An Evaluation Strategy for Conservation Goals in the Mississippi Alluvial Valley

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Abstract—The population goals and habitat objectives established by the Mississippi Alluvial Valley Migratory Bird Initiative are based on several unverified assumptions. We have developed an evaluation strategy that identifies research needed to verify these assumptions. We also have outlined a monitoring strategy designed to track progress toward achieving habitat objectives and population goals.

Several assumptions, based on the best available scientific data, were made to establish population goals and habitat objectives for the conservation of wintering waterfowl, migrating shorebirds, and breeding Neotropical migratory birds (NTMBs) in the Mississippi Alluvial Valley (MAV). Conservation goals were established for each of these three species groups based on perceived habitat requirements and limitations on the availability of habitat during critical periods in the life history of these species. Unique research and monitoring strategies have been developed to evaluate progress toward goals for each species group. In each case, research will focus on testing the validity of assumptions used in establishing conservation goals, whereas monitoring is used to assess progress toward achieving population goals and habitat objectives that have been established.

Waterfowl

The goal of the Lower Mississippi Valley Joint Venture of the North American Waterfowl Management Plan is to provide sufficient foraging habitat within the MAV to support wintering populations of 4.3 million ducks and 1.0 million geese (Lower Mississippi Valley Joint Venture Management Board 1990). Foraging habitat for wintering waterfowl is assumed to be the primary determinant of carrying capacity within the MAV. It is further assumed that foraging habitats consist of a combination of flooded cropland, forested wetlands, and moist-soil areas, and that these habitats are located on both public and private lands. The Lower Mississippi Valley Joint Venture Evaluation Plan (Loesch and others 1994) provides detailed information regarding research needs for testing assumptions used in developing population goals and foraging habitat objectives for wintering waterfowl. Major evaluation issues include: (1) establishment of a geographic information system to assess progress toward habitat objectives; (2) testing the assumption that foraging habitat limits carrying capacity; (3) assessing relationships among waterfowl habitat, farming practices, and water quality; and (4) determining waterfowl population responses to habitat changes. Current studies address key assumptions such as: (1) the size and distribution of wintering waterfowl populations (Reinecke and others 1992); (2) winter survivorship (Reinecke and others 1987); (3) the distribution of flooded habitat during winter (Uihlein and others 1994); (4) the availability of forage; and (5) avian use of managed habitats (McAbee 1994).

Shorebirds

The MAV Migratory Bird Initiative has established a goal of providing foraging habitat for one-half million shorebirds during southward migration. Most of this habitat will be provided on managed public lands through development and management of shorebird foraging habitat. Because of generally dry conditions in the MAV during late summer, water must be actively managed on these shorebird management units (Helmers 1992). Critical assumptions for establishing shorebird conservation goals include: (1) foraging habitat limits the carrying capacity of the MAV and is most limited during late summer and fall; (2) about one-half million shorebirds pass through the MAV during southward migration; (3) the average duration of southward migration, during which time shorebirds forage in the MAV, is ten days; (4) migrating shorebirds require about 8 g of invertebrate forage per day; (5) one ha of managed shorebird foraging habitat provides about 20 kg of invertebrate forage; and (6) managed habitats will attract and support migrating shorebirds. Research is needed to address each of these assumptions. Below we have listed research questions associated with shorebird conservation in the MAV and suggested possible mechanisms to address these questions.

Objective I: Assess the Availability and Distribution of Foraging Habitat—Research is needed to determine the extent and distribution of shallow water foraging

In: Bonney, Rick; Pashley, David N.; Cooper, Robert J.; Niles, Larry, eds. 2000. Strategies for bird conservation: The Partners in Flight planning process; Proceedings of the 3rd Partners in Flight Workshop; 1995 October 1-5; Cape May, NJ. Proceedings RMRS-P-16. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

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habitat during southward migration (15 July-30 September) of shorebirds. The distribution of habitat between public and private lands must be assessed to provide estimates of the area flooded by managed and unmanaged water.

