11-20-2014

Presence of Semi-Aquatic Turtles in Indianapolis Golf Course Ponds

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Director, Honors Program
Date

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Level of Honors conferred: University _Summa Cum laude_

Departmental

Presence of semi-aquatic turtles in Indianapolis golf course ponds

A Thesis

Presented to the Department of Biological Sciences

College of Liberal Arts and Sciences

and

The Honors Program

of

Butler University

In Partial Fulfillment

of the Requirements for Graduation Honors

Melissa Anne Jones

November 20, 2014

Abstract

The consequences of increasing urbanization in many areas have led to an increase in environmental awareness. Urban green spaces, such as golf courses, can increase biodiversity and serve as valuable wildlife habitats in otherwise inhospitable areas. Golf course ponds have the potential to provide suitable habitats for semi-aquatic turtles in urban areas. Previous research on semi-aquatic turtle inhabitation has been conducted on suburban golf courses. This study investigates the viability of urban Indianapolis golf courses as habitats for semi-aquatic turtles. Golf course ponds show similar turtle occupancy compared to nearby control ponds. However, when compared to a past random pond sampling in Washington Township, this study's golf course ponds show significantly higher occupancy. Other factors, such as pond distance to the nearest road and pond surface area were also significantly different between the two pond groups. My results demonstrate the potential for urban golf course ponds to provide viable habitats for semi-aquatic turtles. Ultimately, golf courses could be deliberately designed to serve as a safe haven for wildlife, such as turtles, in an urban area.

Introduction

Today, more than half of the world's population lives in cities, with a projection of an even larger percentage living in cities in the near future (UNFP, 2007). With so many people living in urban areas, the study of urban ecology has grown rapidly in recent years (Grimm et al. 2000). Researchers, however, have only recently become more aware of the potential for urban green spaces to counterbalance some of the negative consequences of urbanization such as air pollution, runoff, and decreased biodiversity. There are many types of urban green spaces, such as parks, gardens, and remnant woodlots. Green spaces provide many benefits from the personal level to the global level. For example, green spaces can reduce the heat island effect, reduce air pollution, and protect native wildlife and vegetation (Bilgili and Gokyer 2012, Foley et al. 2005).

One of the most poorly studied kinds of green spaces is the golf course. While the primary goal of the fifteen thousand golf courses in the United States is the game itself, courses are increasingly being constructed in a manner to minimize ecological disruption. The planning, construction, and management of courses can be guided to use natural resources efficiently, educate golfers about their responsibility to the environment, and protect habitats for wildlife and plants (Semlitsch et al. 2007, GCSAA 2013). Many wildlife species are able to use golf courses as a habitat, and recently researchers have been investigating how to provide proper guidelines for course managers to shape their courses to be environmentally conscious (Semlitsch et al. 2007). Golf courses cannot replace natural habitats, but with correct conditions they can be a good substitute, especially if they are near other green spaces. For example, golf courses built with local birds' normal environment in mind housed many birds, including some threatened species (Terman 1997). Other research shows that mammals, amphibians, and reptiles can benefit from golf courses designed to mimic their natural habitats (Hodgkison et al. 2007). So far, there have been more studies on how birds and mammals benefit from green spaces than amphibians and reptiles; however, each golf course has the potential to provide good habitats for any of these animals, depending on how well the course's resources are used (Hodgkison et al. 2007). If constructed with the correct environment in mind, golf courses can serve as a home for many types of wildlife, including semi-aquatic turtles.

