Rhode Island
Saltwater Anglers
Foundation

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FY2013 Rhode Island Recreational Fishing Advancement Grant
PROJECT APPLICATION

The Rhode Island Saltwater Anglers Foundation, Inc. (Foundation) is a nonprofit 501(c)3 organization, created to preserve our marine fisheries, sponsor educational and public awareness programs, environmental protection, restoration projects, and youth activity programs that foster recreational fishing, safety and conservation for the recreational fishing community in southern New England.

The Foundation is interested in promoting and investing in a project that will have benefit to the recreational fishing community by providing support to a researcher affiliated with either **Roger Williams University** or the **University of Rhode Island**.

The Foundation is willing to fund a project exclusively with our funding, however we encourage applicants to leverage this private funding with Federal or State funding to allow these funds to be used as a key part of a larger project.

The Foundation may award one or multiple projects. In addition to submitting all application materials to the e-mail address below, the application should be submitted by U.S. mail to the Foundation office.

The maximum amount available for an individual project is $15,000. These funds may be used for on-the-ground habitat conservation and improvement projects, research, culture specific to species of recreational interest, or for projects that will in some other way benefit recreational fishermen in Southern New England.

Project Title: Mercury contamination in scup (*Stenotomus chrysops*) from Rhode Island waters
Project Location: Roger Williams University, Bristol, RI

Applicant Information

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Yr of study: NA Department: NA
Name of key advisor: NA Phone: NA

PROJECT CONTACT

Lead Project Officer (if different from applicant): Same as above
Address: See above
Phone: See above E-mail: See above

FUNDING INFORMATION

Funding being sought for: Monitoring, Research, and Outreach
Funding amount requested: $12,166 Total cost of project: $12,166

PROJECT ELIGIBILITY

No Will any amount of the requested funds be applied to previous expenditures?
No Will the requested funds be used for operation or maintenance of facilities?
Yes Is the project primarily a research study?

I. PROJECT DESCRIPTION

A. Project description

Mercury is a widespread and toxic environmental contaminant that adversely affects human health, and exposure occurs mainly through the consumption of contaminated fish.[1] To minimize mercury exposure, U.S. federal and state agencies issue consumption advisories to inform the public of the possible health risks of eating fish. However, consumption advisories are limited by several key factors. First, advisories are frequently predicated on nationally aggregated data that broadly estimate fish mercury concentrations.[1,2] Therefore, advisories often lack the appropriate detail to accurately report contamination risks of fish collected from a specific body of water or human demographic. This concern is especially warranted for the northeastern U.S., a region that relies heavily on local commercial and recreational fisheries. Second, national advisories emphasize fish species that are identified as high-risk for mercury, and thus, there is a paucity of information for low-risk species. The latter, consequently, undermines the health benefits provided by fish that pose little threat to the health of fish-consuming citizens.[3-5]

The Rhode Island Department of Health (RI DOH) has issued consumption advisories for freshwater fish based on species- and site-specific estimates of mercury concentrations. With respect to estuarine and marine fish, however, the RI DOH refers to the issued warnings from the U.S. Food and Drug Administration (FDA) for fish consumption.[2] By default, RI has based advisories on nationally aggregated data, and recommends not eating swordfish, shark, bluefish, and striped bass (note that advisories for bluefish and striped bass are for organic contaminants, not mercury). Until recently, it was unknown whether these species in RI waters contain mercury levels consistent with national averages, and therefore justify their inclusion in the advisories. Conversely, edible fishes not recognized as significant health risks, and therefore excluded from consumption advisories, may have mercury levels exceeding FDA action levels. Recent work by Dr. Taylor, Associate Professor of Marine Biology at Roger Williams University (Bristol, RI), has elucidated mercury bioaccumulation patterns in recreational fisheries from RI coastal waters. Here, Dr. Taylor concluded that the mercury content of these fish (e.g., striped bass, bluefish, tautog, black sea bass, summer flounder, and winter flounder), in many instances, do not reflect nationally aggregated data.[6-8] To this end, current RI consumption advisories for saltwater fish may be overly or insufficiently protective in limiting mercury exposure.

The purpose of this proposed investigation is to examine mercury contamination in scup *Stenotomus chrysops* – a coastal finfish species that supports an important recreational fishery in RI waters. The specific objectives of this study are threefold: (1) Analyze mercury concentrations in scup as a function of body size in order to assess bioaccumulation patterns, (2) Evaluate scup mercury levels relative to the threshold values established by the U.S. FDA and Environmental Protection Agency[1,2], and compare these results to health risks associated with consuming other finfish, and (3) Work collaboratively with the RI DOH to develop meaningful consumption advisories for RI residents, including recreational anglers. Acquiring such data will support public health risk assessments and risk management decisions related to the issuance of fish consumption advisories.

B. Importance of project to recreational fishing

Relative to the general population, specific U.S. subpopulations are more susceptible to mercury toxicity because of their elevated rates of fish consumption. For example, economic status, ethnic and cultural identity and practices, and coastal residency are important factors governing fish consumption, and thus, mercury exposure.[9-11] Recreational anglers in the U.S. are also a subpopulation of concern because they are high-end consumers of fish and fishery products.[12-17] This concern is especially

warranted for RI residents, where the state supports an extensive saltwater recreational fishery. In 2011, for example, the annual recreational landing of 1,414,037 kg constituted ~ 10% of the total recreational landings in the North Atlantic.[18] Further, nearly 38,000 residents (4% of the state's population) purchased saltwater fishing licenses in 2011, a relatively high number considering that saltwater licenses have only been required in the state for the past two years.[19] These data indicate that RI residents, especially recreational anglers, are a more highly exposed group to mercury toxicity relative to the national average.

The focal species in the proposed study is the scup *Stenotomus chrysops*. Scup support a lucrative recreational fishery in RI with a 2011 annual landing equal to 326,302 kg, which represents ~ 23% of the total recreational catch in the state.[18] Moreover, Dr. Taylor recently disseminated a food frequency questionnaire (FFQ) to RI recreational anglers to obtain more accurate estimates of fish eating habits of the state's residents. Of the 183 responses received from the FFQ, 25.8% of the individuals reported eating scup in the summer of 2012. Scup may therefore represent an important source of mercury for fish-consuming individuals, given the prominence of this species as a dietary resource in RI.

C. Objective of the project with reference to recreational fishing

The objectives of this study are threefold:

(1) Measure mercury concentrations in the filet (muscle) tissue of scup, and analyze the results as a function of fish body size in order to assess mercury bioaccumulation patterns.

(2) Evaluate scup mercury levels relative to the threshold values established by the U.S. Food and Drug Administration and Environmental Protection Agency[1,2], and compare these results to health risks associated with consuming other finfish (e.g., striped bass, bluefish, tautog, black sea bass, summer flounder, and winter flounder).

(3) Work collaboratively with the RI Department of Health to develop meaningful consumption advisories for RI residents, including recreational anglers.

D. Proposed methods to be used

From June to August 2013, scup will be collected from Narragansett Bay and Rhode Island Sound/Block Island Sound using otter trawls and hook & line. Total mercury will be measured in filet (muscle) tissue of these scup, as well as previously archived samples, using combustion atomic-absorption spectrophotometry.[20] Roger Williams University (RWU) will be the performance site for these analytical procedures. Mercury data will then be statistically compared to scup size to assess bioaccumulation patterns. Results from this study will be further evaluated relative to the mercury levels in other finfish[6-8], U.S. FDA and EPA action levels[1-2], and current consumption advisories for this species.[19] The project methods are further elaborated in the following section (II. Project Design).

The proposed research will be completely supported by the funds requested from the RI Saltwater Anglers Foundation. It is important to note that a considerable portion of the requested funds will be used to support a RWU undergraduate student and their personal research endeavors. To this end, the proposed study will engage students in meaningful scientific research, and thus, provide a strong foundation for undergraduate education. This philosophy of education complements the mission of RWU, as well as supports a fundamental principal of the RI Saltwater Anglers Association and it constituents.

