Water Quality's Effect on Insect Emergence and the Yellow-Headed Blackbird: A Cascading Effect of Landscape Development on Wetlands in Northern Illinois

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Abstract

Wetlands play an essential role in the breeding ecology of the yellow-headed blackbird (*Xanthocephalus xanthocephalus*) in Northeastern Illinois. However, yellow-headed blackbirds are endangered and their nesting grounds are in need of protection. In this study, I examined water quality, insect emergence, and surrounding landscape in site quality for nest success. Data were collected in 2004, a wet year, and 2005, a dry year. The variability in years made it difficult to determine the driving forces behind site quality; however, the surrounding landscape played a significant role. Wetlands surrounded by grasslands or agriculture contributed to site quality because these habitats provide a supplemental food source.

Introduction

Wetlands have high biological productivity and a rich biota making it a valuable aspect of any landscape (Gibbs, 2000). However, wetlands have a history of loss, especially in Illinois. Historically, Illinois contained 8.2 million acres of wetlands (Weller, 1994). Currently, there are 1.2 million acres of wetlands left, which accounts for only 3.2 percent of the state, a 90 percent loss (IDNR, 2001). The driving force behind wetland loss is the economic value of wetlands as potential land for farming and urban development (Douglas and Johnson, 1994). Holland *et al.* (1995) found that the predominant cause of wetland loss in a rapidly urbanizing area was urban development. In Illinois, most wetlands are being lost to agriculture, but in Northern Illinois wetlands are being threatened by urban development.

In addition to wetland loss, wetlands are also threatened by degradation, which is detrimental to the wetland environment and to organisms that rely on wetlands. Some causes of wetland degradation are fragmentation, siltation, run-off, altered hydrology, and introduction of invasive species (IDNR, 2001). Degradation leads to a reduction in wetland functions and a decrease in water quality (USEPA, 1990). The need for good water quality is necessary for a wetland to maintain many of its primary functions. The importance of water quality to wetlands is reflected in the Clean Water Act of 1972 and in the water quality standards for wetlands set by the United States EPA.

Rapid urban development can cause alterations in the natural functions of a wetland that can lead to changes in the water quality of the wetland (Gosselink and Mitsch, 2000). Some natural functions of a wetland that could be altered include chemical transformations and nutrient cycling. These changes in the water quality can impact the fauna utilizing the wetland (e.g., insect emergence). Urban development can lead to increases in pollution due to run-off from roads and lawns, which can also affect the water quality of the wetlands. Poor water quality due to pollution can decrease the amount of insects, such as dragonflies present in a wetland (Watson *et al.*, 1982). If water quality is altered it can result in low emergence of insects that can strongly influence the breeding success of wetland bird, such as the yellow-headed blackbird (*Xanthocephalus xanthocephalus*).

Yellow-headed blackbird is a polygynous species that relies on wetlands for breeding (Weller, 1999). This species needs high quality habitats in order to have successful breeding. A high quality site for this species is one that is larger than 1 ha, has a large area of open water, has a water level greater than 0.7m, and contains emergent vegetation that is strong enough to support nests (Ward, 2005a). The density of prey available for feeding fledglings is an important aspect of a good nesting ground (Brodmann and Reyer, 1999). Yellow-headed blackbirds feed their young emerging aquatic insects. According to Voigts (1976), the most productive wetlands for insects are ones which have large open areas combined with areas of dense emergent vegetation.

In Illinois, the yellow-headed blackbird is an endangered species (Heidorn *et al.*, 1991) because of reduced immigration and small populations (Ward, 2005a). This species is currently restricted to Cook, DuPage, McHenry, and Lake Counties of Illinois, an area experiencing rapid urban development which threatens many wetland habitats. It is important to maintain the current population of this species by preserving healthy wetlands because few new immigrants come to Illinois but the current breeding population is very successful (Ward, 2005a). Since insect emergence is important to breeding success and will influence whether or not the birds will return to the area to nest again (Greenwood and Harvey, 1982), it is important to understand how insect emergence is affected by changes in water quality.

In the case of the yellow-headed blackbird, Odonata is the primary insect order preferred as a food source for the young (Orians and Wittenberger 1991). Food availability is directly correlated with nest production (Ward, 2005b). Therefore, the availability of Odonata plays a significant role in nest success. In addition to being a primary food source of yellow-headed blackbirds, Odonates contribute to the biodiversity of wetlands by being both a predator and a prey for many organisms (Hornung and Rice, 2003). Due to their role in many trophic interactions occurring in wetlands Odonates are sensitive to wetland degradation (Stewart and Samways, 1998), making this group a good bio-indicator of wetland health.

The main goal of this study was to examine how landscape use, water quality, insect emergence, and nest production in the yellow-headed blackbird relate and how they contribute to the decline of the yellow-headed blackbird in Illinois.

Methods

The 13 study sites are located in Cook, McHenry, Lake, and DuPage counties (Fig. 1). All of these counties are within the breeding population of the yellow-headed blackbird. The study sites have been placed into four different groups based on yellow-headed blackbird nest productivity for both years. Each year the sites were ranked based on nest productivity. The rankings for both years were used to create the groupings. Sites ranked 1 or 2 were high quality, sites ranked 3 thru 5 were medium quality, sites ranked 7 thru 8 were low quality, and sites where nesting did not occur were listed as none.

