National Park Service
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Natural Resource Stewardship and Science

Streamside Bird Monitoring

Eastern Rivers and Mountains Network 2007–2012 Summary Report

Natural Resource Data Series NPS/ERMN/NRDS—2013/449

ON THE COVER
Pileated woodpeckers (*Dryocopus pileatus*) along Adams Creek at Delaware Water Gap National Recreation Area, June 2009.
Photograph by Terry Master.

Streamside Bird Monitoring

Eastern Rivers and Mountains Network 2007–2012 Summary Report

Natural Resource Data Series NPS/ERMN/NRDS—2013/449

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Contents

Page

Figures v

Tables vii

Appendixes vii

List of Key Acronyms ix

Executive Summary xi

Acknowledgments xiii

Introduction and Background 1

Rationale for Monitoring Birds 1

Streamside Birds 3

Objectives 3

Purpose of this Report 3

Methods 5

Target Population and Sample Sites 5

Sample Site Selection 6

Sampling Site Summary 7

Delaware Water Gap National Recreation Area 8

New River Gorge National River 10

Gauley River National Recreation Area 12

Bluestone National Scenic River 14

Allegheny Portage Railroad National Historic Site 16

Fort Necessity National Battlefield 18

Friendship Hill National Historic Site 20

Field Methods 22

Contents

Page

Analyses....22

Sampling Effort and Species Detected....22

Louisiana Waterthrush Detections....23

Bird Guilds as Indicators of Ecological Condition....23

Results and Discussion....27

Sampling Effort and Species Detected....27

Louisiana waterthrush detections....28

Bird Guilds as Indicators of Ecological Condition....32

Literature Cited....37

Figures

Page

Figure 1. National parks in the Eastern Rivers and Mountains Network (ERMN). 2

Figure 2. Example of a streamside bird sampling site which consists of a 1-km reach with five point count stations spaced at 250-m intervals. 6

Figure 3. Locations of 24 sampling sites selected for monitoring streamside birds at Delaware Water Gap NRA. 9

Figure 4. Locations of 25 sampling sites selected for monitoring streamside birds at New River Gorge NR. 11

Figure 5. Locations of six sampling sites selected for monitoring streamside birds at Gauley River NRA. 13

Figure 6. Locations of three sampling sites selected for monitoring streamside birds at Bluestone NSR. 15

Figure 7. Locations of three sampling sites selected for monitoring streamside birds at Allegheny Portage Railroad NHS. 17

Figure 8. Locations of three sampling sites selected for monitoring streamside birds at Fort Necessity NB. 19

Figure 9. Locations of two sampling sites selected for monitoring streamside birds at Friendship Hill NHS. 21

Figure 9. Map of the study area and specific sampling sites used by O'Connell et al. (2000) to develop the Bird Community Index (BCI). 25

Figure 10. Louisiana waterthrush at nest with nestlings. 28

Figure 11. Average number of point count stations where at least one adult Louisiana waterthrush was detected during Streamside Bird Monitoring at Delaware Water Gap NRA, 2007-2012. 29

Figure 12. Average number of point count stations where at least one adult Louisiana waterthrush was detected during Streamside Bird Monitoring at New River Gorge NR, 2007-2012. 30

Figure 13. Average number of point count stations where at least one adult Louisiana waterthrush was detected during Streamside Bird Monitoring at Allegheny Portage Railroad NHS (ALPO), Fort Necessity NB (FONE), Friendship Hill NHS (FRHI), Gauley River NRA (GARI), and Bluestone NSR (BLUE), 2007–2012. 31

Figures

Page

Figure 14. Bird Community Index of biotic integrity (O'Connell et al. 2000) for Delaware Water Gap NRA based on Streamside Bird Monitoring, 2007-2012. 33

Figure 15. Bird Community Index of biotic integrity (O'Connell et al. 2000) for New River Gorge NR based on Streamside Bird Monitoring, 2007-2012. 34

Figure 16. Bird Community Index of biotic integrity (O'Connell et al. 2000) for Allegheny Portage Railroad NHS (ALPO), Fort Necessity NB (FONE), Friendship Hill NHS (FRHI), Gauley River NRA (GARI), and Bluestone NSR (BLUE) based on Streamside Bird Monitoring, 2007-2012. 35

Figure 17. Percentage of sampling sites falling into four condition classes defined by the Bird Community Index of biotic integrity (O'Connell et al. 2000) for the Mid-Atlantic Highlands, Eastern Rivers and Mountains Network, and parks within the network. 36

Tables

Page

Table 1. Site name, unique site identifier, year established, reach length, and number of point count stations per site for 24 sampling sites selected for streamside bird monitoring at Delaware Water Gap NRA. 8

Table 2. Site name, unique site identifier, year established, reach length, and number of point count stations per site for 25 sampling sites selected for streamside bird monitoring at New River Gorge NR. 10

Table 3. Site name, unique site identifier, year established, reach length, and number of point count stations per site for six sampling sites selected for streamside bird monitoring at Gauley River NRA. 12

Table 4. Site name, unique site identifier, year established, reach length, and number of point count stations per site for three sampling sites selected for streamside bird monitoring at Bluestone NSR..... 14

Table 5. Site name, unique site identifier, year established, reach length, and number of point count stations per site for three sampling sites selected for streamside bird monitoring at Allegheny Portage Railroad NHS..... 16

Table 6. Site name, unique site identifier, year established, reach length, and number of point count stations per site for 3 sampling sites selected for streamside bird monitoring at Fort Necessity NB..... 18

Table 7. Site name, unique site identifier, year established, reach length, and number of point count stations per site for two sampling sites selected for streamside bird monitoring at Friendship Hill NHS. 20

Table 8. Biotic integrity elements, guild categories, response guilds, and guild interpretations used in the Bird Community Index (BCI; O'Connell et al. 1998a, 1998b, and 2000) of ecological integrity. 24

Appendixes

Page

Appendix A. Bird species detected and total number of detections (by park) during implementation of the ERMN Streamside Bird Monitoring Protocol 2007–2012..... 41

Appendix B. Incidental non-avian species observed during field sampling for the ERMN Streamside Bird Monitoring Program, 2007-2012..... 45

List of Key Acronyms

ALPO	Allegheny Portage Railroad National Historic Site
BLUE	Bluestone National Scenic River
BCI	Bird Community Index
DEWA	Delaware Water Gap National Recreational Area
ERMN	Eastern Rivers and Mountains Network
FONE	Fort Necessity National Battlefield
FRHI	Friendship Hill National Historic Site
GARI	Gauley River National Recreational Area
I&M	Inventory and Monitoring
JOFL	Johnstown Flood National Memorial
NB	National Battlefield
NERI	New River Gorge National River
NHS	National Historic Site
NMem	National Memorial
NPS	National Park Service
NR	National River
NRA	National Recreation Area
NSR	National Scenic River
SOP	Standard Operating Procedure
SRR	Scenic and Recreational River
UNT	Unnamed Tributary
UPDE	Upper Delaware Scenic and Recreational River

Executive Summary

The mission of the National Park Service is to "preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations." Park managers and planners need reliable scientific information about the condition and trend of the natural resources for their parks to accomplish this mission. The NPS established a long-term ecological monitoring program to help provide that information. The NPS ecological monitoring program is termed the Inventory and Monitoring (I&M) Program and is implemented programmatically through 32 ecoregional "networks" or groupings of parks linked by geography and natural resource characteristics. The Eastern Rivers and Mountains Network (ERMN) includes nine national parks in New Jersey, New York, Pennsylvania, and West Virginia.

The ERMN undertook an extensive, stake-holder driven, peer-reviewed planning process to identify key natural resources for long-term monitoring. The results included "streamside birds," which refers to the breeding bird community surrounding streams. The area sampled in this protocol is along park streams which are typically forested with a closed canopy over the stream. Therefore, the streamside bird community sampled is largely synonymous with and comparable to what other monitoring programs refer to as "forest birds," "breeding birds," or "landbirds." The important difference, and the purpose of including the term "streamside," is not the bird community *per se*, rather that the physical area sampled is limited to the land area surrounding streams in each park.

Point count surveys are the most widely used quantitative method for monitoring bird populations and are used in the protocol as well. The survey technique involves using a standardized methodology to record ("count") all birds seen or heard during a fixed amount of time at count locations ("points"). The resultant counts are used as an index of population abundance and are amenable to a number of analytical techniques to correct for potential detection biases.

The sampling unit, or sample site, is a stream "reach" defined as a 250-m to 1-km length of stream established within the authorized NPS park boundary. Each reach has 2–5 point count stations depending on reach length. Point count stations are spaced 250 m apart. Individual point count stations are located up to 25 m upslope of the stream (either side) to avoid excessive stream noise interfering with bird detections. Moreover, the effective bird detection distance is approximately 100 m. Therefore, the target population and the area of inference is the community of breeding birds within a 125-m buffer of the perennially flowing, closed canopy stream network in each park. All references in this report to "streamside birds" are meant to imply this target population and area of inference.

The streamside bird monitoring protocol is implemented in seven ERMN parks (all parks except Upper Delaware Scenic and Recreational River [SRR] and Johnstown Flood National Memorial [NMem]). Sixty-six sampling sites were established throughout these seven ERMN parks. Each sampling site and any associated point count stations are visited two times per year between May and July. During each visit, an observer traverses the stream reach twice (i.e., upstream and downstream), stopping at each point count station to conduct 10-minute point counts and associated data collection. Each time the reach is traversed is referred to as a "pass." By waiting

10 minutes between passes, each of these passes is considered an independent sample; therefore, each site is sampled four times per year (two visits per year and two passes per visit).

This report summarizes the first six years (2007–2012) of protocol implementation and provides an overview of the methods, sites, and effort thus far, as well as summaries of the species detected and total number of detections (as an index of abundance). This report also calculates Bird Community Index (BCI; an index of biotic integrity) at the park- and stream-reach scale and provides estimates of Louisiana waterthrush (*Parkesia motacilla*) occupancy at the stream-reach scale. The Louisiana waterthrush is an obligate riparian breeder that is particularly well sampled by this protocol and has been argued to be an indicator species of riparian ecological condition.

Key findings include:

1) The ERMN contains a rich streamside bird community with 123 species detected and presumed to be breeding within the park(s).

2) Nearly one in four species detected (24%) is of continental and/or regional conservation concern, which highlights the importance of national parks to avian conservation.

3) Four of the eight most frequently detected species (Acadian flycatcher [*Empidonax virescens*], wood thrush [*Hylocichla mustelina*], Louisiana waterthrush, and hooded warbler [*Wilsonia citrina*]) are Partners in Flight (PIF) Continental Stewardship Species, indicating that the majority of the global population breeds in eastern forests and areas such as national parks have a responsibility to maintain these populations.

4) Wood thrush and worm-eating warbler (*Helmitheros vermivorum*) were also frequently detected in ERMN parks and are PIF Continental Watch List Species (species that face multiple conservation threats throughout their range), illustrating the important conservation role ERMN parks have in maintaining their populations.

5) Swainson's warbler (*Limnothlypis swainsonii*), which was detected very locally but regularly in rhododendron thickets at Gauley River National Recreation Area, is a PIF Continental Watch List and Continental Stewardship Species.

6) Louisiana waterthrush was detected at all parks and was the sixth most detected species constituting 5% of total detections. However, the relationship between stream condition and Louisiana waterthrush is unclear and awaits a more thorough analysis.

7) Based on the Bird Community Index of biotic integrity, the majority of sites throughout the ERMN have bird communities indicative of "high" or "highest" ecological condition. This means that the bird community is comprised of more species in specialist guilds than generalist guilds, reflecting a relatively intact, extensive, and mature forest structure.

8) ERMN parks had a much higher percentage of sites (95%) in the "high" and "highest" ecological condition classes when compared to the region surrounding the parks (43% in the "high" or "highest" classes). Moreover, no ERMN sites were considered to have "low" ecological condition, and only three sites (5%) in the ERMN had "medium" condition compared to 21% "low" and 36% "medium" in the region surrounding the ERMN.

Acknowledgments

The Eastern Rivers and Mountains Network (ERMN) would like to thank the staff, managers, and resource specialists from all the parks in the network. Without their knowledge and support the ERMN could not have accomplished this effort. We hope the information gained through the sustained implementation of the Streamside Bird Monitoring Protocol proves to be highly relevant and effective for preserving and protecting park resources. We would also like to thank and acknowledge the many technicians who made this possible (especially those that return year after year): Scott Stollery, Nikki Flood, Joe Yuhas, Kirk Stodala, Brad Ross, Nick Ernst, Scarlett Philibosian, Adam Sabatine, Elijah Carter, Doug Gilbert, Gary Lewandrowski, Jason Heinen, Jennifer Dupree, Jason Liddle, Lisa Schreffler, Ryan Lovell, and Brad Romano.

Introduction and Background

The mission of the National Park Service (NPS) is to "preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations". Given this mission, the overarching natural resource management objective for all parks is to pass the resources on to future generations in a condition that is as good as, or better than, the condition that exists today (NPS 2006). Park managers and planners need reliable scientific information about the condition and trend of the natural resources for their parks to address this management objective. The NPS established a long-term ecological monitoring program termed the Inventory and Monitoring (I&M) Program (NPS 1999, Fancy and Bennetts 2012) to help provide that information.

The NPS I&M Program is implemented programmatically through 32 ecoregional "networks" or groupings of parks linked by geography and natural resource characteristics. The network approach, through shared funding and professional staff, also facilitates collaboration, information exchange, and economies of scale (Fancy et al. 2009). One of those networks, the Eastern Rivers and Mountains Network (ERMN), includes nine national parks in New Jersey, New York, Pennsylvania, and West Virginia (Figure 1). The ERMN undertook an extensive, stake-holder driven, peer-reviewed planning process to identify key natural resources for long-term monitoring (Marshall and Piekielek 2007).

One purpose of the ERMN monitoring program is to collect and analyze data and report information that will help park management maintain or improve the ecological condition of park streams, including the rivers that they are tributary to, the watersheds they drain, and the surrounding forests. Stream, forest, and watershed condition are evaluated, in part, using measures of ecological integrity including streamside bird species and communities (Marshall et al. 2012 and this report), benthic macroinvertebrates and water quality (Tzilkowski et al. 2013), and watershed land use, configuration, and type (Marshall and Piekielek 2007). Streamside bird and benthic macroinvertebrate monitoring efforts share a common sampling design. Collocation of monitoring sites is intended to provide multiple lines of evidence to better evaluate trends in ecosystem condition at local and landscape scales with both terrestrial and aquatic components.

Rationale for Monitoring Birds

Birds are an important component of park ecosystems, have been extensively studied, and exhibit numerous characteristics that support their use as cost-effective ecological indicators (O'Connell et al. 2000, Roberge and Angelstram 2006). In particular, their high body temperature, rapid metabolism, and prominent position in most food webs make them a good indicator of local and regional ecosystem change. Birds also respond in predictable and well-documented ways to ecological gradients such as the extent of forest cover (O'Connell et al. 2000), intensity of acidic deposition (Hames et al. 2002, Mulvihill et al. 2008), and, importantly, habitat loss and fragmentation (Robinson and Wilcove 1994, Faaborg et al. 1995, Robinson et al. 1995, Rosenberg et al. 1999).

