A FRAMEWORK FOR COORDINATED BIRD MONITORING IN THE NORTHEAST

Northeast Coordinated Bird Monitoring Partnership

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Executive Summary

Bird monitoring has played an important role in bird conservation-planning in the northeastern United States, providing essential information on avian distribution, relative abundance, and population trends. Some monitoring initiatives have also quantified habitat associations and population responses to management actions and environmental change. Because of their potential to inform management decisions and advance bird conservation, monitoring programs have proliferated in recent decades under the direction of government agencies, universities, and non-governmental organizations (NGOs). However, lack of coordination among institutions and across spatial scales has resulted in inefficient use of scarce resources. In addition, a failure to integrate monitoring programs more fully into the conservation decision-making process has often limited the effectiveness of bird monitoring to advance conservation. This document describes a framework for strengthening the scientific basis for bird conservation in US Fish and Wildlife Service Region 5 through establishment and implementation of the Northeast Coordinated Bird Monitoring (NECBM) Partnership.

The framework is a set of principles, tools, and procedures to help biologists, biometricians, data managers, and wildlife administrators achieve five overarching goals:

1. integrate monitoring into bird management and conservation decision-making;
2. broaden the scope of current monitoring for species that are most at risk;
3. coordinate monitoring programs among organizations and integrate them across spatial scales;
4. increase the value of monitoring information by improving survey design, field methods, and data analysis; and
5. maintain bird population monitoring data in modern data management systems.

These goals parallel those contained in *Opportunities for Improving Avian Monitoring*, a 2007 report by the Monitoring Subcommittee of the US North American Bird Conservation Initiative (NABCI 2007).

Operational elements of the framework include: regular workshops, a competitive grants program, a website, a Register of Northeast Bird Monitoring Programs, and a system for archiving, analyzing, and accessing data. Working groups may use these tools and a set of recommended procedures to develop regionally coordinated bird surveys. Monitoring plans have been drafted for a number of focal groups and will be modified as collaborators determine the most effective and practical means of achieving shared objectives.

In addition to guiding monitoring efforts at the regional scale, implementation of the framework will address the management issues and monitoring needs identified in wildlife action plans of thirteen states from Virginia to Maine, plus the District of Columbia. Anticipated benefits include better integration of monitoring into conservation decision-making, robust survey design and analysis, consistent field methods, improved data management, and more frequent and informative reporting. A coordinated approach could also increase power to detect spatial patterns and temporal trends, while placing local results into a regional context. Coordinated surveys that incorporate structured decision-making have the potential to increase the relevance

of bird monitoring to management and conservation. Finally, gains in efficiency could reduce the cost of monitoring and enable greater attention to historically neglected bird groups.

To enhance the conservation value of bird monitoring, it will be necessary to modify current methods and/or shift resources from programs that do not meet basic criteria to those that provide useful data at the appropriate geographic scale. Such decisions will be difficult due to prior investment in uncoordinated initiatives. However, working groups are already developing strategies that substantially retain the value of previously established programs while upgrading in areas where past monitoring has not met information needs. With the structure provided by this framework, Northeast bird monitoring is poised to make major improvements in effectiveness, scope, utility, and efficiency.

Introduction

This document describes a framework for improving the state of bird monitoring in the northeastern US through establishment and implementation of the Northeast Coordinated Bird Monitoring Partnership. The goals of this partnership closely follow those outlined at the national level by the US NABCI Monitoring Subcommittee Report, *Opportunities for Improving Avian Monitoring* (NABCI 2007), which called for:

- *improvements in effectiveness, better alignment of monitoring programs with clearly articulated management or conservation objectives and priorities;*
- *improvements in scope, increasing the number of species for which we can make more informed conservation or management decisions;*
- *improvements in utility, especially in the areas of statistical design and data management and accessibility; and*
- *improvements in coordination and efficiency, leading towards standardization and synergy among agencies and organizations and across spatial scales.*

Realizing these improvements will be a demanding enterprise, requiring evaluation and integration of existing monitoring programs, as well as development of new initiatives. Yet, meeting the challenge will significantly strengthen the scientific basis for bird conservation in the Northeast and beyond.

Opportunities to improve bird monitoring in the Northeast

The Northeast Coordinated Bird Monitoring Partnership was formed in 2006 in order to:

1. provide support to the 13 states of the Northeast region and the District of Columbia for fulfilling the bird monitoring component of their wildlife action plans;
2. develop and implement a coordinated bird monitoring framework in the Northeast region;
3. identify key wildlife and habitat management issues for which bird monitoring can serve as an evaluation tool;
4. assist in the development of monitoring programs for game and non-game species that are not well covered by any current program, particularly those with restricted distributions, declining trends, and known threats;
5. develop a coordinated system for archiving and accessing bird monitoring data; and
6. provide a pilot project for establishment of coordinated bird monitoring programs as recommended by the US NABCI Monitoring Subcommittee.

The Partnership promotes coordination among state, federal, NGO, and university biologists. It also seeks opportunities to coordinate between biologists and biometricians, across management and political units, and among programs that target different avian taxa. Anticipated benefits of coordination include cost-effective survey design, standardization of field methods, robust statistical analysis, improved data management, and enhanced information exchange among scientists, decision-makers, and the general public. A coordinated approach could provide regional context for local results, while increasing power to detect changes in avian distribution and abundance. Coordinated surveys that address management issues and incorporate

environmental covariates have the potential to increase the relevance of bird monitoring to conservation. Finally, gains in efficiency can reduce the cost of bird monitoring.

Bird conservation and monitoring in the Northeast

The Northeast Coordinated Bird Monitoring Partnership acknowledges and builds upon a rich history of bird-conservation planning within the region. Early recognition that birds from a wide variety of taxonomic groups and habitats were in decline (Keast and Morton 1980, Howe et al. 1989, Robbins et al. 1989, Kushlan and Hafner 2000) led to the development of partnership initiatives focused on proactive conservation measures at regional and continental scales. Following the lead of the 1986 North American Waterfowl Management Plan, Partners in Flight (PIF) formed in 1990 to address the conservation needs of non-game terrestrial birds, especially Neotropical migrants. Identification of priority bird species, habitats, and conservation strategies resulted in a set of bird conservation plans for all northeastern physiographic areas (www.Partnersinflight.org; summarized in Pashley et al. 2000, Rosenberg and Wells 2005) and for all North American landbirds (Rich et al. 2004). Similar initiatives produced continental plans for Ruffed Grouse (Dessecker et al. 2006), shorebirds (Brown et al. 2001) and colonial waterbirds (Kushlan et al. 2002), as well as Northeast regional assessments for the latter two groups (Clark and Niles 2000, MANEM Waterbird Working Group 2006).

All of these planning initiatives relied heavily on existing information provided by long-term monitoring programs as part of their assessment of conservation need among species. Specifically, long-term population trend is incorporated explicitly as one of several categorical factors (i.e., declining, stable, increasing) in assessing overall conservation need; population trend is given equal weight among risk factors in PIF's landbird assessment (Carter et al. 2000, Beissinger et al. 2000, Panjabi et al. 2005), whereas trend is given extra weight in assessment of shorebird and waterbird species. Because reliable trend information is not available for many rare, hard-to-detect, or historically neglected bird species, uncertainty regarding trend also is explicitly incorporated into species assessment. Initiatives have begun to identify gaps in our knowledge of population trends, as well as recommendations for filling these gaps (e.g., Dunn et al. 2005). In addition to population trends, existing long-term monitoring programs are also a primary source for information on range size, relative population size, and relative importance of regions within a species' range – all critical factors in the species assessment process.

Recently, biologists from thirteen northeastern states and the District of Columbia incorporated these regional conservation priorities into comprehensive wildlife conservation strategies, also known as state wildlife action plans. Throughout the Northeast, 280 bird species were identified as species of greatest conservation need (SGCN) in one or more of the plans (Appendix 1). This number, which represents approximately 80% of the region's regularly occurring bird species, includes species that are rare or threatened within individual states in addition to species identified as continental or regional priorities. Although SGCN lists vary among the states, the plans consistently emphasize the need for improved bird monitoring.

Over 450 bird monitoring programs already exist in the Northeast, operating at local to international scales. A number of well-designed and adequately funded projects have yielded information that has spurred or guided bird conservation and conservation planning. Widespread deficiencies in design and implementation, however, have generally hampered the delivery of

conservation outcomes. In addition, lack of coordination has resulted in redundant effort for some species and inefficient data collection for many others. Many priority species remain poorly monitored. In some cases, we lack sufficient knowledge of population trends, population sizes, habitat requirements, and other limiting factors to understand the true conservation status of native birds. Finally, management and analysis of bird monitoring data remains fragmentary and inadequate to meet the needs of decision makers. Regionally coordinated monitoring and data management are needed to build effective bird conservation programs.

The North American Breeding Bird Survey (BBS) stands out among other bird monitoring programs in the Northeast for its longevity, geographic coverage, taxonomic breadth, and data accessibility. It has been an essential resource for bird conservation planning in the region. BBS counts, maps, and trend estimates are available online for 215 northeastern species, with records dating back to 1966. The data may be queried at multiple spatial and temporal scales. In the Northeast, BBS trend estimates for 49 species are rated high for regional credibility (Sauer et al. 2005). The BBS allows new monitoring efforts to concentrate on taxa that are locally distributed, occupy remote or specialized habitats, and/or are not best surveyed with morning point counts. Efforts are underway to add value to the Breeding Bird Survey by addressing potential sources of bias and improving geographic coverage (USGS 2007).

State breeding bird atlases document the distribution and breeding status for all species that summer in the region, satisfying a key information need for conservation planning. Atlas data can also aid in the design of other avian surveys. All northeastern states have completed at least one atlas and the list of second atlases is growing. Results from the second generation of atlases reveal significant changes in avian distribution that can inform habitat management and conservation.

The Breeding Bird Survey and state breeding bird atlases provide strength to this framework by collecting information on multiple species throughout the region. Bird monitoring partners should seek to complement and support these initiatives as they align resources to fill remaining gaps in knowledge.

Monitoring is integral to bird conservation

Bird monitoring is a strategic conservation action involving repeated measurement of avian distribution, abundance, demographics, and/or health. Monitoring occurs at various spatial and temporal scales for two main purposes: to assess the status of bird populations and to evaluate the response of bird populations to environmental change (natural or anthropogenic). Information on avian distribution and population trends has been critical to conservation planning and implementation in the Northeast, as described above. Yet targeted monitoring to evaluate conservation or management options has rarely occurred as part of a structured decision-making process. In recent years, many federal agencies have championed greater use of monitoring as an evaluation tool.

Understanding the status and trends of bird populations represents only an initial step in developing science-based conservation strategies to reverse declines and improve habitat conditions for high-priority species. After priority species and habitats are identified, clear conservation objectives must be set at appropriate scales to address the needs of these species

and habitats. Nichols and Williams (2006) describe a clear and rigorous outline for structured conservation decision-making, based on the iterative process known as adaptive management (Holling 1978, Walters 1986). The steps in this process proposed by Nichols and Williams are:

1. set conservation objectives;
2. determine potential management actions;
3. formulate *a priori* hypotheses and models of system response to management actions;
4. assign measures of confidence to competing models; and
5. develop a monitoring program that provides estimates of system state and possibly other relevant variables.

In adaptive management, monitoring results are used to discriminate among competing models and evaluate management actions. Although this idealized process has been applied to the adaptive harvest management of well-studied game species such as Mallard (Nichols and Williams 2006), its application to a broad range of non-game species is hampered by vast gaps in knowledge of limiting factors, habitat requirements, and in some cases even basic knowledge of species' status required to set conservation objectives. Nonetheless, the Nichols and Williams approach provides a critical and expanded role for bird monitoring that is different from most traditional monitoring initiatives and will require a change in thinking among monitoring proponents, land managers, and administrators of management and granting programs. In some cases, existing monitoring programs may be applied to meet the goals of this structured decision-making approach, or they may be "retrofitted" through improvements in design or implementation. This different approach is especially important, though, for the development of new monitoring programs, which through careful design may advance conservation more rapidly by evaluating management alternatives, while still providing important information on population status and trends.

