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Fish and Habitat relationships: A comparison study for habitat similarities.

Abstract

Fish abundance and diversity at four different habitats within Douglas Lake differing in substrate composition were compared. Minnow traps were set at the different sites for three periods of 48 hours and the fish caught were identified and counted. No significant differences in average Shannon-Weiner, species richness, or catch per unit effort among sites were found. However there is clear evidence that many fish prefer a vegetative habitat. Furthermore there was similarity in average species richness, the diversity, and CPUE between a woody and cobble substrate. Together, the four habitats suggest a relationship among some fish families for example crappie fish, bullheads, bluegill, largemouth bass, and rock bass were found together in similar habitats.

Introduction

Understanding fish habitat preferences could help predict how future shoreline development in a lake will affect species diversity. On the past many heavily impacted lakes in Central North America did not undergo single large, drastic alterations but were subject to very small modifications to structural components of habitats and gradual shifts in land use (Jennings, et al. 1999). Cumulative effects of development include both alteration of physical habitat in the littoral zone and the increase of nonpoint inputs of nutrients, silt, and contaminants (Jennings, et al. 1999). For this reason we are testing different habitats for distribution of fish to know which communities will be affected if shoreline development occurs because certain habitats hold more fish.

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We expect to find more fish in the deep, structured habitat below trees or among roots, log jams, and woody debris [because these] represent natural shelter against predation (Poulet et al. 2005). Likewise areas of increased vegetation will hold more fishes because of greater cover and thus increased protection from predation (Reighard, 1915). In small lakes, juvenile sunfishes (Centrarchidae) commonly occupy vegetated habitats, reducing the risk of predation by piscivorous fish (Mittelbach 1988). Similarly, in the presence of bass, bluegill remain in or near dense vegetation, whereas in the absence of bass they shift to feeding in open habitat (Mittelbach, 1988). Smallmouth bass prefers a rocky substrate whereas rock bass prefers a heavily vegetated substrate (George & Hadley 1979). Furthermore bluegill may compete with young perch and other members of the sunfish family on vegetative habitats to avoid predation (Mittlebach 1988).

Vegetation is important for food but the type and amount of food eaten by species of a fish vary between years, seasons, and size groups (Clady 1974). Likewise habitat complexity associated with plants provides a competitive refuge (Hargeby, et al. 2005). For example rock bass prefer[s] a heavily vegetated habitat, and feeds on prey associated with vegetation (George & Hadley 1979). Adult largemouth bass employ[s] a variety of feeding behaviors that facilitate pray capture in both cobble and vegetated habitats(Olson et al.2003). Likewise rock bass and small mouth bass prefer cool, weedy, or rocky lakes (George & Hadley 1979). The occurrence together of the members of the vegetation community is not attributed to a single factor, but to food, protection, and breeding conditions among others (Reighard 1915).

Our study took place in Douglas Lake in Michigan. The littoral zones of Douglas Lake contain a variety of habitats and microclimates. Fish occupy certain habitats more than others

due to varying factors: food supply, suitability for spawning, escape of predation, water temperature, amount of light and nutrient levels being a few (Reighard 1915).

The objective of our study was to determine whether habitat preferences of fish will be towards those areas of increased shelter, as distribution is often driven by predation (He & Lodge 1990). We wanted to determine of a higher abundance of fish will be collected in areas of increased vegetation, due to an increased protection from predators. We hypothesized that different species of fish will prefer vegetative and woody habitats compared to sandy or cobble habitats, depending on the productivity and location of the habitat. Our focus on percent cover and habitat substrate yields a better understanding of the habitat similarities between emergent vegetation, large woody debris, medium woody debris, and small woody debris which remain relatively unchanged across seasons (Hatzenbeler et al.2000).

Materials and Methods

We conducted our study at four sites in Douglas Lake, Cheboygan County, Michigan, west of the boat well at the University of Michigan Biological Station (UMBS), Grapevine Point, Big Shoal, and Hook Point (figure 1).

