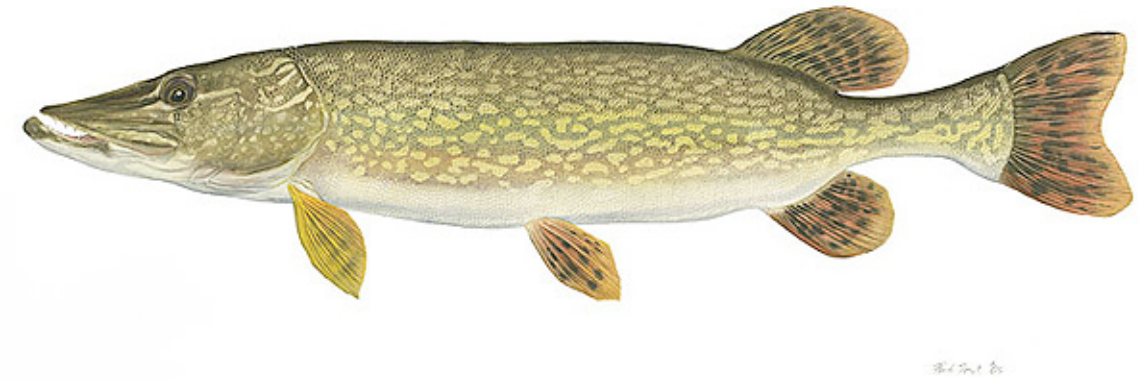
Northern Pike (*Esox lucius*) Home Range Area and Average Depth



Telemetry 4825 Final Paper

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Introduction

Northern pike (*Esox lucius*) are large ambush predators of other fish in northern temperate lakes. Cook and Bergersen (1998) found that in the summer these fish tend to occupy shallow water with large amounts of vegetation. They also reported that the pike in their study showed low levels of activity with most activity occurring at dawn or dusk.

Some studies (Minns, 1995) have suggested a correlation between a fish's size and the size of it's home range. Others (Jepsen et al., 2001) suggest that individual fish within populations show different hunting behavior based on preference and prey availability. Some fish stay in one small area, some remain in a few favorite areas, and others move frequently and lack a distinct home range. Jepsen et al. suggest that in areas with higher prey density a small home range may be possible, while areas with low prey density may force the fish to move more frequently.

Our study focused on the home range size and average depth of pike and whether these were correlated to the length of the fish. We also took data on the vegetation types, water temperature, and activity patterns but due to time constraints we were unable to analyze this data in depth. It is included in our raw data in Appendix B for future uses.

Methods

A total of 6 pike were trapped using sunken weir nets at four different locations in Lake Itasca in northern Minnesota on May 25th and 26th of 2010. All

pike were placed in a holding tank until surgery could be performed and again until they were ready for release.

The pike captured on the 25th were implanted and released that same day. Those captured on the 26th were implanted and released on the 27th. Fish were submerged in a tub of water with a dosage of 250 mg/l of MS-222. The amount of time until the anesthetic took effect was recorded, as well as the amount of time the surgery took and how long until the fish had recovered from the anesthetic. Each fish was implanted with a activity/mortality transmitter. Fish were allowed to recover in the holding tanks and released that afternoon in the same location they had been captured at.

The pike were located from a boat via homing using a 4 element yagi antenna and a 165 Mhz receiver. When the signal became omni-directional we recorded the location from a GPS unit (UTM zone 15N, NAD 27), the dominant vegetation, the activity mode of the animal, the depth, and the water temperature. We planned to located the fish three times a day (morning, afternoon, and evening) whenever weather and schedules permitted. We also tracked the fish every two hours during one 24 hour period to determine if there was any nocturnal activity.

We measured the conductivity of the water at the deepest part of the lake (10 m, location UTM zone 15N 333441, 5232972) to allow us to estimate the attenuation of our signals. To determine our standard error of location we chose a fish with an inactive signal and had three people locate the fish and record the location. Between each location we left the area and returned from a different direction to avoid bias.

For our data analysis we calculated the average depth each pike was found at, and the average depth for all of the pike combined. We also calculated our standard error of location. We used the Arcview 9.x software to generate the minimum convex polygon and perform a fixed kernel estimate and percent volume contour for each pike.

Results

We located four of the six pike 29 times each. One pike had a faulty transmitter and was never located (165.657) and another had a weak signal that was only heard twice and was never located (165.646, heard just off Bear Paw Point). The average depth for each pike is listed in **Table 1** (all tables, graphs, and figures are located in Appendix A), and the average depth for all four pike combined was 1.00 meters. **Figure 1** shows the minimum convex polygon for each of the four fish and Table 1 lists the area of each pike's home range. **Figures 2-5** show the percent volume contour for each fish at 50%, 90%, and 95%. **Graph 1** shows a linear regression for the effects of fish length on average depth. **Graph 2** shows the effects of fish length on the area of the home range while **Graph 3** shows the relationship between average depth and home range area.

