

Migrant Shorebird Use of a Wetland Complex in the Illinois River Valley

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ABSTRACT

Wetland restoration efforts along the Illinois River face challenging questions regarding river connectivity and water management. To improve understanding of the functional relationship among river connectivity, wetland hydrology, and use by migratory shorebirds, we surveyed a wetland complex along the Illinois River during the spring and summer/fall migrations of 2003 and spring migration of 2004. Twenty-four species of shorebirds and over 150,000 shorebird use-days were recorded. Migration chronologies varied significantly among sites, with time lags ranging from 0 to 52 days during a single spring or summer/fall migration. Wetland impoundments with greater connectivity to the Illinois River were vulnerable to flood events, resulting in sporadic use by shorebirds. Management at impoundments with more protection from flood events provided more consistent shorebird habitat. The Illinois River is designated as a stopover region of international importance for shorebird conservation due to its extensive use by shorebirds during the summer/fall migration. However, the density of shorebird use during the spring migration was also high in the second year of our study, demonstrating that shorebird counts at single stopover locations or for a single year can lead to incorrect conclusions about migration chronology and provide misleading directions for management. To improve stopover habitat for migrating shorebirds, we recommend a balance among strategies for managing hydrology and cooperation among landowners to provide diverse habitat with available alternative sites in case traditional habitat is lost during floods or droughts.

INTRODUCTION

The Western Hemisphere Shorebird Reserve Network (WHSRN) was founded in 1986 to protect migratory shorebirds through conservation of key habitats (Harrington and Perry, 1995). WHSRN and partner organizations have protected over 8 million ha of critical shorebird habitat across the Americas (Harrington et al., 2002). However, the criteria used for designation of critical habitat by WHSRN give priority to single sites that receive heavy migratory and wintering use (Haig et al., 1998). Shorebirds migrating through the interior U.S. may use a complex of permanent, semi-permanent, and ephemeral wetlands within a relatively small geographic area (Skagen and Knopf, 1994).

Shorebird use of any single wetland within this complex may vary greatly among years and thus be insufficient for WHSRN designation. If a wetland complex regularly receives high shorebird use, a more comprehensive and inclusive designation policy may be warranted to identify wetland complexes of significant conservation value (Farmer and Parent, 1997).

Shorebirds migrating through in the Illinois River valley exploit a highly degraded watershed. Levees constructed in the 1900's have greatly reduced seasonal flooding and most historic wet-prairie habitat in the Illinois River watershed has been converted to agriculture (Havera and Bellrose, 1985). In recent years, land acquisition and wetland restoration along large river systems aim to reverse the anthropogenic degradation of pre-disturbance environments. However, wetland restoration and management on rivers with large watersheds is challenging. Successful wetland management needs to be addressed at a large spatial scale, and data are needed on how wetland connectivity to a river and water level management practices affect the quality of these sites as stopover areas for migrating shorebirds. Accordingly, we conducted an observational study at a wetland complex in the Illinois River valley to assess shorebird habitat use in relation to wetland connectivity and management strategies. We tested the hypothesis that shorebirds will use the various wetlands within a complex concurrently. We predicted that deviations from concurrent migration chronologies will reflect variation among sites in hydrology, driven by river connectivity and management decisions.

METHODS AND MATERIALS

We sampled four study areas that were part of a large wetland complex along the Illinois River in west-central Illinois (Fig. 1). The floodplain wetlands included backwater lakes, sloughs, and marshes that were federally or state-managed. Two field sites, Chautauqua National Wildlife Refuge (NWR) (40°38'N, 89°99'W) and Emiquon NWR (40°32'N, 90°09'W), were managed by the U.S. Fish and Wildlife Service (USFWS). Chautauqua NWR, located 8 km NNE of Havana, Illinois, was established in 1936 and contains 1,816 ha of large backwater lakes and bottomland and upland forest. Chautauqua has been designated as a stopover of international importance by the WHSRN (Harrington and Perry, 1995). The refuge contained two large impoundments protected from most river flood events by levees and contained more water control structures than the other study sites. Emiquon NWR was a 856-ha refuge comprised of backwater lakes, sloughs, forested wetlands, and a variety of other terrestrial habitats, and was divided into two main units: the South Globe and the Wilder Tract. Due to the recent acquisition of Emiquon NWR by the USFWS in 1993, much of the refuge was newly established wetland.

