Final Report to the VMRC and RFAB

Project Title:	What is the cause of menhaden recruitment failure? Quantifying the role of striped bass predation.
Report Number:	2007 - Final
Principal Investigators:	Dr. Nathan G. Smith & Dr. Cynthia M. Jones
Period of Performance:	July1, 2005 – Dec 31, 2006
Award Number:	RF 05-01
Funding Total:	$76,186 to ODU

Introduction:

Our research submission to the RFAB proposed one year of research with the following objectives:

1) Establish baseline Atlantic menhaden isotopic signature for comparison with striped bass isotopic signatures.
2) Describe current seasonal diet patterns of young striped bass
3) Determine whether predation by striped bass on menhaden combined with menhaden harvest exceeds menhaden supply

We were able to successfully address the first two objectives and take some preliminary steps toward addressing the third objective. Atlantic menhaden baseline stable isotope values were established for menhaden in Chesapeake Bay. We also used stable isotope analysis to examine seasonal diet changes in young striped bass within the Bay. Because variability was so high in menhaden stable isotope values (contrary to our expectations), we were unable to provide a definitive estimate of striped bass predation on menhaden. Our analyses do however provide an important first step toward answering that question and provide an avenue for future research.

Accomplishments:

We analyzed carbon and nitrogen isotope values for ~1100 menhaden and striped bass tissue samples. These samples included 330 menhaden samples from 2005-06, and 308 striped bass samples from 5005-06. Variation in carbon and nitrogen signatures for both striped bass and menhaden was greater than expected. There was, however, correlation between the two species that indicated striped bass isotope values consistent with a diet of menhaden for some individuals.

Collection and analysis of menhaden carbon and nitrogen signatures from 2005 and 2006 provides valuable baseline data for future work in Chesapeake Bay (Figure 1). Variation in both carbon and nitrogen isotope values was larger than expected. Interestingly, menhaden nitrogen isotope values were more indicative of a diet of zooplankton than a diet of phytoplankton. Previous studies of menhaden diet based on stomach contents indicated phytoplanktivory, but while they may consume phytoplankton, zooplankton may be much more important than previously reported. Because of this, menhaden nitrogen isotope values were not as distinct from other prey species in the Bay as we predicted. Menhaden carbon signatures also varied on a latitudinal gradient with fish from the upper Bay more depleted in carbon than menhaden from the mid and lower Bay.

