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Diet of Juvenile Alabama Shad (*Alosa alabamae*) in Two Northern Gulf of Mexico Drainages

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Abstract - Understanding food-web ecology is valuable to conservation by linking interactions of multiple species together and illustrating the functionality of trophic exchange. *Alosa alabamae* (Alabama Shad), an anadromous species, reproduces in northern Gulf of Mexico drainages from February through May, and for this study, the Pascagoula and Apalachicola rivers were chosen to sample juvenile Alabama Shad. The age-0 fish mature within these rivers and have the potential to impact the food web of the systems in which maturation occurs. The focus was to determine if diet changes as Alabama Shad mature, and to identify diet differences between drainages. Diets of Alabama Shad <50 mm standard length (SL) consisted primarily of a dark, almost black material labeled as unidentifiable organics, while larger Alabama Shad, >50 mm SL, fed almost exclusively on insects. Many groups of aquatic and terrestrial insects were found in the stomachs of this species. Alabama Shad diets also differed among drainages, with the Apalachicola River being dominated by terrestrial insects, and the Pascagoula River having both terrestrial and aquatic insects. Diet and trophic placement of Alabama Shad may allow managers to understand the importance of this fish within its natal rivers.

Introduction

Alosa alabamae Jordan and Evermann (Alabama Shad) is an anadromous species, reproducing in northern Gulf of Mexico river drainages during spring and spending the first summer and fall in rivers before moving into the Gulf of Mexico (Mettee and O'Neil 2003). As age-0 Alabama Shad grow, habitat preferences tend to shift from sand bar to open channel and steep bank habitats (Mickle et al. 2010). One might expect shifts in diet to coincide with the observed change in habitat use and juvenile size.

Currently, the Alabama Shad is listed as endangered by the International Union for the Conservation of Nature (IUCN) and threatened by the American Fisheries Society (Meadows et al. 2006). Many states including Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, and Missouri list the Alabama Shad as a species of greatest conservation need (Meadows et al. 2006). The specific objectives of this paper were to determine if juvenile Alabama Shad diets change as they mature and whether diets differ between drainages.

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Methods

Fish collections were conducted with an electrofishing boat during June and October of 2007 and 2008 in the Pascagoula (10 sites) and Apalachicola (4 sites) river basins. The stomachs and lower intestines of collected Alabama Shad were excised, and food items were preserved in 10% formalin. Stomach contents from all Alabama Shad were initially identified and categorized as unidentifiable organics, algae, insect, or fish using a dissecting microscope at 16x power. Insect and fish items were then identified further to order or appropriate lower taxonomic level using aquatic and terrestrial insect keys and counted (Merritt and Cummins 1984, 1995; Voshell 2002). Fifteen percent of the items were quality-checked using blind validation by professional taxonomists. Alabama Shad collected were separated into four different size groups (<50 mm, 50–70 mm, >70–90 mm, >90 mm) based on a previous ontogenetic study in which these size groups were found in different habitats (Mickle et al. 2010).

Results

In total, 211 juvenile Alabama Shad were collected: 115 from the Pascagoula River, and 96 from the Apalachicola River. Stomach contents from Alabama Shad <50 mm SL (n = 47, Pascagoula River only) were primarily unidentifiable organics (Fig. 1), including semi-decomposed algae and various other materials that were not further identified. Of the remaining 164 fish >50 mm, 76 Alabama Shad (46%) had stomach contents that were identifiable. Diet items within the >50 mm Alabama Shad stomachs included the orders Coleoptera (aquatic lifestage), Diptera (terrestrial lifestage), Ephemeroptera (aquatic lifestage), Hemiptera (terrestrial lifestage), Hymenoptera (aquatic lifestage), Lepidoptera (terrestrial lifestage), Odonata (aquatic lifestage), and Orthoptera (terrestrial lifestage). Although sampling was conducted in the large tributaries as well as the mainstem in the Pascagoula basin, diet items did not differ between tributary and mainstem sites as compared in exploratory analysis, so samples were combined.