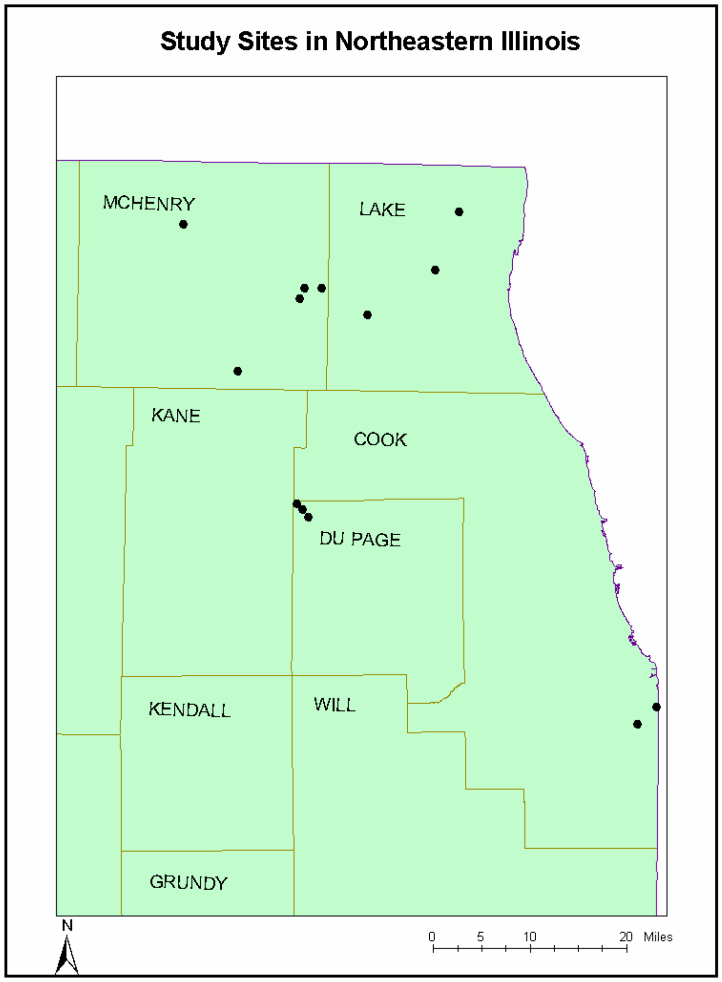

Fig. 1: Map of Study Sites – This map shows the 13 study sites and the counties in which they reside.

Water quality and insect emergence were collected at the same time for each site approximately every 10 days. Each site contained insect emergence traps placed randomly within the wetland at the edge of the emergent vegetation (Fig. 2). The traps floated at the water surface with an open area of 30cm by 30 cm and a cone of mesh extended from the base to a kill jar (Ward, 2005b). The insects collected from the traps were identified to order and Odonata were identified to family (Daly *et al.*, 1998, Merritt and Cummings, 1984). The insects were counted and dry biomass in grams was determined. In 2005, a net collection survey was done to determine the different species of Odonates at each site. All species that were collected were identified by me and Ed DeWalt, aquatic entomologist with the Illinois Natural History Survey. The collection was submitted to Illinois Natural History Survey Insect Collection at the University of Illinois at Urbana-Champaign.

Fig. 2: Insect Emergence Trap – An example of an insect emergence trap used during this study. This trap was located at Wadsworth and the picture was taken in 2005 after the wetland had dried out.

The following variables were tested to evaluate water quality: pH, temperature, dissolved oxygen, conductivity, total suspended solids, alkalinity, hardness, chlorophyll *a*, nitrate, ammonia, and total phosphate. Dissolved oxygen, pH, and temperature were measured *in situ* and at three different levels; the surface, the middle, and the bottom of the water column using handheld meters. A 250mL water bottle was used to collect water to analyze the remaining variables at a later time (Fig. 3).

Fig. 3: Collecting a Water Sample – Cassandra Allsup collects water for later analysis at Broberg marsh in 2004.

Conductivity was determined using a conductivity meter. Total suspended solids were determined by filtering approximately 100 mL of water onto a pre-weighed and dried glass microfiber filter, type 934-AH. The filtered sample was then dried at 103°C for one hour and weighed. Alkalinity and hardness were determined by titration of sulfuric acid for alkalinity and EDTA titrant for hardness. Chlorophyll *a* was determined by a color spectrophotometer (Marker and Jinks, 1982). Nitrate, ammonia, and total phosphate were determined by the USEPA certified Hach method using a Hach DR/580 colorimeter (Fig. 4).

Fig. 4: Hach Test for Phosphate – An example of the set up for testing for phosphate using the Hach Method.

Nest productivity was monitored using nest counts that were done from mid May to mid July. In both years of this study complete data on the nest productivity for each site was not possible so the incomplete data was used to rank the different sites. In 2004 the sites were ranked based on young per successful nest and in 2005 the sites were ranked based on number of young observed per adult.

Landscape analysis was done using ArcGIS (ESRI, 2001), a Geographical Information System, to determine percent land use with in a buffer of 0.25km surrounding the wetland. A 1993 geodatabase of aerial photographs were used to digitize the areas around the wetlands. The digitized areas were placed into seven categories as a percentage of the total area. The 7 categories are open water, forest, meadow, agriculture, developed, roads, and wetlands. Once each year a vegetation survey was conducted to identify the dominant flora for each wetland.

Statistical analysis was not conducted on the data presented here. However, further analysis of the data is currently being undertaken.

Results

Sites varied in size from 35.4 to 773.0 km, but the vegetation at each site was similar (Fig. 5, Appendix A). Most sites are dominated by narrow leaf cattail (*Typha angustifolia*), but Eggers Woods is mainly Common Reed (*Phragmites australis)*.

Fig. 5: Vegetation at Two Sites – The picture on the left is of Black Tern and shows the narrow-leaf cattails present at most sites; an insect trap is located in the middle. The picture on the left is of Eggers Woods and shows the common reed that dominates this site, in addition, to the industry located near the site.

Five sites; Eggers Woods, Hegewisch, Pratt Wayne I, Broberg and Almond had a decrease in quality category from 2004 to 2005 (Table 1). Pratt Wayne II went from low quality in 2004 to medium quality in 2005. Pratt Wayne IIA was only sampled in 2005, but yellow-headed blackbirds were seen using this wetland in 2004. In 2004 nesting did not occur at four sites and in 2005 six sites did not have nests.

