Food Habits of a Re-Introduced River Otter (*Lontra canadensis*) Population in Western New York- Annual Diet, Temporal and Spatial Variation in Diet and Prey Selection Conclusions

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<u>Chapter 1</u>- Food Habits of a Re-Introduced River Otter (*Lontra canadensis*) Population in Western New York- Annual Diet and Temporal Variation in Diet

Melissa Skyer

ABSTRACT:

River otters were re-introduced to Western New York by the Department of Environmental Conservation between 1995 and 2000. The success of this population relies heavily on the availability of suitable prey. Diet was investigated via frequency of prey occurrence in scats from 2004-2006. Overall diet was comprised mostly of fish and crayfish. The major fish taxa were Centrarchidae (sunfish), Cyprinidae (carp), and Salmonidae (trout); less common were Esocidae (pike) and Castostomidae (sucker). All fish species combined occurred at 100% frequency during the winter and spring months, but declined during the summer and fall. Sunfish prey were at their highest frequency in the winter and spring months (50-60%), and tapered off to 10-20% in the summer and fall. Carp in the diet showed a seasonal trend, highest in the spring at 30%, 10-20% during the summer and winter, and <10% in the fall. Trout occurred in the diet mostly in the spring (<20%) and was low in frequency for the rest of the year. Crayfish consumption displayed an inverse seasonal relationship to fish, and was highest in the summer (80%) and fall (60%) but was rare in winter and spring. Minor prey items (less than 5% of the diet) were insects, mice, a bird, and a freshwater mussel. Vegetation occurred in scats with other prey types at a frequency of 28.8%. Vegetation in the diet dominated in the fall at 60% and the spring at 20%, with no occurrences in the winter and summer months. The food habits of this re-introduced population closely resemble those

of other studies on both *Lontra canadensis* and *Lutra lutra*, suggesting that prey resources are adequate in type and abundance to support river otter dietary needs in Western New York.

INTRODUCTION:

River otters (*Lontra canadensis*) are carnivorous mammals that rely primarily on aquatic prey (Carss, 1995). They forage in linear riparian home ranges between 15-35 kilometers (Kruuk, 1994); thus typical prey items include fish, amphibians, crustaceans, mammals and insects. Diet varies by habitat, along with seasonal changes in prey availability and abundance (Larsen, 1984). Different otter populations rely on different proportions of prey types, depending on geographic location, availability of prey, season, and preference (Morejohn, 1969; Larsen, 1984; Stenson and Badgero, 1984).

River otters in North America were greatly depleted due to unregulated trapping, water pollution, and the anthropogenic disturbance of wetland habitat (www.dec.state.ny.us). By the mid 1900s many otter populations in North America had declined significantly or become extirpated (Serfass, 2000). Research on river otters was initiated to enhance understanding of the biology of these "key wetland species" (Mason and MacDonald, 1986), with conservation being the ultimate goal. Approximately 270 river otters were re-introduced in Western New York between 1995 and 2000, from wild populations caught in the Adirondacks, to facilitate the natural re-colonization of the area (www.dec.state.ny.us). The New York River Otter Project released 31 individuals in Black Creek in 1998 and 7 individuals in nearby Honeoye Lake in 2000.

Studies of otter diet have utilized scat (or fecal) analysis as a non-invasive means of determining prey consumption (Larsen, 1984; Kruuk and Conroy, 1987; Cottrell, 2002). Most prey species contain hard parts such as scales or exoskeletons that are indigestible and pass out of the system. Diet from prey remains in scat can be quantified using two main approaches: frequency of occurrence and bulk (volume) methods (Jenkins, 1979; Kruuk, 1994; Carss, 1995). The frequency analysis method determines the proportion of total samples collected that contain a particular prey type, while bulk analysis determines the number of occurrences of a particular item as a percent of all identifiable items recorded per scat sample. Some experts in the field (Jenkins, 1979; Jenkins and Walker, 1979; Kruuk, 1994) have cautioned that using scat analysis is not a good representation of the otter diet, as the complete diet is inaccurately estimated by only analyzing the remains of hard parts in the samples. However, studies on captive otters fed diets of known composition, and subsequent scat analysis by Erlinge (1968), determined that frequency analysis of scats was the better measure of the diet, and provided a more accurate estimation than the bulk methods.

Otters are bioindicators of ecosystem health (Kruuk, 1994). The goal of my study was to partially assess the success of re-introduced river otters in Western New York by determining the composition of, and describing seasonal shifts in, their diet. Mortality, body condition and reproductive success are closely related to seasonal environmental changes, especially in food sources (Kruuk and Conroy, 1987). Furthermore, food availability and quality appear to be important limiting factors on otter population size (Kruuk and Conroy, 1987; Kruuk, 1994); thus having direct implications for the re-colonization success of the re-introduced otters.

METHODS:

Study sites:

Field research was conducted between October 2004 and January 2006. The three creeks in the study area include sites where otters were released by the New York River Otter Project: Black Creek, Oatka Creek and Honeoye Creek are tributaries in the lower Genesee River watershed, a drainage basin that extends from Northern Pennsylvania to Lake Ontario in Monroe County, New York. (Figure 1) The landscape around the study steams is mainly deciduous forest, containing red and sugar maple, red and white pine, black cherry and non-endemic California privet (*Ligustrum ovalifolium*) underbrush. Terrestrial wildlife includes beaver, white tailed deer, mink, raccoon and fox. The depth of the tributaries ranges from 0.3 to 1.83 meters, with creek beds of limestone and shale. The temperature of the area averages from -8.9°C in the winter to 26.7°C in the summer, so the creeks freeze over at least partially each winter.

Sample collection and analysis:

Otter latrine sites were located by surveying each creek by canoe or hiking the banks: each creek was visited at least twice a month during the study period. Altogether 13 km was covered on Black Creek, 10 km on Oatka Creek, and 7 km on Honeoye Creek. Each individual scouting trip averaged 0.5-1 km when on foot, and 1-2 km by canoe. Only half of each scat sample was collected, as they often serve as territory markings in this species (Kruuk, 1994). GPS coordinates were recorded for all locations and scat samples were stored in sealed plastic bags in a freezer at 0 degrees F. Thawed samples were washed with water through a series of 30-cm diameter sieves with mesh sizes from

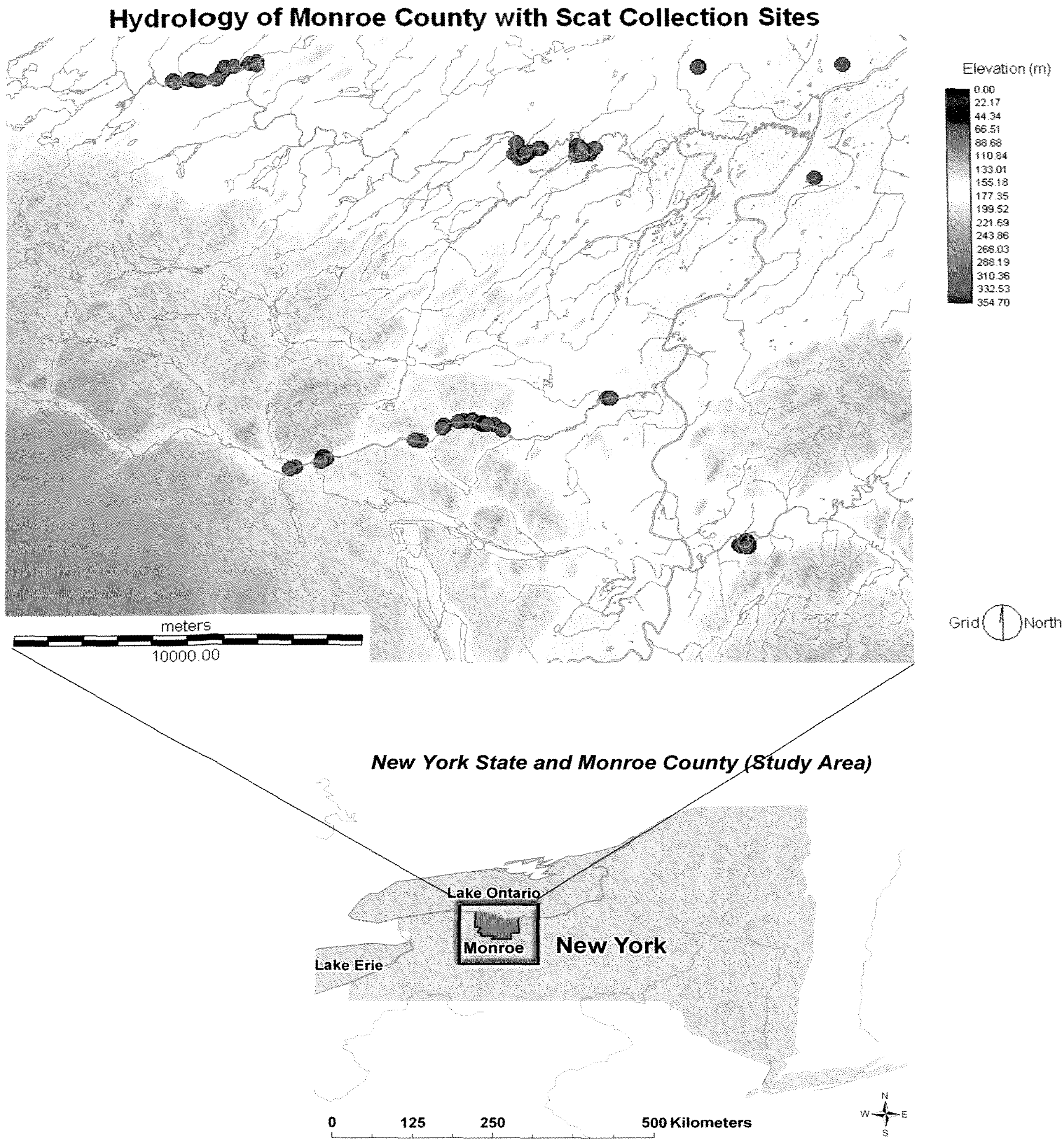

Figure 1. New York State and Monroe County (Latitude 43" N, Longitude -77" W; generated in ArcView) and Hydrology of Monroe County (elevation scale) and Sample Location sites (red circles) on Black, Oatka, and Honeoye Creeks (generated in IDRISI Kilimanjaro).

