



Proposal Submission to

Recreational Fishing Advisory Board

By

THE VIRGINIA INSTITUTE OF MARINE SCIENCE  
COLLEGE OF WILLIAM AND MARY

Quantifying the Economic and Behavioral Effects of Alternative Regulatory Measures in  
Virginia's Recreational Cobia (*Rachycentron canadum*) Fishery

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June 2016

# VIRGINIA SALTWATER RECREATIONAL FISHING DEVELOPMENT FUND

## SUMMARY PROJECT APPLICATION

Please complete all fields. This page should be used as a coversheet for a detailed application.

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**NAME AND ADDRESS OF APPLICANT:** Andrew M. Scheld, Hamish J. Small, and Susanna Musick, Virginia Institute of Marine Science, College of William & Mary, P.O. Box 1346, Gloucester Point, VA

**PROJECT LEADER (name, phone, email):** Andrew M. Scheld, 804.684.7160, [scheld@vims.edu](mailto:scheld@vims.edu)

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**DESCRIPTIVE TITLE OF EVENT:** Quantifying the Economic and Behavioral Effects of Alternative Regulatory Measures in Virginia's Recreational Cobia (*Rachycentron canadum*) Fishery

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**PROJECT LOCATION:** Virginia Institute of Marine Science

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**BRIEF PROJECT SUMMARY: (include a detailed description of activity as an attachment)**

Cobia, *Rachycentron canadum*, is a recreationally important species in Virginia and other South Atlantic states. Amendment 20B to the Coastal Migratory Pelagic Resources Fishery Management Plan set recreational annual catch limits for the Atlantic migratory group of cobia at 630,000 pounds in 2015 and then 620,000 pounds/year beginning in 2016 (80 FR 4216, January 27 2015). In recent years, recreational landings have exhibited significant inter-annual variability while angler interest in the species has continued to grow. To limit quota overages and meet biological targets, federal and state managers are currently considering a variety of management measures.

Recreational saltwater fisheries generate significant benefits to individual anglers and coastal communities. Sales of fishing-related goods and services (fuel, bait, tackle, lodging, and food) are often major drivers in local economies and individual anglers derive substantial non-market benefits through fishing-related activities. Recreational fishery management measures which influence trip-taking and angling behavior can therefore have broad economic consequences. The proposed research seeks to investigate Virginia recreational angler decision-making and preferences with respect to cobia management, in order to better understand the economic effects of regulatory changes. We will survey a random subset of recreational saltwater fishing license holders to obtain data on: 1) cobia fishing experience, avidity, and attitudes; 2) fishing mode(s) and method(s); 3) trip expenditures; 4) angler demographics; and 5) preferred trip alternatives (including target species). Discrete choice experiments and random utility models will be used to analyze regulatory preferences, angling-related values, and species targeting decisions. Additionally, statistical models of angler decision-making will be used to evaluate changes in fishing-related expenditures arising under different cobia management strategies.

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**EXPECTED BENEFITS: (Describe how your project directly benefits the average Virginia recreational angler)**

The knowledge and models which result from this research will enable identification of regulatory alternatives which maximize economic and social benefits in the management of the recreational cobia fishery. This will allow biological targets to be achieved without undue economic costs. Furthermore, the survey and modeling framework developed through this research will be transferable across fisheries, potentially yielding future benefits in the management of other recreationally important species. Our research will benefit current and future Virginia recreational saltwater fishing licenses holders by providing a means to incorporate angler values and preferences in assessment of cobia management alternatives. Extensive engagement with the stakeholder community and managers throughout survey development, as well as in dissemination of survey findings, will further relationships and avenues of communication between the Virginia Institute of Marine Science, the Virginia Marine Resources Commission, and Virginia recreational anglers.

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**SUMMARY COSTS: (Please attach a detailed budget including all sources of recipient funding)**

**SUMMARY COSTS\***

<b>Requested VMRC Funding:</b>	\$103,986
<b>Recipient Funding:</b>	\$36,419
<b>Total Costs:</b>	\$140,405

\*First year costs of multi-year project; see detailed budget

**Title: Quantifying the Economic Impacts Resulting from Restrictive Management Measures  
in the Recreational Cobia Fishery in Virginia**