Site	Year	Quality	Rank		Site	Year	Quality	Rank
Eggers Woods	2004	High	2		Black Tern	2004	Medium	3
	2005	Medium	4			2005	Medium	5
Hegewisch	2004	Medium	5		Broberg	2004	Medium	4
	2005	Low	6			2005	Low	7
Pratt Wayne I	2004	Low	7		Tony	2004	High	1
	2005	None	0			2005	High	1
Pratt Wayne II	2004	Low	6		Almond	2004	Low	8
	2005	Medium	3			2005	None	0
Pratt Wayne IIA	2005	High	2		Wadsworth	2004	None	0
Black Crown	2004	None	0			2005	None	0
	2005	None	0		Exner	2004	None	0
Stickney Run	2004	None	0			2005	None	0
	2005	None	0					

Table 1: Site Quality – The chart shows the nest productivity rankings and quality for each site and year.

In 2004, Almond had the highest total insect dry mass of 2.46 grams (Fig. 6) and the highest Odonate dry mass of 2.116 grams (Fig. 7).

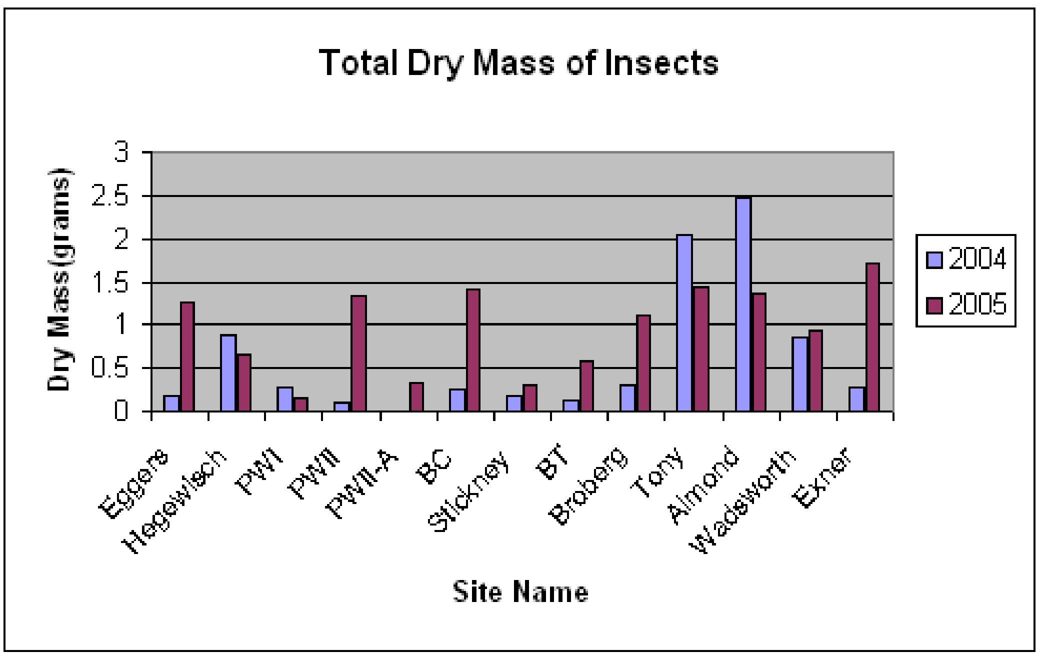

Fig. 6: Total Dry Mass of Insects – The bar graph shows the total dry mass of insects in grams for each site in 2004 and 2005.

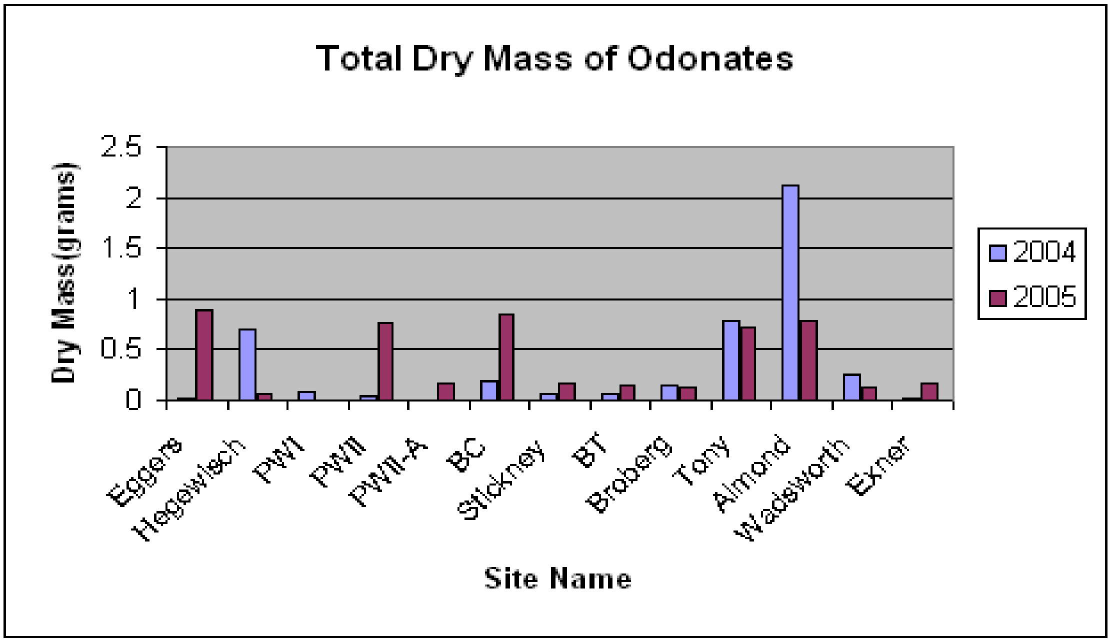

Fig. 7: Total Dry Mass of Odonates – The bar graph shows the total dry mass of Odonates in grams for each site in 2004 and 2005.