2 mm to 0.01 mm. Components caught by the sieves were air dried, examined with a dissecting microscope (25X), and separated by visually distinct characteristics.

Crayfish exoskeletons were easy to identify in scats; when a cheliped (claw) was present it was measured from the base joint to the tip with a ruler (in cm). Crayfish body lengths were estimated from a regression (Figure 2) relating whole crayfish body length to cheliped size (from specimens collected at study sites).

Fish scales were washed a second time with dish soap and hot water until they were thoroughly cleaned (transparent) and then mounted between two microscope slides. Scales were viewed under an inverted microscope at 50X magnification (Bausch and Lomb) and identified with a dichotomous key reference collection (Daniels, 1996), or by comparison with known scale samples collected by electrofishing. Visually distinct scale characteristics such as general shape, radii and ctenii structures sufficed to identify most scales to the species level. We were unable to identify the centrarchid (sunfish) family scales to the species level by either naked eye measurements or microscopic observation, due to similarity in shape, size and scale characteristics. Other prey types were identified by appropriate taxonomic experts.

To determine the ages of fish consumed by otters, annual growth rings on the scales were counted outward from the focus of the scale, with the focus as zero and each ring as one year (Jearld, 1983). Some scales displayed a fuzzy appearance and did not contain a focus; these replacement scales (grown after an injury to original scales) were unable to be accurately aged. If a scat sample contained scales of the same species, but the ages were more than 2 years apart, it was counted as more than one fish consumed.

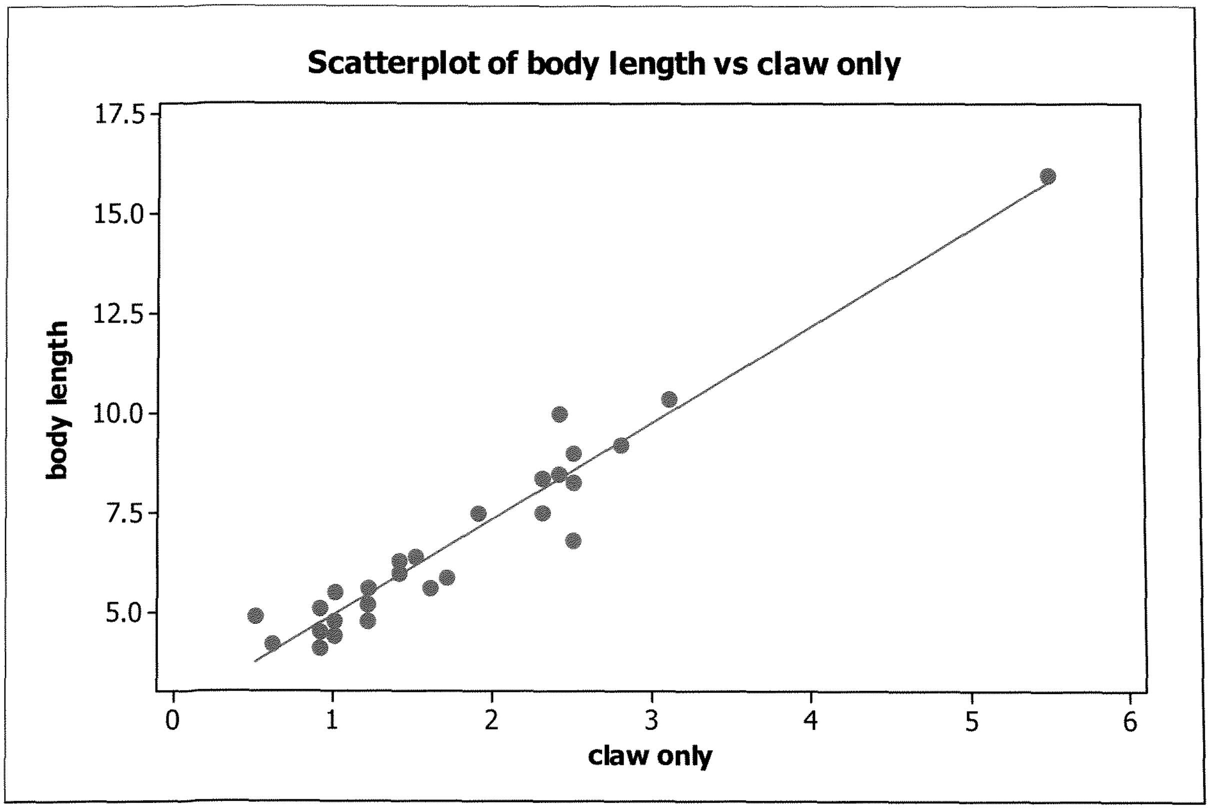

Figure 2. Crayfish regression relating total body length in cm. to cheliped length in cm, created in MINITAB. y= 2.53 + 2.42x (y=total body length; x=cheliped length) r=0.935.

Diet was evaluated using frequency of occurrence; in which prey items were recorded according to the number of scats in which they occurred. All scats containing a particular prey item were then expressed as a percentage of the total number of scats. The volume or weight of remains in individual scats was not used as a measure of prey importance because of differences in the density and size of the various diagnostic items (Erlinge, 1968; Stenson and Badgero, 1984). Scat samples containing only vegetation were excluded from the analysis, and presumed to be raccoon, based on genetic analysis of several typical pure vegetation samples which were identified as raccoon rather than river otter (B. McElwee, personal communication). Two other samples containing crayfish were also excluded based on DNA analysis, and others used in this study are in the process of being confirmed as river otter scats. Samples with vegetation that were mixed with fish or crayfish were included as they were considered to be more typical of the otter carnivorous diet.

Thirty two samples were obtained and analyzed from Black Creek, 25 from Oatka Creek, and 14 from Honeoye Creek. Seasonally, I analyzed 11 scats from winter, 20 from spring, 20 from summer, and 20 from fall. Data from the two year study period were pooled. There was limited scouting activity in winter because it was harder to access the riparian zones and to locate scats under the snow. Trites and Joy (2005) found that between 59 and 94 scat samples were sufficient to distinguish changes in diet between seasons or areas; thus the 71 suitable scats collected were deemed sufficient for my analysis.

Seasons were classified as fall (Sept.-Nov.), winter (Dec.-Feb.), spring (Mar.-May) and summer (Jun.-Aug.). Overall prey consumption frequency and seasonal fluctuations were examined using Chi square goodness of fit. Statistical significance was set at $p<0.05$ (www.fourmilab.com).

RESULTS:

Fish were present in 50 of the 71 total scat samples (70.4% frequency), followed by crayfish (53.5%). Centrarchid (sunfish) species occurred in 35.2% of the samples collected. Sunfish could not be distinguished to the species level by analysis of scale morphology, but species found in the streams by electrofishing included pumpkinseed (*Lepomis gibbosus*), bluegill (*L. macrochirus*), rock bass (*Ambloplites rupestris*), smallmouth bass (*Micropterus dolomieu*), and largemouth bass (*Micropterus salmoides*). Other major prey categories were vegetation (corn or privet berry remains), common carp (*Cyprinus carpio*) and brown trout (*Salmo trutta*). Minor prey species that accounted for less than 5% of the otter diet were northern pike (*Esox lucius*), mice, a freshwater mussel, unidentified avian feathers and grasshopper appendages (Table 1).

Otters did not prey on identified prey types equally (71 scats/12 prey types, $X^2=289.92$, df=11, $p<0.001$). When probabilities were re-calculated (71/5) for the top five prey groups (approximately 10% frequency and above), the results were also statistically significant ($X^2= 53.97$, df=4, $p<0.001$).

Table 1. Prey item, classification, number (n), and frequency of hard-part remains identified in river otter scat collected in Western NY from October 2004-January 2006. (Total scats n=71).

Food item	Classification to lowest taxa	(n)	% Frequency
Fish (all species)	Teleostei	50	70.4
Crayfish	Cambaridae	38	53.5
Sunfish	Centrarchidae	25	35.2
Plant Matter (Corn, Berries, Bark)	Plantae	18	25.3
Carp	Cyprinidae	13	18.3
Brown Trout	Salmonidae	6	8.5
Unidentified Fish	Teleostei	3	4.2
Northern Pike	Esocidae	2	2.8
Grasshopper	Insecta	2	2.8
Mouse Bones	Musculus	2	2.8
Bird Feathers	Aves	1	1.4
White Sucker	Castostomidae	1	1.4
Freshwater Mussel	Bivalvia	1	1.4

The average number of prey taxa in a scat samples was 1.7 ± 0.71 (n=71), with scats containing up to three different food types in varying combinations (Figure 3). It was common for samples containing fish scales to be comprised of more than one fish and fish of more than one species. Differences in total taxa counts per season were not statistically significant (X^2=0.666, df=3, p=0.88), with eight in the fall, six in the winter, seven in the spring and nine in the summer.

