Tom Aepelbacher
Final Project Paper
Rivers, Lakes, and Wetlands

Fish distributions among habitats in the littoral zone of Douglas Lake

Abstract:

The purpose of this study is to sample fish community composition in different habitat types found in Douglas Lake in Cheboygan County, Michigan and to determine if the composition of the community varies with habitat. To set up this study, we chose four different habitat types: sandy, cobble, woody debris, and vegetated. At each different habitat location in Douglas Lake, we set up a gang of five minnow traps that were used to sample the fish species diversity and abundance at each habitat type. The Kruskal-Wallis test shows that there is not a statistically significant difference in species richness, CPUE per day, and diversity index values between the four sites that we sampled. There is no statistical difference but the data supports a trend in which species diversity, species richness, and average CPUE per site is highest at the vegetated habitat and lowest at the sandy habitat.

Introduction:

Fish habitat selection is based on protection from predators, water temperature, and food availability among other reasons (Hargeby, et al. 2005). Habitat and fish community composition can vary at different depths and distances from the shore. This can result in differences in community composition between different habitats within the littoral zone for fishes (Mittelbach 1981).

Escape from predation is an important factor in habitat selection. Habitat use can represent responses to structural features, such as substrate and vegetation or to biotic

factors such as distribution of food, competitors, and predators (Tonn and Paszkowski 1986). Some species, such as bluegill and yellow perch, experience ontogenetic niche shifts as they develop in order to avoid predation (Paukert and Willis 2002; Hargeby, et al. 2005). When bluegill are juveniles they feed on macroinvertebrates in vegetated areas in the littoral zone. When the bluegill mature to adults they move out to the open water where they are big enough to avoid predation (Paukert and Willis 2002). Rock bass, bluegill, pumpkinseed, smallmouth bass, and yellow perch are a few fish species found in the shallow vegetated areas in Douglas Lake to avoid predation and for a higher abundance of food sources (Reighard 1915).

We sampled small fish that live in the protected littoral zone in these different habitats to determine if distribution of different species of fish varies with habitats in Douglas Lake (Werner 1983). To achieve this, we used minnow traps for sampling to acquire a list of the species inhabiting each site; minnow traps are ideal for this sort of sampling because they are an efficient passive gear for catching small fish species (Tonn and Magnuson 1985). We also examined and compared distribution and abundance of each fish species at each sampling location.

We expected to see more fish in areas of increased vegetation, for example due to cover and thus increased protection from predation (Poulet, et al. 2005). We hypothesize that fish community composition will vary within the four different habitat types sampled in Douglas Lake. We expect to see more fish in areas of increased vegetation.

Methods:

To explain potential correlations among species diversity, abundance, and habitat type, we quantified each habitat. To accomplish this, we collected data for abiotic and biotic factors such as percent vegetation cover, substrate size, surrounding riparian vegetation and temperature at each sampling location. This enabled a comparison between each habitat type.

We sampled fish at four different habitats in Douglas Lake. These sites were a woody debris habitat at Grapevine Point, a cobble area located on the west side of the UMBS boat well, a sandy area on the south end of Big Shoal, and a vegetated habitat at Hook Point (Fig 1). At each site we set a gang of five minnow traps perpendicular to shore with one exception being the line of traps near the boat well where they were arranged in a diagonal line from shore to ensure that each trap was on a cobble area. Traps were 1.5 meters apart and in water less than one meter deep. Minnow traps were set for 48 hours, 3 times. We counted and identified to the level of species of individuals captured in each minnow trap.

At each trap, we measured water temperature, depth, and percent cover of substrate.

To calculate species diversity, we used species richness and the Shannon-Weiner index of species diversity. We also used a Kruskal-Wallis test to compare diversity between the four different habitats sampled in Douglas Lake

Results:

Abiotic

At each sampling site, depth was recorded for each trap. The depth of traps at the UMBS boat well ranged from an average of 29 cm to 34 cm. The average depths at Grapevine Point ranged from 21.7 cm to 35.3 cm. The average depths at Big Shoal went from 29 cm to 34 cm. The depths at Hook point ranged from 29.5 cm to 68 cm. The average depth of traps at each sampling location increased as distance from shore increased. The location with the largest increase in depth was Hook Point and the sampling location with the smallest difference in depth was Big Shoal and the UMBS boat well.

The average water temperature at the UMBS boat well was 25^{o}C. Average water temperature at Grapevine Point was 24.3^{o}C. The average water temperature at Big Shoal was 28^{o}C and the average temperature at Hook Point was 26.3^{o}C. The average temperature ranged between sites with the highest temperature of 28^{o}C at Big Shoal and the lowest temperature at Grapevine Point at 24.3^{o}C.

The average air temperature at the boat well was 25^{o}C. The average air temperature at Grapevine Point was 25^{o}C. The average air temperature at Big Shoal was 27.7^{o}C and the average temperature at Hook Point was 76.3^{o}C. The average air temperature differed between sampling locations. The sampling site with the highest air temperature was Hook Point and the air temperature was the lowest at the boat well and Grapevine Point where the air temperature was 25^{o}C.

