Amphibian Conservation in Urban Areas

Emma Trewhitt

University of Nebraska-Lincoln

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Abstract:

The topic of amphibian decline has become a primary concern partially due to increased urbanization causing habitat loss and fragmentation (Fahrig, 2003). Focusing on this, a project was outlined with the main goal to enhance the conservation and ensure sustainable biodiversity of native amphibians within a substantially urbanized habitat. Currently, there are several storm water retention ponds, and aesthetic ponds around the parking lot and within the Omaha Henry Doorly Zoo. Utilization of these ponds by amphibian species will be examined through frog call surveys and visual occurrences. From the results of these surveys, we are better able to understand how urban ponds have the potential to addresses storm water management, and amphibian conservation through lessening the effects of habitat loss and fragmentation.

Introduction

The numbers of amphibians world-wide are declining more rapidly than any other group of animals (Garcia-Gonzalez et al., 2012). This is primarily due to disease such as Chytrid and Ranavirus, and increased urbanization which causes habitat loss, habitat fragmentation as well as increases the amount of impervious surfaces, creating more polluted runoff into our waterways (Gallagher et al., 2014).

Chytrid is known to become lethal when it invades the epidermal cells causing hyperkeratosis (thickening of the outermost layer of skin) effecting respiration, and loss of electrolytes. Behaviorally, amphibians being effected by
chytrid tend to be more sluggish, and remain out in the open more compared to those not being effected by the fungus, leading to higher predation rates (Longcore et al., 2007). Ravanvirus causes hemorrhages in the ventral skin, and can cause mortality rates of juvenile amphibians exceeding 90% (USGS, 2013).

In the United States, both these diseases are abundantly present, and ranavirus has cause mass mortality in amphibian populations in 25 states (USGS, 2013). However, the focus of this study is more centralized on the effects of increased urbanization including habitat loss and fragmentation as well as increased runoff from impervious surfaces. These require localized solutions that can be applied by every day citizens with the hope that its will be easier to implement on a large scale basis.

Habitat loss and fragmentation as well as increasing runoff from impervious surfaces, which increases pollution in to critical waterways, are all noted to have a significant effect on species abundance and diversity (Buskirk, 2005; Gallant, et al. 2007). Habitat loss is defined as the overall decrease in available habitat, while habitat fragmentation is defined as the splitting up of habitat into smaller patches (Fahrig, 2003). Fragmentation has a negative effect on breeding of amphibians, as they aren’t as able to migrate between populations (Fahrig, 2003). This limits breeding opportunities which leads to a decrease in genetic diversity, and an overall decrease in species fitness (DeVere et al., 2009). Decreased water quality has the potential to negatively effect populations of amphibians due to their permeable skin that allows the transfer of pollutants more easily into their bodies (Gallagher et al., 2013).
For this study, urban ponds will be categorized into two areas. First, bio-retention (or storm water) ponds, whose primary goal is to catch runoff from impervious surfaces. These surfaces can include toxic substances such as motor oil, pesticides, fertilizers, heavy metals and salts each of which contributes to impaired water quality and has a negative effect on flora and fauna in the area, as well as the water quality downstream (City of Lincoln Watershed Management 2013; Pitt et al., 1995). Increased urban runoff and lower water quality has been linked to lower species diversity, and lower species density. Amphibians have been shown to be especially sensitive to urban development and pollution due to their ability to easily absorb this pollution cutaneously (Cook et al., 2006). Storm water retention ponds do a few things to improve the quality of urban runoff. First, they slow the flow: slowing down the rate at which water is rushed in to our lakes and streams not only reduces the amount of erosion (as sediment is a major source of pollution also) but allows time for many precipitates to filter out, keeping them out of our waterways. Storm water retention ponds also allows for plants to filter out pollutants and increase water infiltration in to the ground (City of Lincoln Watershed Management 2013). Second, are ponds used for aesthetic or other purposes. Even if their main purpose isn’t to address water quality, these ponds can also have many of the same benefits of bio-retention ponds, if constructed correctly. The strategic placement of both these categories of ponds can address habitat loss as well as fragmentation by providing more breeding habitats, as well as corridors to other habitats which is proven to reduce genetic isolation and disease. (Gallant et al., 2007). Because of this, urban ponds and
wetlands have been cited as just as important to amphibian survival as natural areas as the trend of urbanization increases. One study even went as far as to note that 89% of ponds in an urban watershed used for breeding activity by amphibians were storm water ponds or otherwise artificially made (Brand et al., 2010). The implementation of these habitats in to our urban environment has become a critical step in amphibian conservation (Garcia-Gonzalez et al., 2012).

