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 2010

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

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 2011 (17)
Date of Issue: 26 May 2011

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 guidance in our monitoring activities. 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. Finally, we thank D. Holm (Illinois Department of Natural Resources) and B. Bushman (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 2010. 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 (Table 1) at Emiquon during spring migration with a spotting scope and binoculars from fixed vantage points. Additionally, we counted birds while traveling between vantage points. We initiated bi-weekly inventories when ice receded (early March) and concluded around mid-April, when most migrants had departed.

Although our ground inventories were designed to monitor waterfowl, we recorded abundance of raptors and other waterbirds 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 waterfowl by species (except wood ducks).

We converted abundance estimates to use-days to evaluate overall waterbird use of Emiquon (UDs; 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.

Due to redundancy with our aerial waterfowl inventories, fall ground counts at Emiquon were discontinued in 2010. Thus, our 2010 fall abundance, UD estimates, and yearly comparisons were based upon aerial inventory data.

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 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 prevented us from making some observations.

Brood Observations

We monitored waterbird production at Emiquon in 2010 through passive brood observations (Rumble and Flake 1982). We conducted bi-weekly brood surveys between early June and mid-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 2010 ($n = 60$ 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° C to constant mass and weighed to the nearest 0.1 mg using a Mettler electronic balance. 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 2010, 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°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 using an electronic balance. Due to the extensive processing time, we sub-sampled a portion (≥2.5% by mass) of some small seed samples to estimate biomass. The percent composition of seeds and debris in the subsample was multiplied by the small seed sample mass to extrapolate total small seed abundance 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 estimates of energetic carrying capacity for waterfowl, expressed as energetic use-days (EUD). A 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 2010 to document changes in wetland area, plant species composition, and vegetation assemblages. We traversed east-west transects spaced at 500 m intervals on foot, all-terrain vehicle, or by 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 2010 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), mud flats, floating-leaved aquatic vegetation (e.g., American lotus), 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; Cowardin et al. 1979, Suloway and Hubbell 1994, Stafford et al. 2010). We also included a category to account for 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 a more-or-less 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, prairie cordgrass). Likewise, willows occurred in bottomland forest and scrub-shrub habitats, but they were not a stand-alone habitat category in 2010.

RESULTS

Waterfowl Abundance

Spring

We conducted 5 ground inventories from 3 March to 20 April 2010 (Table 3) and 4 aerial inventories from 15 March to 5 April 2010 (Table 4). Peak abundance reached 42,056 via ground inventory on 23 March and 87,145 on 29 March via aerial inventory. We observed 23 species of waterfowl during spring (19 duck species, 3 goose species, and 1 swan species).

Northern shoveler was the most abundant species during ground inventories, accounting for 22.1% of total waterfowl abundance, followed by lesser scaup (15.2%) and ruddy ducks (15.0%). Diving ducks were slightly more abundant than dabbling ducks, accounting for 54.6% and 45.4% of the total waterfowl abundance, respectively. We estimated spring UDs were 1,074,691 based on ground inventories.

Fall

We conducted 14 aerial inventories at Emiquon from 8 September to 3 January (Table 5). We observed 21 species of waterfowl (17 duck species, 3 goose species, and 1 swan species) with a peak abundance of 62,872 on 8 November. Northern pintails (17.6%) were the most abundant species, followed by gadwalls (17.0%) and American green-winged teal (15.7%). Estimated waterfowl UDs at Emiquon totaled 3,819,574. Dabbling ducks (3,475,903 UDs) accounted for 91.0% of UDs, whereas only 8.1% of waterfowl use was attributable to diving ducks (309,346 UDs).

Non-Waterfowl Abundance

Spring

In addition to waterfowl, we documented 11 waterbird and raptor species during ground counts in spring 2010 (Table 6). Peak abundance of non-waterfowl species based on ground inventories was 26,535 individuals and occurred on 23 March, whereas aerial inventories revealed a peak of 96,075 on 5 April (Table 7). American coots were the most common species observed and accounted for 85.7% and 97.5% of non-waterfowl abundance based on ground and aerial inventories, respectively. American coot abundance peaked at 25,888 (93,130 via aerial inventories), while their overall use of Emiquon totaled 650,588 UDs. Other commonly observed species included American white pelicans, double-crested cormorants, and pied-billed grebes.

Fall

We also estimated abundances of American white pelicans, American coots, double-crested cormorants, and bald eagles during 14 aerial inventories of waterfowl (Table 8). American coots were the most abundant of these species, with a peak estimate of 95,040 on 2 November; they constituted 97.6% of non-waterfowl abundance during fall. Likewise, American coots accounted for 97.3% (3,094,350 UDs) of non-waterfowl use, followed by American white pelicans (1.9%), and double-crested cormorants (0.7%). Nearly half (44.2%) of all waterbird use (including waterfowl) at Emiquon was attributable to American coots.

Waterfowl Behavior

We conducted behavior observations on 4 days between 10 March and 20 April 2010. Species observed included northern shoveler, gadwall, lesser scaup, ring-necked duck, and ruddy duck. Overall, these species spent most of their time feeding (58.1%), followed by locomotion (20.9%; Table 9). However, when considered by guild, dabbling ducks spent 81.2% of their time feeding, whereas diving ducks only spent 19.7% of their time feeding. Locomotion (38.3%) and resting (30.6%) were the most common activities of diving ducks.

Brood Observations

We completed 6 fixed-point brood surveys from 4 June to 12 August 2010 and recorded 142 waterbird broods comprised of 4 species (Table 10). The most abundant broods recorded were wood ducks (n = 91), followed by Canada geese (n = 32), mallards (n = 15), and pied-billed grebes (n = 4). Brood observations peaked (n = 35) on 14 July, and age classes of broods increased throughout the observation period.

Aquatic Invertebrates

We collected 20 sweep-net samples on 19 April, 24 June, and 17 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 – 26.1 mg/m^3, June – 43.9 mg/m^3, August – 186.7 mg/m^3). We identified 40 taxa with Cladocera (90.0%), Coenagrionidae nymph (66.7%), Chironomidae larvae (65.0%), and Caenidae nymph (65.0%) occurring in the largest percentage of samples (Table 11). Aeshnidae (18.9 mg/m^3), Libellulidae (8.9 mg/m^3), and Cladocera (7.4 mg/m^3) provided the greatest biomass per volume; although, Aeshnidae occurred in only 5% of the samples (*n* = 3; Table 11). Total biomass averaged 85.6 mg/m^3 over the 3 sampling periods.