In 2005, Exner had the highest total insect dry mass of 1.179 grams and Eggers Woods had the highest Odonate dry mass of 0.89 grams. Damselflies were the dominant Odonate type collected from the insect emergence traps (Table 2) and species of the Family Coenagrionidae were the dominant damselfly (Table 3).

Site	Damselfly 2004	2005	Dragonfly 2004	2005
Eggers Woods	1	35	0	17
Hegewisch	44	32	8	0
Pratt Wayne I	9	0	0	0
Pratt Wayne II	4	77	0	0
Pratt Wayne IIA	-	24	-	0
Black Crown	15	176	0	0
Stickney Run	9	7	0	0
Black Tern	4	8	2	1
Broberg	11	18	5	0
Tony's Pond	55	115	10	0
Almond	145	83	7	3
Wadsworth	25	18	0	1
Exner	4	29	0	0

Table 2: Total Number of Damselflies and Dragonflies – The table shows the distribution of Odonates into damselflies and dragonflies for each site in 2004 and 2005.

In net collection surveys conducted in 2005 at all of the sites the following damselflies were caught: *Lestes sp.*, *Enallagma civile*, *Ishnura sp. Ishnura hastata*, *Ishnura verticalis*, and *Nehalennia irene*. In the same survey the following dragonflies were caught: *Trapexostigma lacerata*, *Libelllula lydia*, *Libellula luctuosa*, *Erythemis simplicicollis*, *Pachydiplax longimanus*, and *Sympetrum rubicundulum.*

Site	Lestidae 2004	2005	Coenagrionidae 2004	2005
Eggers Woods	0	10	1	25
Hegewisch	16	0	28	32
Pratt Wayne I	6	0	3	0
Pratt Wayne II	1	35	3	42
Pratt Wayne IIA	-	7	-	17
Black Crown	0	0	15	176
Stickney Run	1	1	8	6
Black Tern	1	0	3	8
Broberg	11	9	0	9
Tony’s Pond	1	3	54	112
Almond	2	0	143	83
Wadsworth	4	3	21	15
Exner	1	0	3	29

Table 3: Damselfly Families – The table shows the distribution of damselflies into the two families found at the study sites.

Average conductivity in 2004 ranged from 241 +/- 23.7 to 941 +/- 96.9 µSiemens(S) per liter. Only Hegewisch had an average conductivity over 900 µS/L, which is considered above normal for a freshwater system. In 2005, average conductivity ranged from 349 +/-35.1 to 1537 +/- 136.8 µS/L. Three sites had an average conductivity over 900 µS/L; Hegewisch (1537 +/- 136.8 µS/L), Pratt Wayne I (1019 +/- 120.5µS/L), and Almond (914 +/- 40.9 µS/L). Average hardness in 2004 ranged from 144 +/- 14.1 to 488 +/- 67.5 mg/L $CaCO_3$ with Hegewisch having the highest average hardness. In 2005, Hegewisch had the highest average hardness at 1000 +/- 135.0 mg/L $CaCO_3$ and the range was 158 +/- 31.2 to 1000 +/- 135.0 mg/L $CaCO_3$. Average alkalinity and average nitrate both varied greatly from 2004 to 2005 (Table 4).

Site	Alkalinity 2004	2005	Nitrate 2004	2005
Eggers Woods	182 +/- 14.3	200 +/- 48.9	0.4 +/- 0.5	3.7 +/- 2.9
Hegewisch	184 +/- 19.7	333 +/- 78.8	0.45 +/- 0.7	2.3 +/- 2.3
Pratt Wayne I	201 +/- 25.3	202 +/- 21.8	0.25 +/- 0.3	2.15 +/- 1.4
Pratt Wayne II	185 +/- 18.9	213 +/- 18.5	0.05 +/- 0.1	1.7 +/- 1.5
Pratt Wayne IIA		182 +/- 28.9		1.8 +/- 1.2
Black Crown	175 +/- 24.4	213 +/- 42.8	0 +/- 0.5	2.2 +/- 1.6
Stickney Run	220 +/- 43.9	232 +/- 36.6	0.15 +/- 0.2	2.55 +/- 4.0
Black Tern	188 +/- 16.8	200 +/- 28.8	0.2 +/- 0.5	1.8 +/- 2.2
Broberg	134 +/- 14.0	135 +/- 29.9	0.05 +/- 0.2	0.8 +/- 1.2
Tony's Pond	144 +/- 11.3	164 +/- 14.0	0.1 +/- 0.5	2.1 +/- 1.9
Almond	186 +/- 6.8	182 +/- 6.5	0 +/- 0.7	1.2 +/- 2.7
Wadsworth	154 +/- 32.4	204 +/- 49.3	0.4 +/- 0.5	1.1 +/- 1.9
Exner	187 +/- 14.7	200 +/- 58.1	0.1 +/- 0.3	1.2 +/- 1.3

Table 4: Average Alkalinity and Nitrate – The table shows the average alkalinity (mg/L $CaCO_3$) and nitrate (mg/L) including standard deviation for all sites in 2004 and 2005.

Average alkalinity ranged from 134 +/- 14.0 to 220 +/- 43.9 mg/L $CaCO_3$ in 2004 and 135 +/- 29.9 to 333 +/- 78.8 mg/L $CaCO_3$ in 2005. Values over 200 mg/L $CaCO_3$ are considered high, 2 sites were over this amount in 2004 and 9 sites in 2005. Average nitrate ranged from 0 +/- 0.5 to 0.45 +/- 0.7 mg/L in 2004 and 0.8 +/- 1.2 to 3.7 +/- 2.9 mg/L in 2005. All sites were well below the high level of 10 mg/L. Average ammonia, phosphate, and total suspended solids tended to be much higher in 2005 than in 2004 (Fig.s 8,9,10).

