Fall 12-2011

Prey Selection by the Northern Watersnake, Nerodia sipedon

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Environmental Studies 499H

Senior Thesis

Abstract

Prey selection and composition of the northern waternake, *Nerodia sipedon* was investigated between 8/2010 and 3/2011 by palpation of stomach contents in the field and conducting laboratory trials. 41 snakes were captured, five yielded prey contents. Fish parts, freshwater mussels, and an insect exoskeleton were found. No amphibians were found despite availability at study sites. Snakes in the laboratory underwent 22 trials, feeding on 11 occasions. Snakes fed on an equal number of both fish species, revealing no selection. Further research is needed to determine the rate of digestion of *N. sipedon.*

Introduction

Snakes of the genera *Nerodia* have been widely studied. Investigations regarding diet composition and prey selection are well documented in the literature~~.~~ (Green, 1994; Mushinsky and Vodopich, 1982; King, 1993; King 1986; Kofron, 1978). Data that supports the prey composition and potential selection of the Northern water snake, *Nerodia sipedon,* in Nebraska will be gathered. It is known that in Nebraska, *N. sipedon* feed ~~on mostly~~mostly on fish and amphibians but will also feed on small mammals and nestling birds~~ as well~~ (Fogell, 2010~~.~~). However, no one has ever quantitatively studied what the prey composition of *N. sipedon* is in Nebraska, or if any selection of prey occurs by watersnakes in the state~~s in the state~~.

Most studies in the literature were conducted under field conditions ~~where~~ in which snakes were hand collected and stomach contents were emptied and identified (Jones et al., 2009; Greene et al., 1994; Meyer, 1992; King, 1986, 1993, 1999; Kofron, 1978). Some studies also involved field observations (Drummond, 1983; 1985; Raney and Roeker, 1947; Muschinsky and Hebrard, 1977). ~~There do exist a few studies~~A few studies~~d~~ exist in which~~where~~ experiments were conducted under laboratory conditions (Himes, 2003; Mushinsky, 19~~0~~82).

Comment [KP1]: So what about these studies? Were they better or worse than field studies? Or the same?

In none of these studies ~~found~~were diet contents found in snakes compared to the proportions of each prey available at study~~the experimental study~~ sites. In past studies, all prey selection of ~~*Nerodia* *Nerodia sp.*~~ ~~*sipedon*~~ has been inferred by comparisons of gape size and prey size (King, 2002, 1993, 1986), according to the prey-predator size theory (Shine, 1991). No statements in any of these studies refer to snakes selecting according to prey species or shape; only prey length is mentioned.

This study is composed of a field component and a lab component. The field component involves hand collecting of snakes and emptying them of stomach or fecal contents by palpating each snake caught (Kofron, 1978; Carpenter, 1958). All samples were then preserved in Germ-X and later analyzed in a lab. Each prey item was separated and counted. By comparing these prey items to the known prey availability at the two study sites, this study hopes to find trends reflecting selection by water snakes. This work will also serve as a quantitative record of prey items fed u~~n~~pon in eastern Nebraska.

The second component of ~~the~~ investigation, lab experiments, allow~~s~~ snakes to choose between a wide-bodied carp and a fusiform-shaped trout of comparable length~~s~~. This laboratory component will provide revealing knowledge to fisheries managers as it investigates preference by *N. sipedon* for a game fish compared with an introduced exotic species.

The goal of this study is to further the knowledge of this species in Nebraska so ~~that~~ they may be better conserved, especially if this species were to ever become threatened.

Questions this study hopes to address are: will prey selection vary between snakes in Nebraska and snakes in other states? Will *N. sipedon* from Nebraska be specialist or generalist feeders? Will prey selection vary between two sites with different prey

Comment [KP2]: Is this gape or gap? I just don't know what gape is

Comment [KP3]: Which study? Your study or the study that you site?

Comment [KP4]: Nursing term!!!

Comment [KP5]: Is it Nebraska in general or just eastern Nebraska?

availabilities? This study will hypothesize that *N. sipedon* in Nebraska will be generalist feeders (Lagler and Sayler, 1945; Drummond, 1983) showing no difference in selection between sites according to prey availability. Watersnakes are predicted to show no preference for one fish species in the laboratory trials.

Materials and Methods

This study took place from 08/2010 to 03/2011. Field data was collected during two field seasons. Season one took place from 08/2009 and 10/2009, season two between 04/2010 and 10/2010. All gathering of field data took place at two study sites: Memphis State Recreation Area in Memphis, Nebraska and Schramm Park State Recreation Area near Gretna, Nebraska. Memphis is a 163-acre state recreation area containing a 48-acre lake. The Nebraska Game and Parks Commission restored the site in 2002, when an additional 3,760 feet of shoreline were added. Much of this shoreline contains rock, which provides habitat for the snakes. It was also stocked with largemouth bass, channel catfish, sunfish, and bluegill.