The conductivity of the water in Lake Itasca was 248.1 μS at 25°C, making our estimated attenuation for the 160 MHz transmitters about 6dB/m. We calculated our standard deviation to be 11.21 meters and the standard error of the GPS unit was assumed to be 15 meters.

Discussion

We found a strong correlation (Graph 1, R=0.94) between the length of the fish and the average depth at which it was found. This is consistent with previous studies which have shown that larger fish tend to be found in shallower water. This would make sense if the shallow water is better territory with more abundant food and hiding places.

The correlation between fish length and the area of the home range was weaker (Graph 2, R=0.79) but did suggest that larger fish were occupying smaller home ranges. There are several possible reasons why our results contradicted those of other studies. One possibility is that our sample size of only four fish is simply too small to show statistically significant trends. Another possibility is that the home range is selected based on habitat quality as well. The largest fish in our sample (165.711, 53.5 cm) occupied the smallest home range. We had some trouble locating this fish as it was so close to shore that at times we could not reach it with our boat. It also failed to move for most of the study, which prompted us to examine its location on foot. We found that it was occupying a shallow stretch of water around some fallen logs, and that there was an abundance of food there. A large number of dead aquatic animals were floating among the logs and numerous small fish and aquatic arthropods could be seen beneath the surface. We hypothesize that this territory, though the smallest, is the highest quality of those immediately available, so if size indicates fighting ability or dominance the largest fish would monopolize it.

If we were to apply the idea of behavioral types suggested by Jespen et al. to our fish we would find that the largest fish (165.711) is the first type with a single

small territory. Our smallest fish (165.693) would be the second type which occupies and moves between a few small territories. Another possibility is that this fish was only occupying one small range but was forced out by conditions or an unmarked fish. This idea is suggested by the fact that it remained in one small area until the second to the last day of tracking, after which it remained in the new small area. The two fish of middling size (165.621 and 165.671) would be the last type, which moves frequently over a large area.

We found a very weak positive correlation (Graph 3, R=0.59) between average depth and home range size, but concluded that this was not statistically significant. We also found that the fish were always located in vegetation and showed individual preferences to type of vegetation, but due to time limitations were unable to do an analysis to determine if this affects home range size or selection.

Conclusion

Overall our results show that larger northern pike tend to occupy shallower waters than their smaller conspecifics. We also found that the larger pike tended to have smaller home ranges, which is the opposite of what we expected. We suggested several reasons for this including low sample size, habitat quality, and dominance. Further studies into why larger fish have smaller ranges would yield interesting results. We also collected other information which we did not analyze due to time and space restrictions. Further analysis of this data could examine vegetation preference, activity patterns, and the effects of water temperature on

activity levels. Other research could look into how gender and age affect home range size.

Acknowledgements

We would like to thank the Department of Natural Resources for allowing us to use pike captured in their wier nets; John Ross for capturing the pike and implanting transmitters as well as advice and assistance in designing our data collection process and schedule; Larry Kuechle for his advice and assistance on data collection, transmitters, and analysis; and the University of Minnesota Lake Itasca Research Station for allowing us the use of their equipment and software.

References

Cook, M.F., and E.P. Bergersen. 1988. Movements, habitat selection, and activity periods of northern pike in Eleven Mile Reservoir, Colorado. Transactions of the American Fisheries Society 117.5:495.

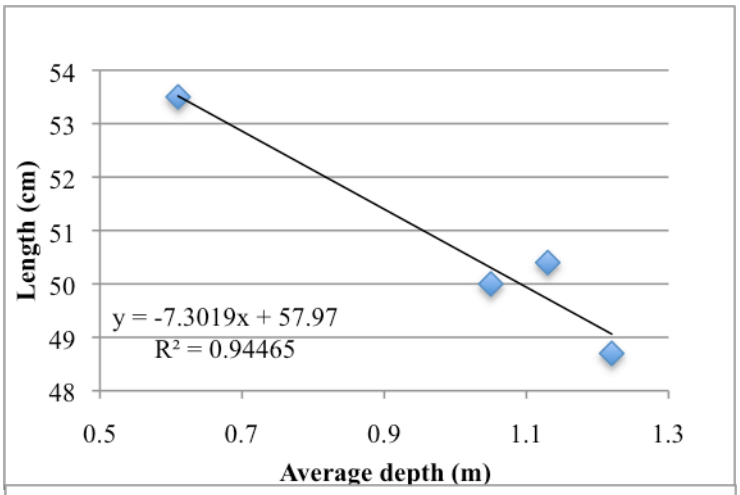
Jepsen, N., S. Beck, C. Skov, and A. Koed. 2001. Behavior of pike (Esox lucius L.)> 50 cm in a turbid reservoir and in a clearwater lake. Ecology of freshwater fish 10.1:26.

