

Analysis of home range in Northern Pike (*Esox lucius*)

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Introduction:

Northern pike (*Esox lucius*) are a freshwater predator that obtains their prey via ambushing. Studies have found that the activity of pike is correlated to their size such that larger pike move farther and faster (Eklov 1992). However, compared to other predatory fish pike move less frequently and are independent hunters (Eklov 1992). Pike are most commonly found in shallower water and prefer vegetation for cover in order to ambush their prey. In particular, larger pike have been shown to prefer shallower water closer to shore than the smaller pike (Jespen et al. 2001). In addition, pike have been found to be most active in low light conditions, especially around dusk and dawn, although some studies indicated no variation in activity over the 24 hour day (Jespen et al. 2001).

This study focused on determining the home range and territory of northern pike in Lake Itasca over a two week time frame. The home range of an animal is the area that is used in the course of normal activities which contains sufficient resources to survive and reproduce. In addition to determining the home range, the territory, or the region which the animal defends, was also measured by looking at where the pike spent the most amount of time. Some factors focused on were the correlation between pike size, area of the home range, and the depth of the water. We hypothesized that larger pike would inhabit shallower water and have a larger home range than smaller pike.

Materials and Methods:

A total of six northern pike were captured from Lake Itasca using sink weir nets and placed in a tank overnight. Activity/Mortality transmitters were then surgically implanted just

beneath the stomach of each fish; 250 mg/l of ms-222 were used to anesthetize the fish, with water temperature kept constant at 18°C and pH at 7.0. The total knockout, surgery and recovery time were recorded, along with weight, length, age and capture location of each fish. The pike were then released one day after capture at the sights where they were originally captured. After release, one transmitter malfunctioned and a second fish was unable to be located.

The remaining four pike were tracked over a two week period via homing from 31 May until 8 June utilizing a four element Yagi antenna and a 165 MHz receiver. The GPS coordinates of each fish were recorded, along with the activity level, habitat vegetation, depth and temperature. The fish were tracked a minimum of twice a day, usually once in the morning and again in the evening, with one 24 hour time frame in which the GPS coordinates were taken every 2 hours for a total of 29 locations recorded. The water conductivity was measured at the deepest location in Lake Itasca (10 m, X/Y 333,441/5,232,972) and the attenuation was then determined. In addition, standard error was measured by taking successive readings on one fish within a ten minute time frame and calculating the standard deviation to estimate error size. An additional ± 15 m error was added for the GPS standard error.

The data were then analyzed using the Arcview 9.x software to run a Minimum Convex Polygon (MCP) and kernel analyses on each pike to indicate the home range and intensity of occupation for the two week period. Lake Itasca is located in UTM zone 15 and datum NAD 27 was used for the analyses. To identify the relationship between pike length and home range area, and pike length and depth the data were graphed in excel.

Results:

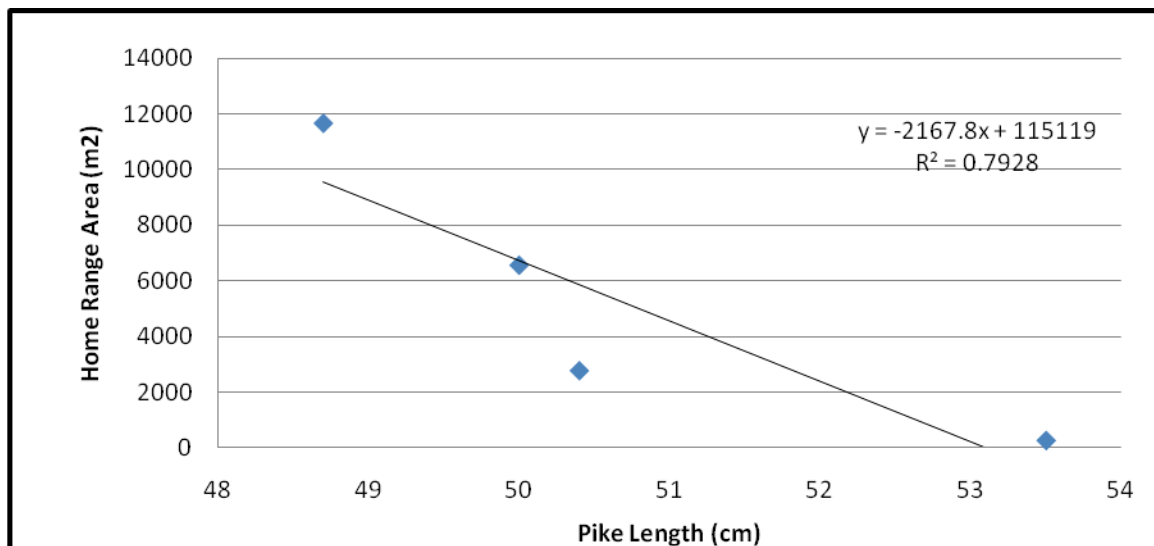
For each of the four pike, 29 total GPS coordinates were taken and maps were generated indicating their MCP (Figure 3) and kernel analyses (Figure 4-7) results. For pike 165.671, the

