ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

William Shilts, Executive Director
Prairie Research Institute

Brian D. Anderson, Director
Illinois Natural History Survey
1816 South Oak Street
Champaign, IL 61820-6964
217-333-6830

Waterbird and Wetland Monitoring at The Emiquon Preserve

Annual Report 2011

Christopher S. Hine,
Randolph V. Smith,
Aaron P. Yetter,
Michelle M. Horath,
Joshua D. Stafford,
and
Heath M. Hagy

Forbes Biological Station
Frank C. Bellrose Waterfowl Research Center

Prepared for: The Nature Conservancy

Project Name: Monitoring of Key Attributes and Indicators of Waterfowl at The Nature Conservancy's Emiquon Preserve
Contract Number: C07-032

UNIVERSITY OF ILLINOIS
at Urbana-Champaign

INHS Technical Report 2012 (15)
Date of Issue: 1 May 2012

ACKNOWLEDGEMENTS

Funding for this project was provided by The Nature Conservancy's Illinois River Project Office, contract number C07-032. We would like to thank D. Blodgett, J. Beverlin, T. Hobson, M. Lemke and S. McClure of the Illinois River Project Office and J. Walk of the Peoria Office for their input and in our monitoring activities and use of field equipment. We also appreciate our colleagues at the Illinois Natural History Survey's (INHS) Illinois River Biological Station for allowing use of field and laboratory equipment and personnel. Finally, we thank D. Holm (Illinois Department of Natural Resources), J. Randa (U.S. Fish and Wildlife Service), B. Ruebush (INHS), and T. Locker (INHS) for their assistance in conducting brood surveys and M. Cruce for providing flight services during waterfowl inventories.

Historically, the wetlands of the Illinois River valley (IRV) provided extensive and valuable habitat to migrating waterbirds and other wetland-dependent wildlife in the Upper Midwest. Despite dramatic anthropogenic alterations, the IRV remains a critical ecoregion for migratory birds. Restoration and reclamation efforts are ongoing in attempts to return structure and function to backwater wetlands in the region. For example, The Nature Conservancy's (TNC) Emiquon Preserve (hereafter, Emiquon) is the most substantial effort to date, directly restoring, enhancing, or protecting >2,700 ha of former wetlands and associated uplands in the central IRV. To guide the restoration process at Emiquon, TNC identified key ecological attributes (KEAs) of specific biological characteristics or ecological processes that would indicate restoration success (The Nature Conservancy 2006), and several KEAs were related to waterbird communities and their habitats. Thus, we monitored the response of wetland habitats and waterbirds to restoration efforts at Emiquon relative to desired KEAs during 2011. Specifically, we evaluated: 1) abundance, diversity, and behavior of waterfowl and other waterbirds through counts and observations; 2) productivity by waterfowl and other waterbirds through brood counts; 3) plant seed and invertebrate biomass for waterfowl during migration and breeding, and; 4) composition and arrangement of the vegetation community through geospatial wetland covermapping.

METHODS

Avian Abundance

We estimated abundance of avifauna by species at Emiquon during spring migration with a spotting scope and binoculars from fixed vantage points and while traveling between vantage points (Table 1). Count methodology and observation locations remained fixed to provide a consistent index relative to waterfowl and other waterbird abundances. We initiated weekly inventories when ice receded (mid-February) and concluded mid-April, when most migrants had departed. Although our ground inventories were designed to index waterfowl abundance, we recorded abundances of other waterbirds and raptors encountered incidentally.

We also estimated waterbird abundance aerially at Emiquon as part of the Illinois Natural History Survey's (INHS) waterfowl inventories (Havera 1999). Aerial inventories were conducted approximately weekly (weather permitting) during spring and fall from a fixed-wing, single-engine aircraft at altitudes of 60–140 m and speeds of 160–240 km/hr (Havera 1999:186, Stafford et al. 2008). A single observer estimated abundances of American coots, American white pelicans, double-crested cormorants, bald eagles, and all waterfowl by species (except wood ducks).

We converted abundance estimates to use-days (UDs) to quantify overall waterbird use of Emiquon (Stafford et al. 2008). Use-days are estimates of bird abundance extrapolated over a period of interest (i.e., fall or spring). For example, 100 birds using a wetland for 10 days equals 1,000 UDs. This method is useful for comparing waterbird use among sites, years, and seasons, and for relating abundances to other metrics (e.g., energetic carrying capacity). Our spring 2011 UD estimates were calculated using ground inventory data, whereas fall UD estimates were based on aerial inventories to facilitate comparison among other wetlands in the IRV.

Waterfowl Behavior

We conducted behavioral observations using scan sampling to evaluate the functional response of ducks to wetland restoration and habitat change at Emiquon (Altmann 1974). This method allowed for a rapid assessment of waterfowl behavior that could be conducted simultaneously with ground counts (Paulus 1988). One scan sample consisted of recording the behavior (e.g., feeding, resting) and sex of 50 individuals of the same species, in the same flock.

We attempted to conduct 10 scan samples (5 scans per species) during each ground count for species that were present throughout the migration period to maximize sample sizes and inference. However, dense vegetation, long distances between observation points and duck concentrations, and difficulty in approaching flocks undetected limited the number of behavior observations and species observed.

Brood Observations

We monitored waterbird production at Emiquon in 2011 through passive brood observations (Rumble and Flake 1982). We conducted bi-weekly brood surveys between early June and early August using 4 observers at fixed points along the east and west shores of Thompson Lake and on the north levee. This approach intended to maximize coverage and minimize double counting and disturbance associated with a single observer moving between points. Surveys began at sunrise and lasted for one hour to coincide with the period when broods are most active (Ringelman and Flake 1980, Rumble and Flake 1982). During each survey, we continually scanned the wetland using spotting scopes and binoculars and documented species, number of young and adults, and brood age class of all waterbirds (Gollop and Marshall 1954).

Aquatic Invertebrates

We collected 20 sweep-net samples bi-monthly during waterbird breeding and brood-rearing periods (i.e., April–August) in 2011 (n = 60 total samples) to estimate abundance of nektonic invertebrates. We collected samples from random locations in shallow water (≤46 cm) along the margins of Thompson Lake using a 454 cm^2 (~0.05 m^2) D-frame sweep-net with a 500 µm mesh (Voigts 1976, Kaminski and Murkin 1981). We preserved samples in 10% buffered formalin solution containing Rose Bengal until processing. In the laboratory, we rinsed samples through a 500 µm sieve to remove substrate and vegetation. Invertebrates were removed from samples by hand and identified according to the lowest practical taxonomic level (e.g., Family; Pennak 1978, Merritt and Cummins 1996). Invertebrate samples were dried at 70^{o} C to constant mass and weighed to the nearest 0.1 mg. Samples containing >200 individuals of a single invertebrate taxa were sub-sampled (up to ¼) using a Folsom plankton splitter. We converted invertebrate biomass estimates to per-unit-volume (mg/m^{3}) to account for different volumes of water sampled with each net sweep.

