and after data entry to verify that data are correct and logical, including:

1. Visual review at data entry. The data fields recorded on the datasheet are compared to those entered in the database to make sure they are consistent. In doing so, technicians verify each record after input and immediately correct any errors.
2. Visual review after data entry.
 - a. Field crews work in pairs to ensure that data entered into the database match the original records, and any discrepancies are identified and reconciled. They compare the dates and sites entered into the database with a separate site-visit log.
 - b. The supervisor reviews the database on a weekly basis to check for data integrity, including proper entry of all visits as reported on the site-visit log, entry of all point counts on both passes (during second sampling period or 3rd and 4th rounds), entry of required fields in data forms, proper determinations of pairing status codes and age, species detections include those that are expected at that site or have supporting documentation, and surveys are conducted within the required time frame (for detailed protocol see SOP “Conducting Streamside Surveys”). The supervisor compiles any questions or concerns regarding the database in a Word document, referring to each problem by visit ID and record number. The supervisor sends this document to field crews within five days of receiving a database submission so that crews have sufficient time to address the concerns before submitting their next bout of data entry the following week.
 - c. Summary queries and tallies. Error detection queries are used to detect omitted or unassociated records. These include comparisons with the field schedule to check for discrepancies, species lists by park to check for birds not typically found in a park or region, and tabulations of the number of birds detected at each point count by visit to identify outliers.
3. Submit proofed database to supervisor weekly or upon request. First, compact and repair the database within MS Access. Then, rename the database with the last visit ID entered in the filename.

4. Place the renamed database file and responses to questions from supervisor regarding previous database submissions into a zipped folder. To do so, open Windows Explorer, browse to the three files, right-mouse-click, choose Send to... Compressed (zipped) folder, and email this zipped file to the crew supervisor or transfer using a USB flash drive.

Records Management and Archiving

Following data entry and verification, all completed raw data is filed in a binder for the current year at the coordinator's office. In addition, the electronic databases that have been entered and proofed are kept on a secure NPS FTP server (<ftp://63.220.43.40/ERMN/>) backed up on computers used at the respective park units and at the ERMN headquarters, and contributed to the Bird Point Count Database managed by USGS Patuxent (<http://www.pwrc.usgs.gov/point/>). Hard copies of all data will also be scanned and stored digitally as Adobe Acrobat PDFs; and stored at ERMN headquarters.

The ERMN maintains an archive directory on the ERMN server where survey data will be archived annually. Databases will be stored in the archive directory, separated by park unit and by field season. The database will be archived annually once the data has been incorporated by the ERMN data manager. All data files in the archive directory are stored in read-only format. Each year, a CD-R will be created annually with the raw field data from the most recent field season, the updated MS Access database, the accompanying annual report, and the monitoring protocol.

Data Dissemination

All requests for data from the ERMN streamside bird monitoring database must be directed first to the ERMN Avian Ecologist. Any request for data must include the following:

1. Descriptions of the study rationale
2. Study objectives
3. How the ERMN bird monitoring data will be used to meet these objectives
4. Any planned products based on these data.

Release of the data is at the discretion of the ERMN Avian Ecologist and the ERMN coordinator. Stipulations for release of data include:

1. Any proposal, manuscript, or report produced based on these data is subject to review by the ERMN Avian Ecologist and the ERMN Coordinator before publication.
2. At the discretion of the designated ERMN Avian Ecologist (and any predecessors; henceforth, them), the potential user agrees to name them in the Acknowledgements section or includes them in the author list for any publication based on these data.

Upon a signed agreement of the stipulations above, the ERMN Avian Ecologist directs the data requester to the ERMN Data Manager, who then releases the data.

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Standard Operating Procedure (SOP) #8

Data Analysis

Version 0.5 Draft

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP is currently in development. Below is an outline of the data analysis options, including definitions of terms and pro/con lists for software and analytical approach alternatives.

The data analysis for the streamside bird monitoring program has one overarching objective: to evaluate bird communities as indicators of biotic integrity in the parks. See “Rationale for Monitoring Streamside Birds” and “Recommendations for Routine Data Summaries and Analysis” in the protocol narrative for explanation of focal species and overview of analytical approaches, respectively. Data for analyses should be formatted using a combination of database queries (see SOP 7 “Data Management”) and programming software. Data for this monitoring protocol are amenable to many types of analyses (see SOP 5 “Conducting Streamside Surveys”) to address specific objectives; an outline for an example procedure for data analysis is presented here.

I. Specific objectives

- A. Estimate stream-reach scale occupancy of songbird species in selected watersheds of the ERMN.
- B. Estimate trends among years in stream reach-scale occupancy probabilities for songbird species in selected ERMN watersheds.
- C. Calculate the Bird Community Index (BCI) of biotic integrity for individual stream reaches in the ERMN.

II. Data formatting for summaries and analyses

A. LOWA transect surveys

1. Analyses

- a) All LOWAs
- b) LOWA breeding pairs
- c) LOWAs using main channel

2. Detection history

- a) One per 250-m transect interval
- b) 8 detections per year = 4 visit days $\times$ 2 passes per visit day

B. Point-count surveys

1. Multi-species analyses

- a) Regular to common forest-interior songbird species
 - (1) Detected during $\geq 3\%$ of point-count surveys
- b) Selected forest-interior songbird species
 - (1) Per-pass detection probability $>10\%$
 - (2) One species per guild of interest, e.g. hemlock-associate, ground-nesting, year-round resident

2. Detection history

- a) One per 75-m count circle
- b) 4 detections per year = 2 visit days $\times$ 2 passes per visit day

III. Software applications

A. Microsoft Access database queries

- 1. Summaries of detections by year, transect, species, and/or guild;
- 2. Initial data formatting for further formatting in Python (see below)
- 3. Calculation of BCI;

B. Python code

- 1. Formats data from Access for occupancy modeling; for code, contact Brady Mattsson (brady.mattsson@gmail.com).
- 2. Download and install Python: <http://www.python.org/download/>
- 3. Code imports queries from Access and exports formatted data as a comma-delimited CSV file.

C. R2WinBUGS program

1. R and WinBUGS used together for occupancy modeling; for sample code, contact Brady Mattsson (brady.mattsson@gmail.com) .
2. Download and install R: <http://cran.r-project.org/mirrors.html>
3. Download and install WinBUGS: <http://www.mrc-bsu.cam.ac.uk/bugs/>
4. R program imports CSV file, further formats data, generates model code, executes program in WinBUGS, generates convergence diagnostics using packages CODA and BOA.
5. Contact Brady Mattsson (brady.mattsson@gmail.com, 706-534-0896) for instructions on running R2WinBUGS program.

IV. Modeling approach

- A. Hierarchical Bayesian dynamic occupancy model (HBDO) to examine potential annual changes in distribution of selected songbird species.
- B. Estimation of occupancy at point-count stations and transect intervals while accounting for the following sources of variability in species detection:
 1. Perceptability (e.g., observers, stream noise, topography, vegetation)
 2. Availability (e.g., breeding phenology, territory density, singing rate)

V. Model selection and inference

- A. Parameter estimates are summarized as posterior means and 95% Bayesian credibility intervals (BCIs; 2.5th – 97th percentiles of the posterior distribution): mean [lower BCI, upper BCI].
- B. Support for competing models is based on BCIs surrounding inclusion probabilities following a reversible-jump Markov-chain Monte Carlo procedure.
 1. $BCI > 0.05$ indicates support for a focal parameter
 2. $BCI < 0.95$ indicates support against a focal parameter
 3. BCI that includes 0.05 and 0.95 indicates mixed support for a focal parameter.
- C. Evidence for trends in occupancy are based on comparisons of initial (i.e., 2007) and ending occupancy:
 1. Projected stable occupancy probability (PSO) estimate (i.e., $PSO = I / [I + E]$, where I = immigration probability and E = emigration probability) is used if there is support for constant occupancy dynamics.

