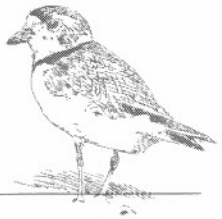
Shorebirds:

Overview for the Prairie Pothole Joint Venture

Figure 1. Boundaries of the Prairie Pothole Region (PPR) of North America. The Prairie Pothole Joint Venture is the U. S. portion of the PPR, and the Prairie Habitat Joint Venture (PHJV) is the Canadian portion of the PPR.

Shorebirds:



An Overview for the Prairie Pothole Joint Venture

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The Prairie Pothole Joint Venture (PPJV) historically has focused much of its efforts on waterfowl populations and waterfowl habitat. In its 1995 Implementation Plan, the PPJV expanded its scope to "stabilize or increase populations of declining wildlife species that depend on wetland/grassland complexes, with special emphasis on non-game migratory birds." The PPJV is embracing an integrated approach to wetland management that combines the needs of waterfowl and nongame species. Emphasis is being placed on the importance of relationships between species' life history requirements and seasonal habitat use, and the importance of managing wetlands to mimic historical water regimes for long-term productivity (see Appendix 2).

This document provides an overview of shorebirds in the prairie pothole region of the United States and Canada-what is known and what still needs to be done to better manage habitat for these migratory birds. The paper will first discuss what biologists and managers already know about shorebirds: natural history, migration ecology and management options that benefit breeding and migrant shorebirds in the region. Based on this information, the paper then proposes the creation of a shorebird habitat monitoring network. This network would assess the spatial and temporal availability of migration stopover habitat and assist in the coordination of management activities across a broad region. And finally, other research and education needs are highlighted.

PPJV Shorebird Community

Shorebirds are a diverse group of birds of the Order Charadriiformes. More than 50 species occur in North America, and 36 of these occur regularly in the PPJV (Table 1).

Breeding Populations:

Thirteen species of shorebirds breed within the PPJV and require habitat for nesting and brood rearing. Two of these species merit special attention: the piping plover, which is listed under the U.S. Endangered Species Act (ESA); and the mountain plover, which recently has been proposed for listing under the ESA.

Piping plovers have a limited distribution within the PPJV, mostly along the Missouri River corridor, in saline wetlands in central and northwestern North Dakota, and in central South Dakota. Mountain plovers are terrestrial shorebirds and within the PPJV are restricted to a few sites in northeastern Montana. The remaining eleven breeding species are more widely distributed within the PPJV and nest in a broad range of wetland and upland habitats, such as gravel substrates, edges of alkaline wetlands, and moderately vegetated mid-grass prairie (see Appendix 1).

Migratory Populations:

Twenty-three species of shorebirds migrate through the PPJV, some traveling up to 21,000 km annually between arctic breeding grounds in Canada and Alaska to wintering areas in Central and South America. The majority of spring migration through the PPJV extends from early April to early June and fall migration from early July through September, although the timing varies among species.

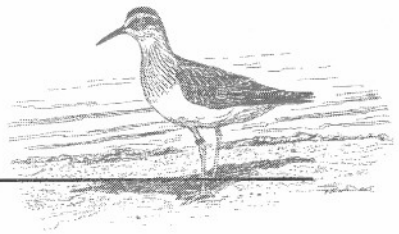
The PPJV hosts a substantial portion of the shorebirds in the vast midcontinent region, including more than 25% of the small shorebirds in spring (Table 2) and nearly 22% of medium-sized shorebirds in fall (Table 3). (Skagen et al 1998 derived these statistics by mapping shorebird distributions in 18 states and three Canadian provinces of midcontinental North America using information from a variety of sources.)

In spring, the region is especially important to long-distance migrants such as Baird's sandpiper, Hudsonian godwit, white-rumped sandpiper, and several other species of small and medium-sized sandpipers. In the fall, the region is important to medium-sized long-distance migrants such as American golden-plover, pectoral sandpiper and stilt sandpiper. Figures 2-5 present shorebird distributions within the PPJV and midcontinental North America during spring and fall for three groups based on bird body size (Skagen et al. 1998). Further information on distribution and timing of shorebird migration in the midcontinental United States can be viewed on the Internet at http://www.mesc.usgs.gov/shorebirds (Skagen et al. 1998).

Habitat Requirements:

As a group, shorebirds are morphologically diverse and use a wide range of habitat types, including dry grasslands, sand and gravel beaches, natural wetlands, and shallowly-flooded agricultural fields (Johnsgard 1981). During migrations in the midcontinent, shorebirds are associated primarily with shallow waters and moist mudflats of freshwater or alkaline wetlands. More than 70% of the species require water depths of less than 10 cm, and many are restricted to water depths of less than 5 cm; phalaropes generally forage in deeper water (Helmers 1992; Skagen et al. 1998).

Species vary in their use of foraging habitat, not only in relation to water depth, but also vegetation structure and distribution (Burger et al. 1977, Rundle and Fredrickson 1981, Colwell and Oring 1988, Hands 1988, Helmers 1991). Although shorebird foraging substrates range from bare (no vegetative cover) to vegetative cover exceeding 75%, most species use sites with less than 25% cover. Many shorebirds prefer vegetation height to be less than



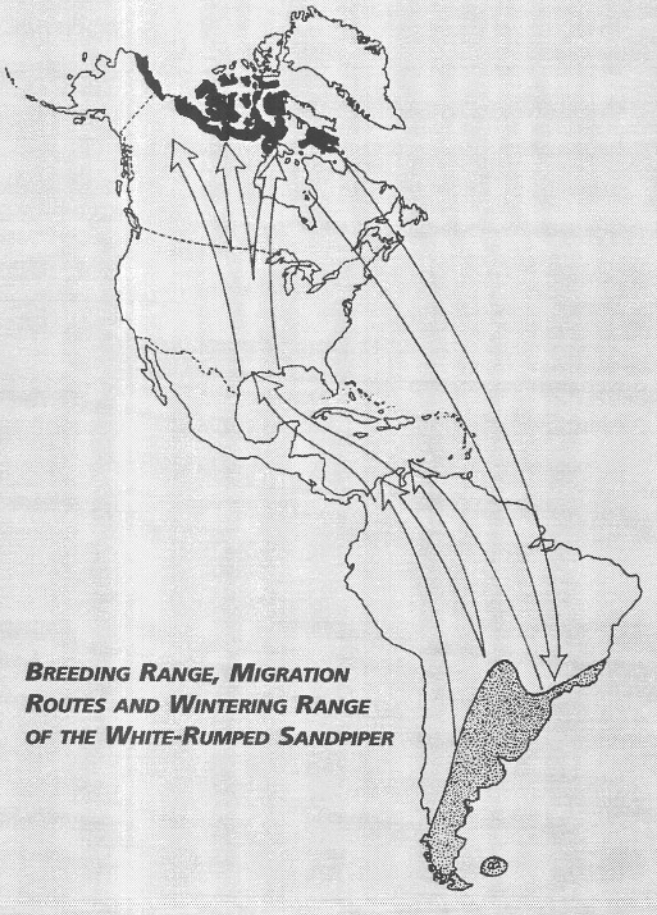
half of their body height, although some species forage in taller vegetation. Upland habitats associated with wetlands provide feeding and nesting habitats for several species (Ryan and Renken 1987, Ryan et al. 1984, Colwell and Oring 1988).