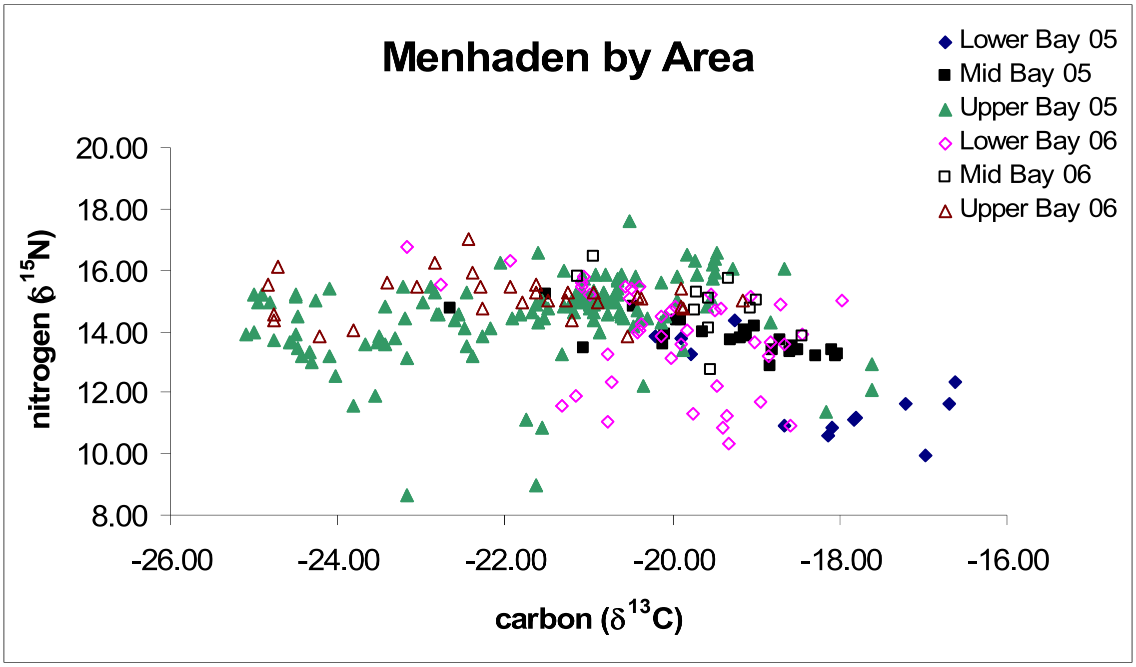

Figure 1. Carbon and nitrogen isotope values for 2005-06 Chesapeake Bay Atlantic menhaden. While there seems to be significant variation in the isotopic signatures of menhaden in the Bay, there are some general differences on a latitudinal gradient. In both years, menhaden from the Upper Bay tended to be more depleted in $\delta^{13}C$ than those from the Mid or Lower Bay.

We saw little evidence of a developmental shift in diets of menhaden as predicted by the literature. We expected differences in nitrogen stable isotope signatures of menhaden based on size, with larger fish indicating diets of phytoplankton and smaller fish consuming more zooplankton. There was no trend based on size or age, with nearly all fish having nitrogen stable isotope values consistent with a diet of zooplankton.

Striped bass carbon and nitrogen stable isotope values were also highly variable over the course of our study (Figure 2). As with menhaden, there was a latitudinal trend in carbon isotope values with higher carbon signatures in the Lower Bay. Additionally, striped bass nitrogen isotope values were more enriched in the Upper Bay. This likely indicates a combination of different diets in the different portions of the Bay in combination with unequal baseline values due to water sources.

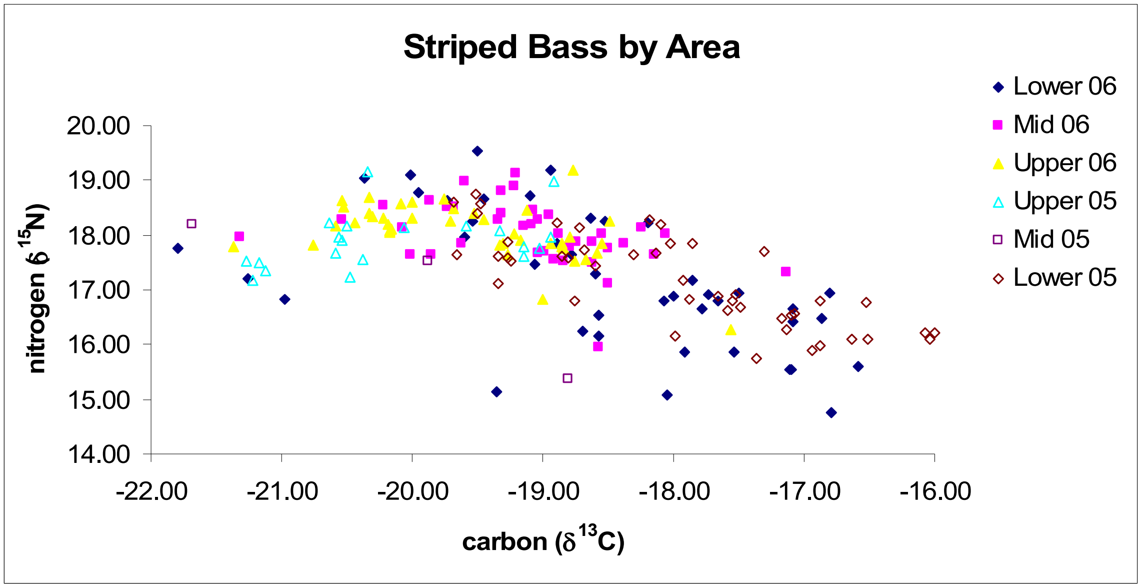

Figure 2. Carbon and nitrogen isotope values for striped bass muscle tissue from late 2005 and early 2006. As with menhaden, there is an evident latitudinal trend in isotopic values of carbon and nitrogen isotopes found in striped bass. Striped bass from the Lower Bay tend to be enriched in $\delta^{13}C$ and depleted in $\delta^{15}N$.

