Implications of Different Shorebird Migration Strategies for Habitat Conservation[1]

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Abstract

Shorebird migration strategies vary by species, migration distance and route, time of year, and resources at staging and stopover sites. The Western Hemisphere Shorebird Reserve Network has been highly successful in the identification, designation, and protection of important migration habitats for many species that stage in traditional areas. Recently, conservation efforts also focus on species and populations that disperse broadly on the landscape and that exhibit opportunistic use of available habitat in highly dynamic wetland systems. This unpredictability makes the conservation of wetland stopover habitats in the interior of North America highly challenging. We present an approach to identifying landscapes and wetlands critical to en route migrants in extensive ephemeral wetland systems.

Key words: ephemeral wetlands, migration stopover areas, shorebirds, wetland conservation.

Introduction

Shorebird migration strategies vary by species, migration distance and route, time of year, and resources at staging and stopover sites. There are several well-known examples of species or populations that stage in few key sites for long periods of time, lay on considerable fat stores, and 'jump' long distances (Myers et al. 1987, Piersma 1987). The Western Hemisphere Shorebird Reserve Network (WHSRN), a voluntary, non-regulatory coalition of more than 240 private and public organizations in seven countries, has been highly successful in the identification, designation, and protection of important migration habitats for many of these species groups (http://www.manomet.org/srn/; Harrington and Perry 1996). Currently, WHRSN has 54 designated sites totaling 20 million acres at the international, hemispheric, national, and regional levels.

Recently, conservation efforts also focus on species and populations that refuel only briefly at stopover sites, disperse broadly on the landscape, and 'hop' shorter distances between sites (Skagen 1997, Haig et al. 1998, Warnock et al. 1998). Many shorebirds crossing the North American interior exhibit opportunistic use of available habitat in highly dynamic wetland systems (Skagen and Knopf 1993, 1994; Warnock et al. 1998). In such systems, the use of specific wetlands within and between years is highly unpredictable.

The prairie wetlands of the glaciated regions of the northern U.S. Great Plains and into Canada, a region commonly referred to as the prairie pothole region (PPR), provides stopover resources for large populations of long- and intermediate-distance migrant during spring and fall (*fig. 1*; Skagen and Knopf 1993, Skagen et al. 1999). The PPR covers more than 700,000 km^2 and extends from north-central Iowa to central Alberta. During the Pleistocene Epoch, retreating glaciers carved a landscape dotted with millions of depressional wetlands or potholes. The climate of the PPR is highly dynamic with great interannual variation in rainfall, resulting in a complex association between prairie wetlands and groundwater tables (Euliss et al. 1999) and highly variable water levels in these extensive ephemeral wetland systems.

The unpredictability of shorebird habitat availability and the broad dispersion of migrating shorebirds in the PPR make conservation of critical wetland stopover habitats highly challenging. For example, wetlands that host large numbers of birds in one year may have no suitable shorebird habitat during many other years because conditions are too wet or too dry. In spring 1992, peak counts of all shorebird species at Dry Lake, Clark County, South Dakota, US, totaled more than 50,000 birds (Skagen 1997), yet waters were too deep for shorebird use from 1993 – 2002 (S. Skagen, unpubl. data). The extensive mudflats of Minnewaukan Flats, Devil's Lake, North Dakota, US, hosted more than 80,000 shorebirds during spring 1993 (Skagen 1997); this area has been inundated with water from fall 1993 to the present. When important sites are unsuitable, the

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challenge is to determine whether shorebirds overfly the region, congregate in alternate sites, or disperse across the landscape.

An approach to identifying landscapes and wetlands critical to en route migrants is clearly needed for habitat management, conservation, and restoration efforts in extensive ephemeral wetland systems. Such an approach would differ substantially from successful approaches in landscapes with fewer wetlands and in which the presence of shorebird habitat is more predictable. We are developing an approach that incorporates habitat and landscape modeling at multiple scales and under various climate regimes and that will be useful in apportioning shorebird survey effort and interpreting shorebird distribution and abundance data in wet, dry, and transition years.