Importance Of Stopover Sites

The region from the Gulf of Mexico north through the Great Plains and prairies of Canada is one of the major migration routes for shorebirds in North America (Myers et al. 1987). This route traverses the PPJV, where shorebirds make extensive use of wetlands during their annual migrations. Because long-distance migrations are energetically expensive, shorebirds require these stopover sites where they can periodically rest and feed. Shorebirds consume vast quantities of invertebrates to fuel their journeys; availability of abundant food resources at migration stopovers is critical.

In the prairie potholes, dramatic fluctuations in water levels are commonplace, and shallow water and mudflat habitats are highly unpredictable in space and time. Because of the dynamic nature of wetlands within the PPJV, many shorebirds are opportunistic and dispersed across the changing landscape rather than concentrated at predictable staging areas as they are along the Atlantic and Pacific coasts.

Historically, the highly dynamic and diverse complexes of prairie wetlands probably provided nearly ideal habitat



Breeding Range, Migration Routes and Wintering Range of the White-Rumped Sandpiper

The white-rumped sandpiper (*Calidris fuscicollis*) is a long-distance migrant that depends on refueling areas in the PPJV during spring migration. This small calidrid shorebird, weighing an average of 40-50 grams, makes an annual round-trip migration of approximately 21,000 km, one of the longest bird migrations in the Western Hemisphere. In March and April, they depart their wintering grounds in Patagonia. Arrival in the United States occurs in May with surprisingly little latitudinal variation. By mid-May, large numbers begin to arrive in the Great Plains, some at key stopover sites and others scattered among smaller wetlands. In the PPJV, this species is especially numerous in the eastern Dakotas in late May. Here, they refuel before they proceed to the arctic breeding grounds in late May or early June. The brief breeding season is in June and July.

Adults begin the southward migration immediately after the breeding season with juveniles following one to two months later. In fall, white-rumped sandpipers gather along the northern Atlantic Coast and southern James Bay; very few birds use the Central Flyway. Fall migrants then make a non-stop trans-Atlantic flight before staging in northeastern South America. Most arrive on the Patagonian wintering grounds by early November.

options for migrating shorebirds. Wetland complexes ensure the occurrence of suitable habitat under a variety of climactic conditions and facilitate food searching by en-route migrants (Skagen and Knopf 1993, 1994; Farmer and Parent 1997). However, since European settlement, changes in land use with high impact on seasonal and ephemeral wetlands have probably impaired the ability of the ecosystem to consistently provide needed resources for this diverse group of wetland-dependent species.

Population Estimates

Currently there are no solid estimates of population sizes or population trends for shorebirds in the PPJV or for the interior of North America. Broad-scale monitoring of shorebirds across interior landscapes is a formidable challenge because of the vastness of the regions, the inaccessibility of many sites, and the variability of both wetland condition and shorebird occurrence. Scientists in the Great Basin, a region similarly vast and variable as the PPJV, estimate that an extensive effort of both ground and aerial surveys at multiple sites over a large region would require 7 to 23 years to detect 5-10% population declines (Warnock et al. 1998).

Despite long-term surveys in the eastern United States and along the Pacific Flyway, more information is needed to estimate shorebird population sizes and trends at continental and hemispheric scales. In 1997, the Manomet Center for Conservation Sciences and Federal Aid of US Fish & Wildlife Service initiated the US Shorebird Conservation Plan with the overall goal "to restore and maintain populations of all species of shorebirds in the Western Hemisphere". This goal necessitates estimates of population sizes and trends for all shorebird species. One of the Plan's many objectives is to develop a national shorebird monitoring protocol, soon to be completed. Preliminary estimates of hemispheric populations of all shorebirds are also being derived from a variety of sources including breeding, migration, and winter surveys (Morrison et al., in prep.). More information on the shorebird plan is available on the website for Manomet Center for Conservation Sciences at http://www.manomet.org/USSCP.htm.

Shorebird Habitat Management Tools

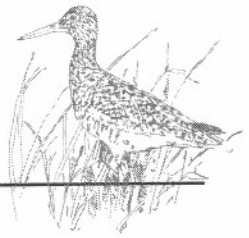
Managing for shorebirds in the PPJV is challenging for a variety of reasons. (1) Wetland conditions are dynamic and often unpredictable throughout the season and across the region; (2) migrating shorebirds are extremely mobile and will travel extensively and frequently to find suitable habitat; (3) there is a need to provide diverse wetland habitats for waterfowl and other wetland-dependent birds; (4) shorebird habitat is not easily monitored using remote sensing and GIS capabilities; (5) most wetlands are on private land; and (6) many wetlands do not have water management capabilities.

Even though managers must deal with these limitations, they do have tools at their disposal to maintain or increase shorebird use, including: water level manipulation; upland habitat management; restoration of wetlands and habitat protection. These tools are summarized below and further discussed in Appendix 1.

Water Level Manipulation:

Most wetlands in the PPJV are natural or restored wetlands on private lands with little or no opportunity for water level manipulation, and only a small proportion are managed wetlands with water control capabilities. Hence, approaches that require active water manipulations have limited application in this region.

There are times, however, when active water-level management for shorebirds could be critical. For example, biologists suspected that in the springs of 1993 and 1995, there was a grave shortage of suitable habitat for shorebirds across the broad region from Kansas to central North Dakota. During these two years with above normal spring water levels across the northern Great Plains, many of the ephemeral and seasonal wetlands were inundated,



with deep water extending into vegetated wetland margins. Because of this, the natural wetlands provided no unvegetated shallow water habitat, and there was little suitable migration stopover habitat for shorebirds. Although sheetwater covered fields in several areas, shorebirds were sighted there infrequently (Skagen, unpubl. data). It is during such times that active management for shorebirds may be particularly important.

Drawdown and reflooding of wetlands with water management capabilities can create habitat for shorebirds if proper attention is paid to timing, water depth, and duration. Moist-soil management—the process of drawing down or irrigating a wetland to create mudflats that promote germination of annual plants—can be especially effective (Appendix 1; Fredrickson and Taylor (1982) and Fredrickson (1991) have summarized generalized strategies and techniques for management of moist-soil units).

Not all managed wetlands can support shorebirds, however. Dugouts and other basins with steep banks may not provide shallow water habitat that is preferred by shorebirds. In western parts of the PPJV, water level management can affect salinity levels and, in turn, adversely impact invertebrate communities (van der Valk 1989, Wollheim and Lovvorn 1995, Rubega and Robinson 1997). Managers should also be aware of potential problems with avian botulism when fall drawdowns are implemented (Locke and Friend 1987).

Upland Habitat Management:
Wetland and grassland habitats in close juxtaposition are important to several interior-nesting shorebirds. Species such as marbled godwit and willet require a mosaic of wetland types from ephemeral to semi-permanent, interspersed with short to moderate height grasslands for nesting and brood rearing (Ryan et al. 1984, Ryan and Renken 1987). Habitat manipulations such as fire, grazing, and mowing can be used to alter the vegetative structure of wetlands and adjacent uplands (Ryan et al. 1984, Appendix 1). Successful nesting may also depend on hydrologic conditions during the breeding season (Johnsgard 1981, Ryan et al. 1984, Colwell and Oring 1988).

