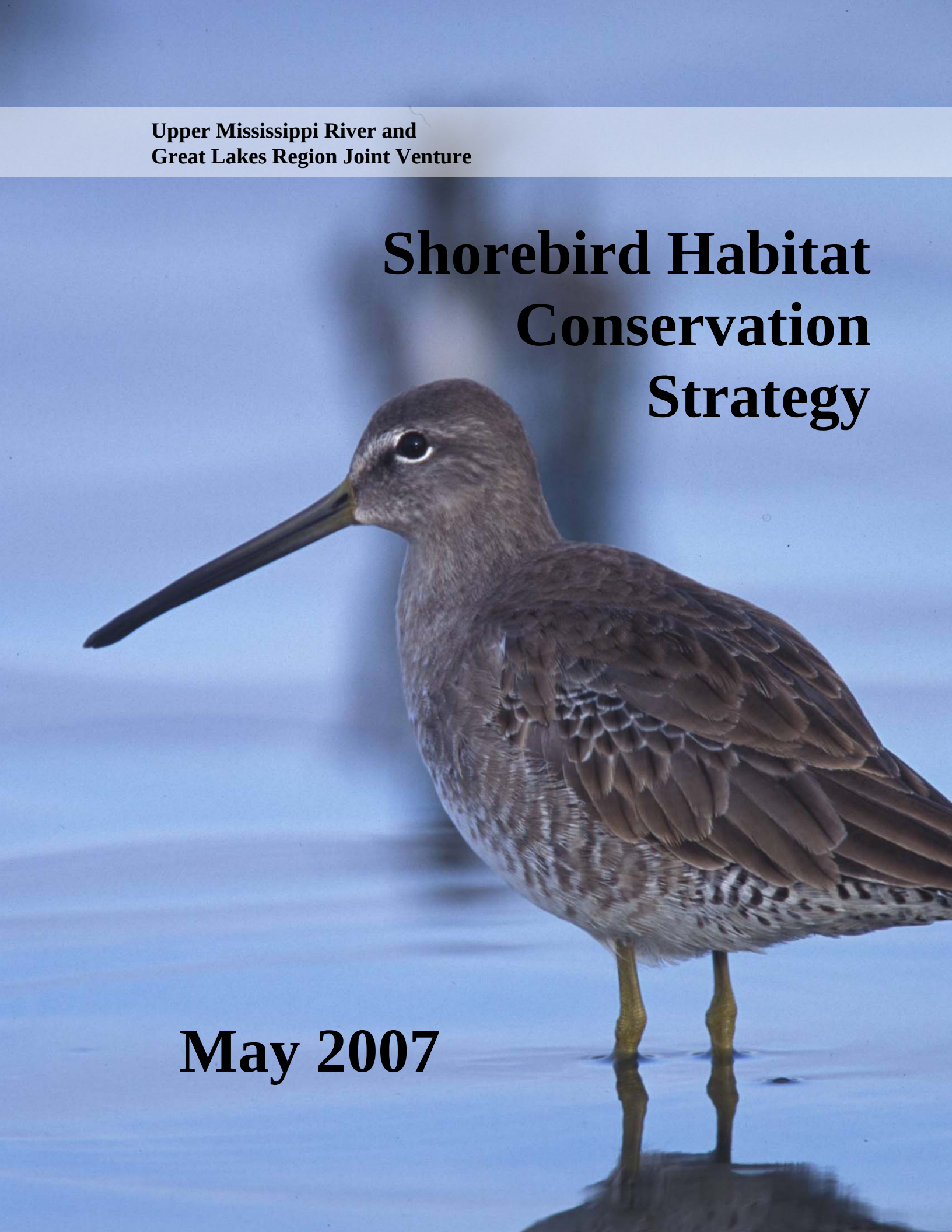
Upper Mississippi River and
Great Lakes Region Joint Venture

Shorebird Habitat Conservation Strategy



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Plan Summary

Bird habitat conservation is typically implemented at local scales, but avian ecologists have recognized the need to integrate continental migratory bird priorities into local habitat recommendations. In this strategy we attempt to "step-down" continental shorebird conservation priorities to the Joint Venture (JV) region and to smaller scales within the region, providing wildlife managers guidance in designing landscapes with greater value to shorebirds. We estimated where, what, when and how much habitat is needed to increase and sustain populations of priority shorebird species at target levels. The strategy goal is to *"Establish efficient habitat conservation to maintain or increase carrying capacity for populations of priority shorebird species consistent with continental and JV regional goals."*

Population estimates and objectives are continually being refined for shorebirds, and we recognize population estimates used in this strategy may soon be dated. Nonetheless, science-based recommendations were developed to efficiently and effectively increase landscape carrying capacity through shorebird habitat protection, restoration, and enhancement. In addition, this strategy was developed to complement JV habitat conservation plans for other bird groups including waterfowl, waterbirds, and landbirds.

In order to scientifically link population and habitat objectives for this diverse bird group, several "JV focal species" were selected for habitat planning. Each breeding JV focal species represents a specific cover type. Likewise, foraging guilds that correspond to different cover types were selected for migration habitat planning and monitoring. Migration habitat objectives for the JV region were generated from continental estimates of spring population size. Thus a primary assumption of this strategy, and one that requires evaluation, is habitat carrying capacity established to accommodate spring populations will also suffice during autumn migration.

Regional shorebird population and habitat trends, in concert with population estimates and an assessment of limiting factors, provide a biological planning foundation. Planning steps included characterizing and assessing the landscape for JV breeding focal species and migration guilds, modeling population response, identifying conservation opportunities, and developing a landscape design with a capacity expected to sustain current populations plus eliminate population deficits. Much of the technical information, including habitat models and decision support maps, appears in breeding focal species and feeding-guild accounts (Appendix A and B). Sections on monitoring and research needs, adaptive management, and program coordination are also provided.

Our intent in this JV Shorebird Habitat Conservation Strategy is to establish explicit regional goals for shorebird habitat conservation and identify and use available survey data and new technological tools to increase planning efficiency. The unpredictable nature of shorebird migration routes and stopover duration make planning for this bird group especially challenging. However, we establish a scientific process for habitat objective-setting plus identify assumptions and research needs to improve

subsequent iterations of the strategy. This plan is a "living document" that will be refined periodically as knowledge of regional shorebird conservation improves and new spatial data becomes available and can be incorporated.

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Background and Context

Originally focused on habitat for breeding and migrating waterfowl, the 1998 Upper Mississippi River and Great Lakes Region Joint Venture (JV) implementation plan (USFWS 1998) recognized the potential value of wetland conservation for other bird species. Although the 1998 JV plan did not contain specific conservation priorities and strategies for shorebirds, the JV partnership embraced habitat conservation for non-waterfowl species with a general goal to "contribute to the protection and/or increase of habitats for wetland and associated upland wildlife species in the Joint Venture, with emphasis on declining non-waterfowl migratory birds."

The North American Bird Conservation Initiative (NABCI 2000), conceived after the 1998 JV plan, addresses conservation needs of all North American bird species through coordinated delivery of habitat conservation for waterfowl, shorebirds, other waterbirds, and landbirds. Continental population assessments, species prioritization, and general planning guidelines have been completed for each of these four bird groups. The proven collaboration and synergistic record of JVs suggest they provide the best means to implement regional all-bird conservation. Therefore a primary role of the JV is to coordinate and facilitate delivery of bird habitat conservation, "stepping down" continental bird-group plans to the JV region. More specifically, the goal of this strategy is to ***"Establish efficient habitat conservation to maintain or increase carrying capacity for populations of priority shorebird species consistent with continental and JV regional goals."***

The United States Shorebird Conservation Plan (USSCP) was completed in 2001 (Brown et al. 2001), and it outlines the need for shorebird conservation at 3 spatial scales. At the hemispheric scale the goal is to maintain and restore shorebird populations in the Western Hemisphere through international cooperation. At the national scale the plan describes population estimates and a conservation assessment. Lastly, continental-scale population goals, species priorities, and general habitat concerns of the USSCP are regionalized to 11 shorebird-planning units. The west side of the Upper Mississippi Valley / Great Lakes (UMVGL) planning unit largely overlaps the JV region (Figure 1). Information in the UMVGL Shorebird Conservation Plan (de Szalay et al. 2000) was especially valuable when developing this JV Shorebird Habitat Conservation Strategy.

The goal of the UMVGL Plan (de Szalay et al. 2000) was to ensure available foraging and nesting sites over a range of climatic conditions by managing for a variety of shorebird habitat types. The plan describes 1) major shorebird habitats in the region, 2) threats to shorebird habitat, 3) shorebird occurrence and regional priorities, 4) general habitat conservation strategies that include habitat goals but not population objectives, and 5) population monitoring and research needs. The UMVGL planning region includes all of Bird Conservation Regions (BCRs) 12, 13, 22, 23, and 24, whereas the JV region encompasses nearly all of BCRs 22 and 23, and a large proportion of BCR 12 (Figure 1). Relatively small portions of BCRs 13, 24, and 28 comprise the remainder of the JV region. Consequently, this JV Strategy has adopted, with minor modifications explained

herein, the population assessments and conservation priorities expressed in the USSCP and UMVGL plans.

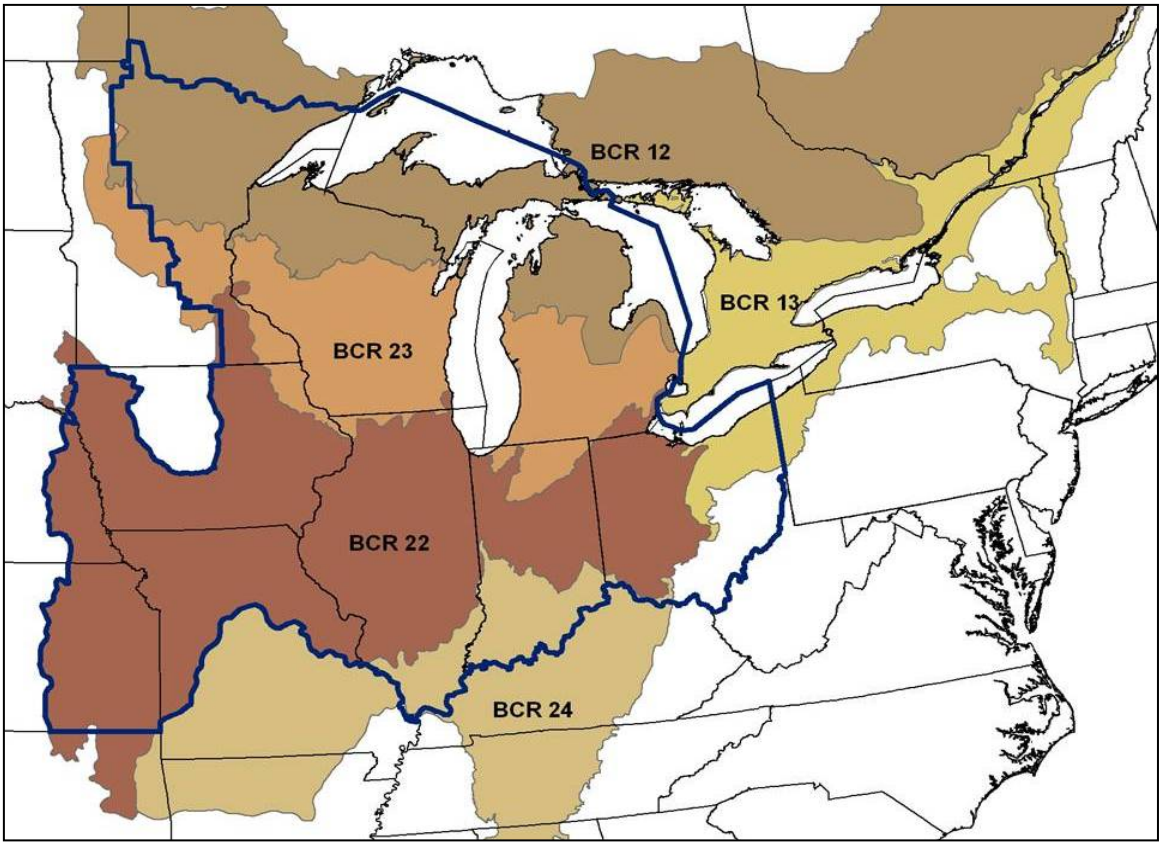

Figure 1. Boundaries for the Upper Mississippi Valley / Great Lakes (UMVGL) shorebird planning region and associated Bird Conservation Regions (BCRs), plus the area encompassed by the Upper Mississippi River and Great Lakes Joint Venture (JV) region (blue line). The JV region largely consists of BCRs 22 (Eastern Tallgrass Prairie), 23 (Prairie Hardwood Transition), and the U.S. portion of 12 (35%, Boreal Hardwood Transition). Portions of BCR 24 (19%, Central Hardwoods), 13 (11%, Lower Great Lakes / St. Lawrence Plain), and 28 (7%, Appalachian Mountains) also are within the JV boundary. Southeast Ohio (part of BCR 28) is not within the UMVGL shorebird region but is part of the JV region.

Shorebirds are a diverse group including plovers, yellowlegs, godwits, and sandpipers (see Appendix C for a list of species included in this document and their scientific names). Nearly all are wetland-dependent species during most if not all stages of their annual life cycle. Notable exceptions include Upland Sandpiper, American Woodcock, and Killdeer, species that are more associated with terrestrial habitats. Although some species nest within the JV region, this area primarily provides habitat for spring and autumn migration (Table 1). The Atlantic and Pacific coasts are well known as important migration corridors for shorebirds in North America, but the importance of interior regions of the continent is gaining recognition. The JV region includes three migration staging areas identified as regionally significant by the Western Hemisphere Shorebird Reserve Network (WHSRN): Chautauqua (Illinois) and Swan Lake (Missouri) National Wildlife Refuges and the Lake Erie Marshes (Ohio and Michigan). The JV region also encompasses most of the Great Lakes shoreline, plus portions of the

Mississippi, Missouri, Illinois, and Ohio River floodplains which serve as important migration corridors for shorebirds.

Eight species of shorebirds have a history of breeding in the UMVGL region (Table 1) and a ninth, the Black-necked Stilt, appears to be pioneering into the region. Relative to other shorebird planning regions, the UMVGL area provides extremely important breeding habitat for two species, Piping Plover (Great Lakes population) and Killdeer, and it has common or locally abundant breeding populations of Spotted Sandpiper, Wilson's Snipe, and American Woodcock. Only two species, Wilson's Snipe and Killdeer, are winter residents, but all 34 species occur during migration (Table 1). The region is considered extremely important for seven migrant species, including Greater and Lesser Yellowlegs, Least Sandpiper, Pectoral Sandpiper, Dunlin, and Short- and Long-billed Dowitchers.

Table 1. Breeding, migration, and wintering status[a] of shorebirds in the Upper Mississippi River and Great Lakes region and associated Bird Conservation Regions (BCRs), adapted from UMVGL Shorebird Conservation Plan (de Szalay et al. 2000). Vagrant species are not included.

Species[b]	Regional migration and breeding status	Boreal Hardwood Transition (BCR 12)	Lower Great Lakes / St. Lawrence Plain (BCR 13)	Eastern Tall Grass Prairie (BCR 22)	Prairie Hardwood Transition (BCR 23)	Central Hardwoods (BCR 24)
Black-bellied Plover	M	M	M	M	M	
American Golden-Plover	M	m	M	**M**	M	M
Semipalmated Plover	M	m	M	M	M	M
Piping Plover (Great Lakes)	M, **B**	M, **B**	M	M	M, B	m
Killdeer	M, **B**	M, B	M, **B**	M, **B,** w	M, **B**	M, B, w
Black-necked Stilt[c]	m, b			m, b		m, b
American Avocet[c]	m			m	M	m
Greater Yellowlegs	**M**	M	M	**M**	**M**	M
Lesser Yellowlegs	**M**	M	M	**M**	**M**	M
Solitary Sandpiper	M, b	M, b	M	M	M	m
Willet	m	m	m	m	M	m
Spotted Sandpiper	M, B	M, B	M, B	M, B	M, B	M, b
Upland Sandpiper	m, b	M, b	m, b	m, b	m, b	m
Whimbrel	m	m	m	m	M	m
Hudsonian Godwit	M	M	m	M	M	m
Marbled Godwit (Great Plains)	m	m	m	M	M	m
Marbled Godwit (Hudson Bay)	M	M		m	M	m
Ruddy Turnstone	M	M	M	M	M	m
Red Knot	m	m	m	m	M	m
Sanderling	M	M	m	M	M	m
Semipalmated Sandpiper	M	M	M	M	M	M
Western Sandpiper	m	m	m	m	M	m
Least Sandpiper	**M**	**M**	**M**	**M**	**M**	M
White-rumped Sandpiper	M	M	m	M	M	m

Species[b]	Regional migration and breeding status	Boreal Hardwood Transition (BCR 12)	Lower Great Lakes / St. Lawrence Plain (BCR 13)	Eastern Tall Grass Prairie (BCR 22)	Prairie Hardwood Transition (BCR 23)	Central Hardwoods (BCR 24)
Baird's Sandpiper	M	M	m	M	M	m
Pectoral Sandpiper	**M**	M	**M**	**M**	M	m
Dunlin	**M**	m	**M**	M	M	m
Stilt Sandpiper	M	m	M	M	M	m
Buff-breasted Sandpiper	M	m	M	M	M	m
Short-billed Dowitcher	**M**	m	**M**	M	M	m
Long-billed Dowitcher	**M**	m	**M**	**M**	**M**	m
Wilson's Snipe	M, B	M, B	M, b	M, b, w	M, b	m, w
American Woodcock	M, B	M, B	M, B	M, B	M, B	M, B
Wilson's Phalarope	M, b	M, b	m, b	M	M	m
Red-necked Phalarope	m		m	m	M	m

[a]Codes: B = breeding, M = migration, W = wintering. **B**, **M**, **W** = high concentrations; region extremely important to species relative to majority of other regions. B, M, W = common or locally abundant; region important to species relative to other regions. b, m, w = uncommon to fairly common; region within species' range but occurs in low abundance relative to other regions (Brown et al. 2001).
[b]Bold names are JV focal species selected for habitat planning and monitoring emphasis and explained later in the strategy text. Scientific names are provided in Appendix C.
[c]Species not included in UMVGL Plan but has been occurring in the region in recent years (Robert P. Russell, USFWS, personal communication).

Cover types important to breeding and foraging shorebirds in the JV region include natural and managed wetlands, river floodplains, sand and gravel bars, lake shorelines, reservoirs, and flooded agricultural fields. Parts of the region are undergoing intensive development resulting in wetland loss and degradation, while other areas are heavily forested and contain few wetlands suitable for use by most shorebirds. Like many wetland-dependent species, shorebird populations are believed to have declined significantly during the past century due to habitat change. Wetland losses have been most severe in the southern portion of the JV region, with five states (Iowa, Illinois, Indiana, Missouri, and Ohio) having lost >80% of their historic wetland area since European settlement (Dahl and Johnson 1991, Dahl 2000). In the western portion of the JV region a drier climate can cause habitat quality to be unpredictable. Likewise, fluctuating water levels on the Great Lakes impact availability of habitat for species using beach and mudflat shorelines on this system.

Population Status and Trends

A USSCP technical working group assessed the conservation status of shorebirds that breed in the U.S. and Canada (Brown et al. 2000). The assessment established five conservation priority categories based on expert knowledge of shorebird population trends, distribution, relative abundance, and habitat threats. These categories were

adopted as a conservation priority rating system (5 = highly imperiled, 1 = lowest concern), and both continental and regional scores were developed (Table 2). "Highly imperiled" species were those with statistically significant ($P < 0.10$) population declines, low abundance (<25,000 birds), restricted breeding ranges (<2.5% of the continent), and currently documented threats to breeding or wintering habitats. "High concern" species included apparent but not statistically significant ($P \geq 0.10$) population declines; continental populations <150,000, breeding distribution <5% of the continent, and potential threats to breeding or wintering habitat exist but have not yet occurred. Species of "moderate concern" were those with apparently stable population trends or the trend was unknown, continental populations <300,000, no known threats to breeding and non-breeding habitats, and breeding and non-breeding distributions were generally not highly restricted to small areas of the continent. Species of "low concern" or not at risk had apparently stable to increasing population trends, low threat to breeding or non-breeding habitats, and breeding and non-breeding ranges were not highly restricted.

Table 2. Priority scores[a] for shorebirds in the Upper Mississippi Valley and Great Lakes Shorebird Planning Region from the National Shorebird Conservation Assessment (Brown et al. 2000).

	Continental							Regional						
Species[b]	Population trend	Relative abundance	Threats to breeding habitat	Threats to non-breeding habitat	Breeding distribution	Non-breeding distribution	Priority	Population trend	Relative abundance	Threats to breeding habitat	Threats to non-breeding habitat	Breeding distribution	Non-breeding distribution	Priority
Black-bellied Plover	5	3	2	2	2	1	3	5	3	2	3	2	1	3
American Golden-Plover	**5**	**3**	**2**	**4**	**2**	**3**	**4**	**4**	**3**	**2**	**3**	**2**	**3**	**3**
Semipalmated Plover	3	3	2	2	1	1	2	3	3	2	3	1	1	2
Piping Plover	**5**	**5**	**5**	**4**	**5**	**4**	**5**	**5**	**5**	**5**	**4**	**5**	**5**	**5**
Killdeer	**5**	**1**	**3**	**3**	**1**	**2**	**3**	**5**	**1**	**3**	**3**	**1**	**2**	**3**
Black-necked Stilt	3	3	3	2	1	2	2							
American Avocet	3	2	3	4	2	3	3							
Greater Yellowlegs	3	4	2	2	2	1	3	3	4	4	3	2	1	4
Lesser Yellowlegs	5	2	2	3	2	1	3	3	2	2	3	2	1	2
Solitary Sandpiper[c]	4	5	4	2	3	2	4	3	4	4	3	3	2	4
Willet	3	3	3	3	3	3	3	3	3	3	3	3	3	2
Spotted Sandpiper	3	3	2	2	1	1	2	3	3	3	3	1	1	2
Upland Sandpiper	**5**	**2**	**2**	**4**	**2**	**3**	**4**	**4**	**2**	**4**	**3**	**2**	**3**	**4**
Whimbrel[c]	4	5	2	3	4	3	4	5	4	2	3	3	2	4
Hudsonian Godwit[c]	3	5	3	4	4	4	4	3	4	3	3	4	4	4
Marbled Godwit[c]	4	5	4	4	3	3	4	4	3	4	3	3	3	4
Ruddy Turnstone[c]	4	5	2	4	2	2	4	4	3	2	3	2	2	3
Red Knot[c]	5	4	2	5	4	2	5	5	2	2	3	3	3	3
Sanderling	**5**	**2**	**2**	**4**	**2**	**1**	**4**	**5**	**2**	**2**	**3**	**2**	**1**	**3**
Semipalmated Sandpiper	5	1	2	3	3	3	3	5	1	2	3	3	3	3
Western Sandpiper	5	1	2	4	4	2	4	3	1	2	3	4	2	3
Least Sandpiper	5	2	2	2	2	2	3	5	2	2	3	2	2	3
White-rumped Sandpiper	3	2	2	2	3	3	2	3	2	2	3	3	3	2
Baird's Sandpiper	3	2	2	2	3	3	2	3	2	2	3	3	3	2

	Continental							Regional						
Species[b]	Population trend	Relative abundance	Threats to breeding habitat	Threats to non-breeding habitat	Breeding distribution	Non-breeding distribution	Priority	Population trend	Relative abundance	Threats to breeding habitat	Threats to non-breeding habitat	Breeding distribution	Non-breeding distribution	Priority
Pectoral Sandpiper	3	2	2	3	2	3	2	3	2	2	3	2	3	2
Dunlin[c]	**4**	**2**	**2**	**4**	**4**	**3**	**4**	**5**	**2**	**2**	**3**	**2**	**3**	**3**
Stilt Sandpiper	3	3	3	4	3	3	3	3	3	3	3	3	3	3
Buff-breasted Sandpiper[c]	5	5	3	4	3	4	5	4	5	3	3	3	4	4
Short-billed Dowitcher	**5**	**4**	**2**	**4**	**3**	**2**	**4**	**5**	**2**	**2**	**4**	**3**	**2**	**4**
Long-billed Dowitcher	2	2	2	3	4	3	2	2	2	2	3	4	3	2
Wilson's Snipe	**5**	**1**	**3**	**2**	**1**	**2**	**3**	**5**	**1**	**2**	**3**	**1**	**2**	**3**
American Woodcock	**5**	**1**	**4**	**4**	**2**	**3**	**4**	**5**	**1**	**4**	**3**	**2**	**3**	**4**
Wilson's Phalarope	**5**	**1**	**3**	**4**	**2**	**5**	**4**	**4**	**1**	**3**	**4**	**2**	**5**	**4**
Red-necked Phalarope	4	1	2	3	2	1	3	4	1	2	3	1	3	3

[a]Highest (5 = highest) species priority scores indicate greatest concern (Brown et al 2001). An update to the continental priority scores was completed in August, 2004 (U.S. Shorebird Conservation Plan 2004).

[b]Bold names and scores are JV focal species selected for planning and monitoring emphasis and explained later in the strategy text.

[c]Shorebird species with priority scores updated based on new information since the USSCP (U.S. Shorebird Conservation Plan 2004).

In addition to regionalizing species priority, the continental assessment also evaluated area priority, where "area importance" (AI) scores were applied to each BCR (Table 3). AI scores were derived from knowledge and expert opinion of shorebird distributions, frequencies of occurrence, and relative abundance within BCRs. The scores reflect perceived importance of management and protection activities relative to other regions, plus the seasons during which a BCR is important, including breeding, migration, and winter (Brown et al. 2000). The USSCP system applies scores (1-5) to individual BCRs and shorebird planning regions according to the following criteria:

5 = high concentrations are known to occur, region has high importance to the species, and is critical to supporting hemispheric populations,

4 = common or locally abundant within the region, with large numbers known or suspected to occur, and the region is known or suspected to be important to supporting hemispheric or regional species populations,

3 = uncommon to fairly common within the region, region is within the species' range and the species occurs regularly within the region, but with low abundance,
2 = occurs rarely and with low frequency within the region, but the region is within the expected range of the species, and management is generally not warranted for the species within the region.

1 = occurs only unpredictably, irregularly, or as a vagrant within the region, which is outside the expected range of the species.

Table 3. Shorebird area importance (AI) scores[a] for Bird Conservation Regions (BCR) within the Upper Mississippi Valley and Great Lakes Shorebird Planning Region from the National Shorebird Conservation Assessment (Brown et al. 2000).

Species[b]	Boreal Hardwood Transition (BCR 12)	Lower Great Lakes / St. Lawrence Plain (BCR 13)	Eastern Tall Grass Prairie (BCR 22)	Prairie Hardwood Transition (BCR 23)	Central Hardwoods (BCR 24)
Black-bellied Plover	4	4	4	4	
American Golden-Plover	**3**	**4**	**4**	**4**	**3**
Semipalmated Plover	3	4	4	4	3
Piping Plover	**5**	**4**	**4**	**4**	
Killdeer	**4**	**5**	**5**	**5**	**4**
Black-necked Stilt[c]					
American Avocet[c]					
Greater Yellowlegs	4	4	5	5	4
Lesser Yellowlegs	4	4	5	5	4
Solitary Sandpiper	4	4	4	4	
Willet	3	3	3	3	
Spotted Sandpiper	4	4	4	4	4
Upland Sandpiper	**3**	**3**	**3**	**3**	**3**
Whimbrel	3	3	3	3	3
Hudsonian Godwit	4	3	4	4	
Marbled Godwit	3	3	4	3	
Ruddy Turnstone	4	4	4	4	
Red Knot	3	3	3	3	
Sanderling	**4**	**3**	**4**	**4**	
Semipalmated Sandpiper	4	4	4	4	4
Western Sandpiper	3	3	3	3	
Least Sandpiper	5	5	5	5	4
White-rumped Sandpiper	4	3	4	4	3
Baird's Sandpiper	4	3	4	4	3
Pectoral Sandpiper	4	5	5	4	3
Dunlin	**3**	**5**	**4**	**4**	**3**
Stilt Sandpiper	3	4	4	4	3
Buff-breasted Sandpiper	3	4	4	4	3
Short-billed Dowitcher	**3**	**5**	**4**	**4**	**3**
Long-billed Dowitcher	3	5	5	5	3
Wilson's Snipe	**4**	**4**	**4**	**4**	**3**
American Woodcock	**4**	**4**	**4**	**4**	**4**
Wilson's Phalarope	**4**	**3**	**4**	**4**	
Red-necked Phalarope		3	3	3	

[a]Larger AI scores represent greater importance of the area to high concentrations and supporting hemispheric populations.

[b]Bold names and scores are JV focal species selected for planning and monitoring emphasis and explained later in the strategy text.

[c]Species occurs in low but growing numbers in JV region. AI scores were not provided for these BCRs in the National Shorebird Conservation Assessment.

Only one species occurring in the JV region, Piping Plover, was considered highly imperiled by the USSCP (Brown et al. 2001), but a status update added Buff-breasted Sandpiper and Red Knot to this category (U.S. Shorebird Conservation Plan 2004). In addition, recent status report identifies twelve species (Solitary Sandpiper, Upland Sandpiper, Whimbrel, Hudsonian Godwit, Marbled Godwit, Buff-breasted Sandpiper, Short-billed Dowitcher, American Woodcock, Wilson's Phalarope, Ruddy Turnstone, Sanderling, and Dunlin) as high continental concern. Compared to the USSCP (Brown et al 2001), the revision removes Greater Yellowlegs from the high concern category, but adds Ruddy Turnstone, Sanderling, and Dunlin (U.S. Shorebird Conservation Plan 2004). All 15 of these highly imperiled and high continental concern species are common migrants in the region, except Whimbrel. This species is considered a minor migrant, although a large proportion of the Whimbrel population from Hudson Bay migrates through the region.