2. Otherwise, ending occupancy is defined as the occupancy probability during the last year analyzed.

D. Strength of evidence for a trend may be classified as follows:

1. Strong evidence -- BCI for ending occupancy excludes that of initial occupancy
2. Moderate evidence -- BCI for ending occupancy is below mean initial occupancy and BCIs overlap each other, or
3. Weak evidence -- mean for ending occupancy is below that of initial occupancy and BCIs overlap the respective means.

Examples of these analysis results can be found in the 2007-2009 summary reports produced for each park in the streamside bird monitoring program. Reports can be accessed from the ERMN website (<http://science.nature.nps.gov/im/units/ERMN/>).

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Standard Operating Procedure (SOP) #9

Reporting

Version 0.5 Draft

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP addresses the design, submission, and review of reports on streamside bird survey data collected in the ERMN. This SOP begins where SOP 8 “Data Analysis” ended and describes six types of reports.

1) Annual Report

- a) The ERMN reporting strategy requires an Annual Report for each protocol. Such reports are produced in March-April based on results from the previous federal fiscal year (October 1 – September 30) and any protocol revisions since the last Annual Report.
- b) Purposes of the Annual Report include:
 - i) Archive annual data and document monitoring activities for the year
 - ii) Describe the current condition of the resource and provide alerts if data are outside bounds of known variation
 - iii) Document changes in monitoring protocols
 - iv) Promote communication within the park or network
- c) The Data Analysis SOP produces various tables and graphics in other software formats that must be imported into the (Microsoft Word) Annual Report Template for the Streamside Bird Protocol.
- d) The ERMN avian ecologist will prepare an Annual Report based on results from the previous field season and any changes to the protocol. The ecologist will then submit the report to the Network Coordinator for review by January 31 of every year, according to specific guidelines set by the Network Coordinator.

2) Analysis and Synthesis Report

- a) The ERMN reporting strategy requires an Analysis and Synthesis report every 3-5 years for each Vital Sign.
- b) Purposes of the Analysis and Synthesis reports include:
 - i) Determine patterns/trends in condition of resources being monitored
 - ii) Discover new characteristics of resources and correlations among resources being monitored
 - iii) Analyze data to determine amount of change that can be detected by this type and level of sampling
 - iv) Provide context by interpreting data for the park within a multi-park, regional, or national context
 - v) Recommend changes to management of resources
- c) In preparing the Annual Work Plan for bird monitoring, the ERMN avian ecologist, together with the Network Coordinator, will plan and budget for preparation of an Analysis and Synthesis report based on results from the bird monitoring every 3 years.

3) Protocol Review Report

- a) The ERMN reporting strategy requires periodic Protocol Review reports for each Vital Sign. The anticipated schedule is that review would be held at about 5 year intervals.
- b) Purposes of the Protocol Review report include providing:
 - i) Periodic formal reviews of operations and results
 - ii) Review of protocol design and products to determine if changes are needed
 - iii) Quality assurance through the peer review process
- c) Working with the Network Coordinator, the ERMN avian ecologist will plan and budget for a Protocol Review Workshop and report every 5 years, beginning 5 years after the initial protocol is approved and after completion of the first Analysis and Synthesis report.
- d) The ERMN avian ecologist will follow the Network SOP# on Revising Protocols in incorporating any changes recommended by the protocol review process.

4) Scientific Journal Articles and Book Chapters

- a) The ERMN reporting strategy encourages periodic publication of monitoring program results in scientific journal articles and book chapters. Purposes of these peer-reviewed publications include:
 - i) Documenting and communicating advances in knowledge
 - ii) Ensuring quality assurance through the peer review process
- b) In preparing the Annual Work Plan, the ERMN avian ecologist, together with the Network Coordinator, will plan and budget for writing of manuscripts suitable for submission to peer-reviewed scientific publications, as findings warrant.

5) ERMN Vital Signs Monitoring Conference (Biennial)

- a) The ERMN reporting strategy includes a Vital Signs Monitoring Conference to be held every two years. Purposes of the conference are to:
 - i) Review and summarize information on ERMN Vital Signs
 - ii) Help identify emerging issues and generate new ideas

- b) In preparing the Annual Work Plan, the ERMN avian ecologist, together with the Network Coordinator, will plan and budget for travel to the Biennial ERMN Vital Signs Monitoring Conference.

6) **Other Symposia, Meetings and Workshops**

- a) The ERMN reporting strategy requires participation in symposia, meetings and workshops, at regular intervals.
- b) Purposes of participation in these activities are to:
 - i) Review and summarize information on a specific topic or subject area
 - ii) Communicate latest findings with peers
 - iii) Help identify emerging issues and generate new ideas

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Standard Operating Procedure (SOP) #10

Revising the Protocol

Version 0.5 Draft

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure outlines how to make changes to the protocol narrative and accompanying SOPs, and how to track these changes. The bird monitoring plan has been carefully developed to reflect the most appropriate methods. However, as more is learned about field methodologies, as techniques are honed, as statistical approaches develop, or as technology changes (e.g., GPS), this monitoring plan and its associated SOPs may require modifications. Biologists editing the monitoring plan or the associated SOPs are to follow the procedures described below.

Procedures:

1. All edits of the monitoring plan require review for clarity, style and content.
2. Minor changes or additions to existing methods will be reviewed in-house by ERMN staff. The ERMN project coordinator should be notified of all changes.
3. If a significant change in methodology is desired, an outside review is required. Regional and National staff of the National Park Service with familiarity in avian research and data analysis will be selected as reviewers. Experts that are affiliated with organizations other than the NPS, but are well-versed in these areas, will also be consulted. Significant changes will not be made without approval of the ERMN coordinator and the ERMN avian ecologist.
4. Staff will document their edits and protocol versioning in the Revision History Log that accompanies the monitoring plan or whichever SOP is being edited. Version numbers increase incrementally by hundredths (e.g. version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the following information: previous version number; date of revision; revision editor

(author); sections and page numbers for changes made; editing rationale (reason for change); and new version number.

5. Inform the ERMN data manager about changes to the plan or SOPs so the new version number can be incorporated in the Metadata of the project database. The database may have to be edited by the Data Manager to accompany changes in the Protocol Narrative and SOPs.
6. Put the revised version in all locations where the monitoring plan and SOPs are stored (at ERMN and NPS) and move the last version to a folder specifically marked as “retired versions”.
7. Provide all individuals involved with the project, including all on-the-ground biologists, with the revised monitoring plan and/or SOPs, as appropriate.

Appendix A. Glossary of key terms used in the Streamside Bird Monitoring Protocol for the Eastern Rivers and Mountains Network.