Flooded habitat can be determined from classified Multispectral Scanner (MSS) images obtained during the period of southward migration. Using these data, the area and distribution of suitable foraging habitat can be estimated and an effort made to detect all major shorebird stopover areas within the MAV. A database of stopover habitats for shorebird foraging needs to be assembled from reports of knowledgeable observers, areas reported by wildlife managers as being managed for shorebirds, areas identified on remotely sensed imagery, and from aerial reconnaissance. As shorebird management units are created on national wildlife refuges and state wildlife management areas, their location and area will be added to an MAV-wide database. This database of shorebird management units will be used to monitor progress toward shorebird foraging habitat objectives. Aerial transect surveys may be required to assess the proportion of the total suitable shallow water foraging habitat that is included in the shorebird habitat database.

Objective II: Estimate the Number of Shorebirds Using the MAV During Southward Migration—Statistically based, MAV-wide surveys of shorebird populations should be conducted to estimate the shorebird population during southward migration. The georeferenced database of shorebird stopover habitats should be used to ensure that major shorebird concentrations are accounted for in surveys of shorebirds. International Shorebird Survey (Manomet Bird Observatory 1993) sites within the MAV should continue to be monitored and additional sites established. If possible, International Shorebird Survey data should be related to population estimates from MAV-wide surveys using ratio or regression estimators (Cochran 1977).

Objective III: Determine Foraging and Energetic Requirements of Shorebirds—Literature reviews are needed to assess the extent to which foraging requirements of shorebird species are known. Where a paucity of data exists for shorebird species with large populations within the MAV, laboratory studies and field experiments are needed to assess species- and time-specific forage requirements of these species. An assessment of the metabolic use of foods obtained from lands managed for shorebirds should be conducted.

Objective IV: Assess Food Availability on Managed Habitats—To ascertain the quantity and types of food available to migrating shorebirds, we suggest sampling shorebird management units on public lands and suitable unmanaged habitats on private lands. Mud core samples should be used to assess the abundance and types of invertebrates over time and under different management strategies (e.g., flood-up versus draw-down).

Objective V: Determine the Phenology of Southward Migration Through the MAV—Research is needed to determine the duration of southward migration, the average number of stopover sites used, and the average length of stay at each stopover within the MAV.

Observations of color-marked or tagged individuals, concurrent with intensive monitoring of foraging habitats, may provide information on individuals and allow estimates of duration of stay at stopover sites and rate of passage through the MAV. To accomplish this, shorebirds must be uniquely color marked in the northern part of the MAV such that they can be recognized by field personnel using binoculars or spotting scopes. After releasing color-marked birds, observers located strategically throughout the MAV would record all color-marked individuals encountered. Time and distance between repeated observations would provide insight into the temporal dynamics of shorebird migration. If shorebirds were indelibly color marked, subsequent observations during monitoring of International Shorebird Survey sites or other shorebird foraging sites may provide information on movements and survival of shorebirds using the MAV.

Alternatively, or in addition, radio-instrumented shorebirds could be used to estimate the duration of passage through the MAV. To accomplish this, individuals of at least two species of shorebirds should be radio-tagged in the northern part of the MAV. These birds would subsequently be monitored from the ground and from aircraft. One or more radio-locations should be obtained daily for each radio-tagged shorebird until they leave the MAV. Repeated radio-locations provide estimates of daily movements among stopover sites, provide information on the location of stopover sites, and provide an estimate of the time required to pass through the MAV.

Objective VI: Assess the Effectiveness of Management at Providing Suitable Foraging Habitat—The effectiveness with which foraging habitat can be provided on public lands will, in large part, be dictated by the management strategies employed by land managers. Research and monitoring is needed to assess the extent to which lands managed for shorebirds are used by migrant shorebirds, and to determine the most efficacious management strategies. Also of interest is the impact of shorebird management on the use of these areas by waterfowl and other waterbirds. To accomplish this, we recommend that local personnel monitor avian use of shorebird management units. Where possible, these data would become part of the International Shorebird Survey database. Temporal changes in species and abundance of shorebirds would be related to geographic location, local conditions, and management strategies. Specific shorebird management units or management strategies that support little shorebird use should be replaced with alternate locations or modified management techniques.