Three (Piping Plover, Upland Sandpiper, and American Woodcock) of the nine species that breed in the JV region have highly imperiled or regional priority status based on the continental assessment (Brown et al. 2001). Five species that breed in the JV region are detected on the North American Breeding Bird Survey (BBS). Although BBS data for shorebirds should be used with caution due to detection rates (Sauer et al. 2005), the BBS suggests long-term population declines for American Woodcock and a generally increasing or stable trend for Killdeer and Wilson's Snipe (Table 4). The Woodcock Singing Ground Survey also reveals a long-term (1964-2004) breeding population decline in the JV region and neighboring Ontario, Canada, of -1.8% annually (Kelley and Rau 2006).

Table 4. Long term (1966-2005) and short term (1996-2005) population trend estimates (annual % change) for shorebird species that breed within USFWS Region 3[a] based on the North American Breeding Bird Survey (BBS, Sauer et al. 2006).

	1966-2005			1996-2005		
Species	Trend	p-value[b]	n[c]	Trend	p-value	n
American Woodcock[d]	-2.51	0.75	33	-15.14	0.10	7
Upland Sandpiper	-0.85	0.42	193	3.22	0.28	88
Killdeer	2.08	0.00	582	-0.75	0.08	491
Wilson's Snipe	0.05	0.95	142	4.98	0.02	64
Wilson's Phalarope	-17.47[f]	0.03	4	na[g]	na	na

[a]USFWS Region 3 includes the following states: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.

[b]p-values represent confidence in trend direction with values closer to 0.0 reflecting a greater degree of confidence in the trend; for example, values <0.05 reflect >95% confidence in trend direction.

[c]n = number of BBS routes used for regional trend average.

[d]American Woodcock populations are increasing in some localized areas outside Region 3, including eastern Nebraska (Sharpe et al. 2001)

[f]The BBS homepage cautions using this trend estimate due to small sample size (Sauer et al. 2005).

[g]na = inadequate survey data to generate a trend estimate.

Habitat Characteristics

Shorebirds are a morphologically diverse group that largely occupies an ecological gradient at the upland-wetland interface. Three species are associated primarily with sandy beaches near large water bodies, including Piping Plover, Ruddy Turnstone, and Sanderling. Two species are upland specialists: American Woodcock inhabit moist early succession woodland and Upland Sandpipers are associated with open grassland and prairie. Nesting habitat is variable for species breeding in the JV region. Nest sites for shoreline-associated species are most often associated with sparse to moderate vegetation density whereas those species nesting on upland sites typically use more dense vegetation (Table 5).

Table 5. Nest site location, cover type characteristics, and nesting strategy for shorebirds known to breed in the Upper Mississippi River and Great Lakes Joint Venture (JV) region.

			Vegetation structure		
Species[ab]	Nest site location	Substrate	Height	Density	Nesting behavior
Piping Plover	Beach/dune	Sand/gravel	None	Sparse	Semicolonial
Killdeer	Upland/dry mudflat	Exposed soil/gravel	None	Sparse	Solitary
Black-necked Stilt	Marsh/wet meadow	Herbaceous vegetation	Short	Sparse	Solitary
Spotted Sandpiper	Beach	Sand/rocky	None	Sparse	Solitary
Upland Sandpiper	Upland/prairie	Herbaceous vegetation	Medium/tall	Moderate	Semicolonial
Wilson's Snipe	Wet meadow	Herbaceous vegetation	Medium	Moderate	Solitary
American Woodcock	Upland	Woody vegetation	Medium/tall	Dense	Solitary
Wilson's Phalarope	Upland/wet meadow	Herbaceous vegetation	Medium	Moderate	Solitary

[a]Bold names are JV breeding focal species selected for habitat planning and monitoring emphasis and explained later in the strategy text.
[b]Solitary Sandpiper was not included because it breeds in the Canadian portion of BCR 12, outside the JV region.

There is a broad range of dietary overlap among shorebird species, especially during migration and wintering periods. As a group, shorebirds feed primarily on aquatic invertebrates that live in saturated or shallowly inundated substrates at the margins of wetlands. The food resource, which is dependent on substrate conditions and water depths, is partitioned among species according to body size, leg length, and bill morphology. Migration habitat used by individual species can be described in a few simple dimensions: 1) foraging substrate or water depth, 2) vegetation height, and 3) vegetation density (Table 6). Shorebird use of habitat overlaps with some waterfowl and wading birds at the wet end of the water-level gradient and with some upland birds at the dry end.

Habitat changes such as conversion of shallow-water and ephemeral wetlands to agriculture and urban development, diking and dredging of rivers, and destruction of beaches, sandbars, and barrier islands, have reduced the capacity of the JV region to support breeding and migrating shorebirds. However not all changes in shorebird habitat are due to human activities. Changes in Great Lakes water levels influence shorebird habitat, with wind-driven seiches causing water levels to change daily or hourly,

Table 6. Foraging sites, mode of feeding, and habitat characteristics of migrating shorebirds occurring in the Upper Mississippi River and Great Lakes Joint Venture (JV) region.

	Primary foraging sites							Foraging mode			Vegetation height			Vegetation cover		
Species[a]	Shrubland	Grassland	Beach	Dry mudflat	Wet mudflat	Shallow water (0-5 cm)	Moderate water (5-20 cm)	Terrestrial pecking / gleaning	Aquatic gleaning / sweeping	Probing	0-5 cm	5-20 cm	>20 cm	None to sparse	Sparse to moderate	Moderate to dense
Black-bellied Plover				X				X			X			X		
American Golden-Plover				**X**				**X**			**X**			**X**		
Semipalmated Plover					X			X			X			X		
Piping Plover			**X**					**X**			**X**			**X**		
Killdeer				**X**				**X**			**X**			**X**		
Black-necked Stilt							X		X			X	X		X	
American Avocet							X		X		X			X		
Greater Yellowlegs						X			X			X			X	
Lesser Yellowlegs						X			X			X			X	
Solitary Sandpiper					X				X			X			X	
Willet						X			X			X			X	
Spotted Sandpiper					X			X	X	X	X			X		
Upland Sandpiper		**X**						**X**				**X**			**X**	**X**
Whimbrel							X	X	X	X		X				X
Hudsonian Godwit							X			X		X			X	
Marbled Godwit							X			X		X			X	
Ruddy Turnstone			X					X	X	X	X			X		
Red Knot					X				X	X		X		X		
Sanderling			**X**						**X**	**X**		**X**		**X**		
Semipalmated Sandpiper					X				X	X		X		X		
Western Sandpiper					X				X	X		X		X		
Least Sandpiper					X				X	X		X		X		
White-rumped Sandpiper					X				X	X		X		X		
Baird's Sandpiper				X					X	X		X		X		
Pectoral Sandpiper					X				X	X		X		X		
Dunlin					**X**				**X**	**X**		**X**		**X**		
Stilt Sandpiper						X			X	X						
Buff-breasted Sandpiper				X				X	X			X		X		
Short-billed Dowitcher						**X**			**X**	**X**		**X**		**X**		
Long-billed Dowitcher						X			X	X		X		X		
Wilson's Snipe					**X**				**X**	**X**			**X**		**X**	
American Woodcock	**X**									**X**			**X**			**X**
Wilson's Phalarope							**X**		**X**		**X**				**X**	
Red-necked Phalarope							X		X		X				X	

[a]Bold names are JV focal species selected for planning and monitoring emphasis and explained later in the strategy text.

inundating or exposing mudflat and sand shoreline areas. Great Lakes water levels also respond during the year to weather events and over longer periods to climate and precipitation cycles (Figure 2). Monthly and yearly differences in water levels result in significant change of coastal shorebird habitats.

Much of the shallow water and mudflat zone used by staging and feeding shorebirds has been lost in the JV region. In addition, habitat quality in agricultural portions of the region is degraded due to sedimentation and high levels of nutrient and pesticide from adjacent agricultural fields. In more urbanized settings, industrial effluents add toxic compounds and heavy metals into wetland complexes and to the Great Lakes and their shorelines. Although landscape conversion to agriculture and development is a most obvious influence on shorebird habitat, climate change and pollution may have an important but less predictable impact. A comprehensive list of threats to regional shorebird habitat has been developed (Appendix D).

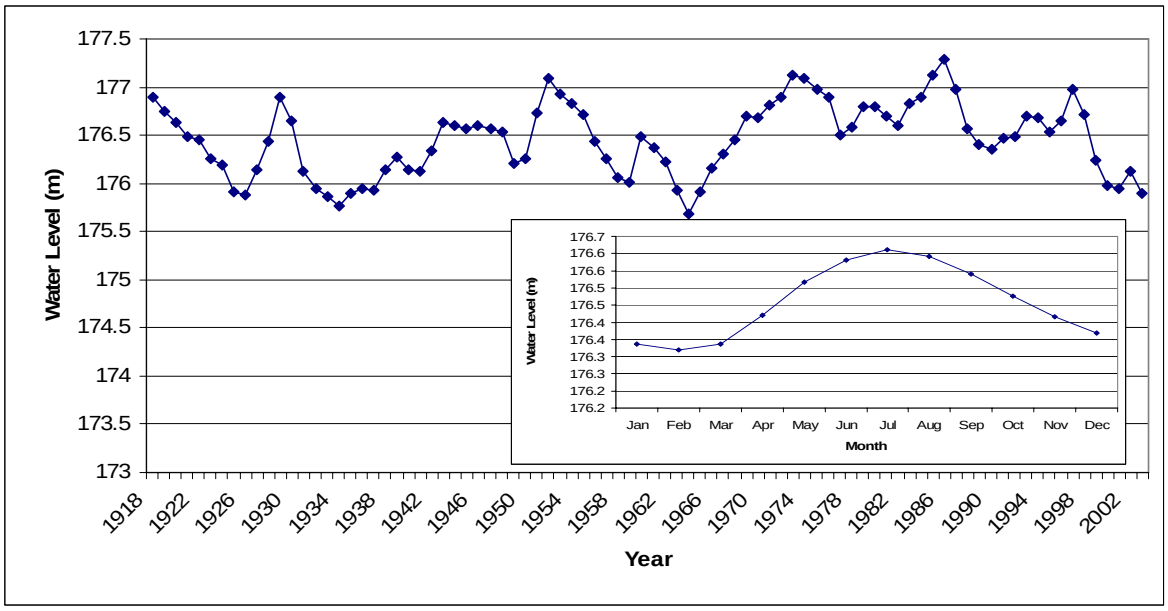

Figure 2. Annual average measure above sea level for the Lake Michigan-Huron system, 1918-2003. Inset is the average monthly change in water level for system during the same period (U.S. Army Corps of Engineers 2005).

The UMVGL Shorebird Conservation Plan (de Szalay 2000) was based on the assumption that accomplishing waterfowl habitat objectives will ensure that shorebird population goals and habitat objectives are also met. Shorebirds undoubtedly benefit from conserving wetlands and associated grasslands (waterfowl habitat), but the magnitude of benefit depends on the specific water and vegetation conditions that prevail after habitats are conserved, enhanced, or restored. Besides waterfowl habitat conservation, other human activities have inadvertently created or maintained potential shorebird habitat. Reservoirs, stock ponds, sewage lagoons, flooded agricultural fields, and sand and gravel pits with shallow water margins are providing habitat to some shorebird species.

Biological Foundation

Assembling the biological foundation or underpinnings for conservation planning included identification of factors believed to be limiting shorebird populations. These factors were then translated and quantified into landscape attributes that can be used in biological models describing expected species-habitat relationships. Population goals and "deficits" (population goal – current population = population deficit) were calculated, and JV focal species were selected for planning emphasis and habitat model development.

Planning Framework

The purpose of this JV Shorebird Strategy is to provide a science and partnership based action plan for habitat conservation founded on the U.S. and UMVGL Shorebird Conservation Plans, but with boundaries, habitat conditions, conservation needs, and partner goals characteristic of the JV region. Habitat objectives were linked to JV population goals based on current understanding of population-habitat relationships of shorebird species that breed in or migrate through the region. However, information provided is based on imperfect knowledge that we expect will improve as shorebird conservation activities are implemented and monitored. This strategy will be modified as new information emerges from the domains of both science and management.

Designing landscapes to meet regional bird conservation objectives is a new science, which has been described in a "five element process" (Will et al. 2005). Using the elements of this process, biologically-based, spatially explicit, landscape-oriented habitat objectives are developed for supporting and sustaining bird populations at goal levels. Conservation partners work together to assess habitat conditions and ownership patterns, evaluate current species distributions and bird-habitat relationships, and determine where on the landscape habitat conservation effort can most efficiently be delivered to support explicitly-stated population objectives. Objectives must be explicit for performance measurement and to develop a foundation for adaptive management.

Specifically, the five elements include 1) landscape characterization and assessment, 2) bird population response modeling, 3) conservation opportunities assessment, 4) optimal landscape design, and 5) monitoring and evaluation. Although available information was incomplete and imperfect, these elements were used to develop shorebird habitat objectives and, more importantly, to initiate a process for adaptive planning. Population status and goals were identified for several species commonly breeding in the JV region or occurring during migration. The five element process was applied primarily to a group of JV breeding focal species and migration guilds, but each represented a different community type important to shorebirds during breeding and migration periods.

We attempted to assess resource status and trends for JV focal species and use this information to develop conservation strategies in a landscape context. Analysis of digitized and spatially referenced data and techniques used to generate explicit habitat

objectives (i.e., what, where, when, and how much habitat is needed) are described in JV focal species and guild accounts (Appendices A and B). Although identifying landscape trends important in influencing shorebird populations was part of this planning process, our ability to quantify shorebird habitat was limited by the classification systems used to define cover types for digital spatial datasets currently available at the regional level. Moreover, availability of some critical cover type data (e.g., National Wetland Inventory) was inconsistent across the JV region and the need to update this 20-30 year-old information became increasingly obvious during development of this strategic plan.

Migration and Distribution

Nearly all North American shorebirds breed in northern temperate, boreal, and arctic regions. Twenty five of 34 species occurring in the UMVGL region nest in arctic or boreal regions of Alaska and Canada, whereas eight species nest in prairie or boreal communities within the UMVGL region (Table 1). Shorebirds typically travel long distances from their summer breeding areas to their wintering grounds, often in Central and South America. Along these migration routes shorebirds require suitable habitat to rest and replenish fat reserves. Most species occurring in the JV region are classified as "intermediate distance migrants" with total migration distances from latitudes roughly in the middle of North America to latitudes in the middle of South America (Skagen and Knopf 1993).

Different migration patterns were identified for shorebirds that move through the Great Plains (including the western portion of the JV region). These include narrow band, jump, cross band, widespread, and a combination of narrow band and widespread (Skagen et al. 1999). "Narrow band" migrants have a gradual migration that is concentrated in a narrow front within approximately 10^{o} of longitude (Figure 3). A small number of sites may support high proportions of narrow band shorebirds within a given year, but these sites can shift due to seasonal or yearly changes in habitat conditions. "Widespread" migrants also move gradually but are distributed broadly across the landscape. Individual areas rarely support large proportions of species populations that migrate through the region, but large concentrations may occur at a few widely distributed sites. "Jump" migrants move more directly from wintering to breeding habitats and therefore can over-fly much of the region. Relatively small numbers and proportions of species populations would occur at migration stopover sites. "Cross band" migrants move in a relatively narrow front that is oriented east-west as well as north-south. These birds may concentrate in localized stopover areas or they may largely over-fly the region some years.

Of the shorebirds occurring in the JV region, narrow band and widespread are the most common migration patterns (Table 7). These migrants are typically long and intermediate distance species but also include short distance species. Jump-pattern shorebirds normally have an intermediate and long-distance strategy, whereas cross band pattern includes short and intermediate distance migrants. Some species exhibit migration behavior that includes multiple patterns (Table 7). Moreover, these are generalized migration patterns that often change due to weather and habitat distribution

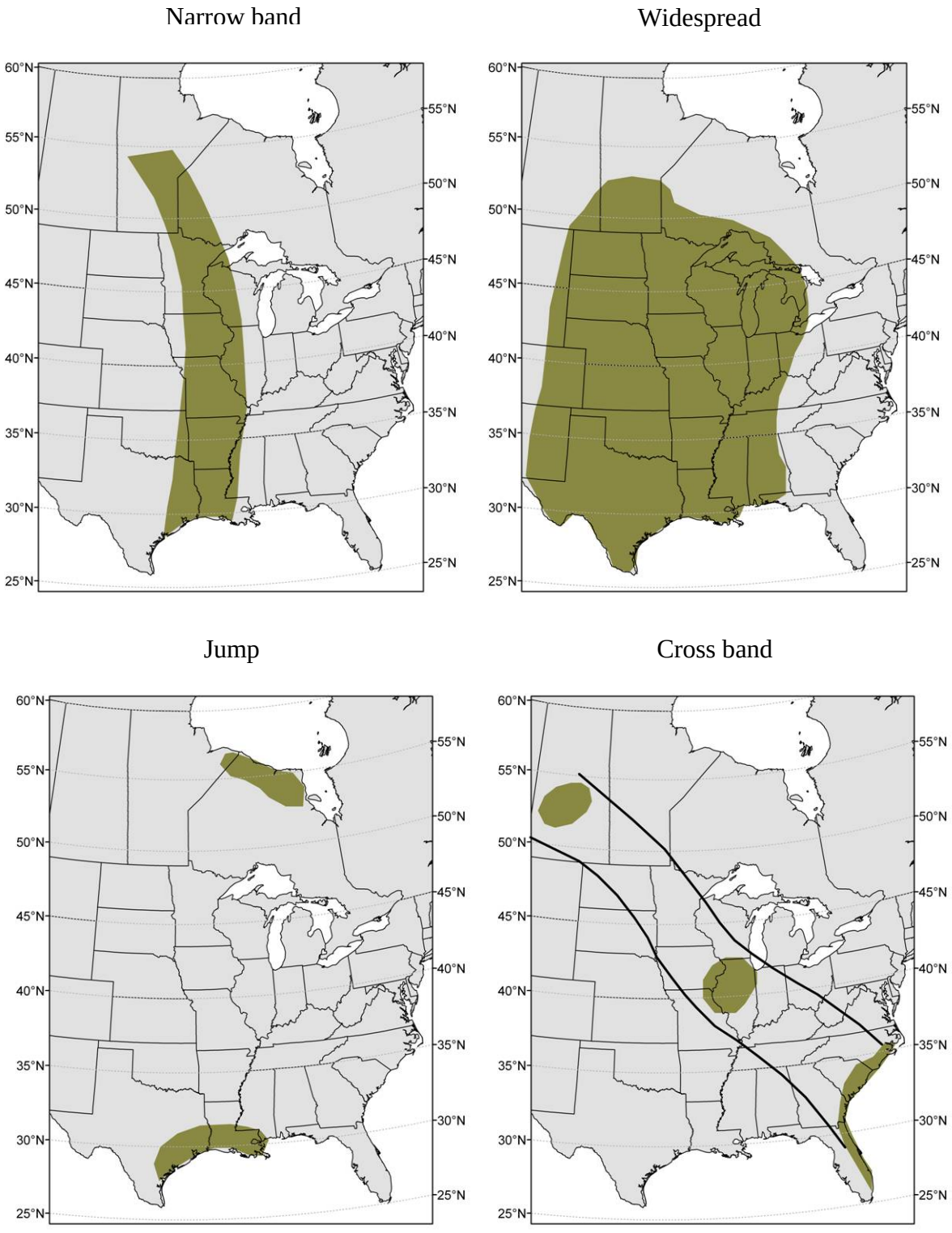

Figure 3. Conceptual shorebird migration patterns, modified from Skagen et al. (1999).

during different years and seasons. Criteria used to classify species by migration pattern are explained in detail by Skagen et al. (1999) based on population surveys and observation records compiled from locations west of the Mississippi River. Migration patterns detected in this study may not fully apply to more easterly regions of the continent, but they do provide useful insight into migration chronology and how migrating shorebirds might move through the JV region.

Table 7. Migration and staging characteristics of shorebirds occurring in the Upper Mississippi River and Great Lakes Joint Venture (JV) region, modified from Skagen et al. (1999).

	Migration pattern				Relative migration distance			Estimated stopovers[b]	
Species[a]	Narrow band	Jump	Widespread	Crossband	Short	Intermediate	Long	Number of stops	Duration at stops (days)
Black-bellied Plover			X			X	X	1	1-5
American Golden-Plover	**X**						**X**	**1-2**	**5-10**
Semipalmated Plover			X			X	X	2	1-5
Piping Plover	**X**				**X**			**1**	**1-5**
Killdeer			**X**		**X**			**2**	**5-10**
Black-necked Stilt			X		X	X		1	1-5
American Avocet	X			X	X	X		1	1-5
Greater Yellowlegs			X			X	X	2	5-10
Lesser Yellowlegs			X			X	X	3	5-10
Solitary Sandpiper			X			X	X	2	5-10
Willet	X			X	X			1	1-5
Spotted Sandpiper			X			X		2	5-10
Upland Sandpiper			**X**			**X**		**1**	**1-5**
Whimbrel	X					X	X	1	1-5
Hudsonian Godwit	X						X	1	1-5
Marbled Godwit	X			X	X	X		1	1-5
Ruddy Turnstone		X	X			X	X	1	1-5
Red Knot	X	X				X	X	1	1-5
Sanderling			**X**			**X**	**X**	**2**	**1-5**
Semipalmated Sandpiper			X			X	X	2	5-10
Western Sandpiper	X			X		X		1	5-10
Least Sandpiper			X			X	X	2	5-10
White-rumped Sandpiper	X						X	2	5-10
Baird's Sandpiper			X				X	2	5-10
Pectoral Sandpiper			X				X	3	5-10
Dunlin			**X**			**X**		**1-2**	**5-10**
Stilt Sandpiper	X						X	2	1-5
Buff-breasted Sandpiper	X	X					X	1	1-5
Short-billed Dowitcher			**X**			**X**	**X**	**2**	**1-5**
Long-billed Dowitcher	X					X		1	5-10
Wilson's Snipe			**X**		**X**			**2**	**5-10**
American Woodcock			**X**		**X**			**2**	**5-10**
Wilson's Phalarope			**X**			**X**	**X**	**1**	**1-5**
Red-necked Phalarope	X						X	1	1-5

[a]Bold names are JV focal species for habitat planning and monitoring emphasis and explained later in the strategy text.
[b]Estimated number of stops and duration at stops based on expert opinion (compiled by Bob Russell, FWS).

Limiting Factors

Factors limiting population growth for a majority of shorebird species occurring in the JV region are unknown. Gradual conversion of early succession forest to mature cover is probably limiting the American Woodcock (Kelley 2006), whereas human and pet disturbance of Great Lakes coastal areas resulting from development and recreation is limiting Piping Plovers (USFWS 2003). Other factors potentially limiting both breeding and migrating shorebird populations include loss of ephemeral and shallow open-water wetlands, reduction in water quality, and declining availability of aquatic invertebrates found in these communities.

In addition to habitat concerns, shorebird populations are restrained by relatively low reproductive rates making population recovery a gradual process. Small clutch size with fewer than four eggs is common, and many species, particularly arctic nesting shorebirds, will not re-nest after an initial attempt is unsuccessful (Brown et al. 2001). Low recruitment of young along with continued loss of shallow wetlands (Ducks Unlimited 2005) creates significant challenges for shorebird management in the JV region.

Currently there is little information on the amount and quality of habitat needed to support various shorebird species. Data on breeding densities and site-specific attributes are needed to generate meaningful breeding habitat management objectives. Furthermore, information on migration abundance, stopover times, energy requirements, and the amount of energy provided in different communities are needed to develop migration habitat objectives. Using available research on limiting factors and nutrition, explicit population objectives, and species-demographic information, simple biological models can be used to generate habitat objectives. Habitat objectives can then be refined through an adaptive approach as new information is gained through research and monitoring.

Population Goals

Strategic planning for bird conservation includes establishing bird population goals and demographic benchmarks (e.g., population size, recruitment, survival, bird use-days, etc.) that can be measured or estimated. Continental population estimates have been developed for shorebirds (Morrison et al. 2000, 2001, and 2006), but they are admittedly crude, especially for species that breed in remote regions, migrate over long distances, and for which there are no systematic population surveys. Nevertheless, estimates have been developed using the best available abundance data and knowledge of distribution and life history, and these continental values were partitioned into regional population estimates and goals to establish a starting point for conservation planning.

Focal Species

Due to the large number of shorebirds occurring in the JV region, a smaller subset of "JV focal species" was chosen for emphasis in this conservation strategy. Separate JV focal species were selected for breeding and migration habitat planning and population monitoring. In addition, guilds of species (Root 1967) with similar feeding habitat requirements were used to develop migration habitat objectives. The use of focal species is a conservation assessment "shortcut," reducing the number of models required for developing habitat objectives for a full suite of species. In effect, a single JV focal species was selected to represent a general cover type used by multiple species of shorebirds for breeding. Likewise, monitoring results based on breeding and migrating JV focal species are assumed to reflect the suite of species they represent.

The criteria for selecting breeding JV focal species typically included stable or declining population, a high importance level of the JV region to the continental population, some understanding of factors limiting the population, and a potential to monitor populations. Migrating focal species were selected based on regional importance (significance of JV region to species), an ability to identify and manage for a habitat-limiting factor, the potential for monitoring, and migration chronology. Using species guilds allowed calculation of food resources needed for all migrating shorebirds in primary cover types used by these species.

Breeding JV focal species selected for planning emphasis included Killdeer, Wilson's Snipe, Piping Plover, Upland Sandpiper, and American Woodcock. Unique for shorebirds, the Upland Sandpiper and American Woodcock are largely terrestrial, therefore their habitat objectives will be addressed in the JV Landbird Habitat Conservation Strategy. The remaining species represented the following cover types (Table 5): dry mudflat (Killdeer), wet meadow/mudflat (Wilson's Snipe), and beach (Piping Plover). Scientists have quality estimates of population size and demographics for the beach nesting Piping Plover, and a recovery plan for the Great Lakes population (USFWS 2003) will be used for habitat conservation recommendations. Therefore, JV breeding shorebird habitat planning will be focused primarily on communities to accommodate Killdeer and Wilson's Snipe. These include dry mudflat / agriculture, and wet meadows with open water.

JV migrant focal species were also selected to represent specific cover types (Table 6), but these species are only a component of the guilds used for calculating habitat objectives. Their potential suitability for monitoring was the impetus for their selection. The species included American Golden-Plover, Dunlin, Short-billed Dowitcher, Wilson's Phalarope, and Sanderling. American Golden-Plover uses dry mudflat / agricultural areas which are also important for Black-bellied Plover. Dunlin is most associated with wet mudflat, whereas Short-billed Dowitcher uses shallow-water (<5 cm deep). Wilson's Phalarope typically use relatively deep water sites (5-20 cm deep), which are also important for Marbled Godwits. Finally, Sanderling was selected to represent beach during migration, and their habitat requirements overlap with Ruddy Turnstone.

Derivation of Breeding Population Goals

Population estimates, goals, and deficits for breeding shorebirds in the JV region were established using the best available information (Table 8). This included using estimated proportions of breeding populations in BCRs from Partners in Flight (PIF) conservation assessments derived from the BBS and species-specific breeding surveys for American Woodcock and Piping Plover. State bird atlases and expert opinion also provide information for species like Spotted Sandpiper and Wilson's Phalarope whose breeding populations are not well surveyed. Continental population goals can be distributed across BCRs within the JV region according to the proportion of a species' total breeding range that occurs within each BCR. Although some population estimates may be inaccurate due to crude survey information, a process has been established to step-down continental population objectives to BCRs within the JV region. When available, improvements to shorebird surveys and updated continental population estimates will be used to refine future iterations of this strategy.

Table 8. Breeding population estimates, goals, and deficits[a] by Bird Conservation Region (BCR)[b] for shorebird species in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. The JV largely consists of BCRs 22, 23, and the U. S. portion of 12 (35% of BCR 12); areas of BCR 24 (19%), 13 (11%), and 28 (7%) also are within the JV boundary. Population deficits are included for BCRs 24, 13, and 28 when >5% of the estimated JV-wide population occurs in that portion of the BCR. Bold names are JV breeding focal species selected for planning emphasis and monitoring.

	Continental population information			JV region population information		
Species and BCR	Estimate[c]	Target (proportional increase, %)[d]	Proportion in region (%)[e]	Estimate[f]	Goal[g]	Deficit
Piping Plover (GL)	116	160				
BCR 12			100.00	116	0	0
BCR 23			0.00	0	0	0
BCR 22			0.00	0	0	0
Total			100.00	116	300[h]	184[h]
Killdeer	1,000,000	22				
BCR 12			0.98	3,442	8,399	4,957
BCR 23			4.75	47,500	115,900	68,400
BCR 22			14.40	144,000	351,360	207,360
BCR 13			0.42	461	1,125	664
BCR 28			0.16	115	280	165
BCR 24			0.60	1,137	2,775	1,637
Total			21.31	196,655	479,838	283,183
Black-necked Stilt	175,000	0				
BCR 23			0.00	10	0	0
BCR 22			0.01	20	0	0
BCR 24			0.10	170	0	0
Total			0.11	200	0	0
Spotted Sandpiper	150,000	0				
BCR 12			0.22	114	114	0
BCR 23			0.24	360	360	0
BCR 22			0.21	315	315	0
BCR 13			0.07	11	11	0
BCR 28			0.01	1	1	0

	Continental population information			JV region population information		
Species and BCR	Estimate[c]	Target (proportional increase, %)[d]	Proportion in region (%)[e]	Estimate[f]	Goal[g]	Deficit
Total			0.74	800	800	0
Upland Sandpiper	350,000	34				
BCR 12			0.52	635	850	216
BCR 23			0.89	3,115	4,174	1,059
BCR 22			8.46	29,610	39,677	10,067
BCR 13			0.25	97	130	33
BCR 24			0.06	37	49	12
Total			10.18	33,493	44,881	11,388
Wilson's Snipe	2,000,000	117				
BCR 12			0.46	3,210	6,965	3,755
BCR 23			0.08	1,600	3,472	1,872
BCR 22			0.00	0	0	0
BCR 13			0.05	111	242	130
Total			0.59	4,921	10,678	5,757
American Woodcock[i]	3,500,000	26				
BCR 12			11.91	540,714	615,202	74,488
BCR 23			2.73	232,114	312,731	80,617
BCR 22			4.06	62,761	100,692	37,931
BCR 13			0.49	13,276	24,131	10,855
BCR 28			0.37	8,741	18,746	10,005
BCR 24			0.82	11,977	20,380	8,403
Total			20.38	869,583	1,091,882	222,299
Wilson's Phalarope	1,500,000	87				
BCR 12				47	88	41
BCR 23				85	159	74
BCR 22				24	45	21
Total			0.00	156	292	136

[a]Population deficit = population goal - current population estimate.