Two additional field sites were Rice Lake State Fish and Wildlife Area (SFWA) (40°48'N, 89°90'W) and Banner Marsh SFWA (40°53'N, 89°85'W), managed by the Illinois Department of Natural Resources. The initial 959-ha purchase of Rice Lake SFWA in 1945 included a large bottomland lake about 8 km up river from Chautauqua. More recent land acquisitions increased the total land area to 2,290 ha. Banner Marsh SFWA was a 1,766-ha site that was acquired during the 1980s. The land was mined for coal between 1956 and 1973, creating many lakes and marshes of various sizes and depth.

Each site was ranked according to increasing river connectivity (i.e., vulnerability to flood events) as follows: Banner Marsh (floods when river stage reaches 28 ft at the Havana, IL gage), Emiquon (17.6 ft), Chautauqua (16.4 ft), and Rice Lake (11.0 ft). Water management practices varied among sites and will be discussed in relation to the response in use by shorebirds.

We surveyed shorebirds during spring and summer/fall migration in 2003 (17 March to 14 November) and spring migration in 2004 (28 February to 25 June). Each site was visited about once every 5 days and only portions of the sites with suitable shorebird habitat, determined by the presence of shallow water and mudflats, were surveyed. We adjusted survey routes as locations of habitat changed with fluctuating hydrology. When shorebirds were greater than 100 meters from the observer, small *Calidris* sandpipers were grouped as “peeps”. Long-billed (*Limnodromus scolopaceus*) and Short-billed Dowitchers (*Limnodromus griseus*) were grouped as “dowitchers” throughout the surveys. Shorebird use-days for each site were calculated by multiplying the mean number of individuals of a species observed on two consecutive surveys by the number of days between those counts (Rundle and Fredrickson, 1981). To account for variation in quantity of shallow water and mudflats among sites and seasons, we estimated the density of shorebirds per 100 ha. To obtain an estimate of size, we delineated available shorebird habitat at each site during each season on a Digital Orthophoto Quadrangle to estimate total shorebird habitat. We then used the editor toolbar in ArcGIS 8.1 to create a polygon to estimate total area of shorebird habitat (mudflats and water <10cm) at each site during the fall and spring migration.

To evaluate the degree that all wetlands in this complex are used similarly, shorebird use-days among sites and within years were compared using a cross-correlation analysis. We assumed that migrating shorebirds could select among sites in this wetland complex, and that differences in use by shorebirds reflect differences in relative habitat quality among sites that may change over time. Results are reported as cross-correlation coefficients with the time lag (days) at which cross correlation was maximized. A time lag of zero would indicate the two sites being compared received concurrent shorebird use during migration. A positive or negative time lag describes the temporal difference between sites. The magnitude of the cross-correlation coefficient measures the strength and direction of the migration chronology between sites; higher coefficients correspond to increased similarities. Statistical analysis was performed using the R software environment (R Development Core Team, 2004; <http://www.R-project.org>).

RESULTS

We observed 24 species of shorebirds and the wetland complex provided over 150,000 shorebird use-days during the study, with individual species of shorebirds ranging from 10 to 38,171 use-days. Spring migration at the wetland complex peaked in early May in 2003 (109 shorebird use-days/100ha) and 2004 (688 shorebird use-days/100ha) and in early August in 2003 (1014 shorebird use-days/100ha) (Fig. 2). The most frequently observed species (>26,500 use-days) were Lesser Yellowlegs (*Tringa flavipes*), Pectoral Sandpipers (*Calidris melanotos*), Killdeer (*Charadrius vociferous*), and ‘peeps’ (*Calidris* spp.); together, these species comprised more than 80% of the total shorebirds surveyed. The migration chronology for shorebird use-days among sites for the spring and sum-

mer/fall migration in 2003 showed high variation (Fig. 3 and 4; Table 1). The time lag when cross-correlation of shorebird use at two sites was maximized ranged from 0 to 52 days. The average time lag for all the comparisons of shorebird use among sites for spring, 2003 was 25.7 days and the summer/fall 2003 migration was 23.3 days. Much less variation of temporal use among the study sites existed in spring, 2004, when the average time lag was 0.7 days.