II. PROJECT DESIGN

A. Scup samples

Archived scup samples. From 2006 to 2012, scup were collected from Narragansett Bay (NB) and Rhode Island Sound/Block Island Sound (RIS/BIS) using otter trawls and hook & line. Scup captured in the field were immediately placed on ice for transportation and frozen at –20 ºC after returning to the laboratory. In the laboratory, individual scup were partially thawed, measured for wet weight (g) and total length (cm), and ~ 1 g wet weight of muscle tissue was excised from the dorsal region above the operculum (i.e., gill cover). For final preservation, muscle tissue samples were freeze-dried for 48 hr, and subsequently weighed (g dry weight), homogenized with a mortar and pestle, and stored at room temperature. A total of 108 and 391 samples were collected from NB and RIS/BIS, respectively, during the specified time period. Of these samples, 50 from NB and 20 from RIS/BIS have been analyzed for total mercury concentration. Thus, 429 samples (NB and RIS/BIS combined) still require mercury analysis, with an emphasis on NB samples.

Additional collection of scup samples. Following the procedures identified above, additional sample collection and preparation will occur May-August 2013 in order to increase samples sizes of large scup (> 26.7 cm; recreational size limit), expand the spatial coverage of the study, and to account for annual variations in scup mercury content. Dr. Taylor has the goal of analyzing at least 100 scup per habitat (NB and RIS/BIS). Note that these collection procedures require a permit from the RI Department of Environmental Management, Division of Fish and Wildlife. Roger Williams University obtains these permits annually, and permitting will be in place prior to any field collections for the proposed study.

B. Fish mercury analysis

Total mercury will be measured in scup muscle tissue using automated atomic absorption spectrophotometry (DMA-80 Direct Mercury Analyzer, Milestone, Inc.). The DMA-80 Analyzer is housed at Roger Williams University, and has a detection limit of 0.01 ng mercury. The thermal decomposition technique employed in this study is outlined in EPA Method 7473.[21] The DMA-80 Analyzer will be calibrated using a combination of aqueous standards and certified reference materials purchased from the National Research Council Canada, Institute of Environmental Chemistry (Ottawa, Canada). For quality control, all samples will be analyzed as duplicates (acceptance criteria = 10% error), and blanks will be analyzed every 10 samples to assess instrument accuracy and potential drift.

Prior to statistical analysis, total mercury data will be converted to wet weight using a wet/dry ratio measured for each scup tissue sample. To assess patterns of mercury bioaccumulation, the effect of scup total length (cm) on mercury concentration (ppm wet weight) will be analyzed with a least-squares exponential regression. Spatial and temporal variations in scup mercury content will also be analyzed with independent one-way analysis of variance (ANOVA) models using location (NB and RIS/BIS) or year (2006-2013) as fixed factors. Moreover, to evaluate potential risks to human consumers, scup mercury data will be analyzed relative to the U.S. FDA and EPA mercury action levels of 1.0 ppm and 0.3 ppm, respectively.

Dr. Taylor has performed comprehensive studies of mercury contamination in other recreational fishes from NB, including striped bass, bluefish, tautog, black sea bass, summer flounder, and winter flounder.[6-8] In the proposed research, scup mercury contamination will be statistically compared to these other species. Specifically, to assess differences in mercury bioaccumulation rates among fish species, two-way ANOVA models will be used to test for homogeneity of slopes (i.e., interaction

effects between size and species) of the linearized exponential regressions (semi-logarithmic transformation).

C. Developing and disseminating better advisories

Dr. Taylor will work collaboratively with the RI Department of Health (DOH) to update and improve their fish consumption advisories (Robert Vanderslice, Chief of the Office of Environmental Health Risk, *personal communication*). Advisories will be created for the focal species of this project (scup), as well as other premier recreational fishes (striped bass, bluefish, tautog, black sea bass, summer flounder, and winter flounder). Advisories will be based on data from this project and Dr. Taylor's previous research because of their comprehensiveness with respect to species- and location-specific information.