[b]Bird Conservation Regions (BCRs): BCR 12 = Boreal Hardwood Transition, BCR 13 = Lower Great Lakes / St. Lawrence Plain, BCR 23 = Prairie Hardwood Transition, BCR 28 = Appalachian Mountains, BCR 22 = Eastern Tallgrass Prairie, BCR 24 = Central Hardwoods

[c]Continental estimates from Morrison et al. 2006, except for Piping Plover and American Woodcock. Great Lakes Piping Plover estimate from recent surveys (58 breeding pairs, Westbrock et al. 2005) and American Woodcock estimate from the American Woodcock Conservation Plan (Kelley 2006).

[d]Continental targets for increase from USSCP, except for Piping Plover (USFWS 2003) and American Woodcock (Kelley 2006).

[e]Estimated percentage of breeding population in each BCR within JV region from Partners in Flight (PIF) Species Assessment database derived from Breeding Bird Survey relative abundance counts, except for Wilson's Phalarope where information comes from state bird atlases and expert opinion.

[f]JV population estimates derived by multiplying the PIF percentage of breeding population to the estimated continental population. Estimates for BCR 12, 13, 24, and 28 are also multiplied by the proportion of land area for that BCR within the JV boundary.

[g]Goals derived by multiplying JV population estimate by continental target for increase, except for Piping Plover (USFWS 2003) and American Woodcock (Kelley 2006).

[h]Goal population from recovery plan is 200 pairs in Michigan and 50 pairs outside Michigan in potentially any BCR. Population deficit is not BCR specific.

[i]Continental and BCR population estimates are based the number of singing males counted by the American Woodcock Singing Ground Survey (Kelley 2006).

Derivation of Migration Population Goals

Stepping down continental population estimates to conservation planning regions is difficult for migrating shorebirds because only rudimentary knowledge of migration routes exists, particularly in the interior region of the continent. Lacking such information, BCR shorebird population assessments (Brown et al. 2000) were used to estimate the proportions of continental populations that are expected to migrate through the JV region. The importance of BCRs 12, 13, 22-24 (the UMVGL Shorebird planning region) was believed to roughly reflect the JV region's continental contribution to migrating shorebirds. Therefore, we summed AI scores for BCRs 12, 13, 22-24 (Table 3) then divided by the total of AI scores for all BCRs to obtain a proportional (0-1) AI score for each species within the JV region (Table 9). Category one species (low priority) were given a 0 value in this calculation. The JV region proportional AI score was multiplied by the continental population estimate and goal for each species to estimate current and anticipated future numbers of shorebirds expected to use the JV region during spring when population goals are met. BCR population estimates and deficits were similarly calculated. Migration population estimates represent spring migrant populations because they are derived from continental breeding population estimates. This process along with up-dated continental population estimates and evaluation by experts will be used to refine migration population estimates for the JV region in future iterations of this strategy.

Estimates of migrating shorebird abundance can be translated to migration habitat objectives via a population-based "currency" (e.g., bird use-days) that can also be expressed as energetic carrying capacity of habitats needed to support regional population goals. This approach was used to derive migration habitat objectives in this strategy. Although these non-breeding population estimates and deficits are not rigorously derived, they do reflect potential importance of the JV region and its current and expected future contributions to supporting continental population goals.

Table 9. Shorebird migration population estimates, goals, and deficits in spring derived from area importance (AI) scores for the Upper Mississippi River and Great Lakes Joint Venture (JV) region. AI scores for bird conservation regions 12, 13, 22, 23, and 24 were summed to represent the JV region. Continental AI scores are a sum of all BCR AI scores. JV proportion was calculated as the JV region AI score / Continental AI score.

	AI score			Continental population			JV population	
Species[a]	JV region	Continental	JV proportion	Estimate[b]	Goal[c]	Deficit[d]	Estimate	Deficit
Black-bellied Plover	12	93	0.13	200,000	272,700	72,700	25,806	9,381
American Golden-Plover	**14**	**82**	**0.17**	**200,000**	**150,000**	**0**	**100,000[e]**	**0**
Semipalmated Plover	14	99	0.14	150,000	150,000	0	21,212	0
Piping Plover	13	54	0.24	5,945	10,300	4,355	1,431	987
Killdeer	18	110	0.16	1,000,000	2,440,000	1,440,000	163,636	235,636
Black-necked Stilt	0	64	0.00	175,000	150,000	0	300[e]	0
American Avocet	0	70	0.00	450,000	450,000	0	1,000[e]	0

	AI score							
				Continental population			JV population	
Species[a]	JV region	Continental	JV proportion	Estimate[b]	Goal[c]	Deficit[d]	Estimate	Deficit
Greater Yellowlegs	18	107	0.17	100,000	100,000	0	16,822	0
Lesser Yellowlegs	18	109	0.17	400,000	2,240,000	1,840,000	200,000[e]	87,000[e]
Solitary Sandpiper	12	82	0.15	150,000	100,000	0	21,951	0
Willet	9	73	0.12	250,000	250,000	0	30,822	0
Spotted Sandpiper	16	103	0.16	150,000	150,000	0	23,301	0
Upland Sandpiper	12	79	0.15	350,000	470,000	120,000	53,165	18,228
Whimbrel	12	80	0.15	66,000	147,500	81,500	9,900	12,225
Hudsonian Godwit	12	48	0.25	70,000	54,700	0	17,500	0
Marbled Godwit	10	70	0.14	173,500	263,500	90,000	8,000[e]	12,857
Ruddy Turnstone	12	71	0.17	180,000	235,000	55,000	30,423	9,296
Red Knot	9	57	0.16	120,000	470,000	350,000	250[e]	55,263
Sanderling	**12**	**69**	**0.17**	**300,000**	**1,500,000**	**1,200,000**	**52,174**	**189,474**
Semipalmated Sandpiper	16	81	0.20	2,000,000	8,200,000	6,200,000	395,062	1,078,261
Western Sandpiper	9	87	0.10	3,500,000	3,500,000	0	5,000[e]	0
Least Sandpiper	19	106	0.18	700,000	1,400,000	700,000	125,472	125,472
White-rumped Sandpiper	15	61	0.25	1,120,000	400,000	0	275,410	0
Baird's Sandpiper	15	92	0.16	300,000	300,000	0	48,913	0
Pectoral Sandpiper	16	95	0.17	500,000	400,000	0	84,211	0
Dunlin	**14**	**82**	**0.17**	**1,525,000**	**1,525,000**	**0**	**260,366**	**0**
Stilt Sandpiper	14	79	0.18	820,000	200,000	0	145,316	0
Buff-breasted Sandpiper	14	66	0.21	30,000	150,000	120,000	6,364	25,455
Short-billed Dowitcher	**14**	**74**	**0.19**	**306,000**	**414,000**	**108,000**	**57,892**	**20,432**
Long-billed Dowitcher	16	110	0.15	400,000	500,000	100,000	58,182	14,545
Wilson's Snipe	15	105	0.14	2,000,000	4,345,000	2,345,000	285,714	335,000
American Woodcock	16	60	0.27	3,500,000	6,000,000	2,500,000	933,333	666,667
Wilson's Phalarope	**12**	**93**	**0.13**	**1,500,000**	**2,800,000**	**1,300,000**	**193,548**	**167,742**
Red-necked Phalarope	6	71	0.08	2,500,000	5,000,000	2,500,000	211,268	211,268

[a]Bold names are JV migrant focal species selected for habitat planning and monitoring emphasis.
[b]Continental population estimates from Morrison et al. 2006. These estimates include several revisions from estimates published by Morrison et al. 2001 and used in the U.S. Shorebird Conservation Plan (Brown et al. 2001). Adjustments are attributed to new information not actual population increases or decreases; trends for most taxa are declining.
[c]Goal populations from Brown et al. 2001. Population estimates for some species are greater than population goals due to revisions (2006) from the time goals were established (2001). Unfortunately new population goals have not been developed following revision of estimates. New population goals and deficit calculations will appear in the next iteration of this strategy.
[d]Population deficit = population goal - population estimate.
[e]Population estimate adjusted based on expert opinion (Robert P. Russell, USFWS, personal communication).

Habitat Goal and Objectives

The goal of this strategy is to maintain adequate landscape carrying capacity for breeding and migrating shorebird populations at levels that meet a regional obligation stepped down from the continental shorebird plan. Science-based habitat objectives are linked to desired populations for breeding JV focal species (Appendix A) and migration guilds (Appendix B). This approach was necessary to target limited JV partner resources and to generate measurable objectives, thus setting the stage for performance measurement, evaluation, and adaptive management. Habitat objectives generated for JV focal species and guilds are established to reflect and accommodate the needs of all shorebirds using the region, with recognition of the potential inaccuracies due to multiple assumptions used in the objective setting process. However, the JV Technical Committee anticipates continued refinement of this strategy and periodic adjustment of habitat objectives as new biological and environmental information is integrated into the model-based decision process. Our collective intention was to move JV planning emphasis beyond local scales and provide regional focus to where and what habitats and species require more immediate attention. Plan effectiveness will improve as result measures shift from habitat area as the goal (output) to population change as the goal (outcome).

JV partners will employ an array of habitat conservation tools, including maintenance/protection and management, plus restoration and enhancement in working to achieve strategy goals. To increase financial accountability, partners will use a more business-like approach to conservation, evaluating the cost of conservation work relative to the expected return on investment, including duration of benefits. A primary interest in this planning effort is to identify target areas and landscape prescriptions that provide high benefit for shorebird populations at relatively low cost. Actual land values and other economic factors will be incorporated into future iterations of the strategy to help increase benefit/cost recommendations.

"Maintenance and protection" (e.g., acquisition, conservation easement, management) includes actions that seek to maintain existing habitat values and sustainable ecosystems, although plant and wildlife communities may be dynamic at protected sites over time. "Restoration and enhancement" includes actions that restore habitat features (e.g., providing the "missing element") that have been lost or degraded, and creating new shorebird areas that serve as ecological equivalents to lost habitat. "Intensive management" may be viewed as a type of enhancement, but it generally requires annual effort to reach a desired habitat condition (i.e., the system is not self-sustaining). This level of management may be more necessary in areas with few remaining wetlands, especially considering shorebirds require specific water-depth and food resource conditions during migration staging.

Calculating Habitat Objectives

Breeding habitat objectives were established using simple models with area/distance requirements and perceived limiting factors, the missing landscape feature(s) most likely preventing population growth (Appendix A). Migration habitat

objectives were generated with a more complex modeling approach, accounting for shorebird energy needs during migration (explained below). Models were used to calculate the required amount of habitat to accommodate JV breeding focal species and migration guilds in moderate to optimal habitat. "Maintenance and protection objectives" reflect estimated habitat needs of current populations, whereas "restoration and enhancement objectives" were generated based on population deficits.

Migration Habitat Bioenergetics Model

Assuming food energy is a primary factor limiting shorebirds during the non-breeding season, migration habitat objectives can be calculated with a bioenergetics model (Loesch et al. 2006). Migration population estimates for the JV region were based on continental breeding estimates, thus habitat objectives were calculated for spring populations of migrating shorebirds (Appendix B). By default, migration habitat available in spring was assumed to be a limiting factor for all species. This key assumption is probably unrealistic for some species and must be tested, with results incorporated into future habitat models. Intuitively, shorebird habitats such mudflats, bare soils, and open settings seem least abundant during fall due to vegetative coverage. Conversely, natural and agricultural vegetation are diminished in spring and temporary wetlands and moist soil areas are relatively abundant. These seasonal differences suggest fall may be a more habitat-limited period for shorebirds. However, timing of resource availability is likely most critical during the spring, as the migration period is relatively short and precedes the breeding season. In addition, several species have a larger population migrating through the JV region during spring due to differences in seasonal migration routes.

The foraging habitat model consisted of four components for each species: population or carrying capacity goal, duration of stay in the JV region, energy demand/individual, and energy supply/unit area.

$$\text{FORAGING HABITAT} = \text{ABUNDANCE} * \text{USE DAYS} * \text{ENERGY REQUIREMENT} * \text{FORAGE DENSITY}^{-1}$$

where, FORAGING HABITAT is the area (ha) needed to provide sufficient forage; ABUNDANCE is the estimated number of shorebirds using the JV region; USE DAYS is the estimated number of stopover days during migration; ENERGY REQUIREMENT is the estimated daily requirement of food (g) for each individual; and FORAGE DENSITY is the estimated amount of food (invertebrate) mass / m^2 of habitat.

Abundance. Calculating abundance of migrating shorebirds in the JV region is difficult due to general lack of survey data for most species. Current estimates and goals of migrating shorebirds were derived from AI scores and continental population estimates (Table 9).

Use days. Duration of stay for each individual was calculated by multiplying the estimated total number stops in the JV region by the days spent at each stop (Table 7), realizing stopover times for shorebirds can be highly variable depending on species,

season, weather, etc. Multiplying abundance by stopover duration provided an estimate of total use days for each species.

Energy requirement. A series of three calculations was used to determine the required amount of food (g) per day for each individual during migration staging: 1) energy to maintain body mass, 2) energy gained from 1 g (dry weight) of forage, and 3) energy demand of completing migration.

Energy requirement/individual was calculated for each species based on average body mass (Table 10) using the following equation from Kersten and Piersma (1987):

$$\text{EXISTENCE METABOLIC RATE (kj)} = 912 * (\text{BODY MASS [kg]})^{0.704}$$

The amount of energy gained from 1 g (dry weight) of forage was based on the amount of net energy content (NEC) from major food items and the ability to use that available energy, known as assimilation efficiency (AE; assumed to be 73% for invertebrates, Castro et al. 1989). For the purpose of this model the gross energy content (GEC) of forage was assumed to be 23.8 kj/g based on the energy provided by chironomids (Cummins and Wuycheck 1971). The major food items of many shorebird species are aquatic and terrestrial invertebrates, which have similar GEC to chironomids. Understanding of major food items for each shorebird species and energy provided by those items requires additional research. The model used the following equation to calculate the NEC:

$$\text{NEC} = \text{GEC} * \text{AE}$$

The value of maintenance invertebrate mass (MIM) needed to retain an individual's existing metabolic rate (EMR) was calculated as:

$$\text{MIM (g)} = \text{EMR} * \text{NEC}^{-1}$$

To complete migration in good condition an average sized shorebird needs to maintain its current body mass and increase biomass by about 1 g/day. Kersten and Piersma (1987) estimated 2 g of invertebrate forage were required to increase biomass by 1 g/day, a measure called deposition invertebrate mass (DIM). Finally the amount of forage energy requirement (ER) for each individual during migration was calculated as:

$$\text{ER (g)} = \text{MIM} + \text{DIM}$$

Forage density. We assumed an average of 2 g of forage/m^2 of habitat (Loesch et al. 2006), but recognized this value is highly variable based on food items chosen, habitat condition and location, and season.

Table 10. Shorebird foraging guilds and energy required for "existing metabolic rate" (EMR) to maintain body mass for each day during the migration period. EMR was calculated as a function of average body mass (Kersten and Piersma 1987); 1 kilojoule (kj) = 0.239 kilocalorie (kcal).

		Mass (g)		
Foraging habitats	Guild species[a]	Range	Average	EMR (kj)
Beach	Piping Plover	43-63	53	115
	Ruddy Turnstone	84-190	137	225
	Sanderling	40-100	70	140
Dry Mudflat / agriculture	Black-bellied Plover	175-220	180	273
	American Golden Plover	100-200	150	240
	Killdeer	50-100	50	111
	Baird's Sandpiper	30-40	38	91
	Buff-breasted Sandpiper	46-78	62	129
Wet Mudflat / moist soil plants	Semipalmated plover	40-50	47	106
	Solitary Sandpiper	31-65	48	108
	Spotted Sandpiper	29-75	43	100
	Red Knot	125-205	135	223
	Semipalmated Sandpiper	21-32	26	70
	Western Sandpiper	22-35	28	74
	Least Sandpiper	19-30	24	66
	White-rumped Sandpiper	40-60	46	104
	Pectoral Sandpiper	51-94	75	147
	Dunlin	48-64	56	120
	Wilson's Snipe	100-128	100	180
Shallow Water (<5 cm)	Greater Yellowlegs	153-179	160	251
	Lesser Yellowlegs	67-94	80	154
	Willet	200-300	237	331
	Stilt Sandpiper	50-70	60	126
	Short-billed Dowitcher	90-120	100	180
	Long-billed Dowitcher	90-131	110	193
Moderate Water (5-20 cm)	Black-necked Stilt	151-176	163	254
	American Avocet	275-350	310	400
	Whimbrel	310-493	370	453
	Hudsonian Godwit	246-358	270	363
	Marbled Godwit	285-454	358	443
	Wilson's Phalarope	50-75	60	126
	Red-necked Phalarope	30-45	35	86

[a]Black-necked Stilt and American Avocet are rare in the JV region and their energy needs are not included in the current bioenergetics model to calculate habitat objectives. Upland Sandpiper and American Woodcock are not included on this list as they are associated with more terrestrial cover types and habitat objectives for these species are included in the JV Landbird Habitat Conservation Strategy.

Allocation of Habitat Area

JV regional habitat objectives calculated for breeding and migrating shorebirds were stepped-down to smaller, more manageable units. For JV breeding focal species, habitat objectives were identified to the BCR scale and linked to BCR population objectives (Table 8). We further partitioned habitat objectives into State-BCR areas (polygons) by simply multiplying the area proportion of each BCR contained in each state. Stepping-down habitat objectives for migration guilds was more complicated. Habitat area was first parsed to a BCR level for each species using area importance (AI) score proportions (AI proportion = BCR AI / Total AI for all BCRs in JV region). These proportions were multiplied by total regional habitat objectives, resulting in BCR habitat objectives. The area was then stepped-down to State-BCR polygons by multiplying the remaining BCR habitat area by the portion of the BCR contained in each state. Although proportioning habitat based on area appears to deemphasize conservation of specific concentration sites, the potential for wider distribution of habitat across the landscape reflects the variable nature of shorebird migration patterns.

Maintenance and Protection

Shorebird habitat maintenance and protection objectives were identified by state and BCR (Table 11) based on the habitat needs to maintain current estimated shorebird populations in the region. Habitat protection can most effectively be targeted using maps generated for JV breeding focal species and migration guilds that identify current distributions (Appendix A and B, respectively). The cover type identified with the greatest area (98,250 ha) of maintenance need to protect current breeding populations was dry mudflat (Table 10, Appendix A). The relatively large area requirement is necessary to meet the predicted need of an equally large resident Killdeer population. However, this species will also use other community types with similar structure and openness for breeding. Research is needed to analyze factors limiting this population; large areas with high human use may be better suited for nesting Killdeer with minor modification. A more critical protection focus for shorebirds currently breeding in the JV region is the estimated 37,000 ha of wet meadow with shallow open water and 143 ha of strategically located beach (Table 11).

Maintenance and protection of migration habitat necessary to meet current population levels requires 12,400 ha of wet mudflat / moist soil plants, 5,100 ha of shallow-water wetland, 2,700 ha of dry mudflat / agriculture, 1,000 ha of moderate-water depth wetland, and 400 ha of beach (Table 11, Appendix B). Voids in migration habitat were identified using migration stopover information and a soil wetness rating to better target effort at a landscape scale (Figure 4). Potential stopover areas >50 km from current shorebird concentration sites received a higher priority rating in an attempt to create widespread shorebird habitat using a “stepping-stone” approach. The distance of 50 km was chosen as an average distance for shorebird flights between stops (Robert P. Russell, USFWS, personal communication). Maintaining and expanding traditional migration stopovers, plus protecting mechanisms that help assure quality foraging areas which coincide with migration chronology, is a conservation priority.

Table 11. Shorebird habitat maintenance and protection objectives (ha) by state and Bird Conservation Region (BCR) to meet carrying capacity for breeding (*B*) and migrating (*M*) population goals in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. Distribution of protection effort is based on JV focal species[a] breeding population estimates (*B*), migration area importance scores (*M*), and habitat models (Appendix A and B). Objectives are presented in hectares (1 ha = 2.47 acres).

State	BCR	Dry mudflat / agriculture		Wet meadow with open water	Wet mudflat / moist soil plants	Shallow water (<5 cm)	Moderate water (5-20 cm)	Beach	
Season >		*B*	*M*	*B*	*M*	*M*	*M*	*B*	*M*
Iowa	22	15,130	114	0	486	216	58	0	17
	23	833	18	421	78	36	9	0	3
	Total	15,963	132	421	564	252	67	0	20
Illinois	22	17,338	130	0	557	247	66	7	20
	23	389	8	197	36	17	4	0	1
	24	199	130	0	619	265	4	0	0
	Total	17,926	269	197	1,213	529	75	7	21
Indiana	22	6,273	47	0	202	90	24	0	7
	23	1,516	33	767	142	65	17	6	5
	24	369	242	0	1,149	491	8	0	0
	Total	8,159	322	767	1,493	646	49	6	12
Kansas	22 / Total	9,252	70	0	297	132	35	0	11
Michigan	12	695	167	9,734	880	324	59	85	33
	22	583	4	0	19	8	2	0	1
	23	6,768	147	3,422	634	291	77	11	24
	Total	8,046	319	13,156	1,533	623	138	96	58
Minnesota	12	656	158	9,189	831	305	56	0.4	32
	22	1,086	8	0	35	16	4	0	1
	23	3,002	65	1,518	281	129	34	0	10
	Total	4,745	231	10,707	1,147	450	94	0.4	43
Missouri	22 / Total	11,612	87	0	373	166	45	0	13
Nebraska	22 / Total	3,108	23	0	100	44	12	0	4
Ohio	13	230	497	832	2,216	897	239	1	69
	22	7,345	55	0	236	105	28	2	8
	28	57	357	0	1,673	611	97	0	63
	Total	7,633	910	832	4,125	1,612	364	3	141
Wisconsin	12	368	89	5,152	466	171	31	26	18
	22	209	2	0	7	3	1	0	0
	23	11,220	244	5,674	1,052	482	127	6	39
	Total	11,797	334	10,826	1,524	657	159	32	57
All States	12	1,720	414	24,075	2,176	800	147	111	83
	13	230	497	832	2,216	897	239	1	69
	22	71,943	541	0	2,313	1,027	276	9	82
	23	23,731	515	12,000	2,225	1,020	269	22	82
	24	568	372	0	1,768	756	12	0	0
	28	57	357	0	1,673	611	97	0	63
	Total	98,250	2,697	36,907	12,371	5,110	1,039	143	380

[a]JV breeding focal species included Killdeer (dry mudflat), Wilson's Snipe (seasonal herbaceous wetland), and Piping Plover (beach). Focal species representing migration guilds included American Golden Plover (dry mudflat), Dunlin (wet mudflat), Short-billed Dowitcher (shallow water), Wilson's Phalarope (moderate water), and Sanderling (beach).

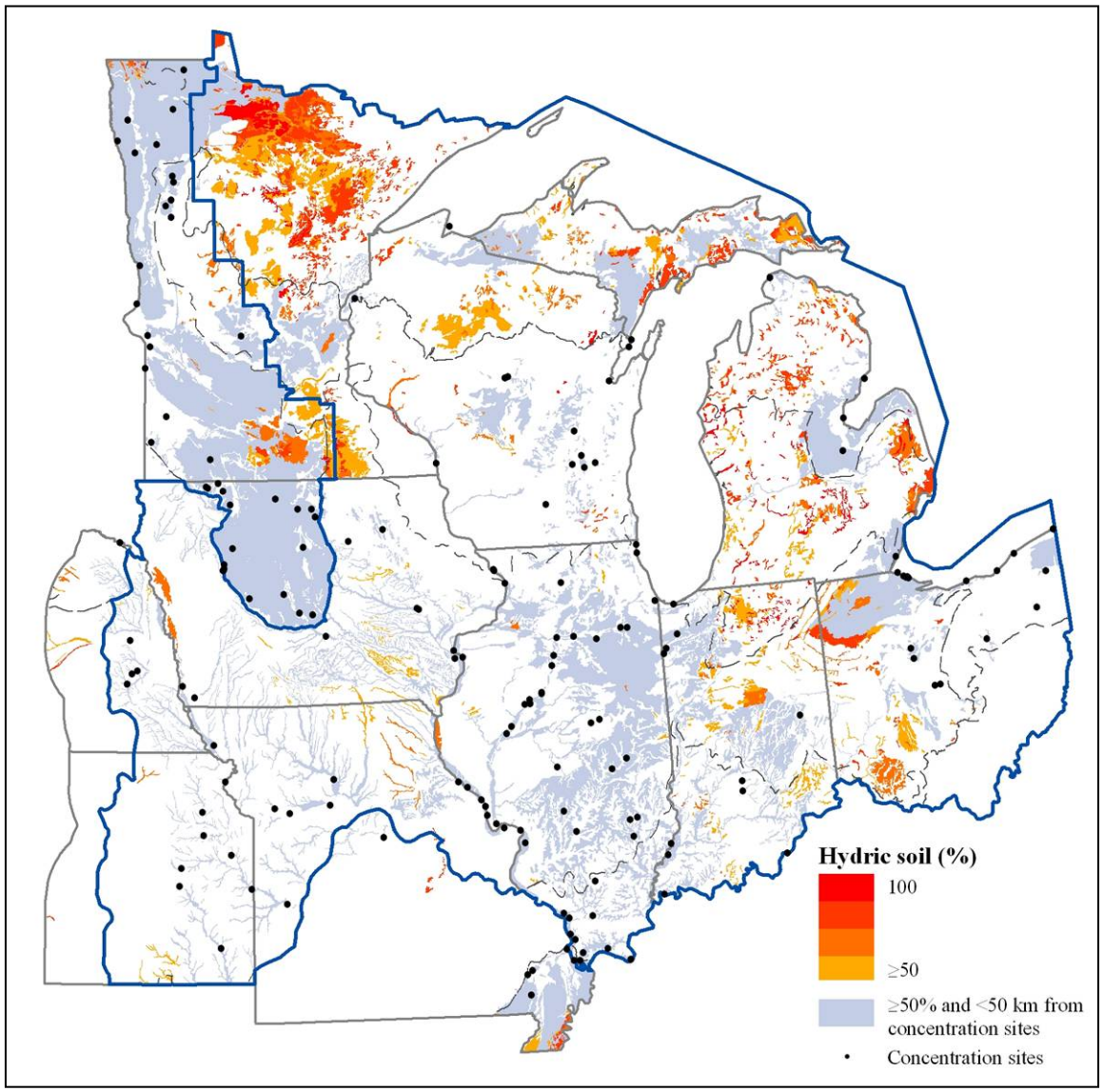

Figure 4. Documented migration staging sites important to shorebirds (dots) and areas with wetlands and greatest wetland restoration potential in the Upper Mississippi River and Great Lakes Joint Venture region. Restoration potential is based on the percent hydric soils (wet soils/previous wetland; STATSGO 1991) and relative importance of location. Wet-soil areas >50 km from known shorebird concentration sites received a higher priority rating (yellow-red) and wet sites <50 km from current staging areas were rated moderate priority (blue); white areas on the map have lower wetland restoration potential.

Some of the habitat area required to accommodate current migrant shorebird populations is already protected through ownership by government agencies or non-government conservation organizations. In the future, we plan to develop a digital GIS layer of all protected conservation lands in the JV region. With this information, we can overlay ownership patterns with priority bird conservation lands, determine the proportion and distribution currently protected, and develop a prioritized strategy for acquisition, conservation easement, and other means to safeguard existing shorebird habitat values.

Several documents are available providing information about shorebird habitat management, including management philosophy in the USSCP (Brown et al. 2001) and various management approaches to consider in the JV region (de Szalay et al. 2000). Specific shorebird habitat management techniques have been provided by Rundle and Fredrickson (1981), Eldridge (1992), and Helmers (1992 and 1993). Reports on managing wetlands for multiple wetland-bird groups are also available (Fredrickson and Taylor 1982, Laubhan and Fredrickson 1993).

Restoration and Enhancement

Shorebird habitat restoration and enhancement objectives for cover types were based on JV breeding focal species and migration-guild population deficits (Table 8 and 9) and associated habitat models (Appendix A and B). We assumed the most effective means to increase a population was to restore adequate habitat to accommodate the number of individuals represented by the deficit (i.e., increase landscape carrying capacity). Restoration implies working in human-influenced areas (e.g., agricultural fields), frequently converting an annual cover type to a perennial native-plant and open wetland community optimal for the target bird species. Management is generally more economical when restoration efforts restore cover suited for the site considering pre-settlement vegetation, current surrounding cover, and critical/irreversible adjustments to landscape hydrology. Likewise, enhancement work must consider landscape capabilities. Properly located enhancement effort that sets back succession, suppresses invasive plants, and provides a missing element to an otherwise suitable landscape typically results in the greatest return on investment.

Increasing the JV region carrying capacity to accommodate breeding shorebird population deficits will require an estimated restoration or enhancement of 141,250 ha of dry mudflat / agriculture and 43,200 ha of wet meadow with shallow open water (Table 12). The large requirement for dry mudflat is needed to accommodate a substantial deficit in the Killdeer population. Expansive breeding cover potentially exists in the region for this species, but it may be degraded by human activities such as the untimely plowing of agricultural fields. Regarding migration habitat objectives, restoration or enhancement activities to meet carrying capacity goals include about 11,600 ha of wet mudflat / moist soil plants, 1,600 ha of dry mudflat / agriculture, 1,600 ha of shallow water-depth wetland, 1,000 ha of beach, and 900 ha of moderate water-depth wetland. General locations to target wetland restoration actions have been identified across the JV region (Figure 4) using a combination of hydric (wetland) soils data and existing shorebird concentration areas. Details with more specific habitat requirements for enhancement planning are provided for each focal species and migration guild (Appendix A and B).