Minns, C.K. 1995. Allometry of home range size in lake and river fishes. Canadian Journal of Fisheries and Aquatic Sciences 52: 1499-1508.

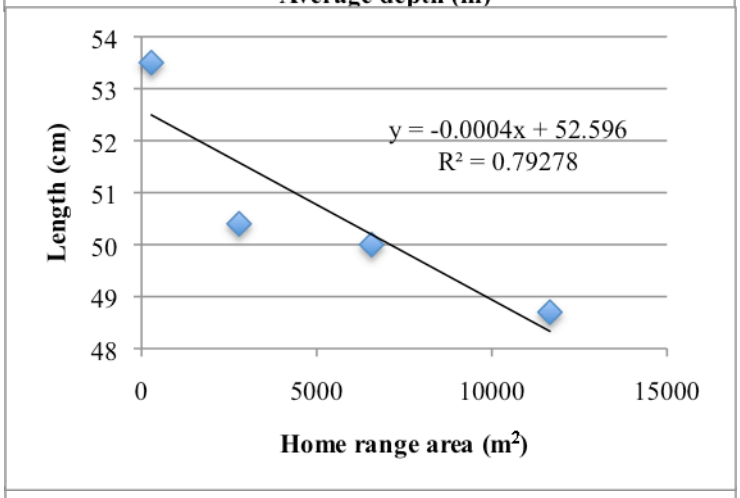
Appendix A: Figures, graphs, and tables

Table 1: Fish weight, length, average depth, and home range size

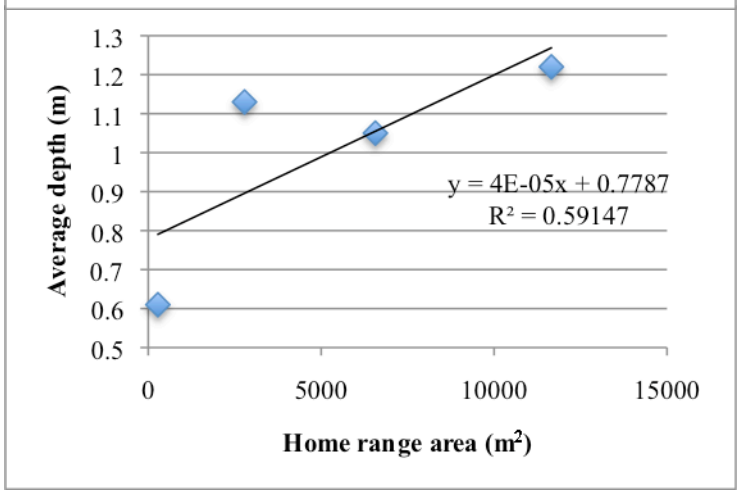
Pike Transmitter Frequency	Weight (g)	Length (cm)	Average Depth (m)	Home Range Area (m^2)
165.671	705	50.0	1.05	6567
165.693	590	48.7	1.22	11657
165.621	648	50.4	1.13	2784
165.711	756	53.5	0.61	278.5
All pike	---	---	1.00	---



Graph 1: Average depth versus length of fish.



Graph 2: Home range area versus length of fish



Graph 3: Home range area versus average depth.