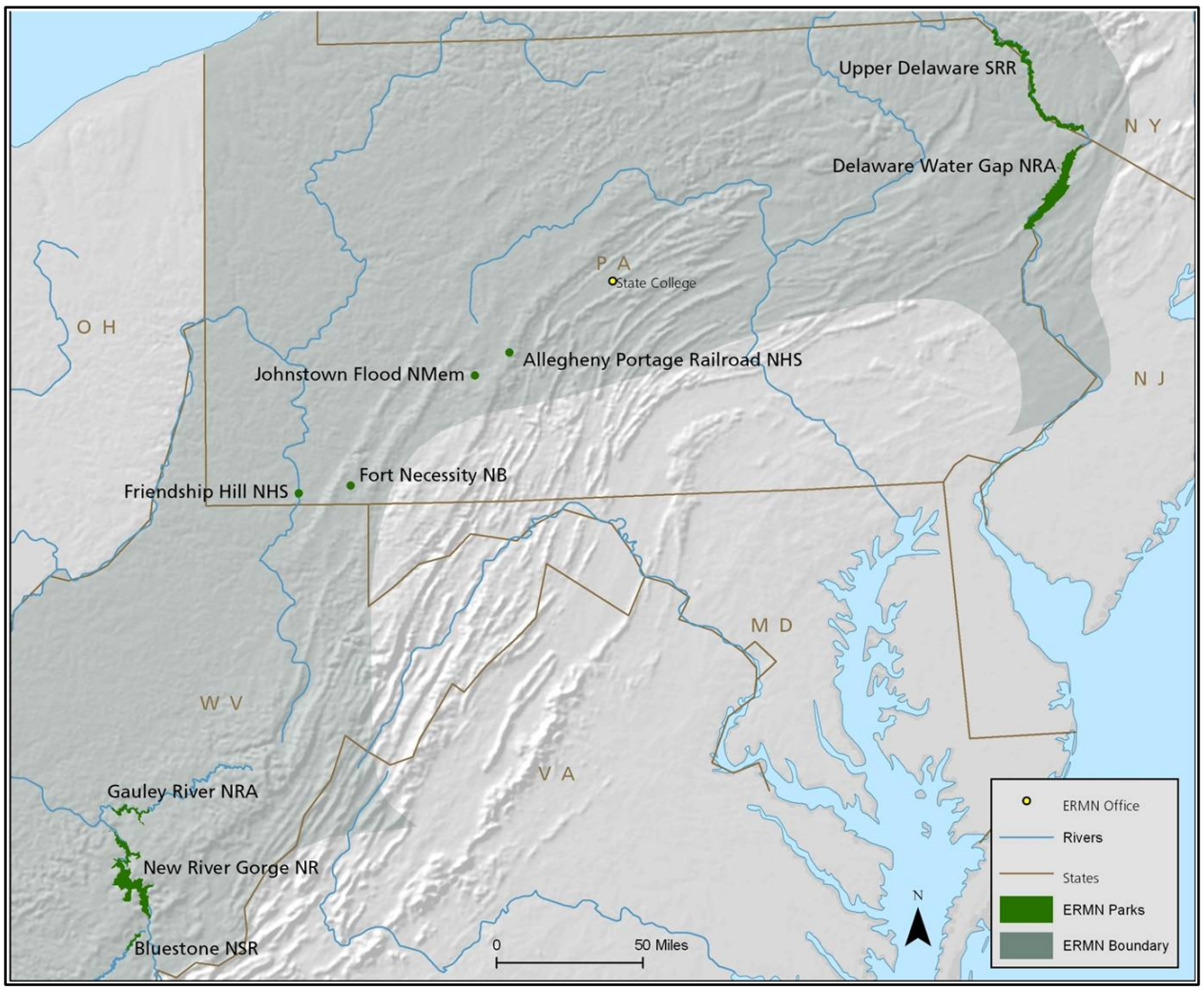

Figure 1. National parks in the Eastern Rivers and Mountains Network (ERMN).

Birds are also attractive as ecological indicators because 1) they are the most easily and inexpensively detected and identified vertebrate animals, 2) their taxonomy is well known, 3) a single survey method is effective for many species, 4) many reference datasets and standard methods are available (e.g., Ralph et al. 1993, 1995), 5) multi-agency groups focused on bird monitoring are working to align objectives, coordinate monitoring efforts, and identify information gaps in North America (e.g., Lambert et al. 2009), and 6) accounting and managing for many species with different ecological requirements promotes conservation strategies at the landscape scale (Maurer 1993, Hutto and Young 2002).

Moreover, birds are a high profile group with wide public interest and many parks provide information on the status and trends of the park's avian community through their interpretive materials and programs. The NPS hosts more visitors each year than any other federally managed lands (NABCI 2011) and one in five Americans watch birds, contributing $36 billion to the U.S. economy in 2006 (Carver 2009), illustrating the influential role the NPS can play in interpreting various ecological stories through birds.

Streamside Birds

"Streamside birds" refers to the breeding bird community surrounding streams. The area sampled in this protocol is along park streams that are typically forested, including a closed canopy over the stream. Therefore, the streamside bird community sampled (Appendix A) is largely synonymous with and comparable to what other NPS monitoring programs refer to as "forest birds" (Ladin et al. 2011), "breeding birds" (Wakamiya 2012), and "landbirds" (Knutson et al. 2008, Faccio et al. 2010, Gostomski et al. 2010). The important difference, and the purpose of including the term "streamside," is not the bird community *per se*, rather that the physical area sampled is limited to the land area surrounding streams in each park.

Objectives

The primary monitoring objectives of the streamside bird protocol are to:

1. estimate occupancy, density, and/or indices of abundance annually for select bird species and guilds at the park (target stream network) and stream reach scale;
2. estimate trends among years in occupancy, density, and/or indices of abundance for select bird species and guilds at the park (target stream network) and stream reach scale;
3. calculate the Bird Community Index of biotic integrity annually at the park (target stream network) and stream reach scale; and
4. compare trends in occupancy, density, and/or indices of abundance for select bird species and guilds within ERMN parks to regional and continental trends.

Purpose of this Report

This report summarizes the first six years (2007–2012) of protocol implementation. The report provides an overview of the methods, sites, and effort thus far, as well as summaries of the species detected and total number of detections (as an index of abundance; objective 1). This report also includes the Bird Community Index (BCI; O'Connell et al. 2000) at the park and stream-reach scale (objective 3) and provides estimates of Louisiana waterthrush (scientific names are in Appendix A) occupancy at the stream-reach scale (objective 1). The Louisiana waterthrush is an obligate riparian breeder which is particularly well-sampled by this protocol and has also been argued to be an indicator species of riparian ecological condition (Mattsson and Cooper 2006, Latta and Mulvihill 2010). Objectives 2 and 4, related to trend estimation, will be addressed in subsequent reports.

Methods

Although a brief overview of the streamside bird monitoring methods is provided here, detailed rationale of the sampling design and field methods, in addition to Standard Operating Procedures, are provided in the protocol (Marshall et al. 2012).

Target Population and Sample Sites

The streamside bird monitoring protocol is implemented at all ERMN parks except Upper Delaware Scenic and Recreational River (SRR) and Johnstown Flood National Memorial (NMem) (Marshall et al. 2012).

Sampling is limited to the breeding season for eastern North America resident and neotropical (Central America, South America, and the Caribbean) migratory bird species, which extends from approximately mid-May through July (depending on latitude) and includes all species that are known to breed or may potentially breed in the streamside sampling areas of the respective parks (Appendix A). Members of the Orders Passeriformes (perching birds including songbirds) and Piciformes (woodpeckers) are particularly well sampled. While detections of nocturnal raptors (Strigiformes), diurnal raptors (Accipitriformes), waterfowl (Anseriformes), waders (Peleconiformes), and turkeys and grouse (Galliformes) do occur, they constitute less than 1% of all detections, which effectively precludes these groups from meaningful trend analyses.

The sampling frame (or sampling area) is defined as the network of perennial streams within the authorized boundary of each ERMN park. A watershed or catchment area of ≥ 1.0 km^2 was used to define streams with perennial flow (Paybins 2003). Large, “open-canopy” streams and rivers (watershed area ≥ 100 km^2) were excluded from the sampling frame because they often host avian communities that are quite different than those found along closed-canopy streams (i.e., waterbirds and edge-associated species). Furthermore, these larger, deeper streams and rivers cannot safely be crossed on foot; if at all. More details are provided in Marshall et al. (2012).

The sampling unit, or sample site, is a stream “reach” defined as a 250-m to 1-km length of stream established within the authorized NPS park boundary. Each reach has 2–5 point count stations spaced depending on reach length (Figure 2). Point count stations are spaced 250 m apart. Individual point count stations are located up to 25 m upslope of the stream (either side) to avoid excessive stream noise interfering with bird detections. Moreover, the effective bird detection distance is approximately 100 m (M. R. Marshall, personal observation). Therefore, the target population and the area of inference is the community of breeding birds within a 125-m buffer of the perennially flowing, closed canopy stream network in each park. All references in this report to “streamside birds” are meant to imply this target population and area of inference.

Figure 2. Example of a streamside bird sampling site which consists of a 1-km reach with five point count stations spaced at 250-m intervals. The site depicted is Arbuckle Creek at New River Gorge NR.

Sample Site Selection

Sample site selection differed between the two largest parks (Delaware Water Gap National Recreation Area [NRA] and New River Gorge National River [NR]) and the remaining five parks included in the protocol. Due to their larger size, only a subset of the many perennial streams and stream reaches could be sampled, given cost and personnel constraints. Consequently, a probabilistic design was employed to ensure unbiased and statistically rigorous inferences about streams and stream reaches that were not sampled but met initial design conditions. Moreover, candidate streams at Delaware Water Gap NRA and New River Gorge NR were stratified based on four characteristics of their contributing watershed including:
1) watershed area or size; 2) percent of watershed area protected (i.e., within NPS or state park boundaries); 3) underlying bedrock geology; and 4) watershed topography. Each of these four intrinsic characteristics has demonstrated direct or indirect effects on water quality parameters and benthic macroinvertebrate communities (Vannote et al. 1980, Church 2002, Klemm et al. 2002, King et al. 2005), which are of primary interest for other ERMN water-based protocols (e.g., Tzilkowski et al. 2013), and were therefore included in the sampling design. Several of these intrinsic conditions, such as the amount of protection from land use change a watershed receives based on land ownership, may also drive the composition of streamside bird communities. Additional description of these four characteristics is provided in Marshall et al. (2012).

Site selection at Delaware Water Gap NRA and New River Gorge NR proceeded in a stratified-random process and occurred in two stages. First, candidate streams were identified and randomly selected for sampling based on strata membership. Second, for all randomly selected candidate streams, an individual stream reach was randomly selected as the sampling site (i.e., location of point count stations). All reaches in these two parks are 1 km in length and, therefore, have five point count stations at each sampling site. The stratified-random site selection process is fully described in Marshall et al. (2012) and a summary of selected sampling sites is below.

Although the stratified-random site selection strategy defined the sampling sites at Delaware Water Gap NRA and New River Gorge NR, that approach was not applicable at the other five parks due to inherent park characteristics (e.g., small parcel size, linear park shape, land ownership patterns) and because, in general, too few streams were available for a logical random approach. To maximize coverage in these parks, all candidate streams (i.e., perennial streams defined by a 1.0–99.9-km^2 watershed area) were evaluated for possible inclusion. Sample sites were, again, limited to reaches within the authorized boundary of the park. However, reach length was allowed to vary from 0.25–1 km depending on the site to include as many of the already limited number of candidate sites as possible. For most parks, all possible candidate streams and reaches are sampled.

Sampling Site Summary

Sixty-six sampling sites (i.e., stream reaches) were selected for monitoring streamside birds. The following sections provide a summary of sampling sites for the seven park units where the protocol is implemented.

Delaware Water Gap National Recreation Area

Established in 1965, Delaware Water Gap NRA encompasses roughly 70,000 acres of mountain ridge, forest, and floodplain on both sides of a 40-mile segment of the Delaware River in Pennsylvania and New Jersey.

Twenty-four sites were selected for streamside bird monitoring (Table 1, Figure 3). Each site is 1 km in length and therefore consists of five point count stations. Monitoring began in 2007 at all sites with the exception of the Toms Creek, UNT (unnamed tributary) to Dingmans Creek, and Raymondskill Creek sites which were initiated in 2008.

Table 1. Site name, unique site identifier (ID), year established, reach length, and number of point count stations per site for 24 sampling sites selected for streamside bird monitoring at Delaware Water Gap NRA.

Site Name	Site ID	Year Established	Reach Length (m)	No. Point Count Stations
White Brook	DEWA.1001	2007	1000	5
Dunnfield Creek	DEWA.1002	2007	1000	5
UNT to Delaware River (Sunfish Pond)	DEWA.1003	2007	1000	5
Vancampens Brook (Millbrook Village)	DEWA.1004	2007	1000	5
Slateford Creek	DEWA.1005	2007	1000	5
Caledonia Creek	DEWA.1006	2007	1000	5
Fuller Brook	DEWA.1007	2007	1000	5
Van Campen Creek	DEWA.1008	2007	1000	5
Little Bushkill Creek	DEWA.1009	2007	1000	5
UNT to Dingmans Creek	DEWA.1010	2008	1000	5
Toms Creek	DEWA.1011	2008	1000	5
UNT to Toms Creek	DEWA.1012	2007	1000	5
Mill Creek	DEWA.1013	2007	1000	5
Hornbecks Creek	DEWA.1014	2007	1000	5
Dingmans Creek	DEWA.1015	2007	1000	5
Adams Creek	DEWA.1016	2007	1000	5
Raymondskill Creek	DEWA.1017	2008	1000	5
Spackmans Creek	DEWA.1018	2007	1000	5
Conashaugh Creek	DEWA.1019	2007	1000	5
Dry Brook	DEWA.1020	2007	1000	5
UNT to Adams Creek	DEWA.1021	2007	1000	5
Sandyston Creek*	DEWA.1022	2007	1000	5
Vancampens Brook (Donkey Hollow)	DEWA.1023	2007	1000	5
UNT to Delaware River (Arrow Island)	DEWA.1024	2007	1000	5

* Reach length was only 750 m, containing four point count stations, until 2010.
UNT = unnamed tributary

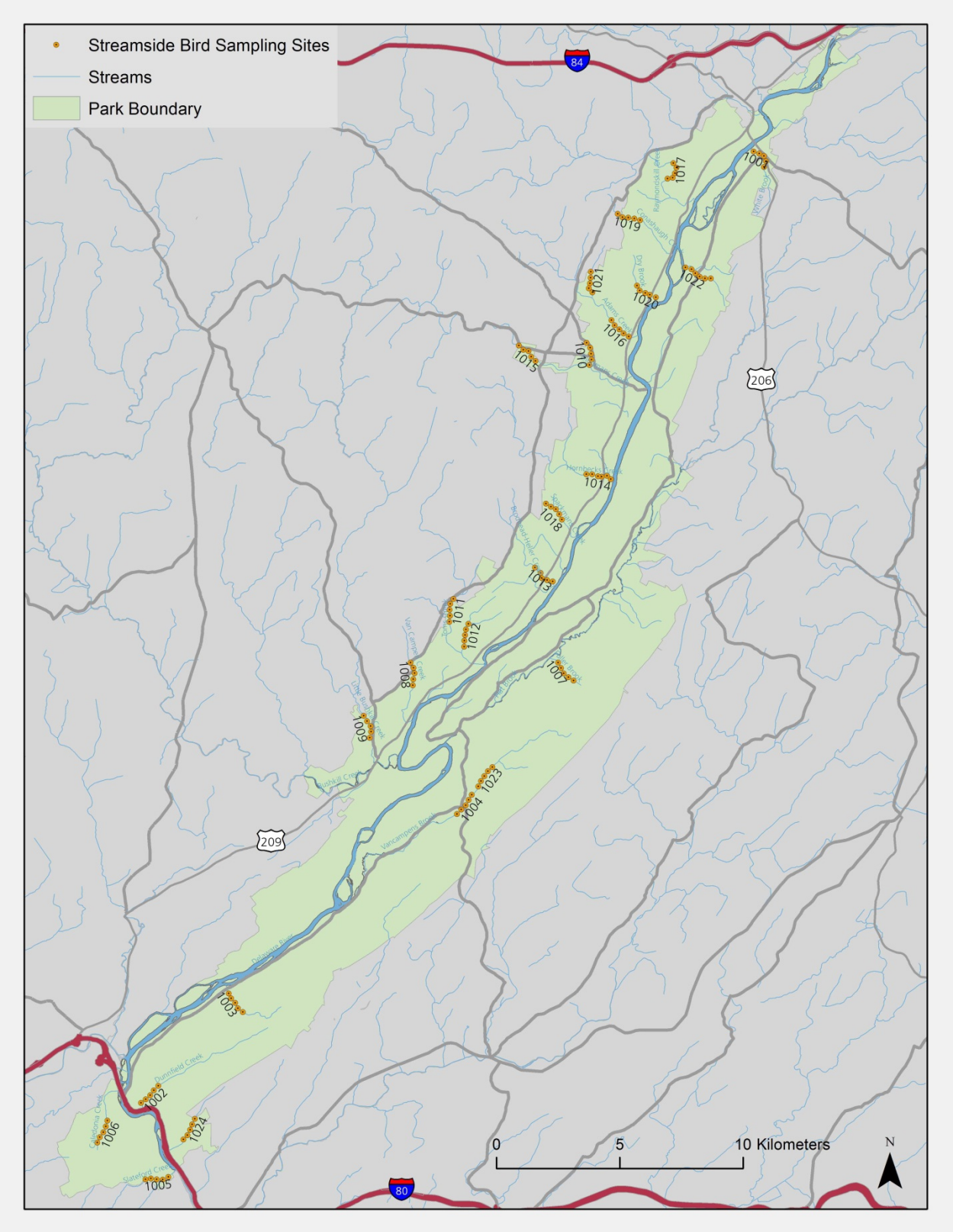

Figure 3. Locations of 24 sampling sites selected for monitoring streamside birds at Delaware Water Gap NRA.

