Setting Local and Regional Objectives for the Persistence of Bird Populations

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Abstract—Managing lands to promote persistence of a wide diversity of native species, often with opposing habitat needs, requires a complex set of decisions to be made at multiple spatial scales. Management goals and objectives for species are established under a variety of constraints, and each land manager faces unique challenges particular to his/her location. However, the ultimate success of a bird conservation plan depends upon coordinated efforts by managers at regional and local scales, emphasizing the need to standardize the decision-making process at all scales. In this paper we outline a suggested process by which decisions about management of North American birds can be made to establish specific objectives and implement actions at regional and local scales. We also provide some suggestions regarding biological criteria that can be used as tools in making management decisions and evaluating management results at regional and local levels.

Managing lands to promote persistence of a wide diversity of native species, often with opposing habitat needs, requires a complex set of decisions to be made at multiple spatial scales (Noss 1983; Probst and Crow 1991; Maurer 1993; Freemark and others 1995; Petit and others 1995). Developing effective plans for highly mobile species such as birds is particularly challenging because bird populations may be regulated during any phase of their life cycle. North American plans that focus on maintaining viable breeding populations may be ineffective if heaviest mortality occurs during migration or winter. Conversely, South, Central, and Latin American plans that focus on maintaining habitats associated with high overwinter survival may be ineffective if an insufficient number of birds are produced during the breeding season. Furthermore, even within North American breeding habitat, it is thought that most species occur as spatially distinct breeding populations that interact by dispersal; the effectiveness of local-scale management actions may be difficult to track if birds disperse to and from the local area.

For these reasons, we discuss the development of effective, regional plans in North America, where a region is defined as the geographic scale that is thought to encompass the majority of natal and breeding dispersal movements of a population (sensu Greenwood and Harvey 1982). We discuss regional planning with the realization that plans can be expanded or altered as more is learned about population regulation and limitation in birds, and about the spatial scale that best defines population interactions.

Flowchart Overview

The overall goal in developing regional bird conservation plans is to maintain viable populations of native species at some predetermined level of regional abundance and distribution. To achieve the stated goal, we propose a decision-making process that follows the form of a flowchart, where each step in the process must be addressed before proceeding to the next step. The decisions are carried out by both "regional" and "local" managers, although the distinction between the two may be obscure. Simplistically speaking, a local manager usually focuses management decisions on achieving local objectives, and implements specific management actions, whereas a regional manager coordinates the management actions of local managers to achieve regionally defined objectives. Refuge or park managers are examples of local managers, while state wildlife biologists or Partners in Flight (PIF) Regional Coordinators are examples of regional managers.

The flowchart can be viewed as a top-down approach where local scale management is influenced by, but not limited to, regional scale objectives. The entire chart is followed first by the coordinated efforts of regional and local managers to address regional priorities, and then subsequently by local managers to address more localized priorities. The process emphasizes the need to develop plans at much larger spatial scales than traditionally have been developed. The process also includes an adaptive management approach, whereby each step in the process can be evaluated and revised to improve the development and implementation of specific

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management objectives (at all relevant spatial scales) to maximize results in an uncertain future.

Step I is to determine the geographic context in which all management objectives will be integrated. This context, which includes the spatial and temporal distribution of habitats and species within an area of concern, will determine the management objectives that are possible, feasible, and optimal for the region in which the plan will be implemented. Once this context is determined, a prioritization scheme can be used to prioritize species for management action (e.g., Hunter and others 1993a; Carter and others, this proceedings; Dunn 1997). The outline presented here assumes that priorities already have been established.

The remainder of the decisions in the process, Steps II through VIII, are outlined by a large box to indicate that all remaining decisions are made in light of this geographic context and the sociopolitical constraints operating within it. In this paper, we focus our discussion primarily on Steps I through VI; more in-depth discussions about the steps that describe monitoring and evaluation (Steps VII and VIII) are described in Twedt and Loesch (this proceedings).