Personnel	Time	Monthly	Year 1		
			Agency	VIMS	Total
<i>Faculty and Staff</i>					
Andrew Scheld	2.50	\$7,989	\$11,984	\$7,989	\$19,973
Hamish Small	1.07	\$4,842	\$5,200	\$0	\$5,200
Susanna Musick	0.75	\$5,692	\$2,846	\$1,423	\$4,269
	-	\$0	\$0	\$0	\$0
	-	\$0	\$0	\$0	\$0
	-	\$0	\$0	\$0	\$0
	-	\$0	\$0	\$0	\$0
<i>Hourly</i>					
Hourly (student) assistance in survey developme	1.00	\$2,923	\$2,923	\$0	\$2,923
	-	\$0	\$0	\$0	\$0
<i>Graduate Research Assistant</i>					
PhD student (6mo yr 2)	-	\$1,971	\$0	\$0	\$0
	-	\$0	\$0	\$0	\$0
			\$20,030	\$9,412	\$29,442
			\$2,923	\$0	\$2,923
			\$0	\$0	\$0
			\$8,012	\$3,765	\$11,777
			\$224	\$0	\$224
			\$31,189	\$13,177	\$44,366
<b>Total Personnel</b>					
<b>Communications/Printing</b>			\$1,000	\$0	\$1,000
<b>Supplies</b>			\$1,000	\$0	\$1,000
<b>Consultant/Skilled Services</b>			\$49,500	\$0	\$49,500
<b>Travel</b>			\$500	\$0	\$500
<b>Subaward Agreements</b>					
<i>Name of Subaward Agency</i>			\$0	\$0	\$0
<i>Name of Subaward Agency</i>			\$0	\$0	\$0
<b>Tuition</b>			\$0	\$0	\$0
<b>Vessels</b>			\$0	\$0	\$0
<b>VIMS Communications/Publication Center</b>			\$0	\$0	\$0
<b>Nutrient Analysis</b>			\$0	\$0	\$0
<b>Seawater Research Lab</b>			\$0	\$0	\$0
<b>Equipment</b>			\$0	\$0	\$0
<b>SUBTOTAL: Direct Costs</b>			\$83,189	\$13,177	\$96,366
<b>Facilities &amp; Administrative Costs</b>		<b>25.0%</b>	\$20,797	\$23,242	\$44,039
<b>TOTAL</b>			<b>\$103,986</b>	<b>\$36,419</b>	<b>\$140,405</b>

**Title: Quantifying the Economic Impacts  
Resulting from Restrictive Management**

Personnel	Time	Monthly	Year 2		
			Agency	VIMS	Total
<i>Faculty and Staff</i>					
Andrew Scheld	1.00	\$8,388	\$8,388	\$8,388	\$16,776
Hamish Small	0.29	\$5,084	\$1,494	\$0	\$1,494
Susanna Musick	0.25	\$5,977	\$1,494	\$0	\$1,494
	-	\$0	\$0	\$0	\$0
	-	\$0	\$0	\$0	\$0
	-	\$0	\$0	\$0	\$0
	-	\$0	\$0	\$0	\$0
<i>Hourly</i>					
Hourly (student) assistance in survey developme	-	\$0	\$0	\$0	\$0
	-	\$0	\$0	\$0	\$0
<i>Graduate Research Assistant</i>					
PhD student (6mo yr 2)	6.00	\$2,070	\$12,420	\$0	\$12,420
	-	\$0	\$0	\$0	\$0
			\$11,376	\$8,388	\$19,764
			\$0	\$0	\$0
			\$12,420	\$0	\$12,420
Fringe, 40% salaries; 7.65% hourly			\$4,550	\$3,355	\$7,905
			\$0	\$0	\$0
<b>Total Personnel</b>			<b>\$28,346</b>	<b>\$11,743</b>	<b>\$40,089</b>
<b>Communications/Printing</b>			\$0	\$0	\$0
<b>Supplies</b>			\$0	\$0	\$0
<b>Consultant/Skilled Services</b>			\$0	\$0	\$0
<b>Travel</b>			\$300	\$0	\$300
<b>Subaward Agreements</b>			\$0	\$0	\$0
<i>Name of Subaward Agency</i>			\$0	\$0	\$0
<i>Name of Subaward Agency</i>			\$0	\$0	\$0
<b>Tuition</b>			\$7,221	\$0	\$7,221
<b>Vessels</b>			\$0	\$0	\$0
<b>VIMS Communications/Publication Center</b>			\$0	\$0	\$0
<b>Nutrient Analysis</b>			\$0	\$0	\$0
<b>Seawater Research Lab</b>			\$0	\$0	\$0
<b>Equipment</b>			\$0	\$0	\$0
<b>SUBTOTAL: Direct Costs</b>			<b>\$35,867</b>	<b>\$11,743</b>	<b>\$47,610</b>
<b>Facilities &amp; Administrative Costs</b>			\$7,162	\$11,296	\$18,458
<b>TOTAL</b>			<b>\$43,029</b>	<b>\$23,039</b>	<b>\$66,068</b>

## PROJECT SUMMARY

**Applicant Organization:** Virginia Institute of Marine Science, College of William and Mary

**Project Title:** Quantifying the Economic and Behavioral Effects of Alternative Regulatory Measures in Virginia's Recreational Cobia (*Rachycentron canadum*) Fishery

**Principal Investigator:** Andrew M. Scheld, Assistant Professor, Department of Fisheries Science, Virginia Institute of Marine Science, College of William & Mary, P.O. Box 1346, Gloucester Point, VA 23062; Phone: 804.684.7160; Email: [scheld@vims.edu](mailto:scheld@vims.edu)

