Report for 2002NJ1B: Effects of the Biopollutant, Phragmites australis, On the Nutritional Status (Biochemical Condition) of Juvenile Weakfish, New Directions Incorporating Otolith Chemical Signature Analysis

- Conference Proceedings:
    - Litvin, Steven, Vincent Guida and Michael Weinstein. 2003. Habitat utilization patterns of a juvenile marine transient: effects on biochemical condition and impicatioins on the value of habitat for fish production at the Estuarine Research Federation Bi-Annual Meeting, Seattle, WA. Sept. 14 18, 2003. (Abstract is accepted)

Report Follows:

Priority Issues and Research Objectives

Phragmites australis ranks among the most aggressive biopollutants in wetland landscapes. By altering the marsh through its influence on hydroperiod, and geomorphology, *P. australis* reduces nekton access to the marsh plain, and by affecting the exchange of materials including organisms (trophic relays; Kneib 1997), presumably negatively influencing the production of commercially and recreationally important species. In the past 50 years, *P. australis* has become the dominant macrophyte in many brackish marshes of the mid-Atlantic seaboard. For example, more than 16,000 ha of salt marsh are presently covered with a near monoculture of *Phragmites* on the Delaware side of the Delaware Bay, and the magnitude of coverage is similar on the New Jersey side (Weinstein and Balletto 1999, Figure 1). While millions of dollars are invested in attempts to eradicate *Phragmites*, primarily through the use of potentially toxic herbicides, we have no real idea of its influence on nekton secondary production. Because marine transients contribute significantly to the $50 billion fishery of the coastal United States, it is critical that we quantify the effects of *P. australis* on habitat quality and function, especially for the nekton that depend upon coastal marshes during their first year of life. This is the key value of the proposed study that addresses the issue of restoring coastal ecosystem health and establishing indicators of their function.

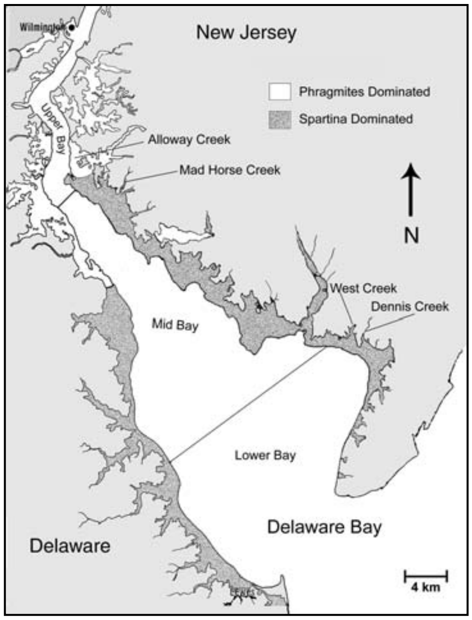

Figure 1.

Type III marine transients, including weakfish (*Cynoscion regalis*) and many taxa of commercial and recreational value, are species whose young use estuaries as “fine grained” environments, consisting of “boundary-less” habitat units, all of which may contribute to growth and survival during their first year of life (Levins 1968). Such species exhibit substantial flexibility in behavior and adaptive strategies to optimize growth and survival during the first growing season. However, abundant food at individual locations does not preclude young weakfish from establishing temporary residency in specific areas, at least long enough to take on the “signatures” of locally produced sources of organic matter. We previously identified seven sub-regions, including tidal marshes, of Delaware Bay where juvenile weakfish were seasonally abundant, and where different suites of primary producers contributed nutrients to secondary production in this species during the period June through October of each year (Figure 1).

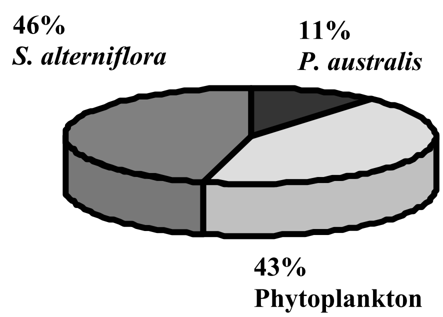

Figure 2. Relative Contribution of Primary Producers to the Nutrition of Juvenile Weakfish (> 60mm SL) Collected Just Prior to Emigration at the Mouth of Delaware Bay Derived from C and S Isotope Based Three Source Mixing Model.