The chart flows as follows (fig. 1): Once the geographic context and species priorities are known (I), managers must decide (II) what is the "object of management" at the regional scale. That is, they must define exactly what will be targeted for management—habitats or species, or both—and then set management objectives at a regional scale. Given the object(s) of management and regional objectives, managers must then (III) assess what constitutes high-quality habitat within the region for each object of management. Once the basis for habitat quality is known for each object of management, regional and local managers together (IV) model the spatial or temporal arrangements of habitats at a regional scale to determine a plan that optimizes management when all objects of management are considered simultaneously. Based on the model simulations, recommendations can be made, and (V and VI) specific management objectives can be implemented at the local scale. Adaptive management requires (VII) short- and long-term monitoring and assessment of progress of management efforts toward local and regional goals. Depending on results from monitoring/assessment efforts, (VIII) any or all of the steps (including Step I) can be revised to improve management effectiveness. The flowchart can be followed to assess regional priorities, but also can be used by local managers to set local scale priorities and objectives.

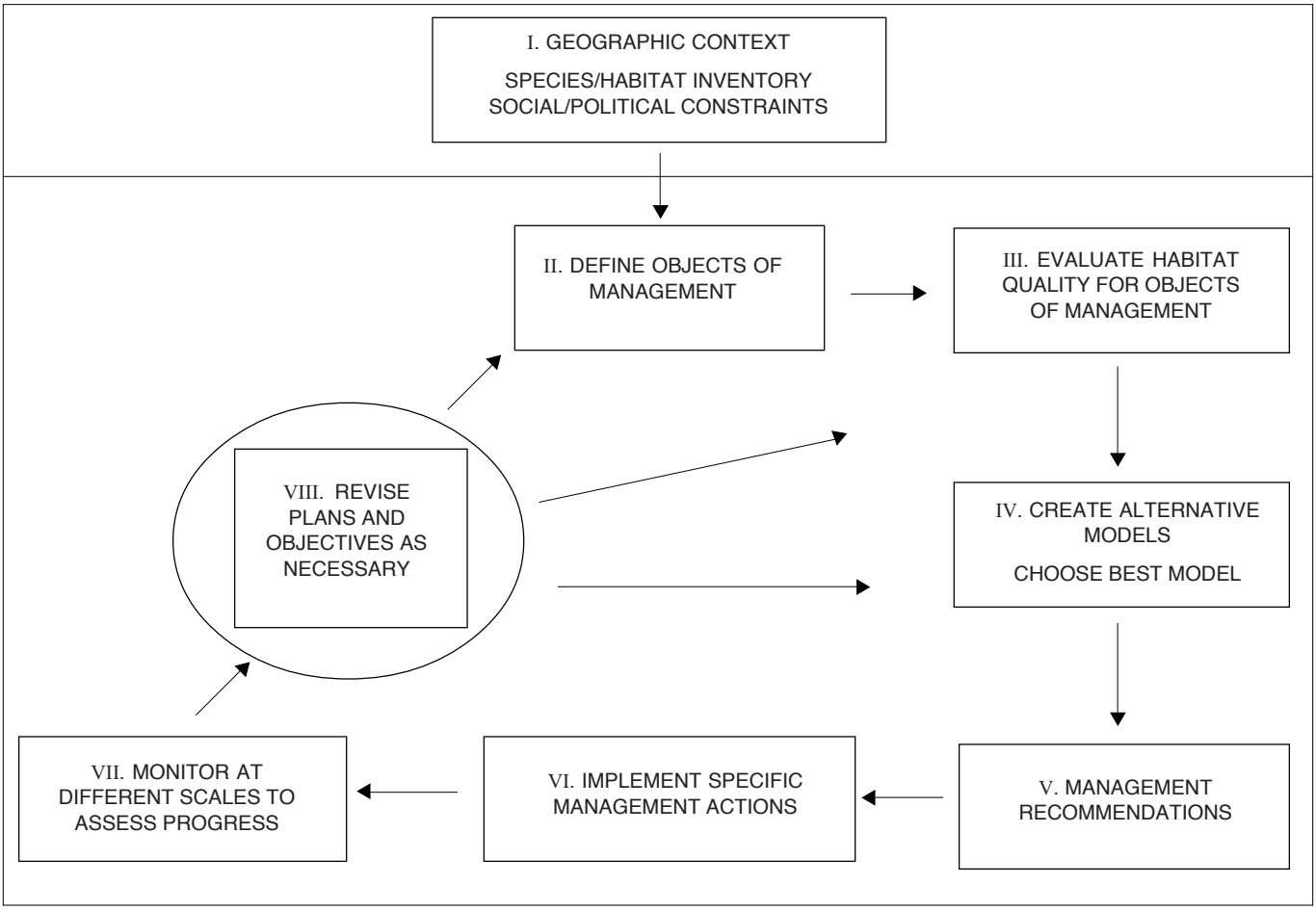


Figure 1—Flowchart.

Step I: Identify the Geographic Context of a Management Plan

The first step is to define the spatial and temporal context for management actions.

Spatial Context—This step defines the regional scale for management, and identifies species and habitats that occur within the defined area. We suggest that biological considerations should underscore the actual number and sizes of each regional unit within North America. For example, if the regional units are too small relative to the distance that birds disperse from one breeding season to the next, then regional plans may be confounded by dispersal of individuals into and out of the region of concern, and may complicate the evaluation of management actions. In contrast, if regional units are too large relative to the size of average populations, then development of regional plans may be unwieldy and ineffective. Thus, the size and number of regional units must be carefully considered from a biological perspective before any plans are drawn. Given the biological context, additional attention should be given to social, economic, and political constraints.

The scale selected by PIF for conservation planning is that of the physiographic area (Williams and Pashley, this proceedings). physiographic areas vary in size from 20,000 km^2 (Subtropical Florida) to 2,000,000 km^2 (Boreal Forest). The selection of this scale undoubtedly influences which species become management priorities. Because physiographic area boundaries often cut across political boundaries, implementation of management objectives may take place at various scales, such as within states. Additionally, at