**Co-Investigator:** Hamish J. Small, Associate Research Scientist, Department of Aquatic Health Sciences, Virginia Institute of Marine Science, College of William & Mary, P.O. Box 1346, Gloucester Point, VA 23062; Phone: 804.684.7745; Email: [hamish@vims.edu](mailto:hamish@vims.edu)

**Co-Investigator:** Susanna Musick, Marine Recreational Specialist, Marine Advisory Services, Virginia Institute of Marine Science, College of William & Mary, P.O. Box 1346, Gloucester Point, VA 23062; Phone: 804.684.7166; Email: [susanna@vims.edu](mailto:susanna@vims.edu)

**Area of Interest:** Research & Data Collection

**Project Location:** Virginia Institute of Marine Science

**Project Duration:** 18 months (January 2017 – June 2018); 12 months year 1 (January 2017 – December 2017), 6 months year 2 (January 2018 – June 2018)

**Project Summary:** Cobia, *Rachycentron canadum*, is a recreationally important species in Virginia and other South Atlantic states. Amendment 20B to the Coastal Migratory Pelagic Resources Fishery Management Plan set recreational annual catch limits for the Atlantic migratory group of cobia at 630,000 pounds in 2015 and then 620,000 pounds/year beginning in 2016 (80 FR 4216, January 27 2015). In recent years, recreational landings have exhibited significant inter-annual variability while angler interest in the species has continued to grow. To limit quota overages and meet biological targets, federal and state managers are currently considering a variety of management measures.

Recreational saltwater fisheries generate significant benefits to individual anglers and coastal communities. Sales of fishing-related goods and services (fuel, bait, tackle, lodging, and food) are often major drivers in local economies and individual anglers derive substantial non-market benefits through fishing-related activities. Recreational fishery management measures which influence trip-taking and angling behavior can therefore have broad economic consequences. The proposed research seeks to investigate Virginia recreational angler decision-making and preferences with respect to cobia management, in order to better understand the economic effects of regulatory changes. We will survey a random subset of recreational saltwater fishing license holders to obtain data on: 1) cobia fishing experience, avidity, and attitudes; 2) fishing mode(s) and method(s); 3) trip expenditures; 4) angler demographics; and 5) preferred trip alternatives (including target species). Discrete choice experiments and random utility models will be used to analyze regulatory preferences, angling-related values, and species targeting decisions.

Additionally, statistical models of angler decision-making will be used to evaluate changes in fishing-related expenditures arising under different cobia management strategies.

**Expected Benefits:** The knowledge and models which result from this research will enable identification of regulatory alternatives which maximize economic and social benefits in the management of the recreational cobia fishery. This will allow biological targets to be achieved without undue economic costs. Furthermore, the survey and modeling framework developed through this research will be transferable across fisheries, potentially yielding future benefits in the management of other recreationally important species. Our research will benefit current and future Virginia recreational saltwater fishing licenses holders by providing a means to incorporate angler values and preferences in assessment of cobia management alternatives. Extensive engagement with the stakeholder community and managers throughout survey development, as well as in dissemination of survey findings, will further relationships and avenues of communication between the Virginia Institute of Marine Science, the Virginia Marine Resources Commission, and Virginia recreational anglers.

**Funds requested (year 1): \$103,986**

Cost sharing (year 1): \$36,419

Project cost (year 1): \$140,405

**Funds requested (year 2): \$43,029**

Cost sharing (year 2): \$23,039

Project cost (year 2): \$66,068

**Total funds requested: \$147,015**

Total cost sharing: \$59,458

Total project cost: \$206,473

## PROJECT DESCRIPTION

### I.) Need

Cobia, *Rachycentron canadum*, is a cosmopolitan coastal pelagic fish species distributed throughout tropical and subtropical Atlantic, Indian, and western Pacific oceans (Shaffer and Nakamura 1989). In spring and summer months, cobia in the western North Atlantic migrate with warming waters from Florida northward and aggregate in high-salinity estuaries, including the Chesapeake Bay, to spawn (Shaffer and Nakamura 1989). Commercial and recreational fisheries for this species exist from the Gulf of Mexico to Virginia, however the recreational sector has historically accounted for the majority of landings. Cobia are presently managed jointly in federal waters by the South Atlantic Fishery Management Council (SAFMC) and the Gulf of Mexico Fishery Management Council (GMFMC) under the Coastal Migratory Pelagic Resources Fishery Management Plan. The species is managed as two separate groups (Gulf and Atlantic), with the southern boundary of the Atlantic group set at the FL/GA border based upon conventional tagging and genetic data (SEDAR 2013). The most recent stock assessment, which incorporated data through 2011, indicated that the Atlantic group (GA to NY) was not overfished and that overfishing was not occurring (SEDAR 2013).