Most of the stomach contents of Alabama Shad <50 mm were unidentifiable organics, suggesting filter feeding or particulate feeding of smaller prey (Fig. 1). It should be pointed out that all fish <50 mm were collected exclusively in the Pascagoula River. The Pascagoula River fish displayed a decreasing trend of the unidentified organics and algae similar to the Apalachicola population, with both terrestrial and aquatic insects increasing in the 50–70 mm and >70–90 mm size groups (Fig. 1). All size classes in the Apalachicola River displayed large occurrences of terrestrial insects within their stomachs, whereas the Pascagoula River showed both terrestrial and aquatic insects dominating the two largest size classes, >70–90 mm and >90 mm (Fig. 1). Terrestrial insects dominated all size groups of shad collected in the Apalachicola Rivers, with unidentified organics and algae becoming less present with increasing fish

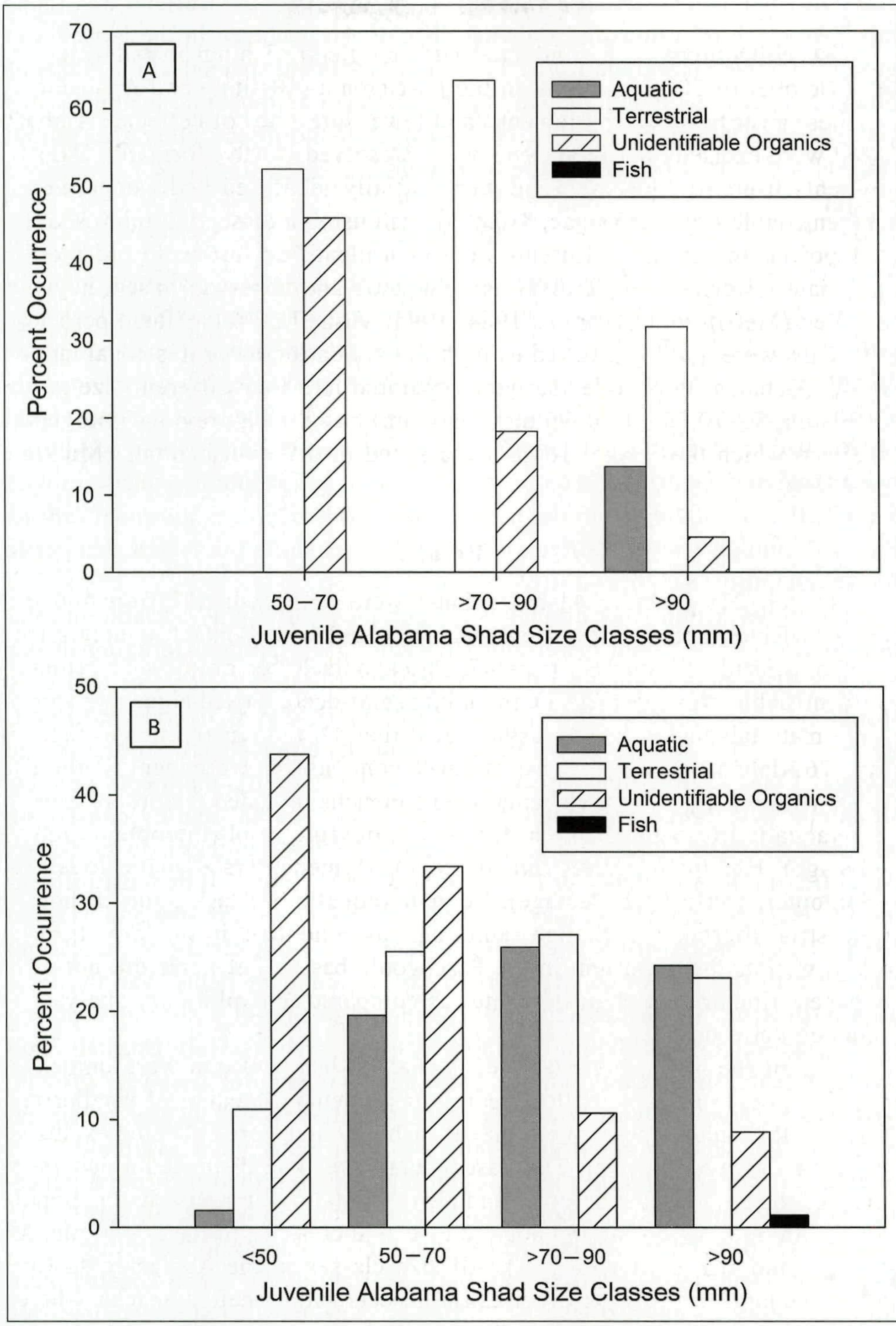

Figure 1. Percent occurrence of aquatic invertebrates (overall classification by Merritt and Cummins 1984), terrestrial invertebrates (overall classification by Merritt and Cummins 1984), unidentified organics and algae, or fish diet items found within the four size classes of juvenile Alabama Shad from the Apalachicola (A) and Pascagoula (B) rivers.

size. Only one fish (*Ammocrypta beani* Jordan [Naked Sand Darter]) was found in the stomach of a juvenile Alabama Shad and it occurred in the largest size group from the Pascagoula River. This finding was unexpected as the Alabama Shad has a terminal mouth, which is not associated with benthic feeding, while Naked Sand Darters are benthic. No fish were found in any other size groups (Fig. 1), which may be due to gape limitation.

Discussion

Although small and large juvenile Alabama Shad ingested different orders of insects, the variability of diet within the size groups was comparable, which suggests that they are generalist insect feeders. The larger Alabama Shad had a diet dominated by Ephemeroptera nymphs. This order possesses almost exclusively aquatic juvenile larvae that emerge in open water where the large Alabama Shad were collected (Merritt and Cummins 1984). The habitat shift seen in age-0 Alabama Shad may be driving the observed diet shift and would be consistent with a generalist diet strategy. Similar findings were shown with *Etheostoma rubrum* Raney & Suttkus (Bayou Darter), in which the diet shifted to match changes in food availability (Knight and Ross 1994).