Each site was visited three times at 48 hours intervals for one week. The UMBS boat well is located west of South Fishtail Bay and is mainly characterized by a cobble substrate. Grapevine Point is mainly characterized by woody debris and the presence of logs in the water due to trees that have been wind thrown on to the shore. Big Shoal has sandy (very fine to medium fine grains) substrate and shallow (29-34cm) water making it the shallowest of the sites. Finally, Hook Point is characterized by a hook shape that creates a small embayment of calm

water which allows vegetation to grow. The substrate of this site was mostly mucky and sandy silt and the surface was primary covered by the water lily.

We used minnow traps to capture fish at each site. Traps were set for 48 hours, 3 times, with the exceptions of the traps at Big Shoal which were set for 2 periods of 48 hours and one period of 72 hours. The minnow traps were set in groups of five for a total of 20 traps. Each group of traps was set on a line with an interval of 1.5 m between traps. Most of the traps were set perpendicular to the shore, with the exception of the Boat well (cobble) site and the Hook Point (vegetative) site due to logs and deepwater at each sites respectively. The traps on these two sites (Hook Point and the Boat well) were set with an angle almost parallel to the shore.

At each site, we measured abiotic factors including air and water temperature, depth, and substrate composition. Substrate at each site was quantified as a percent of cover using a one meter square quadrant.

We combined data form the five traps at each site and calculated the catch per unit effort (CPUE) per site per day and the Shannon-Weiner diversity index. We used a Kruskal-Wallis test to compare the mean CPUE and Shannon-Weiner index across all four sites.

Results

Abiotic factors

Depth declined linearly with the number of traps at the sites as the traps were farther away from shore. Depths measurements were taken when traps were collected. At site 1, west of UMBS boat well, depth increased on average from 22cm at trap one to 53 cm at trap five, at site 2, Grapevine Point, depth increased on average from 22 cm at trap one to 49cm at trap five, at site 3, Big Shoal, depth increased on average from 30cm at trap one to 35 cm at trap five and at site 4, Hook Point, depth increased on average from 25cm at trap one to 69 at trap five.

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There was a slow and steady change in water temperature by site per date. The temperatures ranged from 23-33ºC in all the sites. The temperature remained similar between the air and water temperature per site.

The percentage coverage differed greatly per site. At the west of UMBS boat well substrate was 50%-60% cobble, and the rest was sand. At Grapevine Point substrate was 30-50% of woody debris. At this site some rocks and sand was present but not measured. At Big Shoal substrate was mostly fine to medium coarse sand with <less than one percent shells and pebbles. At Hook Point substrate was 75%-90% murky silt sand covered in average by 75%-80% water lily.

Biotic factors

At the west of UMBS boat well there were only bluegill, rock bass, small mouth bass, and yellow perch present (table 1). We are able to see a relationship between bluegill and yellow perch as our last pair in our hierarchical cluster (figure 2). This site also had an average CPUE of 0.33 (figure 3) which was approximately the same CPUE to the woody substrate Grapevine point (figure 3). This is also re-stated with the hierarchical cluster analysis (figure 4) which tells us that the west of the UMBS boat well and Grapevine point are most similar.

There was a smaller CPUE for bluegill and small mouth bass at Grapevine Point (table 1). This site also had the lowest average CPUE (figure 3). At this site only bluegill, rock bass, small mouth bass, and yellow perch were present. In this site a relationship between crappie and rock bass was present (figure 2). On this site the average CPUE of largemouth bass (0.33) was similar to the vegetative Hook Point (table 1).

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Big Shoal had an average CPUE of 2.17. At this site small mouth bass was the only species present with a CPUE of 2.17 (table 1). Hence this site had the lowest average species richness index (figure 6) and the lowest average species diversity index (figure 4).

On average there was a greater CPUE for bluegill, pumpkinseed, rock bass, and yellow perch at Hook Point (table 1). At this site there were neither crappie nor small mouth bass nor bullheads present. Pumpkinseeds were only present at Hook Point establishing a relationship with largemouth bass which is at the same time related to bullhead (figure 2). In addition in this site is the only place in which yellow perch occurs with pumpkinseed establishing the most different relationship (figure 2). This site had the highest average CPUE of all the sites over the three sampling periods (figure 3), the highest average species richness index (figure 3), and the highest average species diversity index (figure 6). This site was also the most different of all of the sites and is the one that is least related (figure 2).