home range area was measured at 6567 m² while the average depth was 1.05 m. Pike 165.693 had an average depth of 1.22 m and a home range area of 11657 m² while 165.621 was found at average depth of 1.13 m and home range area of 2784 m². Lastly, fish 165.711 had an average depth of 0.61 m and a home range area of 278.5 m. This data, along with dominant vegetation, fish length and weight are recorded in Table 1. Figures 2-5 show the kernel analyses for each pike with the outermost line indicating 95% confidence, than 90%, and the inner most circle depicting 50% confidence. The lengths of the pike were then plotted against the home range area (Figure 1) and average depth (Figure 2).

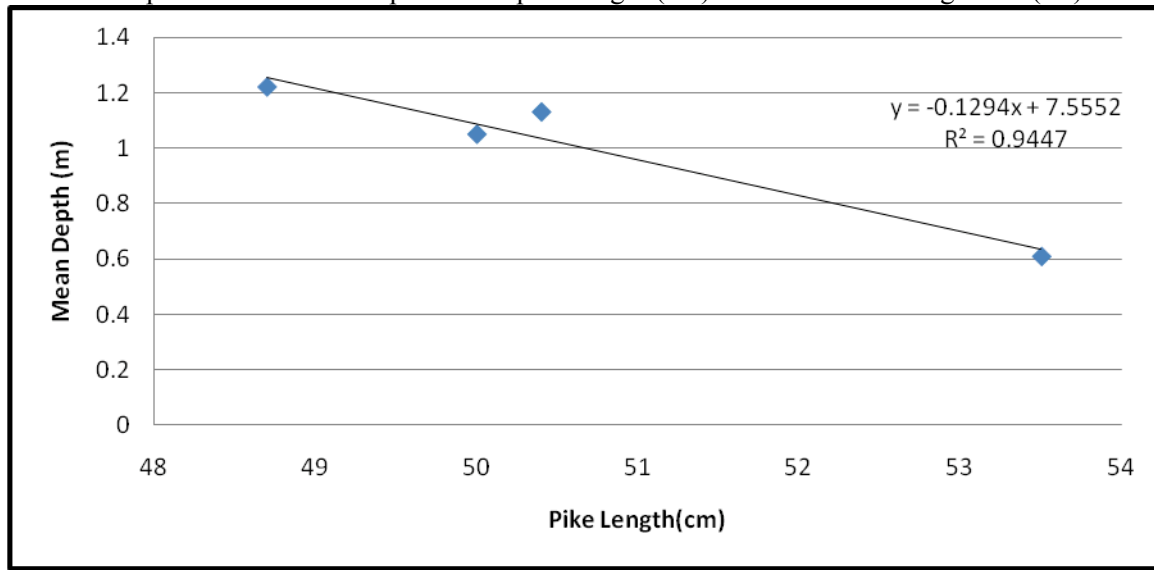
The water conductivity was measured at 248.1 μS, and using the conductivity chart, the attenuation was calculated to be about 6.0 dB/m. The standard error for the measurements was found to be ±11.21 m with an additional ±15 m for GPS error.

