Short term radio telemetry assessment of northern pike, *Esox lucius,* habitat in a small eutrophic lake

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July 22, 2008
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Abstract

Northern pike, *Esox lucius*, which has nearly cosmopolitan distribution in the northern hemisphere is the top predator in many coolwater habitats. It is known as a keystone species and can affect species composition, abundance and distribution. Our study took place in Brown Lake, on UNDERC property in Gogebic County, Michigan. Habitat preferences were examined by radio telemetry. Seven northern pike had passive radio tags implanted and were released. 12 tracking events, 6 during the day and 6 at night, were completed. Pike showed a significant preference for the littoral zone, and they showed statistically significant preference for sandy substrate and submergent vegetation.

Introduction

Northern pike, *Esox lucius* is known as a keystone species and a top predator in coolwater habitats, which affects fish species composition, abundance and distribution (Craig 2008). It is a highly important sport fish, often growing to large size and providing trophy fishing opportunities (Margenau et al. 2008). Pike spawn earlier than muskellunge, *Esox masquinongy*, and when occurring sympatrically, young pike usually prey on muskie fry and begin to dominate the fish community (Oehemke 1951; Kerr and Oliver 1996). The goal of this study is to provide managers wishing to manage for muskellunge in small lakes where pike and muskie are sympatric a description of preferred pike habitat and behavior.

Radio telemetry is described as a suitable method of observing pike habitat and behavior (Koed et al. 2006). In previous studies size, sex and season have been examined as factors controlling habitat use over long time scales (Kobler et al. 2008). Movement of

pike in lakes and reservoirs has been studied using telemetry previously, but these studies have shown great variation among behavior populations (Jespen et al. 2001).

Studies have showed the importance of aquatic vegetation to pike (Chapman and Mackay 1984) as pike are known primarily as ambush predators, which feed on prey among dense vegetation (Savino & Stein, 1989). Also pike have been known to prefer woody debris such as downed trees which create open water near dense vegetation but they have also been shown to select the habitats with the greatest fitness according to the idea free distribution theory (Haugen et al. 2006).

While many studies examine the role of vegetation in pike habitat preference, few examine substrate type preferences. There is at least one study, however, shows that inorganic substrates are among the poorest habitat for spawning pike due to poor ability for vegetation to grow and thus spawning sites are reduced (Casselman and Lewis 1996), but a literature search showed no studies on adults' preferential substrates.

In our study we wished to examine patterns of behavior over a short time period, with special emphasis on differences between day and night and habitat choices. We hypothesize that pike will preferentially choose littoral zone habitats with submergent vegetation, and muddy substrate. We also hypothesize that activity will increase at night.

Study Site

Brown Lake a highly eutrophic ecosystem located in Gogebic County, Michigan all of which lies on property owned by the University of Notre Environmental Research Center. The lake is 63 acres (25.5 ha) and is fairly shallow with a maximum depth of 5.49m. The lake drains to the northwest through Brown Creek, which was blocked near the outlet by a beaver dam approximately four feet tall. The lake is very turbid with a Secchi depth of less than 1m and high conductivity (133.5 µS). Fish assemblage in the lake consists of northern pike, walleye, black crappie, yellow perch, bluegill, pumpkinseed, golden shiner and white sucker. A small number of large adult muskellunge are known to exist in the lake, but it is unknown if they are naturally reproducing. Percentages of littoral zone substrates are reported in table 1.

Table 1. Percent composition of littoral zone. Three substrates were found, reported in the left hand column. Their approximate percentages of littoral zone composition are reported in the left column

Littoral zone substrate type	Percent littoral zone composition
mud/muck	70
Sand	25
rock/gravel	5

Materials and Methods

Seven northern pike in Brown Lake were tagged with radio transmitters. Tracking was manual, using a small boat with an electric motor and telemetry receiver. Fish were tracked six days with one day and one dusk tracking event, for a total of 12 sampling events. Fish location and habitat were recorded, as was movement. Movement was

identified by high power trackings followed immediately by low power trackings and *vice versa*. Habitat was divided into shore vegetation, littoral vegetation and substrate. Percent substrate composition was estimated by recording physical observations on a map. These percentages were used in X^2 analysis.

