# 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<br>Old Dominion University<br>800 W 46th St.<br>Norfolk, VA 23508 |

## DESCRIPTIVE TITLE OF PROJECT:

Population Dynamics of Overwintering Speckled Trout on the Elizabeth River in Chesapeake Bay, Virginia

## PROJECT SUMMARY:

Speckled trout are an important recreational fish in the Chesapeake Bay. This species migrates out of the Bay as average water temperatures decline in the fall and winter months. However, a small subpopulation remain in the Bay to overwinter in warm effluent waters released from the Dominion Power Station on the Elizabeth River. These overwintering fish are targeted by a growing recreational fishery. Angler reports have indicated that these Elizabeth River fish maintain a longer spawning season when compare to fish that migrate. As little is unknown about this subpopulation, we propose a one-year project to examine age composition, growth, and reproductive potential of these fish as this unique subpopulation may add disproportionally more recruits to the bay wide fishery

## EXPECTED BENEFITS:

Population characteristics of overwintering speckled trout in Chesapeake Bay will be defined and reported to VMRC as basic information to conducting future stock assessment and to making management policies. The Elizabeth River fish may contribute heavily to the production of recruits to the overall trout population in the Bay. Therefore, this work will determine the contribution and the importance of these fish to the overall trout population for anglers Bay wide. Moreover, this work will strengthen the ties between anglers and scientific data collection. This interaction will better bridge the gap in crossing between anglers, applied scientist, and resource managers.

## COSTS:

The histological analysis, limited fishery independent sampling, and travel will be a main cost for this project. Supplies for laboratory related activities such as sectioning otoliths for ageing and gonad preparation will also be required.

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| **VMRC Funding:** | $64,871 |
| **Recipient Funding:** | $12,975 |
| **Total Costs:** | $77,846 |

**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**

**Population Dynamics of Overwintering Speckled Trout on the Elizabeth River in Chesapeake Bay, Virginia**

Proposal for consideration by the Virginia Recreational Fishing Advisory Board

Stacy Beharry and Cynthia M. Jones
Center for Quantitative Fisheries Ecology
Old Dominion University

**Summary – The thermal discharge in the Elizabeth River has attracted an overwintering group of speckled trout that are providing recreational fishing opportunities, and potential commercial conflicts. Virtually nothing is known about the importance of these fish to the Chesapeake Bay population. We submit this proposal subsequent to a request from interested anglers that we evaluate these fish.**

**Statement of the problem**

Recreational anglers have expressed interest in understanding the population dynamics of overwintering speckled trout (*Cynoscion nebulosus*) in the Elizabeth River in the Chesapeake Bay watershed. Speckled trout migrate during the winter months to warmer waters outside the Bay. However, a small group of trout overwinters in the warm effluent waters of the Dominion Power Station on the Elizabeth River. The warmer water attracts trout during the fall, and as water temperature decline elsewhere, fish remain in the river. These overwintering fish are targeted by a growing fishery, yet little is known about the changes in the reproductive potential and survival that may be due to prolonged exposure to warmer water temperatures.

There have been numerous reports that fish found in the Elizabeth River during the winter months have an extended spawning season, when compared to fish that undergo the annual migration to waters outside the Chesapeake Bay at the onset of cold temperatures. Additionally, recreational anglers have reported the presence of small young of the year individuals in the Elizabeth River long after the traditional spawning season has ended (Personal communication Sheldon Arey, recreational angler). Therefore, this "subpopulation" may be governed by different reproductive rates and may add disproportionally more individuals to the overall speckled trout population in the Bay.

Currently, little is known about the reproductive biology of overwintering fish. Moreover, the age structure and size composition of this subpopulation is also unknown. With a growing fishery, it is important to determine this subpopulation's relative importance in the production of recruits to the overall fishery. As the population in the Bay is closed (young come from Bay fish and not elsewhere), any highly productive area can change population dynamics. Therefore, to effectively manage the population of speckled trout in Chesapeake Bay it is necessary to understand the population dynamics of the trout overwintering in the Elizabeth River.

