PRELIMINARY STUDIES OF LARVAL AND JUVENILE GIZZARD SHAD AND ATLANTIC MENHADEN IN THE HUDSON RIVER

A Final Report of the Tibor T. Polgar Fellowship Program

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ABSTRACT

Gizzard shad (*Dorosoma cepedianum*) and Atlantic menhaden (*Brevoortia tyrannus*) are herrings that occur in the Hudson River. Gizzard shad are relatively new to the fish community and are able to switch feeding habits when resources become depleted. Atlantic menhaden are long-time components of the fish community and use the tidal river as a nursery. Both species have complex feeding habits. This report includes the locations and habitat descriptions of the sampling sites where these species were caught. I analyzed the stomach contents of larval and juvenile gizzard shad and juvenile menhaden. I also compared diet analysis results to stable isotopic ($\delta^{13}C$ and $\delta^{15}N$) compositions of muscular and stomach tissue of larval, juvenile, and adult gizzard shad and juvenile Atlantic menhaden collected from the Hudson River (39-238 km) during May- September. $\delta^{15}N$ revealed differences between detrital sources for juvenile gizzard shad and Atlantic menhaden. The $\delta^{15}N$ ratio of muscular tissue became more enriched as the location of sampling moved upstream. The life stages of gizzard shad separated out isotopically, reflecting the feeding habits, however, sampling was not controlled for geographic variation. Adult gizzard shad were collected from the Mohawk River whereas juveniles were only collected in the tidal Hudson. Further studies need to sample in open surface water for juvenile gizzard shad <38mm to better understand the trophic impacts on the Hudson River ecosystem. In addition, the variation in composition of detritus should be examined to detect the differences in quality of juvenile gizzard shad and Atlantic menhaden diets.

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INTRODUCTION

Dorosoma cepedianum (gizzard shad), is a relative newcomer to the Hudson River. In the 1980's gizzard shad were first noted in power plant entrainment surveys (K. Hattala, New York State Department of Environmental Conservation, pers. comm.). Since then, numerous sitings have occurred. Today, commercial American shad fishermen capture many gizzard shad adults in their nets. Gizzard shad larvae have also been entrained in power plant facilities, but few observations of subadults have been reported. This report describes a preliminary study to determine where subadult *D. cepedianum* occur in the Hudson River, what they are eating, and whether their diets reflect what they actually assimilate into somatic tissue.

The gizzard shad is predominantly a freshwater species, residing in lakes, reservoirs, and sluggish rivers; however, they tolerate brackish water (Smith 1995). In freshwater systems, particularly reservoirs in the mid-west and south, gizzard shad tend to be abundant and dominate the fish community (45% of fish biomass; Drenner et al. 1982) (Dettmers and Stein 1992, Yako et al. 1996). Larvae and young < 30 mm total length feed primarily on crustacean zooplankton, then at total lengths ≥30 mm switch to an omnivorous diet (Yako et al. 1996, Gu et al. 1996).

It was thought that gizzard shad > 38 mm shifted to detritivory, but research indicated that *D. cepedianum* consume zooplankton as it becomes available and that detritivory is in fact facultative (Yako et al. 1996, Stein et al. 1995). Prey selection by gizzard shad is determined by size and mobility (Cramer and Marzolf 1970, Drenner et al. 1982).

The implications of the gizzard shad shifting its diet may have profound effects on community structure. Stein et al. (1995) suggest that neither top-down nor bottom-up trophic pressures control *D. cepediamm*, because as zooplankton resources decline, it adjusts by feeding on benthic-detrital ooze or phytoplankton.

Young gizzard shad grow rapidly and are able to avoid predation by the end of their first year (Stein et al. 1995, Dettmers and Stein 1992, Gu et al. 1996, Mundahl and Wissing 1987). Not only does this strategy reduce their vulnerability to young piscivores, but in addition, by spawning early gizzard shad greatly reduce zooplankton resources. This, in turn, increases competition between obligate zooplanktivores (including early life history of piscivorous species), negatively affecting their growth and recruitment (Dettmers and Stein 1992, Kutkuhn 1958, Stein et al. 1995, Cramer and Marzolf 1970).