Neotropical Migratory Birds

Unlike the energetically based foraging habitat assumptions used to establish population goals for wintering waterfowl and migrating shorebirds, population goals for NTMBs assume the need for spatial requirements of territorial individuals. To ensure that source populations exist within forested habitat, several assumptions have been made. These assumptions fall into five broad categories: (1) habitat availability; (2) species distribution; (3) breeding bird densities; (4) source populations; and (5) genetic viability.

We assumed that habitat availability is the primary limiting factor for populations of birds breeding in bottomland hardwood forests in the MAV and that maintaining or restoring "suitable" forest patches (i.e., patches of adequate size, shape, and management) will provide adequate habitat for these species. We also assumed that the breeding bird densities recorded in Hamel (1992b) based on data from the southeastern U.S. reflect the average densities of birds in the MAV. Further, territory distribution within forest patches is assumed to be such that the target number of 500 breeding pairs of the appropriate species (with some exceptions; e.g., Swallow-tailed Kite, [*Elanoides forficatus*]) will occur within suitable forest patches. Each suitable forest patch is assumed to support a source population of each of its representative breeding species; that is, populations that on average produce more offspring than the number required to replace mortality of adults within the forest patch. Finally, we assumed that gene flow within and among populations in forest patches is sufficient to maintain and/or increase the current genetic diversity of the species within the MAV. Evaluation of the MAV Migratory Bird Conservation Initiative for forest-breeding NTMBs will focus on testing these assumptions through a series of objectives.

Objective I: Quantify Bottomland Hardwood Forests in the MAV—A key assumption in the MAV Migratory Bird Initiative is that bottomland hardwood forest habitat is critical to meeting population goals for a majority of breeding migratory birds. To assess the current availability, fragmentation, and isolation of forested habitat within the MAV, an inventory of forest distribution is required. Information is needed not only on the area and distribution of forested habitat but also on the number, area, and "interior area" of contiguous forest patches, and a qualitative assessment of these forest patches (e.g., land ownership, habitat type, hydrological regime).

Using 1992 (spring and fall) thematic mapper (TM) imagery and geographic information system technology, USGS Biological Resource Division and U.S. Fish and Wildlife Service personnel classified the area and distribution of bottomland hardwood forests within the MAV. Forests have been tentatively classified into five primary habitat types: Three hydrologically defined bottomland hardwood forest classes, forest edge habitat, and other forest habitats. Discrete forest patches have been delineated and, in cooperation with The Nature Conservancy, public land boundaries have been defined. From these data, we have obtained: (1) an estimate of the total area of bottomland hardwood forest, by state; (2) estimates of the number of discrete forest patches, their size distribution, and their geographic distribution; (3) estimates of the area of forest in public and in private ownership; and (4) estimates of the forest habitat type within these forest patches.

Within each state, GAP analysis projects (Scott and others 1993) will provide an independent estimate of the area of forested habitat and patch distribution for verification of the above estimates. Databases of public lands, private lands under forest easements (e.g., lands enrolled in the Wetland Reserve Program), and corporate lands managed for forest products have been initiated; these databases should be maintained and periodically updated. Finally, to assess progress toward habitat objectives, periodic updates of land cover derived from remotely sensed data are recommended at 10 to 15 year intervals.

Objective II: Assess the Relationship Between Forest Patches and Breeding Birds—The remaining forests within the MAV are fragmented, and their ability to support NTMBs may be further reduced by intrusion of agriculture, transportation networks, flood control structures, or timber management. Isolation, resulting from forest fragmentation and other anthropogenic impacts, may adversely affect avian diversity and abundance (Robinson 1992).

Although recent studies provide information on the relationship between forest area and species richness (Robbins and others 1989a), and other studies provide information on specific forests within the MAV (Dickson 1978; Christman 1984), these studies have not elucidated the relationship between forest area or forest type and avian richness and abundance in the MAV. Additional information is needed on the diversity and abundance of breeding birds using forest patches of different sizes and different forest types in the MAV.