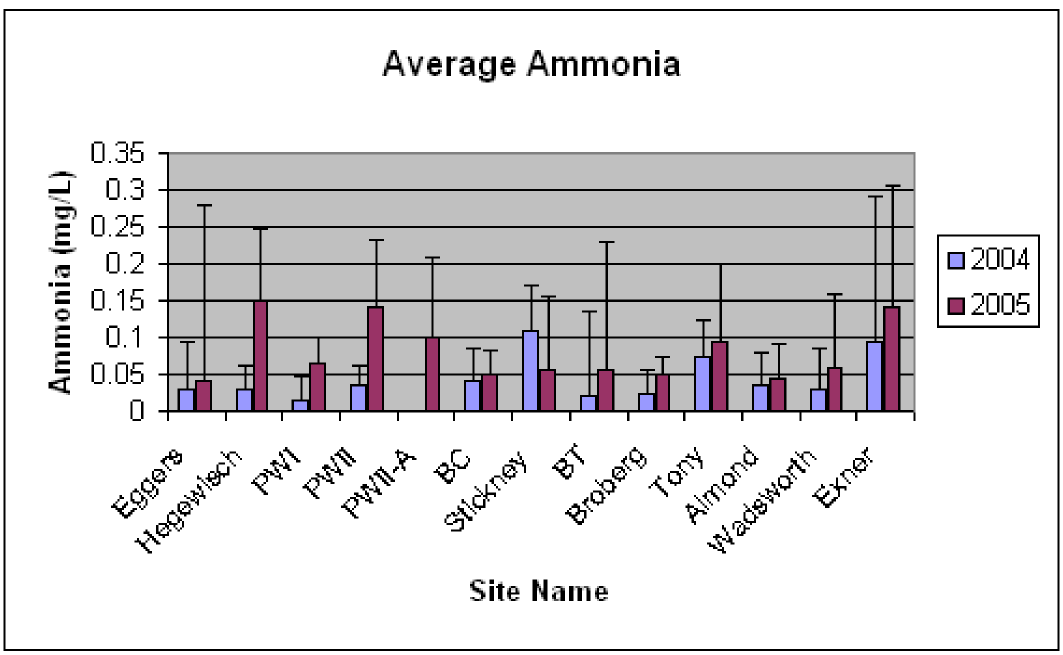

Fig. 8: Average Ammonia – The bar graph shows the average ammonia in mg/L plus standard deviation for each site in 2004 and 2005.

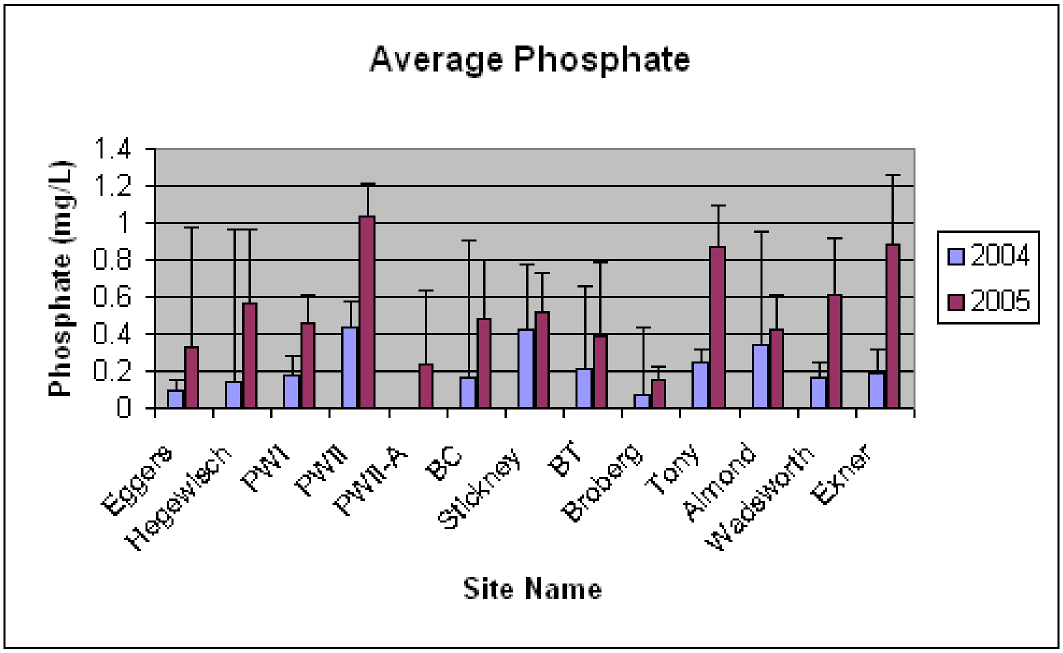

Fig. 9: Average Phosphate - The bar graph shows the average phosphate in mg/L plus standard deviation for each site in 2004 and 2005.