Moist-soil Plant Seeds

We extracted 20 core samples from random locations at Emiquon on 14 October 2010. Average moist-soil plant seed biomass was 629.5 kg/ha (dry mass; Table 12). Large seeds contributed 421.9 kg/ha, whereas small seeds accounted for the remaining 207.6 kg/ha. The estimated energetic carrying capacity from moist-soil plant seeds in 2010 was 5,389 EUDs/ha.

Wetland Covermapping

We mapped all wetland vegetation associated with Thompson and Flag lakes in 9 days during 8–20 September 2010 and documented 11 habitat categories. Aquatic bed (1,036.3 ha) was the most abundant habitat type, followed by open water (248.7 ha), non-persistent emergent (217.7 ha), and persistent emergent (199.0 ha; Table 13, Fig. 1). We covermapped 1,974.1 ha and documented 68 plant species (Table 2).

DISCUSSION

Waterfowl Abundance

Spring

During spring 2010, ground inventories indicated UDs declined for the first time and were the lowest since monitoring began (1,074,691 UDs). This UD estimate represented a 42.6% decrease from spring 2009 (1,872,144 UDs) and a 24.4% decrease from spring 2008 (1,421,670 UDs). Because the size of the wetland changed considerably, we also expressed duck use estimates as densities (UD/ha). Similarly, duck-use densities were lowest during spring 2010 (553 UD/ha) compared to a high of 4,902 UD/ha during fall 2007. The low UD/ha estimate for spring 2010 was somewhat surprising given that fall 2009 UDs (>3 million) were relatively high. It's probable this apparent decline was a function of the frequency of ground inventories (bi-weekly) rather than actual reductions in waterfowl abundance. For instance, aerial inventories indicated a peak in waterfowl abundance that was more than twice that of ground inventories occurred during a week when a ground count was not conducted. Furthermore, ice melt was late during spring 2010 and inventories did not begin until 3 March, whereas in prior years they began mid-February. It's possible that spring migration was compressed in 2010 and ducks did not stay as long as in previous springs.

Fall

Our fall 2010 estimate of duck UDs (3,787,499) was 10.7% greater than in fall 2009 and the highest since monitoring began in 2007. This was undoubtedly influenced by a 33% increase in use by dabbling ducks (highest recorded); however, diving duck use declined by nearly 62%. Northern pintails were the most abundant duck at Emiquon, and their use (663,895 UDs) in fall 2010 increased 233% from fall 2009. The 2010 UD estimate was the third highest recorded for northern pintails at a single location in the Illinois River valley (IRV) since aerial inventories began in 1948 (M. Horath, unpublished data). This is particularly noteworthy as continental population estimates of northern pintails have been below the North American Waterfowl Mangement Plan (NAWMP) goal (5.6 million) for 35 years (Zimpfer et al. 2010). Blue-winged teal use (659,503 UDs) also increased by an impressive 275% over fall 2009 estimates and was the highest ever recorded from aerial inventories in the IRV and central Mississippi River valley. Likewise, use of Emiquon by American green-winged teal (607,868 UDs) and gadwalls (607,453 UDs) was also the highest recorded in the IRV (M. Horath, unpublished data). These dramatic increases in use by dabbling ducks and the substantial decline in diving duck use may have been at least partially attributed to changes in wetland habitat conditions at Emiquon. For instance, the late-season drawdown created large areas of shallow water habitat along with mudflats that early-migrant dabbling ducks find attractive, while reducing the amount of submersed aquatic vegetation favored by many diving ducks. Moreover, the amount of forage produced in other IRV wetlands was limited in 2010 due to flooding during the growing season, further contributing to the attractiveness of Emiquon to waterfowl.

We also calculated duck use per unit area of wetland (UD/ha) because the size of wetland area at Emiquon has changed considerably each year since restoration efforts began. The estimated duck-use density was 2,690 UD/ha during fall 2010. To compare duck use at Emiquon with another important waterfowl refuge in the IRV, we calculated fall duck-use densities at Chautauqua National Wildlife Refuge (CNWR) during 1991−2008. Duck-use densities at CNWR averaged 2,632 UD/ha during this period, and ranged from 133−9,925 UD/ha. Therefore, duck-use density at Emiquon during fall 2010 was slightly higher than the average duck-use density at CNWR, and was the highest observed since fall 2007.

Non-Waterfowl Abundance

Spring

Similar to waterfowl, we observed an apparent reduction in non-waterfowl bird use and diversity during spring 2010 ground inventories. American coot abundance and UDs declined 69.1% and 50.2%, respectively, from spring 2009 estimates and were the lowest to date. Nevertheless, the apparent reductions in abundance from ground inventories were not reflected in our observations during aerial inventories. For example, aerial inventory data indicated a peak abundance of 93,130 American coots (highest recorded in spring) occurred on 5 April, whereas ground inventories revealed a peak of only 25,888 on 23 March. Ground inventories were only conducted bi-weekly, and aerial inventories (conducted weekly) detected large increases followed by a sudden decline in American coots between ground inventories (22 March−8 April). Consequently, it seems logical that ground inventories missed the peak migration of American coots due to the bi-weekly schedule of our surveys. Thus, we will conduct ground inventories weekly during spring 2011.

Fall

The UD estimate of American coots at Emiquon during fall 2010 (3,094,350) was 27% lower than the fall 2009 estimate. However, American coot (4,249,563 UDs) use in fall 2009 was the highest observed for any surveyed location since the inception of aerial inventories in the IRV (M. Horath, unpublished data). Correspondingly, the fall 2010 UD estimate was the second highest ever recorded for coots in the IRV. Use of Emiquon by American white pelicans (+45.2%), bald eagles (+257%), and double-crested cormorants (+53.4%) increased substantially over fall 2009 and exponentially since 2007. It is difficult to overemphasize the regional importance of Emiquon to migratory waterbirds, especially given that use by some species in 2010 was higher than previously recorded at any other wetland in the IRV since aerial surveys began in 1948.