New River Gorge National River

Established in 1978, New River Gorge NR encompasses more than 70,000 acres of rugged mountainous terrain along a 53-mile segment of the New River in West Virginia.

Twenty-five sites were selected for streamside bird monitoring (Table 2, Figure 4). Each site is 1 km in length and therefore consists of five point count stations. Monitoring began in 2007 at all sites with the exception of the Big Branch, Davis Branch, and Keeney Creek sites which were initiated in 2008.

Table 2. Site name, unique site identifier (ID), year established, reach length, and number of point count stations per site for 25 sampling sites selected for streamside bird monitoring at New River Gorge NR.

Site Name	Site ID	Year Established	Reach Length (m)	No. Point Count Stations
Batoff Creek	NERI.1001	2007	1000	5
Mill Creek	NERI.1002	2007	1000	5
Meadow Creek	NERI.1003	2007	1000	5
UNT to Meadow Creek	NERI.1004	2007	1000	5
Fall Branch	NERI.1005	2007	1000	5
Big Branch	NERI.1006	2008	1000	5
Laurel Creek	NERI.1007	2007	1000	5
Dowdy Creek	NERI.1008	2007	1000	5
Slater Creek	NERI.1009	2007	1000	5
Buffalo Creek	NERI.1010	2007	1000	5
UNT to Buffalo Creek	NERI.1011	2007	1000	5
Arbuckle Creek	NERI.1012	2007	1000	5
UNT to Laurel Creek (Highland Mtn)	NERI.1013	2007	1000	5
UNT to Laurel Creek (Backus Mtn)	NERI.1014	2007	1000	5
Davis Branch	NERI.1015	2008	1000	5
Little Laurel Creek	NERI.1016	2007	1000	5
Richlick Branch	NERI.1017	2007	1000	5
Wolf Creek	NERI.1018	2007	1000	5
Keeney Creek	NERI.1019	2008	1000	5
Camp Branch	NERI.1020	2007	1000	5
Ephraim Creek	NERI.1021	2007	1000	5
Fire Creek	NERI.1022	2007	1000	5
Bucklick Branch	NERI.1023	2007	1000	5
Bills Branch	NERI.1024	2007	1000	5
Kates Branch	NERI.1026	2007	1000	5

UNT = unnamed tributary.

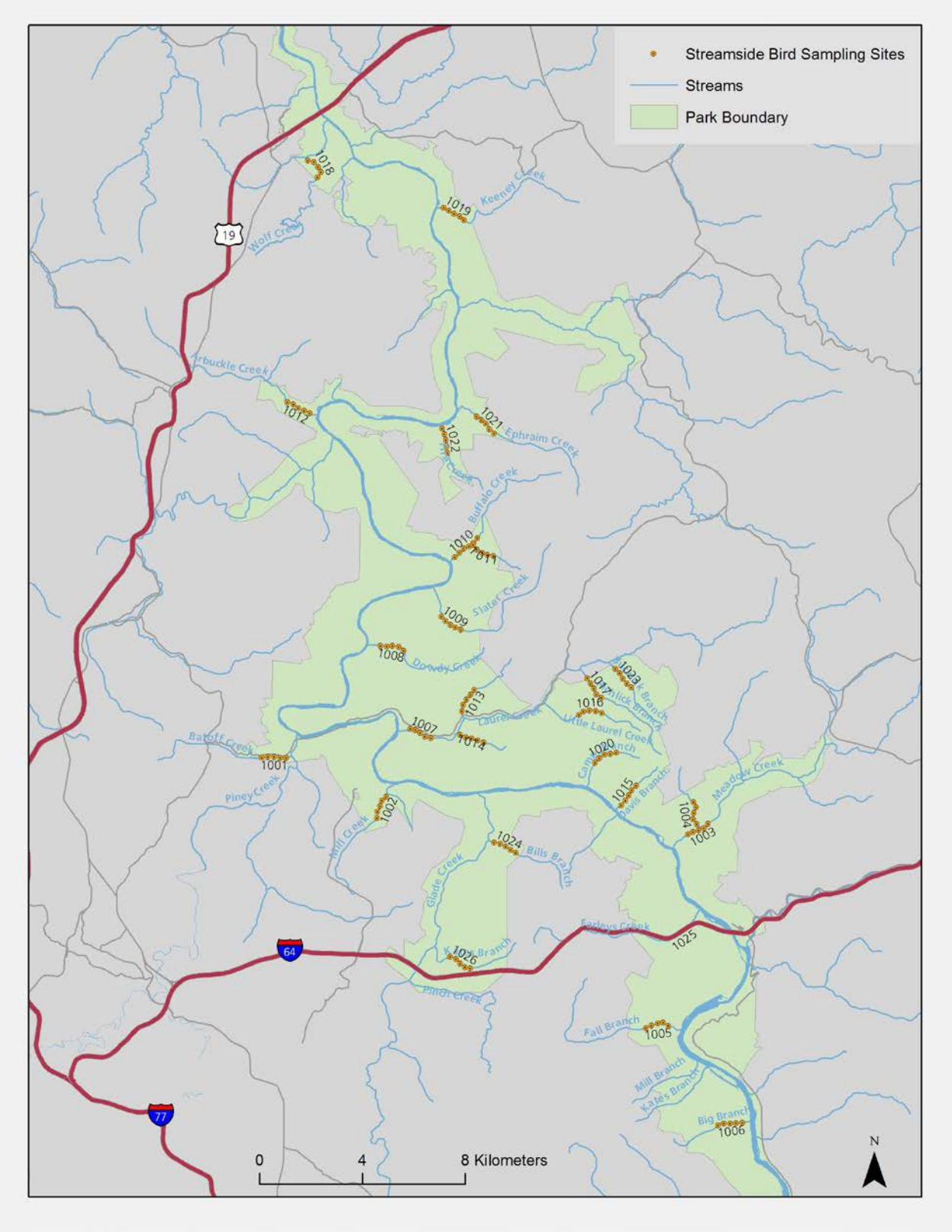

Figure 4. Locations of 25 sampling sites selected for monitoring streamside birds at New River Gorge NR.

Gauley River National Recreation Area

Established in 1988, Gauley River NRA encompasses more than 11,000 acres of rugged mountainous terrain along 25 miles of the Gauley River and five miles of the Meadow River in West Virginia.

Six sites met the site selection criteria defined above, but only three (Laurel Creek, Horseshoe Creek, and Meadow Creek) were randomly selected for inclusion and initiated in 2007 (Mattsson and Marshall 2010). Peter's Creek and Meadow River were too large to meet the size criterion and were therefore excluded. It was later decided that Gauley River NRA had too few candidate sites for a logical random approach and all candidate sites were then considered for inclusion and established in 2012 (Table 3, Figure 5). Reach length varies by site, ranging from 750 m to 1 km, and therefore sites consist of either four or five point count stations.

All six sites are located within the authorized boundary of the park, but none lie entirely on federally owned land. Permissions have been granted from the landowners for access and monitoring but in the event that landownership changes, new permissions must be sought to continue monitoring these sites.

Table 3. Site name, unique site identifier (ID), year established, reach length, and number of point count stations per site for six sampling sites selected for streamside bird monitoring at Gauley River NRA.

Site Name	Site ID	Year Established	Reach Length (m)	No. Point Count Stations
Laurel Creek	GARI.1001	2007	1000	5
Horseshoe Creek	GARI.1002	2007	1000	5
Meadow Creek	GARI.1003	2007	1000	5
Sugar Creek	GARI.1004	2012	1000	5
Ramsey Branch	GARI.1005	2012	750	4
Mason Branch	GARI.1006	2012	750	4

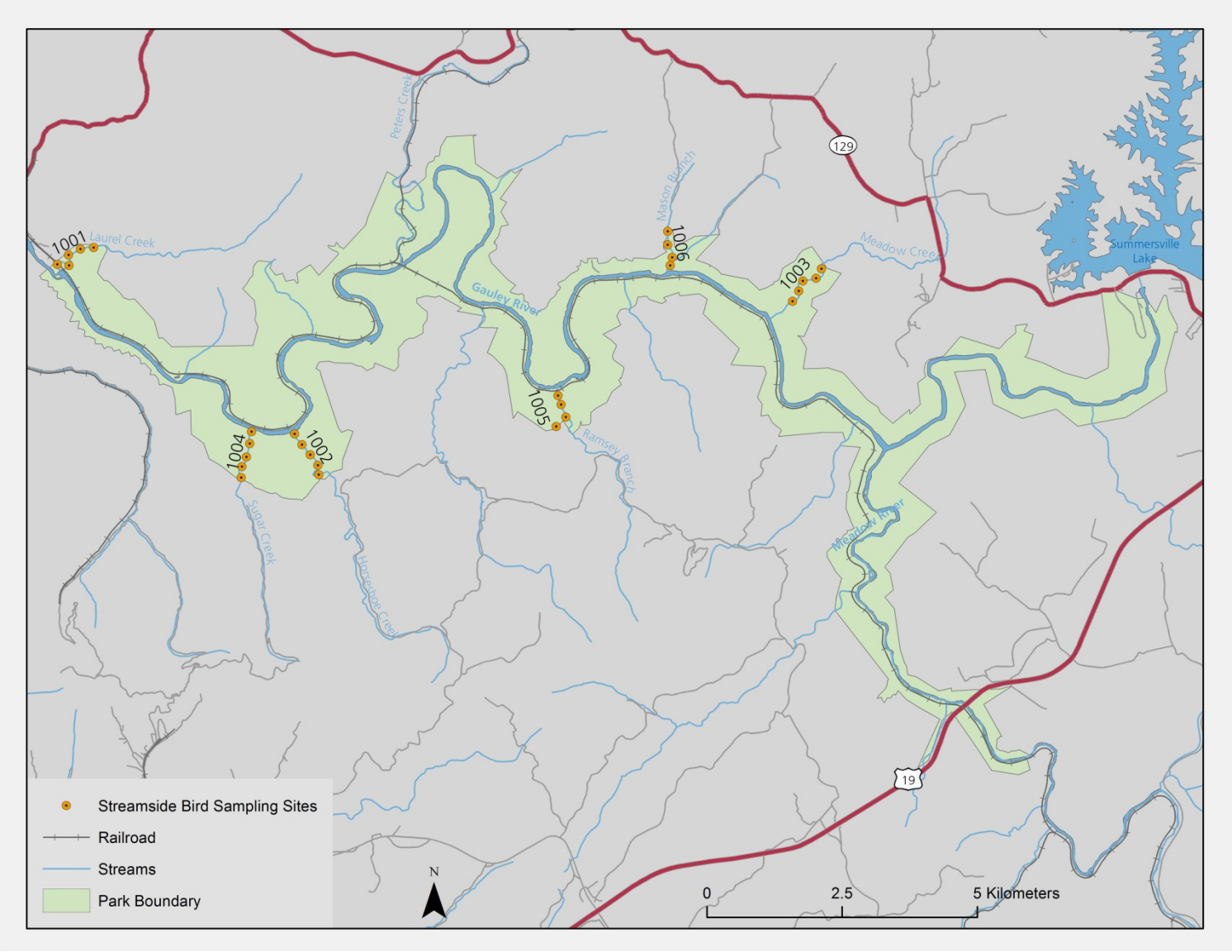

Figure 5. Locations of six sampling sites selected for monitoring streamside birds at Gauley River NRA.

Bluestone National Scenic River

Established in 1988, Bluestone NSR encompasses more than 4,000 acres of Bluestone Gorge and 10.5 miles of the Bluestone River in southern West Virginia.

Five sites met the site selection criteria defined above and three are currently included in the streamside bird monitoring protocol (Table 4, Figure 6). Reach length varies by site, ranging from 500 m to 1 km, and therefore sites consist of three to five point count stations. Landowner permission to access one of the three sites (Jarrell Branch) was granted in 2012. A site along Indian Branch (BLUE.1001) was included and sampled in 2009 but discontinued due to excessively steep, unsafe terrain and several waterfalls. Landowner permission to access the fifth candidate site (Tony Hollow; BLUE.1005) has not yet been granted. Despite the requirement for private landowner permission for access, each site is located within the authorized park boundary on federally and/or state-owned land. Permission has been granted to sample on state park land.

Table 4. Site name, unique site identifier (ID), year established, reach length, and number of point count stations per site for three sampling sites selected for streamside bird monitoring at Bluestone NSR.

Site Name	Site ID	Year Established	Reach Length (m)	No. Point Count Stations
Mountain Creek	BLUE.1002	2009	750	4
Little Bluestone River	BLUE.1003	2009	1000	5
Jarrell Branch	BLUE.1004	2012	500	3

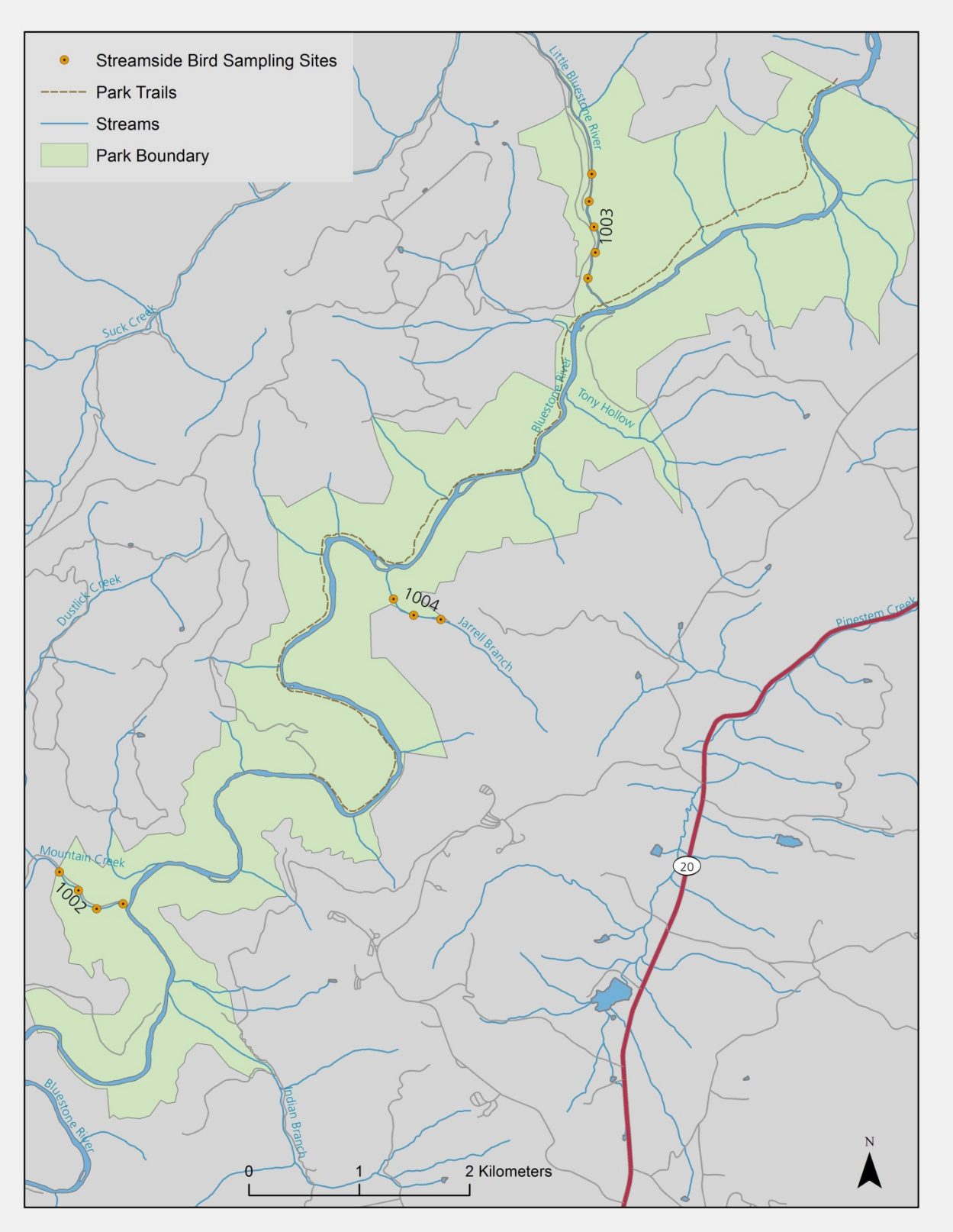

Figure 6. Locations of three sampling sites selected for monitoring streamside birds at Bluestone NSR.