In March 2016, NOAA Fisheries announced that the recreational fishery for the Atlantic stock would close in federal waters on June 20<sup>th</sup> 2016, reopening January 1<sup>st</sup> 2017 (81 FR 12601, March 10 2016). The closure was the result of accountability measures which were triggered by a large 2015 recreational overage. According to estimates from the Marine Recreational Information Program (MRIP), the recreational sector is thought to have harvested 1,541,535 pounds in 2015—nearly two and a half times their annual catch limit (ACL). Announcement of the closure was met with protest by fishermen in North Carolina and Virginia, who might be disadvantaged disproportionately due to the seasonal migratory behavior of cobia. Following the federal announcement, fisheries management bodies in North Carolina and Virginia both decided to forgo a concurrent closure of state waters, opting instead for strict minimum size and possession limits. The current management and regulatory climate surrounding the recreational fishery for Atlantic cobia may exist for some time. Annual recreational landings (GA-VA) have been highly variable in recent years, and since 2004, the recreational ACL of 620,000 pounds is thought to have been exceeded more often than not (SAFMC 2016a). Recognizing this, as well as the inequity of current accountability measures, federal managers are now considering a variety of management alternatives (e.g., changes in minimum size, bag, and vessel limits) (SAFMC 2016b).

It has become widely recognized that recreational fisheries significantly contribute to local, regional, and national economies and culture (Aas 2008; NOAA 2015). In Virginia, the importance of recreational angling has been acknowledged for some time (Kirkley and Kerstetter 1997; Kirkley et al. 1999). Recent estimates from the National Marine Fisheries Service (NMFS) indicate that saltwater recreational fishing in Virginia generated close to half a billion in sales while supporting over 5,000 jobs during 2014 (NMFS 2016). Management actions which lead to shifts in harvester behavior (e.g., fishery closures or restrictive size/possession limits) may therefore hold wide-ranging economic and social implications (Fulton et al. 2011; Fenichel et al. 2013). Understanding Virginia recreational angler decision-making, regulatory preferences and behavioral responses will allow for enhanced forecasts and evaluation of angler effort, harvests, and the economic effects which might arise from recreational cobia management measures.

## **II.) Objective**

The primary objective of this research is to develop an understanding of Virginia recreational angler decision-making and preferences with respect to cobia management. This will allow the effects of regulatory alternatives, in terms of effort, harvests, and expenditures, to be forecast and evaluated. We will achieve this objective by surveying a representative sample of Virginia recreational anglers and using statistical models to analyze their responses. The full scope of work cannot be achieved in one year alone, therefore it is our intent to request additional funding for a second year (2018). Survey development (project months 1-7) and implementation (project months 8-10) will take place during the first year of the project while additional funding will be requested for a second year to carry out analysis (preliminary analysis will take place in year 1). Note that costs for both years have been included in this proposal.

## **III.) Expected Results or Benefits**

The knowledge and models which result from this research will enable identification of regulatory alternatives which maximize economic and social benefits in the management of the recreational cobia fishery. This will allow biological targets to be achieved without undue economic costs. Furthermore, the survey and modeling framework developed through this research will be transferable across fisheries, potentially yielding future benefits in the management of other recreationally important species. Our research will benefit current and future Virginia recreational saltwater fishing licenses holders by providing a means to incorporate angler values and preferences in assessment of cobia management alternatives. Extensive engagement with the stakeholder community and managers throughout survey development, as well as in dissemination of survey findings, will further relationships and avenues of communication between the Virginia Institute of Marine Science, the Virginia Marine Resources Commission, and Virginia recreational anglers.

## **IV.) Approach**

The proposed research will proceed in three stages: survey development, survey implementation, and analysis of survey responses and dissemination of findings. All three aspects are crucial to meeting the stated research objective, however it is not possible to satisfactorily accomplish all in one year. We therefore intend, if funded, to request a second year of follow-on funding during the next funding cycle. In what follows, all three research stages will be discussed, though it is anticipated that the majority of the third stage (analysis of survey responses, dissemination of findings) will be accomplished during the second year of the research project. As a result of the sophisticated survey techniques proposed in this research, as well as the broad and complex implementation strategy and a legal obligation to maintain confidentiality of high-volumes of angler response data, the services of a third-party survey research firm will be sought (e.g., QuanTech, Rockville, MD).

### Survey Development (PIs Scheld, Small, and Musick)

The angler survey will be developed during the first six months of the project. Initial stages of development will include contacting managers and VMRC staff, bait and tackle shop owners, charter captains, fishing clubs, and recreational saltwater fishing license holders to identify relevant questions, tradeoffs, and ranges for variables of interest (e.g., catch, trip costs). Initial



survey scoping will take approximately two months (project months 1-2). Following this, the survey will be developed in close collaboration with key stakeholders and the hired survey research firm. To maximize coverage and total responses while maintaining a representative sample, it is anticipated that the survey instrument will be web-based (contact PI Scheld for a link to a web-based survey currently distributed to Atlantic bluefin tuna charter/headboat permit holders, which might serve as an example). Two months are allocated to development and testing of the survey instrument (project months 3-4). Once the initial survey instrument is developed, two focus groups will be held to review questions and related materials (e.g., reminder emails/mailings, informed consent language, etc.). Each focus group will be composed of 6-10 recreational saltwater fishing license holders identified during initial survey scoping (or through existing contacts). Focus groups will be held during the fifth month of the project. Final revisions will be made to the survey following focus groups (project month 6).

