Breeding Biology of Red-winged Blackbirds (*Agelaius phoeniceus*) in Stormwater Retention Ponds on the College at Brockport Campus

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Abstract

Red-winged Blackbirds (*Agelaius phoeniceus*) often breed in stormwater retention ponds. I studied the breeding biology of the species in seven small retention ponds at the College at Brockport, to evaluate their breeding success in a created habitat relative to data from studies in natural habitats. I also determined how habitat characteristics affect the breeding biology of Red-winged Blackbirds. The College at Brockport population had harem sizes with up to four females per male. There was a significant positive relationship between pond area and the number of male territories. I found 47 nests, at least four of which wer second nestings; average clutch size was 3.7 eggs. The nesting season began with the first clutch on 26 April 2017 with peak hatching dates from 27 May until 2 June and peak fledging dates from 7 June until 16 June. The nesting season ended when the last nest fledged, which was around 22 July 2017. Apparent nest success was 78.3%, with predation rates of 10.0%. In studies from similar habitats, apparent nest success was often much lower, ranging from 3.0 to 71.0% with predation rates ranging from 30.0% up to 97.0% in some areas. There was no significant difference between successful and unsuccessful nests in distance from nest to pond edge or open water, water depth, vegetation height, and density between. Based on my results the retention ponds provide good breeding habitat for Red-winged Blackbirds but stormwater ponds should be managed properly for wildlife use. Management practices such as discouraging invasive species, reducing over-abundance of emergent vegetation, and occasional dredging would benefit wildlife use of the retention ponds.

Introduction

Red-winged Blackbirds (*Agelaius phoeniceus*) are one of the most abundant and commonly studied birds in North America. Much information is known about their breeding biology (Pinowski and Kendeigh 1977, Yasukawa and Searcy 1995). Found in both wetland and upland habitats, Red-winged Blackbirds range from Alaska to Costa Rica and from the Atlantic to the Pacific (Yasukawa and Searcy 1995). They are strongly territorial and breed in nearly all marshes and many upland habitats (Orians 1980). Red-winged Blackbirds can be strongly polygynous, with up to 15 females nesting in one male's territory depending on the population. In wetland populations up to 90 percent of males and 99 percent of females are polygynous. Polygyny is favored due to low cost to the females and lower risk of nest predation associated with having more females nearby (Yasukawa and Searcy 1995).

More than 50% of wetlands in the conterminous United States have been lost over the past 200 years (Dahl 1990). As a result, stormwater retention ponds may provide new habitat for various wetland-dependent wildlife, including waterfowl and other avian species. For example, Red-winged Blackbirds have become abundant in stormwater retention ponds (Sparling *et al*. 2007). These man-made wetlands often are constructed in developed areas to process pollutants associated with urbanization. Retention ponds are designed to hold water, sediments, and contaminants, and keep pollutants out of natural waterways. However, because stormwater retention ponds retain contaminants many people question the quality that stormwater wetlands provide for wildlife, as the ponds may act as toxic sinks (Sparling *et al.* 2004).

The presence of Red-winged Blackbirds in retention ponds can help determine how suitable the habitat may be for other wildlife (Sparling *et al.* 2007). Because few studies have been done on the breeding biology of the Red-winged Blackbirds in retention ponds, I studied a population of Red-winged Blackbirds in seven small retention ponds in Brockport, New York. The objectives of my study were to: (1) gather information on the breeding biology of Red-winged Blackbirds in the man-made retention ponds on the College at Brockport campus and compare my data to those of other studies, (2) determine how habitat characteristics of the ponds affect the breeding biology of the species, and (3) use data related to objectives one and two to suggest how to manage retention ponds so that they serve as good wildlife habitat for Red-winged Blackbirds. In 2017, I gathered data on the number and sex ratio of mated birds in the population, breeding territories, nests, eggs, nestlings, nest success, and nest habitat characteristics.

Materials and Methods

I studied a population of Red-winged Blackbirds in seven retention ponds on the College at Brockport campus in Monroe County, New York. All of the ponds were dominated by broad-leaf (*Typha latifolia*) and narrow-leaf cattail (*Typha angustifolia*) and their hybrid (*Typha* x *glauca*) and two ponds had small patches of reeds (*Phragmites* sp.). The ponds varied in shape, ratio of vegetation to open water, and had areas from over 250 m^2 to nearly 2,500 m^2. Parking lots, roads, and buildings dominated the land surrounding the study area. I studied the breeding biology of the population from 20 February to 12 July 2017. From February to April, I observed the population of Red-winged Blackbirds and recorded the arrival dates of males and females, settlement on territories, and any notable foraging and nest-building activity. I began weekly focal sampling observations for several of the males in early April. During these observations, I watched each male for 10 min and recorded whether they were on or off territory every 30 s. These data determined how the proportion of time the males spent on territory changed throughout the breeding season.

