GREAT LAKES HEALTH

Exploring the Role of Food Availability to Yellow Perch Recruitment Success

Final Report

Objectives

Count zooplankton already collected from Green Bay

Contribute to a lakewide understanding of mechanisms limiting recruitment of yellow perch

Provide information useful to fisheries managers.

Summary
We have completed all laboratory experiments quantifying larval yellow perch growth, survival, and prey selection. Small larval yellow perch grow and survive best while feeding on small zooplankton, whereas larger yellow perch larvae had higher growth and survival while feeding on larger zooplankton. We have also completed experiments measuring foraging costs and estimated the net energetic gain of larger yellow perch larvae feeding on two zooplankton taxa. Interestingly, there appears to be a tradeoff between the high capture efficiency, but high handling time of cladocerans, and the low capture efficiency, but lower handling times of copepods that results in similar net energetic gain between these two prey items. These findings have been applied to the management of yellow perch in Lake Michigan through reporting of our findings to the lakewide Yellow Perch Task Group. We are currently writing a manuscript for publication on our experimental findings.

Accomplishments
This project has advanced our basic scientific knowledge of larval fish ecology, and can be applied to the management of yellow perch in Lake Michigan. Recruitment in fishes is often determined during their early life history where mortality is very high. Starvation is one of the important sources of mortality during this period; thus, understanding how food availability influences growth, survival and ultimately recruitment is important both to understanding the basic ecology of fishes and for improved fishery management. Our results can be used as a model to investigate recruitment processes for other fish species. Our findings can also be directly applied to the management of yellow perch in Lake Michigan. For instance, our results demonstrate that the composition of the zooplankton food for larval yellow perch will affect, either positively or negatively, growth and survival of these early life stages. By tracking changes in zooplankton composition and density, dur ing spring, managers can better predict whether strong or weak year-classes of yellow perch will be produced. In turn, managers can than set fishing regulations to more closely match expected future recruitment.

Keywords
yellow perch, zooplankton, foraging, larval fish ecology, Lake Michigan

Narrative Report
During the summers of 2000 and 2001, we conducted a series of experiments to investigate growth, survival, prey selection and foraging behavior of larval yellow perch foraging on different zooplankton taxa. To account for important ontogenetic changes that occurred during their early life history, such as first feeding and swim bladder inflation, we conducted experiments on 4 size-classes of larval yellow perch: newly-hatched (5-7 mm), small (7-12 mm), medium (12-16 mm) and large (>16 mm). Yellow perch egg skeins

collected from Lake Michigan during late May and early June were hatched and larvae reared in lab facilities at the Lake Michigan Biological Station. Zooplankton taxa used as treatments in all our experiments were cladocerans, adult copepods, copepod nauplii, rotifers and a foodless control. Common taxa in these groups included: Brachionus spp. (rotifers), Ceriodaphnia spp. and Bosmina spp. (cladocerans), and cyclopoid and calanoid copepods (both adult and naupii). These taxa are also present in the Lake Michigan zooplankton assemblage.

We conducted growth and survival experiments concurrently using 38- L aquaria in a controlled laboratory setting. Larvae were placed in several aquaria with different zooplankton treatments and allowed to feed for several days while we measured their growth and survival. Our results indicated an ontogenetic diet shift in the taxa that produced the best growth and survival. Newly-hatched and small larvae grew and survived best while feeding on copepod nauplii and adult copepods. However, the zooplankton taxa that produced the best growth and survival for larvae larger than 12 mm shifted to cladocerans and adult copepods, and larval growth and survival decreased while feeding on copepod nauplii. Rotifers were only used for the newly-hatched size class because they were always avoided during a pilot study, but newly-hatched larvae had little or no growth and low survival while feeding on them. Thus, copepod nauplii and adult copepods produced the best growth and surv ival for smaller larvae, but a shift occurred around 12 mm favoring adult copepods cladocerans. Furthermore, rotifers appear to be a poor food item for larval yellow perch.

We also measured prey selection of larval yellow perch to observe if larvae selected prey items that produce the best growth and survival. Using the same zooplankton taxa and experimental setup as the growth/survival experiments, we allowed larvae to forage for one hour in aquaria that contained equal densities of the zooplankton treatment taxa. We later dissected their digestive tract and enumerated and measured the contents. Yellow perch larvae generally selected prey items that confer the best growth and survival. Smaller larvae positively selected copepod nauplii and adult copepods, and avoided cladocerans and rotifers. Larger larvae positively selected cladocerans and adult copepods, and avoided copepod nauplii (rotifers were excluded from these size-classes). Overall, prey selection patterns for larval yellow perch closely followed trends from the growth and survival experiment.

