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Proposal Submitted to:

Virginia Marine Resources Commission
Recreational Fishing Advisory Board
2400 Washington Avenue, Newport News, VA 23607

By

THE VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM & MARY

Tracking Decadal Changes in Striped Bass Recruitment: A Calibration Study of Seine Surveys in Chesapeake Bay

1 May 2015 – 30 April 2016

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15 December 2014

VIRGINIA SALTWATER RECREATIONAL FISHING DEVELOPMENT FUND
SUMMARY PROJECT APPLICATION*

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PRIORITY AREA OF CONCERN Research	**PROJECT LOCATION** James, York, and Rappahannock rivers, VA

DESCRIPTIVE TITLE OF PROJECT

Tracking Decadal Changes in Striped Bass Recruitment: A Calibration Study of Seine Surveys in Chesapeake Bay

PROJECT SUMMARY: This project seeks to establish calibration factors for the nets currently used by Maryland and Virginia to conduct the juvenile striped bass seine surveys. These factors are necessary because the material from which these nets are constructed is no longer available and a new material (of unknown efficiency) will need to be used in 2015 and future years.

EXPECTED BENEFITS: Results of this study will provide calibration factors to permit continuation of the long-term time series of recruitment indices for striped bass in Chesapeake Bay. Without such factors, data from past years will not be comparable to data collected in 2015 and subsequent years.

COSTS:

VMRC Funding: $78,022

Recipient Funding: $11,249

TOTAL COST: $89,271 1 May 2015 – 30 April 2016

Detailed budget included with proposal.

Updated 07/11/12

***This form alone does not constitute a complete application, see application instructions or contact Rob O'Reilly at 757-247-2247 or rob.o'reilly@mrc.virginia.gov**

Tracking Decadal Changes in Striped Bass Recruitment:

A Calibration Study of Seine Surveys in Chesapeake Bay

Problem Statement & Background

In the Chesapeake Bay, the abundance of juvenile striped bass is monitored annually using beach seine surveys of tidal freshwater and brackish habitats. These surveys are conducted by scientists at VIMS and the Maryland DNR during the summer when young-of-the-year striped bass are readily available to beach seines, and have been ongoing since 1967 (VA) and 1954 (MD). Using abundance estimates derived from seine catches, a recruitment index for each jurisdiction is provided to fisheries managers for use in stock assessments and to guide the adjustment of quotas for the subsequent fishing year. The Striped Bass Management Plan requires states with striped bass 'spawning/nursery grounds' to maintain a monitoring program of annual juvenile production; the Atlantic Coastal Fisheries Cooperative Management Act (PL 103-206) gives this requirement the force of federal law.

In the early 1980s, when the Atlantic coast population of striped bass experienced a significant decline, juvenile striped bass surveys in VA and MD were standardized to improve comparability and to permit estimation of a baywide index for the species. Since that time, both surveys have used a 100' (30.5m) long, 4' (1.22m) deep, 1/4" (0.64cm) mesh minnow seine. Due to the demanding use of these nets in the field, they are periodically replaced with nets manufactured to the same specifications. In 2014, the VA team placed an order for new nets with Nichols Net & Twine (the customary supplier) but was informed that the net material used in past years (1/4" knotless oval mesh) was no longer available. The nets currently in hand were used for the 2014 season, but they will not last beyond 1 or 2 additional field seasons. Thus, the VA team will need to replace nets in 2015 (and in subsequent years) with a different net material. This change in survey gear necessitates a calibration study to develop conversion factors to ensure continuity of the index from the long-term survey.

Along with the implementation of standard sampling protocols, consistency of net materials is critical to ensuring constant and equal catchability of the VA and MD surveys, both geographically and temporally. When informed of the lack of net material for building replacement nets, the VA team contacted the MD team to discuss options for future net purchases. Further discussions revealed that, in fact, the VA team had switched to using a ¼" knotless oval mesh material in 1999 and was no longer using the standard ¼" knotted mesh that has been used by scientists in MD since the late 1960s (Table 1). The MD team has been able to continue using the ¼" knotted mesh material because in the late 1990s, MD purchased the entire supply of the material at that time and constructed as many nets as possible. Currently, MD scientists estimate having enough nets to last another 5 years or so.