Methods:

An extensive literature review was completed to provide a basis on amphibian recruitment and viability in urban areas. This information along with data collected in the field was used to assess the potential use of urban ponds as amphibian habitat.

When the Omaha Zoo constructed a new parking lot around what was once Rosenblatt Stadium, they had to comply with The City of Omaha has a NPDES (National Pollution Discharge Elimination System) Municipal Storm Water Discharge Permit to address storm water runoff. Part of this permit requires post construction run-off control from impervious surfaces by means of different best management practices, one of which includes bio-retention ponds (City of Omaha, 2013). Figure 1 shows the ponds created that were to be monitored, denoted by yellow pin points. However, after several 4” or greater rains in the Omaha area, it became clear that the ponds would not hold water for more than 24 hours, so these ponds were eliminated from the study.
Three ponds in the Garden of the Senses at the Omaha Henry Doorly Zoo were previously bleached in order to keep them aesthetically pleasing to visitors, but this practice was stopped in 2013 due to the sighting of Bullfrogs in the area. These ponds were monitored weekly under the following parameters to assess their progress in becoming satisfactory urban habitats for amphibians.

Water Quality Monitoring

To provide a basis of information to compare if amphibian recruitment differed between ponds, approximately every week the temperature, pH and salinity levels of each pond were taken using an ExStik© meter. Following August 21, the dissolved oxygen was also taken at each pond weekly. There was trouble getting the ExStik© meter to work correctly work before that date, therefore reliable data was not able to be taken. To get a standardized reading the ExStik© was allowed to stabilize for at least 15 seconds before a reading was taken at each pond and then rinsed with distilled water between each pond and before storage.

Plant and Food Source Assessment

Again as a basis to compare amphibian recruitment, available plant matter to be used for juvenile food sources or shelter was noted.

Species Diversity and Population Recruitment

To assess the species richness of amphibians using these ponds, two passive acoustic readers (Frogloggers) were set within a close proximity to the
ponds, but over 50 feet away from each other to avoid overlap, and set to record the first five minutes of every hour from 6pm-1am from April 14 through Labor day weekend. Four tree frog refugia, which were constructed from 1/2” pvc pipe, sealed at one end with a hold drilled about half way up, then water filled up to the hole, were strategically placed around the ponds and checked weekly for use. Also, all visual occurrences of amphibians were documented. To evaluate population recruitment, when tadpoles were found the species was recorded. A few tadpoles of each species were then captured and kept in the Herpetology Lab on the University of Nebraska-Lincoln campus and cared for until they morphed in to young frogs to note any abnormalities in development (UNL IACUC- #977 P.I. - Ferraro).

Results:

The tree frog refugia resulted in zero occurrences throughout the summer. In early May, a breeding event was recorded in pond 1. Approximately 100 tadpoles were morphed in the lab resulting mostly in cricket frogs. There were two Woodhouse’s toad tadpoles, one of which morphed but died before it was able to be released, and a second that never fully morphed into a froglet. Both fatalities were from unknown causes. Two weeks later, there was a second breeding event in pond 1. The tadpoles were of the same species, so none were taken to the lab for further observation. The frog loggers resulted in 5 positive species identifications:
• Blanchard’s Cricket Frog (*Acris blanchardi*)

• Chorus Frog (*Psudacris maculata*)

• Copes Gray Treefrog (*Hyla chrysoscelis*)

• Woodhouse’s Toad (*Anaxyrus woodhousii*)

• Bullfrog (*Lithobates catebienas*)

The water quality parameters taken can be summarized in figures 2 and 3, and tables 1 and 2. The pH average hovered between 8-8.5 for each pond. Temperatures rose steadily throughout the year but all ponds remained within 4 degrees Celsius of each other. The average salinity for each pond remained within normal freshwater ecosystem levels (Fischer, 1993). Dissolved oxygen averages were within guild lines for freshwater aquatic life (EPA, 1986).

