Proposal Submission to

The Virginia Marine Resources Commission
Recreational Fishing Advisory Board

By

The Virginia Institute of Marine Science
College of William and Mary

Restoration of Submerged Aquatic Vegetation (SAV) Habitat In Chesapeake Bay and the Virginia Coastal Bays

BUDGET PERIOD: May 1, 2013 to April 30, 2014

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RESTORATION OF SUBMERGED AQUATIC VEGETATION (SAV) HABITAT IN CHESAPEAKE BAY AND THE VIRGINIA COASTAL BAYS

A PROPOSAL SUBMITTED TO:

THE VIRGINIA RECREATIONAL FISHING LICENSE DEVELOPMENT FUND

BY

SCHOOL OF MARINE SCIENCE
VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY

PRINCIPAL INVESTIGATOR
Robert J. Orth

VIRGINIA RECREATIONAL FISHING DEVELOPMENT FUND PROJECT APPLICATION

NAME AND ADDRESS OF APPLICANT	PRINCIPAL INVESTIGATORS
Virginia Institute of Marine Science P.O. Box 1346 Gloucester Point, VA 23062-1346	Robert J. Orth
PRIORITY AREA ADDRESSED HABITAT RESTORATION AND EDUCATION	**PROJECT LOCATION** VIMS

DESCRIPTIVE TITLE OF PROJECT

Restoration of Submerged Aquatic Vegetation (SAV) Habitat in Chesapeake Bay and the Virginia Coastal Bays

PROJECT SUMMARY

Seagrasses, one of the most valuable habitats in the world, remain absent or sparse in many areas of the Chesapeake Bay and its tributaries and the Virginia Coastal Bays. The goal of the seagrass restoration program is to establish seagrass in areas that formerly supported this habitat and especially in areas that are important for recreational fishing. The objectives of our 2013/14 work are to build on previous years successes by completing the following: 1. Continue seagrass restoration in areas that are suitable for large scale plantings using seeds, targeting areas the seaside coastal lagoons, 2. Monitor success of previously planted areas; and 3. work collaboratively with Chesapeake Bay conservancy (e.g. TNC) and state management groups (e.g.,VMRC) to assist in baywide SAV restoration efforts.

EXPECTED BENEFITS

Restoration of seagrass habitat to areas that once supported these productive communities will provide additional foraging areas for several species of recreationally important finfish species (e.g. speckled trout, striped bass, red drum), and their preferred food items, especially species such as juvenile blue crabs.

COSTS

May, 1, 2013, through April 30, 2014
VMRC Funding: $148,286
VIMS Funding: $ 44,345
Total Cost $192,631

detailed budget included with proposal

INTRODUCTION

The value of seagrass beds as nursery areas and as feeding grounds for several species of commercially and recreationally important fish and crustaceans is well established (Peterson, 1918; Thayer, et al., 1984; Orth and van Montfrans, 1990). The 1997 Chesapeake Bay Blue Crab management plan established seagrass beds as one of the most important nursery habitats for the blue crab, especially newly settled juveniles (Chesapeake Executive Council, 1997). The importance of established seagrass beds in the lower Chesapeake Bay are often cited in newspaper accounts as prime fishing locations for recreationally important species such as speckled trout. The seagrass beds along the seaside eastern shore once supported a significant commercial bay scallop fishery in the late 1920s and 1930s but disappeared when eelgrass disappeared (Orth, et al., 2006, 2010). In addition, SAV beds are an important indicator of water quality (Dennison, et al., 1993) and their abundance is now embedded in the water quality standards of both Virginia and Maryland.

The dramatic decline of submerged aquatic vegetation (SAV) in Chesapeake Bay in the early 1970s resulted in many shallow water areas becoming devoid of any vegetation (Orth and Moore, 1983). Forty years later, many of these same areas remain either unvegetated or very sparsely vegetated (Orth et al., 2011). A major focus of SAV research in Chesapeake Bay was initially on water quality effects limiting regrowth of SAV (Dennison et al., 1993). However, recent observations in areas experiencing natural revegetation and experiments on the seed dispersal ecology of eelgrass (Orth et al., 1994; 2003) suggests that transplanting efforts may be an important component to restore or enhance seagrass habitat to historic levels.