The variation in shorebird-use among the sites was partially explained by hydrology conditions in response to river flooding events. At Rice Lake during the 2003 spring and fall migration, river levels breached the levees and temporarily offered shallow water habitat in impoundments managed for walk-in duck hunting, increasing shorebird use, but quickly flooded impoundments to depths >1m, leading to a decline in shorebird use (Fig. 3). During the 2004 spring migration, the main impoundment at Rice Lake began to recede from flood waters in early May, and 1,384 shorebirds of 9 species were observed using the impoundment in one day (Fig. 4). Shortly after, the river levels increased and flooded the impoundment; the window of opportunity for shorebird habitat in early May was about 10 days. Other sites, such as Emiquon during the spring migration, benefit from the river flood events, offering managers the opportunity to slowly open water control gates allowing water to flood moist soil impoundments (Fig. 3). The Illinois River flooded in March in 2004, two months earlier than the previous year, and allowed USFWS staff to elevate water levels in the Wilder Tract by opening water control structures. Because staff had mowed the entire unit in February 2004, the flood water that entered Wilder Tract provided shorebirds access to mudflats with less than 25% vegetation cover, an amount recommended by Helmers (1992).

Although river connectivity and flood events dictate hydrology at sites with little protection from the river, management decisions played a large role in the hydrology at the sites, influencing shorebird use. Shorebird use-days at Emiquon during the spring migration increased from 2,458 in 2003 to 16,691 in 2004 (Fig. 3 and 4). In 2003, the Wilder Tract supported very little shallow-water habitat or shorebird use during early-spring and the first flood of the Illinois River in May quickly elevated the water level into emergent vegetation, principally native smartweed (*Polygonum pennsylvanicum*). During the spring of 2003, the South Globe remained in agricultural production and Killdeer were the only shorebird species observed using the unit. The South Globe unit was taken out of agricultural production for the first time in 2004, at which time the corn and bean stubble was flooded to create extensive shallow water. This resulted in an increase in the availability of shorebird habitat at Emiquon from the spring of 2003 to 2004.

We observed little variation between years in shorebird use-days at Chautauqua. Management in the South Pool is constrained by invasive vegetation, principally willow (*Salix* spp.) and cocklebur (*Xanthium* spp.; Bowyer et al., 2005) and water levels are maintained greater than one meter throughout the spring, which was too deep for shorebirds to utilize (Hamer, 2004). In mid-summer when river levels receded, refuge staff opened water control structures to provide a gradual drawdown (5 to 7 cm/week) and a continuous availability of food resources. As a result, Chautauqua received over 100,000 shorebird use-days during the summer/fall migration in 2003 (Fig. 3). Greater than 90% of the shorebirds using Banner Marsh during the study occurred at an impoundment

where the water levels were manipulated to allow construction of levees and hunting blinds or the production of corn.

DISCUSSION

Under conditions where habitat quality for shorebirds was similar at all sites, we expect shorebird chronologies among sites in this wetland complex to be highly correlated with a zero time lag. Instead, we observed variable shorebird use of this wetland complex, likely due to changes in the availability of foraging habitat. Unpredictable wetland habitat, yielding spatially and temporally variable shorebird use of this stopover habitat, is characteristic of wetlands in the Mississippi Alluvial Valley (MAV). As the distance between wetlands decreases and the proportion of the landscape composed of wetlands increases, shorebirds make more inter-wetland movements (Farmer and Parent, 1997). The close proximity of our 4 study sites suggests that shorebirds had the opportunity to sample all of the sites. Thus, differences in shorebird use of these sites likely reflect the amount and quality of stopover habitat. The availability of foraging microhabitat at each study site was a function of topography, river connectivity, precipitation, and management practices by site personnel.

The shorebird migration chronology of a site unprotected from the river, such as Rice Lake SFWA, shows short peaks of shorebird use followed by periods of very little use by shorebirds because flood events created deepwater habitat that was not suitable for shorebirds. This finding emphasizes the opportunistic ability of shorebirds to rapidly exploit newly exposed invertebrate resources. However, sites with more protection (i.e. higher levees) from the river and more water control capabilities provided more consistently shorebird habitat. In these cases, managers should avoid maintaining stable water conditions, which could increase the potential of invertebrate depletion by shorebird predation (Hamer et al. 2006).