Figure 1
Figure 3

Average pH for Ponds

Temperature Changes

Temperature Degree C

Time

Figure 3
Table 1

<table>
<thead>
<tr>
<th>Pond</th>
<th>Average Salinity (ppt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond 1</td>
<td>0.24</td>
</tr>
<tr>
<td>Pond 2</td>
<td>0.35</td>
</tr>
<tr>
<td>Pond 3</td>
<td>0.32</td>
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<tr>
<td>Pond 4</td>
<td>0.28</td>
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</table>

Table 2

<table>
<thead>
<tr>
<th>Pond</th>
<th>Average Dissolved Oxygen (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond 1</td>
<td>5.90</td>
</tr>
<tr>
<td>Pond 2</td>
<td>6.07</td>
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<tr>
<td>Pond 3</td>
<td>4.97</td>
</tr>
<tr>
<td>Pond 4</td>
<td>6.77</td>
</tr>
</tbody>
</table>

Discussion and considerations:
Not finding any tree frogs in the refugia could merely be a matter of chance, as the site was only checked on every couple of days, and does not lead to the conclusion that they weren’t there, as the frog loggers recorded them plentifully. The frog loggers provided a solid basis of knowledge on the species richness of the area, which is a promising sign for the coming years in using this site for amphibian recruitment. There were only tadpoles found in the first and fourth pond, regardless of the fact that none of the water quality parameters were significantly different (though this isn’t too surprising, as they are from the same water source). The lone bullfrog tadpole found in pond 4 does not seem to be the result of a breeding event as bullfrogs frequently lay clutches upwards of 20,000 eggs, resulting in many more than just one tadpole (Boone et al., 2004). It is probable that it was moved there from another pond possibly by a raccoon, or a small child, as this is a zoo. I would hypothesize there are a few reasons the first pond had successful breeding events while the others did not. The first pond had more shade from the overhanging tree, which also provided more organic matter which when decomposed provides a food source for algae, and then the algae provides a food source and shelter for tadpoles (Ferraro, personal communication).

It would have been beneficial to be able to monitor storm water ponds in the area, however several studies have noted their use (Brand et al., 2010; Gallagher et al., 2014; Garcia-Gonzales et al., 2012). For other urban ponds, there are some precautions to be noted if amphibians habitat is part of the goal. The proximity to fertilizer use, road runoff and other pollutants should be monitored
in an attempt to keep the waters as clean as possible (Gallagher et al., 2014; Pillsbury, 2008). Though some predation by birds or raccoons cannot easily be controlled, keeping ornamental fish in these ponds is not advised as they have the potential to predate upon egg clutches and tadpoles (Hopey, 1994).

Through all the methods used to account for amphibian diversity in the area, 6 species of the possible 10 known to inhabit the area (Fogell, 2010) were accounted for. This provides a solid basis for the zoo to work from in making a case to improve the area to better suit more amphibian recruitment such as providing more shaded areas in the pond and more areas for the shelter of tadpoles. A longer study would be needed to analyze the area for continued recruitment and its ability to support a stable population. It would also be beneficial to be able to monitor more water quality parameters to further investigate the differences between ponds that have recorded breeding activity and those that do not. Also, to measure those parameters more often as some things like dissolved oxygen may fluctuate throughout the day. Overall, this study makes the area look promising in the hopes that it is capable of supporting amphibian populations in the coming years and agrees with literature emphasizing the importance of urban ponds as an amphibian oasis.

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References Cited:


