

Utilization of Golf Courses and Other Urban Green Spaces as Amphibian Refugia

Ann Calhoun (Dr. David McCullough)
Wartburg College, Waverly, Iowa



Abstract

The objective of this study was to examine amphibian use of urban greenspaces such as golf courses as indication of habitat quality. The survey focused on two golf courses, one well established (~65 yr) and one relatively new (5 yr). Since amphibians are frequently viewed as bio-indicators of habitat quality, their density and diversity at our study sites will help us understand how these areas play a role in providing adequate habitat in an urban setting. Species present at the new course are of particular interest in order to comprehend how it is functioning as habitat in a successional fashion. Results indicate several frog and toad (anuran) species are utilizing habitat provided by both courses—supporting the hypothesis that habitat conditions are minimally suitable for some amphibian species. Additional species were located at control sites indicating that, while course habitat may be conducive to housing some species, it appears that others may be excluded for reasons still under investigation. Data collected allows us to determine quality of current habitat and provides benchmark evidence for future research on urban amphibian communities.

Introduction

Current rates of urban expansion have taken a toll on natural areas utilized by wildlife around the world. Golf courses and other urban greenspaces have been found to serve as habitat and resource areas for some species of plants and animals. As urbanization continues, these areas may be relied upon more heavily to serve as critical habitat areas for displaced organisms. The goal of this study is to better understand how urban greenspaces in north east Iowa play a role in providing suitable habitat for amphibians. Diversity of amphibian populations should indicate habitat quality and suitability provided by these areas.

Research on amphibian populations has increased since global declines in amphibian species were first noted in the 1980's (Nickens, 2000; Lannoo, Lang, Waltz and Phillips, 1994). In order to try to unravel the mystery behind this phenomenon, as well as define possible problems and repercussions this decline may imply, studies have focused on assessing existing amphibian populations and their habitat. Multiple theories, ranging from anthropogenic causes to natural extinction cycles attempt to explain why this decline may be occurring. This observed decline in amphibian species on a global scale may be indicative of a shift in world climate, weather patterns, or overall environmental health (Lawler, White, Sifneos, and Master, 2003).

"Using bioindicators as an early warning of pollution or degradation in an ecosystem can help sustain critical resources" (Biological Indicators, 2003). Due to the sensitive aquatic and terrestrial lifestyles of amphibians, many scientists believe habitat quality may be determined based on their presence or absence in specific ecosystems (Cogalniceanu & Miaud, 2003; Harlow, 1997). In this sense, amphibians are viewed as reliable bioindicators of habitat quality.

Local research may be of significance in understanding what is affecting amphibians at a finer scale. Information gained on a more refined scope can then be compiled and integrated with other research efforts to extrapolate to a landscape scale approach—in turn contributing information to the global community at large. Insight into the status of amphibians and other sensitive populations at a local level also aids in understanding which site specific conservation practices have positive and negative impacts on particular habitats.

Species were surveyed and identified at two golf courses (one relatively new and one well established) in conjunction with two nearby control sites. Presence and diversity of amphibians were used to test the hypothesis that golf courses are providing adequate habitat to house and support amphibian populations. Species present at the newly established golf course are of particular interest and should be instrumental in comprehending how this space is functioning as refugia in a successional manner as habitat matures.

Materials and Methods

Sites were surveyed during spring and summer 2004. Survey sites for the project included: Centennial Oaks Golf Course, Waverly Municipal Golf Course, Babcock Woods and Three Rivers Pond. All were located within Waverly city limits, Bremer County, Iowa. Centennial Oaks Golf Course and Waverly Municipal Golf Course served as the experimental sites of the project, while Babcock Woods and Three Rivers Pond served as control sites due to their proximity to the experimental sites, record of continued establishment, and relatively natural state.

Intensive trapping occurred for 10 weeks, during which traps were regularly checked every 24 to 48 hours to prevent mortality. Organisms trapped were counted, identified by species, sexed if possible and released. Water temperature was typically noted. Collapsible funnel-style minnow traps were utilized for opportunistic live-capture at all sites.

Nocturnal auditory surveys and water quality sampling were conducted every three to five weeks during the summer months (June-August). Nocturnal auditory survey protocol from the USGS North American Amphibian Monitoring Project (North American... 2004) was consulted and slightly modified. Surveys were initiated at dusk and typically ran into late evening hours. Sites were visited for a period of at least five minutes to detect any vocalizing anurans. If no species were vocalizing within five minutes, the surveyor advanced to the next survey site. If vocalizations were occurring, the surveyor noted all identifiable species and created a tape recording (approx. 5-15 min. in length) for permanent record purposes. Tape recordings were later analyzed in the laboratory using call comparisons from an auditory CD (Biodiversity of Iowa Aquatic Habitats, 2001) to positively identify and account for any species not noted in the field.

Visual surveys were also used for data collection. This method allowed inclusion of species that managed to evade trapping devices. Water samples were periodically collected and analyzed for pH, levels of nitrates, phosphates, dissolved oxygen, alkalinity and hardness using HACH kits and standard protocols.

