Strategy to Accelerate the Protection and Restoration of Submerged Aquatic Vegetation in the Chesapeake Bay

Executive Summary

This document presents a revised strategy to accelerate the protection and restoration of submerged aquatic vegetation, or SAV, in the Chesapeake Bay and its tidal tributaries. Research, monitoring and implementation projects over the past 40 years have demonstrated that SAV is one of the most important biological communities in the Chesapeake Bay. The Chesapeake Bay Program (CBP) has committed significant resources during this period to determine the causes for the declining SAV populations in the Bay and its tributaries and to identify and develop the most appropriate methods for protecting and restoring SAV populations. The present strategy is based on consensus among the formal and informal partners of the CBP and the recommendations of the Science and Technical Advisory Committee (STAC) report "Evaluation of the Effectiveness of SAV Restoration Approaches in the Chesapeake Bay" (CRC# STAC 11-03). The original version of this document was adopted in 2003, fulfilling the following commitment in the program's *Chesapeake 2000* agreement:

> By December 2002, implement a strategy to accelerate protection and restoration of SAV beds in areas of critical importance to the Bay's living resources.

By adopting this revised strategy, the Chesapeake Bay Program partners recommit to four major initiatives that must be successfully implemented to restore our SAV resource to historic levels:

SAV Protection and Restoration Initiatives

1. ***Meet CBP water clarity criteria in areas designated for SAV use***. In order to meet current and future SAV restoration goals, it is essential to fulfill the CBP water clarity criteria in areas and at depths that are designated by Maryland, Virginia and the District of Columbia for the application of that criteria (i.e., SAV use). The water clarity criteria reflect the minimum light requirements that are necessary for the growth and maintenance of SAV populations throughout the shallow waters of the Chesapeake Bay and its tidal tributaries. Meeting these criteria in the Bay's SAV designated use areas will provide the water clarity conditions necessary to support at least 185,000 acres of SAV, which is the existing CBP goal for SAV restoration. (Principal Staff Committee, http://www.chesapeakebay.net/content/publications/cbp_28933.pdf)

2. ***Provide existing SAV beds greater protection from anthropogenic activities and invasive species***. To increase protection for existing SAV beds and to manage resource and user conflicts as SAV populations increase, the CBP partners will:

    - Characterize threats posed to SAV by climate change and sea-level rise. Make recommendations to maintain SAV populations in the face of climate change.

- Maintain full implementation and enforcement of existing SAV regulatory protection provisions to minimize use conflicts (see Appendix 2, Review of Existing SAV Protection Provisions).

- Develop and implement new tributary and/or segment-specific protection guidelines for SAV populations that take into account multiple uses by different groups in the Bay community and investigate the implications of resource trade-offs (e.g., wetland creation in areas occupied by SAV).

- Examine existing regulatory programs and determine whether they are adequate for implementing the tributary-specific guidelines identified above. Maryland, Virginia, the District of Columbia and the federal government will consider recommendations to modify existing regulatory programs to implement and enforce such guidelines.

- Advocate using the 185,000 acre goal footprint in addition to current populations when reviewing permit applications or considering changes to existing regulations governing fisheries or sub-aqueous land management.

3. ***Accelerate SAV restoration and understanding of ecosystem processes by planting 20 acres of new SAV beds annually.*** SAV planting projects can accelerate the restoration of the Chesapeake Bay and its tributaries if they are targeted in areas that have suitable water quality and are designed to benefit specific living resources. These plantings also increase our knowledge of habitat requirements and site selection criteria necessary for successful restoration. Large-scale planting projects require ample sources of plant material. Significant gains have been made in developing methodologies for plant propagation, seed collection, processing and storage. Sufficient annual financial resources are essential for planting efforts, monitoring the success of these projects and analyzing the results to feedback into the adaptive management cycle. Improving the coordination of baywide SAV restoration and protection activities will be necessary if we are to sustain this level of restoration.

4. ***Enhance SAV research, citizen involvement and education.*** Increased understanding of how to restore SAV populations efficiently and effectively is critical to our efforts to restore the Chesapeake Bay. This cannot be accomplished without a continuing commitment to research restoration technologies and the basic biological requirements of individual SAV species. To ensure long-term stewardship of this restored resource, we must further expand our efforts to educate the public about the critical importance of SAV.

Budget Implications

To fully fund and implement the actions called for in this document, we anticipate it will cost approximately $7,883,400 over 5 years (Table 1).

The following strategy describes the rationale for and actions associated with each of these initiatives, including an estimated budget.

Introduction

More than 40 years of research in the Chesapeake Bay and throughout the world have shown that SAV constitutes one of the most important biological communities in an estuary. SAV beds influence physical conditions in the Bay and are integral to the needs of many other Bay species. Through photosynthesis, SAV converts inorganic carbon, nitrogen and phosphorous into organic molecules, cells and tissues that other plants and animals can use for energy and growth. The plants provide shelter and substrate for invertebrates that serve as a food source for other organisms. SAV beds shelter spawning fish and their offspring, and SAV is the principal food source for many waterfowl. Even the detritus from SAV is used by filter-feeding organisms such as clams and oysters.

SAV also influences water quality, both directly and indirectly. SAV uses sedimentary and water-column nutrients, sequestering them in their tissues during the growing season, when high nutrient levels would otherwise contribute to algal growth that can reduce water clarity and cause low dissolved oxygen. SAV beds also attenuate current and wave energy, which causes suspended sediment to settle and protects against shoreline erosion. Both of the above mechanisms directly contribute to improvements in water clarity. SAV also sequester nutrients and carbon ("blue carbon") in their root structures.