Although mesh size is not a concern – all materials are described as ¼" mesh – mesh geometry varies significantly among the different materials used to construct nets. The standard knotted mesh forms a rhombus-shaped opening, whereas the opening in the knotless material is oval. Currently available netting appears more similar to the knotted mesh because the opening is shaped like a rhombus, but the material itself is significantly thinner and lighter in color (Figure 1). It is unknown how these aspects affect net performance and relative catch efficiency, where efficiency is defined as the probability of capturing fish within the volume swept by the seine. For example, a thinner mesh is less massive and easier to haul through the water, potentially improving catch efficiency. Another possibility is that a net constructed with the lighter mesh may not be detected by fishes as readily as a net made from the darker-colored, knotted mesh, and thus the lighter net may have a higher catch efficiency than the knotted mesh net. Finally, a lighter, thinner mesh may be more likely to tear or snag on underwater debris thereby increasing costs and time required to complete the survey.

Based on the recent development concerning replacement nets, the VA and MD teams identified the need for three calibration experiments that will ensure the long-term continuity of the seine surveys in the Chesapeake Bay:

> (1) VA oval mesh vs. MD knotted mesh -- relative catch efficiency of the oval mesh net used by VA since 1999 must be compared with relative catch efficiency of nets constructed from the knotted mesh material (and previously used in VA);
>
> (2) VA oval mesh vs. 'new' mesh -- relative catch efficiency of the oval mesh net used by VA since 1999 must be compared with relative catch efficiency of nets constructed from the 'new' lighter, rhomboid replacement mesh; and
>
> (3) MD knotted mesh vs. 'new' mesh -- relative catch efficiency of the knotted mesh net used by MD must be compared with relative catch efficiency of nets constructed from the 'new' lighter, rhomboid replacement mesh.

The first calibration will permit comparison of VA catches from 1999 to 2014 with MD catches from 1999 to 2014, and with VA and MD catches from 1967 to 1998; the second experiment will permit comparison of VA catches from 1999 to 2014 with future catches in VA; and the third will permit comparison of MD catches from 1960s to 2014 with future catches in MD. Together these three calibrations are required to ensure consistency through time within and among jurisdictions in Chesapeake Bay.

Objective

The objective of this study is to conduct three calibration experiments with seine nets currently used or scheduled for use by the striped bass seine surveys in Chesapeake Bay. These experiments involve three types of nets:

> Comparison 1 -- VA oval mesh vs. MD knotted mesh,
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> Comparison 2 -- VA oval mesh vs. 'new' mesh, and
>
> Comparison 3 -- MD knotted mesh vs. 'new' mesh.

Methods: Field

The VA and MD teams will work together to facilitate the conduct of the calibration study proposed for the 2015 field sampling season. Net exchanges will be implemented to permit the VA team to deploy the MD knotted mesh net in VA waters and the MD team to deploy the VA oval mesh in MD waters (comparison 1; Table 2). The VA team will conduct comparisons 2 and 3 in VA waters, thereby comparing relative catch efficiencies of seines constructed from the 'new' mesh to seines constructed of oval mesh (comparison 2) and knotted mesh (comparison 3) materials. Furthermore, the teams will work closely with the ASMFC Striped Bass Technical Committee to ensure communication, feedback, and support from the mandating body.

<u>Comparison 1:</u> Calibration experiments generally take the form of paired deployments conducted in the same area at the same time with different gear, and in our case, with seines constructed from two types of mesh (Table 2). The same habitat must be sampled because location-specific factors (depth, temperature, current, turbidity, bottom topography, sediment characteristics, and fish community composition) may affect the availability of fishes to the gear and the efficiency of the gear. Ideally, paired deployments occur at the same time, or close together in time to avoid changes in the available fish community. We know from many years of seining these systems that two seine hauls completed 30 minutes apart at the same site yield significantly different catches, both in terms of the numbers of fish captured as well as the species composition of the catch. Waiting longer at a site to complete the second deployment is also not desirable because fish availability may change and because tidal state will change (according to protocols used in VA, all beaches are seined at or around low tide; many of the beaches in VA tributaries are intertidal). Thus, the use of adjacent sites is preferred.