The presence of semi-aquatic turtles on golf courses has been studied in the suburbs of Charlotte, NC (Price et al. 2013, Eskew et al. 2010, Guzy et al. 2013, Failey et al. 2007, and Harden et al. 2009). In this research, golf course ponds were compared to farm ponds and residential ponds to analyze the presence of turtles. Overall turtle abundances of golf course ponds equaled those of farm ponds and were greater than those of residential ponds. Possible reasons for decreased abundances in residential areas included road mortality and neighborhood predators (Price et al. 2013). Road mortality was higher in females than in males, likely due to their increased movement while nesting (Eskew et al. 2010). As pond size increased, turtle abundance increased as well, and abundances on golf courses decreased in those courses with more residential area surrounding the boundaries (Price et al. 2013). A study by Guzy et al. (2013) involved trapping semi-aquatic turtles and recording landscape types around ponds at golf courses, farms, and residential areas. The golf course ponds were richer in species than both other pond types, and several species including the eastern mud turtle (*Kinosternon subrubrum*) and snapping turtle (*Chelydra serpentina*) were more likely to be living on golf courses with more green space connected to the pond. The turtles also did very well in areas resembling native wetlands, especially when females needed to find nesting sites (Guzy et al. 2013). These results suggest that golf course ponds, with the proper adjacent green space, have the potential to provide a better habitat for semi-aquatic turtles than other types of suburban ponds and surrounding areas.

The same research group studied the same ponds on another occasion, examining other factors including species abundance, sex ratios, and size distributions. In these characteristics, there were no significant differences between pond types, leading the researchers to believe that the landscape surrounding the ponds might be more important to turtles than the pond type itself (Failey et al. 2007). This could be because semi-aquatic turtles require terrestrial habitats, specifically for nesting and overwintering, as well as aquatic areas. Suburban Charlotte golf courses have also been studied regarding terrestrial preferences. Most preferences varied between species, but all species studied avoided man-made landscapes such as pavement (Harden et al. 2009). Both sliders (*Trachemys scripta*) and snapping turtles displayed high survivorship in these golf course ponds, although mud turtles showed lower survivorship relative to other pond types. These results suggest that human modifications to their habitat affect different species in different ways (Eskew et al. 2010). It is unknown to what extent golf courses in urban areas can serve as a refuge for turtles, but these studies around suburban Charlotte golf courses provide a template for studies of semi-aquatic turtles in more urban areas.

Indianapolis is home to several semi-aquatic turtle species and previous studies on the assemblage provide important background information about the ecology of turtles in this urban area. Conner et al. (2005) reported on a mark-recapture study along the

Central Canal and the Indianapolis Museum of Art lake. They documented the presence of six species: spiny softshell turtle (*Apolone spinifera*), painted turtle (*Chrysemys picta*), common map turtle (*Graptemys geographica*), common musk turtle (*Sternotherus odoratus*), common snapping turtle, and red-eared slider. In this baseline study, common map turtles were the most common species in the canal, and red-eared sliders were most common in the lake (Conner et al. 2005). Looking more specifically at the ecology of the map turtle and the red-eared sliders in the Central Canal, turtles' movements were tracked to see whether there was a preference of locations along the canal. Overall, the turtles surveyed preferred woodland and commercial areas, and tended to avoid parts of the canal near roads. While hibernating, an even stronger preference was given to woodland areas along the canal (Ryan et al. 2008). Snapping turtles along the Central Canal displayed similar patterns (Ryan et al. 2014). The turtles were clearly influenced by human activities because they avoided roads, so knowledge of their habitat use is essential to conserving these turtles (Ryan et al. 2008, Ryan et al. 2014). An important part of many semi-aquatic turtles' lives is basking, so basking sites are also critical for their habitats. Map turtles along the Central Canal preferred banks with plenty of rocks, while sliders and painted turtles preferred to use deadwood as basking sites (Peterman and Ryan 2009). Despite the urbanized environment along the Central Canal in Indianapolis, semi-aquatic turtles have been able to acclimate well, suggesting that these turtles are certainly present in the urban city of Indianapolis. This study investigates the presence of semi-aquatic turtles on urban golf courses in

Indianapolis. This will provide information about the potential for golf course ponds to provide an adequate habitat for turtles in this and other urban areas.