The U.S. Department of Health and Human Services mandates that human-subjects research must be reviewed and approved by an Institutional Review Board to ensure the safety and appropriate use of humans as subjects in research studies. At the College of William & Mary the Protection of Human Subjects Committee (PHSC) serves this role, and prior to holding focus groups or implementing the survey, all research materials will have to be approved. This process can take more than a month, though previous experience on a similar project suggests two or three weeks may be more likely. PHSC review and approval will be required twice: once before holding focus groups (project month 4) and again before survey implementation (project month 7).

Scheld will lead survey development and all related tasks. Small will identify key stakeholders, work with Scheld in initial scoping and throughout survey development, and plan, organize, and run focus groups (with Scheld). Musick will help plan and organize focus groups (note that Musick will be responsible for organizing and running the additional focus group discussed in *Integration with other proposed cobia research*). The project team will also employ hourly help by a VIMS graduate student for survey development and outreach.

### *Survey Questions*

The survey will look to gather data on: 1) cobia fishing experience, avidity, and attitudes; 2) fishing mode(s) and method(s); 3) trip expenditures; 4) angler demographics; and 5) preferred trip alternatives (including target species). Questions will include a mix of multiple choice and open response as well as likert-type scales and paired comparisons.

Discrete choice experiments (DCEs) will be used to identify preferred trip alternatives. DCEs present respondents with multiple alternatives, each made up of several different attributes, and ask that they choose their most preferred (Louviere et al. 2000). This approach has been found to reduce many biases commonly encountered in stated preference studies (e.g., hypothetical bias, protest responses, yea-saying) and is considered a valuable tool in the assessment of non-market goods and services (Hanley et al. 1998; Freeman et al. 2014). There are several examples of applications in recreational fisheries, where researchers are frequently concerned with preferences and values regarding regulatory variables and non-regulatory, trip-specific attributes (see e.g., Aas et al., 2000, Carter and Liese, 2012, and Lew and Larson, 2012). Below is an example DCE from a study PI Scheld is currently directing.

FEATURES	OPTION A	OPTION B	OPTION C
Bag limits (per vessel)	3 School per day 0 Large School/Small Medium per day 0 Large Medium/Giant per year	0 School per day 3 Large School/Small Medium per day 1 Large Medium/Giant per year	Do not go bluefin tuna fishing.
Catch	2 School 2 Large Medium/Giant	1 Large School/Small Medium 1 Large Medium/Giant	
Legal harvest	2 School	1 Large School/Small Medium 1 Large Medium/Giant	
Hooked and lost	2	0	
Trip cost to you	\$400	\$200	
	<u>OPTION A</u>	<u>OPTION B</u>	<u>OPTION C</u>
Please indicate the option you like the <b>BEST</b> → (Select one):	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Please indicate the option you like the <b>LEAST</b> → (Select one):	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Figure 1.** DCE used in a study to evaluate regulatory preferences and angler decision-making in the Atlantic bluefin tuna recreational fishery (Scheld and Goldsmith, 2016)

The DCEs used in this study will offer respondents three alternatives—two different fishing trips as well as a no trip option (see Figure 1). Each trip alternative will be composed of two or three regulatory attributes (e.g., minimum size and possession limits) and two or three non-regulatory attributes (e.g., catch and cost). Additionally, to better understand how fishing pressure may shift between recreational targets, some DCEs will include a species attribute, e.g., a cobia trip vs. a trip catching bottom fish (flounder, sheepshead, or seabass). Anglers will thus be presented with two possible fishing trips, each potentially differing in terms of catch (numbers and species), regulations (and therefore legal harvest), and cost. They will then be asked to select their most and least preferred options from among the two trips and no-trip alternative. This strategy simulates real-world recreational angling decision making, and the resulting choices allow researchers to evaluate how decisions are made and tradeoffs assessed. To limit cognitive burden while still obtaining data from several choice occasions, each angler will be presented with 4-6 DCEs (Louviere et al. 2000). An efficient blocked fractional factorial experimental design will be selected using macros in the statistical software SAS (see Kuhfeld 2005).

### Survey Implementation (PIs Scheld and Small)

Project PIs (Scheld and Small) will engage in outreach to the angling community prior to survey implementation to explain the survey's purpose and increase response rates (project months 7-8). Outreach activities may involve attending local angling club meetings, contacting key stakeholders, and providing information about the study to fishing clubs, bait and tackle shops, and local media outlets.