Waterfowl Behavior

Ducks observed at Emiquon spent most of their time feeding (58.1%) during spring 2010. However, dabbling ducks (gadwalls, northern shovelers) spent 81.2% of their time feeding, whereas diving ducks (lesser scaup, ring-necked ducks, ruddy ducks) spent only 19.7% of their time feeding. Although we lack food habits data of waterfowl utilizing Emiquon, our observations were generally consistent with those from other time-activity studies of Anatids. For example, Paulus (1988) reported species that foraged on leafy aquatic vegetation spent more time feeding. Aquatic plants, an abundant food source at Emiquon, are usually characterized by high water and fiber content and lower gross energy. Gadwall diets in Louisiana consisted almost entirely (95%) of aquatic vegetation and algae, and consequently, they spent 80% of their time during the day feeding to meet nutrient requirements (Paulus 1984). In contrast, non-breeding diving ducks (*Aythya*) foraging primarily on animal matter usually spent <30% of their time feeding (Paulus 1988, Bergan et al. 1989, Crook et al. 2009), because these foods contain higher gross energy and more nutrients than vegetation (Driver et al. 1974). Thus, waterfowl species with diets containing animal foods would be expected to spend less time foraging than those with diets dominated by vegetation.

Brood Observations

Total broods observed at Emiquon in spring 2010 (*n* = 142) increased 24.6% from spring 2009 (*n* = 114), but species diversity declined 42.8% between 2009 (*n* = 7) and 2010 (*n* = 4), and was the lowest recorded to date. Likewise, observations of pied-billed grebe broods were the lowest (*n* = 4) since surveys began, representing a 63.6% decline from spring 2009. We did not detect the first grebe broods until 29 July, which was 3 weeks later than the first grebe broods observed in 2008 and 2009. The most unexpected change in brood sightings at Emiquon involved American coots. We could not document any American coot reproduction during 2010. We recorded a 45.8% decline in the number of coot broods between 2008 (*n* = 24) and 2009 (*n* = 13), but did not anticipate this reproductive failure in 2010. Late-spring phenology and habitat disturbances from high water and shifting ice for 2 consecutive years likely caused nesting conditions to be less favorable for American coots and pied-billed grebes. Our anecdotal observations indicated that there was more open water and less hemi-marsh for nesting waterbirds during spring brood surveys. In contrast, observations of wood duck broods (*n* = 91) in 2010 were the highest to date, representing a 35.8% increase over 2009. Further, observations of Canada goose broods (*n* = 32) increased dramatically (+357%) over 2009 and also represented the highest count thus far. Canada geese may have exploited the apparent increase of muskrat (*Ondatra zibethicus*) lodges as nesting islands in Flag Lake during spring 2010. Similar to 2008 and 2009, age classes of broods continued to increase throughout the spring-summer observation period. Most of the broods were flighted and indistinguishable from adults by 12 August. Although species diversity declined and should be monitored further, broods continued to increase and survive to flight stage, indicating that Emiquon provided quality brood-rearing habitat for resident waterfowl in 2010.

Aquatic Invertebrates

Diversity of aquatic invertebrates at Emiquon in 2010 (*n* = 40 taxa) was comparable to that observed in 2009 (*n* = 39 taxa) and nearly 54% greater than the number of taxa identified in 2008 (*n* = 26). While diversity remained high, biomass estimates for aquatic invertebrates in 2010 declined substantially from previous years. Total invertebrate biomass in 2010 (5,303.7 mg) declined 42% from 2008 (9,120.7 mg) and 63% from 2009 (14,476.6 mg) estimates. Likewise, mean invertebrate biomass per sweep-net sample in 2010 (85.6 mg/m^3) was 32% and

45% less than estimates of biomass in 2008 (126.0 mg/m^3) and 2009 (155.6 mg/m^3), respectively.

It's probable that low snail abundance at least partially explained the decline in invertebrate biomass observed in 2010. Snails, especially Physidae and Planorbidae, had been the most important contributors to invertebrate biomass during the previous 2 years. For instance, physid biomass was 72 mg/m^3 in 2008 and 2009, while planorbids accounted for 20 mg/m^3 and 55 mg/m^3 in 2008 and 2009, respectively. Conversely, physids contributed only 6.7 mg/m^3, while planorbids provided merely 4.7 mg/m^3 to the invertebrate biomass in 2010.

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). We believe the most reasonable cause is change in vegetation structure and assemblage due to the late-season drawdown at Emiquon during 2010. In previous years, the water level increased and inundated vegetation around the wetland perimeter where our sampling occurred. However in 2010, the water level was stable early in the sampling period but declined later in summer. This may have reduced preferred snail habitat by eliminating emergent vegetation and reducing submergent vegetation at the wetland periphery where we sampled (Voigts 1976). Additionally, we only sampled along the western shore of the wetland, and therefore, this decline may have been an artifact of our sampling design. We do not know if unsampled islands of emergent vegetation experienced similar declines. Regardless of the cause, the decline in snails is worrisome, as they provide an important food source for other invertebrates, fish, and waterbirds.

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, special attention should be given to invertebrate populations in 2011, as a continued decreasing trend should raise questions regarding the health of the wetland.

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 good in 2010 (629.5 kg/ha), representing a 168% increase over the 2009 estimate (235.3 kg/ha), and the highest since fall 2007 (992.4 kg/ha). Correspondingly, estimated energetic carrying capacity in 2010 (5,389 EUDs/ha) increased dramatically over the fall 2009 estimate (2,015 EUDs/ha) and was the highest since 2007 (8,496 EUDs/ha). 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 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 2010 were similar to estimates used by the UMRGLRJV and those reported at IDNR sites, but less than the estimates for CNWR. We note that while moist-soil seed abundance at Emiquon increased substantially during 2010, the amount of seed actually available to waterfowl during fall was limited. Most of the moist-soil vegetation observed during fall 2010, especially large stands along the east side of Flag Lake, were never inundated and could not be used by migratory waterfowl. These areas will likely provide abundant forage if water levels increase during spring 2011.