Our research program in seagrass habitat restoration, funded in part by the Virginia Saltwater Recreational License Fund, couples basic factors limiting seagrass recruitment, growth and survival, with the applied aspects of seagrass restoration. We are also interested in the relevance of this restoration effort for important recreational species such as speckled trout. We are exploring these relationships by using transplanted beds of eelgrass, the dominant species of SAV in the lower Chesapeake Bay, in areas that were historically vegetated prior to 1972, and are presently unvegetated, or very sparsely vegetated, as well as in the seaside coastal lagoons which once supported abundant grassbeds up until 1933. A major goal is to understand factors that limit the re-growth of eelgrass and how restored areas function to support recreational fisheries. In those areas where habitat restoration is successful, we are examining the dynamics of plant colonization, either from vegetative growth or from seeds. Our restoration program has relevance in the overall context of Chesapeake Bay's Executive Council's Directive to restore seagrass beds to their historical distributions (Chesapeake Executive Council, 1989, 1990, 2003).

The overall goal of this long-term project is aimed at addressing several of the priority areass of the Recreational Fishing Development Fund. Besides improving and enhancing habitat through restoration, we conduct research and gather data to improve the techniques to restore grasses and better understand the roles these beds play for recreational fisheries. This project also supports educational opportunities, primarily with non-profit Chesapeake Bay conservation groups. Many of these groups have learned from our experiences with this project and incorporated such information to their own seagrass restoration efforts to improve their own success rates (e.g. The Nature Conservancy, Chesapeake Bay Foundation).

IMPORTANT FINDINGS TO DATE

Our most significant achievement to date has been the successful re-establishment of eelgrass to the Virginia Coastal Bays. These bays had not had eelgrass since 1933 which had once supported an incredibly commercially and recreationally valuable bay scallop population (Orth et al 2006, 2010). Through 2012, we had broadcast over 47 million seeds into 365 acres. Seed dispersal from plants in the restored plots to nearby unvegetated areas has resulted in an estimated 1900 ha (approx.4700 acres) containing eelgrass by 2012 in these four bays, almost 14 times the originally seeded area (Fig. 1). Not only are we seeing more bottom covered with grass but the areas are getting denser as noted in the description of each bay below. This project is undoubtedly one of the most successful restoration projects in the world today.

South Bay, where seeding began in 1999, showed the greatest spread and increase in coverage of the four bays. Eelgrass was first mapped for this bay in 2001, when 15.7 ha was recorded, all being sparse seagrass cover (Fig. 2). This increased to 200 ha, also sparse cover, in 2006. By 2011, 1,075.53 ha (2,656.56 acres) were mapped, with 63.6% classified as moderate to dense cover. Aerial photographs from 2001 to 2010 show the rapid spread of eelgrass in South Bay especially between 2006 and 2010 (Fig. 3). Recently obtained photography (not mapped at the time of this report) from June, 2012, shows the persistence of this dense, continuous bed in South Bay (Fig. 4).

Seed distribution in Cobb Bay began in 2001. Eelgrass was first mapped for this bay in 2003 when 3.9 ha, all sparse cover, was recorded (Fig. 2). By 2006, 41 ha were mapped with 11% considered moderate to dense cover. By 2011 eelgrass coverage increased to 364.69 ha (900.78 acres), with 75.8% classified as moderate to dense cover. Fig. 5 shows the area in Cobb Bay from recently obtained photography (not mapped at the time of this report) from June, 2012, showing the dense, continuous bed in this bay.