Schramm Park State Recreation Area was once used as the state fishery. Schramm contains 11 ponds that are stocked with a wide variety of state and exotic fish, including bass, catfish, gar, carp, and trout.

At both sites snakes were located using visual searching during daylight hours~~, between~~ (Between 9:00 AM and 7:00 PM). At Schramm, visual searching was conducted on foot by walking around the perimeter of each pond. Snakes were either hand captured or collected with a 5 -foot long mesh net. At both sites snakes were released within 100m of capture site.

Comment [KP6]: Also, down the fish hatchery thing that's not a pond

At Memphis visual searching on foot also took place, though a single or two-man kayak was usually used. Snakes were spotted and then hand collected, often by entering the water and sneaking up on them. Snakes were stored in modified pillowcases and processed immediately at a site on shore.

Each day, water surface temperature was measured (Extech Pocket IR Thermometer measured to the nearest degree, error of 2.5%.) by holding device approximately 50cm from water surface (Mushinsky, 1980). This measurement was taken once upon arrival at site, and again at each site of capture. Ground temperature was taken once upon arriving at site and again at each site of capture. Ground temperature was measured using the same Extech Pocket IR Thermometer. Percent relative humidity and wind speed were measured upon arrival at site using a Kestrel 400. At site of capture Global Positioning System location was taken in Latitude/Longitude using a DeLorme Earthmate PN 20. Snakes that were captured were sexed by probing posterior of cloacal opening with a blunt probe ca 1 mm in diameter (King, 1986) Snout vent length was measured to the nearest mm using a flexible tape-measure. Mass was taken using Pescola spring scales of 100g (snakes <100g) and 1000g (snakes <100g) measured to the nearest gram. Snakes were then palpated to induce vomiting or defecating by sliding the thumb and forefinger gently along ~~digestive tract or~~ intestinal tract (Kofron, 1978; Carpenter, 1958). Samples were bagged in 1 -quart plastic bags and sealed with Germ-X to preserve contents. In other studies, samples were usually preserved in formalin 10% (Greene, 1994), but in this study Germ-X was used because of availability.

Comment [KP7]: These are the same thing. You mean intestines or along the esophagus.

All controlled laboratory experiments took place between 10/2010 and 3/2011. All work was done in the University of Nebraska-Lincoln H~~h~~erpetology L~~l~~aboratory. Snakes

were held in a .75m by 1 m-eter cage. The cage contained a hide rock and a 5-gallon aquatic feeding enclosure with paper substrate. The cage had a light over it during trials in order to see feeding enclosure more clearly. All but one snake wereas removed from cages during each trial (Himes, 2003). Four fish were introduced to the aquatic feeding enclosure in the cage. Water temperature was held between 9.0 and 20 degrees Centigrade (Forseth and Jonsson, 1994). This was the required temperature range to keep trout alive. In eEach trial, two trout and two goldfish were introduced to the water container. Snakes were left alone and then visually checked every half-hour to minimize disturbance. It was recorded which species of fish were eaten, and in what order. Snakes were allowed 24 hours to digest before being reintroduced for another trial.

Comment [KP8]: Every half hour for how many hours?

Three of the five snakes underwent 5 trials. The fourth snake underwent 7 trials. The fifth snake died early in the study and only participated in three trials.

Note: The original protocol for the field experiments involved using a 6' X 2' X 3' enclosure half filled with water. Snakes were too stressed out by presence of an observer and so they did not feed. This is why protocol changed to use the cage with the feeding enclosure.

