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Distribution patterns of river otters, Lontra canadensis, within Monroe County, New York

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Distribution patterns of river otters, *Lontra canadensis*, within Monroe County, New York

by

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Abstract:

River Otters, *Lontra canadensis* were reintroduced to western NY after being extirpated in the early 1900's. The goal of this project was to understand what environmental variables influence habitat selection of river otters, within Monroe County, New York. Water chemistry and the use of benthic macroinvertebrates were investigated to assess the water quality and human impacts. The research area included three tributaries of the Genesee River: Black, Honeoye, and Oatka Creeks. At identified latrine sites, I collected macroinvertebrates at 9 sites and water chemistry at 30 sites to provide an index of the water quality. Geographical Information Systems (GIS) was used to incorporate land use and determine if there are any relationships between water quality and habitat preference. A statistical analysis of the chemistry and invertebrate sites showed that there is not enough evidence to conclude that a significant positive correlation exists between water quality and river otter habitat selection. However, the data suggest that other possible parameters are influencing selection or there just isn't a significant enough difference between the creeks to deter otter inhabitance. With more confirmed otter sites, more data collection may show that there is indeed a significant correlation.

Acknowledgements:

"Feeling gratitude and not expressing it is like wrapping a present and not giving it." -- William Arthur Ward

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Introduction:

HISTORY AND BACKGROUND INFORMATION

The historic range of river otters (*Lontra canadensis*) in North America stretches from Alaska to Florida (Reid et al. 1994). River otters inhabit a diverse range of water bodies, which includes freshwater lotic habitats (Reid et al. 1994). Since the mammal is semi-aquatic, the otter requires specific habitat features that provide food, shelter, and secluded areas (Prenda and Granado-Lorencio 1996). Diet requirements are almost entirely aquatic whereas shelter, toilet sites, and resting areas are located on land (Reid et al. 1994).

Despite the scarcity of natural predators and fatal diseases, river otters within many regions of North America were extirpated by the early 1900's due to human intervention. Habitat loss through development of land, and the use of chemicals and other water pollutants in their freshwater habitat has contributed to their decline (NYROP 1994; Kimber et al. 2000). Throughout much of Europe and North America, river otter populations were once highly abundant. In many cases they were viewed as pest species to local fisheries. Trapping for both the elimination of otters and fur harvesting was viewed as one of the most important reasons for population declines in the European otter, *Lutra lutra* (Mason and Macdonald 1993). Overall, human intervention has resulted in the destruction of integral habitat necessary for the river otter survival within North America.

During the 1970's there was an increased concern about otter declines in North America. Improvements in furbearer management techniques and water quality coincided with increased concern for the otter (Raesley 2001). As a result, many wildlife management agencies developed methods for restoring/enhancing otter populations which included many different reintroduction programs. Within North America alone, 21 States and one Canadian Province have undertaken river otter reintroduction projects (Pennsylvania Game Commission 2004). A better understanding of the interaction between freshwater ecosystems and river otters could lead to establishment of new populations. Because otters are heavily reliant on terrestrial and aquatic ecosystems, changes such as the improvement in water quality, trapping regulations, and conservation of otter habitat have been encouraging factors for re-establishment of otter populations within New York (Pennsylvania Game Commission 2004). In 1996, New York State adopted its own reintroduction program; the New York River Otter Project (NYROP). The otter populations throughout western New York were naturally expanding, but the NYSDEC felt it was necessary to increase the rate of recolonization. Therefore, all river otters used within the reintroduction project were trapped from remnant otter populations located within isolated areas of the Adirondacks and Catskill regions and were released to nine areas deemed suitable by the NYDEC within western New York (NYROP 2004). With help from numerous collaborators outside of the NYSDEC, the Seneca Park Zoo, Cornell University, many local schools, and the general public, the NYROP successfully reintroduced 279 river otters to western New York by the year 2000 (NYROP 2004).

DIET/HABITAT

River otters are known as opportunistic predators; their diets consist mainly of fish and crustaceans (Blundell et al. 2002; Hanson 2003), but other prey includes reptiles, amphibians, birds, aquatic insects, small mammals and mollusks (Berg 1999; Erlinge 1968; Route and Peterson 1988). Home ranges can vary depending on richness of food resources and habitat. *Lontra canadensis* are known to forage in social groups in some habitats (Blundell et al. 2002), which in turn can impact their home ranges. Wetlands and other regions with high levels of shoreline diversity tend to be favored by river otters (Mason and MacDonald 1986). Some studies have established that otters have clear preferences for specific substrates. For example, sections with riffles, large boulders and/or with gravel are preferred over areas with sandy or muddy bottoms (Durbin 1993). This could also be related to the type of prey species that inhabit these areas. Carss (1990) found that otters were more successful and preferred to hunt/catch large salmon in riffles as oppose to deeper water. Habitat selection appears to depend on available vegetation and substrate types.

Anthropogenic activities such as agricultural practices, housing development and angling have been known to interfere with otter inhabitance (Tuzun et al. 2005) limiting their available habitat. In many cases, the habitat destruction and degradation includes water development which alters stream flow and channel morphology, water pollution, and the loss of important riparian vegetation (Boyle 2003).

Like the river otter, the European mink, *Mustela lutreola* has encountered declines as a result of anthropogenic pressures. A study completed in France shows that along with suitable habitat, and food availability, poor water quality is one of three anthropic habitat modifications that was critical for the European mink's decline (Lode et al. 2001). Since both species are near the top of the food chain and are piscivorous animals, habitat requirements are very similar.

WORK AT RIT

Since river otters are semi-aquatic and very elusive, a true understanding of habitat selection is diverse. In order to generate an understanding of habitat preference, spraint recovered gives us an idea of habitat usage. The research being conducted at Rochester Institute of Technology (RIT) involves surveys along creek banks to search for latrine sites, tracks, and other evidence of river otter presence. A latrine site is defined as an area where otter spraint is found within one meter of other otter spraint (Kruuk et al. 1986). Other methods of studying river otter populations involve analyzing fur-harvest data, interviews with local residents, using mark recapture techniques, and tracking river otter locations with radio transmitters (Breaux et al. 2002). The NYROP surgically implanted radio transmitters before releasing 28 of the otters to the Genesee River at Letchworth State Park between 1996 and 2000. It was concluded that 21 of the 28 otters demonstrated signs of establishing home ranges within the Genesee River and its tributaries during the two years they were monitored (Spinola 2003). Otters have large home ranges where the males tend to be larger than those of females. Depending on location, some home ranges extend from 5 to 71km for males in The Rocky Mountain National Park, and in Idaho they have ranged from 50 to 80km (Mack 1985; Melquist and Dronkert 1987). The extent seems to depend on the size and shape of the individual watershed.

My study used GIS as a tool to map otter sites with comparison to downloaded roadways and collected water quality data. Benthic organisms (macro-invertebrates) and some non-bioaccumulative organics have been collected as parameters of water quality. Macroinvertebrates can be useful indicators of water quality because these communities respond to integrated stresses over time, which reflects fluctuating environmental conditions(Bode et al. 2002). Community responses to various pollutants (e.g. organics) may be assessed through interpretation of diversity, known organism tolerances, and in some cases, relative abundances and feeding types.

In total, 31 river otters were released in 1998 into Black Creek and Honeoye Creek near the Genesee River within Monroe County, New York (Bruce Penrod, personal communication, 2006). Since the release, no coordinated effort has been conducted to analyze the status of the river otter populations within Monroe County. The success of the reintroduction program within this region is unknown, thus integrating water quality data with a study of otter distribution patterns and habitat selection would be very useful.

PROJECT GOALS

The purpose of my research is identify otter distribution patterns within Monrow county through the use of Geographical Information Systems(GIS) and special variables. GIS was used to help identify otter distribution patterns from Geographical Positioning Systems (GPS) used to mark latrine sites and other characteristic markings of otter activity, such as tracks or slides. Water quality data obtained through chemistry and macroinvertebrate collection has allowed for comparisons to be made. Digital analysis of environmental features within the study area such as land use/land cover will be obtained using this technique. Ultimately this method of mapping otter activity will improve otter research since it will allow for a better analysis of otter population distributions and habitat selection features such as land use and cover.

Comparisons can be drawn between inhabited versus non-inhabited creeks or areas along the same creeks, which have similar characteristics outside of water quality. This approach has enabled me to help answer the question of whether or not the water quality data that I have collected plays a role in habitat selection by the river otters. It was expected that otters would avoid human conflict and areas or creeks with poor quality water. The GIS was used to visualize and map these regions which provide the best otter habitat based on these two parameters.

The conservation and restoration of native species requires an understanding of their environment. Determining whether or not populations become established and what types of habitat they inhabit is an important aspect of reintroduction projects (IUCN 1998). An analysis of factors contributing to habitat selection will allow for a better understanding of distribution patterns of *Lontra canadensis* reintroduced into Monroe County, New York, and planning for future reintroduction projects.

Materials/Methods:

The banks of Honeoye Creek, Black Creek, and Oatka Creek in Monroe County have been scanned for otter latrine sites since January 2001. We search the banks of the three creeks looking for river otter spraint and any other otter signs, such as slides or tracks. Surveys are via canoe during the warmer months from May to November to gain access to both bank sides. Accessible sites were chosen randomly on each bank side, and were scanned for latrine sites approximately 20 meters in both directions. During the rest of the year due to inclement weather, surveys were conducted on foot, where researchers walked up a single bank-side.

To maintain consistency in the data, each creek was visited in succession and we tried to survey each of the three creeks once per week. From 2005 to 2007, sites that have been deemed potential latrine areas and are accessible by foot and canoe have been mapped as the areas visited. At each potential latrine site, many different environmental variables are recorded: bank slope, vegetation cover, water current, and signs of human disturbance (e.g. roads, houses, near by garbage). These will potentially allow for comparisons to be drawn between sites with otter activity, as opposed to those without. Comparisons can also be made between those areas with similar environmental characteristics.

We collect spraint samples for diet analysis and genetic testing for studies currently being conducted by other researchers. Half of each spraint sample is collected at the latrine site, since otters are known to use latrine sites frequently (Kruuk et. al 1986), this method allows for minimal disturbance and remnants of spraint ill still be present. The position of each latrine site is recorded using Garmin Global Positioning System (GPS) Etrex Vista units and later entered into the compatible software of Environmental Systems Research Institute Inc. (ESRI) geographic information systems (GIS) computer software ArcGIS 9.

To be classified as a latrine site, it needs to contain at least one spraint sample; if there are other indicators, such as slides or tracks which could be identified using field guides, an area is considered possible otter habitat. If multiple spraint samples were found within 5 meters of each other, the spraint samples were marked as the same latrine site (Breaux et. al 2002). Otherwise, each spraint found that was greater than 5 meters away was classified as a different latrine site and was marked with as a distinct point in the GPS database.

In order to analyze the locations marked by the GPS units, the data were entered into ArcGIS 9.0. The points were saved as DBF 4 (dBase IV) files using Microsoft Excel. The locations were then loaded into ArcGIS with a geographic reference using the North American Datum (GCS, NAD) 1983. Cornel University GeoSpatial Repository (CUGIR) was used to download the Monroe County 2002 hydrography census map and the road data information (GCS, NAD 1983) and was added as a layer. 2002 Land Use Land Cover (LULC) data files were downloaded to provide information about the land use surrounding the study area within Monroe County.

Within the three creeks, ten different sites were chosen for the chemistry collection (Figure 1). These ten locations are based on previous sampling done by the RIT River Otter Research Lab.

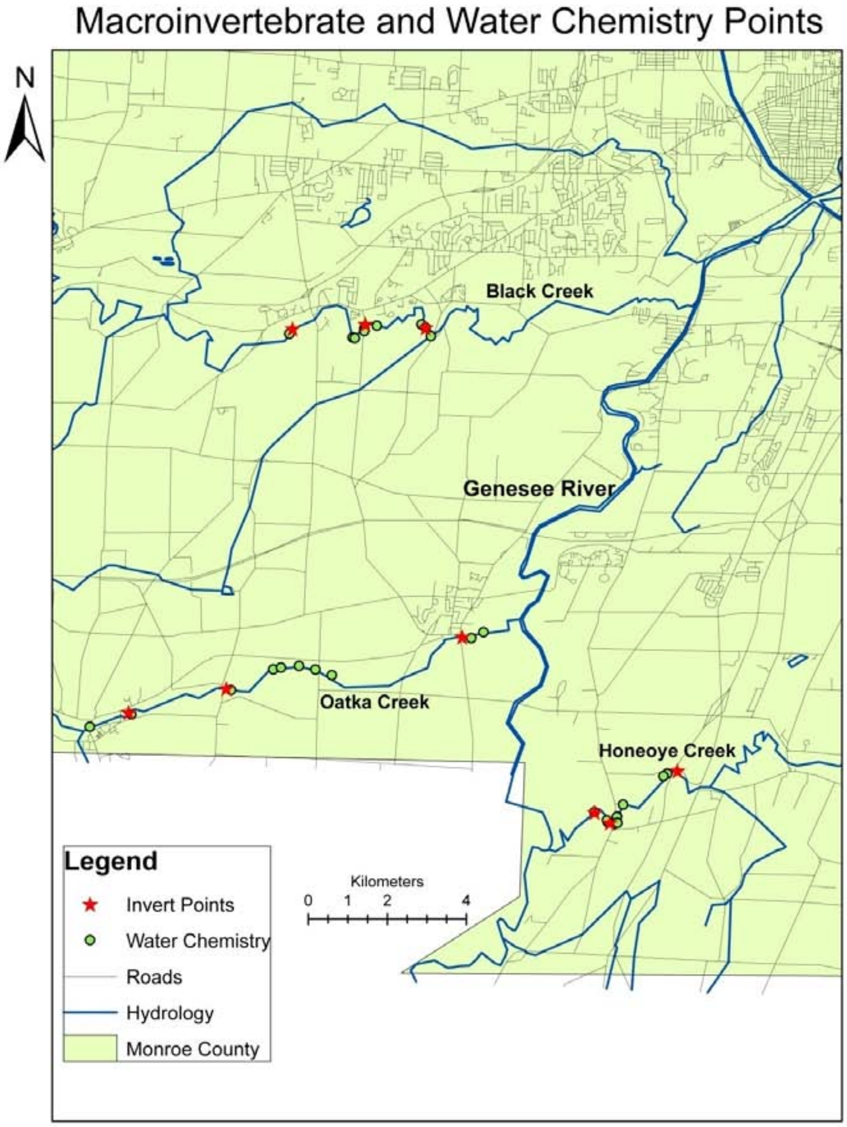

Figure 1: Macroinvertebrate and water chemistry sites within the three creeks. The three macroinvertebrate sites were chosen based on wadeable areas located within my study area. The 10 water chemistry sites were originally chosen based on otter latrine sites and potential latrine sites, but with further analysis they were not all confirmed otter spraint sites (McIlween, 2006).

Originally, five of the sites were classified as areas that otters most frequently used as latrine sites and the remaining five were sites that otter sign has not been found, but had been marked as potential sites. These potential sites are sites which have many of the characteristics of otter latrine sites such as relatively low banks, good vegetative cover (ground and canopy), and low human disturbance. After further genetic and diet analysis, the original believed otter sites were not all confirmed as river otter spraint. Based on genetic confirmation and spraint contents, otter latrine sites were identified and mapped (Figure 2). Without genetic identification, the spraint was classified as otter if fish scales or crayfish remains were recovered from the spraint. If berries, corn or other vegetative remains were found in the spraint without the presence of fish scales or crayfish, it was classified as non-otter.

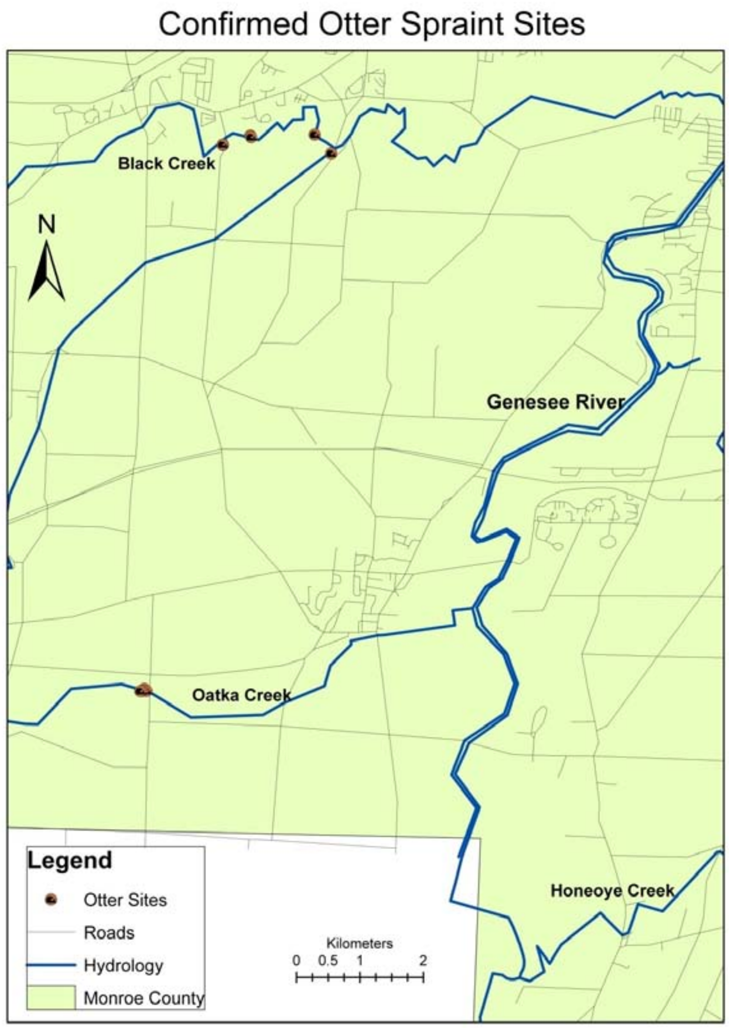

Figure 2: Confirmed otter latrine sites. There were 14 confirmed otter latrine sites based on DNA and spraint species analysis; 10 were located on Black Creek and 4 on Oatka Creek

Water chemistry data was collected once a week for all ten sites per creek (Appendix E) from June to August, 2006. Invertebrates were collected between June 1st and June 10th and once more between August 13th and August 19th in 2006, at each of the three sites per creek (Appendix A). According to Bode et al. (2002), the spring and fall are the best times for collecting and identifying macroinvertebrates based on life cycles. The three sites I chose are wadeable sites located throughout the creeks, which hold good habitat for invertebrate collection. These sites are spread out over our study area (Figure 1).

In terms of water quality measurements, dissolved oxygen (DO), phosphates, and nitrates were measured using an EPA approved Thomas Scientific AccuVac test kits. The DO was calculated using the dissolved oxygen reagent set method 8166 (HRDO Method) with a range of 0-15mg/L O_2. Phosphorous was calculated using the PhosVer 3 (Ascorbic acid) method 8048 (Orthophosphate Method) with a range of 0.02 to 2.50 mg/L PO43-. The nitrates were calculated using Cadmium Reduction Method Method 8171 with a range of 0.1 to 10.0 mg/L NO_3^--N. Water temperature and pH were measured using a Beckman 410 series pH Meter, which had an accuracy of ±0.01 for the pH and ±0.5°C for temperature.

For the statistical analysis of the water chemistry, Mintab 14 was used to analyze the data. A general linear model (GLM) was used to compare sites within each creek, and the overall differences between the three creeks for all the measured chemistry data. For these tests, if the p-value is greater than 0.05, then the null hypothesis was accepted and it was classified as insignificant, and for anything below 0.05 the null was rejected and a significant difference was noted.

Land Use/Land Cover information for the areas surrounding the latrine sites was downloaded from the USGS website. ArcGIS was used to project the LULC data from Albersus into UTM Zone 18, NAD83 and then exported as a Geotiff. Once exported, the Geotiff was then imported into Idrisi. Each creek was digitized and a 30 by 30 meter buffer was used at each latrine site. Information regarding the LULC is displayed in Appendix D.

Macroinvertebrates were collected following the protocol of the Quality Assurance Work Plan for Biological Stream Monitoring in New York State (Bode et. al 2002). The traveling kick sample was used to collect the benthic organisms from the creeks. This method is performed by disturbing the bottom sediments upstream and catching the dislodged organisms in the standard D-frame dip net held downstream. Sampling was performed for 5 minutes gradually moving over a 5 meter diagonal transect of the stream. The net contents were then emptied into a pan and specimens collected were preserved in the field using 75% ethanol.

The macroinvertebrates collected were later identified to the genus level using Peckarsky (1990) with the aid of a 10-40x dissecting stereoscope. These values were used for various biological models (Appendix A) to address the water quality impact according to the Quality Assurance Work Plan for Biological Stream Monitoring (Bode et. Al 2002). The models were incorporated using a biological index profile which uses four metrics to quantify the water quality as a single index (Figure 3).