Term	Definition
Abbreviations	
ALPO	Allegheny Portage Railroad National Historic Site
BLUE	Bluestone National Scenic River
DEM	Digital elevation model
DEWA	Delaware Water Gap National Recreation Area
ERMN	Eastern Rivers and Mountains Network
FIO	Forest-interior obligate
FONE	Fort Necessity National Battlefield
FRHI	Friendship Hill National Historic Site
GARI	Gauley River National Recreation Area
GIS	Geographic information system
GPS	Global positioning system
JOFL	Johnstown Flood National Memorial
LIDAR	"Light detection and ranging"; optical remote sensing for mapping submeter-resolution ground cover characteristics.
LOWA	Louisiana Waterthrush (<i>Seiurus motacilla</i>)
NERI	New River Gorge National River
NHD	National Hydrography Dataset
UPDE	Upper Delaware Scenic and Recreational River
VCP	Variable-circular plot; see also point count station.
WV	West Virginia
Words and phrases	
Focal species, biological background	
Bank-nesting riparian obligates	Bird species that depends on habitats adjacent to flowing water for food and reproduction (i.e., Louisiana Waterthrush).
Benthic macroinvertebrates	Invertebrate species that dwell within the stream channel, usually along the creek bed, and are visible without a microscope
Community	Assemblage of species that occur together within a defined area or habitat (e.g., stream reach, forest stand, watershed, or park).
Ecosystem integrity	The level at which an ecosystem has been modified by humans.
Focal species	Species of the streamside bird community that will be included in the analysis, and these include passerines and woodpeckers.
Forest-interior specialists	Species that increase in density with increasing amount of forest in the landscape (e.g., Ovenbird).
Guild	A group of bird species that share ecological characteristics, such as habitat associations or nest locations.
Habitat-association guild	Group of bird species that tend to be more common or more frequent in certain stand types than in others.
Indicator species	One or more species whose distribution patterns reflect watershed conditions
Nest-placement guild	Group of bird species that build their nests in specific location in a forest (e.g., dead wood).
Spatiotemporal distribution	Distribution of birds across space (i.e., watersheds) and time (i.e., years).
Species richness	Number of species in a defined area (e.g., watershed, park).
Stand	Forested area comprised of relatively homogenous tree species composition and range of age classes.
Streamside bird assemblages	See streamside bird community
Streamside bird community	Bird community that occurs along tributary streams of the ERMN.
Subjects	Bird species and/or guilds.

Term	Definition
Synanthropic guild	Group of bird species that tend to be more common or more frequent near human dwellings, including residential developments and farms.
10-m digital elevation model	A 10-m resolution raster (i.e., gridded map) of elevation estimates within watersheds.
1st-3rd order streams	Perennial or intermittent streams that are downstream of other such tributaries with at most one tributary of their own.
Abiotic characteristics	Physical and chemical characteristics of a watershed, including climate, topography, bedrock geology, and precipitation amounts and acidity.
Acid-neutralizing capacity	Ability of a given watershed to ameliorate the impacts of acid precipitation.
Area-weighted statistics	Summary statistics for some parameter across an entire watershed (e.g., mean elevation), measured within grid cells of some fixed resolution - see for example 10-m digital elevation model.
Baseflow	Water originating from groundwater sources rather than overland flows.
Bedrock fertility score	Inverse of acid-neutralizing capacity. Watersheds with a higher score are more prone to acidification, whereas watersheds with a lower score are less prone to acidification.
Biotic characteristics	Biological characteristics of a watershed, including all life forms that dwell in the watershed.
Buffering capacity	See acid-neutralizing capacity.
Candidate watersheds	Watersheds that met criteria for the bird monitoring protocol but were not necessarily selected for the surveys.
Closed-canopy streams	Streams that are shaded by tree canopy throughout the year.
Drainage area	Land area that drains into a particular point within a watershed.
Fertility score	See bedrock fertility score.
Intermittent	Mixture of surface and subsurface flow along a stream channel.
Intrinsic conditions	Traits of a watershed that remain relatively static through time, including watershed size, topography, preserved lands, and bedrock geology.
Open-canopy creeks	Creeks and rivers that lack shading by tree canopy throughout the year.
Preserved land	Land that is owned by a federal agency (e.g., National Park Service) or designated as a state park.
Protected area	See preserved land.
Relief	Area-weighted standard deviation of elevation for a particular watershed.
Stream morphology	Physical dimensions of a stream channel, including the ratio of length to width and range of sediment sizes (e.g., sand, cobbles, boulders).
Stream network	Contiguous stream reach(es) that correspond to a designated range of watershed sizes, which may comprise one or more branches.
Tributary watersheds	Watersheds that flow into the featured river of its respective park, within the federally mandated boundary.
Underlying features	See intrinsic conditions.
Watershed boundaries	Borders of the drainage area for a particular watershed.
Watershed size	See drainage area.
Watershed topography	Surface features of a watershed, including changes in elevation and slope.
Stressors	
Acid precipitation	Precipitation that is abnormally high in sulfuric and nitric acid content that is caused by atmospheric pollutants.
Eutrophication	Enrichment of waters with nutrients and/or minerals that spur growth of aquatic plants and algae and ultimately depletion of dissolved oxygen.
Sedimentation	Increased flow of fine sediments (e.g., sand, silt, and clay) over land and into streams, usually caused by land use change.
Urban development	See urbanization.
Urbanization	Construction of paved roads, buildings, and lawns.
Inventory & Monitoring	
Status	Streamside bird community metrics during one year of monitoring.
Trends	Changes in the status of the streamside bird community across multiple years.

Term	Definition
Vital signs	Subset of biotic and abiotic elements and processes that are selected to represent conditions of park ecosystems that have important human values (e.g., water quality, birds, benthic macroinvertebrates).
Park ownership	
Federally authorized boundary	Extent of area to which the mission of each National Park applies, though some land within this boundary may be privately owned as inholdings.
Park management units	Boundaries of land owned by the National Park Service.
Private inholdings	Privately owned land within the federally authorized boundary of a National Park.
Study design, sampling, and parameter estimation	
A priori	Knowledge about a system gained or assumed before sampling from that system.
Accuracy	Closeness of an estimate to the true parameter value.
Bias	Inaccuracies in model-based predictions (e.g., bird community metrics).
Bird community metrics	A suite of parameters used to represent a bird community, including use, occupancy, abundance, species richness, and local extinction and colonization.
Colonization	Probability that an unoccupied sample unit becomes occupied during a subsequent sampling occasion.
Detection probability	Probability that an individual or species is detected, given that it is available for detection within a sampling unit.
Distance method	Analytical approach to estimating relative abundance that assumes abundance is a function of distance between detections of individuals and an observer.
Study design, sampling, and parameter estimation (continued)	
Dynamic parameters	Probabilities of colonization and extinction.
Emigration	See extinction.
Extinction	Probability that an occupied sample unit becomes unoccupied during a subsequent sampling occasion.
Immigration	See colonization.
Imperfect detection	Principle that individuals or species, though available for detection at a sampling unit, remain undetected.
Occupancy	Probability that a site is occupied, while accounting for imperfect detectability
Optimized	Obtaining a high benefit-to-cost ratio, where benefits include accuracy and precision of parameters, and costs include time, money, and energy.
Parameter estimates	Quantities that describe aspects of a study system, e.g., bird community metrics.
Pearson's correlation	A measure of correlation between two variables (e.g., area-weighted means for watershed elevation and watershed slope across a set of watersheds).
Point count	A timed survey during which an observer records all bird species seen or heard and documents time of detection and location of and distance to the bird.
Point count station	Physically marked location where an observer stands while recording bird detections, vegetation characteristics, and stream noise levels.
Point transect	Series of point-count stations established every 250 m along tributary streams in the ERMN.
Precision	Level of consistency across sampled values for a given parameter.
Random sampling	Drawing of units (e.g., watersheds or points within a watershed) independently and according to some probability distribution, where each unit has a pre-assigned probability of inclusion in the sample.
Replication	Multiple, independent samples from a sampling frame.
Sample units	Defined areas of study for the purpose of estimating parameters such as bird community metrics.
Sampling frame	A list of all possible spatial units (i.e., stream segments) that may be sampled as part of the monitoring program.