Although wetland management is challenged by river flood events, unpredictable precipitation, and invasive species, management decisions are one of the largest factors affecting the availability of shorebird habitat. Management decisions at Emiquon NWR allowed more water into the Wilder Tract and flooded the agriculture field in the South Globe which resulted in shorebird use during the spring of 2004 to be over 6 times that of the previous year.

Because of the dynamic and unpredictable nature of interior wetlands such as this MAV wetland complex, migrant shorebirds in the interior flyway show site fidelity to larger wetland complexes rather than to particular wetlands (Skagen and Knopf, 1994). Thus, interpreting shorebird counts at single stopover locations alone can bias conclusions about migration chronology and provide misleading directions for management efforts. The abundance of habitat and shorebirds at Chautauqua NWR during the summer/fall migration creates a migration chronology with a summer/fall peak about 11 times the magnitude of the spring migration, allowing designation of this refuge as a WHSRN site. However, when we account for the quantity of habitat available during the spring and fall migration, we see that the complex can receive high shorebird use per unit area during the spring migration as well (e.g. Fig. 2; spring of 2004). Although the density of shorebird use during the spring does not reach that of use during the summer/fall migration, we

expect more shorebirds migrating in the latter, due to the addition of juvenile birds and a slower turn-over rate (Lyons and Haig 1995; Dunn et al., 1998). As Chautauqua NWR is representative of Illinois stopover locations, this disproportionate use in summer/fall might be misinterpreted as shorebirds exhibiting elliptical migration and bypassing Illinois in the spring. This view would not consider that management of these sites may detract from habitat availability in the spring.

Many factors must be considered for management of interior wetlands, and management strategies are not universally effective across time and space. Recent emphasis has been placed on providing resources for a broad group of wildlife with an integrated approach to wetland management (Laubhan and Fredrickson, 1993; Erwin, 2002). This approach emphasizes wetland management at the landscape scale. Management should not rely on meeting all wildlife needs at individual wetlands, but should integrate and exploit the diverse characteristics provided by an entire wetland complex. Thus, managers of different areas need to cooperate to insure the needs of diverse flora and fauna are met.

Management strategies for shorebirds on big river ecosystems are often hindered by unpredictable flood events. The establishment of drainage and levee districts on the Illinois River in the early 1900's reduced the space for flow and increased flood stages (Havera and Bellrose, 1985). Large flood events at the wrong time could greatly reduce available habitat. Flood waters breached the levee on the South Pool of Chautauqua in mid-June 2004. A flood event occurring in early-August would devastate the habitat relied upon by the large concentration of shorebirds that traditionally use this site during the summer/fall migration. A flood of this nature might also produce shallow water habitat in agricultural fields but the value of this habitat to shorebirds is poorly understood. Conservation of interior migrating shorebirds demands availability of nearby alternate sites when traditional sites are lost (Smith et al., 1991; Skagen and Knopf, 1994), underlining the need for diverse complexes.

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Figure 1. Location of 4 study sites in west-central Illinois (Chautauqua and Emiquon NWR, Rice Lake and Banner Marsh SFWA) along the Illinois River.