Food webs within river drainages are complex and highly variable in relation to season and flow (Power and Dietrich 2002). Optimal-foraging theory predicts that animals should select the most profitable prey items and only specialize if the types of prey items differ markedly in overall profitability (energy gain minus search, capture, and handling costs) (Futuyma and Moreno 1988). If prey items are all of similar profitability, the theory predicts an animal will forage in a manner that minimizes search time by consuming any prey item encountered (e.g., a generalist feeding strategy). In that case, variability in the abundance or distribution of prey items will be most influential in determining diet and may result in a broad diet (Futuyma and Moreno 1988). Many insectivorous stream fishes feed on a wide variety of insects but may specifically key in on the currently most abundant items. Variability is usually present, but the strategy may be closer to that of a specialist during brief temporal cycles. Within variable systems such as Gulf Coastal Plain rivers, a generalist strategy may be more advantageous for first-year growth. Diet was variable between drainages and size classes, which was consistent with the fish feeding opportunistically on prey items most available. This finding was consistent with the basic optimal-foraging theory fitting a generalist strategy. Specialist strategies would be expected to be seen in very stable systems where competition is intense (i.e., niche compression; Holling 1973, Stahl and Stein 1994). Patterns of prey availability in these coastal plain drainages may be quite stochastic, which is expected to reduce competitive interactions that would favor more of a specialist strategy.

Although this species exhibits a generalist diet strategy, food-item diversity may be crucial to compensate for the ontogenetic changes that are occurring for age-0 Alabama Shad. To properly conserve this rare species, the food webs of native rivers must be protected. These variable systems must have multiple food items from different sources that fish species can utilize. In order to conserve Alabama Shad, managers must monitor the habitats, water quality, and resources that this species is using during the first year of life.

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