Term	Definition
Simulations	Sampling numbers iteratively and randomly from probability distributions via computer programs based on pilot data to to better understand the consequences of particular sampling designs for parameter estimation.
Spatial replicates	Independent samples in separate locations.
Stratification	Dividing sampling frame into groups (i.e., strata) to account for variation of intrinsic conditions among watersheds.
Temporal replicates	Independent samples at the same location during multiple sampling occasions.
Time-of-detection method	Analytical approach to estimating relative abundance that assumes individuals may be tracked across time intervals within a point count.
Transect	See point transect.
Transect interval	A subset of a point transect, i.e., the stream segment between two adjacent point count stations.
Uniform distribution	A probability distribution with equal probabilities for all values between a minimum and maximum value (e.g., 0 and 1).

Appendix B. Forest-interior obligate songbird species and other bird species expected to occur along tributary streams and therefore included in the streamside bird monitoring program for the Eastern Rivers and Mountains Network.

Common name	Code	Scientific name	TSN ^a	NERI GARI BLUE	DEWA	FRHI	FONE	ALPO
Forest-interior obligate songbird species								
Hairy Woodpecker	HAWO	<i>Picoides villosus</i>	178262	X	X	X	X	X
Pileated Woodpecker	PIWO	<i>Dryocopus pileatus</i>	178166	X	X	X	X	X
Acadian Flycatcher	ACFL	<i>Empidonax virescens</i>	178339	X	X	X	X	X
Scarlet Tanager	SCTA	<i>Piranga olivacea</i>	179883	X	X	X	X	X
Red-eyed Vireo	REVI	<i>Vireo olivaceus</i>	179021	X	X	X	X	X
Blue-headed Vireo	BHVI	<i>Vireo solitarius</i>	179010	X	X		X	X
Black-and-White Warbler	BAWW	<i>Mniotilta varia</i>	178844	X	X		X	X
Swainson's Warbler	SWWA	<i>Limnothlypis swainsonii</i>	178848	X				
Worm-eating Warbler	WEWA	<i>Helmitheros vermivorus</i>	178850	X	X			
Black-throated Blue Warbler	BTBW	<i>Dendroica caerulescens</i>	178888	X	X			
Cerulean Warbler	CERW	<i>Dendroica cerulea</i>	178903	X	X	X	X	
Blackburnian Warbler	BLBW	<i>Dendroica fusca</i>	178904		X		X	X
Black-throated Green Warbler	BTNW	<i>Dendroica virens</i>	178898	X	X	X	X	X
Ovenbird	OVEN	<i>Seiurus aurocapillus</i>	178927	X	X	X	X	X
Louisiana Waterthrush	LOWA	<i>Seiurus motacilla</i>	178935	X	X	X	X	X
Kentucky Warbler	KEWA	<i>Oporornis formosus</i>	178937	X		X	X	
Hooded Warbler	HOWA	<i>Wilsonia citrina</i>	178972	X	X	X	X	
Canada Warbler	CAWA	<i>Wilsonia canadensis</i>	178977	X	X			
American Redstart	AMRE	<i>Setophaga ruticilla</i>	178979	X	X	X	X	X
Winter Wren	WIWR	<i>Troglodytes troglodytes</i>	178547	X	X			
Brown Creeper	BRCR	<i>Certhia americana</i>	178795	X	X		X	
White-breasted Nuthatch	WBNU	<i>Sitta carolinensis</i>	178775	X	X	X	X	X
Red-breasted Nuthatch	RBNU	<i>Sitta canadensis</i>	178784		X		X	
Veery	VEER	<i>Catharus fuscescens</i>	179796	X	X	X		
Hermit Thrush	HETH	<i>Catharus guttatus</i>	179779		X		X	

Common name	Code	Scientific name	TSN ^a	NERI GARI BLUE	DEWA	FRHI	FONE	ALPO
Others bird species expected to occur								
Common Merganser	COME	<i>Mergus merganser</i>	175185		X			
Mallard	MALL	<i>Anas platyrhynchos</i>	175063		X	X		
Wood Duck	WODU	<i>Aix sponsa</i>	175122		X			
Canada Goose	CAGO	<i>Branta canadensis</i>	174999	X	X	X	X	
Great Blue Heron	GBHE	<i>Ardea herodias</i>	174773		X	X		
Green Heron	GRHE	<i>Butorides virescens</i>	174798		X			
American Woodcock	AMWO	<i>Scolopax minor</i>	176580		X			
Solitary Sandpiper	SOSA	<i>Tringa solitaria</i>	176615		X			
Spotted Sandpiper	SPSA	<i>Actitis macularia</i>	176612		X			
Mourning Dove	MODO	<i>Zenaida macroura</i>	177125	X	X	X	X	X
Turkey Vulture	TUVU	<i>Cathartes aura</i>	175265		X	X		
Black Vulture	BLVU	<i>Coragyps atratus</i>	175272		X			
Sharp-shinned Hawk	SSHA	<i>Accipiter striatus</i>	175304	X	X			
Cooper's Hawk	COHA	<i>Accipiter cooperii</i>	175309		X			
Red-tailed Hawk	RTHA	<i>Buteo jamaicensis</i>	175350	X	X	X	X	
Red-shouldered Hawk	RSHA	<i>Buteo lineatus</i>	175359	X	X	X		
Broad-winged Hawk	BWHA	<i>Buteo platypterus</i>	175365		X		X	X
Bald Eagle	BAEA	<i>Haliaeetus leucocephalus</i>	175420		X			
Wild Turkey	WITU	<i>Meleagris gallopavo</i>	176136		X	X	X	X
Ruffed Grouse	RUGR	<i>Bonasa umbellus</i>	175790		X			
Barred Owl	BDOW	<i>Strix varia</i>	177921		X			
Eastern Screech-Owl	EASO	<i>Otus asio</i>	177856		X			
Great Horned Owl	GHOW	<i>Bubo virginianus</i>	177884		X	X		X
Yellow-billed Cuckoo	YBCU	<i>Coccyzus americanus</i>	177831	X	X	X		X
Black-billed Cuckoo	BBCU	<i>Coccyzus erythrophthalmus</i>	177834		X	X	X	
Belted Kingfisher	BEKI	<i>Ceryle alcyon</i>	178106		X			
Downy Woodpecker	DOWO	<i>Picoides pubescens</i>	178259	X	X	X	X	X
Red-bellied Woodpecker	RBWO	<i>Melanerpes carolinus</i>	178195	X	X	X	X	X
Northern Flicker	NOFL	<i>Colaptes auratus</i>	178154		X	X	X	X
Chimney Swift	CHSW	<i>Chaetura pelagica</i>	178001	X	X	X	X	X
Ruby-throated Hummingbird	RTHU	<i>Archilochus colubris</i>	178032	X	X	X	X	X
Great Crested Flycatcher	GCFL	<i>Myiarchus crinitus</i>	178309	X	X	X	X	X