Allegheny Portage Railroad National Historic Site

Established in 1964, Allegheny Portage Railroad NHS encompasses slightly more than 1,200 acres of land area in central Pennsylvania to preserve and commemorate the historic Allegheny Portage Railroad. The park's main unit is located within the Blair Gap Run watershed which, along with its natural resource values, serves as a municipal water supply for the cities of Altoona and Hollidaysburg, Pennsylvania. Due to the linear, winding nature of the park and Blair Gap Run, there are only short segments of Blair Gap Run and its tributaries that flow through park property. An attempt was made to establish streamside bird monitoring sites along as many of these segments as possible.

Four sites met the site selection criteria defined above and three are included in the streamside bird monitoring protocol (Table 5, Figure 7). Reach length varies by site, ranging from 500 m to 1 km, and therefore sites consist of either three or five point count stations. The fourth possible site (along the headwaters of Blair Gap Run near the Lemon House) was not established because of excessively loud road/truck noise that precluded auditory sampling of birds. However, this site will be re-evaluated for inclusion in 2013 by attempting to sample on weekends when truck traffic noise should be diminished.

Table 5. Site name, unique site identifier (ID), year established, reach length, and number of point count stations per site for three sampling sites selected for streamside bird monitoring at Allegheny Portage Railroad NHS.

Site Name	Site ID	Year Established	Reach Length (m)	No. Point Count Stations
Millstone Run	ALPO.1001	2007	1000	5
UNT to Blair Gap Run (Foot of Ten)	ALPO.1002	2008	500	3
Blair Gap Run (Muleshoe)	ALPO.1003	2009	500	3

UNT = unnamed tributary.

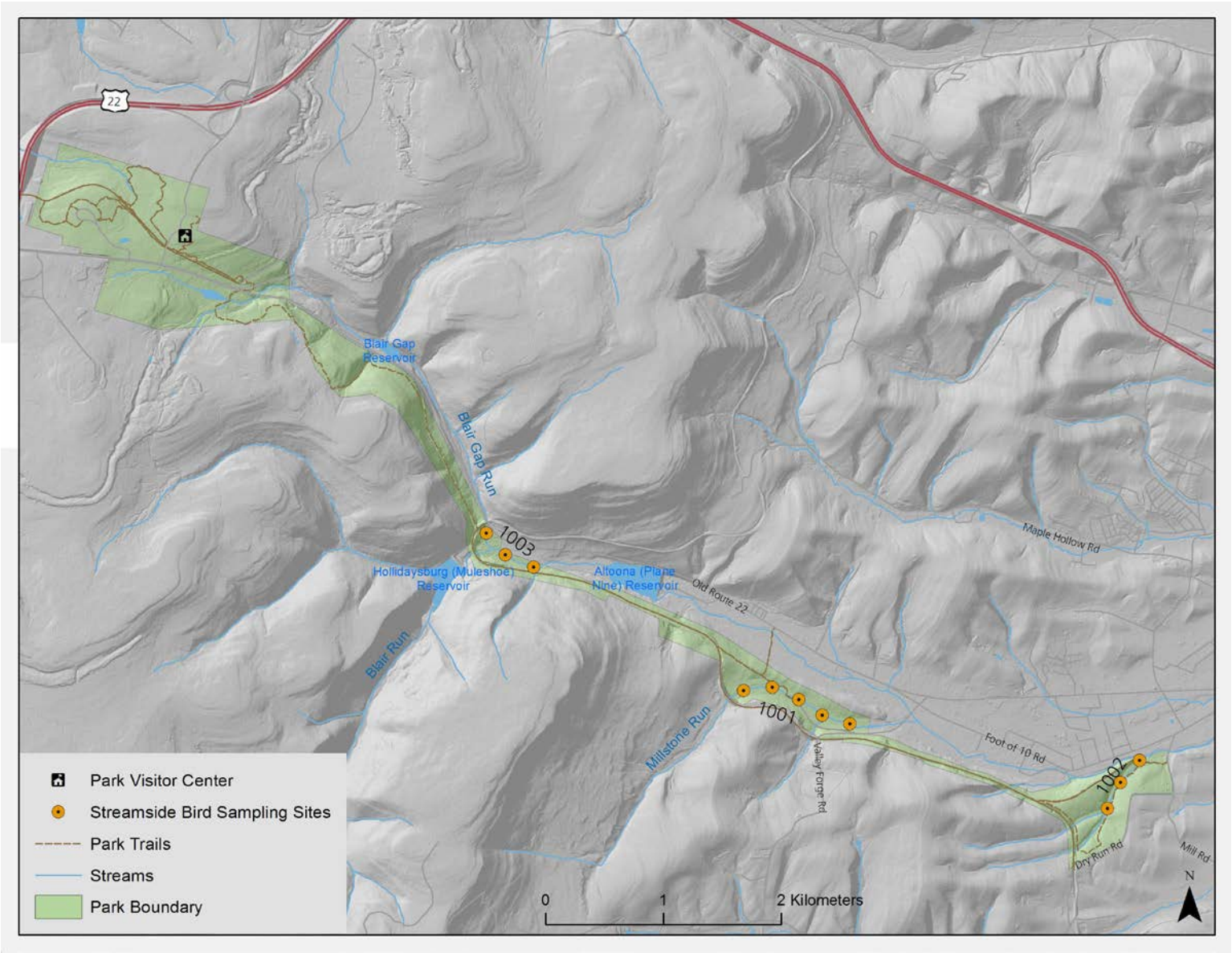

Figure 7. Locations of three sampling sites selected for monitoring streamside birds at Allegheny Portage Railroad NHS.

Fort Necessity National Battlefield

Established in 1931, Fort Necessity NB encompasses slightly more than 900 acres of land area in southwest Pennsylvania to preserve and commemorate the early career of George Washington and the battle of Fort Necessity. The park's main unit is located on a slight plateau with several small streams originating on (and flowing off) park property. An attempt was made to establish streamside bird monitoring sites along as many of these segments as possible.

Three sites met the site selection criteria defined and are included in the streamside bird monitoring protocol (Table 6, Figure 8). Reach length varies by site, ranging from 250 m to 1 km, and therefore sites consist of two to five point count stations. Great Meadows Run was not considered a candidate site because it is maintained as an open area for cultural resource interpretation. This decision will be revaluated and a site along Great Meadows Run may be established in 2013.

Table 6. Site name, unique site identifier (ID), year established, reach length, and number of point count stations per site for three sampling sites selected for streamside bird monitoring at Fort Necessity NB.

Site Name	Site ID	Year Established	Reach Length (m)	No. Point Count Stations
UNT to Scotts Run (Picnic Loop)	FONE.1001	2008	250	2
UNT to Great Meadows Run	FONE.1002	2008	1000	5
UNT to Scotts Run (Rankin Rd)	FONE.1003	2008	500	3

UNT = unnamed tributary.

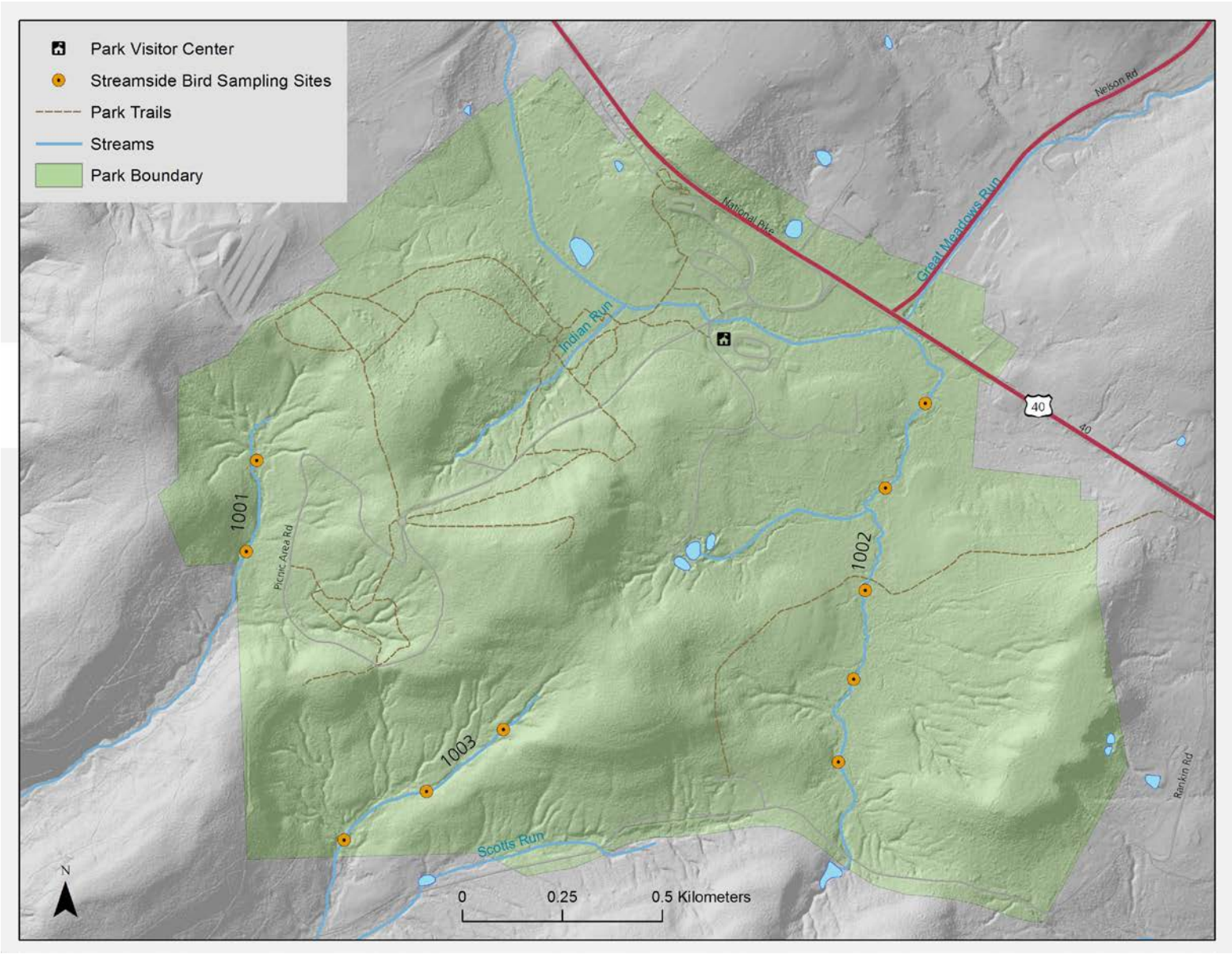

Figure 8. Locations of three sampling sites selected for monitoring streamside birds at Fort Necessity NB.

Friendship Hill National Historic Site

Established in 1978, Friendship Hill NHS encompasses roughly 675 acres of land area along the Monongahela River in southwest Pennsylvania to commemorate and interpret Albert Gallatin, U.S. Secretary of Treasury for thirteen years under Presidents Jefferson and Madison.

The park has two perennially flowing streams and sites were established along both of them for streamside bird monitoring (Table 7, Figure 9). Reach length varies by site, ranging from 750 m to 1 km, and therefore sites consist of either four or five point count stations.

Table 7. Site name, unique site identifier (ID), year established, reach length, and number of point count stations per site for two sampling sites selected for streamside bird monitoring at Friendship Hill NHS.

Site Name	Site ID	Year Established	Reach Length (m)	No. Point Count Stations
Ice Pond Run	FRHI.1001	2008	1000	5
Dublin Run	FRHI.1002	2008	750	4

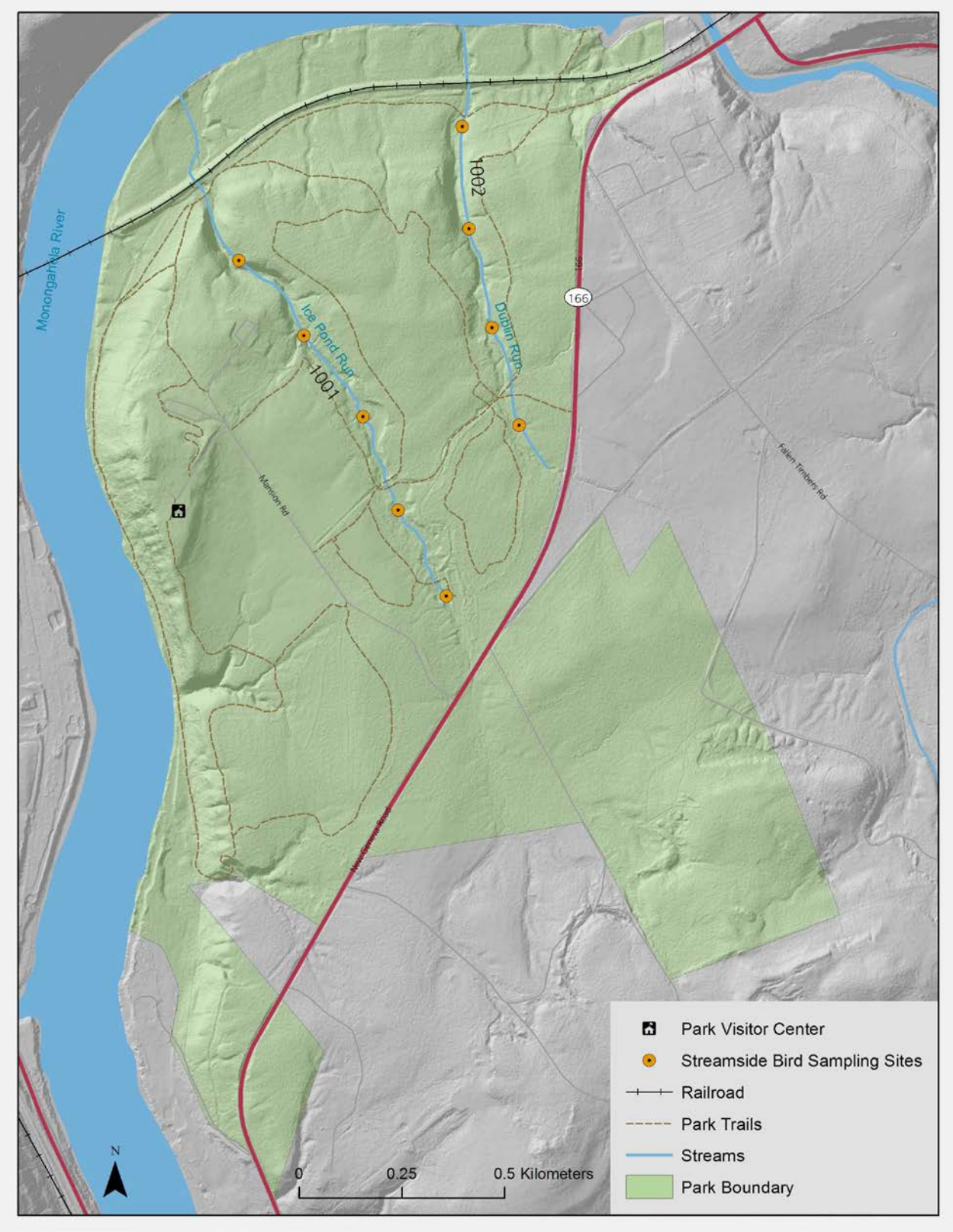

Figure 9. Locations of two sampling sites selected for monitoring streamside birds at Friendship Hill NHS.

Field Methods

Point count surveys are the most widely used quantitative method of monitoring bird populations and are used in the protocol as well (Marshall et al. 2012). The survey technique involves using a standardized methodology (e.g., Ralph et al. 1995) to record ("count") all birds seen or heard during a fixed amount of time at count locations ("points"). The resultant counts are used as an index of population abundance and are amenable to a number of analytical techniques to correct for potential detection biases.

Each sampling site (i.e., stream reach) and their associated point count stations are visited two times per year between May and July. During each visit, an observer traverses the stream reach twice (i.e., upstream and downstream), stopping at each point count station to conduct the 10-min point count and associated data collection. Each time the reach is traversed is referred to as a "pass". By waiting 10 minutes between passes, each of these passes is considered an independent sample. Therefore, each site is sampled four times per year (two visits per year and two passes per visit).

Each visit begins at sunrise and ends 4.5 hours after sunrise. Ideally, the visits are rotated among observers to account for observer biases; however, this is not always the case due to logistical and personnel constraints.

During point counts, the following information for each individual bird detected is recorded: 1) species identity; 2) type of detection (e.g., song, call, drumming, visual); 3) the distance of first detection (<50 m, 50–75 m, or >75 m of the point count station); 4) each 1-min interval the bird is detected; 5) if the bird is a juvenile; and 6) if the bird is flying over the canopy at the time of detection. Additional information is provided in Marshall et al. (2012).