Moist-soil Plant Seeds

During 2011, we estimated above- and below-ground biomass of moist-soil plant seeds by extracting a 10-cm diameter x 5-cm depth soil core in standing vegetation at 20 random points along the west shore of Thompson Lake (Stafford et al. 2006, 2008, Kross et al. 2008). We collected soil cores during fall following seed maturation and froze samples in individually labeled bags until processing. Prior to sorting, we thawed core samples at room temperature and soaked them in a 3% solution of hydrogen peroxide (H_2O_2) to dissolve clays (Bohm 1979:117, Kross et al. 2008). We washed samples with water through a #60 (250 µm) sieve and dried for 24 hours at 87^{o}C (Greer et al. 2007, Stafford et al. 2008). We then threshed dried materials over a series of 4−5 sieves (mesh sizes 14 [1.40 mm], 18 [1.00 mm], 35 [500 µm], 45 [355 µm], and 60 [250 µm]) to further separate seeds from debris (Greer et al. 2007). We classified seeds as large if they were retained by the 14, 18 or 35 sieve (e.g., *Echinochloa spp., Polygonum spp.*) and small if they remained in the 45 or 60 sieves (e.g., *Cyperus spp.*, *Amaranthus spp.*). We separated all large seeds from debris by hand and weighed to the nearest 0.1 mg. Due to the extensive processing time, we sub-sampled a portion (≥2.5% by mass) of some small seed samples to estimate biomass (Hagy et al. 2011). The proportion of seed (% by mass) in the subsample was multiplied by the small seed sample mass to extrapolate total small seed mass in the core. We combined small and large seed masses to estimate total seed biomass per core (Stafford et al. 2008). We used biomass data from core samples to estimate overall moist-soil plant seed abundance (kg/ha; dry mass) at Thompson Lake using PROC MEANS in SAS v9.2 (SAS Institute, Inc., 2004).

We used our overall estimates of forage abundance to calculate energetic carrying capacity for waterfowl, expressed as energetic use-days (EUD). An EUD is defined as the number of days an area of land could support a mallard-sized duck (Reinecke et al. 1989). Our EUD calculations assumed an average true metabolizable energy of 2.5 kcal/g for moist-soil plant seeds (Kaminski et al. 2003) and an average daily energy expenditure of a mallard of 292 kcal/day (Prince 1979, Reinecke et al. 1989).

Wetland Covermapping

We mapped the wetland vegetation of Thompson and Flag lakes during fall 2011 to document changes in wetland area, plant species composition, and vegetation assemblages. We traversed east-west transects spaced at 500 m intervals by foot, all-terrain vehicle, or airboat and delineated changes in vegetation composition (e.g., moist-soil, hemi-marsh) using a handheld global positioning system (GPS; Bowyer et al. 2005, Stafford et al. 2010). We recorded plant species encountered (Table 2) along transect lines and delineated habitat assemblages or other physical features (e.g., vegetation islands, ditches) outside transects using a GPS and hand-drawn maps. We digitized wetland vegetation in ArcGIS 10 using field notes and the GPS waypoints overlaid on 2011 high-resolution aerial photographs from Sanborn Map Company, Chesterfield, MO (Bowyer et al. 2005, Stafford et al. 2010).

Our classifications of wetland habitats at Emiquon generally followed those defined by Cowardin et al. (1979) and Suloway and Hubbell (1994). Woody vegetation was classified as bottomland forest if trees were >6 m in height or scrub-shrub if trees were ≤6 m tall (Cowardin et al. 1979). Other wetland classifications included non-persistent emergent vegetation (e.g., moist-soil plants; Fredrickson and Taylor 1982), persistent emergent vegetation (e.g., cattails and bulrushes), mudflat, aquatic bed (e.g., coontail), hemi-marsh (open water or aquatic bed interspersed with persistent emergent; Weller and Spatcher 1965), and open water (water devoid of vegetation above or near the water surface; Cowardin et al. 1979, Suloway and Hubbell 1994, Stafford et al. 2010). In addition to Cowardin classifications, we documented floating-leaved aquatic vegetation, such as American lotus and watershield as independent categories to more closely monitor spatial changes in these taxa. We were unable to independently delineate aggregations of long-leaved pondweed due to interspersion throughout submersed aquatic vegetation in 2011; thus, long-leaved pondweed was included in the aquatic bed category. We also included a category to account for some areas of upland vegetation (e.g., goldenrod and foxtail) growing within the wetland basin that were flooded or insular.

We attempted to be as descriptive as possible when categorizing wetland vegetation, and as such, some vegetation assemblages occurred in multiple categories. For instance, cattail was present in 2 habitat classes: hemi-marsh and persistent emergent. We categorized cattail as hemi-marsh if there was approximately even interspersion of cattail and open water or aquatic bed. We classified cattails as persistent emergent when they occurred alone as a dense monotypic stand or when they were accompanied by other persistent emergent species (e.g., bulrush, bur reed, and prairie cordgrass). Likewise, willows occurred in bottomland forest and scrub-shrub habitats.

RESULTS

Waterfowl Abundance

Spring

We conducted 9 ground inventories from 18 February to 14 April (Table 3) and 4 aerial inventories from 14 March to 7 April 2011 (Table 4). Peak waterfowl abundances reached 119,095 during a ground inventory on 2 March and 33,395 on 14 March during an aerial inventory. We observed 24 species of waterfowl during spring (19 duck species, 3 goose species, and 2 swan species). Lesser snow geese were the most abundant species during ground inventories, accounting for 49.5% of total waterfowl abundance, followed by ruddy ducks (11.5%) and northern shovelers (8.3%). Diving ducks were slightly more abundant than dabbling ducks, accounting for 26.6% and 21.8% of the total waterfowl abundance, respectively. Estimated spring UDs were 2,203,221 based on ground inventories.

Fall–Winter

We conducted 16 aerial inventories at Emiquon from 30 August 2011 to 4 January 2012 (Table 5). We observed at least 21 species of waterfowl (17 duck species, 3 goose species, and unidentified swan species) with a peak abundance of 90,985 on 24 October. Mallards (22.1%) were the most abundant species, followed by northern pintails (20.4%) and American green-winged teal (16.5%). Estimated waterfowl UDs at Emiquon totaled 4,354,668 during fall. Dabbling ducks (3,965,248 UDs) accounted for 91.1% of UDs, whereas only 8.1% of waterfowl UDs was attributable to diving ducks (352,943 UDs).

Non-Waterfowl Abundance

Spring

In addition to waterfowl, we documented 12 waterbird and raptor species during ground counts in spring 2011 (Table 6). Peak abundance of non-waterfowl species observed during ground inventories was 12,086 individuals and occurred on 24 March, whereas aerial inventories revealed a peak of 17,520 individuals on 21 March (Table 7). American coots were the most common species observed and accounted for 88.4% and 87.7% of non-waterfowl abundance based on ground and aerial inventories, respectively. American coot abundance peaked at 10,964 (15,650 via aerial inventories), while their overall use of Emiquon totaled 317,963 UDs. Other commonly observed species included American white pelicans, double-crested cormorants, and bald eagles.

Fall–Winter

We also estimated abundances of American white pelicans, American coots, double-crested cormorants, and bald eagles during 16 aerial inventories of waterfowl (Table 8). American coots were the most abundant of these species, with a peak estimate of 135,300 on 24 October; constituting 98.0% of non-waterfowl abundance during fall. Likewise, American coots accounted for 98.0% (2,988,510 UDs) of non-waterfowl use, followed by American white pelicans (1.2%) and double-crested cormorants (0.8%). American coots contributed 40.4% of all waterbird use (including waterfowl) during fall at Emiquon.