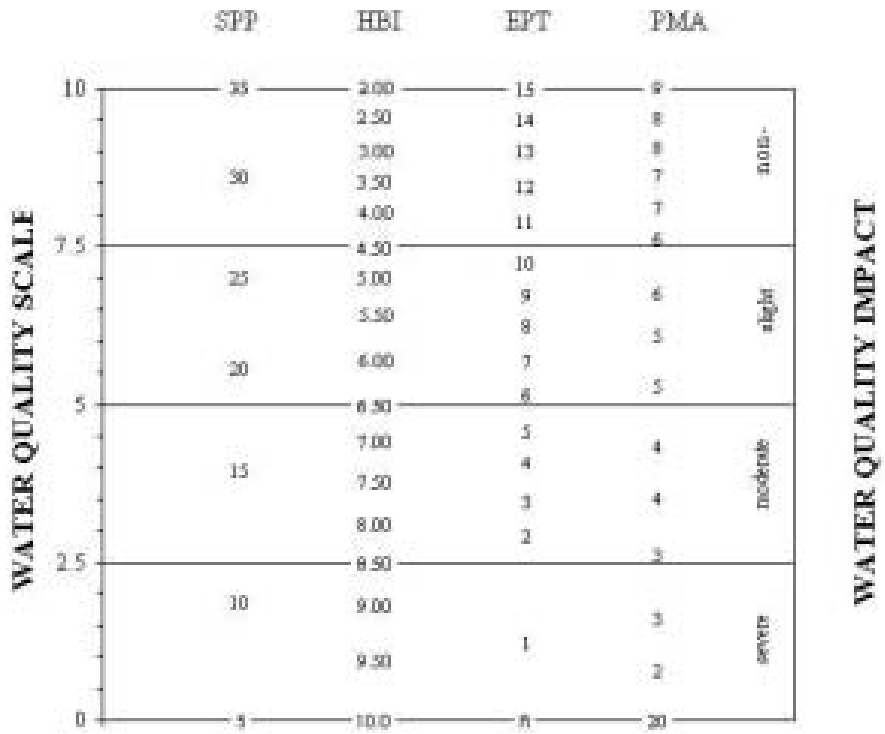

Figure 3: The water quality impact values based on the 0-10 scale created by using the Species Richness (SPP), Hilsonhoff Biotic Index (HBI), EPT Richness, and Percent Model Affinity (PMA) models (Bode et al. 2002).

The four metrics used are (1)Species richness based on the total number of species present, (2)EPT richness which calculates index based on number of *Ephemeroptera* (stoneflies), *Plecoptera* (mayflies), and *Trichoptera* (caddisflies) present, (3) Hilsenhoff Biotic Index using individual species tolerance levels, and (4)Percent Model Affinity (PMA) which compares similarity to a non-impacted model. The values from these tests were then placed on a scale from 0-10 which provided a single water quality index for each creek.

Results:

Sprainting Activity

Within the study area, confirmed otter spraint was located at two of the three creeks (Table 1). These confirmations were based on diet found within the spraint (i.e. fish scales and/or crayfish) and DNA identification. Black Creek contained 10 identified otter spraints distributed over 5 different sites. Figure 4 shows one of the more frequently visited sites in relation to water quality and invertebrate sampling sites. Oatka Creek had 4 confirmed otter spraints, all located within 105 meters of one another (Figure 3). Using the general linear model, a p-value of 0.685 was calculated revealing no significant difference between any of the creeks in terms of number of visits.

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Figure 4: Black Creek sample site showing confirmed otter site, invert site and water chemistry site as a layer on an aerial photo.

Table 1: The number of surveys completed on the three creeks and the total number of confirmed otter spraint recovered from those creeks.

	# of times surveyed	Confirmed Spraint Recovered
Black Creek	72	10
Honeoye Creek	56	0
Oatka Creek	70	4

Water Chemistry

Based on the general linear model, there was no significant difference in any of the water quality measurements between sites within each creek. As a result, all chemistry data comparisons were made between creeks, rather than different sites within each creek. Since there was no difference between seasons statistical tests were then based on the averages for the two collections periods in the spring and fall (Table 2).

Table 2: The following chart displays the averages of the fall and spring data collected in the three creeks in 2006.

Creek	DO(mg/l)	Temp(°C)	Nitrate(NO3-) (mg/L)	Phos(PO4-3) (mg/L)	pH
Honeoye	9.09	*20.10	*1.58	*0.37	8.00
Black	9.18	18.86	1.00	0.20	8.07
Oatka	*9.99	16.15	1.33	0.22	*7.92

Dissolved Oxygen was significantly different between creeks with a p-value of 0.00; Oatka Creek differs from Honeoye and Black, but Honeoye and Black are not different from each other. Nitrates **(NO_3^{-N})** were significantly different between creeks with a p-value of 0.035; Oatka was not significantly different than Black Creek or Honeoye, but Honeoye is significantly higher than Black Creek. The phosphorous **(PO_4^{-3})** was significantly different between creeks with a p-value of 0.00; Black and Oatka Creeks were significantly lower than Honeoye, but did not differ from each other. For the pH there was a significant difference between creeks with a p-value of 0.00. Black Creek differs from Honeoye and Oatka, but Honeoye and Oatka do not differ from each other.

Oatka Creek Otter Sample Site

Figure 5: Oatka Creek sample site displaying the four otter sites and a water chemistry site as a layer on the aerial photos.

Benthic Macroinvertebrates

The three studied creeks were ranked based on the four benthic macroinvertebrate water quality indices (Table 3). For these measurements the values were calculated and placed on a 0-10 scale which ranks them according to a water quality impact level. For example, the average of the four water quality indices for Honeoye was 5.51 on the water quality scale which ranks it as slightly impacted on the water quality scale (Figure 3).

Table 3: Water quality impact of the three creeks

Creek	Average	Classification
Honeoye	5.51	Slightly Impacted
Black	4.59	Moderately Impacted
Oatka	7.10	Slightly impacted

After using a general linear regression model, there was no significant difference between any of the measured indices between sites at any of the creeks (P-values all measured greater than 0.05). Therefore the water quality based on benthic macroinvertebrates is calculated between creeks.

Table 4: Macroinvertebrate indices for the three creeks

Creek	SPP	EPT	HBI	PMA
Honeoye	4.56	8.80	6.61	2.07
Black	3.09	7.61	6.35	1.29
Oatka	1.82	10.00	*8.87	*7.69

Since there was no difference between the spring and fall seasons for any of the creeks, all comparison were made based on averages of the two seasons. Table 4 shows that SPP did not show any significant difference between any of the creeks with a p-value of 0.553. For the EPT richness, again there was no significant difference between any of the creeks ($p = 0.375$). HBI showed a significant difference between creeks ($p=0.00$). Black and Honeoye Creeks differ from Oatka, but not from one another. PMA is significantly different between creeks ($p= 0.00$). Black and Honeoye Creeks are significantly lower than Oatka, but not from each other.

Land Use/ Land Cover

Land use and land cover was used to display and determine what major types of land use were associated within the study area. The LULC was completed for a thirty meter buffer surrounding the study area within all three creeks (appendix D). Because riparian vegetation has been identified as one key aspect to river otter habitat selection (Prenda and Granado 1996), the thirty meter buffer would ensure that the area surrounding the banks of the creeks was included. Since there were numerous LULC classifications, only those classifications that made up greater than 10% of the buffer were used. Table 5 shows the major three LULC types found within the three creeks and their percentages. Within these top three, it is important to make note that none of them contain any form of residential or some type of development. In fact, Black Creek is the only one of the three creeks that has any form of development classified through the LULC within the study area greater than 10%, and it was developed open sapce.

Table 5: The three greatest LULC within the three creeks including there percentage of the 30 by 30m buffer.

Category	Oatka Creek	Black Creek	Honeoye Creek
Woody Wetlands	25.3%	33.3%	--
Mixed Forest	30.6%	--	19.6%
Deciduous Forest	16.1%	13.5%	20.7%
Pasture/Hay	--	17.0%	19.0%

Discussion:

This analysis explores some parameters that may influence river otter habitat selection. The overall objective was to determine whether or not water quality itself was a factor for selection. After addressing the biological indicators and chemical properties of the three creeks there was not a clear-cut correlation between water quality and the presence of river otters.

