Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley

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Abstract—The goal of the Lower Mississippi Valley Joint Venture of the North American Waterfowl Management Plan is to provide sufficient habitat to support 4.3 million wintering ducks and 1.0 million wintering geese annually. Under the assumption that the amount of foraging habitat is the primary limitation to supporting waterfowl population goals in the Mississippi Alluvial Valley (MAV), a habitat objective to make available 285,000 ha of waterfowl foraging habitat is divided among seven states. This habitat objective is further divided between public and private ownership and among three habitat types: Bottomland hardwood forest, moist-soil sites, and agricultural fields. Management objectives for shorebirds within the MAV which provide foraging habitat for 0.5 million shorebirds during their southward migration have been tentatively established. Several as yet unverified assumptions were used in establishing these objectives; consequently, we caution that the objectives are subject to revision as the assumptions are tested. We assumed that 0.5 million shorebirds move through the MAV during late summer and fall, each foraging for an average of 10 days. During this migration period, foraging shorebirds are assumed to require sufficient forage to gain 1 g of biomass per day, in addition to their basal metabolic needs. Given an invertebrate food supply that provides 17.6 kj • g^{-1}, we calculated that an average 45 g shorebird requires about 8 g of invertebrate forage per day. Further assuming that each ha of managed shorebird habitat can provide 20 kg of invertebrate food resources available to shorebirds, we extrapolated a need for 2000 ha of shorebird foraging habitat. We suggest that the bulk of this foraging habitat be provided on public lands and that it be distributed throughout the MAV.

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Waterfowl

Long-term declines in waterfowl populations prompted the development of the North American Waterfowl Management Plan (NAWMP) during the early 1980s. The NAWMP identified the Mississippi Alluvial Valley (MAV) as one of several regions in North America containing habitat vital to the recovery of waterfowl populations. The Lower Mississippi Valley Joint Venture (LMVJV) was organized in the late 1980s to develop a strategy for conserving, managing, and restoring wetland habitats that support wintering waterfowl populations in a joint venture area that includes the MAV. Midwinter Waterfowl Inventory data, harvest data from 1970 to 1979, and population goals set in the NAWMP were used to set state-specific waterfowl population goals. The overall goal for the MAV is to provide habitat to support 4.3 million wintering ducks and 1.0 million wintering geese annually.

Assuming that foraging habitat is limiting for waterfowl wintering in the MAV, we calculated the energetic needs of waterfowl, winter mortality rates, length of the wintering period, and the energy available in various foraging habitats. Then we incorporated the population goal to determine that approximately 285,000 ha of foraging habitat are needed to support wintering waterfowl in the MAV. Within each state, habitat goals are divided between public and private ownership and three main foraging habitats: Bottomland hardwood forest, moist-soil sites, and agricultural fields. Availability of waterfowl foraging habitat depends on adequate precipitation and resultant ponding or overbank flooding, and water-control infrastructure (i.e., levees, dikes, water-control structures, pumps) to facilitate flooding. The rationale and methodology used to develop these waterfowl population goals and habitat objectives for waterfowl have been published previously (Lower Mississippi Valley Joint Venture Management Board 1990; Loesch and others 1994). Refer to these documents for details and clarification of waterfowl goals and objectives.

Shorebirds

Although some shorebirds breed (Robbins and others 1986) or winter (Ouchley 1992) in the MAV, many more shorebirds, both total individuals and species, use this floodplain as a migratory corridor between breeding areas to

the north and wintering areas to the south (Helmers 1994; Twedt and others 1998) (table 1). Thus, we feel that the greatest conservation need for shorebirds within the MAV is foraging habitat during migration.

Typically, winter floodwater that recedes during early spring and the agricultural practice of shallow-flooding rice fields during late spring provide abundant shallow-water and mudflat foraging habitat within the MAV during northward migration. During southward migration, however, in late summer and fall, naturally occurring floodwater is rare because of seasonally low precipitation. Also, agricultural fields are purposefully kept dry at this time to facilitate harvest of crops. Therefore, the period from 15 July through 30 September has tentatively been identified as the time interval when foraging habitat for migrating shorebirds is least available. Our primary conservation objective is to ensure that adequate shallow-water habitat is available in the MAV to meet or exceed the foraging requirements of shorebirds during their southward migration.

Establishing Shorebird Population Goals

Neither census data nor any specific estimates of shorebird populations moving through the MAV during southward migration are available. To establish such an estimate and thereby set a tentative population goal, we examined data from International Shorebird Survey sites (Manomet Bird Observatory 1993) and consulted shorebird biologists (e.g., D. L. Helmers and B. A. Harrington) knowledgeable of migration patterns and continental population estimates (Howe and others 1989). Based on these sources, we have assumed that about 0.5 million shorebirds (table 1) move through the MAV during fall migration. Maintenance of this number is our population goal. This is a relatively unambitious effort to maintain the assumed status quo, and should be reexamined within the context of evolving continent-wide goals for shorebird populations.

Table 1—Shorebird species, mass, and hypothesized abundance during southward migration through the Mississippi Alluvial Valley (Manomet Bird Observatory 1993).

Common name	Scientific name	Mass (g)	Abundance
Wilson's Phalarope	*Phalaropus tricolor*	50	171
American Avocet	*Recurvirostra americana*	150	232
Black-necked Stilt	*Himantopus mexicanus*	125	778
Common Snipe	*Gallinago gallinago*	150	2,374
Dowitcher species	*Limnodromus* spp.	125	2,242
Stilt Sandpiper	*Calidris himantopus*	75	3,310
Red Knot	*Calidris canutus*	140	162
Pectoral Sandpiper	*Calidris melanotos*	60	121,077
White-rumped Sandpiper	*Calidris fuscicollis*	40	221
Baird's Sandpiper	*Calidris bairdii*	40	690
Least Sandpiper	*Calidris minutilla*	25	151,119
Dunlin	*Calidris alpina*	35	7,866
Semipalmated Sandpiper	*Calidris pusilla*	30	37,713
Western Sandpiper	*Calidris mauri*	30	3,382
Sanderling	*Calidris alba*	60	5,052
Calidris spp. ('peeps')	*Calidris* spp.	30	32,286
Marbled Godwit	*Limosa fedoa*	200	39
Greater Yellowlegs	*Tringa melanoleuca*	125	3,235
Lesser Yellowlegs	*Tringa flavipes*	75	21,120
Solitary Sandpiper	*Tringa solitaria*	60	2,608
Willet	*Catoptrophorus semipalmatus*	175	92
Upland Sandpiper	*Bartramia longicauda*	125	237
Buff-breasted Sandpiper	*Tryngites subruficollis*	50	964
Spotted Sandpiper	*Actitis macularia*	40	4,112
Black-bellied Plover	*Pluvialis squatarola*	150	769
American Golden-Plover	*Pluvialis dominica*	130	449
Killdeer	*Charadrius vociferus*	50	91,838
Semipalmated Plover	*Charadrius semipalmatus*	35	4,765
Piping Plover	*Charadrius melodus*	40	121
Ruddy Turnstone	*Arenaria interpres*	140	405
Other shorebirds		40	571
	mean weighted mass	= 45	total = 500,000

Estimating Forage Needs of Shorebirds During Migration

Although data on the composition of species moving through the MAV are fragmentary, some information for the MAV during southward migration is available from International Shorebird Survey sites as well as from local study sites (e.g., Reid and others 1983; Ouchley 1992; Twedt and others 1998). These data indicate that although shorebirds as small as 30 g and as large as 200 g migrate through the MAV, the average mass (weighted by abundance) of individual shorebirds in the area is 45 g (table 1). This average mass was used as an assumption of shorebird body mass for calculating estimates of energetic needs and foraging habitat requirements.