Waterfowl Behavior

We conducted behavior observations (75 scans) during 10 days between 18 February and 18 April 2011. Species observed included mallard, blue-winged teal, northern shoveler, lesser scaup, ring-necked duck, and ruddy duck. Overall, these species spent most of their time feeding (53.3%), followed by resting (26.6%; Table 9). However, when considered by guild, dabbling ducks spent 69.7% of their time feeding, whereas diving ducks only spent 28.9% of their time feeding. Diving ducks were observed resting (40.4%) most frequently.

Brood Observations

We completed 6 fixed-point brood surveys from 1 June to 5 August 2011 and recorded 125 waterbird broods comprised of 7 species (Table 10). The most abundant broods recorded were wood ducks (n = 67), Canada geese (n = 32) and mallards (n = 20). Brood observations peaked (n = 34) on 20 July, and age classes of broods increased throughout the observation period.

Aquatic Invertebrates

We collected 20 sweep-net samples on 20 April, 24 June, and 16 August (n = 60 total samples). Mean water volume sampled per sweep was 1.2 m^3. As invertebrate communities developed, mean invertebrate biomass (mg/m^3; dry mass) increased each sampling period (April: 1.4 mg/m^3, June: 32.8 mg/m^3, August: 167.0 mg/m^3). We identified 36 taxa with Cladocera (95.0%), Copepoda (73.3%), and Chironomidae (70.0%) occurring in the largest percentage of samples (Table 11). Physidae (27.9 mg/m^3), Planorbidae (21.9 mg/m^3), and Caenidae (2.4 mg/m^3) provided the greatest biomass per volume. Total biomass averaged 67.1 mg/m^3 over the 3 sampling periods.

Moist-soil Plant Seeds

We extracted 20 core samples from random locations along the west shore of Thompson Lake on 24 October 2011. Average moist-soil plant seed biomass was 1,116.2 kg/ha (dry mass; Table 12). Large seeds contributed 937.2 kg/ha, whereas small seeds accounted for the remaining 179 kg/ha. The estimated energetic carrying capacity from moist-soil plant seeds in 2011 was 9,556.8 EUDs/ha.

Wetland Covermapping

We mapped all wetland vegetation associated with Thompson and Flag lakes in 18 days from 13 September to 24 October 2011 and documented 12 habitat categories. Aquatic bed

(1,071.7 ha) was the most abundant habitat type, followed by open water (323.5 ha), persistent emergent (223.3 ha), and hemi-marsh (109.3 ha; Table 13, Fig. 1). We covermapped 1,820.6 ha and documented 76 plant species (Table 2).

DISCUSSION

Waterfowl Abundance

Spring

During spring 2011, we nearly doubled the number of ground inventories (n = 9) conducted from spring 2010 (n = 5). We adjusted our schedule during 2011 from bi-weekly to weekly ground inventories to avoid missing peak waterfowl abundances during a condensed spring migration period. Early ice-out coupled with increased frequency of ground inventories reflected substantial increases in abundance and UD estimates in spring 2011. Peak waterfowl abundance increased 183% in spring 2011 (119,095) over spring 2010 (42,056) and occurred three weeks earlier in 2011 (2 March) than in 2010 (23 March). Likewise, our UD estimate more than doubled in 2011 (2,203,221 UDs) compared to 2010 (1,074,691 UDs), and represented the highest spring waterfowl UD estimate reported since monitoring began at Emiquon. Heavy use of Emiquon by lesser snow geese (peak – 101,500) along with the change in counting methodology likely influenced the increases in peak populations and UDs observed in spring 2011.

Aerial waterfowl inventories also revealed an earlier peak in waterfowl abundance during spring 2011 (14 March) compared to 2010 (29 March), but the peak population estimate declined 62% in 2011. The decline in the peak estimate was impacted by the timing of aerial inventories rather than an actual reduction in waterfowl using Emiquon. Aerial inventories did not begin until 14 March, subsequent to the peak in waterfowl abundance documented by ground inventories on 2 March.

Fall–Winter

Our peak waterfowl abundance estimate from aerial inventories in fall 2011 (90,985) was 45% higher than fall 2010 (62,872), and it occurred 2 weeks earlier (24 Oct) than in 2010 (8 Nov). The waterfowl UD estimate of 4,354,668 in fall 2011 represented a 14% increase over the 2010 estimate (3,819,574 UDs), and it's the highest since monitoring began at Emiquon in 2007. Likewise, use by northern pintails (1,003,810 UDs) and American green-winged teal (784,930 UDs) increased 51% and 29%, respectively, representing the highest UD estimates for these species at Emiquon. Moreover, northern pintail and American green-winged teal use at Emiquon was the highest recorded at a single location in the Illinois River valley (IRV) since aerial inventories began in 1948 (M. Horath, unpublished data). Use by both dabbling and diving ducks in fall 2011 increased 14% from 2010; however, diving duck use remained 56% below the peak in fall 2009 (806,785 UDs). Mild weather conditions during fall 2011 likely contributed significantly to the increased use by waterfowl at Emiquon. With the exception of short periods of cold weather, above normal temperatures prevailed and kept most of the wetland area open nearly the entire inventory period (Angel 2012).

Non-Waterfowl Abundance

Spring

In contrast to waterfowl, we documented significant declines in non-waterfowl peak abundances and UDs in spring 2011. The peak abundance estimate of non-waterfowl species from ground inventories in 2011 (12,086) was 54% less than the 2010 estimate (26,535). Moreover, aerial inventories indicated an even larger drop of 82% in the peak population of non-waterfowl species at Emiquon in spring 2011. These observed declines were attributed to the reduction in the peak population of American coots, as they comprised 88% of the non-waterfowl species. The peak population of American coots in spring 2011 was 58% and 83% lower than the 2010 estimates from our ground and aerial inventories, respectively. Similarly, use of Emiquon by American coots in spring 2011 (317,963 UDs) declined 51% from spring 2010 (650,588 UDs). Explanations for these declines are unclear at this time, but we speculate the availability of forage for American coots may have been limited in early spring.

Fall–Winter

American coot use of Emiquon during fall 2011 (2,988,510 UDs) recovered from the low use observed in spring and was similar to use during fall 2010 (3,094,350 UDs). The peak population estimate of 135,300 American coots on 24 October 2011 was 42% higher than the peak in fall 2010 (95,040), and it was the greatest observed to date at Emiquon. While American coot use during fall remained high at Emiquon, we observed noticeable declines in use by bald eagles (-62%) and American white pelicans (-38%) from 2010 UD estimates. However, fall 2010 UD estimates (bald eagle – 796 UDs; American white pelican – 60,963 UDs) were the highest recorded for these species at Emiquon. Bald eagle (305 UDs) and American white pelican (37,478 UDs) use of Emiquon in 2011 was comparable to 2009 UD estimates (bald eagle – 223 UDs; American white pelican – 41,993 UDs).

Waterfowl Behavior

Ducks at Emiquon spent most of their time feeding (53.3%) during spring 2011, which was similar to 2010 observations (58.1%). However, dabbling ducks (blue-winged teal, mallards, and northern shovelers) spent 69.7% of their time feeding, whereas only 28.9% of diving duck (lesser scaup, ring-necked ducks, and ruddy ducks) activity was devoted to feeding.