Two adjacent seine survey sites will be sampled; this requires identification of adjacent stretches of beach that are large enough (> 100-150 m) to permit deployment of paired seines (each seine is 30.5 m long). Furthermore, such sites should be relatively free of vegetation, woody debris, pilings, or other obstacles; we also wish to avoid muddy or marshy sites as deployment can be highly variable in these conditions. We expect that the disturbance associated with deployment of a seine may propagate along the beach, so adjacent sites will be selected to minimize disturbance effects. In MD, due to the limited availability of crew and the additional time required, only beaches near Annapolis will be included in this comparison. All primary (n=18) and auxiliary (n=21) sites in VA were assessed for suitability for inclusion in this comparison. We identified 21 sites in VA potentially suitable for comparison hauls: Rappahannock River sites 69, 55, 50, 41, 37, 21, and 12; James River sites 68, 62, 56, 51, 46, 42, 29, 22, and 12; Mattaponi River sites 52, 47, and 44; and Pamunkey River sites 45 and 36 (Figures 2 and 3).

Because juvenile striped bass are available and vulnerable to beach seines only during a portion of the year (July to mid-September), comparison 1 will be completed at the same time as the VA and MD seine surveys that provide annual striped bass recruitment indices (Fabrizio et al. 2014; Durell 2014). Due to the intensity of sampling, the requirement to sample at low tide in VA, and the wide geographic distribution of sampling sites, the comparison will be conducted in a manner that does not interfere with or otherwise compromise the collection of data for the mandated annual seine surveys in VA and MD. Therefore, logistical modifications are warranted. In VA, the implementation of adjacent paired tows will necessitate the hiring of a dedicated field crew (hereafter 'calibration team'). The calibration team is necessary because of the additional time needed to deploy and process the comparison hauls. In MD, state biologists will perform the paired hauls along a uniform stretch of beach near Annapolis; this will occur after completion of the normally scheduled rounds in MD (most likely during the latter half of July and the latter half of August). Our goal is to obtain at least 30 paired tows with catches of striped bass, half of those occurring in MD and the other half in VA. This is the minimum number of paired tows that can reliably yield a calibration factor (Independent Review Panel Report 2009; Miller et al. 2010). Standard seine survey protocols for deployment of gear, measurement of water quality conditions (temperature, salinity, secchi depth), and fish handling will be used in the comparison study. Thus, we will count and measure all juvenile striped bass as well as other species captured during seining, namely, American shad, Atlantic menhaden, white perch, Atlantic croaker, spot, spottail shiner, Atlantic silverside, inland silverside, and banded killifish. Catches from the VA seine survey have been used to estimate indices of abundance for these species and we expect to continue providing such data (particularly for American shad and Atlantic menhaden due to Virginia's compliance requirements to the ASMFC). To ensure the continuity of these time series, a species-specific calibration factor will be required for each species.

Comparisons 2 and 3: Ideally, comparisons 2 and 3 (which compare seines constructed of the 'new' mesh material with seines currently used in VA and MD) would be conducted at the same sites as the seine survey. As noted previously, multiple hauls must be deployed at each site (>30) to obtain sufficient samples to permit estimation of calibration factors (Independent Review Panel Report 2009). During the mandated seine survey in VA, a particular site is sampled every 14 days or so; this frequency of sampling does not appear to affect catches. However, we are unsure of the potentially negative effect of additional, repeated sampling at these sites. Therefore, to assess relative catch efficiency of seines constructed with the 'new' mesh, we propose an approach that capitalizes on the direct comparison of two mesh types by deploying a block net in a shallow estuarine area (Table 2). This will minimize interference with the mandated seine survey and provide data suitable for estimation of relative catch efficiency for the 'new' net. These comparisons will take place in VA only.