Important prey types were examined graphically (Figure 4) and statistically for seasonal variation in consumption. Crayfish occurrence showed a significant seasonal trend, being highest in the summer (nearly 80%) and fall months (60%), but decreasing to <40% in the winter and 20% in the spring (X^2=14.5, df=3, p=0.001). Sunfish also showed significant seasonal shifts, peaking between 50 and 60% during the winter and spring, and then dropping off to 10-30% in the summer and fall (X^2=11.96, df=3, p=0.0075). Seasonal fluctuations of carp in the diet were significant, with visual analysis trends showing a peak in occurrence during the spring (30% occurrence), decreasing in both summer and winter, with fall at approximately 5% (X^2=6.39, df=3, p=0.0075). Trout frequency was similar to that of carp, peaking in the spring, but even then consisting of less than 20% of the total river otter diet. The lowest frequency values for trout were observed in the summer and fall (X^2=5.99, df=3, p=0.1120). The frequency of vegetation was significantly higher in the spring (60%) and fall (20%) than in the summer and winter when there was little or no vegetation in the diet (X^2=33.55, df=3, p<0.001).

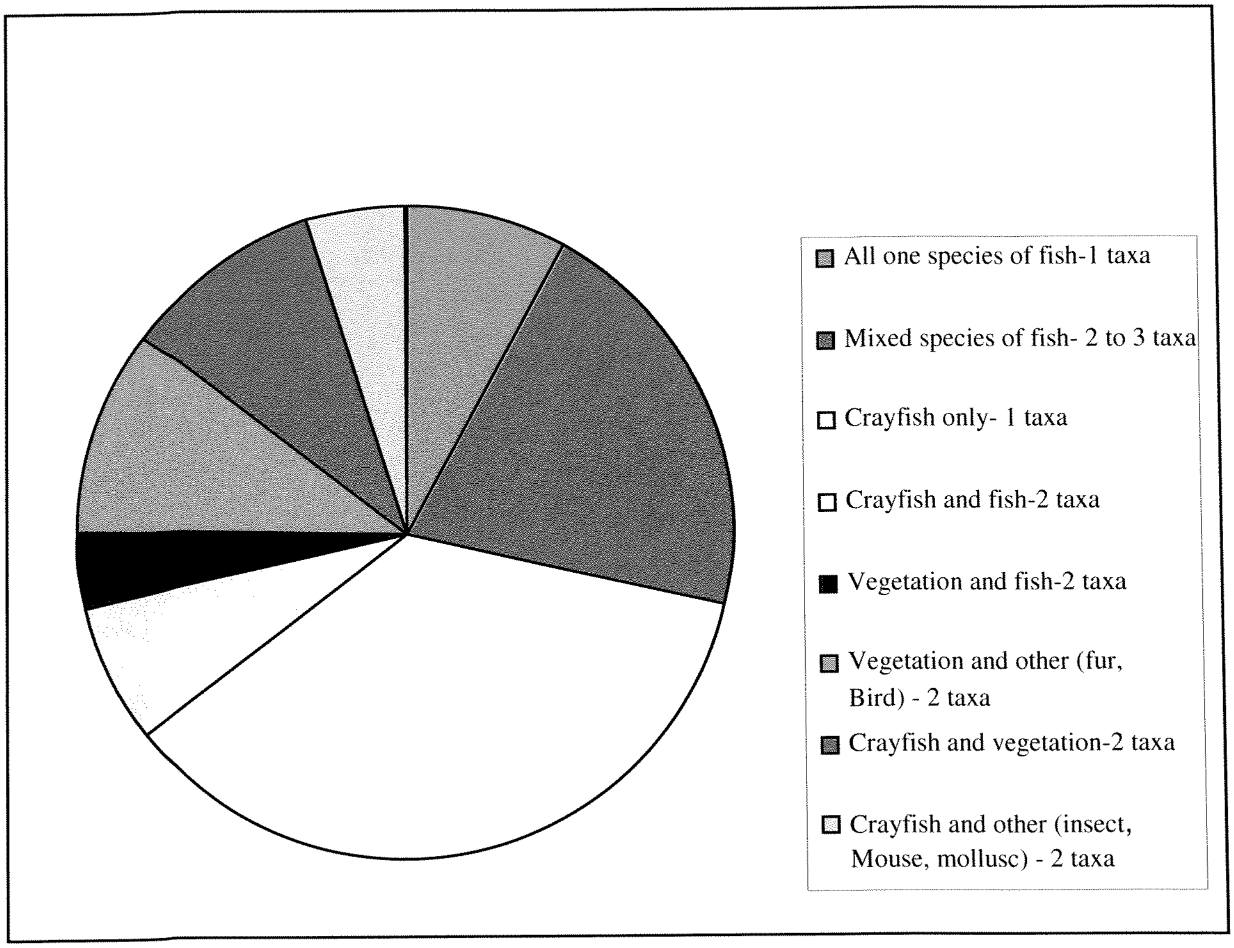

Figure 3. Composition of scats by prey combinations.

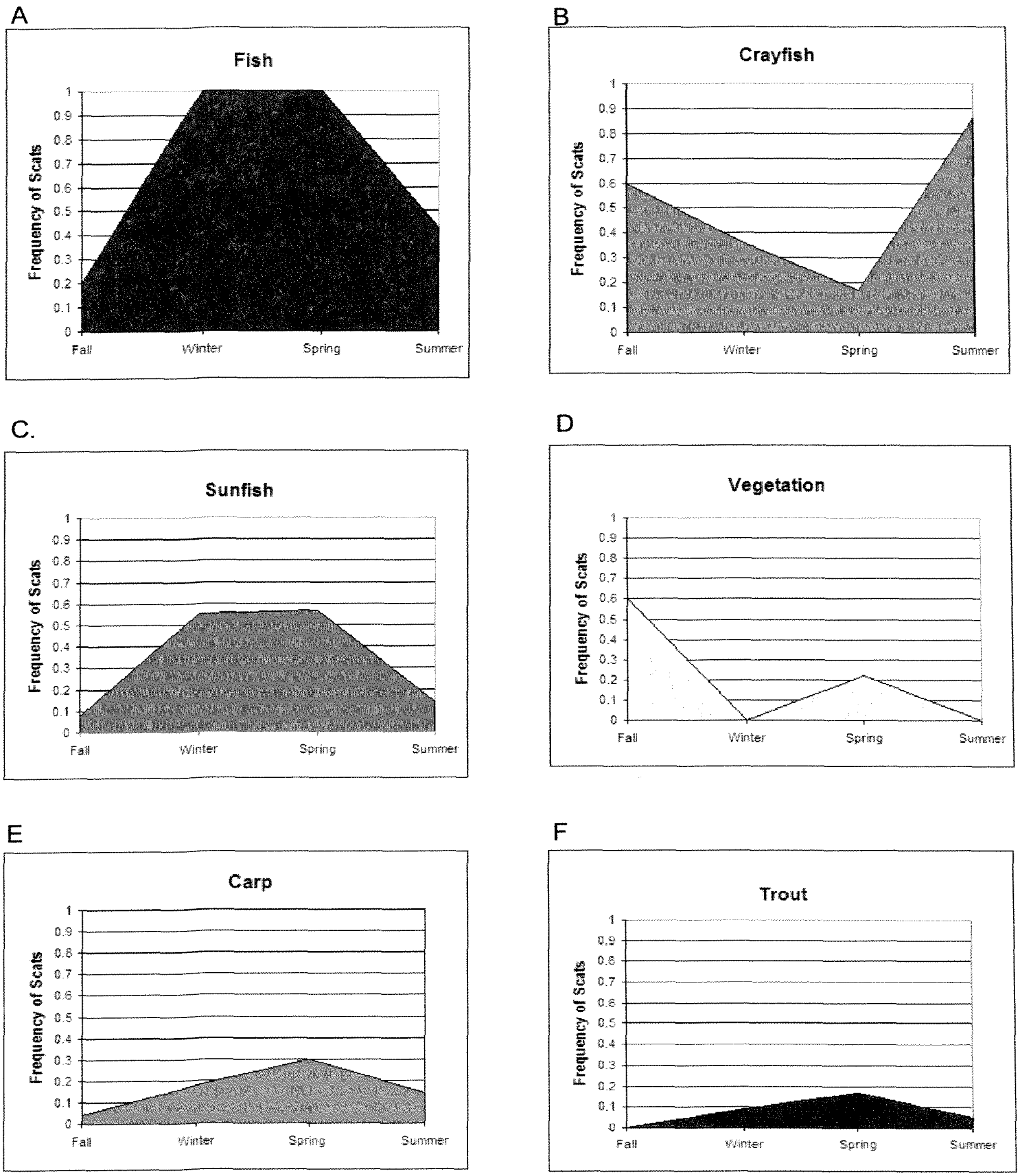

Figure 4. Temporal variation in main prey types. Frequency of occurrence of prey in scats collected in each season.
A) all fish species combined, B) crayfish, C) Sunfish, D) vegetation, E) Carp, F) Trout

Based on annuli counts of scale samples, the majority of fish ingested were adults. (Carlander, 1969 and 1977) The average ages of sunfish (centrarchids), carp and brown trout ingested were 6 ±1.6 years (n=31), (6.4±1.78, n=10) and (4.6±1.5, n=3) years, respectively. The average size of recovered crayfish claws was 2.15 cm, which corresponded to an average sized crayfish of 7.73 cm based on the regression equation.