Nichols and Williams (2006) were critical of monitoring programs designed solely to provide status and trend information (surveillance monitoring), primarily arguing that this type of monitoring is a less efficient use of resources than monitoring targeted at well-articulated conservation objectives within an adaptive management construct. Nonetheless, effective bird monitoring must be conducted at multiple spatial and temporal scales, with broad-scale, long-term monitoring playing several important roles. These include: identifying conservation priorities, helping to direct allocation of limited resources to specific regions or programs, and identifying conservation issues associated with population change (US NABCI 2007). Long-term monitoring at regional and continental scales also provides broader spatial and temporal context for interpreting the outcomes of shorter-term management and conservation activities.

NECBM Partners have expressed strong support for the use of existing monitoring programs to inform conservation priority-setting at state and regional scales, and for the value of understanding population trends for common, as well as threatened bird species. This framework seeks to integrate monitoring more efficiently into the conservation decision-making process, without devaluing the continuation of large-scale, long-term monitoring programs such as the Breeding Bird Survey. Ultimately, our collective goal is to advance bird conservation, and given the state of our knowledge of many North American species, expanding resources for both types of monitoring will be essential.

Overarching Goals for Improving Bird Monitoring to Advance Conservation

The purpose of this framework is to improve bird monitoring in the Northeast through implementation of five overarching goals that apply to all bird groups. These goals parallel those of the US NABCI Monitoring Subcommittee in its 2007 report.

Goal 1: Integrate monitoring into bird management and conservation decision-making processes and ensure that monitoring is aligned with management and conservation priorities.

This is the most important of the five goals, in that few existing monitoring programs currently fulfill the need to evaluate bird population responses to conservation and management activities. The remaining goals of this framework are aligned to advance this one. It is also the most difficult, as it challenges both the bird monitoring community and the management community to expand their thinking beyond traditional paradigms. Furthermore, an open and honest dialogue will be required to bridge the divide that currently exists between those with different perspectives on bird monitoring.

Because of traditional separations within agencies and among organizations, the links between bird monitoring and bird management are weak in the Northeast. Many northeastern bird monitoring programs gather information that is not effectively used to advance bird conservation. In some cases, large monitoring datasets are based on inadequate sampling design and are not adequate to inform conservation decision-making. In other cases, monitoring data are accumulated but inadequate budgets prevent these data from being properly analyzed or made available to managers. Meanwhile, effects of management decisions or environmental factors on vulnerable bird populations remain poorly understood. Major land-management and easement programs, such as those under the Farm Bill or the North American Wetland Conservation Act, for example, do not include a bird-monitoring component, which could be accomplished efficiently for a fraction of the total program cost.

Whereas issues affecting bird populations, such as climate change and land-use policies, have been identified in the many existing bird conservation plans, explicit conservation objectives and management or policy options have not yet been defined for most bird groups. A step in that direction took place during the first Northeast Coordinated Bird Monitoring Workshop in 2006. The workshop focused attention on nine principal issues for which bird monitoring could serve as an evaluation tool (Lambert 2007). Urban/suburban development and non-native species topped the list, followed by incompatible management practices (agricultural, silvicultural, and wetland), environmental contaminants, and energy / communication infrastructure. Recreation, habitat alteration by natural processes / altered natural succession, climate change, and winter habitat loss rounded out the list of priority concerns. These and fourteen additional threats to bird populations are summarized in Appendix 2, with written sources contained in Appendix 3. As a next step, working groups are in the process of developing monitoring plans that will more fully address management issues.

Goal 2: Broaden the scope of current monitoring for species that are most at risk and for which we have inadequate information to make effective management decisions.

Basic information on status, trends, and management responses is lacking for many species in greatest need of conservation. Filling in gaps for poorly monitored species or groups of species has been a primary focus of the non-game bird initiatives faced with assessing the conservation status of often hundreds of species to assign conservation priorities. In cases where the status of species cannot be adequately assessed because of inadequate or nonexistent monitoring data (i.e., no information on trend and in many cases on distribution or population size), specific gaps have been identified and recommendations have been suggested for improved or new monitoring programs (e.g. Dunn et al. 2005). Especially important are gaps for species that are considered high priority based on other factors (e.g., threats, small populations).

In the Northeast, a decade of conservation planning and working group discussions at regional and state levels has identified several groups of species in need of improved monitoring, and these have formed the initial basis for focal species working groups within NECBM. High-priority species identified by PIF in the Northeast that have been poorly monitored (i.e., not well covered by BBS or other large-scale programs) include salt-marsh sparrow species, birds of high mountaintop communities (especially Bicknell's Thrush), nocturnal species, rare and patchily distributed grassland birds, and other patchily distributed species in other habitats (e.g., Cerulean Warbler, Golden-winged Warbler). Large gaps in monitoring also have been identified for most colonial waterbirds, shorebirds, secretive marsh birds, seabirds, and migrating land birds. Gaps even remain for some hunted species (e.g., sea ducks), even though most game birds are aggressively monitored.

In many cases, a basic understanding of status and trend is a prerequisite to the development of conservation objectives and the initiation of a structured decision-making process to address conservation issues. Therefore, an important goal for NECBM partners is to expand existing monitoring programs and develop new programs to better monitor species at risk for which we have inadequate information. These new monitoring efforts should not only provide basic status and trend data, but also should strive for maximum utility within a structured decision-making context, as outlined under Goal 1.

An assessment of bird monitoring needs, based on a review of state wildlife action plans and meetings with bird conservation practitioners, appears in Appendix 4.

Goal 3: Coordinate monitoring programs among organizations and integrate them across spatial scales to solve conservation or management problems effectively.

Northeastern bird monitoring has been a highly fragmented enterprise in need of a unifying organizational structure. The failure to coordinate among organizations and integrate monitoring programs across spatial scales has resulted in inconsistent goals and methods, gaps in spatial and taxonomic coverage, redundant data collection for some species, and unrelated databases. Lack of opportunity for collaboration between biologists and statisticians has magnified the problem, resulting in *ad hoc* survey designs and missed opportunities to evaluate management and conservation actions. In the absence of regional coordination, bird conservationists working at local and state levels lack the ability to identify and reduce threats that operate at larger spatial

scales. It is an objective of this framework to improve this situation, with the recognition that major cultural changes may be required.

Goal 4: Increase the value of monitoring information by improving survey design, field methods, and data analysis.

Many of the Northeast's bird monitoring programs feature survey designs, field methods, and analytical approaches that are lacking in rigor and usefulness. Fundamental problems include unclear goals and limited relevance to management and conservation. In many cases, target populations or the area of inference are poorly defined. Abundance indices are rarely corrected for variation in detection rates. Frequently, monitoring programs are initiated without due consideration for appropriate analysis methods or power requirements. These shortcomings give rise to inefficiencies and ambiguous or misleading results, and prevent us from answering many important questions regarding Northeast bird conservation.

An objective of this framework is to ensure that Northeast monitoring programs adhere to the following standards..

1. Clearly articulated survey objectives provide a management and/or conservation decision-making context for the program.
2. Primary response variables are measures of abundance or population performance (i.e. demographics) serving as reliable indicators of population status and/or trends.
3. Geographic scope and spatial sampling units are explicitly defined.
4. Taxa and inferential populations are defined.
5. Published survey protocols define temporal sampling frame and measurement procedures.
6. Survey protocols address issues of precision and bias.
7. Consistency in geographic coverage and survey protocols ensure collection of comparable data.
8. Continuity in survey operations allows achievement of program objectives.
9. Training programs are established for survey protocols.
10. Survey protocols include data collection on environmental covariates to help explain population changes.
11. Appropriate analytical procedures are identified or developed.

Goal 5: Maintain bird population monitoring data in modern data management systems. Recognizing legal, institutional, proprietary, and other constraints, provide greater availability of raw data, associated metadata, and summary data for bird monitoring programs.

The current approach to managing northeastern bird monitoring data does not ensure adequate quality control, data security, metadata development, access to raw data, or access to data summaries. Some long-term data sets are in danger of being lost. These limitations hamper bird

conservation efforts by restricting the flow of information from bird monitoring practitioners to habitat stewards, policy makers, conservation organizations, and other decision-makers.

New, web-based applications have the potential to substantially improve access to bird monitoring data, and thus their utility for bird conservation in the Northeast. The Avian Knowledge Network (AKN; http://avianknowledge.net) is an international organization of government and non-governmental institutions focused on understanding the patterns and dynamics of bird populations across the Western Hemisphere. AKN organizes information from multiple sources to enable the discovery, visualization, and exploratory analysis of observational data. Information-sharing relationships have been negotiated between AKN and other major databases (including the Bird Point Count Database and the National Waterbird Monitoring Partnership) in order to avoid the problem of competing archives. Both the AKN and the Natural Resources Monitoring Partnership (NRMP; http://nrmp.nbii.gov/) are aligned with federal database standards. They operate in concert to organize and serve information on bird monitoring initiatives.

The Register of Northeast Bird Monitoring Programs catalogs over 450 distinct initiatives (http://www.nebirdmonitor.org/tools-resources/neregister/view). This high number demonstrates the dedication and innovation that have distinguished bird monitoring in the Northeast since it began in 1900 with the Christmas Bird Count. It also indicates extraordinary institutional capacity and a deep pool of volunteer and professional observers. At the same time, the long list highlights the insularity that has characterized much of the bird monitoring activity in the region.

The Register is designed as a coordination tool, not as a substitute for institutional participation in the more detailed metadata documentation programs of the Natural Resources Monitoring Partnership (the Monitoring Program Locator and Protocol Library). Nonetheless, alignment between Northeast Register and NRMP data fields should facilitate the development of these preliminary records into a more detailed database.

Approach to Coordination

A Framework for Coordinated Bird Monitoring in the Northeast establishes overarching goals to strengthen and align the region's numerous monitoring initiatives. In addition, this framework: synthesizes information on monitoring priorities; identifies key management issues that could be addressed by monitoring; and presents tools and procedures to meet information needs.

The Partnership's steering committee, composed of state, federal and NGO representatives, will oversee evolution of the framework through periodic updates and regular action planning. The first framework action plan has been drafted and will be finalized at the 2007 Northeast Coordinated Bird Monitoring Workshop. Another function of the steering committee is to advise the Northeast bird monitoring coordinator, who is responsible for administering six key coordination mechanisms. These are: a website for sharing information, the Register of Northeast Bird Monitoring Programs, a Northeast node of the Avian Knowledge Network, annual workshops, working groups organized by focus topic, and a survey design and implementation fund. Each of these operational elements is integral to the framework.

The Northeast Coordinated Bird Monitoring website, (www.nebirdmonitor.org), provides access to the Register of Northeast Bird Monitoring Programs and AKN. It also provides workshop information, a bird monitoring reference library, and working group progress reports, to include updates of focal group monitoring plans. By centralizing information for northeastern bird monitors, the website offers easily accessible resources for coordinating bird surveys across the region.

The Register of Northeast Bird Monitoring Programs lists monitoring initiatives, as well as their sponsoring institutions and principal investigators. Most entries include contact information and web links to facilitate communication and public access to monitoring results. Many of the records also include information on survey scope, frequency, and methods. Data fields correspond with those utilized by the Natural Resources Monitoring Partnership, administered by the US Geological Survey (USGS), and the Bird Monitoring Data Registry, an AKN initiative. Alignment of the Northeast Register with these more comprehensive efforts to document monitoring programs offers partners a head start in developing complete project metadata. First created in 2007 based on information gathered during research, interviews and meetings, the Register will require biennial updates to maintain currency. Data fields for the Register are listed in Appendix 5.