Table 12. Shorebird habitat restoration and enhancement objectives (ha) by state and Bird Conservation Region (BCR) to meet carrying capacity for breeding (*B*) and migrating (*M*) population goals in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. Distribution of restoration effort is based on JV focal species[a] breeding population deficits (*B*), migration population deficits (*M*), and habitat models (Appendix A and B). Habitat objectives are presented in hectares (1 ha = 2.47 acres).

State	BCR	Dry mudflat / agriculture		Wet meadow with open water	Wet mudflat / moist soil plants	Shallow water (<5 cm)	Moderate water (5-20 cm)	Beach
Season >		*B*	*M*	*B*	*M*	*M*	*M*	*M*
Iowa	22	21,751	67	0	443	69	52	46
	23	1,198	11	493	72	11	8	8
	Total	22,949	77	493	514	80	60	53
Illinois	22	24,927	77	0	507	79	59	52
	23	560	5	230	33	5	4	4
	24	286	81	0	625	90	5	0
	Total	25,772	163	230	1,166	174	68	56
Indiana	22	9,019	28	0	183	28	22	19
	23	2,180	19	897	130	21	15	14
	24	531	151	0	1,161	166	9	0
	Total	11,730	198	897	1,475	216	46	33
Kansas	22 / Total	13,301	41	0	271	42	32	28
Michigan	12	1,000	97	11,386	851	104	47	88
	22	838	3	0	17	3	2	2
	23	9,730	86	4,004	582	93	68	62
	Total	11,568	186	15,391	1,449	200	117	152
Minnesota	12	944	92	10,750	803	98	45	83
	22	1,562	5	0	32	5	4	3
	23	4,316	38	1,776	258	41	30	28
	Total	6,821	135	12,526	1,093	144	78	114
Missouri	22 / Total	16,694	51	0	340	53	40	35
Nebraska	22 / Total	4,468	14	0	91	14	11	9
Ohio	13	331	303	975	2,032	276	218	170
	22	10,560	32	0	215	33	25	22
	28	82	184	0	1,504	198	96	168
	Total	10,974	520	975	3,751	507	338	360
Wisconsin	12	529	52	6,027	450	55	25	47
	22	300	1	0	6	1	1	1
	23	16,131	143	6,638	964	154	112	103
	Total	16,960	196	12,665	1,421	210	138	150
All States	12	2,472	241	28,163	2,104	257	117	218
	13	331	303	975	2,032	276	218	170
	22	103,430	318	0	2,104	326	247	218
	23	34,117	303	14,040	2,039	326	238	218
	24	817	232	0	1,786	256	15	0
	28	82	184	0	1,504	198	96	168
	Total	141,250	1,581	43,178	11,570	1,640	929	991

[a]JV breeding focal species included Killdeer (dry mudflat), Wilson's Snipe (wet mudflat), and Piping Plover (beach). Focal species representing migration guilds included American Golden Plover (dry mudflat), Dunlin (wet mudflat), Short-billed Dowitcher (shallow water), Wilson's Phalarope (moderate water), and Sanderling (beach). Population "deficit" = population goal – current estimate.

Uplands surrounding restoration sites and existing wetlands should also be taken into consideration for management or restoration because some resident shorebird species rely on uplands for nesting and foraging. Furthermore, uplands with native plant communities retain or improve water quality in adjacent basins and create suitable landscape structure for many species of birds. Because habitat enhancement for one species may result in loss of site value for others, habitat treatments must consider all species potentially using a site. Species of greatest concern from various bird groups can be found in the other JV bird-group strategies.

Significant potential for net increase in shorebird habitat exists in the agriculturally dominated portion of the JV region where a majority of wetlands have been drained and river systems degraded. Continued development of "wildlife-friendly" agriculture programs included in the U.S. Farm Bill can positively impact shorebird abundance in the region by preserving and restoring wetlands plus adjoining upland cover. Effective shorebird conservation will require collaboration with those implementing federal agriculture programs, and shorebird habitat restoration and protection maps should be used to help target Farm Bill conservation efforts. County-level and site-specific planning will be enhanced with an understanding of area soil characteristics, particularly the location and extent of hydric soils (potential wetland restoration sites). These data are available for the entire JV region through the U.S. Department of Agriculture at www.soils.usda.gov/survey.

Although the rate of wetland destruction has slowed in recent years, losses still occur in the JV region (Ducks Unlimited 2005), particularly in areas dominated by agriculture and human development. These proposed shorebird habitat restoration and enhancement objectives are "net area" estimates. In other words, loss of existing shorebird habitat during the strategy implementation period will have to be added to plan restoration objectives. Likewise, degradation of existing shorebird habitat must be considered in the habitat accounting process.

Monitoring and Research

Monitoring and research effort in bird conservation are often closely related. In this plan monitoring is designed and implemented to measure progress toward meeting population goals and habitat objectives (i.e., performance measurement). Research, on the other hand, is designed to answer specific questions that arise from uncertainties or assumptions inherent in conservation planning and implementation. Explicit monitoring and research objectives identified here were considered highest priority for strategy achievement and to build knowledge for the next plan iteration.

Monitoring Progress Toward Population Goals

Our measures of regional abundance are crude for most shorebird species, but we assume they provide an adequate starting point for goal setting and determining monitoring needs. The process of stepping down population estimates and goals to the JV region and BCR levels helped clarify our responsibility in fulfilling continental

conservation targets. However, an effective monitoring strategy is required to measure progress toward meeting population and habitat objectives at the regional scale.

Current surveys include species-specific monitoring of breeding populations, such as the Woodcock Singing-ground Survey, to more general monitoring programs like the International Shorebird Survey (ISS) and Breeding Bird Survey (BBS). These long term programs collectively provide information on distribution, densities, and population trends. The Woodcock survey is a systematic effort producing relatively high quality data for this species, at least at regional and continental levels. Due to the low density of survey routes, however, these data are less useful at smaller scales. The ISS may be used for peak migration staging numbers, migration timing, and responses to management actions at specific sites. It cannot be used to estimate population trends because survey design is not systematic or randomized and is therefore subject to large observer bias. The BBS is more statistically rigorous but is conducted from roadsides. It is useful for inland and upland species like Killdeer and Upland Sandpiper, but detection and route locations are inadequate for other shorebirds that occur in the Great Lakes coastal zone or remote wetland sites.

Monitoring efforts will need to be improved or expanded for key species not adequately captured with these techniques. For example, the BBS could potentially provide more insight to shorebirds if done earlier in the season. The ISS could be adjusted to include stratified random samples and a standardized sampling framework. Because shorebird habitat quality can be highly unpredictable and change yearly depending on climatic conditions, new or expanded monitoring effort must be carefully planned using appropriate sampling design.

Monitoring Objectives

By 2012, a monitoring program will be developed to validate and improve estimates of breeding and migrating shorebird populations and trends in the JV region, with emphasis on JV focal species. This effort will include estimates of population size, migration timing, duration of stay, and use days for migrating shorebirds, plus status and trends of breeding species.

Specific short-term ($\leq$ 5 years) survey needs have been identified by shorebird group to help fill more immediate information gaps.

- *Coastal migrants* -- Sanderling, Dunlin, Piping Plover, Ruddy Turnstone, Semipalmated Sandpiper, and Black-bellied Plover,. Surveys should be conducted during autumn and spring via a stratified random sampling approach perhaps using a network of volunteers.
- *Interior-migrating plovers* -- American Golden-Plover, Black-bellied Plover, and Killdeer. Surveys should be conducted during spring migration only and focus on interior wetlands and flooded agricultural fields. Surveys should be conducted on stratified random plots or roadside transects within areas of Illinois, Indiana, and Ohio known historically to be staging areas.

- *Other interior-migrating shorebirds* -- Wilson's and Red-necked Phalarope, Pectoral Sandpipers, and Greater and Lesser Yellowlegs. Surveys should be conducted during spring migration and focus on interior wetlands, coastal marshes and estuaries using cluster sampling or a stratified random plot design.

Specific long-term survey needs include annual surveys of two key breeding species.

- *Upland Sandpiper* -- Establish a regional breeding population survey, stratified by state Breeding Bird Atlas records.
- *Wilson's Snipe* -- Establish a singing-ground survey similar to or coincident with the Woodcock survey in the northern portion of JV region.

Other monitoring resources useful in population assessment include state Breeding Bird Atlases. This information, in combination with BBS data, can be used to evaluate state-level breeding population estimates, distribution, status, and long-term trends for Killdeer, Spotted Sandpiper, Wilson's Phalarope, American Woodcock, and Wilson's Snipe. Regarding migration, limited opportunity currently exists to obtain meaningful population trend estimates in interior habitats due to annual variation in weather and habitat conditions. Until improvements to the ISS or other migration-staging surveys are completed, migrant population estimates for the JV region will be updated based on changes in continental breeding population estimates.

Finally, in addition to documenting area use, JV partners must strive to evaluate habitat quality as it relates to productivity and survival (VanHorne 1983). Smaller scale monitoring projects that target JV focal species may be necessary to better understand the effect of local conservation efforts on the fitness of shorebirds. Baseline information on vital rates (breeders) and physical condition (migrants and breeders) must be determined and a monitoring protocol eventually established.

Research Needs

Two kinds of research have been identified to assure evaluation and an adaptive management approach to this strategy. Hypothesis-driven research will be used to test assumptions inherent in formulating population goals and translating these into habitat objectives. Evaluative research will be conducted to better understanding how and why implementation of habitat conservation strategies achieve or fail to achieve their intended results. There is a degree of overlap which complements these forms of research, but the former is typically addressed at larger spatial and longer temporal scales, while the latter is often best addressed at more sub-regional or local (e.g. project-specific) scales. The specific research objectives stated here should emphasize JV focal species unless indicated otherwise.

Hypothesis-driven Research Objectives

Wildlife management often requires professionals to make important decisions with incomplete knowledge, and this involves making assumptions. There were many assumptions associated with development of population and habitat objectives, especially

when developing biological models used to quantify habitat objectives for JV breeding focal species and migration guilds. Decision model parameters and associated assumptions are stated explicitly (Appendix A and B) so they may be tested and adjusted when new information becomes available.

By 2012, research will be developed to build or refine biological models that relate breeding shorebird population responses to landscape/habitat changes. This requires identification and understanding of how habitat factors influence vital rates (e.g., survival, and nesting/fledging success) plus knowledge of how vital rates influence population growth and sustainability.

Nesting success and fledging rates for shorebirds breeding in the JV region must be determined, and they may be measured indirectly by analyzing age ratios. Habitat characteristics and limiting factors used in models must be evaluated. In the short-term, they too may be measured indirectly through analysis of body mass, nutrition, and physiological condition. In addition, population viability analyses should also be conducted for breeding JV focal species.

By 2012, research will be developed to improve bioenergetics models used to evaluate landscape/habitat carrying capacity for migrating shorebirds including analyses of energetic carry capacity, and habitat characteristics important to shorebird abundance and population dynamics (e.g., distribution and abundance of shorebirds in relation to indices like wetland abundance and landscape composition).

Evaluation of carrying capacity should include 1) comparison of food abundance and availability to foraging shorebirds in agricultural land, shoreline, and wetland habitats, 2) quantification of energetic carrying capacity -- total area of cover type vs. wetted perimeter, 3) renewal rates of energetic density, emphasizing invertebrate food resources, and 4) diet composition during autumn and spring by foraging guild and energy content of diet items.

Assumptions made for fall and spring migration behavior and associated calculations of carrying capacity must also be evaluated, including 1) estimated stopover duration and turnover rates, 2) number of stops in the JV region and distance between stops to analyze refueling rates and migration energetics (technology improvements may soon make telemetry a viable option for this research), and 3) migration routes and corridors (e.g., extend the Biogeographical Profile of Shorebird Migration in Midcontinental North America to the JV region; see Skagen et al. 1999).

Evaluative Research Objectives

JV focal species were selected to represent guilds or the needs and habitats used by suites of associated shorebirds. These were largely species of high conservation concern that also had at least some life history information useful in regional conservation decisions. However, because limiting factors are not well understood for most shorebirds, population response to management is difficult to predict. Moreover,

population response by a JV focal species may or may not be replicated by shorebirds using similar habitats. Thus the assumption a full suite of species will respond similarly to habitat conservation must be evaluated.

By 2012, a combined monitoring and research protocol will be developed to better track priority migrating shorebirds (JV focal species) in order to 1) identify primary and secondary use areas, 2) characteristics that influence habitat suitability, 3) bird health (e.g., body condition) as related to nutrition and habitat suitability, and 4) change in habitat abundance.

In combination with population inventory, quantity and quality of wetland and adjacent upland habitats important to shorebirds will be evaluated, Effort should include 1) updating the National Wetland Inventory or similar spatial cover-type data needed to assess habitat availability, plus create or identify sources for soil moisture, hydric soils, and elevation data to quantify ephemeral wetlands under wet, average, and dry water conditions. This information can provide a foundation for annual JV administrative tracking of accomplishments and quantification of habitat change (i.e., losses in the face of restorations). Evaluating change in wetland abundance should also include development of criteria and data layers to support wetland restoration planning: high resolution elevation data, surface/subsurface soils, geology, and topography. Other useful sources of information may be historic wetland and drainage district maps.

Because many public wetland areas are currently managed to benefit migrating dabbling ducks, compatibility in water-level and vegetation management for waterfowl and shorebirds should be examined. Specifically, shorebird migration phenology must be determined in relation to seasonal water-level fluctuations and management regimes. In addition, the relationship between autumn vegetative coverage and availability of invertebrate food resources to migrants in spring and fall should be determined.

The relative distribution of migrating shorebirds to existing habitat complexes, including coastal concentration areas and migration corridors, must be determined. This analysis should include testing the assumption habitat restoration or management sites away from current concentration sites will be used. Finally, evaluative research should also assess impacts of potential non-habitat limiting factors such as disturbance (e.g., human activity and development on beaches), the effect of contaminants on vital rates and food abundance, placement of communication and wind power development, light pollution, and diseases.

Measuring Performance

The number of shorebirds occupying the JV region in any given year is not solely dependent on habitat availability and condition within the region. During years with poor breeding habitat and reproduction, fewer migrant shorebirds may be found staging even when habitat availability and condition are above average. Therefore, regional shorebird goals are best viewed as guidelines for defining habitat objectives, and they may be an inappropriate short-term performance metric.

The JV has supported research to increase knowledge of shorebird ecology in the region and is committed to improving understanding of management effectiveness. Activities of JV partners implementing this strategy are expected to increase resources and landscape carrying capacity for shorebirds and, in turn, directly and indirectly impact specific vital rates (e.g., survival, nest success, recruitment). Thus JV performance can be measured by the net change in resources available for shorebirds within the region and in some instances the impact those changes have on vital rates. The abundance and distribution of shorebirds may provide another direct measure of performance. However, uncontrollable environmental factors must be considered and accounted for when using this measure.

Net Change in Resources

Resource availability within the JV region will be maintained by protecting existing quality habitat and increased by restoring and enhancing habitat as prescribed. Habitat conservation will be tracked by JV partners and JV staff, providing the estimated area (by cover type) and general location of protected and restored habitat. Concurrent habitat loss also must be estimated to determine net habitat change. Remote sensing technology typically provides the best means for landscape analysis. However, remotely identifying the quantity of shorebird habitat in a given year will continue to be a challenge due its dynamic nature and the ability of remote sensors to accurately depict shallow water and mudflat zones. Model-based estimates of habitat gains and losses may have to be used to estimate change outside of JV partner efforts.

Meaningful increases in resource availability due to “habitat enhancement” will also be difficult to document and will require estimates of average productivity prior to and after enhancement of key shorebird cover types. A study is currently under way to determine average wetland food resources available for waterfowl and shorebirds during spring migration across the region (T. Yerkes, Ducks Unlimited; M. Eichholz, Southern Illinois University; and R. Gates, Ohio State University). Future research using similar techniques can provide an estimate of change in habitat quality after substantial implementation activities have occurred.

Measuring performance for breeding shorebirds might include a comparison of bird demographics inside and outside JV focus areas. JV partners have identified primary and secondary focus areas to deliver conservation (USFWS 1998), and survey data can be segmented into “high partner influence” vs. “low effort/no influence” (control) areas. Assuming similar environmental influences on neighboring units, shorebird population growth or density should be greater in high influence zones. Portions of the JV region without local-scale breeding surveys may find trend data available through the BBS useful as a coarse measure of population change for breeding species in high vs. low influence areas.

Vital Rates as a Measure

The impact of JV activities on breeding shorebird populations may be measured through temporal changes in vital rates, including nest success, brood survival, recruitment, and body weights. Initial research is needed to establish baseline information, with subsequent evaluation to determine if implementation activities are increasing vital rates within the JV region.

When developing this strategy we assumed nutrient acquisition was the most limiting factor for shorebirds outside the breeding season, and nutrients acquired during migration influence both annual survival and productivity. If this assumption is correct, then comparisons between nutrient reserve dynamics of migratory shorebirds prior to and after JV implementation activities may be useful in measuring desired outcomes (i.e., higher nutrient reserves reflect greater reproductive fitness and survival). Obviously many environmental factors, such as reserves acquired outside the JV region, temperatures, wind speed, and wind direction during migration, will need to be accounted for in this assessment.

Adaptive Management

The term "adaptive management" implies different themes to different people, often depending on their background and the conservation arena within which they work (i.e., research, management, administration). JV partners have used it in a broad and inclusive sense to describe the use of cyclic planning, implementation, and evaluation to improve management performance. Adaptive Resource Management (ARM; Lancia et al. 1996) provides an explicit framework that ensures monitoring data are relevant and useful in making management decisions and providing a foundation to improve future decision-making through an iterative cycle of biological prediction and testing.

Although ARM does not need to be complex, it does require commitment. Critical preconditions for successful ARM include stakeholder consensus regarding objectives and a commitment to manage adaptively. ARM can increase JV partner effectiveness and efficiency by improving capacity in all three iterative steps: planning, implementation, and evaluation. Planning, at all levels, is based on a set of assumptions, often embodied in implicit or explicit models like those used in the JV breeding focal species and guild accounts (Appendix A and B). These models predict how shorebirds should respond to habitat changes and management actions (i.e., implementation of breeding habitat prescriptions should eliminate breeding population deficits). Strategic planning incorporates this biological foundation, with a set of assumptions, in selecting priority areas and specific habitat objectives required to achieve population goals. While the challenges are many, application of ARM concepts will be a priority in the implementation and refinement of JV shorebird conservation.

Timetable and Coordination

This Shorebird Habitat Conservation Strategy is part of a broad all-bird JV plan scheduled to be implemented between 2007 and 2022. Although the general all-bird plan has a 15-year time horizon, the more technical bird-group conservation strategies will be updated more frequently as part of the plan-implement-evaluate cycle of adaptive management. Shorebird habitat objectives are stated explicitly by State and BCR units (Table 11 and 12) to provide JV partners guidance in shorebird management decisions linked to the continental shorebird conservation plan. Planning assumptions, monitoring, and research needs also are identified. Knowledge gained through management actions and completion of research, monitoring, and testing of habitat models and assumptions will dictate the intervals for refinement of this shorebird habitat strategy.

Strategy development and refinement will continue to be the responsibility of the JV Technical Committee. Plan approval and implementation remain the responsibility of the JV Management Board and their associated conservation organizations and state and local partners. Information sharing, outreach, and tracking of accomplishments will be coordinated through the JV Central Office (Minneapolis, MN) whereas GIS spatial data, habitat model development, and collaboration with research and science partners will be the responsibility of the JV Science Office (East Lansing, MI). JV partners have a proven record of achievement following the 1998 JV Implementation Plan, and using the habitat objectives, decision-support tools, and research and monitoring recommendations provided in this strategy, partners should continue to increase conservation efficiency and effectiveness for shorebirds as well as other bird groups.

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Appendix A. Breeding shorebird species accounts with population and cover type information used for habitat planning in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. JV focal species were used to develop habitat conservation objectives and represent primary cover types. Population goals and estimates are measured in individual birds. The equation below can be used to calculate annual population change required for goal achievement during the 15-year plan time period. Species accounts for other (currently non-focal) shorebirds will be added to this living document to increase information content over time; thus far Spotted Sandpiper and Wilson's Phalarope have been completed.

JV Focal Species (account primary author)	**Last revised**
Piping Plover (Greg Soulliere)	August 2006
Killdeer (Brad Potter)	May 2006
Wilson's Snipe (Brad Potter)	May 2006

Other breeding species accounts

Spotted Sandpiper (Brad Potter)	May 2006
Wilson's Phalarope (Greg Soulliere)	June 2006

Habitat conservation objectives for the largely terrestrial Upland Sandpiper and American Woodcock will be included in the Joint Venture Landbird Habitat Conservation Strategy. However, species accounts for both are also included here.

Upland Sandpiper (Brad Potter)	May 2006
American Woodcock (Brad Potter)	May 2006

Calculating Population Growth

$$FP = CP\ (1 + r)^t$$

$$r = \sqrt[t]{FP/CP} - 1$$

FP = Future population (goal)
CP = Current population
r = rate of increase (growth / year)
t = time periods (years)

Piping Plover (*Charadrius melodus*)
Species Account for Habitat Planning

Joint Venture population deficit based on Great Lakes Piping Plover Recovery Plan	
Population goal (150 pairs)	300
Population estimate (58 pairs)	116
Deficit	184

Species range map: Cornell Lab of Ornithology

Breeding habitat requirements

Community types: Open, sparsely vegetated Great Lakes beach with limited human disturbance and predation. Optimal areas include wide unforested, unsaturated sand beach with areas of cobble (1-4 cm stones)/debris, vegetation, and dunes along open coastline bays, islands, and sand spits. Nesting may occur behind (inland from) dunes, often adjacent to a river or ephemeral pond that functions as an alternate feeding site for chicks.

Timing: Arrive in mid to late April, with nests initiated by mid to late May. Females lay 3-4 eggs in 6-8 days, both sexes incubate about 28 days. Eggs hatch from late May to late July and precocial chicks fledge about 25 days later (mostly late July – early August).

Area / distance: Beach characteristics include: width >7 m, shoreline length >0.4 km, dune area ≥2 ha, some cobble cover (0-45%) or patches of debris, ≤50% vegetation, and >35 m from forest edge. Mean home range is 35 ha.

Limiting factors: Undisturbed beach nesting and brood rearing sites are assumed to limit population. Habitat alteration (erosion control, development), off-road vehicles, human foot traffic and pets, and natural predators influence nest success and brood survival.

Population monitoring

Current survey effort: Breeding sites in Michigan and Wisconsin are surveyed annually and nests are monitored in an effort coordinated by the U.S. FWS. The International Piping Plover Census surveys current and historic breeding and wintering areas range-wide at least once every 5 years.

Recommended monitoring: Continuation of current annual population monitoring, with periodic range-wide inventories.

Research to assist planning

Current and ongoing projects: A population viability analysis is being completed; adults and chicks are leg-banded annually.

Research needs: Factors affecting over-winter survival and an assessment of migration habitat needs and availability. A genetic analysis of the population is needed.

Biological model results

Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: A biological model was not developed because breeding and migration habitat for this species are especially dynamic and resolution of digital spatial data is inadequate. Critical habitat units have been defined in the Federal Register (U.S. Fish and Wildlife Service 2001) and are considered essential to the recovery effort. The JV region contains 33 of 37 critical habitat units, totaling of 205 km of beach shoreline. At $\geq$7 m wide, this equates to $\geq$144 ha of critical beach area (1,435,000 m^2 = 205,000 m * 7 m).

Recommendations

Habitat actions: Areas designated as "critical habitat" have been identified for Great Lakes Piping Plover. Specific areas for beach nesting within critical habitat units change with Great Lakes water levels and the dynamic nature of beach/dune systems; these processes are outside the control of managers. However, habitat managers should focus on the following priorities: 1) protection of designated critical habitat units of greatest importance to Piping Plovers through acquisition and conservation easement, 2) restoration of processes to retain optimal habitat on altered shoreline along with removal of invasive species, 3) limit human disturbance in areas used by Piping Plovers, and 4) recognition of species needs when planning habitat conservation for other bird species. The current volunteer effort, coordinated by the U.S. FWS, to patrol nesting areas and deter excessive human and pet activity during nesting and brood rearing appears to be an effective management action.

Monitoring and performance: The Michigan and Wisconsin survey effort coordinated by the U.S. FWS should detect population change adequate to measure management performance. A 100% population increase over 15 years requires an average annual increase of 5%.

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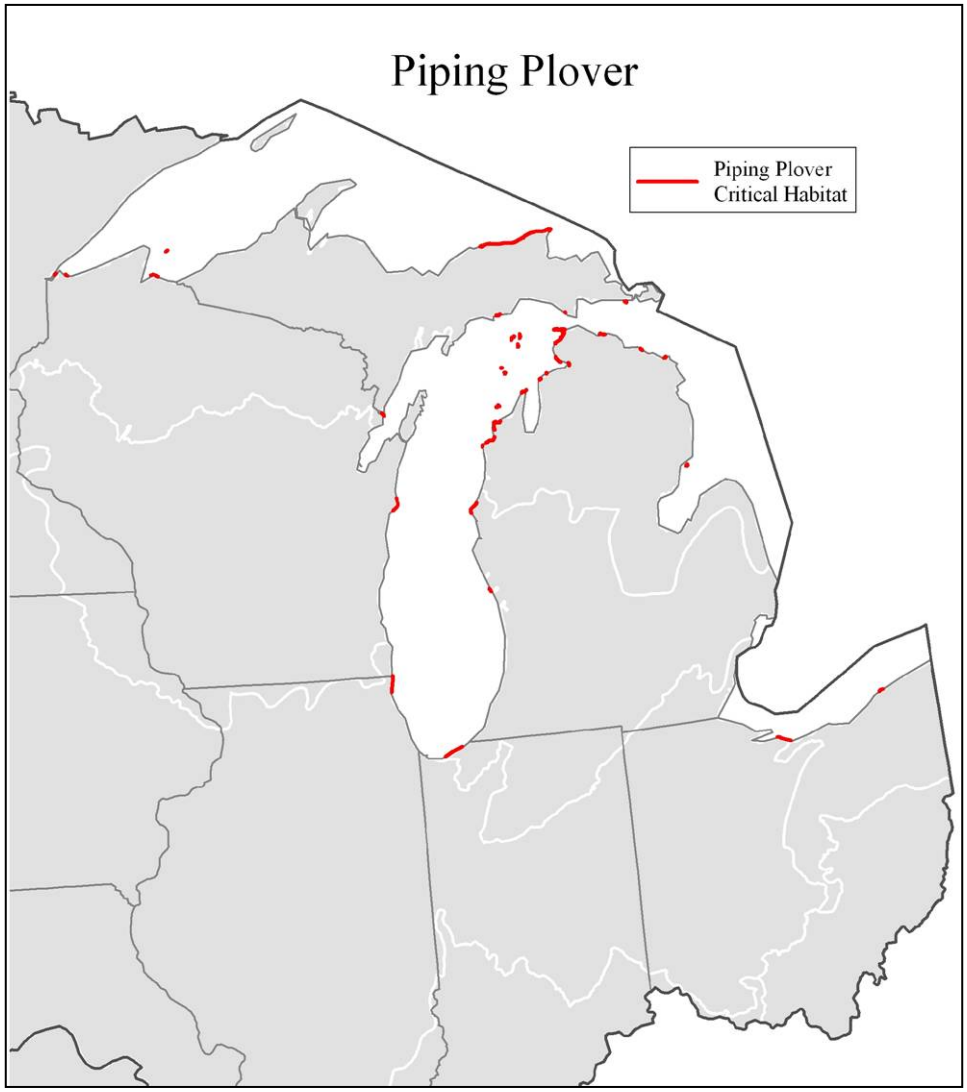
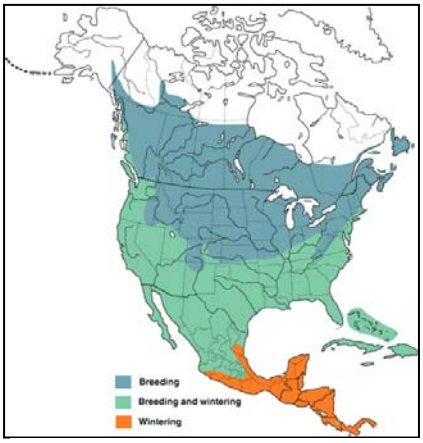
Distribution

Critical habitat areas for breeding were defined in the Federal Register (U.S. Fish and Wildlife Service 2001). These areas were derived from research, historic records, habitat surveys, expert opinion, and nest location data since 1984.



Killdeer (*Charadrius vociferus*)
Species Account for Habitat Planning

Joint Venture population deficit based on combined USSCP, BBS, and expert opinion	
Breeding population goal	480,000
Population estimate	196,500
Deficit	283,500



Species range map: Cornell Lab of Ornithology

Breeding habitat requirements
Community types: Naturally occurring open areas such as mudflats, sandbars, and heavily grazed short-grass pasture. Also uses many anthropogenic locations like cultivated fields, athletic fields, airports, golf courses, and graveled parking lots and roof tops. Nests are typically placed on a raised area compared to the surrounding terrain.
Timing: Nests April to June, with peak nesting in May. Normally 4 eggs are incubated 22 - 28 days, and peak hatch is early June.
Area / distance: Apparently territorial, with home range about 6 ha but smaller during nesting. Densities of breeding Killdeer vary greatly depending on cover type and nesting substrate. For purposes of modeling a density of 1 pair/ha of optimal habitat will be used.
Limiting factors: Killdeer are assumed to be limited by the amount of naturally occurring breeding habitat. Sites created by human-modified conditions are abundant but have greater predation and destruction of nests.