Specifically, we need research to: (1) evaluate the efficacy of breeding bird point count methods for assessing the relationship between birds and habitats; (2) determine the relationship between avian species richness and forest area-habitat type within the MAV; (3) determine the relationship between relative bird abundance and forest area-habitat type within the MAV; and (4) develop models to predict the distribution and relative abundance of breeding birds based on landscape and vegetative characteristics of forest patches.

An assessment of point count techniques applied to bottomland hardwood forests, based upon standards of the Partners in Flight Monitoring Group (Ralph and others 1993), was conducted and resulted in specific point count recommendations for forests in the MAV (Smith and others 1993; Hamel and others 1996). Following these recommendations, point count surveys and vegetation sampling were conducted within randomly selected forest patches as well as on selected public lands within the MAV. These data will be combined with landscape characteristic data to assess the relationship between forest patch characteristics and species richness and abundance. Species specific surveys have been used to systematically inventory forest patches for the presence of Cerulean Warbler (*Dendroica cerulea*) and Swainson's Warbler (*Limnothlypis swainsonii*). Using these data, as well as other count and Breeding Bird Survey data, models that depict bird distribution within and among forest patches of the MAV are being developed.

Land managers are encouraged to develop lists of breeding and wintering birds for each managed area. Established Breeding Bird Surveys within the MAV should be conducted annually. Breeding Bird Atlases could be used to corroborate predictions of species distributions within the MAV.

Breeding Bird Point Counts should be established and conducted annually in each of 50 or more disjunct stands of the following habitats: (1) semipermanent flooded forests such as those dominated by cypress or tupelo [SAF types 101, 102, 103, 104]; (2) frequently flooded forests such as those dominated by overcup oak, water hickory, willow, or red maple [SAF types 95, 96]; (3) infrequently flooded bottomland hardwood forests such as those dominated by red oaks, sweetgum, sugarberry, or ash [SAF types 61, 62, 63,

64, 65, 88, 89, 91, 92, 93, 94]; (4) upland forests located within the MAV (Macon's and Crowley' Ridges) or within the adjacent "bluff" forests [including pine, hardwood, and mixed pine-hardwood forests]; (5) early successional forests resulting from timber harvest or forest plantings; (6) grasslands; and (7) agricultural habitats. Until a regional or national repository for point count data is established, these data should be submitted in standard ASCII format (Hamel and others 1996) to the Breeding Bird Point Count Repository, c/o Mark S. Woodrey, Mississippi Museum of Natural Science, 111 North Jefferson Street, Jackson, MS 39201.

Objective III: Determine Breeding Bird Densities in Bottomland Hardwood Forests in the MAV With Respect to Intrinsic and Extrinsic Patch Characteristics—The assumption that the breeding densities reported in Hamel (1992b) are reflective of densities in the MAV requires validation. To assess the adequacy of forest patches of known area for harboring a minimum number of breeding pairs, the density of breeding birds within forest patches must be ascertained. A potential problem arises from the assumption that the habitat within and among forest patches is uniformly suitable for breeding by a particular species, and that breeding bird densities are constant over time and space. This obviously is a faulty assumption, because variation within and among patches is the essence of habitat selection. Thus, stochastic breeding bird densities are required that reflect the prevailing habitat conditions (i.e., breeding bird density estimates with associated confidence intervals). Research is needed to estimate breeding bird densities within bottomland hardwood forest patches in the MAV and to refine those estimates based on (a) patch characteristics and (b) habitat types.

To accurately assess actual breeding bird density, counts of breeding pairs must be made over sufficient areas to measure population sizes at a landscape scale. Accurately assessing actual density of breeding birds over such large areas (i.e., thousands of ha) is not economically feasible. Therefore, we intend to assess the densities of the birds indirectly, primarily by using the results of point count surveys. These provide information on the relative abundance of breeding birds and can be used as an index to their actual density. Although a number of assumptions are required to go from relative abundance, as determined through point count protocols, to actual breeding bird densities, the most practical option is an indexing approach, such as using point count surveys. By assessing actual densities on small plots, such as 10 to 50 ha spot-mapping plots used in demographic assessments, and indexing those densities to relative abundance estimates derived from point count surveys on those same sites, we intend to extrapolate densities from point count surveys applied over larger areas and among forest patches with different characteristics using ratio or regression estimators (Cochran 1977).