Atlantic menhaden (*Brevoortia tyrannus*), a marine herring, is an important component of the fish community in the Hudson River. After spawning on the coast, young menhaden move into the Hudson River estuary and use it as a nursery. Typically, menhaden were found in southern brackish areas of the river; however, in recent years menhaden have been captured as far north as Albany (R. Schmidt, Simons Rock College, pers. comm.).

B. tyrannus and *D. cepediamm* both switch as juveniles from zooplankton to detritus feeding. As stated above, gizzard shad are facultative detritivores. Juvenile menhaden feed mostly on zooplankton, and as adults are herbivores and detritivores, but may still feed on zooplankton (Maryland Department of Natural Resources).

Stable isotope analysis (SIA) is a research tool that can provide information on element cycles in ecosystems, and serving as a means of tracing ecological processes. In most ecological studies, stable isotope composition is expressed in terms of δ (del) which are parts per thousand (‰) from the standard, $(R_{sample}/R_{standard} - 1) \times 1000$ (Peterson and Fry 1987, Limburg 1998). For this study $\delta^{13}C$ and $\delta^{15}N$ ratios were used. The ratios of carbon stable isotopes (^{13}C:^{12}C) elucidate the indirect sources of energy and matter. Nitrogen stable isotope ratios (^{15}N:^{14}N) reveal the relative position of organisms in the food web. The combined use of stable isotope analysis and a diet study provides more complete information on a species' food resource and trophic status, than does a diet study alone.

The difference in stomach content and muscle tissue are to be expected by a 3.5‰ shift towards the heavier isotope ^{15}N up the food chain because ^{14}N tends to be lost (Fry 1991). Nitrogen undergoes more fractionation than carbon (Fry 1991), due to its greater involvement in various metabolic processes (e.g., excretion). The percent composition of elemental (vs. isotopic) nitrogen and carbon for juvenile menhaden and gizzard shad may reflect differences in food quality.

In this project, I surveyed most of the extent (39km-238km) of the tidal Hudson to determine where gizzard shad and menhaden were found, and I compared their diets. By the method of SIA, I could examine trophic relationships among species and life stages, examine differences in stable isotope signals along the Hudson River, and relate my results to other research. Also in this project, Atlantic menhaden are compared to gizzard shad. Atlantic menhaden are a long-term component of the Hudson River fish fauna, whereas gizzard shad are recent invaders. Because of trophic similarities, I compared their diets and assimilation of C and N in order to assess the potential for competition.

METHODS

Twenty-one sites were sampled from May 2000-September 2000 along the tidal Hudson River, Figure 1. Three of the sampling locations were larval sampling sites and the rest were juvenile beach seine sites.

Larval Sampling

Larval sampling began in May 2000 and continued through July 2000 for a total of thirteen sampling events. A one meter, 500-micron mesh, 0.5-meter diameter plankton net was used to sample larval gizzard shad. Five major tributaries of the Hudson River were investigated: Esopus Meadows, Wappinger Creek, Fishkill Creek, Roundout Creek, and Moodna Creek. Esopus Meadows and Fishkill Creek were abandoned as sites due to the location of dams, which were too close to the Hudson River. Ten samplings were conducted between 9:00 and 18:00 hrs and 20:00 and 24:00 hrs. The procedure for sampling was as follows: depending on flow velocity, the plankton net was weighted with 5-10 pounds (window sash-weights), and lowered into the tributary from a bridge with the opening of the net facing into the current. The net was allowed to fish for 20-minute intervals. Duration of sampling was shorter when flow velocity was high. The samples were preserved in 70% ethanol and brought back to the laboratory for processing.

