

Opportunities for Improving North American Avian Monitoring

Draft Interim Report

North American Bird Conservation Initiative Monitoring Subcommittee

September 5, 2006

Bea Van Horne, U.S.D.A Forest Service, Co-chair
Paul Schmidt, U.S. Fish and Wildlife Service, Co-chair

Brad Andres, U.S. Fish and Wildlife Service
Jonathan Bart, Partners in Flight
Richard Bishop, US-NABCI Committee Member
Stephen Brown, U.S. Shorebird Conservation Plan
Charles Francis, Canadian Wildlife Service, Canada
Debbie Hahn, US-NABCI Coordinator
Dale Humburg, Missouri Department of Conservation
Mark Koneff, North American Waterfowl Management Plan
Bruce Peterjohn, North American Waterbird Conservation Plan
Ken Rosenberg, Cornell Laboratory of Ornithology
John Sauer, U.S. Geological Survey
Robert Szaro, U.S. Geological Survey
Christina Vojta, U.S.D.A. Forest Service

TABLE OF CONTENTS

Title Page.....	1
Table of Contents.....	2
Introduction.....	3
Report Context.....	4
Goals, Recommendations, and Actions.....	5
1. Fully integrate monitoring with bird conservation and management.....	5
2. Monitoring programs are coordinated among institutions and across spatial scales...8	8
3. Increase the value of monitoring programs by improving statistical design.....10	10
4. Maintain bird population monitoring data in up-to-day data management systems..11	11
Appendix 1 (Agency/Initiative Goals, Objectives, and Priorities for Monitoring).....	15
Appendix 2 (Goals and Objectives for Bird Monitoring).....	29
Appendix 3 (Overview of Some Current Monitoring Programs).....	32
Appendix 4 (Evaluation Criteria).....	37
Appendix 5 (Data Management Systems).....	38
Literature Cited.....	41

INTRODUCTION

The past decade has seen a proliferation of bird conservation initiatives, including the North American Waterfowl Management Plan, Partners in Flight, the U.S. and Canadian Shorebird Conservation Plans, Waterbird Conservation for the Americas, the Northern Bobwhite Conservation Initiative, and other gamebird initiatives. These initiatives have undertaken comprehensive priority-setting and conservation planning efforts for all major bird groups at the continental scale as well as numerous regional and local planning activities. Under the coordinating umbrella of the North American Bird Conservation Initiative, these efforts have resulted in expanded partnerships for implementing conservation objectives within Joint Ventures and Bird Conservation Regions (BCRs), with participation by many federal and state wildlife resource agencies and non-governmental organizations. Information on the status of bird populations, from a wide variety of bird monitoring programs, has been critical to these conservation planning and implementation efforts.

Monitoring, and the subsequent act of evaluation, are integral components of an iterative, science-based approach to bird conservation and management. Furthermore, the value of monitoring and evaluation is often judged by how well the information is regularly integrated into decision-making for management or conservation. For example, monitoring information can significantly influence an array of conservation and management decisions, such as altering land management practices, determining species in highest need of conservation and management intervention, investing more resources to uncover the causes of declining populations, identifying land units that will likely provide source populations, and regulating harvest of game birds.

Monitoring information also enables evaluation of the effectiveness and efficiency of specific management or conservation interventions, thus facilitating an adaptive approach. Effectiveness and accountability require demonstrating not just that work has been done on a number of acres, but that it has led to desired outcomes, such as enhancements to bird populations or other natural resources. Thus, the effectiveness of an intervention at a local scale is often measured by direct or indirect population performance, and therefore needs to be pooled over regional, flyway, and range-wide scales to truly assess population-level success and to gain a broader context for any local changes. Documenting outcomes improves accountability, which, in turn, leads to decisions gaining wider acceptance by society.

Effective bird conservation requires monitoring information at a variety of spatial scales. Broad-scale monitoring provides context to identify priorities for more targeted monitoring that seeks to understand the causes of population changes. Broad-scale monitoring also provides essential information for prioritizing species for conservation actions, directing the allocation of limited conservation resources, and identifying emerging conservation issues associated with changes in population levels. For example, monitoring information sheds light on how environmental changes, wrought by natural processes and unintentional, human-induced actions, affect bird populations. Targeted monitoring activities are critical to assess the effectiveness of current management practices and answer questions that will affect the future management of natural resources. Holthausen et al. (2005) concluded that different monitoring approaches need to be used in concert to achieve valid outcomes for informed conservation and management.

Monitoring programs have provided vital information to bird conservation and management over the years, but room for improvement exists. Incorporation of quality standards into monitoring programs, use of common protocols for data collection, and coordination of monitoring among agencies and initiatives have the potential to greatly improve results and outcomes, boosting support for bird conservation programs. Moreover, greater sharing of monitoring and evaluation information among practitioners is needed to increase knowledge about ecological systems and enhance decision-making.

Improvements for bird monitoring fall into four broad categories:

- *improvements in effectiveness*, specifically better aligning monitoring at all stages with clearly articulated management or conservation objectives and priorities;
- *improvements in scope*, broadening the range of species for which we can make informed conservation or management decisions;
- *improvements in value and 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 institutions and across spatial scales.

The report organizes recommendations for improvements around four broad goals, each of which addresses major problems or factors limiting our ability to most effectively use bird monitoring to inform bird conservation and management.

REPORT CONTEXT

The U.S. North American Bird Conservation Initiative (NABCI) Committee (Committee), a public-private coalition to improve the conservation of birds and their habitats in Canada, the United States, and Mexico, has taken a leadership role in the effort to coordinate monitoring. In general, the Committee is working to increase the effectiveness of existing and new bird conservation initiatives by enhancing coordination among them, and by fostering greater cooperation among the nations and peoples of the continent. Considering the importance of improving our understanding of bird population trends in relationship to habitat change and management, the Committee identified the need to coordinate bird monitoring efforts as their highest priority at this time.

The Committee chartered its Monitoring Subcommittee (Subcommittee) to provide it with “technical support to foster federal, state, non-governmental organization, and international cooperation for effective monitoring of bird populations and pertinent environmental conditions and to develop methods to fully integrate monitoring into conservation and management decisions.” This task follows an initial report produced under the direction of the Association of Fish and Wildlife Agencies (AFWA) Bird Conservation Committee (Coordinated Bird Monitoring Working Group of the Association of Fish and Wildlife Agencies 2004) and a report by the USDA Forest Service recommending strategies for monitoring terrestrial species (Holthausen 2005). Furthermore, the Committee charged the Subcommittee to:

- develop guidelines for monitoring, including protocols for data collection, accessibility, and analysis;
- find ways to integrate monitoring into a science-based management and conservation system;
- develop means to coordinate monitoring efforts across implementation entities where scale and question indicate a common goal;
- assess participant capacities to contribute to monitoring efforts (e.g., field observers, data entry, statistical analysis); and
- oversee an assessment of current major monitoring efforts and make recommendations for continuation or change.

This report presents the Subcommittee’s progress on the tasks outlined above and offers a concise set of agreed upon goals, recommendations, and actions. The Subcommittee’s intent is to insure that monitoring is included as a substantial and integral portion of the costs of management and conservation projects, and that all monitoring efforts are based on consistent and scientifically valid methodologies and produce useful information in an efficient manner. In addition, ongoing regional efforts to coordinate bird monitoring are in need of guidance and support.

GOALS, RECOMMENDATIONS, AND ACTIONS

As background for discussion, members of the U. S. NABCI Monitoring Subcommittee drafted summaries from existing documents and polled their respective constituencies to generate a list of monitoring goals and objectives for each participating agency and bird initiative. From this background information (presented in Appendix 1), similar objectives were grouped into broad themes that represent shared goals and objectives among NABCI partners (Appendix 2). Based on these goals and objectives, and on discussions among subcommittee members, we identified four broad goals for improving the current state of bird monitoring in North America. The remainder of this report is organized around these broad goals. Under each goal we state the specific problems that need to be addressed, then provide recommendations and actions to address the problems.

Goal 1. Fully integrate monitoring with bird conservation and management and ensure that it is aligned with management priorities.

- *Challenge:* Monitoring programs are often not directly integrated with bird conservation/management initiatives.
- *Challenge:* Many conservation and management actions do not adequately incorporate monitoring into evaluation.

- *Challenge:* Management actions needed for some species are unclear because monitoring is not sufficient to determine current population status or ecological threats to healthy and sustainable populations.

If the bird conservation and management communities value an iterative, science-based approach to decision-making, then monitoring, and the subsequent act of evaluation, must become integral components of their practice. Greater demand for resources, increased public involvement in management, and growing concerns about sustainability of species and ecosystems, mean that best professional judgment alone is no longer sufficient. Society needs and wants to better understand its land and water resources and how they are changing over time. Achieving this understanding requires purposeful and directed monitoring and evaluation to guide decision-making.

In current practice, however, monitoring data often do not directly contribute to decision-making or evaluation of management effects. To be most effective, monitoring programs must be implemented in the context of and with direct relevance to conservation actions. Generally referred to as adaptive management (Holling 1978, Walters 1986), the process of iterative, integrated decision-making is based on clear definition of management goals, integration of existing research and monitoring into predictive models, implementation of selected management actions, and monitoring to assess consequences of management. Adaptive Harvest Management (Williams et al. 1996, Johnson et al. 1997, Johnson and Williams 1999) provides perhaps the best model for incorporating monitoring information into decision-making for waterfowl management and wetlands conservation. For most migratory non-game bird species, however, a much less well-developed infrastructure exists to evaluate monitoring priorities and to incorporate monitoring results into management decisions. Even here, however, adaptive management provides a useful framework to purposefully and efficiently apply monitoring to conservation and policy decisions.

For many species, information amassed from existing monitoring efforts is insufficient to answer even the most fundamental questions regarding their status, leaving little basis for conservation and management decisions. Ensuring that monitoring programs generate initial estimates of population status and trend, particularly for focal species, and incorporating this information into listing decisions for species, under the Endangered Species Act (ESA) or the Convention on International Trade in Endangered Species (CITES), is a high priority for the Migratory Bird Program of the U.S. Fish and Wildlife Service (USFWS). Similarly, identifying species most at risk of slipping into threatened or endangered status is a primary focus of the non-game bird initiatives involved in NABCI. Assessing status and managing for species before they become listed is also a key goal of the State Wildlife Grants Program and the U.S. Forest Service (USFS), which manages its extensive forests and rangelands to maintain avian biodiversity. Included in this assessment is the identification of species considered at-risk, but for which we lack adequate monitoring data to evaluate current or future status; examples include most shorebirds, waterbirds, and secretive marshbirds. Besides hampering our ability to assess these species under ESA or CITES, lack of monitoring programs for many non-game birds severely limits our ability to assess the effects of important policy or management decisions, such as those regarding aquaculture, marsh restoration, grazing, timber management, or mountaintop mining.