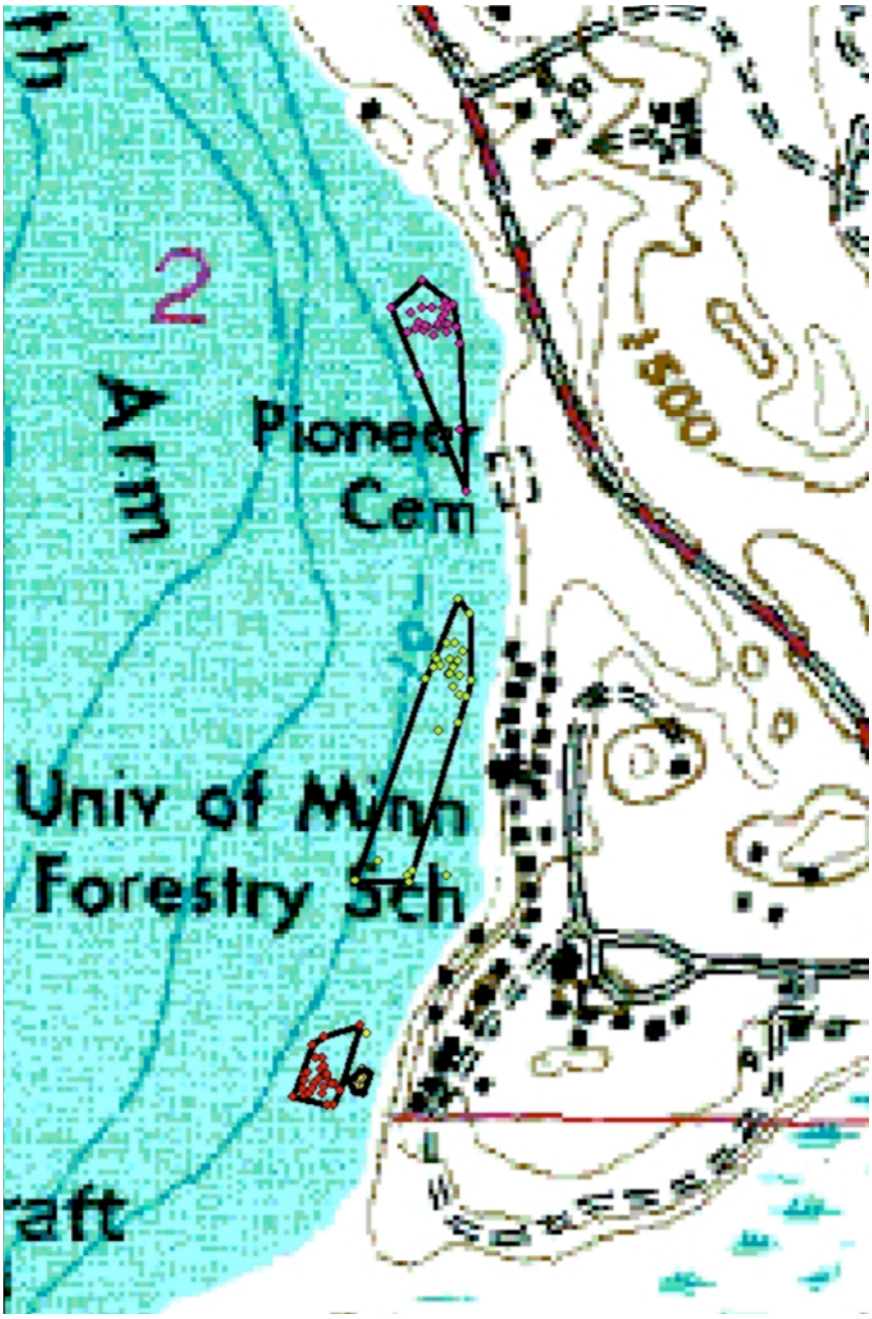


Figure 1: Minimum Convex Polygon for all four pike. Pink locations are for 165.671, green locations are for 165.693, red locations are for 165.621, and yellow locations are for 165.711.