D. Outreach: Communicating research results to recreational fishers

Dr. Taylor has been active in the RI community, disseminating results of his on-going mercury studies to local recreational anglers. Examples of these outreach activities include Dr. Taylor and his research team designing and operating a display booth at the 9th Annual New England Saltwater Fishing Show (NESFS) (Providence, RI; March 9-11, 2012); coordinated by the RI Saltwater Anglers Association (RISAA). The display booth was largely dedicated to Dr. Taylor's mercury research in local fisheries, and this information was presented to the convention attendees. Because of its success, Dr. Taylor was again invited (and accepted) to host a booth at the 10th Annual NESFS (March 8-10, 2013). Dr. Taylor has also presented his mercury research to locals at the Galilee Fishing Tournament and Seafood Festival (Port of Galilee, Narragansett, RI; September 7-9 2012); an event again coordinated by RISAA. The outreach activities initiated by Dr. Taylor, and facilitated by the positive relationship with RISAA, will continue during the proposed study.

III. EVALUATION QUESTIONS

A. Does the project address current **recreational fish habitat**?

No. The charge of the proposed research does not explicitly address recreational fish habitat. This research program will, however, evaluate scup mercury contamination as a function of habitat (e.g., estuary vs. ocean).

B. Does the project address current **recreational fish abundance**?

No. The charge of the proposed research does not explicitly address recreational fish abundance. This research program will, however, rely on cooperative sampling with other surveys with this key objective, e.g., RI Department of Environmental Management and University of Rhode Island/Graduate School of Oceanography bottom trawl surveys.

C. Does the project address the current understanding of **recreational fish abundance, behavior and/or environmental conditions**?

Yes. The proposed research will directly address the prevalence of mercury, a pervasive and toxic environmental contaminant, in fishery resources.

D. Will the project address a **current problem(s) in the recreational fishery**?

Yes. Relative to the general population, specific U.S. subpopulations are more susceptible to mercury toxicity because of their elevated rates of fish consumption. For example, economic status, ethnic and cultural identity and practices, and coastal residency are important factors governing fish consumption, and thus, mercury exposure.[9-11] Recreational anglers in the U.S. are also a subpopulation of concern, yet information on their dietary habits and mercury intake are lacking. Of the few studies that have addressed this topic, recreational anglers often have elevated mercury body burdens because of their higher consumption of local fish.[12-17] It is important to note, however, that with few exceptions, these prior investigations focused almost exclusively on freshwater recreational anglers or were conducted internationally, whereas in the U.S., the majority of fish consumed by recreational anglers are of estuarine and marine origin.[21]

Rhode Island supports an extensive saltwater recreational fishery. In 2011, the annual recreational landing of 1,414,037 kg constituted ~ 10% of the total recreational landings in the North Atlantic.[18] Nearly 38,000 residents (4% of the state's population) purchased saltwater fishing licenses in 2011, a relatively high number considering that saltwater licenses have only been required in the state for the past two years.[19] Despite the prominence of this recreational fishery, estimates of fish consumption for estuarine and marine species by the state's residents are not well documented.

Dr. Taylor disseminated a food frequency questionnaire (FFQ) to RI recreational anglers and their families to obtain more accurate estimates of fish eating habits of RI residents. The FFQ evaluated the person's basic fish eating habits [e.g., frequency of consumption, source of fish (locally caught vs. store bought)], and was disseminated using two mechanisms: (1) online web-survey tool (SurveyMonkey) that is maintained by the RI Saltwater Anglers Association, and (2)

hard copy questionnaires presented to attendees of the Galilee Fishing Tournament and Seafood Festival (Port of Galilee, Narragansett, RI; September 7-9, 2012).

Dr. Taylor received 183 responses to the abovementioned FFQ. Of these respondents, 76.2% were male and the mean age of the sampled population was 54.6 (range = 21-81). The mean fish consumption rate of the respondents was 52.3 grams per day (g/d) (range = 2.2-198.4 g/d). This rate of fish consumption was significantly higher than estimates of national fish consumption rates (8.3-10.9 g/d; *t*-test: $p < 0.0001$) and Atlantic Coast regional consumption rates (39.5 g/d; *t*-test: $p < 0.0001$).[1] Moreover, the fish consumption rates reported by RI anglers and their families was equivalent to the high-end fish eating habits of New York and New Jersey harbor anglers (52.8 g/d; *t*-test: $p = 859$).[1] The results of the FFQ therefore suggest that RI anglers and their families may be at greater risk for mercury contamination because of their elevated fish consumption rates. Hence, acquiring data on the mercury content of local estuarine and marine fishes is particularly warranted and necessary to support public health risk assessments and risk management decisions related to the issuance of fish consumption advisories.

