

PARTNERS IN FLIGHT RESEARCH NEEDS ASSESSMENT SUMMARY

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INTRODUCTION

An important component of the PIF International Conference in McAllen, TX in February 2008 was the incorporation of a Needs Assessment Process in all of the conference sessions. Throughout the McAllen sessions, a number of critical information gaps were identified, pointing to future research that will be needed to establish bird conservation objectives and accomplish bird conservation goals. This document is a summary of the research needs topics identified in the McAllen sessions, placed in the larger context of PIF research needs information. This summary is not intended to be a comprehensive evaluation of landbird research needs, nor a literature review or synthesis of such research needs and research topics. This report was developed by compiling and organizing the research needs identified in McAllen (Rich et al. 2008) and then placing the needs within the context of other PIF-related documents that have identified research needs, including:

- North American Landbird Conservation Plan (Rich et al. 2004) – http://www.partnersinflight.org/conservation_plans/default.htm;
- PIF Continental Watch List Species Research and Monitoring Needs – <http://www.partnersinflight.org/WatchListNeeds>;
- PIF Research and Monitoring Needs Database – <http://www.partnersinflight.org/pifneeds/searchform.cfm>;
- Priority research needs for the conservation of neotropical migrant landbirds (Donovan et al. 2002) – http://www.uvm.edu/envnr/vtcf-wru/Donovan/Donovan_et_al_2002.pdf; and

- Science for avian conservation: priorities for the new millennium (Ruth et al. 2003) – http://www.fort.usgs.gov/Products/Publications/pub_abstract.asp?PubID=941

Three broad research areas were highlighted during the McAllen sessions:

(1) Filling crucial gaps in our knowledge of priority bird species; (2) Studying effects of human actions on birds and habitats of conservation concern; and (3) Socio-economic research. For each of these broad categories, we identify more specific topics of greatest importance to furthering our understanding of bird conservation needs; these may serve as a rough set of priorities for conservation research in the near future. In addition, we highlight the common theme of modeling as a research tool, which was identified among the research needs in most McAllen sessions. Finally we identify several key areas that need attention as next steps for the PIF research community; these include: (1) Meta-analyses of published research results; (2) Communicating research results to bird conservation implementers; (3) Evaluating assumptions and success; and (4) Building/maintaining research and monitoring capacity.

Based on this synthesis, we recommend a basic process that anyone who wants to conduct or fund high priority landbird research can use to identify research priorities. The process involves use of the following components: (1) the information provided below about key research themes; (2) the PIF Species Assessment database <http://www.rmbo.org/pif/pifdb.html> and other PIF publications like the PIF North American Bird Conservation Plan (Rich et al. 2004) http://www.partnersinflight.org/conservation_plans/default.htm; and (3) resources available on research needs, which are usually species-specific (e.g., PIF Research and Monitoring Needs database and

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PIF Continental Watch List Species Research and Monitoring Needs. By identifying the highest priority species at your scale of interest (international, national, regional, or local), considering species-specific research needs for these species and the larger priority research themes presented here, and finally, and most importantly, looking for commonalities—ways to address research needs across multiple high priority species—you can develop a good idea of the most important research needs that you can address. In some cases using a focal species approach to addressing priority species needs may be effective, especially when it is difficult or expensive to collect the needed data on the highest priority species or all species of interest.

Many people seeking to design research to address high priority needs will not be focused

only on national/continental level priorities, but rather will have specific regional or local interests, capabilities, and missions. Therefore, stepping down the more general, continental level priorities we present to a locally and/or regionally relevant level is a crucial component of the process. We provide an example of how this process might be used to identify research priorities at a regional level in the separate text box.

FILLING CRUCIAL GAPS IN OUR KNOWLEDGE OF PRIORITY BIRD SPECIES

Detailed ecological/life history information needed for effective conservation of most of our priority landbird species is still largely lacking despite nearly a century of life-history and ecological studies (Ruth et al. 2003). Although bird

Southwestern Grasslands—Determining Research Priorities

This is an example of how someone with particular regional interests might use the information and suggested process we present to identify priority research needs. In this example, we assume that this person (perhaps a graduate student) is only able to conduct research in Arizona or New Mexico and has an interest in grassland habitats.

1) The PIF North American Landbird Conservation Plan (Rich et al. 2004)—both Table 1 and the section on the Southwest Avifaunal Biome—combined with maps of bird distributions in Arizona and New Mexico, identify 5 Watch List species—Scaled Quail (*Callipepla squamata*), Swainson's Hawk (*Buteo swainsoni*), Sprague's Pipit (*Anthus spragueii*) (winter), Baird's Sparrow (*Ammodramus bairdii*) (winter), and McCown's Longspur (*Calcarius mccownii*) (winter)—and 1 Stewardship Species—Cassin's Sparrow (*Aimophila cassinii*)—in the region.