From March to July, I took monthly water samples from each pond to determine the quality of water in the study area and tested them for nitrogen, phosphorus, and chlorophyll. To do this, I filled a 60 mL syringe with 50 mL of water from the pond and then filtered the water through a chlorophyll filter. The filter was then wrapped and stored in labeled aluminum foil. Water samples from each pond were also collected in labeled 250 mL plastic bottles. Both the bottles and the filters were frozen until the samples were later analyzed. Total phosphorus and nitrogen were analyzed using an auto-analyzer (Murphy and Riley 1962, APHA 2008). Chlorophyll-a values were analyzed using a spectrophotometer (Jeffery *et al*. 1997, Turner Designs 1999, Turner Designs 2001, APHA 2008).

Some adult birds were caught using mist nets or Potter traps baited with seed. Tarsus length and beak length were measured for each individual using calipers and reproductive condition was examined, based on cloacal protuberance for males or brood patches for females (King and Mewdalt 1987). Each bird caught was marked with a plastic colored band in order to help distinguish individuals and determine their territorial boundaries.

Once the nesting season began, I searched the ponds every few days to locate nests. When found, I numbered and marked nests by tying a strip of labeled flagging tape to a piece of cattail at the shore of the pond, parallel to the nest. I checked the nests for eggs at least every 2 d. When I found eggs in the nests, the maximum length and maximum breadth were measured to the nearest 0.1 mm with a caliper and mass was taken to the nearest 0.1 g by placing the egg in a nylon sock and hanging it on a 10-gram scale. Length and breadth measurements were used to calculate volume with the equation $V = 0.507LB^2$, where V = Volume, L = maximum egg length, and B = greatest egg breadth (Hoyt 1979). Hatchability was defined as percentage of eggs present at hatching time that produced nestlings (Koenig 1982). Once a clutch was finished, I continued to check the nest at least every other day until hatching to determine if the eggs were depredated and to record the hatch date and incubation period. Incubation period was defined as number of days between when the female started incubating the eggs, usually when the last or second to last egg was laid, until the last successful egg hatched (Norment 1992). On day four or five of the nestling period, I observed each nest for 1 h in the morning and recorded the number of male and female visits to each nest. I also took notes on behaviors of the adult birds during these observations. On day nine of the nestling period, nestlings were weighed a in nylon sock on a 100-gram scale to the nearest 0.1 g and tarsus and wing length were measured with calipers to the nearest 0.1 mm. After nestlings were measured, the nests were checked daily to determine if the young had fledged successfully, the length of nestling period, and apparent nest success. Length of nestling period was defined as number of days from when the first egg hatched until the last nestling successfully fledged (Norment 1992). Apparent nest success was defined as the proportion of nests with at least one bird surviving and fledging from a nest.

When the majority of the nests were fully fledged, I measured vegetation characteristics surrounding the empty nests (Caccamise, 1977, Weatherhead and Robertson 1977, Picman *et al*. 1993, Grandmaison and Niemi 2007). For each nest, I measured the distance from the shore, along with distance to the nearest section of open water that was at least 1 m^2 in area. Additional measurements such as water depth, nest height to the top of the nest cup, and vegetation height were also recorded. Percent cover in a 1 m^2 quadrat surrounding the nest was to the nearest 5%. This percentage focused on vegetation at nest height, so any fallen or broken plant stalks were not included in the estimate. I estimated percent cover from above the nest by placing a 15 cm ruler on the nest cup and taking a picture from 1 m above the rim of the nest cup. This percentage was based on how much of the ruler could be seen in the picture. I used a Robel pole

(Robel *et al*. 1970) to measure vegetative nest concealment for three of the cardinal directions for each nest, with the exception of the direction of open water. Finally, I recorded the vegetation species in which each nests was constructed.

I compared egg mass, nestling mass, and female feeding visits across ponds with sufficient sample size of nests ($n \geq 5$). I completed similar comparisons to determine if there was a correlation between nestling mass and female nest visits and brood sizes. For these comparisons data were first tested for normality using the Anderson-Darling test. If normally distributed, data were compared using a one-way ANOVA and a Tukey pairwise comparison. If not normally distributed, I used a Kruskal-Wallis test. A Kruskal-Wallis test was also used to compare time each male spent on territory during focal sampling. I compared predation rates of earlier and later nests by separating nest data into two equal groups by incubation date and comparing the predation rates from each group. Vegetation characteristics of successful and unsuccessful nests were compared using two-sample t-tests. I used linear regression to analyze the relationship between the number of Red-winged Blackbird territories and log of pond area. Daily nest survival rates were calculated with the program MAYFIELD, and then used to calculate probability of nest survival (Bart and Robson 1982) based on a 24-day nesting period (Mayfield 1961).

Results

The population of Red-winged Blackbirds in my study consisted of approximately 14 males and 34 females. While several of the males were monogamous, the majority of the population was polygynous, with up to four females per male (Table 1). The regression plot of number of territories versus log of pond area (m^2) showed that as pond size increased, the number of resident females also increased (r^2=0.812, P=0.006; Figure 1, Table 2).