The survey will be distributed to a random sample of recreational saltwater fishing license holders over a two to three month period (project months 8-10). Roughly 30,000 license holders will be randomly selected and asked to participate in the study. The final sampling frame will be decided upon after conversations with VMRC, though it will be restricted to those anglers with valid email addresses. Selected anglers will first be notified through an invitation email which explains the study and provides a link and unique identifier. A reminder email will be sent one week later to those who have not yet participated, followed by a reminder postcard after more two weeks, and a final email reminder four to five weeks after the initial invitation. Best practices in implementation strategy will be followed to maximize response rates (see Dillman et al. 2009). All angler data received through the survey will be kept confidential and stored on secure servers, as is typically required in human subjects research.

### Survey Analysis (PIs Scheld and Small)

Data on cobia fishing experience, avidity, and attitudes; fishing mode and method; trip expenditures; and angler demographics will be analyzed using standard statistical tools. Initial analysis of this data (e.g., descriptive statistics, group t-tests) will occur as soon as survey response data has been cleaned and made available to the researchers by the contracted survey research firm (project month 11 or 12). Analysis of preferred trip alternatives using random utility models will occur in the second year of the project (project months 13-18).

Random utility models (RUMs) are a statistical tool for understanding decision-making and behavior. RUMs decompose choice alternatives into observable and unobservable random factors, and assume that individuals make choices which maximize their well-being, or utility (McFadden 1974). Over the last several decades, a number of RUMs have been developed to explore various types of discrete choice problems, where individuals must choose from among a limited set of alternatives (see Train 2009). Most models take the general form:

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_j e^{V_{nj}}},$$

where the probability that person  $n$  chooses alternative  $i$  ( $P_{ni}$ ) is a function of the observable attributes of alternative  $i$  ( $V_{ni}$ ) as well as those of all alternatives  $j$  ( $V_{nj}$ ). Observable attributes typically enter  $V_{ni}$  linearly while unobservable random factors are assumed to be Gumbel-distributed (Train 2009). The parameters returned after statistically fitting a RUM correspond to the change in utility resulting from a change in an observable variable, which can then be used to evaluate probabilistic changes.

We will utilize RUMs to analyze data from DCEs, where survey respondents select their preferred trip alternatives. Data on both trip-specific attributes and individual factors (e.g., demographic data or cobia fishing experience and avidity) will enter the models, allowing choices to be influenced by inter-alternative tradeoffs and angler-specific variables. Model results will

allow us to address several important management questions. For example, do changes in cobia possession limits or size restrictions lead to species switching or changes in overall angling effort (i.e., taking vs. not taking a trip)? Additionally, RUM results, together with trip expenditure data and data on cobia fishing experience and avidity, will allow for analysis of the direct expenditure impacts resulting from cobia management measures (e.g., total lost sales resulting from a catch-and-release only fishery). By evaluating angler decision-making in DCEs over a range of different size restrictions and possession limits (including zero), we will be able to predict trip decisions given a particular regulatory setting and infer the associated changes in fishing-related sales. Angler willingness to pay will also be calculated for a variety of trip attributes (e.g., catch, legal harvest) and used to assess the value of recreational cobia fishing opportunities to Virginia saltwater anglers. Throughout survey analysis, researchers will be in close contact with VMRC staff to identify relevant management questions and scenarios.

Scheld will lead survey analysis and will be responsible for all RUM modeling. Small will assist in initial analysis of survey data. A VIMS graduate student research assistant will work with Scheld on statistical analyses and RUM modeling during year 2.

#### Dissemination of Findings (PIs Scheld, Small, and Musick)

Findings will be communicated to managers, recreational anglers, and stakeholders. A short summary of results will be emailed to those involved in the study as well as other interested parties. Additionally, the data, models, and results collected and developed as part of this research will be made available to VMRC for management purposes. Scheld, Small, and Musick will all engage in drafting and disseminating findings.

#### Consideration of the Charter Sector

Though our study is focused on only recreational saltwater fishing license holders, we will consider the charter sector in several ways. First, this group of stakeholders will be involved in our initial survey scoping. Charter captains will aid in developing key aspects of the survey (e.g., substitute target species, types of trip expenditures, etc.) as well as in understanding important similarities, differences, and any overlap among their clientele and the population of recreational saltwater fishing license holders. Second, fishing mode questions will be included in the survey and those recreational saltwater fishing license holders who charter fish for cobia (and other stocks) will be identified. Preferences, decision-making, and responses to management by this group of individuals can then be analyzed and assessed for differences with those who do not charter fish. Third, results from our study regarding angler preferences and values should be useful to those in the charter industry. Specifically, findings such as angler willingness to pay for trips with restrictive regulations (e.g., low or zero possession limits) will provide the charter sector robust quantitative data on which to base projections of anticipated effects.

#### Integration with other proposed cobia research

VIMS researchers submitting cobia research proposals in the June 2016 Virginia Saltwater Recreational Fishing Development Fund (VSRFDF) cycle will work cooperatively to capitalize on project dissemination, angler participation, and data and sample collection. The VIMS Marine Advisory Services Marine Recreation Specialist (Musick) will serve as a central point of contact for stakeholders interested in the projects and coordinate information requests with each project's Principal Investigator.