2) The New Mexico and Arizona PIF Bird Conservation Plans include the above mentioned species and add additional state-level priority species including: Aplomado Falcon (*Falco femoralis*), Burrowing Owl (*Athene cunicularia*), Loggerhead Shrike (*Lanius ludovicianus*), Botteri's Sparrow (*Aimophila botterii*) and Grasshopper Sparrow (*Ammodramus savannarum*).

3) Both the national and state level plans confirm that southwestern grassland is a priority habitat that supports priority species. They also confirm that there are a variety of priority research needs associated with rangeland management issues, as discussed in general in this document.

4) By looking at species-specific information available on the PIF Continental Watch List Species Research & Monitoring Needs webpage, the PIF Research and Monitoring Needs database, and the Arizona and New Mexico Bird Conservation Plans, one can begin to identify common research needs within the larger category of rangeland management. Two common issues are the effects of grazing and fire regimes, including in the winter which is the only season when some of these priority species are found in this region. In addition, another common theme is the number of gaps in information about habitat associations and demographics for many of these priority species.

5) This process suggests that a research project to study the effects of differing grazing and/or fire regimes on grassland birds in Arizona and New Mexico AND collect as much life history/ecology/demographic data in the process, would address high priority research needs in this region.

6) An important part of this process before moving forward with developing research proposals is a survey of the literature and consultation with state and regional conservation and research experts. It is always important to know what research has already been done or is in the process of being done (perhaps since some of the PIF references were developed and perhaps not yet published). This interaction will benefit the prospective researcher, managers, and funding sources; redundant research will be avoided, the prospective researcher will make contact with other researchers already working in the region, and managers will be informed about research being conducted and have an opportunity to give input into research development.

conservation research as a whole has been moving toward broader, multi-species efforts, filling in these gaps in our species-specific knowledge remains crucial to accomplishing bird conservation. In fact, filling in these gaps may well be the highest short term research priority for Partners in Flight. Without these data it is neither possible to address many of the other research needs categories listed here nor design effective conservation objectives and implementation plans. For example, developing models of bird populations or habitat associations requires specific demographic, habitat needs, and important site information as input.

Understanding which factors are the most important limiting factors for a species will allow us to avoid dedicating limited resources to the wrong question or focus. Because our knowledge gaps vary depending on the priority species, and because it is beyond the scope of this document to prioritize these across species, we present the most important types of information gaps that need to be addressed. It would be fair to say, with the possible exception of species that are also listed under the U.S. Endangered Species Act, that we have not compiled the crucial life history or ecological information we need for conserving most of our priority landbird species.

HABITAT NEEDS/ASSOCIATIONS

Perhaps the most critical information needed to implement bird conservation is a precise understanding of the habitat factors that are important to priority species from various habitats and management regimes, at various spatial scales, and across the full life cycle. Knowledge of habitat requirements is crucial for developing models to predict responses to management practices as well as for setting appropriate habitat objectives for conservation. Factors important to consider include vegetative structure and composition, diet/prey resources, habitat quality and quantity, successional stage, micro-habitat, abiotic characteristics (e.g., elevation, slope, aspect, precipitation), and landscape characteristics (e.g., patch size, isolation, area requirements/sensitivity).

Although general habitat relationships for most species are generally known, we usually lack precisely defined management prescriptions, or best management practices, that can be implemented by land managers to benefit priority species. Many species show geographic variation in habitat requirements, so management prescriptions need to be regionally specific. In addition, studies of habitat relationships have been concentrated during the breeding season,

and our knowledge of habitat requirements on the wintering grounds or during migration is even more fragmentary. This area of research is probably where new modeling techniques and approaches will have the greatest impact (see below).

DEMOGRAPHICS

Information about a species' demography across the full life cycle is necessary for identifying limiting factors to populations, modeling bird response to management practices, and setting population objectives. Demographic information is also critical for evaluating and even defining habitat quality. In spite of this importance, research on demographics, even for common bird species, still lags far behind other kinds of research and monitoring. Factors important to consider include annual and lifetime productivity, survivorship, emigration, immigration, mortality, longevity, parentage, population sustainability, and population viability. For most species, we lack basic demographic data to evaluate whether populations are limited more by quantity or quality of breeding habitat or by overwinter survival.

For nearly 20 years, the Monitoring Avian Productivity and Survivorship (MAPS) <http://www.birdpop.org/maps.htm> program has attempted to standardize the collection of demographic data across a variety of species and breeding habitats, and more recently Monitoreo de Sobrevida Invernal (MoSI) (Monitoring Overwintering Survival, in English) <http://birdpop.org/MoSI/MoSI.htm> has expanded this methodology to migratory species on their wintering grounds. Both of these programs were mentioned as important in numerous McAllen sessions, yet they remain poorly funded and rely on a patchy network of volunteers. A high priority should be the critical evaluation of MAPS and MoSI, with a commitment to support these, and other demographic monitoring programs at a level necessary to produce data most useful for managing populations of priority bird species.