A block net will be deployed within a shallow area deemed suitable for sampling by beach seines, and provided that the number of striped bass encircled by the block net is known, then the catch efficiency of a seine deployed within the area blocked by the net can be determined. By introducing marked fish into the blocked area, the number of striped bass encircled by the block net can be known precisely. Based on our experience with an experimental block net study in 2012, we know that sufficient numbers of wild juvenile striped bass cannot be captured and marked at a given site in an efficient manner (on average, we capture less than 10 juvenile striped bass per haul). Instead, we will release a known number of tagged hatchery fish into the block-net area. Because it may not be possible to remove all tagged hatchery fish from the experimentally blocked area at the end of the experiment, some hatchery fish may be released into the wild. As a result of this potential introduction, we will use striped bass from a local hatchery (the VDGIF-run King & Queen Hatchery in Stevensville, VA) to avoid introducing genetically different strains into VA waters. Fish will be maintained at the VIMS Seawater Research Laboratory, where they will be allowed to acclimate to ambient York River conditions. All fish will be batch-marked using visible implant elastomer tags and held for at least 5 days prior to use in the block-net experiment. We are aware that swimming performance and escape behaviors of hatchery and wild fish may differ, however, we are interested in the *relative* catch efficiency of the two seine net types, and thus, these differences should not appreciably affect those calculations.

The VA calibration team will conduct the block-net experiment in the York River, VA, using seine nets constructed of knotless oval mesh, knotted rhomboid mesh, and knotless rhomboid mesh. The work will occur in the period July to mid-September (the same time period as the seine survey in VA). Environmental conditions (temperature, salinity, and turbidity) during the block net experiment will be recorded with a continuously recording water-quality sonde deployed at the block net site (YSI 6920); we will not measure dissolved oxygen because shallow waters are typically well oxygenated and because we have not encountered hypoxic (<2 mg/l) conditions in sampled areas (Fabrizio et al. 2014). Secchi depth will also be recorded. The environmental data will be used to examine hypotheses about sources of variation in seine net catches.

For each block-net deployment, a beach-seine sweep will be conducted with each of three nets – the VA oval mesh net (hereafter, net A), the MD knotted rhomboid net (hereafter, net B), and the 'new' knotless rhomboid net (hereafter, net C); blocks nets will be deployed on 18 occasions for a total of 54 sweeps (18 per net type; Table 3). The block net will be installed at a suitable seine site (e.g., the beach near Tyndall's Point on the York River) and 100 marked hatchery fish will be released within the area encompassed by the block net. After allowing for random distribution of fish within the block-net area, net A will be deployed and the number of marked fish captured by the seine will be tallied; all fishes captured will be identified to species and measured. Marked fish captured in net A will be released alive outside the block-net area and an equal number of marked fish will be returned to the block-net area so that the number of marked fish encircled by the block net remains at 100. (Fish captured once by the seine will not be 'reused' in the experiment because such fish will likely incur handling stress which may render them more susceptible to capture.) Disturbance of the sediment will be allowed to subside and no less than 30 minutes later, net B will be deployed within the block net. Fish will be processed as before, and net C will be used to complete the third sweep. Although this description suggests net A will be fished first, followed by B and C, the order in which nets will be fished will be randomized for each block-net deployment. At the conclusion of the last net sweep, the block net will be hauled to shore and the remaining marked fish will be counted and measured. In this manner, we can estimate the loss rate from the block net area (which we assume is 0%). The block net will be dismantled and any remaining fish, including marked striped bass that have been counted and measured, will be released alive. Depending on the efficiency of the nets, we estimate that we will require no more than 300 marked fish for each block-net deployment (each day). Block-net deployments will occur on each of 18 days, resulting in a total of 18 replicates for each net type (1 replicate/net/day x 18 days = 18 replicates/net). Thus, the block-net experiment (comparisons 2 and 3) requires about 5,400 marked hatchery fish.

Methods: Analyses

<u>Comparison 1</u> – Knotless oval vs knotted rhomboid nets

We expect to obtain at least 30 paired hauls containing juvenile striped bass; the nets used in this comparison are the knotless oval and the knotted rhomboid nets. The calibration factor, ρ, can be expressed as the ratio of net-specific catchabilities, *q*:

$$\rho = \frac{q_A}{q_B}$$

assuming that fish density is homogeneous across the space sampled by nets *A* and *B*. Because we cannot estimate catchabilities directly (and instead use catch rates to estimate ρ), ρ represents the relative catch efficiency of net *B* to net *A* (Miller 2013). Efficiency is the probability of capturing animals within the volume swept by the seine net. Information for this model comes from the number of stations where each species is observed and the total number of individuals observed (Miller et al. 2010). The observed catches of juvenile striped bass will be used to estimate the relative efficiency of paired hauls (i.e., the calibration factor). The calibration factor will then be used to multiply the catch from seines constructed of the knotless oval mesh to obtain the equivalent catch from seines constructed of the knotted rhomboid mesh (i.e., using the MD catches as the 'standard'). Calibration factors (relative catch efficiency) will be estimated for all other species for which we can obtain more than 30 paired hauls.