Seed distribution in Spider Crab Bay began in 2003. Eelgrass was first mapped in this bay in 2004 when only 0.3 ha, all sparse cover, was recorded (Fig. 2). In 2006, 1.6 ha were mapped as all sparse cover. By 2011, 129.59 ha (320.09 acres) were mapped, with 56.6% considered moderate to dense cover. A decline in eelgrass coverage was noted in 2011 from 2010 which may be an artifact of the photography which was flown late in 2011 where several areas that had eelgrass in 2010 were masked with turbid water. Fig. 6 shows the region in Spider Crab Bay that is being restored from recently obtained photography (not mapped at the time of this report) from June, 2012, showing the region with individual plots from earlier years still noted and where eelgrass which was not mapped in 2010 is now present.

Seed distribution in Hog Island Bay began in 2006. Seagrass was first mapped in this bay in 2007 when 25.5 ha, all sparse cover, were recorded (Fig. 3). By 2011, 199.31 ha ((492.30 acres) were mapped, with 33.5% considered moderate to dense cover. Fig. 7 shows the area in Hog Island Bay from recently obtained photography (not mapped at the time of this report) from June, 2012, showing the dense, continuous bed in this bay.

Linked to the successful eelgrass efforts has been an ongoing effort to re-establish the bay scallop. Initiated in 2009, tens of thousands of bay scallops have been placed in cages in South Bay to facilitate successful spawning in 2009-2012. Our first intensive bay scallop survey in

July, 2012, of a 1000 acre in South Bay, found an estimated 1.9 million scallops <20 mm and 46,000 scallops > 20 mm, suggesting that the proof of concept of seeding an area with bay scallops could enhance the population. We expect this work to continue in collaboration with Dr. Mark Luckenbach from the VIMS Wachapreague lab.

While the seaside restoration in our most notable success, our eelgrass restoration efforts in the James River in the late 1990s, funded by the RFAB, has successfully established eelgrass along the north shore from Monitor Merrimac Bridge Tunnel to the Hampton Roads Bridge Tunnel. Much of this eelgrass persists today and has expanded (Orth et al., 2011).

Finally, our experimental work on seeds has shown that burying them rapidly in the fall by hand or mechanically can enhance the seedling establishment rate (Marion and Orth, 2012, unpublished data). This is important as it results in re-establishing areas with eelgrass more rapidly with fewer seeds. This important data has resulted in our efforts to design an underwater planter that can bury seeds effectively and efficiently.

PROJECT GOALS

Restore seagrass beds in lower Chesapeake Bay and the Coastal Bays.
Collect and disperse seeds in large areas while conducting additional restoration experiments that optimize growth and spread of seagrass in Virginia waters, and monitor the success of previously planted areas, with emphasis on the seaside of the eastern shore.

Partner with various educational and conservancy groups that are working toward successful SAV restoration.
Continue to work collaboratively with Bay conservancy groups, such as The Nature Conservancy (TNC), as well as other bay state management groups (MD Dept. of Natural Resources) to assist and enhance baywide SAV restoration efforts, again with emphasis of the seaside of the eastern shore.

PROPOSED 2013-2014 WORK

GOAL 1. Large scale restoration efforts and additional experiments to enhance seedling establishment rates. The objectives are: 1. Collection of seeds; 2. Processing and storage of seed material; 3. Distribution of seeds; 4. Monitoring of plant success; 5. Experiments to better understand factors controlling seedling success.

1. Seed collection

Harvesting of flowering shoots with seeds will follow general protocols that have previously proven successful for collecting and storing large quantities of seeds (Marion and Orth 2010). Based on our previous work with harvesting seeds that has shown that there is generally a 2-3 week window to harvest mature reproductive shoots with ripe seeds, we will harvest flowering shoots using a combination of hand collections and machine harvesting from a large and dense eelgrass bed located on the seaside of the eastern shore in June, 2012. Flowering shoots with viable seeds will be placed in mesh bags and returned to the VIMS laboratory for storage.

2. Processing of seed material and storage of seeds

Harvested flowering shoots will be stored in facilities on the VIMS campus at Gloucester Point. Following our established protocol, all material (including flowering shoots as well as vegetative shoots that are collected incidentally) will be placed in large holding tanks (500 gallons) that receive a continuous flow of seawater and is aerated. Flowering shoots will be monitored daily for seed release. When seeds were fully released (mid-July), they will be separated from all detritus and plant material using techniques described in Marion and Orth (2010). Seeds will then be stored in small tubs in a temperature-controlled tank inside the VIMS SAV greenhouse. The tank will be supplied with re-circulating seawater (30 PSU and 20 C). Seeds will be checked daily to ensure their viability is not compromised by bacterial or fungal growth.

3. Distribution of seeds

Our previous work in the seaside bays and in Chesapeake Bay has shown that broadcasting eelgrass seeds has proven to be a very effective technique for restoring eelgrass on larger scales (Orth et al. 2012). We will continue to place seeds in selected locations in the coastal bays to insure continued success of eelgrass in these areas. One acre plots will be established at as many locations as possible based on our seed collections locations. Seed broadcasting will be conducted in September and October. Position of each plot will be pre-determined in the laboratory by overlaying either the 1.0 acre plot on a map of the region and recording the corners of the plot in our GIS system. In the field prior to placing seeds in the plots, markers buoys will be placed at the four corners of each plot as determined by a Trimble GPS, accurate to sub-meter distances allowing for a very accurate location of the corners, and thus not requiring any permanent posts denoting plots.

Seeds will be broadcast in each plot at a density of 100-200,000 seeds per acre based on the availability of seeds. The timing of the seed broadcasting will be prior to natural seed germination in November (Moore et al., 1993) and to minimize loss of seeds due to seed predation during summer months (Fishman and Orth 1996). Seeds will be broadcast in a pattern to facilitate as even a distribution as possible.

We have been testing an underwater planter over the last few years, and its development is advancing slowly (VIMS, unpublished data). We will continue to work on the design and conduct experiments to insure successful establishment with the objective of seedlings exceeds our broadcast method for large scale restoration.

4. Monitoring plant success

We will monitor plant success both in the spring and fall. Monitoring in the spring yields information on seedling establishment rates. This is a measure of the number of plants that germinated and survived winter storms. Our second monitoring effort measures success of spring plants surviving through the summer heat and turbidity peaks. Monitoring of plants in both time periods was similar. Initially at each plot marker buoys will be placed of the corner of each plot using a Trimble GPS to re-locate each corner. Two divers position themselves at opposite sides of the plot and swim along each diagonal of the plot counting all seedlings in 1 0.5 m wide path. Total number of seedlings are then extrapolated for the entire plot and divided by the number of seeds broadcast to arrive at a seedling establishment rate.

Assessment of the overall distribution of seagrasses especially the success of the seaside expansion will be from mapping the extent of seagrass coverage from aerial photography. The entire shoreline of the seaside coastal bays will be photographed at an altitude of 12,000 ft in the spring of 2013, as part of the VIMS annual SAV survey. Methods for this assessment, including acquisition and mapping protocols, can be found on the VIMS web site: (http://web.vims.edu/bio/sav/sav11/index.html).

5. Experiments to improve seedling success

Our research continues to demonstrate the high potential of seeds for SAV restoration, and our ongoing work has been aimed at dramatically improving seedling establishment rates by understanding the site-specific role of seed burial in determining seedling success rates across a range of exposure and sediment regimes (unpublished data). Seagrass sites have a range of exposures and burial depth to insure successful establishment could be very site specific. Our objective is to more thoroughly understand site specific parameters in improving seedling success. In addition, we hope to incorporate this information into our seed planter which continues to undergo annual improvements, which includes an effective seed delivery system to the planter.

GOAL 2. Maintain partnerships with conservancy and bay state management groups.

Many conservancy groups are conducting restoration projects on their own, utilizing lessons learned via our work with this project. The future of SAV restoration baywide will require both the ability to grow SAV in an aquaculture setting, so that wild beds remain undisturbed, but also to utilize existing beds as a seed source as we are currently doing for eelgrass seeds. One of our main efforts will be to continue the partnership with The Nature Conservancy as they coordinate volunteer groups to help collect seeds for the seaside restoration effort.