Appendix 3 describes some of the current continental and regional bird monitoring programs. The purpose of this overview is to raise awareness of both the strengths and weaknesses of existing programs, and to highlight information gaps that need to be filled in the future.

Future proposals for surveys and evaluation should demonstrate relevance and utility to bird conservation and management. Effectively incorporating considerations of conservation objectives, scale, and stakeholders into monitoring programs will require much greater focus on why monitoring is needed, who will be involved, where conservation actions are occurring, and how new information will improve decision-making. Specifically, developing models that integrate monitoring data into decision-making is essential to adaptively manage bird populations.

All those engaged in bird conservation, including policy-makers, biologists, managers, and statisticians, will need to address the following fundamental issues and questions:

- Explicit objective – What is the resource management or policy decision that will be informed by the monitoring program?
- Minimum requirements – How much change is important to detect? How confident do you need to be in the conclusions drawn from evaluation of the monitoring data?
- Scale and scope - Where will the management decision apply?
- Stakeholders - Who else has the same management question or species focus? Who has a stake in answering the management question?
- Monitoring - What specific information is needed to make an informed management or policy decision?

At the same time, managers must take advantage of information on bird populations obtained through long-term, regional, and continental programs because these data provide a broader spatial and temporal context for interpreting short-term outcomes of project monitoring (Holthausen et al. 2005).

Recommendation 1.1 Establish a policy level expectation that monitoring will be explicitly acknowledged as an integral element of bird conservation.

Action 1.1. Develop a Memorandum of Understanding among NABCI partners to implement the action items from this report.

Who: U.S. NABCI Committee

Action 1.2. Develop active and ongoing collaborations of policy-makers, biologists, statisticians, and other stakeholders when developing monitoring programs and defining uses of information.

Who: Policy-makers should ensure participation of these groups

Action 1.3. Encourage existing resource management projects and regulatory and granting programs to include monitoring as an evaluation component when budgeting for projects. Funding should include all aspects of a monitoring program (e.g., design, implementation, coordination, web accessibility of results).

Who: U.S. NABCI Committees and bird conservation community

Action 1.4. Incorporate monitoring as a requirement into appropriate State Wildlife Grant projects that affect bird populations. Monitoring should be designed to coordinate across scales (see goal 2) and among states and their partners.

Who: Association of Fish and Wildlife Agencies (AFWA), USFWS, and state agencies

Recommendation (1.2): Broaden the scope of current monitoring for species that are most at risk and for which we have inadequate information to make management decisions.

Action 1.2.1. Review and prioritize the species most in need of new or improved monitoring programs and outline for NABCI how the results of program improvements can be actively integrated into management and conservation decisions at local and rangewide scales.

Who: Bird conservation initiatives, Federal Agencies, States

Action 1.2.2. Complete the design of needed new or improved programs according to the above determined priorities and coordinate among NABCI partners for cost-effective implementation of new or expanded monitoring programs at appropriate scales.

Who: Bird conservation initiatives, Federal Agencies, States.

Goal 2. Monitoring programs are coordinated among institutions and integrated across spatial scales to effectively solve conservation or management problems.

- *Challenge:* Monitoring programs are not sufficiently coordinated among institutions, resulting in unnecessary redundancies and inefficient use of funds.
- *Challenge:* Monitoring programs are not sufficiently integrated across spatial scales to effectively solve conservation or management problems.

We define “coordination” as the ability to align the various elements of a monitoring program (i.e., design, implementation, analysis, reporting, and evaluation) among stakeholders across appropriate spatial and temporal scales. Effective coordination among stakeholders requires identifying mutual informational needs, developing collaborative approaches, leveraging fiscal resources, building information networks to report and share results, and identifying leadership.

Coordination among institutions is challenging because each agency or organization initiates its own monitoring programs with funds it usually receives through programmatic channels. Requests for monitoring funds are often made two to three years in advance, so availability of funds to partner organizations in any given year is unpredictable. If a monitoring program is

pursued individually, without coordination, the efficiency and utility of the results - and the management and conservation it is supposed to support – often suffer.

A lack of long-term organizational commitment, including specifically appointed leadership, has hindered coordination of bird monitoring efforts. Such commitment and leadership is required to successfully coordinate and align the various elements of a monitoring program among stakeholders across a BCR. Without it, collective monitoring efforts will fail.

The Committee endorsed BCRs to facilitate bird conservation planning, implementation, and evaluation within ecologically distinct regions with similar bird communities, habitats, and resource management issues. Therefore, the Subcommittee recommends that BCRs should be the starting point for assessing coordinated monitoring opportunities. From the BCR level, the spatial scale should be enlarged or reduced depending on the scale of the priority management or conservation questions identified. Within each BCR, representatives of the existing institutional infrastructure (e.g., all-bird state conservation initiatives, Flyway Technical Committees, Joint Ventures, regional bird initiative working groups) would meet to agree upon priority management questions and to improve coordination of existing monitoring programs.

The scale of many current bird monitoring efforts does not always directly relate to the spatial extent of a specific management or conservation question. Moreover, local efforts are not well-coordinated and thus cannot contribute to larger scale programs. Developing effective and efficient coordinated bird monitoring programs, that simultaneously provide information to conservation and management decision-making at multiple spatial and temporal scales, is a challenge to the bird conservation and management community.

The NABCI initiatives have recognized the need for improved coordination, and several regional efforts to coordinate bird monitoring have been started. Completion of State Wildlife Action Plans, the appearance of state all-bird conservation initiatives, increased participation among agencies in broad conservation partnerships, and technological advances that facilitate shared data acquisition and management create opportunities for increased coordination.

Recommendation 2. Ensure that monitoring efforts are effectively coordinated across appropriate spatial scales and among participating and affected stakeholders.

Action 2.1. Expand and complete a bird monitoring project registry that conforms to international metadata standards, including all projects in the Bird Studies Canada database, and incorporate into the Natural Resource Monitoring Partnership¹ where appropriate.

Who: NBII, NRMP partners, Cornell Lab of Ornithology, Bird Studies Canada, MAPS Program

Action 2.2. Use criteria in Appendix 4 to assess how well existing monitoring programs meet current conservation needs and communicate results to appropriate stakeholders.

Who: NABCI monitoring subcommittee, AFWA, USFWS, USGS, USFS

¹ http://biology.usgs.gov/status_trends/nrmp/MonitoringPartnership.htm

Action 2.3. Encourage conservation partners to both support ongoing coordination efforts and develop an enhanced integrated approach to bird monitoring that addresses relevant conservation or management issues.

Who: Joint Ventures, bird conservation initiatives, other BCR partners

Goal 3. Increase the value of monitoring programs by improving statistical design.

- *Challenge:* The value of many monitoring programs is often limited by design flaws.

Monitoring information must be credible and meet fundamental statistical survey requirements such as providing inference for the entire population of interest and appropriately estimating or controlling for detection of animals during sampling. Poor statistical design is often a consequence of limited input from policy makers, biologists, or statisticians during the collaborative process of establishing a monitoring program. Biologists define biologically-meaningful attributes to be sampled, sample sites, timing of sampling, and constraints on detection of the sampled attributes. Statisticians provide the quantitative components to permit inference within the goals and biological constraints, defining sampling frameworks that allow for selection of sample sites, additional sampling needed to address detectability issues, and predicting the number of samples required to attain the goals. They also contribute to analysis and communication of results.

For bird surveys, specific design issues include:

- *Defining the role of monitoring information in management.* Explicit statements of management goals and information needs are critical to designing monitoring programs that inform management. The increasing use of models in management is clarifying information needed from monitoring, as models contain precisely-defined state variables, time periods, and geographic scopes. The statistical designs of the programs are a natural consequence of the information needs, as the response variable, temporal and spatial scopes of inference, needed precision, and analysis method are all based on the needs.
- *Defining target populations.* The sampled population in monitoring programs must represent the target population. Improvements in many surveys can be made to sample areas or habitats that contain segments of the population of interest (e.g., the survey is confined to roadsides or to portions of species' ranges). Without such improvements it is often difficult to draw inferences from the survey to the unsampled portions of the population.
- *Sampling response variables appropriately.* Using relative abundance indexes often requires assumptions that cannot be easily verified. A statistically sound approach may require the design of monitoring programs that directly estimate abundance (or other population attributes) by applying methods that permit estimation of detection rates to test assumptions of detectability over space and time.

- *Specification of appropriate analysis methods.* Many monitoring programs are designed and implemented without any clear notion of how the data will be analyzed. Designing monitoring programs based on clear statements of goals allows for an exact specification of the procedure to be used in the analysis, and provides a clear framework for evaluating the survey design. No monitoring program should be considered without such a specification. Understanding the analysis is fundamental to any design, as any consideration of statistical power or predicted precision of results must be based on the analysis to be applied to the data.
- *Periodic review.* Ongoing monitoring programs require periodic reviews to ensure that their designs are sufficient to meet emerging information needs. Programs should be assessed for the value of the information to conservation and management decision-making and design flaws should be modified to better meet information needs.
- *Coordination and consistency.* Coordination and consistency of large-scale survey methods will greatly enhance the value of the information generated by the surveys. Evaluation of replicated management activities among regions requires consistent monitoring designs. Aggregating information over regions also requires monitoring designs that provide reliable information. Surveys conducted at local scales that do not have appropriate sampling frames or detectability estimation procedures cannot be credibly aggregated to provide regional estimates.

Recommendation 3. Every monitoring program should be designed and periodically reviewed in consultation with input from policy makers, managers, and statisticians familiar with bird conservation and survey design.

Action 3.1. Develop and implement a process to review and modify the design of on-going surveys to better meet current information needs.

Who: Policymakers, survey managers/coordinators

Action 3.2. Assure that statisticians advising on the design of monitoring programs are knowledgeable about relevant practices and guidelines developed at the national or continental level by developing and conducting symposia and seminars for professional interaction/development.

Who: Statisticians and relevant biological staff

Action 3.3. Identify survey design and analysis issues where consensus is lacking and develop procedures to resolve issues.

Who: Staff involved in survey design (e.g., biologists, statisticians, program managers)

Action 3.4. Develop and adhere to design standards that allow for sound inferences about the target population and permit aggregation of data over temporal and geographic scales.

Who: Statisticians and survey program managers

Goal 4. Maintain bird population monitoring data in up-to-date data management systems. Recognizing legal, institutional, and other barriers, provide greater availability of raw data, associated metadata, and summary data for bird monitoring programs.