Prior to estimation of calibration factors, we will determine factors affecting catches of the two nets. Specifically, we will use a negative binomial regression to determine how catch is affected by conditions at the time of capture (temperature, salinity, secchi depth), fish size, order of deployment (first or second), field crew (MD or VA), and mesh type. Because catch data are count data, we will use models appropriate for observations from a negative binomial distribution; if the catches are less dispersed than what is expected from a negative binomial distribution, then a Poisson regression may be used instead. For this analysis, we will analyze all outcomes of the paired-haul field experiment, and we expect that some of the pairs will have zero catches; therefore, a zero-inflated negative binomial regression may be considered for analysis. This analysis will verify the need for a calibration factor and allow us to examine how the particular field crew implementing the comparison affects catch rates of the nets. For example, if the catchability of the nets differs (thereby requiring a calibration factor), then we would expect to find a significant effect of mesh type on catch. We included fish size in the model because catchability may be affected by fish size and because growth of juvenile striped bass is rapid in summer; we may find that size-dependent calibration factors will be required. The (zero-inflated) negative binomial regression will allow us to test these and similar hypotheses, and therefore allow us to develop more appropriate calibration factors for the juvenile striped bass seine surveys.

Several estimators of the relative catch efficiency have been proposed for use as calibration factors, and the selection of the appropriate estimator depends on the heterogeneity of the length distributions of the catch and on spatial heterogeneity in fish densities (Cadigan and Dowden 2010). As previously noted, length distributions may be heterogeneous, so we will consider models that allow investigation of this assumption. Similarly, because paired hauls will be conducted in adjacent areas (the same beach), spatial heterogeneity may be negligible; as with length, we will consider models that permit testing of this assumption. For example, based on the results of a simulation study, Cadigan and Dowden (2010) demonstrated that an accurate estimate of ρ can be obtained using a logistic regression that includes fixed net effects and random site effects to account for spatial variation in fish distributions. In another simulation study, Miller et al. (2010) considered the performance of 7 estimators that differed in the assumptions about the source of variability (variation among catches, variation in the calibration factor among sites) and the correlation of catches among sites. They concluded that the maximum likelihood estimate of the beta-binomial estimator of ρ and the ratio estimator of ρ performed well and both estimators could account for overdispersion among catches (Miller et al. 2010). Furthermore, the beta-binomial estimator allowed incorporation of length effects (Miller et al. 2010). Another possible estimator is the ratio of paired means estimated from a negative binomial regression (Cadigan and Bataineh 2012); this approach may be extended to incorporate the effects of fish length and site characteristics (such as slope of the beach, and substrate type). Based on these recent studies, we will consider the ratio estimator, the negative-binomial estimator, the beta-binomial estimator, and the logistic regression estimator with random site effects and fixed net effects.

Comparisons 2 and 3 – new rhomboid net vs knotless oval and knotted rhomboid (block-net experiment)

The block-net experiment in the York River will yield 3 sets of paired hauls (each with 18 replicates) containing juvenile striped bass. The nets used in this comparison will be constructed of knotless oval, knotted rhomboid, and new rhomboid meshes. Based on the number of fish remaining in the block-net area at the conclusion of the third seine-net sweep, we will estimate the loss factor and adjust catch rates for this loss. This is analogous to adjusting survival rates derived from mark-recapture studies using an estimate of the tag-loss rate. For example, if after the third sweep, we retrieve 25 fish in the seine and 70 fish in the block net (not captured by the seine), then 5 marked fish escaped the block-net area and were unavailable to the seine. The adjusted catch (catch') of the seine is therefore given by:

$$catch' = \frac{proportion\ captured}{(1 - proportion\ lost)} \times 100$$

where the proportion captured is calculated as the number of marked fish retained by the seine divided by the number of marked fish released in the block-net area, and the proportion lost is the number of fish unaccounted for by the seine and the block-net divided by the number of marked fish released in the block-net area. To determine when the loss occurred, we will attach small water-proof video cameras to the foot of the block net; these videos will allow us to monitor escapement of striped bass from the block-net area. In the absence of video recordings, we would not know when the loss occurred, and we would have to assume that the loss occurred prior to the first sweep and immediately after release of the first 100 striped bass into the block-net area. If, however, the loss occurs during or after the third sweep and we had no video to inform us, then estimates of the adjusted catch for sweeps 1 and 2 would be overestimated.