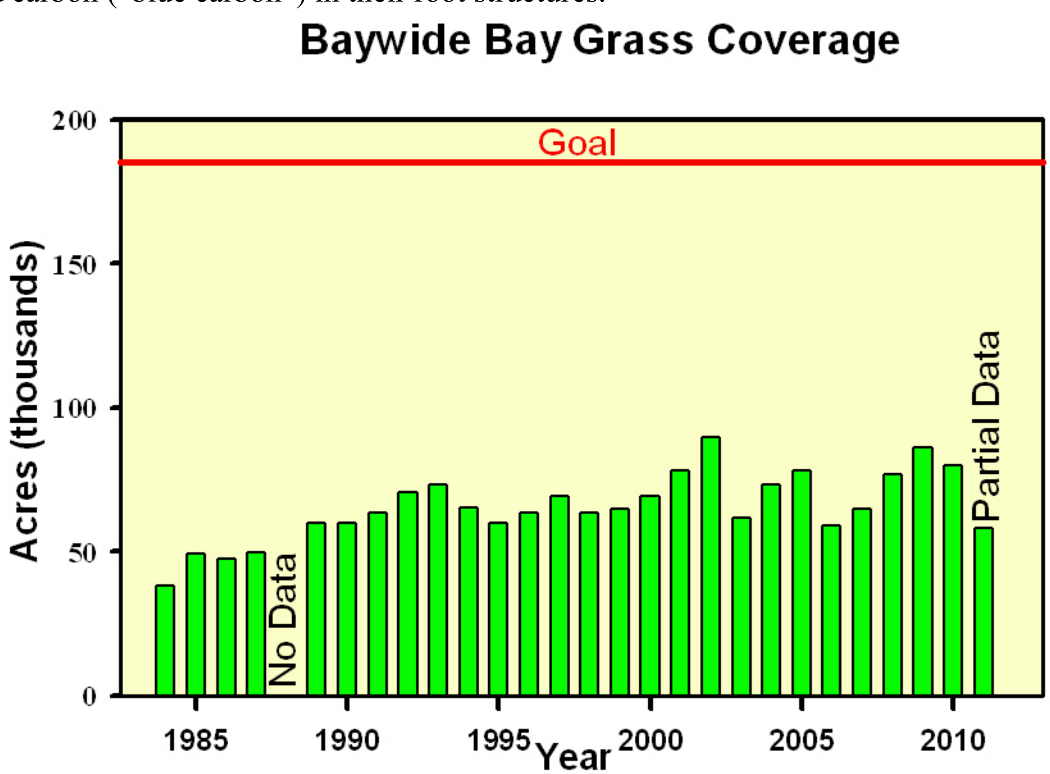

Figure 1: Areal coverage of SAV, 1984 through 2011

On April 15th, 2003, the Chesapeake Bay Program's Principals' Staff Committee approved a SAV restoration goal of 185,000 acres as part of the *Chesapeake 2000* agreement. Though dated, this goal of 185,000 acres is still appropriate for how much SAV should be present in a restored Bay in 2025. The partner states of the Bay Program have adopted this goal, consistent with the Chesapeake 2000 agreement. The SAV distribution used to establish the goal included data from aerial photographs taken in the following years: 1938, 1952, 1964, 1978, 1986–1991, and 1996–2001. The bay-wide SAV goal is the sum of acreage targets for each of the 78 Chesapeake Bay segments. The segment-specific targets are based on the single best year acreage on record for each segment, within the depth to which the segment exhibited sufficient SAV persistence or abundance. The achievement of the bay-wide goal, as well as the local tributary basin and segment specific restoration goals, will be based on the single best year SAV acreage within the most recent three year record of survey results. The SAV workgroup advocates keeping the 185,000 acre SAV goal for management and regulatory purposes.

For the past 40 years scientists, legislators, federal and state resource managers and concerned citizens have worked cooperatively to develop policies and plans to protect, preserve and enhance SAV in Chesapeake Bay. These efforts resulted in five Chesapeake Bay agreements and a number of strategies, policies and federal and state guidelines for protecting SAV (see Appendix A, History of CBP SAV Initiatives, page 18). These management efforts depend upon our recognizing both the habitat value of SAV to many fish and shellfish species and the link between water quality conditions and the occurrence of SAV.

Because of these linkages, the distribution of SAV in the Bay and its tidal tributaries is being used as a measure of progress in the restoration of living resources and water quality. For example, the new water clarity criteria that were developed for the Bay are based in large part on SAV requirements for water clarity conditions that allow enough light to reach plants' underwater leaves to promote growth.

1. Strategy to Protect and Restore SAV through Protection and Restoration of Habitat Quality

ACTION 1.1: Continue to support the attainment of Chesapeake Bay Program water clarity criteria by monitoring and analysis, including aerial survey mapping and shallow water monitoring programs. Attaining sufficient water clarity is the most significant action necessary to protect and restore SAV in the Chesapeake Bay. This is a cross-cutting action with the Protect & Restore Water Quality Goal Implementation Team (GIT3) and the Maintain Healthy Watersheds GIT (GIT4).

- Assess water clarity attainment in each segment, using aerial survey and shallow water monitoring data. This is an on-going effort, performed annually. Consolidate data and analyses into a central location and make these data available for peer review.
- By December 2014, correlate water clarity and SAV data to determine trends in water quality attainment (e.g. is an area that currently passes for water clarity trending toward failure, or conversely, is an area that is failing trending towards passing in the future). Update this action annually thereafter.

The *Chesapeake 2000* Agreement committed the signatories to define the water quality conditions necessary to protect aquatic living resources. For SAV, water clarity criteria have already been developed (Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries, EPA 903-R-03-002). Collectively, these water quality parameters provide the best and most direct measures of the effects of excessive nutrient and sediment pollution on the Bay's aquatic living resources including fish, crabs, oysters and SAV.

The scientific understanding of the effects of water quality on aquatic Bay living resources, combined with long-term Bay monitoring and state-of-the-art linked Bay airshed/watershed water quality models, enable Bay Program partners to develop criteria for water quality measures that directly influence Bay aquatic living resources, including fish, crabs and SAV. Loading caps have been established to help address the causes of reduced water quality conditions, including excessive nitrogen, phosphorus and sediment. Bay models enable the partners to effectively translate the desired dissolved oxygen, water clarity and chlorophyll *a* conditions into reduced loadings of nutrients and sediments from the surrounding watershed and airshed. Bay science has shown that nutrient and sediment loads, not merely their ambient concentrations, have had the greatest impact on oxygen, light and algae levels in the Bay's tidal waters.

Water clarity is a measure of the amount of sunlight that penetrates the water and reaches SAV leaves. Poor water clarity is caused by sediments and other suspended particles, including algae, and sediment on SAV leaves. The current water quality criteria applies to areas where SAV occurred historically or now occurs, at varying depths up to 2 meters deep, depending on the area of the Bay. Areas in which SAV has never occurred, or where natural factors prevent its growth (e.g., strong currents or rocky bottoms) are excluded. The water clarity criteria reflect the different light requirements for underwater plant communities that inhabit low-salinity versus higher salinity shallow water habitats throughout the Bay and its tidal tributaries.
A document describing the Chesapeake Bay's water clarity criteria in greater detail (http://www.chesapeakebay.net/content/publications/cbp_13142.pdf) was adopted by the CBP Executive Council in December 9, 2003. These criteria are applied to a tidal water designated use (i.e., SAV habitat). The refined tidal water SAV habitat designated use, along with the water clarity criteria, was adopted by Maryland (COMAR 26.08.02.03-3), Virginia (9VAC25-260-185), Delaware (regulation 7401) and the District of Columbia (Rule 21-1104) into their state water quality standards. In turn, these standards are the basis for setting nutrient and sediment loading caps to achieve water clarity that will support SAV in the areas and at the depths to which the SAV habitat designated use is applied by the jurisdictions.

ACTION 1.2: By December 2014**,** revisit and review implementation of water quality criteria and standards and reassess as they relate to meeting these goals. It is important to recognize that regulatory Nutrient and Clarity Criteria for delisting the Bay can differ from conditions necessary for the plants' survival.

- The standards to be removed from the impaired waters list are currently being modified and we need to play an active role in influencing how the standards are being set in order to best facilitate SAV. It is also logical that rivers should not be delisted for water clarity if SAV is not present, even if they meet the water clarity requirements. The fact that they do not have SAV should be indicated.

- Adequate water clarity is needed in specific locations at specific times for SAV growth and persistence. Water clarity criteria should reflect this need of the resource.
- Based on previous restoration attempts, it has become apparent that water quality thresholds for the establishment of new SAV beds are different from existing water clarity standards. Therefore, new restoration water clarity thresholds need to be established, based on the results of the proposed Submerged Aquatic Vegetation Habitat Requirements and Restoration Targets: Third Technical Synthesis.

ACTION 1.3: Annually track progress toward the 185,000 acre SAV goal. Progress toward the goal will be measured by the annual aerial survey which currently is compiled by the Virginia Institute of Marine Sciences for the Annual Bay-wide Submerged Aquatic Vegetation Mapping Program. This program maps the distribution of SAV during the peak growing season using aerial photography and ground-truthing. Aerial photographs are digitized for analysis and combined with ground-truthing data in a central SAV distribution database, available through the CBP website.

2. Strategy to Accelerate Protection of Existing SAV Beds

For purposes of this section, protection of existing SAV beds, includes not only avoiding or minimizing the direct mechanical disruption of SAV beds by anthropogenic activities (e.g., dredging, improper vessel operation (resulting in boat wakes and propeller scarring) or aquaculture activities) but also disruption by invasive animal species (such as the mute swan). Additionally, indirect effects need to be controlled as well. For example, localized water quality degradation can be generated by anthropogenic activities (e.g., sedimentation and excessive turbidity resulting from clam dredging). Also, attention needs to be paid to the indirect impacts of harmful algal blooms and exotic plant species such as water chestnut and water lettuce. Of increasing concern is the potential impact of climate change and relative sea-level rise on SAV. Recognizing that SAV abundance throughout most of the Chesapeake Bay is greatly reduced from historic acreages, it is assumed that if the water clarity criteria are achieved, the overall coverage of SAV will increase. As both human and SAV populations increase, the potential for use conflicts increases as well. These strategies should be implemented to accommodate these continued increases. The annual aerial survey will continue to be the primary tool to detect the effects of damaging activities on SAV.

2.1. Characterize Threats to SAV

ACTION 2.1.1: By December 2013 characterize threats posed to SAV by climate change and sea-level rise. Make recommendations to maintain SAV populations in the face of climate change.

The Chesapeake Bay is considered at high risk for the negative impact of sea level rise. Flooding and erosion of shorelines and marshes may lead to reduced water clarity and changes in SAV habitats, making areas adjacent to marshes unsuitable for SAV growth. It is possible that some of the lack of success of SAV restoration efforts to date is linked to global climate change. For example, some Chesapeake Bay species are considered cold-water SAV (i.e. eelgrass). A global increase in temperature may stress these plants and decrease their success rate when compared with warmer water species in the Chesapeake Bay. If this is anticipated to be an important factor affecting SAV in the Bay, it may be appropriate to favor heat-tolerant SAV species in planting and transplanting efforts.

ACTION 2.1.2: By December 2014, identify and implement shoreline management options that promote suitable adjacent bottom for SAV growth. Explore engineering options that expand the area of suitable SAV habitat.

