VIRGINIA SALTWATER RECREATIONAL FISHING DEVELOPMENT FUND
SUMMARY PROJECT APPLICATION*

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NAME AND ADDRESS OF APPLICANT:	PROJECT LEADER (name, phone, e-mail):
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PRIORITY AREA OF CONCERN:	**PROJECT LOCATION:**
Research and Data Collection	Center for Quantitative Fisheries Ecology Old Dominion University Norfolk, VA 23508

DESCRIPTIVE TITLE OF PROJECT:

Sheepshead diet in Chesapeake Bay between 2006 and 2008, Virginia

PROJECT SUMMARY:

Our previous study has found that sheepshead in Chesapeake Bay is a unique stock with local reproduction and its own vital rates. Specifically, the sheepshead in Chesapeake Bay lives longer and are larger and heavier at a given age compared to its southern counterparts. However, little is known about what biotic and abiotic factors result in such a longer lifespan and higher growth rate of Chesapeake Bay sheepshead. Answers to those questions will not only enhance our understanding to biology and ecology of sheepshead in Chesapeake Bay but also assist fisheries management to choose a management option to more effectively use this natural resource. This study is to examine if the high growth rate and long lifespan of sheepshead is mainly or partially due to their unique forage base in Chesapeake Bay.

EXPECTED BENEFITS:

Fisheries management
The results from this study may provide an evidence to support trophy fish management policies on sheepshead population in Chesapeake Bay. The unique forage base for Chesapeake Bay sheepshead may provide recreational fishermen with a sheepshead trophy fishery which other regions of Atlantic can't provide.

COSTS:

October, 2010 – September, 2011

VMRC Funding:	$27,724
Recipient Funding:	$8,110
Total Costs:	**$35,834**

Detailed budget must be included with proposal.

Updated 11/12/08

***This form alone does not constitute a complete application, see application instructions or contact Sonya Davis at 757-247-8155 or sonya.davis@mrc.virginia.gov**

Budget

	VMRC	ODU	
PERSONEL:			
Salary of Jones (0.5 month)	**6,030**		
Undergraduate Student	**12,480**		
Faculty Release Time (Dr. Jones)		**6,030**	
Fringe Benefits	**$3,169**	**2,080**	
	$21,679	**$8,110**	
GENERAL EXPENSES:			
Supplies for stomach processing	**500**		
	$500		
TOTAL DIRECT COSTS	**$22,179**	**$8,110**	
INDIRECT COSTS (25%)	**$4,551**	**$0**	
TOTAL SPONSOR COST	**$27,724**	**$8,110**	**23% match**
TOTAL PROJECT COSTS			**$35,834**

Sheepshead diet in Chesapeake Bay between 2006 and 2008, Virginia

Proposal for consideration by the Virginia Recreational Fishing Advisory Board

Hongsheng Liao and Cynthia M. Jones
Center for Quantitative Fisheries Ecology
Old Dominion University

Statement of Problem

In 2006, Virginia recreational anglers and Coastal Conservation Association (CCA) expressed concern about potential overfishing on sheepshead (*Archosargu probatocephalus*) population and their interest in carefully developing a fishery for sheepshead in Chesapeake Bay. To respond to the public concern and interest, Center for Quantitative Fisheries Ecology (CQFE) at Old Dominion University conducted a 3-year study on Chesapeake Bay sheepshead population dynamics. With strong public support and working very closely with Virginia Marine Resources Commission, the study found that sheepshead in Chesapeake Bay is a unique stock with local reproduction and its own vital rates. Specifically, the sheepshead in Chesapeake Bay lives longer and are larger and heavier at a given age compared to its southern counterparts (Liao et al 2009). For example, the maximum age of sheepshead in Chesapeake Bay is 35 years old whereas sheepshead in other areas live in excess of 20 years old (Beckman et al. 1991). Moreover, the sheepshead in Chesapeake Bay are 7 lbs. in average with about 20 in. fork length at age 8 whereas sheepshead in other areas are only 4 lbs. in average with about 16 in fork length at the same age (**Figure 1** and**Figure 2**).

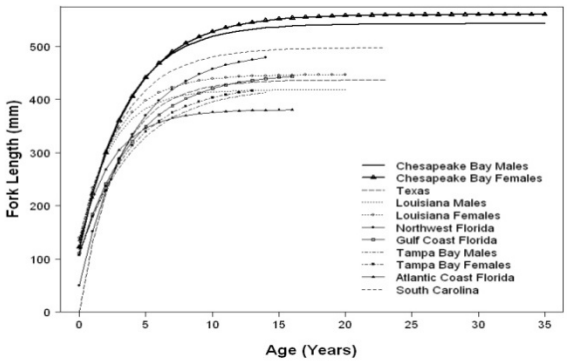

Figure 1. von Bertalanffy length growth curve for Chesapeake Bay and those published for sheepshead from other areas.