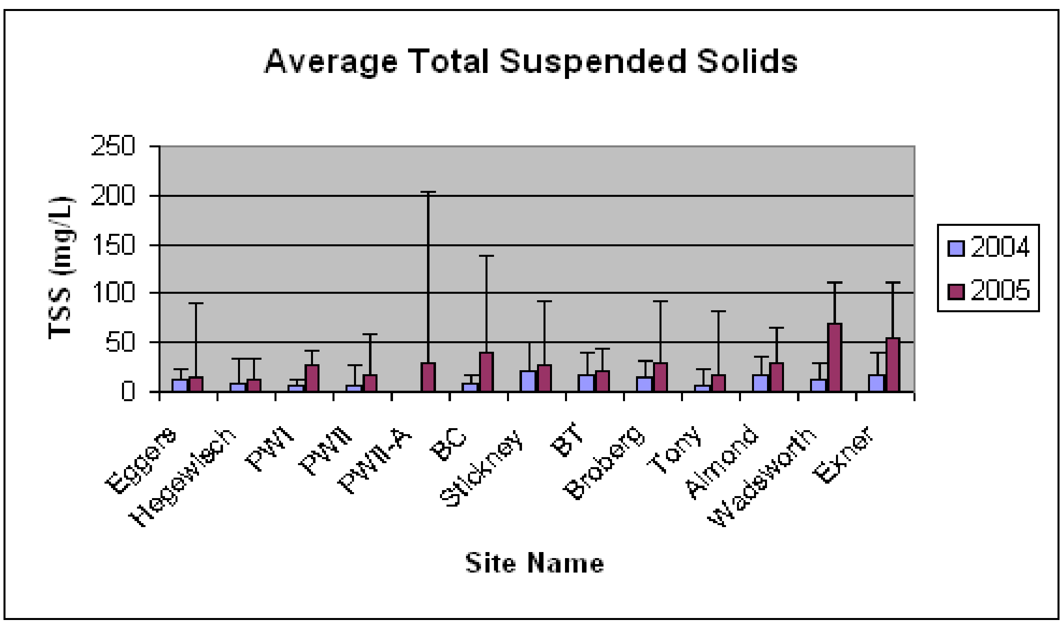

Fig. 10: Average Total Suspended Solids - The bar graph shows the average total suspended solids (TSS) in mg/L plus standard deviation for each site in 2004 and 2005.

Chlorophyll *a* were extremely low for both years (under 1 µg/L), but in 2005 two sites had chlorophyll *a* over 1 µg/L. In 2005, Black Crown contained 2.84 +/- 1.5 µg/L of chlorophyll *a* and Exner contained 1.53 +/- 1.2 µg/L of chlorophyll *a*; however, most rivers in Illinois contain over 3 µg/L of chlorophyll *a*. In 2004, more sites had an average percent saturation of oxygen under 50% than in 2005 (Table 5). A majority of sites had an average pH over 7.9 in 2005 and most sites had an average pH between 7.0 and 7.9 in 2004 (Table 6).

Site	**% SAT Top 2004**	**Std. Dev.**	**2005**	**Std. Dev.**	**% SAT Medium 2004**	**Std. Dev.**	**2005**	**Std. Dev.**	**% SAT Bottom 2004**	**Std. Dev.**	**2005**	**Std. Dev.**
Eggers Woods	87.62	47.7	75.40	49.6	40.06	33.5	75.40	51.4	18.32	30.0	30.35	51.8
Hegewisch	15.09	62.6	52.15	40.0	13.73	39.7	52.15	21.9	10.78	27.1	35.50	18.0
Pratt Wayne I	76.90	59.0	194.15	58.8	29.40	24.0	194.15	57.4	14.32	11.0	133.95	53.1
Pratt Wayne II	129.21	48.5	173.85	66.5	115.18	52.1	173.85	49.0	67.48	43.2	76.95	35.7
Pratt Wayne IIA			56.90	46.9			56.90	43.7			40.30	41.8
Black Crown	71.89	45.6	116.15	77.5	36.45	46.7	116.15	71.2	17.28	45.4	120.40	67.3
Stickney Run	43.58	36.8	83.40	45.3	40.69	36.2	83.40	43.0	27.60	33.1	49.20	42.9
Black Tern	69.58	32.2	73.70	50.4	57.21	29.2	73.70	38.0	16.95	30.2	42.90	26.3
Broberg	7.70	32.0	59.85	31.6	6.73	23.9	59.85	20.5	2.11	21.8	41.70	19.8
Tony's Pond	114.01	38.3	82.80	39.4	92.48	29.2	82.80	33.8	46.32	28.6	58.30	30.4
Almond	80.31	46.2	83.00	41.9	66.36	41.1	83.00	33.4	58.30	36.9	33.30	26.2
Wadsworth	32.04	35.5	59.30	47.6	26.13	23.7	59.30	51.1	13.45	19.0	52.25	54.0
Exner	72.30	46.3	79.55	77.3	43.10	57.9	79.55	60.7	16.67	23.6	69.80	49.7

Table 5: Percent Oxygen Saturation – The table shows the percent oxygen saturation and standard deviation at three points in the water column for all sites in 2004 and 2005.

Site	pH Top 2004	Std. Dev.	2005	Std. Dev.	pH Medium 2004	Std. Dev.	2005	Std. Dev.	pH Top 2004	Std. Dev.	2005	Std. Dev.
Eggers Woods	7.65	0.6	7.45	0.7	7.6	0.4	7.5	0.8	7.2	0.3	7.2	0.7
Hegewisch	7.35	3.4	7.7	0.5	7.25	2.5	7.65	0.3	7.2	2.0	7.6	0.3
Pratt Wayne I	7.6	2.2	9	0.7	7.45	1.9	8.75	0.6	7.35	2.0	7.9	0.8
Pratt Wayne II	9.8	2.1	9.85	0.8	9.5	1.8	9.4	0.7	9.45	1.8	8.9	0.7
Pratt Wayne IIA			7.4	0.6			7.4	0.4			7.25	0.4
Black Crown	7.9	3.8	8.65	0.7	7.7	3.4	8.7	0.6	7.55	2.9	8.4	0.6
Stickney Run	7.4	1.7	7.6	0.3	7.3	1.5	7.5	0.3	7.2	1.5	7.5	0.3
Black Tern	7.2	2.9	8.1	0.6	7.05	2.7	8.05	0.4	6.9	2.4	7.7	0.3
Broberg	7	4.1	7.65	0.2	7	3.7	7.5	0.2	6.8	3.6	7.45	0.2
Tony’s Pond	9.2	2.7	9.3	0.6	9.2	2.1	9.3	0.6	8.9	1.7	9.1	0.8
Almond	8.2	1.7	7.9	0.5	8.1	1.5	7.5	0.4	8.1	1.6	7.3	0.5
Wadsworth	7.5	2.6	8	0.6	7.4	2.1	7.85	0.7	7.1	2.3	7.55	0.8
Exner	7.6	2.0	8.15	0.7	7.5	1.9	8.4	0.5	7.3	1.7	7.8	0.7

Table 6: Water Column pH - The table shows the pH and standard deviation at three points in the water column for all sites in 2004 and 2005.