this time there is little evidence that any physiographic area encompasses the majority of dispersal movements of a population. Theory suggests that dispersal (natal and breeding) should be limited in geographic extent (Shields 1982), yet banding recovery data suggest that dispersal may be wide-ranging. The selection of the physiographic area, however, is thought to have more biological meaning than political boundaries, because physiographic areas contain a collection of relatively homogeneous habitats (Williams and Pashley, this proceedings). Boundaries can be adjusted as more practical solutions become apparent, and as we learn more about bird distributions and their relevance to boundary designations.

Temporal Context—Step I also identifies the temporal context in which management actions will be evaluated. The lack of a defined temporal context has been problematic with previous attempts of adaptive management (D. Bonter, personal communication), indicating the need to identify a specific time period for initiation of reviews. The evaluation (see Step VII) includes an assessment of whether objectives have been met, and also re-evaluations of species priorities, which are scheduled at approximately 5-year intervals (D. Pashley, personal communication). Five years may be an appropriate interval for evaluating priority species. However, considering the time required to go through the planning process (up to two years), and to manipulate habitats, five years is likely to be too short for assessing the entire management plan. Ten to twenty years may be more suitable because populations are then given sufficient time to respond to specific management actions. However, in rapidly changing environments, 20 years might be too long if species decline without being noticed. In these cases, or where an immediate response to a management action is expected, more frequent evaluation may be warranted. Although evaluation of the entire management plan may take place infrequently (every 10-20 years), monitoring of populations to assess response to management should occur throughout the process, preferably on an annual basis.

All future steps must be considered within the context established by this geographic and temporal context.

Step II: Define the Object(s) of Management and Set Objectives

Step II, a critical point, is where the "object of management"—the unit upon which management objectives will be based—is determined. For example, in the Northern Tallgrass Prairie, 27 of 185 species have been identified as management priorities (Fitzgerald and others 1998). Potential objects of management include, but are not limited to: These 27 individual priority species; umbrella species whose habitat requirements encompass the requirements of other species (e.g., Murphy and Wilcox 1986); focal species that include priority and non-priority species which are most sensitive to a process that threatens their persistence or to the management practices being used in a given habitat type (Lambeck 1997); or all species that share a general macrohabitat type (species-habitat suites).