Population monitoring
Current survey effort: N. A. Breeding Bird Survey (BBS).
Recommended monitoring: Population should continue to be monitored with the BBS.

Research to assist planning
Current and ongoing projects: None identified in the JV region.
Research needs: None identified in the JV region.

Biological model results
Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: $H = d/2 * h$ $141{,}250 = 283{,}500/2 * 1$

H = minimum new habitat area required to eliminate deficit (ha)
d = regional population deficit (birds)
h = minimum habitat area required for a pair of birds (ha)

Recommendations

Habitat actions: Maintain existing high quality habitat areas and add (restore / create) >141,250 ha of breeding habitat at multiple sites within current Killdeer breeding range. Restoration and enhancement areas should be maintained with short vegetation height (<1 cm) and disturbance should be minimal during the nesting season. The estimated area of habitat needed to accommodate current breeding populations is 98,250 ha (98,250 = 196,500 / 2 * 1).

Monitoring and performance: There is a need to improve population monitoring to better measure population change and habitat management performance. However, the International Shorebird Survey (ISS) and BBS may be adequate to measure trends for breeding Killdeer. Eliminating the current population deficit requires a 60% population increase or an average annual increase of 3.4% over a 15 year period.

References

Brown, S., C. Hickey, B. Harrington, and R. Gill eds. 2001. United States shorebird conservation plan, 2nd ed. Manomet Center for Conservation Sciences. Manomet, MA. 60pp.

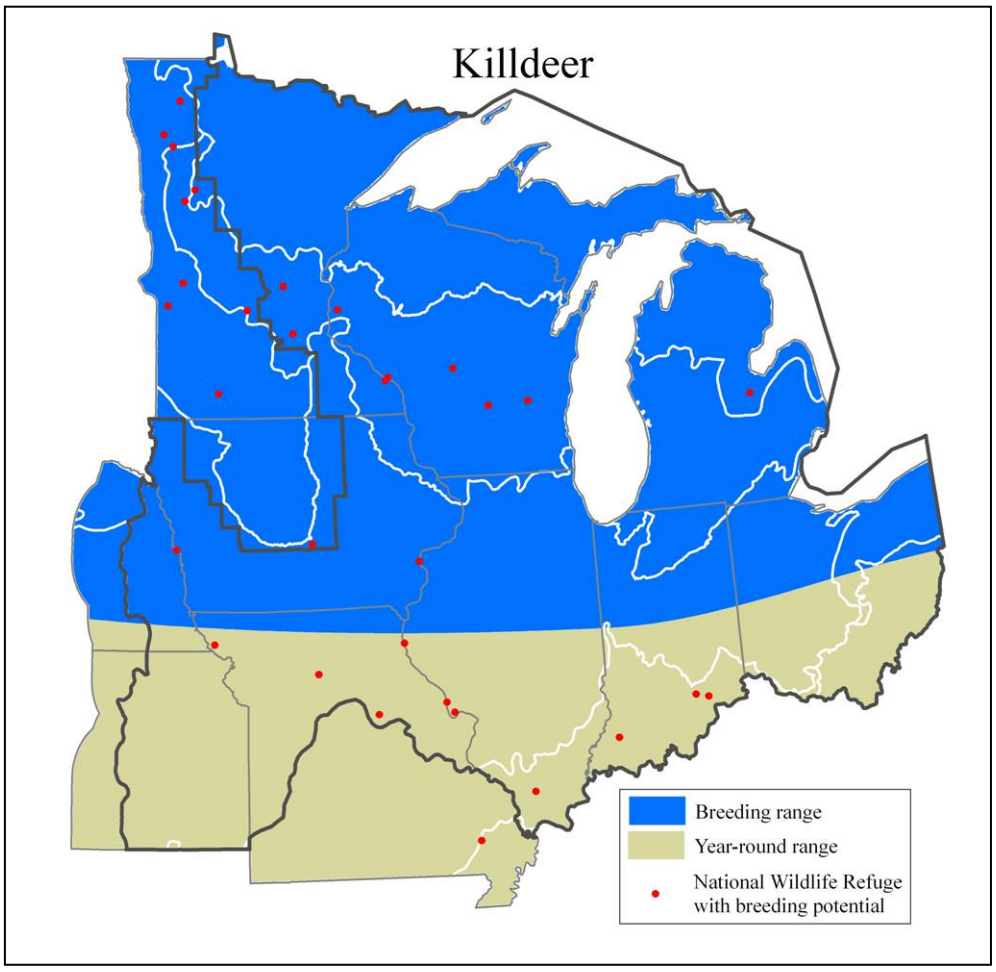
Jackson, B. J. S., and J. A. Jackson. 2000. Killdeer (*Charadrius vociferus*). *In* The Birds of North America, No. 517 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Ridgely, R. S., T. F. Allnutt, T. Brooks, D. K. McNicol, D. W. Mehlman, B. E. Young, and J. R. Zook. 2005. Digital Distribution Maps of the Birds of the Western Hemisphere, version 2.1. NatureServe, Arlington, Virginia, USA.

Russell, R. P. 2006. Shorebird management priorities for national wildlife refuge system lands in Region 3. USFWS, Division of Migratory Birds. 9pp.

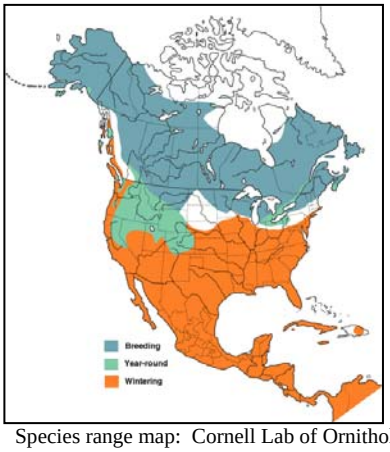
Distribution

Due to limited information about breeding shorebirds in the JV region, breeding distribution is based on the National Wildlife Refuge (NWR) System lands in Region 3 (Appendix E) and breeding range maps from NatureServe. NWR System lands that currently have breeding or potential for breeding populations are identified as red dots.



Wilson's Snipe (*Gallinago delicata*)
Species Account for Habitat Planning

Joint Venture population deficit based on combined USSCP, BBS, and expert opinion	
Breeding population goal	11,000
Population estimate	5,000
Deficit	6,000



Species range map: Cornell Lab of Ornithology

Breeding habitat requirements
Community types: Uses sedge bogs, fens, and willow and alder swamps, but occurs in marshy fringes of ponds and river floodplains with mixed mud flats. Areas with clumps of herbaceous vegetation on highly organic soil are preferred. Sites with tall dense vegetation such as cattail and reed are avoided.
Timing: Nests late March to May, normally 4 eggs are incubated 18 - 20 days, and peak hatch is late May.
Area / distance: Often nests near water on a hummock or clump of grass. Nesting densities may differ among cover types with an average of 6.7 pairs/100 ha (sedge bogs = 5.5 pairs/100 ha, fens = 5.3 pairs/100 ha, and swamps = 9.5 pairs/100 ha).
Limiting factors: Species requires clumped vegetation on highly organic soils for breeding. Many wetlands are assumed unsuitable because of dense vegetation (successional stage).

Population monitoring
Current survey effort: BBS, but it may be insufficient for this wetland species.
Recommended monitoring: Singing (winnowing)-ground survey similar to or coincident with Woodcock surveys should be conducted in northern portion of JV region (above line from northeastern Ohio to Chicago IL and Minneapolis MN). Detections will be recorded during secretive marshbird surveys on national wildlife refuges, and this species should be included in any national marshbird survey effort.

Research to assist planning
Current and ongoing projects: None identified in the JV region.
Research needs: None identified in the JV region.

Biological model results
Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: $H = d/2 * h$ $\quad 45{,}000 = 6{,}000/2 * 15$

H = minimum new habitat area required to eliminate deficit (ha)
d = regional population deficit (birds)
h = minimum habitat area required for 1 pair (ha)

Recommendations

Habitat actions: Maintain (protect) existing habitat area and quality, and add (restore / enhance) ≥45,000 ha of breeding habitat (see requirements above) at multiple sites within current breeding range. Management of wetlands should encourage early serial stages, setting back vegetation too dense or tall for breeding. The estimated area of habitat needed to accommodate current breeding populations is 37,500 ha (37,500 = 5,000/2 * 15).

Monitoring and performance: There is a need to improve population monitoring to better measure population change and habitat management performance. However, the International Shorebird Survey (ISS) and BBS may be adequate to measure trends for breeding populations. Eliminating the current population deficit requires a >100% population increase or an average annual increase of 5% over a 15 year period.

References

Brown, S., C. Hickey, B. Harrington, and R. Gill eds. 2001. United States shorebird conservation plan, 2nd ed. Manomet Center for Conservation Sciences. Manomet, MA. 60pp.

Mueller, H. (2005). Wilson's Snipe (*Gallinago delicata*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Wilsons_Snipe/.

Ridgely, R. S., T. F. Allnutt, T. Brooks, D. K. McNicol, D. W. Mehlman, B. E. Young, and J. R. Zook. 2005. Digital Distribution Maps of the Birds of the Western Hemisphere, version 2.1. NatureServe, Arlington, Virginia, USA.

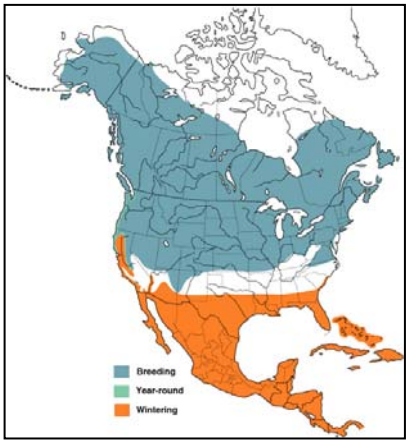
Russell, R. P. 2006. Shorebird management priorities for national wildlife refuge system lands in Region 3. USFWS, Division of Migratory Birds. 9pp.

Distribution

Due to limited information about breeding shorebirds in the region, breeding distribution is based on the National Wildlife Refuge (NWR) System lands in Region 3 (Appendix E) and breeding range maps from NatureServe. NWR System lands that currently have breeding or potential for breeding populations are identified as red dots.

Spotted Sandpiper (*Actitus macularia*)
Species Account for Habitat Planning

Joint Venture population deficit based on combined USSCP, BBS, and expert opinion	
Breeding population goal	800
Population estimate	800
Deficit	0



Species range map: Cornell Lab of Ornithology

Breeding habitat requirements
Community types: Various cover is used including shoreline, grassland, and even forested areas. Territories always contain a nearby lake or river, semi-open cover for nesting, and patches of dense vegetation for brood rearing.
Timing: Nests May to June, with peak nesting in late May, normally 4 eggs are incubated 19 - 22 days, and peak hatch is in June.
Area / distance: Can breed in very high densities. Some sites have >10 pairs/ha. A density of around 1 pair/ha is more common.
Limiting factors: Breeding Spotted Sandpipers are at the population goal level. Continued habitat loss along the Great Lakes shoreline and inland lakes due to development may result in future declines in the region.

Population monitoring
Current survey effort: N.A. Breeding Bird Survey (BBS).
Recommended monitoring: BBS and International Shorebird Survey (ISS) but modifications are necessary to improve statistical design.

Research to assist planning
Current and ongoing projects: None identified in the JV region.
Research needs: None identified in the JV region.

Biological model results
Objective: There is currently no population deficit for Spotted Sandpipers. Habitat objectives for other wetland associated species should be beneficial to this species.
Calculation: No deficit identified for JV region.

Recommendations
Habitat actions: Maintain existing habitat area. Habitat work for other wetland dependent species should help maintain or increase breeding populations of Spotted Sandpipers.
Monitoring and performance: None recommended.

References

Brown, S., C. Hickey, B. Harrington, and R. Gill eds. 2001. United States shorebird conservation plan, 2nd ed. Manomet Center for Conservation Sciences. Manomet, MA. 60pp.

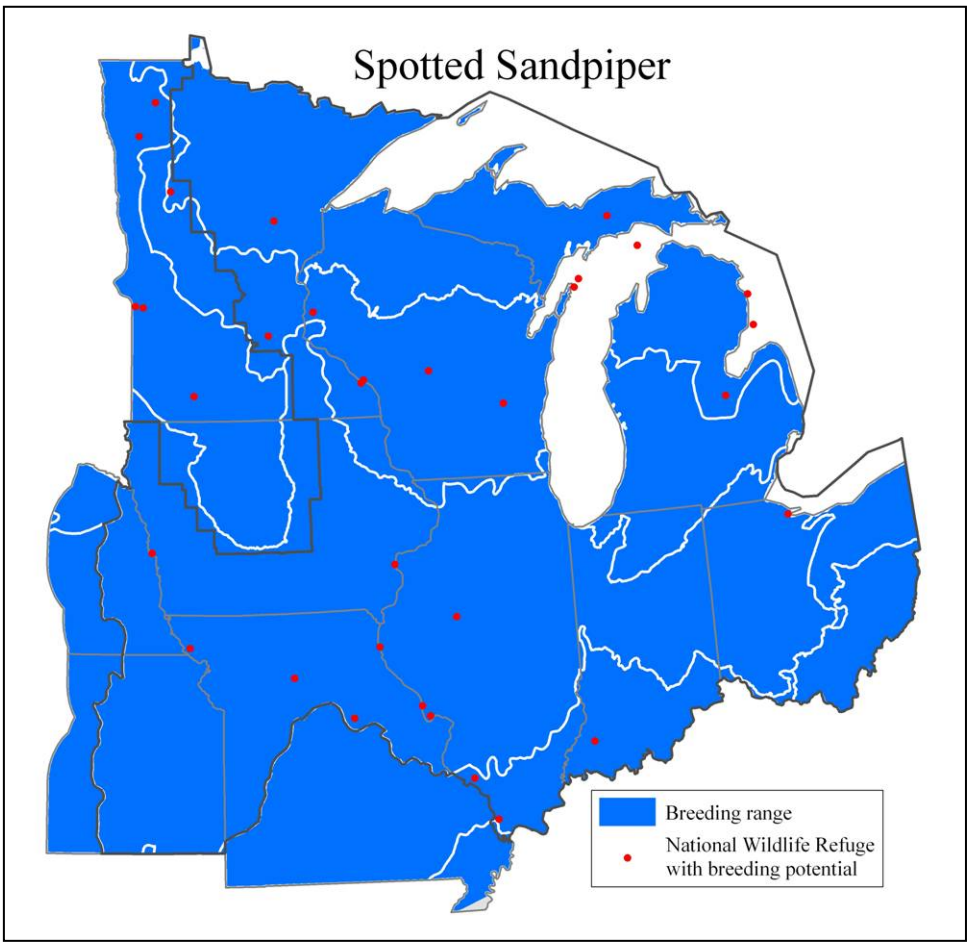
Oring, L. W., E. M. Gray, and J. M. Reed. 1997. Spotted Sandpiper (*Actitis macularia*). *In* The Birds of North America, No. 289 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Ridgely, R. S., T. F. Allnutt, T. Brooks, D. K. McNicol, D. W. Mehlman, B. E. Young, and J. R. Zook. 2005. Digital Distribution Maps of the Birds of the Western Hemisphere, version 2.1. NatureServe, Arlington, Virginia, USA.

Russell, R. P. 2006. Shorebird management priorities for national wildlife refuge system lands in Region 3. USFWS, Division of Migratory Birds. 9pp.

Distribution

Due to limited information about breeding shorebirds in the region, breeding distribution is based on National Wildlife Refuge (NWR) System lands in Region 3 (Appendix E) and breeding range maps from NatureServe. NWR System lands that currently have breeding or potential for breeding populations are identified as red dots.



Wilson's Phalarope (*Phalaropus tricolor*)
Species Account for Habitat Planning

Joint Venture population deficit based on combined USSCP, state bird atlases, and expert opinion	
Breeding population goal	300
Population estimate	160
Deficit	140

Species range map: Cornell Lab of Ornithology

Breeding habitat requirements
Community types: Shallow herbaceous wetlands with mixed open-water and patchy vegetation such as cattail, bulrush, prairie cordgrass; sewage treatment ponds, wet prairies, and potholes also are used. Species nests in idle, hayed, or grazed grassland adjacent to wetland or within wetland vegetation. Prefers tilled and early succession wetlands with short and patchy vegetation in a wetland/grassland complex. Scattered pairs or small colonies may use wet prairie restorations and large marsh complexes.
Timing: Nests May to July, peak clutch initiation late May to early June. Normally 4 eggs are incubated 23 days (by males), and peak hatch is mid- to late June.
Area / distance: Non-territorial, nest density about 1/ha. Wetland-grassland complexes >100 ha preferred; nests <100 m inland from the water edge.
Limiting factors: Lack of large early succession grassland-wetland complexes with grassy fringes around shallow marsh for breeding is assumed to limit populations: this type of habitat often absent from undisturbed (later succession) wetlands.

Population monitoring
Current survey effort: N.A. Breeding Bird Survey, but it is likely inadequate for status determination due to small population in JV region.
Recommended monitoring: None recommended due to limited population in JV region.

Research to assist planning
Current and ongoing projects: None identified in the JV region.
Research needs: An assessment of migration habitat needs and availability.

Biological model results
Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: $H = d/c * h$ $\quad 2{,}300 = 140/6 * 100$

H = minimum new habitat area required to eliminate deficit (ha)
d = regional population deficit (birds)
c = average colony population size (birds)

h = minimum habitat area required / colony (ha)

Recommendations

Habitat actions: Maintain (protect) existing habitat area and quality, and add (restore / enhance) >2,300 ha of breeding habitat (see requirements above) at multiple sites within primary current and historic breeding range (roughly 50% MN, 25% WI, and 25% MI, see distribution map). Large drained wetlands may be restored and/or existing degraded sites may be managed to restore required native grassland and marsh/open-water characteristics. Well timed (non-breeding season) disturbance including fire, haying, and grazing may be important at exiting late-succession wetland-grassland complexes.
Monitoring and performance: Eliminating the current population deficit requires a 100% population increase or an average annual increase of 5% over a 15 year period.

References

Brown, S., C. Hickey, B. Harrington, and R. Gill eds. 2001. United States shorebird conservation plan, 2nd ed. Manomet Center for conservation sciences. Manomet, MA. 60pp.

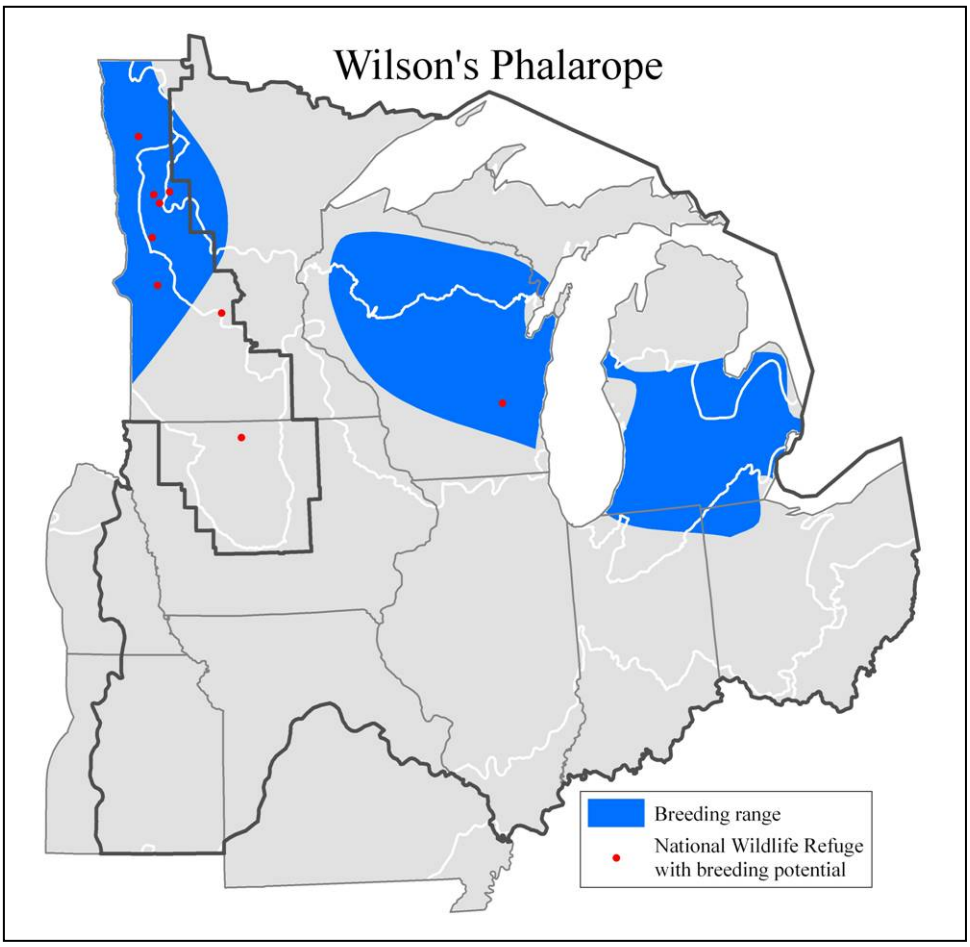
Colwell, M. A. and J. R. Jehl, Jr. 1994. Wilson's Phalarope (*Phalaropus tricolor*). *In* The Birds of North America, No. 83 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Ridgely, R. S., T. F. Allnutt, T. Brooks, D. K. McNicol, D. W. Mehlman, B. E. Young, and J. R. Zook. 2005. Digital Distribution Maps of the Birds of the Western Hemisphere, version 2.1. NatureServe, Arlington, Virginia, USA.

Russell, R. P. 2006. Shorebird management priorities for national wildlife refuge system lands in Region 3. USFWS, Division of Migratory Birds. 9pp.

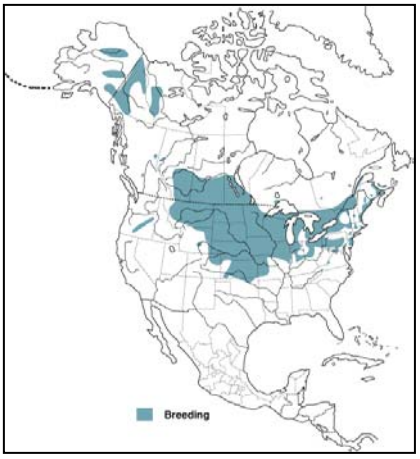
Distribution

Due to limited information about breeding shorebirds in the region, breeding distribution is based on the National Wildlife Refuge (NWR) System lands in Region 3 (Appendix E) and breeding range maps from NatureServe. NWR System lands that currently have breeding or potential for breeding populations are identified as red dots.



Upland Sandpiper (*Bartramia longicauda*)
Species Account for Habitat Planning

Joint Venture population deficit based on combined USSCP, BBS, and expert opinion	
Breeding population goal	45,000
Population estimate	33,000
Deficit	12,000



Species range map: Cornell Lab of Ornithology

Breeding habitat requirements

Community types: Primarily open grassland including native prairie, dry meadows, pastures, hayfields, short-grass savanna and minimally in cultivated fields. Preferred sites contain low to moderate forb cover, minimal woody cover, moderate grass cover, moderate to high cover with plant litter, and little to no bare ground. Vegetation 8-40 cm in height is preferred for nesting. Landscapes surrounding nesting sites are typically level with little tall vegetation. In some locations highway right-of-ways and airport grasslands contain the only suitable cover for breeding.

Timing: Mid-April to early August with egg laying May-June, incubation 21-28 days, and young fledged in 30-34 days.

Area / distance: Loosely colonial while breeding, with densities up to 10 pairs/km^2 (1 pair/10 ha). Prefers grasslands >100 ha in size, infrequently found in grasslands <50 ha.

Limiting factors: Lack of large grassland areas having short, medium, and tall grasses in close proximity for nesting, brooding, and foraging is assumed to limit populations. Habitat loss due to fragmentation by urbanization and cultivation, along with natural forest succession, appear to be the most serious habitat threats. Invasive species such as spotted knapweed may be an important threat to nesting because of plant density and excessive height.

Population monitoring

Current survey effort: N.A. Breeding Bird Survey (BBS) and intermittent surveys conducted on state lands and national wildlife refuges.

Recommended monitoring: BBS considered adequate at this time. Also, need migration monitoring and winter inventory in South America.

Research to assist planning

Current and ongoing projects: None identified in the JV region.

Research needs: Need more information on demographics, particularly how many hatchlings reach flight stage and proportion of 1-year olds that breed. Information is needed on numbers being harvested in South America. Currently there is little knowledge of the impacts of pesticides and herbicides. Further information is needed on migration habitat use and availability, plus an assessment of wintering habitat.

Biological model results

Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: $H = d/2 * h$ $60,000 = 12,000/2 * 10$

H = minimum new habitat area required to eliminate deficit (ha)
d = regional population deficit
h = habitat area used / pair (ha)

Recommendations

Habitat actions: Maintain current grassland/openland area and improve vegetation structure on grasslands potentially suitable for upland sandpipers. Restore, enhance, or create 60,000 ha of grassland of appropriate size (>100 ha or > 50 ha in largely open landscapes) within current breeding range (see maps). The estimated area of habitat needed to accommodate current breeding populations is 165,000 ha (165,000 = 33,000/2 * 10). Carter (1998) provides information on management of grasslands for Upland Sandpipers.

Monitoring and performance: BBS population monitoring is considered adequate for this region. For more accurate population trends, an annual census of known breeding locations can be conducted. Eliminating the current population deficit requires a 41% population increase or an average annual increase of 2.3% for a 15 year period.

References

Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The U.S. Shorebird Conservation plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.

Carter, J. W. (Revised by G. Hammerson and D.W. Mehlman) 1998. The Nature Conservancy Species Management Abstract: Upland Sandpiper (*Bartramia longicauda*). The Nature Conservancy, Arlington, VA.

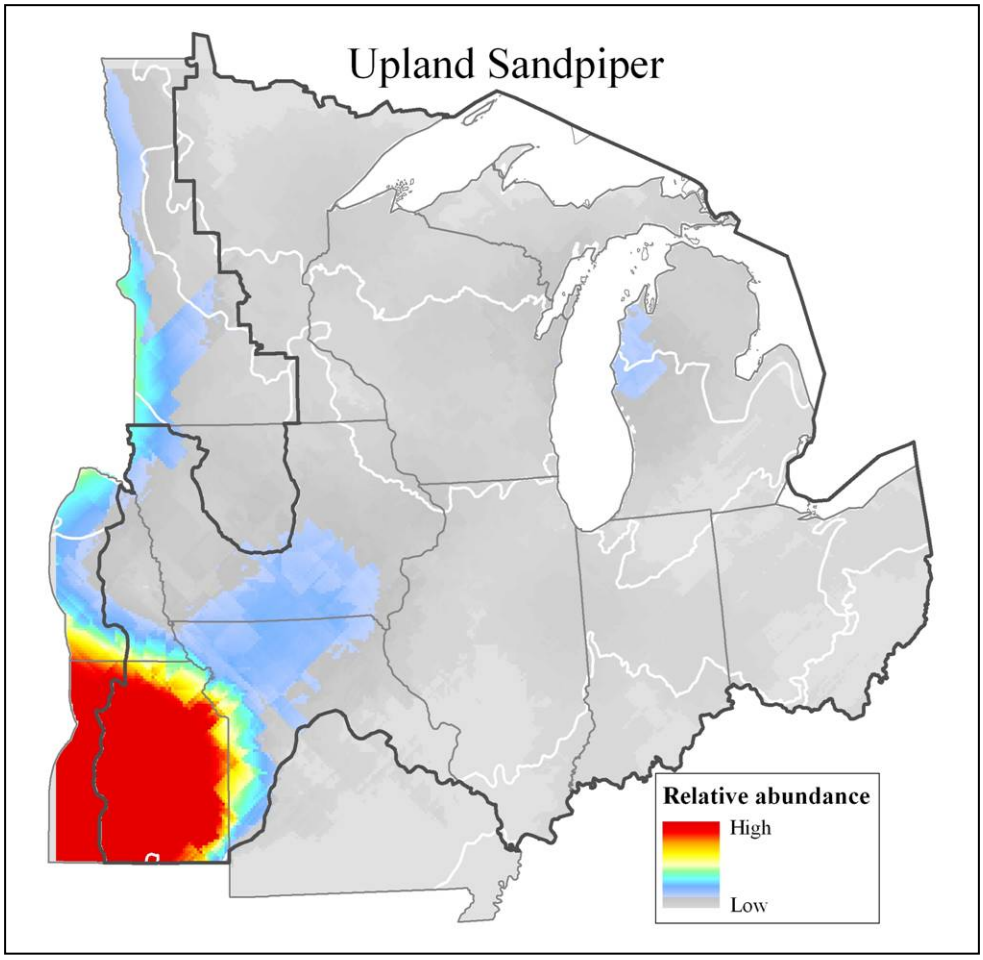
Houston, C. S. and D. E. Bowen, Jr. 2001. Upland Sandpiper (*Bartramia longicauda*). *In* The Birds of North America, No. 580 (A. Poole and F. Gill, eds.) The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Houston, R. 2001. Upland sandpiper habitat model. U.S. Fish and Wildlife Service, Gulf of Maine Program. Falmouth, ME.
See www.fws.gov/r5gomp/gom/habitatstudy/metadata/upsandhab83.htm for metadata.

PIF. 2000. Partners in Flight: Species assessment database. Rocky Mountain Bird Observatory, Fort Collins, CO.

Relative abundance and distribution

Source: Interpolated from BBS counts. Counts are total number of Upland Sandpipers identified during road-side surveys, 1995-2004.