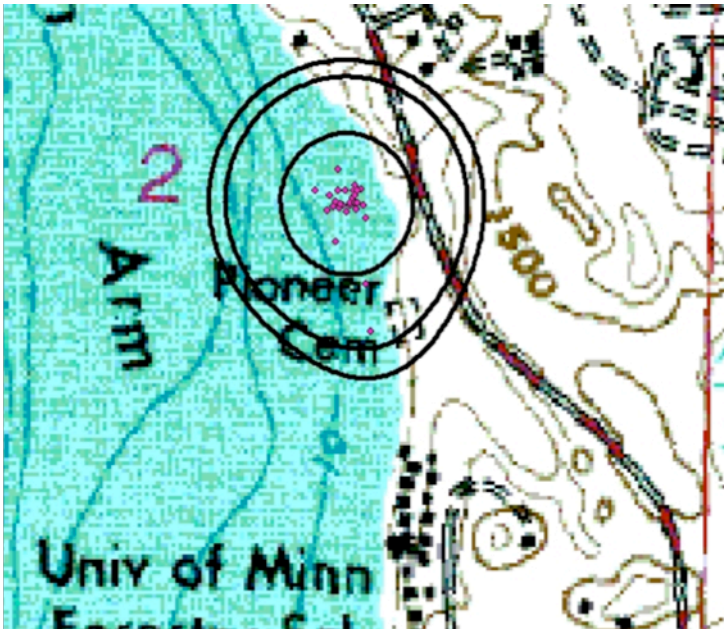


Figure 2: Percent volume contours for 50%, 90%, and 95% for frequency 165.671

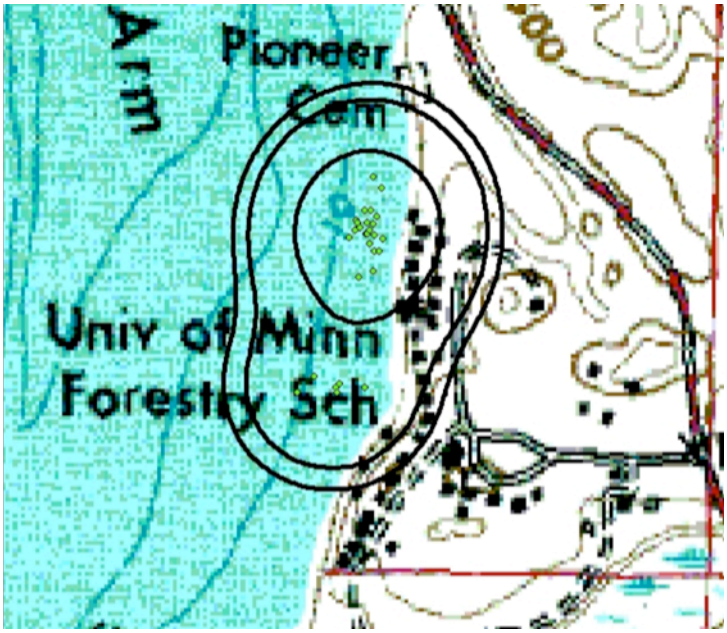


Figure 3: Percent volume contours for 50%, 90%, and 95% for frequency 165.693

Figure 4: Percent volume contours for 50%, 90%, and 95% for frequency 165.621

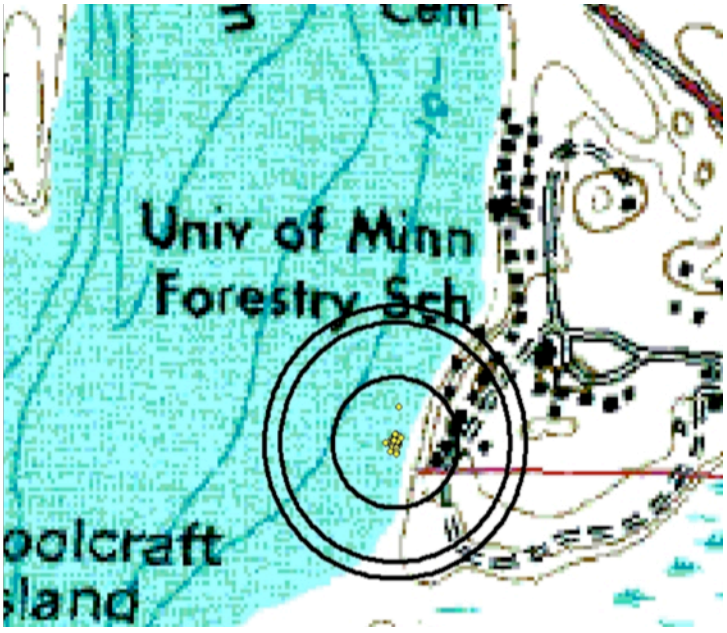


Figure 5: Percent volume contours for 50%, 90%, and 95% for frequency 165.711

Appendix B: Implant data and raw data

Transmitter implants 2010

Species: Northern Pike
Transmitter type: Activity/Mortality
Activity/Mortality
Anesthetic: MS-222
Frequency: 165.657
Weight: 447 g
Length: 44.3 cm
Capture Date: 5-26-2010
Capture Location: North DNR Trap
Release Date: 5-27-2010
Release Location: North DNR Trap
Surgery:
Date: 5-27-2010
Water Temperature: 18°C
pH: 7.0
Anesthetic Dosage: 250 mg/l
Start Time: 11:06 am
Time to go down: 1:39
Surgery Time: 6:50
Recovery Time: 12:00
Comments: abrasions on back, transmitter acting funny, signal dropped out during check

Species: Northern Pike
Transmitter type:

Anesthetic: MS-222
Frequency: 165.671
Weight: 705 g
Length: 50 cm
Capture Date: 5-25-2010
Capture Location: Pioneer Cemetery
Release Date: 5-25-2010
Release Location: Pioneer Cemetery
Surgery:
Date: 5-25-2010
Water Temperature: 17°C
pH: 7.0
Anesthetic Dosage: 250 mg/l
Start Time: 11:12 am
Time to go down: 1:30:32
Surgery Time: 6:50
Recovery Time: 17:00
Comments: lots of neoscus parasites, net marks on skin

Species: Northern Pike
Transmitter type: Activity/Mortality
Activity/Mortality
Anesthetic: MS-222
Frequency: 165.711
Weight: 756 g
Length: 53.5 cm
Capture Date: 5-25-2010
Capture Location: Faculty Cabin Line
Release Date: 5-25-2010
Release Location: Faculty Cabin Line
Surgery:
Date: 5-25-2010
Water Temperature: 17°C
pH: 7.0
Anesthetic Dosage: 250 mg/l
Start Time: 11:25 am
Time to go down: 1:50.90
Surgery Time: 5:23.90

Species: Northern Pike
Transmitter type:

Anesthetic: MS-222
Frequency: 165.693
Weight: 590 g
Length: 48.7 cm
Capture Date: 5-26-2010
Capture Location: Faculty Cabin Line
Release Date: 5-27-2010
Release Location: Faculty Cabin Line
Surgery:
Date: 5-27-2010
Water Temperature: 18°C
pH: 7.0
Anesthetic Dosage: 250 mg/l
Start Time: 10:30 am
Time to go down: 1:20
Surgery Time: 8:42