SEASONAL CONNECTIVITY AND FULL LIFE CYCLE LIMITING FACTORS

Recent studies have emphasized how periods of the annual cycle are linked for migratory species, and how events on migration or on the wintering grounds affect subsequent reproductive fitness. Aside from a few intensively studied model systems, we lack basic information for most species regarding seasonal connectivity. For a few priority species, a mystery

remains regarding the location of important sites or habitats most frequently used on migration routes or during winter—this is especially true for species that migrate to South America. Without this information, full life cycle conservation cannot be accomplished, leaving the possibility that we are focusing our efforts and resources on the wrong place or time.

Inter-seasonal effects are poorly understood within most bird migration systems—for two primary reasons. First, we have a poor understanding of how individuals and populations are connected between specific breeding and non-breeding locations. Second, the majority of research is still conducted during the breeding season, leaving us with an inadequate understanding of fundamental natural history and ecology of migrant birds during the non-breeding season.

The goal of a specific session at McAllen on “Focal species conservation: Lessons from the non-breeding season” was to illuminate the research priorities and agenda for the next 5–10 years and to develop a clear process for bringing scientific data into conservation action plans for high-priority migratory birds. In particular, there already exists a tremendous capacity and desire within Latin America and the Caribbean to address research gaps. In addition, several new initiatives, such as the Southern Wings Program http://www.fishwildlife.org/all-bird_LAC_projects.html that will direct conservation funding to address wintering-ground issues were discussed at the McAllen sessions—these will depend on improved knowledge of migratory connectivity between breeding and wintering areas. To build a wintering grounds strategic plan, states need to know which of their species are being limited (or could be limited) by non-breeding issues and what sorts of projects to fund in order to address this issue. New methodologies, such as refined analysis of stable isotopes and genetic markers, will make it easier to identify specific connections between sites, and incorporating these studies into future conservation plans is a high priority.

The research required to fill these gaps is traditionally considered basic research and is usually accomplished through species-specific field studies and/or short-term, directed monitoring programs. Based on the life history/ecology information gaps identified in McAllen, the highest priority research in this category should focus on filling information gaps: (1) for the highest priority species or groups of species; (2) for bird communities in high priority habitats; and (3) that, if filled, would help address particular conservation efforts (e.g., effects of wind turbines, climate change, bird trade).

Although much of the research to fill these gaps remains to be done, in some cases what is needed is a synthesis of existing information that is already available but not compiled in a single location where it is easy for researchers, modelers, and managers to access. A high priority for Partners in Flight is development of a database that provides a compilation of existing information about species’ demographics, habitat associations, and other crucial life history information in a user friendly format, perhaps initially focusing on the highest priority species.

STUDYING EFFECTS OF HUMAN ACTIONS ON BIRDS AND HABITATS OF CONSERVATION CONCERN

There are many ways in which humans influence birds and their habitats. Because this is an area over which we have some influence (i.e., we can make decisions about how we manage resources or affect the environment), it is particularly important that we understand how our actions are affecting birds and their habitats so that bird conservation strategies can be most effective.

Based on the discussions in McAllen and other PIF-related research resources, there are four common themes and concepts that should be applied to research addressing human effects on birds and habitats: (1) Research should be conducted and research results delivered to implementers with a multi-species perspective that recognizes the context in which most managers work; (2) Because many implementers manage resources for multiple uses, research on management actions should evaluate both biological and economic values (see the Socio-Economic Research section below) of various practices, and should evaluate compatibility of practices with other management goals; (3) All research should be done in an adaptive framework that will benefit both scientists and managers; and (4) Research should be aimed at developing better resource management, restoration, and mitigation techniques.

This category of research needs is large and a series of sub-categories have been identified that represent the most important management issues or policies affecting priority species and the most important potential threats to birds and their habitats that need to be addressed. An important next step will be to more clearly define threats and limiting factors, using the lexicon defined by Salafsky et al. (2008), and more closely align research needs to address these threats.

Based on the research needs identified at McAllen and in other PIF forums, the most

important future research directions are associated with management or policies in forests, agricultural systems, and wetlands, direct mortality effects (including from energy development and extraction), effects of wildlife trade, and climate change.

STUDYING EFFECTS OF HABITAT MANAGEMENT AND POLICY

Several sessions at McAllen focused on the effects of various silvicultural practices on bird populations and on implementing conservation plans to benefit priority forest communities. A critical need was identified to develop guidelines for forest managers on structure, species composition, and spatial arrangement of forest and shrubby habitat to provide for priority bird species. Forestry practices that are important to study include even-aged management, high-elevation logging, short-rotation plantations, thinning, clear cutting, removal of dead trees/snags, salvage logging, open canopy management, fire control/suppression, prescribed burns, insect control, management of understory, management for early successional habitat, and forest restoration.

