New Opportunities for Bird Conservation Research[1]

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Abstract

It is accepted and acknowledged that effective conservation requires a scientific basis, and it is accepted and acknowledged that scientific research benefits conservation. However, there has been little effort to bring together the resources of the research communities—both academic and government-based—with the conservation planning and implementation programs. Most scientific research is driven by either the investigator's own research interests or, on the government side, by the relatively short-term, relatively local management needs of natural resource managers. Also lacking is a comprehensive system to bring new or existing science to the conservation programs and resource managers. Developing a system to help planners and managers find and apply existing data is a critical need. And finally, there is a need to find funding for each of these components—setting the research agenda, conducting the research, and making it available to planners and managers. This session reviewed several promising opportunities to knit together ornithological research and bird conservation work.

Introduction

In the United States, most ornithological research is conducted with federal funds appropriated by Congress to one of the federal research agencies such as the U.S. Geological Survey (USGS), U.S. Forest Service, and the Smithsonian Institutions, or to the National Science Foundation for competitive grants programs for researchers at universities and other research centers. It is particularly difficult to persuade the government to fund research for non-biomedical biology, or as it might be better described, "the biology of the natural world."

The bird conservation community and the ornithological research community can and should take measures that will help persuade those who control the federal purse strings to provide more funding for ornithological research.

Making better use of existing funding is a critical first step. Despite efforts by Partners in Flight, the National Park Service, and others, there is no cohesive, prioritized bird conservation research agenda at any scale. Efforts to date have resulted in incomplete, duplicative lists using different organizational levels for taxa, geographical and temporal scopes, and information needs.

In 2003, the U.S. Geological Survey was spending about $25 million on bird research—without a cogent, well-thought out program of bird research. As a research agency whose primary mission is to undertake the research needed by the land and natural resource managers in the Department of the Interior—park superintendents, refuge managers, and others who manage hundreds of millions of acres of land in every kind of ecosystem and habitat—the agency stretched these dollars across a very large number of management-oriented research projects that tend to be very localized and short-to-medium term. This research is important, but it doesn't add up to a comprehensive package of research designed to provide a solid underpinning for bird conservation planning, implementation, and evaluation. There aren't enough biologists and research dollars to do enough of either the near-term management research or the long-term, large-scale research that is required to understand biological systems. The dollars are further stretched by the need to provide information transfer and technical assistance to the natural resource managers.

Gaps in our knowledge go unfilled. Ornithologist J. M. Scott (pers. comm.) estimates that of the 800 or so bird species in North America there are fully 100 species about which we have little or no literature, other than a few field notes dating back 80 years. Incredible though that may seem, it was only recently that the breeding habitat of the Marbled Murrelet was discovered. Just a few years ago the migratory pathway of the Blackpoll became known. And after years of trying to limit the cowbird populations in Michigan, biologists learned that Kirtland's Warbler needs young jackpine forest for

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nesting, and a little fire would go a long way to the recovery of this species.

If for no other reason than that dollars are limited, a rigorous research priority list is critical; that it could make it easier to obtain more federal funding is another compelling reason. Government budget officials within agencies and in the Congress place higher value on programs that are well-designed to meet identified needs and that are coordinated across agencies.

It cannot be said enough: a list is not a list of priorities. The tendency of bird conservation efforts and other conservation planners is to make lists. Everything on the list is a priority of equal weight. Limited funding, however, forces hard choices. Something has to be first, something else has to wait. Criteria for priority-setting would be helpful. For instance, a project that has applications for a wide region might take priority over a very small-scale project. The extent to which the research is needed to design and assess specific bird conservation projects should be considered. Research that meets the needs of the projects implemented by the Joint Ventures or the states (through the North American Waterfowl Conservation Act grants or the State Wildlife Grants, respectively), is another possible consideration for determining priorities.

Data sharing will also increase the value of existing research. While scientists have a legitimate interest in safeguarding the results of their research efforts in order to make use of the data for publications, there should be a means for scientists to make their data publicly available and fully accessible when they choose to do so. The availability of such data could make it possible to identify trends, obtain baseline or historical data, generate or eliminate research questions, and compare results of studies.