***Background***

Speckled trout are a common resident to estuaries along the eastern coast of the United States from Chesapeake Bay, Virginia to as far south as Mexico (Bortone 2003). In the Chesapeake Bay, the trout population resides at the northern extent of the species range. Unlike populations

further south, these fish are forced to undergo an annual migration by leaving the Bay when water temperatures decline in the fall to lethal limits (Dorval et al. 2005, 2007). This is the only speckled trout population that undergoes an annual migration as temperatures in the Bay during the winter months are below the tolerance limit for these fish. Tagging studies have revealed fish tagged in Virginia waters collected in neighboring states further south during winter months (Lucy and Bain 2001, 2003, 2007). The Chesapeake population is also unique as temperature restricts the spawning season, and fish only reproduce in warm waters from May to July (Brown 1981). However, in populations further south, such as Mexico, trout can spawn year round (Bortone 2003). This difference in spawning is attributed to shorter summers and cooler average water temperatures in the Bay.

Fisheries management recognizes the role physical parameters have on structuring the biological characteristics of populations. Important life history events such as timing of migration, spawning, and juvenile settlement are all regulated by environmental factors such as temperature (Beitinger and Fitzpatrick 1979). Currently, the small subpopulation of speckled trout that do not migrate, but overwinter in the Elizabeth River where there is a constant warm effluent, may show different reproductive characteristics than individuals that are exposed to normal declines in temperatures during the fall.

In the Chesapeake Bay, speckled trout are targeted by both recreational and a small commercial fishery. Landings for the commercial fishery in 2009 were 27,687 lbs while recreational catch in Virginia, estimated by Marine Recreational Fisheries Statistics Survey (MRFSS), reported a total catch of 85,358 lbs. With a predominantly recreational fishery, understanding the contribution of the Elizabeth River fish to the overall population is necessary for management.

**Project Objectives**

Our proposed research seeks to address the changes in population dynamics of speckled trout overwintering in the Elizabeth River. Specifically, we will determine the changes in ontogenetic processes such as maturity and spawning events of overwintering fish. By conducting histological inspections of the ovaries from overwintering fish we can determine whether Elizabeth River fish are more productive than fish that have migrated outside the Bay. We will determine if overwintering fish spawn earlier in the spring or have an extension of the season in the fall as reported by recreational anglers. We will test the hypothesis that there is no difference in maturity and spawning season between fish that overwinter in the warm effluent to those individuals that leave the Bay. By testing this hypothesis we will determine the consequences of long term exposure to warmer waters on reproduction.

We will also determine the age and size composition of the overwintering fish and compare it to the structure of the overall population. We have sampled this species for over ten years in the Bay. Using this time series of catch composition for comparison, we can determine if the overwintering age and size structure varies significantly from the overall population. This comparison of overwintering fish (warmer temperature) to the rest of the population (normal temperature) we will gain better understanding of the “selective mortality” that can occur as temperatures change. By testing the hypothesis that there is no difference in age or size between both groups we will determine whether the warmer waters in the river favor a specific age group

or size. Target dates for completion of work will be one year from the starting date of October 2011 if funded. See the timeline below for the completion of objectives.

## Methods/Approach

### *Fish collections*

We will collect speckled trout from the Elizabeth River by collaborating with local angler clubs. The Center for Quantitative Fisheries Ecology has strong ties to the local angling community. We have obtained fish carcass donations from anglers in previous projects through a cooler collection program in collaboration with the Virginia Marine Resources Commission (VMRC). Additionally, we will give scientific talks to specific angler's club to raise awareness about fish donations in order to obtain samples throughout the winter months. By having donations through the fishing community we can sample a longer period allowing us to have full sampling coverage when spawning occurs. We will also collect fish not overwintering in the river through a current commercial sampling collaboration with VMRC. These fish will be used to compare to fish that stay. Besides fishery dependent sampling we will also target speckled trout specifically to collect gonads to guarantee that ovaries are intact and fixed within a few hours of capture to ensure that samples are not degraded.

### *Histology*

The reproductive biology of speckled trout is well studied and we will implement widely used techniques for histological analysis. Ovaries will be weighed (0.1 g) and preserved in 10% buffered formalin until fixed. A 3mm wide cross section will be removed and stored in 70% ethanol. These prepared samples will be sent to Fish and Wildlife Research Institute in Florida for histological slide preparation. Samples will be embedded in paraffin, sectioned and stained using hematoxylin and eosin-Y to facilitate histological classification. We will examine each ovary for the presence of each stage of oocyte development, presence and age of post-ovulatory follicles (POFs). Oocyte development will be divided into five stages: unyolked, partially yolked, yolked, germinal vesicle migration, and germinal vesicle breakdown (Lowerre-Barbieri et al. 2009).