Additional forestry issues or characteristics that affect bird populations and communities include successional change, stand age and structure, fragmentation (patch size and isolation), comparisons of natural and anthropogenic disturbance, importance of patchy resources like tree fall gaps, dead trees/snags, and importance of old growth. For each of these topics, we need to measure changes resulting from forest management and provide quantitative estimates of this response. As we are successful in using data-driven habitat/population models to drive management decisions, we need to ensure that habitat enhancement programs are accompanied by effectiveness monitoring to evaluate the success of these programs.

There was a particular emphasis in McAllen on the need for research on the effects and best uses of Farm Bill conservation programs for grassland and other birds. Several sessions identified the need for more published studies that measure multi-species responses to agricultural management actions and an evaluation of the loss of CRP lands at regional scales. Depending on the geographic region and priority species involved, there is the need to study the effects on birds of agricultural practices such as mowing/haying, harvesting, tillage methods, conservation set-asides, pest control (both herbicides/pesticides and other methods targeting avian pests), biomass/biofuel crops, as well as the timing of some of these practices. There is

also the need to document demographic consequences of birds settling in agricultural landscapes.

Some of the research needs associated with western rangeland management are similar to those described above, but they also include effects of rangeland management practices such as grazing by domestic livestock and native herbivores, shrub control/range improvement, prescribed fire, exotic and invasive plants, and issues such as multiple use, and comparisons of different grazing regimes and intensities.

Although most of the focus in McAllen was on landbird priorities, a session on marshbird conservation emphasized the need for research to guide wetland restoration and to evaluate its effectiveness. Research needs associated with wetland management practices include information about the effects of buffers, ditching, draining, impounding, dredging, burning, grazing, open water management, water level management, harvesting, peat removal, restoration, and flood control. In addition, addressing issues such as water rights in the West and multi-species management (e.g., different needs for waterfowl, shorebirds, and landbirds) is important.

ANTHROPOGENIC SOURCES OF MORTALITY

There are both direct and indirect mortality effects of anthropogenic activities on birds. Millions of birds are directly killed each year by a variety of anthropogenic factors including man-made structures, vehicles, and invasive predators; yet the implications of this mortality for conservation of priority bird populations remains poorly understood. Several sessions at McAllen addressed direct mortality issues, and general research priorities identified in these sessions include: (1) Development of better methods for assessing bird mortality and comparing relative risks; (2) Research on mortality rates associated with wind power and telecommunication tower sites that focuses on developing mitigation recommendations; and (3) Development of models to better understand compensatory and cumulative effects of various anthropogenic (and natural) causes of mortality and to determine whether there are regional differences in mortality from various sources.

Given the current and future proliferation of wind power development as a source of "green" energy, there is a critical need to understand its full impacts on migratory and other birds. Current knowledge is based on local and short-term studies, involving small numbers of wind turbines, and may underestimate the risk to birds. Additional research is needed, using

standardized methodologies, to assess impacts of existing wind power facilities, and predictive models based on all available sources of data (e.g. radar, acoustic monitoring, observations) need to be developed to assess the risk to birds from the “build-out” of wind power throughout North America. Results of these risk assessment models will be critical for siting of wind facilities and for the development of operational mitigation procedures.

Research is needed on other energy infrastructure such as power lines, and development of other tall structures such as telecommunication towers. It should focus on the effects of different tower designs (height, guyed vs unguyed), lighting design/configurations, and tower location. As with wind power energy, research is needed on how to measure mortality, and what factors and behaviors influence mortality.

A more accurate assessment of mortality from all of these different anthropogenic sources will be useful in preparing a relative “scale of attrition” attributable to each human-associated (anthropogenic) source of avian mortality. In addition, a PIF White Paper should be developed regarding cumulative effects, including population level effects, from all anthropogenic sources of mortality based on the best currently available science, recognizing for some sources of mortality that data gaps/voids are huge.

In addition, research is needed on the indirect effects of energy and telecommunication development on birds. This research should encompass studies of the effects of the exploration phase, drilling, building collection, delivery, and transportation/transmission infrastructure, waste disposal, noise and visual structure disturbance, water/soil contamination, habitat loss/degradation, fragmentation, contaminants, and changes in predator/prey interactions. Research is also needed to identify the best mitigation methods.

INTERNATIONAL TRADE IN WILD BIRDS

Recently, the international trade in wild-caught birds has received greater attention as a mortality factor for migratory passerines, as well as for parrots. This topic was the focus of at least one session in McAllen, where the need for research to evaluate ties between captive breeding and the wild-caught bird trade (e.g., does captive breeding result in reductions in trade of wild-caught birds?) was identified. There also is a need to investigate the link between bans, enforcement, and success or failure of policies on bird trade. A rare quantitative example of this has taken place recently in Bolivia (see <http://www.birdlife.org/news/>

[news/2007/12/bolivia_trade.html](http://www.birdlife.org/news/2007/12/bolivia_trade.html)); this can be used as a model to guide research in other countries. The big question in linking conservation with trade in birds seems to be whether to ban trade altogether or establish quotas of harvested birds. While neither policy is effective without enforcement, the decision between these policies could be aided by better area-specific quantitative data.