Which of these "objects of management" will best achieve the overall goal? First and foremost, the object must be selected so that effects of a management scheme are measurable and can be evaluated. For example, if the object of management is a priority species, then measurable features such as abundance, distribution, and reproductive success must be related to specific management actions, and then evaluated in terms of success or failure. Objects of management for which outcome measures are vague should be avoided (e.g., "viable populations of forest birds").

The current PIF planning process uses "species-habitat suites" as objects of management. This approach is designed to achieve the goal of maintaining viable regional populations and to "keeping common birds common." The PIF prioritization scheme is based not only on identifying species in need of immediate conservation action, such as those that are sharply declining, but also on identifying species that are unique to a region. It also focuses on identifying those species within a region where regional persistence is critical not only for the region, but also for the species' persistence across its range. The result is a list of priority species from various habitats which are grouped into species-habitat suites. Birds within the suites represent focal species, and management for those species is thought to ensure persistence of other, non-priority species. Whether managing for "species-habitat suites" will achieve long-term goals more effectively than other "objects of management" is likely to be a focus of conservation interest in the coming decade.

Setting Objectives—Once objects of management have been selected, region-level population and habitat objectives

are determined. An objective is a clearly defined statement of what is intended to be accomplished in a given amount of time. A clearly defined objective establishes a set of criteria that can be evaluated in terms of success or failure; ambiguous objectives will cause confusion among various land managers and cannot be evaluated. For example, if an objective is to provide sufficient habitat to maintain Bobolink populations, mixed impressions among managers will result. Some might think "Bobolink populations" is a few singing males in the region; others might think "Bobolink populations" is a single viable source population. Some might think Bobolink habitat is native prairie; others might think Bobolink habitat is Conservation Reserve Program lands. Clearly stated objectives specify what is to be done and when (W. Porter, personal communication), for example: "Maintain habitat in the Northern Tallgrass Prairie Physiographic Region to support 5,000 breeding territories of Bobolinks with average nesting success of >40% by the year 2020." As PIF conservation plans are developed, considerable thought will be needed to establish objectives that are well defined. This will be a long and complicated process.

Our flowchart incorporates an adaptive management phase in every step, emphasizing the need to explicitly state each objective and the means by which management actions can be evaluated. As such, if the object of management is a priority species and a regional goal is to maintain viable populations of at least 5,000 individuals, then measures of both population viability and abundance should be used to assess the success of management actions. In contrast, if an object of management is a particular habitat that accommodates a suite of species, (e.g., maintain 5,000 ha of old-growth forest), then assessment of management strategies should be habitat-based.

Considerations for Setting Objectives—In our opinion, objectives for objects of management should be population based (numbers of individuals), rather than habitat based (amount of habitat). First, numerical objectives appear to be easier to "sell" from a policy standpoint (e.g., the huge success of the North American Waterfowl Plan is based, in part, on the establishment of numerical objectives). Second, if numerical objectives are achieved, sufficient habitat likely has been managed. In contrast, setting habitat objectives may be achievable (e.g., maintain 3,000 ha of riparian forest), but population numbers may not be maintained on those habitats. Habitats, for example, can change in quality and go from "prime" to "poor" even when habitat size, configuration, or structure are not changed. This can happen when factors extrinsic to the patch itself affect the quality of the patch, or when factors intrinsic to the patch vary over time.

Consider the Everglades National Park, where decreased water levels—owing to urban, suburban, and agricultural development outside of park boundaries—has impacted the hydrology and habitat quality of the park itself, although the area has remained constant. If densities decrease as habitat quality decreases, the same area will support fewer individuals. Thus, use of numerical population objectives may provide an important cushion for unforeseen impacts, both intrinsic and extrinsic, on habitat quality in a changing environment.