Common name	Code	Scientific name	TSN ^a	NERI	DEWA	FRHI	FONE	ALPO
				GARI BLUE				
Eastern Phoebe	EAPH	<i>Sayornis phoebe</i>	178329	X	X	X	X	X
Eastern Wood-Pewee	EAWP	<i>Contopus virens</i>	178359		X	X	X	X
Least Flycatcher	LEFL	<i>Empidonax minimus</i>	178344		X			
Blue Jay	BLJA	<i>Cyanocitta cristata</i>	179680	X	X	X	X	X
Common Raven	CORA	<i>Corvus corax</i>	179725	X	X	X	X	
American Crow	AMCR	<i>Corvus brachyrhynchos</i>	179731	X	X	X	X	X
Fish Crow	FICR	<i>Corvus ossifragus</i>	179737		X			
European Starling	EUST	<i>Sturnus vulgaris</i>	179637		X	X		X
Brown-headed Cowbird	BHCO	<i>Molothrus ater</i>	179112	X	X	X	X	X
Red-winged Blackbird	RWBL	<i>Agelaius phoeniceus</i>	179045	X	X	X	X	X
Eastern Meadowlark	EAME	<i>Sturnella magna</i>	179034			X		
Baltimore Oriole	BAOR	<i>Icterus galbula</i>	179083		X	X	X	X
Common Grackle	COGR	<i>Quiscalus quiscula</i>	179104		X	X	X	X
Purple Finch	PUFI	<i>Carpodacus purpureus</i>	179186		X		X	
House Finch	HOFI	<i>Carpodacus mexicanus</i>	179191		X			
American Goldfinch	AMGO	<i>Carduelis tristis</i>	179236	X		X	X	X
White-throated Sparrow	WTSP	<i>Zonotrichia albicollis</i>	179462		X			
Chipping Sparrow	CHSP	<i>Spizella passerina</i>	179435	X	X	X	X	X
Field Sparrow	FISP	<i>Spizella pusilla</i>	179443	X		X	X	X
Dark-eyed Junco	DEJU	<i>Junco hyemalis</i>	179410	X	X			
Song Sparrow	SOSP	<i>Melospiza melodia</i>	179492	X	X	X	X	X
Swamp Sparrow	SWSP	<i>Melospiza georgiana</i>	179488				X	
Eastern Towhee	EATO	<i>Pipilo erythrophthalmus</i>	179276	X		X	X	X
Northern Cardinal	NOCA	<i>Cardinalis cardinalis</i>	179124	X		X	X	X
Indigo Bunting	INBU	<i>Passerina cyanea</i>	179150	X		X	X	X
Summer Tanager	SUTA	<i>Piranga rubra</i>	179888	X				
Barn Swallow	BARS	<i>Hirundo rustica</i>	178448			X	X	
Cedar Waxwing	CEDW	<i>Bombicilla cedrorum</i>	178532	X	X	X	X	X
Yellow-throated Vireo	YTVI	<i>Vireo flavifrons</i>	179009	X	X	X	X	X
Blue-winged Warbler	BWWA	<i>Vermivora pinus</i>	178853	X	X	X	X	
Northern Parula	NOPA	<i>Parula americana</i>	178868	X	X	X	X	X
Yellow Warbler	YWAR	<i>Dendroica petechia</i>	178878	X	X	X	X	X
Yellow-rumped Warbler	YRWA	<i>Dendroica coronata</i>	178891		X			

Common name	Code	Scientific name	TSN ^a	NERI GARI BLUE	DEWA	FRHI	FONE	ALPO
Magnolia Warbler	MAWA	<i>Dendroica magnolia</i>	178886		X		X	X
Chestnut-sided Warbler	CSWA	<i>Dendroica pensylvanica</i>	178911	X	X		X	X
Yellow-throated Warbler	YTWA	<i>Dendroica dominica</i>	178905	X		X		
Pine Warbler	PIWA	<i>Dendroica pinus</i>	178914	X	X		X	
Prairie Warbler	PRAW	<i>Dendroica discolor</i>	178918			X	X	
Common Yellowthroat	COYE	<i>Geothlypis trichas</i>	178944	X	X	X	X	X
Gray Catbird	GRCA	<i>Dumetella carolinensis</i>	178625	X	X	X	X	X
Brown Thrasher	BRTH	<i>Toxostoma rufum</i>	178627		X	X	X	X
Carolina Wren	CARW	<i>Thryothorus ludovicianus</i>	178581	X	X	X		X
House Wren	HOWR	<i>Troglodytes aedon</i>	178541		X	X		X
Tufted Titmouse	TUTI	<i>Baeolophus bicolor</i>	178738	X	X	X	X	X
Black-capped Chickadee	BCCH	<i>Poecile atricapilla</i>	178699	X	X		X	X
Carolina Chickadee	CACH	<i>Poecile carolinensis</i>	178709	X		X		
Golden-crowned Kinglet	GCKI	<i>Regulus satrapa</i>	179865	X	X		X	
Blue-gray Gnatcatcher	BGGN	<i>Polioptila caerulea</i>	179853	X	X	X	X	X
Wood Thrush	WOTH	<i>Hylocichla mustelina</i>	179777	X	X	X	X	X
American Robin	AMRO	<i>Turdus migratorius</i>	179759	X	X	X	X	X
Eastern Bluebird	EABL	<i>Sialia sialis</i>	179801			X		X

^a TSN = Taxonomic Serial Number. The TSN is unique identifier for each species catalogued within the Integrated Taxonomic Information System (ITIS).

Appendix C. Stratified random ordering for watershed selection across 16 substrata for New River Gorge National River (NERI) of the Eastern Rivers and Mountains Network.

Watersheds selected in order of increasing, randomly assigned round number unless otherwise noted, and rare substrata were favored for selection. Within a round, watersheds with higher random numbers (indicated next to watershed name) were favored for selection over those with lower numbers unless a watershed from the previous round was excluded. Selected watersheds in boldtype. Bolded watersheds also sampled during 2007 unless otherwise noted, and non-bolded watersheds not sampled in 2007 and excluded from bird monitoring due to lack of resources unless otherwise noted. Abbreviations: Cr = Creek, Br = Branch, Mtn = Mountain, UN = unnamed, R = right (looking upstream), L = left (looking upstream), T = tributary, btwn = between.