Recovery Time: 12:48
Comments: net marks on skin, full belly

Species: Northern Pike
Transmitter type: Activity/Mortality
Activity/Mortality
Anesthetic: MS-222
Frequency: 165.621
Weight: 648 g
Length: 50.4 cm
Capture Date: 5-26-2010
Capture Location: North DNR Trap
Release Date: 5-27-2010
Release Location: North DNR Trap
Surgery:
Date: 5-27-2010
Water Temperature: 18°C
pH: 7.0
Anesthetic Dosage: 250 mg/l
Start Time: 10:42 am
Time to go down: 1:26
Surgery Time: 7:32
Recovery Time: 11:00
Comments: none

Recovery Time: 7:00
Comments: none

Species: Northern Pike
Transmitter type:

Anesthetic: MS-222
Frequency: 165.646
Weight: 649 g
Length: 49 cm
Capture Date: 5-26-2010
Capture Location: South DNR Trap
Release Date: 5-27-2010
Release Location: South DNR Trap
Surgery:
Date: 5-27-2010
Water Temperature: 18°C
pH: 7.0
Anesthetic Dosage: 250 mg/l
Start Time: 10:54 am
Time to go down: 1:31
Surgery Time: 6:32
Recovery Time: 5:00
Comments: none

Raw Data

HSBR- Hard stem bull rush
YL- Yellow Lily
WR- Wild Rice

Pike Transmitter Number: 165.671								
Date	**Time**	**X coordinate**	**Y coordinate**	**Vegetation**	**Activity**	**Depth (m)**	**Temp. (˚C)**	**Comments**
2010152	13:30-14:30	333,726	5,233,049	HSBR	1	-----	-------	
2010152	19:00-20:00	333,717	5,233,053	HSBR, YL	1	0.90	20.80	
2010153	6:15-6:45	333,712	5,233,028	HSBR, YL	1	1.10	13.90	
2010153	19:10-19:35	333,738	5,232,867	HSBR, YL	0	0.90	18.10	
2010153	21:10-21:31	333,732	5,232,928	HSBR, YL	1	1.00	18.00	
2010153	23:00-23:25	333,720	5,233,023	HSBR, WR	1	1.00	17.70	
2010154	1:15-1:45	333,696	5,233,073	HSBR, WR	1	0.90	18.10	
2010154	3:05-3:41	333,716	5,233,046	WR, HSBR	1	0.90	14.50	
2010154	5:05-5:37	333,702	5,233,027	HSBR, WR	1	1.10	14.60	
2010154	7:35-8:03	333,711	5,233,031	HSBR, WR	1	1.10	14.20	moving around, hard to pinpoin
2010154	9:04-9:29	333,706	5,233,020	HSBR, WR	1	1.10	17.00	
2010154	10:56-11:28	333,732	5,233,012	WR	1	1.00	26.00	
2010154	13:00-13:25	333,721	5,233,046	HSBR, WR, YL	1	1.00	20.40	
2010154	14:55-15:20	333,717	5,233,031	HSBR, WR	1	1.00	21.40	
2010154	17:00-17:25	333,729	5,233,027	WR	1	1.00	22.00	
2010154	19:00-19:20	333,715	5,233,037	YL, HSBR, WR	1	1.10	23.10	
2010155	11:28-11:48	333,682	5,233,022	HSBR, WR	1	1.10	22.00	
2010155	19:40-19:55	333,684	5,233,041	HSBR, WR, YL	1	1.10	19.70	
2010156	6:50-7:15	333,721	5,233,031	HSBR, WR	1	1.10	18.60	
2010156	18:55-19:08	333,666	5,233,046	HSBR, WR	1	1.20	22.20	
2010157	12:00-12:20	333,705	5,233,046	YL, HSBR, WR	1	1.20	21.30	
2010157	18:00-18:20	333,692	5,232,982	HSBR, WR	1	1.20	22.00	
2010158	12:15-12:30	333,716	5,233,021	HSBR, WR	1	1.10	20.60	
2010158	17:52-18:10	333,693	5,233,032	HSBR, YL, WR	1	1.10	21.60	
2010159	6:55-7:15	333,690	5,233,026	HSBR, WR	1	1.10	18.30	
2010159	10:40-11:05	333,697	5,233,025	HSBR, WR	1	1.00	20.40	
2010159	16:29-16:50	333,695	5,233,046	HSBR, WR	1	1.10	24.50	
2010159	18:50-19:05	333,699	5,233,029	HSBR, WR	1	1.00	23.10	
2010160	18:43-18:57	333,717	5,233,040	YL, HSBR, WR	1	1.00	20.60	