Step III: Evaluate Habitat Quality for the Object(s) of Management

Step III involves identifying the full range of habitats that can be used by each object of management in the region, assuming that objects of management are species or species combinations. The emphasis here is on identifying high-quality habitats that allow populations to persist at the regional level (habitats where productivity and/or survival is high). The end result is a list of habitats, sizes, and configurations that could be targeted for management to achieve regional objectives. Objects of management require region-specific evaluation of high-quality habitat and its spatial arrangement for two reasons. First, populations may differ regionally in demography, density, and dispersal ability (e.g., edge versus center of the geographic range). Second, the constitution of high-quality habitat for the same object of management may vary regionally. For example, birds nesting along forest-edges that are situated in heavily forested landscapes may experience high nesting success, but birds nesting along forest edges in highly fragmented landscapes are likely to experience low nesting success (Donovan and others 1997). In this situation, edges are "low quality" for breeding in one landscape type and "high quality" in another.

Considerations for Assessing High-Quality Habitat—Conservation biologists and wildlife managers have used several criteria for determining high-quality habitat for an object of management. These include, but are not limited to:

- Minimum number of pairs supported (e.g., habitat conditions needed to support 10 breeding pairs).
- Nesting success adequate to support local breeding populations (e.g., habitat conditions needed to achieve a "high" nesting success over time).
- Presence of an area-sensitive priority species (e.g., forest area needed for area-sensitive species to occur with some degree of regularity).
- High density of a priority species.
- Habitat that promotes high survival levels.
- Habitat that facilitates dispersal among local areas.

When assessing high-quality habitat for each object of management, a few key issues must be considered. First, the ability of a population to sustain itself locally may be unrelated to the density of individuals or the size of a local habitat; sinks can support many individuals, and sources can be numerically quite small. Thus numbers can be misleading, and management plans should aim to protect a diversity of habitats and landscapes used by the species, not just areas where the species is most common. Second, source and sink populations can be characterized by their relative importance depending on their intrinsic rate of growth and the number of individuals present. "Strong" sources are better than weak sources in maintaining regional populations. Third, owing to temporal variation, a habitat patch may oscillate between supporting a source population and a sink population. Fourth, although demographically viable, sources can become extinct via non-demographic processes (e.g., stochastic events), and if regional sources collapse, the

regional population will go extinct. Maintaining multiple sources that are geographically spaced appears to be a good strategy for maintaining regional viability.

Finally, although sinks depend on sources to persist, they may benefit the regional population by "housing" a large proportion of the population at any given time. Additionally, a substantial number of young may be produced in sink habitat even though reproduction occurs at a level below replacement. However, if sinks act as ecological traps that draw birds away from higher quality source habitats, or act as a conduit to spread parasites or disease, then maintenance of sink habitats at a regional level may not be desirable. Planning should be flexible to accommodate new management principles as more is learned about the benefits or detriments of sink habitats in maintaining regional populations.

To evaluate source-sink status, the fecundity (season long reproductive success per individual) and death rates of adults in the population must be measured. Therefore, population trends, presence-absence data, and population density may not be capable of establishing source-sink status (Brawn and Robinson 1996) and may be misleading indicators of habitat quality (e.g., Van Horne 1983; Pulliam 1988). Unfortunately, direct measures of fecundity and survival are perhaps the most data-intensive measurements for assessing high-quality habitats. Surrogate methods are needed. Several indirect measures of productivity have been used to estimate habitat quality, including nesting success, pairing success (e.g., Villard and others 1993), juvenile: adult ratios (e.g., Robinson 1992), and others. While these measures do not directly estimate number of offspring produced per individual per year, they are thought to be correlated with productivity. Variation in numbers over time is another indirect assessment of habitat quality. Because sink populations theoretically fluctuate over time more than sources (Howe and others 1991; Curnutt and others 1996; Boulinier and others 1998), simple measures of change in abundance over time may be an indicator of habitat quality. Of course, criteria used in determining high-quality habitat for an object of management should be carefully considered and tested for their effectiveness.