Analyses

Sampling Effort and Species Detected

This report provides a summary of the sampling effort and species detected thus far. Each species detected during point counts is reported along with the total number of detections across all sites and years (as an index of abundance). Species of continental and/or regional conservation importance as defined by Partners in Flight (www.partnersinflight.org) are also high-lighted. Partners in Flight (PIF), an international consortium of governmental and non-governmental organizations dedicated to the conservation of birds, undertook a semi-quantitative ranking process to prioritize species for conservation action at the continental scale (Rich et al. 2004). They define "Watch List Species" as species that are essentially "in trouble" with multiple conservation threats, and "Stewardship Species" as those species that have a proportionately high percentage (75-90%) of their world population within a single avifaunal biome (in this case, the Eastern avifaunal biome). In essence, there is a broad regional responsibility to conserve these species. The two designations are not mutually exclusive. Panjabi et al. (2012) extended this approach to finer-scale regions and identified species of "Regional Concern." In this case, the region is the Appalachian Mountains Bird Conservation Region (BCR 28) which is used as a planning and conservation framework for the Appalachian Mountains Joint Venture (AMJV; http://www.amjv.org) and the Appalachian Mountains Landscape Conservation Cooperative (LCC; http://applcc.org/). The ERMN lies entirely within the BCR 28 and the Appalachian LCC.

Louisiana Waterthrush Detections

Louisiana waterthrush is a migratory warbler that establishes linear breeding territories along streams throughout the Appalachians (Mattson et al. 2009). The Louisiana waterthrush is a forest interior obligate (O'Connell et al. 2002), the only riparian obligate in the Eastern U.S. (Mattsson et al. 2009), and is a species of regional conservation concern (Panjabi et al. 2012) and a PIF Continental Stewardship Species (Rich et al. 2004). The Louisiana waterthrush is also argued to be an indicator species of riparian ecological condition (Mattsson and Cooper 2006, Latta and Mulvihill 2010), responding negatively to degradation of stream condition. One of the primary reasons point count stations are located along streams in this protocol was to focus sampling on this species (Marshall et al. 2012).

We summarize Louisiana waterthrush occupancy at the stream-reach scale in this report. Occupancy is defined as the presence (i.e., detection) of the species at a point count station. Because there are multiple point count stations per stream reach, we report the maximum number of point count stations the species was detected during a pass per sampling reach. That is, each of the four passes (and associated point counts) per year is an independent opportunity to detect at least one adult Louisiana waterthrush at each point count station (within 75 m). The pass with the maximum number of stations with a detection was used in this analysis. Using this approach and logic, we infer, for example, that if a Louisiana waterthrush adult is detected at three out of five point count stations on a single pass (and are never detected at more than three stations on the other passes), that there were at least three Louisiana waterthrush along that reach in that particular year. No attempt was made to incorporate and account for variation in detection probabilities in this report but this will be done in future analyses.

Bird Guilds as Indicators of Ecological Condition

Birds are often used as indicators of ecological health or integrity and summarizing the "condition" of the bird community and reporting changes in the bird community over time is a primary objective of this program (Marshall et al. 2012).

The Bird Community Index (BCI) is an index of biotic integrity based on the breeding bird communities of the central Appalachians (O'Connell et al. 1998a, 1998b, 2000). The BCI is based on 16 response guilds with each guild broadly classified as "specialist" or "generalist" depending on each guild's relationship to specific elements of biotic integrity (Table 8). Each species is assigned to a response guild and the BCI ranks the overall bird community detected at a site according to the proportional representation of the species in the response guilds. Higher BCI scores (indicating higher biotic integrity) describe a community in which specialists are well-represented relative to generalists.

It is important to recognize that the BCI in its current formulation reflects the land-use and land-cover types of the central Appalachians (e.g., mature and regenerating forest, pasture and row crop, urban and suburban area, and mined lands) each of which, in the absence of irreversible anthropogenic disturbance, would eventually succeed to mature forest. Moreover, specialist guilds tend to be associated with extensive forest cover and a taller, closed-canopy forest. Therefore, the sites with the highest BCI scores reflect bird communities associated with aspects of mature forest structure, function, and composition. For example, sites with higher BCI scores consist of a bird community with fewer omnivores, nest predators/brood parasites, and residents (i.e., generalists); but more bark probers, single-brooded species, and interior-forest obligates

Table 8. Biotic integrity elements, guild categories, response guilds, and guild interpretations used in the Bird Community Index (BCI; O'Connell et al. 1998a, 1998b, and 2000) of ecological integrity.

Biotic Integrity Element	Guild Category	Response Guild	Specialist	Generalist
Functional	trophic	omnivore		X
Functional	insectivore foraging behavior	bark prober	X	
Functional	insectivore foraging behavior	ground gleaner	X	
Functional	insectivore foraging behavior	upper-canopy forager	X	
Functional	insectivore foraging behavior	lower-canopy forager	X	
Compositional	origin	exotic/nonnative		X
Compositional	migratory	resident		X
Compositional	migratory	temperate migrant		X
Compositional	number of broods	single-brooded	X	
Compositional	population limiting	nest predator/brood parasite		X
Structural	nest placement	canopy nester	X	
Structural	nest placement	shrub nester		X
Structural	nest placement	forest-ground nester	X	
Structural	nest placement	open-ground nester	X	
Structural	primary habitat	forest generalist		X
Structural	primary habitat	interior forest obligate	X	

(i.e., specialists). Therefore, the biotic integrity (and inferred ecological condition) described by the BCI moves along a disturbance gradient from relatively intact, extensive, mature forest (high biotic integrity and high BCI scores) to highly human developed or urban landscapes (low biotic integrity and low BCI scores). The ecological condition of the landscape is thus inferred from the BCI measure of biotic integrity.

The BCI was developed by O'Connell et al. (1998a, 1998b, 2000) as a component of the U.S. Environmental Protection Agency, Environmental Monitoring and Assessment Program's (EPA-EMAP) Mid-Atlantic Highlands Assessment. The BCI is particularly amenable to application by the ERMN Streamside Bird Monitoring Program for several reasons. First, the geographic extent of the study area (Figure 9) aligns well with that of the ERMN and, as a result, so do the bird species included. Second, the sampling approaches employed by both efforts (five 10-min point counts along a 1 km transect) are virtually identical, which suggests that differences in BCI score are not due to methodological or sampling differences.

A thorough description of the BCI and how it is calculated is provided in Marshall et al. (2012) but, briefly, bird species are assigned to the guilds and each guild is ranked (i.e., assigned a score) based on the proportion of the total bird species detected at a site within each guild.

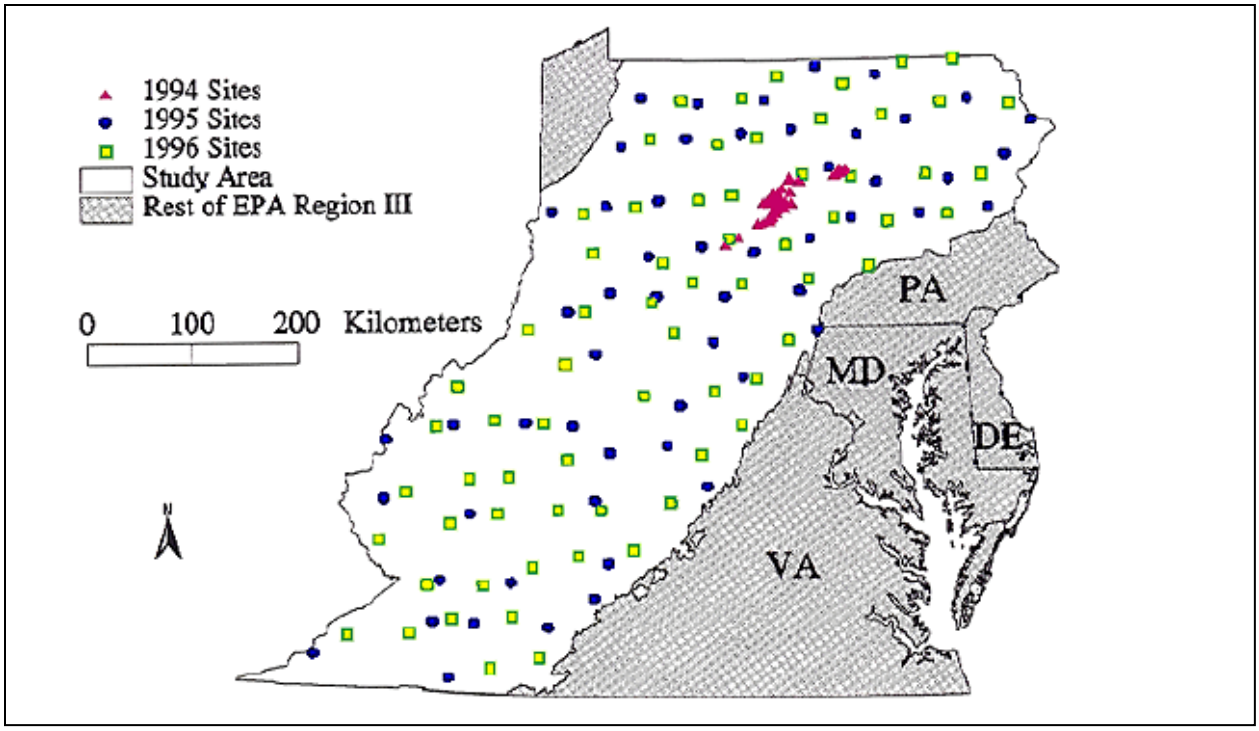

Figure 9. Map of the study area and specific sampling sites used by O'Connell et al. (2000) to develop the Bird Community Index (BCI).

The ranks determined for the 16 guilds are summed to produce an overall BCI score for the sampling unit (e.g., a sample site). O'Connell et al. (1998a, 1998b, and 2000) also established thresholds that place the overall BCI score into one of four ecological condition categories: "excellent" (highest integrity), "good" (high integrity), "fair" (medium integrity), and "poor" (low-integrity rural and low-integrity urban). BCI score thresholds for these condition classes are:

highest integrity:	60.1–77.0
high integrity:	52.1–60.0
medium integrity:	40.1–52.0
low integrity:	20.5–40.0

For the results presented here, the entire bird community detected during all four passes along each site each year was used to calculate BCI scores.

Results and Discussion

Sampling Effort and Species Detected

The 66 sites throughout the ERMN were all sampled four times per year (i.e., four "passes") after they were established; the majority of sites were established in 2007 (Tables 1–7). This sampling effort resulted in 1,424 independent passes of the 66 sites and a total of 6,908 individual point counts during the six years. Twenty different observers conducted point counts, ten of whom conducted point counts in more than one year. Despite the usual logistical and weather related challenges, all sites, passes, and point counts were sampled each year with the following few exceptions: 1) a single point count station was not sampled in 2008 during visit one (both passes) to Big Branch (NERI.1006) due to error; 2) Kates Branch (NERI.1026) was not sampled in 2011 or 2012 due to bridge damage and unsafe crossing of Glade Creek; and 3) one point count station along Sandyston Creek (DEWA.1022) was not established until 2010 and therefore not sampled in 2007, 2008, or 2009.

Including fly-overs and all distance and age categories, 46,278 individual birds were detected representing 123 species (Appendix A). The total number of detections included 417 detections where the observer could not identify the bird to species ("unknown bird") and 121 detections of "unknown" woodpeckers (i.e., a woodpecker of unknown species). These "unknown" categories constituted only 1.1% of detections.

Even though 123 species were detected, not all species were detected in all parks and the vast majority of detections (82%) were of only 25 species (Appendix A). Two species alone (red-eyed vireo and ovenbird) accounted for 24% of the total detections. Conversely, more than half (55%) of the species were detected fewer than 100 times across all years, parks, sites, point count stations, and passes. Nonnative bird species were infrequently detected (one house sparrow detection, five European starling detections, and one mute swan detection). Six detections were of birds (one orange-crowned warbler detection, two yellow-rumped warbler detections, and one blackpoll warbler detection at Gauley River NRA, and two blackpoll warbler detections at New River Gorge NR) that were considered to be migrating northward through the park(s) at the time of detection (i.e., the species does not breed in the park). They were included on the species list, but were flagged as "passage migrants" for possible exclusion from some analyses (e.g., BCI calculations).

Nearly one in four species detected (24%; Appendix A) is of continental and/or regional conservation concern, highlighting the importance of these parks to avian conservation (Rich et al. 2004, Panjabi et al. 2012). Four of the eight most frequently detected species (Acadian flycatcher, wood thrush, Louisiana waterthrush, and hooded warbler), making up nearly a quarter (22%) of the total detections, are PIF Stewardship Species. The primary habitat of these species is late successional deciduous forest, so it is not surprising that they were frequently detected within ERMN parks given current land cover types. However, the PIF designation emphasizes the stewardship responsibility to maintain these populations because the majority of the global population breeds in eastern forests. Wood thrush and worm-eating warbler are PIF Watch List Species and were frequently detected in ERMN parks. These species face multiple conservation threats throughout their range, which further illustrates the important conservation role that ERMN parks have for maintaining their populations.

Swainson's warbler was detected very locally, but regularly, in rhododendron thickets at Gauley River NRA and is a PIF Watch List and Stewardship Species. Two species (indigo bunting and eastern towhee) are also PIF Stewardship Species and were frequently detected in ERMN parks and are of note because their primary habitat is early successional deciduous forest.

Observers documented several non-bird species while conducting point counts, including river otter (*Lontra Canadensis*), fisher (*Martes pennanti*), coyote (*Canis latrans*), wood turtle (*Glyptemys insculpta*), bobcat (*Lynx rufus*), and porcupine (*Erethizon dorsatum*) (Appendix B). Each has been entered into NPSpecies as an observation for the appropriate park.

Louisiana waterthrush detections

Louisiana waterthrush (Figure 10) was detected at all parks and was the sixth most detected species overall; making up 5% of the total detections (Appendix A). The average number of point count stations the species was detected per sampling reach varied by park, reach, and year (Figures 11–13). For each park, a gradient existed among sites, with Louisiana waterthrush being detected at more stations at some sites and fewer stations at others. There was, however, substantial variation among years within a site [reflected in the large standard deviations (SD)].

Assuming the number of point count stations detected is an appropriate index of the number of territories per stream reach, we can apply a proposed threshold of stream integrity based on the presence of Louisiana waterthrush. "Healthy" streams should have at least two territories per kilometer of stream (Mulvihill et al. 2008, Latta and Mulvihill 2010, Newell 2011). This threshold is depicted by the orange horizontal line in Figures 11–13. (Note that the line is actually at 2.3 rather than 2.0 because our sampling design effectively samples 1.15 km of stream.) Using this proposed threshold, 31 of 66 (47%) sampled stream reaches in the ERMN would be considered "healthy" based on the presence of Louisiana waterthrush. While other measures of stream condition, such as benthic macroinvertebrate (BMI) assemblages, support this designation for some streams, several streams that have at least two Louisiana waterthrush per km are considered impaired by BMI (e.g., Ice Pond Run in Figure 13; Tzilkowski et al. 2011a). Conversely, many high quality streams based on BMI (e.g., Ephraim Creek and Bucklick Branch in Figure 12; Tzilkowski et al. 2011b) do not appear to support two territories per km of stream. As a result, the relationship between stream condition and Louisiana waterthrush is unclear at this time and awaits a more thorough analysis that will be reported elsewhere.

Figure 10. Louisiana waterthrush at nest with nestlings. Photo by James P. Mattsson.