Pike Transmitter Number: 165.693

Date	Time	X coordinate	Y coordinate	Vegetation	Activity	Depth (m)	Temp. (˚C)	Comments
2010152	13:30-14:30	333,742	5,232,748	HSBR	1	--------	--------	Spooked up
2010152	19:00-20:00	333,743	5,232,683	HSBR	0	1.00	22.70	
2010153	6:15-6:45	333,725	5,232,695	HSBR	1	1.20	13.30	
2010153	19:10-19:35	333,730	5,232,642	HSBR, YL, WR	0	1.10	17.50	
2010153	21:10-21:31	333,713	5,232,697	HSBR, WR	0	1.40	18.20	massive amount of interference
2010153	23:00-23:25	333,708	5,232,707	HSBR, WR	0	1.30	17.80	
2010154	1:15-1:45	333,728	5,232,720	HSBR, WR	0	1.00	18.90	
2010154	3:05-3:41	333,732	5,232,668	WR, HSBR	1	1.10	14.50	
2010154	5:05-5:37	333,710	5,232,704	HSBR, WR	1	1.40	14.50	Spooked up
2010154	7:35-8:03	333, 730	5,232,763	HSBR, WR	0	1.10	14.40	
2010154	9:04-9:29	333,706	5,232,695	HSBR, WR	0	1.20	17.60	
2010154	10:56-11:28	333,721	5,232,689	HSBR, WR	0	1.30	22.00	
2010154	13:00-13:25	333,730	5,232,702	HSBR, WR	0	0.50	20.60	less interference, only present on this channel
2010154	14:55-15:20	333,738	5,232,667	YL, HSBR, WR	0	1.10	21.30	bad interference
2010154	17:00-17:25	333,723	5,232,704	HSBR, WR	0	1.30	21.30	
2010154	19:00-19:25	333,735	5,232,711	HSBR, WR	0	1.20	21.10	
2010155	11:28-11:48	333,722	5,232,690	HSBR, WR	0	1.30	21.80	
2010155	19:40-19:55	333,719	5,232,719	HSBR, WR	0	1.20	19.20	
2010156	6:50-7:15	333,699	5,232,684	WR, HSBR	0	1.70	18.40	triple click interference
2010156	18:55-19:08	333,732	5,232,286	HSBR, WR	0	1.10	21.90	initally inactive than spooked up
2010157	12:00-12:20	333,725	5,232,695	HSBR, WR	0	1.20	20.10	
2010157	18:00-18:20	333,712	5,232,634	HSBR, WR	0	1.30	23.10	
2010158	12:15-12:30	333,719	5,232,493	YL, WR	0	1.00	23.10	
2010158	17:52-18:10	333,726	5,232,677	HSBR, WR	0	1.10	23.30	
2010159	6:55-7:15	333,681	5,232,249	YL, WR, HSBR	1	1.40	18.10	bad interference
2010159	10:40-11:05	333,683	5,232,486	HSBR, WR, YL	0	1.30	20.00	
2010159	16:29-16:50	333,631	5,232,487	WR	0	1.60	24.60	static and 3-click interference
2010159	18:50-19:05	333,653	5,232,507	HSBR, WR	0	1.40	22.10	
2010160	18:43-18:57	333,686	5,232,497	WR, HSBR, YL	0/1*	1.30	20.00	Spooked up

Pike Transmitter Number: 165.621

Date	Time	X coordinate	Y coordinate	Vegetation	Activity	Depth (m)	Temp. (˚C)	Comments
2010152	13:30-14:30	333,599	5,232,314	WR	1	------	-------	
2010152	19:00-20:00	333,600	5,232,335	HSBR, WR, YL	1	1.20	20.00	
2010153	6:15-6:45	333,599	5,232,279	YL, HSBR, WR	1	1.00	13.70	
2010153	19:10-19:35	333,663	5,232,447	WR	1	1.30	16.80	
2010153	21:10-21:31	333,635	5,232,346	YL, WR	1	0.90	18.20	
2010153	23:00-23:25	333,610	5,232,269	YL, WR	1	1.00	17.80	
2010154	1:15-1:45	333,604	5,232,269	WR, YL, HSBR	1	1.00	18.30	
2010154	3:05-3:41	333,612	5,232,290	WR, YL	1	0.90	14.40	
2010154	5:05-5:37	333,592	5,232,315	HSBR, WR, YL	1	1.40	15.30	
2010154	7:35-8:03	333,591	5,232,289	YL, WR	1	1.20	15.40	
2010154	9:04-9:29	333,581	5,232,278	YL, HSBR, WR	1	1.30	17.40	
2010154	10:56-11:28	333,581	5,232,297	HSBR, WR	1	1.30	22.20	
2010154	13:00-13:25	333,581	5,232,299	HSBR, WR, YL	1	1.20	20.40	
2010154	14:55-15:20	333,570	5,232,277	HSBR, WR, YL	1	0.40	20.30	
2010154	17:00-17:25	333,589	5,232,328	HSBR, WR	1	1.30	22.00	
2010154	19:00-19:25	333,582	5,232,293	YL, WR	1	1.20	20.10	
2010155	11:28-11:48	333,585	5,232,301	HSBR, YL, WR	1	1.10	22.00	a little interference
2010155	19:40-19:55	333,608	5,232,290	YL, WR	1	1.10	19.50	
2010156	6:50-7:15	333,600	5,232,300	YL,WR	1	1.20	18.20	triple click interference
2010156	18:55-19:08	333,616	5,232,283	YL, WR	0	1.10	23.40	
2010157	12:00-12:20	333,604	5,232,295	YL, WR	1	1.20	20.90	lots of interference
2010157	18:00-18:20	333,580	5,232,285	YL, WR	0	1.20	21.50	
2010158	12:15-12:30	333,586	5,232,279	YL, WR	0	1.20	21.90	
2010158	17:52-18:10	333,604	5,232,298	YL, WR	1	1.20	23.60	
2010159	6:55-7:15	333,597	5,232,303	YL, WR	1	1.20	18.40	bad interfernce
2010159	10:40-11:05	333,601	5,232,286	WR, YL	1	1.10	20.20	
2010159	16:29-16:50	333,689	5,232,285	YL, WR	1	1.10	23.60	
2010159	18:50-19:05	333,601	5,232,306	YL, WR	1	1.20	22.30	
2010160	18:43-18:57	333,595	5,232,294	YL, WR	1	1.10	19.80	

