TROPHIC FEEDING OF YELLOW PERCH USING FOOD HABITS, STABLE ISOTOPES AND PARASITES

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Introduction. Yellow perch are generalist predators capable of shifting trophic status depending on the complexity of the local aquatic community (Craig 2000). Much is known about perch biology and host-parasite relationships (Craig 2000 and Johnson and Dick 2001). Consequently perch are an ideal model species to compare its trophic status in aquatic systems of differing community composition and to explore links between stable isotopes and parasite fauna.

Food items recovered from fish stomachs give a glimpse of food consumption over a very short time frame while parasitic endohelminths can indicate what a fish has eaten at least annually and occasionally longer. On the other hand, stable isotopes have been used to infer what a fish has eaten for longer periods of time and, as a consequence, identify its trophic status. The objective was to determine if fish dietary information, the presence of parasite species transmitted through food and stable isotopes could be correlated and thus more accurately predict trophic status than fish size or age.

Methods. Four Canadian Shield Lakes in northwestern Ontario for this study, based on the fish community and their physical features. Yellow perch were collected using gillnets, trap nets and electrofishing throughout the open water season over a two year period. Lengths and weights were recorded and age determined from otoliths. Food items were recorded and complete necropsies for all parasite species were done on all perch. Individual perch were chosen for stable isotopes analyses based on dietary and parasitological information. A sample of muscle tissue was removed from each fish, dried at 45 °C and powdered with mortar and pestle of which 2 mgs were added to tin foil capsules. Samples were analyzed for d¹³C and d¹⁵N isotopic concentrations with a dual inlet ratio mass spectrophotometer. Perch were separated into four length classes (< 60mm, 61-80mm, 81-100, >100), five age classes (0+, 1+, 2+, 3+, and >4+) and three diet or parasite intermediate host categories (zooplankton, benthos and fish). MANOVAS were used to identify significant relationships among perch length, age, diet, parasite fauna and stable isotope ratios.

Results. A total of 1842 perch were collected across all size and age classes. Parasites recovered from perch were Glugea, Ichthyophthirius, Apophallus, Diplostomum, Posthodiplostomum, Clinostomum, Eustrongylydes, Raphidascaris, Spintecius, Crepidostomum, Bunodera, Echinorhynchus, Pomphorhynchus, Proteocephalus, Bothrioccephalus, Uroleidus, and Piscicola. Major food items included Cladocera, Copepoda, Diptera, Trichoptera, Ephemeroptera, Odonata, Cambaridae, Amphipoda and fish.

Both the d¹⁵N and d¹³C differed among lakes (Figure 1). As perch size (Figure 2) and age increased there was a trend towards less negative d¹³C values but no distinct separation of d¹⁵N values.

Figure 1. Range (identified by boundaries) of carbon (d¹³C) and nitrogen (d¹⁵N) isotope ratios of yellow perch in four Canadian Shield lakes.

Figure 2. Range of carbon (d¹³C) and nitrogen (d¹⁵N) isotope ratios of L240 yellow perch separated into four fish size classes.
When apparent trophic position was considered based on observed diets, there was a greater distinction between both C and N isotopic values (Figure 3). There was a trend to more positive $d^{15}N$ and $d^{13}C$ as perch shifted from zooplankton to benthos and then to fish. When perch were categorized by apparent trophic position based on the immediate host sources for their parasite fauna there was the clearest distinction between isotopic ratios (Figure 4).

![Figure 3. Range of carbon ($d^{13}C$) and nitrogen ($d^{15}N$) isotope ratios of L240 yellow perch as categorized by fish diet.](image)

![Figure 4. Range of carbon ($d^{13}C$) and nitrogen ($d^{15}N$) isotope ratios of L240 yellow perch as categorized by parasite fauna (grouped by intermediate host type).](image)

Discussion. Differing $d^{13}C$ values relate to differing contributions of various primary producers to the food chain. The fewer significant correlations between parasites and C ratios suggest that parasites may not be useful predictors of important primary producers in a food chain. Moreover, this study shows that an average N or C isotopic ratio obtained from a small sample of perch does not accurately identify the trophic relationship of individual perch even when they are of similar size and age. Keough et al (1996) found that nitrogen isotopic ratio of young-of-the-year perch indicated zooplanktivory and as perch size increased the ratio shifted to indicate benthivory and finally piscivory. The same trend was observed here with increasing perch size but there were individuals in each size and age class that did not have nitrogen isotopic ratios typical of that group. Some of the largest individuals apparently remained zooplanktivorous as indicated by stable isotopes and their parasite infracommunities. While perch are known to have a generalist diet, some individuals in our study populations may be more specialized in their feeding patterns. Benthivorous perch were the most difficult to correctly place in their original categories by discriminant analysis of host size, age and diet and parasite intermediate hosts. Nevertheless, certain patterns emerged. For example, perch infected with amphipod-derived parasites tended to have more negative $d^{13}C$ and more positive $d^{15}N$ values than those infected with large benthic insect-derived parasites. We believe that benthic invertebrates that consume settled pelagic algae or detritus, such as amphipods, affect the $d^{13}C$ ratios and will be useful discriminators for trophic status. By combining parasite/isotope studies of a few representative fish species of an aquatic system we can make useful predictions about trophic category of individuals regardless of fish size. Further, this approach will be helpful in constructing aquatic food webs.

Acknowledgements. This work was supported through operating grants to T. Dick from the Natural Science and Engineering Research Council of Canada and the Department of Fisheries and Oceans, Government of Canada.