We also need to address the lack of basic information about populations of wild birds targeted for the pet trade. In cases where nations choose to set sustainable quotas, they should acquire enough information on traded birds species to set quotas. In most cases we need to set up monitoring systems and get baseline data on sustainable use of birds, or on preventing trade.

CLIMATE CHANGE

Although most scientists have come to agreement that climate change has anthropogenic causes and therefore is a priority research need, there remains much uncertainty about the most important questions to address and the best approach to addressing these questions. Based on discussions in McAllen, research needs include modeling the effects of climate change on: (1) phenology/timing of life history events (e.g., migration, breeding, availability of food resources); (2) vulnerable species, groups of species, or habitats; and (3) demographic parameters (e.g., productivity, survival, and mortality). Setting priorities for climate change research on birds will require additional discussion and collaboration among scientists, managers, and policy decision-makers in order to identify the highest priority research needs.

Based on discussions in McAllen, climate change research should help us develop a better understanding of the ecological mechanisms and drivers that are influenced by climate change. With limited resources, research should focus on identifying and then testing hypotheses about the species, communities, and habitats most susceptible to climate change and their predicted responses to climate change. It is also important to develop better climate change models that will help bird conservation planning and implementation. These include climate change models that can be integrated with bird-habitat models to assess future habitat capacity and set realistic conservation objectives; incorporation of demographic parameters (not just abundance or distribution data) in linking climate change to birds; stepping information down to scales that make sense for conservation implementers; and models that look at habitat connectivity, ecosystem integrity, conservation design.

Some obvious examples of priority climate change research focused on vulnerable species and habitats include: (1) effects on high elevation montane habitat and avian communities across North America, supporting priority species such as Bicknell's Thrush, Black Rosy-Finch, and Brown-capped Rosy-Finch; and (2) effects on sea-level rise and therefore salt marsh communities supporting global populations of Saltmarsh Sharp-tailed Sparrow, Nelson's Sharp-tailed Sparrow, and Seaside Sparrow. For these and other vulnerable communities, research is needed on stability and connectivity between different parts of species' ranges, movements between habitat patches, and effectiveness of protected area networks.

Although some information is already known about climate change effects on birds, especially as a result of research in Asia and Europe (Wormworth and Mallon 2008), many research issues remain to be identified, prioritized and pursued in North America. To this end, we believe that a high priority next step for PIF is to organize a workshop (or conference, or other means) to bring together researchers (biologists and climatologists), managers, and conservation organizations to begin the necessary discussions and to develop a unified strategy for climate change research. In addition, PIF has identified database management priorities that will help to bring important bird data resources (e.g., BBS, CBC, PIF species databases, Avian Knowledge Network) to bear for climate change research.

SOCIO-ECONOMIC RESEARCH

Socio-economic research has not received much attention in bird conservation planning and implementation discussions in the past. However, it was definitely a subject of great importance in McAllen. By virtue of the need to involve people in bird conservation and the need to present bird conservation priorities within the context of the other social and economic needs of target audiences, it is clear that socio-economic research should play an important part in developing and disseminating information about our conservation goals. Based on discussions in McAllen, research needs are focused on ways to improve conservation delivery and understand socio-economic factors that influence conservation. Research topics that need to be more fully explored by the conservation community include the following.

ECOTOURISM

Research is needed to understand the ecotourism market and how it can be used to

promote bird conservation (e.g., comparing different markets, evaluating successes and failures in business reports). This is especially important in Latin American and Caribbean countries where conservation infrastructure is less developed.

AUDIENCE MOTIVATION

Research is needed to determine what approaches are most effective in motivating interest and involvement in conservation activities by various target audiences. This might involve education/outreach approaches, on-the-ground conservation partnership efforts, and the effective use of media. Audiences should include the general public, birders, resource managers, policy decision-makers and politicians, research scientists, industry, etc.

ECONOMICS

Research is needed to evaluate the economics of various conservation-oriented management practices (e.g., to compare the financial returns and economic sustainability of various silviculture alternatives—to do a cost-benefit analysis) and to measure the ecosystem services provided by birds (e.g., bird consumption of pest insects and the resulting reduction in need for chemical pesticide application) in order to help managers determine which management actions will be most effective.

URBAN/SUBURBAN GROWTH

Research is needed to understand how urban/suburban growth affects bird populations and conservation efforts and to determine how this information can be integrated with bird-habitat-related modeling efforts. Specifically needed are new urban/suburban growth models that can inform and be integrated with habitat-related analyses and projections as a means of assessing habitat capacity and realistic potential for meeting regional bird population objectives.