AKN is the principal data accessibility tool for the Northeast Coordinated Bird Monitoring Partnership. It is administered by the Cornell Lab of Ornithology in partnership with the Cornell University Department of Computer Science. AKN features a secure, persistent data archive with owner-specified access and innovative data display capabilities (spreadsheets, tables, charts and maps). It also provides tools for exploratory analysis of observational data via data mining techniques that rank variable importance. This approach reveals spatial and temporal patterns of avian distribution and abundance, based on real-time query and analysis of millions of bird records and over 1,100 environmental, climatic, and human demographic variables. The data discovery, visualization, and analysis tools of AKN are still in development. Northeast bird monitors can add value to the system by working with AKN's regional coordinator to upload observational records and develop replicable queries. A number of other tools exist to improve management of bird monitoring data in the Northeast, such as the USGS Bird Point Count Database (www.pwrc.usgs.gov/point/) and HawkCount.org. These complement AKN's data summarization and dissemination tools, by providing both data entry and retrieval capability.

The NECBM Survey Design and Implementation Fund provides small grants to projects that monitor changes in avian abundance, distribution, and/or demographics in multiple northeastern states or in a manner that can be broadly applied in USFWS Region 5. To be competitive, proposals must: address bird monitoring needs and management issues identified in state wildlife action plans; demonstrate the support and involvement of key partners in the region; provide long-lasting benefit to the Northeast; and meet evaluation standards contained in the Northeast framework. Because funds are limited, they are targeted toward alignment of existing resources through coordinated efforts.

Northeast Coordinated Bird Monitoring workshops provide regular communication, coordination, and professional development opportunities for bird monitoring specialists. Plenary sessions, working group break-outs, and consultation with biometricians facilitate the transfer of information that is essential to this coordination effort. Large annual workshops were

held in 2006 and 2007 in order to launch collaborations. More frequent meetings among key partners may be necessary to meet future coordination needs. Co-location with professional conferences or with meetings of related initiatives will be considered, beginning in 2008.

Working groups form the basic operational units for coordination. They may be organized by habitat association (e.g., grassland birds), activity (e.g., migration), methodology (e.g., bird atlasing), period of observability (e.g., night birds), or management issue. Working groups are composed of government and NGO biologists, biometricians, and conservation professionals with expertise in monitoring to conserve bird populations. The Survey Design and Coordination Worksheet (Appendix 6) is the main planning instrument for working groups. It is intended to focus working group discussions and document key decisions regarding objectives, survey design, field methods, data management, and analytical approaches. The worksheet also outlines a process for integrating monitoring and management through structured decision-making (after Nichols and Williams 2006). This process may be appropriate for monitoring at local and regional scales, depending on the scope of management influence. Completion of the Survey Design and Coordination Worksheet will enable working groups to meet the evaluation criteria listed under Goal 4 of this framework.

Working groups are encouraged to develop three main products from the worksheet.

1. A monitoring plan that provides justification for monitoring the target populations, defines conservation and monitoring objectives, details a regionally coordinated survey design, and specifies standard procedures for data collection, management, analysis and reporting. This document may follow guidelines recommended by Oakley et al. (2003). It may also refer to an existing, published protocol. The monitoring plan should include or be accompanied by a set of specific tasks, responsible parties, estimated costs, and a timeline for implementation.
2. An AKN-compatible database or identification of an existing database that meets the needs of the coordinated monitoring program.
3. Documentation of project metadata in the NRMP Monitoring Locator and Monitoring Protocol Library.

Preliminary monitoring plans have been drafted for thirteen bird groups and compiled in a framework supplement entitled “Draft Coordinated Monitoring Plans for Northeastern Birds”. Because most coordinated efforts are in the early stages of development, these plans are incomplete and subject to ongoing discussion and revision. The plan for monitoring marsh birds is relatively advanced and is included as a model for other groups (Appendix 6). Once fully developed, monitoring plans should be circulated for comment by potential collaborators not involved in their development. Finally, working groups should seek peer review from established technical committees and/or field biologists who specialize in the subject matter, plus at least two biometricians. Peer-reviewed products will guide and generate support for coordinated monitoring of the target populations.

Working groups require active leadership in order to successfully apply framework tools and procedures to the development of coordinated programs. An effective working group leader:

1. invites the participation of a geographically and institutionally representative group of partners who offer the knowledge and skills necessary to complete essential tasks;

2. maintains focus, momentum, and continuity of the working group by phone, email, conference calls and face-to-face meetings;
3. produces meeting goals, agenda, and action items;
4. delegates tasks to working group members;
5. ensures thorough documentation of working group progress;
6. solicits feedback and assistance from the Northeast bird monitoring coordinator and members of the Partnership's steering committee;
7. identifies funding opportunities and facilitates development of funding requests.

Active members are just as important to the success of working groups, particularly if they demonstrate the flexibility needed to develop a unified approach.

Management Issues, Monitoring Targets, and the Formation of Working Groups

Review of state wildlife action plans and discussions with state, federal, and NGO partners identified management issues (or threats) influencing bird populations (Appendix 2), as well as monitoring targets grouped primarily by habitat (Appendix 4). This accounting of threats and targets integrates and builds upon work by Northeast Partners In Flight, the Northeast Shorebird Conservation Plan, the Mid-Atlantic / New England / Maritimes Waterbird Conservation Plan, the North American Waterfowl Management Plan, The Ruffed Grouse Conservation Plan, and the Draft American Woodcock Conservation Plan.

The merits of organizing working groups by management issues or monitoring targets were evaluated at the 2006 Northeast Coordinated Bird Monitoring Workshop (Lambert 2007). Workshop participants expressed a unified commitment to addressing management issues, however most favored doing so in collaborations organized by monitoring targets. Although initial focus is on standardizing objectives and methods for certain groups of birds, participants in this project may form collaborations based on threats. Management-oriented groups may be composed of representatives from diverse, habitat-based initiatives. Regardless, working groups are urged to justify the allocation of monitoring effort to the target populations (Table 1) and develop survey designs that assess population status and address the principal threats to birds (Table 2 and Appendix 2). The Survey Design and Coordination Worksheet (Appendix 6) is a useful tool for accomplishing these complementary goals.

Table 1. Rationale for selecting monitoring targets

	Lack of information	Regional responsibility	Small continental population(s)	Habitat threatened	Evidence of decline
Birds at sea and in coastal waters	x	x		x	
Birds in migration	x			x	x
Colonial waterbirds / beach-nesting birds	x			x	x
Forest birds		x		x	x
Grassland birds	x	x		x	x
Marsh birds	x	x	x	x	x
Mountain birds	x	x	x	x	x
Night birds	x			x	x
Scrub-shrub birds				x	x
Shorebirds	x		x	x	x
Upland game birds				x	x
Urban birds	x	x		x	x
Waterfowl	x			x	x

Table 2. Priority management issues and their relationship to monitoring targets

	Develop-ment	Non-natives	Incompatible management	Contam-inants	Energy and communication infrastructure	Rec-reation	Succession / altered succession or disturbance	Climate change	Winter habitat loss
Birds at sea / in coastal waters	x	-	x	x	x	-	-	x	-
Birds in migration	x	x	x	x	x	-	x	x	x
Colonial waterbirds beach-nesting birds	x	x	x	x	x	x	-	x	-
Forest birds	x	-	x	-	-	-	x	x	x
Grassland birds	x	x	x	x	-	-	x	x	x
Marsh birds	x	x	x	x	-	x	x	x	x
Mountain birds	x	-	x	x	x	-	x	x	x
Night birds	x	x	x	x	-	x	x	-	x
Scrub-shrub birds	x	x	x	-	-	-	x	-	x
Shorebirds	x	x	x	x	x	x	-	x	-
Upland game birds	x	-	x	-	-	-	x	-	-
Urban birds	x	x	x	x	x	-	-	x	x
Waterfowl	x	x	x	x	-	x	x	x	x

- no evidence to indicate a threat to multiple species within this class at scale of Bird Conservation Region (BCR)
x potential for adverse impact on multiple species within this class may warrant attention by monitoring initiatives

Generalized Roles and Responsibilities of Government Agencies, Non-governmental Organizations, and Partnership Initiatives in Bird Monitoring

Role definition is critical to successful coordination

A large task can be quickly and efficiently completed with the help of others. However, large and complex jobs, such as regional bird monitoring, can be difficult to accomplish if the roles of collaborating individuals and institutions are not adequately defined. Failure to clarify roles may result in duplicated effort or incomplete tasks. In coordinated bird monitoring, some cooperators are best suited to design surveys, others to collect, manage, or analyze data. Individuals with strong organizational and communication skills may be well suited to coordinate volunteers. Regardless, the existence of clearly defined roles that match individual skills to need promotes synergy.

Who are the players?

Broad participation and a shared vision among partners are essential for successfully coordinating any complex activity. Coordination of bird monitoring at a regional scale requires players to know their personal and institutional strengths and engage them constructively with others. Such collaborations may improve the effectiveness and efficiency of bird monitoring, without requiring increased capacity or expertise within individual agencies and organizations. Because northeastern bird monitoring involves many players and a variety of targets, there is no single formula for allocating responsibility. Roles must be defined by working group members according to the needs of the target and the capacity of collaborating institutions. Because no single entity or association has the resources to meet existing information needs at the regional scale, each coordinated effort will involve a unique set of government agencies and NGOs. The following, generalized description of roles and responsibilities is based on legal mandates and missions of partners within the bird conservation community. Some of this information first appeared in NABCI 2007.

- US Fish and Wildlife Service's Migratory Bird Program (MBP) is the principal federal agency charged with protecting and enhancing populations of migratory birds in the United States. It has legal responsibility under various treaties to monitor the status and trends of migratory bird populations. As such, the MBP will play a role in many aspects of monitoring, including identification of management issues, funding support for monitoring, supporting the coordination of monitoring activities, and design, implementation, and assessment of specific programs.

- US Geological Survey similarly provides science support for monitoring of all bird species (and other taxa as well); in particular, taking the lead in experimental design, analysis of monitoring data, development of data management systems, and evaluation of monitoring programs across agencies, organizations, and geographic scales. The importance of participation by USGS in support of regional monitoring, especially through design and analysis, cannot be understated.

- US Forest Service, National Wildlife Refuges, National Park Service, and other federal land-management agencies play a major role in identifying broad-scale management issues, implementing monitoring programs to address these issues on their lands, and incorporating monitoring results into the decision-making process. National Forests, National Wildlife Refuges, and National Parks also provide an interface with the public, creating opportunities to engage prospective volunteers in bird monitoring.

- State wildlife agencies have legal responsibility for monitoring upland game birds and state-listed endangered and threatened species. They play a key role in identifying regional and local management issues and implementing bird monitoring programs within their jurisdictions. Many states lack sufficient capacity to implement the full range of monitoring programs for all birds. Survey design, statistical analysis, and database management are three areas in which resources or expertise are often lacking. Therefore, states will benefit greatly from regional coordination that capitalizes on assets shared among state agencies, federal agencies, and non-governmental organizations. Technical committees formed within the Northeast Association of Fish and Wildlife Agencies could play a key role in the review and endorsement of regional monitoring designs.

- Many NGOs include in their missions the design, coordination, and implementation of bird monitoring programs, often at the regional or national scale. Although often dependent, at least in part, on federal or state agency funding, these NGOs have the ability to leverage funding through effective use of trained and competent volunteers, intern programs, ties with academic institutions, and supplemental private funding. Such collaboration among agencies and NGOs increases overall capacity and cost-effectiveness of monitoring, especially for nongame species. NGOs should continue to play a vital role in conjunction with government agencies in recruiting, training, and coordinating the use of volunteer observers for monitoring programs across the region.