Habitat Protection and Restoration:
The protection and restoration of wetland habitat, which are priorities for waterfowl management in the PPJV, may also increase shorebird use. Emphasis should be placed on providing a diversity of wetland types for shorebirds so that shallow water habitat may be present under different climactic conditions. In addition, grassland easement programs for private lands (through the U.S. Fish & Wildlife Service and Ducks Unlimited) may also benefit shorebirds, especially if targeted on habitat providing critical value to shorebirds (e.g., saline systems for piping plover).

Important stopover sites can be nominated for special designation under the Western Hemisphere Shorebird Reserve Network (WHSRN), administered by Manomet Center for Conservation Sciences (Myers et al. 1987). Stopover sites can be classified as Hemispheric Sites (host at least 500,000 shorebirds annually, or 30% of the flyway population for a given species), International Sites (host at least 100,000 shorebirds annually, or 10% of the flyway population for a given species), or Regional Sites (host at least 20,000 shorebirds annually, or 5% of the flyway population for a given species). Within the PPJV, Benton Lake National Wildlife Refuge in Montana is currently the only WHSRN site. Plans call for the expansion of the WHSRN system in the PPR, and for sites recognized by WHSRN to receive benefits including management assistance, personnel training, and participation in the activities of the entire WHSRN network.

Considerable information on effective shorebird management at the local level (species and guild migration chronologies, habitat use, food requirements, and techniques for water manipulation) is summarized in Helmers (1992), Skagen (1997), and Skagen et al. (1998).

Shorebird Habitat Monitoring Network

Given the dynamics of variable wetland conditions and the mobility of shorebirds, managers need to work on a landscape scale to effectively manage for these birds. Currently, managers do not have a way to keep track of shorebird habitat conditions across the PPJV, nor do they have the ability to assess if, when and where habitat shortages (i.e., lack of suitable stopover habitat), or "ecological hurdles", occur. This knowledge would enhance their abilities to manage habitat for shorebirds and target areas for habitat acquisition, protection and restoration.

Therefore, a proposal is being made for the creation of a regional, internet-based communication network that would keep land managers and biologists appraised of the distribution and status of shorebird stopover habitat during migration and shorebird movements within the U.S. interior (see page 7). The communication network would also provide guidance on the necessity, timing, and extent of habitat management actions, and would enable land managers to prioritize and coordinate management activities on a landscape scale. The management planning process would also carefully consider potential effects on other wetland-dependent species.

The proposed network would:

1. assess the status of migratory stopover habitat for shorebirds and determine if, where, and when critical habitat shortages occur.

2. identify ecological hurdles and target these areas for adaptive management.

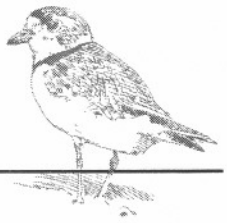
3. provide instantaneous interpretation of the habitat data so that managers can choose management actions in a timely fashion.

4. provide current information on habitat conditions and distribution to be used by concurrent population monitoring programs to stratify survey effort.

5. assist in building, testing, and refining models that predict habitat availability for shorebirds based on remote sensing technology and climate information.

6. provide information that land managers and the general public can use to further our understanding of shorebird migration in this region. The internet site will provide links to shorebird management documents and will facilitate acquisition of new shorebird distribution information.

The proposed shorebird habitat monitoring network would link refuges and other land managers into a cohesive group, capable of monitoring habitat availability and general shorebird movements during migratory periods. Participants would be trained to ensure that efforts would be coordinated and that standardized procedures would be used. Information would be summarized weekly.



Proposed Approach for Shorebird Management in the Prairie Pothole Joint Venture

The Challenge

- To provide breeding and stopover resources for shorebirds

Constraints

- Wetland conditions are dynamic and unpredictable in time and space
- Need to consider requirements of a diverse wetland bird community
- Lack of water management capabilities in most wetlands
- Most wetland habitat is on private lands
- Habitat not easily monitored using remote-sensing & GIS capabilities

Approach

- Internet-based communication system to monitor shorebird habitat during migration
- Assess if, when, and where habitat shortages (i.e., "ecological hurdles") occur
- When "ecological hurdle is detected, recruit wetlands with water control capabilities for active management
- Apply habitat and water management tools when necessary
- Identify areas for habitat acquisition and restoration
- Coordinate with shorebird monitoring efforts

(from Skagen and Pelizza, unpublished proposal)

Education Needs

There is a need to inform land managers about the potential for managing their wetlands for a diversity of wildlife. There is also a need to promote further involvement of private landowners in shorebird conservation initiatives because a significant portion of shorebird habitat is on private land. These needs can be approached by providing workshops and technical information to public and private land managers, by developing and distributing educational materials, and by providing technical assistance. Brochures, web sites, and other educational materials can familiarize landowners with wetland-dependent wildlife, including shorebirds, and provide general information on species requirements and wetland enhancement techniques. Cooperation between private, state, and federal agencies could further enhance the effectiveness of educational efforts.

Research Needs

There is still much to learn about shorebirds and their use of the PPJV. This region contains considerable shorebird habitat that is ephemeral, and as a result, the abundance and distribution of shorebirds are highly variable. The following topics need further research so that the PPJV can effectively manage for shorebirds and contribute to the regional goals of the US Shorebird Conservation Plan.

These goals are to (1) provide sufficient high-quality habitat to ensure that shorebirds in each region are not limited by availability or configuration of habitat, (2) ensure that efforts to provide habitat for shorebirds are integrated into multiple species habitat management initiatives where appropriate, and (3) increase understanding of how local habitat conditions affect shorebird abundance and use of a region and, in turn, how conditions affect hemispheric shorebird populations.

Issues to be addressed include:

- Shorebird use of temporary flooded fields, including the timing of recolonization of these sites by chironomids and their exploitation by shorebirds. The status, abundance, and availability of invertebrate food resources in agricultural fields are not known.

- Assessment of body condition (trends through time and variation) relative to availability and distribution of food resources. Is body condition a useful indicator of overall habitat quality at a regional scale?

- Duration of stay and turnover rates at stopover sites to be used to refine population estimates.

- Modeling of wetland conditions, availability, and shorebird habitat use under various weather and climate regimes using remote sensing information and shorebird distribution data.

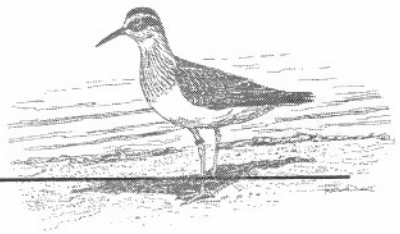
- Effects of pesticides and herbicides on shorebird food availability.

- Understanding the scale of shorebird dispersal within the PPJV. Specifically, do shorebirds concentrate at particular sites, and, if so, does this vary seasonally?

- Use of genetic markers to delineate shorebird subpopulations, if they exist.

- Species-specific flexibility in microhabitat use during migration.

- Potential for shorebird management, given this information.