EVALUATION

The science of evaluation is an increasingly important component of socio-economic research. An important aspect is the testing and implementation of evaluation metrics that will allow PIF to measure success. Another component is to link measurable education outcomes with conservation plan objectives and evaluate progress.

MODELING APPROACHES—RESEARCH TOOLS FOR BIRD CONSERVATION

A common theme throughout the McAllen sessions was the increased use of various modeling approaches to address a wide range of research questions. Modeling can mean many things to many people. Models can be descriptive or predictive. They can be extremely simple—making a connection between a single variable such as canopy cover and a single response variable such as bird abundance. Or models can include multiple factors and be complex and applicable at multiple scales. Ecological models, and many related models (e.g., climate, hydrologic, economic), are critical tools for bird conservation planning and design, providing planners and implementers with better information on population status and trends, predictions about population dynamics, and the consequences of management actions, allowing planners to integrate information across spatial and temporal scales. Because models are tools to answer particular research questions, there is substantial overlap with the subjects described above. It is useful to think about the types of models that might be used to address bird conservation research questions. Although we describe three types of models below, it is important not to think about these three kinds of models separately, since the models are often interactive and use many of the same variables.

MODELING BIRD DISTRIBUTION AND POPULATIONS

Models are needed to define/describe: population size estimates; bird species distributions; and population dynamics (e.g., metapopulations, source/sink populations, density dependence, population viability, population trends, limiting factors). Two important concepts arose in these discussions: (1) We need to incorporate demographic parameters (e.g., reproduction, mortality, survival, emigration, etc.) into bird population models, not just presence/absence, abundance or density; and (2) we need to tie together the entire life cycle of birds in modeling distribution and populations (including breeding, migration, winter, etc.).

Two priority research needs associated with bird distribution and population models and specific to bird conservation were identified: (1) Models are needed to compare population sizes, dynamics and demographics in various locations, habitats, and management regimes. (2) Because modeling is often based on relationships or assumptions that change over time, and because multiple researchers often model the same systems in different locations and over

different spatial and temporal scales, dynamic modeling tools are needed that allow researchers to efficiently build upon each other's achievements and update models as new information becomes available. Recent advances in social networking tools and open source software provide many opportunities for researchers to combine expertise and time toward common modeling goals (see http://litcentral.freebase.com/view/base/litcentral/views/species_habitat_relationships). It is a high priority for PIF to contribute to or help develop resources of this sort.

MODELING BIRD-HABITAT RELATIONSHIPS

Models are needed to describe bird-habitat relationships, using the broadest possible definition of "habitat" to include physical, abiotic, and biological factors. Habitat can include landscape characteristics, habitat quality/quantity, local and micro-habitat characteristics, and it can represent past, current, potential, or predicted habitat. For these models to be effectively used, habitat variables should be meaningful and relevant to the managers who will apply the model results (i.e., current and desired conditions). Bird response variables can be presence/absence, abundance, density, and/or demographic parameters. These kinds of models can identify habitat components that are important to species and groups of species, and can include predictive components.

Three important concepts about bird-habitat models were identified: (1) species-specific, basic bird-habitat models are still needed for some systems/species because in some cases extrapolation from related models doesn't work (e.g. marshbirds); (2) bird-habitat models can/should be used to guide habitat restoration, identify gaps in our knowledge, guide other management actions, and set habitat and population objectives at various spatial and temporal scales; and (3) full life cycle bird-habitat models for priority species are crucial to effective conservation implementation.

MODELING LANDSCAPE-LEVEL FACTORS (INCLUDING ABIOTIC FACTORS)

For bird conservation planning and implementation at regional, national, and continental scales, modeling at the landscape level is crucial to accomplishing our goals. These kinds of models can be among the most complex, and frequently incorporate abiotic, environmental, and socio-economic components as well as the bird distribution/population and habitat components in the models mentioned above. Landscape-level models that would be

useful in bird conservation planning, objective setting, and implementation could include: (1) descriptive models of changes in landscape attributes over space and time (e.g., comparing existing and historic landscape conditions); (2) predictive models of change (e.g., bird distribution, abundance, and demographics; habitats/landscapes—distribution, abundance, and quality; resources like wind and power infrastructure) at various temporal and spatial scales that include effects of management actions, human populations, succession, etc.; (3) Conservation design models to help design reserves, identifying optimum size, shape, and location; (4) models that identify conservation opportunities by determining distribution, conservation status, land ownership, potential of priority habitat types; and 5) models that identify the landscape-level limiting factors that are important to birds, such as area and landscape patterns needed by area-sensitive species, factors that vary at different scales, and habitat fragmentation.

Overall, modeling is a critical tool to use in conducting research and presenting research results in a way that will benefit bird conservation. This is such a rapidly developing field that one of the priority research needs is to continue to develop new methods to understand/predict spatial distribution, density, and vital rates in bird populations, and to develop new statistical analyses methods and modeling techniques that are particularly aimed at addressing the needs of bird conservation planning, design, and implementation.

NEXT STEPS

META-ANALYSES OF EXISTING DATASETS AND PUBLICATIONS

Many datasets have already been collected and much information is already known about the distributions of species, and natural and anthropogenic factors affecting populations of species. However, these data are often contained within disparate databases and knowledge is described in thousands of publications. There is therefore a need to consolidate existing data into data management systems such as the Avian Knowledge Network (AKN) (<http://www.avianknowledge.net>) so that they can be used to test hypotheses as well as evaluate spatial and temporal trends in bird populations in ways that extend beyond the extent and scope of individual projects. Similarly, there is a need to summarize the results of previous research within spreadsheets or databases that can be analyzed both quantitatively and qualitatively.

Some research needs that can be addressed through these consolidated sets of data and knowledge include: (1) Quantifying shifts in species life history strategies over their geographic ranges that would necessitate the implementation of different management and mitigation strategies at different locations across the landscape; (2) Quantifying spatial variation in threats (e.g., towers, lighting, wind farms, biofuel production) to bird populations that might better inform regionally focused policy changes; (3) Quantifying variation in demography (e.g., fecundity, survival, productivity, predation, nest parasitism) of species among different ecological communities that could be used to inform management strategies; (4) Quantifying direct causes of shifts in phenology that are indirectly due to climate change; and (5) Quantifying shifts in species geographic ranges due to urban and residential development, competition, disease, etc.

COMMUNICATING RESEARCH RESULTS TO BIRD CONSERVATION IMPLEMENTERS

The importance of effectively transmitting research results to end users (bird conservation planners, implementers, and regulators) cannot be overstated. It is research that provides the scientific framework on which bird conservation is built; this strong scientific foundation will also provide political support for management actions. Perhaps the most important way to ensure that research results reach the right audience is for researchers, planners, and managers to work together from the onset of research projects so that the design, conduct, and results of research are relevant and available to the end-users. Ultimately both researchers and managers must be involved in transmitting that information to those who need it and can use it. It is particularly important that data are made available to the locations where the data were collected (e.g., get data/results back to the country or the land management agency where they were collected). Many of the tools or processes for transmitting research results involve a large component of education/communication and will require collaboration between scientists, educators, and end users to develop useful products.

There is a great need for tools that will transmit research results to managers and allow managers to apply the information to their conservation decisions and actions. Perhaps the most important type of tool being discussed in the bird conservation community currently is Decision Support Tools (DSTs), instruments used for conveying scientific information that

informs decision-making through synthesis and interpretation of quantifiable and repeatable scientific data (Alexander et al. in this proceedings). In addition, some information needs can be addressed by the development of: (1) Best Management Practices (BMPs) which could be about habitat management, habitat enhancement/restoration, conservation practices, or education subjects; (2) management guidance documents (e.g., guidance on available, accepted mitigation practices for species “take” or habitat loss); and (3) Literature syntheses that compile and summarize the results of applicable research on particular conservation subjects (e.g., a white paper on the cumulative effects of all anthropogenic sources of bird mortality).

One key concept that arose from McAllen was that managers prefer tools that provide guidance on groups of species or communities rather than single-species tools, as well as tools that address a variety of management options. Ruth et al. (2003) identified four key themes regarding the development of application tools and other management-directed research: (1) collaboration between scientists and end-users; (2) a rigorous decision-making process; (3) direct, unambiguous links between science, management, and decision-making; and (4) user-friendly access.

EVALUATING ASSUMPTIONS AND SUCCESS

It is important that all aspects of bird conservation planning and implementation incorporate adaptive management concepts. Including evaluation components enables us to assess our progress and determine whether goals and objectives are being met and whether the assumptions on which our actions are based were correct. Research is needed to develop better tools for such evaluations, and research is needed to actually evaluate assumptions and success. Based on discussions at McAllen, evaluations of assumptions and success are required in many bird conservation processes:

- Research and monitoring—Evaluate the assumptions behind research and monitoring projects and results to determine whether they are correct.
- Decision Support Tools and Best Management Practices—Test or “ground truth” DSTs and BMPs to ensure that the models and assumptions on which they are based are correct, and to assess their overall utility.
- Conservation Planning Initiatives—Evaluate their success in bringing together the correct partners and accomplishing

on-the-ground conservation (e.g., Partners in Flight and other bird initiatives, Joint Ventures).