Wetland Covermapping

The wet area of Emiquon declined by nearly 18% from 2009; however, the total mapped area in 2010 increased by more than 9%. Abundant precipitation and high water in 2008 and 2009 followed by receding water levels in 2010 created favorable conditions for the expansion of wetland vegetation, particularly moist-soil plants (non-persistent emergent). The area occupied by non-persistent emergent vegetation (217.7 ha) increased more than 8 fold over 2009 (23.6 ha) and was the highest estimate of this habitat type documented at Emiquon. Similarly, persistent emergent vegetation (199.0 ha) increased substantially (349%) from 2009 (44.3 ha), representing the highest estimate for this habitat type. The increase in persistent emergent in 2010 was largely due to the 59% reduction in hemi-marsh habitat, which was the lowest hemi-marsh estimate (119.8 ha) since 2007. Receding water levels stranded cattails causing a swing from hemi-marsh to persistent emergent habitats. Likewise, receding water in 2010 created 83.2 ha of mudflat; a habitat that was absent from the wetland in 2008 and 2009. We also observed a reduction (>12%) in the area of aquatic bed (1,036.3 ha) from 2009 estimates; although, aquatic bed remained the largest habitat type, occupying >52% of the total mapped area at Emiquon.

The KEAs related to habitat composition specify <10% invasive species coverage and 100% exclusion of purple loosestrife. Similar to 2009, we encountered some invasive species during wetland mapping, including Eurasian watermilfoil, reed canarygrass, common reed, and purple loosestrife. Occurrences of reed canarygrass, common reed, and purple loosestrife appeared to be in relatively small and isolated patches, whereas Eurasian watermilfoil appeared to be expanding throughout the aquatic bed. Interestingly, we did not document curly pondweed and found only one purple loosestrife plant in 2010. Albeit we did not measure the spatial extent of invasive plants, Eurasian watermilfoil will likely be a concern in future years. While invasive plant species at Emiquon appeared to be in check, continued awareness of the expansion of existing species and establishment of new invasives is paramount to their control.

Fall shorebird habitat at Emiquon improved significantly in 2010. A late-season drawdown created large expanses of open mudflats and sheetwater conducive for foraging by shorebirds and early-migrant waterfowl. 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. This habitat was relatively abundant at Emiquon in 2010, and its availability coincided with the fall shorebird migration. Consequently, Emiquon produced high quality foraging habitat for fall-migrating shorebirds, and anecdotal observations indicated considerable shorebird use in 2010.

LITERATURE CITED

Altmann, J. 1974. Observational study of behavior: sampling methods. Behavior 49:227-267.

American Ornithologists' Union. 1998. Check-list of North American Birds, 7th ed. American Ornithologists' Union, Washington, D.C.

Bergan, J. F., L. M. Smith, and J. J. Mayer. 1989. Time-activity budgets of diving ducks wintering in South Carolina. Journal of Wildlife Management 53:769-776.

Bohm, W. 1979. Methods of studying root systems. Springer-Verlag, Berlin, Germany.

Bowyer, M. W., J. D. Stafford, A. P. Yetter, C. S. Hine, M. M. Horath, and S. P. Havera. 2005. Moist-soil plant seed production for waterfowl at Chautauqua National Wildlife Refuge, Illinois. American Midland Naturalist 154:331–341.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish Wildl. Serv. FWS/OBS 79/31. Washington, D.C: U.S. Government Printing Office.

Crook, S.L., W.C. Conway, C.D. Mason, and K.J. Kraai. 2009. Winter time-activity budgets of diving ducks on eastern Texas reservoirs. Waterbirds 32(4):548−558.

Driver, E.L., L.G. Sugden, and R.J. Kovach. 1974. Calorific, chemical and physical values of potential duck foods. Freshwater Biology 4:281–292

Eldridge, J. 1990. Aquatic invertebrates important for waterfowl production. Waterfowl management handbook. U.S. Department of the Interior, Fish and Wildlife Service. Fish and wildlife leaflet 13.3.3. Washington, D.C.

Fredrickson, L. H., and T. S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. United States Department of the Interior, Fish and Wildlife Service Resource Publication 148. Washington, District of Columbia.

Gollop, J.B., and W.H. Marshall. 1954. A guide for aging duck broods in the field. Mississippi Flyway Council Technical Section Report. 14pp.

Greer, A. K., B. D. Dugger, D. A. Graber, and M. J. Petrie. 2007. The effects of seasonal flooding on seed availability for spring migrating waterfowl. Journal of Wildlife Management 71:1561–1566.

Havera, S. P. 1999. Waterfowl of Illinois: status and management. Illinois Natural History Survey Special Publication 21.

Kaminiski, R.M., and H. R. Murkin. 1981. Evaluation of two devices for sampling nektonic invertebrates. Journal of Wildlife Management 45(2):493-496.

Kaminski, R. M., J. B. Davis, H. W. Essig, P. D. Gerard, and K. J. Reinecke. 2003. True metabolizable energy for wood ducks from acorns compared to other waterfowl foods. Journal of Wildlife Management 67:542–550.

Kefford, B. J., L. Zalizniak, J. E. Dunlop, D. Nugegoda, and S. C. Choy. 2009. How are macroinvertebrates of slow flowing lotic systems directly affected by suspended and deposited sediments? Environmental Pollution. 158:543–550.

Kross, J., R. M. Kaminski, K. J. Reinecke, E. J. Penny, and A. T. Pearse. 2008. Moist-soil seed abundance in managed wetlands in the Mississippi Alluvial Valley. Journal of Wildlife Management 72:707–714.

Merritt, R. W. and K. W. Cummins. eds. 1996. An introduction to the aquatic insects of North America. Kendal/Hunt, Dubuque, IA, USA.

Paulus, S. L. 1984. Activity budgets of nonbreeding gadwalls in Louisiana. Journal of Wildlife Management 48:371-380.

Paulus, S. L. 1988. Time-activity budgets of nonbreeding Anatidae: a review. Pages 135-149 *in* M. W. Weller, editor. Waterfowl in winter. University Minnesota Press, Minneapolis, Minnesota, USA.

Pennak, R.W. 1978. Fresh-water invertebrates of the United States. 2nd ed. John Wiley and Sons, Inc., New York. 803 pp.