The amount of energy (kj) required by a 45 g shorebird to maintain its existence metabolic rate (EMR) was calculated following Kersten and Piersma (1987) as:

$$\text{EMR (kj)} = 912 \bullet (\text{BODY MASS [kg]})^{0.704}$$

$$102.77 \text{ kj} = 912 \bullet (0.045 \text{ kg})^{0.704}$$

Thus, 103 kj are required per day to sustain a 45 g shorebird.

For the purpose of modeling, we have assumed that chironomids are a primary food item consumed by shorebirds. One g (dry weight) of chironomids has a gross energy content of 23.8 kj (Cummins and Wuycheck 1971). Because the assimilation efficiency of birds feeding on invertebrates is approximately 73 percent (Castro and others 1989), the net energy content (NEC) of chironomids is about 17.6 kj per g:

$$\text{NEC} = \text{GROSS ENERGY CONTENT} \bullet \text{ASSIMILATION EFFICIENCY}$$

$$17.6 \text{ kj} \bullet \text{g}^{-1} = 23.8 \text{ kj} \bullet \text{g}^{-1} \bullet 0.73$$

The mass of invertebrates that a 45 g shorebird requires to maintain its existence metabolic rate can then be extrapolated as:

$$\text{MAINTENANCE INVERTEBRATE MASS } (IM_{MAINTENANCE}) = \text{EMR} \bullet \text{NEC}^{-1}$$

$$5.84 \text{ g} = 102.77 \text{ kj} \bullet \text{d}^{-1} \bullet (17.6 \text{ kj} \bullet \text{g}^{-1} \bullet \text{d}^{-1})^{-1}$$

Thus, a 45 g shorebird requires about 6 g of invertebrate forage each day to maintain its body mass.

To provide the fat reserves necessary to complete migration, however, shorebirds must increase their biomass by about 1 g per day. Assuming about 2 g of invertebrate forage must be consumed each day to increase biomass by 1 g (Kersten and Piersma 1987), the mass of invertebrates required for fat deposition ($IM_{DEPOSITION}$) becomes 2 g per day. The daily food requirement during migration ($IM_{MIGRATION}$) of a 45 g shorebird then becomes about 8 g:

$$\text{MIGRATION INVERTEBRATE MASS } (IM_{MIGRATION}) = IM_{MAINTENANCE} \bullet IM_{DEPOSITION}$$

$$8 \text{ g} \bullet \text{d}^{-1} = 6 \text{ g} \bullet \text{d}^{-1} + 2 \text{ g} \bullet \text{d}^{-1}$$

Determining Habitat Requirements for Migrating Shorebirds

For the purpose of proposing the amount of habitat required to support migrating shorebirds, we have assumed that habitat will be provided primarily in the form of shallow water managed to create optimal foraging depths for shorebirds and about 2 g of benthic invertebrates are available per square meter (Helmers, personal communication). Consequently, an average shorebird requires about 4 m^2 of foraging habitat each day. Over the duration of an assumed 10-day migration period, each shorebird migrating through the MAV would therefore require 40 m^2 (0.004 ha) of managed foraging habitat. Assuming an equal habitat need for each of the 0.5 million shorebirds that we assume move through the MAV during southward migration results in an overall shorebird habitat objective of 2,000 ha (ca. 5,000 acres) in the MAV between 15 July and 30 September.

$$\text{FORAGING HABITAT} = IM_{MIGRATION} \bullet \text{DURATION} \bullet \text{FORAGE DENSITY}^{-1} \bullet \text{POPULATION}$$

$$2{,}000 \text{ ha} = 20{,}000{,}000 \text{ m}^2 = 8 \text{ g} \bullet \text{bird}^{-1} \bullet \text{d}^{-1} \bullet 10 \text{ d} \bullet [2 \text{ g} \bullet (\text{m}^2)^{-1}]^{-1} \bullet 500{,}000 \text{ birds}$$

Following is a summarized list of the assumptions that were used in setting these shorebird habitat objectives:

- About 500,000 individual shorebirds migrate through the MAV each year; the average duration of stay of each individual is ten days.
- The time period in which shorebird habitat is critical in the MAV is during southward migration from approximately 15 July to 30 September.
- The average mass of one of these shorebirds is 45 g.
- The daily food requirements (for maintenance plus needed fat gain) of this average-sized bird is about 8 g.
- Chironomids are the primary food source for these birds, and about 2 g of these and other benthic invertebrates are available to foraging shorebirds in each square meter of habitat. One ha of managed habitat will produce about 20 kg of forage.