The average percent cover for substrate at the boat well was 33% cobble and 67% sand. The percent cover at Grapevine Point was 1.6% cobble, 38% woody debris, and 60.4% sand. The percent cover of the substrate at Big Shoal was 99% sand and 1% cobble. The percent cover for substrate at Hook Point was 99% sand/silt with a 74%

cover of vegetation on top of the water. All vegetation at Hook Point was white water lilies.

Biotic

The average species richness at the UMBS boat well was 1.7 species. The average species richness for Grapevine Point was 2 species. The average species richness at Big Shoal was 1 species. The average species richness at Hook Point was 4 species. The sampling site with the greatest species richness was Hook Point. The sampling site with the lowest species richness was Big Shoal.

The average diversity index value at the boat well was 0.53. The average diversity index value for Grapevine Point was 0.68. Average diversity index value for Big Shoal was 0.87. The average index value for Hook Point was 1.2. Among the four sampling sites, Hook Point had the largest average index value while the boat well had the lowest average index value.

The average CPUE at the boat well was 0.53. The average CPUE at Grapevine Point was 0.47. The average CPUE for Big Shoal was 0.87. The average CPUE for Hook Point was 4.73. Among the four sampling locations, Hook Point had the highest catch per unit effort while Grapevine Point had the lowest catch per unit effort.

The hierarchal cluster analysis test shows crappies, bullhead, largemouth bass, and rock bass being grouped very tightly by habitat distribution. Pumpkinseeds are the next closest grouped followed by smallmouth bass. Bluegill and yellow perch are separated the most from the other species by habitat distribution in Douglas Lake (Fig 2)

Discussion:

Some of the fish species we expected to find in the littoral zone of Douglas Lake included yellow perch, common shiners, small and large mouth bass, and rock bass, pumpkinseed, and bluegill (Reighard 1915).

Fish community composition and distribution within Douglas Lake are affected by different habitat types. Habitat use patterns can represent responses to structural features such as substrate and vegetation (Tonn and Paszkowski 1986). Substrate complexity and vegetation cover contribute to habitat differentiation. Average CPUE increases as habitat complexity increases (Hatzenbeler, et. al 2000) (Fig 3). CPUE is lowest at the sandy sample site, higher at the cobble area, higher in the woody debris habitat, and highest at the highly vegetative habitat. Average species richness and average species diversity follow the same trend with Big Shoal (sandy) being the least diverse, the UMBS boat well location (cobble) being more diverse, Grapevine Point (woody debris) is more diverse than the cobble area, and Hook Point (vegetative being the most diverse) (Fig 4) (Fig 5). CPUE is higher in the cobble area than in the sandy area because cobble provides more cover and possibly has more macroinvertebrates amongst the rocks. The habitat with woody debris has more protection from predation for smaller fish species because submerged logs, roots, and trees provide a natural shelter from predation (Poulet, et al. 2005). Vegetative habitats are the most diverse because they contain invertebrates that usually increase in density with an increase in plant density (Paukert and Willis 2002). Bluegills inhabit these highly vegetative areas because they consume the benthic macroinvertebrates that are most abundant in areas with high aquatic plant density where detritus is abundant (Paukert and Willis 2002). Like bluegills, perch also inhabit vegetative areas within a lake's littoral zone when they

are towards the beginning of their life cycle. Perch start out as planktivores in the pelagic zone and switch to the vegetative littoral areas where they feed on benthic macroinvertebrates (Mittelbach 1988, Hargeby, et. al 2005). This explains why in our study the average CPUE for both bluegills and perch is the highest at the vegetative sampling habitat, Hook Point, rather than at the other habitat types (Table 1).

To understand the relationship between the fish species that make up the communities found at each type of habitat within the lake, we used a hierarchical cluster analysis test. The hierarchical cluster analysis test created a dendogram that exhibits the relationship between fish species sampled at the four sampling locations (Fig 2). Figure 2 shows that crappies, largemouth bass, bullheads, and rock bass are on the same stage of the dendogram which means that they have similar habitat distributions. They are then most similar to pumpkinseeds, and then smallmouth bass. Bluegill and yellow perch are similar to each other in habitat distribution but both do not have a very similar habitat distribution to the rest of the sampled species (Fig 2). This relationship can also been seen in the relationship between sites (Fig 6). The UMBS boat well and Grapevine Point have similar fish communities which include the crappies, largemouth bass, bullheads, and rock bass. Big shoal is then the next most similarly related fish community. Hook Point has a very different community composition than the other three sites. This is related to the high amount of species richness found in the vegetated habitat. This is also where high abundances of perch and bluegill were captured in our study. The low amount of species richness and high abundance of smallmouth bass at Big Shoal can be explained by predation. Cyprinids are found in the sandy shoals of Douglas Lake (Reighard 1915). Young smallmouth bass were most likely found at the sandy habitat of

Big Shoal due to their predation on the cyprinids (Reighard 1915). Reasons for no cyprinids being captured in the minnow traps would be that the smallmouth bass may have consumed the cyprinids before the traps were checked.

The fish community distributions at different habitat types within Douglas Lake are sculpted by the abiotic and biotic factors that control them such as percent substrate cover, amount of vegetation, abundance of food (macro invertebrates), and predation. Our results are distinctive enough to suggest that there is a difference in fish community composition between different habitats but the statistical analysis of our data does not show a large enough difference to determine whether or not there is a significant difference between fish community composition for each habitat type.

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