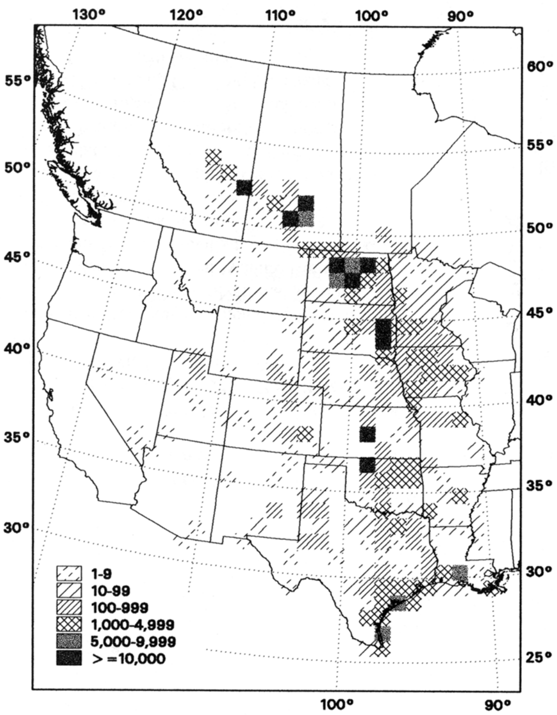

Figure 1— Distribution of long-distance migrating shorebirds in spring throughout midcontinental North America (reprinted with permission from Skagen et al. 1999).

Methods

We used a training dataset collected in eastern South Dakota during April and May of 1991, 1992, 1993, and 1995, during which we conducted shorebird surveys and recorded habitat conditions in 212 wetlands across 12 counties. Each wetland was buffered at various radii (1 km, 3 km and 5 km), and total area of wetlands of various types (temporary, seasonal, semipermanent, and permanent palustrine wetlands, and lacustrine systems), and total area of various land use types (grassland, cropland, and other) were determined using U.S. Fish and Wildlife Service National Wetland Inventory data and U.S. Fish and Wildlife Service land use database. Using AIC modeling techniques (Burnham and Anderson 1998) in an exploratory, not confirmatory, fashion, we constructed numerous habitat and landscape models and selected the most parsimonious models. This information was then used to define landscape types in an experimental design for a new field effort.

Our analyses included following predictor variables based on wetland attributes (wetland type [temporary, seasonal, semi-permanent, and permanent palustrine], wetland area and perimeter, area of habitat suitable [defined for each species of interest; for most Calidrid species, suitable habitat is the area of unvegetated wet mud and shallow water], and area of vegetated habitat), and landscape attributes within buffers of 1, 3, and 5 km radii (area of temporary and seasonal wetlands, area of semi-permanent palustrine wetlands and lakes, area of all wetland types combined, area of cropland [tilled annually], and area of grassland [including hayland, CRP, and pasture]). We ran logistic regression models based on shorebird presence during species-specific migration windows (the time period during which 90 percent of sightings occurred) and linear regression models using only wetlands with the species of interest present, again during species-specific migration windows (90 percent).

Results

Especially common in the PPR during spring are long-distance migrating shorebirds (*fig. 1*), species that travel an average of more than 14,000 km, including American Golden Plover (*Pluvialis dominica*), Hudsonian Godwit (*Limosa haemastica*), White-rumped Sandpiper (*Calidris fuscicollis*), Baird's Sandpiper (*C. bairdii*), Pectoral Sandpiper (*C. melanotos*), and Stilt Sandpiper (*C. himantopus*). Intermediate-distance migrants, species that traverse on average 6,000 - 12,000 km, that commonly stop over in the PPR include Lesser Yellowlegs (*Tringa flavipes*), Semipalmated Sandpiper (*C. pusilla*), Least Sandpiper (*C. minutilla*), and Long-billed Dowitcher (*Limnodromus scolopaceus*).