Methods

I used a passive surveying method to minimize disruption of both turtles and golf course patrons. Eight different Indianapolis golf courses, with a total of 26 ponds, as well as 19 haphazardly selected ponds (e.g. detention basins) of similar size, located within the general vicinity of each golf course (within 0.6 kilometers) were surveyed. Golf courses chosen were public courses managed by Indy Parks and Recreation (Appendix I) so as to easily gain permission to survey all courses. Surveying took place between May and August on days with sunshine and with minimal to no rain.

A modified point-count survey technique, similar to those frequently used to survey birds (e.g., Ralph et al. 1995) was used. Starting at any point around each pond, I walked the perimeter slowly while looking quietly for turtles with the aid of binoculars. Any turtles observed were noted and classified to species if possible. If a turtle of any species was observed at a pond, the pond was considered "occupied." If there was no confirmed observation on the first visit, the pond was revisited up to two more times; if no turtles were observed after three visits, the pond was considered "unoccupied." The same technique was used for the non-golf course reference ponds.

I used ArcGIS (http://www.esri.com/software/arcgis) to collect pond area and perimeter data via a layer containing data for all ponds in Marion County. I used Google Earth to measure distances (to the nearest meter) from each pond to the nearest road, nearest major road (defined as a road busier than neighborhood roads), nearest larger body of water, nearest major body of water (defined as a river, canal, lake, or reservoir), and nearest neighborhood (defined as a cluster of houses at least 250m by 250m in area). The approximate age information about each pond and its corresponding nearest neighborhood was estimated using MapIndy (http://maps.indy.gov/Mapindy/). The age of the pond was recorded as the time between present and the pond's first appearance in historical aerial photography.

I compared the presence/absence likelihood between this study's golf course ponds and control ponds using Fisher's exact test. Each additional variable was tested for significant differences between golf course and control ponds using a two-sample t-test assuming equal variances. Additional comparisons of the current study's golf course pond data were also made with data from a similar study in Washington Township in 2010.

Results

I found that 74% of control ponds (n=19) were occupied by turtles, and 86% of golf course ponds (n=26) were occupied. The occupancy of the two groups were not significantly different (Fisher's exact test, $P=0.14$). On average, the control ponds and golf course ponds had similar ages (Table 1; $t=-0.58$, $df=43$, $P=0.28$), surface areas (Table 1; $t=1.36$, $df=36$, $P=0.09$), and perimeters (Table 1; $t=1.20$, $df=36$, $P=0.12$). Golf course ponds were significantly farther from the nearest road (Figure 1; $t=-4.2$, $df=43$, $P<0.001$), the nearest major road (Figure 2; $t=-2.64$, $df=43$, $P=0.0057$), and the nearest neighborhood (Figure 3; t=-3.72, df=43, P<0.001). Control ponds were farther from the nearest body of water (Figure 4; t=1.91, df=43, P=0.031) and the nearest major water source (Figure 5; t=2.12, df=43, P=0.02). The majority of turtles observed were red-eared sliders, but several painted, map, and snapping turtles were also identified.

Because there were few apparent differences between golf course ponds and the controls, I compared the golf course pond data to another data set I considered a 'control.' This data set consisted of similar presence/absence observations collected from randomly selected ponds throughout Washington Township in the summer of 2010. In the 2010 study, 27.5% of ponds (n=51) were occupied. This 2014 study's golf course ponds were significantly more occupied than control ponds observed in 2010 (Fisher's exact test, P<0.001). Golf course ponds were located significantly farther from the nearest road (Figure 6; t=-6.49, df=75, P<0.001) and the nearest major road (Figure 7; t=-2.52, df=75, P=0.0069) and were also larger in area (Table 1, Figure 8; t=-1.75, df=73, P=0.042). Both sets of ponds were similar in age (Table 1; t=0.27, df=75, P=0.39), perimeter (Table 1; t=-1.22, df=73, P=0.11), and distance to the nearest body of water (t=0.59, df=75, P=0.28).

