

## Questions on Werner and Hall - March 7, 2008

### Methods/Design

Charlie

I don't understand how "switch size" was determined for each sample of fish. How does the procedure outlined in the lake studies methods section determine size at which the bluegills switched areas in the lake? Also, why does Table 1 say that some lakes had "no switch"?

Jessica

*"...growth, which integrates energy available over time, is a more accurate reflection of the importance of foraging in the pelagic zone to fitness of the fish. Small fish caged in the pelagic zone of Lawrence Lake increased in mass by 3.3 g over the 45-d experiment compared with 1.1 g increase for free-ranging fish of the same size. Thus, growth rates (grams per day) were three times as great in the pelagic habitat as in the littoral zone, which experimentally substantiates the above conclusions (p. 1358, Werner & Hall, 1988)."*

Does the fact that the caged fish were not exposed to predation risk confound Werner and Hall's conclusions that the small fish in the pelagic zone grew bigger than the small fish in the littoral zone? Is it realistic to think that fish held captive in an underwater cage would demonstrate statistically comparable foraging behavior to their non-captive peers in danger of predation?

Rosie

In their experimental studies section, the authors studied the growth-rate of bluegills in the pelagic zone by putting them in cages in this zone. They note that the density of the resulting bluegills in cages is about 3x as high as that estimated if the entire bluegill population were to forage in the pelagic zone. Doesn't this imply that they've simulated unrealistic situations, and obtained data that would be very different from an unmanipulated study? Do they take account of this in analyzing their data?

Zach

Are there evolutionary reasons why bass prefer smaller fish? With such a high mortality rate of smaller fish in open water, might there be a shift to larger bluegills overall, rather than just a larger average shift size?

Carlie

Regarding the portion of the experiment that stocked bluegill in an artificial pond and

introduced bass to measure predation rate:

Do the largemouth bass in these lake systems have any natural predators (herons, snapping turtles, etc.)? How would the absence of natural predators in the artificial pond affect the foraging rate of the bass and, therefore, effect the mortality rate of the bluegill? Was competition between the bass themselves a factor?

p

## Results

Cara

In examining growth rate in the different zone between lakes, Werner and Hall find that fish in littoral zone of Lawrence lake have a higher growth rate than fish in the littoral zone Warner lake, and fish in the pelagic zone of Warner lake have a higher growth rate than fish in the pelagic zone of Lawrence lake (p.1359). They state that "all else being equal" fish in Warner lake would be expected to switch at a smaller size, but their data shows the opposite phenomenon. What significance does this data have?

Neal

Was the pelagic zone more profitable because prey had a higher nutritional value or because prey was more common?

Christine

The authors found that although the diet shift was found at a body size that was particular for each lake, the habitat shift itself was more complicated. They found that bluegills first start feeding from the water column above the littoral zone before shifting completely to the pelagic zone, thereby gradually introducing zooplankton into their diet. What might be the advantage to switching diet suddenly while gradually shifting habitat? Has this strategy proven to be "safer" for bluegills? Is there any other behavior in bluegills that may shed light on the purpose of this gradual habitat switch?

Indrani

The authors successfully present the "way in which the trade-off between growth rate and predation risk may influence the timing of ontogenetic habitat shifts in a species" and discuss the consequences of such shifts to community structure, and in particular mention intra- and interspecific size class interactions including competition between bluegill and small bass.

Is it possible that intra- and interspecific interactions, such as competition, play an important role in driving the habitat shift rather than the other way around?

For instance, could there be selection in favour of bluegills that occupy the same habitat as small bass and potentially prevent recruitment of bass to piscivorous and reproductive sizes, thereby influencing habitat shift?

-Ben

Is competition, among bluegills or with other species, an unexplored factor in this scenario? To what extent might the resource matching rule be limiting the individual or population growth of bluegills that remain in predator-free habitats? Also, I don't understand how they are quantifying predation risk, given that they are using dozens or hundreds of fish in a large pond.

Heidi

Werner and Hall (1988) mention that bass "patrol" the area between the littoral and pelagic zones of the lake, and that this barrier strongly influences the shifting of bluegills between the two areas throughout the life cycle (p.1362). The researchers also bring up that vegetation in the littoral zone contains many other small fish, including the young of piscivorous ones. However, the researchers do not go into detail on how the interaction between the bass and the bluegills is maintained. Wouldn't one expect that the bass would learn to dive down and snatch bluegills as well as other small fish from amongst the vegetation? Also, wouldn't the bass evolve to eat smaller and smaller or larger and larger bluegills such that the bluegills must leave the vegetation for the first time at a smaller size and the second time at a larger size than they currently do?

Britta

What other variables, beyond energy intake and predation risk, could have been involved in the fishes' decision to move from one setting to the other? Could factors such as competition for resources (nutrients, energy, mates) in a limited environment have played a role in the bluegills' move to open water? How would neglecting these other variables have impacted the current study's findings?

Heather

Werner and Hall mention that the habitat switch at 80 mm is likely genetic, since they found the switch to be similar in all of the similar lakes they studied. Because these are different populations, couldn't genetic differences also explain the differences in size at which feeding habits switched in the various lakes? Can this study say anything about heritability?

Jeff

The article states that, "the fact that the switch is relatively constant at approx. 12 mm among lakes may indicate that it is genetically set." Is it possible that it isn't completely genetic and that public information, as in the case with the red crossbills, is also playing a part? Perhaps it is a trait that some fish have and others don't, yet they switch anyhow because of public information?

Chloe

Werner and Hall mention that the bluegill and largemouth bass have a unique relationship since they are predator-prey as well as competitors. How could this relationship be better studied and observed? Could the impact on time of habitat shift in bluegills be better understood by exploring this complex relationship?

Hannah

How do behavioral reactions to a predator have far-reaching consequences for the bluegill and how might this be responsible for shaping its evolution?

Thorson

How does the study show that young bluegills are forced into the vegetation refuge, and that there is not some other reason such as nutrient availability that keeps them there?