Stickney Run has the greatest percent wetland area among the thirteen study sites (Table 7). Hegewisch has the greatest percent forest and open water areas and Pratt Wayne I has the greatest percent meadow and barren area. Black Tern has the greatest area of open water, Tony’s Pond has the greatest area of agricultural land, and Wadsworth has the greatest area of road.

Site Name	Wetland	Open Water	Forest	Meadow	Agriculture	Developed	Road	Barren
Eggers Woods	4.58	2.38	22.29	54.47	0.00	11.62	4.66	0.00
Hegewisch	6.06	9.04	27.31	11.62	0.00	41.12	4.85	0.00
Pratt Wayne I	14.61	7.03	11.81	184.44	46.08	1.97	0.00	18.13
Pratt Wayne II	13.46	0.82	3.66	11.15	66.78	3.12	0.00	1.03
Pratt Wayne IIA	8.84	0.45	0.00	54.45	33.08	0.00	2.09	1.09
Black Crown	12.37	14.50	5.47	26.83	15.34	15.82	0.77	8.89
Stickney Run	27.34	1.45	13.06	34.09	6.52	9.92	0.00	7.62
Black Tern	20.69	16.66	1.07	48.96	0.61	12.01	0.00	0.00
Broberg	15.45	7.25	5.52	10.05	32.23	24.36	3.66	1.48
Tony's Pond	2.80	1.39	0.00	9.56	71.28	7.00	1.56	6.41
Almond	21.40	1.10	14.65	31.58	12.83	16.75	1.69	0.00
Wadsworth	14.29	10.48	27.03	27.59	4.63	7.89	7.62	0.48
Exner	22.05	3.71	2.53	17.65	10.97	39.33	3.40	0.37

Table 7: Percent Landcover – The table shows the percent landcovers for all of the study sites.

Discussion

The data show a lot of variability from one year to the next, especially in the water quality of the sites. This is most likely due to the differences in precipitation for each year; 12.7 inches in 2004 and 4.7 inches in 2005 at Chicago O'Hare Airport (Illinois State Water Survey, 2006). All of the study sites had lower water levels in 2005 with most sites having no water present by the end of July (Fig.11). The dramatic difference in precipitation and therefore water levels at each site influenced the water quality, insect emergence, and nest success.

Fig. 11: Broberg Marsh in 2005 – The picture shows Brenda Molano-Flores trying to walk through the knee deep mud at Broberg marsh in July of 2005.

The lack of precipitation seems to explain the yearly differences seen in site quality. For example, Pratt Wayne I was nearly dry by mid-May in 2005 and many of the yellow-headed blackbirds that used the site in 2004 were seen prospecting at the other two Pratt Wayne sites at the end of the breeding season in 2004. Tony's Pond was a high quality site for both years and had standing water throughout 2005. The success of this site can be explained by the extra food source available to the breeding birds. Tony's Pond is located on an animal farm, making hay and grain available for scavenging. Yellow-headed blackbirds will use nearby grasslands as supplementary feeding grounds; therefore, the conditions at Tony's Pond make it that much easier for nests to succeed (Orians, 1966).

Although, Almond had the greatest insect emergence in 2004 nest success was low (Fig. 12). This may reflect variability in yearly insect availability. Insect emergence in 2005 was considerably lower and this site did not have a drastic change in water level because it is a deep water site, also water quality was with in moderate levels. Therefore, factors beside water quality and precipitation are influencing insect availability at Almond.

Fig. 12: Almond Marsh – Almond marsh, as seen in 2004, is bordered by narrow-leaf cattails with a large area of deep water.

Exner had the greatest insect emergence in 2005, but it did not have any nests. However, the major contributors to total insect dry mass for Exner were Diptera, 1.42 grams of 1.72 grams, and not Odonates as is the case for most other sites. Exner had one of the highest total suspended solids levels of the year due to low water levels and Diptera are more tolerant of elevated levels of suspended solids than other insects, which would contribute to the success of Diptera at this site in 2005 (Taylor and Roff, 1986).

Conductivity and hardness were the highest at Hegewisch for both years, but with a dramatic increase in 2005 for both variables. Pratt Wayne I had a dramatic difference in conductivity from 2004 to 2005, nearly 400 μS/L. The high levels are probably due to the early drying out of this site, it was nearly completely dry by the end of May (Fig.13).

Fig. 13: Pratt Wayne I in 2005– The picture shows Pratt Wayne I at the end of 2005 overgrown with vegetation because of the absence of standing water all season.

Alkalinity, nitrate, total suspended solids, and pH were higher in 2005, which is most easily explained by the decrease in precipitation seen that year. Ammonia tended to be at acceptable levels at all sites. Chlorophyll *a* was extremely low, but this is probably due to problems with the collection method. Chlorophyll *a* degrades very easily and quickly so it should be processed within 48 hours, which was not possible due to the other aspects of this project (Aminot and Rey, 2000). Percent saturation of oxygen tended to be lower in 2004 than in 2005, but this was more pronounced at the middle and bottom of the water column. The differences are probably due to the differences in water levels at the sites in the different years because once the water became shallow I would only take one reading instead of three.

The highest quality sites tended to have moderate water quality variables and moderate insect emergence rates including odonate emergence rates. These sites also tended to be surrounded by a large percentage of meadow or agricultural landscapes, both of which can be used as a supplemental food source for the yellow-headed blackbirds. Therefore, it seems that the surrounding landscape has the most influence on the nest success of the yellow-headed blackbird than any other factor, but mainly because of its usefulness in providing an extra food source beyond the variable supply of insect emergence.