As VIMS is the only state, federal, or University groups actively involved in day-to-day SAV restoration in the Chesapeake Bay region, we will also continue to assist conservancy groups with their restoration efforts by providing technical advice and training sessions as requested and by inviting these groups to help us in our projects, including seed collections in the late spring. Our objective is to develop unique partnerships between scientists, educators, and the general public to restore bay grasses where possible.

PRODUCTS

Quarterly reports will be submitted to VMRC outlining progress and results to date for that quarter as well as planned activities for the next quarter. Reports will be due as required by VMRC. In lieu of a final report, we will continue to analyze data and write papers in a publishable format and submit these to peer review journals (e.g Orth et al. 2010, 2012, Marion & Orth 2010, 2012). We will also make presentations at scientific meetings as well as general public meetings as requested.

TIMELINE

TASK	2013 J	J	A	S	O	N	D	2014 J	F	M	A	M
Collect and Maintain Seeds	X	X	X	X								X
Disperse Seeds				X	X							
Monitor Transplants	X				X						X	
Data Analysis			X				X	X	X	X		
Quarterly Reports				X				X			X	

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Figures

Fig. 1. Number of hectares seeded compared to number of hectares mapped from aerial photography from 1997-2012.

Fig. 2. Area of seeding in each of four bays (left axis), and area mapped in two density classes by aerial photography each year (right axis). ND indicates no mapping data for 2005.

Fig. 3. Aerial photographs of South, Cobb, Spider Crab and Hog Island bays in June, 2012, with eelgrass in the area bounded by the white line for each bay. Scale is approx. 1:24,000 (1 inch = 2000 ft).

Figure 1

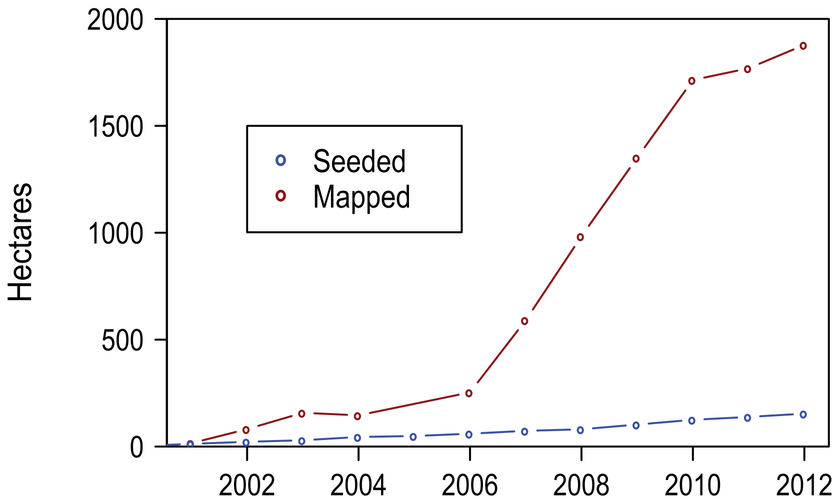
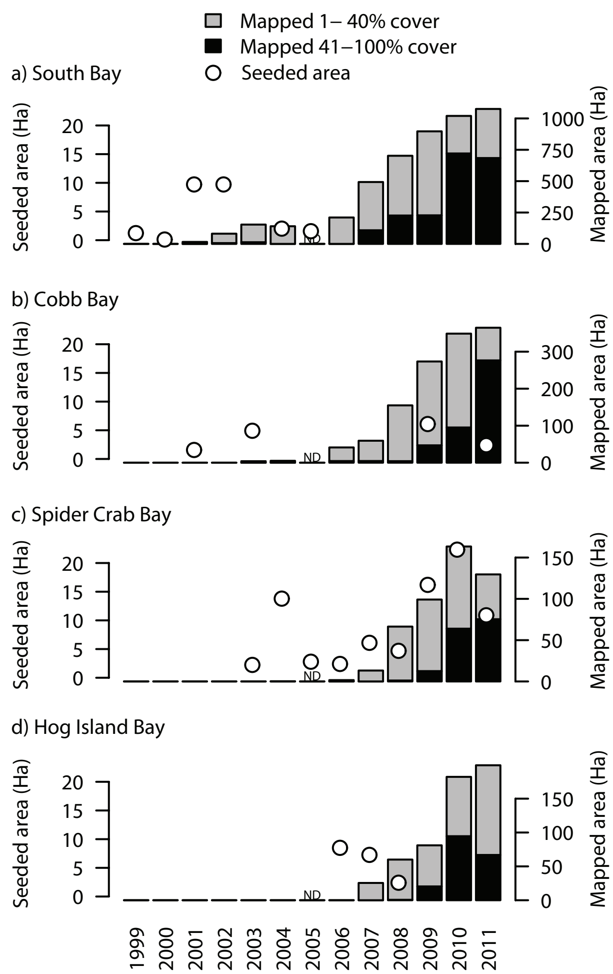
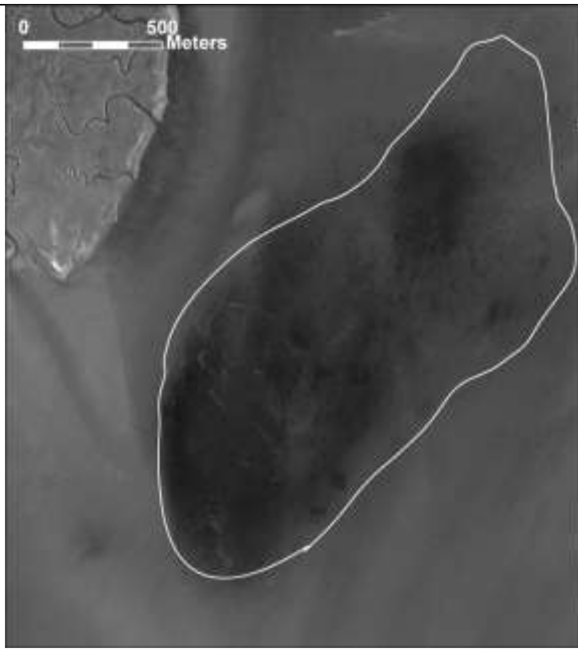