The first males arrived at the stormwater retention ponds on 22 February 2017 and the first females arrived on 26 March 2017. The nesting season began around the 26 April and continued until mid-July, with females in the population incubating eggs between 30 April and 11 July; nestlings were present from 12 May until 22 July (Figure 2). I located a total of 47 nests throughout the breeding season. Incubation was 13 days on average and nestlings remained in the nest for an average of 11 days before fledging. Peak hatching dates were from 27 May until 2 June and peak fledging dates were from 7 June until 16 June. Four of the females had second nests after their first nests fledged. The population had an average clutch size of 3.71 ± 0.11 (n=40) eggs per nest (Table 3). The clutch sizes were not statistically different across ponds 2, 3, 4, and 6 (Kruskal-Wallis, p=0.781, DF=3)

The proportion time that males spent on territory throughout the season had high variability. There was no significant difference in time spent on territory between the beginning and end of the season. However, the difference in the proportion of time each observed male spent on territory was significant (Kruskal-Wallis, H=23.20, p=0.010, DF=10, Table 4).

Average egg volume was for the population was 3875.53 ± 56.73 cm^3 (n=41) while average egg mass was 4.194 ±0.062 g (Table 3). Egg mass was not significantly different across ponds 2, 3, 4, and 6 (ANOVA, F=0.71, P=0.551; Table 3). Hatchability for the population was 97% (n=152); only one egg was infertile and six did not hatch due to embryo death. The average mass of nestlings at 9 days of age was 29.0 ± 0.79 g; nestling mass on day 9 did not differ significantly between ponds 2, 4, and 6 (ANOVA, F=0.55, P=0.581; Table 3). Average tarsus length for the nestlings was 26.7 ± 0.3 mm and average wing length was 22.7 ± 0.3 mm (Table 3).

In only five of the 26 nests I observed were nestlings fed by males. Typically the males only fed nestlings from the first females with which they mated. Female visits ranged from three to 14 visits/h, and there was no significant difference in the median number of female visits/nest compared across ponds 2, 4, and 6 (Kruskal-Wallis, H=0.77, P=0.682, DF=2; Table 5). There was also no significant difference in the number of female visits to nests with brood sizes of 2, 3, or 4 nestlings (Kruskal-Wallis, H=3.90, P=0.142, DF=2; Table 6).

Apparent nest success for the population was 0.783, while the proportion of nests that were fully depredated was 0.095 (n=47, Table 2). Only one of the nests was depredated during the nestling period, while the other five nests were depredated during the incubation period. When comparing predation rates earlier and later in the nesting season, I found that 0.217 of the first 50% of all nests were depredated, while only 0.045 of latter half of the nests were depredated. Overall probability of nest survival for the population as calculated with Program MAYFIELD was 0.7394; probability of nest survival was 0.7800 for pond 2, 0.6403 for pond 3, 0.5749 for pond 4, and 0.8227 for pond 6 (Table 2).

Vegetation characteristics did not differ between successful and unsuccessful nests, and mean values for nest site characteristics differed little between successful and unsuccessful nests (Table 7).

The water quality analysis of the ponds revealed that the habitat was eutrophic to hypereutrophic based on the chlorophyll-a values, which ranged from 2.58 to 128.4 ug/L. Chlorophyll-a values increased as the breeding season went on but there was more fluctuation with phosphorous and nitrogen concentrations. Phosphorus concentrations ranged from 0.015 to 0.210 mg/L with highest average levels in ponds one and four lowest levels in pond five. Nitrogen concentrations ranged from 0.577 to 2.369 mg/L (Fig. 3, 4, and 5).

Discussion

The breeding biology of the population of Red-winged Blackbirds that I studied was similar to those of other studies, except that the College at Brockport population had higher apparent nest success, and lower predation and brood parasitism rates. As is typical for the species, males arrived before females in the spring (Yasukawa and Searcy 1995). Arrival of males in February and females in late March was a few weeks sooner than Nero (1956) found in Wisconsin as migration dates may have changed over the years or be different due to geographic location. After arrival, initiation of nest building was in late April, which was comparable to another study of breeding biology in Connecticut (Robertson 1972). Earlier arrival dates may be due to climate change. Ledneva *et al*. (2004) found that Red-winged Blackbirds have arrived 2.5 days earlier with each 1.0° C increase in mean temperature two months prior to arrival.

The breeding biology of Red-winged Blackbirds on the College at Brockport campus was typically similar to results found in other studies, relative to polygyny, clutch size, egg mass, and egg volume. The population I studied had a male: female sex ratio of 1:2.43, which was comparable to other studies, for example, Pinowski and Kenleigh (1977) found an average sex ratio of 1:208 over eighteen studies. There can be up to fifteen females per male in some wetland populations (Yasukawa and Searcy 1995), however many studies have found no more than three females per male (Nero 1956), while I found as many as four females mated with one male. Larger ponds tended to have higher degrees of polygyny, along with more nests, perhaps due to increased space and resource availability. Clutch size from my study was an average of 3.71, which is slightly larger than in most studies reported in Yasukawa and Searcy (1995) who found an average of 3.28 eggs/clutch over 20 studies. Also, clutch size from my study was slightly larger than another study in western New York, which found mean clutch size of 3.4

eggs (Cronmiller and Thompson 1980) and a study in retention ponds in Maryland, which found a mean clutch size of 3.2 to 3.4 eggs (Sparling *et al.* 2007). Egg mass was also slightly larger than similar studies; Yasukawa and Searcy (1995) found average egg mass to range from 4.02 to 4.09 g in four different studies while in my study, average egg mass was 4.19 g. The average egg volume in my study was 3875 mm^3 and was comparable to other studies, which found average egg volume to be 3880 mm^3 (Yasukawa and Searcy 1995).