DISCUSSION:

Major prey in the diet:

Fish were the predominant prey found in otter scats, occurring in 70.4% of the samples. The piscivorous nature of river otters has been well documented in other studies on Northeastern populations (Hamilton, 1961, Knudsen and Hale, 1968). River otters appear to utilize fish as their main food source regardless of geographical location, (Carss, 1995) including populations in Montana (Greer, 1955), Idaho (Melquist and Hornocker, 1983) and Arizona (Taylor and Rettig, 2003). The diet of river otters that forage in marine habitats (both *Lontra canadensis* and *Lutra lutra*) also is composed primarily of fish, as demonstrated by populations in Scotland (Jenkins and Walker, 1978), Alaska (Larsen, 1984), British Columbia (Stenson and Badjero, 1984) and Portugal (Beja, 1991).

The centrarchid (sunfish) family comprised half of the fish identified in the diet (35.2% of 70.4%). Similarly, Tumilson and Karnes (1987) found centrarchids to be the most common taxon consumed (63% frequency annually). Other studies also show that sunfish are an important family on which otters feed (Hamilton, 1961; Knudsen and Hale 1968), especially during the winter (Sheldon and Toll, 1964; Lauhachinda and Hill, 1977). Sunfish appear to be preferred prey because they occupy shallow and muddy or weedy waters that provide a predatory advantage to otters (Tumilson and Karnes, 1987). The otters studied by Knudsen and Hale (1968) in the Great Lakes region consumed a significantly higher quantity of sunfish compared to other families such as cyprinids and salmonids. However, Hamilton's (1961) study in the Adirondack region of New York found that cyprinids, such as carp and other minnows were taken three more often as centrarchids.

In this study carp were second to centrarchids in frequency (17.8% compared to 35.2%). The salmonid (trout) family occurred in only 8.5% of scats; however, this prey group may have been underestimated as the scale remains are very small and hard to recover. Minor fish species consumed were northern pike (Esocidae) and white sucker (Castostomidae). Melquist and Hornocker (1983) listed Cottidae (sculpins), Castostomidae (suckers), and Cyprinidae (carp and minnows) as the top three families of fish both available to and consumed by an Idaho population of otters. These families, along with salmonids, are common fishes in rivers of the Western United States, where centrarchids are not present (J. Haynes, personal communication).

<u>Seasonal variation in major prey:</u>

Fish were present in 100% of winter and spring scats, but in only 20% of fall and 43% of summer samples. Crayfish ranked second to fish in the overall diet (53.5% of scats). The occurrence of crayfish in the diet peaked in the summer and fall, was low in the winter and spring, and displayed an inverse relationship to that of fish, as observed in other studies (Lagler and Ostenson, 1942; Hamilton, 1961; Knudsen and Hale, 1968; Tumilson and Karnes, 1987; Taylor and Rettig, 2003).

In my study, crayfish were favored over fish in otter diets during the summer and fall, but because they burrow into stream bed during the winter and spring they are probably very difficult for otters to access. However, when crayfish are available they may be easier for otters to capture than more motile fish. Although crayfish are a large component of the otter diet, because their occurrence varies significantly among seasons they are considered to be of secondary importance to fish prey (Carss, 1995).

The high occurrence of sunfish in the winter diet may be explained by slower swimming in colder waters, typical of ectotherms whose metabolism and activity levels are depressed by low temperatures. A common characteristic of the sunfish family is a spring spawning season, with male nest guarding (www.dec.ny.state.us). This behavior may make sunfish more vulnerable to predation in the spring, as otters follow the creek bed while foraging in shallow waters (Erlinge, 1968). Sunfish are small to medium sized catches, and may be preferred for both ease of capture and handling.

Carp consumption was highest in the spring and lowest in the fall. Cyprinid frequency was consistent year round in Melquist and Hornocker (1983), but the species that appeared in their study were native minnows, not carp. Carp in New York aggregate and spawn in the spring and summer months, usually in very shallow waters (www.dec.ny.state.us). During spawning carp behavior includes much splashing at the surface, and their bodies may be entirely exposed in air (www.dec.ny.state.us). This behavior may call attention to groups of carp; resulting in search-free and substantially sized meals for otters.

Trout consumption, like carp, was highest during the spring months of this study. Melquist and Hornocker (1983) found salmonids to occur more frequently in otter scats during the fall and winter months, but Hamilton (1961) found trout to be the least common fish species ingested during the winter. It is possible that trout scales were overlooked or washed away when my samples were processed, and that the seasonal differences in this taxon were inaccurately calculated. Seasonal fluxes in trout were not statistically significant, possibly because of the low sample size of scats that contained this prey type. More likely, differences in climate affect trout life cycles in New York and Idaho, with trout as the dominant taxon in Idaho streams year-round. The increase in trout consumption during the spring in my study streams was most likely a result of stocking with hatchery reared fish by the NYS DEC in May.

Minor prey/food types in the diet:

Plant matter recovered from scats was either corn or privet berry remains. Vegetation mixed with other prey types in a scat was observed in 25.3% of scat samples. Vegetation in the diet was highest in the fall and spring, when preferred aquatic prey was lowest in abundance. In the winter vegetation was not present on the creek banks, or was covered by snow. Knudsen and Hale (1968) found vegetation frequency of occurrence to range from 15-50% of the overall diet, but did not distinguish between seasons. They speculated that vegetation was ingested incidentally when other food types were consumed. Taylor and Rettig (2003) reported 45.3% frequency of occurrence of vegetation in Arizona, although in volume it represented very little of the scats. The scats in this study contained small to moderate amounts of vegetation. This may mean that smaller volumes of vegetation were not purposely ingested by otters, or that scats with larger quantities of plant material were raccoon. Interestingly, Hamilton's study of New

York otters (1961) and Carss' (1995) review of diet across many populations did not mention vegetation in the diet at all. Plant material in marine foraging populations appears to be much reduced; Larsen's (1984) Alaska study reports less than 1% frequency of occurrence and Beja's (1991) Portugal study did not find any vegetation in the diet. This difference may be accounted for by the manner in which marine and freshwater otters consume their prey; generally marine otters eat at the sea surface while freshwater otters often take their catch to the bank before consuming it (Conroy and Jenkins, 1986; Kruuk and Conroy, 1987). It is unlikely that vegetation is purposely ingested for food, which is expected for carnivores.

Minor prey types in otter scats included insects (grasshopper legs), field mice, feathers of one unidentified bird and one freshwater mussel. Insects occurred in 2.8% of scats in our study; this contrasts with Hamilton (1961), who found "astonishingly large numbers of aquatic insects eaten by otters examined, especially during winter months". In Arizona, Taylor and Rettig (2003) found that insects occurred at a frequency of 22.6%, also much higher than the present study. Mouse remains were found in only two of 71 scats, and were identified by bones and the presence of fur. Samples containing only fur were not counted as part of the diet, as otter grooming regularly results in fur material in the digestive tract (Greer, 1955 and Carss, 1995). Mammal remains accounted for less than 8% frequency of occurrence in Melquist and Hornocker (1983), less than 5% in Hamilton (1961) and Knudsen and Hale (1968), and less than 1% in Beja (1991) and Larsen (1984). In both marine and freshwater habitats mammals are not a significant part of the diet, as otter anatomy is designed specifically for catching prey in aquatic media (Kruuk, 1994). In freshwater habitats Hamilton (1961), Knudsen and Hale (1968), and

Carss (1995) found bird remains to occur at a frequency of 0-2%. The marine diets as investigated by Larsen (1984) and Beja (1991) were similarly devoid of birds, at less than 1% frequency of occurrence. Melquist and Hornocker's (1983) study in Idaho identified birds in 20% of scats, all of which were waterfowl that were presumed to be injured, young, sick or dead prior to capture. The occurrence of birds as prey in both marine and freshwater habitats is probably very low because they would be extremely difficult for otters to capture. Freshwater mussels were noted by Hamilton (1961), Knudsen and Hale (1968), Carss (1995) and Taylor and Rettig (2003) to be minor prey (less than 1% frequency of occurrence) in the diet of river otters. Morejohn (1969) found otters in a California creek to consume large numbers of freshwater mussels; however, frequency of occurrence was not reported, nor was data on other prey in the diet.

<u>Otters and humans:</u>

In the past, as well as today, controversy surrounding the river otter's food habits exists among sport fishermen. The misconception that otters deplete game fish has been widespread across the United States since the 1940s (Lagler and Ostenson, 1942). From the diet constructed in this study and others by scat analysis, there appears to be little overlap between fish of interest to otters and those of sport fishermen.

Otters' main prey are smaller sunfishes, crayfish and undesirable carp. Since sunfish could not be discriminated by species, it is possible that young largemouth and smallmouth bass are consumed by otters; if such consumption were substantial, it could reduce the availability of larger bass to sportsmen, but this idea is untested. On the other hand, the sunfish consumed may have been pumpkinseed and bluegill, of lesser interest to fishermen. Otters may even be beneficial to recreational fishing, as they consume smaller fish that may compete with larger game fish (Lagler and Ostenson 1942; Knudsen and Hale, 1968). Brown trout and northern pike favored for sport fishing were not substantial components of the diet.