To account for variation in breeding bird density due to structural habitat variation within patches, we have assumed that habitat variability provides suitable breeding habitat at some particular rate. This rate is reflected in the observed density of the species in forest patches having similar characteristics. By providing areas large enough to accommodate the target number of breeding pairs at their observed density, we believe that we have accounted for this source of variation. To test the validity of this approach, we will assess the habitat used by breeding individuals of the species and compare the occurrence of habitat used to its availability within forest patches. Where existence of apparently suitable habitat differs from the rate of use, factors other than habitat limitation may be implicated in the distribution of the species (Rappole and McDonald 1994).

Established point count data will be used to assess annual variation in the relative abundance of breeding birds and as an index to actual breeding bird densities. In addition, a minimum of 10 Breeding Bird Censuses (Hall 1964), with associated concurrent point counts, should be established within bottomland hardwood forests within the MAV. Both Breeding Bird Censuses and point counts should be conducted annually.

Objective IV: Quantify Species-Specific Demography of Bottomland Hardwood Forest Breeding Bird Populations in the MAV (Productivity, Survival, Dispersal, and Modeling)—The assumption that the proposed forest patches of 4,000, 8,000, and 40,000 ha (10,000, 20,000, and 100,000 acres) will support source populations of forest breeding bird species within their respective size classes is difficult to evaluate. Only species-specific demographic analyses, over broad geographic areas and over extended time periods, can accurately assess this assumption. To evaluate populations within forest patches, we need information regarding avian productivity, specifically nest survivorship, nest parasitism rates, nest predation rates, and renesting effort. Additionally, data are needed on age-specific survival of individuals, dispersal, and philopatry. Obtaining all these data is time consuming, difficult, and expensive, but they are essential to understanding the ability of forest patches of different sizes to support populations of breeding birds.

Our assumptions about habitat utilization, patch characteristics, and survivorship are currently based upon the habitats of breeding adults as we understand them. Few or no data exist on differences in habitat utilization between breeding adults and non-breeding adults during the breeding season, or between adults and their offspring subsequent to the breeding season. Research designs that identify habitat use and dispersal of post-breeding adults and of young-of-the-year will be extremely useful to evaluating the landscape conditions that promote source populations.

Logistic and fiscal constraints mandate collection of demographic data at only a few locations. We assume, however, that demographic parameters can be related to forest patch characteristics, and thereby extrapolated to other, similar forest patches within the MAV. To accomplish this goal, we must be able to relate demographic parameters to forest patch metrics and within-patch vegetation characteristics.

Species-specific data on productivity, survival, and dispersal are needed within forest patches of different sizes (<4,000 ha, 4,000 to <8,000 ha, 8,000 to <40,000 ha, and >40,000 ha) and in different habitats or under different management regimes. Productivity data are needed on (1) nest survival, (2) rate of nest parasitism, (3) rate of nest predation, and (4) rate of renesting. By extension, data are needed on annual and lifetime productivity of individuals.

Data on age- and sex-specific survival of individuals are needed. Specific survival estimates are needed (a) within the breeding season, and (b) among breeding seasons.

Age- and sex-specific rates of philopatry, and/or rates of dispersal, are needed to bolster estimates of individual survival, both as a measure of population stability and to provide information on gene flow among forest patches. Specifically, information is needed on: (1) dispersal and habitat use by post-fledging and post-breeding birds within the same season; (2) rate and distance of dispersal of birds between natal and subsequent breeding sites; and (3) rate and distance of dispersal of adult breeding birds among breeding seasons. The impact of forest management on rates and distances of dispersal also needs to be examined. Finally, predictive models need to be created that estimate species-specific demographic parameters within a forest patch based on the characteristics of the patch.

Demographic studies currently are under way in bottomland hardwood forests in the MAV from southern Illinois to southern Louisiana. Current studies are being conducted on different target species and species groups, by different personnel, and with different overall objectives. However, these studies follow similar, mutually agreed upon methodologies of data collection. Most of the studies will obtain estimates of productivity, nest survival, nest parasitism rates, and nest predation rates.