Summary

The Prairie Pothole Joint Venture is committed to an integrated approach to wetland management that addresses the needs of many wildlife species, including waterfowl, shorebirds, and other wetland-dependent species. A landscape conservation approach involving both public and private lands is important in reaching these goals. Thirteen species of shorebirds breed within the PPJV, and 23 species migrate through on energetically expensive, long distance migrations, seeking abundant food resources and resting areas with minimal disturbance. The PPJV hosts a substantial portion of the shorebirds in the vast midcontinent region, including more than 25% of the small shorebirds in spring and nearly 22% of medium-sized shorebirds in fall. Because of the dynamic nature of wetlands within the PPJV, many shorebirds are opportunistic and dispersed across the changing landscape. Since European settlement, changes in land use have probably impaired the ability of the ecosystem to consistently provide for the resource needs of this diverse group of wetland-dependent birds.

Managing for shorebirds in the PPJV is challenging because of the dynamic nature of wetland condition in time and space and because of the need to provide diverse wetland habitats for waterfowl and other wetland-dependent birds. Effective management for migratory shorebirds requires knowledge of chronologies, of nesting and foraging habitat requirements of several guilds of breeding and migrating shorebirds, and of available habitat management tools. To address these needs, In addition, an internet-based communication network to enable land managers to focus, prioritize, and coordinate habitat management actions on a regional scale is proposed.

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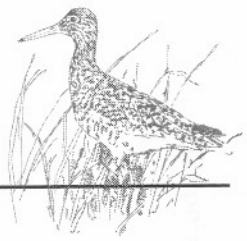

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Table 1. *Status [breeder (B) or migrant (M)], body size [small (S), medium (M), or large (L)][1], seasonal abundance [spring (S) and fall (F)][2], and foraging guilds[3] of shorebirds occurring in the PPJV.*

Species	Status	Body size	Seasonal abundance	Foraging guild
Black-bellied Plover	M	M	S: Uncommon, F: Uncommon	terrestrial/aquatic gleaner
American Golden-Plover	M	M	S: Common, F: Uncommon	terrestrial/aquatic gleaner
Semipalmated Plover	M	S	S: Common, F: Common	terrestrial/aquatic gleaner
Piping Plover	B/M	S	S: Rare, F: Rare	terrestrial/aquatic gleaner
Killdeer	B/M	M	S: Common, F: Common	terrestrial/aquatic gleaner
Mountain Plover	B/M	M	S: Rare, F: Rare	terrestrial gleaner
Black-necked Stilt	B/M	L	S: Rare, F: Rare	aquatic gleaner/sweeper
American Avocet	B/M	L	S: Common, F: Common	aquatic gleaner/sweeper
Greater Yellowlegs	M	M	S: Common, F: Common	aquatic gleaner
Lesser Yellowlegs	M	M	S: Common, F: Common	aquatic gleaner
Solitary Sandpiper	M	M	S: Common, F: Common	aquatic gleaner
Willet	B/M	L	S: Uncommon, F: Uncommon	aquatic gleaner
Spotted Sandpiper	B/M	M	S: Common, F: Common	terrestrial/aquatic prober/gleaner
Upland Sandpiper	B/M	M	S: Uncommon, F: Uncommon	terrestrial/aquatic gleaner
Whimbrel	M	L	S: Rare, F: Rare	terrestrial/aquatic gleaner/prober
Long-billed Curlew	B/M	L	S: Uncommon, F: Uncommon	terrestrial/aquatic gleaner/prober
Hudsonian Godwit	M	L	S: Uncommon, F: Rare	aquatic prober
Marbled Godwit	B/M	L	S: Uncommon, F: Rare	aquatic prober
Ruddy Turnstone	M	M	S: Rare, F: Rare	terrestrial/aquatic gleaner/prober
Red Knot	M	M	S: Rare, F: Rare	aquatic prober/gleaner
Sanderling	M	M	S: Uncommon, F: Uncommon	aquatic prober/gleaner
Semipalmated Sandpiper	M	S	S: Common, F: Common	aquatic prober/gleaner
Western Sandpiper	M	S	S: Rare, F: Uncommon	aquatic prober/gleaner
Least Sandpiper	M	S	S: Common, F: Common	aquatic prober/gleaner
White-rumped Sandpiper	M	S	S: Common, F: Rare	aquatic prober/gleaner

Table 1 (continued). *Status [breeder (B) or migrant (M)], body size [small (S), medium (M), or large (L)][1], seasonal abundance [spring (S) and fall (F)][2], and foraging guilds[3] of shorebirds occurring in the PPJV.*

Species	Status	Body size	Seasonal abundance	Foraging guild
Baird's Sandpiper	M	S	S: Common, F: Common	aquatic prober/gleaner
Pectoral Sandpiper	M	M	S: Common, F: Common	aquatic prober/gleaner
Dunlin	M	M	S: Common, F: Uncommon	aquatic prober/gleaner
Stilt Sandpiper	M	M	S: Common, F: Common	aquatic prober/gleaner
Buff-breasted Sandpiper	M	M	S: Uncommon, F: Uncommon	terrestrial/aquatic gleaner
Short-billed Dowitcher	M	M	S: Common, F: Common	aquatic prober/gleaner
Long-billed Dowitcher	M	M	S: Common, F: Common	aquatic prober/gleaner
Common Snipe	B/M	M	S: Common, F: Common	aquatic prober/gleaner
American Woodcock	B/M	M	S: Uncommon, F: Uncommon	terrestrial/aquatic prober
Wilson's Phalarope	B/M	M	S: Common, F: Common	aquatic/pelagic gleaner
Red-necked Phalarope	M	M	S: Uncommon, F: Uncommon	aquatic/pelagic gleaner

[1]After Skagen and Knopf (1993)

[2]Common: Very likely to be seen in the appropriate habitat.

Uncommon: Present, but likely to be seen only in small numbers.

Rare: Not likely to be seen, and then only in small numbers.

[3]After Helmers (1992)

Table 2. Maximum numbers of shorebirds reported at important spring stopover sites in the Prairie Pothole Joint Venture (PPJV). Percentages are based on the sums of maximum counts reported within midcontinental North America (from Skagen et al. 1998).

	Location	Count
All shorebirds		
1.	Minnewaukan Flats, Devil's Lake, Benson Co., ND	82,789
2.	Dry Lake, Clark Co., SD	53,979
3.	Lake Thompson, Kingsbury Co., SD	20,675
4.	Minot sewage lagoons, Ward Co., ND	18,063
5.	Milwaukee Lake, Lake Co., SD	16,661
6.	Lake County, SD	12,822
7.	Blue Lake, McLean Co., ND	12,620
8.	Devil's Lake sewage ponds, Ramsey Co., ND	11,244
9.	Benton Lake NWR, Cascade Co., MT	10,266
10.	Kingsbury County, SD	9,010
Total of all shorebirds in the PPJV		***428,846***
Percentage of all shorebirds in midcontinent region		***14.7%***
Large shorebirds		
1.	Benton Lake NWR, Cascade Co., MT	3,127
2.	Lake Thompson, Kingsbury Co,. SD	1,083
3.	Minot sewage lagoons, Ward Co., ND	720
4.	Minnewaukan Flats, Devil's Lake, Benson Co., ND	710
5.	Kingsbury County, SD	692
6.	West of Horsehead Lake, Kidder Co., ND	687
7.	Granville, McHenry Co., ND	650
8.	Northwest of Medina, Kidder Co., ND	444
9.	Denbigh, McHenry Co., ND	414
10.	East of Cherry Lake, Kidder Co., ND	401
Total of all large shorebirds in the PPJV		***18,830***
Percentage of large shorebirds in midcontinent region		***5.0%***

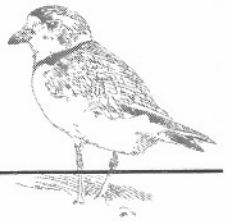


Table 2. (continued) Maximum numbers of shorebirds reported at important spring stopover sites in the Prairie Pothole Joint Venture (PPJV). Percentages are based on the sums of maximum counts reported within midcontinental North America (from Skagen et al. 1998).