- *Challenge:* A large proportion of existing monitoring data is either unavailable or insufficient to aid decision-making for conservation and management.

Management of monitoring data is an important but frequently overlooked aspect of bird population monitoring. Discussions of bird population monitoring frequently revolve around setting objectives and developing appropriate survey designs and protocols, but issues associated with managing and accessing information are also important. Even if a monitoring program is well designed using state-of-the-art survey protocols, the program cannot meet its objectives if its data are not readily accessible to users.

Bird population monitoring data are currently managed through the haphazard creation of data management systems. Some monitoring efforts devote resources towards centralizing data management processes, but frequently, data management is the responsibility of local or regional programs with little or no coordination among them. The Breeding Bird Survey (BBS) serves as an example of a monitoring program with well-managed, current data that are easily accessed over the Internet as both raw data and summarized results. At the other extreme, some monitoring programs have data in a combination of hard copy and electronic formats that are inaccessible to users. A spectrum of data management systems exists between these extremes, producing data of variable quality and availability.

Current inadequacies involve all aspects of managing data including quality control, security of data systems, metadata creation, and accessibility to raw data and summarized reports. Accessibility involves the timeliness of data processing, ability to download raw data in user-friendly formats, and production of timely summaries. Archiving “legacy” data is becoming increasingly important to avoid losing baseline data of value for future comparative studies. Developing accessible permanent archival repositories of monitoring information requires greater attention. Additional issues related to managing bird population monitoring data are discussed in Appendix 5.

A coordinated approach to data management will use resources more efficiently and create uniform and readily accessible data to support decision-making. Developing and using common data management systems would greatly benefit bird conservation and management. These common data systems should be standardized and readily accessible, while reducing the resources necessary to manage data, allowing more resources to be allocated for data collection. Monitoring data must be web-accessible to enhance data entry, data sharing, and timely use for bird conservation and management. Developing and maintaining web-based data entry and retrieval pages can be costly, especially given the need to constantly improve these systems to meet the demands of changing technologies. Creating funding sources to support these activities would improve the quality and comparability of bird population monitoring data.

Data comparability may not be readily apparent to users unfamiliar with each monitoring program. Unless users understand how, when, and why data were collected, they may not be able to assess whether data from multiple surveys are comparable. Metadata allows users to make this determination, so access to the metadata record is as important as access to raw data. Keeping metadata current is important to reflect changes within a program. Metadata involves both geographic and data components, and developing complete metadata records for both components should be required of all bird population monitoring data management systems.

Recommendations to address these inadequacies are described below. Though essential, it will be challenging to alter existing approaches for managing monitoring data. Data management requirements should be identified as monitoring programs are developed and revamped. Database managers, biologists and GIS specialists should be involved at initial stages of project development to define these requirements. Sufficient resources should be dedicated for proper maintenance and timely availability. Approximately 20 percent of the BBS budget is devoted to data management efforts; therefore, similar proportions of the budgets of other monitoring programs will likely need to be dedicated to data management.

Data management is integral to the successful management and conservation of bird populations. A substantial commitment to improve current data management practices is necessary to fully realize the potential of bird population monitoring programs.

Recommendation 4. Develop a comprehensive plan for integrating and managing bird population monitoring data.

Action 4.1. Involve database managers, GIS specialists, biologists, and data analysts at the outset of program development to ensure that appropriate data are collected, maintained, and readily accessible in formats that expedite analysis and summarization of results.

Who: Developers of each monitoring program

Action 4.2. Develop a plan for quality data management repositories available for “common” use by the monitoring community, identify potential “gaps” in current data management systems, outline alternatives for managing data, and identify resources necessary.

Who: Data managers, biologists, and analysts

Action 4.3. Develop a set of minimum standards for data management, quality control, and data accessibility that apply to bird population monitoring programs.

Who: Data managers, biologists, and analysts

Action 4.4. Ensure appropriate metadata are created and readily available for all monitoring data sets through coordination with on-going efforts to develop metadata for bird population monitoring programs.

Who: Cornell Lab of Ornithology, National Biological Information Infrastructure (NBII)

Action 4.5. Make program reports and summaries routinely available in the peer-reviewed literature or accessible over the Internet in a timely manner.

Who: Federal and state agencies and non-governmental organizations.

APPENDICES

Appendix 1. Agency/Initiative Goals, Objectives, and Priorities for Monitoring

The following accounts were provided by each agency and bird initiative to summarize their individual goals and objectives for monitoring. Some monitoring goals are specific to agency mandates and policies and were not necessarily developed to meet bird conservation objectives. These differing perspectives and priorities, however, serve as a necessary basis for understanding the roles of various partners in coordinating bird monitoring programs to benefit bird conservation.

Federal and State Agencies

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) has the legal mandate and trust responsibility, established through more than 25 primary conventions, treaties, and laws, to maintain healthy migratory bird populations for the benefit of the American public. The USFWS has four principal goals that support this core mission: 1) conserve, protect, restore, and enhance fish, wildlife, and plant populations entrusted to our care, 2) conserve an ecologically diverse network of lands and waters — of various ownerships — providing habitats for fish, wildlife, and plant resources, 3) provide opportunities to the public to enjoy, understand, and participate in the use and conservation of fish and wildlife resources, 4) support and strengthen partnerships with tribal, state, and local governments and others in their efforts to conserve and enjoy fish, wildlife, plants and their habitats. Bird monitoring information assists USFWS programs in meeting their legal mandates in the following ways.

1. *Determine Status of Migratory Birds and the Need to List Any Bird Species as Threatened or Endangered.* For decades, the USFWS has used monitoring information from spring waterfowl surveys to assess population status and set, in conjunction with the States, waterfowl harvest regulations. These data are also used to assess progress toward population objectives defined in the North American Waterfowl Management Plan, which include model-based approaches for assessing effects of environmental factors. The Service coordinates similar surveys for American woodcock and mourning doves, and Service biologists have conducted a variety of aerial surveys to determine population status of migratory gamebirds (e.g., Sandhill cranes, trumpeter swans, seaducks). Many monitoring projects for nongame migratory birds are at the stage of providing initial estimates of population status, particularly for shorebirds, waterbirds, and secretive marshbirds. The Service Migratory Bird Program has identified a set of focal species to initiate assessments in 2006 and beyond. Monitoring information on population status and trend are incorporated into decisions regarding listing of species under the Endangered Species Act (ESA) or the Convention on International Trade in Endangered Species (CITES).

2. *Understand the Effects that Environmental Factors have on Migratory Bird Population Dynamics.* Concurrent monitoring of environmental factors is useful to help

understand what drives bird population dynamics. For example, pond counts conducted in the prairie-parkland region in conjunction with aerial waterfowl counts have helped elucidate relationships between environment conditions and duck population dynamics that are fundamental to waterfowl harvest regulation and habitat conservation planning.

3. *Regulate and Manage Take of Migratory and Threatened/Endangered Birds.* To determine the effectiveness of harvest regulations, the Service monitors the harvest of migratory gamebirds, including subsistence harvest of non-waterfowl. Take associated with permits for religious observances, falconry, and Bald Eagle de-listing will require monitoring programs, and the efficacy of long-line fishery deterrent streamers on reducing seabird by-catch is being evaluated. Data management tools have been developed to annually assess the number of permits issued for migratory bird species. Law enforcement monitors adherence to hunting regulations or violations of the Migratory Bird Treaty Act, ESA, CITES, or Bald and Golden Eagle Protection Act.

4. *Evaluate the Recovery of Listed Bird Species.* The USFWS uses monitoring information to evaluate the success of endangered species recovery plans. Monitoring has included, for example, singing male counts, pair counts, and indicators of reproductive success. For some species like the Kirtland's warbler, parasitism rates have been monitored to judge the effectiveness of brown-headed cowbird trapping.

5. *Set Spatially-explicit Management and Conservation Priorities.* Monitoring information at local sites helps managers determine proper management and conservation priorities. In some areas of the country, bird monitoring information is being incorporated into landscape models that prioritize areas for protection, enhancement or restoration. Monitoring systems have also been used to develop and evaluate these predictive models.

6. *Assess Effectiveness of Projects Implemented on Lands Owned by the USFWS or Influenced by USFWS Grants, Programs, or Policies.* The National Wildlife Refuge System (NWR) uses monitoring information to evaluate the effectiveness, and sometimes efficiency, of a variety of management and conservation interventions — the response, for example, of marine bird productivity to removal of exotic predators, grassland bird nest density to periodic burning, migrant shorebird numbers to water level manipulations. In the latter example, monitoring was designed to include numerous NWRs in the northeastern U.S. In most instances, however, monitoring is implemented to provide information to the immediate NWR manager. For Joint Ventures, Partners for Fish and Wildlife, and other programs, evaluation of project effectiveness extends beyond USFWS-owned lands.

7. *Report Efficiency of Base Funding and Grant Programs.* Efficiency of delivering habitat has been traditionally reported in number of acres protected, enhanced, or restored and dollars leveraged by USFWS grant programs in conjunction with private, State, or Federal landowners. The USFWS will be increasingly challenged to link projects with positive responses in trust resource bird populations. Beyond biological accomplishments, grants for migratory bird projects are audited for adherence to stated

objectives and legal constraints.

8. *Determine How the American Public Uses and Enjoys Birds and USFWS Lands.* The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation has been conducted about every five years since 1955. It provides information on the number of participants in fishing, hunting, and wildlife watching (observing, photographing, and feeding wildlife), and the amount of time and money spent on these activities. The Survey is one of the Nation's most important wildlife recreation databases. It is the only source of comprehensive information on participation and expenditures that is comparable on a state-by-state basis. It is used for estimating the economic impact of wildlife-related recreation for each state; for estimating the value of wildlife resources lost due to pollution or disease such as whirling disease in fish; for use in critical habitat analysis of threatened species; and for preparing environmental impact statements, budgets, and legislative proposals.

USDA Forest Service

Forest Service national policy and guidelines do not provide specific goals or objectives related to bird monitoring, but they do provide overall general goals related to all forms of natural resource monitoring, and also offer insights into the types of data considered of value to the Forest Service. Some of the underlying themes of various goal statements are that monitoring should:

- Produce highly credible data,
- Provide useful information for management decisions,
- Provide useful information to stakeholders, and
- Demonstrate collaboration with partners.

Specific goals and objectives for monitoring are generally contained within the specific Land and Resource Management Plan (LRMP) for each planning unit (one or more national forests or grasslands). Goals and objectives for monitoring specific bird species are contained in recovery plans or biological opinions for federally listed species, and are sometime reiterated in LRMPs.

The goal statement from the Forest Service Framework for Inventory and Monitoring (2000) is as follows:

Forest Service leadership is committed to using state-of-the-art methods and a systems approach to provide highly credible data and information to meet a wide range of customer business needs in collaboration with our land management partners.

Accompanying principles elaborate on this vision:

- Utilize a systems approach to inventory and monitoring that adopts a holistic view, recognizes complexity and interactions, and accounts for the dynamic nature and finite capacities of ecosystems.

- Inventory and monitoring are done with the clear purpose of meeting the agency business requirements (at all scales and organizational levels) as determined by the needs of our varied customers and partners.
- Inventory and monitoring are conducted in coordination, cooperation, and collaboration among Forest Service program areas and organizational units and with partners and customers.
- Inventory and monitoring methods and results are scientifically credible and meet rigorous quality assurance and quality control standards.
- Leadership clearly defines the structure for implementing the Framework; provides the resources needed to accomplish the tasks; and is held and holds others accountable for the success of inventory and monitoring programs.

Many national forests are still operating under the 1982 planning regulation (36 CFR Part 219), where monitoring language for Management Indicator Species is explicitly stated in Section 219.19(a)7: *Population trends of the management indicator species will be monitored and relationships to habitat changes determined.*

The 2004 planning rule provides only general direction for monitoring and removes the requirement to monitor management indicator species (36CFR Part 219.6(3)(b)(2)).

The plan-monitoring program shall provide for:

1. Monitoring to determine whether plan implementation is achieving multiple use objectives;
2. Monitoring to determine the effects of the various resource management activities within the plan area on the productivity of the land;
3. Monitoring of the degree to which on-the-ground management is maintaining or making progress toward the desired conditions and objectives for the plan; and
4. Adjustment of the monitoring program as appropriate to account for unanticipated changes in conditions.

A Forest Service Handbook was prepared in 2005 to interpret and implement the 2004 planning rule (FSM 1909.13 from Land Management Planning Handbook). When developing the monitoring program, the Responsible Official shall:

1. Involve the public in designing the monitoring program (36 CFR 219.9(a)),
2. Consider multi-agency approaches,
3. Design the monitoring program to form the basis for continual improvement,
4. Design monitoring and the evaluation of monitoring results to take into account the best available science (FSM 1921.8), and

5. Focus on resource areas where human influence is likely to cause a change over time.

U.S. Geological Survey

Migratory bird monitoring is a critical component of the USGS Biological Resources and Monitoring SubActivity (BRM). BRM has seven research programs all of which have monitoring wildlife species as part of some aspect of their priorities. The BRM USGS Status and Trends Program is specifically designed to focus on monitoring and assessment. The Program's broad-based goal and details of specific strategies for migratory birds are listed below.

GOAL: Collect, manage, archive, and share critical, high-quality monitoring data in cooperation with our partners to enable a determination of the status and trends of biological resources.

- Incorporate Measurement of Detection Probability into Survey Design.

Interpretation of results from the BBS or any other survey will be significantly enhanced, if methods to measure detection probability can be incorporated into the survey protocol.

- Provide High-Quality Bird-Banding Services to Partners.

Banding is essential for developing harvest management models for waterfowl, and more recently mourning doves, tracking individual bird histories in many kinds of research studies, and as a tool in environmental education. Because the services must be efficient, the BBL needs sufficient operational support.

- Increase the Number of Species Effectively Monitored by Long-term Surveys.

Effective long-term monitoring of all bird species in the U.S. is a stated goal of Partners in Flight, the National Shorebird Initiative, the Waterbird Initiative, and the North American Waterfowl Management Plan, as well as planning efforts for various species of resident game birds, the five organizational components of the North American Bird Conservation Initiative (NABCI).

- Expand the Geographic Scope of Existing Surveys

Because most bird conservation programs have a species focus, or measure effectiveness of habitat management actions in terms of response of species, designs of long-term surveys should, when possible, allow for population inferences across the entire ranges of species.

- Improve Bird Population Database Infrastructure and Data Delivery to Partners

Status and trends surveys are most valuable to resource management partners when their databases are actively managed relational databases, delivered as part of either a centralized or distributed network electronically accessible through a single web portal.

- Increase Efforts to Incorporate Measurement of Potential Causative Factors into Population Surveys

The value of surveys is greatly enhanced when data on habitat or other factors likely to be causing the observed changes are collected along with the population data itself.

Association of Fish and Wildlife Agencies (States)

Goals and objectives for bird monitoring that are the responsibility of the AFWA and member state and provincial agencies are reflected in the AFWA strategic plan (AFWA 2006) goals of the Bird Conservation Committee (Bird Conservation Committee of AFWA 2006), State Wildlife Action Plans, and individual state agency missions and goals. Integrating efforts across agency boundaries will promote sound resource management and strengthen federal, state, provincial, territorial and private cooperation in conserving fish and wildlife and their habitats in the public interest. Coordinated monitoring must protect state authority and support provincial and territorial authority for wildlife conservation.

Critical issues affecting states, provinces, and territories include 1) adequate funding to support wildlife conservation, 2) an adequate habitat base to sustain fish and wildlife populations and those physical, chemical, biological and social factors that directly impact wildlife resources, 3) public and political support and coordination necessary to fulfill our mission, and 4) efficient and effective internal operations and business systems to maximize benefits to the wildlife resources and the public.

The specific focus on bird conservation varies considerably across geographies and within States. The recently completed State Wildlife Action Plans provide lists of species of greatest conservation need that will guide much of the monitoring the States conduct and participate in the future. State species of concern lists will also guide monitoring.

Monitoring priorities include the following:

1. Assess or evaluate management and/or conservation actions (e.g., habitat management),
2. Develop management and conservation actions,
3. Trend information for management of species (e.g., harvest),
4. Prioritize species for management and conservation,
5. Maintain diversity,
6. Evaluate how well an agency is meeting its objectives,
7. Determine information gaps, and

8. Understanding stakeholder activity, attitudes, and desires.

Priorities among agencies for bird monitoring and conservation will require integrated programs, communication, regulation, policy, and legislation.

- *Interagency Working Relationships*: To cultivate relationships and mutual understanding among those officially engaged in the conservation of our natural resources, and especially to coordinate the efforts of public administrative agencies responsible for the protection, preservation and management of the fish, wildlife, forests, waters and soils of North America;
- *Information Transfer*: To distribute literature and, by other available means, to develop a more general public understanding and appreciation of the economic and ethical importance of conserving the forests, waters and soils, and of managing wisely our fish and wildlife as part of natural and managed ecosystems, and as a source of recreation and food for our citizens;
- *Natural Resources Management and Restoration*: To promote fish and wildlife management, and to investigate and advise with respect to the introduction of new species and varieties of fish and wildlife;
- *Natural Resources Legislation*: To create and foster a healthy public sentiment in favor of better laws for protection of natural resources; to assist in the enactment of laws for the adequate protection and management of said natural resources; to obtain as far as possible uniformity in same; and to correct irregularities and inconsistencies in existing laws;
- *Natural Resources Regulations*: To assist the duly constituted authorities in enforcing laws for the protection of natural resources, including fish and wildlife and their habitat; and
- *Natural Resources Litigation*: Generally to take all such legal and other proper actions as will further the cause of maintaining an adequate supply of fish and wildlife and other natural resources.

Bird Conservation Initiatives

Partners In Flight

The following are the goals and objectives for bird monitoring to meet the objectives of the North American Landbird Conservation Plan (Rich et al. 2004). Details of monitoring needs for landbirds, including priorities for filling in monitoring gaps and suggestions for new and expanded monitoring programs, are provided in Dunn et al. 2005a.

Continental Goals and Objectives for Bird Monitoring

Goal I. To detect and assess significant population declines in any native North American bird species.

Objective 1. Assess monitoring status of 448+ landbird species, with ability to detect a 50% population decline within a 20-year period.

Objective 2. Identify species (or groups) not adequately monitored to meet objective 1.

Objective 3. Identify specific program improvements or new monitoring programs that can address species identified under objective 2.

Objective 4. Prioritize continental monitoring needs – which new or improved programs are needed (where) to address monitoring status of highest concern species?

Goal II. To inform sound policies and prioritize actions by land-management agencies that affect native bird populations (esp. species of conservation concern).

Objective 1. Identify overarching management issues (policy, land-use) of greatest importance to bird populations (in N. American Landbird Plan)

Objective 2. Incorporate monitoring needs for priority bird species into agency management plans – to address overarching issues

Objective 3. Coordinate bird monitoring programs across agencies and institutions to increase efficiency, reduce redundancy, and therefore increase overall capacity to effectively monitor species of highest concern.

Goal III. To investigate causes of population change in species of interest

Objective 1. Conduct demographic monitoring to determine whether population change is driven primarily by reproduction or survival.

Objective 2. Communicate monitoring results to research community to encourage more detailed research into causes of population changes of interest.

Goal IV. To evaluate success of conservation planning and actions – are bird populations responding and improving?

Objective 1. Measure direct response to local management actions

Objective 2. Detect regional response to management at local scales

Objective 3. Link regional and local monitoring with continental population objectives.

North American Waterfowl Management Plan (NAWMP Plan Committee, 2004)

Scaup population management. Greater and lesser scaup have not traditionally been distinguished separately in continental waterfowl breeding population surveys due to difficulties in distinguishing these species from the air. The combined continental scaup population estimate has been declining since the 1970s and concern over the status of these species has led recently to harvest restrictions. Lack of species-specific estimates of abundance and trend also hamper

efforts to understand the causes of population changes and set meaningful conservation objectives.

Conservation Objective: Develop sustainable species-specific harvest strategies and regional habitat conservation strategies for greater and lesser scaup.

Management Actions: Harvest regulations, regional habitat conservation objectives and strategies stepped down from continental population objectives, environmental policies that address population stressors such as contaminants.

Management Uncertainties: Species specific population trajectories and spatial patterns of population change are currently unknown due to survey limitations. Agents causing population change and the timing and scale at which these processes operate are also unknown.

Monitoring: Monitor continental breeding population of both species utilizing a combination of aerial and ground based methods. Adjust timing of breeding surveys to coincide with scaup nesting phenology. Monitor environmental and weather factors thought to impact scaup breeding propensity and success. Evaluate the feasibility of winter surveys to monitor sea duck winter concentration areas, possibly in conjunction with statistically rigorous sea duck surveys. Monitor environmental parameters including contaminants and offshore human activities (e.g., fisheries and by-catch, shipping, pollution) along with weather to assess possible effects on scaup populations.

Stakeholders: State and federal conservation agency managers and policy makers, NAWMP Habitat Joint Ventures.