Furthermore, the Kurskal-Wallis shows no significance for differences in diversity indices, species richness indices or average CPUE values between sites.

Discussion

The west of UMBS boat well and the Grapevine Point are most similar in average CPUE, average species richness indices, and average species diversity indices. This suggests that the minnow traps yielded similar results at both of these sites. For example we see that crappie and rock bass tend to be found together at Grapevine Point which is also the only site in which crappie is present.

. Differences is habitat use between adult largemouth bass and smallmouth bass have been well documented, with largemouth bass occupying vegetated habitats and smallmouth bass occupying areas with cobble substrate (Olson, et al. 2003). From our hierarchical Cluster

analysis of CPUE we see a trend of crappie, bullhead, largemouth bass, rockbass, and occasionally pumpkinseed present together. Hence we say that there is a similarity between fish that prefer a cobble substrate and a woody debris habitat, but between these two most species prefer the woody habitat, Grapevine Point. Furthermore all the sites overlapped on fish distribution making Big Shoal, west of UMBS boat well, and Grapevine Point the most similar.

Smallmouth bass was found alone at Big Shoal but it can be found together with bluegill at the cobble, west of the UMBS boatwell. Likewise traps set in sandy habitat, Big Shoal had a higher CPUE (2.17) than any of the other habitats for the smallmouth bass, the only species present. This high average CPUE value but low average species richness and diversity indices suggest that only smallmouth bass prefer this sandy habitat. The preference towards a sandy habitat was not expected because habitat use for smallmouth is expected to be areas with cobble substrate like the west of the UMBS boat well in which it was also present. Likewise the smallmouth bass establish a similarity between the west of UMBS boat well and Big Shoal due to the fact that these were the only sites in which smallmouth bass was present.

Smallmouth bass occupies areas with cobble substrate (Olson et al. 2003) in which bluegill was also present, bluegill is found to have a similar trend to yellow perch. This creates our last pair of fish between yellow perch and bluegill that are present together at the west of the UMBS boatwell and at Hook Point.

Hook Point was the most different site due to the fact that it had the highest CPUE for bluegill, pumpkinseed, rock bass, and yellow perch than the other sites. This implies that the vegetated habitat improves growth as a consequence of increased food resources, and thus reduced competition (Hargeby et al. 2005). Also largemouth bass were found almost exclusively in vegetated habitats, smallmouth bass were predominantly associated with areas of cobble

substrate (Olson et at. 2003). Likewise, Hook Point is the only site in which largemouth bass is interacting with pumpkinseed hence establishing a relationship between them, and with the presence of bass small bluegills remain in or near dense vegetation (Mittelbach 1988).

The most closely related are the pairs of fish (crappy, rock bass), (bullhead, largemouth bass) (figure 1) with similarities in Grapevine Point and west of UMBS boat well. Smallmouth bass was expected to prefer coarse substrates (boulder, rubble, and cobble), medium-sized substrates (pebble or gravel), or clay hard pan substrates over fine substrate (sand, fine sand, silt)(Rankin 1986) were it was mostly found in our study alone.

This study demonstrates that some habitats are more suitable than others depending on the species in question. Here we see that there was a high amount of similitude between the cobble substrate, west of UMBS boat well and the woody debris substrate of Grapevine Point. Most of the species though seem to have a preference towards the vegetative Hook Point site. This is explained by the fact that small fish are concentrated in the vegetative littoral zone in response to predation risk (Mittelbach 1988) although habitat use by age-0 fish is very similar to that of adults (Olson et al. 2003). This site, Hook Point was the one that most differ to the other ones having and impact on the species richness and the diversity indices present.

References

Clady M.D. (1974). Four habitats of yellow perch, small mouth bass and large mouth bass in two unproductive lakes in Northern Michigan. *American Midland Naturalist* **91**(2):453-459.

George, E. L. and Hadley W. F. (1979). Food and habitat partitioning between Rock bass (*Ambloplites rupestris*) and Smallmouth bass (*Micropterus dolomieui*) Young of the Year. *Transitions of the American Fisheries Society* **108**: 253-261.