Diet and otter conservation:

The River Otter Action Plan suggested by Serfass (2000) stresses the need for research on the diet of re-introduced populations, because conserving these top carnivores has direct implications for protecting other aquatic resources. Dietary data, along with other information about re-introduction success, can help establish comprehensive management plans for this species because understanding temporal relationships between predators and prey is critical for recognizing factors that might limit the success of re-introductions. With reproduction success, individual body condition and viability so closely linked to food availability, the importance of understanding and quantifying diet is clear (Kruuk and Conroy, 1987). Shortages of suitable prey result in stress to otters, increased mortality and depressed production of offspring (Kruuk, 1994). Re-introduction projects would do well to investigate the abundance and species composition of prey in potential release locations in order evaluate the suitability of the aquatic habitat. Since the diet investigated in this study is similar to other locations, it appears that the re-introduced population in Western New York has satisfactory access to available prey types and quantities.

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH:

It appears that otter diet varies depending on geographic location and prey availability, but the importance of fish as primary prey, and crayfish seasonally, is unmistakably clear. Studies of river otter populations in the United States have shown trends for major and minor fish species similar to those in this paper, with variation occurring only in ranking of the major species' relative importance (Hamilton, 1961; Knudsen and Hale, 1968; Melquist and Hornocker, 1983).

Suggestions for future studies include the continued collection of scat samples from the study area, particularly in the winter when sources of error may have arisen from low samples sizes. Winter sampling was difficult since the creeks were at least partially frozen and unsafe to cross on foot, and snow often covered fresh scats, making it impossible to detect them. Perhaps a dog trained to sniff out otter scats would be useful, particularly in the winter months. A recent Smithsonian National Zoological Park website cites the increased popularity and effectiveness of this low tech methodology (www.nationalzoo.si.edu). S. Wasser and B. Davenport are credited with this idea, and to date dogs can be trained to locate scats of specific species or individual animals. This methodology is especially useful for animals that cover a lot of ground or are hard to track. Wasser and Davenport et al. (2004) have used this technique in combination with DNA analysis of scats to study black and grizzly bears in the Pacific Northwest. Scat-sniffing dogs are also used to study tigers, cougars, lynx, wolves, foxes, and ferrets, so it seems appropriate that river otters' could be added to this list of carnivores.

Paucity in data from Honeoye Creek is also a potential source of error in this study. DNA analysis of each scat is expensive and time consuming, but would provide information about the number of individuals whose diet was estimated. This would also eliminate non-otter scats, possibly indicate preferences of individual animals, and permit an estimate of the size of the re-introduced population.

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Chapter 2- Food Habits of a Re-Introduced River Otter (*Lontra canadensis*) Population in Western New York- Spatial Variation and Prey Selection Conclusions

Melissa Skyer

ABSTRACT:

River otters were re-introduced to Western New York by the Department of Environmental Conservation between 1995 and 2000. The success of this population relies heavily on the availability of suitable prey. Diet was investigated via frequency occurrence scat analysis from 2004-2006 at three creek locations: Black Creek, Oatka Creek and Honeoye Creek. The data set was too small for Chi square goodness of fit or Chi square two way statistical analyses to differentiate between creeks and also account for different prey types and seasonal shifts. However, tentative conclusions were drawn from graphical analyses. Black Creek otters relied primarily on sunfish (Family Centrarchidae), crayfish (Family Cambaridae) and carp (Family Cyprinidae) as prey. The Oatka Creek diet consisted of mainly crayfish, with vegetation also occurring at a notable frequency. The main items in the diet of Honeoye Creek otters were vegetation, crayfish and minor prey species, in decreasing order of importance. Five electrofishing trips established the relative abundance of fish and crayfish in each creek. These data were compared to dietary information, to see if prey consumption could be explained by availability alone. For Black Creek it seems that the dietary preference for sunfish, crayfish and carp can be explained by availability. The diet of Oatka Creek

otters contained more crayfish than expected from availability estimates. In Honeoye Creek, crayfish and sunfish consumption was much higher than their incidence during electrofishing. More research needs to be done to determine other factors affecting otter prey selection; possible influences include swimming speed, size, ease of capture and caloric content of prey species; individual preferences of otters; or that electrofishing did not produce reliable estimates of relative prey abundance.

INTRODUCTION:

River otters (*Lontra canadensis*) are carnivorous animals that rely primarily on aquatic prey (Carss, 1995). They forage in linear riparian home ranges between 15-35 kilometers, (Kruuk, 1994) thus typical prey items include fish, amphibians, crustaceans, mammals and insects. Different otter populations rely on different proportions of prey types, depending on geographic location, availability of prey, preference and season (Morejohn, 1969; Larsen, 1984).

Foraging is energetically expensive, as dives are performed in cold temperatures, and the prey items are often agile and hard to capture (Kruuk, 1994). It is also expensive in terms of time expenditure; Melquist and Hornocker (1983) found that foraging and feeding behaviors accounted for 62% of total activity and behavior. Pffifer et al. (1998) found the energy expenditure for otters during foraging to be as high as 12.3 Watts per kilogram of body mass, a value three times the resting metabolic rate of 4.1 Watts/kg. With costs of river otter foraging behavior so high, these opportunistic feeders display prey selectivity, choosing by both species and size to maximize energy intake (Kruuk, 1994). Research to date offers many explanations for otter prey selection, including prey motility/vulnerability (Erlinge, 1986; Kruuk, 1994), size, and abundance (Ryder, 1955; Jenkins, 1979; Stenson and Badgero, 1984).

Optimal foraging theory has been used to create equations that relate energy expended to energy assimilated for different prey resources utilized by predators (Stephens and Krebs, 1986). Expenditures can be measured in currencies of time or energy. The foundation of optimal foraging theory is that a predator will maximize energy intake or minimize time expended in making selections between prey types. The underlying assumption is that foraging efficiency is an important component of fitness, and therefore should be maximized by natural selection (Ostfeld, 1982). Foraging theory was not explored in detail in this study, but would be useful to further describe prey selection mechanisms of river otters.

This study also explored diet variation among the three creeks and assessed a possible selection mechanism for prey types in the diet. Data collected from electrofishing trips established available proportions of crayfish and fish prey, and was compared to the diet analyzed in Chapter 1 to examine the role of prey availability in food selection.

METHODS:

Information regarding study sites, scat sample collection and analysis are presented in Chapter 1.

Determining prey availability:

Five electrofishing trips were conducted between 2004 and 2006, two on Black Creek (July 2005 and May 2006), two on Oatka Creek (October 2005 and May 2006) and one on Honeoye Creek (November 2005). Electrofishing was performed by boat and on foot using 150 Volts. Each trip sampled 0 .8 to 2.4 kilometers of the creeks, at locations where scat samples were normally collected. Seine nets (mesh size 7 mm.) were also used to supplement the specimens captured for identification. Fish and crayfish species were identified, measured for total length (from the tip of the head with jaws closed to the tip of the tail fins, with lobes compressed; Carlander, 1977) and weighed with an electronic scale before being returned to the water. Many carp were caught and included in abundance estimates, but only four individuals were measured and weighed. "Minnow" (Family Cyprinidae: fathead minnow [*Pimephales promelas*] and bluntnose [*P. notatus*]; Family Umbridae: central mudminnow [*Umbra limi*]) numbers were pooled. Darters (Family Percidae), shiners, dace and chubs (all Family Cyprinidae) were commonly collected during electrofishing trips, but were so small in size that they were not measured or weighed. Electrofishing data from different seasons was combined for each creek.

RESULTS:

Because of generally small or variable sample sizes, statistical analyses were unable to determine significant differences in river otter diets among streams. However, graphical analysis provided some insights into potential differences in diet. Sunfish and carp were the most frequent remains in scats from Black Creek; scats from Oatka Creek had mostly crayfish and vegetation remnants, while there was a high occurrence of crayfish, vegetation and minor prey species in scats from Honeoye Creek (Figure 1).

Proportions of prey types collected during electrofishing trips were used to estimate their availability/relative abundance. Half of the specimens captured from Black Creek were crayfish and sunfish (Figure 2). Less commonly captured fish were carp, darters and suckers, although these occurred in substantial amounts. Trout was the most commonly electrofished prey caught in Oatka Creek; with crayfish and sunfish included, these three groups comprised half of the samples collected (Figure 3). Darters, suckers and dace were also captured during these trips, but in lower proportions. Minnows predominated in the single electrofishing trip to Honeoye Creek (Figure 4).

Smaller sized fish such as minnows, darters, shiners, chub and dace may not be useful to otters, as the energy obtained might not justify the expenditure for search, capture and consumption. Thus, these smaller fish species were excluded from abundance estimates in Figures 5-7.