Habitat preferences of substrate, shore vegetation and aquatic vegetation were analyzed using chi-squared analysis (N=64). In order to analyze day vs. night movement, an exact binomial test was used on only those fish that were moving (N=10)

Results

Based on unweighted telemetry data, northern pike preferred habitat of sandy substrate and submergent vegetation, figure 1, (chi-squared =6.105, df=1, p=0.013). Chi-squared statistical analysis of shore and substrate did show a significant negative response to coarse woody debris and mud (X^2=9.472, df=1, p=0.002). However, when shore littoral zone substrate types were weighted by approximate proportion, chi-squared showed a stronger response of pike toward sandy substrate (p<0.001). Pike found in open water were omitted from substrate and vegetation tests because it was impossible to determine pelagic substrate, and presumably no vegetation was present. All the possible pair-wise comparisons tested are listed in table 2.

Table 2. Chi-squared test significance. Parameters of pairwise tests are reported with corresponding p-values

Test paramaters	p-value
Shore habitat and substrate	0.002
Vegetation and substrate	0.013
Day vs. night in open water	0.796
Unweighted substrate only	0.006
Weighted substrate only	<0.001
Moving vs. Time	0.031
Pelagic vs. littoral	<0.001

Pike were only found in the pelagic zone 18.9% of the time and those that were in the pelagic zone showed no preference for being in open water during the day or at night. But there was however, in all fish, a marginally significant trend of more movement at night than during the day (exact binomial test, 1:1 ratio, p=0.109).

Discussion

Northern pike did show significant non-random habitat choice. Pike preferred vegetated littoral zone with a sandy substrate. The findings that pike prefer vegetated habitat correspond to many earlier studies (Klefoth et al. 2008; Eklov 1997; Chapman & Mackay 1984). One factor that may contribute to pike's preference of vegetation is the fact that prey species heavily utilize macrophytes for cover, and pike congregate around the vegetation. Pike are known as sit and wait predators (Savino and Stein 1989), stalking and attacking only nearby prey. Our results also confirm that pike are mainly sedentary. The vegetation affords the pike sufficient hunting ground. The tradeoff is that often if too

dense, larger individuals cannot penetrate the cover (Skov et al. 2003). This probably explains why pike selected against areas where submergent and emergent vegetation were both present. These patches were just too dense to hunt in.

A literature search revealed no insights into possible factors contributing to pike preference for sandy substrate. Our telemetry data showed, contradictory to our hypothesis, that pike do indeed prefer sandy substrate. There is however, at least one study that shows that pike select against sandy substrate (Casselman and Lewis 1996). One possible explanation for the selection of sand is enhanced contrast between prey and the background. Contrast of prey decreases with turbidity of water (Utne-Palm 2002). In order to maximize contrast, pike may preferentially choose a sandy substrate, which is lighter in color than mud so that prey contrast can be maximized, and thus hunting efficiency is maximized.

We found a marginally significant result indicating that pike are more active at dusk and dark, which is somewhat consistent with the literature. Our result though, was probably skewed by inconsistent evening tracking times. Some trackings were carried out at dusk and some were carried just after dusk. This is a problem because Jarvalt et al. (2005) indicates that pike are most active at dusk, but when it becomes completely dark, they are almost entirely inactive. If this study were to be carried out again in the future, all evening tracking would be conducted at dusk.

In order to determine factors controlling pike habitat preference, more studies must be completed. I propose a more intensive radio telemetry study should be undertaken. In order to truly determine preferences, active tags should be used that record activity patterns and physical characteristics. Tracking should be more intensive, with a

fish being monitored for longer periods of time instead of just locating them. In addition,

lab experiments should attempt to determine if contrast really is the driving factor of

substrate preference.