With the exception of migration timing, all of these assumptions require critical attention.

Establishing Habitat Objectives for Migrating Shorebirds

Shorebird objectives were established for the entire MAV and then allocated among states to ensure an adequate geographic dispersion of shorebird habitat (table 2). The available land base and the perceived ability of each state to achieve shorebird objectives were taken into consideration in these state allocations. The state habitat objectives will subsequently be allocated to individual management units of public land.

Table 2—Proposed distribution of shorebird habitat among states making up the Mississippi Alluvial Valley (MAV).

State	Hectares
Arkansas	520
Illinois	70
Kentucky	35
Louisiana	520
Mississippi	600
Missouri	70
Tennessee	185
MAV total	2,000

Different shorebird species use water of different depths, but the total range of utilized conditions—from damp mud to several cm—covers only a portion of any water management unit at any time. Over time, this band shifts with gradual flooding, draw down, or evaporation, and these shifts are necessary to expose new foraging opportunities to the birds. Careful attention can maximize the value of managed impoundments to shorebirds over the course of migration, but it is unlikely that more than 10% of a unit will be useful at any single point in time. The total amount of land required to achieve a targeted area of shorebird habitat at the most important times during migration can be determined only on the basis of knowledge of management unit conditions and potential.

Shorebirds primarily use wet open areas that, in late summer and early fall, generally occur exclusively on public lands managed primarily for waterfowl. Thus, shorebird objectives will be implemented within the context of habitat objectives for late fall-early winter waterfowl. It will be important to test for compatibility between these species groups. Early shorebird flooding may benefit some early migrant ducks, for example, Blue-winged Teal (*Anas discors*). On the other hand, fields flooded in July or August may produce less waterfowl forage later in the fall than would be produced if the fields had remained dry throughout the summer.

The perceived opportunities to create managed shorebird foraging habitat within states correspond, in large part, with the distribution of public lands among those states. We have initially restricted shorebird foraging habitat objectives to managed shallow-water habitats of public lands

Figure 1—Proposed balance sheet, for use in tracking progress toward shorebird foraging-habitat objectives, depicts three potential shorebird habitats and three management categories.

	Public managed	Private managed	Unmanaged
Mudflat—Drawdown	?	?	?
Moist Soil—Flooded	?	?	?
Cropland—Flooded	?	?	?
Objective (ha)	5,000	?	?

because of limited opportunities to establish shorebird foraging habitat on private lands during late summer and fall. Unlike foraging habitat for wintering waterfowl, which may be provided in flooded croplands on private lands within the MAV, the presence of unharvested crops and generally dry conditions during late summer restricts the ability of many private landowners to create shorebird habitat. We are not suggesting, however, that shorebird habitat is nonexistent on private lands. There certainly are opportunities, especially at aquaculture facilities, for the creation of additional shorebird foraging habitat on private lands (Sykes and Hunter 1978; Hands and others 1991). Enhancement of these lands should be encouraged wherever possible. Thus, although our habitat objectives focus on establishing managed foraging habitat for shorebirds on public lands, we recognize the contribution of unmanaged habitats, as well as the benefit of habitat on private lands, toward meeting the energetic requirements of shorebirds during southward migration. We suggest that a balance sheet (fig. 1), similar to that developed to monitor progress toward waterfowl habitat objectives (Loesch and others 1994), can be used to monitor the status of shorebird habitat within the MAV and to assess progress toward meeting habitat objectives.

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