As described for comparison 1, factors affecting catches of each pair of nets will be explored using a negative binomial regression or a zero-inflated negative binomial regression. Conditions at the time of capture (temperature, salinity, turbidity), fish size, order of deployment (first, second, third), and mesh type will be included in the model describing catches from each net. As before, this analysis will verify the need for a calibration factor and allow us to test hypotheses about the effects of factors such as fish size and water quality conditions.

Next, we will develop an estimate of relative efficiency for each pair of nets (*A* and *B*, *A* and *C*, *B* and *C*) and use this as the calibration factor for striped bass following methods outlined in the subsection, 'Comparison 1'. The calibration factor will be used to multiply the catch from seines constructed of the new rhomboid mesh to obtain the equivalent striped bass catch from seines constructed of the knotless oval mesh and the knotted rhomboid mesh.

The block-net experiment will yield calibration factors for the new net for juvenile striped bass only; however, a ratio approach using calibration factors from comparison 1 can be used to derive factors for other species. For example, if the calibration factor for white perch is 0.9 (knotless oval to knotted rhomboid) and for striped bass is 0.7 (knotless oval to knotted rhomboid), then the species-to-species ratio is 0.9/0.7 or 1.286. This factor (1.286) can be used to calibrate the catches of white perch from the new rhomboid net relative to the new net. This requires several steps and the assumption that catches of each species are independent of the other species present, but may be a feasible approach without requiring an additional year of calibration hauls.

Expected Results

From the proposed experiments, we will estimate calibration factors for the two types of nets currently used by the VA and MD seine survey teams; these factors will be available for juvenile striped bass and other species that currently support or once supported important commercial fisheries or that serve as forage for Chesapeake Bay piscivores. These species include American shad, Atlantic menhaden, white perch, Atlantic croaker, spot, spottail shiner, Atlantic silverside, inland silverside, and banded killifish. We will also estimate calibration factors for the new (rhomboid) net for juvenile striped bass. Although the relative efficiency of the new net will not be known for species other than striped bass (because only hatchery striped bass will be released into the block-net area), we can derive calibration factors for other species by using a ratio approach. Finally, results of our modeling will provide insight on the factors affecting changes in net efficiency, factors such as crew, fish size, and environmental conditions.

References

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Budget: (1 May 2015 – 30 April 2016)

Personnel	Time	Monthly	Agency	VIMS	Total
Faculty and Staff					
Principal investigator (1 week)	0.25	$13,493	$3,373	$0	$3,373
Co-PI (1 week)	0.25	$6,147	$1,537	$0	$1,537
Lab spec ($14/hr; 16 weeks, 40 hr/wk)	-	$0	$8,960	$0	$8,960
Lab spec ($14/hr; 16 weeks, 40 hr/wk)	-	$0	$8,960	$0	$8,960
Lab spec ($14/hr; 16 weeks, 40 hr/wk)	-	$0	$8,960	$0	$8,960
Personnel, salaried			$31,790	$0	$31,790
Fringe, 40% salaries;			$12,716	$0	$12,716
Total Personnel			$44,506	$0	$44,506
Supplies			$9,237	$0	$9,237
Travel			$600	$0	$600
Vessels			$630	$0	$630
Seawater Research Lab 650 sq ft/month x $1.14/sq ft/month x 3 months			$2,223	$0	$2,223
Equipment			$7,240	$0	$7,240
SUBTOTAL: Direct Costs			$64,436	$0	$64,436
Facilities & Administrative Costs		**25.0%**	$13,586	$11,249	$24,835
TOTAL			**$78,022**	**$11,249**	**$89,271**

Budget justification:

Personnel: The PI and co-PI request 1 week of time for this project; 3 marine laboratory/field specialists will be hired for 4 months to conduct the calibration experiments (comparisons 1, 2, and 3), obtain and maintain hatchery striped bass in the VIMS Seawater Laboratory, assist in data collection, and maintain instruments (water quality meters, etc.).