- Establish physical parameters of SAV habitat criteria and use to advise shoreline engineering manuals.
- Link to Wetland Action Team to support cross-cutting Habitat Goal Implementation Team strategies

2.2. Manage the Regulatory Program Effectively

ACTION 2.2.1: An on-going action is to charge States to avoid SAV anthropogenic disturbance and/or loss to the greatest extent possible, strive to require compensation in cases of permitted losses, and promote information exchange among jurisdictions and regulations within jurisdictions that support such actions Employ the "avoid, minimize, and mitigate" philosophy during permit application review.

ACTION 2.2.2: By December 2013, Maryland, Virginia, the District of Columbia and federal agencies will develop tributary-specific guidelines for protecting SAV from disturbance. Review the adequacy of existing federal and state programs to meet these guidelines and report to the CBP on their findings including strategies to develop new SAV protection measures, where necessary. Additionally, consideration of all known SAV habitat should be given using the existing historic SAV coverages and the data used in the development of the 185,000 acre goal. Protecting these areas that are known to have supported SAV in the past is critical to ensure there are adequate shoals available to reach the restoration goal.

The CBP Habitat Goal Implementation Team will facilitate this process to seek consistency across jurisdictions. In implementing Regulatory Program Management our objectives will be to:

- Maintain full implementation of existing SAV regulatory protection provisions to minimize resource and user conflicts (see Appendix 2, Review of Existing SAV Protection Provisions).

- Develop and implement new tributary and/or segment-specific protection guidelines for SAV populations that take into account multiple uses by different groups in the Bay community and investigate the implications of resource trade-offs (e.g., wetland creation in areas occupied by SAV).

- Examine existing regulatory programs and determine whether they are adequate for implementing the tributary-specific guidelines identified above. Maryland, Virginia, the District of Columbia and the federal government will consider recommendations to modify existing regulatory programs to implement and enforce such guidelines.

- Advocate using the 185,000 acre goal footprint in addition to current SAV populations when reviewing permit applications or considering changes to existing regulations governing fisheries or sub-aqueous land management

2.3. Establish SAV Protected Areas (PAs)

ACTION 2.3.1: By December 2017, identify potential SAV protected areas (PAs) in areas of critical importance to living resources in Chesapeake Bay. This exercise will include consideration of current and historical SAV abundance, the current amount of SAV protected, water quality conditions and potential for use conflicts, among other issues. A GIS map of SAV areas in need of protection will be created to assist in evaluating and communicating PA strategies. Revisit feasibility of using historic coverage (single best year GIS layer) to continue implementing SAV protection measures and activities that support these strategies. Encourage state sub-aqueous land leasing practices to facilitate permits and renewals in such a way that protects existing and/or historical SAV areas. Establish criteria for adjacent shoreline stabilization practices that affect SAV beds. Consider using the adjacent critical zones (state established, county enforced) in addition to the marine protected areas. Consider additional criteria for donor beds/ seed source beds. This action is linked to Action 3.3.4

ACTION 2.3.2: Continue implementation of protection for the PAs identified in Action 2.3.1. Since it is impractical to characterize all existing and potential threats to SAV, and recognizing the historic benefits of establishing refuge areas for many fish and shellfish species, it is likewise desirable that certain areas of the Chesapeake Bay be established that will exclude uses that are destructive to SAV. Such areas will serve as critical sources of seeds and propagules for the continued health of Chesapeake Bay SAV populations. We anticipate that establishing these PAs would dovetail with similar efforts undertaken to protect other resources (such as oyster sanctuaries) to create a baywide strategy for resource protection.

2.4. Minimize Impacts of Invasive Exotic Species

ACTION 2.4: In accordance with the *Chesapeake 2000* commitments for exotic species, work with the Mid Atlantic Panel on Aquatic Invasive Species (MAPAIS) to develop and implement plans to manage invasive species that have the potential to negatively affect SAV abundance. This is an on-going action.

Exotic species may significantly damage Chesapeake Bay SAV beds. Several such species currently living in the Bay have threatened existing SAV beds and pose major threats to SAV restoration if populations increase (e.g., mute swans, water chestnut, water lotus and water lettuce). We must continue to identify species with such potential and take appropriate actions to minimize their impact on SAV.

3. Strategy to Accelerate SAV Restoration and Understanding of Ecosystem Processes through the Planting and Transplanting of New SAV Beds

Through water quality improvements and the protection of existing SAV beds, CBP partners will create conditions conducive to the natural expansion of existing SAV beds. The following strategies focus on planting and transplanting new beds in order to accelerate SAV recovery in areas that have suitable water quality but suffer either from a lack of propagules or a low population of native SAV species. The objective is not to try to replant entire habitats in the Chesapeake Bay, but rather to establish parent beds that will expand naturally over time to other suitable areas. This action is supported by the STAC report (CRC# STAC 11-03, recommendation 2). Estimates of the funding levels required for the completion of this section are presented in Table 1.

3.1. Strategic Targeting of Restoration Projects

ACTION 3.1.1: Annually perform water quality assessments via fixed-station water quality monitoring, and expand efforts to use spatially and temporally intensive monitoring in shallow areas (i.e. CONMONs and DATAFLOW) to more fully characterize SAV habitat conditions and assess long-term inter-annual changes that have occurred (i.e., are specific locations good, getting worse, or getting better?). Recommend water quality monitoring programs that meet the needs of developing new restoration thresholds (Strategy 1: to protect and restore SAV through protection and restoration of Habitat Quality)

ACTION 3.1.2: By December 2014, improve and implement a Bay-wide GIS-based targeting system that uses monitoring data, depth, historic coverage, biological objectives, potential threats, potential benefits of newly vegetated areas and other factors to target areas most suitable for SAV restoration. Use the results of the STAC review to improve targeting tools, and require that results of plantings feed back into future versions of the targeting system. This action should be updated annually. SAV planting and transplanting projects should be targeted within CBP segments based on water quality suitability, biological objectives and potential threats. In order to identify sites that would most benefit from planting, sufficient habitat quality data is necessary to adequately characterize the SAV habitat conditions.