Five species belonging to the sunfish family were captured during electrofishing: smallmouth bass (*Micropterus dolomieu*), one largemouth bass (*M. salmoides*), rock bass (*Ambloplites rupestris*), pumpkinseed (*Lepomis gibbosus*) and bluegill (*L. macrochirus*) (Table 1). Within the sunfish family the largest species by length and weight were rock bass and bluegill, (respectively) while pumpkinseed and smallmouth bass were the smallest in length and weight. Northern pike (*Exox lucius*) and common carp (*Cyprinus carpio*) were the largest fish captured during the electrofishing trips. Brown trout were also of notable size, approximately half the length and weight of pike and carp. The

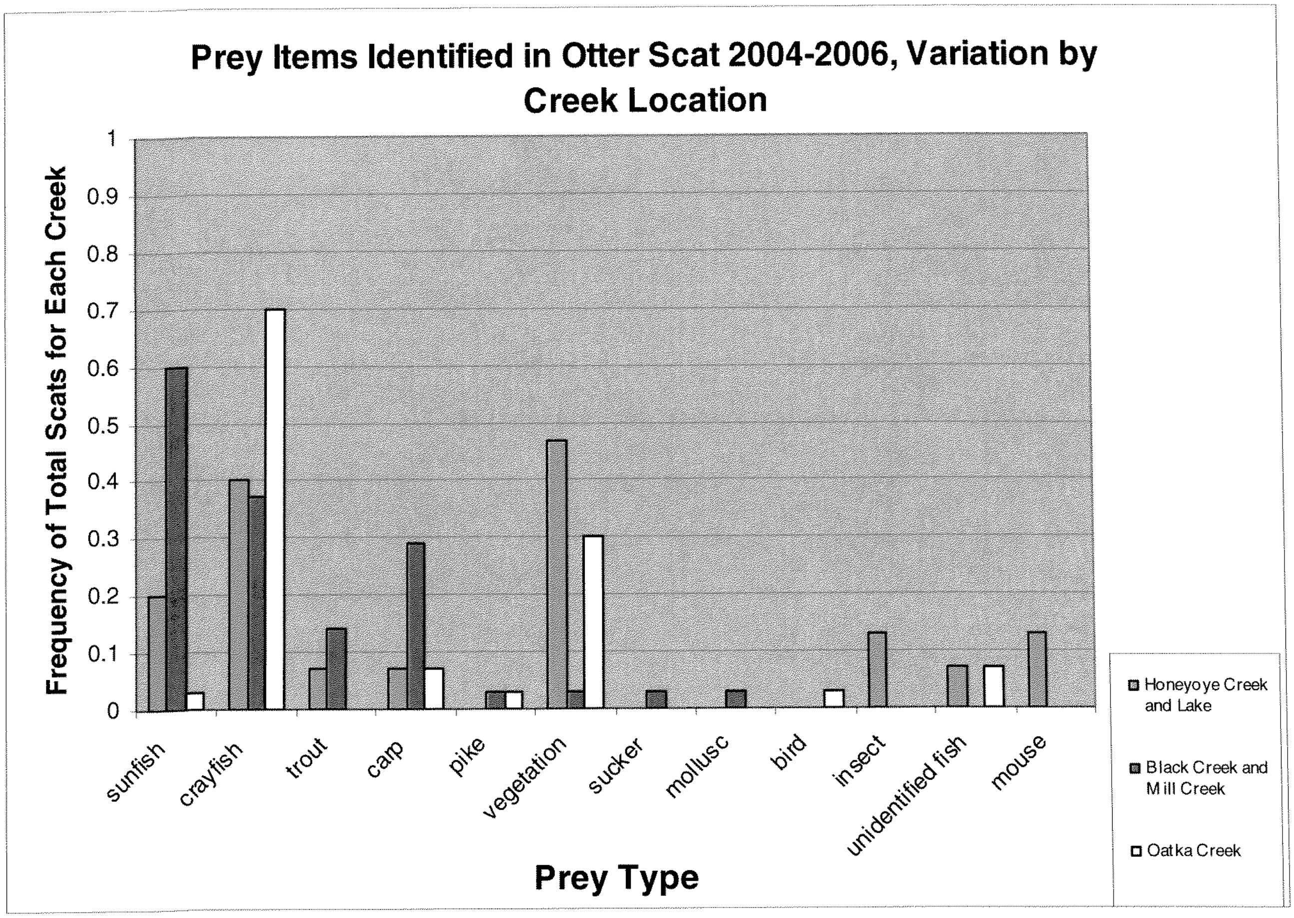

Figure 1. Spatial variation in overall diet from otter scats, comparison of Honeoye Creek, Black Creek and Oatka Creek.

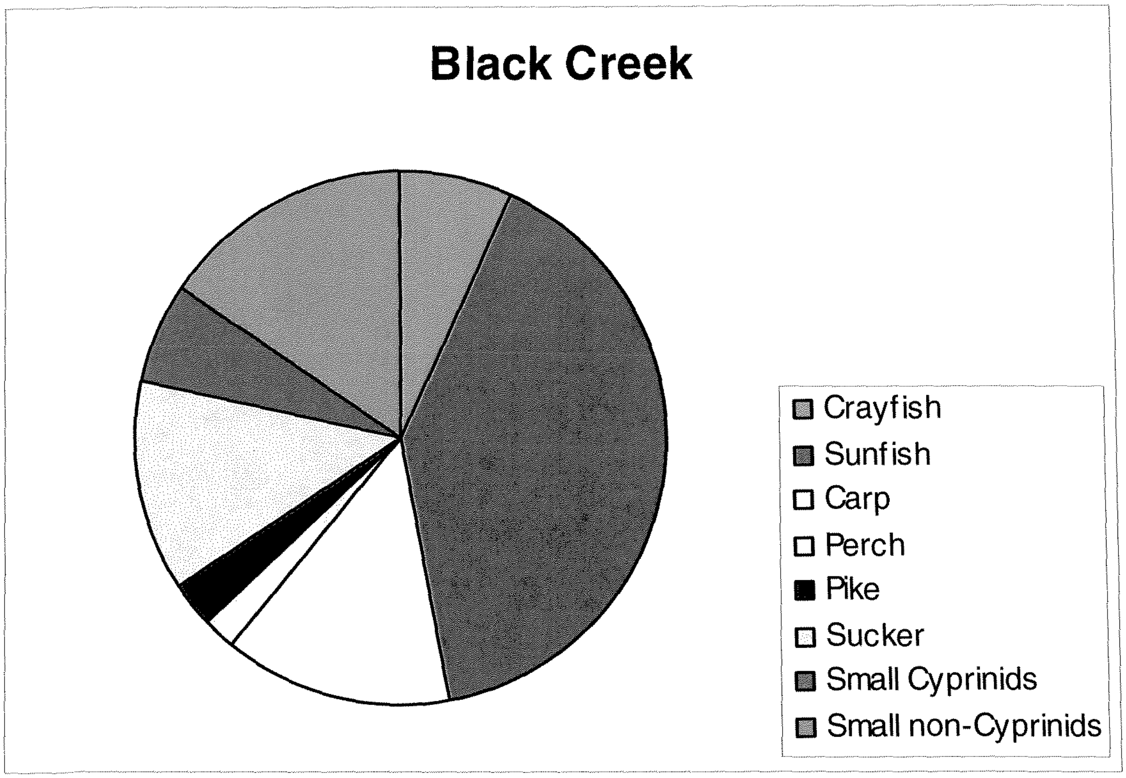

Figure 2. Electrofishing and seine net data from Black Creek, two trips combined to estimate prey abundance, all species captured included.

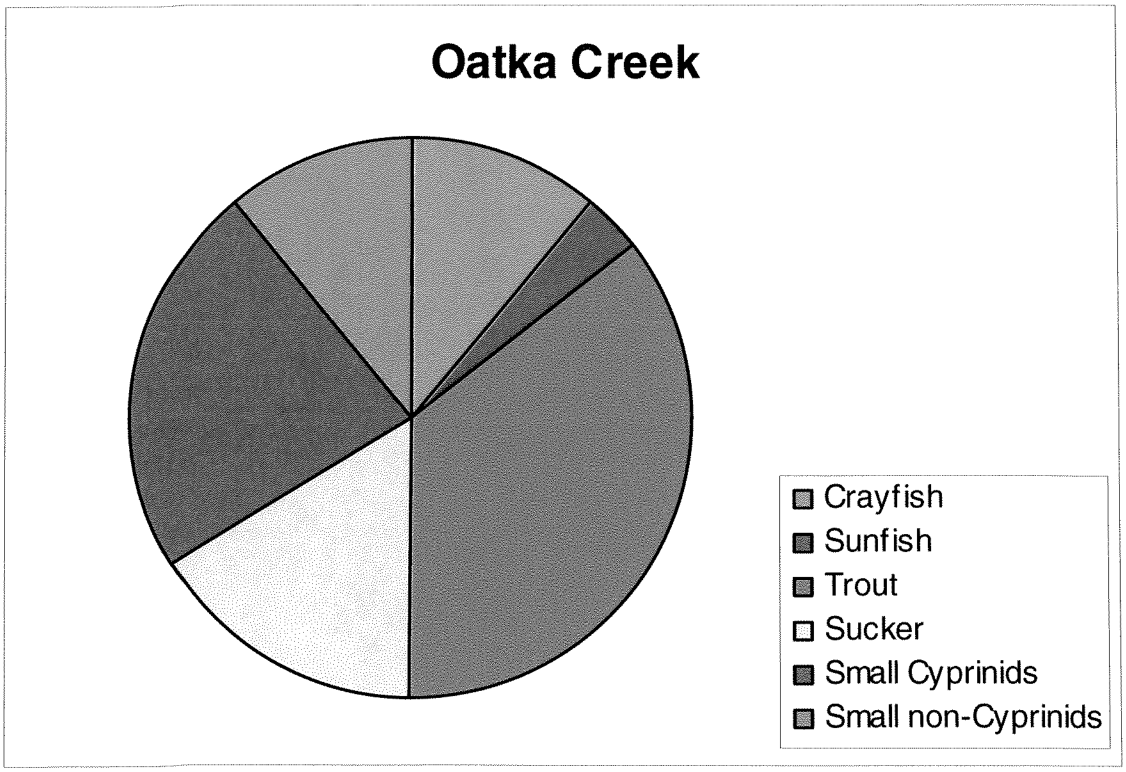

Figure 3. Electrofishing and seine net data from Oatka Creek, two trips combined to estimate prey abundance, all species captured included.