Another way to maximize the use of existing funding requires the involvement of the academic research community. These researchers rely primarily on competitive grants from agencies such as the National Science Foundation (NSF). The research is investigator-driven. Researchers can and do submit proposals for research on subjects of interest to them, within fairly-loosely defined categories and priorities established by panels of experts convened by the NSF for this purpose, and by NSF program officers. Some of this research, which tends to be basic in nature, provides exactly the right kind of information for the development and implementation of bird conservation plans. However, the research conducted with NSF funding is not driven by, focused on, or even informed by bird conservation plans. So, for instance, while Partners in Flight is developing conservation plans based on assumptions about viable population sizes and trying to assess outcomes of the plans. However, the plans are developed despite gaps in data on life history and population dynamics, untested assumptions about habitat relationships, and a dearth of understanding of characteristics of source and sink habitats for most species. Meanwhile, NSF-funded biologists are out there doing some of this and some of that.

The will on the part of the academic research community to serve bird conservation exists. The challenge is to find a way to knit together these independent researchers and the bird conservation initiatives at all levels - from the specific projects funded by Joint Ventures to the broad scale development of population objectives.

Even with a list, with clearly-identified priorities, and even with the full involvement of the academic research community, there won't be enough money. This current administration is implementing “performance-based” budgeting. Some of the performance measures are managerial in nature, but what really counts is how the program succeeds in reaching clear and well-reasoned goals. This doesn't mean how many papers were produced or published or how many talks were given in scientific meetings. What budget officials want to know is how the money spent for bird research has helped to reach the goal of conserving bird populations. The stated intent is to reward the programs that do well by giving those programs more money.

There is one more critical ingredient in the recipe for more funding. The administration proposes a budget to Congress and Congress decides how much to actually provide for each agency and program. Conservation organizations and other groups such as the Ornithological Council spend considerable time working to persuade the administration and Congress to provide more funding for all aspects of bird conservation programs, including research. However, the help of the entire bird conservation community is needed. It is important to meet with elected officials, either in Washington or when legislators are in their home districts, to show them what bird conservation is about and to explain why research is such an integral part of conservation. Ornithologists should write to their congressional representatives, explaining what they do, why it is important, and thanking those members for NSF or NRI funding—or wherever their federal funding comes from. Ornithologists should invite their elected officials to visit labs or research sites to show them what the federal research dollars fund and why it matters. Bird conservation organizations should organize bird walks for their elected officials and explain what we need to know and why we need to know it. Nothing is more effective than showing people who control the purse strings why bird conservation is so important and why research is such an integral part of conservation.

The sections that follow summarize talks focused on programs with promise for filling research needs for bird conservation. The first, by Janet Ruth, an ecologist with the U.S. Geological Survey, described an exciting effort to develop a cohesive framework for bird conservation research. The next three look at ways to bring together the research and conservation sectors. Session co-convenor Robert Cooper described an effort to form a research cooperative to integrate research into regional bird conservation work through funding from what was then the hoped-for funding from the Conservation and Reinvestment Act or other sources. Three existing but underappreciated resources—the U.S. Geological Survey Cooperative Research Units, the newer but rapidly-developing Cooperative Ecosystem Studies Units, and the Breeding Bird Biology and Monitoring Database (BBIRD) were described by Ken Williams, Larry Norris, and Penn Lloyd, respectively. The importance of making data available cannot be underestimated. Elizabeth Martin explained how the National Biological Information Infrastructure (NBII) and the Bird Conservation Node of the NBII will meet that need.

Science for Avian Conservation: A USGS Workshop To Identify Research Priorities

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In October 2000, the U.S. Geological Survey (USGS) convened a planning workshop entitled "Science for Avian Conservation: Understanding, Modeling, and Applying Ecological Relationships." Although the effort, one in series of workshops called "Integration and Collaboration for Emerging Biological Issues and Research Goals" was sponsored and organized by the USGS, and was intended to help the USGS define its own role in conducting research to support bird conservation, the larger goal was to assist bird conservation initiatives in defining goals and developing new approaches for research. The workshop participants thus included many scientists from USGS, as well as some from other federal agencies, academia, and non-governmental organizations. The workshop and its outcomes are more fully described in Ruth et al. (2003).