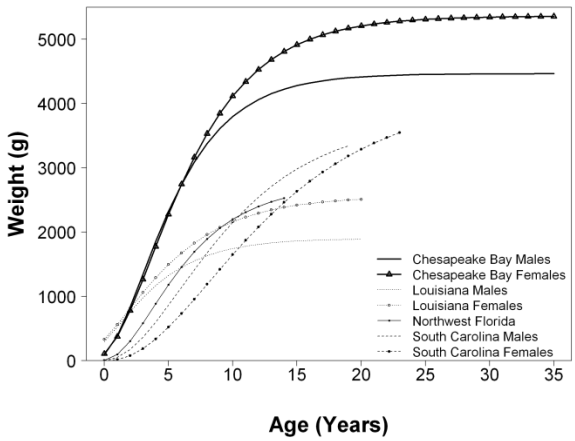

Figure 2. von Bertalanffy weight growth curve for Chesapeake Bay and those published from other areas.

However, little is known about what biotic and abiotic factors result in such a longer lifespan and higher growth rate of Chesapeake Bay sheepshead. Answers to those questions will not only enhance our understanding to biology and ecology of sheepshead in Chesapeake Bay but also assist fisheries management to choose a management option to more effectively use this natural resource. Our assumption is that the high growth rate and long lifespan of sheepshead may be mainly or partially due to their unique forage base in Chesapeake Bay.

Background

The relationship between spatial variations of growth rates and diets among fish populations have been thoroughly studied for freshwater species (Chen and Harvey 1995; Madenjian et al. 1998). Chen and Harvey (1995) reported that different growth rates among white sucker populations in Ontario Lakes were attributed to both population density and food supply by examining abundance of littoral chironomid larvae, preferred prey for white sucker. Madenjian et al. (1998) found that lake trout in Lake Michigan had a higher growth rate in nearshore than in offshore waters because lake trout in nearshore consumed mainly prey fish whereas lake trout in offshore consumed mainly invertebrates. A few studies of such a relationship have been found for marine fish species. For example, Boldt and Rooper (2009) found that condition of juvenile Pacific ocean perch (*Sebastes alutus*) varied with the quantity or quality of pelagic prey items consumed by the Pacific ocean perch. Some previous studies of sheepshead diets have been conducted, however, mainly in states in South Atlantic Bight and Gulf of Mexico.

It has been reported that sheepshead starts to shift their diets at round 50 mm body length. Fish less than 50 mm long mainly consumed ostracods, gammarids, copepods, and polychaetes (Hildebrand and Cable 1938; Springer and Woodburn 1960). However, the diet of sheepshead large than 50 mm long consisted mainly of hard-shelled organisms, i.e.,

mollusks, echinoderms, and barnacles (Jennings 1985; Sedberry 1987). Spatial variation in deits of sheepshead are also reported in previous studies. For example, Ogburn (1984) found that sheepshead fed on both algae and invertebrates, but algae were an important source of nutrients for both juvenile and adult sheepshead collected in North Carolina. However, Sedberry (1987) found that bryozoans were important in the diets of juvenile and adult sheepshead collected in the South Atlantic Bight. Bivalves, echinoderms, and ascidians were important in the diets of sheepshead larger than 350 mm standard length (Sedberry 1987). In Georgia, adult sheepshead fed on bryozoans, oysters, barnacles, and decapod shrimp (Music and Pafford 1984). Feeding activity was greatest in Georgia waters during the spring, summer, and fall and dropped dramatically during the winter. Overall, sheepshead are omnivorous fish, feeding on whatever is available in their habitats. There are no studies on diet of Chesapeake Bay sheepshead and no comparisons of sheepshead diets between Chesapeake Bay and other regions.

Significance

1) Theoretically, when a stock is open to exploitation for a certain time, population characteristics start to change. For example, age composition may shift from a majority of older fish to younger fish and individual growth rates may increase. By examining the sheepshead diet in Chesapeake Bay, we may examine if change in growth rates is due to either exploitation or unique forage base in Chesapeake Bay.

2) This study will also contribute biological, ecological, and conservation knowledge on sheepshead in a broad geological range. It has been reported that sheepshead are widespread from Nova Scotia to Brazil (Robins and Ray 1986). However, we have not found any studies on sheepshead diet north of North Carolina. Knowledge of this species in Virginia will provide information to conservation of this species and especially on the potential of connectivity between stocks.

3) Comparison of sheepshead diet in Chesapeake Bay to those in other regions may explain why their growth rate is higher in Chesapeake Bay than in other regions.

4) Provide an evidence to support trophy fish management policies on sheepshead population in Chesapeake Bay. The unique forage base for Chesapeake Bay sheepshead may provide us with a sheepshead trophy fishery which other regions of Atlantic can't provide.

Objectives

This study would be the first to evaluate sheepshead diets in the Chesapeake Bay. Our specific objectives are to: 1) identify prey taxa of sheepshead in Chesapeake; 2) characterize prey importance of sheepshead in Chesapeake Bay; 3) explore seasonal and age variation in diets of sheepshead.

Hypotheses:

$H0_1$: Sheepshead doesn't prefer a certain prey taxes in the Chesapeake Bay.
Ha_1: Sheepshead prefers a specific prey tax in Chesapeake Bay.

$H0_2$: There is no temporal difference in diets of sheepshead in the Chesapeake Bay.
Ha_2: There is a temporal difference in diets of sheepshead in the Chesapeake Bay.