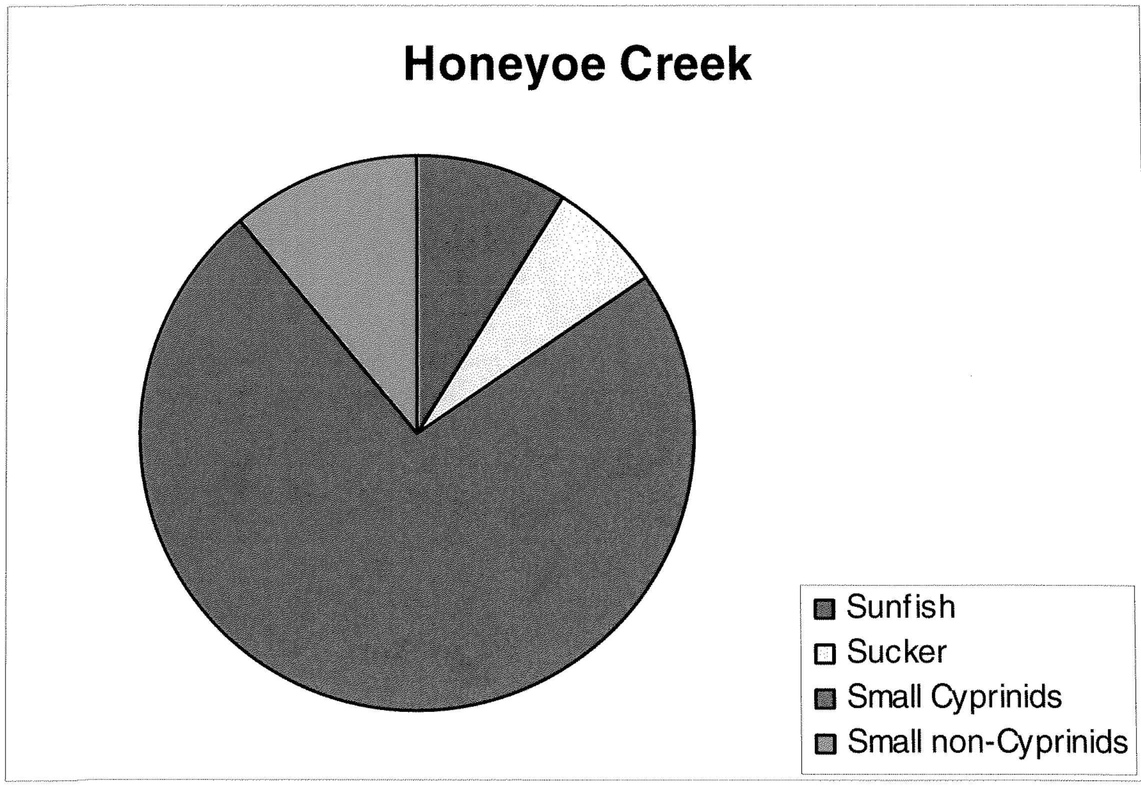

Figure 4. Electrofishing and seine net data from Honeoye Creek, one trip to estimate prey abundance, all species captured included.

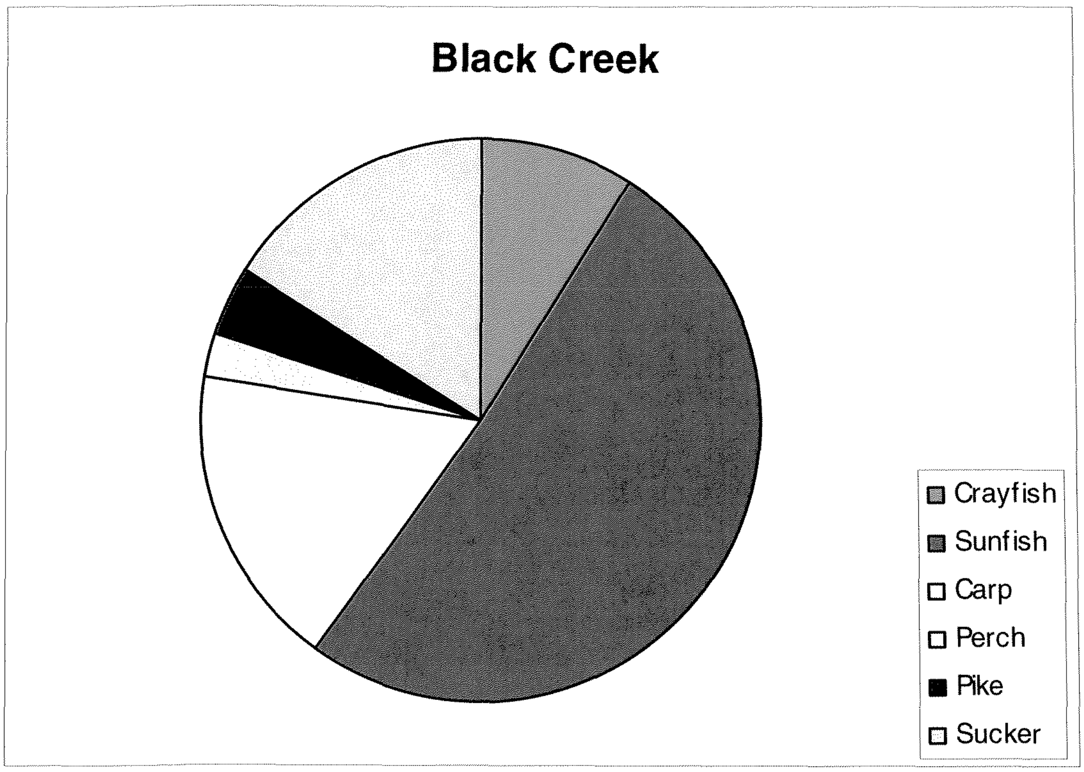

Figure 5. Electrofishing and seine net data from Black Creek, two trips combined to estimate prey abundance, small fish species captured excluded.

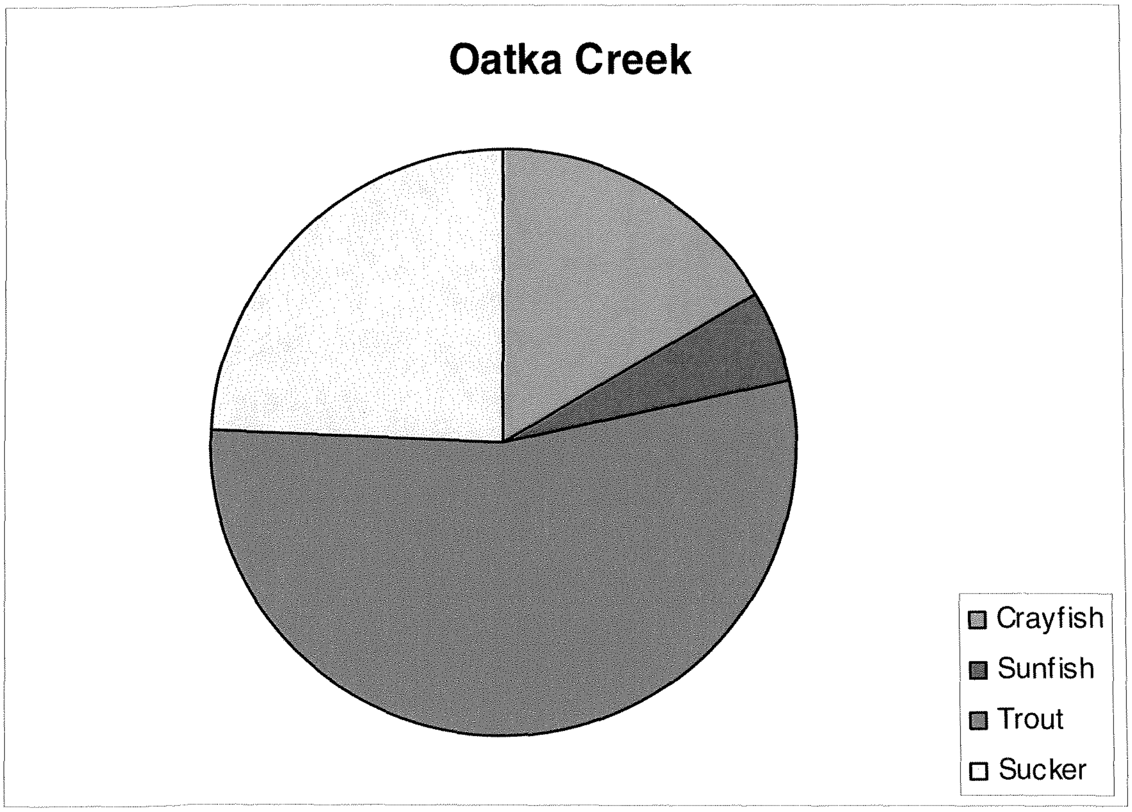

Figure 6. Electrofishing and seine net data from Oatka Creek, two trips combined to estimate prey abundance, small fish species captured excluded.