During the nestling stage, I found no differences in number of female feeding visits/h with different brood sizes. Few studies have been done on brood size effects and female feeding visits, although in an experiment with added nestlings, there were more female feeding visits at the experimental nests with added nestlings than at control or natural nests (Cronmiller and Thompson 1980). More information on female visits to nests without adjusted brood sizes would be beneficial.

My data suggest that Red-winged Blackbirds nesting in stormwater retention ponds at the College at Brockport had higher rates of nesting success than in most other populations. Apparent nest success was 0.78, while the probability of nest survival was 0.73, with only 0.10 of the known nests lost to predation. Robertson (1972) found nest success in Ontario wetlands to average 0.53, while success rates averaged only 0.34 in uplands. Caccamise (1977) recorded nest success varying from 0.50 to 0.71 in a tidal marsh, while Grandmaison and Niemi (2007) found nest success rates ranging from 0.03 and 0.69 and predation rates between 0.31 and 0.97 in wetlands along Lake Superior. Weatherhead and Robertson (1977) found nest success of 0.39 and predation rates of 0.44 in marshes in Ontario marshes. In a study of Red-winged Blackbirds in stormwater retention ponds in Maryland, apparent nest success ranged from 0.52 to 0.70, with a nest survival probability of 0.57 to 0.74, depending on the habitat type surrounding the stormwater retention pond (Sparling *et al.* 2007). In my study, nest survival probabilities ranged from 0.57 to 0.82 and daily nest survival was 0.99 overall. Finally, daily survival rates in my study (0.98) were higher than found by Linz *et al*. (2014), for Red-winged Blackbird nestings, which were approximately 0.93.

High apparent nest success in this study was likely due to low predation rates. Robertson (1972) found that predation rates were 0.30 in wetlands habitats, which was lower than 0.45 in upland habitats, while the predation rate in my study was only 0.10. The predators in this study were most likely to be snakes or crows (*Corvus corax*) because none of the nest cups of depredated nests were destroyed or damaged by the predators. Additionally, there were some nests where only one or two of the nestlings disappeared, which could be due to predation by snakes, although, snakes are typically more thorough predators and do not leave nestlings (Stake *et al*. 2005). Despite this evidence, predators could not be definitely identified for my population. Habitat surrounding the ponds likely decreased predation rates at these sites. The ponds were in a developed area surrounded by parking lots and buildings. While there were woods nearby, separation by roads and developed areas may lead to fewer predators such as red foxes (*Vulpes vulpes*) and raccoons (*Procyon lotor*).

A second factor behind the high apparent nest success in my population was the absence of interspecific brood parasitism by Brown-headed Cowbirds (*Molothrus ater*). Interspecific brood parasitism varies greatly among Red-winged Blackbird populations. Freeman *et al*. (1990) found that cowbird parasitism affected an average of 7.7% of Red-winged Blackbird nests in four different years in Washington. However, in a study in South Dakota, Brown-headed Cowbird parasitism affected an average of 74% of Red-winged Blackbird nests (Blankespoor *et al*. 1982). Parasitism by cowbirds can lead to an increase in nest abandonment and cowbirds may depredate or remove some of the host's eggs (Clotfelter and Yasukawa 1999). The lack of parasitism in this study could be due to group defense or lack of suitable surrounding habitat for cowbirds (Freeman *et al*. 1990).

High apparent nest success in the College at Brockport population may have contributed to lack of a significant difference between the vegetation surround successful and unsuccessful nests. Another possible explanation for the lack of differences could be the time at which I gathered the vegetation data. A similar study, which found more significant differences, measured the vegetation after the young fledged each nest (Caccamise 1977). Since I measured the vegetation surrounding nests at the end of the breeding season, the cattails had grown into dense stands. I predict that earlier nests may have been more susceptible to predation as they were not as obscured by vegetation. Predation rates in my study were over four times higher for the first half of nests than the second half of nests. (Grandmaison and Niemi (2007) found that nest concealment was an important factor in protecting Red-winged Blackbird eggs and nestlings from predation. Another potential reason for lack of significant differences between the vegetation surrounding successful and unsuccessful nests may have been species' behavior as Red-winged Blackbirds may rely on group defense more than nest concealment to deter predators (Borgmann and Conway 2015).

For future research, I recommend banding the adult birds when they first arrive at the study site to get more of the population banded and develop a better understanding of territorial behavior. In this study, I studied vegetation surrounding the nests near the end of the breeding season with the assumption that habitat surrounding the ponds changed at an equal rate for all nests. By late June, when I completed the vegetation study, the cattails in the ponds had become very high and dense. For future studies, I think it would be better to study the vegetation right after the nestlings fledge. However, it would be important to ensure that no active nests are disturbed during the vegetation survey. To avoid this, vegetation density could be estimated and given a categorical value within 5 m of the nest rather than using a Robel pole (Jobin and Picman 1997, Grandmaison and Niemi 2007). I predict that the earlier nests may be more susceptible to predation because the vegetation is less dense. If the vegetation were studied right after the young fledge the nest, researchers would need to be wary of surrounding nests in the pond.