3.2. Develop Sources of Plant Material For Restoration and Research

ACTION 3.2: By December, 2017 identify, evaluate and recommend techniques and facilities capable of producing adequate quantities of seeds and plants for restoration and research plantings. Develop production techniques for additional species.

ACTION 3.2.1: By December 2013 identify SAV refugia and repositories (reference sites, seed stores, plant storage facilities, tissue bank, etc.) that could supply emergency plant material in the event of a disaster event.

Considerable work has been done since 2003 on developing protocols for producing planting units (both seeds and whole plant). However, with a few exceptions, the capacity to utilize these techniques to produce the quantities of planting units necessary for meaningful restoration does not exist. There are several potential sources, including SAV beds that are established specifically to serve as sources of plant material; laboratories and nurseries capable of propagating SAV for restoration purposes; and wild collection (when it can be achieved without damaging the donor populations, or when it is harvested from areas that would be lost due to construction activities). The genetic diversity of SAV beds should be taken into consideration, both the genetic diversity of donor populations as well as resulting restored populations.

3.3. Perform Large-Scale SAV Planting and Follow-Up Monitoring

ACTION 3.3.1: By December 2014, develop and publish on the web proven SAV restoration protocols that include species selection, production schedules, use of pilot projects, transport and planting methods, acclimation needs of plants (to the restoration site conditions) and follow-up monitoring templates. Revise as the state of the science evolves. References, resources and methodologies will be placed on the Bay Program SAV website as they are compiled.

ACTION 3.3.2: By December 2014, the SAV workgroup will coordinate with the Chesapeake Bay Program's ChesStat staff to construct an on-line database that will allow individuals, groups and agencies to enter the design and results of new SAV restoration projects and to view ongoing and completed projects.

ACTION 3.3.3: Based on experience gained between the 2003 – 2008 planting efforts and the recommendations of the STAC report, the workgroup will strive to plant 20 acres of SAV per year at multiple sites in suitable areas within the tidal waters of the Chesapeake Bay. Conduct appropriate follow-up monitoring and include findings in SAV restoration web databases. Projects will be explicitly designed and targeted to refine restoration methods, test site selection protocols (as called for in the STAC report) and research ideas outlined in Strategy 6 in addition to providing essential ecosystem functions.

- At the end of 3 years after planting, restoration success will be evaluated compared to this metric; at least 20% of the entire planted area will have at least a 10% density cover of the planted SAV species, as estimated either by surface or diver surveys. Monitoring of restored areas should be conducted frequently, so as to provide as much data as possible to refine targeting and production techniques and to examine the impact of possible extreme events in the time between planting and three-year evaluation.

Investments in planting and transplanting projects will focus on species and techniques with a documented history of success based on the past 40 years of SAV restoration (Appendix 3). Projects should use proven planting techniques, performed in areas with suitable conditions. All projects should begin with pilot plantings and then, if successful, should be implemented on a larger scale. These pilot projects should be monitored for at least two growing seasons and should be designed to improve overall knowledge of the factors contributing to restoration success or failure. SAV planting and transplanting projects should be designed and implemented to optimize the overall ecological value of the restored bed.

A successful restoration project should persist over time and have as many of the attributes of natural SAV beds as possible, including sustainability, plant density, species diversity, high quality fish and shellfish habitats, reproduction and dispersal of SAV propagules, water quality improvement capacity and wave attenuation. In all cases, appropriate follow-up monitoring of both the bed's health and associated habitat parameters should be conducted to enable assessment of the reasons for success or failure. The group or agency implementing the project will judge the success of their particular SAV beds. In the regulatory context, where SAV restoration is a mitigation or remediation requirement, the jurisdictional regulatory agency will establish the definition of successful restoration for the specific project, using the above success metric as a guide. Maryland, Virginia and the District of Columbia should maintain coordinated, accessible databases on the web that describe all SAV planting projects and the results of follow-up monitoring. Inclusion of information into this database should be a requirement of any permits necessary for planting. This will allow other members of the SAV community to learn from prior projects.

For species that have not shown reasonable success in pilot restoration projects, investments will be limited to projects designed to determine limiting factors, to test restoration methods or to answer other questions critical to removing barriers to accelerating restoration. Research is needed in support of SAV restoration for other native species (STAC report, recommendation 5) and to better understand parameters other than light that may limit SAV growth. Research needs are addressed in detail in Section 6.

4. Strategy to Improve Coordination of SAV Protection and Restoration Activities

SAV restoration activities are part of a baywide effort that involves many partners. Success will depend on a coordinated approach that will foster communication and the pooling of resources, wherever possible. The existing CBP framework is the most appropriate venue for this task.

4.1. Conduct Regular Meetings to Discuss Restoration Activities

ACTION 4.1.1: The SAV Workgroup will hold conference calls as needed among interested parties to discuss ongoing and planned projects.

ACTION 4.1.2: The SAV Workgroup will hold an annual SAV restoration coordination workshop to review the year's progress, facilitate transfer of improved propagation and planting techniques and coordinate projects for the coming year.

ACTION 4.1.3: Regulatory agencies will hold regular meetings to address SAV protection issues.

4.2. Annually Disseminate Results of Restoration and Research Activities to Management and the Public

ACTION 4.2.1: The SAV Workgroup will distribute an annual report of protection and restoration activities undertaken by workgroup members and others in the watershed. This information will be available electronically on the CBP and partners' websites.

ACTION 4.1.2: The SAV Workgroup will solicit 1-page research summaries from Principal Investigators performing SAV and SAV related research in the watershed . This information will be available electronically on the CBP and partners' websites.