Although we lack food habits data for waterfowl using Emiquon, other studies have suggested that the proportion of time spent feeding by waterfowl is directly influenced by the content of their diet (Driver et al. 1974, Paulus 1984, 1988, Bergan et al. 1989, Crook et al. 1989). Consequently, species with diets with high nutrient content allocate less time to feeding. Furthermore, there is evidence that some species of diving ducks forage more at night than during diurnal periods (Takekawa 1987, Bergan et al. 1989, Custer et al. 1996). Additionally, other factors can influence estimates of time spent foraging, such as food abundance (Kaminski and Prince 1981, Benoy 2005) or behavioral observation methods (Baldassarre et al. 1988). Thus, we are uncertain of why diving ducks apparently spent less time foraging compared to dabbling ducks. However, our estimates of time allocated to feeding by diving ducks fall within published ranges (Paulus 1988).

Brood Observations

Total broods observed at Emiquon in spring 2011 (*n* = 125) decreased 12% from spring 2010 (*n* = 142), but the number of species increased 75% between 2010 (*n* = 4) and 2011 (*n* = 7). Wood duck brood observations declined 26.4%, whereas sightings of Canada goose broods (*n* = 32) remained the same, and mallard broods increased 33% (*n* = 20) from spring 2010 to 2011. Most notably, we documented reproduction of the Illinois endangered common moorhen at Emiquon in 2011. We had 2 observations of common moorhen broods late in our sampling period (20 July and 5 August). These were the first observations of this species since our monitoring began. Few observations of pied-billed grebe and American coot broods continue to be a point of concern. Sightings of pied-billed grebe broods in 2011 were the lowest (*n* = 2) since surveys began, representing a 50% decline from spring 2010 and an 82% reduction from the highest count (*n* = 11) in 2009. We did not detect grebe broods until our last survey (5

August), which was a month later than the first grebe broods observed in 2008 and 2009. Likewise, we observed only 1 American coot brood in 2011 and did not document any broods of this species in 2010. Sightings of American coot broods have rapidly declined since the high count (n = 24) recorded in 2008. Lastly, age classes of broods continued to increase throughout the spring-summer observation period, similar to previous years, indicating high survival of broods at Emiquon.

Aquatic Invertebrates

Taxonomic richness of aquatic invertebrates at Emiquon in 2011 (n = 36 taxa) was slightly less than that observed in 2010 (n = 40 taxa) and 2009 (n = 39 taxa) but 38% greater than 2008 (n = 26). While the number of taxa remained relatively high, biomass estimates for aquatic invertebrates in 2011 continued to decline substantially from previous years. Total invertebrate biomass in 2011 (4,472.9 mg) declined 15% from 2010 (5,303.7 mg) and 69% from the high recorded in 2009 (14,476.6 mg), and was the lowest estimate recorded to date. Likewise, mean invertebrate biomass per sweep-net sample in 2011 (67.1 mg/m^3) was 22% less than 2010 (85.6 mg/m^3) and 57 % less than the 2009 estimate (155.6 mg/m^3).

Snail abundance remained low in 2011 samples; although, there was a substantial increase from 2010 estimates. Snails, especially Physidae and Planorbidae, had been the most important contributors to invertebrate biomass at Emiquon. Despite increases in snail biomass in 2011, physids (27.9 mg/m^3) and planorbids (21.9 mg/m^3) still remained well below 2009 estimates of 72.3 mg/m^3 and 55.3 mg/m^3, respectively. Snail abundance could be influenced by several factors, including abundance of food and predators (Weber and Lodge 1990), sedimentation (Kefford et al. 2009), and vegetation structure and assemblage (Voigts 1976).

The KEA related to availability of food resources during the waterfowl nesting and brood-rearing periods desired the presence of epiphytic and benthic invertebrates. Emiquon continued to support diverse invertebrate communities important to breeding waterfowl, such as snails (Gastropoda), water fleas (Cladocera), amphipods (Amphipoda), beetles (Coleoptera), earthworms (Oligochaeta), flies (Diptera), caddisflies (Trichoptera), dragonflies and damselflies (Odonata) (Eldridge 1990). Nevertheless, the continued decline in invertebrate biomass should raise questions regarding the health of the wetland and warrants further monitoring and investigation.

Moist-soil Plant Seeds

A desired KEA for Emiquon was an annual moist-soil plant seed production of 578 kg/ha, with ≥800 kg/ha considered to be very good production. In this context, moist-soil plant seed abundance was excellent in 2011 (1,116.2 kg/ha), representing a 77% increase over the 2010 estimate (629.5 kg/ha), and the highest observed at Emiquon. Correspondingly, estimated energetic carrying capacity in 2011 (9,556.8 EUDs/ha) increased substantially over the fall 2010 estimate (5,389 EUDs/ha) and was the highest recorded at the preserve. For comparison, the Upper Mississippi River and Great Lakes Region Joint Venture (UMRGLRJV) of the North American Waterfowl Management Plan uses a seed abundance estimate of 514 kg/ha for waterfowl conservation planning in this region (derived from Souillere et al. 2007). Moist-soil plant seed yields at Illinois Department of Natural Resources (IDNR) waterfowl management areas averaged 691.3 kg/ha and energetic carrying capacity averaged 5,918 EUDs/ha during 2005–2007 (Stafford et al. 2008). Finally, Bowyer et al. (2005) estimated moist-soil plant seed abundance at Chautauqua National Wildlife Refuge (CNWR) averaged 790 kg/ha, corresponding to 6,760 EUDs/ha during 1999–2001. Thus, seed abundance and energetic estimates for moist-soil plants at Emiquon during 2011 were significantly greater than estimates used by the UMRGLRJV and average estimates reported at CNWR and IDNR sites.

Wetland Covermapping

The wet area of Emiquon increased by 7% from 2010; however, the area of wetland vegetation in 2011 decreased by nearly 8%. Most of the decline in wetland habitat was attributed to a 72% loss in moist-soil vegetation (non-persistent emergent). Receding water levels in 2010 created favorable conditions for the expansion of wetland vegetation, particularly moist-soil plants. Consequently, the area of non-persistent emergent vegetation in 2010 (217.7 ha) was the largest observed at Emiquon. Conversely, drier conditions prevailed in 2011 resulting in some areas of moist-soil plants giving way to upland vegetation, which is generally not mapped. The amount of hemi-marsh at Emiquon in 2011 (109.3 ha) was the lowest estimate since 2007 (29.9 ha). Hemi-marsh declined by nearly 9% from the 2010 estimate (119.8 ha) and 62% from the high in 2009 (290.4 ha). Undoubtedly, this reduction was in large part due to the draw-down in summer 2010. Cattails were stranded as water levels receded, causing a shift from hemi-marsh to persistent emergent habitats. Moreover, openings in dry hemi-marsh were likely colonized by additional persistent emergent vegetation, contributing further to the reduction of hemi-marsh habitat. Persistent emergent vegetation (223.3 ha) at Emiquon increased 12% from 2010 (199.0 ha), representing the highest estimate for this habitat type and nearly a six-fold increase since 2007 (32.9 ha). Likewise, the open water area (323.5 ha) in 2011 increased 30% from our 2010 estimate (248.7 ha), and it’s the largest estimate we’ve documented for this habitat category at Emiquon. The increase in open water may have been partially explained by the 2010 drawdown, which reduced the area of aquatic bed by 13%; although, this habitat type increased slightly in 2011. Furthermore, our anecdotal observations of common carp (*Cyprinus* *carpio*) activity and reduced water clarity in Thompson Lake could be plausible explanations for the increase in open water at Emiquon. Further surveillance of wetland habitats at Emiquon should provide additional insight into the causes of these changes.