In order to ensure future high habitat quality for Red-winged Blackbirds, the stormwater retention ponds need to be managed efficiently. This will not only benefit the Red-winged Blackbirds but other species that live in the ponds, including amphibians and reptiles. The water quality of the ponds was eutrophic to hypereutrophic, indicating a need to manage the water quality. Eutrophication leads to reduced species diversity and increased cyanobacteria, which poses risks to human health and wetland ecology (Codd 2000). Use of road salt and pesticides or herbicides should be limited near these ponds to maintain a higher water quality. Vegetation should be managed to maintain a hemi-marsh habitat with a mix of emergent vegetation and open water. Emergent vegetation has positive effects, such as filtering nutrients, providing substrate for macroinvertebrates, and providing oxygen, and negative effects such as reduced dissolved oxygen and increased diseases (Thullen *et al* 2005). Red-winged Blackbirds prefer to nest in sparser vegetation as it allows sunlight to penetrate the water, increasing aquatic productivity and therefore attracting insect larvae (Bernstein and McLean 1980). To prevent the cattails from becoming too prevalent in the ponds, they can be cut to below the water level in the fall, which will kill them and result in more open water for the following breeding season (Thullen *et al*. 2005) Invasive species such as *Phragmites* sp. should also be removed or prevented from establishing themselves. Another way to manage these retention ponds would be to dredge the sediment occasionally, to allow the ponds to be fully effective. However, this process can be very disturbing to birds and especially amphibians (Hamer *et al*. 2012). Additionally, dredging should occur outside of the breeding season to avoid interfering with the breeding biology of the species. The best time for this would be in late summer or early fall.

When planning construction of future stormwater retention ponds, use by Red-winged Blackbirds also should be considered. Future stormwater ponds should have more gradual slopes and should be planted with native species. Ponds with steeper slopes are more likely to flood and therefore lose nests than ponds with shallow sides (Sparling *et al*. 2007) but may to resist cattail invasion for longer. Steepness of slopes is a more important consideration for larger ponds rather than the small small ponds such as those in my study. Pocket marshes, which are wide enough for at least five male territories, are better for Red-winged Blackbirds than strip marshes, which are narrow with linear territories bordering each other. The pocket marshes attract more birds, have higher nest success rates, in part because nests can be placed farther from pond edges to avoid terrestrial predators (Beletsky and Orians 1996, Weatherhead 1995).

In conclusion, further research should be done on retention ponds as habitat for Red-winged Blackbirds to determine the optimal amount of open water, type of vegetation, and water quality for the species. Research on potential contamination of eggs or nestlings in stormwater wetlands would be beneficial. Management strategies of stormwater wetlands for use by wildlife should be taken into consideration. Despite potential harms of stormwater retention ponds for wildlife, the ponds at the College at Brockport provide great habitat for Red-winged Blackbirds, as apparent nest success was much higher than found in most other studies.

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Tables and Figures

Table 1. Frequency distribution of male Red-winged Blackbirds with 1, 2, 3, or 4 females in their territory on the College at Brockport campus, 2017.

	Frequency of males
1 Female	3
2 Females	4
3 Females	4
4 Females	3

Table 2. Summary data for pond characteristics, territory settlement, and nest success of the population of Red-winged Blackbirds at the College at Brockport, 2017; see methods section for definition of apparent nest success and probability of nest survival.

	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6	Pond 7	Total
Males	1	3	2	4	1	3	0	14
Females	1	9	3	8	2	11	0	34
Open water (%)	35	20	30	30	60	70	0	
Area (m^2)	585	1,274	704	1,345	257	2,446	392	
Apparent nest success (n)	1 (1)	0.833 (12)	0.667 (6)	0.667 (12)	1 (2)	0.846 (13)		0.835 (46)
Predation rate	0	0.083	0.167	0.167	0	0.154		0.095
Probability of nest survival		0.7800	0.6403	0.5749		0.8227		0.7394

Table 3. Egg and nestling measurements for Red-winged Blackbirds in stormwater retention ponds at the College at Brockport, 2017.

	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6	Mean (SE)
N (egg mass, volume, hatchability)	1	10	6	10	2	12	
Mean Egg mass (g)	4.50	4.02	4.14	4.23	4.47	4.26	4.27 (0.08)
Egg volume (mm^3)	4190	3769	3766	3950	3970	3915	3927 (64)
Hatchability (%)	100.0	94.7	95.0	90.0	100.0	100.0	96.6 (1.7)
N (nestlings)	1	10	4	7	2	11	
Nestling mass (g)	31.13	30.51	27.97	27.93	28.53	28.85	29.15 (0.52)
Tarsus length (mm)	28.70	26.80	26.59	26.59	26.07	26.67	26.90 (0.37)
Wing length (mm)	22.40	23.05	23.10	22.21	22.25	22.64	22.61 (0.16)

Table 4. Observed percentage of time Red-winged Blackbirds spent on territory on the College at Brockport Campus, 2017.