Stratification variable / park unit			Watershed name, random number assignment					
% Watershed preserved:			< 90%			≥ 90%		
Bedrock fertility:			< Mean bedrock fertility		≥ Mean bedrock fertility		< Mean bedrock fertility	
Relief:			< Mean SD elevation	≥ Mean SD elevation	< Mean SD elevation	≥ Mean SD elevation	< Mean SD elevation	≥ Mean SD elevation
Tributary watershed area:			Medium-sized watersheds 1-9.9 km ²					
Round 1	Short Cr ^a , 0.9492	Ephraim Cr, 0.6546	-	Big Br, 0.9060	UNT to Laurel Cr (Backus Mtn), 0.4321	Dowdy Cr, 0.7377	-	-
Round 2	Little Laurel Cr, 0.9141	UNRT to Buffalo Cr, 0.6201	-	UNRT to Meadow Cr, 0.7432	-	Bucklick Cr, 0.1558	-	-
Round 3	Batoff Cr, 0.8761	Slater Cr, 0.6006	-	Kates Br (New River) ^{b,e} , 0.6637	-	-	-	-
Round 4	Richlick Cr, 0.8671	Bills Br, 0.5831	-	Camp Br, 0.8671	-	-	-	-
Round 5	UNT to New River (Buery Mtn) ^a , 0.8417	Fire Cr, 0.5236	-	Mill Br ^{b,e} , 0.5903	-	-	-	-
Round 6	UNT to Laurel Cr (Highland Mtn), 0.5329	Little Manns Cr ^b , 0.464	-	UNLT to Meadow Cr, 0.4459	-	-	-	-
Round 7	Kates Br (Glade Cr), 0.5302	River Br, 0.3163	-	Davis Br^f, 0.4116	-	-	-	-
No. watersheds surveyed	5	5	-	4	1	2	-	-

Appendix C. Continued.

Stratification variable / park unit

% Watershed preserved:

< 90%

≥ 90%

Bedrock fertility:

< Mean bedrock fertility

≥ Mean bedrock fertility

< Mean bedrock fertility

≥ Mean
bedrock
fertility

Relief:

< Mean SD
elevation

≥ Mean SD
elevation

< Mean
SD
elevation

≥ Mean SD
elevation

< Mean SD
elevation

≥ Mean SD
elevation

Low

High

Tributary watershed area:

Medium-sized watersheds 1-9.9 km²

Round 8	Fern Cr, 0.5254	Little Piney, 0.0685	-	Sewell Br, 0.3069	-	-	-	-
Round 9	Camp Cr, 0.4117	UNT to New River (Terry Top Tr), 0.0654	-	UNT to New River (across Sewell Br), 0.2635	-	-	-	-
Round 10	Manns Cr, 0.3685	-	-	Panther Br, 0.0991	-	-	-	-
Round 11	Craig Br, 0.3063	-	-	UNT to New River (Gwin Ridge Tr), 0.0969	-	-	-	-
Round 12	Second Fork, 0.2920	-	-	-	-	-	-	-
Round 13	Butcher Br, 0.2282	-	-	-	-	-	-	-
Round 14	UNT to New River (Prince Amtrak), 0.0969	-	-	-	-	-	-	-
Round 15	UNT to New River (S Stone Cliff), 0.1667	-	-	-	-	-	-	-
Round 16	Marr Br, 0.1542	-	-	-	-	-	-	-
Round 17	UNLT to Buffalo Cr, 0.0648	-	-	-	-	-	-	-
Round 18	Polls Br, 0.0265	-	-	-	-	-	-	-

Appendix C. Continued.

Stratification variable / park unit			Watershed name, random number assignment						
% Watershed preserved:			< 90%			≥ 90%			
Bedrock fertility:			< Mean bedrock fertility		≥ Mean bedrock fertility		< Mean bedrock fertility		≥ Mean bedrock fertility
Relief:			< Mean SD elevation	≥ Mean SD elevation	< Mean SD elevation	≥ Mean SD elevation	< Mean SD elevation	≥ Mean SD elevation	Low High
Tributary watershed area:			Large-sized watersheds 10 - 99.9 km ²						
Round 1	Wolf Cr, 0.9596	Mill Cr, 0.6181	-	Lick Cr ^c , NA	-	-	-	-	
Round 2	Arbuckle Cr, 0.7273	Buffalo Cr, 0.5719	-	Farley's Cr ^{d,e} , 0.2805	-	-	-	-	
Round 3	Pinch Cr ^{d,e} , 0.4620	Laurel Cr , 0.3314	-	Meadow Cr , 0.7688	-	-	-	-	
Round 4	Keeney Cr, 0.4359	-	-	Fall Br, 0.2015	-	-	-	-	
Round 5	Glade Cr (Babcock), 0.0229	-	-	-	-	-	-	-	
No. watersheds surveyed	3	3	2						
^a Treacherous traversal									
^b < 5 points on public land									
^c Open canopy, misclassified									
^d Too noisy									
^e Surveyed in 2007 but not in 2008									
^f Surveyed in 2008 but not in 2007									

Appendix D. Stratified random ordering for watershed selection across 16 substrata for Delaware Water Gap National Recreation Areas (DEWA) of the Eastern Rivers and Mountains Network.

Candidate watersheds include those with ≥ 1 km of stream length inside federal land and 1- 99.9 km² drainage area. Open-canopy creeks and rivers were therefore excluded. Selected watersheds in bold type. Unbolded watersheds were dry or intermittent during the initial site visit in April 2007. Bolded watersheds also sampled 2007-2009 otherwise noted. Abbreviations: Cr = Creek, Brk = Brook, Mtn = Mountain, UN = unnamed, R = right (looking upstream), L = left (looking upstream), T = tributary, btwn = between.

Stratification variable / park unit		Watershed name, random number assignment						
% Watershed preserved:		< 90%			$\geq 90\%$			
Bedrock fertility:		< Mean bedrock fertility		$\geq$ Mean bedrock fertility		< Mean bedrock fertility		$\geq$ Mean bedrock fertility
Relief:		< Mean SD elevation	$\geq$ Mean SD elevation	< Mean SD elevation	$\geq$ Mean SD elevation	< Mean SD elevation	$\geq$ Mean SD elevation	Low High
Tributary watershed area:		Medium-sized watersheds 1-9.9 km ²						
Round 1	Slateford Cr, 0.9009	UNT (Arrow Island), 0.1386	UNT to Adams Cr, 0.9677	-	Vancampens Brk (Donkey), 0.9386	Dunnfield Creek, 0.7997	UNT to Delaware River (Minisink Island), 0.9967	-
Round 2	Mill Cr, 0.2993		Conashaugh Cr, 0.7797	-	Caledonia Cr, 0.6697	Fuller Brk (Upper), 0.7527	Dry Brk, 0.8405	-
Round 3	-	-	Van Campen Cr, 0.7659	-	UNT to Delaware River (Coppermine), 0.2936	UNT to Delaware River (Sunfish Pond), 0.3356	UNT to Delaware River (Ranger Station), 0.8149	-
Round 4	-	-	Upper Hornbecks Cr, 0.7226	-	Fuller Brk (Lower), 0.0536		UNT (Namanock Island), 0.6601	-
Round 5	-	-	White Brk, 0.6154	-	-		Kittatinny Cr, 0.6123	-
Round 6	-	-	UNT to Dingmans Cr^a, 0.1911	-	-		Denmark Cr, 0.6601	-
Round 7	-	-	Spackmans Cr, 0.0823	-	-		UNT to Toms Cr, 0.4102	-
No. watersheds surveyed	1	1	6	-	3	2	3	-

Appendix D. Continued.

