

Home Range of *Esox lucius* in Lake Itasca

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Northern pike, *Esox lucius*, are freshwater predatory North American fish renowned and beloved by anglers for their fierce fight and delicious filets. Pike are ambush hunters; light vertical stripes on a dark green background blend into vegetation in shallow, sunlit waters. Pike are most active at dawn and dusk, likely because their prey is as well. Pike survive best in cold, well-oxygenated mesotrophic lakes and often times won't breed and even starve themselves if conditions are too warm.

The objective of this study was to monitor the movements and activity levels of pike in Lake Itasca in north central Minnesota. Pike were chosen because their large body size and lack of predators negate the majority of the concerns that the encumbrance and extra weight of a radio transmitter, whether it be internal or external. Internal transmitters with external whip antennas were used in preference of external transmitters and internal transmitters with encapsulated helicoil antennas because they would encumber the fish less. Whip antennas also provide more range, transmitting a strong signal into the water from any angle. A helicoil antenna projects its signal down the central axis of the coil, meaning the antenna would have to be pointed directly into the antenna coil, which could slow tracking by limiting the angles a fish can be located from. However, externally projecting antennas have been shown to collect algae and contribute to fish mortality at high temperatures (Ross & McCormick, 1981). To combat this, the water temperature in Lake Itasca averages 20°C during the summer months, sufficiently slowing algal growth along the antenna.

Methods

Weir nets were sunk into four locations along the eastern shore of the north arm of Lake Itasca. Six pike were captured from these nets, weighed, measured, and held in an overflow tank at 18°C. Since the pike spawning season was over, sex was impossible to determine without intrusive surgery. Five of the pike were individually anaesthetized via immersion in MS-222 diluted to 250mg/L in water until they were disoriented and swimming upside down. Special care was taken during surgery to not overdose the fish and to maintain steady flow of water over the fish's gills. Radio transmitters with Teflon-coated whip antennas and distinct frequencies (Advanced Telemetry Services, Isanti, MN) were inserted into the body cavities the pike following the shielded needle procedure described by Ross and Kleiner (1982). The tags were designed to weigh less than 2% of the fish's body weight so as to not interfere with normal fish behavior after being released. Fish were released at their capture sites after a short recovery period; i.e. when all the fish were swimming upright and cohesively.

Pike were located twice daily from a boat using a portable 4-element yagi antenna attached to a 165 MHz receiver (ATS, Isanti, MN). The GPS map was aligned with NAD27 and coordinates were taken when the transmitter signal became acutely omnidirectional. Water temperature and depth were assessed with an echolocator. Vegetation and weather were noted visually. A continuous 24-hour trial was also conducted, with readings every two hours. A total of 29 locations were recorded for each of four of the pike. Activity level was assessed as based on the regularity of the signal; erratic signal indicated activity, a fast regular signal indicated mortality, and a slow steady signal indicated non-activity. GPS data were processed using ArcView 9 software. Minimum convex polygons were created for each pike to ascribe home range; the area was found after connecting the outermost recorded locations by straight lines.

Kernel analyses was also used ascertain the likelihood of fish presence within an area. Presence areas were encircled at ranges corresponding to 50%, 90%, and 95% confidence intervals.

Results

Of the five tagged fish, four were locatable after the second day. GPS coordinates were standardized to be accurate within 15m of observer-recorded locations, which had a standard error of 11.21m. Water conductivity of Lake Itasca was 248.1 μS ; attenuation at about 6.0 dB/m. Home range size varied from 287.5m² to 11657m². Fish size ranged from 590g, 48.7cm to 756g, 53.5cm. Average water depth varied from 0.61m to 1.22m. Fish size was inversely associated with home range size and water depth; the largest fish had the smallest home range in the shallowest water and vice versa. Fish stayed relatively close to their capture and release points, with the exception of one individual who moved roughly 100m southwest of its previous position, extending its home range in that direction.

Discussion

Generally, it has been found that pike home range is proportional to pike size (Ross & Winter, 1981). The inverse association between pike size and home range is inconsistent with other studies, possibly due to food availability. The largest pike, with the smallest home range, was located near a snag extending out into shallow water into a patch of wild rice and yellow lilies. The smallest pike shifted its position about three-quarters of the way through the study, extending its home range about 100m southwest of its former position. Since the small individual did not return to its former position after it had moved, it may be more accurate to assess two minimum convex polygons and eliminate the area artifact created from migrational movement.

The wind and weather affected the position of the boat, often making it difficult to attain the most acute omnidirectional signal and may have induced a higher level of variability in recorded GPS locations than would pike movement alone. Interference from an unknown source was encountered on several of the signals midway through the study, though it did not prevent fish locations from being recorded.