Male location	Number of weeks	Median Time on territory (%)
2N	12	35
2S	12	0
2W	12	12.5
3E	12	42.5
3W	12	30
4N	12	25
4S	12	20
4W	12	32.5
6N	12	2.5
6S	12	15
6W	12	17.5
Overall	132	

Table 5. Number of female nest visits/h compared across ponds on the College at Brockport campus, 2017 (Kruskal Wallis, H=0.77, p=0.682).

Pond	# of nests	Median # of visits/h
2	8	7
4	8	8
6	11	6
Overall	27	

Table 6. Number of female nest visits/h relative to brood sizes on the College at Brockport Campus, 2017 (KruskalWallis, H=3.90, p=0.142).

# of nestlings	# of nests	Median # of visits
2	6	9.5
3	10	6
4	10	6
Overall	26	

Table 7. Nest site characteristics (mean ± SE) for the population of Red-winged Blackbirds in stormwater retention ponds at the College at Brockport, 2017.

Variable	Successful (n=31)	Unsuccessful (n=9)	Test statistic (t)	P-value
Distance from shore (m)	3.07 ± 1.50	2.5 ± 1.42	-1.05	0.331
Water depth (cm)	35.8 ± 17.5	37.2 ± 19.7	0.11	0.857
Nest height (cm)	51.4 ± 12.8	51.3 ± 14.4	0.02	0.984
Mean Robel score	14.95 ± 2.72	13.54 ± 3.34	-1.16	0.271
% cover in 1m2 quadrat	25.16 ± 9.85	25.6 ± 18.1	0.06	0.951
% cover from above	31.3 ± 23.3	27.2 ± 13.5	-0.66	0.514

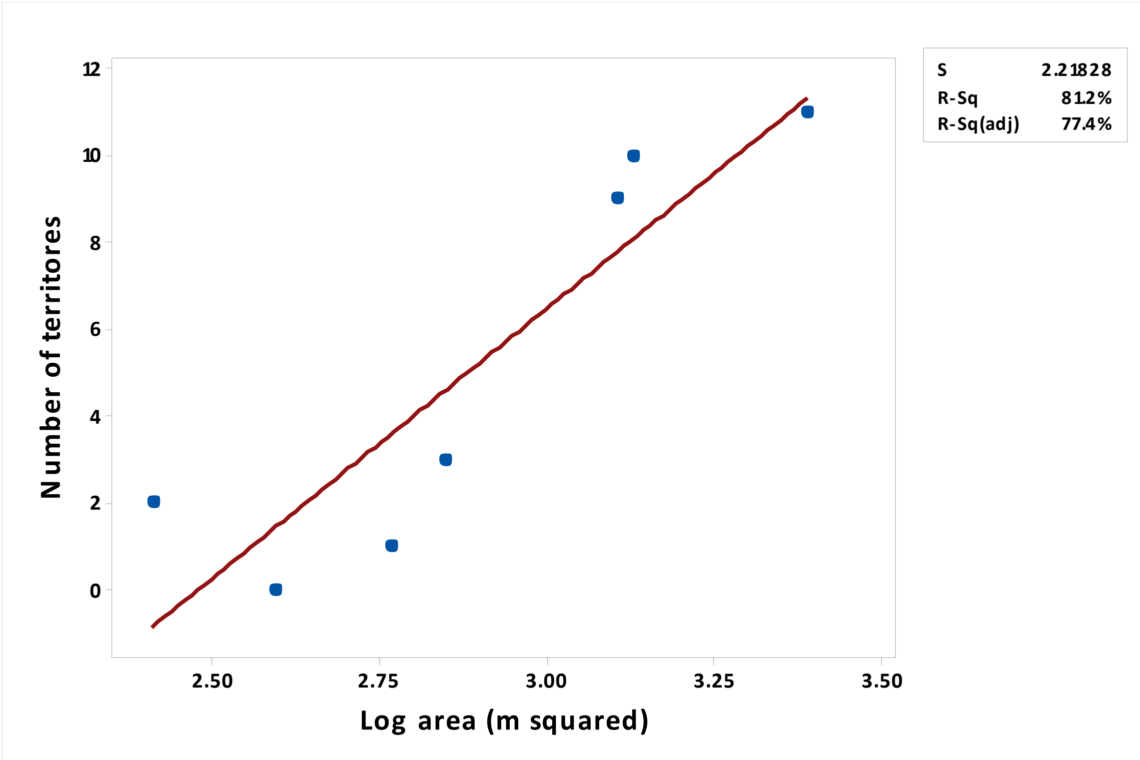

Figure 1. Number of resident female Red-winged Blackbird vs. area of stormwater retention ponds, College at Brockport, 2017 (P=0.006).