Mottled duck population management. No systematic and comprehensive surveys of the mottled duck breeding range currently exist. Breeding surveys are conducted annually on NWRs along the Texas Gulf Coast and suggest Western Gulf Coast mottled ducks breeding in Texas have declined recently. A statistically rigorous breeding population survey does exist for Florida mottled ducks. Mid-winter surveys are not considered adequate to assess the status of this species or to develop effective harvest strategies or conservation plans.

Conservation Objective: Develop sustainable species-specific harvest strategies and regional habitat conservation strategies for Western Gulf Coast mottled ducks.

Management Actions: Harvest regulations, regional habitat conservation objectives and strategies stepped down from continental population objectives, conservation policies that address potential population stressors such as alligator predation.

Management Uncertainties: Range-wide population trajectories and spatial patterns of population change are currently unknown due to limitations of breeding survey coverage. Agents causing population change and the timing and scale at which these processes operate are also unknown.

Monitoring: Develop a range-wide breeding population survey for Western Gulf Coast mottled ducks to determine if declines on Texas coastal NWRs are representative of population-wide trajectories. Monitor environmental, weather, and other (e.g., predation) factors thought to impact mottled duck breeding success.

Stakeholders: State and federal conservation agency managers and policy makers, the Gulf Coast Joint Venture.

Sea duck population management. Many sea duck species have not traditionally been adequately monitored through continental waterfowl breeding population surveys because large portions of some species northern breeding ranges lie outside surveyed areas and because of the cost and specialized equipment requirements of operating in arctic regions. Traditional winter surveys do not include offshore habitats utilized by some species. Available population estimates of scoters, long-tailed ducks, and some eider populations have declined over recent decades.

Conservation Objective: Develop sustainable species-specific harvest strategies and regional habitat conservation strategies for sea ducks, especially scoters, long-tailed ducks, and eiders, not adequately monitored through traditional breeding and wintering surveys.

Management Actions: Harvest regulations, regional habitat conservation objectives and strategies stepped down from continental population objectives, environmental policies that address potential population stressors such as contaminants, fisheries by-catch, and offshore development in wintering areas (e.g., sand mining for beach nourishment, wind power development).

Management Uncertainties: Species specific population trajectories and spatial patterns of population change are currently unknown due to survey limitations. Agents causing population change and the timing and scale at which these processes operate are also unknown.

Monitoring: The Sea Duck Joint Venture of the NAWMP has identified priority breeding and wintering surveys for populations of sea ducks recognized by the NAWMP. Monitor species-specific breeding populations of certain arctic breeding sea ducks possibly in conjunction with surveys of arctic nesting geese. Adjust timing of breeding surveys to coincide with sea duck nesting phenology. Monitor environmental and weather factors thought to impact sea duck breeding propensity and success. Evaluate the feasibility of winter surveys to monitor scaup winter concentration areas, possibly in conjunction with statistically rigorous diving duck (e.g., scaup) surveys. Monitor environmental parameters including contaminants and offshore human activities (e.g., fisheries and by-catch, shipping, pollution) along with weather to assess possible effects on sea duck populations.

Stakeholders: State and federal conservation agency managers and policy makers, the Sea Duck Joint Venture, and NAWMP Habitat Joint Ventures.

Population-scale, multi-regional conservation planning. The NAWMP is predicated on the assumption that the cumulative effects of regional conservation actions implemented or directed (e.g., conservation programs or policies such as the CRP or WRP programs) through joint ventures will result in range-wide habitat conditions suitable for attainment of NAWMP continental population objectives. A challenging aspect of conservation planning for migratory waterfowl is accounting for cross-seasonal effects of regional habitat and weather conditions on duck populations. Knowledge of the effects of regional conditions on intra-seasonal movements, migration timing and patterns, body condition, survival, and settling patterns would assist in development of regional conservation strategies that account for cross-seasonal influences on population abundance and demography. Comprehensive, large-scale monitoring programs for the mallard already exist and similarities to other dabbling species in habitat requirements and migratory behavior make the mallard a good candidate for investigation.

Conservation Objective: Develop coordinated regional habitat conservation strategies for mallards (and possibly other species of interest, e.g., northern pintail) that account for cross-seasonal influences of habitat and weather conditions.

Management Actions: Regional habitat conservation objectives and strategies stepped down from continental population objectives that are sensitive to heterogeneity and stochasticity in regional habitat and weather conditions.

Management Uncertainties: The effects of within season and annual variation in habitat availability and quality and weather conditions on within season movements, migration, body condition, survival and settling patterns of ducks are poorly understood.

Monitoring: Conduct a coordinated, large-scale satellite and conventional telemetry study of mid-continent mallards (and possibly other species of interest) in conjunction with traditional banding, population, and harvest surveys to track within season and annual movement patterns, monitor body condition, and estimate survival rates. Monitor weather, habitat, and other environmental parameters in key habitat regions to assess the effects of environmental variability on mallard movements, body condition, survival, and settling.

Stakeholders: State and federal conservation agency managers and policy makers, NAWMP Habitat Joint Ventures.

Duck production in the prairie-parkland region. Information on annual duck production from the prairie-parkland region provides important verification of predictions made during the process of establishing annual hunting regulations, predictions made without knowledge of changes in habitat conditions that occur between spring breeding surveys and early summer. Species-specific indices of production as well as spatial and temporal pattern in these indices are also critical to validating the predictions of models used in habitat conservation planning in the prairie-parkland region and in refining these models. Budget constraints in the FWS forced the cancellation of the long-standing Waterfowl Production and Habitat Survey, that was conducted every July. This survey has not been conducted since 2003. Prior to the cancellation of this

survey it had come under scrutiny because it lacked methods to estimate detection rates, did not provide species-specific indices, and did not provide insight into season-long production.

Conservation Objective: Validate and refine models to predict prairie-parkland duck production at local and regional scales in order to establish effective harvest regulations and develop appropriate habitat conservation strategies.

Management Actions: Harvest regulations, regional habitat conservation objectives and strategies stepped down from continental population objectives, land use policies such as the CRP.

Management Uncertainties: Local and regional duck production and the relationship of production to landscape attributes, weather conditions, and population size.

Monitoring: Develop improved procedures to monitoring duck production from the prairie-parkland region. These methods should result in species-specific indices to production that can be summarized at local and regional scales and can be related to landscape attributes, breeding population estimates, and weather conditions. The FWS and CWS have recently begun to explore a variety of ground-based and aerial survey methods to assess production, and these efforts should continue in a coordinated fashion.

Stakeholders: State and federal conservation agency managers and policy makers, NAWMP Habitat Joint Ventures, HAPET Offices.

Waterbird Initiative

Population monitoring programs support two major goals of the Waterbird Conservation Plan for the Americas (Kushlan et al. 2002.) Data collected by these programs are integral for achieving the species and population goal of ensuring “sustainable distributions, diversity and abundance of waterbird species throughout each of their historical or naturally expanding ranges in the lands and waters of North America, Central America, and the Caribbean.” Monitoring information also identifies locations receiving significant use by waterbirds, helping to meet the habitat goal “to protect, restore and manage sufficient high quality habitat and key sites for waterbirds throughout the year to meet species and population goals.” Effective monitoring to meet these goals requires surveillance and management-based approaches combined with information on demographic parameters and environmental covariates, carefully crafted to obtain data at appropriate geographic and temporal scales. This multi-dimensional approach fosters collaboration among agencies and individuals concerned about waterbirds, resulting in efficient use of limited resources, better informed management decisions, and broad support for conservation actions.

Monitoring information will meet the objectives of the Waterbird Initiative by:

- Establishing population status and trends for all waterbirds in North America, Central America, and the Caribbean,

- Defining sustainable population goals for all species at regional and continental scales,
- Identifying key marine, coastal, and freshwater habitats for breeding, wintering, migrating, roosting, and foraging waterbirds,
- Increasing our understanding of waterbird habitat requirements and how habitat management activities can be improved to benefit their populations,
- Collecting data on demographic parameters for some species to identify factors responsible for population changes, and
- Identifying significant threats to waterbird populations and habitat quality in order to take appropriate conservation actions.

U.S. Shorebird Conservation Plan

At a regional scale, the goal of the plan is to ensure that adequate quantity and quality of habitat is identified and maintained to support the different shorebirds that breed in, winter in, and migrate through each region. At a national scale, the goal is to stabilize populations of all shorebird species known or suspected of being in decline due to limiting factors occurring within the U.S., while ensuring that common species are also protected from future threats. At a hemispheric scale, the goal is to restore and maintain the populations of all shorebird species in the Western Hemisphere through cooperative international effort.

Monitoring goals of the U.S. Shorebird Conservation Plan (Brown et al. 2001):

- Conduct statistically valid monitoring of long-term, species-specific population trends. This goal is critical to determining the status of existing populations, and the long term effects of large scale conservation activities.
- Provide more precise estimates of population size for shorebird species. This goal allows for conservation planning at a variety of scales, based on accurate information about species distribution and status.
- Monitor shorebird use of major staging areas, migration pathways, and wintering areas. This goal supports management activities targeted to specific life history stages of shorebirds, helps identify key areas for shorebird conservation, and helps measure the success of local conservation activities.
- Ensure that shorebird population information is effectively integrated into national bird conservation planning and implementation. This goal supports the appropriate use of monitoring data in design and evaluation of conservation activities, and encourages communication between diverse wildlife research, monitoring, and management agencies and organizations.

Objectives to achieve these national monitoring goals are detailed in the Shorebird Plan. Few shorebird species are monitored adequately at this time, and despite their widespread distribution, information regarding many shorebird species is lacking. The Program for Regional and International Shorebird Monitoring was developed to address all of the monitoring goals of the Plan.

Resident Game Bird Planning Efforts

Monitoring is an integral component in management programs for resident game birds in many states. Currently, monitoring techniques including but not limited to: spring/fall bobwhite quail surveys, ruffed grouse drumming surveys, wild turkey brood surveys, booming ground surveys for prairie chickens, and harvest surveys are conducted utilizing varying techniques and protocols. There is a need for standardization amongst and between states and BCRs if these tools are to be of greatest value in evaluating the success of the various resident game bird planning efforts.

Appendix 2: Goals and Objectives for Bird Monitoring

Based on the stated monitoring goals and objectives of each agency and bird initiative (see Appendix 1), several common themes emerged that reflect shared priorities across the bird conservation community. In the table below, we list the goal statements of each NABCI partner that fall within these broad themes. Note that some broad goals of bird monitoring, such as determining causes of population declines or assessing human dimensions, remain beyond the scope of the present report.