Previous research, demonstrated that C, N and S derived from *Phragmites australis* dominated marshes of the Mid and Upper Delaware Bay support significant secondary production of juvenile weakfish, especially when fish are between about 20 mm and 60mm SL. Although the results of MANOVA and Discriminant Analysis suggest that young weakfish exhibit considerable site fidelity early in the growing season based on the reclassification of individual fish , their pattern of size-dependent movement down estuary as they grow, makes it clear that the *Phragmites* signal is “diluted” in the lower Bay, most likely by tissue turnover, in the late summer and early fall when larger juveniles are “staging” prior to emigration from the Bay. Residual *Phragmites* stable isotope signatures, however, are still clearly recognizable at the time when juveniles are preparing to exit the Bay (Figure 2).

To address the "dilution" issue (seasonal movement of larger individuals down Bay), and to identify the temporal-spatial history of habitat utilization, including the time spent in the upper Bay influenced by *P. australis* primary production, sagittal otolithes are being provided to Dr. Simon Thorrold of the Woods Hole Oceanographic Institution (WHOI). Dr. Thorrold has graciously agreed to use otolith microprofiles using carbon and oxygen stable isotopes ratios to track the previous temporal history of habitat utilization by bay mouth emigrants in the fall (Thorrold et al. 2001, 1998). In this way, we will have a complete record of the organic matter source history of all *survivors* exiting the Bay, as well as their nutritional status (using lipid analysis), and can estimate the contribution of *Phragmites*-dominated marshes to both secondary production and "quality" of individuals migrating hundreds of kilometers to over wintering areas (in terms of energy reserves).

As the tertiary link in many food chains, fishes are often reliable indicators of the condition of complex ecosystems. Thus, data on the intensity and direction of fat deposition, and the level of body fat reserves can not only be used to assess the "degree of well being", but also serve to integrate the overall value of habitats to their production. While the qualitative composition of food consumed influences the protein metabolism of fishes, it does not greatly alter the amino acid composition of proteins in the body. On the other hand, the lipid composition of the body is greatly influenced by dietary lipids. More specifically, it is the triacylglycerols (the main constituent of reserve energy) and free fatty acids that are influenced by diet (Shulman and Love 1999).

Fat storage depots may occur in numerous locations in finfishes (Shulman 1974): but in juvenile weakfish fatty deposits in muscle tissue appear to predominate. As in other species, energy is generally stored as neutral fats, triacylglycerols that account for up to 75% of all reserve lipids, but the storage may also be in the form of free fatty acids. In some species, more than three-quarters of the migration will be done *after* lipid reserves have been depleted and the fish must rely solely on muscle protein as a source of oxidative reserves (Shulman 1974), but the extent to which this may occur in weakfish is unknown.

Research Methods and Expected Results

Given the site fidelity (temporary residency) observed, could you infer that some of the seven sub-regions of Delaware Bay that have been defined (Figure 1) are more important than others in supporting weakfish production? If the biochemical condition and growth of juvenile weakfish from these sub-regions differs, as others suspect it does (Lankford and Targett 1994; Grecay and Targett 1996; Paperno *et al.* 2000), then recruitment to adult populations may be partially a function of habitat (sub-region) quality.

To address this hypothesis, aliquots of homogenate from two groups of juvenile weakfish are being analyzed for neutral lipid content, via thin layer chromatography-flame ionization detection (Parrish 1987), and subjected to carbon, nitrogen and sulfur stable isotope analysis. In addition, Dr. Thorrold will develop a carbon and oxygen microprofiles for a sagittal otolith of each individual. The first group of juvenile weakfish, up to 15 individuals < 60 mm SL from each sub-region, will be used to build a "baseline" of isotope values (otolith and homogenate) that will be used to elucidate the habitat utilization history of the second group of juvenile weakfish, up to 60 larger juveniles collected at the mouth of Delaware Bay just prior to emigration in 2001, via the same stable isotope parameters (Thorrold 1998, Litvin et. al. in prep). The neutral lipid content data will then be used to investigate the effect of differential habitat residency on the biochemical condition of the emigrating young-of the-year weakfish.

Progress to Date

Despite several months of delay due to the failure of an essential piece of equipment (a freeze drier which has been replaced) the weakfish collected for this study are in the midst of preparation for stable isotope, otolith and TLC/FID analysis.

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