Ornithological research was historically small-scale, species-specific, and not keyed to the needs of conservation and management activities. As bird conservation efforts grew rapidly in the 1980s and 1990s, some researchers and some research programs recognized the need to take an integrative, interdisciplinary approach and to work at larger temporal, spatial, and organizational scales. Nevertheless, a deliberate program of avian conservation research has not developed. As bird conservation has coalesced and reached a level of organization that encompasses all birds in all landscapes—in the form of the North American Bird Conservation Initiative (NABCI)—there is a need to identify an approach to research that provides information to support "the full spectrum of bird conservation through regionally-based, biologically-drive, landscape-oriented partnerships" as U.S. NABCI Committee (2000). The workshop participants were asked to identify science that should be conducted and science approaches that could be used to address this very large and very complex need.

After a series of talks and break-out discussions, the workshop participants concluded that the research needed could be categorized into five priority research areas:

Avian Life History, Populations, and Ecology

Through a mix of project types, we can fill gaps in detailed ecological information for many species. Specific research focuses identified were: the factors affecting population dynamics throughout the annual cycle and across the migratory range of a species; understanding metapopulations; and gaps in our knowledge of life history and distribution, with an emphasis on high-priority species (as defined by the specific initiatives). The role of well-designed monitoring plans, tied to management objectives and conducted at the appropriate geographic scales, was stressed. A consensus developed that monitoring programs have limited use in determining causes of population changes unless the monitoring is linked to research programs. Responses to changes in land management and other changes in habitat also need to be studied.

Habitat and Environment

The effects of habitat quantity, quality, and distribution on bird populations were deemed to be priority research areas. There is a need for monitoring of key environmental factors affecting birds, such as hydrology, climate, habitat, food, and disease agents. Better capabilities for remote sensing and collection of field data are needed. Application of scientific information to guide habitat management is needed and could take place in the context of an adaptive management pro-

gram that relies on models to guide management activities and on monitoring to assess the results.

Integration of Ecological Information

Modeling was considered to be a critical predictive tool that would guide management choices. Population models for priority bird species are needed; research is particularly needed to improve the ability of models to address density-dependent growth, bird-habitat associations at different spatial scales, and situations where estimates of vital rates are not available. Using models that link environmental factors such as water quality or climate to bird population dynamics can also aid in conservation planning and operations.

Bird Conservation Planning

The bird conservation plans were necessarily developed without complete information about and understanding of the reasons for changes in bird populations. Assumptions were made, and these assumptions need to be tested with research. The plans should be revised if research shows that the assumptions are incorrect.

Scientific guidance will be required to integrate the different priorities and goals of the various bird conservation plans (and other species and habitat plans for that matter) into multispecies strategies.

Communication of Ecological Information

Synthesizing and integrating scientific information and making it available to managers and policy makers is important. Better data management, display, and analyses are needed. Ways to link existing data sets, modeling and application tools, and information products are a high priority and should be available to scientists, managers, policy makers, and the public. The systems should be developed in collaboration between the scientist and the users and provide direct linkages from science to management questions.

Adaptive resource management (ARM) was cited as a means for integrating scientific information with conservation and management processes. The process is iterative, linking monitoring and assessment, science-based decision making through models and other information, evaluation of the results of management decisions, and refinement of management through incorporation of the results into refined modeling. These ARM concepts describe the components required for accomplishing the bird conservation goals identified by the North American Bird Conservation Initiative.

Approaches to Cooperative Research on Conservation and Management of Migratory Birds

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Introduction

Although we have made impressive gains in our knowledge of the ecology of migrant landbirds, the state of knowledge regarding effective management practices for these and other nongame species is far from adequate. How do we gain this knowledge as quickly, reliably, and efficiently as possible? In the Southeast United States, we have addressed this question by taking preliminary steps towards establishing a Southeastern Migratory Bird Research Cooperative. The main objective of the Cooperative would be to address priority management questions by selecting and funding large-scale manipulative experiments over multiple study sites (states) using identical methods across sites, and to facilitate the dissemination of results and recommendations to Southeastern land managers. Initially, we hoped that the funding base for the Cooperative would come from the Conservation and Reinvestment Act (CARA). Although CARA has not happened as originally envisioned, the need for cooperative approaches to research on management is still there. This paper describes the original ideas regarding the purpose, structure and activities of the Cooperative, and to briefly describe the cooperative approaches now taking place in the Southeast in the absence of adequate funding for the Cooperative.

Research Priorities

Recently, the Southeastern Working Group of Partners in Flight developed a list of research needs for Southeastern species. While the nature of such a list is hierarchical, with specific needs within more general categories, the priority needs were summarized into the following general categories:

(1) Ascertain the abundance and distribution of priority species and their habitats, and quantify the relationships between those species and their habitats;

(2) Ascertain the effects of alternative management practices, as well as options within types of management, on vital rates of populations of priority species;

(3) Ascertain the compatibility of single species (e.g., game or endangered species) management with management of priority species;

(4) Ascertain the relationships between the vital rates of populations of priority species and landscape features;

(5) Ascertain the most effective ways to restore habitats of priority species; and

(6) Ascertain the extent to which, by meeting habitat needs of priority species, the habitat needs of other nongame species are being met as well.

It is recognized that these needs are pertinent for migrating and wintering populations as well as breeding populations.

In developing this list, a number of questions were raised. For example, if we have all these uncertainties about managing this resource, how do we apply management practices in the face of this uncertainty? Further, how do we monitor the success or failure of our management options? How do we gain the knowledge needed as quickly, reliably, and efficiently as possible? How can we meaningfully compare the results of studies or management actions done in similar habitats but in different parts of the Southeast? And how do we deal with the fact that birds are just a part of the resource we are ultimately charged with managing? It was becoming apparent quickly that a new approach was needed.

Goals and Objectives of the Cooperative

The goal of the Cooperative was to gain knowledge about the ecology and management of Southeastern migratory birds as quickly, reliably, and efficiently as possible using appropriate funding sources. Specific objectives of the Cooperative were: (1) to identify priority research needs involving migratory birds in the Southeast, and specific projects of greatest need; (2) to identify professionals to conduct research to address those needs; (3) to design large scale manipulative experiments involving alternative management options to be conducted at a number of replicate sites throughout the Southeast; (4) to develop standardized procedures for collecting data in those experiments so as to maximize comparability among replicate sites; (5) to report results in a timely manner by publishing a series of land manager's guides and peer-reviewed publications in scientific journals; (6) to enlist the moral and fiscal support and cooperation of each of the southeastern states, identify additional funding sources, and obtain funding; and (7) implement studies developed through the Cooperative.

Structure and Functioning of the Cooperative

First, a Research Oversight Committee was to be formed that would identify major research needs, investigators to meet those needs, and assure accountability for how funding is spent and for high-quality information obtained from that funding. The Committee would be comprised of Partners in Flight coordinators from the 12 cooperating states and representatives from federal agencies, non-government organizations, industry, and academia. Proposals for particular projects would be solicited via a formal call for proposals. The competing proposals would be from different teams of investigators, and would be reviewed by the Committee. We envisioned that each project would be awarded to a lead institution (and a project leader), with collaborating principal investigators from cooperating institutions to be funded via subcontract from the lead institution.

Projects would usually take the form of large-scale manipulative experiments and would feature the characteristics of good experimental design such as replication, controls, and randomization (Hurlbert 1984). Many would feature a before-after, control-intervention design, so that several years of pretreatment data could be collected before the management alternatives (treatments) would be applied, followed by several years of post-treatment data collection. A key feature is that each experiment would be replicated in several locations (i.e., states), which would be treated as blocks in the design. Each site would be a stand-alone experiment, but by replicating the study in several states we would get an estimate of spatial variability of results across sites, and conclusions would be more applicable to the southeast as a whole, instead of to just one or two sites.

Several projects would be active at any particular time, but not every state would be a site for every project. However, this situation is desirable because each state would benefit from the results obtained from every study. In other words, the results would be applicable to the Southeast as a whole, and all partners benefit.

In addition to the experimental design, field methods would be identical across sites, often following standardized protocols such as those for the Breeding Bird Inventory and Research Database (BBIRD), which includes protocols for nest monitoring, point counts, and vegetation sampling (Martin et al. 1997).

The actual Cooperative was to be housed at a location such as a university. All data collected on all projects would be housed in electronic form. By combining data from multiple projects, additional important questions involving migratory bird management could be

addressed. For example, each of the field sites would be located in a habitat patch within a landscape with certain features (patch size and insularity, percentage of different land cover types surrounding the patch, fractal dimension, connectivity, etc.). Therefore, in addition to investigating the specific questions of interest on a number of sites, plus analyzing those data among sites, we often would be able to combine many of the sites from several projects to answer questions at a landscape scale. Furthermore, we could and should be able to direct some effort to answering some questions pertaining to parts of the life cycle of these birds previously overlooked—migrating and wintering ecology. Thus, in several ways the whole of this approach is greater than the sum of the parts.

For the Cooperative to succeed, it must provide results to land managers in a timely fashion so that they can implement desired alternatives. We anticipated that these findings would be published as a series of land managers guides, written at the same level and in the same spirit as *A Land Manager's Guide to Point Counts of Birds in the Southeast*, by Hamel et al. (1996), and targeting a more general audience. Because the work will be scientifically rigorous, cooperators also would be encouraged and expected to publish results in peer-reviewed scientific journals, which would serve to give the program greater prestige and notoriety within the scientific community.

Funding the Cooperative and Some Alternatives

This was obviously a very ambitious and expensive endeavor; we had originally envisioned approaching the states to contribute some of the funds they were to receive from CARA each year as base funding for the Cooperative. These funds would then be used as leverage to obtain additional funds from federal agencies, NGOs, industry, and the like. We presented this idea to the Southeastern state directors of Fish and Wildlife Agencies in 1998 and they unanimously agreed to the concept in principle. However, they made it clear that they did not have that funding available then, and would not unless something like CARA became enacted.

Unfortunately, because CARA was not enacted, the anticipated source of funding for cooperative research on migratory birds in the Southeast has not materialized. Instead, cooperative approaches to investigating management questions involving priority species have been initiated on an opportunistic basis. Three examples of this new, species-based approach are the Painted Bunting Initiative, the Swallow-tailed Kite Initiative, and the Cerulean Warbler Technical Group. The first two involve the lower Atlantic Coast states (Florida, Georgia, and South Carolina) and do not include any manipulative experiments at this time. The objectives of those efforts are to share data, use similar approaches when feasible, and pool resources to find adequate funding. The Cerulean Warbler Cooperative is a new effort that involves most Southeastern states included in the range of the Cerulean Warbler, and features a manipulative experiment in forest management similar to that described above. Efforts will be made to use identical field methods and experimental designs in multiple states to understand more about how to create forest habitat for this species.

The advantages to cooperative approaches such as those outlined above are obvious; reliable information is obtained quickly, efficiently, and rigorously, for a minimal cost. The alternative to cooperative approaches is to proceed as before, letting each state administer its own migratory landbird research and management program rather than participate in a cooperative effort. However, I believe that very little usable information for managing the migratory bird system on regional/landscape scales is likely to be produced if the cooperative approach is not used. Given enough time, we can learn using the old approach, as evidenced by what we have learned about managing game species. However, time is something we do not have. If we are not careful, we may find that what we have learned will allow us to state with certainty why a large number of these species went extinct before we acted.

U.S. Geological Survey Cooperative Research Units

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Introduction

Dating back to 1934, when Jay Norwood "Ding" Darling, served as Chief of the Bureau of the Biological Survey and created the Cooperative Wildlife Research Units, this research program marries federal funding for university faculty at state universities to state funding for research. Darling, as Iowa State Fish and Game Commissioner, started a single cooperative research program at Iowa State College to train wildlife biologists. When, in 1939, the Bureau of the Biological Survey was transferred from the Department of Agriculture to the Department of the Interior, the cooperative research units went along. Managed by the U.S. Fish and Wildlife Service until 1993, when the Department of the Interior biologists were transferred from the management agencies into the National

Biological Survey (later renamed the National Biological Service, and ultimately transferred to the U.S. Geological Survey where it is now known as the Biological Discipline), the units continue as cooperatives among the U.S. Geological Survey, host universities, state natural resource agencies, the Wildlife Management Institute, and the U.S. Fish and Wildlife Service. After more than 40 years of operation, the program was officially born in 1960, when the Cooperative Units Act (16 U.S.C. 753a-753b, 74 Stat. 733), as amended, Public Law 86-686, September 2, 1960, was enacted. The statute authorized the Secretary of the Interior to enter into cooperative agreements with colleges and universities, state fish and game agencies, and nonprofit organizations for the purpose of developing adequate, coordinated, cooperative research and training programs for fish and wildlife resources.