<u>HONEOYE CREEK</u>

Even though the New York River Otter Project released river otters into Honeoye Creek in 1994, after 56 creek visits no confirmed otter sites were identified. Of the three creeks within the Monroe County study area, it was the only creek with no confirmed sites. Even though it was the least popular creek in terms of the number of visitations, there was no significant difference ($p = 0.245$) between the number of times each creek was visited, thus it is unlikely that the lack of otter detection was due to less survey effort but instead reflects an avoidance of the creek by river otters.

Using the biological water quality models (Appendix A), Honeoye Creek was ranked at 5.51 and is considered to be slightly impacted. Ranked in the same category as Oatka Creek, overall water quality does not seem to be the determining factor as to otter inhabitance. If you look at the chemistry of the creek itself, there are some significant differences from the other two creeks though. The nitrates measured in Honeoye are significantly higher than from those of Oatka Creek, and the phosphorous levels are also significantly higher than both Oatka and Black Creek. The presence of high levels of both nitrates (N) and phosphorous (P) might be a contributing factor as to a lack of otter use within Honeoye Creek. Skyer (2006) showed that all three creeks studied provided sufficient prey species for otter survival, so the high N and P levels do not appear to impact available prey.

Since very little genetic work, other than that being conducted at RIT, has been completed on the river otter populations within New York, it would be interesting to determine whether or not the otter populations are declining, or whether they are migrating elsewhere. It is interesting to note that the release site (Figure 6) was very close to the Genesee River, and the otters may have used this as a corridor to relocate elsewhere.

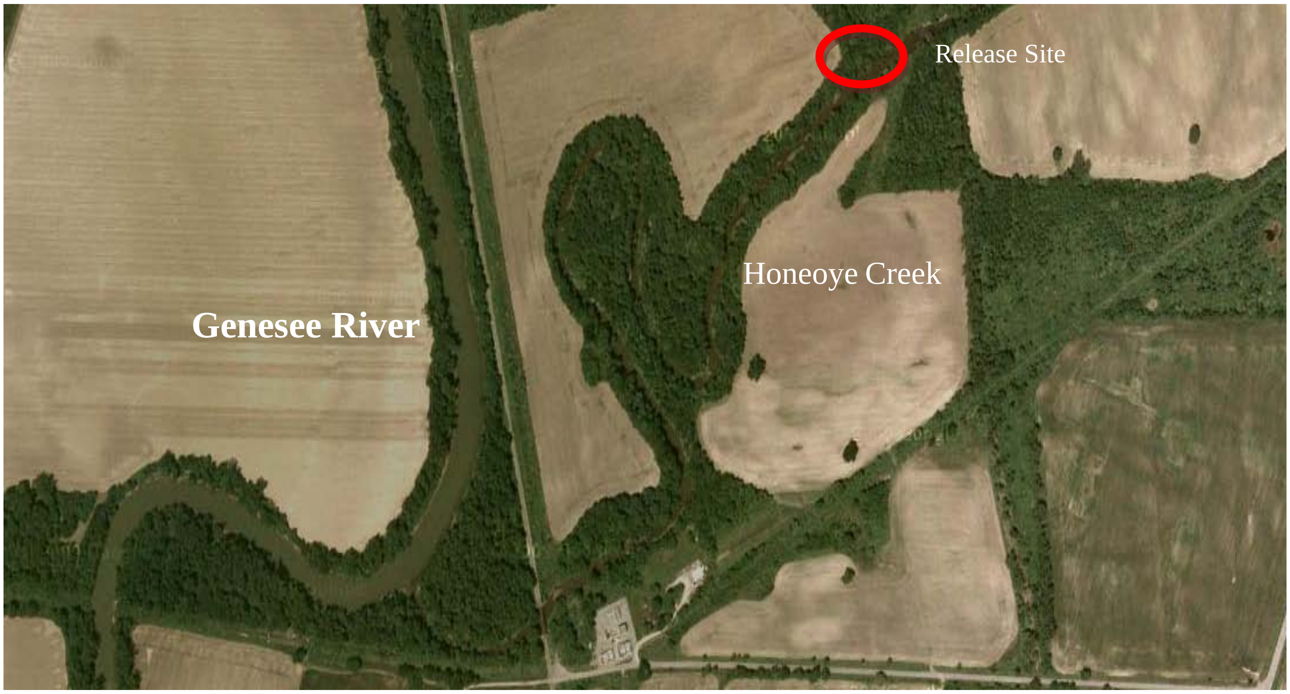

Figure 6: Department of Environmental Conservation River otter release site on Honeoye Creek.

We are currently looking to expanding our research area within the Honeoye creek basin. Otter tracks and word from local fishermen suggest that otters might still be using the creek. As it stands, Honeoye might possess other factors that could deter otters from using this creek. Further research and confirmation of sites will address these issues.

BLACK CREEK

Of the three creeks used in this study, Black Creek had the largest number of confirmed otter spraint sites. There were ten confirmed (Figure 1), and they were spread out over 4 different sampling sites. Although Black Creek was visited the most of the three creeks, there was no significant difference in visitations between creeks so that would not account for the greater number of confirmed sites. The sites themselves were all located within two kilometers of each other (figure1), and each site had more than one otter spraint collected over the study period. Since home ranges of otters are much greater than two kilometers and no DNA work has been completed to determine whether or not different otters have visited these sites, it is not known whether or not the spraint is a result of more than one otter.

Black Creek was one of the release sites for the NYROP and was viewed as suitable habitat for otter survival (NYROP 2000). Based on the data that I have collected, no immediate trends can be linked between water quality and river otter inhabitance. It could be that the otters have adequate living conditions to continue living in Black Creek, and it is not necessary to migrate. It is inconclusive whether or not water quality is in fact a determining factor for otter presence and more work needs to be completed to try and determine what characteristics influence their presence.

OATKA CREEK

After incorporating the genetics work and diet analysis, there were four confirmed otter spraint collected. The spraint samples were all recovered within 105 meters of one another at different points in time, suggesting that this is a preferred otter spraint site. Since the spraint collected from Oatka were greater than 5 meters apart and located on different sides of the creek, these were distinguished as four discrete latrine sites.

From the water quality analysis, Oatka creek ranked the highest in terms of the water quality models at 7.10 and is considered slightly impacted. Chemistry data showed that nitrates and phosphorous levels are not significantly different from Black Creek, but are significantly lower than Honeoye. One very interesting point in terms of the water chemistry itself is the significantly higher dissolved oxygen levels within Oatka creek. The average DO levels in Oatka were 9.99mg/L, and these levels suggest numerous properties that can be associated with the creek. The first obvious characteristic was the temperature of the water having a significant difference from the others creeks with an average of 16.1^{o}C. At lower temperatures the water holds more dissolved oxygen and certain species of fish can only survive within particular levels of thermal and dissolved oxygen (DO) environments. According to the NYSDEC, Oatka creek is stocked with brown trout because it is suitable habitat for their survival (NYSDEC 2007). Elliott (1976) showed that temperature requirements for the maintenance and optimum energy intake for brown trout range from 3.8-19.5^{o}C. Since Oatka Creek is cooler in temperature and has sufficient DO levels (Appendix B), it is suitable habitat for the trout to survive. Thompson and Stelle (in review) demonstrated that captive river otters prefer Brown Trout over other prey species including sunfish and crayfish. The otters' preference is explained by optimal foraging theory, since trout provide the greatest energetic gain after accounting for caloric content and metabolic costs associated with chasing and handling each prey. This suggests that the river otters may have dispersed to Oatka Creek for the food source present. Dubuc (1990) found that the most important factor that determined river otter habitat was food availability. Therefore based on the water chemistry data, DO and temperature could be indirectly influencing river otter habitat selection. Since Oatka Creek offers suitable habitat for a preferred prey species for river otters, reasons for otter use here could be different from those of Black Creek.