The KEAs related to habitat composition specify <10% invasive species coverage and 100% exclusion of purple loosestrife. We encountered some invasive species during wetland mapping in 2011, including Eurasian watermilfoil, reed canarygrass, and common reed. We did not observe purple loosestrife in 2011; however, TNC staff removed multiple plants from the preserve throughout the year (T. Hobson, pers. commun.). Similar to 2010, occurrence of reed canarygrass appeared to be in relatively small patches, whereas Eurasian watermilfoil was more widespread in 2011. Although we did not measure the spatial extent of individual invasive species, we compared the proportion of covermap polygons that contained Eurasian watermilfoil among years. As we suspected, the proportion of aquatic bed and hemi-marsh polygons containing Eurasian watermilfoil was greatest in 2011 (76.6%), followed by 2010 (64.3%), 2009 (27.1%), and 2008 (0.2%). Eurasian watermilfoil was not documented at Emiquon in 2007. While this technique did not measure spatial coverage, it did emphasize how quickly this species spread and became a substantial part of the submersed aquatic macrophyte community. Likewise, we encountered more locations with common reed in 2011 (n = 16) than in previous years (2010, n = 6; 2009, n = 1). Formerly isolated to a few locations on the north end of the preserve, patches of common reed were scattered to the extreme south end of the wetland in 2011. The wet years of 2008 and 2009 followed by the drawdown in 2010 likely influenced the spread of common reed at Emiquon. Control of Eurasian watermilfoil and common reed should be a priority in the near future. Continued awareness of the advancement of existing species and establishment of new invasive species is essential to their control.

Fall shorebird habitat at Emiquon declined substantially in 2011. The increase in wet area at Emiquon in 2011 significantly reduced (-86%) the amount of mudflat (11.8 ha) compared to the 2010 estimate (83.2 ha). The KEA associated with fall shorebird foraging habitat sought to provide exposed mudflats and areas of shallow water <5cm deep during 20 July–31 August. Although mudflats diminished in 2011, anecdotal observations indicated Emiquon still provided some shallow water areas conducive for shorebird foraging.

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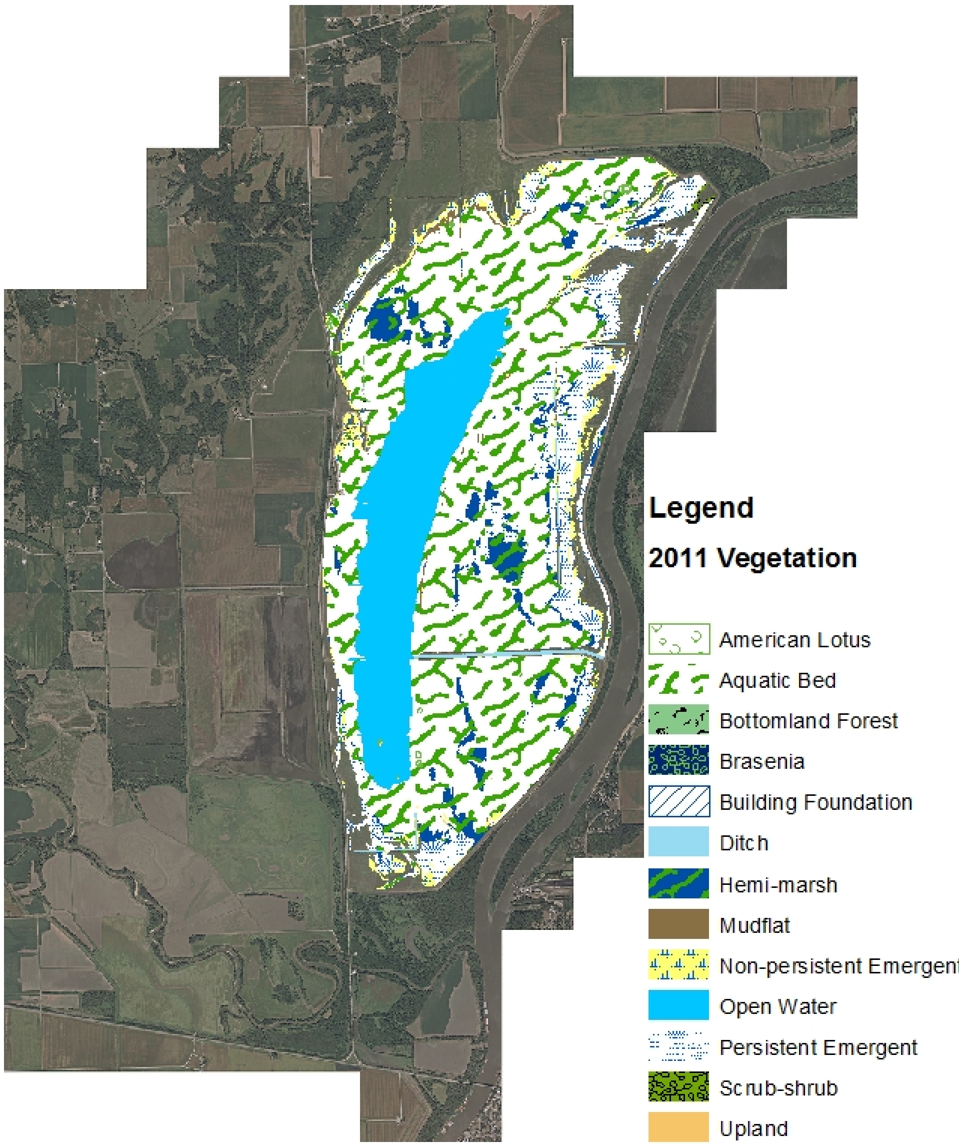

Figure 1. Wetland habitat map of The Emiquon Preserve, 13 September–24 October, 2011.

Table 1. Avian species observed during monitoring activities at The Emiquon Preserve, 2011.