Staff from VIMS will also work together to host a central, introductory stakeholder focus group workshop in early winter 2017 (costs included in this proposal). The workshop will be coordinated and facilitated by VIMS Marine Advisory Services' staff. The focus group will include cobia anglers, cobia charter captains, and top cobia taggers from the Virginia Game Fish Tagging Program. This workshop will provide an opportunity for all VIMS' staff working on VSRFDF projects to give an overview of their projects, data needs and field collection methods, and give an opportunity for anglers to give direct feedback. As many of the anglers in the stakeholder focus group will potentially be working on all of the projects, this workshop should also centralize outreach efforts and make it easier for anglers to contribute.

#### **V.) Location**

Survey development will take place at VIMS, the location of the hired survey research firm, and at fishing clubs, bait and tackle shops, and other locations where researchers will discuss the project with stakeholders. Survey implementation (web launch and mailings) will occur at the offices of the hired survey research firm. Survey analysis will take place at VIMS.

#### **VI.) Estimated Cost**

##### **Funds requested (year 1): \$103,986**

Cost sharing (year 1): \$36,419

Project cost (year 1): \$140,405

##### **Funds requested (year 2): \$43,029**

Cost sharing (year 2): \$23,039

Project cost (year 2): \$66,068

##### **Total funds requested: \$147,015**

Total cost sharing: \$59,458

Total project cost: \$206,473

The proposed total budget includes the costs of survey development, implementation, analysis and dissemination of findings (see Table 1 for a breakdown of requested funds). Survey development, implementation, and initial analysis will take place during year 1 of the project. RUM modeling and analysis of management driven questions will take place during year 2 of the project. Project costs are separated by year below. Salaries and tuition include 5% increases per annum.

#### **Year 1**

Personnel: Scheld requests 1.5 months of support for leading all project tasks (survey development, implementation, and initial analysis of responses). Small requests 1.0 months of salary support for survey development, including organizing and running of focus groups (with Scheld), outreach to the recreational angling community, and initial analysis of survey response data. Musick requests 0.5 months of support for assisting in survey development (e.g., by connecting Scheld and Small with recreational anglers and angler-groups), helping to plan and organize the two survey-related focus groups, and leading the cooperative cobia research focus

group to be held in early 2017. Scheld and Musick will provide salary match of 1.0 and 0.25 months, respectively. Funds are also requested to pay for 1.0 months of student help in survey development (PhD workshop rate of \$18.27/hour). VIMS fringe benefits rates of 40% (salaried) and 7.65% (hourly) apply.

Communications/Printing: Funds are requested for printing of outreach materials, including descriptions and advertisements of the angler survey, to be distributed to stakeholder groups (fishing clubs, bait and tackle shops) and local media outlets prior to survey implementation.

Supplies: Support is sought for holding two focus groups as part of survey development and one introductory, multi-project focus group (see *Integration with other proposed cobia research*). One survey development focus group and the introductory, multi-project focus group will be held at VIMS. A second survey development focus group will be held in Virginia Beach (e.g., in a hotel conference room). Costs per focus group are estimated at: \$250 (multi-project, VIMS); \$250 (survey development, VIMS); and \$500 (survey development, Virginia Beach). Costs include food and beverage for focus group participants, as well as renting a conference space and any necessary audio/visual equipment and other technology (e.g., laptops).

Consultant/Skilled Services: The proposed project requires the services of focus group participants and a survey research firm. Focus group participants will be treated as independent contractors and paid a flat hourly rate, which will cover their time and travel (\$25/hour x 3 hours x 10 participants x 2 focus groups = \$1,500). A survey research firm will be hired to develop and implement the survey (\$48,000). Costs for the contracted survey research firm are based upon previous experience of PI Scheld and an informal, non-binding quote from QuanTech, Inc.

Travel: Project PIs request funds to travel to VMRC and the locations of various stakeholders.

Facilities & Administrative Costs: Funds are requested for facilities and administrative costs and charged at 25% direct costs.

## **Year 2**

Personnel: Scheld requests 1.0 months of support for leading statistical analyses and modeling, and for working with other project PIs to communicate findings from the research. Small requests 0.5 months of salary support for assisting in survey analyses and communicating findings. Musick requests 0.25 months of support for communicating findings to stakeholder groups. Scheld will provide salary match of 1.0 months. One semester of stipend for a VIMS graduate student is also requested. The student will work on statistical analyses and modeling. VIMS fringe benefits rates of 40% for salaried employees apply.

Travel: Project PIs request funds to travel to VMRC and the locations of various stakeholders.

Tuition: One semester of tuition for a VIMS graduate student is requested.

Facilities & Administrative Costs: Funds are requested for facilities and administrative costs and charged at 25% direct costs.