Although obtaining adequate demographic data on certain high-priority species is difficult, some demographic data on species such as Cerulean Warbler are becoming available. Additionally, demographic data from studies of more common species, such as Acadian Flycatchers (*Empidonax virescens*) and Prothonotary Warblers (*Protonotaria citrea*), on a wider array of sites, are being obtained. Results of current demographic studies will be extrapolated to other sites and to other species within these sites. Additional research, however, will be needed to confirm the appropriateness of extrapolation.

Survival of individuals, including age-specific estimates within and among seasons, is difficult to assess, because we have little data on the dispersal of individuals. Data on site fidelity and dispersal are similarly difficult to obtain, and require extensive investigations across both area and time to estimate. Minimal estimates of survival of individuals and site fidelity, however, are being obtained through color marking of individuals in mark-recapture studies or through constant-effort mist netting. Application of open population models (e.g., Pollock and others 1990; Lebreton and others 1992) to these data should result in estimates of survival with defined confidence limits that can be used for stochastic population modeling.

We intend to derive species-specific predictive models of demographic parameters from data obtained on studies in forest tracts of different sizes and under different forest management regimes. By examining demographic parameters of selected species under different landscape conditions, we will be able to evaluate the assumption that demographic parameters can be predicted from forest patch characteristics. Subsequent demographic studies will be required in forest patches not used to develop models to examine the validity of these predictive models.

Estimates of demographic parameters should be monitored using techniques such as MAPS constant-effort mist netting (DeSante and others 1993b; DeSante and Burton 1994a) and bird nest searching protocols (Martin and Guepel 1993a; Martin and others 1997). Future work should be treated as experimental tests of predictions derived from the results of initial studies.

Objective V: Determine Optimal Number of Populations and Population Sizes Required to Maintain Genetic Viability—We assumed that the number of source populations proposed within the MAV constitutes an adequate number of breeding individuals within an overall meta-population to ensure long-term maintenance of genetic diversity and population viability. We are not now in position to test whether the proposed minimum of 500 breeding pairs is sufficient to ensure viability within a forest patch, nor do we have sufficient data to support meta-population dispersal within the MAV. The proposed number of 500 pairs, however, establishes a target for planning and for eventual genetic assessment of these populations as more data on demographics and dispersal become available.

Data needed to begin a meta-population analysis within the MAV include species-specific estimates of: (1) survival rates of hatching-year birds, (2) rates and distances of dispersal of young to breeding sites, (3) among year dispersal of breeding adults, and (4) rates of gene flow among breeding populations.

Summary

The evaluation strategy outlined above builds upon an evaluation plan developed for wintering waterfowl by the Lower Mississippi Valley Joint Venture. This enhanced evaluation strategy identifies research needs that are targeted at providing verification of the assumptions used to establish conservation goals for wintering waterfowl, migrating shorebirds, and forest-breeding landbirds. Monitoring strategies have been proposed that will gauge progress toward habitat objectives and, ultimately, population goals.

Although proposed research and monitoring are primarily directed at the objectives identified in the MAV Migratory Bird Conservation Initiative, other research needs that are related to migratory landbirds in the MAV have been identified, including: (1) habitat use during migration; (2) use of nonforested habitats; (3) use of food resources; and (4) winter habitat use.

More specific research objectives, including investigators, study plans, cooperators, and time tables, have been identified for wintering waterfowl (Loesch and others 1994). Similarly detailed research objectives currently are being developed for shorebirds and forest-breeding birds. In all cases, however, completion of proposed research and implementation of monitoring plans will require increased levels of personnel and funding. Given sufficient support, we are optimistic that many of these objectives can be achieved within the next 10 years. A notable exception, however, is quantifying demographic parameters of forest breeding birds. With four forest patch classes, different habitats, and different management strategies to assess, obtaining necessary demographic data for even a few species could take considerably longer.

Investigation of these issues, however, will require a considerable expenditure of effort and time to obtain even minimally adequate information on some of these relationships. All monitoring and research undertaken in the MAV will require a tremendous amount of cooperation.