	Location	Count
Medium shorebirds		
1.	Minnewaukan Flats, Devil's Lake, Benson Co., ND	36,300
2.	Dry Lake, Clark Co., SD	12,267
3.	Lake Thompson, Kingsbury Co., SD	10,281
4.	Minot sewage lagoons, Ward Co., ND	9,032
5.	Kingsbury County, SD	8,107
6.	Freezeout Lake, Teton Co., MT	7,559
7.	Milwaukee Lake, Lake Co., SD	7,210
8.	Benton Lake NWR, Cascade Co., MT	6,832
9.	Lake County, SD	6,503
10.	Medicine Lake NWR, Sheridan Co., MT	5,458
Total of all medium shorebirds in the PPJV		***195,565***
Percentage of medium shorebirds in midcontinent region		***13.1%***
Small shorebirds		
1.	Minnewaukan Flats, Devil's Lake, Benson Co., ND	45,779
2.	Dry Lake, Clark Co., SD	41,247
3.	Blue Lake, McLean Co., ND	11,529
4.	Milwaukee Lake, Lake Co., SD	9,375
5.	Lake Thompson, Kingsbury Co., SD	9,311
6.	Minot sewage lagoons, Ward Co., ND	8,311
7.	Devil's Lake sewage ponds, Ramsey Co., ND	6,949
8.	Lake County, SD	6,304
9.	Sheyenne Lake, Eddy Co., ND	5,665
10.	Kcorn wetland, T17N R56W S22-23, Clark Co., SD	5,653
Total of all small shorebirds in the PPJV		***214,451***
Percentage of small shorebirds in midcontinent region		***26.3%***

Table 3. Maximum numbers of shorebirds reported at important fall stopover sites in the Prairie Pothole Joint Venture (PPJV). Percentages are based on the sums of maximum counts reported within midcontinental North America (from Skagen et al. 1998).

	Location	Count
All shorebirds		
1.	Minnewaukan Flats, Devil's Lake, Benson Co., ND	63,889
2.	Devil's Lake, Ramsey Co., ND	23,800
3.	North Dakota State University, Fargo, Cass Co., ND	22,146
4.	Benton Lake NWR, Cascade Co., MT	17,748
5.	Union Slough NWR, Kossuth Co., IA	14,960
6.	Minot sewage lagoons, Ward Co., ND	11,227
7.	J. C. Salyer NWR, McHenry/Bottineau counties, ND	9,975
8.	North of Grand Forks lagoons, Grand Forks Co., ND	8,081
9.	Benson County, ND	5,770
10.	Wells County, ND	5,703
Total of all shorebirds in the PPJV		***303,683***
Percentage of all shorebirds in midcontinent region		***14.5%***
Large shorebirds		
1.	Long Lake NWR, Burleigh/Kidder Co., ND	2,220
2.	Minnewaukan Flats, Devil's Lake, Benson Co., ND	2,020
3.	Benton Lake NWR, Cascade Co., MT	1,533
4.	Devil's Lake, Ramsey Co., ND	1,019
5.	Arrowwood NWR, Stutsman Co., ND	554
6.	Lisbon, Ransom Co., ND	426
7.	Minot sewage lagoons, Ward Co., ND	348
8.	Veseth wetlands, Phillips Co., MT	250
9.	Southeast of Waubay, Day Co., SD	190
10.	Steele County, ND	174
Total of all large shorebirds in the PPJV		***11,386***
Percentage of large shorebirds in midcontinent region		***2.4%***

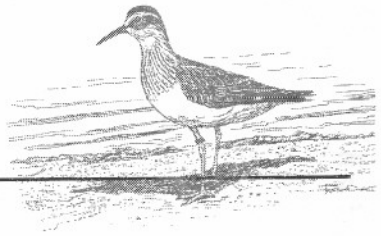


Table 3. (continued) Maximum numbers of shorebirds reported at important fall stopover sites in the Prairie Pothole Joint Venture (PPJV). Percentages are based on the sums of maximum counts reported within midcontinental North America (from Skagen et al. 1998).

	Location	Count
Medium shorebirds		
1.	Minnewaukan Flats, Devil's Lake, Benson Co., ND	54,816
2.	Devil's Lake, Ramsey Co., ND	21,125
3.	North Dakota State University, Fargo, Cass Co., ND	19,769
4.	Benton Lake NWR, Cascade Co., MT	15,673
5.	Union Slough NWR, Kossuth Co., IA	12,426
6.	J. C. Salyer NWR, McHenry/Bottineau counties, ND	9,715
7.	Minot sewage lagoons, Ward Co., ND	9,312
8.	North of Grand Forks lagoons, Grand Forks Co., ND	6,099
9.	Wells County, ND	5,703
10.	Benson County, ND	5,491
Total of all medium shorebirds in the PPJV		***252,268***
Percentage of medium shorebirds in midcontinent region		***21.6%***
Small shorebirds		
1.	Minnewaukan Flats, Devil's Lake, Benson Co., ND	7,053
2.	McHenry and Wells counties, ND	3,000
3.	Union Slough NWR, Kossuth Co., IA	2,533
4.	North Dakota State University, Fargo, Cass Co., ND	2,363
5.	North of Grand Forks lagoons, Grand Forks Co., ND	1,884
6.	Orwell WMA, Otter Tail Co., MN	1,753
7.	Denbigh, McHenry Co., ND	1,690
8.	Devil's Lake, Ramsey Co., ND	1,656
9.	Minot sewage lagoons, Ward Co., ND	1,567
10.	Grand Forks AFB, Grand Forks Co., ND	826
Total of all small shorebirds in the PPJV		***40,030***
Percentage of small shorebirds in midcontinent region		***8.7%***

Figure 2. Seasonal use of the Prairie Pothole Region of North America by migrating shorebirds of all sizes (based on maximum counts at more than 3000 sites). Modified from Skagen et al. (1998).