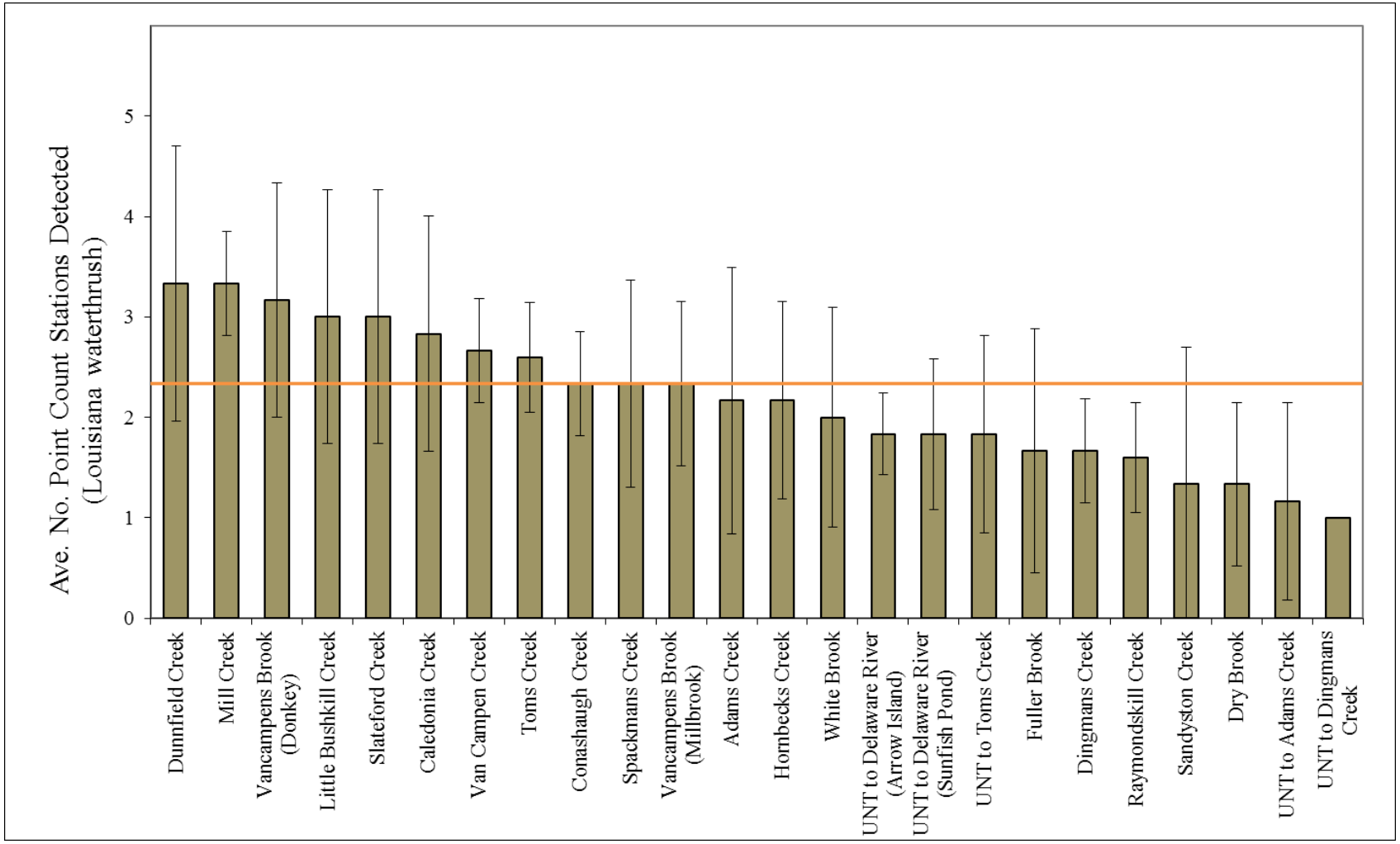

Figure 11. Average number of point count stations where at least one adult Louisiana waterthrush was detected during Streamside Bird Monitoring at Delaware Water Gap NRA, 2007-2012. Bar height represents the mean of five or six years of sampling (Table 1). Error bars are ±1 SD. Horizontal orange line reflects a proposed threshold of stream integrity based on the presence of Louisiana waterthrush ("healthy" streams should have at least 2 territories per kilometer of stream).

29

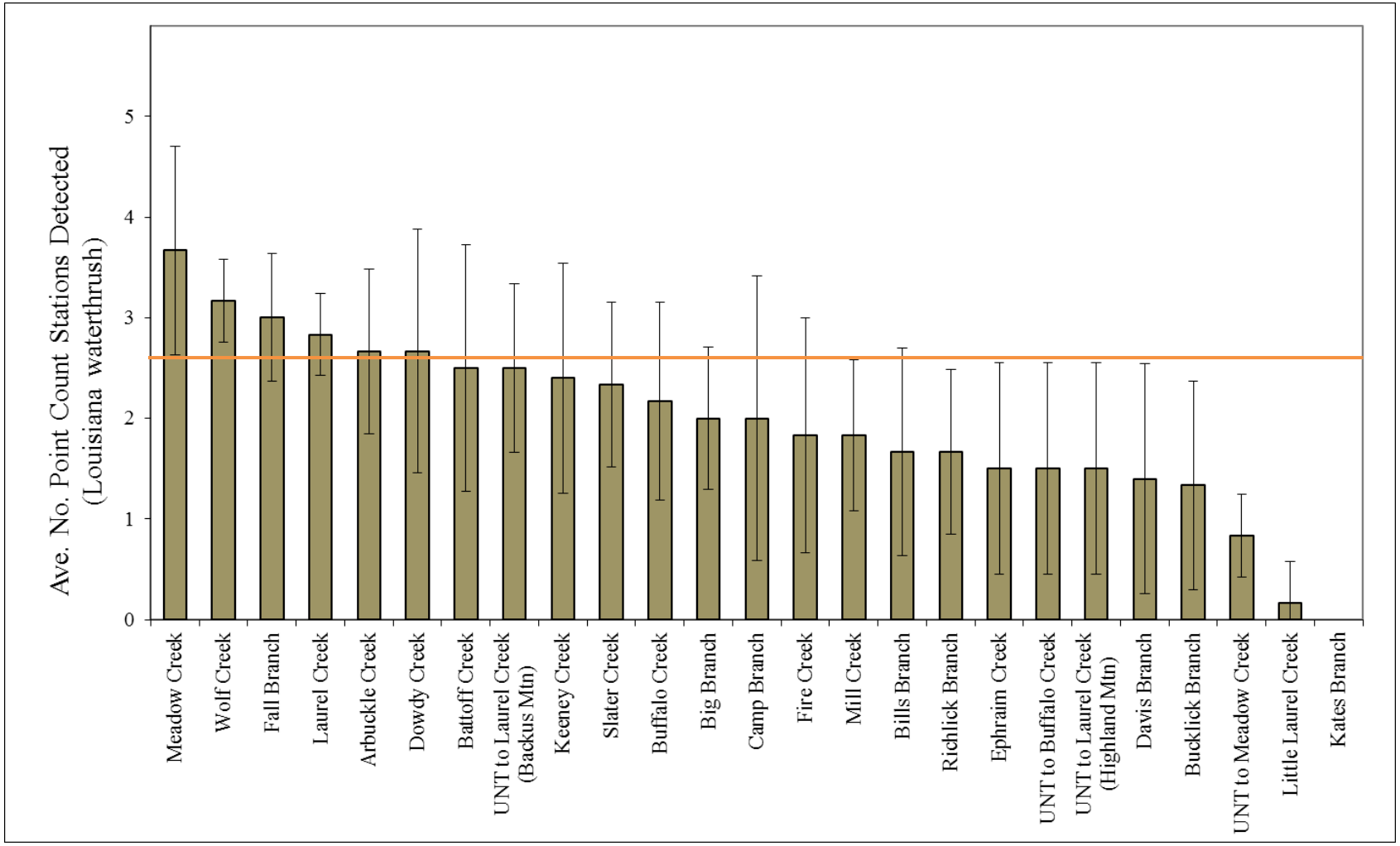

Figure 12. Average number of point count stations where at least one adult Louisiana waterthrush was detected during Streamside Bird Monitoring at New River Gorge NR, 2007-2012. Bar height represents the mean of five or six years of sampling (Table 2). Error bars are ±1SD. Horizontal orange line reflects a proposed threshold of stream integrity based on the presence of Louisiana waterthrush ("healthy" streams should have at least 2 territories per kilometer of stream).

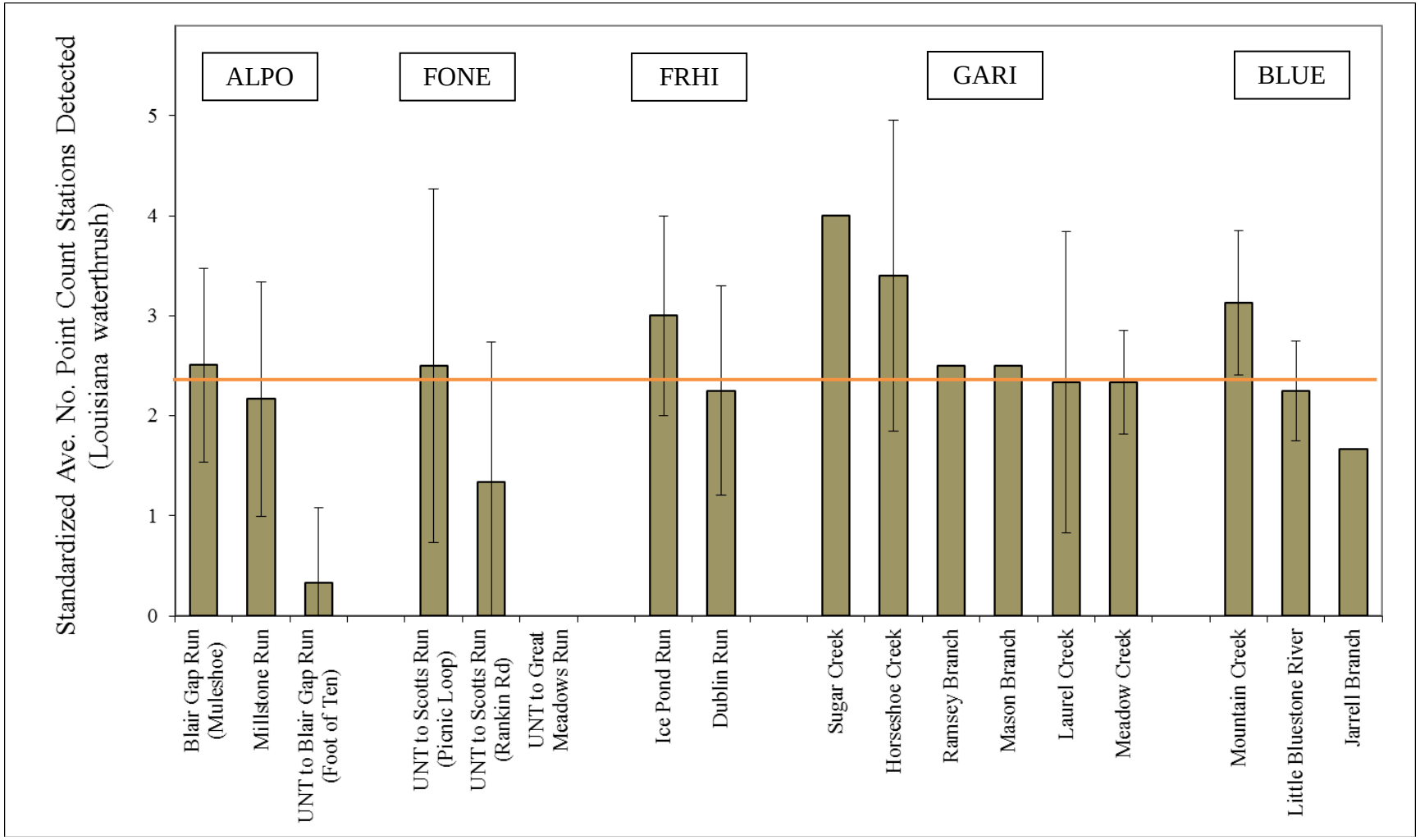

Figure 13. Average number of point count stations where at least one adult Louisiana waterthrush was detected during Streamside Bird Monitoring at Allegheny Portage Railroad NHS (ALPO), Fort Necessity NB (FONE), Friendship Hill NHS (FRHI), Gauley River NRA (GARI), and Bluestone NSR (BLUE), 2007–2012. Bar height represents the mean of one to six years of sampling (Tables 3–7). Error bars are ±1SD. Horizontal orange line reflects a proposed threshold of stream integrity based on the presence of Louisiana waterthrush ("healthy" streams should have at least two territories per kilometer of stream). All sites standardized to five point count stations per site to allow network-wide comparisons.

31

Bird Guilds as Indicators of Ecological Condition

Based on the Bird Community Index (BCI; O'Connell et al. 2000), the majority of sites across the ERMN have bird communities indicative of "high" or "highest" biotic integrity (Figures 14–16) meaning that the bird community is comprised of more species in specialist guilds than generalist guilds and reflects a relatively intact, extensive, and mature forest structure. The three parks in West Virginia all had average BCI scores indicating "highest" or "excellent" biotic integrity (New River Gorge NR 62±3.0 (mean±1SD); Gauley River NRA 60±2.4; Bluestone NSR 64±2.8); whereas Delaware Water Gap NRA (58 ± 3.0) and the three western Pennsylvania parks (Allegheny Portage Railroad NHS 55±5.9; Fort Necessity NB 56±6.2; Friendship Hill NHS 55±0.6) all had average BCI scores indicating "high" or "good" biotic integrity.

Similar to the pattern seen with Louisiana waterthrush, a gradient of BCI scores among sites existed within each park (Figures 14–16). However, there tended to be less variation in the BCI among sites within a park (e.g., all sites at New River Gorge NR were "high" or "highest" ecological integrity) and within sites across years (i.e., most sites were scored in the same condition class all years of sampling).

O'Connell et al. (2000) applied the BCI to the entire mid-Atlantic region (referred to as the Mid-Atlantic Highlands or MAHA; Figure 9) and, based on 126 randomly selected sites, determined the proportion of the MAHA region in each of the four condition classes. Recognizing that this analysis is a snapshot of condition from 1996 and was not restricted to "streamside" sampling sites, it provides an unparalleled context for which to compare the results obtained from within ERMN park boundaries (Figure 17). ERMN parks have a much higher percentage of sites (95%) in the "high" and "highest" condition classes compared to the surrounding MAHA region (43%). Moreover, no ERMN sites were considered to have "low" biotic integrity and only three sites (5%) in the ERMN had "medium" integrity compared to 21% "low" and 36% "medium" in the surrounding MAHA region (Figure 17).

It is interesting to note that the BCI score for a site was negatively correlated with species richness for the site (comparison of 2012 BCI scores and site richness for New River Gorge NR and Delaware Water Gap NRA; Marshall *unpublished data*). It appears that the species contributing to this higher richness tended to be in generalist guilds, leading to a lower BCI score. While more species were detected overall at Delaware Water Gap NRA (Appendix A) and at each site in 2012 (mean richness per site = 33 species) compared to New River Gorge NR (mean richness per site = 25 species), the average 2012 BCI score for Delaware Water Gap NRA (57.7) was five points lower than for New River Gorge NR (62.9). This difference translated to an average condition score of "highest" ecological integrity for New River Gorge NR and only "high" for Delaware Water Gap NRA in 2012. While it is not yet entirely clear what is driving these differences, it is possible that it is due to the wider range of land-cover types and successional forest stages (and associated bird communities) within Delaware Water Gap NRA.

While increasing or maintaining high levels of "biodiversity" (in this case, bird species richness) may be a relevant and important management objective, these results suggest high avian species richness may come at the expense of the highest ecological condition that the BCI represents. In this case, extensive cover of intact and mature eastern deciduous forest that provides habitat for bird species in specialized structural, functional, and compositional guilds may be a more desirable management objective.