The accuracy of the pike home range could be furthered by taking more readings. The course of the study was less than three weeks during the late spring of 2010; comparisons between winter and summer ranges would show a greater degree of movement, both laterally and vertically as temperature and food availability change. Two or three more extended 24 hour surveys should also be conducted to determine pike activity levels throughout a diel cycle.

Acknowledgments

We would like to thank Dr. Jon Ross for his assistance with handling the fish during the surgical procedures and Larry Kuechle for his assistance with tracking techniques using the telemetry equipment. We would also like to thank ATS for their donation of the radio transmitters and the use of their receivers and antennas as well as the University of Minnesota Itasca Biological Station and Laboratories for hosting this study and for use of their boats.

References

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- Ross, MJ & McCormick, J. 1981. Effects of external radio transmitters on fish. *Prog. Fish-Cult.* 43(2):67-72.
- Ross, MJ & Winter, J. 1981. Winter movements of four fish species near a thermal plume in northern Minnesota. *Transactions of the American Fisheries Society* 110:14-18.

Data

Frequency	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. Four northern pike, *Esox lucius*, received internal radio transmitters with externally protruding whip antennas. Their movements were tracked with a 4 element yagi antenna attached to a portable receiver and their locations recorded via GPS twice daily, including a 24 hour survey, for a total of 29 data points per fish. Water depth and temperature and vegetation were recorded at each location as well. ArcView software was used to create minimum convex polygons from GPS data to assess home range area.