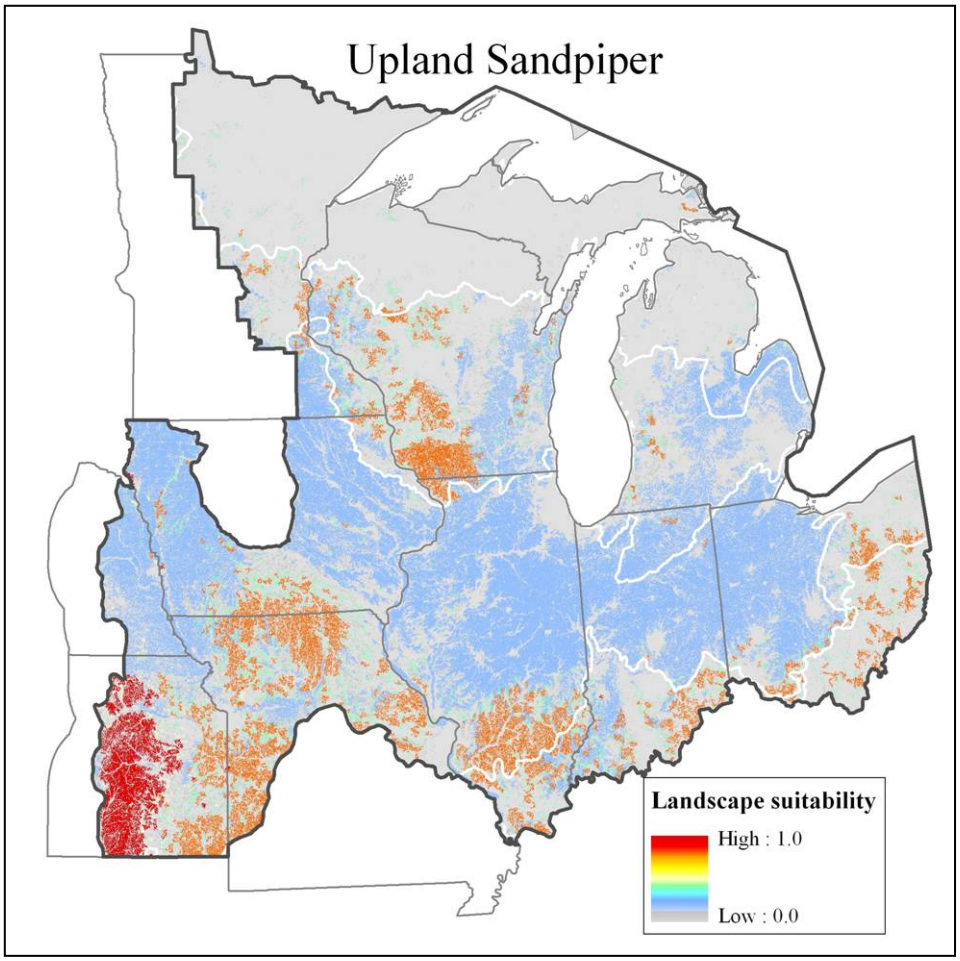
Landscape Suitability Index (LSI) and Model Image

Landscape suitability scores for cover types used by Upland Sandpipers (modified from Houston 2001) using the 1992 National Land Cover Dataset (NLCD). LSI scores closer to 1.0 represent greater suitability for Upland Sandpipers.

Output options	LSI score
Grassland / herbaceous >200 ha	1.0
Pasture / hay >200 ha	0.8
Grassland >50 ha and <200 ha	0.5
Pasture / hay >50 ha and <200 ha	0.4
Cultivated land[a] >200 ha	0.2
Grassland >20 ha and <50 ha	0.1
Cultivated land >50 ha and < 200ha	0.1
Pasture / hay >20 ha and <50 ha	0.08
Cultivated land >20 ha and <50 ha	0.02

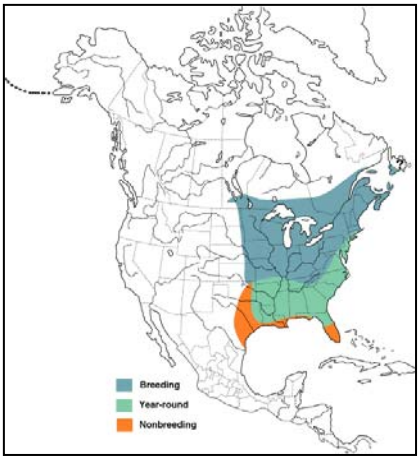
[a] Cultivated land is a combination of row crops and small grains.

This image is developed from a landscape cove-type model using species literature and expert opinion. It does not reflect site specific attributes (e.g., suitable nesting substrate) and landscape suitability scores do not reflect abundances at all locations.



American Woodcock (*Scolopax minor*)
Species Account for Habitat Planning

Joint Venture population deficit based on American Woodcock Management Plan	
Population goal (singing males)	1,070,000
Current estimate (singing males)	860,000
Deficit	212,000



Breeding habitat requirements
Community types: Early-succession forest stands in close proximity. Male woodcock courtship displays occur on singing grounds which are typically forest clearcuts, natural openings, trails, pastures, cultivated fields, and agricultural fields reverting to grasses and brush. Young growth hardwood stands near singing grounds are used for nesting and brood rearing. Stem densities of nesting areas vary between 14,600-49,000 stems/ha.
Timing: Nesting occurs mid- to late April, hatching in early to mid-May, and young leave nest within hours.
Area / distance requirements: Singing grounds are typically >0.2 ha and near nesting areas. Nocturnal use areas consist of 3-5 ha openings within larger diurnal use sites. Ideal landscapes include various aged early-succession forests stands on 200-400 ha tracts within 1-3 km of each other.
Limiting factors: Loss of early succession forest from maturation, declines in openings from farm abandonment, drainage and conversion of bottomland hardwoods to agriculture and pine plantations, fire suppression, and urbanization are assumed to limit populations.

Migration habitat requirements
Required community types: Little is known about migration habitat requirements. Preferred cover is likely early-succession forest.
Timing: February - April and September - November
Limiting factors: Loss of early succession forest with soil moisture suitable for abundant food resources during migration may be contributing to population decline.

Population monitoring
Current survey effort: Woodcock Singing Ground Survey and N.A. Breeding Bird Survey.
Recommended monitoring: Woodcock Singing Ground Survey is a quality monitoring technique, particularly valuable for trends and large-scale population analysis.

Research to assist planning
Current and ongoing projects: None identified in the JV region.
Research needs: Better understanding of habitat use during migration.

Habitat model results

Objective: To eliminate population deficit through efficient and effective habitat management.

Calculation: Habitat objectives developed by the Woodcock Task Force and presented in the American Woodcock Conservation Plan (Kelley 2006) were used for associated areas of the JV region. Objectives are based on restoring American Woodcock historic densities (1970s) with the current land base (see Kelley 2006 for details on objective calculations).

Recommendations

Maintain and protect current land area of early-succession forest and restore/enhance 5,000,000 ha of required breeding habitat. Reaching objectives should result in a halt of Woodcock population declines by 2012 and positive population growth by 2022. Distribution of habitat objectives by State-BCR polygon is presented in the JV Landbird Habitat Conservation Strategy.

References

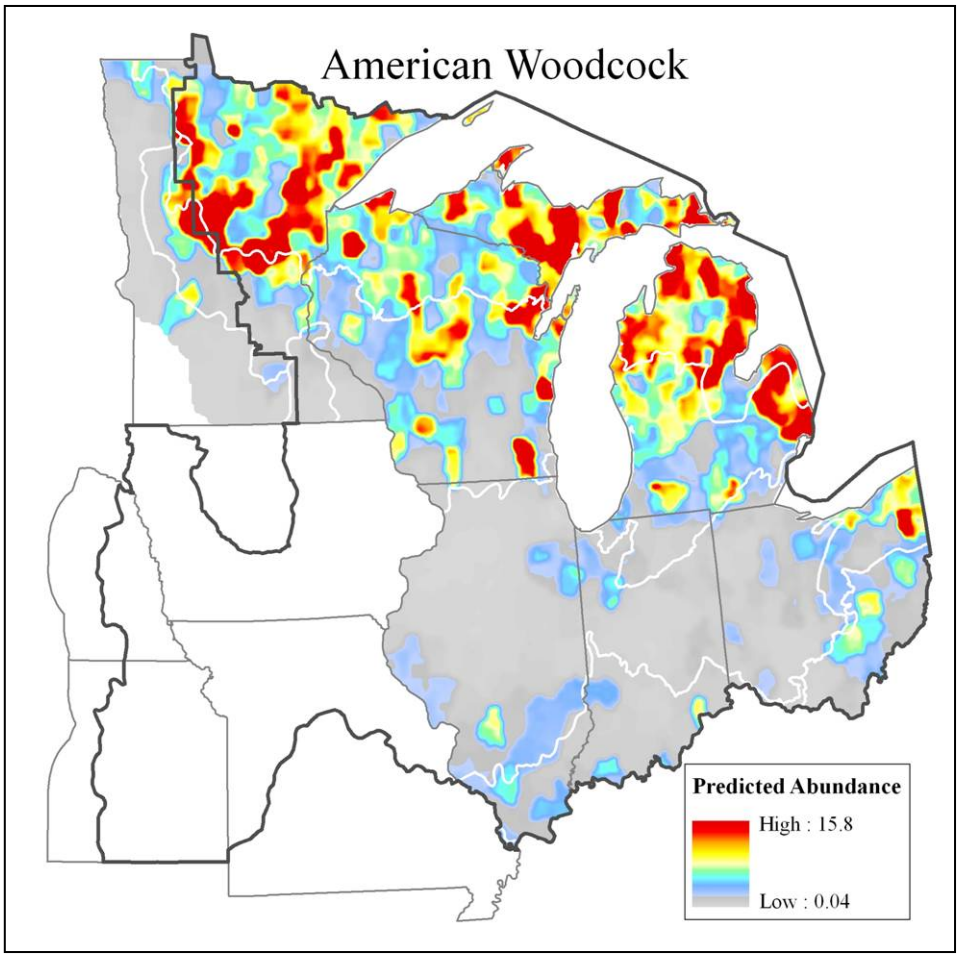
Kelley, J. 2006. *Draft* American Woodcock Conservation Plan. Woodcock Task Force. Division of Migratory Birds, Washington, D.C.

Keppie, D. M. and R. M. Whiting, Jr. 1994. American Woodcock (*Scolopax minor*). *In* The Birds of North America, No. 100 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Thogmartin, W. E., J. R. Sauer, and M. G. Knutson. In press. Modeling and mapping abundance of American woodcock across their breeding range in the United States. Journal of Wildlife Management.

Relative Abundance and distribution

Predicted abundance and distribution of breeding American Woodcock based on North American Woodcock Singing Ground counts, habitat, year effects, and observer effects (Thogmartin, In press).



Appendix B. Migratory shorebird guild accounts with population and cover type information used to develop habitat conservation objectives for the Upper Mississippi River and Great Lakes Joint Venture (JV) Region. Population estimates for species using these primary cover types during migration are measured in individual birds and use days on quality foraging habitat; deficits = goal – current estimate. Use day estimates and habitat objectives are for spring migration.

Species/habitat guild (account primary author)	Last revised
Dry mudflat / agriculture (Brad Potter)	July 2006
Wet mudflat / moist soil plants (Brad Potter)	July 2006
Shallow-water (Brad Potter)	July 2006
Moderate-water depth (Brad Potter)	July 2006
Beach (Brad Potter)	July 2006

Dry-Mudflat Shorebirds
Guild Account for Migration Habitat Planning

Foraging habitat

Non-forested open sites, often wetlands without standing water, that have no vegetative cover or sparse vegetation that is short to medium height. Wet agricultural fields are important for spring migrating American Golden-Plovers. Foraging methods include terrestrial pecking and gleaning (Black-bellied Plover, American Golden-Plover, Killdeer, and Buff-breasted Sandpiper), aquatic gleaning and sweeping (Baird's Sandpiper and Buff-breasted Sandpiper), and probing (Baird's Sandpiper).

Joint Venture migration population and use day estimate and deficit.

	Migration abundance		Use days	
Guild species	Estimate	Deficit	Estimate	Deficit
Black-bellied Plover	25,806	9,381	129,030	46,905
American Golden-Plover	100,000	0	1,500,000	0
Killdeer	163,636	235,636	2,454,540	3,534,540
Baird's Sandpiper	48,913	0	978,260	0
Buff-breasted Sandpiper	6,364	25,455	31,820	127,275
Total	344,719	270,472	5,093,650	3,708,720

Migration timing

Migration timing for group peaks April to May and July to October, depending on species and latitude (modified from Skagen et al. 1999; see maps below for latitude locations and concentration areas).

	Spring		Fall	
Species/Latitude	Timing	Peak	Timing	Peak
Black-bellied Plover				
35° - 40°	March - June	Late-April	July - November	October
40° - 45°	Late-March - May	Early-May	Late-July - October	Late-September
45° - 50°	Late-March - June	Late-May	July - November	September
American Golden-Plover				
35° - 40°	March - Late-May	April	August - November	Late-September
40° - 45°	March - June	May	August - November	October
45° - 50°	April - Late-May	May	July - November	Late-September
Killdeer				
35° - 40°	Early-March - June	May	July - December	September
40° - 45°	Early-March - June	Early-April	July - November	Mid-August
45° - 50°	Early-March - June	Early-April	July - November	August
Baird's Sandpiper				
35° - 40°	March - Late-May	Early April	July - October	August
40° - 45°	March - Late-May	Late April	July - October	Late-July
45° - 50°	Late-March - June	Late April	July - October	Late-July
Buff-breasted Sandpiper				
35° - 40°	April - Late-May	May	July - October	September
40° - 45°	April - May	May	July - September	August
45° - 50°	Late-April - May	May	July - September	August

Limiting factors

Quantity and quality of suitable dry-mudflat areas with available invertebrate foods during migration are assumed to limit populations in this guild.

Objective

Increase regional carrying capacity for this shorebird guild to goal levels (goal = current population + deficit) through effective and efficient habitat conservation that is considerate of other species of concern.

Habitat model

Habitat maintenance and restoration objectives were derived using an energetic-model, converting use day requirements into habitat objectives. See strategy text for energetic-model methods.

	Use days		Habitat (ha)	
Guild species	Estimate	Deficit	Maintenance	Restoration
Black-bellied Plover	129,030	46,905	114	42
American Golden-Plover	1,500,000	0	1,185	0
Killdeer	2,454,540	3,534,540	1,027	1,479
Baird's Sandpiper	978,260	0	355	0
Buff-breasted Sandpiper	31,820	127,275	15	60
Total	5,093,650	3,708,720	2,697	1,581

Recommendations

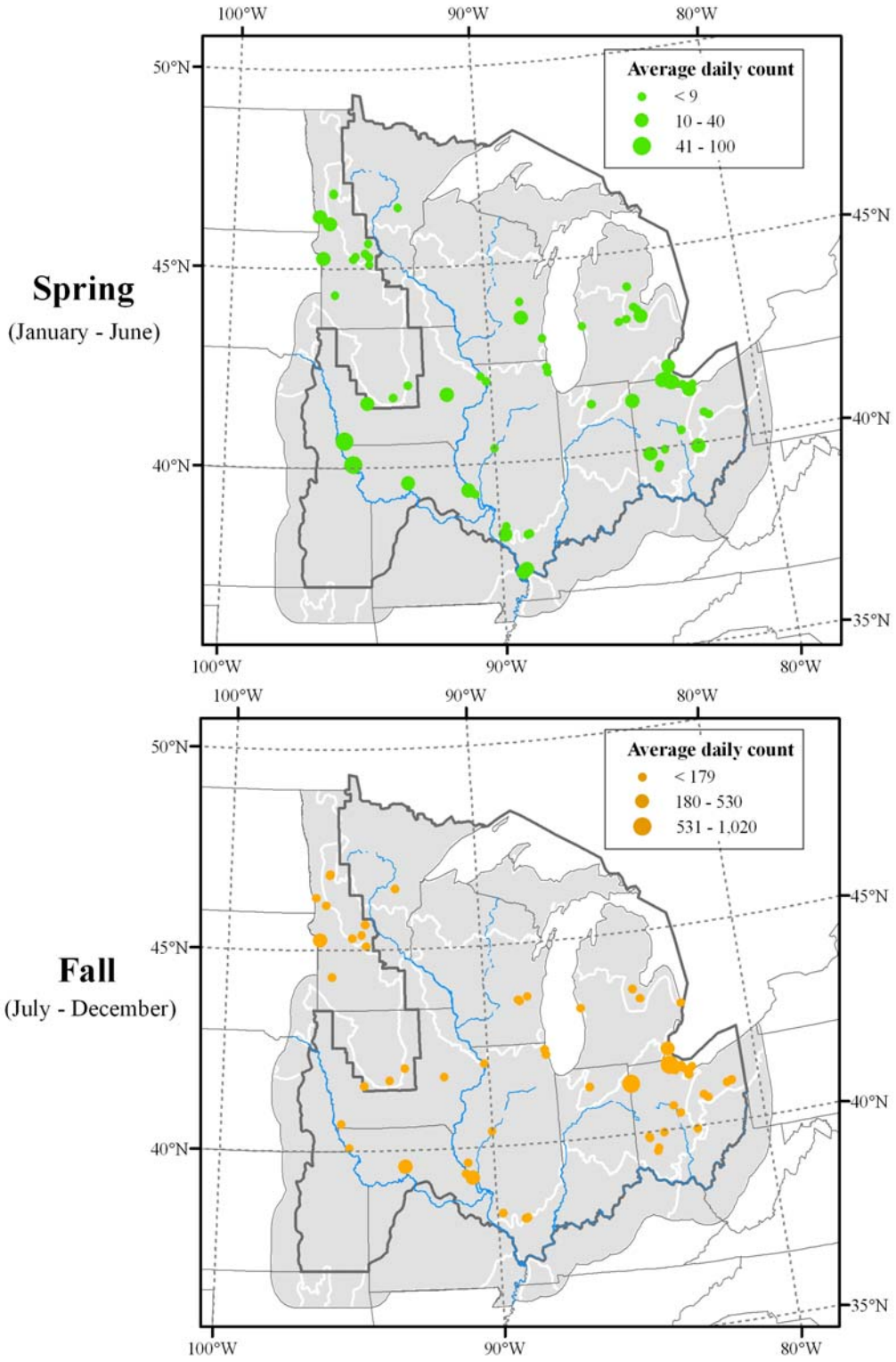
Maintain/protect 2,700 ha of existing wetland area containing or capable of producing dry-mudflats with adequate food resources, and manage for dry-mudflat shorebirds during peak migration periods. Restore or enhance 1,600 ha of wetland containing dry-mudflats to increase carrying capacity, adequately meeting the nutritional needs of identified population deficits. See Table 11 and 12 and Figure 4 in text for recommended protection and restoration locations.

References

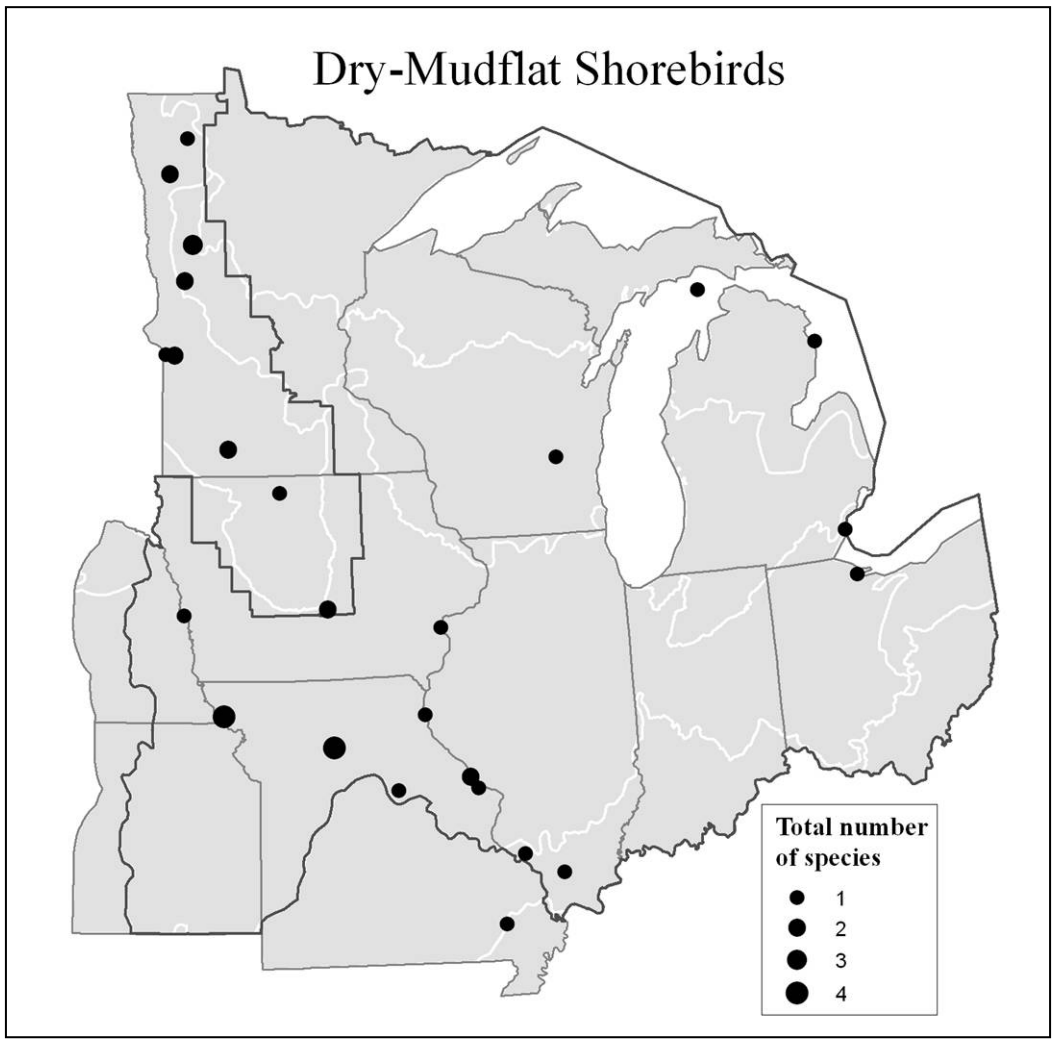
Russell, R. P. 2006. Shorebird management priorities for national wildlife refuge system lands in Region 3. USFWS, Division of Migratory Birds. 9pp.

Skagen, S. K., P. B. Sharpe, R. G. Waltermire, and M. B. Dillon. 1999. Biogeographical profiles of shorebird migration in mid-continental North America. Biological Science Report USGS/BRD/BSR--2000-0003. U.S. Government Printing Office, Denver, Colorado. 167pp.

Migration abundance and distribution for dry-mudflat shorebird guild
Average number recorded at various locations in spring (1 January and 30 June) and fall (1 July and 31 December) from the International Shorebird Survey, 1990-2004.



Locations of national wildlife refuges and wetland management districts with higher conservation potential for migrating shorebirds in the dry-mudflat guild (Appendix E). Larger dots represent a greater number of species (total species in guild = 5).



Wet-Mudflat Shorebirds
Guild Account for Migration Habitat Planning

Foraging habitat

Most wet-mudflat species (9) forage in open wetland sites with little to no vegetation. Two species (Solitary Sandpiper and Wilson's Snipe) will forage in moderate vegetative cover. The Semipalmated Plover uses areas with short vegetation, while the Wilson's Snipe may use areas of tall vegetation. All other species in this guild typically use areas with sparse short to medium height vegetation. The most common foraging methods for the guild are aquatic gleaning, sweeping, and probing. There are two exceptions, the Semipalmated Plover which forages by terrestrial pecking and gleaning, and the Solitary Sandpiper which only uses aquatic gleaning and sweeping.

Joint Venture migration population and use day estimate and deficit.

	Migration abundance		Use days	
Guild species	Estimate	Deficit	Estimate	Deficit
Semipalmated Plover	21,212	0	212,120	0
Solitary Sandpiper	21,951	0	439,020	0
Spotted Sandpiper	23,301	0	466,020	0
Red Knot	250	55,263	1,250	276,315
Semipalmated Sandpiper	395,062	1,078,261	7,901,240	21,565,220
Western Sandpiper	5,000	0	50,000	0
Least Sandpiper	125,472	125,472	2,509,440	2,509,440
White-rumped Sandpiper	275,410	0	5,508,200	0
Pectoral Sandpiper	84,211	0	2,526,330	0
Dunlin	260,366	0	3,905,490	0
Wilson's Snipe	285,714	335,000	5,714,280	6,700,000
Total	1,497,949	1,593,996	29,233,390	31,050,975

Migration timing

Migration timing for group peaks April to May and July to September, depending on species and latitude (modified from Skagen et al. 1999; see maps below for latitude locations and concentration areas).

	Spring		Fall	
Species/Latitude	Timing	Peak	Timing	Peak
Semipalmated Plover				
35° - 40°	March - Late-May	Late-April	July - October	Late-August
40° - 45°	Late-March - June	Early-May	July - October	August
45° - 50°	April - June	May	July - October	August
Solitary Sandpiper				
35° - 40°	March - June	Late-May	July - October	Late-July
40° - 45°	April - May	April	July - Late-August	July
45° - 50°	April - May	Early-May	July - September	Early-August
Spotted Sandpiper				
35° - 40°	April - June	May	July - October	Late-July
40° - 45°	April - June	Late-April	July - October	July
45° - 50°	April - June	April	July - September	July
Red Knot				
35° - 40°	March - Late-May	May	July - October	September
40° - 45°	April - Late-May	May	July - October	Late-August
45° - 50°	Late-April - June	Late-May	July - October	September
Semipalmated Sandpiper				
35° - 40°	March - June	Early-May	July - October	Late-July

40° - 45°	April - June	Late-May	July - September	Early-August
45° - 50°	April - June	Late-May	July - September	August
Western Sandpiper				
35° - 40°	Late-March - May	May	July - October	Early-August
40° - 45°	April - May	Early-May	July - October	Early-September
45° - 50°	April - May	May	July - September	Late-August
Least Sandpiper				
35° - 40°	March - June	Early-May	July - November	Early-September
40° - 45°	Early-April - May	Late-April	July - October	Late-July
45° - 50°	Early-May - May	May	July - October	Late-August
White-rumped Sandpiper				
35° - 40°	Late-April - June	May	NA	September
40° - 45°	Late-April - June	May	NA	NA
45° - 50°	Late-April - June	May	NA	NA
Pectoral Sandpiper				
35° - 40°	Late-March - May	May	July - October	August
40° - 45°	Late-March - June	Early-May	July - October	Late-August
45° - 50°	April - Late-May	May	July - October	Late-August
Dunlin				
35° - 40°	Late-March - June	May	July - November	October
40° - 45°	Late-April - June	Early-May	October - November	Late-October
45° - 50°	Early-May - June	May	August - October	August
Wilson's Snipe				
35° - 40°	January - June	April	July - December	September
40° - 45°	February - June	April	July - November	October
45° - 50°	March - June	April	July - November	October

Limiting factors

Quantity and quality of mudflat areas and available invertebrate foods during migration are assumed to limit populations of this guild.

Objective

Increase regional carrying capacity for this shorebird guild to goal levels (goal = current population + deficit) through effective and efficient habitat conservation that is considerate of other species of concern.

Habitat model

Habitat maintenance and restoration objectives were derived using an energetic-model approach, converting use days into habitat objectives. See text for energetic-model methods.

	Use days		Habitat (ha)	
Guild species	Estimate	Deficit	Maintenance	Restoration
Semipalmated Plover	212,120	0	86	0
Solitary Sandpiper	439,020	0	180	0
Spotted Sandpiper	466,020	0	180	0
Red Knot	1,250	276,315	1	205
Semipalmated Sandpiper	7,901,240	21,565,220	2,378	6,491
Western Sandpiper	50,000	0	16	0
Least Sandpiper	2,509,440	2,509,440	728	728
White-rumped Sandpiper	5,508,200	0	2,205	0
Pectoral Sandpiper	2,526,330	0	1,323	0
Dunlin	3,905,490	0	1,738	0
Wilson's Snipe	5,714,280	6,700,000	3,536	4,146
Total	29,233,390	31,050,975	12,371	11,570

Recommendations

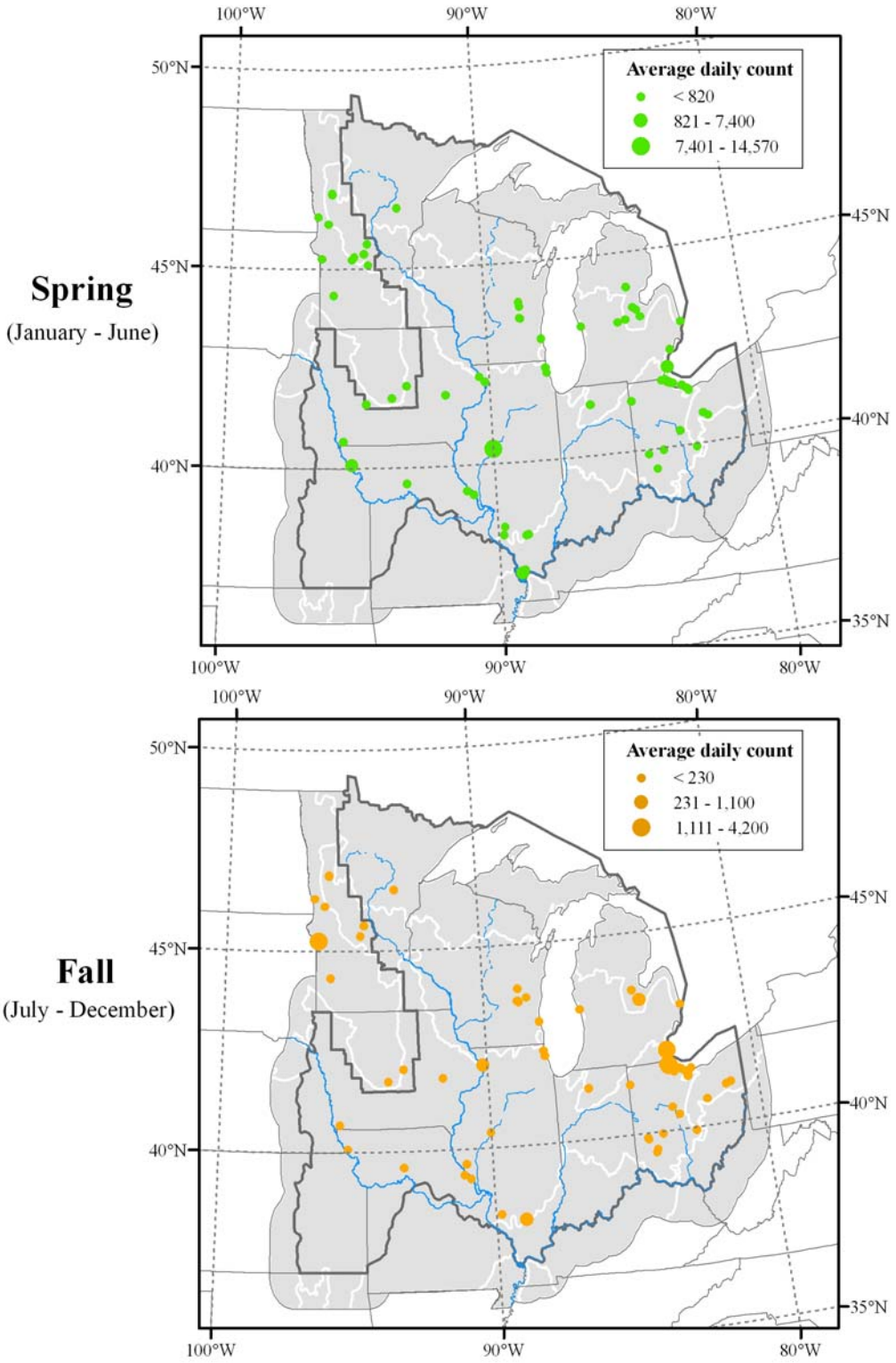
Maintain/protect 12,400 ha of mudflat with adequate food resources for wet-mudflat shorebirds during peak migration periods. Restore or enhance 11,600 ha of wet-mudflat to adequately meet the nutritional needs of population deficits. See Table 11 and 12 and Figure 4 in strategy text for recommended protection and restoration locations.