This study was conducted during two years of extremes, so no definite conclusions can be made. Further research should be done to determine the complete role of the extreme weather conditions in the water quality and insect emergence. Based on the data that were gathered the following recommendation can be made, that all wetland sites, in this study and any other wetlands in the area, should be managed to include more grasslands in the vicinity of each wetland. The added potential food source could attract more yellow-headed blackbirds to the wetland because this would make food availability more stable for the breeding season instead of relaying on insect emergence alone.

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Appendix A: Dominant Vegetation of the Study Sites

Site	Wetland Size	Majority	Other
Eggers Woods	74.5 km	**Common Reed** *Phragmites australis*	**Coontail** *Ceratophyllum demersum* **Purple Loosestrife** *Lythrum salicaria* **Lesser Duckweed** *Lemma minor* **Broadleaf Arrowhead** *Sagittaria latifolia* **Star Duckweed** *Lemma trisulca* **Common Water-meal** *Wolffia columbiana*
Hegewisch	110.9 km	**Narrow-leaf Cattail** *Typha angustifolia* **Softstem Bulrush** *Scirpus validus*	**Broadleaf Arrowhead** *Sagittaria latifolia* **Common Reed** *Phragmites australis* **Coontail** *Ceratophyllum demersum* **Water Buttercup** *Ranunculus longirostris* **Lesser Duckweed** *Lemma minor*
Pratt Wayne I	108.2 km	**Narrow-leaf Cattail** *Typha angustifolia*	**Lesser Duckweed** *Lemma minor* **Coontail** *Ceratophyllum demersum*
Pratt Wayne II	168.1 km	**Narrow-leaf Cattail** *Typha angustifolia* **Broadleaf Cattail** *Typha latifolia*	**Lesser Duckweed** *Lemma minor* **Coontail** *Ceratophyllum demersum* **Common Water-meal** *Wolffia columbiana* **Sago Pondweed** *Potamaogetan pectinatus* **American Water Plantain** *Alisma subcordatum*
Pratt Wayne IIA	37.6 km	**Narrow-leaf Cattail** *Typha angustifolia*	**Broadleaf Arrowhead** *Sagittaria latifolia* **American Water Plantain**

			Alisma subcordatum **Lesser Duckweed** *Lemma minor* **Softstem Bulrush** *Scirpus validus* **Broadleaf Arrowhead** *Sagittaria latifolia*
Black Crown	384.7 km	**Narrow-leaf Cattail** *Typha angustifolia* **Broadleaf Cattail** *Typha latifolia*	**Lesser Duckweed** *Lemma minor* **Common Water-meal** *Wolffia columbiana* **Coontail** *Ceratophyllum demersum*
Stickney Run	400.7 km	**Narrow-leaf Cattail** *Typha angustifolia*	**Star Duckweed** *Lemma trisulca* **Lesser Duckweed** *Lemma minor* **Common Water-meal** *Wolffia columbiana* **Sago Pondweed** *Potamaogetan pectinatus* **Coontail** *Ceratophyllum demersum* **Curly Pondweed** *Potamogeton crispus*
Black Tern	197.5 km	**Narrow-leaf Cattail** *Typha angustifolia*	**Lesser Duckweed** *Lemma minor* **Water Buttercup** *Ranunculus longirostris* **Common Water-meal** *Wolffia columbiana* **Sago Pondweed** *Potamaogetan pectinatus* **Coontail** *Ceratophyllum demersum*
Broberg	381.8 km	**Broadleaf Arrowhead** *Sagittaria latifolia* **Giant Burreed** *Sparganium eurycarpum* **Softstem Bulrush** *Scirpus validus*	**Lesser Duckweed** *Lemma minor* **River Bulrush** *Scirpus fluvuatilis* **Broadleaf Cattail** *Typha latifolia*
Tony's Pond	35.4 km	**Narrow-leaf Cattail** *Typha angustifolia*	**Star Duckweed** *Lemma trisulca* **Lesser Duckweed** *Lemma minor* **Common Water-meal**

			Wolffia columbiana **Sago Pondweed** *Potamaogetan pectinatus* **Coontail** *Ceratophyllum demersum*
Almond	125.8 km	**Narrow-leaf Cattail** *Typha angustifolia*	**Star Duckweed** *Lemma trisulca* **Lesser Duckweed** *Lemma minor* **Coontail** *Ceratophyllum demersum* **Common Water-meal** *Wolffia columbiana*
Wadsworth	373.9 km	**Narrow-leaf Cattail** *Typha angustifolia*	**White Water Lily** *Nympaea odorata* **Star Duckweed** *Lemma trisulca* **Lesser Duckweed** *Lemma minor* **Coontail** *Ceratophyllum demersum* **Common Water-meal** *Wolffia columbiana*
Exner	773.0 km	**Narrow-leaf Cattail** *Typha angustifolia* **Broadleaf Cattail** *Typha latifolia*	**Lesser Duckweed** *Lemma minor* **Coontail** *Ceratophyllum demersum* **Common Water-meal** *Wolffia columbiana* **Sago Pondweed** *Potamaogetan pectinatus*

Appendix B –Budget

Grant funds were used as budgeted.

Budget Period: July 1, 2004 – June 30, 2005

Travel:		$900
F & A (10%)		$90
Total		$990

INHS Cost Share

Permanent Salaries	$881 (2%, Molano-Flores)
Fringe	$260 (29.53%)
TOTAL	$1,142
F & A (40.7%)	$465

Total Costs:	$1,606	
TOTAL PROJECT COSTS		$2,596

Budget Justification:

Travel

The study wetlands are in four different counties so it will be necessary to travel by car to the different wetlands and sampling will occur once a week so we will not be staying in the area, but will be traveling from Champaign, IL to the study area.

Salary

Salary & fringe benefits are not requested for the principal investigator. The PI is a Teacher's Assistant and paid by departmental funds through Animal Biology at the University of Illinois. Molaon-Flores will guide Roberts (as supervisor) in this project, and her contributed efforts (2% salary and fringe benefits @ 29.53%) will serve as a cost share and is paid by the Illinois Natural History Survey's operating funds.