<u>CONCLUSIONS</u>

Prior to completing the project, it was assumed that there would have been a large enough difference between the three creeks to be able to draw solid conclusions based on the differences between land use and water quality. Unfortunately, after collecting the data and completing the statistical analysis there was not significant enough differences to compare required habitat for the river otters. Based on water quality, the difference was minimal and none of the creeks were actually listed as being severe or even highly impacted. Given that the creeks themselves varied in some degree, river otters may simply have a tolerable range in which they can survive. Since there have been otter sightings and/or evidence of otters within the three creeks, ultimately it might just be that the creeks within the Monroe County study area, are tolerable in terms of water quality for otter inhabitance.

According to Prenda (1996) and Hanson (2003), otters require three habitat features that are necessary for survival; food, shelter, and secluded areas (Prenda et.al 1996; Hanson 2003). Skyer (2007) showed that the prey resources within our three studied creeks were in abundance to support otter dietary needs, so food availability was not a limiting factor. After addressing the land use of the study area with GIS through the LULC, there seem to be sufficient riparian vegetation throughout the three creeks that provide necessary secluded areas. In a 30 meter buffer surrounding the study area, woody wetlands, mixed forest, or deciduous forest made up the majority of the land use. Only one of the creeks showed that development of any sort was greater than 10%, and even still, it was developed open space (Appendix D). A study completed in the Humboldt River watershed in Nevada shows that the otters only occupied remnant areas of intact riparian vegetation (Bradely 1986). After extensive study within the three creeks and the use of LULC data, the results show that there could very well be sufficient water course quality, and cover through vegetation.

The third parameter necessary for otter habitat is suitable den sites. This would be a good project in the future to incorporate all three parameters river otters require. Although no work has been completed thus far in terms of potential den sites, according to Hanson (2003), sign of beaver activity is a great sign that otters could be present. Numerous signs of beaver presence have been observed within the study area so this could provide one source of den sites. Since watersheds can be altered by beaver activity, beavers provide excellent habitat for otters (Hanson 2003). Both species require very similar habitat, they also provide den sites through abandoned beaver lodges. According to Kiesow (2006), river otters use two types of lodges along river banks, beaver lodges and bank dens. The watersheds of Monroe County appear to provide the three key habitat requirements necessary for river otter survival.

LIMITATIONS

There were several limitations within this project that may have affected the outcome. Although the river otter lab at RIT has been conducting work with the river otters within Monroe County for three years, including research efforts focusing on genetics and diet analysis, there have been challenges. With very little difference in the initial identification of the spraint, raccoon and otter can be difficult to differentiate. As a result, much of the spraint we collected, some of which was originally believed to be otter, has turned out as raccoon. Without concurrently investigating genetics and diet, it is difficult to identify whether or not the spraint collected is truly that of river otters.

With more spraint analysis, we will be able to determine larger numbers of confirmed sites and draw more accurate conclusions as to otter habitat surrounding these sites.

A second limitation is the total area covered in our research efforts. It is important to consider that otter home ranges can vary vastly. Our study area only included a few accessible kilometers within some of the creeks. Since home ranges can be up to 70 miles, the study area might not be sufficient enough for conclusive comparison to be made between habitat preference and otter presence.

The third restriction was the length of time the experiment covered. Since the project began in the summer of 2006, two seasons worth of data collection might not have been the sufficient to address the project goals. Although the analysis of macroinvertebrates addresses the water quality over time, more water chemistry collection would have provided a more reliable view of the actual chemical properties of the creeks.

FUTURE WORK

Several steps can be taken to further investigate this project. Since there have only been 14 confirmed collections of otter spraint to date, future work is necessary in order to create a solid understanding of otter habitat selection. With a greater number of site visits and collection, it will allow or a much better analysis of the river otter habitat selection.

With more field work being completed, there should be a greater number of confirmed otter sites. With a better understanding of preferred latrine sites, the percentage of successful spraint collection and identification should increase. With this, the project can be extended and made more site specific. Toilet sites can be used as the primary study area and common characteristics can be determined for site selection. Once common latrine sites have been established you can narrow the focus on more specific characteristics of these areas.

Additionally, more chemical collection could be done to determine what types of contaminants are present. Since there have only been 14 total confirmations of river otter activity, there could be other water chemistry properties that are limiting otter inhabitance. For example, many other studies have looked at mercury, and polychlorinated biphenyls as limiting factors to otter and other related species, such as mink survival (Harding et. al 1999; Kimber and Kollias 2000; Lode et. al 2001; Mason and MacDonald 1986). Taking a look at the presence of PCB's within the water column would allow for a better analysis as to whether or not they play a part in habitat selection.

Since dens are the third key factor listed as habitat necessities for otter survival (Hanson 2003), work completed in identification of den sites would be particularly helpful. It is assumed that with sufficient riparian vegetation and beaver activity that lack of den availabilities is not an issue, it still needs to be addressed. In saying this, a larger buffer could be used for the LULC within the researched area to determine whether or not development is inhibiting den availability.

The completion of the suggested future work will provide more accurate results and should allow for a better understanding of river otter habitat selection. More knowledge and understanding of *Lontra canadensis* preferred habitat will allow for greater success with future reintroduction efforts.

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APPENDIX A: Macroinvertebrate Calculations and values

NOTE: The following information regarding the types of indices and what they are measures of comes directly from the Quality assurance Work Plan for Biological Stream Monitoring in New York State (Bode et al. 2002).

1. Species Richness: This is the total number of species or taxa found in the sample. Higher species richness values are mostly associated with clean-water conditions.

Species per creek

Creek	Number of Taxa
Honeoye	**17**
Black	**12**
Oatka	**9**

Average per site at each creek

Creek	Site 1	Site 2	Site 3
Honeoye	**9.5**	**8.5**	**7**
Black	**8**	**7.5**	**6.5**
Oatka	**6.5**	**7.5**	**7.5**

Calculations:

SPECIES RICHNESS
SPP>35 replace with 10
SPP>26 replace with (((SPP-26)/9)*2.5)+7.5
SPP>18 replace with (((SPP-18)/8.5)*2.5)+5
SPP>10 replace with (((SPP-10)/8.5)*2.5)+2.5
SPP<5 replace with 0
SPP<11 replace with ((SPP-5)/5.5)*2.5

Average for each creek

Creek	SPP
Honeoye	4.55882
Black	3.08824
Oatka	1.81818

Average SPP for each site within each creek

Creek	Site 1	Site 2	Site 3
Honeoye	2.05	1.59	0.91
Black	1.36	1.14	0.68
Oatka	0.68	1.14	1.14

2. EPT Richness: EPT denotes the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in a 100-

organism subsample. These are considered to be mostly clean-water organisms, and their presence generally is correlated with good water quality.