Due to the high variability in Atlantic menhaden stable isotope values in our Chesapeake Bay samples, attributing a specific value for the importance of menhaden in striped bass diets becomes exceedingly difficult. There were also no clear seasonal patterns evident in the stable isotope values of striped bass (Figure 3). Striped bass signatures indicated very different diets on an individual fish basis, and there was similarly high variability on a seasonal basis. While it is clear that some individual striped bass were not consuming menhaden, it is also evident that some bass isotopes were consistent with menhaden as a large proportion of the diet. As a follow up to these results, we plan to continue exploring stable isotope signatures of other potential prey items of striped bass in Chesapeake Bay to provide a more complete picture of the food web linkages that are important to striped bass.

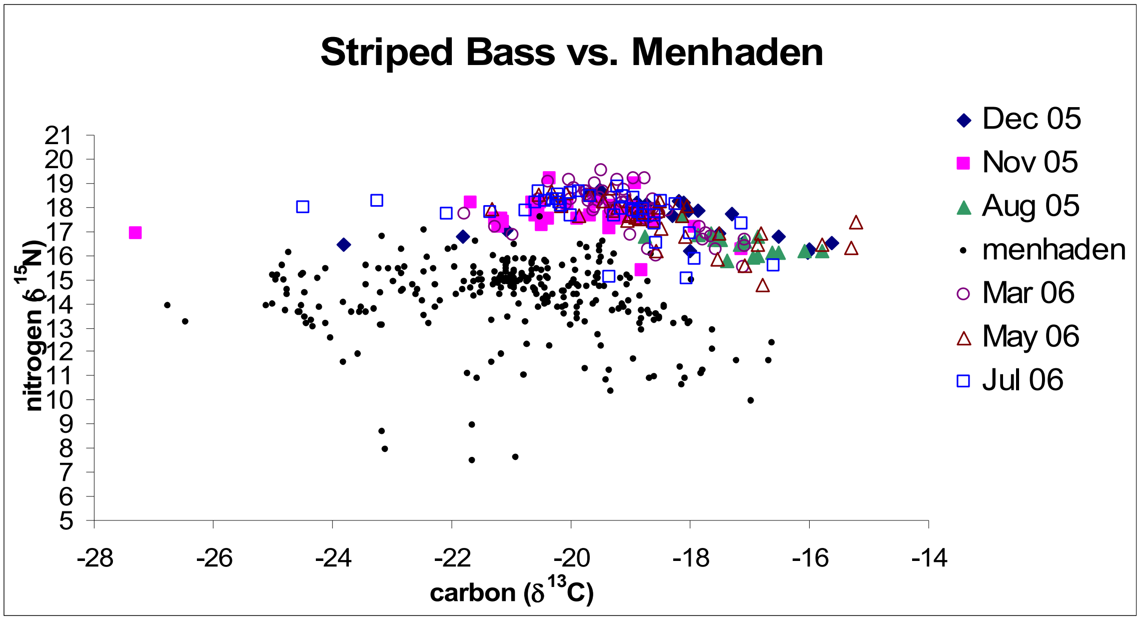

Figure 3. Carbon and nitrogen isotope values for striped bass from 2005 and 2006 compared to menhaden values. Wide variation in carbon signatures for both striped bass and menhaden complicate analyses, but it is clear that some striped bass signatures are consistent with a diet of menhaden while others are not.

In addition to the muscle tissue samples for striped bass, we also examined liver tissue and scale samples. While there was little evidence in the muscle tissue samples alone for seasonal diet shifts, comparison of the relationships between liver and muscle tissue isotope values for each individual fish provide evidence for seasonal diet changes. While scales had different carbon and nitrogen isotope values than muscle tissue, the differences were similar seasonally for the duration of our study. This opens the possibility of using scale isotope values to predict muscle tissue isotope values and could allow the use of archived scales to determine historic diet composition.

This research has provided valuable data on baseline menhaden and striped bass stable isotope values in Chesapeake Bay and their relation. We have answered some important questions as well as identified new questions (i.e. Why are carbon values for menhaden so variable?) We are currently preparing these results for journal publication and pursuing additional funding to continue this line of research. Data from this study can be used as a starting point for future research to address those questions.