2000
1500
1000
500
0
Hectares
Seeded
Mapped
2002
2004
2006
2008
2010
2012

Figure 2

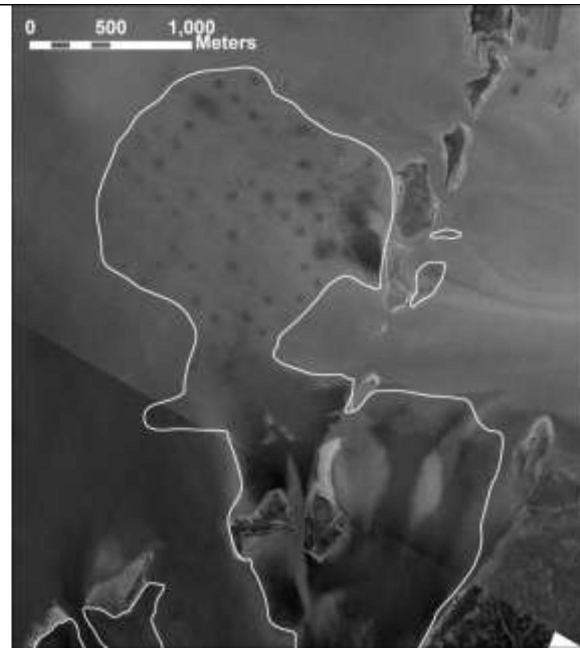


Mapped 1– 40% cover
Mapped 41–100% cover
Seeded area
a) South Bay
b) Cobb Bay
c) Spider Crab Bay
d) Hog Island Bay
Seeded area (Ha)
Mapped area (Ha)
ND
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