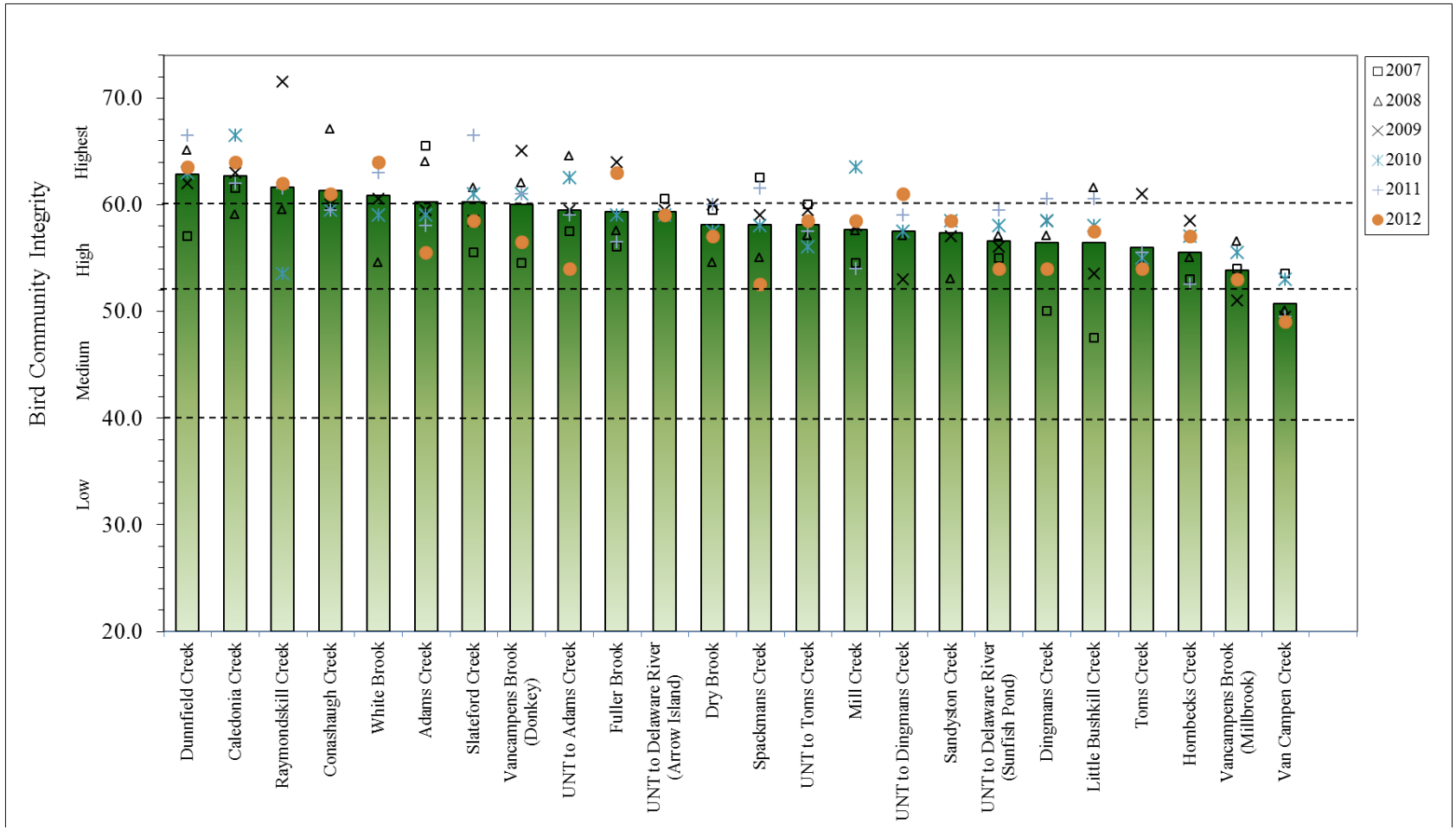

Figure 14. Bird Community Index of biotic integrity (O'Connell et al. 2000) for Delaware Water Gap NRA based on Streamside Bird Monitoring, 2007-2012. Bar height represents the mean of five or six years of sampling (Table 1). Points depict values for individual years. Higher values indicate higher ecological integrity. Dashed horizontal lines depict thresholds between low, medium, high, and highest ecological integrity.

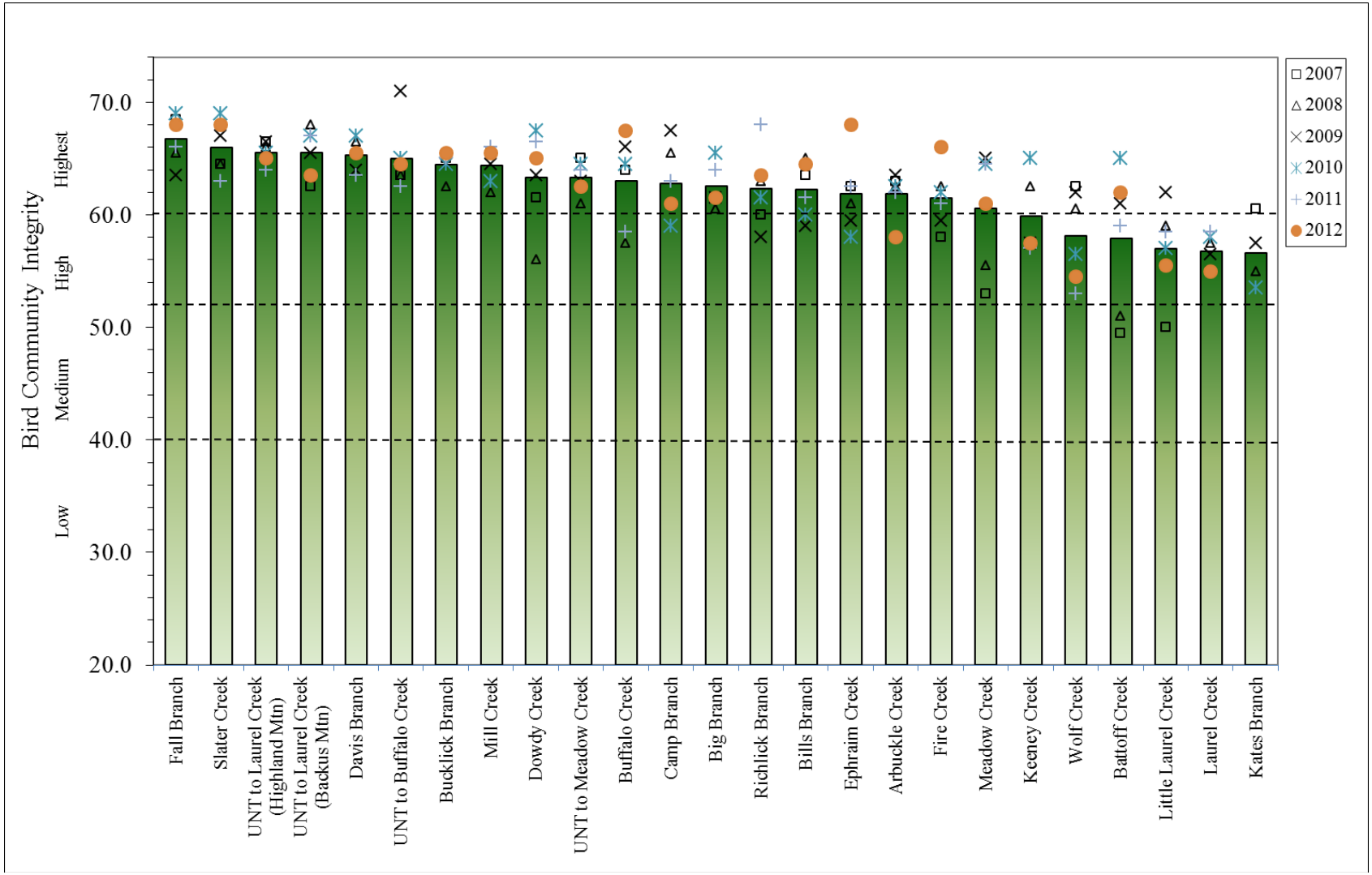

Figure 15. Bird Community Index of biotic integrity (O'Connell et al. 2000) for New River Gorge NR based on Streamside Bird Monitoring, 2007-2012. Bar height represents the mean of five or six years of sampling (Table 2). Points depict values for individual years. Higher values indicate higher ecological integrity. Dashed horizontal lines depict thresholds between low, medium, high, and highest ecological integrity.

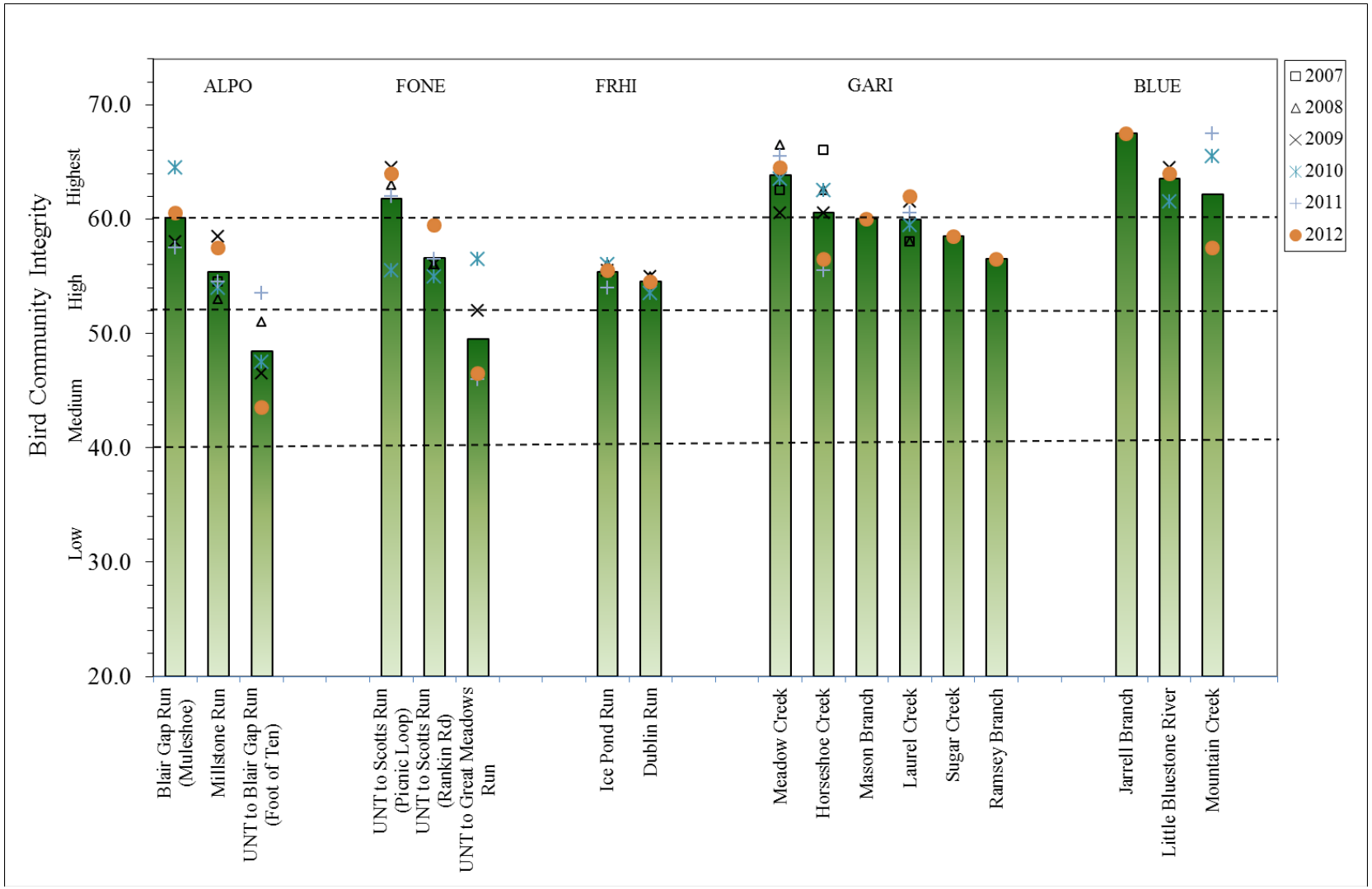

Figure 16. Bird Community Index of biotic integrity (O'Connell et al. 2000) for Allegheny Portage Railroad NHS (ALPO), Fort Necessity NB (FONE), Friendship Hill NHS (FRHI), Gauley River NRA (GARI), and Bluestone NSR (BLUE) based on Streamside Bird Monitoring, 2007-2012. Bar height represents the mean of one to six years of sampling (Tables 3 - 7). Points depict values for individual years. Higher values indicate higher ecological integrity. Dashed horizontal lines depict thresholds between low, medium, high, and highest ecological integrity.

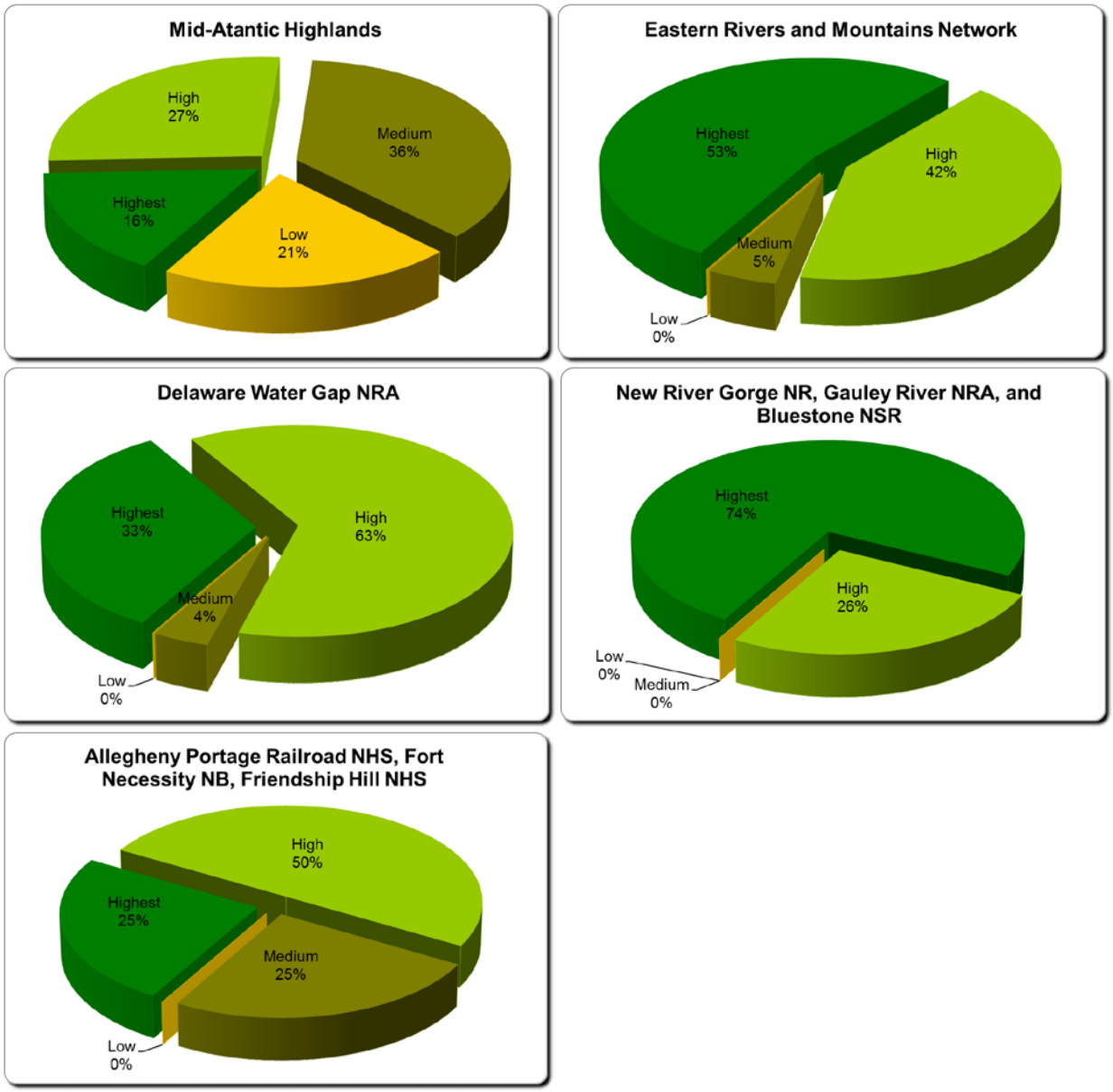

Figure 17. Percentage of sampling sites falling into four condition classes defined by the Bird Community Index of biotic integrity (O'Connell et al. 2000) for the Mid-Atlantic Highlands, Eastern Rivers and Mountains Network, and parks within the network.

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Appendix A. Bird species detected and total number of detections (by park) during implementation of the ERMN Streamside Bird Monitoring Protocol 2007–2012. Species are sorted taxonomically.