**Table 1.** Funds requested by project year

Budget Item	Year 1	Year 2
Personnel, salaried	\$20,030	\$12,420
Personnel, hourly	\$2,923	\$0
Personnel, grad assist	\$0	\$11,376
Fringe, salaried	\$8,012	\$4,550
Fringe, hourly	\$224	\$0
Tuition	\$0	\$7,221
Communications/Printing	\$1,000	\$0
Supplies	\$1,000	\$0
Consultant/Skilled Services	\$49,500	\$0
Travel	\$500	\$300
Facilities & Administrative	\$20,797	\$7,162
<b>Total</b>	<b>\$103,986</b>	<b>\$43,029</b>

## References

- 80 FR 4216 (80 Federal Register 17, pp. 4216-4226). January 27, 2015. "Fisheries of the Caribbean, Gulf of Mexico, and South Atlantic; Coastal Migratory Pelagic Resources in the Gulf of Mexico and Atlantic Region; Amendment 20B."
- 81 FR 12601 (81 Federal Register 47, pp. 12601-12602). March 10, 2016. "Fisheries of the Caribbean, Gulf of Mexico, and South Atlantic; 2016 Recreational Accountability Measure and Closure for Atlantic Migratory Group Cobia."
- Aas, Ø., W. Haider, and L. Hunt. 2000. Angler responses to potential harvest regulations in a Norwegian sport fishery: a conjoint-based choice modeling approach. *N. Am. J. Fish. Manage.* 20:940-950.
- Aas, Ø., ed. 2008. *Global challenges in recreational fisheries*. Oxford, UK: Blackwell.
- Carter, D.W., and C. Liese. 2012. The economic value of catching and keeping or releasing saltwater sport fish in the southeast USA. *N. Am. J. Fish. Manage.* 32:613-625.
- Dillman, D. A., J. D. Smyth, and L. M. Christian. 2009. *Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. New York: Wiley.
- Fenichel, E.P., J. K. Abbott, and B. Huang. 2013. Modelling angler behaviour as a part of the management system: synthesizing a multi-disciplinary literature. *Fish Fish.* 14:137-157.
- Freeman III, A. M., J. A. Herriges, and C. L. Kling. 2014. *The measurement of environmental and resource values: theory and methods*. Resources for the Future, Washington, D.C.
- Fulton, E. A., A. D. M. Smith, D. C. Smith, and I. E. van Putten. 2011. Human behaviour: the key source of uncertainty in fisheries management. *Fish Fish.* 12:2-17.
- Hanley, N., R. E. Wright, and V. Adamowicz. 1998. Using choice experiments to value the environment. *Envir. and Res. Econ.* 11(3-4):413-428.
- Kirkley, J. E., and D. W. Kerstetter. 1997. "Saltwater angling and its economic importance to Virginia." Virginia Institute of Marine Science, Gloucester Point, Virginia.
- Kirkley, J. E., N. Bockstael, K. E. McConnell, and I. E. Strand. 1999. "The economic value of saltwater angling in Virginia". Virginia Institute of Marine Science, Gloucester Point, Virginia.
- Kuhfeld, W. F. 2005. "Marketing research methods in SAS." *Experimental Design, Choice, Conjoint, and Graphical Techniques*. Cary, NC, SAS-Institute TS-722.
- Lew, D. K., and D. M. Larson. 2012. Economic values for saltwater sport fishing in Alaska: a stated preference analysis. *N. Am. J. Fish. Manage.* 32:745-759.



Louviere, J. J., D. A. Hensher, and J. D. Swait. 2000. *Stated Choice Methods: Analysis and Application*. Cambridge: Cambridge University Press.

McFadden, D. 1974. "Conditional logit analysis of qualitative choice behavior." In *Frontiers in Econometrics*, P. Zarembka. Academic Press, New York. pp. 105-142.

NMFS (National Marine Fisheries Service). 2016. Fisheries Economics of the United States, 2014. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-F/SPO-163, 237p.

NOAA (National Oceanographic and Atmospheric Administration). 2015. National Saltwater Recreational Fisheries Implementation Plan 2015-2018. National Marine Fisheries Service, Silver Spring, MD.

SAFMC (South Atlantic Fishery Management Council). 2016a. "Cobia Management Issues Summary."

SAFMC (South Atlantic Fishery Management Council). 2016b. "Coastal Migratory Pelagics Framework Amendment 4: Management Measures for Atlantic Cobia."

Scheld, A. and W. Goldsmith. 2016. Characterizing the behavior and preferences of anglers in the recreational fishery for Atlantic bluefin tuna (*Thunnus thynnus*) along the U.S. east coast. NOAA Saltonstall-Kennedy Grant Program. Award number NA15NMF4270291.

SEDAR, 2013. SEDAR - South Atlantic Cobia Stock Assessment Report. SEDAR, North Charleston, SC, p. 412.

Shaffer, R.V., and E. L. Nakamura. 1989. Synopsis of biological data on the cobia *Rachycentron canadum*. Pisces: Rachycentridae. NOAA Tech. Rep. NMFS 82 (FAO Fisheries Synopsis 153), 21 p.

Train, K. E. 2009. *Discrete Choice Methods with Simulation*. 2<sup>nd</sup> ed. Cambridge: Cambridge University Press.