AOU Code[a]	Common Name	Scientific Name
ABDU	American black duck	*Anas rubripes*
AGWT	American green-winged teal	*Anas crecca*
AMCO	American coot	*Fulica americana*
AMWI	American wigeon	*Anas americana*
AWPE	American white pelican	*Pelecanus erythrorhynchos*
BAEA	Bald eagle	*Haliaeetus leucocephalus*
BCNH	Black-crowned night heron	*Nycticorax nycticorax*
BEKI	Belted kingfisher	*Megaceryle alcyon*
BLGO	Lesser snow goose (blue phase)	*Chen caerulescens*
BLTE	Black tern	*Chlidonias niger*
BNST	Black-necked stilt	*Himantopus mexicanus*
BUFF	Bufflehead	*Bucephala albeola*
BWTE	Blue-winged teal	*Anas discors*
CAGO	Canada goose	*Branta canadensis*
CANV	Canvasback	*Aythya valisineria*
COGO	Common goldeneye	*Bucephala clangula*
COME	Common merganser	*Mergus merganser*
DCCO	Double-crested cormorant	*Phalacrocorax auritus*
COMO	Common moorhen	*Gallinula chloropus*
GADW	Gadwall	*Anas strepera*
GBHE	Great blue heron	*Ardea herodias*
GHOW	Great horned owl	*Bubo virginianus*
GREG	Great egret	*Ardea alba*
GRHE	Green heron	*Butorides virescens*
GWFG	Greater white-fronted goose	*Anser albifrons*
HOME	Hooded merganser	*Lophodytes cucullatus*
HOGR	Horned grebe	*Podiceps auritus*
KILL	Killdeer	*Charadrius vociferus*
LBHE	Little blue heron	*Egretta caerulea*
LESC	Lesser scaup	*Aythya affinis*
LSGO	Lesser snow goose	*Chen caerulescens*
MALL	Mallard	*Anas platyrhynchos*
MUSW	Mute swan	*Cygnus olor*
NOHA	Northern harrier	*Circus cyaneus*
NOPI	Northern pintail	*Anas acuta*
NSHO	Northern shoveler	*Anas clypeata*
PBGR	Pied-billed grebe	*Podilymbus podiceps*
PEFA	Peregrine falcon	*Falco peregrinus*
RBGU	Ring-billed gull	*Larus delawarensis*

Table 1. Continued

AOU Code[a]	Common Name	Scientific Name
RBME	Red-breasted merganser	*Mergus serrator*
REDH	Redhead	*Aythya americana*
RNDU	Ring-necked duck	*Aythya collaris*
RTHA	Red-tailed hawk	*Buteo jamaicensis*
RUDU	Ruddy duck	*Oxyura jamaicensis*
SACR	Sandhill crane	*Grus canadensis*
SORA	Sora	*Porzana carolina*
SWAN	Unknown swan	*Cygnus* spp.
TRUS	Trumpeter swan	*Cygnus buccinator*
WODU	Wood duck	*Aix sponsa*

[a]According to the American Ornithologists' Union Check-list, 1998.

Table 2. Plant species encountered during wetland covermapping at The Emiquon Preserve, 2011.

Common Name	Scientific Name
Ammania (Long-leaved ammania)	*Ammania coccinea*
American lotus	*Nelumbo lutea*
Arrowhead (S. calycina)	*Sagittaria calycina*
Ash	*Fraxinus* spp.
Aster	*Aster* spp.
Barnyardgrass	*Echinochloa crus-galli*
Bidens cernua (Nodding Beggartick)	*Bidens cernua*
Bidens frondosa (Devil's Beggartick)	*Bidens frondosa*
Bog bulrush	*Schoenoplectus mucronatus*
Boneset	*Eupatorium* spp.
Brasenia (Watershield)	*Brasenia schreberi*
Brome (Smooth)	*Bromus inermis*
Bur reed	*Sparganium* spp.
Carex	*Carex* spp.
Cattail	*Typha* spp.
Chara	*Chara* spp.
Chufa	*Cyperus esculentus*
Clover	*Trifolium* spp.
Cocklebur	*Xanthium* spp.
Coontail	*Ceratophyllum demersum*
Cottonwood (Eastern Cottonwood)	*Populus deltoides*
Crabgrass	*Digitaria* spp.
Creeping water primrose	*Ludwigia peploides*
Curly dock	*Rumex crispus*
Decurrent false aster	*Boltonia decurrens*
Elm	*Ulmus* spp.
Elodea (Waterweed)	*Elodea* spp.
Eurasian water milfoil (Milfoil)	*Myriophyllum spicatum*
Ferruginous flatsedge	*Cyperus ferruginescens*
Fog fruit	*Phyla* spp.
Foxtail	*Setaria* spp.
Goldenrod	*Solidago* spp.
Hoary vervain	*Verbena stricta*
Horned pondweed	*Zannichellia palustris*
Horseweed	*Conyza spp.*
Largeseed smartweed	*Polygonum pensylvanicum*

Table 2. Continued.

Common Name	Scientific Name
Lambsquarters	*Chenopodium album*
Lemna (Duckweed)	*Lemna minor*
Lesser ragweed	*Ambrosia artemisiifolia*
Locust	*Robinia* spp.
Longleaf pondweed	*Potamogeton nodosus*
Marsh smartweed	*Polygonum hydropiperoides*
Marshpepper smartweed	*Polygonum hydropiper*
Mint	*Mentha* spp.
Morning glory	*Ipomoea* spp.
Mullein	*Verbascum* spp.
Naiad	*Najas* spp.
Nodding smartweed	*Polygonum lapathifolium*
Panicum (Fall)	*Panicum dichotomiflorum*
Phragmites (Reed)	*Phragmites* spp.
Pigweed	*Amaranthus* spp.
Plantain	*Plantago* spp.
Pokeweed	*Phytolacca* spp.
Prairie cordgrass	*Spartina pectinata*
Rattlesnake master	*Eryngium yuccifolium*
Redroot flatsedge	*Cyperus erythrorhizos*
Reed canarygrass	*Phalaris arundinacea*
Rice cutgrass	*Leersia oryzoides*
River bulrush	*Scirpus fluviatilis*
Sago pondweed	*Stuckenia pectinata*
Shallow sedge	*Carex lurida*
Silver maple	*Acer saccharinum*
Small pondweed	*Potamogeton Pusillis*
Softstem bulrush	*Schoenoplectus Tabernaemontani*
Sowthistle	*Sonchus* spp.
Spikerush	*Eleocharis spp.*
Switchgrass	*Panicum virgatum*
Tealgrass	*Eragrostis hypnoides*
Thistle	*Cirsium* spp.
Torrey's rush	*Juncus torreyi*
Velvetleaf	*Abutilon spp.*
Water plantain	*Alisma* spp.
Water smartweed	*Polygonum amphibium*

Table 2. Continued.

Common Name	Scientific Name
Wild rye	*Elymus* spp.
Willow	*Salix* spp.
Woolgrass	*Scirpus cyperinus*

Table 3. Estimates of waterfowl abundance from ground inventories at The Emiquon Preserve during spring 2011.