Stratification variable / park unit		Watershed name, random number assignment						
% Watershed preserved:		< 90%			≥ 90%			
Bedrock fertility:		< Mean bedrock fertility		≥ Mean bedrock fertility		< Mean bedrock fertility		≥ Mean bedrock fertility
Relief:		< Mean SD elevation	≥ Mean SD elevation	< Mean SD elevation	≥ Mean SD elevation	< Mean SD elevation	≥ Mean SD elevation	Low High
Tributary watershed area:		Large-sized watersheds 10 - 99.9 km ²						
Round 1	Adams Cr, 0.759	-	Lower Hornbecks Cr, 0.4725	-	-	Vancampens Brk (Millbrook), 0.2835	-	-
Round 2	Mill Cr, 0.6259	-	-	-	-	-	-	-
Round 3	Dingmans Cr, 0.5442	-	-	-	-	-	-	-
Round 4	Little Bushkill Cr, 0.4301	-	-	-	-	-	-	-
Round 5	Toms Cr ^a , 0.3604	-	-	-	-	-	-	-
Round 6	Raymondskill Cr ^a , 0.2538	-	-	-	-	-	-	-
No. watersheds surveyed	6	-	1	-	-	1	-	-

^aNot surveyed during 2007 due to logistical constraints

Appendix E. Field Forms.

Field forms. All field forms are formatted for “Rite-in-the-Rain”® looseleaf paper. Original field forms are created in an excel spreadsheet and available from the network coordinator and data manager.

Forms include:

- A. Crucial Information Field Forms
 - 1. First Sampling Period
 - 2. Second Sampling Period
 - 3. Vegetation Surveys
 - 4. Stream Noise Surveys
- B. Transect Survey Field Forms
 - 1. Transect Datasheet with sample data
 - 2. Transect Datasheet Description
- C. Stream Noise and Vegetation Field Survey Forms
 - 1. Stream Noise and Vegetation Survey Datasheet with sample data
 - 2. Stream Noise and Vegetation Survey Datasheet Description
- D. Point Count Survey Field Forms
 - 1. Point Count Survey Datasheet with sample data
 - 2. Point Count Survey Datasheet Description
- E. Streamside Bird Species List for the ERMN

Appendix E.A.1: Field Form—First Sampling Period – Crucial Information

First Sampling Period – Crucial Information

➤ **Before leaving house**

- o Equipment: binoculars, boots, water, snack, rite-in-rain binder, extra pencil, Garmin, extra AA batteries, charged NPS radio, map + directions to site
- o Datasheets: transect, vegetation + stream noise

➤ **Survey**

- o Basic procedure: walk 1-km transect, pause for 5-10 min, return along transect
- o Transect markers: record time, refresh or put up new flagging if needed
- o Point-count stations: refresh or put up new flagging if needed, locate or install tree tag (note if missing), conduct vegetation survey, see also Vegetation Surveys – Crucial Information
- o LOWA observations throughout transect:
 - *Time*: first/last observed if > 1 min, observe ≤ 5 min to gather evidence of breeding status
 - *Location*: upstream marker number (1-4); vertical/horizontal distance from ground/stream
 - *Status*: vocalizations; distance/behavior from/of other LOWA; nest material or food in bill
 - *Age*: Tail length, contrast of markings on head and breast, flanges/gape, begging

Appendix E.A.2: Field Form—Second Sampling Period – Crucial Information

Second Survey Period – Crucial Information

➤ **Before leaving house**

- o Equipment: binoculars, boots, water, snack, rite-in-rain binder, extra pencil, Garmin, extra AA batteries, sound meter, NPS radio, map + directions to site
- o Datasheets: point count, transect, vegetation + stream noise

➤ **Survey**

- o Basic procedure: walk 1-km transect, pause for 5-10 min, return along transect
- o Transect markers: record time, refresh or put up new flagging if needed
- o Point-count stations: refresh or put up new flagging if needed, conduct vegetation and stream noise surveys (see Vegetation Survey / Stream Noise Survey – Crucial Information)
- o Point-count surveys: conduct 5-min point count for all bird species seen/heard:
 - *Time*: Start time, minute-by-minute detections
 - *Location*: point ID, distance band, quadrat
 - *Bird count*: species code, detection type, multiple individuals of one species
 - *Notes*: nest material or food in bill, age, movements between quadrats or distance bands
- o LOWA transect survey: Between point counts; see First Survey Period – Crucial Information

Appendix E.A.3: Field Form—Vegetation Surveys – Crucial Information

Vegetation Surveys – Crucial Information

- **Before leaving house:** See First or Second Sampling Period – Crucial Information
- **Conduct surveys once per point during each visit**
 - *Record station ID*, refresh or put up new flagging if needed
 - *%Cover*
 1. Vegetation cover for 3 height categories within 50 m in each quadrat
 2. UC = upstream toward or beyond creek, UH = upstream toward hill, DC = downstream toward creek, DH = downstream toward hill
 3. First sampling period: evergreen cover only
 4. Second sampling period: total vegetation cover
 - *Hemlock score:* [First sampling period only]
Dominant condition within 50 m of point count station:
 0. No hemlocks observed.
 1. Good – dark green needles 2/3 – 3/4 from top; lower branches may lack needles
 2. Fair – pale green with some needle loss; bare fine twigs on lowest branches
 3. Weak –defoliated 1/2 – 3/4 from base; large, dead branches on lower trunk
 4. Poor –completely defoliated and in various stages of decay
 - *Notes:* Recent disturbances (e.g., downed trees, construction)

Appendix E.A.4: Field Form—Stream Noise Surveys – Crucial Information

Stream Noise Surveys – Crucial Information – Second Sampling Period Only

- **Before leaving house:** See Second Sampling Period – Crucial Information
- **Conduct surveys once per point during each of last two visits**
 - *Record station ID*, refresh or put up new flagging if needed
 - *Stream dB in each quadrat:*
 1. Press & hold DH until “1” displays, press MAX until “5” displays, push RESET to begin 5-second reading. If “LO” displays, then record 49.
 2. Avoid taking reading when intermittent sounds (e.g., bird song, wind) interfere.
 3. **UC** = upstream toward or beyond creek, **UH** = upstream toward hill, **DC** = downstream toward creek, **DH** = downstream toward hill
 - *Notes:* Unavoidable sound interferences (e.g., bird song, wind, traffic)

[illegible]

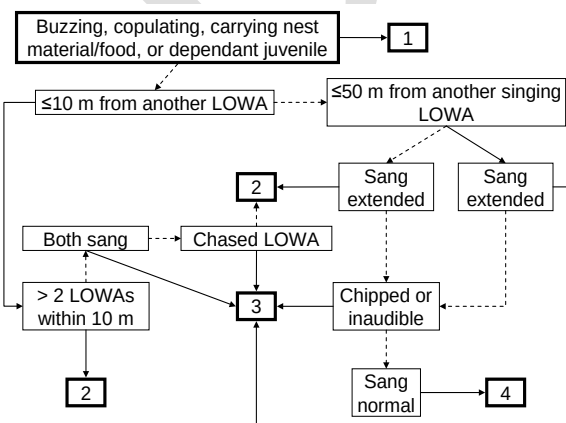
Appendix E.B.2: Description of Transect Datasheet

❖ Header

- **Site:** Name of streamside transect (e.g., Meadow Creek); specify 4-letter park code for park unit (e.g., NERI).
- **Obs:** Observer initials
- **Date:** M/DD/YY (e.g., 3/31/10)
- **p of :** Page x of total.
- **Notes:** Optional -- weather or reasons for a late start (e.g., navigation problems)