Prince, H. H. 1979. Bioenergetics of postbreeding dabbling ducks. Pages 103-117 *in* T.A. Bookhout, editor. Waterfowl and wetlands: an integrated review. Proceedings of the

1977 Symposium of the North Central Section of the Wildlife Society, Madison, Wisconsin, USA.

Reinecke, K. J., R. M. Kaminski, K. J. Moorehead, J. D. Hodges, and J. R. Nassar. 1989. Mississippi Alluvial Valley. Pages 203–247 *in* L.M. Smith, R.L. Pederson, and R.M. Kaminski, editors. Habitat management for migrating and wintering waterfowl in North America. Texas Tech University Press, Lubbock, Texas, USA.

Ringelman, J.K., and L.D. Flake. 1980. Diurnal visibility and activity of blue-winged teal and mallard broods. Journal of Wildlife Management 44:822-829.

Rumble, M.A., and L.D. Flake. 1982. A comparison of two waterfowl brood survey techniques. Journal of Wildlife Management 46(4):1048-1053.

SAS Institute. 2004. SAS/STAT user's guide. SAS Institute, Cary, North Carolina. USA.

Soulliere, G. J., B. A. Potter, J. M. Coluccy, R. C. Gatti, P. W. Brown, C. L. Roy Nielsen, M. W. Eichholz, and D. R. Luukkonen. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Waterfowl Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, MN. 112 pp.

Stafford, J. D., R. M. Kaminski, K. J. Reinecke, and S. W. Manley. 2006. Waste rice for waterfowl in the Mississippi Alluvial Valley. Journal of Wildlife Management 70:61–69.

Stafford, J.D., A.P. Yetter, M.M. Horath, C.S. Hine, and R.V. Smith. 2008. Illinois waterfowl surveys and investigations. Final Report. Federal Aid in Wildlife Restoration Act, Illinois. W-43-R-53-54-55. INHS Technical Report 2008 (44). November. 103 pp.

Stafford, J.D., M.M. Horath, A.P. Yetter, R.V. Smith, and C.S. Hine. 2010. Historical and contemporary characteristics and waterfowl use of Illinois River valley wetlands. Wetlands 30:565-576.

Suloway, L. and M. Hubbell. 1994. Wetland Resources of Illinois: An Analysis and Atlas. Illinois Natural History Survey Special Publication 15.

The Nature Conservancy. 2006. Key attributes and indicators for Illinois River conservation targets at The Nature Conservancy's Emiquon Preserve. The Nature Conservancy, Peoria, Illinois. 32 pp.

Voigts, D.K. 1976. Aquatic invertebrate abundance in relation to changing marsh vegetation. American Midland Naturalist. 95:313-322.

Weller, M. W., and C. E. Spatcher. 1965. Role of habitat in the distribution and abundance of marsh birds. Iowa State University, Agriculture and Home Economics Experiment Station Special Report 43.

Weber, L. M., and D. M., Lodge. 1990. Periphytic food and predatory crayfish: relative roles in determining snail distribution. Oecologia. 82: 33–39.

Zimpfer, N.L., W.E. Rhodes, E.D. Silverman, G.S. Zimmerman, and M.D. Koneff. 2010. Trends in duck breeding popultations, 1955–2010. U.S. Fish and Wildlife Service, Div. of Migratory Bird Mgmt. Administrative Report. 2 July. 26 pp.

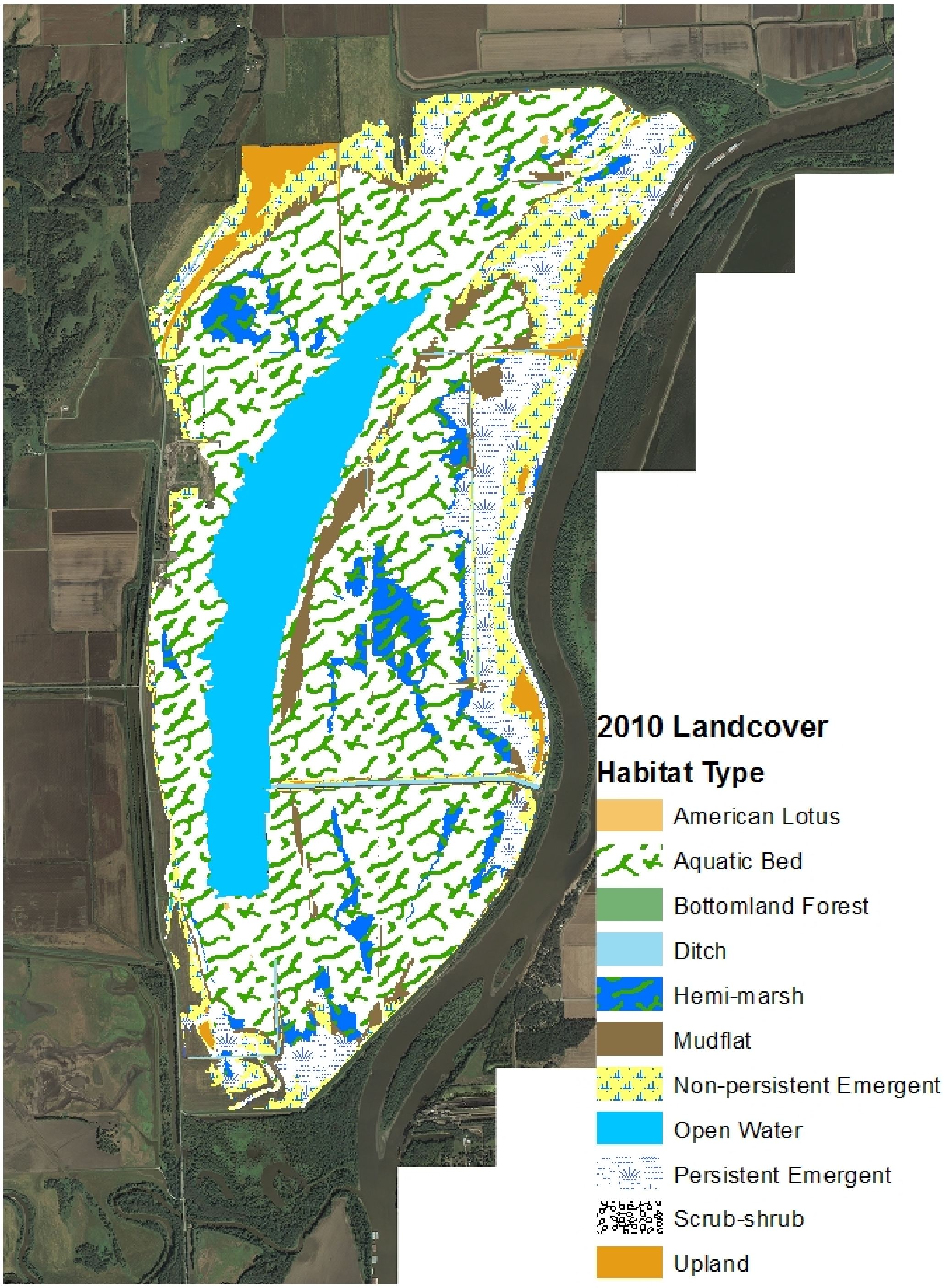

Figure 1. Wetland habitat map of The Emiquon Preserve 8–20 September 2010.