	Inventory Dates									
Species[a]	18 Feb	24 Feb	2 Mar	11 Mar	16 Mar	24 Mar	31 Mar	7 Apr	14 Apr	Total (%)
ABDU	0	6	8	0	0	0	0	0	0	14 (0.0)
AGWT	0	25	982	1,480	499	1,379	1,019	821	23	6,228 (2.0)
AMWI	0	78	0	535	177	43	14	156	4	1,007 (0.3)
BUFF	0	31	38	1,235	790	919	1,392	771	271	5,447 (1.7)
BWTE	0	0	0	1	0	104	144	449	290	988 (0.3)
CAGO	220	895	674	160	77	28	28	20	31	2,133 (0.7)
CANV	75	285	742	1,390	880	108	84	16	8	3,588 (1.1)
COGO	75	543	667	51	76	0	0	0	0	1,412 (0.4)
COME	250	665	700	1,527	315	0	0	0	0	3,457 (1.1)
GADW	0	232	840	1,461	1,762	1,539	722	372	47	6,975 (2.2)
GWFG	1,025	1,643	900	25	20	18	0	0	0	3,631 (1.2)
HOME	0	81	68	422	147	41	65	113	136	1,073 (0.3)
LESC	75	120	2,423	5,041	4,544	4,718	1,656	1,031	90	19,698 (6.3)
LSGO	3,900	36,950	101,500	12,600	300	150	10	21	13	155,444 (49.5)
MALL	2,135	4,338	6,355	4,405	1,949	1,003	903	1,019	402	22,509 (7.2)
MUSW	0	7	7	7	6	5	3	4	4	43 (0.0)
NOPI	79	494	1,539	1,915	826	25	0	0	0	4,878 (1.6)
NSHO	0	13	43	342	723	7,658	9,483	6,120	1,541	25,923 (8.3)
RBME	0	0	0	4	18	40	30	0	0	92 (0.0)
REDH	75	50	72	157	153	0	0	5	0	512 (0.2)
RNDU	50	240	600	1,650	3,770	4,539	503	715	6	12,073 (3.8)
RUDU	0	43	865	2,518	4,742	9,508	10,653	6,123	1,659	36,111 (11.5)
TRUS	0	7	72	59	98	71	3	0	0	310 (0.1)
Unk. Ducks	245	0	0	0	0	0	0	0	0	245 (0.1)
WODU	0	0	0	0	0	14	6	0	8	28 (0.0)
Total	8,204	46,746	119,095	36,985	21,872	31,910	26,718	17,756	4,533	313,819

[a] See table 1.

Table 4. Estimates of waterfowl abundance from aerial inventories at The Emiquon Preserve during spring 2011.

	Inventory Dates				
Species[a]	14 Mar	21 Mar	28 Mar	7 Apr	Total (%)
MALL	2,135	1,935	1,005	905	5,980 (6.7)
ABDU	220	180	50	0	450 (0.5)
NOPI	880	735	100	0	1,715 (1.9)
BWTE	0	735	200	50	985 (1.1)
AGWT	2,135	3,840	985	1,505	8,465 (9.5)
AMWI	805	735	0	50	1,590 (1.8)
GADW	3,970	2,985	985	905	8,845 (10.0)
NSHO	1,255	4,625	5,450	5,715	17,045 (19.2)
LESC	8,420	1,885	690	600	11,595 (13.1)
RNDU	4,270	785	100	0	5,155 (5.8)
CANV	830	370	0	300	1,500 (1.7)
REDH	500	735	0	0	1,235 (1.4)
RUDU	5,655	3,770	3,990	6,220	19,635 (22.1)
COGO	0	180	0	0	180 (0.2)
BUFF	450	760	420	100	1,730 (1.9)
COME	1,130	470	10	0	1,610 (1.8)
HOME	50	0	50	0	100 (0.1)
CAGO	30	20	10	10	70 (0.1)
GWFG	20	205	0	0	225 (0.3)
LSGO	600	5	0	0	605 (0.7)
SWAN	40	40	2	0	82 (0.1)
Total	33,395	24,995	14,047	16,360	88,797

[a] See table 1.

Table 5. Estimates of waterfowl abundance from aerial inventories at The Emiquon Preserve during fall 2011.

	Inventory Dates																
Species[a]	30 Aug	6 Sep	12 Sep	22 Sep	10 Oct	17 Oct	24 Oct	1 Nov	15 Nov	21 Nov	30 Nov	7 Dec	12 Dec	23 Dec	28 Dec	4 Jan	Total (%)
MALL	810	1,995	2,210	3,095	3,695	3,820	9,620	12,255	18,760	10,280	9,100	16,840	16,400	1,250	1,310	400	111,840 (22.1)
ABDU	0	0	0	0	0	250	0	0	0	160	0	55	0	0	0	0	465 (0.1)
NOPI	160	1,995	1,105	7,690	17,175	22,750	22,600	26,250	2,915	635	150	10	0	0	0	0	103,435 (20.4)
BWTE	8,620	7,995	8,865	9,575	6,810	3,020	1,130	0	0	0	0	0	0	0	0	0	46,015 (9.1)
AGWT	0	1,000	4,420	405	13,630	15,200	18,040	17,500	11,660	1,590	100	0	0	0	0	0	83,545 (16.5)
AMWI	0	0	0	380	2,040	3,020	6,765	3,500	585	0	0	0	0	0	0	0	16,290 (3.2)
GADW	0	0	0	1,910	1,360	7,550	11,275	17,500	8,745	4,770	700	440	300	300	420	0	55,270 (10.9)
NSHO	160	1,000	1,105	0	3,395	5,790	11,325	3,500	1,750	4,770	150	50	100	0	0	0	33,095 (6.5)
LESC	0	0	0	0	0	0	2,255	440	585	160	350	0	100	0	220	0	4,110 (0.8)
RNDU	0	0	0	0	0	0	2,255	440	2,915	7,760	0	1,000	200	100	0	0	14,670 (2.9)
CANV	0	0	0	0	0	0	0	1,750	1,750	320	20	15	100	0	0	0	3,955 (0.8)
REDH	0	0	0	0	0	0	400	440	0	160	0	0	0	0	0	0	1,000 (0.2)
RUDU	0	0	0	0	500	500	4,510	5,250	2,915	955	1,520	765	100	800	400	200	18,415 (3.6)
COGO	0	0	0	0	0	0	0	0	0	0	0	0	100	300	100	0	500 (0.1)
BUFF	0	0	0	0	0	0	0	0	0	0	200	10	100	150	50	0	510 (0.1)
COME	0	0	0	0	0	0	0	0	0	0	0	40	200	440	900	450	2,030 (0.4)
HOME	0	0	0	0	10	0	0	0	40	250	60	0	350	10	350	0	1,070 (0.2)
CAGO	235	80	60	80	370	285	810	205	330	50	100	0	200	550	75	105	3,535 (0.7)
LSGO	0	0	0	0	0	0	0	0	300	0	0	0	400	10	1,100	0	1,810 (0.4)
GWFG	0	0	0	0	0	0	0	0	300	0	0	250	300	2,100	1,700	200	4,850 (1.0)
SWAN	17	0	0	0	0	0	0	0	0	0	51	0	0	0	0	30	98 (0.0)
Total	10,002	14,065	17,765	23,135	48,985	62,185	90,985	89,030	53,550	31,860	12,501	19,475	18,950	6,010	6,625	1,385	506,508

[a] See table 1.

Table 6. Estimates of waterbird and raptor abundance from ground inventories at The Emiquon Preserve during spring 2011.