Pike T.#	Weight (g)	Length (cm)	Home Range Area (m ²)	Vegetation*	Ave. Depth (m)
165.671	705	50	6567	HSBR, WR	1.05
165.693	590	48.7	11657	HSBR, WR	1.22
165.621	648	50.4	2784	YL, WR	1.13
165.711	756	53.5	278.5	YL, WR	0.61

Table 1: The weight, length, home range area, vegetation and average depth for each pike. The vegetation data listed here is based on the most common combinations of plants recorded over the two week time frame.



Graph 1: The relationship between pike length (cm) versus the home range area (m²).



Graph 2: The relationship between pike length (cm) versus the average depth (m) at which the pike were found.

Discussion:

The results of the experiment indicated that, although pike are ambush predators, they still have relatively large home ranges through which they traverse for resources. The MCP analysis indicated that the home range for pike 693 was the largest with a total area of 11657 m². Originally, pike 693 was centralized in the northern portion of its home range until the last four days of the study during which the fish moved 200 meters south to a new range. This caused the overall area to be significantly larger than any of the other pike. In contrast to 693, pike 711 had a small home range of only 278.5 m². This may be due to an abundance of resources in the area thus allowing 711 to not have to spend as much time searching for food. As the MCP analysis shows, the outermost points make up the outline of each fishes home range. Within each polygon, however, there are regions with numerous points which represent the pikes territory or the place that is readily defended by the pike. As shown by 621 and 711, their home ranges overlap, but their territories do not. The kernel analyses further show the core area of each fish, with the central ring indicating the 50% confidence of the fish's presence. The one downside of

the kernel analysis is the inclusion of land in the home range of the fish, which immensely increases the fish's home range.

The comparison between pike length and home range area indicated that larger pike had a smaller home range than small pike did. This result contradicts the findings of the study by Eklov (1992) which saw that larger pike had a larger home range. However, a study by Jespen et al. (2001) found similar results as our study, in which the size of the fish did not indicate its home range area. Further, since our data set was small the overall trend if more pike had been included may shift to show a more random pattern similar to that seen in Jespen et al (2001) study. Another factor that may contribute to this trend was the abundance of resources in the largest fish's home range. If more resources were readily available than the fish would not have to traverse a large distance on a regular basis and thus have a smaller home range.

The second comparison between pike length and average depth indicated that larger pike favored shallower water. This result is congruent to the findings of Jespen et al. (2001) which found larger northern pike located in either a lake or river favored both shallower water and some type of vegetation. This result is expected since several small fish prefer shallower water, thus it is more likely for an ambush predator especially of larger size to locate itself to a site abundant in resources. Thus, our hypothesis for larger fish preferring shallower water was supported while our second hypothesis for larger fish having a larger home range was not.

Conclusions:

Northern pike are an ambush predator that may or may not have a large home range area based upon the abundance of resources in the area. As the results indicated, larger pike preferred shallower water but had a smaller home range area which contradicts some previous research. Future analyses of home range in pike could focus on the inclusion of more replicates over a

longer time frame to gain a better understanding of movement patterns especially as seen in the case of pike 621 which had a drastic change in territory during the last few days of the study. A longer time frame could reveal whether such drastic movements are regularly occurring or whether some change in environment forced this change.

References:

- Eklov, P. 1992. Group foraging versus solitary foraging efficiency in piscivorous predators: the perch, *Perca fluviatilis*, and pike, *Esox lucius*, patterns. *Animal Behavior*, 44, 313-326.
- Jespen, N., Beck, S., Skov, C., and Koed, A. 2001. Behavior of pike (*Esox lucius*) >50 cm in a turbid reservoir and in a clearwater lake. *Ecology of Freshwater*, 10, 26-34.