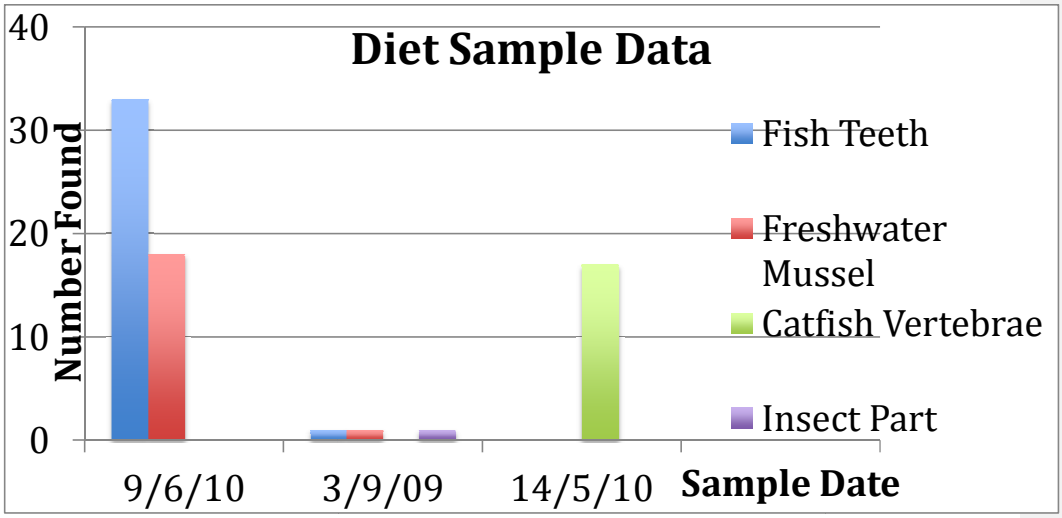
Results

Field Study

Forty-one snakes were captured in this study. During season one, 13 snakes were captured., Sseven snakes were caught from Schramm and six snakes from Memphis. During season two, 28 snakes were captured, with 15 from Schramm and 13 snakes from Memphis. Stomach samples were collected from five snakes: all during season two. Three fecal samples were collected during season one, but they were not analyzed due to

improper storage. One snake was observed feeding on a whole small channel catfish during season one. Usable data was only obtained from three of the five samples. Analysis revealed that these samples contained: 34 fish teeth, 19 freshwater mussels, 19 catfish vertebrae, and one insect exoskeleton.

Table 1: animal parts removed from digestive tract samples.



Lab Experiment

Twenty-two trials were conducted, accounting for 44 trial hours. Only four out of five snakes underwent trials in the feeding enclosure. These four snakes fed on 11 occasions. Seven~~7~~ trout were eaten and seven~~7~~ carp were eaten. Table two shows the number of trials each snake underwent, the amount of times they fed, and what species of fish they preyed upon each occasion. During different trials, snakes fed on just one carp, one trout, one trout and one carp, or two carp. Snakes are identified by the last two digits of their PIT Tag number. Table three shows the total amount of each species fed upon.

Comment [KP9]: CONFUSING!

Table 2: Results of laboratory trials.

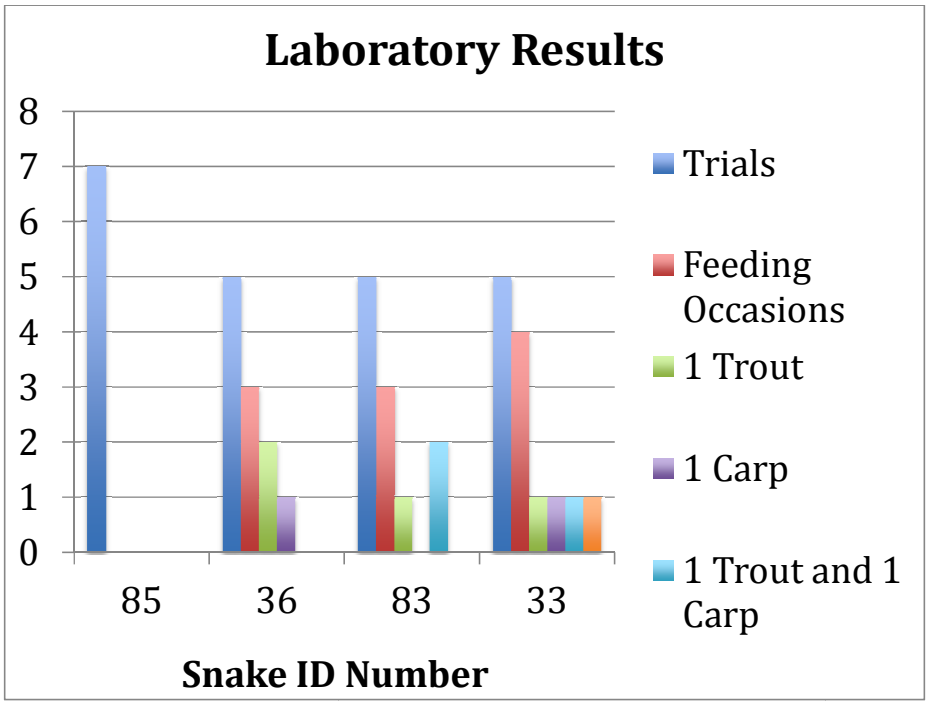
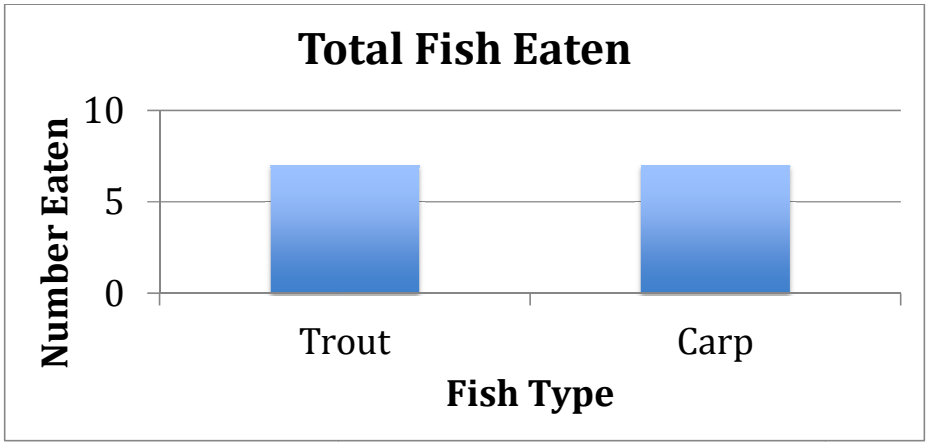