- Management activities—Evaluate the effectiveness of management programs and techniques in meeting management objectives (e.g., habitat enhancement, population management, restoration, mitigation, agricultural programs like CRP, and population recovery/relocation/release).
- Conservation policy/enforcement actions—Evaluate whether these actions (e.g., regulations, bans, quotas, fines) are effective in meeting their objectives. The example from McAllen was actions aimed at controlling the bird trade.
- Education/Outreach programs and tools—Evaluate their effectiveness in meeting conservation objectives (e.g., IMBD, Flying Wild, Project Feeder Watch, birding trails, education curriculums, banding education programs, landowner programs).

Those developing and conducting evaluations should answer questions such as: Are the expectations of users/planners being met? What are the best means of measuring success? What are the best parameters to measure? Are these efforts contributing successfully to meeting conservation goals and objectives? Are the right outcomes being accomplished? Are there complementary or redundant efforts? Are efforts being focused on the right audiences and users?

BUILDING/MAINTAINING RESEARCH AND MONITORING CAPACITY

Resources (funds, people, capacity, infrastructure, etc.) are needed in order to conduct the research and monitoring activities that will address the needs identified here and elsewhere. Current funding levels among agencies and organizations that conduct and support research and monitoring are not sufficient to support the level of work that is required to ensure that our conservation objectives are met. Based on discussions in McAllen, the following four capacity issues are the highest priority for PIF at this time:

- Encourage/ensure that the necessary resources are available for continued and increased research on complex bird conservation issues by “traditional” research sources (e.g., USGS, USDA Forest Service Research Stations, universities, Joint Ventures, federal and state resource management agencies, etc.).

- Provide additional support for nontraditional data providers (e.g., NGOs, bird observatories, Avian Knowledge Alliance) that provide important supplemental research and monitoring capabilities.
- Encourage/ensure that the necessary resources are available to support infrastructure, data collection, database management, and data analyses for newer data sources now being used in modeling for conservation (e.g., Avian Knowledge Network, e-Bird, MoSI).
- Build/support capacity among our partners in Latin America and the Caribbean—training, guidance, research exchange, funding, supervision and mentoring, and increased communication and coordination. This also requires a mechanism to ensure that data in the hands of “outside” researchers is returned to the country of origin.

LITERATURE CITED

- ALEXANDER, J. D., J. L. STEPHENS, G. R. GEUPEL, AND T. C. WILL. 2009. Decision support tools: bridging the gap between science and management, pp. 283–291. *In* T. D. Rich, C. Arizmendi, D. W. Demarest, and C. Thompson [eds.], *Tundra to Tropics: Connecting Birds, Habitats and People*. Proceedings of the 4th International Partners in Flight Conference, 13–16 February 2008. McAllen, TX. *Partners in Flight*.
- DONOVAN, T. M., C. J. BEARDMORE, D. N. BONTER, J. D. BRAWN, R. J. COOPER, J. A. FITZGERALD, R. FORD, S. A. GAUTHREAU, T. L. GEORGE, W. C. HUNTER, T. E. MARTIN, J. PRICE, K. V. ROSENBERG, P. D. VICKERY, AND T. B. WIGLEY. 2002. Priority research needs for the conservation of Neotropical migrant landbirds. *Journal of Field Ornithology* 73:329–340.
- 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. INIGO-ELIAS, J. A. KENNEDY, A. M. MARTELL, A. O. PANJABI, D. N. PASHLEY, K. V. ROSENBERG, C. M. RUSTAY, J. S. WENDT, AND T. C. WILL. 2004. *Partners in Flight North American landbird conservation plan*. Cornell Lab of Ornithology. Ithaca, NY.
- RICH, T. D., B. DALE, L. LONG, C. J. RALPH, K. ROSENBERG, E. SANTANA, A. SUTTON, AND X. VEGA. 2008. *Partners in Flight Bird Conservation Needs Assessment: Results of the 4th International Partners in Flight Conference*. *Partners in Flight*. McAllen, Texas, USA. [Online.] <<http://www.partnersinflight.org/events/mcallen/PIF%20Bird%20Conservation%20Needs%20Assessment.pdf>> (26 June 2009).
- RUTH, J. M., D. R. PETIT, J. R. SAUER, M. D. SAMUEL, F. A. JOHNSON, M. D. FORNWALL, C. E. KORSCHGEN, AND J. P. BENNETT. 2003. Science for avian conservation: priorities for the new millennium. *Auk* 120:204–211.
- SALAFSKY, N., D. SALZER, A. J. STATTERSFIELD, C. HILTON-TAYLOR, R. NEUGARTEN, S. H. M. BUTCHART, B. COLLEN, N. COX, L. L. MASTER, S. O’CONNOR, AND D. WILKIE. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. *Conservation Biology* 22:897–911.
- WORMWORTH, J., AND K. MALLON. 2008. *Bird species and climate change - the global status report*. A report to World Wide Fund for Nature. Climate Risk Pty Limited. Fairlight, NSW, Australia. <<http://www.climaterisk.net>> (26 June 2009).