Discussion

The data I collected did not show significant differences in occupancy between golf course ponds and control ponds. Although a few variables such as distance to nearest road and distance to nearest body of water were statistically different, many aspects of the ponds in this study (e.g., age, perimeter, and area) were similar. However, when comparing the data I collected on golf course ponds to data collected from a random sampling of Washington Township ponds in 2010, there was a significant difference in occupancy, with turtles being more likely to inhabit golf course ponds. A possible reason for the difference in 2010 occupancy and 2014 control pond occupancy could be that 2014 control ponds were too similar to 2014 golf course ponds to actually be considered a control. The control ponds were within the general vicinity of golf courses (691±364m from nearest golf course pond), and therefore the habitat could be considered shared between the control ponds and the golf course ponds. Because 2014 golf course ponds were not found to be significantly more occupied than 2014 control ponds, the 2014 control ponds may not be representative of non-golf course ponds throughout Indianapolis. The 2010 ponds are considered a better set of control ponds. In this case, golf course ponds in Indianapolis appear to provide a better habitat for semi-aquatic turtles than other urban ponds in Indianapolis, which had a much lower occupancy.

There may be a variety of reasons why Indianapolis golf course ponds are more occupied than other urban ponds. For example, the golf course ponds studied were located significantly farther away from the nearest roads and major roads. Ponds closer to roads may come with additional risks to semi-aquatic turtles, especially when moving from one location to another. Not only do roads pose different risks to turtles based on gender, but different species, such as sliders and snapping turtles, are impacted differently by the presence of nearby roads (Eskew et al. 2010). Previously in Indianapolis, turtles have shown a preference for habitats more associated with woodlots, rather than in residential areas that have many roads nearby or in areas adjacent to roads (Ryan et al. 2008, Ryan et al. 2014).

Golf course ponds were also larger in area than the 2010 control ponds, suggesting that golf course ponds may have the ability to accommodate higher population sizes. In other studies, several turtle species have shown positive correlations between abundance and pond area, possibly due to increased resources. However, looking at pond area alone excludes some important information such as surrounding landscape which is also vital to the turtles' habitat (Failey et al. 2007). When it comes to surrounding landscape, nearby roads may be unavoidable for urban ponds because most ponds in urban areas are built for the purpose of collecting storm water; therefore, they are intentionally built close to surfaces such as roads. In addition to roads, however, wooded areas or open green space may impact turtle habitat preferences, so these variables are worth investigating. This study's golf course ponds did have more area to accommodate semi-aquatic turtles than other urban ponds, and additional factors, such as surrounding landscape, may also impact pond preference.

It is possible that some turtles were present in all ponds studied even if they were not observed in this passive survey as some species, such as the musk turtle, have more aquatic tendencies. However, several of the most notable species in Indianapolis (painted turtles, red-eared sliders, map turtles, and possibly snapping turtles) spend time basking, increasing the probability of detection. This baseline study provides information about basic absence and presence of turtles on urban golf courses, hopefully leading to future studies that can provide guidelines for golf course conditions that promote turtle inhabitation.

Turtles are one of many potential kinds of wildlife that can utilize golf courses as a safe haven. Some minor adjustments to course policies and design have the potential to improve wildlife conservation without a major cost to courses and their patrons. Policy adjustments as simple as reminding course patrons and management to be mindful of nearby wildlife can help improve the hospitality of urban golf courses. There is also a wide variety of potential design adjustments that can make golf courses better habitats for wildlife. Based on this study's findings, increased presence of basking sites within ponds and increased surrounding woodland areas are potential enhancements to specifically increase turtle presence in urban golf course ponds. Conserving a broader wildlife scope, The Bear Trace, a golf course in Chattanooga, Tennessee, plays host to bald eagles, deer, bobcats, and many other wildlife species. After adjusting course management philosophy, The Bear Trace made several environmentally friendly improvements, such as switching grass types. The course also has many nesting boxes and feeders for birds, and the management monitors both water quality and recycling projects (Carson, 2014). The Bear Trace is an environmental leader, and although this course is not in an urban area like Indianapolis, there is plenty of potential to improve upon urban golf course design in order to be more environmentally conscious.