To understand the foraging costs and benefits of larval yellow perch feeding on the different zooplankton treatments, we measured the capture efficiency and handling time of larvae foraging on zooplankton. We initially hoped to quantify these foraging behaviors for all sizes of larvae and all zooplankton taxa, but quickly realized that we could only observe successful capture events for larvae larger than 12mm feeding on adult copepods and cladocerans. Thus, using 4- L behavioral arenas, we observed medium and large size-classes of yellow perch larvae feeding on cladocerans and copepods. We measured the number of strikes and captures to determine capture efficiency, and the time between a successful capture event and the resumption of searching to determine handling time. These data were combined with estimates of zooplankton biomass and caloric density from the literature to estimate the net energetic gain of the two prey taxa for medium and large larvae. Specific ally, based on our estimates, we calculated the number of calories gained per strike, and the number of calories gained per second of handling time. Interestingly, there appears to be a tradeoff between capture efficiency and handling time that results in similar net energetic gains for cladoceran and adult copepods. Although cladoceran prey were difficult to handle for yellow perch larvae, they captured cladocerans more efficiently. Conversely, yellow perch larvae had a much lower handling time while foraging on adult copepods, but perch larvae also captured them less efficiently as compared to cladocerans. Thus, the number of calories per strike was higher for cladocerans due to their higher capture efficiency, but the calories per second of handling time was higher for adult copepods resulting in similar net energetic gain between the two zooplankton taxa.

These results help fishery managers understand how zooplankton availability influences growth, survival and ultimately recruitment of yellow perch in Lake Michigan, particularly given the recent changes that have occurred in the zooplankton assemblage. During the late 1980's, when yellow perch were still recruiting well, the zooplankton assemblage was composed of approximately 30% (by number) of cladocerans, and 70 % copepods. However, in the current zooplankton assemblage cladocerans are very rare, and copepods are more prominent. Based on our results, we believe that the taxa in the current Lake Michigan zooplankton assemblage should positively influence growth and survival of larval yellow perch. For example, the abundance of copepods should benefit growth and survival of small yellow perch larvae, and the lack of cladocerans should be offset by the increase in adult copepods for larger larvae. We believe that other factors, such as zooplankton density, probably limit growth and survival of larval yellow perch in Lake Michigan.

Lay Summary

Yellow perch have been declining in Lake Michigan during the last decade, and one of the possible reasons for this decline is that changes in the food web have negatively affected growth and survival of larval yellow perch. To address this question, we designed a series of laboratory experiments to examine whether growth, survival and food selection of larval yellow perch changed while feeding on different types of zooplankton, the primary food for yellow perch larvae. Small (<12 mm) yellow perch larvae grew and survived best while they were feeding on small zooplankton; when fed large zooplankton, these larvae did not survive. Larger (>12 mm) yellow perch larvae grew and survived well when feeding on large zooplankton, but grew and survived poorly when feeding on small zooplankton. Larvae of all sizes preferred to eat food that gave them the best growth and survival. Thus, larval yellow perch must have small zooplankton available to survive their first few days of feeding, but then rapidly prefer to eat larger zooplankton for better growth. These results help fishery managers in Lake Michigan predict how changes in the food web will affect recruitment of yellow perch and set regulations accordingly.

International Implications

Yellow perch are common in both inland lakes and Canadian portions of the Great Lakes, and our results are directly applicable to these populations. North American yellow perch (*Perca flavescen*s) are also closely related to European yellow perch (*Perca fluviatilis*), and we feel our results could be generally applicable to managers and researchers working with yellow perch in Europe.

Partnerships

Our research is disseminated through the Yellow Perch Task Group and therefore impacts management of yellow perch in Lake Michigan. Furthermore, our results are leading to a collaboration with Tracy Galarowicz at Central Michigan University to work on larger ecological questions associated with how feeding behavior during the early life stages of fishes affects the choice on when to become piscivorous.

Publications

Presentations

Graeb, B. D. S., and J. M. Dettmers. Zooplankton and larval fish growth: implications for recruitment of yellow perch in Lake Michigan. International Association of Great Lakes Research. June 2001.

Graeb, B. D. S., J. M. Dettmers, and D. H. Wahl. Prey taxa and fish growth: implications for recruitment during the early life history of yellow perch. American Fisheries Society National Meeting. August 2001.

Graeb, B. D. S., J. M. Dettmers, and D. H. Wahl. Prey taxa and fish growth: implications for recruitment during the early life history of yellow perch. Midwest Fisheries and Wildlife Conference. December 2001.

Graeb, B. D. S., J. M. Dettmers, and D. H. Wahl. Tradeoffs between energetic gains from prey and foraging efficiency affect growth and survival of larval yellow perch. American Fisheries Society National Meeting. August 2002.

Undergraduates & Graduates

Brian D. S. Graeb, anticipated thesis completion December 2002.

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