Table 1. Avian species observed during monitoring activities at The Emiquon Preserve, 2010.

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*
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*
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*
RBME	Red-breasted merganser	*Mergus serrator*
REDH	Redhead	*Aythya americana*

Table 1. Continued

AOU Code[a]	Common Name	Scientific Name
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*
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, 2010.

Common Name	Scientific Name
Ammania (Long-leaved ammania)	*Ammania coccinea*
American lotus	*Nelumbo lutea*
Arrowhead	*Sagittaria* spp.
Ash	*Fraxinus* spp.
Aster	*Aster spp.*
Barnyardgrass	*Echinochloa crus-galli*
Bidens	*Bidens* spp.
Black willow	*Salix nigra*
Boneset	*Eupatorium* spp.
Brasenia (Watershield)	*Brasenia schreberi*
Brome (Smooth)	*Bromus inermis*
Brittle naiad	*Najas minor*
Bur reed	*Sparganium spp.*
Carex	*Carex spp.*
Cattail	*Typha spp.*
Chufa	*Cyperus esculentus*
Cocklebur	*Xanthium spp.*
Common reed	*Phragmites spp.*
Coontail	*Ceratophyllum demersum*
Cottonwood (Eastern Cottonwood)	*Populus deltoides*
Creeping water primrose	*Ludwigia peploides*
Devil's beggartick	*Bidens frondosa*
Dogwood	*Cornus spp.*
Elm	*Ulmus spp.*
Elodea (Waterweed)	*Elodea* spp.
Eurasian watermilfoil	*Myriophyllum spicatum*
Ferruginous flatsedge	*Cyperus ferruginescens*
Foxtail	*Setaria spp.*
Goldenrod	*Solidago spp.*
Hooded arrowhead	*Sagittaria calycina*
Japanese millet	*Echinochloa esculenta*
Largeseed smartweed	*Polygonum pensylvanicum*
Lemna (Duckweed)	*Lemna minor*
Lesser ragweed	*Ambrosia artemisiifolia*
Locust	*Robinia spp.*
Longleaf pondweed	*Potamogeton nodosus*

Table 2. Continued.

Common Name	Scientific Name
Marestail	*Conyza spp.*
Marshpepper smartweed	*Polygonum hydropiper*
Milfoil	*Myriophyllum spp.*
Milkweed	*Asclepias spp.*
Morning glory	*Ipomoea spp.*
Mulberry	*Morus spp.*
Naiad	*Najas* spp.
Nodding beggartick	*Bidens cernua*
Nodding smartweed	*Polygonum lapathifolium*
Panicum (Fall)	*Panicum dichotomiflorum*
Peach-leaved willow	*Salix amygdaloides*
Pecan	*Carya ilinoinensis*
Pigweed	*Amaranthus spp.*
Small pondweed	*Potamogeton pusillis*
Purple loosestrife	*Lythrum salicaria*
Redroot	*Cyperus erythrorhizos*
Reed canarygrass	*Phalaris arundinacea*
Rice cutgrass	*Leersia oryzoides*
River bulrush	*Scirpus fluviatilis*
Sagittaria (Arrowhead)	*Sagitarria spp.*
Sago pondweed	*Stuckenia pectinata*
Sallow sedge	*Carex lurida*
Shattercane	*Sorghum bicolor*
Silver maple	*Acer saccharinum*
Softstem bulrush	*Schoenoplectus tabernaemontani*
Spikerush	*Eleocharis spp.*
Switchgrass	*Panicum virgatum*
Velvetleaf	*Abutilon spp.*
Water smartweed	*Polygonum amphibium*
Willow	*Salix* spp.
Watermeal (Wolffia)	*Wolffia spp.*
Woolgrass	*Scirpus cyperinus*

Table 3. Estimates of waterfowl abundance from ground inventories at The Emiquon Preserve during spring 2010.

	Inventory Dates					
Species[a]	3 Mar	10 Mar	23 Mar	8 Apr	20 Apr	Total (%)
AGWT	0	60	23	2	8	93 (0.1)
AMWI	0	42	131	310	0	483 (0.5)
BUFF	38	348	926	828	140	2,280 (2.3)
BWTE	0	0	39	1,990	499	2,528 (2.6)
CAGO	175	96	39	7	24	341 (0.4)
CANV	75	334	234	1	0	644 (0.7)
COGO	150	210	3	0	0	363 (0.4)
COME	0	70	0	0	1	71 (0.1)
GADW	10	370	1,671	2,750	2,260	7,061 (7.3)
GWFG	0	52	0	0	0	52 (0.1)
HOME	10	0	52	0	2	64 (0.1)
LESC	150	1,061	10,220	2,922	401	14,754 (15.2)
LSGO	0	13,731	18	0	2	13,751 (14.2)
MALL	75	2,637	2,194	614	201	5721 (5.9)
MUSW	1	2	2	4	5	14 (0.0)
NOPI	0	168	4	0	0	172 (0.2)
NSHO	0	944	10,016	7,058	3,498	21,516 (22.1)
RBME	0	0	0	0	5	5 (0.0)
REDH	10	88	16	0	0	114 (0.1)
RNDU	225	1,430	8,617	2,085	42	12,399 (12.8)
RUDU	0	525	7,851	4,351	1,805	14,532 (15.0)
TRUS	3	7	0	0	0	10 (0.0)
Unk. Ducks	0	150	0	0	0	150 (0.2)
WODU	0	4	0	10	11	25 (0.0)
Total	922	22,329	42,056	22,932	8,904	97,143

[a] See table 1.