Pike Transmitter Number: 165.711

Date	Time	X coordinate	Y coordinate	Vegetation	Activity	Depth (m)	Temp. (˚C)	Comments
2010152	13:30-14:30	333,642	5,232,338	WR, YL	0/1	------	-------	Initially inactive, activity later with slower beep
2010152	19:00-20:00	333,630	5,232,294	YL, WR	0*	0.80	22.70	mortallity signal: next to South DNR trap
2010153	6:15-6:45	333,638	5,232,303	YL, WR	1	1.00	13.20	still in same location by the South DNR trap
2010153	19:10-19:35	333,651	5,232,---	YL, WR	0	1.10	16.60	
2010153	21:10-21:31	333,640	5,232,292	YL, WR	0	0.40	18.10	
2010153	23:00-23:25	333,641	5,232,290	YL, WR	0/1	0.51	17.80	initially inactive, in close proximity, spooked turned active signal
2010154	1:15-1:45	333,633	5,232,287	WR, YL, HSBR	1	0.60	18.30	
2010154	3:05-3:41	333,624	5,232,292	WR, YL	1	0.80	14.20	
2010154	5:05-5:37	333,632	5,232,297	HSBR, WR, YL	1	0.90	15.70	too close to shore to pinpoint
2010154	7:35-8:03	333,633	5,232,296	YL, WR	1	0.90	14.40	too close to shore to pinpoint
2010154	9:04-9:29	333,630	5,232,282	YL, WR	1	0.40	17.10	
2010154	10:56-11:28	33,634	5,232,291	YL, WR	1	0.70	22.20	
2010154	13:00-13:25	333,639	5,232,282	YL, WR	1	0.50	20.60	
2010154	14:55-15:20	333,639	5,232,292	YL, WR	1	0.40	20.40	
2010154	17:00-17:25	333,632	5,232,289	YL, WR	1	0.40	21.90	still in same location by the South DNR trap
2010154	19:00-19:20	333,634	5,232,288	YL, WR	1	0.60	19.80	
2010155	11:28-11:48	333,641	5,232,292	YL, WR	1	0.30	21.50	
2010155	19:40-19:55	333,640	5,232,292	YL, WR	1	0.60	19.20	further away from tree, actual pinpoint
2010156	6:50-7:15	333,639	5,232,298	YL, WR	1	0.60	18.30	too close to shore to pinpoint
2010156	18:55-19:08	333,638	5,232,286	YL, WR	0	0.50	22.00	
2010157	12:00-12:20	333,636	5,232,293	YL, WR	1	0.50	20.50	
2010157	18:00-18:20	333,638	5,232,282	YL, WR	1	0.70	21.80	
2010158	12:15-12:30	333,638	5,232,279	YL, WR	1	0.60	22.10	
2010158	17:52-18:10	333,643	5,232,300	YL, WR	1	0.50	22.00	
2010159	6:55-7:15	333,637	5,232,303	YL, WR	0	0.60	18.30	
2010159	10:40-11:05	333,644	5,232,299	WR, YL	1	0.50	20.00	
2010159	16:29-16:50	333,637	5,232,294	YL, WR	1	0.60	24.10	
2010159	18:50-19:05	333,640	5,232,295	YL, WR	1	0.50	22.70	
2010160	18:43-18:57	333,636	5,232,296	YL, WR	1	0.60	19.50	