We will implement two techniques used for determining batch fecundity, defined as the number of ripened oocytes in the ovary immediately prior to spawning (Bagenal 1978). For hydrated specimens, the hydrated oocyte method will be used (Hunter et al. 1985, Hunter and Macewicz 1985). In this method, a sub-sample of the gonad is weighed to the nearest 0.1mg. The number of hydrated oocytes is counted and the projection of batch fecundity is calculated by the product of the hydrated count and the weight of the gonads for both lobes. For specimens that are fully matured but not hydrated, an oocyte size-frequency distribution method will be employed (MacGregor 1957, Hunter et al. 1985). With this method the most advanced modal group of oocytes size classes is determined visually by constructing a size-frequency distribution of the oocytes. The total number of oocytes that constitute the most advanced mode is assumed the spawning batch. This method yields similar results as the hydrated method if highly advanced oocytes are used (Hunter and Goldberg 1980; Laroche and Richardson 1980).

Typically, determining the number of batches in a season is difficult. As anecdotal information suggests overwintering fish maintain a longer spawning season, we will sample frequently from August to December so we can estimate the number of batches. Specifically, we will examine

the proportion of the population with post-ovulatory follicles present (evidence of recent spawning). The inverse of this proportion will give the average time between batches. For example, if 30% of the population has post-ovulatory follicles then the average interval between batches is 3 days. Thus, we can estimate the age-specific, batch fecundity and by summing over the season and we can determine total fecundity for the overwintering subpopulation. Additionally, we will compare both batch fecundity throughout the season and estimate the number of batches in a season for overwintering fish.

***Age determination***

All fish will be aged using sagittal otoliths. One otolith will be secured to a microscope slide, and sectioned on a Buehler Isomet saw equipped with two Norton diamond wafering blades separated by a 0.5 mm stainless steel spacer, positioned so that the wafering blades straddles the focus. Transverse sections of otoliths will then be mounted on glass slides using crystalbond. Since annuli form on the otoliths of speckled trout in April or May, annuli will be counted assuming 1 January birthdate (Ihde and Chittenden 2003).Otoliths will be read under a microscope using polarized light and an image analysis system. Procedures to establish quality assurance and reliability of age readings have been incorporated into our laboratory protocols as this species has been aged in our facility for the past 10 years. We will measure precision between age readings done by all readers so that we have consistency. Otoliths will be read double-blind (with no knowledge of time or place of capture, or length of fish). A randomly selected subsample will be read twice by the same reader and by another reader to test consistency among and between readers (Campana et al. 1995, DeVries and Frie 1996). We will use a symmetry test (Bowker 1948) to measure precision and to observe tendencies to over- or underestimate age. Because it is also important to maintain consistency in age readings between years, we will also insert a sample of hard parts read in prior years among currently collected samples following double-blind procedures to test year-to-year consistency in ageing (Campana et al. 1995). We test for potential differences with repeated-measures ANOVA. Such vigilance will maintain age reading consistency and reliability from year to year. We will determine whether age composition between effluent and non-effluent waters differ significantly.

***Age composition and growth***

To evaluate growth, observed length-at-age data will be fitted to a von Bertalanffy Growth function (Ricker 1975).

$$Lt = L_{inf}(1-e)^{(-k(t-t0))},$$

Lt = length at time t,
$L_{inf}$ = asymptotic mean length
t = time
$t_o$ = theoretical age at 0 length
K = growth coefficient (instantaneous rate).

Likelihood ratio tests (Kimura 1980) will be used to determine if differences exists between von Bertalanffy parameter estimates between sexes and fish that do not overwinter for mean fork length-at-age data.

***Temperature***
We will compare temperatures for effluent water along with other sites around the Bay. Temperature data is available through from the Chesapeake Bay Program through their Bay Resource Library. To supplement these data, we will also collect temperatures during our fishery independent sampling. We will determine whether there are significant differences in mean temperatures experienced by fish between effluent waters and normal Bay waters.

**Location**
The work will be conducted at the Center for Quantitative Fisheries, Old Dominion University Ecology. A Master's student will be the direct contact between recreational anglers and the center for fish donations.

**Timeline**
*Year 2011*
<u>June to August</u>
1. Search and hire a master's student.
2. Finalize logistics with volunteer fishing groups like Virginia CCA and local angler clubs for collecting fish.