IV. QUALIFICATIONS

A. Statement of qualifications

Dr. Taylor has the expertise and experience to successfully conduct and manage the proposed project. He has specific training in fisheries ecology and environmental toxicology, particularly as it pertains to mercury dynamics in estuarine and marine systems. Over the last 7 years, Dr. Taylor has been an investigator in the National Institutes of Health RI IDeA Network of Biomedical Research Excellence (INBRE) program. During this time, Dr. Taylor and his undergraduate students have studied the source and fate of mercury contaminants in Narragansett Bay, including measuring mercury levels in local fisheries. Further, Dr. Taylor has developed a highly successful student training model that has resulted in numerous joint faculty-student peer-reviewed publications (6; see below) and presentations (>160). Dr. Taylor has also been active in the RI community, disseminating results of his on-going mercury studies to local recreational anglers. These outreach activities have been instrumental in developing positive relationships with the general public. In summary, Dr. Taylor has produced high quality scholarly work that is directly related to the proposed research, while also simultaneously incorporating undergraduate students in an active research program and effectively communicating the scientific results to the RI public. These experiences will ensure the successful completion of the proposed study's objectives.

B. Relevant publications (* denotes Roger Williams University undergraduate student)

Taylor, D.L., J.C. Linehan*, D.W. Murray, W.L. Prell (2012) Indicators of sediment and biotic mercury contamination in a southern New England estuary. Mar. Pollut. Bull. 64:807-819.

Szczebak, J.S.* and **D.L. Taylor** (2011) Ontogenetic patterns in bluefish *Pomatomus saltatrix* feeding ecology and the effect on mercury biomagnification. Environ. Toxicol. Chem. 30:1447-1458.

Payne, E.J.* and **D.L. Taylor** (2010) Effects of diet composition and trophic structure on mercury bioaccumulation in temperate flatfishes. Arch. Environ. Contam. Toxicol. 58:431-443.

Piraino, M.P.* and **D.L. Taylor** (2009) Bioaccumulation and trophic transfer of mercury in striped bass (*Morone saxatilis*) and tautog (*Tautoga onitis*) in the Narragansett Bay (Rhode Island, USA). Mar. Environ. Res. 67:117-128.

Evers, D.C., R.P. Mason, N.C. Kamman, C.Y. Chen, A.L. Bogomolni, **D.L. Taylor**, C.R. Hammerschmidt, S.H. Jones, N.M. Burgess, K. Munney, and K. Parsons (2008) An integrated mercury monitoring program for temperate estuarine and marine ecosystems on the North American Atlantic coast. EcoHealth. 5:426-441.

Chen, C., A. Amirbahman, N. Fisher, G. Harding, C. Lamborg, D. Nacci, and **D.L. Taylor** (2008) Marine ecosystems: Spatial patterns and processes of production, bioaccumulation, and biomagnification. EcoHealth. 5:399-408.

V. BUDGET

A. Budget table

Expense	Cost ($)
Personnel	
Undergraduate student summer salary (35 hr/wk, 10 wk)	4,000
Undergraduate student academic year salary ($10/hr, 50 total hr)	500
Fringe benefits (7.65% on summer salary only)	306
Undergraduate student summer housing (10 wk)	1,250
Field supplies	
Boat fuel ($200/trip, 8 trips)	1,600
Misc. fishing equipment (rigs, hooks, line, bait)	300
Misc. field equipment (batteries, buckets, data sheets)	500
Laboratory supplies	
Fisher brand glass storage vials (40 ml)	450
Fisher brand glass shell storage vials (10 ml)	500
Fisher brand pump oil	280
Fisher brand label tape	150
Nalgene fine line black ink pens	125
Indirect costs (49% on salary only)	2,205
Total cost	12,166

B. Budget justification

Personnel. Dr. Taylor is requesting support for one RWU undergraduate student for the duration of the grant period to assist with many aspects of the proposed research. The annual salary for the student is $4,000 and $500 for the summer and academic year, respectively. Fringe benefits are requested for the student researcher at the rate of 7.65% for summer only ($306). Additional funds are requested to provide RWU summer housing for the student researcher ($1,250).