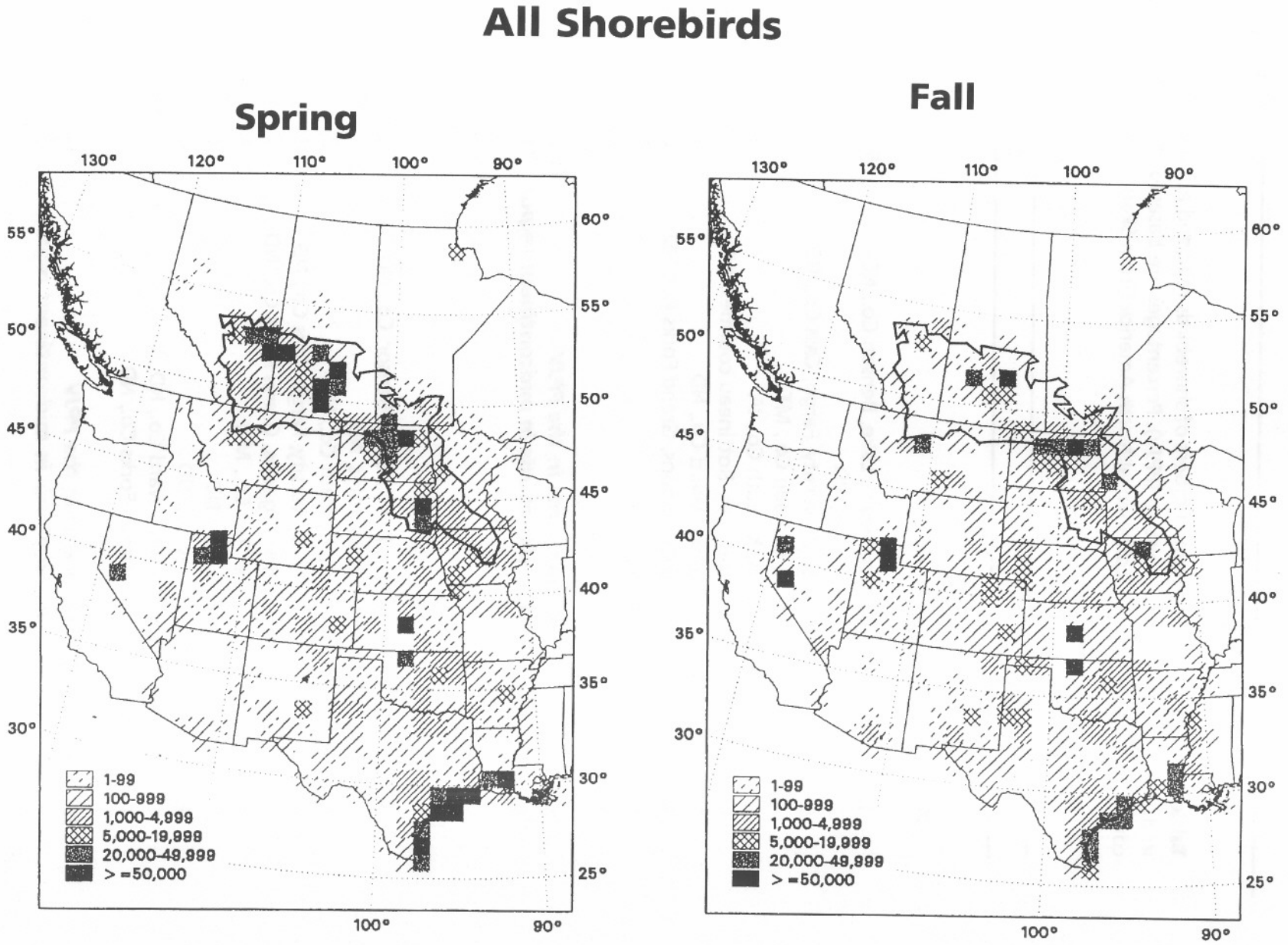


Figure 3. Seasonal use of the Prairie Pothole Region of North America by migrating small shorebirds (based on maximum counts at more than 3000 sites). Modified from Skagen et al. (1998).

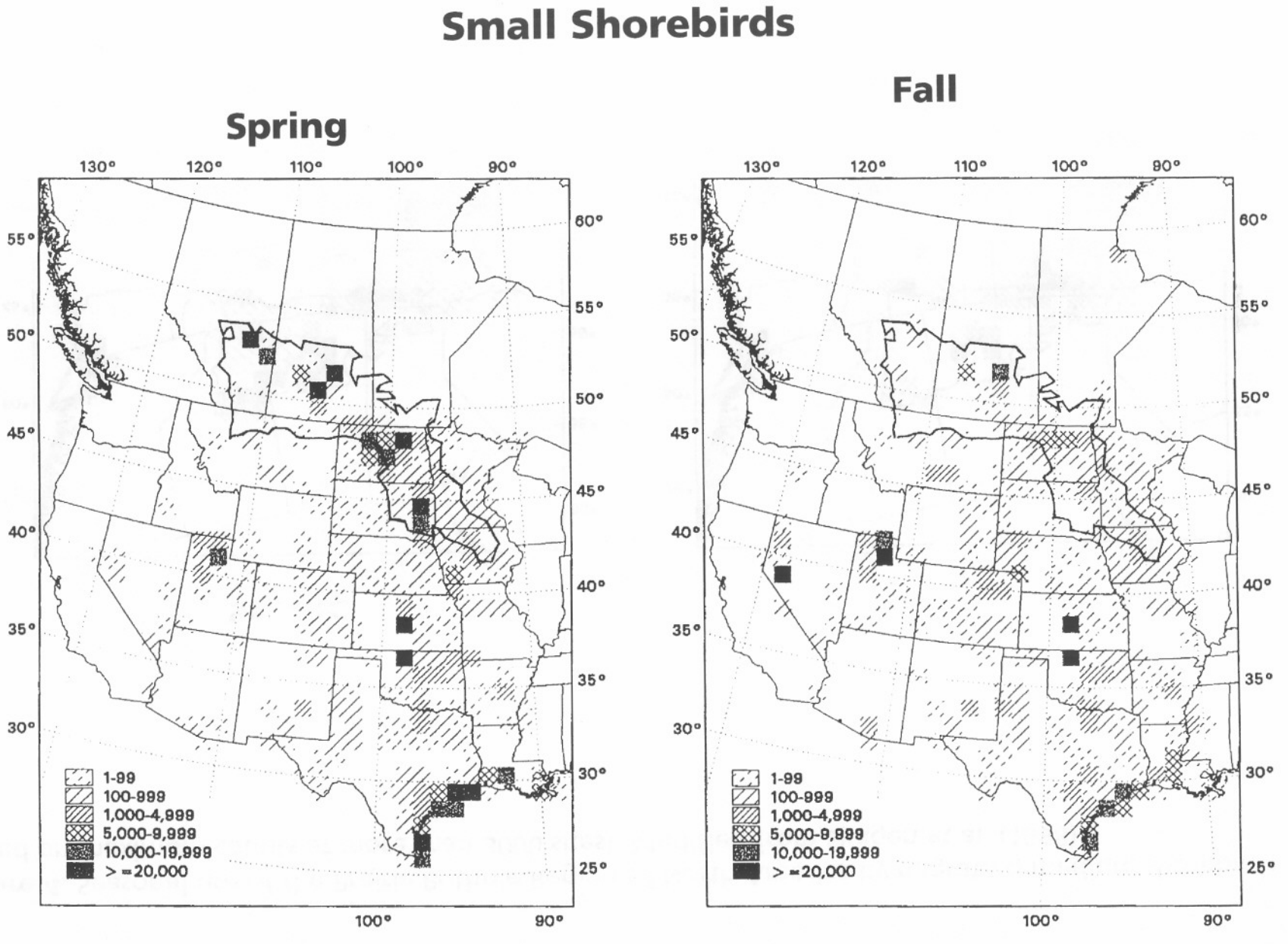


Figure 4. Seasonal use of the Prairie Pothole Region of North America by migrating medium shorebirds (based on maximum counts at more than 3000 sites). Modified from Skagen et al. (1998).