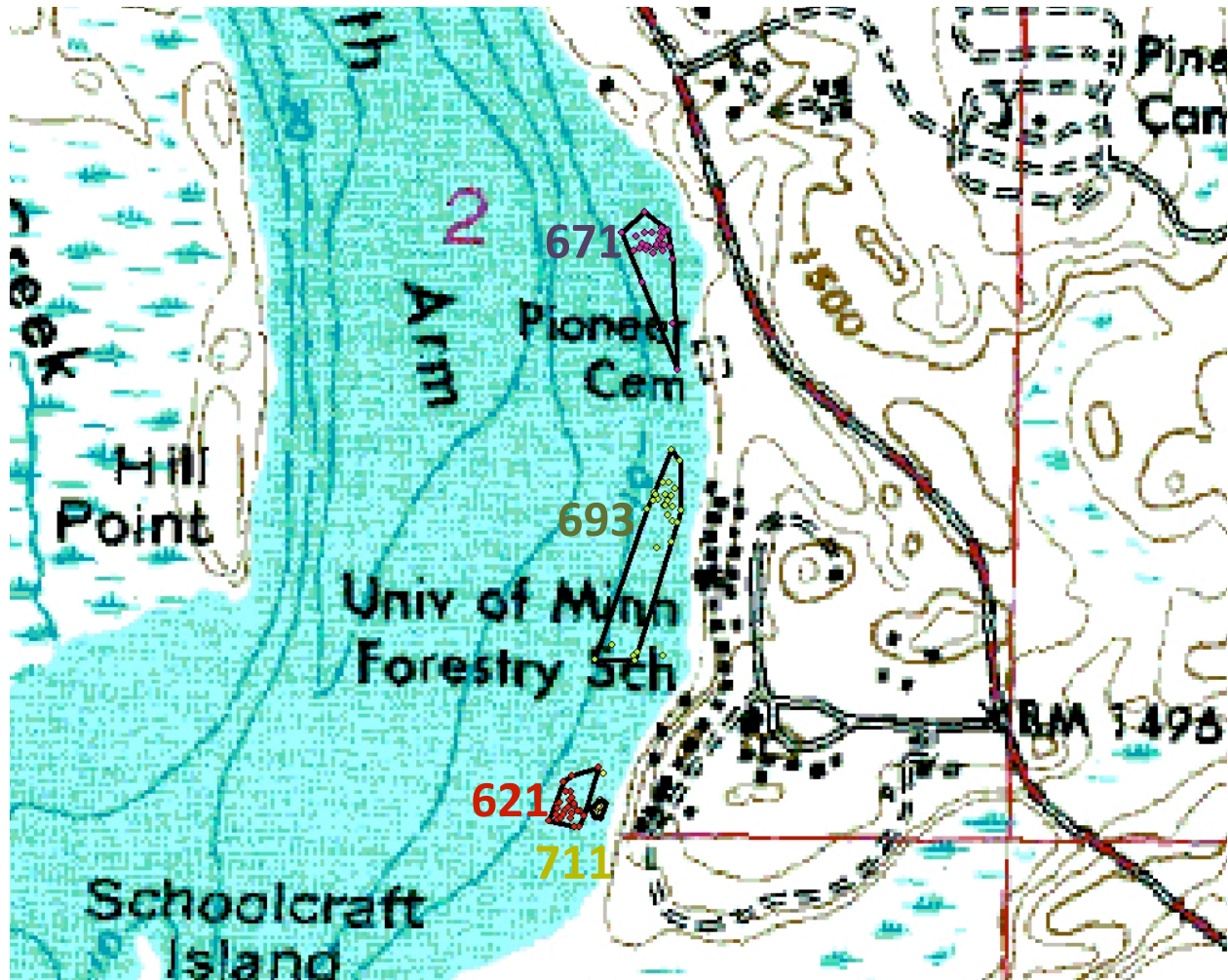


Figure 1. Minimum convex polygons created using ArcView software for four northern pike along the eastern shore of the northern arm of Lake Itasca, MN. Pike were assigned individual 165MHz radio frequency tags, abbreviated to three decimal places, ex.165.711MHz is 711. Home range size varied from 287.5m² to 11657m². Migrational movements were not censored from the survey and are the most likely cause for the large variance in home range size.

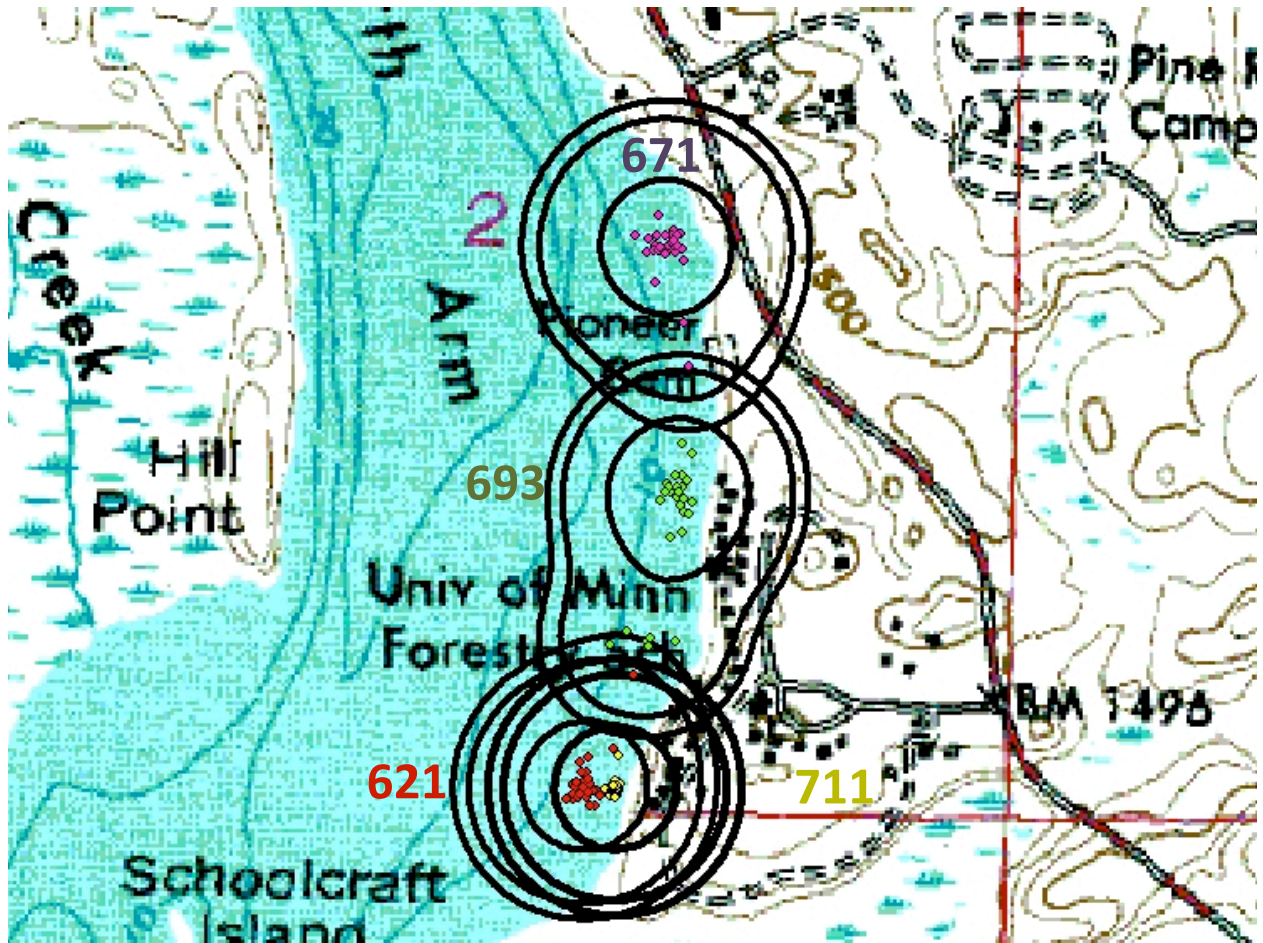


Figure 2. 50%, 90%, and 95% kernel analyses for four northern pike along the eastern shore of the northern arm of Lake Itasca, MN.