❖ Columns

- **Sp:** Bird Species 4-letter code.
- **UP#:** Nearest upstream transect marker number ID (1-4).
- **UPdst:** Initial stream distance (m) from UP# to bird (0-250). If transect marker in view or within 50 m, then visually estimate distance from UP# along stream channel to bird. Otherwise, record reading from GPS unit from current position to nearest UP# (see SOP 6 “Using Global Positioning System (GPS) Units”). If bird was only heard, then precede distance estimate with a tilde (~). Write distance in box, e.g. 10.
- **LRpos:** Minimum horizontal distance (m) and direction (L = left or R = right when facing UPSTREAM) from channel edge to bird (0-200). Birds perched anywhere within or directly above channel receive a distance of 0. If bird was only heard, then precede distance estimate with a tilde (~). Write distance and direction in box, e.g. 10 L.
- **Ht:** Height or minimum vertical distance (m) from stream or ground (i.e., rock or litter; not fallen tree) to bird (0-100). If bird was not seen, then precede height estimate with a tilde (~). If bird is flying above canopy, write “fly over” in the notes. Write height in box, e.g. 10.
- **Move:** Maximum distance and direction (m) bird moved from initial location (L/R, U = upstream, D = downstream). Movements recorded only if bird moves >0.5 m. Write distance and direction in box, e.g. 50 D, especially for movements that lead bird into a different transect interval than its initial location. If bird was only heard, then precede distance estimate with a tilde (~). Use plus (+) sign to indicate that bird flew out of view, e.g., 50⁺D. If bird makes multiple distinct movements (e.g., L and U, R and D), then make separate rows on the transect form for each movement and write in notes “Same as above”.
- **Time:** Military time of first detection; format: HH:MM (05:00 – 12:59). For observations longer than 1 minute, record the time of last detection as well. Write start time above stop time (if needed) in box, e.g., 08:00 [top of box] 08:05 [bottom of box].
- **Detection Type (Hear):** Type of vocalization, in order of decreasing information content (enter highest-ranking vocalization if multiple heard): Z = buZZing (adult LOWA only), G = beGging (juvenile only), H = high-pitched call, E = Extended song, N = Normal song, C = normal Call, S = Song of unknown type, D = Drumming (woodpeckers only), T = Tapping, Q = Quiet (seen only). Write detection type in box, e.g., Z.
- **Age:** Age of bird A=adult, J=juvenile, U=unknown. During first sampling period, typically all birds are adults. In some rare cases, early breeders such as LOWA may have young fledglings during the second visit.
- **Pr:** Pairing status certainty for LOWAs (1= certainly paired, 2= probably paired, 3= unknown 4= probably unpaired); see chart below to determine pairing status:



- **Notes:** Ancillary information, including justifications for species identity, age (e.g., tail length), or pairing status (e.g., copulation, carrying nesting material). Use the entire next row if needed.

Appendix E.C.1: Field Data Form—Stream Noise and Vegetation Datasheet with example data

[illegible]

Appendix E.C.2: Description of Stream Noise and Vegetation Datasheet

❖ Header

- **Year:** Format = YYYY (e.g., 2010)
- **Obs:** Observer initials, including middle initial

❖ Columns

- Visit-specific
 - **Site:** Name of streamside transect (e.g., Meadow Creek); specify 4-letter park code if name reused within park unit (e.g., NERI); use multiple rows if needed.
 - **Mo:** Month format = M (3-6)
 - **Day:** Format = DD (01-31)
- Point-specific (5 points = 5 rows per visit)
 - **WP:** Point count ID in GPS unit; format = W (1-5).
 - **Stream dB:** Noise level in decibels (dB) detected by Radioshack ® meter while pointed toward center of each quadrat (**UC** = upstream toward or beyond creek, **UH** = upstream toward hill, **DC** = downstream toward creek, **DH** = downstream toward hill). If sound reading is “LO”, then record 49.
 - **%Cover:** Percent vegetation cover for three height categories (i.e., **0.5-2 m**, **2-5 m**, **>5m**) within 50 m in each quadrat (see “Stream dB” above). Range: 0-100 per quadrat-height category.
 - **Hemlock score:** Enter predominant score for hemlock condition within 50 m (0-4):
 0. No hemlocks observed.
 1. Good – trees retaining most needles and live branches at least 2/3 – 3/4 of the way down the trunk and appearing dark green (even some healthy hemlocks lose the lowest branches depending upon shadiness).
 2. Fair – trees paler in color with some loss of needles and the appearance of bare fine twigs on the lowest branches.
 3. Weak – trees defoliated 1/2 – 3/4 of the way up the trunk with only large, dead branches sticking out of the lower trunk, only the crown retains needles.
 4. Poor – trees completely defoliated and in various stages of decay.
 - **Notes:** Recent disturbances (e.g., downed trees, construction) or reasons for skipping part/all of survey (e.g., inclement weather).

[illegible]

Appendix 5.D.2: Description of Point Count Survey Datasheet

❖ Header

- **Site:** Name of streamside transect (e.g., Meadow Creek); specify 4-letter park code if name reused within park unit (e.g., NERI)
- **Date:** M/DD/YY (e.g., 3/31/10)
- **Obs:** Observer initials, including middle initial
- **Notes:** Optional -- weather or reasons for a late start (e.g., navigation problems)

❖ Columns

- **WP:** Point count ID; format = W (1-5).
- **Start:** Military time at start of count; format: HH:MM (e.g., 10:23).
- **Sp:** 4-letter code – see Appendix B
- **Age:** 1-letter code for age: A=adult, J=juvenile, U=unknown
- **Detection Type (Hear):** Type of detection, in order of decreasing information content (enter highest-ranking vocalization if multiple heard):
 - Z = buZzing (adult LOWA only)
 - G = beGging (juvenile only)
 - E = Extended song
 - N = Normal song
 - C = Calling or Chipping
 - S = Song of unknown type
 - D = Drumming (woodpeckers only)
 - T = Tapping
 - Q = Quiet (seen only)
- **Dist:** Horizontal distance category of first detection (i.e., <50 m, 50-75 m, 75+ m)
- **Qdr:** Quadrat radiating from point count station (UC = upstream toward or beyond creek, UH = upstream toward hill, DC = downstream toward creek, DH = downstream toward hill), DU = downstream unknown direction, UU = upstream unknown direction.
- **1st:** Minute of first detection (i.e., 1-5), required only if tally not recorded.
- **Tally:** Standard pattern to illustrate the exact minute(s) of detection (e.g., ['] only detected in minute 1, [:] = detected in minutes 1 & 2, [. '] = detected in minutes 2 & 3, [:] = detected in minutes 3 & 4, [. :] = detected in minutes 4 & 5).
- **Notes:** Ancillary point count data may include weather conditions or ambient noise levels. Write “no birds detected” if such is the case. Otherwise, ancillary bird data may include movements among distance bands or quadrats, sex for silent, sexually-dimorphic species, and breeding activities such as courtship or carrying nesting material or food (mating status/nesting stage).

Appendix F. Database documentation for the Streamside Bird Monitoring Protocol database.

This appendix is under development and will be included in later versions.

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The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS D-XXX, Month Year



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