Appendix

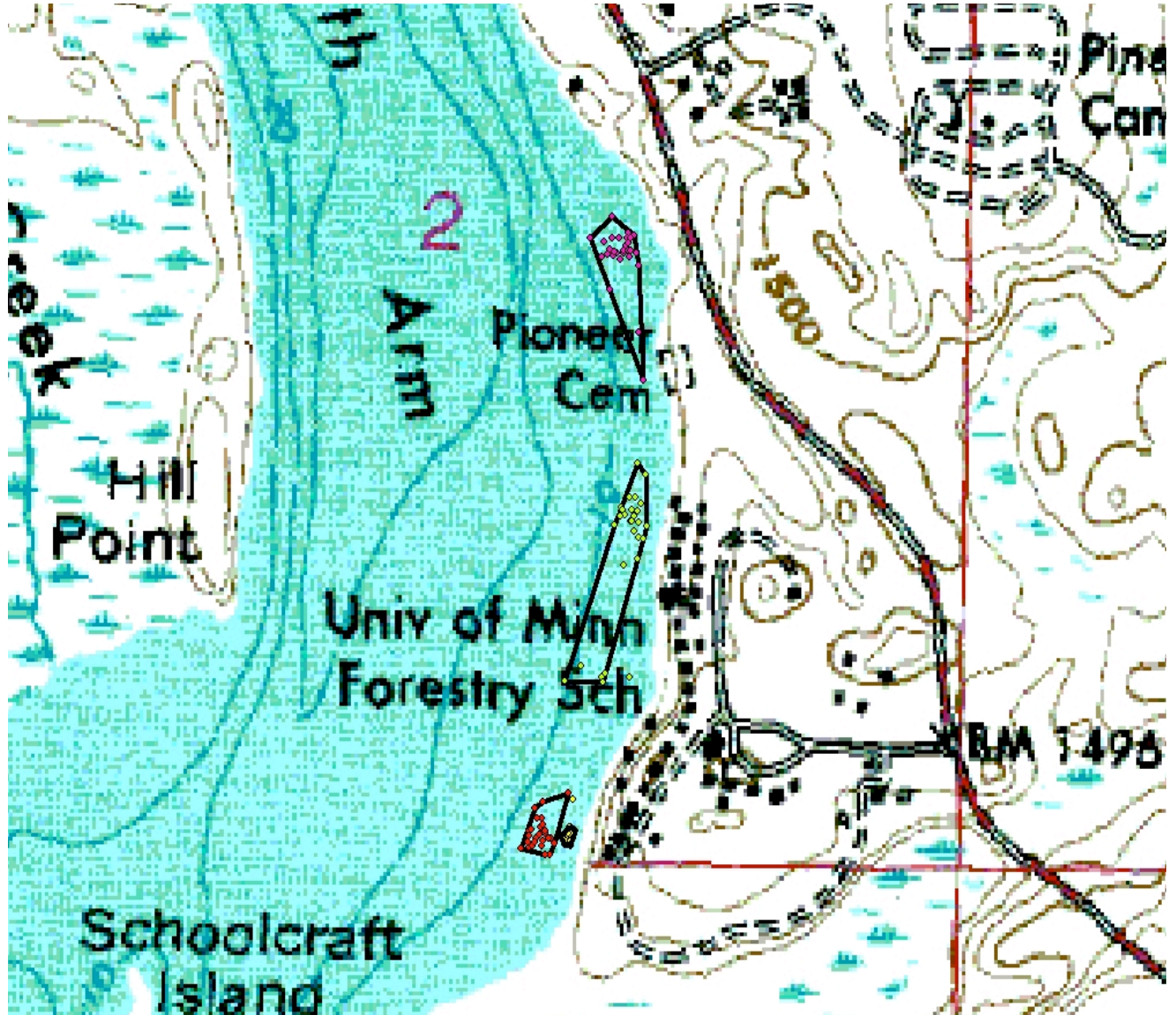


Figure 3: Minimum convex polygon analysis for all four northern pike.