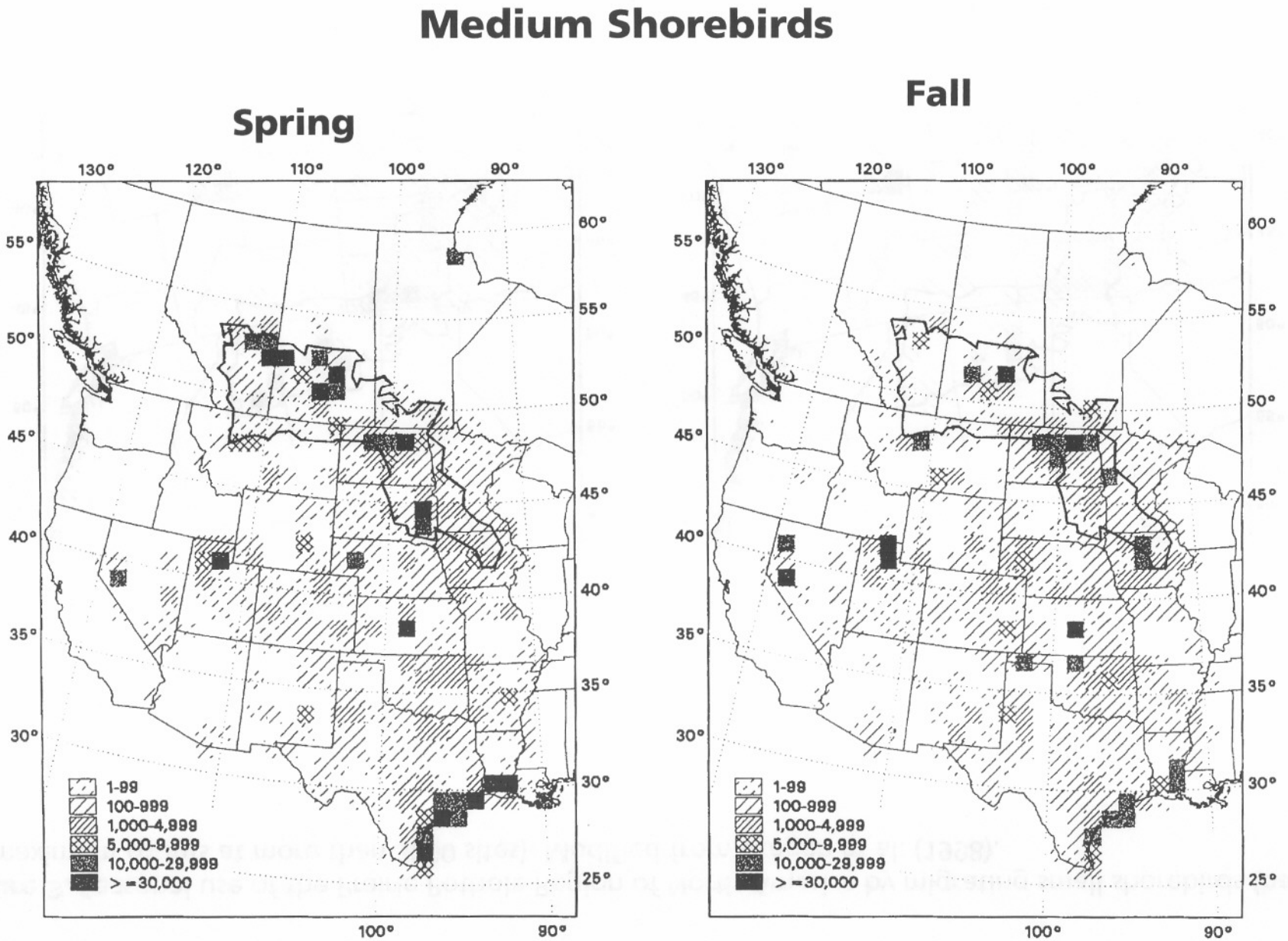
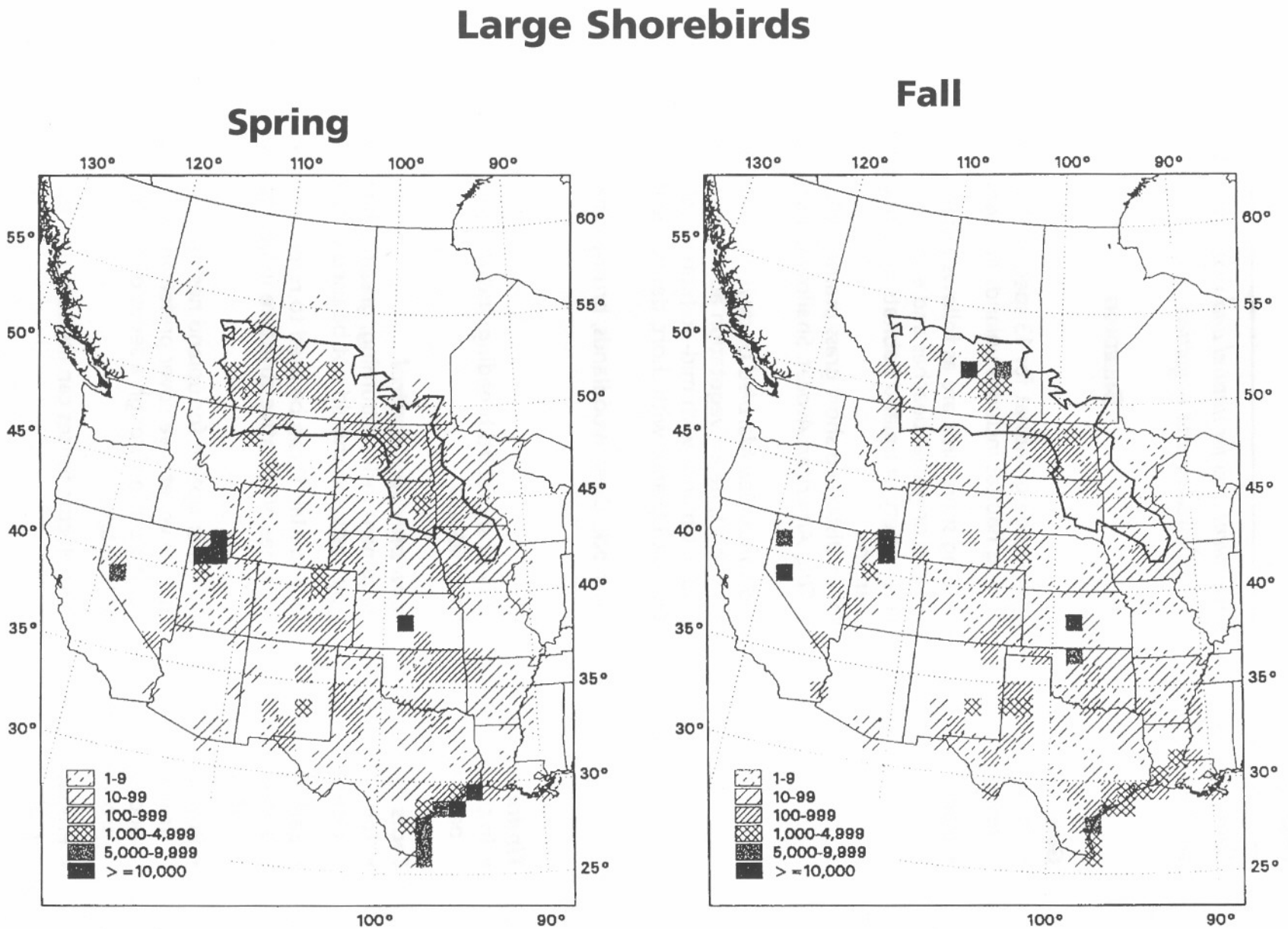