- Academic institutions can play an important role in working with the bird monitoring community to develop new monitoring protocols and survey designs as well as to evaluate the effectiveness of existing monitoring programs. The statisticians, biometricians, and research biologists at academic institutions are well suited for assisting with these tasks.

- Joint Ventures (JVs) in the Northeast (Atlantic Coast JV and Appalachian Mountains JV) provide a forum for coordinating bird conservation including monitoring programs at the Bird Conservation Region and Atlantic Flyway scales, particularly those monitoring programs that help evaluate the effects of habitat-based conservation actions on priority bird populations. Through their broad-based partnerships, JVs should play an increasing role in generating support (organizational and monetary) for integrating large-scale monitoring with management activities and in providing science support for designing regional monitoring programs and analyzing results. The Atlantic Coast JV has waterfowl and all-bird technical committees consisting of representatives from the Atlantic Flyway region that could provide ongoing guidance on monitoring needs,

support for implementation, and a link to administrators on the JV Management Board.

- Flyway councils also provide a framework for support and coordination of monitoring of migratory species, primarily waterfowl, but more recently nongame species (for which there is a federal management nexus). The Atlantic Flyway Council and technical committees are key groups for the identification and discussion of management issues affecting migratory birds. An important role for Flyway Council members could be to ensure long-term support for their staff to participate in monitoring activities. Furthermore, if technical committees embrace monitoring, their expertise could be applied to survey design, data collection, and analysis.

- Bird conservation initiatives under the North American Bird Conservation Initiative maintain primary responsibility for identifying priorities for monitoring species at the continental scale, including filling gaps in monitoring for species of concern. They are also responsible for identifying overarching conservation and management issues that can be addressed through improved bird monitoring programs. Initiatives will also track the effectiveness of bird monitoring programs in meeting continental population objectives. Regional working groups for the initiatives have played an important coordination role in developing the regional monitoring initiative in the Northeast and will likely continue to have a key role in the coordination of regional monitoring programs in the future, particularly after the initial grant for this initiative expires.

- The US NABCI Monitoring Subcommittee plays a lead role at the national level in promoting effective and efficient bird monitoring strategies through increased cooperation among public and private organizations. The Subcommittee seeks to assure that monitoring programs are cost-effective and provide information relevant to decision-making processes. It has produced a report with recommendations for improving avian monitoring. The Subcommittee will also be assessing the extent and value of existing monitoring programs and providing recommendations for enhancing the efficiency of current and future monitoring efforts.

Expanding capacity through volunteers

Even with the efficiencies possible through coordination, additional help with data collection will be necessary to achieve our monitoring goals at the regional scale. Successful implementation of coordinated bird monitoring at large spatial scales will likely require the use of volunteers, as demonstrated by BBS. Engaging volunteers does not necessarily mean less work for organizations that carry out monitoring. However, under the right circumstances, it may enable increased effort at a marginal increase in cost. It is unknown whether enough volunteers can be recruited and trained to fill all the bird monitoring needs within the Northeast. However, even monitoring efforts during the night (owls and nightjars) and atop some of the region's highest peaks have successfully involved volunteers.

Some level of regional coordination will be necessary to ensure that emerging demand for volunteers is met without a diversion of volunteer effort from valuable, ongoing programs. Nonetheless, recruiting, training, and retaining volunteers require stable funding and are more

likely to be accomplished at a local level. Therefore, communication among volunteer coordinators will be necessary at various scales.

Skill level will be a limiting factor for some monitoring efforts. Training workshops have been used successfully in parts of the region to ensure data quality and should be considered as an important part of volunteer programs. Successful volunteer monitoring programs share several other attributes, including:

- a coordinator with strong organizational skills and sufficient time to attend to the needs of volunteers;
- adequate support (infrastructure and funding) for a coordinator;
- long-term commitment by sponsoring organizations for monitoring;
- methods that are suited to the volunteer skill set; and
- frequent communication between coordinator and volunteers, including performance-related feedback and dissemination of results.

In order to optimize the use of volunteers in bird monitoring, the Northeast Partnership will need to develop regional instruments for volunteer recruitment, training, and evaluation.

Going forward together

In recent decades, bird monitors have launched hundreds of surveys throughout the Northeast. Although some programs have informed stewardship actions, few have realized their full potential to strengthen bird conservation. Multiplying threats and limited monitoring resources demand a new approach that better integrates monitoring and conservation. This framework describes a system of tools and procedures that emphasize coordination, statistical rigor, and modern data management. Implementation of the framework can enable the Northeast Coordinated Bird Monitoring Partnership to enhance the effectiveness, scope, utility, and efficiency of bird monitoring.

In the years ahead, wildlife biologists and administrators will face difficult choices in their effort to increase the value of bird monitoring. It may be necessary to modify current methods or reallocate funds from flawed or duplicate operations to programs that generate more useful information. Already, Northeast partners are developing strategies to align and strengthen monitoring in a manner that builds on previously uncoordinated efforts. They recognize that collaboration among management and political units is essential to reaching common goals. Expanding the coordination effort may require agencies and institutions to dedicate additional funding during the period of transition. However, a more focused and robust system of monitoring will ultimately reduce waste and strengthen the scientific basis for bird conservation in the Northeast.

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APPENDIX 1. Bird Species of Greatest Conservation Need in Northeast (compiled by USFWS)

Landbirds	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV
Acadian Flycatcher	X	X			X			RP/X		MC	SC/X			X
Alder Flycatcher	X				I/X					MC				X
Am. Three-toed Woodpecker						2								
American Kestrel	X			X				SC/X			X		MP	
American Pipit						2	SC/X							
American Redstart	X		1		X									
Bachman's Sparrow					EX/X							I		X
Bald Eagle	X	X	E/1	E/X	T/X	2	E/X	X	T/X	T/HC	X	II	HP	X
Baltimore Oriole	X		2			2		RP/X			X			
Bank Swallow	X		2		X					MC	X			X
Barn Owl	X		2	SC/X	X			SC/X	P/X	MC	E/X	III	MP	X
Barn Swallow						2								
Barred Owl	X		2		X	2		T/X			X			
Bay-breasted Warbler	X					2	X		P/X				MP	
Belted Kingfisher	X										X			
Bewick's Wren					E/X					Ext.		I		X
Bicknell's Thrush			1		X	1	SC, RC/X		P, SC/X			IV****	HP	
Black Vulture			2											X
Black-and-White Warbler	X		2		X	2		RP/X			X	IV		
Black-backed Woodpecker													MP	
Black-billed Cuckoo	X		2		X	2		RP/X	P	MC	X		MP	X
Blackburnian Warbler	X				T/X	2		RP/X		MC	T/X			X
Blackpoll Warbler				SC/X						End/ PV			MP	
Black-throated Blue Warbler	X				X	2		RP/X	P/X	MC	E/X		MP	
Black-throated Green Warbler	X				X	2		SC/X		MC	X			
Blue-gray Gnatchatcher	X					2								
Blue-headed Vireo	X				X			SC/X		MC	X			

Landbirds (cont.)	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV
Blue-winged Warbler	X		1	X	X	1		RP/X	P/X	RS	X		MP	X
Boat-tailed Grackle					X									
Bobolink	X	X	2		X	2		T, RP/X	P/X	MC	X		MP	X
Broad-winged Hawk	X	X	1	X	X			SC, RP/X		MC	X			
Brown Creeper	X	X	E/1		X						X	IV		X
Brown Thrasher	X	X	2	X	X	2		RP	P/X	MC	X	IV	MP	
Brown-headed Nuthatch			2		X							IV		
Canada Warbler	X		2	X	X	2	RC/X	SC, RP/X	P/X	MC	X	IV	HP	
Cape May Warbler	X					2			P/X					
Cerulean Warbler	X	X	E/1		X		RC/X	SC, RP/X	P, SC/X	HC-RS	T/X	II	MP	X
Chestnut-sided Warbler	X		2		X	2					X		MP	
Chimney Swift	X	X	2			2		RP/X		MC	X	IV	MP	
Chuck-will's-widow					X			RP/X				IV		X
Cliff Swallow											H/X			
Cliff Swallow	X		2					SC/X			H/X			X
Coastal Plain Swamp Sparrow					I/X									
Common Nighthawk	X		1		X	2	T/X	SC/X	P, SC/X	MC	SC/X		HP	X
Common Raven	X				X									
Common Yellowthroat											X			
Cooper's Hawk	X		E/1				T/X	T, RP/X	P, SC/X				MP	X
Dark-eyed Junco	X				X									
Dickcissel								RP/X	X	E/HC				X
Double-crested Cormorant			2								X			
Eastern Kingbird	X		2			2		RP/X			X	IV		
Eastern Meadowlark	X	X		X	X	2	X	SC, RP/X	P/X	MC	X	IV	MP	
Eastern Screech-owl	X							RP/X						

Landbirds (cont.)	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV
Eastern Towhee	X	X	2	X	X	2	X	RP/X			X	IV		
Eastern Wood-pewee	X							RP/X				IV		X
Field Sparrow	X	X	2	X	X	2		RP/X			X	IV	MP	X
Golden Eagle					X	2	E, RC/X		E/X	PV				
Golden-crowned Kinglet	X				X						SC/X			
Golden-winged Warbler	X		2	E/X	X		SC, RC/X	SC, RP/X	P, SC/X	HC-RS		I	HP	X
Grasshopper Sparrow	X	X	2	T/X	X	2	T/X	T, RP/X	P, SC/X	MC	T/X	IV	HP	X
Gray Catbird	X							RP/X			X	IV		
Gray Jay													MP	
Gray-Cheeked Thrush	X							SC/X						
Great Crested Flycatcher	X		2			2		RP/X			X			
Great Horned Owl	X	X												
Hairy Woodpecker					X						X			
Henslow's Sparrow			E/1	E/X	T/X			E, RP/X	T/X	HC-RS		I	MP	X
Hermit Thrush	X				X						X			
Hooded Warbler	X	X	E/1		X			RP/X			X			
Horned Lark	X					2	X	SC/X	P, SC/X		SC/X			X
Indigo Bunting	X							RP/X			X			
Ipswich Sparrow	X													
Kentucky Warbler		X	2		X			SC, RP/X	X	MC		IV		X
Kirtland's Warbler												IV****		
Lark Sparrow														X
Least Flycatcher	X		2		X			SC, RP/X			X			
Loggerhead Shrike			E/1		E/X	2		E, RP/X	E/X	E/IC		I		X****
Long-eared Owl	X		1	SC/X	X	2		T/X	P/X	HC	H/X		MP	X
Louisiana Waterthrush	X	X	2	X	X	2		RP/X	P/X	RS	X	IV		X

Landbirds (cont.)	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV
Magnolia Warbler	X				X									
Marsh Wren	X	X	2		X	2		RP/X		HC	SC/X	IV		X
Mourning Warbler				SC/X	E/X									
Nashville Warbler					I/X						X			X
Nelson's Sharp-tailed Sparrow						2	SC/X	RP/X				III***		
Northern Bobwhite	X	X	2	X	X			RP/X	X	IC	X	IV		X
Northern Flicker	X		2			2		RP/X			X			
Northern Goshawk	X				E/X		X	E/X	P, SC/X	PV	SC/X		MP	X
Northern Harrier	X		E/1	T/X	X		E, RC/X	E/X	T/X	HC	E/X	III	HP	X
Northern Mockingbird														
Northern Parula	X		E/1	T/X	X	2		SC/X			T/X	IV		
Northern Rough-winged Swallow	X											IV		
Northern Saw-whet Owl	X				X							II		X
Northern Waterthrush	X				X						X			X
Olive-sided Flycatcher	X				E/X	2			P/X	Ext/IC			MP	X
Orchard Oriole	X										X			
Osprey	X		1				T/X	T/X	P, SC/X	T/PV	SC/X		MP	X
Ovenbird	X	X			X						X	IV		
Palm Warbler							X							
Peregrine Falcon	X		2	E/X	I/X	1	E/X	E/X	E/X	E/HC	X	I	HP	X
Pileated Woodpecker	X				X						SC/X			
Pine Siskin														X
Pine Warbler								RP/X						
Prairie Warbler	X		1	X	X	2		RP/X	X	MC	X	IV	MP	X
Prothonotary Warbler		X	2		X			RP/X	X	HC	SC/X	IV		X
Purple Finch	X					2	X	RP/X			X			
Purple Martin	X					2	E/X				X		HP	
Red Crossbill						2				PV		I**		
Red-bellied Woodpecker						2								
Red-breasted Nuthatch	X				X						X			