EPT for average between creeks

Creek	Ephemeroptera	Plecoptera	Trichoptera	Total
Honeoye	1.83521	0.66666	7.878404	**12.60**
Black	0	3.00	7.21	**10.21**
Oatka	35.32	8.81	29.23	**73.36**

EPT for each site per Creek

Honeoye Creek	Ephemeroptera	Plecoptera	Trichoptera	Total
Site 1	5.5	0.0	1.0	**17.0**
Site 2	0.5	0.0	11.0	**12.3**
Site 3	0.0	1.0	12.0	**13.0**

Black Creek	Ephemeroptera	Plecoptera	Trichoptera	Total
Site 1	0.0	8.0	5.5	**13.5**
Site 2	0.0	1.0	8.0	**9.0**
Site 3	0.0	1.0	10.0	**11.0**

Oatka Creek	Ephemeroptera	Plecoptera	Trichoptera	Total
Site 1	40.5	5.5	12.5	**58.5**
Site 2	34.0	11.0	35.5	**80.5**
Site 3	24.5	7.5	31.0	**81.1**

Calculations:

EPT RICHNESS
EPT>15 replace with 10
EPT>10 replace with (((EPT-10)/5)*2.5)+7.5
EPT>5 replace with (((EPT-5)/5.5)*2.5)+5
EPT>1 replace with (((EPT-1)/4.5)*2.5)+2.5
if EPT = 1 replace with 1.25
if EPT = 0 replace with 0

EPT per creek

Creek	EPT
Honeoye	8.80
Black	7.61
Oatka	10.00

EPT for each site per creek

Creek	Site 1	Site 2	Site 3
Honeoye	10.00	8.65	9.00
Black	9.25	6.82	8.00
Oatka	10.00	10.00	10.00

3. **Biotic Index:** The Hilsenhoff Biotic Index is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). Tolerance values, listed in the species list, are mostly from Hilsenhoff (1987). High HBI values are indicative of organic (sewage) pollution, while low values indicate lack of sewage effects.

Creek	**SITE 1**	**SITE 2**	**SITE 3**	**Average**
Honeoye	5.16	5.21	5.25	5.21
Black	5.19	5.61	5.45	5.42
Oatka	3.31	3.19	2.90	3.13

Calculations:

HILSENHOFF BIOTIC INDEX
HBI <2 replace with 10
HBI <4.51 replace with 10-(HBI-2)
HBI <6.51 replace with 7.5-(((HBI-4.5)/2)*2.5)
HBI <8.51 replace with 5-(((HBI-6.5)/2)*2.5)
HBI >8.50 replace with 2.5-(((HBI-8.5)/1.5)*2.5)

Average HBI for each creek

Creek	**HBI**
Honeoye	6.61
Black	6.35
Oatka	8.87

HBI for each site within each creek

Creek	**Site 1**	**Site 2**	**Site 3**
Honeoye	6.68	6.61	6.56
Black	6.64	6.11	6.31
Oatka	8.69	8.81	9.10

4. **Percent Model Affinity:** This is a measure of similarity to a model non-impacted community based on percent abundance in 7 major groups (Novak and Bode, 1992). Percentage similarity as calculated in Washington (1984) is used to measure similarity to a kick sample community of 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other.

Creek	**SITE 1**		**SITE 2**		**SITE 3**		**Average**
	Spring	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**	
Honeoye	**37**	**28**	**32**	**35**	**28**	**32**	**32**
Black	**30**	**29**	**23**	**32**	**32**	**19**	**27.5**
Oatka	**73**	**75**	**66**	**65**	**53**	**64**	**66**

Calculations:

PERCENT MODEL AFFINITY
PMA >90 replace with 10
PMA >64 replace with (((PMA-64)/26)*2.5)+7.5
PMA >49 replace with (((PMA-49)/15.5)*2.5)+5
PMA >34 replace with (((PMA-34)/15.5)*2.5)+2.5
PMA <20 replace with 0
PMA <35 replace with ((PMA-20)/14.5)*2.5

PMA for each Creek

Creek	PMA
Honeoye	2.07
Black	1.29
Oatka	7.69

PMA for each site within each creek

Creek	Site 1	Site 2	Site 3
Honeoye	2.16	2.33	1.72
Black	1.64	1.29	0.95
Oatka	8.46	7.64	6.97

Water Quality based on the Appendix V. Biological Assessment Profile of Index Values for Riffle Habitats

Creek	Average	Classification
Honeoye	5.51	Slightly Impacted
Black	4.59	Moderately Impacted
Oatka	7.10	Non-impacted

	Oatka	Black	Honeoye
DO(mg/L)	*9.99	9.18	9.09
Temp	*16.15	#18.86	20.10
pH	7.92	*8.07	8.00
Nitrates	1.33	1.00	**%**1.58
Phosphorous	0.22	0.20	*0.37
Quality	7.10 (Slightly impacted)	4.59 (Moderately Impacted)	5.51 (Slightly Impacted)
EPT	10.00	7.61	8.80
HBI	*8.87	6.35	6.61
PMA	*7.69	1.29	2.07
SPP	1.82	3.09	4.56

APPENDIX B: Summary of Results

Summary of averages with significant differences

* Represents a significant difference from the other two creeks
$ Represents a significant difference from Black Creek
# represents a significant difference from Honeoye Creek
%represents a significance difference from Oatka Creek

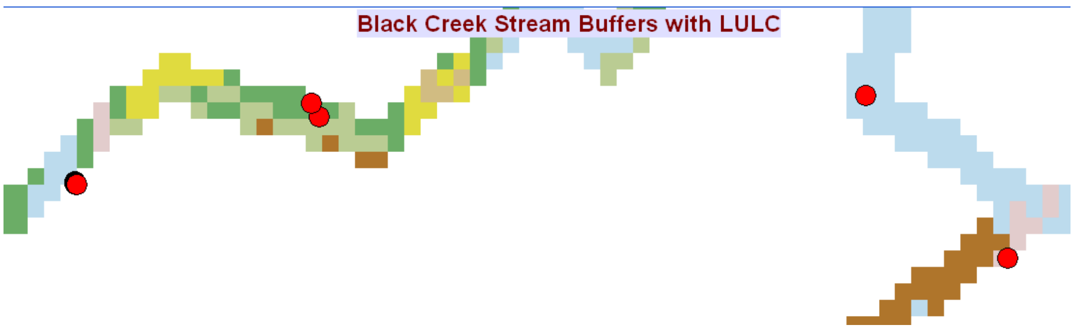
APPENDIX C: Macroinvertebrate Data

Macroinvertebrate community composition: Macroinvertebrates were collected at three different sites within Oatka, Honeoye and Black Creek. The inverts were classified to the genus level and were used in various water quality models. The following table displays the types and numbers found at each site in the spring and fall combined.