	Inventory Dates									
Species[a]	18 Feb	24 Feb	2 Mar	11 Mar	16 Mar	24 Mar	31 Mar	7 Apr	14 Apr	Total (%)
AMCO	0	0	441	5,402	7,803	10,778	10,964	7,774	3,138	46,300 (88.4)
AWPE	0	0		143	392	183	60	303	276	1,357 (2.6)
BAEA	20	44	35	13	5	13	4	1	1	136 (0.3)
BNST	0	0	0	0	0	0	0	0	18	18 (0.0)
DCCO	0	0	0	308	1,417	1,107	774	360	448	4,414 (8.4)
GBHE	0	0	0	0	33	0	7	2	8	50 (0.1)
GREG	0	0	0	0	0	0	6	0	0	6 (0.0)
HOGR	0	0	0	0	0	0	0	0	2	2 (0.0)
NOHA	1	2	2	5	5	2	5	3	1	26 (0.1)
PBGR	0	0	0	0	0	2	5	9	13	29 (0.1)
RTHA	1	1	0	3	3	1	3	2	1	15 (0.0)
SACR	0	0	0	3	0	0	3	0	0	6 (0.0)
Total	22	47	478	5,877	9,658	12,086	11,831	8,454	3,906	52,359

[a] See table 1.

Table 7. Estimates of waterbird abundance from aerial inventories at The Emiquon Preserve during spring 2011.

	Inventory Dates				
Species[a]	14 Mar	21 Mar	28 Mar	7 Apr	Total (%)
AMCO	7,915	13,675	6,695	15,650	43,935 (87.7)
DCCO	25	3,080	1,050	245	4,400 (8.8)
AWPE	425	765	355	210	1,755 (3.5)
Total	8,365	17,520	8,100	16,105	50,090

[a] See table 1.

Table 8. Estimates of non-waterfowl abundance from aerial inventories at The Emiquon Preserve during fall 2011.

	Inventory Dates																
Species[a]	30 Aug	6 Sep	12 Sep	22 Sept	10 Oct	17 Oct	24 Oct	1 Nov	15 Nov	21 Nov	30 Nov	7 Dec	12 Dec	23 Dec	28 Dec	4 Jan	Total (%)
AWPE	100	450	50	270	635	800	735	360	325	210	30	110	25	0	0	100	4,200 (1.2)
AMCO	100	100	100	3,820	20,370	90,600	135,300	86,180	5,880	1,590	800	300	1,100	500	350	500	347,590 (98.0)
BAEA	0	0	1	0	0	3	5	1	5	10	3	8	12	3	9	76	136 (0.0)
DCCO	365	110	350	620	325	1,110	0	0	0	0	10	5	0	0	0	0	2,895 (0.8)
Total	565	660	501	4,710	21,330	92,513	136,040	86,541	6,210	1,810	843	423	1,137	503	359	676	354,821

[a] See table 1.

Table 9. Behavior observations (%) of ducks at The Emiquon Preserve during spring, 2011.

		Activity				
Group	Month	Feed	Rest	Social	Locomotion	Other
Dabbling Ducks	February	57.4	24.7	1.8	10.9	5.2
Dabbling Ducks	March	80.5	8.3	0.5	8.5	2.2
Dabbling Ducks	April	53.1	33.8	0.6	5.0	7.4
Total Dabblers		69.7	17.3	0.8	8.2	3.9
Diving Ducks	March	32.7	31.9	2.6	27.7	5.1
Diving Ducks	April	8.0	86.3	0.0	1.6	4.2
Total Divers		28.9	40.4	2.2	23.6	4.9
Total Ducks		53.3	26.6	1.4	14.4	4.3

Table 10. Waterbird brood observations by species at The Emiquon Preserve, 2011.

Species	Inventory Dates						Total Broods	%
	1 Jun	16 Jun	29 Jun	6 Jul	20 Jul	5 Aug		
WODU	0	4	14	14	19	16	67	53.6
CAGO	9	7	5	2	4	5	32	25.6
MALL	0	2	4	2	9	3	20	16.0
COMO	0	0	0	0	1	1	2	1.6
PBGR	0	0	0	0	0	2	2	1.6
AMCO	0	0	0	0	1	0	1	0.8
BWTE	0	1	0	0	0	0	1	0.8
Total	9	14	23	18	34	27	125	
Average age [a]	2A	2A	2C	2B	2C	2C		

[a] Gollop and Marshall 1954

Table 11. Mean biomass (mg/m^3, dry mass) and percent occurrence of aquatic invertebrates collected at The Emiquon Preserve, 2011.

Taxa	Biomass (mg/m^3)[a]	Percent Occurrence
Gastropoda		
Physidae	27.9	60.0
Planorbidae	21.9	50.0
Lymneidae	0.0	1.7
Ostracoda	0.0	5.0
Cladocera	1.0	95.0
Copepoda	0.3	73.3
Amphipoda	0.5	40.0
Arachnida	0.0	1.7
Hydrachnida	0.2	56.7
Collembola	0.0	11.7
Coleoptera		
Dytiscidae	0.1	48.3
Haliplidae	0.0	3.3
Hydrophilidae	0.9	16.7
Diptera		
Ceratopogonidae	0.4	46.7
Chironomidae	2.4	70.0
Culicidae	0.0	6.7
Sciomyzidae	0.0	1.7
Stratiomyidae	1.6	26.7
Unknown Diptera	0.0	3.3
Ephemeroptera		
Baetidae	0.0	3.3
Caenidae	2.4	63.3
Hemiptera		
Corixidae	0.4	16.7
Gerridae	0.0	1.7
Mesoveliidae	0.1	35.0
Pleidae	0.3	40.0
Saldidae	0.1	10.0
Homoptera	0.2	13.3
Hymenoptera	0.0	3.3
Lepidoptera		
Pyralidae	1.5	28.3

Table 11. Continued

Taxa	Biomass (mg/m^3)[a]	Percent Occurrence
Odonata		
Aeshnidae	0.1	1.7
Coenagrionidae	1.7	55.0
Libellulidae	0.9	30.0
Trichoptera		
Leptoceridae	0.1	11.7
Turbellaria	0.0	8.3
Nematoda	0.0	8.3
Oligochaeta	1.6	65.0
Hirudinea		
Glossiphonidae	0.2	6.7
Hydra	0.2	46.7

[a] Some taxa were not abundant enough to weigh after drying.

Table 12. Moist-soil plant seed abundance (kg/ha, dry mass) and energetic use-days (EUD) per hectare at The Emiquon Preserve, 2011.

		Abundance			EUDs	
Seed Size[a]	n	$\bar{x}$	SE	CV(%)	$\bar{x}$	SE
Large	20	937.2	184.8	88.2	8,024.2	1,582.3
Small	20	179.0	39.8	99.4	1,532.6	340.6
Total	20	1,116.2	193.3	77.4	9,556.8	1,654.6

[a] Moist-soil seeds were classified as large (e.g., millets; retained by a #35 sieve) or small (e.g., nutgrasses, retained by a #60 sieve).

Table 13. Area and proportions of upland and wetland habitats estimated by covermapping at The Emiquon Preserve, 2011.

Habitat	Hectares	%
American Lotus	4.1	0.2
Aquatic Bed	1,071.7	58.9
Bottomland Forest	1.0	0.1
Brasenia	0.1	0.0
Ditch	11.6	0.6
Hemi-marsh	109.3	6.0
Mudflat	11.8	0.6
Non-persistent Emergent	61.5	3.4
Open Water	323.5	17.8
Persistent Emergent	223.3	12.3
Scrub-shrub	2.3	0.1
Upland	0.2	0.0
Total Mapped Area	1,820.6	

Submitted by:

Aaron Yetter
Principal Investigator
Illinois Natural History Survey
Forbes Biological Station

Date:1 May 2012.