Landbirds (cont.)	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV
Red-cockaded Woodpecker					E/X							I		
Red-eyed Vireo					X									
Red-headed Woodpecker	X		E/1		X			T, RP/X	P, SC/X	MC				X
Ring-necked Pheasant											X			
Red-shouldered Hawk	X	X	2		X		SC/X	E/X	P, SC/X	MC			MP	
Rose-breasted Grosbeak	X					2		RP/X			X	IV		
Rough-legged Hawk	X													
Ruby-throated Hummingbird	X													
Ruffed Grouse	X		2	X			X	X	P/X		X		MP	
Rusty Blackbird						2	SC/X		P/X			IV****	MP	
Saltmarsh Sharp-tailed Sparrow	X		1	X	X	1	SC, RC/X	RP/X	P/X		X	II		
Savannah Sparrow	X		2		X			T/X			X			
Scarlet Tanager	X	X	2		X	2		RP/X	P/X	RS	X	IV		
Seaside Sparrow	X		1	X	X		SC/X	RP/X	P, SC/X		SC/X	IV		
Sedge Wren	X		E/1	E/X	E/X	1	E, RC/X	E, RP/X	T/X	T/IC		III***	HP	X
Sharp-Shinned Hawk	X		1	SC/X	X			SC, RP/X	P, SC/X	MC	H/X			X
Short-eared Owl	X		E/1	E/X	E/X	1		E, RP/X	E/X	E/IC	X		MP	X
Snowy Owl	X													
Spruce Grouse							X		E/X				HP	
Summer Tanager					X			RP/X		HC				
Swainson's Thrush	X				X					PV				X
Swainson's Warbler			E/1		E/X			RP/X				II		X
Tennessee Warbler									P/X					
Three-Toed Woodpecker							T/X		P/X					
Veery	X		2		X	2	X	SC/X					MP	
Vesper Sparrow	X		2	T/X	X	2	X	E/X	P, SC/X				HP	X

Landbirds (cont.)	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV
Warbling Vireo	X		2											
Wayne's Warbler					X							I		
Whip-poor-will	X		2	X	X		SC, RC/X	RP/X	P, SC/X	MC	X	IV	HP	X
White Throated Sparrow				X										
White-eyed Vireo	X	X												
Willow Flycatcher	X		2	X	X	2		RP/X	P/X	MC	X	IV		
Winter Wren	X				X			SC/X		MC	SC/X	II		
Wood Thrush	X	X	1	X	X	2	X	RP/X	P/X	RS	X	IV	MP	X
Worm-eating Warbler	X	X	2		X			RP/X	P/X	RS	SC/X	IV		X
Yellow Warbler											X	IV		
Yellow-bellied Flycatcher										E/PV				X
Yellow-bellied Sapsucker					X	2		RP/X				I		X
Yellow-billed Cuckoo	X							RP/X			X	IV		
Yellow-breasted Chat	X		2					SC, RP/X	P, SC/X	MC	H/X	IV		
Yellow-rumped Warbler	X										X			X
Yellow-throated Vireo	X	X	2		X	2		RP/X		MC	X	IV		
Yellow-throated Warbler			2					RP/X						
Shorebirds														
American Golden-plover			2					RP/X	P/X					
American Woodcock	X	X	1	X	X	2	X	RP/X	X	MC	X	IV	MP	X
Black-bellied Plover			2		X				P/X		X	IV***		
Buff-breasted Sandpiper			2						P/X					
Eskimo Curlew				X										
Greater Yellowlegs			2		X	2		RP/X	P/X		X			
Hudsonian Godwit			2					RP/X	P/X			IV****		
Least Sandpiper											X			
Lesser Yellowlegs											X		MP	
Marbled Godwit			2					RP/X	P/X			IV****		
Pectoral Sandpiper											X			

Shorebirds (cont.)	**CT**	**DC**	**DE**	**MA**	**MD**	**ME**	**NH**	**NJ**	**NY**	**PA**	**RI**	**VA**	**VT**	**WV**
Piping Plover	X		E/1	T/X	E/X	1	E/X	RP	E/X	Ext/IC	X	I		
Purple Sandpiper			2		X	2	X	RP/X	P/X		X	IV***		
Red Knot			1	X	X	2		T, RP/X	P/X		X	IV****		
Ruddy Turnstone	X		1	X	X	2		RP/X	P/X		X			
Sanderling	X		1	X	X	2		SC, RP/X	P/X		X			
Semipalmated Plover											X			
Semipalmated sandpiper	X		2		X	2	X	RP/X	P/X		X			
Short-billed Dowitcher			2	X	X				P/X		X	IV****		
Solitary Sandpiper			2		X					MC	X			
Spotted Sandpiper	X		1					SC/X			X			X
Upland Sandpiper	X		E/1	E/X	X	1	E, RC/X	E, RP/X	T/X	T/IC	E/X	I	HP	X
Whimbrel			1	X	X	2		SC, RP/X	P/X		X	IV****		
White-rumped Sandpiper			2								X			
Willet	X		2		X	2	SC/X	RP/X	P/X		SC/X			
Wilson's Plover			2		E/X							I		
Wilson's Snipe		X			X					MC	X			X
Waterbirds														
American Bittern	X	X	2	E/X	I/X	2	RC/X	E, RP/X	P, SC/X	E/HC	E/X	II	HP	X
American Coot			2			2				MC				X
American Oystercatcher	X		E/1	X	X	1		RP/X	P/X		SC/X	II		
American White Pelican			2											
Arctic Tern			2	SC/X		2	T/X							
Atlantic Puffin						2								
Audubon's Shearwater			1					RP/X						
Black Guillemot							SC/X							
Black Rail	X		E/1		E/X			T/RP	E/X			I		
Black Skimmer	X		E/1		X			E, RP/X	P, SC/X		X	II		

Waterbirds (cont.)	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV
Black Tern			2		X	1		SC, RP/X	E/X	E/HC			HP	
Black-crowned Night-heron	X	X	E/1	X	X	2		T, RP/X	P/X	E/PV	SC/X	III	MP	X
Black-necked Stilt			2											
Bonaparte's Gull						2			X					
Bridled Tern			2					RP/X						
Brown Pelican			2		X									
Caspian Tern								SC/X	P/X					
Cattle Egret			2			2		RP/X	P/X		SC/X			
Clapper Rail	X							RP/X			SC/X	IV		
Common Loon	X			SC/X	I/X	2	T/X		P, SC/X				HP	
Common Moorhen	X			SC/X	X	2	X			MC	H/X			X
Common Murre						2								
Common Tern	X		E/1	SC/X	X	2	E, RC/X	SC, RP/X	T/X	E/PV	X	III	HP	
Cory's Shearwater									X					
Dunlin			2		X				P/X		X	IV***		
Forster's Tern			E/1		X			RP/X	P/X			IV		
Glossy Ibis	X		2		X	2		RP/X	P/X		SC/X	III		
Great Black-backed Gull			2								X			
Great Blue Heron	X		2		X	2	X	SC, RP/X		MC	SC/X		MP	X
Great Cormorant	X		2			2								
Great Egret	X		2		X	2		RP/X	P/X	E/PV	SC/X			
Greater Shearwater			2			2		RP/X	X					
Green Heron	X			X				RP/X				IV		
Gull-billed Tern			2		E/X			RP/X	P/X			I		
Herring Gull											X			
Horned Grebe	X		2		X			RP/X	P/X			IV***		
King Rail	X		2	T/X	X			SC, RP/X	T/X	E/PV	SC/X	II		X

Waterbirds (cont.)	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV
Laughing Gull				X	X				P/X					
Leach's Storm-petrel				E/X										
Least Bittern	X	X	2	E/X	I/X	2	SC/X	SC, RP/X	T/X	PV	SC/X	III	HP	X
Least Tern	X		E/1	SC/X	T/X	1	E. RC/X	E, RP/X	T/X		T/X	II		
Little Blue Heron	X		2		X	2		SC, RP/X	P/X		SC/X	II		
Little Gull			2						X					
Manx Shearwater								RP/X						
Northern Gannet					X			RP/X						
Pied-billed Grebe	X		E/1	E/X	X		E, RC/X	E, RP/X	T/X	MC	E/X		HP	X
Razorbill						2		X	X					
Red Necked Phalarope			2			2			P/X					
Red-necked Grebe	X													
Red-throated Loon	X		2		X			RP/X	P/X					
Roseate Tern	X		1	E/X	EX/X	1	E/X	RP	E/X		H/X	IV****		
Ross' Gull			2											
Royal Tern					E/X			RP/X				II		
Sandhill Crane						2								
Sandwich Tern					X									
Snowy Egret	X		2	X	X	2		SC, RP/X	P/X		SC/X			
Sora Rail	X	X	2	X				X		MC	SC/X		MP	X
Thayer's Gull									X					
Tricolored Heron			2		X	2		SC, RP/X	P/X			III		
Virginia Rail	X	X						RP/X		HC		IV		X
Wilson's Phalarope			2					RP/X						
Yellow Rail			2			2			X			IV****		
Yellow-crowned Night-heron	X		E/1		X			T, RP/X	P/X	E/PV	SC/X	II		X

Waterfowl	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV
American Black Duck	X	X	1	X	X	2	X	RP/X	X	MC	X	II	HP	X
Atlantic Brant			2		X			RP/X	X			III***		
Barrow's Goldeneye						2								
Black Scoter	X		2					RP/X	X					
Blue-winged Teal	X								P/X		SC/X		MP	
Bufflehead			2					RP/X						
Canada Goose			1			3, 4, *1		RP/X						
Canvasback	X		2		X			RP/X						
Common Eider			1	X		2		RP/X	X					
Common Goldeneye									X					
Common Merganser	X													
Gadwall											SC/X			
Greater Scaup	X		2			2		RP/X	X			IV***		
Green-winged Teal										PV	SC/X			X
Harlequin Duck				X	X	2		X	P/X		X			
Hooded Merganser	X		2											X
Lesser Scaup	X		2					RP/X	X					
Long-tailed Duck	X		2	X				RP/X	X					
Mallard			2											
Northern Pintail								RP/X	U/X					
Northern Shoveler			2											
Redhead			2									III***		
Ruddy Duck					X	2			P/X	MC				
Surf Scoter	X		2					RP/X	X					
Tundra Swan			2							RS*				
White-winged Scoter	X		2					RP/X	X					
Wood Duck		X						RP/X						

* and **** migrant population

*1 migrant and non-breeding

**Type 1

*** winter population

APPENDIX 1 (cont.). Species of Greatest Conservation Need List Decoder

Connecticut

No ranking system

- Scientific name discrepancies may exist and are still being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance

Delaware

Species are ranked into two tiers (1 and 2)

- Scientific name discrepancies may exist and are still being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance
E – State Endangered
T – State Threatened
SC – State Special Concern

Maine

Species are ranked into two tiers (1 and 2)

- Scientific name discrepancies may exist and are still being settled

Maryland

- Scientific name discrepancies may exist and are being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance
E – State Endangered
T – State Threatened
SC – State Special Concern
EX - Extirpated
I – In need of conservation

Massachusetts

No ranking system

- Scientific name discrepancies may exist and are being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance
E – State Endangered
T – State Threatened
SC – State Special Concern

New Hampshire

No ranking system

- Scientific name discrepancies may exist and are being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance
E – State Endangered
T – State Threatened
SC – State Special Concern
RC – State Regional Concern

New Jersey

No ranking system

- Scientific name discrepancies may exist and are being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance
E – State Endangered
T – State Threatened
SC – State Special Concern
RP – Regional Priority

New York

No ranking system

- Scientific name discrepancies may exist and are being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance
E – State Endangered
T – State Threatened
SC – State Special Concern
U- Unprotected*
P – Protected*
* Unprotected and protected listing will be removed from the final draft

Pennsylvania

Tiered system (see below)

- Scientific name discrepancies may exist and are being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance
IC – Immediate Concern
HC – High Level Concern
MC – Maintenance Concern
RS – Responsibility Species
E – Endangered
T – Threatened
Ext – Extirpated (as breeding species)

Rhode Island

No ranking system

- Scientific name discrepancies may exist and are still being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance
E – State Endangered
T – State Threatened
SC – State Special Concern
H – Heritage Species
EX – Extirpated

Vermont

Species are ranked into two tiers (High Priority or Medium Priority)

- Scientific name discrepancies may exist and are still being settled

HP – High Priority
MP – Medium Priority

Virginia

Four tiered ranking system (I – IV)

- Scientific name discrepancies may exist and are still being settled

Washington D.C.