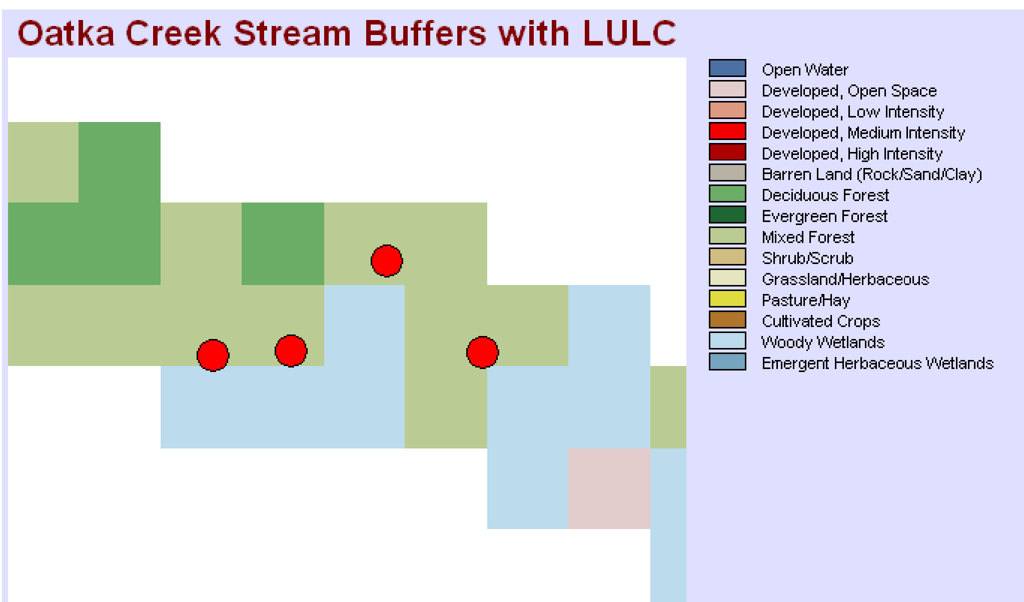
Common Name	Genus	Honeoye Creek			Black Creek			Oatka Creek		
		Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
Scud	***Gammarus***	83	74	82	122	127	118	43	22	15
Mayfly	***Ephemerella***	8	1	0	0	0	0	81	68	49
Mayfly	***Stenonema***	3	0	0	0	0	0	0	0	0
Stonefly	***Agnetina***	0	0	2	0	0	0	11	22	15
Stonefly	***Perlesta***	0	0	0	1	0	0	0	0	0
Stonefly	***Acroneuria***	2	0	0	15	2	2	0	0	0
Caddis fly	***Hydropsyche***	21	22	24	11	16	30	25	59	41
Caddis fly	***Hydroptila***	0	0	0	0	0	0	0	12	21
Riffle beetle	***Stenelmis***	25	29	37	17	25	27	36	13	14
Water penny	***Psephenus***	8	34	30	2	0	3	0	0	0
Alderfly larva	***Sialis***	0	0	0	0	0	0	0	0	1
Hellgrammite	***Nigronia***	7	0	0	18	6	3	0	0	0
Fingernail clam	***Musculium***	19	11	13	7	10	10	0	0	0
Fingernail clam	***Sphaerium***	13	9	6	3	11	6	0	0	0
Snail	***Pleurocera***	3	5	2	0	2	1	0	0	0
Leech	***Helobdella***	0	1	2	4	1	0	0	0	0
Crane fly	***Tipula***	0	0	0	0	0	0	1	1	3
Midge fly larva	***Coelotanypus***	0	0	0	0	0	0	0	0	0
Aquatic worm	***Oligochaeta***	0	0	0	0	0	0	3	3	0
SUM		200	189	200	200	200	200	200	200	159

APPENDIX D: Land Use/ Land Cover Information

(Note: LULC info provided by Barb McIlween)



The above figure displays the Land Use/Land Cover surrounding the latrine sites (red dots) located on Black Creek.



The above figure displays the Land Use/Land Cover surrounding the latrine sites (red dots) located on Oatka Creek.

The following table displays the LULC of Oatka Creek and the percentage they covered within the 30 meter buffer zone.

Category	Oatka Creek	Percentages
Open Water	5	0.2698327
Developed, Open Space	51	2.75229358
Developed, Low Intensity	18	0.97139773
Developed, Medium Intensity	12	0.64759849
Developed, High Intensity	4	0.21586616
Deciduous Forest	298	**16.0820291**
Evergreen Forest	16	0.86346465
MIXED FOREST	568	**30.6529951**
Shrub/Scrub	26	1.40313006
Grassland/Herbaceous	7	0.37776579
Pasture/Hay	254	**13.7075013**
Cultivated Crops	112	6.04425256
WOODY WETLANDS	468	**25.2563411**
Emergent Herbaceous Wetlands	14	0.75553157
Total	1853	100

The following table displays the LULC of Honeoye Creek and the percentage they covered within the 30 meter buffer.

Category	Honeoye Creek	Percentages
Open Water	53	1.49759819
Developed, Open Space	145	4.0972026
Developed, Low Intensity	32	0.90421023
Developed, Medium Intensity	26	0.73467081
Developed, High Intensity	10	0.2825657
DECIDUOUS FOREST	734	**20.7403221**
Evergreen Forest	21	0.59338796
MIXED FOREST	692	**19.5535462**
Shrub/Scrub	179	5.05792597
Grassland/Herbaceous	36	1.01723651
PASTURE/HAY	671	**18.9601582**
Cultivated Crops	419	**11.8395027**
Woody Wetlands	429	**12.1220684**
Emergent Herbaceous Wetlands	92	2.59960441
Total	3539	100

The following table displays the LULC of Black Creek and the percentage they covered within the 30 meter buffer zone.

Category	Black Creek	Percentages
Open Water	51	0.84507042
Developed, Open Space	619	**10.2568351**
Developed, Low Intensity	171	2.83347142
Developed, Medium Intensity	81	1.34217067

Developed, High Intensity	19	0.31483016
Deciduous Forest	815	**13.5045568**
Evergreen Forest	20	0.33140017
Mixed Forest	436	7.22452361
Shrub/Scrub	63	1.04391052
Grassland/Herbaceous	20	0.33140017
Pasture/Hay	1027	**17.0173985**
Cultivated Crops	666	**11.0356255**
WOODY WETLANDS	2009	**33.2891466**
Emergent Herbaceous Wetlands	38	0.62966031
Total	6035	100

APPENDIX E: Summary of Water Chemistry Data

Spring water chemistry data: The following chart displays the average of the ten different sites located throughout the three creeks in the Monroe County study area.

Creek	DO(mg/l)	Temp(°C)	Nitrate(NO3-)(mg/L)	Phos(PO4-3)	pH
Honeoye	**8.66**	**22.93**	**2.09**	**0.44**	**8.02**
Black	**8.36**	**20.64**	**0.70**	**0.20**	**8.11**
Oatka	**9.69**	**18.21**	**1.08**	**0.19**	**7.92**

Fall water chemistry data: The following chart displays the average of the ten different sites located throughout the three creeks in the Monroe County study area.

Creek	DO(mg/l)	Temp(°C)	Nitrate(NO3-)(mg/L)	Phos(PO4-3)	pH
Honeoye	**9.52**	**17.26**	**1.08**	**0.30**	**7.98**
Black	**10.00**	**17.09**	**1.31**	**0.21**	**8.04**
Oatka	**10.28**	**14.09**	**1.58**	**0.25**	**7.92**

Averages of the water chemistry data: The following chart displays the averages of the fall and spring data collected in the three creeks in 2006

Creek	DO(mg/l)	Temp(°C)	Nitrate(NO3-)(mg/L)	Phos(PO4-3)	pH
Honeoye	**9.09**	**20.10**	**1.58**	**0.37**	**8.00**
Black	**9.18**	**18.86**	**1.00**	**0.20**	**8.07**
Oatka	**9.99**	**16.15**	**1.33**	**0.22**	**7.92**