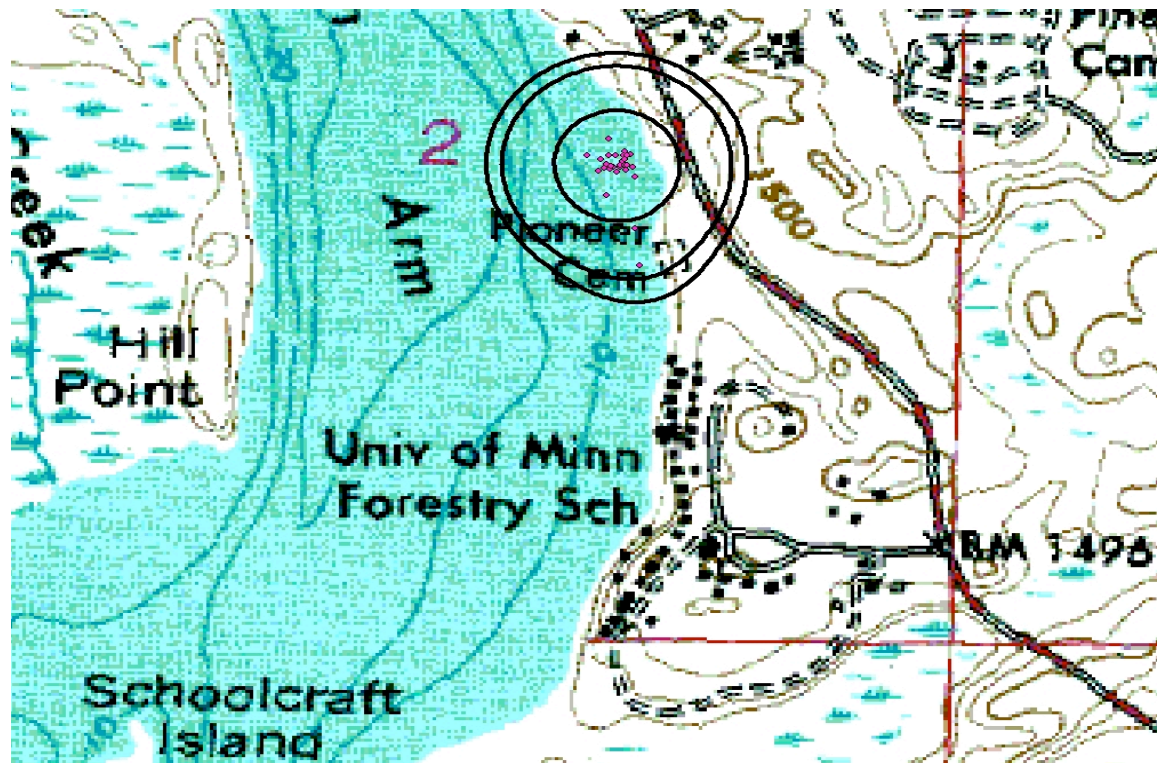


Figure 4: Kernel analysis for 165.671.