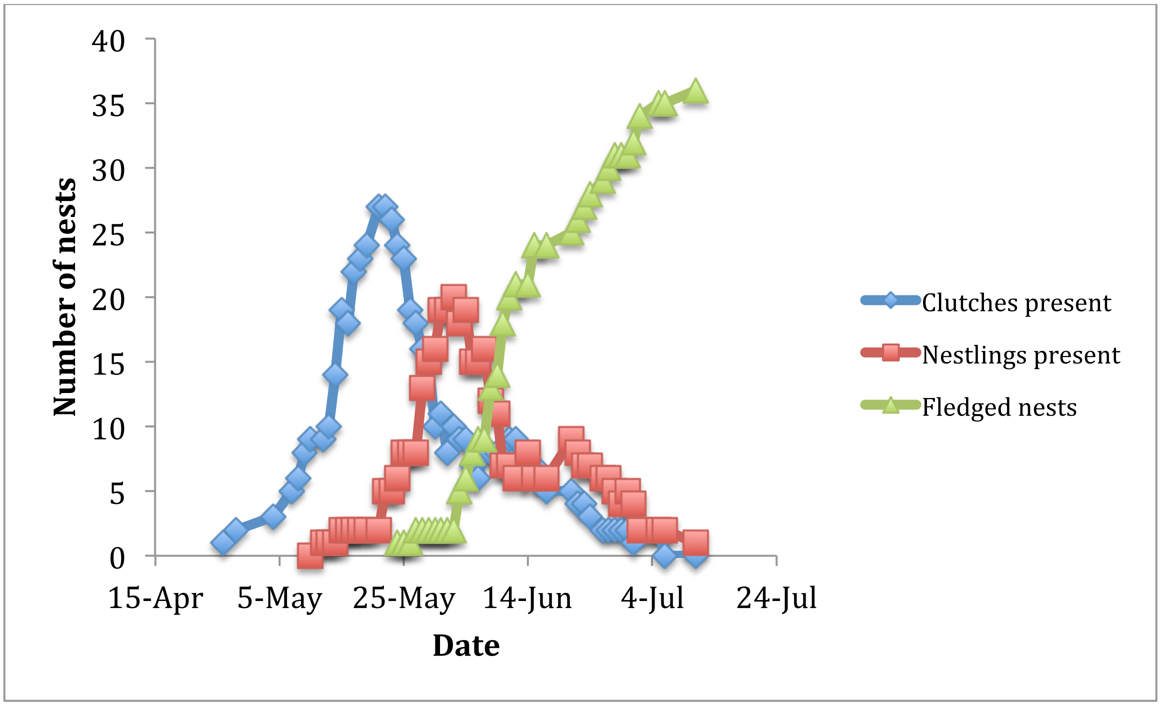

Figure 2. Breeding chronology of Red-winged Blackbirds in stormwater retention ponds at the College at Brockport, 2017, including the number of nests with clutches or nestling present or fledged nests.

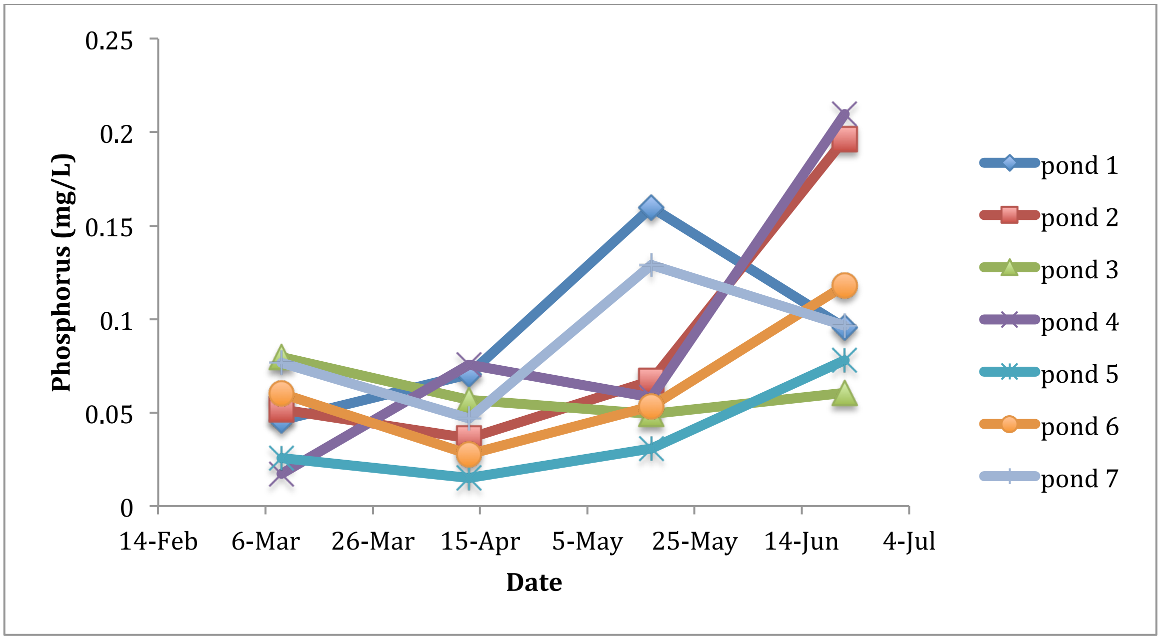

Figure 3. Total phosphorous concentrations for stormwater wetlands on the College at Brockport campus, 2017.