Acknowledgements

I would like to thank Dr. Travis Ryan for his assistance throughout the entire process of this project. Also, thank you to Dr. Carmen Salsbury for providing her input regarding this thesis. Finally, I would like to thank the management of all Indy Parks golf courses I visited for their assistance and cooperation.

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Appendix I

Indy Parks and Recreation public golf courses

1. Coffin Golf Course
2. Eagle Creek Golf Club Sycamore course
3. Eagle Creek Golf Club Pine course
4. Riverside Golf Academy
5. Sahm Golf Course
6. South Grove Golf Course
7. Whispering Hills Golf Course
8. Winding River Golf Course

Table 1. Mean (+/- standard deviation) age, surface area, and perimeter for control ponds (n=19), golf course ponds (n=26), and 2010 ponds (n=51). Surface area and perimeter data not available for 5 control ponds and 2 golf course ponds.

Pond Type	Age (years)	Surface area (m^2)	Perimeter (m)
Control	22.5±16	5262±5129	347±150
Golf Course	25.6±19	3432±3165	281±172
2010	26.5±10	2313±2259	230±167

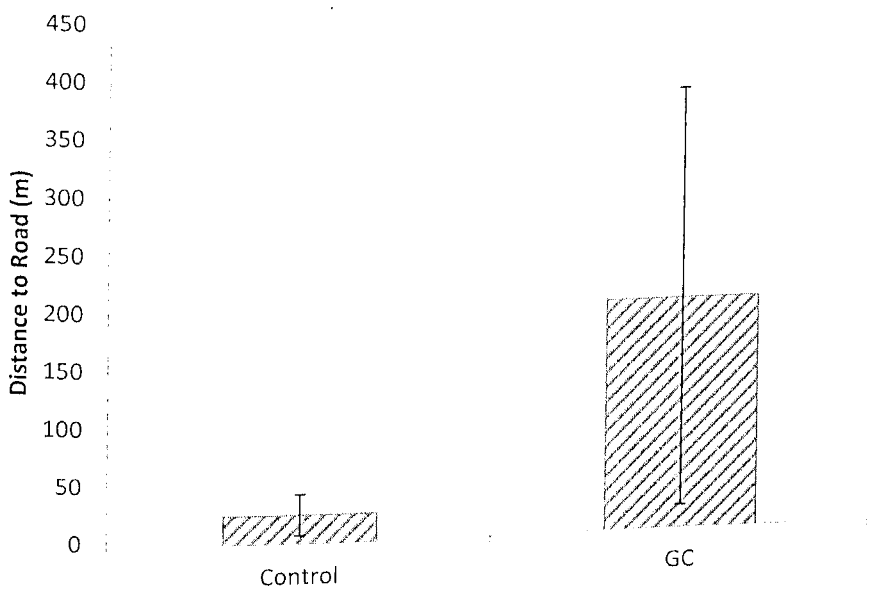

Figure 1. Mean (+/- one standard deviation) distance from pond to nearest road for control ponds (n=19) and golf course ponds (n=26).