Targeting Threats—In the absence of direct measures of fecundity and survivorship for an object of management, identification of threats to persistence or other indirect measures of viability may be used to evaluate high-quality habitat. For example, parasitism by the Brown-headed Cowbird (*Molothrus ater*) reduces fecundity for many species in fragmented Midwestern landscapes, but is not a major threat in heavily forested landscapes, whether in the Midwest or in other regions such as the Northeast. In regions where parasitism is identified as a major threat for a priority species, managers can assess habitat and landscape conditions that limit cowbird abundance, and thus manage indirectly for the priority species.

Step IV: Create Alternative Models of Landscape Configuration Based on Geographic Context

How is a region going to maintain 5,000 Bobolink pairs with an average nesting success of 40% by the year 2020? Once high-quality habitat has been established for each object of management, Step IV involves the collaborative efforts of both regional and local managers to create alternative management plans that will meet regional management objectives when all objects of management are considered simultaneously. This step addresses a regional-scale question: How should we manage the regional landscape (habitats and their configuration) to achieve the regional population (numerical) objectives? The possible habitat/management arrangements (blueprints) that will meet regional objectives may be few or many.

The goal could be achieved by modeling an array of potential management actions at the regional level (landscape configurations), and by coordinating efforts of all public land managers and cooperating private landowners to reach regional population objectives (e.g., Hansen and others 1993). This step uses an adaptive approach that identifies the effect of each management scenario on each object of management. For example, dynamic population models for each object of management can be developed, where each model predicts the response of the object of management to landscape management prescriptions as a function of the initial population or habitat status, environmental conditions, and management actions. The functions provide a measure of the effect of different management policies at the regional scale, and thereby permit identification of optimal policies for the region.

How can this be accomplished? One approach is to link simulation models with GIS to create locally accurate models of populations in landscapes. To achieve this step, information is required on (1) bird-habitat relationships, which depend on a consistent means of counting birds and describing habitat, (2) habitat distribution throughout the region, which depends on a consistent vegetation classification, and (3) satellite imagery, which relies on an accuracy-checked vegetation classification scheme. A simpler approach is to examine current maps of classified vegetation and land ownership, to determine where large tracts of manageable habitat exists, and to develop various management blueprints around such "cursory" information.

The result of any of these exercises will be one or many blueprints thought to be suitable for achieving regional objectives. In reality, physiographic areas can be tens of millions of hectares in size, and developing blueprints of that size entails numerous inherent difficulties.

As a simplified example, one blueprint might suggest the amount and location of the following habitats: At least 4,000 ha of mature hardwood forest (with at least 75% as contiguous habitat), 2,000 ha of wetland forest (with some high level of connectivity), and 1,000 ha of native grassland (with at least 50% as contiguous habitat). A second blueprint for the same physiographic area might prescribe the location of 3,000 ha of mature hardwood forest (with at least 90% contiguous habitat), 2,000 ha of wetland forest (with the same level of connectivity in Blueprint 1), and 2,000 ha of native grassland habitat (with at least 25% as contiguous habitat). The different blueprints will identify the total amount of habitat needed, where it is located, and how it is configured to achieve the regional population objectives.

Blueprints likely will target large tracts of habitat under public jurisdiction, but also may target habitats under private ownership to build cooperative agreements for bird

conservation. Undoubtedly, tactics for successfully achieving regional objectives will vary depending on the social, political, and economic values of the region.

Step V: Make Management Recommendations—Choose the Best Blueprint

Both regional and local plans are developed at this step, which involves the coordinated efforts of all participants within the region. Local managers identify how they can contribute to the regional objectives, and select the blueprint that best achieves consensus. They are presented with a list of priorities (habitat and species) for the region and make management decisions about one, many, or all of the species on the list, working in concert with the regional manager to ensure that regional objectives will be addressed. Coordination of local-scale decisions is needed to ensure that all of the regional objectives are met (e.g., that no regional objectives slip through the management plan because none of the local scale managers elect to manage for a regional object of management).