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Figures
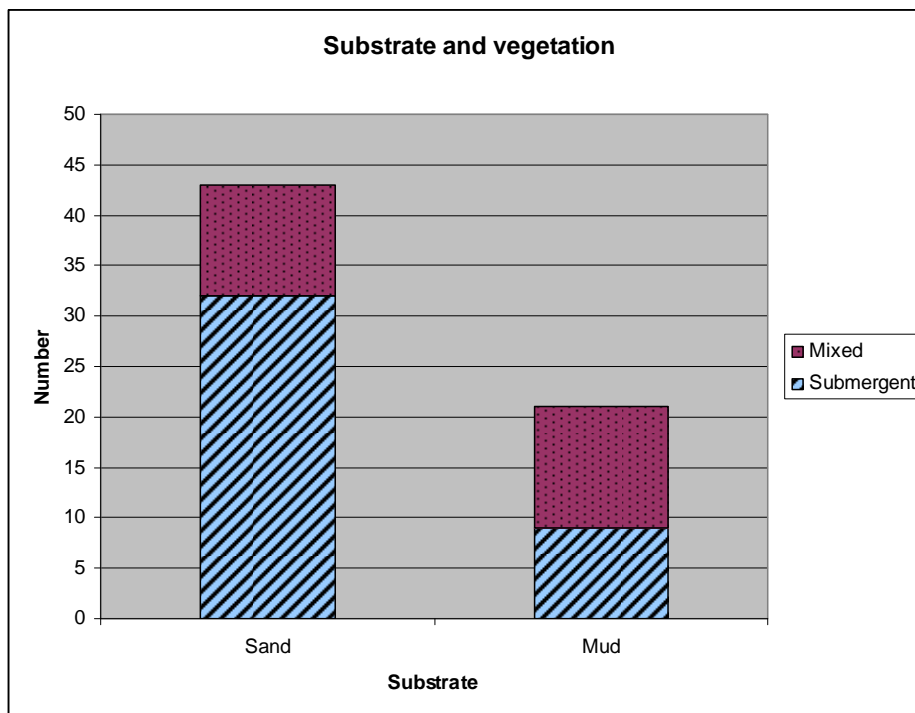
Figure 1. X^2 *of substrate vs. vegetation*. Pike showed significant preference for sandy substrate with submergent vegetation. Mixed vegetation is dotted, submergent only is striped. X^2= 6.105, df=1, p=0.013
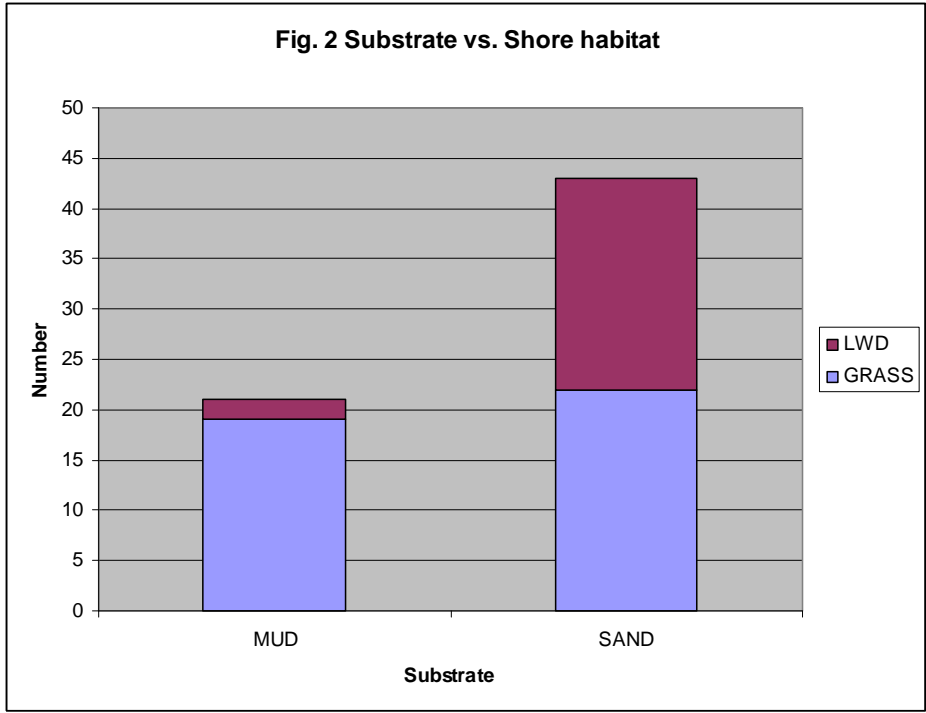
Figure 2 *Substrate vs. shore habitat.* Pike selected against large woody debris and mud, but selected other habitats almost equally. ($X^2= 9.472$, df=1, p= 0.002)
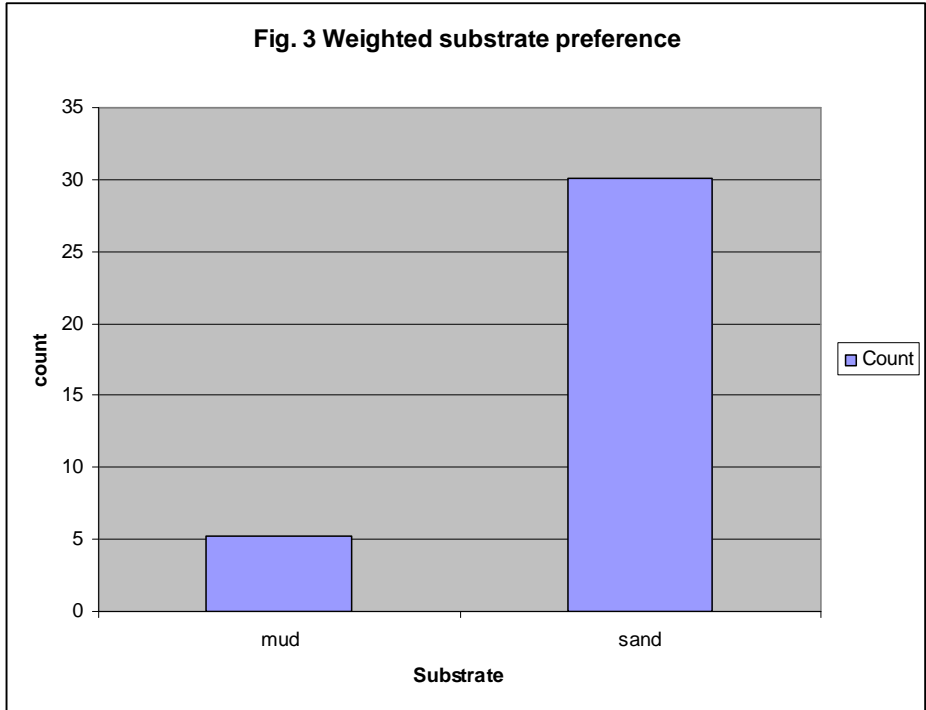

Figure 3 *Weighted substrate preference* Pike selected heavily for sand when substrate alone was analyzed using Pearson's X^2 (17.469, df=1, p<0.001) Sand was weighted as 25% of substrate, mud weighted as 70% of substrate.

Appendix

The original goal of our study was to compare habitat use and migration of pike in two lakes connected by a stream, but this proved impossible due to a large beaver dam separating the lakes and the disappearance of all the fish Kickapoo Lake. If this study is repeated, all beaver dams should be removed from Brown and Kickapoo creeks for some time before the study begins, to ensure clear migration routes.

At the end of our study in Brown lake two fish were missing out of seven and one was presumed dead. All three tags from Kickapoo had disappeared, which resulted in survivorship of 40%. There is a possibility that the tags had expired prematurely, so that the fish were not able to be located. It is also possible that they were preyed upon by eagles. During the study an eagle nest was located between Brown and Kickapoo lakes which had large esocid skulls beneath it.

Acknowledgements