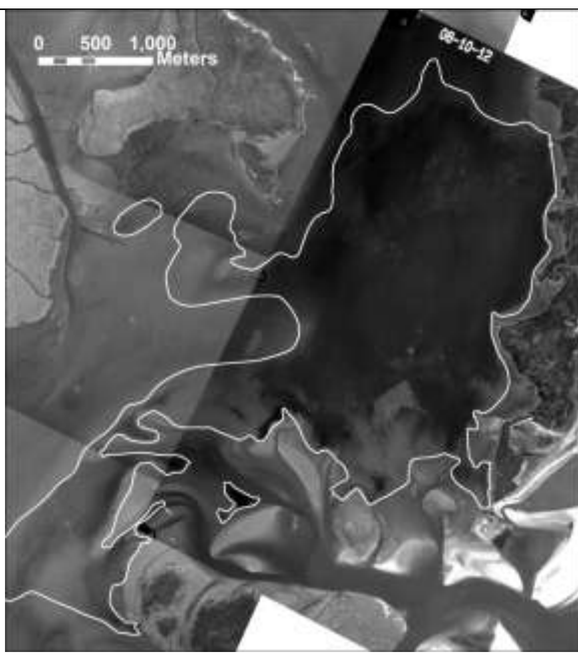
Figure 3.



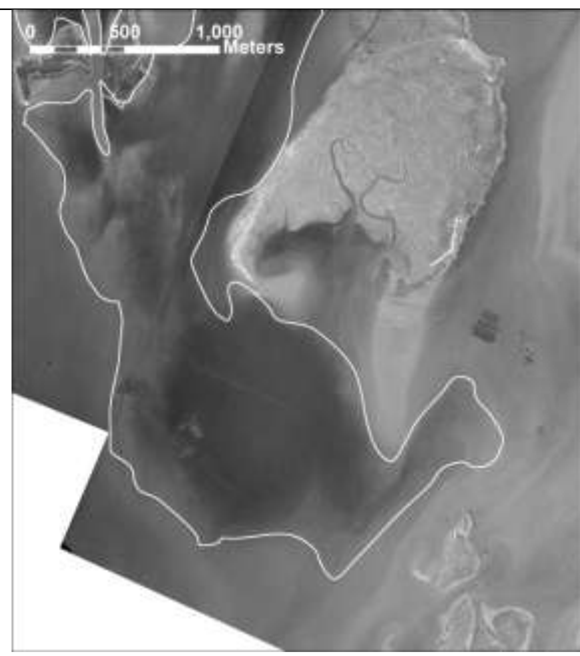
Hog Island Bay



Spider Crab Bay



Cobb Bay



South Bay

Title: Restoration of Submerged Aquatic Vegetation (SAV) Habitat in Chesapeake Bay and the Virginia Coastal Bays

Personnel	**Time**	**Monthly**	**Agency**	**VIMS**	**Total**
Scott Marion	9 mos	$4,808	$43,272	$0	$43,272
Corey Holbert	9 mos	$2,627	$23,643	$0	$23,643
Robert Orth	-	$0	$0	$11,080	$11,080
	-	$0	$0	$0	$0
	-	$0	$0	$0	$0
	-	$0	$0	$0	$0
	-	$0	$0	$0	$0
Hourly					
Technician	-	$0	$15,000	$0	$15,000
	-	$0	$0	$0	$0
Personnel, salaried			$66,915	$11,080	$77,995
Personnel, hourly			$15,000	$0	$15,000
Fringe, 40% salaries;			$26,766	$4,432	$31,198
7.65% hourly			$1,148	$0	$1,148
Total Personnel			$109,829	$15,512	$125,341
Communications/Printing			$0	$0	$0
Supplies			$3,000	$0	$3,000
Travel			$3,000	$0	$3,000
Contractual Services			$0	$0	$0
			$0	$0	$0
			$0	$0	$0
Tuition			$0	$0	$0
Vessels			$3,500	$0	$3,500
Publication Center			$0	$0	$0
Nutrient Analysis			$0	$0	$0
Equipment			$0	$0	$0
SUBTOTAL: Direct Costs			$119,329	$15,512	$134,841
Facilities & Administrative Costs		**25%**	$28,957	$28,833	$57,790
TOTAL			**$148,286**	**$44,345**	**$192,631**