Supplies/Materials. The costs of the RWU field sampling include fuel for University boats (8 sampling trips; $200 fuel per trip = $1,600) and miscellaneous fishing and field equipment ($800). These miscellaneous supplies include fishing rigs, hooks, weights, bait, batteries, buckets, and field data sheets. Funds are also requested to support processing fish samples in the laboratory ($1,505). These expenses include storage vials, pump oil for the Labconco freeze drier, label tape, and markers.

Indirect costs. Facilities and administrative costs (indirect costs) are applied at RWU's negotiated on-campus rate of 49% of the undergraduate student salary ($2,205).

VI. PARTNERS

A. Partner summary

Project Partner	Amount ($)	Cash/In-kind	Federal or Non-federal	Pending/Received
RI DEM	NA	In-kind	Non-federal	Received
RI DOH	NA	In-kind	Non-federal	Received
URI/GSO	NA	In-kind	Non-federal	Received
NIH	~352,000	Cash	Federal	Pending

B. Partner roles

Rhode Island Department of Environmental Management (RI DEM) – Dr. Taylor will work with the RI DEM to collect scup samples for mercury analysis. Specifically, Dr. Taylor will take advantage of the on-going RI DEM bottom trawl survey in Narragansett Bay and Rhode Island Sound to collect samples (Scott Olszewski, *personal communication*).

Rhode Island Department of Health (RI DOH) – Dr. Taylor will work collaboratively with the RI DOH to update and improve their fish consumption advisories (Robert Vanderslice, Chief of the Office of Environmental Health Risk, *personal communication*).

University of Rhode Island/Graduate School of Oceanography (URI/GSO) – Dr. Taylor will work with the URI/GSO to collect scup samples for mercury analysis. Specifically, Dr. Taylor will take advantage of the on-going URI/GSO bottom trawl survey in Narragansett Bay (Fox Island and Whale Rock) to collect samples (Jeremy Collie, *personal communication*).

National Institutes of Health (NIH) – Dr. Taylor will be submitting an NIH Academic Research Enhancement (AREA) grant proposal, with the National Institute of Environmental Health Sciences (NIEHS) as the participating organization. The deadline for this proposal is 24 February 2013 and involves collaborations with Northeastern University (Boston, MA) and the Silent Spring Institute (Newton, MA) (Phil Brown and Laurel Schaider, *personal communications*, respectively). The NIH proposed project includes: (1) the analysis of mercury in commonly-consumed fish in RI estuarine and marine waters, (2) the analysis of mercury in recreational angler hair samples, coupled with detailed food frequency questionnaires, and (3) carrying out public health dissemination and education.

For the NIH project discussed above, Dr. Taylor's successful procurement of funds will be greatly enhanced by demonstrating that the RI Saltwater Anglers Association (RISAA) fully supports the project and will assist in recruiting volunteers for the study. To this end, the RI Saltwater Anglers Foundation proposal discussed herein will be used as evidence for the mutually beneficial relationship that exists between RWU and the RISAA.

VII. TIMELINE OF PROJECT ACTIVITIES

Project Activity	**Anticipated Dates of Implementation**
Project design	February 1 – March 30, 2013
Field work	June 1 – August 9, 2013
Laboratory work:	
Fish tissue preparation	June 1 – November 1, 2013
Fish tissue mercury analysis	April 1 – December 15, 2013
Data analysis and implementation:	
Statistical analysis of mercury data	September 1 – December 15, 2013
Development and revision of consumption advisories	September 1 – December 15, 2013
Project outreach:	
10th Annual NE Saltwater Fishing Show	March 8 – March 10, 2013
Galilee Fishing Tournament and Seafood Festival	September 2013
11th Annual NE Saltwater Fishing Show	March 2014
Final report to the RISA Foundation	January 15, 2014

VIII. LITERATURE CITED

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