References

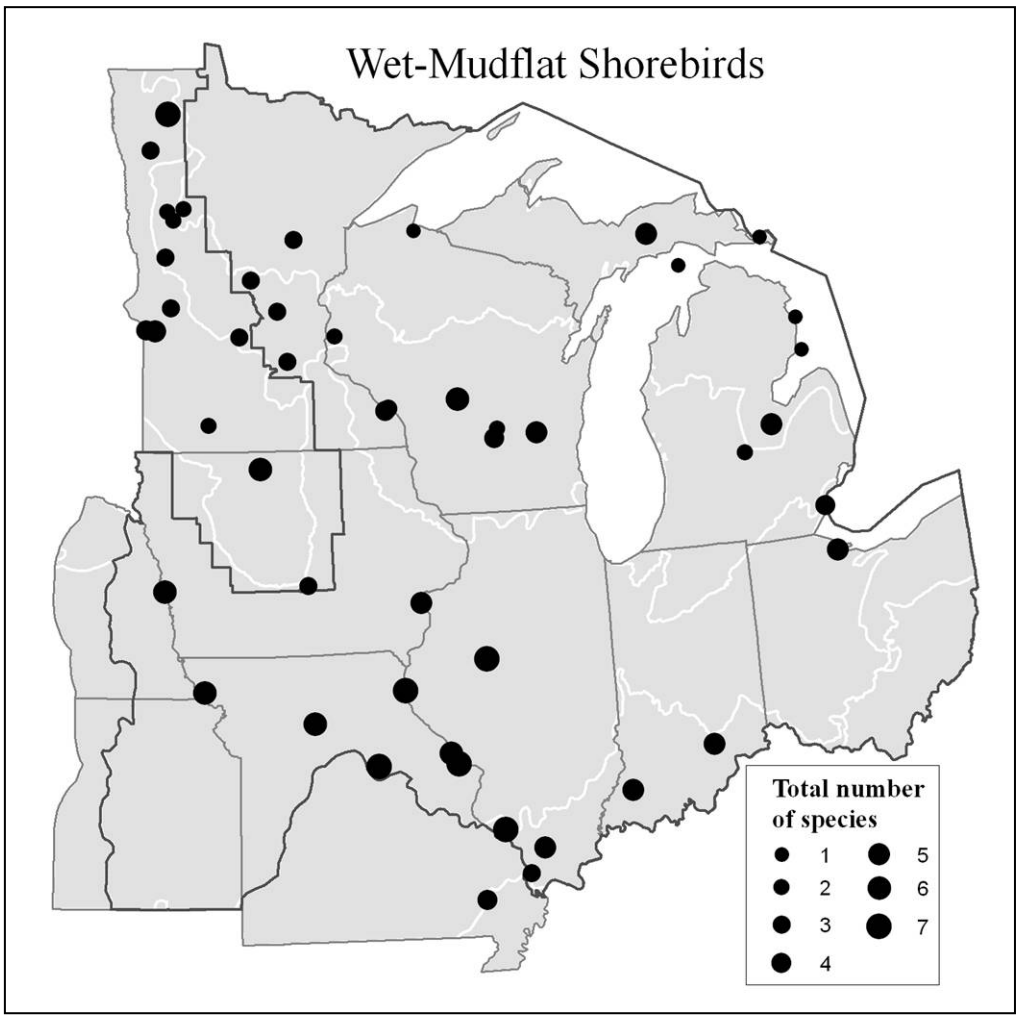
Russell, R. P. 2006. Shorebird management priorities for national wildlife refuge system lands in Region 3. USFWS, Division of Migratory Birds. 9pp.

Skagen, S. K., P. B. Sharpe, R. G. Waltermire, and M. B. Dillon. 1999. Biogeographical profiles of shorebird migration in mid-continental North America. Biological Science Report USGS/BRD/BSR--2000-0003. U.S. Government Printing Office, Denver, CO. 167pp.

Migration abundance and distribution for wet-mudflat shorebird guild
Average number recorded at various locations in spring (1 January and 30 June) and fall (1 July and 31 December) from the International Shorebird Survey, 1990-2004.



Locations of national wildlife refuges and wetland management districts with higher conservation potential for migrating shorebirds in the wet-mudflat guild (Appendix E). Larger dots represent a greater number of species (total species in guild = 11).



Shallow-Water Shorebirds
Guild Account for Migration Habitat Planning

Foraging habitat

Non-forested wetland and agricultural sites with water <5 cm deep and with moderate to no vegetation. Suitable vegetation is typically short to medium height. Foraging methods include aquatic gleaning and sweeping for all species and probing for the Stilt Sandpiper and Short- and Long-billed Dowitchers.

Joint Venture migration population and use day estimate and deficit.

	Migration abundance		Use days	
Guild species	Estimate	Deficit	Estimate	Deficit
Greater Yellowlegs	16,822	0	336,440	0
Lesser Yellowlegs	200,000	87,000	6,000,000	2,610,000
Willet	30,822	0	154,110	0
Stilt Sandpiper	145,316	0	1,453,160	0
Short-billed Dowitcher	57,892	20,432	578,920	204,320
Long-billed Dowitcher	58,182	14,545	581,820	145,450
Total	509,034	121,977	9,104,450	2,959,770

Migration timing

Migration timing for group peaks March to May and July to September, depending on species and latitude (modified from Skagen et al. 1999; see maps below for latitude locations and concentration areas).

	Spring		Fall	
Species/Latitude	Timing	Peak	Timing	Peak
Greater Yellowlegs				
35° - 40°	January - July	March	July - December	August
40° - 45°	March - May	April	July - November	July
45° - 50°	Late-March - May	April	July - November	Late-September
Lesser Yellowlegs				
35° - 40°	March - June	April	July - October	Late-July
40° - 45°	March - May	April	July - October	Late-August
45° - 50°	April - Late May	May	July - October	Late-August
Willet				
35° - 40°	Late-March - June	April	July - October	September
40° - 45°	Late-March - June	April	July - October	July
45° - 50°	April - June	Early-May	July - September	July
Stilt Sandpiper				
35° - 40°	Early-April - June	Early-May	July - October	Early-August
40° - 45°	Early-May - June	Early-May	July - October	Late-August
45° - 50°	Early-May - June	May	July - September	Early-August
Short-billed Dowitcher				
35° - 40°	March - June	May	July - October	Late-August
40° - 45°	April - May	Early-May	July - October	Late-August
45° - 50°	April - May	Early-May	July - October	July
Long-billed Dowitcher				
35° - 40°	March - May	Early-May	July - October	Early-September
40° - 45°	April - May	Late-April	July - October	August
45° - 50°	April - May	Late-April	July - October	August

Limiting factors
Quantity and quality of shallow water (<5 cm deep) area having substrate with abundant aquatic invertebrates for foraging during migration is assumed to limit populations in this guild.

Objective
Increase regional carrying capacity for this shorebird guild to goal levels (goal = current population + deficit) through effective and efficient habitat conservation that is considerate of other species of concern.

Habitat model
Habitat maintenance and restoration objectives were derived using an energetic-model approach, converting use days into habitat objectives. See strategy text for energetic-model methods.

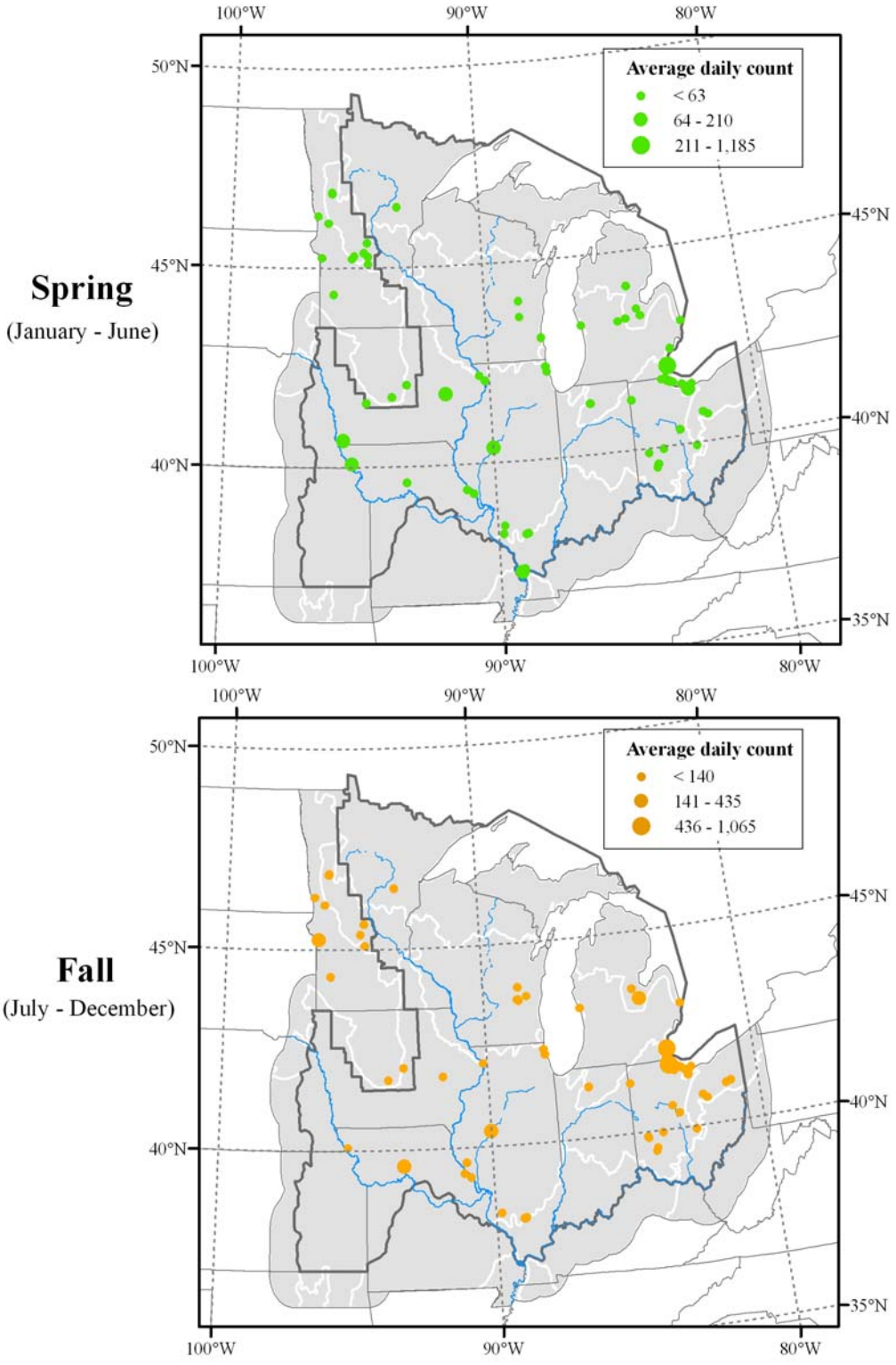
	Use days		Habitat (ha)	
Guild species	Estimate	Deficit	Maintenance	Restoration
Greater Yellowlegs	336,440	0	277	0
Lesser Yellowlegs	6,000,000	2,610,000	3,261	1,418
Willet	154,110	0	162	0
Stilt Sandpiper	1,453,160	0	672	0
Short-billed Dowitcher	578,920	204,320	358	126
Long-billed Dowitcher	581,820	145,450	381	95
Total	9,104,450	2,959,770	5,110	1,640

Recommendations
Maintain/protect 5,100 ha of shallow water with adequate food resources during peak migration periods. Restore or enhance 1,600 ha of shallow water wetland to increase carrying capacity, adequately meeting the nutritional needs for population deficits. See Table 11 and 12 and Figure 4 in strategy text for recommended protection and restoration locations.

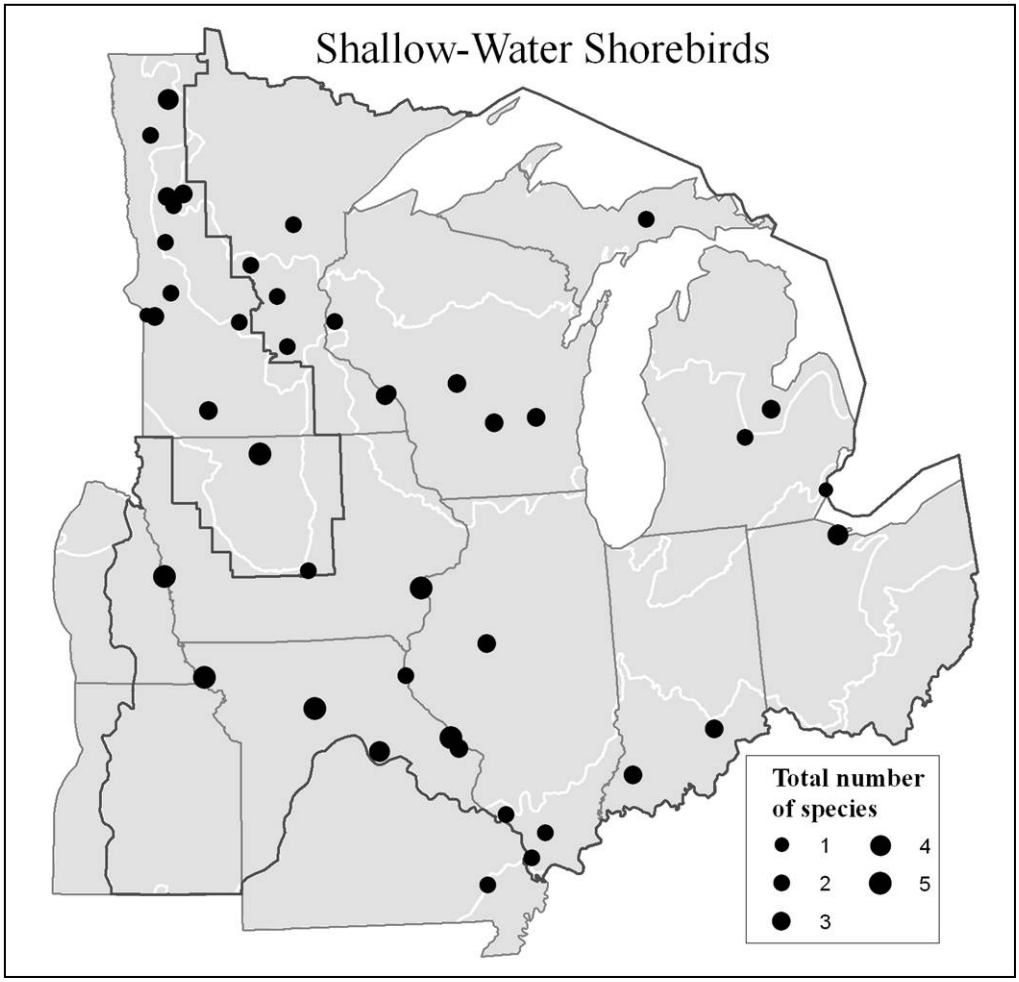
References
Russell, R. P. 2006. Shorebird management priorities for national wildlife refuge system lands in Region 3. USFWS, Division of Migratory Birds. 9pp.

Skagen, S. K., P. B. Sharpe, R. G. Waltermire, and M. B. Dillon. 1999. Biogeographical profiles of shorebird migration in mid-continental North America. Biological Science Report USGS/BRD/BSR--2000-0003. U.S. Government Printing Office, Denver, CO. 167pp.

Migration Abundance for shallow-water shorebird guild
Average number recorded at various locations in spring (1 January and 30 June) and fall (1 July and 31 December) from the International Shorebird Survey, 1990-2004.



Locations of national wildlife refuges and wetland management districts with higher conservation potential for migrating shorebirds in the shallow-water guild (Appendix E). Larger dots represent a greater number of species (total species in guild = 6).



Moderate-Water Shorebirds
Guild Account for Migration Habitat Planning

Joint Venture migration population and use day estimate and deficit.

	Migration abundance		Use days	
Guild species	Estimate	Deficit	Estimate	Deficit
American Avocet	0	0	0	0
Whimbrel	9,900	12,225	49,500	61,125
Hudsonian Godwit	17,500	0	87,500	0
Marbled Godwit	8,000	12,857	40,000	64,285
Wilson's Phalarope	193,548	167,742	967,740	838,710
Red-necked Phalarope	211,268	211,268	1,056,340	1,056,340
Total	440,216	404,092	2,201,080	2,020,460

Foraging habitat

Non-forested wetlands with water 5-20 cm deep and with vegetation ranging from none to dense. Whimbrels are the only species in group that use areas with dense vegetation; others tolerate none to sparse vegetation. When vegetation is present it is typically short to medium in height. Foraging methods include aquatic gleaning and sweeping (American Avocet, Whimbrel, Wilson's Phalarope, and Red-necked Phalarope), probing (Whimbrel, Hudsonian Godwit, and Marbled Godwit), and terrestrial pecking and gleaning (Whimbrel).

Migration timing

Migration timing for group peaks April to May and July to September, depending on species and latitude (modified from Skagen et al. 1999; see maps below for latitude locations and concentration areas).

	Spring		Fall	
Species/Latitude	Timing	Peak	Timing	Peak
American Avocet				
35° - 40°	March - June	Late-April	July - November	August
40° - 45°	March - June	Late-April	July - November	August
45° - 50°	Early-April - June	Late-April	July - November	September
Whimbrel				
35° - 40°	March - May	April	July - September	August
40° - 45°	Late-March - June	April	July - October	July
45° - 50°	April - June	Early-May	July - September	July
Hudsonian Godwit				
35° - 40°	April - May	Late-April	NA	NA
40° - 45°	April - May	Early-May	NA	NA
45° - 50°	April - June	May	August - October	September
Marbled Godwit				
35° - 40°	March - June	April	July - November	Early-August
40° - 45°	Early-April - June	April	July - October	September
45° - 50°	Early-April - June	April	July - September	July
Wilson's Phalarope				
35° - 40°	April - June	May	July - September	August
40° - 45°	April - June	May	July - September	Late-July
45° - 50°	April - June	Late-May	July - September	Late-July
Red-necked Phalarope				
35° - 40°	April - June	May	August - October	August
40° - 45°	Early-May - June	May	July - September	August
45° - 50°	Early-May - June	May	July - September	September

Limiting factors
Quantity and quality of wetlands with suitable shallow water (5-20 cm deep) area and invertebrate foods available for foraging during migration is assumed to limit populations in this guild.

Objective
Increase regional carrying capacity for this shorebird guild to goal levels (goal = current population + deficit) through effective and efficient habitat conservation that is considerate of other species of concern.

Habitat model
Habitat maintenance and restoration objectives were derived using an energetic-model approach, converting use days into habitat objectives. See strategy text for energetic-model methods.

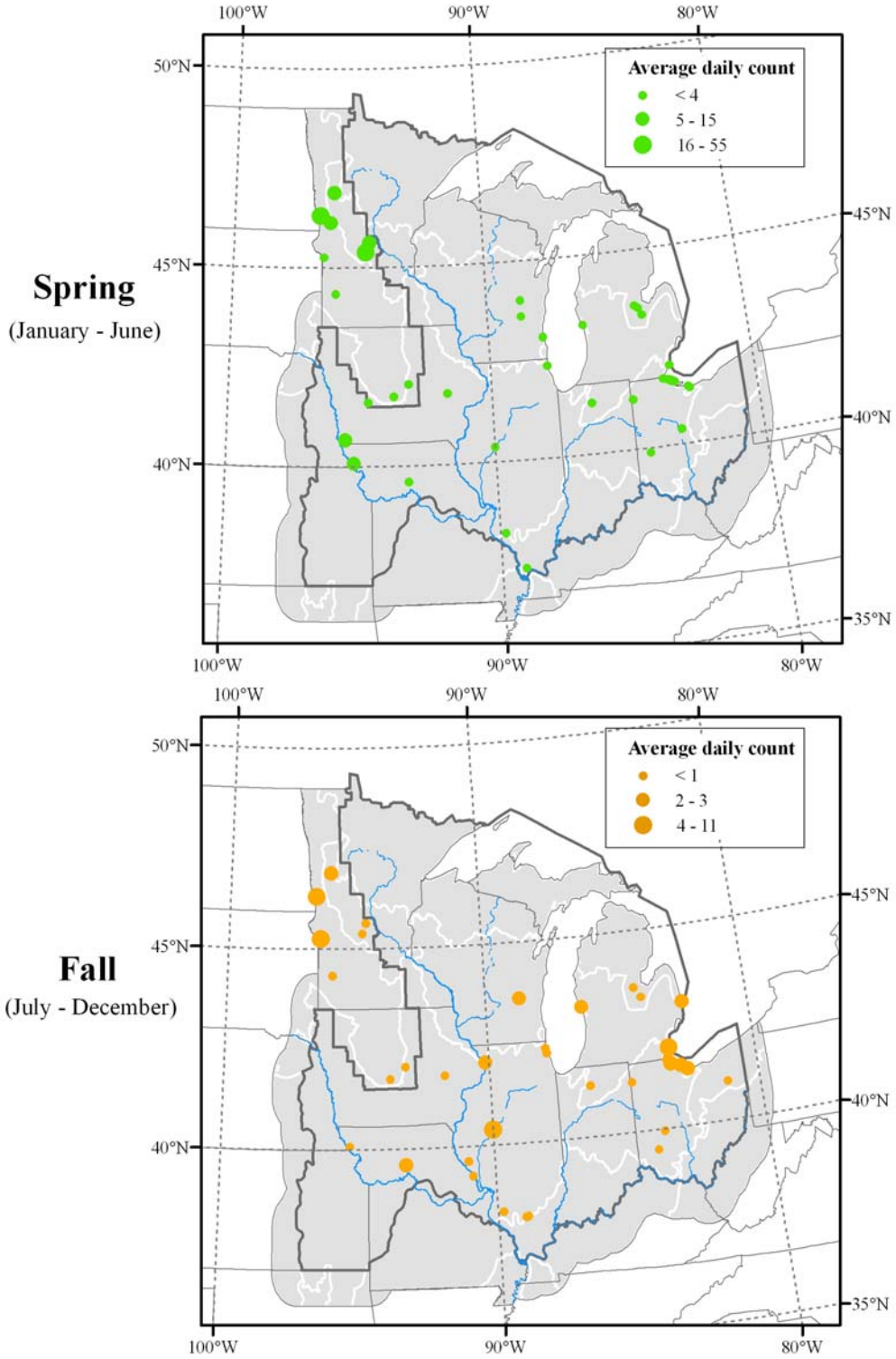
	Use days		Habitat (ha)	
Guild species	Estimate	Deficit	Maintenance	Restoration
American Avocet	0	0	0	0
Whimbrel	49,500	61,125	69	86
Hudsonian Godwit	87,500	0	100	0
Marbled Godwit	40,000	64,285	55	88
Wilson's Phalarope	967,740	838	447	388
Red-necked Phalarope	1,056,340	1,056,340	367	367
Total	2,201,080	2,020,460	1,039	929

Recommendations
Maintain/protect 1,000 ha of wetland area with appropriate water level (5-20 cm deep) and food resources during peak migration periods. Restore or enhance 1,000 ha of moderate-water depth wetlands to increase carrying capacity, adequately meeting the nutritional needs for population deficits. See Table 11 and 12 and Figure 4 in strategy text for recommended protection and restoration locations.

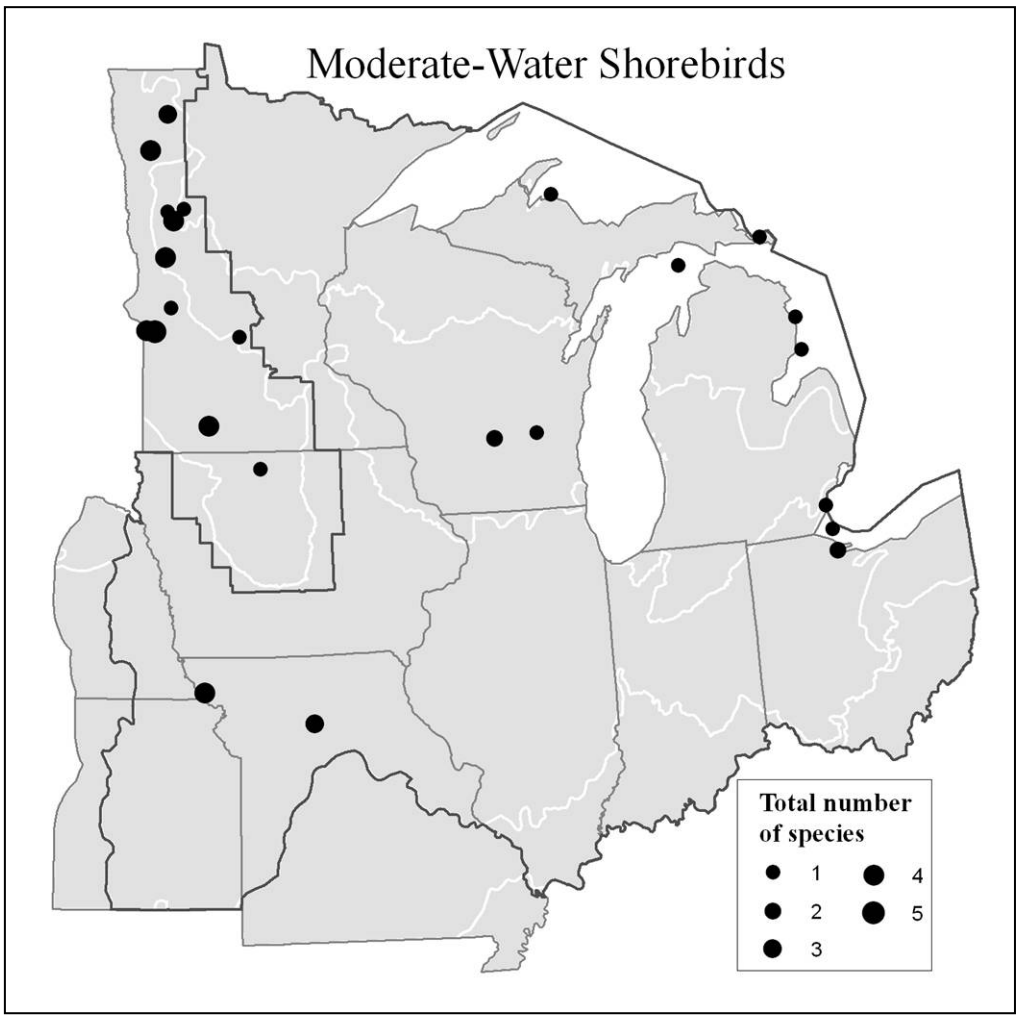
References
Russell, R. P. 2006. Shorebird management priorities for national wildlife refuge system lands in Region 3. USFWS, Division of Migratory Birds. 9pp.

Skagen, S. K., P. B. Sharpe, R. G. Waltermire, and M. B. Dillon. 1999.Biogeographical profiles of shorebird migration in mid-continental North America. Biological Science Report USGS/BRD/BSR--2000-0003. U.S. Government Printing Office, Denver, CO. 167pp.

Migration Abundance for moderate-water shorebird guild
Average number recorded at various locations in spring (1 January and 30 June) and fall (1 July and 31 December) from the International Shorebird Survey, 1990-2004.



Locations of national wildlife refuges and wetland management districts with higher conservation potential for migrating shorebirds in the moderate-water guild (Appendix E). Larger dots represent a greater number of species (total species in guild = 6).



Beach Shorebirds
Guild Account for Migration Habitat Planning

Foraging habitat

Beach sites with little to no vegetative cover. Sparse vegetation is typically short, but sometimes reaching medium height. Foraging methods include terrestrial pecking and gleaning (Piping Plover and Ruddy Turnstone), aquatic gleaning and sweeping (Ruddy Turnstone and Sanderling), and probing (Ruddy Turnstone).

Joint Venture migration population and use day estimate and deficit.

	Migration abundance		Use days	
Guild species	Estimate	Deficit	Estimate	Deficit
Piping Plover	1,431	987	7,155	4,935
Ruddy Turnstone	30,423	9,296	152,115	46,480
Sanderling	52,174	189,474	521,740	1,894,740
Total	84,028	199,757	681,010	1,946,155

Migration timing

Migration timing for group peaks April to May and July to September, depending on species and latitude (modified from Skagen et al. 1999; see maps below for latitude locations and concentration areas).