Figure 5. Seasonal use of the Prairie Pothole Region of North America by migrating large shorebirds (based on maximum counts at more than 3000 sites). Modified from Skagen et al. (1998).



Appendix 1:

Summary of habitat management tools for natural and managed wetlands in the Prairie Pothole Joint Venture during shorebird breeding and migration

BREEDING

Goal

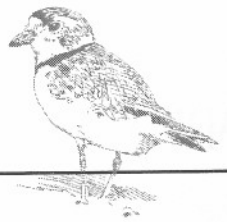
- To provide appropriate breeding habitat for 13 species of shorebirds that nest in this region (Table 1). Breeding habitat includes uplands and wetlands in close juxtaposition.
- Habitat needs for breeding shorebirds are as follows (after Ehrlich et al. 1988):
  - *Piping Plover.* Sand or gravel beaches and edges of alkaline wetlands.
  - *Killdeer.* A wide variety of upland habitats including pastures, fields, and wetland margins.
  - *Mountain Plover.* Disturbed short grass prairie with extensive bare ground.
  - *Black-necked Stilt, American Avocet.* Shallow marshes, ponds, and alkaline wetlands.
  - *Willet, Spotted Sandpiper, Marbled Godwit, Common Snipe, Wilson's Phalarope.* Uplands with short, dense vegetation adjacent to wetlands.
  - *Upland Sandpiper.* Uplands with mid- to high vegetation.
  - *Long-billed Curlew.* Uplands with short, dense vegetation, sometimes near wetlands.
  - *American Woodcock.* Open woodlands, brushy areas, or uplands, usually near water.

Timing and duration

- In the PPJV, the majority of shorebird breeding, including territory establishment, occurs between mid-April and mid-July.

Tools for vegetation and predator control

- Tools for upland management include burning, grazing, haying, and mowing. These techniques may destroy nests and should not be used during the breeding season[1].
- Early spring burns (prior to May 1) can be used to remove vegetative cover in uplands and gravel or sandy beaches. Vegetative structure in uplands may be optimal the year after burning.
- Rotational grazing is another option for upland nesting species. Light to moderate grazing provides moderate vegetative cover preferred by species such as marbled godwit and willet. Moving cattle through a series of management units during the year provides a diversity of habitats.
- Predator barriers such as electric fences can increase nesting success, as illustrated for piping plovers[2]



- Creation of nesting islands on restored wetlands and conversion of peninsulas to islands have been used successfully to reduce predation on shorebird nests. However, islands may attract nesting gulls that may negatively impact breeding shorebirds.

Migration

Goal

- To provide extensive areas of shallow water, preferably with vegetative cover of less than 25% during migration[3-7]. Small shorebirds require water depths below 4-5 cm, medium and large shorebirds can use water up to 12 or 20 cm, respectively.
- Because shorebirds are flexible in their choices of invertebrate foods, management should focus on enhancement of naturally occurring populations of invertebrates[8].

Timing

- In the PPJV, the majority of shorebird migration occurs from early April through early June in spring and from early July through September in fall.

Water and vegetation control

- Flood managed wetlands before migration to allow invertebrates to re-colonize; flood during the fall/winter prior to spring migration and by early July for fall migration. Lower water approximately 2-3 cm per week. To provide habitat for the full range of species throughout migration, draw down individual wetlands at different rates and/or times[3-5].
- Dense vegetation in natural ephemeral, temporary, and seasonal wetlands may be removed by burning or mowing after the basins have dried in late summer/fall or by mowing over ice in winter[9].
- Vegetation of managed wetlands may need to be burned or disked before re-flooding. The litter resulting from mowing and shallow disking will increase substrate for invertebrates[9].

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[1]Hotker 1991, [2]Mayer and Ryan 1991, [3]Rundle and Fredrickson 1981, [4]Hands et al. 1991, [5]Helmers 1992, [6]Colwell and Oring 1988, [7]Eldridge 1990, [8]Skagen and Oman 1996, [9]Fredrickson and Reid 1986.

Appendix 2:

The North American Waterfowl Management Plan and the Prairie Pothole Joint Venture

The United States and Canada signed the North American Waterfowl Management Plan (NAWMP) in 1986. This agreement recognizes that waterfowl are an indicator of environmental health and provides a framework for recovering waterfowl populations and reversing wetland destruction. The goal of the Plan is to restore waterfowl populations to levels of the mid-1970s (62 million breeding ducks and a fall flight of 100 million ducks) by improving and acquiring six million acres (2.4 million ha) of habitat within 34 areas of concern. Since the Plan was signed, additional agreements with Mexico and further legislation such as the North American Wetlands Conservation Act of 1989 have provided increased funding opportunities for wetland and waterfowl conservation.

The Prairie Pothole Joint Venture (PPJV) is one of six original joint ventures under NAWMP and was formed in 1987. The region covered by the PPJV includes portions of five Great Plains states: Montana, North Dakota, South Dakota, Minnesota, and Iowa (Figure 1). The PPJV is part of the larger Prairie Pothole Region (PPR) which also includes the Prairie Habitat Joint Venture (PHJV), a region of grasslands, shallow lakes, and marshes in the Canadian Provinces of Alberta, Saskatchewan, and Manitoba. Since European settlement, the PPJV has experienced extensive wetland losses that vary by state, from 27% in Montana to 98% in Iowa (Prairie Pothole Joint Venture 1996).

The objectives of the PPJV are: (1) by the year 2001, conserve habitat capable of supporting 6.8 million breeding ducks with a 0.6 recruitment rate and an average fall flight of 9.5 million ducks; and (2) stabilize or increase populations of declining wildlife species that depend on wetland/grassland complexes, with special emphasis on non-game migratory birds.

To meet these objectives, the following habitat goals need to be achieved: (1) protect 2 million acres of wetland and associated upland habitat; (2) restore 745,000 acres of wetland and associated upland habitat; and (3) enhance 3.7 million acres of wetland and associated upland habitat.