Hargeby, A., Blom, H., Blindow, I., and Andersson, G. (2005). Increased growth and recruitment of pisciovorous perch, *Perca fluviatilis*, during a transient phase of expanding submerged vegetation in a shallow lake. *Freshwater Biology* **50**: 2053-2062.

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Hatzenbeler, G. B., Bozek, M. A., Jennings, M.J., Emmons, E. E. (2000) Seasonal variation in fish assemblage structure and habitat structure on the nearshore littoral zone of Wisconsin Lakes. *North American Journal of Fisheries Management* **20**(2): 360-368.

He, X. and Lodge D. M. (1990). Using minnow traps to estimate fish population size: the importance of spatial distribution and relative species abundance. *Hydrobiologia* **190**:9-14.

Jennings, M. J., Bozek, M. A., Hatzenbeler, G. B., Emmons E. E., Staggs, M. D. (1999). Cumulative effects of incremental shoreline habitat modification on fish assemblages in North Temperate Lakes. *North American Journal of Fisheries Management* **19**:18-27.

Mittelbach, G. (1988). Competition among refuging sunfishes and effects of fish density on littoral zone invertebrates. *Ecology* **69**(3): 614-623.

Olson, M. H., Young, B. P., and Blinkoff K. D. (2003). Mechanisms underlying habitat use of juvenile largemouth bass and smallmouth bass. *Transactions of the American Fisheries Society* **132**:398-405.

Poulet, N., Lek S., and Argillier C. (2005). Pikeperch habitat use within a canal network spring. *Journal of fish biology* **67**:1460-1474.

Rankin, E.T. (1986). Habitat selection by smallmouth bass in response to physical characteristics in a natural stream. *Transitions of the American Fisheries Society* **115**:322-334.

Reighard, J. (1915). An Ecological Reconnaissance of the Fishes of Douglas Lake, Cheboygan County, Michigan in Midsummer. *Bulletin of the Bureau of Fisheries* **33**: 219-249.

Tables and Figures

Table 1 Catch statistics per site for data compiled over three sampling periods.

Catch Statistics (Average CPUE)				
	Boatwell	Grapevine	Big Shoal	Hook Point
Bluegill	0.17	0.00	0.00	5.83
Pumpkinseed	0.00	0.00	0.00	1.50
Rockbass	0.33	0.17	0.00	0.67
Crappy	0.00	0.33	0.00	0.00
Largemouth Bass	0.00	0.33	0.00	0.33
Smallmouth Bass	0.50	0.00	2.17	0.00
Yellow Perch	0.33	0.17	0.00	3.17
Bullhead	0.00	0.17	0.00	0.00

Figures

Figure 1 At Douglas Lake four habitats were selected for this study. At Grapevine Point the substrate was woody debris, at Big Shoal substrate was sandy, at the West of the UMBS boatwell the substrate was cobble, and at Hook Point the substrate was vegetated.

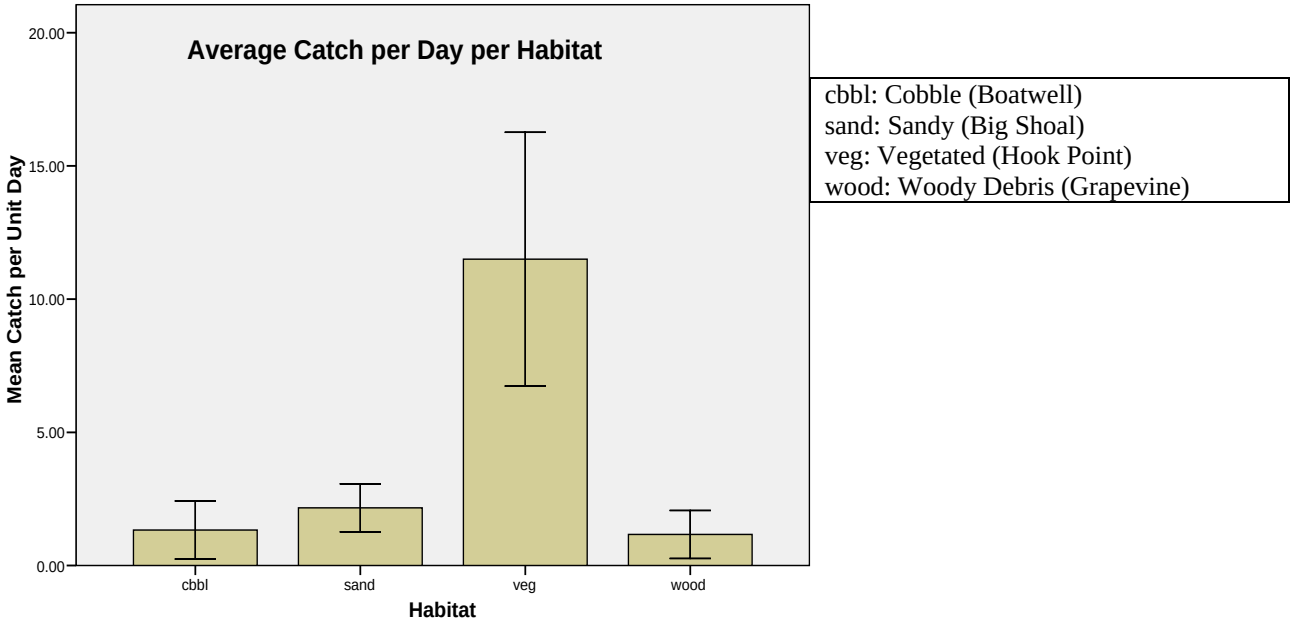

Figure 2 Average catch per day for each site; data was compiled over three sampling periods.

Figures

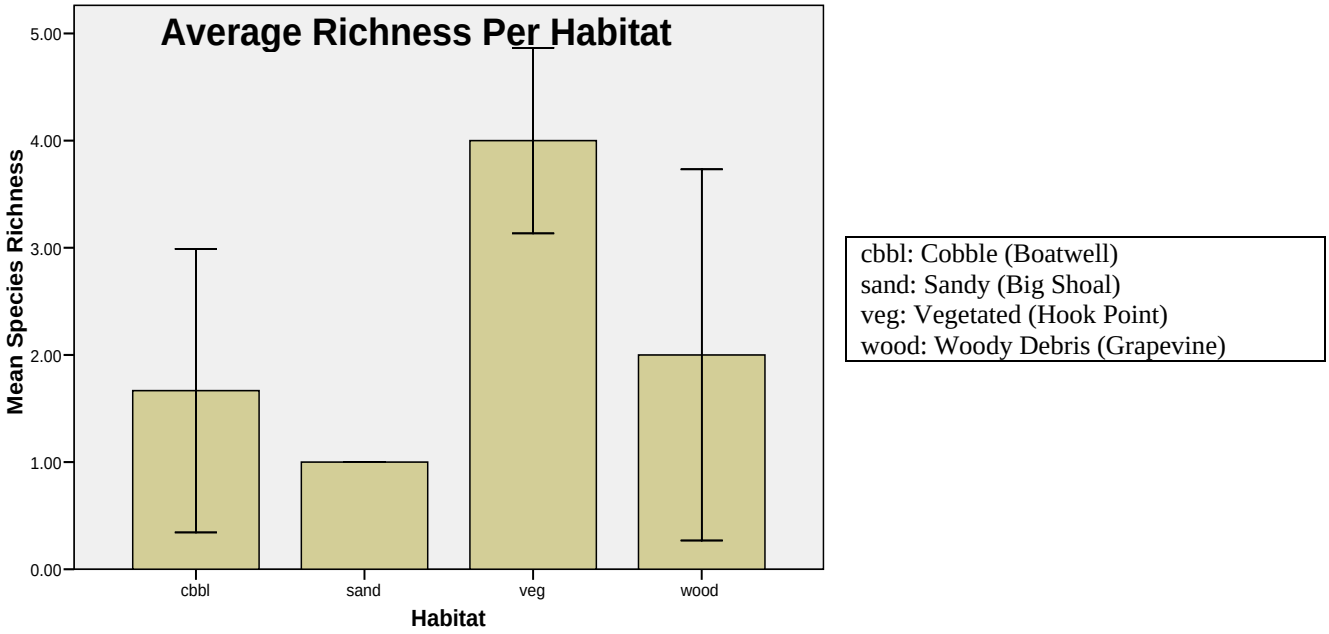

Figure 3 Average species richness per day for each site; data was compiled over three sampling periods. No standard error present for the Big Shoal habitat due to the fact that the Species Richness was 1, meaning that only smallmouth bass was present.