As a simplified example of Steps IV and V, suppose that two priority species have been identified as objects of management for the St. Lawrence Plain physiographic area, the Bobolink (BOBO) and the Golden-winged Warbler (GWWA). For nesting, one species requires grasslands of a certain structure, while the other requires shrubby habitats of a certain structure. Both species require that forest succession be prevented. Multiple regional blueprints are developed that consider different management scenarios, and the plan(s) that achieve both species' population objectives are selected for discussion. Local level managers, aware of the regional goals because they assisted in the regional planning process, identify how they can contribute toward meeting regional goals on their properties. Because BOBOs and GWWAs demand conflicting management actions, some managers may contribute toward BOBO habitat and others may contribute to GWWA habitat. Given the regional priorities, each local manager can then decide how to manage for their target species (following flowchart Steps II-VIII). Both regional and local managers must work together to decide how the regional landscape will be managed to meet regionally defined objectives.

Step VI: Implement Specific Habitat Management Strategies and Actions

Given the regional objectives, management actions are implemented by local managers. Within a local context, managers may have options for implementing actions for the species defined at the regional level. For example, if the GWWA is identified as a priority for the area, then local managers can consider how to restore and enhance GWWA habitat, how to increase the size and number of GWWA source populations, and how to make weak GWWA sources into stronger ones. Local managers can follow Steps II –VIII to make local management decisions to meet local objectives that involve local as well as regional priorities. Implementation of conservation objectives is a huge and critical step in the overall process; however, a more complete discussion of implementation is beyond the scope of this paper.

Step VII: Monitor Bird Populations and Habitats at Local and Regional Levels

Both short- and long-term monitoring are needed to assess how well management efforts are achieving goals for long-term persistence of regional bird populations. In general, the more sophisticated and precise the monitoring, the easier it is to resolve uncertainties about biological mechanisms and thus to improve the management plan (Lancia and others 1996).

Monitoring strategies should be integrated at both regional and local scales. The types and timing of monitoring may be targeted for different locales to ensure regional representation of different types of data (e.g., nest monitoring, constant effort mist netting, surveys, migration monitoring). For example, more extensive and general survey work on distribution and habitat use could be combined with less extensive, but more intensive and detailed field work on productivity and survivorship of priority species. Such an approach facilitates implementation of coarse-filter conservation and management strategies while progressively finer filters are being developed.

The entire process outlined here depends on collecting information that can be used to assess the success of a particular management scheme. To that end, partnerships between the management and scientific communities are critical in developing effective plans for the long-term persistence of regional populations. However, most research studies are conducted at a local scale, and because results may vary dramatically between locations, generalizations regarding population regulation or limitation may be difficult, and management actions based solely on locally conducted studies may be ineffective. As such, national databases can provide necessary information to obtain regional perspectives on bird populations. Existing monitoring programs such as the Breeding Bird Survey and productivity programs such as BBIRD and EMAP should be supported by both scientific and management communities, and new programs targeted at regional scale population dynamics should be implemented.

Step VIII: Revise Management Plan and Objectives as Necessary

Depending on results from monitoring efforts, management plans and/or specific management objectives may need to be revised by changing any one or all of the decisions made previously in the overall flow chart.

Conclusion

Management of lands to promote persistence of all native bird species is not an easy task. Here, we have suggested a plan that emphasizes the importance of considering regional-scale "metapopulation" dynamics in the development of management plans. Our understanding of population dynamics at a regional scale is at an early stage, and our plan

represents only one hypothesis of how lands should be managed at both local and regional scales to promote species persistence. Like all hypotheses, we hope that this approach is tested and then modified as more is learned about the populations that are being managed.

The PIF planning process is currently under way, and is attempting to define priorities and management objectives for all physiographic areas and states. These plans are incorporating some of the guidelines outlined in this paper, and they undoubtedly will evolve as more precise information becomes available about demography, habitat requirements, and management alternatives.

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