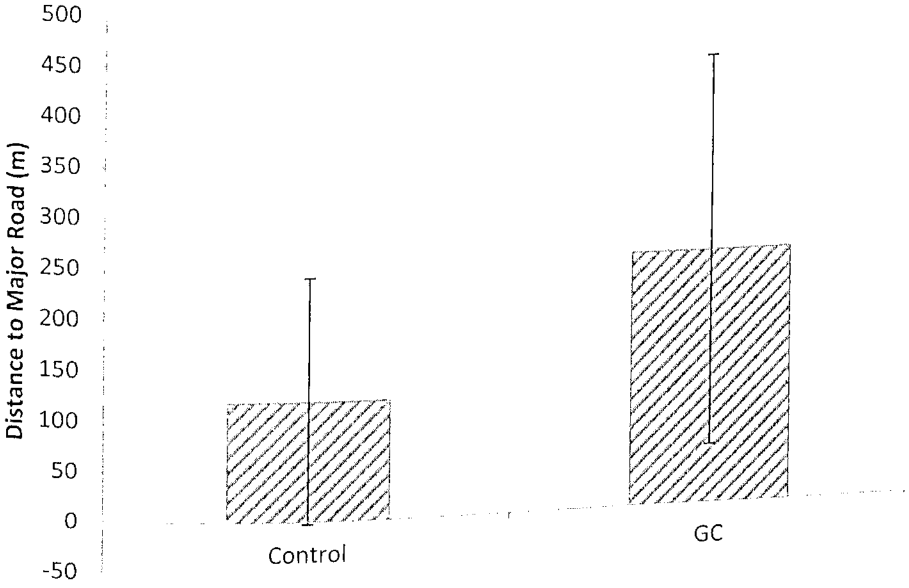

Figure 2. Mean (+/- one standard deviation) distance from pond to nearest major road for control ponds (n=19) and golf course ponds (n=26).

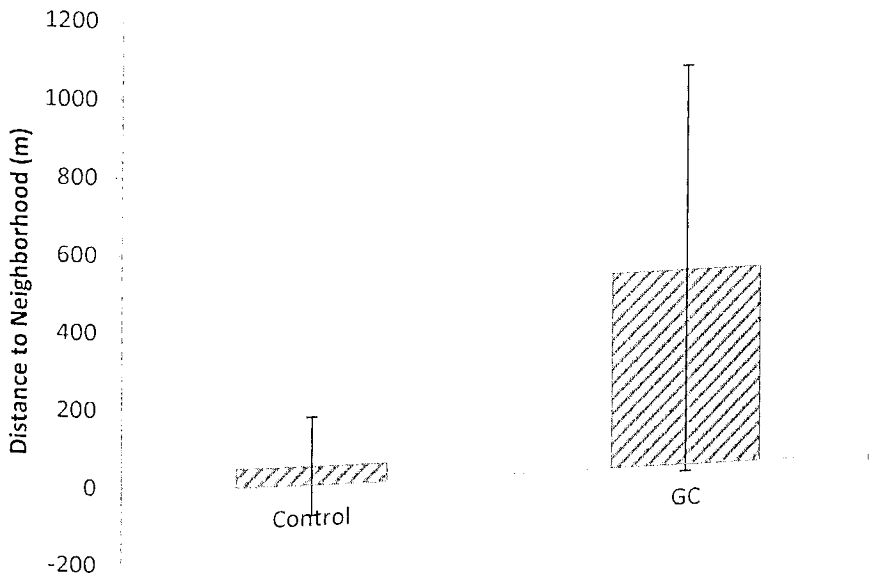

Figure 3. Mean (+/- one standard deviation) distance from pond to nearest neighborhood for control ponds (n=19) and golf course ponds (n=26).