Precipitation during summer 2000 was high, which made sampling difficult and flushed many larval fish out of the tributaries into the Hudson River.

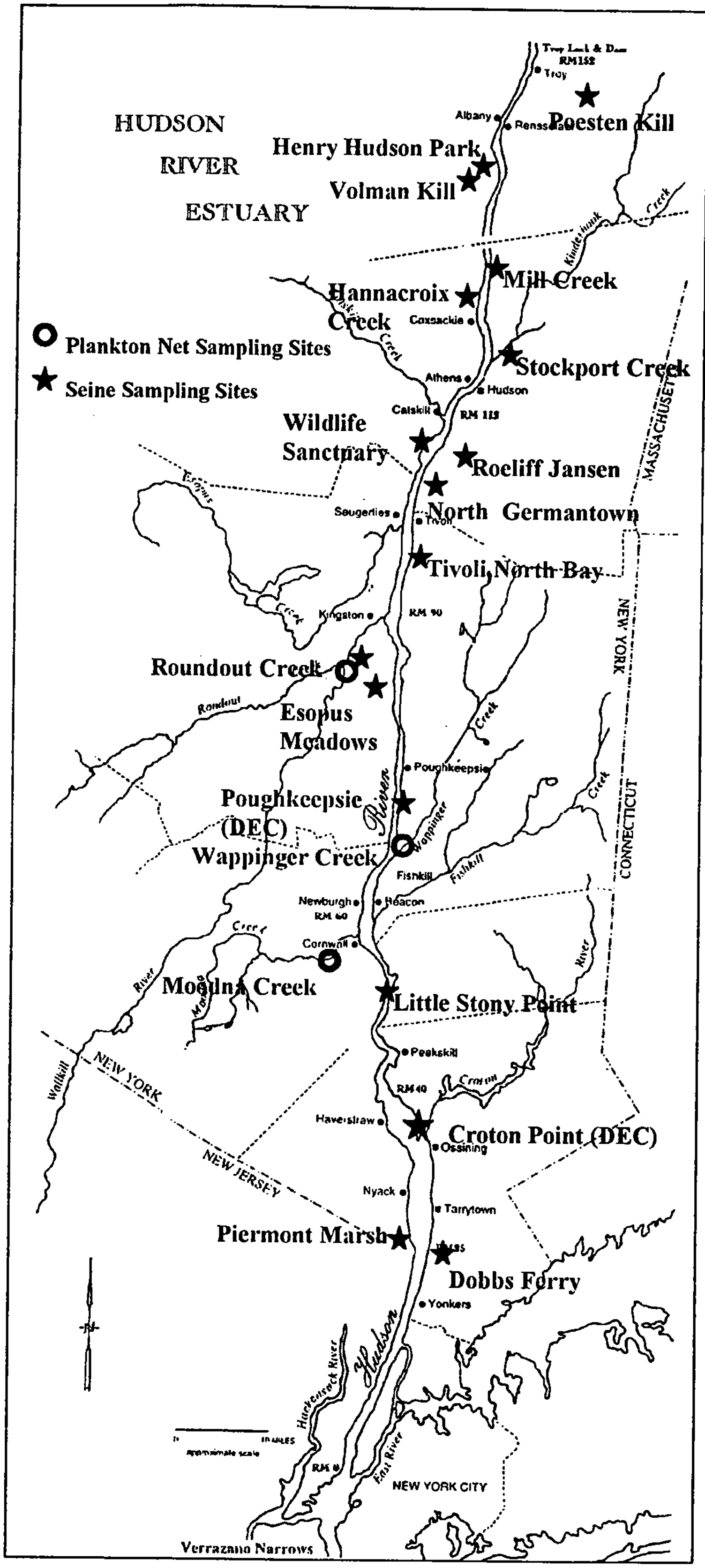

Figure 1. Map of plankton net and beach seine sampling sites in the tidal Hudson River and its tributaries from June-September 2000.