Over the years, the program grew from the initial eight units to 39 Cooperative Research Units (CRUs) in 36 states. Supporting 119 researchers, three field supervisors, and 10 headquarters staff, the CRUs have trained countless graduate students who go on to become natural resource professionals. The training has another purpose, however. The graduate student conduct research needed by the state or federal agencies that provide funding for the research. The Wildlife Management Institute, a private, nonprofit organization, provides some financial support as well as coordination at a national level. The premise of the CRUs is that all cooperating parties contribute resources, all benefit from the leveraging of resources, the cooperators jointly direct CRU activities, and state or federal agencies procure research needed for wildlife management. Research areas covered by the CRUs is wide-ranging. Landscape ecology, biological modeling and analysis, natural resource monitoring, and all manner of wildlife and fisheries investigations, are mainstays. Specific problems such as invasive species and contaminants are also addressed.

Among the many examples of conservation-oriented bird research completed by CRUs in 2002 are projects that used spatially-explicit models to project Bachman's Sparrow (*Aimophila aestivalis*) populations in longleaf pine forests and to determine the effect of fire management regimens on the species' population; developing a means to integrate recapture data into the U.S. Bird Banding Laboratory's bird banding database; and numerous studies of habitat availability for and use by shorebirds and waterbirds.

Perhaps because CRUs are a long-established part of the landscape, they are overlooked as a resource for bird conservation research. However, a quick look at the productivity of the CRUs demonstrates the substantial contribution made by this program: in 2002, the CRUs accounted for 1200 ongoing research projects, 400 publications, 300 technical reports, and 750 presentations. The importance of the CRUs for bird conservation research should be obvious. The CRUs are a proven way for states to procure much-needed research for bird conservation. Should they choose to use State Wildlife Grant funding, for instance, the CRUs are already available to address the research needs identified in state Comprehensive Wildlife Conservation Plans.

The CRUs also provide an important part of the research resource for federal agencies. For instance, in 2002, the CRUs completed 26 projects for the Bureau of Land Management, 57 for the National Park Service, 175 for the U.S. Fish and Wildlife Service, 46 for the U.S. Forest Service, and numerous others for federal agencies and tribes. Private organizations, such as conservation organizations, contracted for another 41 research projects.

The CRUs also provide technical assistance to cooperators. According to the 2002 Cooperative Research Units Annual Report, technical assistance "consists of numerous, diverse tasks ranging from participation on a task force or a recovery team to conducting workshops or symposia to writing newspaper articles." Again, the importance of the CRUs for bird conservation is obvious. Research for bird conservation requires effective application. Resource managers need to call on researchers to participate in processes to address specific management issues. The CRUs make this important work an integral part of the program.

Cooperative Ecosystem Studies Units

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Partnerships are the basis of the recently-developed Cooperative Ecosystem Studies Units (CESUs) which arose from a 1999 interagency agreement to work together to obtain high-quality science for natural resource management in a cost effective way. The basic premise of the CESU program is that meeting the challenges of providing science to manage natural resources requires the skills and capacities of the nation's universities. In a nutshell, the various federal agencies may purchase research from the universities, through a framework of regional cooperatives, each guided by a formal agreement, mission statement, and self-governing structure. Although the concept emanated from discussions between the National Park

Service and the Biological Discipline of the U.S. Geological Survey, the original memorandum of agreement included the Departments of Interior, Agriculture, and Energy. The CESU Network is multi-agency and interdepartmental. Any one or more of the 16 CESUs, biogeographically-organized units that now cover the entire nation, could include the National Aeronautics and Space Administration, the Forest Service, Department of Defense, National Park Service, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Bureau of Land Management, or other federal agencies.

Each CESU is based at a host university that provides space and basic administrative services but other institutions, such as museums or bird observatories, and organizations such as conservation groups may also join these partnerships. Partners can include state agencies, tribes, nonprofit organizations and others. Each CESU is guided by a mission statement that identifies research, technical assistance, education, and other services that it is especially qualified to provide. The CESU network now comprises 120 universities and 34 states, territories, and tribes.