Table 4. Estimates of waterfowl abundance from aerial inventories at The Emiquon Preserve during spring 2010.

	Inventory Dates				
Species[a]	15 Mar	22 Mar	29 Mar	5 Apr	Total (%)
AGWT	425	440	4,390	4,250	9,505 (5.2)
AMWI	100	440	1,500	1,415	3,455 (1.9)
BUFF	200	875	7,315	200	8,590 (4.7)
BWTE	0	0	0	1,415	1,415 (0.8)
CANV	210	440	50	0	700 (0.4)
COGO	1,060	1,310	0	0	2,370 (1.3)
COME	100	0	0	0	100 (0.1)
GADW	1,060	2,185	7,315	7,085	17,645 (9.7)
LESC	1,695	8,740	29,255	11,335	51,025 (28.0)
MALL	3,180	2,185	5,850	2,835	14,050 (7.7)
NOPI	425	440	0	0	865 (0.5)
NSHO	2,120	10,925	14,630	14,170	41,845 (23.0)
REDH	100	100	750	200	1,150 (0.6)
RNDU	3,180	2,185	4,390	1,415	11,170 (6.1)
RUDU	2,120	200	11,700	4,250	18,270 (10.0)
Total	15,975	30,465	87,145	48,570	182,155

[a] See table 1.

Table 5. Estimates of waterfowl abundance from aerial inventories at The Emiquon Preserve during fall 2010.

	Inventory Dates														
Species[a]	8 Sep	14 Sep	20 Sep	11 Oct	18 Oct	25 Oct	2 Nov	8 Nov	16 Nov	23 Nov	3 Dec	14 Dec	28 Dec	3 Jan	Total (%)
ABDU	0	0	0	0	0	0	0	380	370	300	0	0	0	0	1,050 (0.2)
AGWT	1,330	1,215	3,410	11,920	11,370	11,675	7,165	11,545	7,800	1,560	300	0	0	0	69,290 (15.7)
AMWI	0	0	345	2,200	3,290	4,190	2,785	2,290	2,220	500	0	0	0	0	17,820 (4.0)
BUFF	0	0	0	0	0	0	0	380	0	985	555	0	0	0	1,920 (0.4)
BWTE	19,020	24,200	15,495	5,850	2,000	0	0	0	0	0	0	0	0	0	66,565 (15.0)
CAGO	150	125	95	245	140	600	460	500	535	235	70	0	0	0	3,155 (0.7)
CANV	0	0	0	0	0	25	1,395	380	740	300	200	0	0	0	3,040 (0.7)
COGO	0	0	0	0	0	0	0	0	0	960	0	0	0	200	1,160 (0.3)
COME	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100 (0.0)
GADW	870	1,685	2,440	5,700	7,880	7,085	9,880	15,560	18,700	4,830	700	0	0	0	75,330 (17.0)
GWFG	0	0	0	0	0	50	0	200	0	200	0	0	0	0	450 (0.1)
HOME	0	0	0	0	0	0	0	0	20	0	200	0	0	0	220 (0.0)
LESC	0	0	0	0	0	0	0	380	0	300	0	0	0	0	680 (0.2)
LSGO	0	0	0	0	0	0	0	100	100	100	0	0	0	0	300 (0.1)
MALL	1,890	2,490	3,480	5,550	7,730	7,035	7,065	9,205	7,500	7,760	1,600	5	0	0	61,310 (13.8)
NOPI	270	280	3,440	11,070	11,020	9,880	11,250	12,445	15,000	3,320	0	0	0	0	77,975 (17.6)
NSHO	770	700	1,770	3,350	5,485	6,985	4,180	3,815	2,220	1,610	200	0	0	0	31,085 (7.0)
REDH	0	0	0	0	0	0	695	100	0	0	0	0	0	0	795 (0.2)
RNDU	0	0	0	1,100	1,000	1,400	795	2,590	840	100	225	0	0	0	8,050 (1.8)
RUDU	0	0	0	2,200	1,000	4,100	4,180	3,000	3,300	3,120	1,300	150	0	0	22,350 (5.0)
SWAN	0	0	0	0	0	0	10	2	7	0	10	0	0	0	29 (0.0)
Total	24,300	30,695	30,475	49,185	50,915	53,025	49,860	62,872	59,352	26,180	5,360	155	0	300	442,674

[a] See table 1.

Table 6. Estimates of waterbird and raptor abundance from ground inventories at The Emiquon Preserve during spring 2010.

	Inventory Date					
Species[a]	3 Mar	10 Mar	23 Mar	8 Apr	20 Apr	Total (%)
AMCO	1	1,164	25,888	14,781	9,342	51,176 (85.7)
AWPE	0	0	435	2,096	930	3,461 (5.8)
BAEA	0	5	2	0	0	7 (0.0)
BEKI	0	0	0	0	2	2 (0.0)
DCCO	0	0	50	2,545	667	3,262 (5.5)
GBHE	0	0	0	8	96	104 (0.2)
GHOW	0	1	0	0	0	1 (0.0)
GREG	0	0	0	14	0	14 (0.0)
NOHA	0	0	0	3	1	4 (0.0)
PBGR	0	10	160	387	1,152	1,709 (2.9)
RTHA	0	0	0	1	1	2 (0.0)
Total	1	1,180	26,535	19,835	12,191	59,742

[a] See table 1.

Table 7. Estimates of waterbird abundance from aerial inventories at The Emiquon Preserve during spring 2010.

	Inventory Dates				
Species[a]	15 Mar	22 Mar	29 Mar	5 Apr	Total (%)
AMCO	4,240	13,535	58,510	93,130	169,415 (97.5)
AWPE	25	670	415	945	2,055 (1.2)
DCCO	0	150	65	2,000	2,215 (1.3)
Total	4,265	14,355	58,990	96,075	173,685

[a] See table 1.

Table 8. Estimates of non-waterfowl abundance from aerial inventories at The Emiquon Preserve during fall 2010.