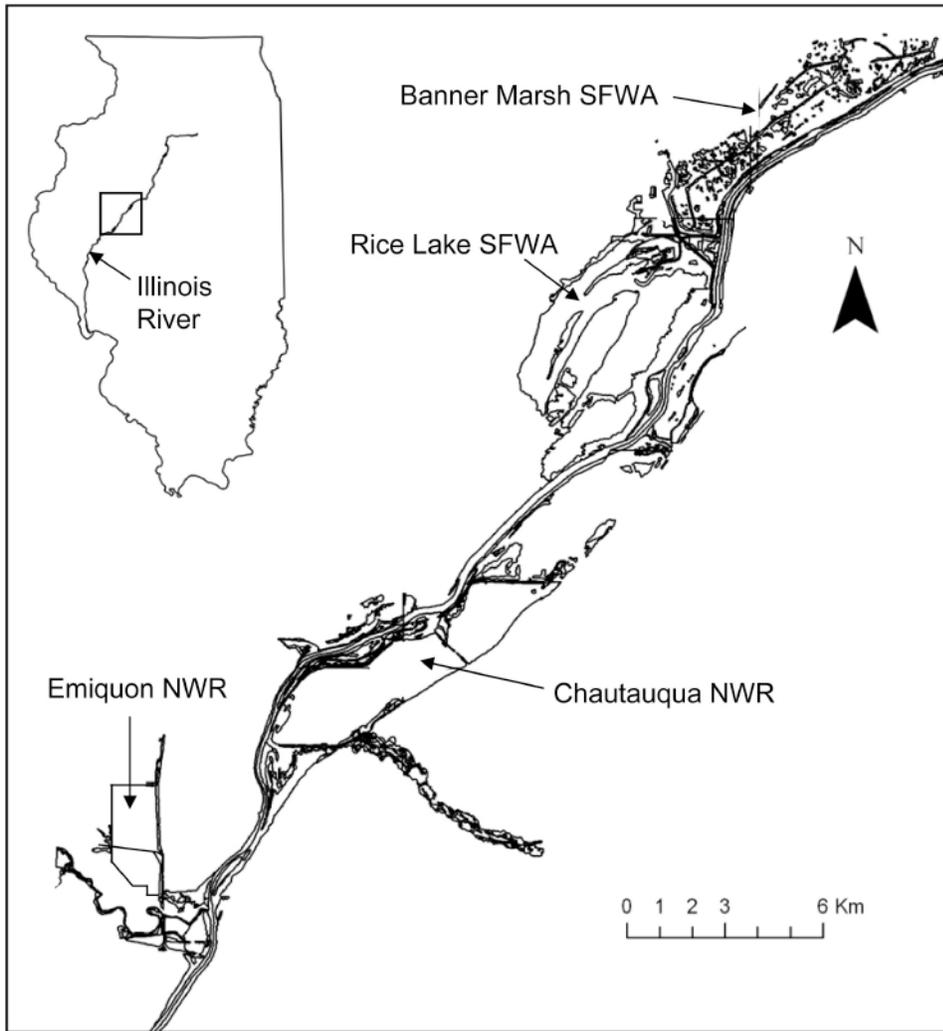


Figure 2. Extrapolated shorebird use-day density (ind./100 ha) at a wetland complex (Rice Lake SFWA, Emiquon NWR, Chautauqua NWR, and Banner Marsh SFWA, Illinois) along the Illinois River during the spring migration and summer/fall migration of 2003 and spring migration of 2004. Spring 2003-2004 comparisons are not possible because of the addition of new habitat created at Emiquon NWR in 2004. Data are presented in a one-week moving average and note difference in scale. One use day equals one individual shorebird using a site on a single day.