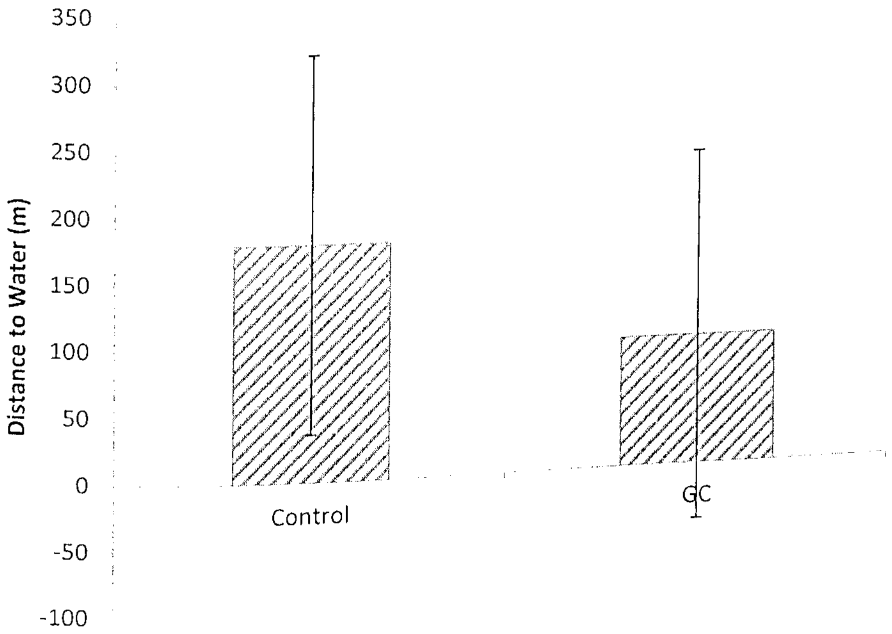

Figure 4. Mean (+/- one standard deviation) distance from pond to nearest body of water for control ponds (n=19) and golf course ponds (n=26).

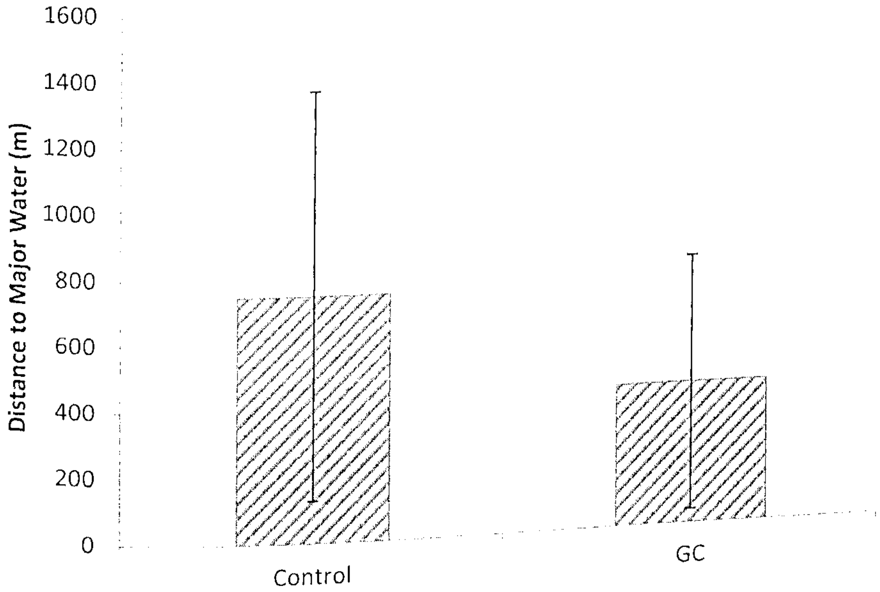

Figure 5. Mean (+/- one standard deviation) distance from pond to nearest major body of water for control ponds (n=19) and golf course ponds (n=26).

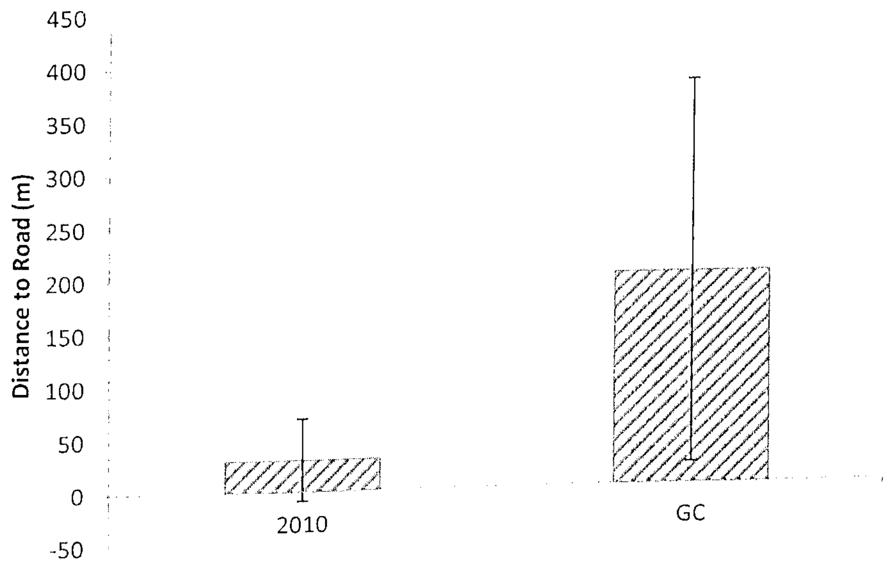

Figure 6. Mean (+/- one standard deviation) distance from pond to nearest road for 2010 ponds (n=51) and 2014 golf course ponds (n=26).