Supplies: For comparison 1, we request funds to purchase fuel for the small vessel used to access the seine survey sites (70 gal x $3.60/gal=$252). Most of our supply costs are associated with comparisons 2 and 3 (block-net experiment). The PI currently has the Visible Implant Elastomer injectors necessary to tag small fish; we request funds to purchase elastomer tags sufficient for tagging up to 5,000 fish ($1,165). We will need to purchase 6 large coolers to hold hatchery striped bass on the beach each day during the block-net experiment ($900); these coolers will require 6 battery-powered bubblers to ensure sufficient oxygenation of the water ($300). We plan to attach 3 remotely-activated, water-proof video cameras to the foot of the block-net to monitor escapement of juvenile striped bass ($1,820); these cameras must have wide-angle lens and be capable of recording images in low light conditions; estimated cost includes upgraded memory to permit recording of multiple videos each day and remote control unit. Maintenance of 5,000 hatchery striped bass in the VIMS Seawater Laboratory requires the purchase of a 2-hp (24,000 BTU) heat exchanger ($4,500); the tanks, plumbing, UV-sterilizers, and filters are available for our use and do not require purchase. We request a small amount of funds for expendable supplies associated with maintenance of striped bass in the Seawater Lab, including replacement valves, tubing, dip nets, and fish food ($300). Additional supplies in the PI's lab will be used in this project and do not require purchase; these include a ruggedized laptop computer for data entry in the field, a fish transportation tank for transporting fish from the hatchery to the VIMS Seawater Laboratory, fish measuring boards, seine nets, a block net, buckets, and foul weather gear.

Travel: We request funds to rent a VIMS truck for travel to local supply stores for small purchases (valves, tubing, etc.), for travel to the hatchery to obtain juvenile striped bass, for transporting fish from the Seawater Lab to the beach on the York River, and for travel to the seine sites for comparison 1 ($600).

Vessels: We request funds for the rental of a small skiff and trailer (vessel $70/day, trailer $20/day x 7 days=$630); this vessel will transport scientists to the seine survey sites to permit completion of comparison 1.

Seawater Research Laboratory: We request funds for space rental in the VIMS Seawater Research Laboratory. We will need to occupy 650 square feet of space in the general use room for 3 months (June, July, August); this space costs $1.14/sq ft/month or $2,223.

Equipment: This study will require purchase of YSI data sonde to continuously record temperature, salinity, and turbidity ($7,240).

Facilities & Administrative Costs: The usual VIMS rate for facilities & administrative costs is 45.7%; we used a 25% rate and show the balance (20.7%) as VIMS match.

Figure 1. Knotless ¼" oval mesh used by the VA seine survey in Chesapeake Bay since 1999 (left side), and the 'new' knotless ¼" rhomboid mesh (right side).

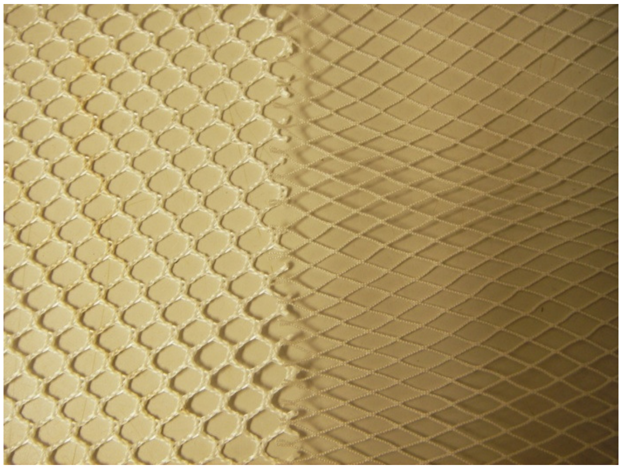

Figure 2. Seine survey sites in the James River, Virginia (A) suitable for deployment of paired seine hauls and (B) not suitable for deployment of paired hauls. The photos show the site at river mile 29 (A) and river mile 77 (B); see Figure 3 for location of sites. Note the large amount of woody debris at the James River 77 site and the relatively small beach.