	Inventory Dates														
Species[a]	8 Sep	14 Sep	20 Sep	11 Oct	18 Oct	25 Oct	2 Nov	8 Nov	16 Nov	23 Nov	3 Dec	14 Dec	28 Dec	3 Jan	Total (%)
AWPE	900	1,140	615	1,130	85	450	620	645	575	330	15	0	0	0	6,505 (1.7)
AMCO	1,720	3,190	4,410	62,865	59,775	92,210	95,040	18,900	19,710	6,340	700	0	0	0	364,860 (97.6)
BAEA	0	0	0	2	5	6	16	14	19	21	10	7	0	0	100 (0.0)
DCCO	205	190	410	550	310	110	300	50	200	0	0	0	0	0	2,325 (0.6)
Total	2,825	4,520	5,435	64,547	60,175	92,776	95,976	19,609	20,504	6,691	725	7	0	0	373,790

[a] See table 1.

Table 9. Behavior observations (%) of ducks at The Emiquon Preserve during spring, 2010.

		Activity				
Group	Month	Feed	Rest	Social	Locomotion	Other
Dabbling Ducks	March	95.6	0.0	1.8	1.7	0.8
Dabbling Ducks	April	77.6	0.9	2.5	12.7	6.3
Total Dabblers		81.2	0.7	2.4	10.5	5.2
Diving Ducks	March	19.7	30.6	0.8	38.2	10.7
Total Ducks		58.1	11.9	1.8	20.9	7.2

Table 10. Waterbird brood observations at The Emiquon Preserve during 2010.

	Observation Dates							
Species[a]	4 Jun	16 Jun	1 Jul	14 Jul	29 Jul	12 Aug	Total Broods	%
WODU	1	10	20	32	26	2	91	64.1
CAGO	18	12	0	1	1	0	32	22.5
MALL	2	3	4	2	4	0	15	10.6
PBGR	0	0	0	0	2	2	4	2.8
Total	21	25	24	35	33	4	142	
Average age[b]	2A	2B	2C	2B	2B	2C		

[a] See table 1.
[b] Gollop and Marshall 1954

Table 11. Mean biomass (mg/m^3, dry mass) and percent occurrence of aquatic invertebrates collected at The Emiquon Preserve, 2010.

Taxa/Life Stage	Biomass (mg/m^3)[a]	Percent Occurrence
Gastropoda		
Physidae	6.7	61.7
Planorbidae	4.7	21.7
Ostracoda	0.0	13.3
Cladocera	7.4	90.0
Copepoda	0.2	61.7
Amphipoda	1.6	55.0
Arachnida	0.0	23.3
Hydrachnida	0.1	35.0
Pseudoscorpion	0.0	1.7
Collembola	0.0	3.3
Coleoptera		
Dytiscidae adult	2.8	5.0
Dytiscidae larvae	0.4	31.7
Total Dytiscidae	3.2	36.7
Elmidae adult	0.0	1.7
Haliplidae adult	0.0	3.3
Haliplidae larvae	0.3	18.3
Total Haliplidae	0.3	21.6
Heteroceridae adult	0.0	1.7
Hydrophilidae adult	0.1	1.7
Hydrophilidae larvae	0.0	11.7
Total Hydrophilidae	0.1	11.7
Noteridae adult	0.6	1.7
Diptera		
Ceratopogonidae larvae	0.7	46.7
Ceratopogonidae pupae	0.0	16.7
Total Ceratopogonidae	0.7	50.0
Chironomidae adult	0.3	6.7
Chironomidae larvae	6.9	65.0
Chironomidae pupae	0.3	16.7
Total Chironomidae	7.5	71.7
Culicidae larvae	0.0	8.3
Ephydridae pupae	0.0	1.7
Stratiomyidae larvae	0.4	21.7
Unknown Diptera	0.0	1.7

Table 11. Continued

Taxa/Life Stage	Biomass (mg/m^3)[a]	Percent Occurrence
Ephemeroptera		
Baetidae nymph	0.5	41.7
Caenidae nymph	3.8	65.0
Hemiptera		
Belostomatidae	2.0	5.0
Corixidae	4.8	31.7
Mesoveliidae	0.7	20.0
Naucoridae	0.0	1.7
Notonectidae	0.4	3.3
Pleidae	0.4	40.0
Unknown Hemiptera	0.0	1.7
Hymenoptera		
Scelionidae	0.0	1.7
Lepidoptera		
Pyralidae larvae	0.3	20.0
Pyralidae pupae	0.3	5.0
Total Pyralidae	0.6	23.3
Odonata		
Aeshnidae nymph	18.9	5.0
Coenagrionidae nymph	1.9	66.7
Libellulidae nymph	8.9	33.3
Trichoptera		
Hydroptilidae larvae	0.0	10.0
Hydroptilidae pupae	0.0	1.7
Total Hydroptilidae	0.0	11.7
Leptoceridae larvae	0.2	13.3
Leptoceridae pupae	0.0	1.7
Total Leptoceridae	0.2	15.0
Unknown Trichoptera	0.0	3.3
Turbellaria	0.5	20.0
Nematoda	0.0	5.0
Oligochaeta	0.3	56.7
Hirudinea	2.0	5.0
Glossiphonidae	0.1	6.7
Hydra	0.0	18.3
Unknown	0.0	1.7

[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, 2010.

Year	Seed Size[a]	n	Abundance $\bar{x}$	Abundance SE	Abundance CV(%)	EUDs $\bar{x}$	EUDs SE
2010	Large	20	421.9	112.3	26.6	3,612	962
	Small	20	207.6	64.5	31.1	1,778	552
	Total	20	629.5	114.5	18.2	5,389	1,237

[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, 2010.

Habitat	Hectares	%
American Lotus	1.0	0.1
Aquatic Bed	1,036.3	52.5
Bottomland Forest	1.0	0.0
Ditch	14.0	0.7
Hemi-marsh	119.8	6.1
Mudflat	83.2	4.2
Non-persistent Emergent	217.7	11.0
Open Water	248.7	12.6
Persistent Emergent	199.0	10.1
Scrub-shrub	0.3	0.0
Upland	53.1	2.7
Total Mapped Area	1,974.1	

Submitted by:

Aaron Yetter
Principal Investigator
Illinois Natural History Survey
Forbes Biological Station

Date:26 May 2011.