To be successful in restoring Chesapeake Bay SAV communities, communication among all involved parties is essential. The SAV Workgroup should hold frequent conference calls to discuss all aspects of ongoing or planned projects. The group should also hold, at a minimum, an annual planning meeting dedicated to restoration efforts. The main goal would be to share results and plan coordinated SAV protection and restoration efforts for the following year. This would be early enough to plan for the upcoming legislative sessions and to apply for project grants. There should be coordinated enforcement of protected areas and an annual meeting of regulatory agencies to address issues. Finally, the SAV Workgroup will annually distribute results of activities to CBP managers and interested parties.

5. Strategy to Enhance Public Communication and Education

Preservation and restoration of SAV represents a tangible example of the importance of improved water quality in the Chesapeake Bay. As SAV restoration techniques are refined and as the scope of planting increases, these SAV beds can be used as a communication tool to make the public more aware of the link between water quality and SAV. SAV-focused educational programs, field experiences, volunteer opportunities and media attention will provide opportunities for establishing and maintaining public support for water quality improvement initiatives. The involvement of volunteers, adults and students in SAV restoration and protection efforts will increase their awareness of SAV and related water quality issues.

5.1 Increase Public Awareness of Involvement in SAV Protection and Restoration

There are many existing and potential avenues for increasing public awareness and involvement in SAV restoration activities. Public understanding and support of SAV restoration efforts is essential to Bay-wide success.

ACTION 5.1.1: The SAV Workgroup will coordinate with the Chesapeake Bay Program's Foster Chesapeake Stewardship Goal Implementation Team (GIT 5) to consider ways to educate the public about the importance of protection and restoration of SAV and will continue to work with GIT 5 to implement and expand public education and outreach programs.

ACTION 5.1.2: The SAV Workgroup will coordinate with the CBP and state webmasters to update SAV restoration and information pages to include information on the status and location of SAV restoration activities, volunteer opportunities and resource information, as needed. The SAV Workgroup will continue to work with the relevant webmasters to maintain SAV-related web pages with updated information aimed at Bay restoration managers, watershed programs and the general public.

ACTION 5.1.3: Continue to involve students and citizens in SAV restoration activities (i.e., grow-out programs in schools, homes and businesses), ground-truthing for the annual aerial survey and water quality monitoring.

ACTION 5.1.4: Work with the CBP Communications Office to coordinate SAV-related press communications among the Bay Program jurisdictions to ensure that the public is receiving consistent messages regarding SAV. Press releases should especially include annual SAV survey results, planting successes and new technologies.

6. Strategy to Conduct Research to Support SAV Protection and Restoration

During the time of large-scale SAV restoration work in Chesapeake Bay (2003 - 2008), significant investment was made in researching fundamental SAV reproductive biology and new restoration methods. Although restoration methods have substantially improved, additional investments in research must be made to improve the success of restoration activities. Since 2008, there has been virtually no funding into restoration research in Chesapeake Bay. Both the restoration experience and the STAC report have elucidated deficiencies in our understanding of SAV restoration needs and have highlighted the need to revisit SAV habitat requirements.

Also, although some significant annual physical damage caused by fishing and boating activities is known to exist, the full extent of these effects and their causes is unknown. Research should be directed toward the extent of physical damage caused by commercial fishing practices, recreational boating and other anthropogenic activities. Effective protection policies may require further research and monitoring to increase our understanding of biotic, abiotic, local vs. global, and anthropogenic impacts on SAV persistence; determine the effectiveness of existing protection policies; develop innovative tools or techniques to enhance protection of threatened SAV beds; and examine costs and benefits of various protection strategies.

6.1. Develop, implement and disseminate results from a Chesapeake Bay SAV Protection and Restoration Research Agenda

ACTION 6.1.1: By December 2013, develop a research agenda that identifies specific research to advance SAV protection and restoration to achieve the 185,000-acre SAV goal.

ACTION 6.1.2: By December 2014, produce "Submerged Aquatic Vegetation Habitat Requirements and Restoration Targets: Technical Synthesis III" to develop restoration specific habitat requirements, as opposed to SAV persistence requirements (current state of understanding)

a. Identify water temperature thresholds for SAV species in the Bay.
b. Identify interactions between other water quality parameters and water clarity requirements for SAV (i.e. salinity, water temperature, dissolved oxygen).
    - Examine the role of extreme events on SAV abundance and restoration.

ACTION 6.1.3: Develop successful, cost-effective, and efficient SAV restoration methods that optimize population success and ecosystem services. Specific objectives for SAV restoration and protection research should include:

1. *Watershed Impacts on SAV.* Determine the extent to which processes and impacts on adjacent watersheds influence SAV survival and growth. Assess impact of watershed improvements on SAV.

2. *Succession*. Determine whether success rate increases if a primary colonizing SAV species is planted first, followed by a climax species (e.g., *Ruppia* followed by *Zostera*).

3. *Species diversity.* Determine the conditions under which planting multiple species in the same location are likely to increase the chances of population survival.

    - Identify and select species with characteristics that maximize ecological function.

4. *Genetic Diversity.* Determine the condition under which planting multiple genotype and locally adapted genotypes are likely to increase chances of population survival.

    - Artificial selection. Select individual plants with desirable geno/phenotypes to increase the chances of population survival.

5. *Propagule choice.* For species that grow well from two or more types of propagules, such as seeds and whole shoots, determine which propagule choice is the most cost-effective under different conditions, comparing total planting cost to the survival rate.

6. *Propagule transport modeling.* Determine connectivity among source beds that act as source of seed material over varying spatial scales.

7. *Size.* Define the ideal size of restoration plots to maximize success.

    - Further understanding of the role of smaller sub-populations

8. *Density and Pattern.* Determine at what density and spatial arrangement SAV should be planted to maximize growth and survival.

9. *Exclosures.* Determine whether the physical protection of plantings and of sporadic populations resulting from natural recruitment results in significantly improved survivorship and the spread of individuals in a population.