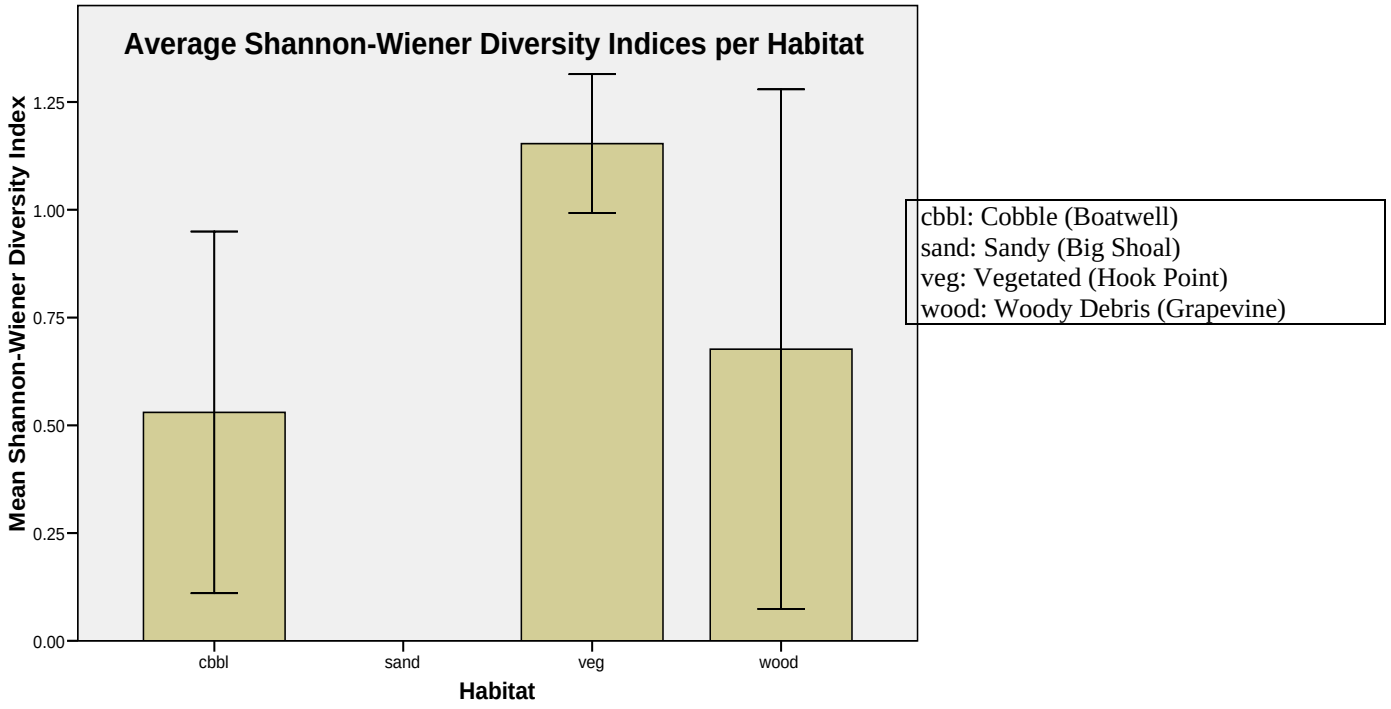

Figure 4 Species diversity was averaged per day for data compiled over three sampling sessions. Note that there is no diversity for the Big Shoal, sandy habitat because only smallmouth bass was present.