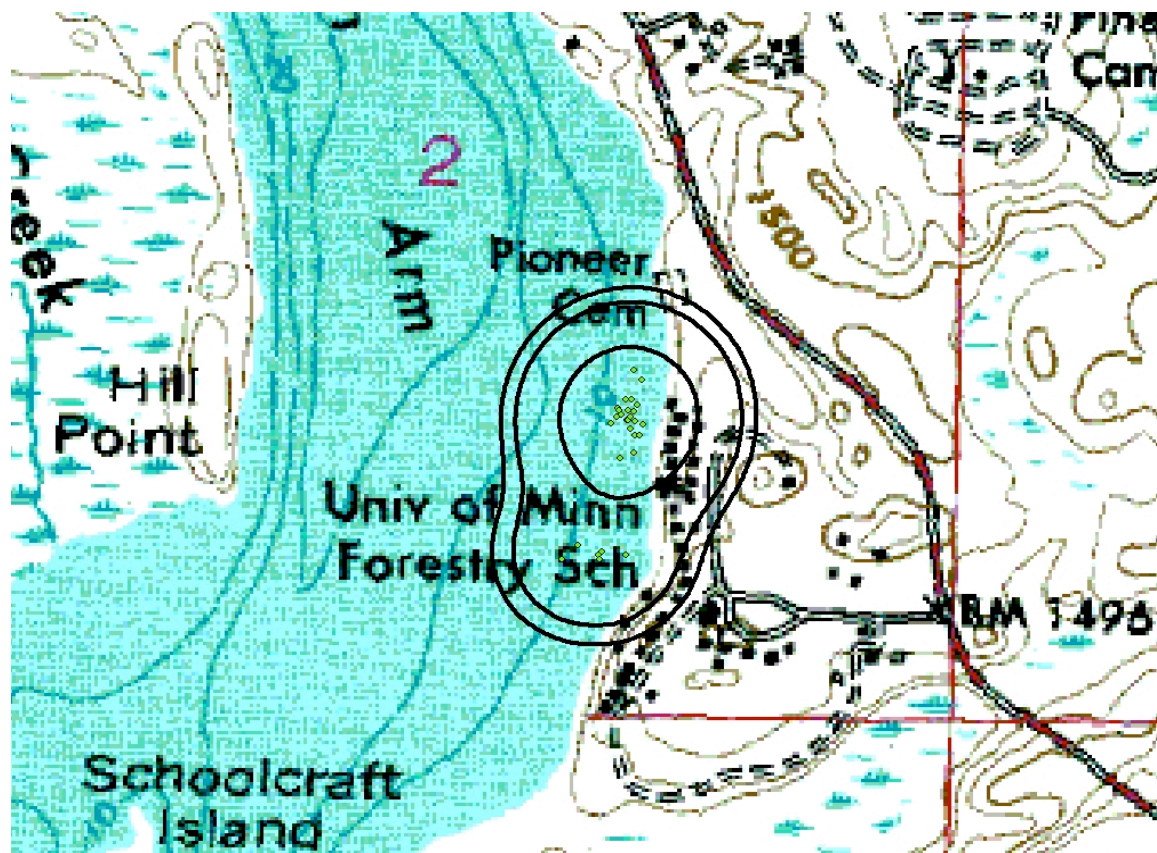


Figure 5: Kernel analysis for pike 165.693.