The most parsimonius logistic regression models to predict spring occurrence of four species common to the region (Semipalmated Sandpiper, White-rumped Sandpiper Pectoral Sandpiper, and Stilt Sandpiper) consistently included positive relationships with the area of suitable habitat within the wetland (*table 1*). Three of these species were more likely to occur in temporary and seasonal wetlands rather than semi-permanent wetlands and all four species showed an association with wetlands surrounded by cropland in one

Table 1— *Wetland and landscape attributes associated with the presence of four species of en route shorebirds during spring migration, 1992-1993, in eastern South Dakota.*

	Semipalmated Sandpiper		White-rumped Sandpiper		Pectoral Sandpiper		Stilt Sandpiper	
Year and general conditions	**1992 dry**	**1993 wet**	**1992 dry**	**1993 wet**	**1992 dry**	**1993 wet**	**1992 dry**	**1993 wet**
Number of wetlands	68	137	53	89	98	145	53	137
Area of suitable habitat in wetland	++	++	++	++	++	++	++	++
Area of vegetated habitat in wetland		----	++	----				
Wetland regime				--	----	----	----	----
Basin area				--				
Basin perimeter				--				
Number of wetlands within 1, 3, or 5 km			----		--			
Area of all wetlands within 1, 3, or 5 km			--			--		++
temporary/seasonal					++	++	----	
semipermanent/permanent	--					----		
Area of cropland within 1, 3, or 5 km	++	+	+	++	++			++
Area of grassland within 1, 3, or 5 km		----						

Note: ++ and ---- represent positive and negative associations in the most parsimonius models. + and -- represent positive and negative associations in closely approximating models (with a Δ AIC < 2.0).

or both years. The appearance of the other basin and landscape attributes in the models was inconsistent. The smaller species, the Semipalmated and White-rumped sandpipers, tended to use the larger semipermanent wetlands during the dry years, when mud/shallow water habitats occurred around the wetland edges, and increased their use of temporary and seasonal wetlands and sheetwater in wet years (χ^2 = 7.043, df = 3, P = 0.071 and χ^2 = 10.78, df = 3, P = 0.013 for Semipalmated and White-rumped Sandpipers, respectively).

Discussion

We offer three possible explanations for the positive association of these Calidrid sandpipers with the area of tilled cropland in the surrounding landscape in spring. First, small shorebirds prefer open habitats with little vegetation, and wetlands surrounded by tilled cropland may provide more open habitats in spring. We found, however, that even after the area of vegetated wetland habitat was included in models, the cropland factor remained important. Second, the topography of highly tilled areas may be flatter and wetlands that occur there may be more shallow-sided, thus more likely to provide the shallow (<5 cm) water habitats needed. This explanation warrants the inclusion of elevation change in future a priori models. And third, greater water fluctuations in wetlands embedded in cropland than those in grassland (Euliss and Mushet 1996) may result in more consistent exposure of invertebrates as foraging areas are depleted (Schneider and Harrington 1981).

The next step in the development of this approach is to refine the species-specific models that relate annual distribution and abundance of migrating shorebirds to habitat and landscape features and climate data. The results from the training set have defined landscape types of interest based on wetland regime/area and cropland area in a new study design. The resulting models ultimately will be used to allocate survey effort, to estimate shorebird abundance regionwide, to identify landscapes important for conservation and wetland restoration, and to provide management decision support at multiple spatial scales.

The dynamic nature of wetlands, whether due to natural or man-altered weather and ecosystem processes, has important implications for shorebird habitat conservation in ephemeral prairie wetlands systems. Site-based approaches are probably less effective in prairie wetland systems because of the difficulty in identifying wetland sites that predictably provide suitable shorebird stopover habitat. This problem may be reduced somewhat if wetland complexes were considered as single entities (Skagen and Knopf 1994, Haig et al. 1998). The geographically extent over which habitats vary and migrant distributions shift, however, would require that such complexes be extensive. Therefore, there is an urgent need for conservation programs that acknowledge and incorporate the shifting distributions of habitats and birds the landscape.

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