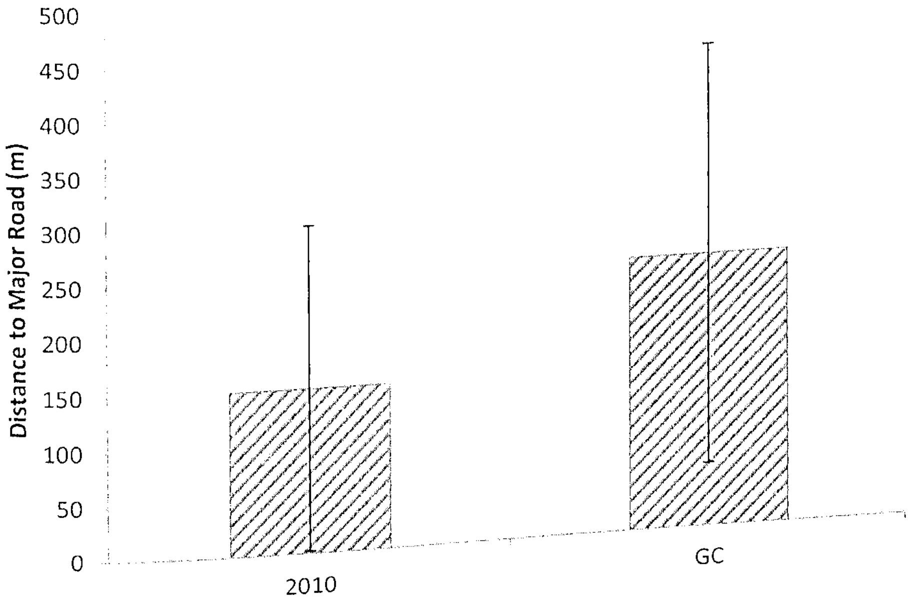

Figure 7. Mean (+/- one standard deviation) distance from pond to nearest major road for 2010 ponds (n=51) and 2014 golf course ponds (n=26).

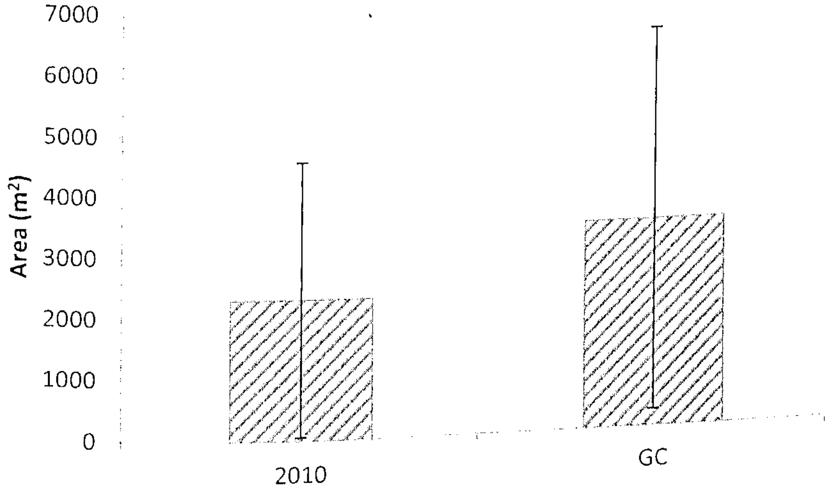

Figure 8. Average (+/- one standard deviation) pond surface area for 2010 ponds (n=51) and 2014 golf course ponds (n=24).