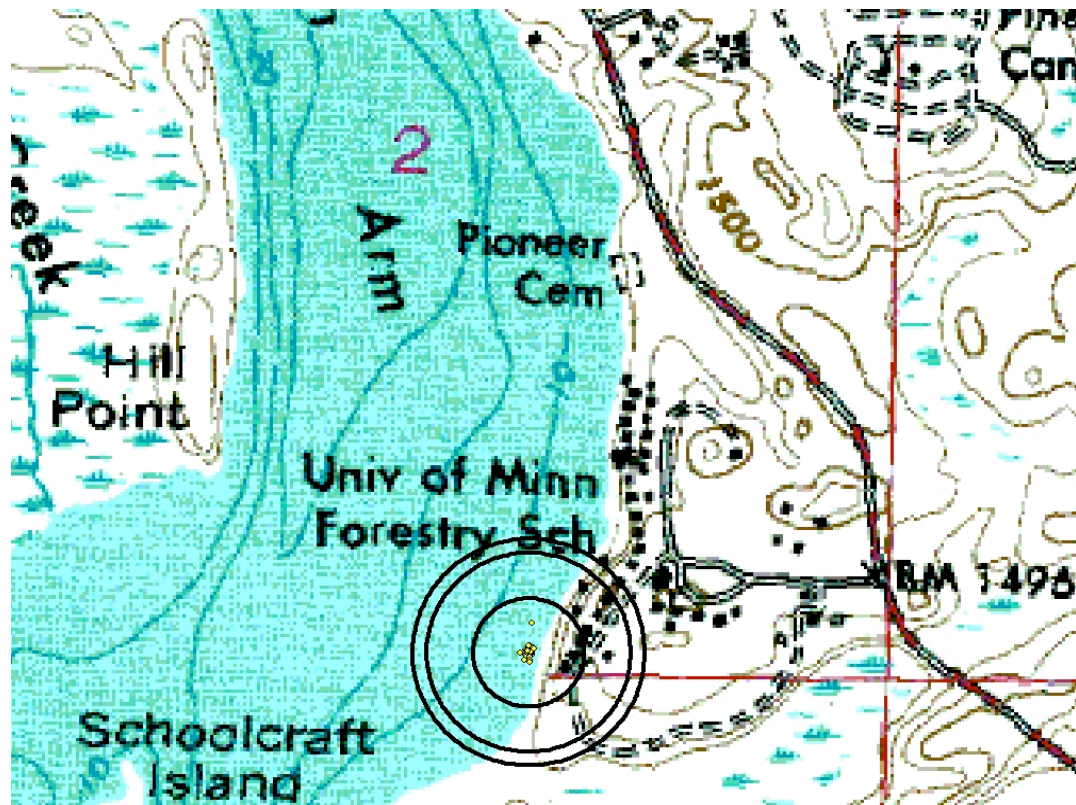


Figure 6: Kernel analysis for pike 165.711.

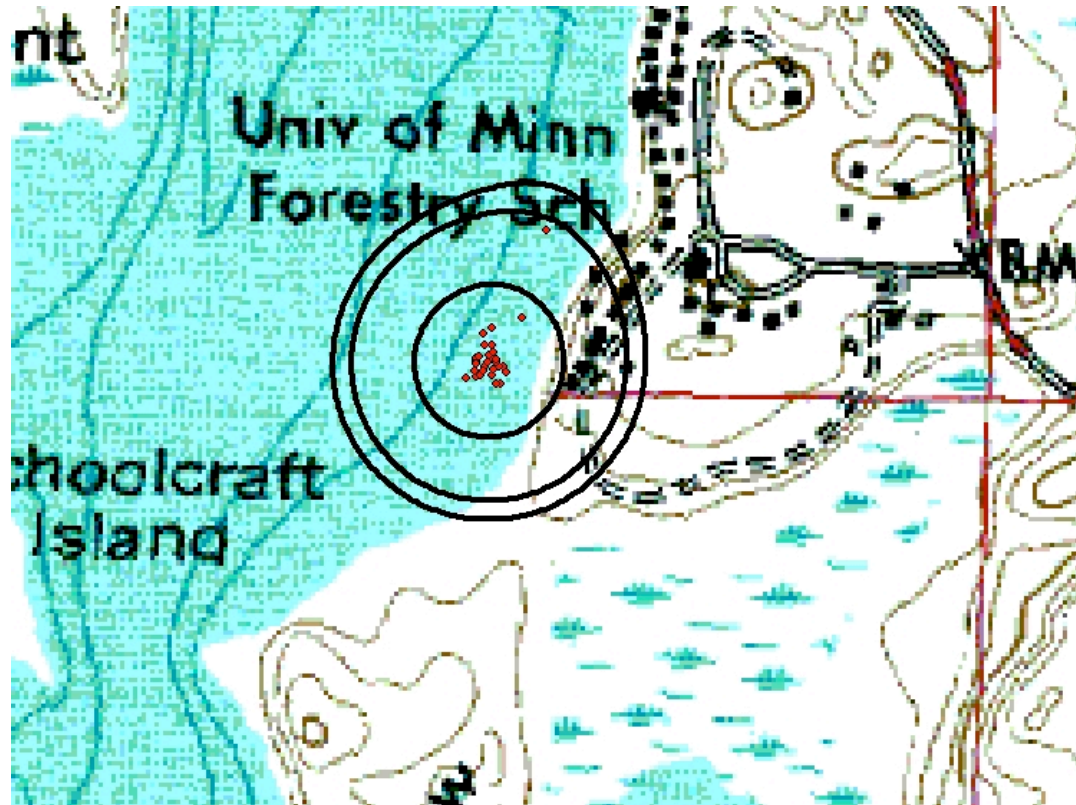


Figure 7: Kernel analysis for pike 165.621.