No ranking system

- Scientific name discrepancies may exist and are being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance

West Virginia

No ranking system

- Scientific name discrepancies may exist and are being settled

X – Denotes whether or not a species is on the list, bears no ranking (prioritization) significance

APPENDIX 2. Threats to Northeastern Bird Populations

	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV	Total States
Development	**X**	**X**	x	x	x	**X**	x	**X**	**X**	**X**	**X**	x	**X**	x	14
Non-native species	**X**	**X**	x	x	x	x	x	**X**	**X**	x	x	x	x	x	14
Environmental contaminants	x	**X**	x		x	x	x	**X**	x	x	x	x	**X**	x	13
Recreation	x	**X**	**X**	x	x	x	x	x	**X**	x		x	x		12
Altered hydrology	x	**X**	x		x	x	x	x	x	x	x	x	x		12
Altered natural succession / natural disturbance	**X**	x	x	x	x	x	x	x	x	**X**			x		11
Energy and communication infrastructure	**X**	x	x	x	x	x	x	**X**	x	**X**		x			11
Climate change	X		x	x	x	x	x		x		x	x	**X**		10
Unregulated take	X	x	x		x	x	x	x	x		x	x			10
Habitat alteration by natural processes	**X**					x	x	x	x	x	x	x	**X**		9
Predation	**X**				x	x	x	x	x		x	x	x		9
Incompatible agricultural practices	x		x		x	x	x	x	**X**	**X**		x			9
Avian disease / parasites	**X**	x	x			x	x		x		x		x		8
Incompatible forest management					x	x	x	**X**	**X**	x		x			7
Acid deposition						x	x		x	x		x		x	6
Overfishing					x	x	x	**X**			x				5
Scarcity	x					**X**	x		x			x			5
Overharvest of game birds		x	x									x	x		4
Air pollution		x								x					2
Habitat loss on migration wintering grounds						x		**X**							2
Mineral extraction												x		**X**	2
Dredging or mining of marine habitats			x												1
Incompatible habitat restoration						x									1

x = identified in State Wildlife Action Plan or during meeting with state wildlife officials

X = given special emphasis in State Wildlife Action Plan or during meeting with state wildlife officials

APPENDIX 3 (cont.). Description of Threat Categories

Acid deposition: damage to trees, food chain effects

Air pollution: smog, ground-level ozone, damage to natural habitat

Altered hydrology: dams, development, draw-downs, water withdrawal, sedimentation, stormwater erosion, alterations to tidal habitats through levies and erosion control, hardened shorelines

Altered natural succession / natural disturbance: heavy browsing by deer, fire suppression, alterations to dune habitats

Avian disease: avian influenza, avian cholera, avian botulism, West Nile Virus, eastern equine encephalitis

Climate change: snow depth, seasonality, shifts in forest communities and wildlife, loss of thermal habitat, volatility/storms, rising sea level, invasive species

Contaminants: mercury, oil spills, flame retardants, lead shot and sinkers, mine drainage, chemical applications (pesticides, herbicides), road salt, point and non-point sources

Development: habitat loss and fragmentation, wetland draining and filling, unregulated riparian and upland development, light pollution, noise pollution, collision and mortality, change in land use and land ownership, transportation infrastructure, barriers to dispersal, airport operations, solid waste disposal

Dredging of nearshore habitats: commercial shellfish dredging, dredging for beach nourishment

Energy and communication infrastructure: windfarms, towers, utility rights-of-way and ROW management, habitat loss and degradation, collision and mortality

Habitat alteration by natural processes: old-field succession, forest maturation, beaver alteration of aquatic habitats

Habitat loss on migration and wintering grounds

Incompatible agricultural practices: hay cropping, habitat conversion, pesticides and runoff, ditching and channelization, livestock overgrazing, inadequate riparian buffers, liming practices, and pond construction

Incompatible forest management: liquidation harvesting, forest type conversion, forest structure conversion, lack of accounting for non-timber values

Incompatible habitat restoration: restoration that benefits some species with detrimental effects on others

Mineral extraction: mountaintop coal mining, sand and gravel operations

Non-native species: plant and animal range expansions, introductions, invasions, resulting habitat conversion and interspecific competition, brood parasitism by cowbirds, detrimental

hybridization, exotic forest pathogens, Phragmites, purple loosestrife, mute swan, resident Canada Geese, etc.

Overfishing: includes overharvest of horseshoe crabs, competition with commercial harvesters

Overharvest of game species: legal overharvest resulting from inadequate management (does not include unregulated take)

Predation: gulls, cats, suburban birds and mammals

Recreation: direct human disturbance, habitat degradation, mortality through beach cleaning, recreational rock climbing, offroad vehicles, motorboats, personal watercraft, unleashed dogs, etc.

Scarcity: demographic stochasticity, population isolation, natural rarity and sensitive life history

Unregulated take: bycatch, poaching

APPENDIX 3. State Wildlife Action Plans and Bird Conservation Plans (hyperlinked)

State Wildlife Action Plans

US Shorebird Conservation Plan

North American Waterbird Conservation Plan

North American Landbird Conservation Plan

North American Waterfowl Management Plan

Step-down conservation plans for:

BCR 13 Lower Great Lakes / St. Lawrence Plain
Landbirds - Lower Great Lakes, St. Lawrence Plain, Allegheny Plateau, BCR 13 in Ontario
Shorebirds - Upper Mississippi Valley/Great Lakes Region, Ontario Region
Waterbirds - Upper Mississippi Valley/Great Lakes Region
Waterfowl - UMR/GL JV Implementation Plan, Eastern Habitat JV (CN)

BCR 14 Atlantic Northern Forest
Landbirds - Eastern Spruce-Hardwood Forest, Adirondack Mountains, Northern New England
Shorebirds - North Atlantic Region
Waterbirds - Mid Atlantic/New England/Maritimes Region
Waterfowl - Atlantic Coast Joint Venture Implementation Plan, Eastern Habitat JV Plan (CN)
All Birds - Atlantic Northern Forest BCR Blueprint

BCR 27 Southeastern Coastal Plain

Landbirds - South Atlantic Coastal Plain, East Gulf Coastal Plain,
Shorebirds - Southeast Coastal Plains-Caribbean
Waterbirds - Southeast U.S.
Waterfowl - South Atlantic Migratory Bird Initiative Plan, Atlantic Coast Joint Venture Waterfowl Implementation Plan
All Birds - South Atlantic Migratory Bird Initiative Plan

BCR 28 Appalachian Mountains

Landbirds - Southern Blue Ridge, Northern Ridge and Valley, Allegheny Plateau, Ohio Hills
Waterbirds - Southeast U.S.
Waterfowl - Atlantic Coast Joint Venture Waterfowl Implementation Plan
All Birds - Appalachian Mountain Bird Conservation Initiative Concept Plan

BCR 29 Piedmont

Landbirds - Mid-Atlantic Piedmont
Shorebirds - Southeast Coastal Plains-Caribbean
Waterbirds - Southeast U.S.
Waterfowl - Atlantic Coast Joint Venture Waterfowl Implementation Plan

BCR 30 New England / Mid-Atlantic Coast
Landbirds - Mid-Atlantic Coastal Plains, Southern New England
Shorebirds - Northern Atlantic
Waterbirds - Mid Atlantic/New England/Maritimes
Waterfowl - Atlantic Coast Joint Venture Waterfowl Implementation Plan

APPENDIX 4. Monitoring Program Needs Assessment (sorted by sum of states)

Species Group	CT	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV	Total States
Grassland birds*	**X**	x	x	**X**	x	x	x	x	x	x	**X**	x	12
Forest birds*	x	x		x	x	**X**	x	**X**	x	x	x	x	11
Freshwater marsh birds	x	x	x	**X**	x	**X**	**X**	**X**	x		x	x	11
Scrub-shrub birds*	x	x		x	x	**X**	x	x	x	x	x	x	11
Nightjars	x	x	x	**X**	x	**X**	**X**	**X**		x		x	10
Colonial waterbirds and beach-nesting birds	**X**	**X**	x		x	x	**X**	x		x	x		9
Salt marsh birds	**X**	**X**	x	**X**	x	**X**	**X**		**X**	x			9
Diurnal raptors (forest breeding)	x	x		x		x	x	**X**		x			7
Beach-nesting birds	**X**	**X**			x	x	**X**			x			6
Shorebirds in migration	**X**	**X**		**X**		x	**X**			x			6
Mountain birds				**X**	x		x	x		x	**X**		6
Offshore marine birds		**X**	x	x		**X**	**X**						5
Owls				x		x		x		x		x	5
Upland game birds	x		x	x		x						x	5
Passerines in migration				x		**X**		**X**		x			4
Waterfowl				x		x	x	x					4
Diurnal raptors (migration)				x		**X**		**X**					3
Nearshore marine birds				x		**X**							2
Wintering waterbirds				x			x						2
Colonial nesting swallows										x			1
Wintering landbirds								x					1
Urban birds	x												1

x = identified in State Wildlife Action Plan or during meeting with state wildlife officials

X = given special emphasis in State Wildlife Action Plan or during meeting with state wildlife officials

* emphasis in some states placed on those not well monitored by BBS

Note: Washington, DC and Delaware have not yet designated species groups for monitoring action

APPENDIX 5. Data fields used in Register of Northeast Bird Monitoring Programs

State

Title

Lead Agency / Organization

Project Contact Name

Project Contact Agency

Project Contact Street Address 1

Project Contact Street Address 2

Project Contact City

Project Contact State

Project Contact Postal Code

Project Contact Country

Project Contact Email Address

URL

Partners

Methodology Keywords

Parameters

Taxonomic Focus Keywords

Habitat Focus Keywords

Sampling Frequency

Season

Project Status

Project Start Date

Project End Date

Monitoring Location Place Name

APPENDIX 6.

Northeast Coordinated Bird Monitoring Partnership
Survey Design and Coordination Worksheet

incorporating key elements of the USGS Patuxent Wildlife Research Center's Manager's Monitoring Manual (http://www.pwrc.usgs.gov/monmanual/) and principles of structured decision-making described by Nichols and Williams (2006)

Focus Topic (species group or conservation/management issue)

Name of Coordinated Effort

Working Group Members (designate chair with * and statistical advisor with **)

Name	Organization	Email	Phone

Who else should be invited to join group?