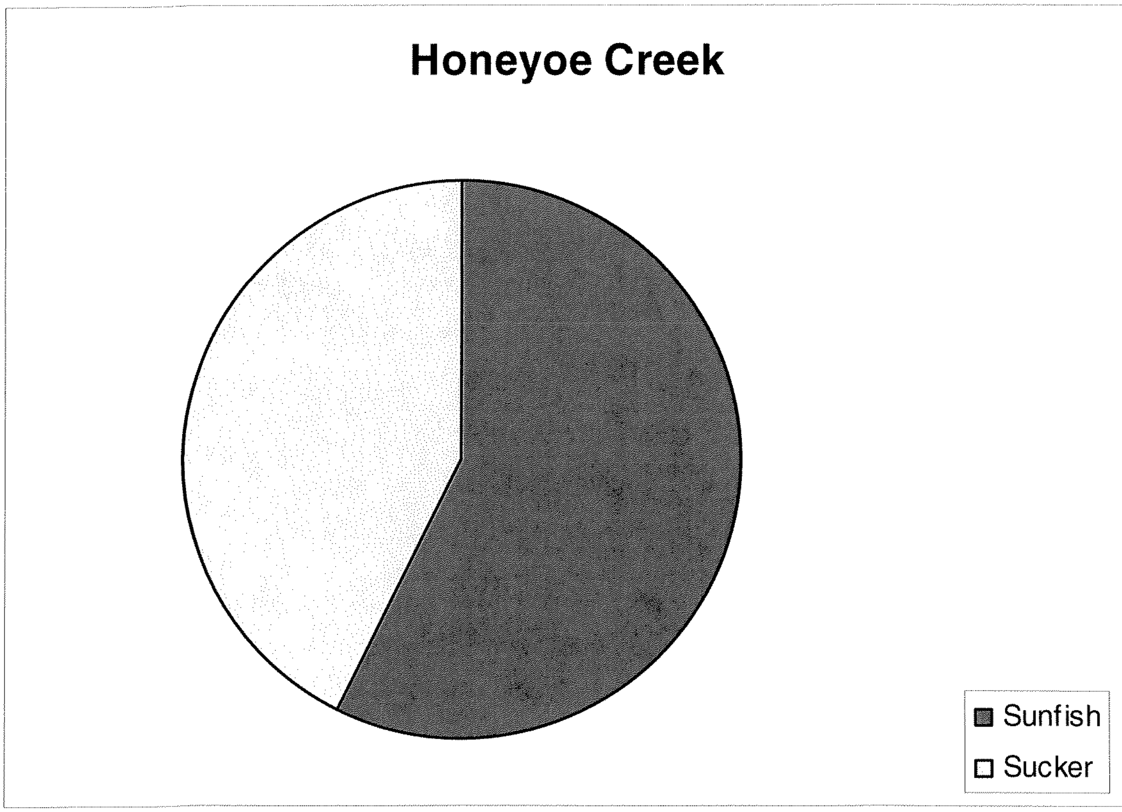

Figure 7. Electrofishing and seine net data from Honeoye Creek, one trip to estimate prey abundance, small fish species captured excluded.

Table 1. Average sizes in mm. (total length) and weights in grams of individual fish and crayfish caught during five electrofishing trips from 2004-2006.

Captured Specimens	**Average Total Length ± S.D. (in mm.)**	**Range (mm.)**	**Average Weight ± S.D. (in g.)**	**Range (g.)**	**n**
Centrarchidae					**48**
Rock bass	130.2 ± 29.0	87-190	55.44 ± 35.4	14-142	9
Largemouth bass	444.0	n/a	1,375.0	n/a	1
Smallmouth bass	86.7 ±10.5	60-101	8.6 ±2.6	3-13	10
Bluegill	118.0 ± 42.3	37-166	46.6 ± 37.5	1-11	7
Pumpkinseed	95.1 ±17.9	68-125	27 ± 20.6	7-79	21
Cyprinidae					**21**
Common carp	523.8 ± 31.2	483-558	1,888.8 ± 272.5	1,509-2,136	4
Minnows	71.7 ± 10.8	55-87	4.4 ± 2.2	1-8	17
Castostomidae					**31**
Northern hog sucker	130.2 ± 84.7	80-312	65.9 ± 119.4	5-362	13
White sucker	141.4 ±119.9	50-446	121.9 ± 294.2	1-1,037	18
Salmonidae					
Brown trout	209.2 ± 90.2	70-360	140.1 ± 135.5	5-498	**42**
Esocidae					
Northern pike	588.0 ± 65.8	531-660	810.3 ± 649.2	85-1,009	**3**
Percidae					
Perch	111.5 ± 2.1	110-113	14.5 ± 6.4	10-19	**2**
Cambaridae					
Crayfish	68 ± 26	41-160	n/a	n/a	**30**

smallest fishes were minnows, averaging 70 mm and weighing less than 5 grams. Crayfish average lengths were similar to those of minnows.

DISCUSSION:

The high frequency of occurrence of crayfish, sunfish and carp in the diet of otters on Black Creek coincided with the proportions of these prey. It appears that in Black Creek the diet variation can be explained in part by the availability of prey resources, a conclusion supported by Tumilson and Karnes (1987) who found diet to be described accurately by availability data alone.

The diet of otters on Oatka Creek is composed mostly of crayfish, more than expected from the availability data. In this case the dietary variation cannot be explained by availability alone. Erlinge (1968) stated that prey availability, as well as vulnerability, affect the proportions in which prey types are taken. Factors such as motility, swimming speed, behavior, and place of living may affect the vulnerability of each prey type. For example crayfish may prove easier to catch because they are less motile than fish. Because of their small size and physical characteristics such as the exoskeleton, it is also likely that crayfish are underrepresented in electrofishing catches than fish (J. Haynes, personal communication).

The diet of Honeoye Creek otters was comprised mostly of crayfish and sunfish, and also had a high occurrence of vegetation. Again, this dietary data does not support the strict availability hypothesis, as the major species identified from electrofishing were small cyprinids (shiners, minnows) and sunfish (respectively). This may be due to inaccurate sampling methods, or show that other methods of prey selection are used by otters.

Vegetation was thought to have been consumed incidentally, not as a main food source. Terrestrial food items like vegetation and other minor prey types such as mammals, birds, insects and mussels were unable to be quantified by electrofishing. Additionally, fish of various species and sizes are not impacted equally the electric current used in electrofishing, this may have also influenced the data collected from these trips (J. Haynes, personal communication).

When small fish species were excluded, the abundance data matched near perfectly to Black Creek otter diets. Sunfish, carp and crayfish were collected during electrofishing at high proportions, with suckers as an intermediate prey group. This matched the dietary data; as sunfish, crayfish and carp were the main prey, with suckers in small quantities. For Oatka Creek, the electrofishing data showed a predominance of trout, sucker, crayfish and sunfish; whereas the diet was composed of crayfish, vegetation, mouse and carp (respectively). It appears that for Oatka Creek the diet could still not be explained by abundance of prey alone. When Honeoye Creek electrofish data was re-analyzed, the main species caught were sunfish and suckers. The diet for Honeoye Creek otters was composed of vegetation, crayfish, sunfish, mouse, trout and carp (respectively). Even when the data was re-analyzed without small fish species, the Honeoye Creek the diet could not explained by abundance alone either.
However, the fact that only one electrofishing trip was conducted on this creek could have skewed the data.

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH:

It appears that some of the diet variation between creek locations can be explained by the availability and proportions of aquatic prey. However, I am more aligned with Erlinge (1968), Melquist and Hornocker (1984) and Kruuk (1994), and believe that other factors are at work to determine the otters preferences for certain prey. Some of these factors include swimming speed, behavior, location of residence, and net energy obtained from each species.

Captive studies would be useful in determining not only prey species preferences, but also size preferences as well. Prey types must be examined for motility, ease of capture and consumption, as well as energy assimilated (digestibility). Optimal foraging theory would be useful to construct an equation to estimate the energy expenditures for each prey type (search time, handling time), in light of the energy assimilated (kcal/unit mass) per species and size prey. This would estimate the optimality of each prey type, and may help to explain otter dietary preferences beyond availability alone.

With the ages of important fish prey consumed by otters already determined in this study, the next step would be to create age/length and age/weight regressions from individuals collected from the three study areas. This would provide a more complete picture of otter diet, allowing for conclusions regarding mechanisms of size selection of prey.

I had hoped to construct a more solid foundation for the optimal foraging theory aspect of this study; however paucity in data (both dietary and electrofish) prevented any definite statistical conclusions. An electivity index of prey types would be a useful continuation of the research completed here. The mean sizes of each prey would need to be converted to mean wet edible biomass in grams, and then converted again to mean caloric content. From this, an estimation of the number of useable kilocalories in an average sized specimen could be determined for each prey type. Additionally, search time and handling times could be estimated by captive experiments, and time expenditure multiplied by active metabolic rate could yield kilocalories exerted per prey type. From this information a ranking system or electivity index (Ostfeld, 1982) would be constructed, with prey items scored as highly profitable and desirable (energy wise) to less profitable in terms of time and/or energy. This index would serve to explain the order in which otter predators should deplete stocks of various prey. The electivity index would then be compared to dietary data, in order to assess its accuracy in predicting prey selection by species and size.

Furthermore, electrofish data collected for each creek and each season would allow for a two way Chi squared statistical analysis to distinguish significant differences in prey selection. Specifically, one additional trip in the fall on Black Creek, one in the summer on Oatka Creek, and fall and summer trips on Honeoye Creek would complete the data already collected. More scat samples collected across the seasons would also augment the preliminary conclusions made here. In this study, progress was made, but there was not enough data across seasons to prove statistical significance between temporal variables, or the possibility of a prey selection mechanism operating in the otter population.

Electrofish data should be supplemented with other prey capture techniques in further research; such as trawling of the creek beds, which would capture all prey without bias for sensitivity to electrical current.

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