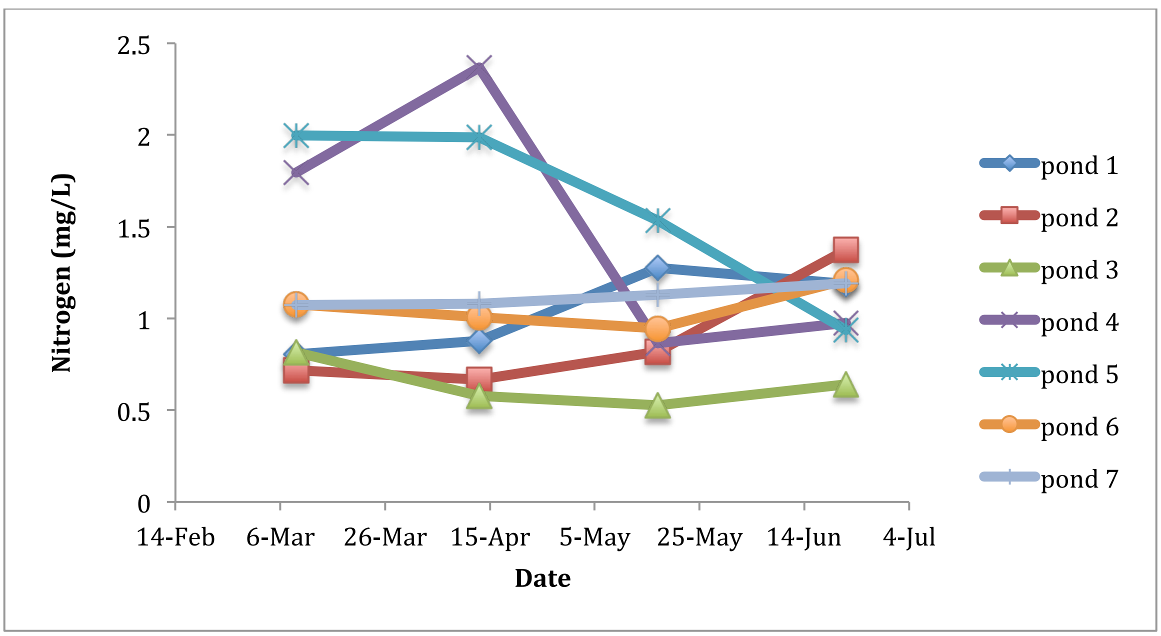

Figure 4. Total nitrogen concentrations for stormwater wetlands on the College at Brockport campus, 2017.

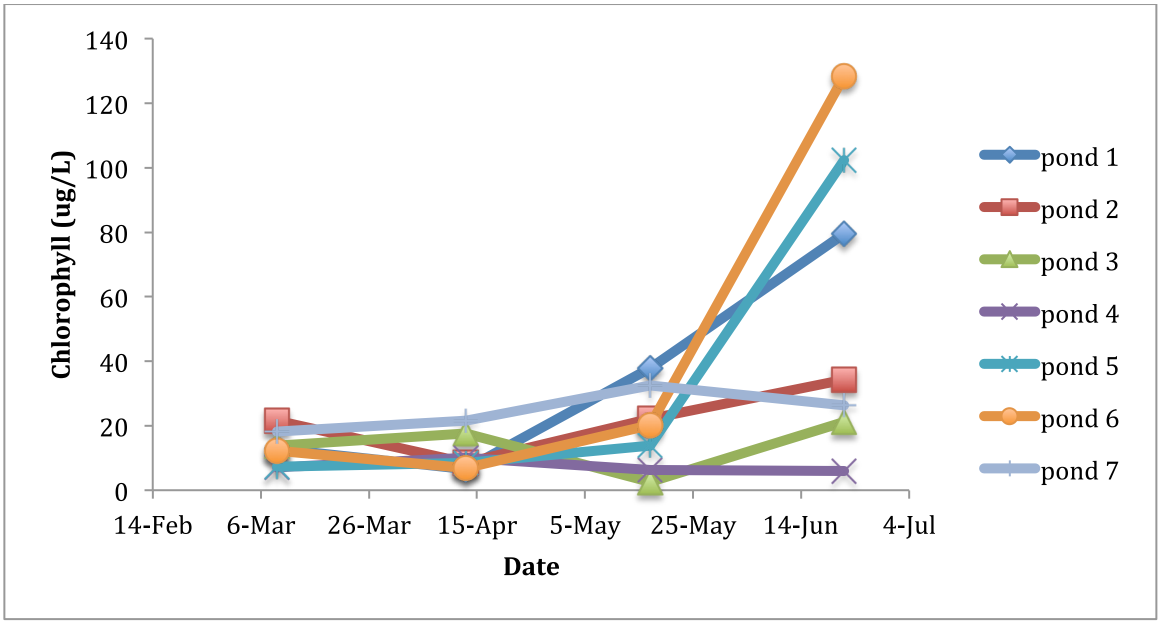

Figure 5. Chlorophyll levels in stormwater retention ponds on the College at Brockport campus, 2017.