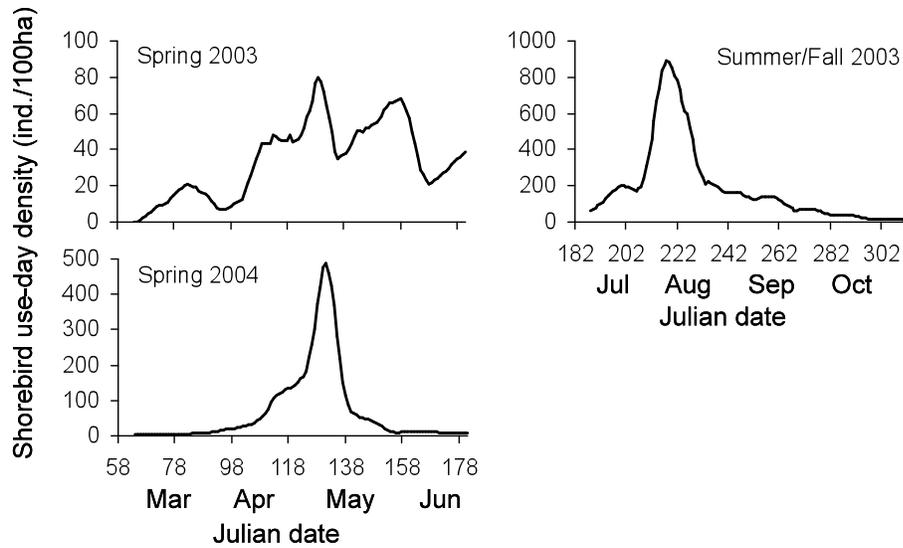


Figure 3. Extrapolated shorebird use-days (one-week moving average) at Rice Lake SFWA, Emiquon NWR, Chautauqua NWR, and Banner Marsh SFWA, Illinois, during the spring migration and summer/fall migration of 2003 (solid line). The right y-axis is the Illinois River stage at the Havana, Illinois gage (dashed line). Study sites vary in size and note difference in scale for Chautauqua during the summer/fall migration. River connectivity refers to the river stage that will flood the impoundment [Rice Lake (11.0 ft), Emiquon (17.6 ft), Chautauqua (16.4 ft), and Banner Marsh (28 ft)], indicated by arrow on left y-axis.

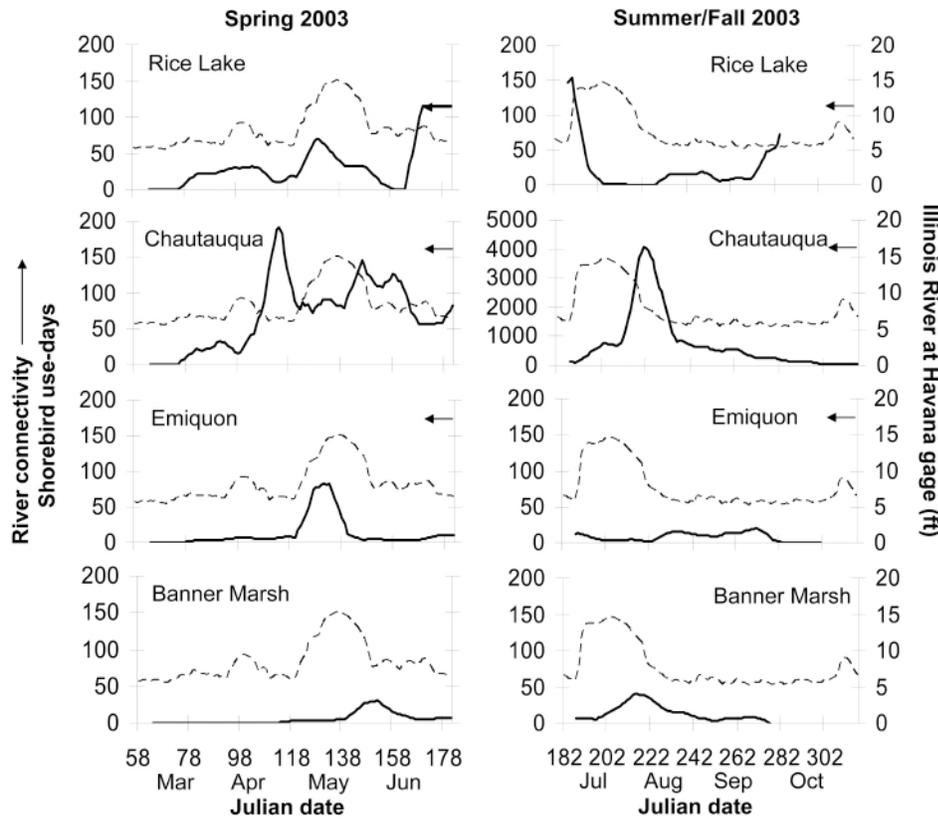


Figure 4. Extrapolated shorebird use-days (one-week moving average) at Rice Lake SFWA, Emiquon NWR, Chautauqua NWR, and Banner Marsh SFWA, Illinois, during the spring migration of 2004. Study sites vary in size. The right y-axis is the Illinois River stage at the Havana, Illinois gage. River connectivity refers to the river stage that will flood the impoundment [Rice Lake (11.0 ft), Emiquon (17.6 ft), Chautauqua (16.4 ft), and Banner Marsh (28 ft)], indicated by arrow on left y-axis.