Information is needed on the basic ecology of SAV, the factors influencing its growth and reproduction and the best methods of restoration. Research into these subjects should be carried out with an ultimate objective of applying what is learned to the Chesapeake Bay SAV restoration goals. Extensive research on restoration methods and habitat requirements needs to be undertaken for most of the Chesapeake Bay's native SAV species. Topics other than those outlined in the habitat requirements should be investigated as possible limiting factors to SAV restoration. Researchers must identify and prioritize research needs by species, because each species may have different habitat requirements. Results of these research projects should be shared with the CBP community.

Five-Year Budget Estimate

The actions called for in this strategy,are far reaching and ambitious. With proper funding and support, however, we can achieve these goals. A five-year plan and budget have been developed in anticipation that the research and development of techniques will result in much higher levels of success. Obviously, the cost of SAV protection and restoration would not be eliminated after this five-year period, however it would then be appropriate to revise costs based on what we have learned.

Table 1. $7,883,400 Five Year Budget Estimate for Completion of Strategy to Accelerate Restoration of SAV through the Annual Planting and Transplanting of 20 Acres of New SAV.

ITEM	DESCRIPTION	ACTIONS	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Jurisdictional SAV Coordinator	Most of the actions called for in this strategy (data analysis, coordination among partners, etc.) can be accomplished by technically competent staff within each jurisdiction. Funds are for 1/4 full-time equivalent (FTE) position in each jurisdiction (MD, VA and DC for a total of $75,000/year) and associated travel and software costs ($10,000/year).	2.1, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.4, 3.1.2, 3.3.1, 3.3.2,3.3.2, 4.1.1, 4.1.3, 5.1.1,5.1.3, 5.1.4	$94,550	$94,550	$94,550	$94,550	$94,550	$472,750
Targeting Restoration Sites	Equipment and implementation costs to carry out intensive, shallow water monitoring (DATAFLOW [DF] and continuous monitoring [CM]) of 10 medium-sized tributaries 2X/month during the SAV growing season. Costs also include expenses for 4 YSI EXO sondes to be deployed at 2 locations in each system in Year 1, and salary, travel, supplies and nutrient analysis for field crews per year	3.1.1, 3.1.2	$86,350 (DF) $226,530 (CM) $713,200 for 40 new sondes **$1,026,080**	$86,350 (DF) $226,530 (CM) **$312,880**	$86,350 (DF) $226,530 (CM) **$312,880**	$86,350 (DF) $226,530 (CM) **$312,880**	$86,350 (DF) $226,530 (CM) **$312,880**	$431,750 (DF) $1,132,650 (CM) **$1,564,400 + $713,200 equipment TOTAL =** **$2,277,600**
Developing large-scale SAV propagation capabilities	Develop techniques for large-scale propagation of plants. Production of sufficient material to plant 20 acres/year. Includes 1/2 FTE for each jurisdiction, supplies, etc.	3.2	$267,100	$267,100	$267,100	$267,100	$267,100	$1,335,500
Implementing large-scale plantings	Plant a total of 20 acres/year of SAV in multiple sites baywide. Includes 1/4 FTE for each jurisdiction, supplies, travel for planting/seeding and follow-up annual monitoring	3.3.3	$134,550	$134,550	$134,550	$134,550	$134,550	$672,550

ITEM	DESCRIPTION	ACTIONS	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Funding annual restoration workshop	Workshop for researchers and managers to compare results of the previous year's research/plantings and coordinate the following year's work.	4.1.2	$3,000	$3,000	$3,000	$3,000	$3,000	$15,000
Public education	Implement education and outreach programs to generate public interest and concern for SAV restoration	5.1.1, 5.1.2, 5.1.4	Existing resources $0	$0	$0	$0	$0	$0
Citizen- and school-based restoration	Involve citizens, students, watershed organizations, businesses and other groups in SAV restoration activities.	5.1.3	$100,000	$100,000	$100,000	$100,000	$100,000	$500,000
Research and technology development	Conduct intensive research to develop successful, cost-effective, and efficient SAV restoration methods that optimize population success and ecosystem services	6.1.1, 6.1.3	$500,000	$500,000	$500,000	$500,000	$500,000	$2,500,000
Produce "Technical Synthesis III)	Conduct intensive research into species-specific habitat requirements of SAV, develop restoration water quality and physical habitat requirements	6.1.2	$110,000					$110,000
		Total	**$2,235,280**	**$1,099,200**	**$1,099,200**	**$1,099,200**	**$1,099,200**	**$7,883,400**

Appendix I

A History of Chesapeake Bay Program SAV Initiatives

The decline of SAV communities, coupled with the general deterioration of the Bay's water quality (due to nutrient enrichment, hypoxic and anoxic conditions and toxics) and the health of its other living resources, including oysters and striped bass, focused enormous political attention on the Chesapeake Bay in the 1970s. This led to an initial five-year, $25 million study of Chesapeake Bay, the formation of the Chesapeake Bay Program and the establishment of a governance structure to oversee the massive effort of restoring the Chesapeake Bay. This effort included studies focused on the magnitude of the SAV decline and its causes. The synthesis of this work and the recognition that the Chesapeake Bay was in serious decline (U.S. EPA 1983 a, b) led to the first *Chesapeake Bay Agreement* signed in 1983 by the Chesapeake Executive Council. The council consists of the governors of the surrounding jurisdictions of Maryland, Virginia and Pennsylvania, the mayor of the District of Columbia, the EPA administrator representing the United States federal government and the chair of the Chesapeake Bay Commission. The commission, formed in 1980, consists primarily of legislative members of the three signatory states, a member of a management agency from each state and one citizen from each state. It advises the state legislatures on matters of Bay-wide concern.