(A)

(B)

Figure 3. Location of seine survey sites in Virginia tributaries of Chesapeake Bay.

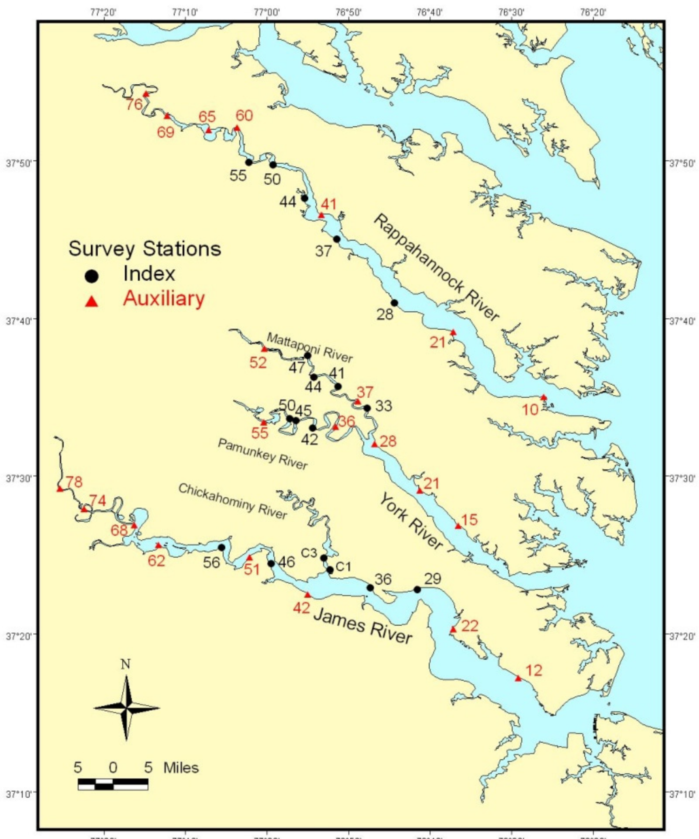

Table 1. Mesh type used by the VA and MD seine surveys in Chesapeake Bay; all meshes are ¼". It is unclear how many more years of use MD will have with knotted rhomboid nets.

Year	Jurisdiction	Mesh type
1967 – 1998	MD	Knotted rhomboid
	VA	Knotted rhomboid
1999 – 2014	MD	Knotted rhomboid
	VA	Knotless oval
2015 - ?	MD	Knotted rhomboid
	VA	Knotless rhomboid (new)

Table 2. Calibration experiments required for seine surveys in VA and MD waters of Chesapeake Bay and its tributaries; all net materials are ¼" but the geometry of the mesh opening differs.

Comparison	Material A	Material B	Application
1	Knotless oval	Knotted rhomboid	Allows comparison of catches for VA from 1999 to 2014 with MD catches and with VA catches from 1967 to 1998
2	Knotless oval	New rhomboid	Allows comparison of catches for VA from 1999 to 2014 with future catches in VA
3	Knotted rhomboid	New rhomboid	Allows comparison of catches for MD from 1954 to 2014 with future catches in MD

Table 3. Block-net experimental protocol for each day (comparisons 2 and 3 described in Table 2). In steps 2, 4, and 6, fish are released outside the area encompassed by the block net and into the York River. Net A is the knotless oval mesh net; net B is the knotted rhomboid net; and net C is the new rhomboid net (see Table 2); the order of deployment of nets will be randomized with each block-net deployment.

Phase	Description	Time (hrs)
1	Deploy block net; measure and release 100 marked hatchery fish into blocked area	2
2	Deploy net A within block net; tally, measure, & release marked (and unmarked) fish	1
3	Measure and release replacement fish into block net area; wait 30 mins	0.5
4	Deploy net B within block net; tally, measure, & release fish	1
5	Measure and release replacement fish into block net area; wait 30 mins	0.5
6	Deploy net C within block net; tally, measure, & release fish	1
7	Dismantle and remove block net, releasing retained fish	1