H03: Sheepshead in Chesapeake Bay doesn't switch their diets when they get older.
Ha3: Sheepshead in Chesapeake Bay switches their diets when they get older.

H04: Sheepshead doesn't have a better forage base in Chesapeake Bay than in South Atlantic and Gulf of Mexico.
Ha4: Sheepshead has a better forage base in Chesapeake Bay than in South Atlantic and Gulf of Mexico.

Methods

Field work

274 stomachs of sheepshead were collected through recreational, commercial, and independent fisheries between May and October from 2006 to 2008. Fish length and weight were measured and weighed to 1 mm and 0.001 lb, respectively, before the stomachs were removed. The fresh stomachs were weighed to 0.1 g, and then preserved either in 10% formalin or in freezer. Fish ages were estimated following the protocol of Center for Quantitative Fisheries Ecology (CQFE) at Old Dominion University.

Laboratory work

Stomach contents will be flushed using freshwater. Percentage of empty stomach will be recorded. Prey invertebrates will be identified either to phylum, class, or order in the laboratory. If prey fish are present, they will be identified to species. Prey invertebrates found in stomachs will be counted. If more than 10 individuals of an invertebrate taxon are found in a stomach, a subsample of 10 randomly selected specimens were measured using Image Pro analysis connected to a microscope. Dry weights of prey invertebrates are estimated using length-weight equations found in the literature (Smock 1980; Meyer 1989), and wet weight was assumed to be 5 times dry weight (Morin and Dumont 1994).

Data Analysis

Data will be grouped into three age groups, young-of-the year (YOY), age 1 to 5, and the fish older than 5 to evaluate potential ontogenetic shift in diets. Each of the three sampling years was divided into two seasons, early season (May to July) and late season

(August to October) to account for potential seasonal shifts in diets. In total, three years x 2 seasons x 3 age groups lead to 18 possible categories, hereafter referred to as comparison unit.

We will use the index of relative importance, expressed as percentages of index of relative importance (%IRI) to describe prey importance for sheepshead in Chesapeake Bay (Cortes 1997). The index of relative importance (IRI) is compound index and composed of the percent frequency (%O), percentage weight (%W), and percentage number (%N) (Pinkas et al 1971). The %IRI provides the optimal balancing of frequency of occurrence, numerical abundance, and abundance by weight of taxa in fish diets.

We will calculate %W, %O, %N, IRI, and %IRI in each comparison unit as follows:

$$\%W_i = 100\frac{W_i}{\sum_{i=1}^{n} W_i} \quad (1)$$

$$\%O_i = 100\frac{O_i}{\sum_{i=1}^{n} O_i} \quad (2)$$

$$\%N_i = 100\frac{N_i}{\sum_{i=1}^{n} N_i} \quad (3)$$

$$IRI_i = \%O_i(\%W_i + \%N_i) \quad (4)$$

$$\%IRI_i = 100\frac{IRI_i}{\sum_{i=1}^{n} IRI_i} \quad (5)$$

,

where n is the total number of prey taxa in a comparison unit. W_i and N_i is the total wet weight (g) and number of prey i in a comparison unit. O_i is the number of sheepshead stomachs containing prey i in a comparison unit. IRI_i is the value of IRI for prey i in a comparison unit.

Expected Results

1. Summary of prey taxa in the diet of Chesapeake Bay sheepshead
2. Identification of important prey taxa to Chesapeake Bay sheepshead
3. Comparison of diets between sheepshead in Chesapeake Bay and in South Atlantic and Gulf of Mexico.
4. Discussion of potential relationships between diet and growth of sheepshead in Chesapeake Bay.

Timeline

Year 2010

September to December

Search and hire a senior undergraduate student and train the student on identifying stomach contents.

Year 2011

January to May

Work on stomach contents

June to August

Data analysis

September

Report the findings to VMRC and the Recreational Advisory Board.

References

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Laboratory Facilities

Center for Quantitative Fisheries Ecology (CQFE) at ODU has both personnel and equipments to conduct research on fish diets. Dr. Liao has four publications in peer-review journals directly about indices of diet importance, diets of six freshwater fish species and their consumption. Ph. D. student Renee Reilly is working on diet of juvenile spotted seatrout collected in Chesapeake Bay, under Dr. Jones supervision. The Age & Growth Laboratory at the CQFE, established by the VMRC in 1997, provides routine processing and ageing of marine finfish with all necessary equipments, such as microscopes and dissecting tools.

Budget justification

We have found that for a project such as this one, that a senior undergraduate student is more cost-effective than a technician. Because the students use the project as part of their study, they are able to provide more commitment to the project's success. The student will process samples, and conduct data analysis. Dr. Liao and Dr. Jones will oversee the project, coordinate sample processes, and assist data analysis. Dr. Jones will be providing her expertise with statistical issues, is requesting a half month direct payment for the studying year, and also is using a portion of her salary as matching funds. The matching part of her salary will be to train and guide the undergraduate student to perform this project and help the student to write up results. The remainder of funds goes to processing supplies and information exchange with local communities and organizations, such as fish clubs.