	Spring		Fall	
Species/Latitude	Timing	Peak	Timing	Peak
Piping Plover				
35° - 40°	Late-March - Late-May	April	July - October	Early-August
40° - 45°	Late-March - June	Late-May	July - Late-September	Early-August
45° - 50°	Mid-April - June	Late-May	July - September	Late-July
Ruddy Turnstone				
35° - 40°	Late-April - June	May	July - October	Early-September
40° - 45°	Late-April - June	May	July - Late-September	August
45° - 50°	Late-April - June	May	July - October	Late-September
Sanderling				
35° - 40°	April - June	May	July - November	Late-September
40° - 45°	April - June	May	July - Late-October	Early-September
45° - 50°	Early-May - June	Late-May	July - October	August

Limiting factors

Quality beach habitats at inland lake and river locations may be limiting some years. Locations around the Great Lakes shoreline are considered adequate.

Objective

Increase regional carrying capacity for this shorebird guild to goal levels (goal = current population + deficit) through effective and efficient habitat conservation that is considerate of other species of concern.

Habitat model

Habitat maintenance and restoration objectives were derived using an energetic-model approach, converting use days into habitat objectives. See strategy text for energetic-model methods.

	Use days		Habitat (ha)	
Guild species	Estimate	Deficit	Maintenance	Restoration
Piping Plover	7,155	4,935	3	2
Ruddy Turnstone	152,115	46,480	114	35
Sanderling	521,740	1,894,740	263	954
Total	681,010	1,946,155	380	991

Recommendations

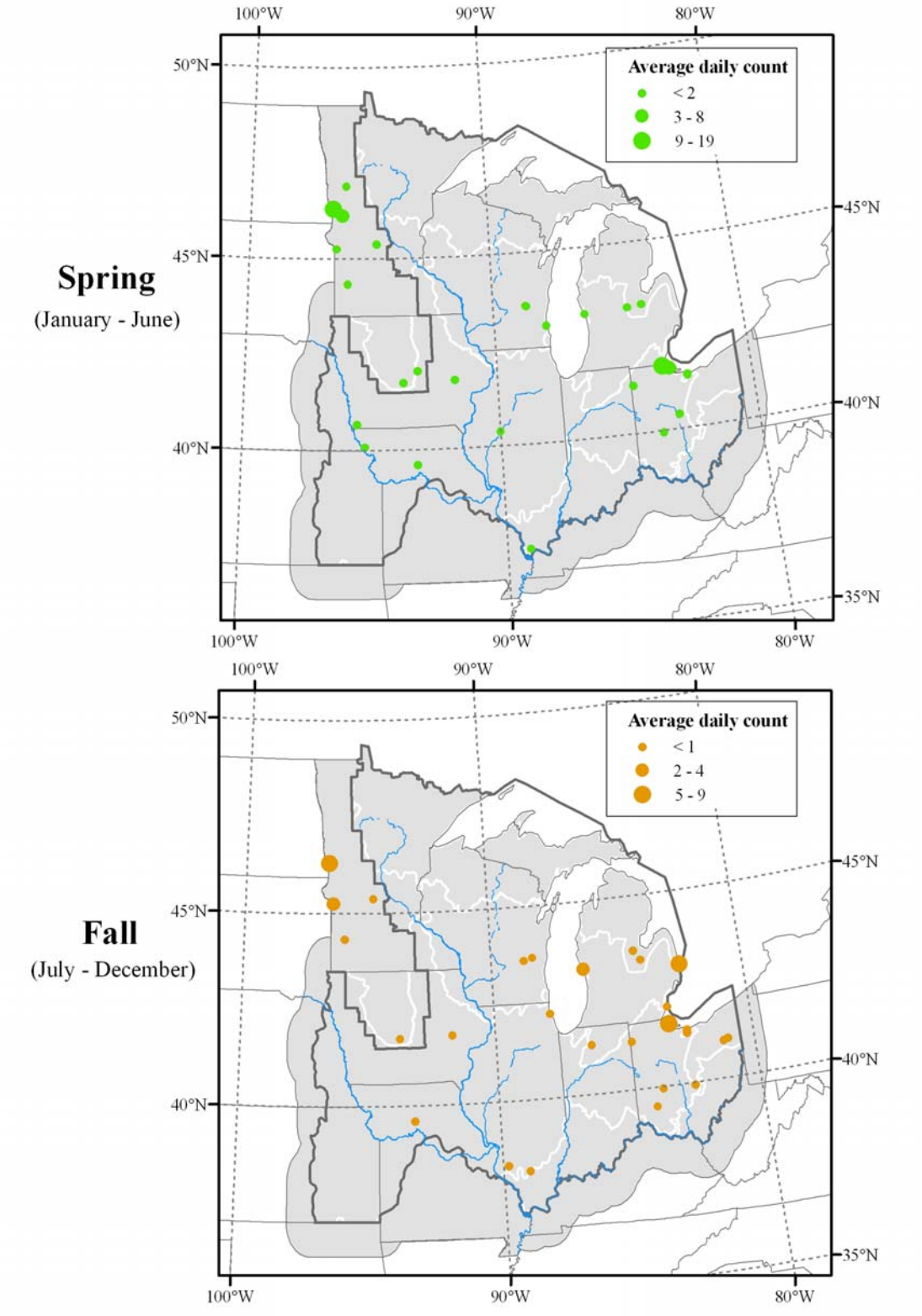
Maintain/protect 400 ha of currently important beach shorebird habitat with adequate food resources during peak migration periods. Restore or enhance 1,000 ha of beach habitat to increase carrying capacity, adequately meeting the nutritional needs for population deficits. See Table 11 and 12 in strategy text for general recommendations on protection and restoration locations.

References

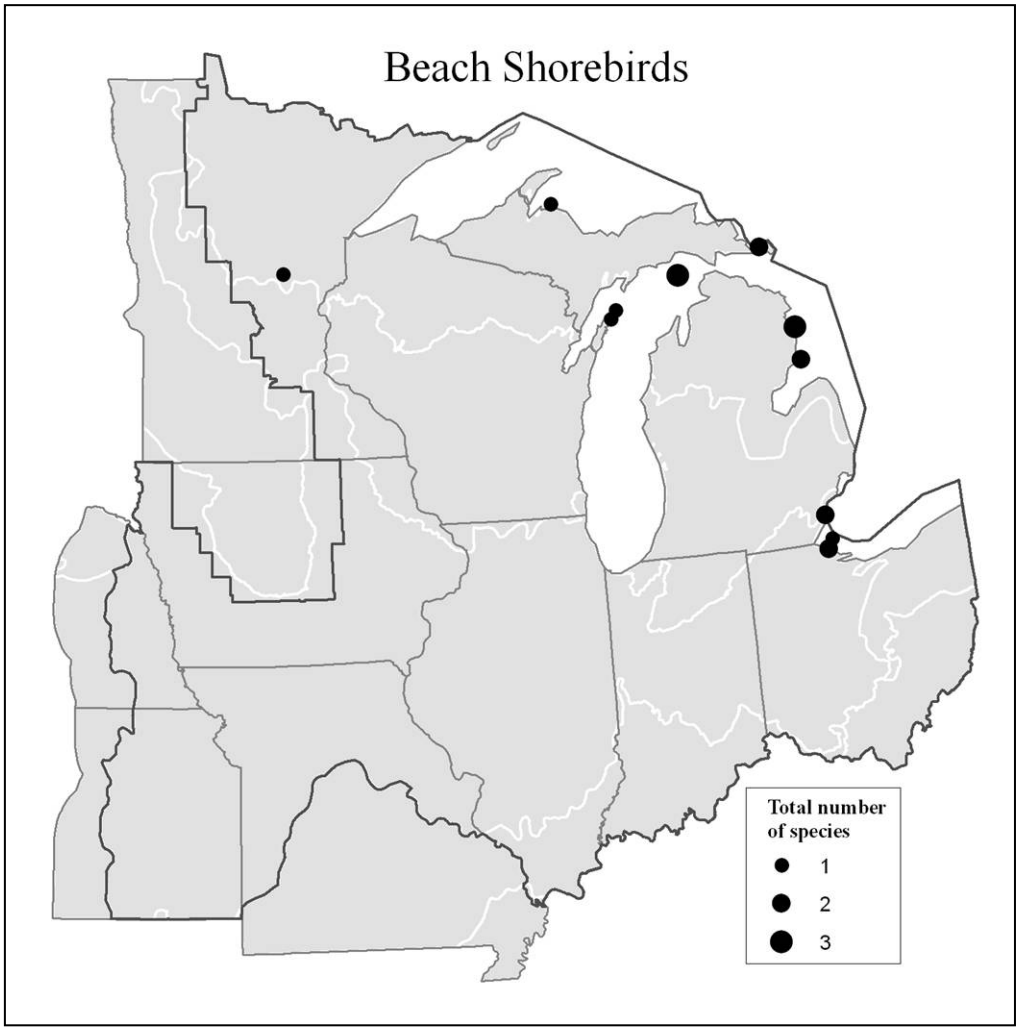
Russell, R. P. 2006. Shorebird management priorities for national wildlife refuge system lands in Region 3. USFWS, Division of Migratory Birds. 9pp.

Skagen, S. K., P. B. Sharpe, R. G. Waltermire, and M. B. Dillon. 1999. Biogeographical profiles of shorebird migration in mid-continental North America. Biological Science Report USGS/BRD/BSR--2000-0003. U.S. Government Printing Office, Denver, CO. 167pp.

Migration abundance and distribution for beach shorebird guild
Average number recorded at various locations in spring (1 January and 30 June) and fall (1 July and 31 December) from the International Shorebird Survey, 1990-2004.



Locations of national wildlife refuges and wetland management districts with higher conservation potential for migrating shorebirds in the beach guild (Appendix E). Larger dots represent a greater number of species (total species in guild = 3).



Appendix C. Common and scientific names of shorebirds occurring in the Upper Mississippi River and Great Lakes Joint Venture region.

Group	Common name	Scientific name
Plover	Black-bellied Plover	*Pluvialis squatarola*
	American Golden-Plover	*Pluvialis dominica*
	Semipalmated Plover	*Charadrius semipalmatus*
	Piping Plover	*Caradrius melodus*
	Killdeer	*Charadrius vociferus*
Stilts and Avocets	Black-necked Stilt	*Himantopus mexicanus*
	American Avocet	*Recurvirostra americana*
Yellowlegs	Greater Yellowlegs	*Tringa melanoleuca*
	Lesser Yellowlegs	*Tringa flavipes*
	Solitary Sandpiper	*Tringa solitaria*
	Willet	*Tringa semipalmata*
Turnstone	Spotted Sandpiper	*Actitis macularia*
	Ruddy Turnstone	*Arenaria interpres*
Curlew	Whimbrel	*Numenius phaeopus*
Godwit	Hudsonian Godwit	*Limosa haemastica*
	Marbled Godwit	*Limosa fedoa*
Sandpiper	Upland Sandpiper	*Bartramia longicauda*
	Red Knot	*Calidris canutus*
	Sanderling	*Calidris alba*
	Semipalmated Sandpiper	*Calidris pusilla*
	Western Sandpiper	*Calidris mauri*
	Least Sandpiper	*Calidris minutilla*
	White-rumped Sandpiper	*Calidris fuscicollis*
	Baird's Sandpiper	*Calidris bairdii*
	Pectoral Sandpiper	*Calidris melanotos*
	Dunlin	*Calidris alpina*
	Stilt Sandpiper	*Calidris himatopus*
	Buff-breasted Sandpiper	*Tryngites subruficollis*
	Short-billed Dowitcher	*Limnodromus griseus*
	Long-billed Dowitcher	*Limnodromus scolopaceus*
Phalarope	Wilson's Phalarope	*Phalaropus tricolor*
	Red-necked Phalarope	*Phalaropus lobatus*
Woodcock	American Woodcock	*Scolopax minor*
Snipe	Wilson's Snipe	*Gallinago delicata*

Appendix D. Threats common to breeding and migrating shorebirds in the Upper Mississippi River and Great Lakes Joint Venture Region.

Category	Threats	Examples
Habitat conversion, especially wetland and grassland loss	Industrial, residential, and recreational development	Housing Commercial facilities Golf courses Ski areas Cell towers Wind farms Roads Shoreline development
	Conversion to agriculture lands	Crop expansion Plantations Wetland draining Wetland filling
	Dredging and channelization	Changes to riparian corridors
	Incompatible natural resource management	Prescribed burn patterns/frequency Wetland/water-level manipulation timing Vegetative planting/manipulation Floodings/dams maintenance and removal
Consumptive use	Sport hunting	Potential excessive harvest rates
Non-consumptive biological resource use	Recreational disturbance	Boating
	Commercial/government disturbance	Military training Heavy equipment movements Aircraft traffic
Pollution	Urban, municipal, and industrial pollution	Solid waste Heavy metals Atmospheric deposition Runoff contaminants Siltation/sedimentation
	Rural and agricultural contaminants	Pesticides Herbicides Nutrient runoff/inputs Nutrient leaching Siltation/sedimentation
Biological interactions	Invasive plants and animals (native and exotic)	Introduced plants Introduced competitors Introduced predators (cats and dogs)
	Disease, pathogens, and parasites	West Nile virus Leucocytozoonosis
Modification of natural processes	Climate change	Natural cycles Human influenced – warming and associated alterations due to change
	Grassland management	Frequency of mowing High intensity grazing
	Fire regime	Fire suppression
	Habitat fragmentation	Transportation infrastructure
Information	Lack of species life history knowledge	Lack of management or inappropriate management due to lack of knowledge
	Social attitudes	Persecution Ignorance Apathy

Appendix E. Shorebird management priorities for National Wildlife Refuge system lands in Region 3.

Robert P. Russell
U.S. Fish and Wildlife Service,
Ft. Snelling, MN
August 2006

The following list notes shorebird species for which Region 3 national wildlife refuges (NWRs) and wetland management districts (WMDs) have a high management potential (Figure 1). The list is based on priority species noted by both the Northern Plains / Prairie Potholes Regional Shorebird Conservation Plan and the Upper Mississippi Valley / Great Lakes Regional Shorebird Conservation Plan, various refuge Comprehensive Conservation Plans, refuge bird checklists, historical patterns of shorebird breeding and migration routes based on state and regional bird reference books, local and regional expert opinion, and local land use patterns that may dictate or indicate a need for species-specific management. This is a living document, subject to revision, based on potential changes in regional and national shorebird populations and land use trends. The list is intended to be used as a guide for managers to focus their efforts on particular species or groups of species (guilds) for which they can make positive benefits to local, regional, and in some cases continental populations of shorebirds either at breeding or stopover sites. *(WHSRN)* designates a Western Hemispheric Shorebird Reserve Network site. If you have questions or comments about this reference, please contact Bob Russell, U.S. FWS Division of Migratory Birds, Minneapolis MN.

ILLINOIS

Chautauqua NWR / Emiquon NWR complex *(WHSRN)*

Breeding: Spotted Sandpiper, American Woodcock
Migration: Semipalmated Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Semipalmated Sandpiper, Least Sandpiper, Pectoral Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Snipe, American Woodcock

Crab Orchard NWR

Breeding: Killdeer, American Woodcock
Migration: American Golden-Plover, Semipalmated Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Least Sandpiper, Pectoral Sandpiper, Wilson's Snipe, American Woodcock

Cypress Creek NWR

Breeding: Spotted Sandpiper
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Wilson's Snipe, American Woodcock

Great River NWR (see Missouri)

Lost Mounds NWR

Breeding: Upland Sandpiper
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Least Sandpiper, Pectoral Sandpiper, Wilson's Snipe, American Woodcock

Mark Twain NWR

Breeding: Spotted Sandpiper, American Woodcock
Migration: Semipalmated Plover, Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Semipalmated Sandpiper, Least Sandpiper, Pectoral Sandpiper, Wilson's Snipe, American Woodcock

Middle Mississippi NWR

Breeding: Spotted Sandpiper
Migration: Semipalmated Plover, Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Semipalmated Sandpiper, Least Sandpiper, Pectoral Sandpiper, Wilson's Snipe, American Woodcock

Two Rivers NWR

Breeding: Killdeer, Spotted Sandpiper, American Woodcock
Migration: Semipalmated Plover, Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Semipalmated Sandpiper, Least Sandpiper, Pectoral Sandpiper, Short-billed Dowitcher, Wilson's Snipe, American Woodcock

Upper Mississippi NWFR (Savanna District)

Breeding: Spotted Sandpiper
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Wilson's Snipe, American Woodcock

INDIANA

Big Oaks NWR

Breeding: Killdeer, American Woodcock
Migration: American Woodcock

Muscatatuck NWR

Breeding: Killdeer, American Woodcock
Migration: Semipalmated Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Snipe, American Woodcock

Patoka River NWR

Breeding: Killdeer, Black-necked Stilt, Spotted Sandpiper, American Woodcock
Migration: Semipalmated Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper,

Pectoral Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Snipe, American Woodcock

IOWA

Desoto NWR/ Boyer Chute NWR

Breeding: Killdeer, Spotted Sandpiper
Migration: Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Pectoral Sandpiper, Semipalmated Sandpiper, White-rumped Sandpiper, Stilt Sandpiper, Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe

Driftless Area-Upper Mississippi NFWR

Breeding: American Woodcock
Migration: American Woodcock

Iowa WMD

Breeding: Killdeer, Upland Sandpiper, Wilson's Phalarope
Migration: American Golden-Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Semipalmated Sandpiper, White-rumped Sandpiper, Dunlin, Stilt Sandpiper, Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe

Neil Smith NWR

Breeding: Killdeer, Upland Sandpiper, American Woodcock
Migration: American Golden-Plover, Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Wilson's Snipe, American Woodcock

Northern Tallgrass Prairie NWR (see Minnesota)

Port Louisa NWR

Breeding: Killdeer, Spotted Sandpiper
Migration: Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Pectoral Sandpiper, Least Sandpiper, Stilt Sandpiper, Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe, American Woodcock

Union Slough NWR

Breeding: Upland Sandpiper, American Woodcock, Wilson's Phalarope
Migration: American Golden-Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Semipalmated Sandpiper, White-rumped Sandpiper, Dunlin, Stilt Sandpiper, Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope

Upper Mississippi NFWR (see Wisconsin)

MICHIGAN

Detroit River International Wildlife Refuge (includes entire designated area)
Breeding: Black-necked Stilt
Migration: Black-bellied Plover, Spotted Sandpiper, Whimbrel, Ruddy Turnstone, Sanderling, Semipalmated Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Snipe

Harbor Island NWR
Migration: Whimbrel, Ruddy Turnstone, Dunlin, Sanderling

Huron Islands NWR
Migration: Whimbrel, Ruddy Turnstone

Kirtland's Warbler NWR
Breeding: Upland Sandpiper

Michigan Islands NWR (Lake Huron islands)
Migration: Whimbrel, Ruddy Turnstone, Dunlin, Sanderling

Michigan Islands NWR (Lake Michigan islands)
Breeding: Piping Plover, Spotted Sandpiper
Migration: Piping Plover, Whimbrel, Ruddy Turnstone, Dunlin, Sanderling, Baird's Sandpiper

Michigan WMD
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Wilson's Snipe

Seney NWR
Breeding: Spotted Sandpiper, Upland Sandpiper, Wilson's Snipe, American Woodcock
Migration: Semipalmated Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Dunlin, Wilson's Snipe, American Woodcock

Shiawassee NWR
Breeding: Killdeer, Spotted Sandpiper, Wilson's Snipe, American Woodcock
Migration: Semipalmated Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Snipe, American Woodcock

MINNESOTA

Agassiz NWR
Breeding: Killdeer, Spotted Sandpiper, Wilson's Snipe
Migration: Semipalmated Plover, Killdeer, Greater Yellowlegs, Lesser

Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Hudsonian Godwit, Marbled Godwit (both James Bay and prairie races), Semipalmated Sandpiper, Least Sandpiper, Pectoral Sandpiper, Long-billed Dowitcher, Short-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope

Big Stone NWR

Breeding: Spotted Sandpiper, Upland Sandpiper
Migration: Hudsonian Godwit, Marbled Godwit, Least Sandpiper, Semipalmated Sandpiper, White-rumped Sandpiper, Buff-breasted Sandpiper, Short-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope, Red-necked Phalarope

Big Stone WMD

Breeding: Killdeer, Spotted Sandpiper, Upland Sandpiper, Marbled Godwit
Migration: Semipalmated Plover, American Avocet, Greater Yellowlegs, Lesser Yellowlegs, Hudsonian Godwit, Marbled Godwit, Least Sandpiper, Semipalmated Sandpiper, White-rumped Sandpiper, Baird's Sandpiper, Buff-breasted Sandpiper, Short-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope, Red-necked Phalarope

Crane Meadows NWR

Breeding: Wilson's Snipe, American Woodcock
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Wilson's Snipe, American Woodcock

Detroit Lakes WMD

Breeding: Killdeer, Willet (restoration needed), Upland Sandpiper, Marbled Godwit, Wilson's Snipe, Wilson's Phalarope
Migration: American Golden-Plover (primarily Polk, Norman & Clay Counties), Willet, Hudsonian Godwit, Marbled Godwit, White-rumped Sandpiper, Pectoral Sandpiper, Buff-breasted Sandpiper, Short-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope, Red-necked Phalarope

Fergus Falls WMD

Breeding: Willet (former breeder, nests across border to west, habitat restoration needed), Upland Sandpiper, Marbled Godwit, Wilson's Snipe, Wilson's Phalarope
Migration: American Golden-Plover (primarily Wilkin Co.), Willet, Hudsonian Godwit, Marbled Godwit, White-rumped Sandpiper, Pectoral Sandpiper, Buff-breasted Sandpiper, Short-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope, Red-necked Phalarope

Glacial Ridge NWR

Breeding: Killdeer, Willet (former breeder, nests across border to west in Dakotas, habitat restoration may be needed), Spotted Sandpiper, Upland Sandpiper, Long-billed Curlew (extirpated from Region 3, potential restoration site), Marbled Godwit, Wilson's Snipe, Wilson's Phalarope

Migration: American Golden-Plover, Willet, Hudsonian Godwit, Marbled Godwit, White-rumped Sandpiper, Pectoral Sandpiper, Buff-breasted Sandpiper, Short-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope, Red-necked Phalarope

Hamden Slough NWR

Breeding: American Avocet, Willet (former breeder, nests to the west in Dakotas, habitat restoration may be needed), Upland Sandpiper, Marbled Godwit, Wilson's Snipe, Wilson's Phalarope
Migration: Greater Yellowlegs, Lesser Yellowlegs, Pectoral Sandpiper, Short-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope

Litchfield WMD

Breeding: Killdeer, Upland Sandpiper, Marbled Godwit, Wilson's Snipe, Wilson's Phalarope
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Wilson's Snipe, Wilson's Phalarope

Mille Lacs NWR

Migration: Ruddy Turnstone

Minnesota Valley NWR

Breeding: Killdeer, Spotted Sandpiper
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Wilson's Snipe, American Woodcock

Minnesota Valley WMD

Breeding: Killdeer, Spotted Sandpiper, Upland Sandpiper (populations currently low, habitat restoration needed)
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Pectoral Sandpiper, Wilson's Snipe

Morris WMD

Breeding: Killdeer, Willet (former breeder, nests to the west in South Dakota, habitat restoration may be needed), Upland Sandpiper, Marbled Godwit, Wilson's Snipe, Wilson's Phalarope
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Wilson's Snipe, Wilson's Phalarope

Northern Tallgrass Prairie NWR (including entire designated region)

Breeding: Killdeer, American Avocet, Spotted Sandpiper, Upland Sandpiper, Marbled Godwit (former breeder, habitat restoration needed in IA, S MN),Wilson's Phalarope (former breeder, habitat restoration needed in IA, S MN),
Migration: American Golden-Plover, Willet, Hudsonian Godwit, Marbled Godwit, White-rumped Sandpiper, Stilt Sandpiper, Buff-breasted Sandpiper,

Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope, Red-necked Phalarope

Rice Lake NWR

Breeding: Spotted Sandpiper, Wilson's Snipe, American Woodcock
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Wilson's Snipe, American Woodcock

Rydell NWR

Breeding: Killdeer

Sandstone NWR

Breeding: American Woodcock
Migration: American Woodcock

Sherburne NWR

Breeding: Killdeer, Upland Sandpiper (formerly larger population present, some habitat restoration needed), Wilson's Snipe, American Woodcock
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Wilson's Snipe, American Woodcock

Tamarac NWR

Breeding: Killdeer, Spotted Sandpiper, Upland Sandpiper, Wilson's Snipe, American Woodcock
Migration: Greater Yellowlegs, Lesser Yellowlegs, Pectoral Sandpiper, Short-billed Dowitcher, Wilson's Snipe, American Woodcock, Wilson's Phalarope

Upper Mississippi NFWR (see Wisconsin)

Windom WMD

Breeding: Killdeer, Spotted Sandpiper, Upland Sandpiper, Marbled Godwit (former or occasional breeder, restoration needed)
Migration: American Golden-Plover, Willet, Hudsonian Godwit, Marbled Godwit, White-rumped Sandpiper, Stilt Sandpiper, Buff-breasted Sandpiper, Short-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope, Red-necked Phalarope

MISSOURI

Big Muddy NFWR

Breeding: Killdeer, Spotted Sandpiper
Migration: Semipalmated Plover, Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Semipalmated Sandpiper, Least Sandpiper, Pectoral Sandpiper, Stilt Sandpiper, Short-billed Dowitcher, Wilson's Snipe, American Woodcock

Great River NWR (includes **Clarence Cannon NWR,** also in Illinois)
Breeding: Killdeer, Spotted Sandpiper, American Woodcock
Migration: Black-bellied Plover, Semipalmated Plover, Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Least Sandpiper, Pectoral Sandpiper, Stilt Sandpiper, Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe, American Woodcock

Mark Twain NWR complex
Breeding: Killdeer, Spotted Sandpiper, American Woodcock
Migration: Semipalmated Plover, Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Semipalmated Sandpiper, Least Sandpiper, Pectoral Sandpiper, Stilt Sandpiper, Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe, American Woodcock

Mingo NWR
Breeding: Killdeer
Migration: Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Pectoral Sandpiper, Wilson's Snipe, American Woodcock

Squaw Creek NWR
Breeding: Killdeer, Spotted Sandpiper
Migration: Black-bellied Plover, American Golden-Plover, Semipalmated Plover, American Avocet, Greater Yellowlegs, Lesser Yellowlegs, Hudsonian Godwit, Marbled Godwit, Least Sandpiper, Semipalmated Sandpiper, White-rumped Sandpiper, Baird's Sandpiper, Pectoral Sandpiper, Stilt Sandpiper, Buff-breasted Sandpiper, Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope

Swan Lake NWR *(WHSRN)*
Breeding: Killdeer, Spotted Sandpiper, Upland Sandpiper
Migration: Black-bellied Plover, American Golden-Plover, Semipalmated Plover, American Avocet, Greater Yellowlegs, Lesser Yellowlegs, Hudsonian Godwit, Least Sandpiper, Semipalmated Sandpiper, White-rumped Sandpiper, Baird's Sandpiper, Pectoral Sandpiper, Stilt Sandpiper, Buff-breasted Sandpiper, Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe, Wilson's Phalarope

OHIO

Cedar Point NWR
Migration: Ruddy Turnstone, Sanderling

Ottawa NWR *(WHSRN)*
Breeding: Spotted Sandpiper, Wilson's Snipe (major former breeding area, additional habitat restoration needed), American Woodcock
Migration: Black-bellied Plover, Semipalmated Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Hudsonian Godwit, Marbled Godwit,

Pectoral Sandpiper, Dunlin, Short-billed Dowitcher, Long-billed Dowitcher, Wilson's Snipe, American Woodcock

West Sister Island NWR
Migration: Whimbrel, Ruddy Turnstone

WISCONSIN

Fox River NWR
Breeding: Wilson's Snipe, American Woodcock
Migration: Solitary Sandpiper, Wilson's Snipe, American Woodcock

Gravel Island NWR
Breeding: Spotted Sandpiper
Migration: Ruddy Turnstone

Green Bay NWR
Breeding: Spotted Sandpiper
Migration: Ruddy Turnstone

Horicon NWR
Breeding: Killdeer, Black-necked Stilt, Spotted Sandpiper, Upland Sandpiper, Wilson's Snipe, Wilson's Phalarope
Migration: American Golden-Plover, Semipalmated Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Pectoral Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Snipe, American Woodcock, Wilson's Phalarope

Leopold WMD
Breeding: Killdeer, Upland Sandpiper, Wilson's Snipe
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Hudsonian Godwit, Pectoral Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Snipe, American Woodcock, Wilson's Phalarope

Necedah NWR
Breeding: Killdeer, Spotted Sandpiper, Upland Sandpiper, Wilson's Snipe, American Woodcock
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Least Sandpiper, Semipalmated Sandpiper, Pectoral Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Snipe, American Woodcock

St. Croix WMD
Breeding: Killdeer, Spotted Sandpiper, Upland Sandpiper, Wilson's Snipe, American Woodcock
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Wilson's Snipe, American Woodcock

Trempeleau NWR

Breeding: Killdeer, Spotted Sandpiper, Upland Sandpiper, American Woodcock
Migration: Greater Yellowlegs, Lesser Yellowlegs, Spotted Sandpiper, Solitary Sandpiper, Wilson's Snipe, American Woodcock

Upper Mississippi River W&FR (including Minnesota, Iowa)

Breeding: Killdeer, Spotted Sandpiper, Wilson's Snipe, American Woodcock
Migration: Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Least Sandpiper, Semipalmated Sandpiper, Pectoral Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Snipe, American Woodcock

Whittlesey Creek NWR

Breeding: Wilson's Snipe
Migration: Wilson's Snipe, American Woodcock

Figure 1. Locations of Region 3 national wildlife refuges (NWRs) and wetland management districts (WMDs) that have a high management potential for shorebirds.