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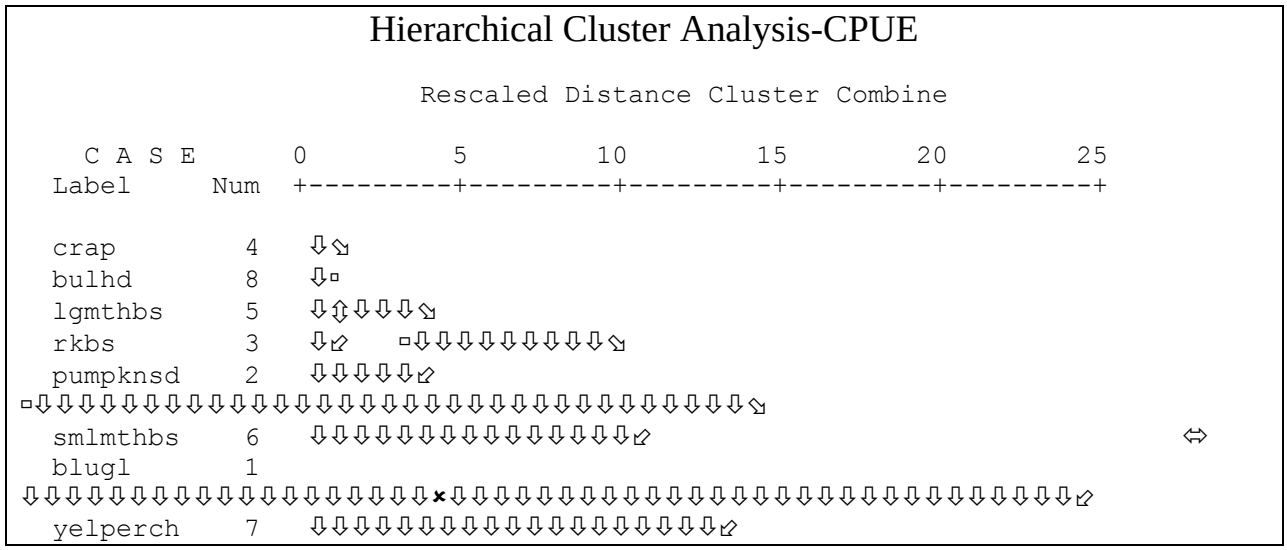

Key:

crap: Crappy bulhd: Bullhead lgmthbs: Largemouth Bass rkbs: Rockbass	pumpknsd: Pumpkinseed smlmthbs: Smallmouth Bass blugl: Bluegill yelperch: Yellow Perch

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Figure 5 Dendrogram showing hierarchical cluster analysis of CPUE for each species.

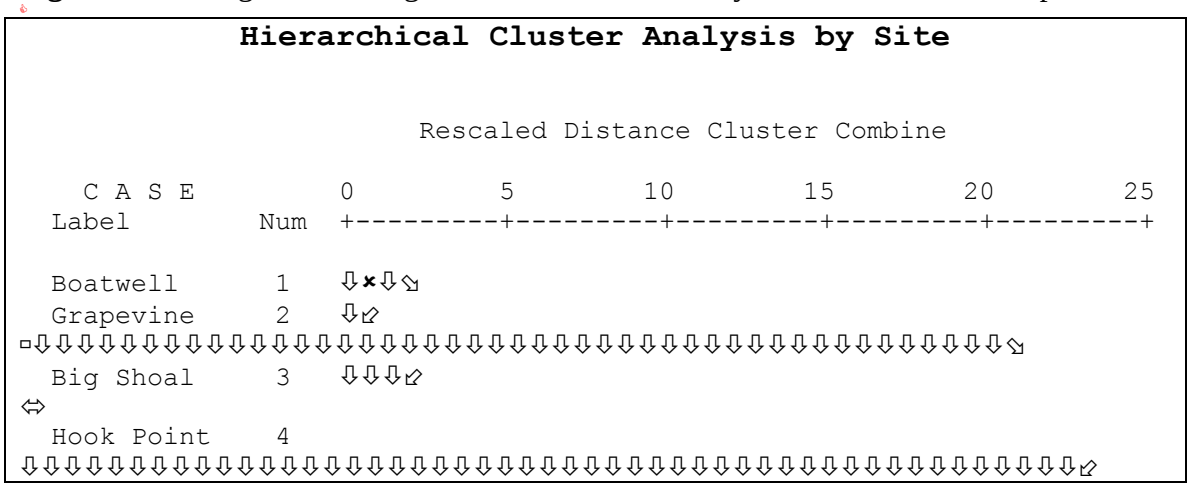

Figure 6 Dendrogram showing hierarchical habitat cluster analysis by site.