Name	Organization	Email	Phone

PART I: STATUS, OBJECTIVES, AND MANAGEMENT CONTEXT

What existing monitoring programs provide information relevant to this focus topic?
Include inactive programs that could supply data for survey design / power analysis or which could be resumed in the future. Refer to the Register of Northeast of Monitoring Projects.

Program	Organization	Contact	Register #

What have monitoring programs produced to date? How well do existing programs address the following evaluation criteria?

Evaluation Criteria	Program 1	Program 2
1. Clear survey objectives providing management or conservation context		
2. Primary response variables indicate population status and/or trends		
3. Geographic scope and spatial sampling unit explicitly defined		
4. Taxa and inferential populations defined		
5. Available published protocols define temporal sampling frame and measurement procedures		
6. Survey protocols address issues of precision and bias		
7. Geographic coverage and survey protocols consistent		
8. Continuity in survey operations to allow achieving program objectives		
9. Training program established for survey protocols		
10. Survey protocols include collecting environmental covariates to explain population changes		
11. Appropriate analytical procedures are identified or developed		
12. Program reports and summaries are routinely published and accessible		
13. Data are stored in accessible data repositories		
14. Roles and responsibilities are clearly defined		

What are the advantages of developing a coordinated survey design for this focus topic?

What are some possible tradeoffs?

What are the bird conservation objectives of this coordinated initiative?

What management and/or conservation options might help achieve those objectives?

Which of these could be practically exercised in a synchronized fashion at the regional scale?

For how long might the action be sustained and/or monitored at that scale?

What management and conservations actions are feasible and worthy of monitoring and evaluation at smaller spatial scales?

State primary monitoring objective(s) in clear terms, providing a management and/or conservation context for the program. Refer to the following general objectives for monitoring programs, as appropriate.

a. Determine status and trends of populations
b. Set population objectives and species/management priorities

c. Determine causes of population change
d. Inform management and policies to achieve conservation
e. Evaluate conservation efforts
f. Inform conservation design
g. Assess human dimensions

State secondary objectives.

What is the conservation, management or policy decision that will be informed by the monitoring program?

What specific data are needed to make an informed conservation, management or policy decision? Who will use the information? How will it be used?

Where will the conservation, management, or policy decision apply?

Who else has the same management question or species focus? Who has a stake in answering the management question?

PART II. SURVEY DESIGN, FIELD METHODS, AND DATA ANALYSIS

Define the target population(s).

Describe geographic scope of the survey
(e.g. Bird Conservation Region 30, USFWS Region 5, etc)

Define sample frame (study area containing all spatial units of the target population from which sample is to be selected). Describe rationale and process for selecting this sample frame. Include geographic data sources.

If monitoring effects of a deliberate management or conservation action, provide a detailed description of the action, including information on geographic scope and timeframe.

If monitoring response of system state to specific management or conservation action(s), develop a set of alternative hypotheses and corresponding predictions. Assign a confidence value (0.00 to 1.00) to each hypothesis.

What is the feedback mechanism by which monitoring results will be used to adjust these confidence values? How will results be integrated into future management and conservation activities?

How are sample units to be selected from this frame?

Standard approaches, as described by Vesely et al. (2006) include:

Simple random sampling

- Makes no assumptions about distribution of features on the landscape
- Unless the sample size is large, may not represent the range of conditions that occur on the landscape
- Generally not appropriate for large-scale monitoring because it is not cost-efficient

Stratified random sampling

- Reduces variation in a sample by allocating observations to individual strata, then randomly locating sample sites within each stratum
- Strength: can increase efficiency by reducing the number of observations required to reach a desired precision level
- Weakness: inflexible; requires assumptions about spatial and temporal variability of strata
- Appropriate for species that occur in low numbers or when different habitats have different probabilities of the species' presence.
- May not be useful for ephemeral habitats or for habitats whose boundaries may change over time

Systematic sampling

- Consists of a fixed, regular pattern of sampling units after random selection of a starting point
- Can be readily augmented by increasing sample site density in strategic locations
- May over sample some strata, under sample others, therefore may be less efficient
- Correlation among sampled observations may occur, increasing complexity of analysis
- Recommended for forest- and regional-scale monitoring of multiple species

Adaptive cluster sampling

- Units selected based on predetermined criterion (e.g. detection of the target species)
- Appropriate for rare or highly aggregated populations
- Pilot studies strongly recommended
- More complex than most other sampling designs

Before-After Control-Impact

- Recommended for monitoring effects of a management treatment
- Ideal design involves replicate treatments and controls
- Several design variants exist

Generalized Random Tessellation Stratified Designs (from Stevens and Olsen 2004)

- Developed for water quality monitoring
- Compromise between systematic & stratified random sampling that resolves problem of periodic/patchy response
- Incorporates randomization
- Is spatially balanced
- Creates an ordered list of sites
- Data from different surveys can be combined if certain design principles are followed
    - Similar target populations are well defined
    - The same frame represents the target populations (i.e., use the same digital coverage)
    - Randomization in site selection
    - Common protocols are used to measure attributes
    - See: www.epa.gov/nheerl/arm for details

Where are the gaps in geographic coverage? How can these be filled?

What analytical procedures will be used? What are the advantages of the chosen alternative

Examples and citations follow. Also, see reviews in Thomas (1996), Vesely (2006), and http://www.mbr-pwrc.usgs.gov/workshops/Trend2003/

Site occupancy models (Mackenzie et al. 2002, Royle and Nichols 2003)
Bayesian inference (Wade 2000)
Profile summary estimates
ANOVA estimates (Lindsey 1993)
Repeated measures ANOVA (Lindsey 1993, Diggle et al. 1994)
Generalized additive models (Fewster et al. 2000, James et al. 1996)
Hierarchical models (ter Braak et al. 1994)

Ad hoc approaches that have been used to handle problematic data sets:
Linear route-regression (Geissler and Sauer 1990)
Non-linear route-regression (James et al. 1996)
Rank-trends (Titus et al. 1990)
Estimating equations (Link and Sauer 1994)
Poisson regression (ter Braak et al. 1994)
Regression of annual indices (Böhning-Gaese et al. 1993)
Design-based linear model (Bart et al. 2003)

How much change is important to detect? How confident do you need to be in the conclusions drawn from the evaluation of the monitoring data? What level of power are you going to use? What alpha level are you going to use and why? Ensure that a regional design is adequate to meet state information needs.

Power is the probability of detecting a meaningful change or the probability of avoiding a type II error. A type II error occurs when you falsely conclude no change. For North American landbirds, Bart et al. (2004) recommended a target of 80% power to detect a 50% decline over 20 years with an alpha level of 0.1. The North American Waterbird Conservation plan set a goal of detecting >50% change over 10 years or 3 generations.

Our goal is to achieve __% power to detect a __% decline over __ years with a P value of ___.

We chose this alpha level because:

What is the sample size needed to achieve this goal?
For information on sample size considerations, visit www.pwrc.usgs.gov/monmanual/samplesize.htm.

How did you determine this sample size requirement? Identify information source(s) consulted for power analysis.
Coefficient of variation tools are available at www.pwrc.usgs.gov/monmanual/cvs/

What sampling procedures will you use to monitor the target population(s)? Why did you choose this method over other alternatives? Attach standard operating procedures and data sheets.

Have your protocols been published and/or peer-reviewed? If so, where?

What is the primary response variable to be measured?
Examples: frequency of occurrence, relative abundance, actual abundance, occupancy, productivity, survivorship, contaminant levels, disease incidence

In what way(s) will you measure detection probability (if applicable)? Is this method appropriate for the monitored habitat(s)?
Options: double-observer, distance-sampling, removal models (timed-interval counts, time record for each individual at first encounter, repeat counts)

What other sources of bias may affect survey results? Which ones can be addressed and how?
Examples: phenological asynchrony, observer skill level, placement of roads or trails

Besides the main response variable, what other attributes of the target population will you measure? How will you measure each?

What physical, chemical, biological, and/or management covariates will be measured to help determine causes of population change or generate hypotheses for further investigation? How will you measure each?

Consider and describe opportunities to investigate scale-related issues by integrating long-term status monitoring at the regional level with complementary effects monitoring on embedded management units (e.g., refuges, parks, etc.)?

At what time(s) of year will you conduct the survey?
Be sure to account for phenological variation throughout survey region.

How often will you conduct the survey?

How will observers be trained in field protocols? Who will train them and how will training be funded?

Do your proposed field and analytical methods align with those being used in other regions? Will it be possible to scale your project up?

PART III. DATA MANAGEMENT

How and when will data be synthesized, archived, and made accessible?

Who will have access to the data?

Describe procedures for controlling data quality.

PART IV: FUNDING NEEDS AND INSTITUTIONAL CONSTRAINTS

What is the anticipated annual cost of this monitoring initiative?

What are existing and potential sources of funding for this work?

What institutional constraints require consideration? How can these be addressed?

Action Planning for Continued Coordination

What needs to be achieved?	How will it be achieved?	What resources are needed?	Who will do this?	When will it be done?
Meet again as working group				
Lead completion of design / coordination strategy				
Secure funds to complete planning (if necessary)				
Develop survey design and standard operating procedures				
Secure peer review by biologists and statisticians				
Prepare NBII metadata				
Produce observer manual				
Train observers				
Collect data				
Coordinate data management				
Analyze data				
Write and circulate reports				

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APPENDIX 7. Draft Northeast Marsh Bird Monitoring Plan

Marsh birds

Justification

The amount of emergent wetland habitat in North America has declined sharply during the past century. Populations of many marsh birds that are dependent on emergent wetlands appear to be declining as well, but we currently lack adequate monitoring programs to determine status and estimate population trends. Rails and bitterns consume a wide variety of aquatic invertebrates and therefore, may be affected by accumulation of environmental contaminants in wetland substrates. Also, marsh birds are vulnerable to invasions of some invasive plant species, such as purple loosestrife and *Phragmites*. Hence, marsh birds may be good "indicator species" for assessing wetland ecosystem quality. Their presence may be considered one measure of success for wetland restoration efforts. In addition, marsh birds have a high recreational value among birders and several rails are considered game species in many States, yet we currently lack effective population surveys on which to base harvest limits. The development of a well coordinated marsh bird monitoring program for USFWS Region 5 will make significant progress towards addressing these issues.

Management issues

Climate change (sea level rise), contaminants, habitat alteration through natural and anthropogenic processes (mosquito control), development (in adjacent uplands), non-native species, altered hydrology, incompatible agricultural practices (in adjacent uplands), and scarcity are important management issues that need to be addressed to conserve marsh birds and the habitats they depend upon.

Status of marsh bird monitoring in the Northeast

Surveys of marsh birds have been conducted by state and federal agencies and other organizations for many years. Some of the earliest coordinated efforts to inventory marsh bird diversity and abundance in the Northeast began with the work of James Gibbs and Scott Melvin in Maine in the late 1980s. Through a series of multiple visits to several dozen wetlands, these authors refined techniques for call-response surveys, which formed the basis for methods that are widely used today. The Marsh Monitoring Program (MMP), of Bird Studies Canada and Environment Canada, initiated marsh bird surveys in States and Provinces around the Great Lakes in 1994.

A recent report compiled by National Audubon (Butcher and Niven 2007) analyzed CBC and BBS data from the last 40 years. American Bittern was one of the top 10 common birds in decline in North America, with a -59% population change during the study period. Data collected during MMP surveys, 1995-2001, detected statistically significant declining trends for American Coot, Black Tern, Pied-billed Grebe, Sora, Virginia Rail, and several other marsh birds, in the Great Lakes region. Additional biological data for marsh bird species can be found within the Upper Mississippi / Lower Great Lakes and Mid-Atlantic / New England Maritime Waterbird Plans and in BCR 30 and 13 Plans.

Surveys for wetland birds, specifically those that inhabit tidal marshes, have also been done sporadically by individual agencies and organizations, often at a local scale. In 1999, Greg Shriver coordinated a large-scale effort to catalog saltmarsh bird diversity in coastal wetlands from Southern Connecticut to New Hampshire and combined those data with information collected simultaneously in Maine. Scientists at the Smithsonian Institution have conducted bird surveys in Chesapeake Bay and elsewhere in the mid-Atlantic Region including a volunteer Coastal Plain Swamp Sparrow survey (http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Swamp_sparrow/Survey/Results/). Bombay Hook National Wildlife Refuge (DE) and Rachel Carson National Wildlife Refuge (ME) have perhaps the longest continuous datasets for monitoring saltmarsh birds, with 8 and 10 years of data, respectively. In most cases, saltmarsh surveys used passive point counts as the primary method of detection; therefore, observations of secretive saltmarsh species (e.g., rails) were incidental.

Visits to a single wetland are not normally considered monitoring. They do, however, provide a baseline from which monitoring (i.e., repeated surveys to a place over time) can occur. Some survey projects have developed into full monitoring efforts by virtue of repeated observations. Some of these occurred by design (NY State Department of Environmental Conservation Marsh Bird Monitoring, USFWS Refuge Marsh Bird Monitoring, etc.) and others by necessity to learn about short- and long-term population trend and changes in distribution. Table 1 provides a list of marsh bird surveys and monitoring projects in the Northeast.

Table 1. Current surveys and monitoring programs for marsh birds in the Northeast

Program	**Organization(s)**
CT, ME, MA, MD, NH, NJ, NY, PA, VA, VT, WV Marsh Bird Surveys/Monitoring	State Agencies and/or NGO partners
National Wildlife Refuge Marsh bird Monitoring	US Fish and Wildlife Service
Canada Marsh Monitoring Program	Environment Canada - Bird Studies Canada
NH Audubon Saltmarsh Bird Monitoring	Audubon Society of New Hampshire
Rachel Carson Saltmarsh Bird Monitoring	US Fish and Wildlife Service
Maine, New York, Vermont Black Tern Surveys/monitoring	State Agencies
Galilee Bird Sanctuary Monitoring	University of Rhode Island, Department of Natural Resources
Connecticut Saltmarsh Sparrow Monitoring	University of of Connecticut
Delaware Coastal Plain Swamp Sparrow Survey	Delmarva Ornithological Society and Smithsonian Migratory Bird Center
Delaware Black Rail Playback Survey	Delaware Department of Natural Resources and Environmental Conservation
Bombay Hook National Wildlife Refuge – salt-marsh bird surveys	US Fish and Wildlife Service

Monitoring objectives

This group of bird species, by nature of their secretive habits and remote habitat, remains poorly understood. Therefore, objectives for this group of birds span a broad set of needs ranging from basic status monitoring, to trend estimation, to monitoring the effects of several

management issues (as well as natural changes) on habitat quality and availability. After review and guidance from the NE Coordinated Bird Monitoring Program (September 2007) the marsh bird workgroup leader decided to specifically state both monitoring and management objectives in an attempt to clarify the needs for this focal group.

Bird monitoring, to be effective, must be conducted at multiple spatial and temporal scales (U.S. North American Bird Conservation Initiative Monitoring Subcommittee 2007) with broad based (surveillance monitoring) providing a context for identifying more intensive and targeted research projects, identifying specific areas or regions that should be prioritized for conservation (i.e. the greatest concentration of least bitterns in the northeast, the relative importance of Delaware Bay to the global breeding population of Saltmarsh Sparrows), and tracking how large-scale environmental changes influence the distribution and abundance of focal species (sea-level rise, surface temperature changes on wetland hydrology). Designing monitoring programs to estimate the occupancy, abundance, and/or changes in these parameters over time requires setting specific monitoring objectives that clearly define the spatiotemporal scales and time frames and effect sizes for assessing changes in monitoring parameters.

Developing monitoring programs that address specific management actions and help define management objectives requires designing programs that establish hypotheses regarding the potential effects of the action on the focal species *a priori* and selecting sample sites and defining sampling intensity to adequately test the stated hypotheses. These targeted monitoring programs are critical to determining management effectiveness and are an integral component of any adaptive management program. Given the scope and the scale of the NECBM effort we think it is valuable and necessary to establish and implement both types of monitoring approaches (Holthausen et al. 2005), especially in a coordinated framework such that data are comparable throughout the region and can provide the necessary information to better understand, conserve, and manage for marsh birds in the Northeast. The lack of institutional and fiscal support for such efforts may presently be lacking (Nichols and Williams 2006) but this can not be the primary justification for selecting one type of monitoring over the other.

Monitoring Objectives

To estimate the distribution, occupancy, and abundance of breeding secretive marsh birds (especially those that are state-listed and/or designated as species of greatest conservation need in state wildlife action plans) using a standardized protocol within the 13 states of the Northeast.

To detect a 25% population decline (relative abundance or site occupancy) of breeding secretive marsh birds (focal species determined by BCR) within the Northeast between 2010 and 2020 (States, sub-regions, and BCR's)

Management Objectives

To evaluate the effects of management actions designed to enhance the habitat quality for waterfowl or shorebirds on secretive marsh bird abundance and reproductive success

To evaluate the effects of management actions that alter marsh hydrology for mosquito control on secretive marsh bird abundance and reproductive success

To use the information from the broad-scale monitoring to inform landscape conservation strategies (e.g., conservation design) at the state and local levels by identifying which habitats (or habitat patches) warrant conservation or regulatory protection.

To determine the distribution, intensity, and additive nature of hunting pressure on secretive marsh bird occupancy and abundance by species and state

To determine the effects of invasive species cover and control efforts on breeding secretive marsh bird occupancy, relative abundance, and reproductive success

Target species

The marsh bird group of target species includes a broad array of wetland-dependent birds (Table 2). A few are freshwater marsh obligates (e.g., Pied-billed Grebe), whereas, several others are tidal marsh obligates (Saltmarsh Sharp-tailed Sparrow, Clapper Rail, Seaside Sparrow). A few species are found in both habitats (Least Bittern, Virginia Rail).

Table 2. Marsh bird target species and SGCN status.

Species	**States listing species as SGCN**
Pied-billed Grebe	CT, DE, MA, MD, NH, NJ, NY, PA, RI, VT, WV
American Bittern	CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VA, VT, WV
Least Bittern	CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VA, VT, WV
Yellow Rail	DE, ME, NY, VA
Black Rail	CT, DE, MD, NJ, NY, VA
Clapper Rail	CT, NJ, RI, VA
KingRail	CT, DE, MA, MD, NJ, NY, PA, RI, VA, WV
Virginia Rail	CT, DC, NJ, PA, VA, WV
Sora	CT, DC, DE, MA, NJ, PA, RI, VT, WV
Common Moorhen	CT, MA, MD, ME, NH, PA, RI, WV
American Coot	DE, ME, PA, WV
Willet	CT, DE, MD, ME, NH, NJ, NY, RI
Forster's Tern	DE, MD, NJ, NY, VA
Black Tern	DE, MD, ME, NJ, NY, PA, VT
Marsh Wren	CT, DC, DE, MD, ME, NJ, PA, RI, VA, WV
Nelson's Sharp-tailed Sparrow	ME, NH, NJ, VA
Saltmarsh Sharp-tailed Sparrow	CT, DE, MA, MD, ME, NH, NJ, NY, RI, VA
Seaside Sparrow	CT, DE, MA, MD, NH, NJ, NY, RI, VA

Design, coordination, and implementation strategy

Coordination of marsh bird monitoring in the Northeast will entail bringing together existing monitoring programs, expanding previous survey efforts, and setting up new efforts altogether. The existing refuge-based monitoring that has been taking place in the Northeast, if expanded to additional sites by other volunteers, state biologists, etc., could have the scope to address many of the objectives outlined above. Use of volunteers may

be more difficult than for other species, such as owls and nightjars, because of the timing and difficulty in accessing marshes. There is hope that a dedicated number of volunteer monitors could be enlisted to supplement data collection by professional observers.

Most likely, a sampling frame will be developed, following the lead of national efforts to unify monitoring protocols. At present, monitoring will entail two-stage cluster sampling using a generalized random tessellation stratification procedure (GRTS). The two-stage cluster sample creates primary and secondary sampling units that should increase logistical efficiency by clustering selected wetlands within primary sampling units. Primary sampling units (PSU's) will be selected using a GRTS procedure to create a spatially balanced design and allow for addition and removal of sample units over time. Within each PSU, a sample of secondary sampling units (specific wetlands or locations within large wetlands) will also be selected using GRTS. These wetlands and sample locations will be the sites included in the marsh bird monitoring effort. The national effort will provide the framework for a sample to make inferences regarding marsh bird population trends at the continental, BCR, and state levels. Regions or sites that have the interest and resources to sample more intensively, and thereby make inferences at smaller spatial scales, will be able to do so in conjunction with the overall sampling design.

Data management is a serious component of any long-term monitoring program and must be considered during the design stage, prior to implementation. The USGS Patuxent Wildlife Research Center is developing a website and database for the efficient storing and sharing of marshbird survey results collected using the Standardized North American Marsh Bird Monitoring Protocol developed by Courtney Conway at the University of Arizona. The website allows biologists to manage their survey information, produce reports, and retrieve a copy of their data on-demand. This data system is currently undergoing beta testing and is scheduled for full release by early June 2007. Marsh bird monitoring efforts in the Northeast will follow the National Marsh Bird Survey Protocol and survey data will be stored in the centralized data management system. Legacy data can and should be integrated into the coordinated marsh bird monitoring effort as long as standardized protocols have been used, sites were selected using some type of probabilistic sampling design, and the data pass quality assurance tests.

Opportunities for cross-group coordination

The four groups which need to communicate on these issues are: the Atlantic Flyway Technical Section, the Mid-Atlantic New England Maritime Planning Unit, the Upper Mississippi / Great Lakes Planning Unit, and the Marsh Bird Working Group of the Northeast Coordinated Bird Monitoring Partnership.

Opportunities to coordinate marsh bird survey efforts with waterfowl monitoring initiatives should be pursued. Waterfowl monitors frequently encounter non-game birds while conducting field surveys. In addition, Flyway Technical committees have the legal responsibility for setting season dates and bag limits for several rail species, which are focal targets for monitoring within the Marsh Bird working group.

Actions and lead institutions

Survey design will largely follow the lead of those who have been collaborating on this subject for over a decade (marsh bird monitoring workshop participants 1998, 2001, 2006) including representatives from many state and federal agencies, and university staff. Kathy Parsons, of the Manomet Center for Conservation Sciences, has been contracted to help facilitate development of a Northeast marsh bird monitoring initiative.

Courtney Conway, of the USGS Arizona Cooperative Fish and Wildlife Research Unit, recently released the latest update (April 2007) to the Standardized North American Marsh Bird Monitoring Protocols, Wildlife Research Report #2007-04. The survey protocol outlines a standardized survey methodology intended for use at the site level (e.g., National Wildlife Refuges and other protected areas). This protocol is currently in use throughout North America.

Development of a Northeast sampling design will be a coordinated effort by Mark Seamans, of the USGS Patuxent Wildlife Research Center (PWRC), and various partners. A pilot sample selection initiative, focusing on coastal salt marsh wetlands and sparrows, is currently being developed by Greg Shiver, of the University of Delaware. The framework utilizes a GRTS methodology. A document describing the sampling framework is currently being finalized and peer reviewed. Release is anticipated within the next few months.

Bruce Peterjohn (USGS PWRC), working in partnership with USFWS Refuges, has coordinated the development of a database to hold all marsh bird survey data collected continentally.

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