Order	Family	Common Name	Scientific Name	Code*	ALPO	FONE	FRHI	BLUE	GARI	NERI	DEWA	Total
Anseriformes	Anatidae	Canada Goose	*Branta canadensis*	CANG						5	17	22
Anseriformes	Anatidae	Mute Swan	*Cygnus olor*	MUSW							1	1
Anseriformes	Anatidae	Wood Duck	*Aix sponsa*	WODU						1	1	2
Anseriformes	Anatidae	American Black Duck	*Anas rubripes*	ABDU							1	1
Anseriformes	Anatidae	Mallard	*Anas platyrhynchos*	MALL							28	28
Anseriformes	Anatidae	Hooded Merganser	*Lophodytes cucullatus*	HOME							1	1
Anseriformes	Anatidae	Common Merganser	*Mergus merganser*	COME							1	1
Galliformes	Phasianidae	Ruffed Grouse	*Bonasa umbellus*	RUGR				4		1		5
Galliformes	Phasianidae	Wild Turkey	*Meleagris gallopavo*	WITU		7	4			7	15	33
Pelecaniformes	Ardeidae	Great Blue Heron	*Ardea herodias*	GBHE							17	17
Pelecaniformes	Ardeidae	Green Heron	*Butorides virescens*	GRHE							1	1
Accipitriformes	Cathartidae	Turkey Vulture	*Cathartes aura*	TUVU			2		1	1	17	21
Accipitriformes	Accipitridae	Bald Eagle	*Haliaeetus leucocephalus*	BAEA					1		5	6
Accipitriformes	Accipitridae	Sharp-shinned Hawk	*Accipiter striatus*	SSHA					1	1		2
Accipitriformes	Accipitridae	Cooper's Hawk	*Accipiter cooperii*	COHA		5			1	5	2	13
Accipitriformes	Accipitridae	Red-shouldered Hawk	*Buteo lineatus*	**RSHA** [2]			12		5	14	6	37
Accipitriformes	Accipitridae	Broad-winged Hawk	*Buteo platypterus*	BWHA	1		2			2	10	15
Accipitriformes	Accipitridae	Red-tailed Hawk	*Buteo jamaicensis*	RTHA	1	4				1	16	22
Charadriiformes	Charadriidae	Killdeer	*Charadrius vociferus*	KILL							1	1
Charadriiformes	Scolopacidae	Spotted Sandpiper	*Actitis macularius*	SPSA							2	2
Columbiformes	Columbidae	Mourning Dove	*Zenaida macroura*	MODO	3	2		3	6	35	132	181
Cuculiformes	Cuculidae	Yellow-billed Cuckoo	*Coccyzus americanus*	YBCU	2	7	4	1	7	39	64	124
Cuculiformes	Cuculidae	Black-billed Cuckoo	*Coccyzus erythropthalmus*	**BBCU** [3]		1					9	10
Strigiformes	Strigidae	Eastern Screech-Owl	*Megascops asio*	EASO						1		1
Strigiformes	Strigidae	Great Horned Owl	*Bubo virginianus*	GHOW		1					5	6
Strigiformes	Strigidae	Barred Owl	*Strix varia*	BADO			1		3	9	1	14
Strigiformes	Strigidae	Northern Saw-whet Owl	*Aegolius acadicus*	NSWO						2		2
Apodiformes	Apodidae	Chimney Swift	*Chaetura pelagica*	**CHSW** [3]	5	3	1			5	11	25
Apodiformes	Trochilidae	Ruby-throated Hummingbird	*Archilochus colubris*	RTHU	7	8	7	2	7	26	22	79
Coraciiformes	Alcedinidae	Belted Kingfisher	*Megaceryle alcyon*	BEKI		1		2	1	7	42	53
Piciformes	Picidae	Red-headed Woodpecker	*Melanerpes erythrocephalus*	**RHWO** [1]						1		1
Piciformes	Picidae	Red-bellied Woodpecker	*Melanerpes carolinus*	**RBWO** [2]	56	41	31	3	8	43	126	308
Piciformes	Picidae	Yellow-bellied Sapsucker	*Sphyrapicus varius*	YBSA						1	1	2
Piciformes	Picidae	Downy Woodpecker	*Picoides pubescens*	DOWO	28	9	34	5	23	93	113	305
Piciformes	Picidae	Hairy Woodpecker	*Picoides villosus*	HAWO	2	6	12	7	10	47	76	160
Piciformes	Picidae	Northern Flicker	*Colaptes auratus*	**NOFL** [3]	11	21	11	1	16	61	103	224

Order	Family	Common Name	Scientific Name	Code*	ALPO	FONE	FRHI	BLUE	GARI	NERI	DEWA	Total
Piciformes	Picidae	Pileated Woodpecker	*Dryocopus pileatus*	PIWO	20	41	23	14	49	229	133	509
Passeriformes	Tyrannidae	Eastern Wood-Pewee	*Contopus virens*	**EAWP** [3]	33	88	86	9	18	121	369	724
Passeriformes	Tyrannidae	Acadian Flycatcher	*Empidonax virescens*	**ACFL** [2,3]	58	123	184	175	174	2288	706	3708
Passeriformes	Tyrannidae	Least Flycatcher	*Empidonax minimus*	LEFL		1					1	2
Passeriformes	Tyrannidae	Eastern Phoebe	*Sayornis phoebe*	EAPH	11	2		17	54	268	252	604
Passeriformes	Tyrannidae	Great Crested Flycatcher	*Myiarchus crinitus*	GCFL	3	4	2		11	34	137	191
Passeriformes	Tyrannidae	Eastern Kingbird	*Tyrannus tyrannus*	EAKI							12	12
Passeriformes	Vireonidae	White-eyed Vireo	*Vireo griseus*	**WEVI** [2]		1						1
Passeriformes	Vireonidae	Yellow-throated Vireo	*Vireo flavifrons*	**YTVI** [2,3]	1	4	5	6	10	22	124	172
Passeriformes	Vireonidae	Blue-headed Vireo	*Vireo solitarius*	BHVI	17	35		36	63	436	193	780
Passeriformes	Vireonidae	Warbling Vireo	*Vireo gilvus*	WAVI							16	16
Passeriformes	Vireonidae	Red-eyed Vireo	*Vireo olivaceus*	REVI	283	298	228	168	191	2168	2515	5851
Passeriformes	Corvidae	Blue Jay	*Cyanocitta cristata*	BLJA	37	48	46	23	60	303	535	1052
Passeriformes	Corvidae	American Crow	*Corvus brachyrhynchos*	AMCR	45	64	113	13	96	322	392	1045
Passeriformes	Corvidae	Fish Crow	*Corvus ossifragus*	FICR							1	1
Passeriformes	Corvidae	Common Raven	*Corvus corax*	CORA	2	6	2		3	18	21	52
Passeriformes	Hirundinidae	Tree Swallow	*Tachycineta bicolor*	TRES							35	35
Passeriformes	Hirundinidae	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	NRWS					2		2	4
Passeriformes	Paridae	Carolina Chickadee	*Poecile carolinensis*	CACH			36	51	56	318		461
Passeriformes	Paridae	Black-capped Chickadee	*Poecile atricapillus*	BCCH	23	53			1		325	402
Passeriformes	Paridae	Tufted Titmouse	*Baeolophus bicolor*	TUTI	62	57	77	20	81	459	393	1149
Passeriformes	Sittidae	Red-breasted Nuthatch	*Sitta canadensis*	RBNU							2	2
Passeriformes	Sittidae	White-breasted Nuthatch	*Sitta carolinensis*	WBNU	37	44	23	9	11	99	112	335
Passeriformes	Certhiidae	Brown Creeper	*Certhia americana*	BRCR		35	3	1	1	5	139	184
Passeriformes	Troglodytidae	Carolina Wren	*Thryothorus ludovicianus*	**CARW** [2]	9		22	16	50	174	25	296
Passeriformes	Troglodytidae	House Wren	*Troglodytes aedon*	HOWR		15					25	40
Passeriformes	Troglodytidae	Winter Wren	*Troglodytes hiemalis*	WIWR	2	1			13	22	46	84
Passeriformes	Polioptilidae	Blue-gray Gnatcatcher	*Polioptila caerulea*	BGGN	3	10	8	14	11	52	144	242
Passeriformes	Regulidae	Golden-crowned Kinglet	*Regulus satrapa*	GCKI	2	2				2	3	9
Passeriformes	Turdidae	Eastern Bluebird	*Sialia sialis*	EABL	1		8			1	9	19
Passeriformes	Turdidae	Veery	*Catharus fuscescens*	VEER						2	844	846
Passeriformes	Turdidae	Hermit Thrush	*Catharus guttatus*	HETH						4	84	88
Passeriformes	Turdidae	Wood Thrush	*Hylocichla mustelina*	**WOTH** [1,2,3]	77	120	60	100	104	1628	936	3025
Passeriformes	Turdidae	American Robin	*Turdus migratorius*	AMRO	57	55	19	2	23	59	272	487
Passeriformes	Mimidae	Gray Catbird	*Dumetella carolinensis*	GRCA	24	24			3	29	417	497
Passeriformes	Mimidae	Northern Mockingbird	*Mimus polyglottos*	NOMO					1	1		2
Passeriformes	Mimidae	Brown Thrasher	*Toxostoma rufum*	**BRTH** [2,3]		3		1			1	5
Passeriformes	Sturnidae	European Starling	*Sturnus vulgaris*	EUST	1						4	5
Passeriformes	Bombycillidae	Cedar Waxwing	*Bombycilla cedrorum*	CEDW	12	16	2		15	21	184	250
Passeriformes	Parulidae	Blue-winged Warbler	*Vermivora cyanoptera*	**BWWA** [1,2,3]							23	23

Order	Family	Common Name	Scientific Name	Code*	ALPO	FONE	FRHI	BLUE	GARI	NERI	DEWA	Total
Passeriformes	Parulidae	Golden-winged Warbler	*Vermivora chrysoptera*	**GWWA** [1,3]		5						5
Passeriformes	Parulidae	Orange-crowned Warbler	*Oreothlypis celata*	OCWA					1			1
Passeriformes	Parulidae	Nashville Warbler	*Oreothlypis ruficapilla*	NAWA							1	1
Passeriformes	Parulidae	Northern Parula	*Parula americana*	NOPA	5	6	1	25	104	151	320	612
Passeriformes	Parulidae	Yellow Warbler	*Dendroica petechia*	YWAR		2	1			2	117	122
Passeriformes	Parulidae	Chestnut-sided Warbler	*Dendroica pensylvanica*	CSWA	1	33				4	12	50
Passeriformes	Parulidae	Magnolia Warbler	*Dendroica magnolia*	MAWA		9				2	3	14
Passeriformes	Parulidae	Black-throated Blue Warbler	*Dendroica caerulescens*	BTBW	1			1	9	128	12	151
Passeriformes	Parulidae	Yellow-rumped Warbler	*Dendroica coronata*	YRWA		1			2		1	4
Passeriformes	Parulidae	Black-throated Green Warbler	*Dendroica virens*	BTNW	36	44	1	13	97	340	975	1506
Passeriformes	Parulidae	Blackburnian Warbler	*Dendroica fusca*	BLBW	1	28				15	331	375
Passeriformes	Parulidae	Yellow-throated Warbler	*Dendroica dominica*	**YTWA** [2]			13	13	28	72		126
Passeriformes	Parulidae	Pine Warbler	*Dendroica pinus*	**PIWA** [2]					1	1	124	126
Passeriformes	Parulidae	Prairie Warbler	*Dendroica discolor*	**PRAW** [1,2,3]		3					58	61
Passeriformes	Parulidae	Blackpoll Warbler	*Dendroica striata*	BLPW					1	2		3
Passeriformes	Parulidae	Cerulean Warbler	*Dendroica cerulea*	**CERW** [1,2,3]		14		2	6	18	12	52
Passeriformes	Parulidae	Black-and-white Warbler	*Mniotilta varia*	**BAWW** [3]		2		21	68	583	231	905
Passeriformes	Parulidae	American Redstart	*Setophaga ruticilla*	AMRE	27	38		37	51	297	485	935
Passeriformes	Parulidae	Worm-eating Warbler	*Helmitheros vermivorum*	**WEWA** [1,2,3]				29	4	132	208	373
Passeriformes	Parulidae	Swainson's Warbler	*Limnothlypis swainsonii*	**SWWA** [1,2]					104	39		143
Passeriformes	Parulidae	Ovenbird	*Seiurus aurocapilla*	OVEN	130	109	60	89	158	1106	3397	5049
Passeriformes	Parulidae	Louisiana Waterthrush	*Parkesia motacilla*	**LOWA** [2,3]	50	27	97	72	157	851	1039	2293
Passeriformes	Parulidae	Kentucky Warbler	*Oporornis formosus*	**KEWA** [1,2,3]						5	4	9
Passeriformes	Parulidae	Common Yellowthroat	*Geothlypis trichas*	COYE	58	119	10		2	3	403	595
Passeriformes	Parulidae	Hooded Warbler	*Wilsonia citrina*	**HOWA** [2]	3	66		2	296	588	334	1289
Passeriformes	Parulidae	Canada Warbler	*Wilsonia canadensis*	CAWA							2	2
Passeriformes	Parulidae	Yellow-breasted Chat	*Icteria virens*	YBCH		1						1
Passeriformes	Emberizidae	Eastern Towhee	*Pipilo erythrophthalmus*	**EATO** [2,3]	62	112	74	6	28	148	144	574
Passeriformes	Emberizidae	Chipping Sparrow	*Spizella passerina*	CHSP		7	3		6		138	154
Passeriformes	Emberizidae	Field Sparrow	*Spizella pusilla*	**FISP** [3]	9	48	4	2		13	15	91
Passeriformes	Emberizidae	Vesper Sparrow	*Pooecetes gramineus*	VESP		1						1
Passeriformes	Emberizidae	Song Sparrow	*Melospiza melodia*	SOSP	16	33	36		9	28	241	363
Passeriformes	Emberizidae	White-throated Sparrow	*Zonotrichia albicollis*	**WTSP** [2]							6	6
Passeriformes	Emberizidae	Dark-eyed Junco	*Junco hyemalis*	DEJU							17	17
Passeriformes	Cardinalidae	Scarlet Tanager	*Piranga olivacea*	SCTA	126	136	102	72	125	1261	898	2720
Passeriformes	Cardinalidae	Northern Cardinal	*Cardinalis cardinalis*	NOCA	36	41	84	9	56	153	127	506
Passeriformes	Cardinalidae	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	RBGR	28	26	1		1	46	71	173
Passeriformes	Cardinalidae	Indigo Bunting	*Passerina cyanea*	**INBU** [2]	43	100	44	9	30	124	169	519
Passeriformes	Icteridae	Red-winged Blackbird	*Agelaius phoeniceus*	RWBL		2				2	101	105
Passeriformes	Icteridae	Common Grackle	*Quiscalus quiscula*	COGR	7	3	2		1	9	145	167

Order	Family	Common Name	Scientific Name	Code*	ALPO	FONE	FRHI	BLUE	GARI	NERI	DEWA	Total
Passeriformes	Icteridae	Brown-headed Cowbird	*Molothrus ater*	BHCO	10	20	14		9	18	228	299
Passeriformes	Icteridae	Baltimore Oriole	*Icterus galbula*	BAOR	1	3	2	2		4	170	182
Passeriformes	Fringillidae	Purple Finch	*Carpodacus purpureus*	PUFI							2	2
Passeriformes	Fringillidae	House Finch	*Carpodacus mexicanus*	HOFI							8	8
Passeriformes	Fringillidae	Pine Siskin	*Spinus pinus*	PISI							1	1
Passeriformes	Fringillidae	American Goldfinch	*Spinus tristis*	AMGO	10	11	4		15	31	40	111
Passeriformes	Passeridae	House Sparrow	*Passer domesticus*	HOSP							2	2
		unknown bird		UNBI	5	1		5	52	229	125	417
		unknown woodpecker		UNWO	3	1		4	6	89	18	121
			Total species:	**123**	**55**	**71**	**50**	**44**	**66**	**83**	**108**	
			Percent of total:		**45%**	**58%**	**41%**	**36%**	**54%**	**67%**	**88%**	

*__BOLD__ indicates species is of continental and/or regional conservation importance. [1] and [2] are Partners in Flight (PIF) species of Continental Conservation Importance where [1] indicates PIF Watch List Species (multiple reasons for conservation concern across its range) and [2] indicates a PIF Stewardship Species (proportionately high percentage of their world population within the Eastern Avifaunal Biome). [3] indicates PIF Regional Concern [Appalachian Mountains Bird Conservation Region (BCR28)].

Appendix B. Incidental non-avian species observed during field sampling for the ERMN Streamside Bird Monitoring Program, 2007-2012. Each, along with additional information, has been entered into NPSpecies as an observation for the appropriate park.

Common name (*Scientific name*)	**Location**	**Date**	**Observer**
black bear (*Ursus americanus*)	Fort Necessity NB (UNT to Great Meadows Run)	06/22/12	Matt Marshall
black bear (*Ursus americanus*)	Bluestone NSR (Little Bluestone River)	06/05/11	Nikki Flood
bobcat (*Lynx rufus*)	Allegheny Portage Railroad NHS (Millstone Run)	06/07/11	Matt Marshall
copperhead (*Agkistrodon contortrix*)	Friendship Hill NHS (Ice Pond Run)	06/16/11	Matt Marshall
coyote (*Canis latrans*)	Friendship Hill NHS (Dublin Run)	06/21/12	Matt Marshall
coyote (*Canis latrans*)	New River Gorge NR (Bucklick Branch)	05/28/08	Nikki Flood
fisher (*Martes pennant*)	New River Gorge NR (Dowdy Creek)	05/30/11	Nikki Flood
orchid species (*Platanthera orbiculata*)	Delaware Water Gap NRA	2009, 2012	Nikki Flood
porcupine (*Erethizon dorsatum*)	Allegheny Portage Railroad NHS (Millstone Run)	07/01/08	Matt Marshall
porcupine (*Erethizon dorsatum*)	Delaware Water Gap NRA (Spackmans Creek)	06/24/12	Scott Stollery
river otter (*Lontra canadensis*)	New River Gorge NR (Buffalo Creek)	06/26/12	Brad Ross
wood turtle (*Glyptemys insculpta*)	Allegheny Portage Railroad NHS (Millstone Run)	05/10/07	Matt Marshall

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.

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