This partnership has obvious benefits to federal research agencies, which gain significant research expertise and other research resources without having to expand their own programs and facilities—something that cannot be achieved with limited federal funding. The universities and their graduate students also benefit because they have increased opportunities for research. Natural resource management agencies, which require more research than the federal research agencies can provide, also benefit because academic researchers receive funding to conduct research of interest to the agency. Managers can procure a wide range of research, from archeology to zoology. Custom-designing research projects also allows agencies to obtain interdisciplinary research, which is often needed for problem-solving.

For individual scientists who want to contribute directly to natural resource management and conservation, the benefit is clear. They now have the opportunity to conduct the research and provide the technical assistance that is needed by natural resource managers. Thus, the CESUs provide opportunities for bird conservation oriented research that should be explored. For instance, a joint venture management board could become a partner of a CESU. State agencies—many already CESU partners—can look to CESUs to help conduct the research needs identified in the Comprehensive Wildlife Conservation Plans that must be submitted to obtain State Wildlife Grants. If the appropriations for the State Wildlife Grants increase, as is hoped, to $350 million per year, there should be a substantial need for research and the states may want to take advantage of the CESUs to purchase some of this research.

The value of the CESUs can be measured partly by the achievements reported at the end of Fiscal Year 2001. After only two full years, with some CESUs still forming and others not yet underway, the CESUs had completed 508 projects totaling $27,038,000 in support funds. Almost half were research projects and 41 percent of the projects involved the biological sciences, while 24 percent were interdisciplinary. The National Park Service was by far the largest funder, purchasing some $19 million worth of research and technical assistance. The Bureau of Land Management followed with $6.3 million in funding. This demonstrated ability to provide the research needed for natural resource conservation and management suggests that the CESUs are a good vehicle for bird conservation research.

Breeding Bird Biology and Monitoring Database

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The Breeding Bird Biology and Monitoring Database (BBIRD), initiated in 1992 and run by the U.S. Geological Survey Cooperative Research Unit at the University of Montana, has the attributes of a model research program for bird conservation. The research addresses a key question for bird conservation: nesting success and habitat requirements of breeding birds. Conservation of bird populations and of biodiversity in general depends on identification and conservation of habitat conditions that support self-sustaining populations of coexisting species. Yet, the necessary breeding biology and habitat information is lacking for most species. BBIRD is comprised of independent investigators from throughout North America who work with, and make their results available to local managers, disseminate results through articles in peer-reviewed journals, and who meet annually to discuss results and issues. With a standardized protocol for data collection and a database that permits data sharing, BBIRD allows examination of large-scale patterns and trends.

Standard protocols for monitoring nesting success and habitat of nongame birds by finding and monitoring nests at replicate plots across North America are available on the BBIRD website at http://pica.wru.umt-.edu/BBIRD/protocol/protocol.htm. Studies at each local site generally include plots within large blocks of relatively unfragmented habitat and plots within an-

other treatment to examine land use issues, such as fragmentation, habitat loss, or silvicultural treatments. Resulting data can allow identification of source (self-sustaining) and sink (non-self-sustaining) populations and the habitat conditions that produce such populations. In addition, local results can be put in the context of larger regional patterns through comparisons of nesting success in different geographic locations. BBIRD also includes point counts to index population size at plots and possible changes across years. Standardized vegetation sampling is conducted at nest sites, non-use plots, and point counts to allow detailed analysis of microhabitat requirements for successful nesting.

By 2002, BBIRD had accumulated more than data on more than 60,000 nests and associated vegetation. Metadata descriptors include nest fate, nest measurement, vegetation and tree measurement, species counts, and weather. These metadata make BBIRD suitable for inclusion in the National Biological Information Infrastructure (see Martin below). Although the NBII Bird Node already includes a link to BBIRD, when the NBII provides the capacity to access and search across multiple databases, BBIRD will provide a very sizeable collection of data critical for bird conservation decisions, such as selection of priority sites for conservation and appropriate habitat management regimens. For instance, BBIRD researchers recently used BBIRD data on Ovenbirds from 15 sites across the United States to determine the relationship between forest fragmentation and nest parasitism, nest predation, and the finite rate of population increase. They demonstrated how the effect of landscape scale from 1km to 100 km affected nesting parameters. BBIRD has also developed a Management Handbook for the U.S. Forest Service to demonstrate the management applications of the scaling approach (see http://pica.wru.umt-.edu/BBIRD/handbook.htm).