<u>September to October</u>
Train the master's student on field and lab techniques, including fish collecting and processing, sample preserving, otolith processing and reading, and histological analysis.

<u>October 2011 to December</u>
1. Bi-weekly sampling to collect gonads from fish.
2. Receive samples from recreational anglers.
3. Process ovary samples for batch fecundity estimation and histological preparation.
4. Process otoliths for age and growth analysis.
5. Ovarian samples are sent for histological preparation.
6. Begin ageing using otoliths.
7. Preliminary fecundity estimates for speckled trout in the Elizabeth River in Chesapeake Bay.

*Year 2012*
<u>January to March</u>
1. Continue bi-weekly sampling to collect commercially harvested fish.
2. Continue to receive samples from recreational anglers.
3. Process ovary samples for batch fecundity estimation and histological preparation.
4. Process otoliths for age and growth analysis.
5. Ovarian samples are sent for histological.
6. Ageing using otoliths.
7. Ongoing data analysis

<u>April to May</u>
1. Final data analysis
2. Prepare the final project report to the VMRC and the recreational Board.

<u>June to September</u>
1. Submit the final project report.

2. Submit the manuscript for peer review.

**Expected Results- Final Products**

***Fisheries management***

Population characteristics of overwintering speckled trout in Chesapeake Bay will be defined and reported to VMRC and local angling clubs as basic information to conducting future stock assessment and to making management policies.

***Academic contributions***

A manuscript will be submitted to a peer-reviewed journal discussing the effects of temperature increases on marginal populations. Specifically, we will discuss the unique subpopulation of trout and its importance to the overall population, as this group may play an important role in producing more recruits to the speckled trout fishery across the Bay.

***Anticipated Benefits***

This project will determine the reproductive potential, and contribution of the Elizabeth river fish to the overall trout population in Virginia waters. Determining the shifts in reproduction will directly impact the way in which this species is fished, and measures that ensure maximum productivity for both the population and the fisher can be established. Additionally, by comparing batch fecundities we will be also be able to identify if overwintering fish are more productive than individuals that migrate. As the trout population in the Bay is closed, any highly productive area can change population dynamics. Although, this work is centered on a lower Bay fishery, it is an important winter fishery. The Elizabeth river fish may contribute heavily to the overall trout population in the Bay. Therefore, this work will determine the contribution and the importance of these fish to the overall trout population for anglers Bay wide.

This work will also promote “citizen science” as the project requires strong involvement with stakeholders. Recreation anglers are a valuable monitoring resource, as they are often the first to notice changes in ecosystem components. In fact, **this proposal is based on information from a local angler who was interested in donating both his time and money to conserve this unique population of overwintering fish**. Increasing angler involvement in science will increase awareness about the factors that govern the growth and development of fish. This project will provide a direct link between resource users and the collection of scientific information used for management.

**Dissemination of Results**

The results of this work will be presented to VMRC as a formal report. The overwintering population of speckled trout has lead to a growing winter fishery. This unique resource should be considered in any evaluation of the speckled trout stock in Chesapeake Bay. In addition, we will disseminate information as the project progresses to the fishing clubs that help collect fish by presenting our results at club meetings. We will also publish results on our website www.odu.edu/sci/cqfe, specifically we will publish the ages of fish caught by anglers on allowing individuals who donated fish to gain a better understanding of the relationship between size at age. We will also make this information available on our facebook page.

**Detailed Budget**

| | RFAB | Match |
|---|---|---|
| **Salaries** | | |
| C. Jones | $6,030 | $0 |
| Graduate student | $24,000 | $0 |
| **Fringe Benefits** | $2,728 | $0 |
| **Equipment** | $1,940 | $0 |
| **Supplies** | | |
| Slides, Nalgene bottles | $1,000 | $0 |
| Blades, Vials | $1,000 | $0 |
| **Travel** | | |
| Meetings | $700 | $0 |
| Collect fish donations | $500 | $0 |
| **Publications** | $500 | $0 |
| **Other** | | |
| Boat | $10,500 | $0 |
| Histology | $3,000 | $0 |
| **TOTAL DIRECT COSTS** | **$51,898** | **$0** |
| **Indirect Costs (25% cap)*** | $12,973 | $12,975 |
| **TOTAL COST** | $64,871 | $12,975 |

*** Unrecoverable difference between 25% cap and 50% ONR negotiated rate is shown as match funding**

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