Resulting species lists were compared and analyzed to note any significant differences in number or types of amphibian species found at project sites. Shannon diversity indices were calculated and a one way ANOVA was calculated in order to analyze statistically significant differences in number of species at experimental versus control sites.

Number of Species per Site

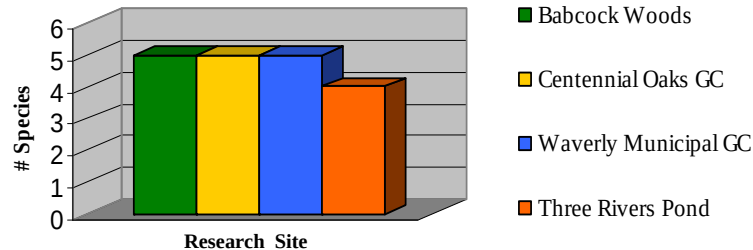


Figure 1—Number of species identified at each of the major research sites. Two adjacent properties (B.Woods and C.Oaks GC) had the same 5 species present as well as Waverly Municipal G.C. Four species were present at Three Rivers Pond, but specific species varied from those utilizing the other survey sites.

Species Observed vs. Expected	
Species Observed During Survey	Expected Species for NE Iowa
Northern Leopard Frog— <i>Rana pipiens</i>	Northern Leopard Frog— <i>Rana pipiens</i>
Green Frog— <i>Rana clamitans</i>	Green Frog— <i>Rana clamitans</i>
Bullfrog— <i>Rana catesbeiana</i>	Bullfrog— <i>Rana catesbeiana</i>
Gray Treefrog— <i>Hyla versicolor</i>	Gray Treefrog— <i>Hyla versicolor</i>
Western Chorus Frog— <i>Pseudacris triseriata</i>	Western Chorus Frog— <i>Pseudacris triseriata</i>
American Toad— <i>Bufo americanus</i>	American Toad— <i>Bufo americanus</i>
	Cricket Frog— <i>Acris crepitans</i>

Table 1—Anuran species identified throughout the survey period in relation to the species expected to inhabit the north east Iowa region.

Research Site	Shannon Diversity Index
Babcock Woods	-1.414
Centennial Oaks G.C. Total	-1.390
Three Rivers Pond	-0.612
Waverly Municipal G.C. Total	-0.290
Entire Survey Area	-1.309

Table 2—Shannon diversity indices calculated for each of the major research areas. An overall Shannon diversity index was calculated for the entire survey area.



Trapping equipment and field materials



Western Chorus Frog—*Pseudacris triseriata*

Results

Results across all survey sites identified a total of six out of seven expected anuran species as defined by north east Iowa range and habitat type (Table 1) (Christiansen & Bailey, 1991). No direct evidence of urodele species (newts and salamanders) was noted. Although, anecdotal information indicates that at tiger salamanders (*Ambystoma tigrinum*) may be present at Waverly Municipal Golf Course. Babcock Woods (control), Centennial Oaks Golf Course (experimental), and Waverly Municipal Golf Course (experimental) were all found to have five species present while Three Rivers Pond (control) had 4 species present (Figure 1).

The same five anuran species were present at Babcock Woods, Centennial Oaks G.C. and Waverly Municipal G.C. (minus green frogs—*Rana clamitans*). The anurans present at Three Rivers Pond differed by three species. One account of a green frog was noted, but American toads (*Bufo americanus*) and Western chorus frogs (*Pseudacris triseriata*) were absent from the Three Rivers site. Bullfrogs (*Rana catesbeiana*) were the only species of tadpoles captured during the survey. Capture rates of bullfrog tadpoles were very high at some trap sites in comparison to others. Overall Shannon diversity index across all sites was -0.892. In order to reduce abundance effect of bullfrog tadpoles, an additional overall diversity index of -1.309 was calculated counting only adult organisms (Table 2). The results of the ANOVA comparing the number of species at the control sites to the number of species at the experimental sites showed no statistical difference between the two groups with $P=0.667$.

Water analyses typically revealed normal ranges of nitrate and phosphate presence (Kalkhoff et al, 2000). Occasional spikes in these readings did occur in samples collected immediately after significant precipitation events, but levels usually dropped back to normal within a few weeks. Hardness, alkalinity, pH, and dissolved oxygen levels remained fairly constant and within acceptable ranges throughout the project's duration (Kalkhoff et al, 2000).

Conclusions

- Site surveys indicate golf courses are providing habitat conditions comparable to control sites and are supporting populations of some amphibian species.
- Management regimes such as no mow zones seem to play a role in maintaining the diversity of organisms occupying the golf courses.
- Shannon diversity indices indicate moderate amphibian diversity at all sites (Table 2).
- Data indicates water quality is not a likely factor in influencing species composition at any of the survey areas.
- Additional amphibian species may be present in the area, but were undetected in this survey.



Northern Leopard Frog—*Rana Pipiens*



Common Bullfrog—*Rana catesbeiana*

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