Analytical tools to allow land managers to assess data - that can be accessed through a publicly-accessible website have been provided. Recently, BBIRD was linked to the National Biological Information Infrastructure Bird Conservation Node, making it more widely available even to land managers who would not otherwise know of its existence. Other tools that are provided include standard protocols, manuals, and data entry instructions and software.

The Second Generation National Biological Information Infrastructure: Vision and Implementation

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The National Biological Information Infrastructure (NBII) is a broad, collaborative program to provide access to data and information on our nation's biological resources. It is designed as a distributed electronic gateway to biodiversity and ecosystem information maintained by a broad federation of partners including government agencies and private sector institutions, including conservation organizations and museums. Currently, NBII—which can be accessed through the internet at http://www.nbii.gov—consists of a set of links and a metadata clearinghouse that direct the user to potential sources of information on our nation's biological resources. In the 1990s, when NBII was first conceived of and developed by the U.S. Geological Survey's Biological Discipline, the first task was to catalogue existing web resources. The key to a useful catalogue—a metadata standard—was an essential first step. Metadata are "data about data." They are descriptors of the content, quality, condition, and other characteristics of data. Examples include geospatial, temporal, and taxonomic information. The NBII created a biological extension to the existing Federal Geographic Data Committee (FGDC) metadata standard. Training programs in metadata and the biological standards were created and are regularly offered. Using these standards, organizations and individuals can submit metadata about their data to the NBII Metadata Clearinghouse (http://www.nbii.gov/datainfo/metadata-/clearinghouse/submitting.html) or search for data that meet the searcher's information needs.

A critical element of biological metadata is a standard for taxonomic nomenclature and classification. If this is lacking, retrieving biological data can be difficult if not impossible. The NBII staff are leading in the development of taxonomic naming standards for North America through the Integrated Taxonomic Information System (http://www.itis.usda.gov). The goal of ITIS is to create an easily accessible database with reliable information on species names and their hierarchical classification. The database will be reviewed periodically to ensure high quality with valid classifications, revisions, and additions of newly described species. The ITIS includes documented taxonomic information of flora and fauna from both aquatic and terrestrial habitats.

However, a second generation NBII is needed in order to provide to natural resource managers, researches, and policymakers the kind of data, information, and analyses needed for decision-making. Instead of simply retrieving information about existing data, the user would be able to actually access the data. A 1998 report issued by the President's Committee of Advisors on Science and Technology (PCAST) entitled Teaming with Life recommended the development of a Next Generation NBII, saying that, "Potentially useful and critically important information abounds, but it is virtually impossible to use it in practical ways. The sheer quantity and diversity of information require an organizing framework on a national scale." What PCAST envisioned was a fully digital, distributed, and interactive system that would allow users access to the nation's holdings of biological and natural resource data. It would include analytical tools and new information technologies. In short, it would allow users to access and analyze all data available on a given subject, across multiple datasets, wherever located. Through a series of regional and thematic nodes, the information would be stored and made available to a wide range of users. The National Research Council of the National Academies of Science endorsed PCAST's recommendation in 2001. By that time, nodes for bird conservation and fisheries and aquatic resources were online. Regional nodes now online include Central Southwest and Gulf Coast, Northern Rockies, Pacific Basin, Pacific Northwest, and Southwest.

Node products and services include: resource catalogues, on-line searchable databases, interactive mapping applications for population, habitat, and climate data, 3-D visualization applications, citizen science training, and support for regional planning activities. The bird conservation node (http://www.nbii.gov/-about/pubs/factsheet/pdf/birdcons.pdf) is intended to provide access to bird population and habitat data, for use in bird conservation planning. As of late 2003, links to bird census and survey databases such as the Breeding Bird Survey and MAPS, along with information about and links to the various North American bird conservation initiatives, were available.

The ability to share and retrieve data across many decades, across geographical regions, ecosystems and habitat types, and among many sources of information at one time promises to be a significant resource for bird conservation planning and assessment. In only a few years, NBII will likely be a central tool for bird conservation.

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