Table 3: Total fish fed upon in trials.



Discussion

Results reflect what is known of *N. sipedon in* other localities; they are generalist opportunistic feeders (Drummond, 1985; Greene, 1994). Field data suggests that fish are the main prey item, despite the availability of amphibians. Intensive sampling during the fall and spring months when snakes are most active might produce more diet samples. In many published studies, sample sizes are upwards of 1000 snakes (King 1986; Bauman and Metter, 1975). ~~I~~ O~~o~~nly ~~captured~~ 41 snakes were captured in this study. A larger sample size would allow the comparison of snake prey samples and availability percentages of fish species at each site. Because only one sample included whole prey, no comparisons of stomach contents and prey availability could be made. At a separate site the summer after the~~my~~ study ended, ~~I papated a young adult watersnak~~a young adult water snake was palpated~~e~~, revealing an adult bullfrog that came out in two pieces. With the fish parts found were also very small freshwater mussels, an insect exoskeleton, and mostly plant matter. It

is likely that these other items were inside of the fish preyed on by the snakes, or when foraging the snakes ingested these other items.

Comment [KP10]: Doesn't make sense. Also don't use "my" or "I"

One interesting trend noted in this study is~~was~~ the activity~~ies~~ level of snakes during different seasons. During fall months, more females were collected while in the spring significantly more males were collected. In the summer no differences between genders were noted. This difference in activity is likely related to reproductive life history of this species, although more work would be needed to make any conclusions. Size differences between the two populations were also significant. The snakes at Memphis were on average longer and weighed more than at Schramm. Rate of snake capture varied with time of day; more snakes were captured between the hours of 9:00 AM and 11:00 AM. This could be related to thermal ecology. Earlier in the day snakes are slower and easier to capture than at the heat of the day. An equal number of snakes were captured during different months of the year.

Comment [KP11]: How much longer and how much heavier

The lab component of the study also confirmed that waternsnakes are generalist feeders. The original methods of the study included capturing tens snakes and running ten trials on each snake. Due to difficulty in capturing snakes at the end of the second fall, ~~I was only able to run~~ trials were only be run on five snakes, one of which died very early, ~~.~~ a~~A~~nother died later in the trials. Although the~~my~~ results reflected generalist tendencies, conducting the same trials using native fish species such as bass and bluegill might provide different results. Bluegill might have a high enough arch compared to the bass to pressure selection. It is possible that goldfish and trout are not morphologically different enough.

Data was obtained in the lab that watersnakes digest prey very quickly (Gibbons and Dorcus, 2004; personal observation). ~~This was likely~~It is likely this is why this study

was unsuccessful in capturing many snakes still digesting prey items. Prey is fully digested in less than a day (Jones et al., 2009). The window of time to encounter intact prey is probably only a few hours (personal observation). Developing a technique to study the rates of digestion in snakes, and even in ectotherms in general could prove to be very helpful to the scientific community.

Data could also be gathered regarding at what external temperature *Nerodia sp.* usually feed. This data could vary by species and locality, but any data in this regard could aid future researchers trying to gather data on *Nerodia sp.* diets.

As an integral part of the aquatic ecosystem, understanding the feeding ecology of watersnakes benefits species on every level. Watersnakes are part of the trophic webs of both their varied prey and their predators, so their trophic influence is significant. This is why understanding the ecology of the Northern watersnake is important, the scientific implications are widespread.

Acknowledgements

I would like to thank the Nebraska Game and Parks commission for allowing me to conduct research on their land. I would like to thank the UCARE program at UNL for funding my research. Most of all I would like to thank Dennis Ferraro for his ideas and his technical support.

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