DETERMINE STATUS AND TRENDS OF POPULATIONS

- Detect and assess significant population declines in any native North American (landbird) species (PIF)
- Conduct statistically valid monitoring of long-term, species-specific population trends (SB)
- Establish population status and trends for all waterbirds in N. America, Cent. America, and Caribbean (WB)
- Track changes in waterfowl abundance and habitat to enable assessment of status and the development of abundance objectives (NAWMP) [relate to habitat changes]
- Determine status of migratory birds and the need to list any bird species as threatened or endangered (USFWS)
- Collect, manage, archive, and share critical, high-quality monitoring data... to enable a determination of the status and trends of biological resources (USGS)
- Document trends for management of species (e.g., harvest) (AFWA)
- Document trends of the management indicator species and determine relationships to habitat changes (USFS)

INFORM MANAGEMENT AND POLICIES TO ACHIEVE CONSERVATION

- Inform sound policies and prioritize actions by land-management agencies that affect native bird populations (PIF)
- Ensure that shorebird population information is effectively integrated into national bird conservation planning and implementation (SB)
- Increase understanding of waterbird habitat requirements and how habitat management can be improved to benefit populations (WB)
- Identifying significant threats to waterbird populations and habitat quality in order to take appropriate conservation actions (WB)
- Inform adaptive management decisions based upon waterfowl population trends and habitat status (NAWMP)
- Regulate and manage the take of migratory birds (USFWS)
- Develop management and conservation actions (AFWA)
- Determine whether plan implementation is achieving multiple use objectives (USFS)

DETERMINE CAUSES OF POPULATION CHANGE

- Investigate causes of population change; conduct demographic monitoring (PIF)
- Collect data on demographic parameters to identify factors responsible for population change (WB)

Improve methods to monitor habitat carrying capacity, vital rates and harvest rates to better understand mechanisms causing changes in abundance (NAWMP)

Understand the effects that environmental factors have on bird population dynamics (USFWS)

Increase efforts to incorporate measurement of potential causative factors into population surveys (USGS)

EVALUATE CONSERVATION EFFORTS

Evaluate conservation planning and actions (are bird pops responding and improving?) (PIF) (NBCI)

Test assumptions underlying habitat conservation objectives, and evaluate conservation actions, seek cohesion of population objectives with adaptive harvest management

Evaluate the recovery of listed bird species (USFWS)

Assess effectiveness of projects implemented on lands owned by the USFWS or influenced by USFWS grants, programs, or policies (USFWS)

Determine Program efficiency and effectiveness (USFWS)

Assess or evaluate management and/or conservation actions (e.g. habitat management) (AFWA)

Evaluate agency objectives (AFWA)

Determine information gaps (AFWA)

Determine the effects of the resource management activities within the plan area (USFS)

SET POPULATION OBJECTIVES AND SPECIES/MANAGEMENT PRIORITIES

Provide more precise estimates of population size for shorebird species (SB)

Define sustainable population goals for all species at regional and continental scales (WB)

Provide science-based biological foundation to address Joint Venture (JV) mgmt. needs. Set spatially explicit management priorities by habitat & species

Set spatially explicit management and conservation priorities (USFWS)

Prioritize species for management and conservation (AFWA)

Establish goals and measure progress in recovery plans or biological opinions for federally listed species, (USFS)

Improve capability to assess population status and trend for poorly monitored waterfowl species to enable development of explicit, internationally recognized population objectives (NAWMP)

INFORM CONSERVATION DESIGN

Monitor shorebird use of major staging areas, migration pathways, and wintering areas (SB)

Identifying key marine, coastal, and freshwater habitats for breeding, wintering, migrating, roosting, and foraging waterbirds (WB)

Disseminate scientific conservation techniques/information to influence conservation/agricultural land use. Set spatially explicit mgmt. and conservation priorities

Set spatially explicit management and conservation priorities (USFWS)

Set goals and objectives for monitoring within the specific Land and Resource Management Plan (LRMP) for each planning unit (one or more national forests or grasslands) (USFS)

Set spatially explicit management and conservation priorities (add NAWMP along with USFWS)

ASSESS HUMAN DIMENSIONS

conduct hunter and harvest surveys to assess hunter attitudes and preferences (USFWS)

Determine how the American public uses and enjoys birds and USFWS lands (USFWS)

Understand stakeholder activity, attitudes, and desires (AFWA)

Measure performance at all scales and organizational levels as determined by the needs of our varied customers and partners (USFS)

KEY

PIF Partners in Flight

SB U.S. Shorebird Conservation Plan

WB North American Waterbird Conservation Plan

NAWMP North American Waterfowl Management Plan

AFWA Association of Fish and Wildlife Agencies

USFWS United States Fish and Wildlife Service

USFS United States Forest Service

USGS United States Geologic Survey

NBCI Northern Bobwhite Conservation Initiative

Appendix 3. Overview of Some Current Monitoring Programs

The NABCI monitoring sub-committee plans to support an evaluation of existing monitoring programs that are continental, national, or regional in scope, in order to identify opportunities to increase efficiency and improve standardization. Here we briefly summarize our knowledge of some existing bird monitoring programs and how they currently contribute to bird conservation. This overview is based on monitoring reports from each of the bird initiatives, on recent overviews published by Bart et al. (2004) and Bart (2005), and on publications related to specific monitoring programs.

Continental, multiple species monitoring programs

This section describes three large scale monitoring programs: the Breeding Bird Survey (BBS) the Waterfowl Breeding Population and Habitat Survey, and the North American Monitoring Avian Productivity and Survivorship (MAPS) program. Generally speaking, the goals of these programs are to obtain and disseminate information on bird abundance and trends (and in the case of MAPS, to provide productivity and survivorship information), in order to make informed management decisions, identify species most in need of conservation attention, and identify research needs. All three programs use consistent survey methods that can be undertaken at a fairly reasonable cost, and all maintain central data repositories from which data analyses can be performed at a variety of spatial scales. Canada and Mexico collaborate on the BBS and Waterfowl surveys, and Canada, also collaborates on the MAPS program.

The Breeding Bird Survey began with 600 routes in 1966 and has expanded to 3,700 routes, with approximately 2,900 routes surveyed annually (Sauer et al. 1997). It was initiated by the USFWS and was transferred to USGS in 1993. The Waterfowl Breeding Population and Habitat Survey is an annual May survey that has been in place since 1955, and covers the Prairie Pothole region, boreal forests, and tundra habitats from South Dakota to Alaska. During the 1990s this survey was expanded to include waterfowl breeding habitats in eastern North America. It is coordinated by the USFWS Division of Migratory Bird Management. The MAPS program was established in 1989 by the Institute for Bird Populations (IBP) and has been a continuously growing program in the number of stations and spatial coverage. Currently there are over 500 stations in the United States and Canada, using a field protocol that was standardized in 1991 (Desante and Nott 2000).

The BBS and Waterfowl Survey programs are remarkable in their long-term stability, the development and maintenance of centralized data repositories, and the use of qualified biometricians for data analysis. For decades, the Waterfowl Breeding Population and Habitat Survey has been the primary source of population information for setting waterfowl management objectives. Data from the Breeding Bird Survey has influenced management actions and sparked research questions particularly since the mid-90's, when the data and analysis tools were made available on the Patuxent Wildlife Research Center website. Because of its shorter history, MAPS does not yet have a long-term database, but it has a centralized data repository, housed at IBP, and employs qualified biometricians for the analyses that have emerged from the first 15 years of standardized data collection.

Continental programs have limitations that primarily stem from the need to keep costs of these vast programs manageable. Many species are not adequately sampled because the short duration of the survey period does not coincide with their breeding phenology. For example, the Waterfowl Breeding Population and Habitat Survey is not optimally timed for most diving ducks (NAWMP Plan Committee 2004). Several woodpeckers and a number of desert species are poorly sampled by the BBS because their breeding activity takes place prior to the survey period (Dunn et al. 2005a).

Other species are not adequately sampled because the survey areas do not include sufficient representation of their breeding range. The core breeding ranges of approximately half of the sea ducks are not adequately covered by the Waterfowl Breeding Population and Habitat Survey (NAWMP Plan Committee 2004). Of the landbirds, 167 species are not adequately monitored because more than one-third of their ranges are within the northern boreal regions (Bart et al. 2004). Breeding Bird Survey routes also are not adequate for most species that breed at high elevations. MAPS was primarily designed for a limited number of landbirds, although this number could increase with expansion of the program into more habitats.

All three programs have limitations related to sampling approaches. Methods to estimate detection probabilities are only partially incorporated into the Waterfowl Breeding Population and Habitat Survey, and such methods are not a part of the BBS sampling design. Unlike these programs, MAPS uses constant-effort mist-netting that enables field personnel to mark individuals so that abundance can be estimated from modified Cormack-Jolly-Seber mark-recapture models (DeSante and Nott 2000). The disadvantage to this approach is that extensive expertise is required to conduct mist netting, band individuals, and accurately separate birds into age categories.

The extensive nature of the BBS and Waterfowl Survey makes it difficult to collect habitat data that could be meaningfully correlated with annual abundance and multi-year trends. Different vegetation types are used as habitat across a species' range, and each of these vegetation types undergoes regional or local changes in quality or quantity. In spite of these shortcomings, these programs provide value in the context of their initial objective of providing abundance and trend information over broad spatial extents (Bart et al. 2004, Bart 2005).

MAPS has begun to incorporate habitat information by using landscape metrics within a 4 km radius of the mist-netting stations, and this appears to be a useful characterization for the targeted species that have been evaluated (DeSante and Nott 2000). Additionally, MAPS data have been successfully used to correlate forest management actions with bird productivity, demographics, and abundance (Nott et al. 2003, 2005). However, habitat information requires additional data collection and funding beyond the core MAPS program, so it is not always obtained.

The Waterfowl Breeding Population and Habitat Survey provides reliable estimates for seven species of dabbling ducks (NAWMP Plan Committee 2004), and the BBS adequately monitors 153 of the 448 species of landbirds that regularly breed in North America (Dunn et al. 2005a). The utility of the Waterfowl Breeding Population and Habitat Survey could be increased for diving ducks and sea ducks by expanding the temporal and spatial extent of this program (NAWMP Plan Committee 2004). Similarly, the number of adequately monitored landbirds

could be increased to approximately 237 species, which represents 53% of all landbirds and 80% of landbirds for which the BBS is an appropriate monitoring method, if recommendations for expanding and improving the BBS are adopted (Bart et al. 2005, Dunn et al. 2005a).

There are no continental programs in place that adequately monitor several groups of species, including colonial waterbirds, secretive marshbirds, nearly all of the shorebirds, and approximately half of the landbirds. The Christmas Bird Count may have some utility in assessing long-term trends of some species, especially those that exhibit obvious range expansions and contractions, and those with large wintering populations within the continental U.S. (Dunn et al. 2005b). Additionally, the eBird program, an on-line database sponsored by the Cornell Lab of Ornithology, enables all citizens to record and retrieve bird observations, and could become a useful tool for observing changes in abundance and distribution of certain bird species.

There is a shared desire under most bird initiatives to increase the proportion of bird species that are monitored under continental programs, and to increase the adequacy of the monitoring effort for those that are marginally included. As new programs are initiated, the development of fully accessible databases should also be advanced (Bart 2005).

Multiple species programs at the regional and multi-state or province scale

A number of multiple species bird monitoring programs are coordinated at the regional or multi-state and province scale. Each program is characterized by one or more standard field protocols for a group of species, but these protocols frequently vary by region. As with the continental programs, the primary objective is to estimate abundance and trend for a suite of species. In some cases, the data are aggregated across a nation or continent, and in other cases the data are managed and reported at a state or multi-state and province scale.

The Midwinter Waterfowl Inventory, which has been conducted annually in early January since the mid- 1940's, is an example of a long-standing, continent-wide survey in which the field protocols vary by state and province (NAWMP Plan Committee 2004). The objective is to obtain a complete census of all waterfowl within a prescribed survey area using a detection method that is considered the best and most practical for a specific area. Although the Midwinter Waterfowl Inventory provides information on many species that are not adequately monitored during the breeding season, the ability to aggregate data and estimate trends is hampered by regional differences in field methods (Eggeman and Johnson 1989). Moreover, it is generally not possible to make inferences about state and regional populations because of the manner in which survey areas are selected, annual differences in survey efforts, and other factors. Despite these limitations, this survey remains the only source of status information for several harvested waterfowl species including brant and tundra swans.

Several colonial waterbird surveys have been conducted since the early 1970s by various Federal, State, and private agencies (Moser and Jones 2000, Kushlan et al. 2002). Included in this suite of multiple species programs are those that target freshwater wading birds and others that focus on seabirds. These surveys provide the only long-term data for the majority of species in these groups, but the data have limited application due to methodological shortcomings and

differences in methodology across regions. Although the need to improve and standardize survey methods is well recognized, many regions are hesitant to abandon current methods that have yielded decades of data. The Waterbird Monitoring Partnership provides a web-accessible database of data from individual waterbird surveys, but because of differences in survey methods, the data are not collated.

The current monitoring situation for shorebirds is similar to that of waterbirds, in that the various programs are regional in scope and use different methodologies. The International Shorebird Survey, Maritimes Shorebird Survey, Western Shorebird Survey, British Columbia Coastal Waterbird Survey, and South Atlantic Migratory Bird Initiative are all migration surveys that use different methods with different sets of strengths and shortcomings. A few shorebird species are also monitored under the BBS and Christmas Bird Count programs. The Program for Regional and International Shorebird Monitoring (PRISM) (Bart et al. 2002) summarizes the current level of monitoring provided for 74 species, subspecies, or distinct populations of shorebirds in Canada and the U.S., under existing programs. Many shorebirds breed in the arctic and boreal regions and are currently inadequately monitored, and for these, PRISM recommends double sampling, with rapid surveys on numerous, randomly selected plots, and intensive work on a subset of these plots to obtain detection rates on the rapid surveys. Arctic surveys that use double sampling have already been established in some areas. The breeding ranges of 17 shorebird species are within the central, temperate regions of North America, but currently only 6 of these are adequately monitored through existing programs. Winter surveys in Central and South America at major shorebird concentration areas are needed for populations of many North American shorebirds.

Hawk migration surveys occur nationwide but are currently regional in scope because data are collected under a variety of protocols and are evaluated regionally. In January 2005, three raptor research organizations (Hawk Migration Association of North America, Hawk Mountain Sanctuary Association, and HawkWatch, International) formed the Raptor Population Index (RPI) Partnership to develop a common set of indices for estimating raptor populations and trends at spring and fall migration sites in Canada, the U.S., and Mexico. Once established, the RPI has the potential to become a continent-wide, multiple species monitoring program for raptors. Currently, data are stored on separate websites for each program and vary from simple data summaries to yearly counts per each migration station.

Several regional monitoring programs for landbirds have been in place for several years, either using point counts or MAPS. Examples are the Northern Rockies Landbird Monitoring Program (12 years), Monitoring Colorado Birds (7 years), Songbird monitoring in the Great Lakes Region (14 years), Landbird Monitoring for the Klamath-Siskiyou Bioregion (14 years), Southern Region Neotropical Migrants and Resident Landbird Monitoring (8 years), and Nevada Bird Count (4 years). Most programs provide web-accessible data summaries and some provide access to raw data. Each of these programs uses different sampling designs, so data and programs will likely remain at the regional scale, but all programs have contributed information to numerous management decisions within their respective regions. The information includes short-term trend data (< 20 years to date) and improvement of regional bird-habitat relationships models.

A national monitoring protocol to measure the response of landbirds and northern bobwhite quail to USDA-FSA CRP-479 conservation practice 33, habitat buffers for upland wildlife, was implemented in summer 2006. The Southeast Quail Study Group developed a multi-stage sampling framework for monitoring CP-33 that insures consistency in data collection among states and facilitates statistically valid measures of effectiveness of the practice regionally and nationally.

The Birds and Burns Network is a regional program that examines fire effects on populations and habitats of wildlife in ponderosa pine (*Pinus ponderosa*) forests (Saab and Powell 2005). The targeted species are cavity-nesters and songbirds. For prescribed fire effects, the Network uses a Before, After, Control, Impact (BACI) design with replication at 9 locations in 8 western states, including locations on National Forests, National Parks, and state and private lands. Additional monitoring is carried out at wildfires in 4 states, to compare prescribed fire and wildfire effects.

Range-wide, single species programs

Single-species monitoring programs are needed for obtaining long-term trends on species that are rare or are restricted to a specific habitat or locality. An estimated 10-15 % of all birds that breed in North America fall into this category, but this estimate is rough because only Partners in Flight has published a detailed evaluation. This evaluation recommends single-species programs for 33 landbirds that represent 7 % of the 448 landbird species that regularly breed in Canada and the U. S (Dunn et al. 2005a). Of these, 10 species currently have single-species, range-wide monitoring programs in place. Many of these species are federally listed, and the monitoring programs are part of the species' recovery plan.

The U.S. Fish and Wildlife Service Division of Migratory Birds and the Canadian Wildlife Service coordinate two single species monitoring programs: the Mourning Dove Call-Count Survey and the Woodcock Singing-Ground Survey. Both surveys provide one source of information considered in the establishment of annual hunting regulations for these species.

Most species with single-species monitoring needs do not have monitoring programs with a consistent protocol across the range of the species. Commonly, different jurisdictions carry out sporadic monitoring with very little consistency in field methods and little to no inclusion of a sampling design. The data have short half-lives, rarely lasting longer than the tenure of the biologist who established the program. Analysis of data is extremely rare and fraught with statistical shortcomings.

State and local programs

State monitoring programs cover a wide range of objectives, including state-specific commitments to species of conservation concern, information needs for harvestable species, and the support of broader monitoring efforts such as the BBS, bald eagle survey, and winter waterfowl survey. State and local programs are well-suited to monitor the effects of specific management actions on bird populations. Little attention has focused on developing an inventory of states' monitoring programs or coordinating extensive states' monitoring efforts.

Appendix 4. Evaluation Criteria

The NABCI Monitoring Subcommittee intends to assess the current state of bird population monitoring in the United States. In doing so, the Subcommittee will review the hundreds of programs throughout the country with the following criteria in mind:

Rationale

- Clearly articulated survey objectives provide management and conservation context.

Design

- Explicitly defined geographic scope and spatial sampling unit.
- Taxa and inferential populations are defined.
- Primary response variables and environmental covariates
- Survey protocols (sampling frame, procedures, precision and bias).
- Appropriate analytical procedures.
- Long-term data storage and access, preferably in a central facility.

Coordination

- Clearly defined responsibilities across geographic coverage.
- Training programs.
- Accessible reports, data and metadata.

Appendix 5. Data Management Systems

1) Defining objectives of data management systems.

Just as most monitoring programs are developed to meet specific objectives, data management systems should be established to meet objectives related to these programs. Most data systems are designed with little consideration of how one system may interact with others. Finding the proper balance between programmatic objectives and the objectives of a larger “network” of databases can be problematic, especially when these objectives are conflicting.

Approaches for resolving this problem: Data managers should describe the objectives of each data management system so that the intended uses and audiences are clearly identified. When data bases are posted on the Internet, the objectives should be evident on the primary entry page into the website, not buried in the metadata.

Resources needed: Defining objectives for data management systems is an educational process for biologists and data managers. A group of data management experts from the bird conservation and the bioinformatics communities should convene to develop recommendations to address this issue, preferably concurrent with a review of the status of existing databases and how these databases could be coalesced into coordinated data management systems.

2) Taxonomic issues.

Avian taxonomy is constantly changing. For data collected over decades, the taxonomic treatment of a single species can change multiple times. Keeping databases current with every taxonomic change and updating historic data to meet new taxonomic treatments can be costly. Most users do not want to become taxonomic experts in order to interpret data sets. Hence, taxonomic treatments must be transparent or major problems can occur. Three somewhat related issues are identified below:

A) **Inconsistent taxonomies used across databases:** Some problems here include using non-standard taxonomies (i.e., not following the AOU within its geographic area of coverage), use of conflicting taxonomies in regions where a “standard” taxonomy does not exist (i.e., in South America), and maintaining data at different taxonomic levels (i.e., storing data at subspecific level in some databases but not in others).

B) **Use of outdated taxonomy:** Interpreting data stored using outdated taxonomic treatments can be problematic, especially if recent data collected using a different and newer taxonomy is also stored in the same database.

C) **Inconsistent updating of existing records:** Results in major data interpretation issues, especially for species whose taxonomic status has been modified multiple times.

Approaches for resolving this problem: At a minimum, data managers should be consistent in their taxonomic treatment of species. Adopting new taxonomic treatments requires updating existing data in accordance with these new treatments. This problem can be addressed by developing a query tool that describes recent taxonomic changes that have occurred for each species and allowing the user to define the specific taxonomic treatments that meet their needs. This query tool can then search databases and retrieve data stored using different taxonomic systems. Such a query tool could be developed based on the AVIBASE search tool developed by Dennis LePage at Bird Studies Canada and available at: (<http://www.bsc-eoc.org/avibase/>).

Resources needed: Funding is required to develop this query tool, whether it is based on AVIBASE or some other application that provides synonyms for current bird nomenclature. A group of data managers and taxonomists may need to develop the requirements for this query tool. Funding would be needed to create the tool.

3) Maintenance of “distributed” data management systems.

Once distributed data management systems are established, they require maintenance in order to function properly. Maintenance is normally conducted at the level of individual databases, causing these costs to be borne by each monitoring program. Some long-term database maintenance issues include:

A) **Maintaining functionality when local databases are updated:** Database modifications are necessary for all systems, especially programs that are fairly new and the data management objectives are not yet well established. Both the database structure and the data collected can change. As these systems change, the process linking distributed databases must be modified to keep the system functioning properly.

B) **Reliable access to data sources:** Local database servers must be online to be accessed by the distributed system. If servers are frequently unavailable, those datasets are not available for use in the system.

C) **Security issues and access to data:** Data security is an ongoing concern and security requirements are constantly changing to meet the challenges posed by new threats. Major changes to security requirements can affect the operations of the entire system and potentially require major maintenance expenses if the entire network is to remain functional.

Approaches for resolving this problem: Maintaining a distributed network of data management systems requires funding on an annual basis. Requiring each system to devote resources towards maintaining their component of this network is not viable given the limited resources available for data management; this approach would eventually result in a network composed of systems receiving substantial institutional support. Given the complexity of network security issues, systems within this distributed network require considerable support from network administrators to circumvent problems as they arise.

Resources needed: Reliable long-term funding sources are required to maintain the functionality of any distributed network of bird population monitoring databases. For important data management systems having minimal institutional support, system administrators may have to provide maintenance and security functions needed to keep the entire network accessible.

Other components required for a fully functional distributed data management system include developing data exchange schemas, applying new technologies to harvest data across the distributed resources as they become available, integrating data across monitoring projects, and acquiring access to data sets and the rights to use data for specific purposes. Some of these components require cooperation from program and database managers, while other aspects such as developing schemas and applying data harvest technologies require additional funding.

4) Balancing the need for “centralized” vs. “distributed” databases.

There are advantages and disadvantages to both types of data management systems. Centralized systems offer economic efficiency because of reduced hardware and software costs.

Distributed systems are more expensive to maintain but offer greater control to program managers. Finding the proper balance to achieve economic efficiency yet retain programmatic control over data is the challenge, and this balance may shift as new technologies emerge. In any case, this issue must be resolved by consensus among system cooperators, facilitators, and administrators. Reducing data management costs should be a goal because those resources can then be shifted to data collection and on-the-ground conservation.

Approaches for resolving this problem: This issue raises the question of how many database systems are necessary to maintain data from bird population monitoring programs. This question may not be answerable today, but the number of database systems should be finite. The number of databases will be larger than the number of database systems, recognizing that multiple agencies/organizations may want to maintain similar database systems that meet their specific information needs while also benefiting the entire bird conservation community.

Resources needed: NABCI should play a lead role in facilitating these discussions, recognizing that it cannot dictate solutions but would attempt to improve coordination among agencies/organizations involved in managing bird population monitoring data sets and improve the efficiency of data management operations. Important issues are control of data and the desire to maintain data resources locally as compared with the increased efficiency, standardization, and persistence of centralized systems. New technologies are blurring some distinctions between these types of data management systems. But data management at any level can be expensive and reduce funding available for conservation purposes. Hence, economies gained from the use of centralized systems results in more resources available for conservation activities.

5) **Permanent archives for monitoring data sets.**

The persistence of bird population monitoring data sets and their availability over time is becoming an increasingly important issue. Some monitoring data have disappeared when scientists retire or change jobs. Even for programs with institutional support, data sets have disappeared following the termination of monitoring programs or when budgetary limitations reduce the funding available to maintain data management systems. Other problems include storing data on archaic hardware or on proprietary data management systems no longer supported by their manufacturers. For all of these situations, the net result is that important bird population data sets may become inaccessible to users.

Approaches for resolving this problem: Permanent data archives to store and maintain bird population data sets are needed so that important information resources are not lost. These archives must be readily accessible for long-term use.

Resources needed: Institution(s) willing to perform this role need to be identified. Funding will be needed to support archival processes and the long-term maintenance of data sets including their periodic transfer to current data storage hardware/software so that they remain accessible to the user community.

LITERATURE CITED

- Association of Fish and Wildlife Agencies. 2006. Strategic plan. Unpublished report, Association of Fish and Wildlife Agencies, Washington, D. C. URL: http://www.fishwildlife.org/about_StrategicPlan.html.
- Bart, J. 2005. Monitoring the abundance of bird populations. *Auk* 122:15-25.
- Bart, J., B. Andres, S. Brown, G. Donaldson, B. Harrington, H. Johnson, V. Johnston, S. Jones, R. I. G. Morrison, M. Sallaberry, S. K. Skagen, and N. Warnock. 2002. Program for Regional and International Shorebird Monitoring (PRISM). Unpublished report.
- Bart, J., K. P. Burnham, E. H. Dunn, C. M. Francis, and C. J. Ralph. 2004. Goals and strategies for estimating trends in landbird abundance. *Journal of Wildlife Management* 68:611-626.
- Bird Conservation Committee of the Association of Fish and Wildlife Agencies. 2006. Bird Conservation Committee Guidance Document. Unpublished report, Association of Fish and Wildlife Agencies, Washington, D. C.
- Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. *The U.S. Shorebird Conservation Plan*, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.
- Coordinated Bird Monitoring Group of the International Association of Fish and Wildlife Agencies. 2004. *Monitoring avian conservation: rationale, design, and coordination*. Association of Fish and Wildlife Agencies, Washington, D.C.
- Desante, D. F. and M. P. Nott. 2000. An overview of the North American Monitoring Avian Productivity and Survivorship (MAPS) Program. Contribution No. 150 of the Institute for Bird Populations, Point Reyes Station, California.
- Dimmick, R. W., M. J. Gudlin, and D. F. McKenzie. 2002. The northern bobwhite conservation initiative. Miscellaneous publication of the Southeastern Association of Fish and Wildlife Agencies, South Carolina.
- Dunn, E. H., B. L. Altman, J. Bart, C. J. Beardmore, H. Berlanga, P. J. Blancher, G. S. Butcher, D. W. Demarest, R. Dettmers, W. C. Hunter, E. E. Iñigo-Elias, A. O. Panjabi, D. N. Pashley, C. J. Ralph, T. D. Rich, K. V. Rosenberg, C. M. Rustay, J. M. Ruth, and T. C. Will. 2005. High priority needs for range-wide monitoring of North American landbirds. *Partners in Flight Technical Series No. 2*. <http://www.partnersinflight.org/pubs/ts/>

- Dunn, E. H., C. M. Francis, P. J. Blancher, S. R. Drennan, M. A. Howe, C. LePage, C. S. Robbins, K. V. Rosenberg, J. R. Sauer, and K. G. Smith. 2005b. Enhancing the scientific value of the Christmas Bird Count. *Auk* 122:338-346.
- Eggeman, D. R. and F. A. Johnson. 1989. Variation in effort and methodology for the midwinter waterfowl inventory in the Atlantic Flyway. *Wildlife Society Bulletin* 17:227-233.
- Holling, C.S., 1978. Adaptive experimental assessment and management. John Wiley & Sons, New York.
- Holthausen, R., R. L. Czaplewski, D. DeLorenzo, G. Hayward, W. B. Kessler, P. Manley, K. S. McKelvey, D. S. Powell, L. F. Ruggiero, M. K. Schwartz, B. Van Horne, C. D. Vojta. 2005. Strategies for monitoring terrestrial animals and habitats. USDA Forest Service General Technical Report RMRS-GTR-161. Fort Collins, Colorado.
- Johnson, F.A., C.T. Moore, W.L. Kendall, J.A. Dubovsky, D.F. Caithamer, J.D. Kelley Jr., and B. K. Williams. 1997. Uncertainty and management of mallard harvests. *Journal of Wildlife Management* 61:202-216.
- _____, and B. K. Williams. 1999. Protocol and practice in the adaptive management of waterfowl harvests. *Conservation Ecology*. 3(1):8. [Online] URL: <http://www.consecol.org/vol3/iss1/art8>
- Kushlan, J. A., M. J. Steinkamp, K. C. Parson, J. Capp, M. A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird Conservation for the Americas: the North American Waterbird Conservation Plan, version 1. Waterbird Conservation for the Americas, Washington, D. C.
- North American Waterfowl Management Plan Committee. 2004. North American Waterfowl Management Plan 2004. Strategic guidance: Strengthening the biological foundation. Canadian Wildlife Service, U.S. Fish and Wildlife Service, and Secretaria de Medio Ambiente y Recursos Naturales. 22 pp.
- Nott, M. P., D. F. DeSante, and N. Michel. 2003. Management Strategies for Reversing Declines in Landbirds of Conservation Concern on Military Installations: A Landscape-scale Analysis of MAPS data. The Institute for Bird Populations, Point Reyes Station, California.
- Nott, M. P., D. F. DeSante, P. Pyle, and N. Michel. 2005. Managing Landbird Populations in Forests of the Pacific Northwest Region. Publication No. 254 of The Institute for Bird Populations, Point Reyes Station, California.
- Moser, T., and S. Jones. 2000. Cooperative migratory bird surveys in North America. Office of Migratory Bird Management, U.S. Fish and Wildlife Service, Washington, D.C.

- North American Waterfowl Management Plan, Plan Committee. 2004. North American Waterfowl Management Plan. Implementation framework: strengthening the biological foundation. Canadian Wildlife Service, U. S. Fish and Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales. 106 pp.
- Powell, D. S. 2000. Forest Service Framework for Inventory and Monitoring. Unpublished report, Ecosystem Management Coordination of USDA Forest Service, Washington, D.C.
- Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY. Partners in Flight website. http://www.partnersinflight.org/cont_plan/ (VERSION: March 2005).
- Saab, V., and H. Powell. 2005. Fire and avian ecology in North America: process influencing pattern. *Studies in Avian Biology* 30:1-13.
- Sauer, J. R., J. E. Hines, G. Gough, I. Thomas, and B. G. Peterjohn. 1997. The North American Breeding Bird Survey Results and Analysis. Version 96.4. Patuxent Wildlife Research Center, Laurel, MD.
- Walters, 1986. Adaptive management of renewable resources. MacMillan, New York.
- Williams, B.K., F. A. Johnson, and K. Wilkins. 1996. Uncertainty and the adaptive management of waterfowl harvests. *Journal of Wildlife Management* 60:223-232.