The 1983 agreement highlighted the need to develop and implement coordinated plans to improve and protect the water quality and living resources of the Chesapeake Bay estuarine system. An elaborate Chesapeake Bay Program management infrastructure was also formed for implementing the recommendations from the agreement that included elected officials, political appointees, scientists, resource managers and citizens (Hennessey 1994).

A second Chesapeake Bay agreement was signed in 1987 that expanded the 1983 commitments to include living resources, water quality, population growth and development, public information, education and participation, public access, and governance (Chesapeake Executive Council 1987). A firm declaration was made to: 1) reduce and control point and nonpoint sources of pollution to attain water quality conditions necessary to support living resources of the Bay; 2) develop, adopt and begin to implement a strategy to equitably achieve by the year 2000 a 40 percent reduction of nitrogen and phosphorus entering the mainstem Chesapeake Bay; and 3) determine the essential elements of habitat and environmental quality necessary to support living resources and to see that these conditions are attained and maintained. One objective of the living resource goal was to restore, enhance and protect submerged aquatic vegetation. A working group of scientists and managers (referred to as the SAV Work Group in the Chesapeake Bay Program management structure) developed the Chesapeake Bay Submerged Aquatic Vegetation Management Policy, which was approved by the Chesapeake Executive Council in 1989 (Chesapeake Executive Council 1989). The goal of the policy was to achieve a net gain in SAV distribution, abundance and species diversity by: 1) protecting existing SAV beds from further losses either from increased degradation of water quality or physical damage to the plants; 2) setting and achieving water and habitat quality objectives that would result in natural restoration of SAV; and 3) setting regional SAV restoration goals in terms of acreage, abundance and species diversity that considered the historical distribution records and potential habitat. An Implementation Plan was approved by the Executive Council in 1990 (Chesapeake Executive Council 1990) that provided a means for developing programs and procedures to ensure that the goals and objectives of the SAV Policy were reached. These included detailed plans for assessment, protection, restoration, education and research.

In 1992, a comprehensive report was published (*Chesapeake Bay Submerged Aquatic Vegetation Habitat and Restoration Targets: A Technical Synthesis*, Batiuk et al. 1992) which summarized the research that had been conducted to meet the commitments in the Implementation Plan. (This was subsequently revised to reflect the increased understanding of plant habitat requirements, specifically that of the light environment [Batiuk et al. 2000].) The major goal of the first SAV technical synthesis was to determine the quantitative levels of relevant water quality parameters necessary to support continued survival, propagation and restoration of SAV (Dennison et al. 1993). Secondary goals were to establish regional distribution, abundance and species diversity targets for the Chesapeake Bay and its tributaries, and to determine the baywide applicability of habitat requirements developed through the case studies in the synthesis. A conceptual model developed in the early stages of the technical synthesis of the interactions and interdependence of the SAV habitat requirements illustrated the water quality parameters that influence SAV distribution and abundance. The primary measures of environmental factors contributing to light availability (identified as the major factor controlling SAV distribution, growth and survival) used to formulate SAV habitat requirements were the following: light attenuation coefficient (K_d), chlorophyll *a*, total suspended solids (TSS), dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP). The appropriate levels of these measures were defined through empirical relationships between these water quality characteristics and SAV distribution, as well as through numerous experimental studies.

The differing species makeup in the various salinity regimes of the Chesapeake Bay led to the establishment of somewhat different habitat requirements based on salinity regime. Seasonal water quality conditions that were found to be associated with the growth, survival and reproduction of SAV to targeted water depths of one meter (MLLW) were used as SAV habitat requirements (Table 1) (Batiuk et al. 1992; Dennison *et al.* 1993). The results of the first technical synthesis were incorporated into the 1992 amendments to the 1987 Chesapeake Bay Agreement, which highlighted the link between water quality conditions and the survival and health of critically important SAV (Chesapeake Executive Council 1992). In addition, it was agreed to use the distribution of SAV in the Bay and its tidal tributaries as documented by baywide and other aerial surveys conducted since 1970, as an initial measure of progress in the restoration of living resources and water quality. Thus, after 1992, SAV was used as an integral barometer of Chesapeake Bay health.

SAV distribution and abundance restoration goals, approached from a baywide and regional perspective, were quantified through a series of geographical overlays delineating actual and potential SAV habitat (Batiuk et al. 1992, 2000). A tiered set of SAV distribution restoration targets consisted of areas previously vegetated between 1971 and 1990 as documented through aerial monitoring programs (Tier I), potential SAV habitat to 1-meter depths at MLLW (Tier II) and 2-meter depths (Tier III) were established (Table 2). These provide management agencies with increasing levels of SAV distribution that might be expected in response to the implementation of Chesapeake Bay water quality restoration strategies (e.g., reducing nutrients by 40 percent). These targets were identified for both the entire Chesapeake Bay and specific segments within the Bay and tributaries. The annual distribution of SAV is then compared to these targets, and progress can be quantitatively assessed. The Tier I target was officially adopted by the Chesapeake Executive Council in 1993 (Directive 93-3, Chesapeake Executive Council 1993) as a specific goal in the Bay clean-up process, along with efforts to restore SAV to their historical levels and to begin to develop a target for restoration of SAV to all shallow water areas delineated as existing or potential SAV habitat to the 1-meter contour. Realizing that there may be limitations to where SAV can physically occur (either due to substrate or energetic conditions), researchers in Maryland and Virginia examined soil conservation aerial photography from the 1930s, 1950s and 1960s and delineated where SAV was present in these photographs. Then, by Bay Program segment, the maximum areal occurrence of SAV by year ("single best year" concept) became the new goal for each segment. Totaling up these segment goals yield a Bay-wide goal of 185,000 acres, which was formally accept as the SAV restoration goal by the Chesapeake Bay Program Executive Council (CBP Executive Council 2003)

Building from advances in monitoring, research data and ecosystem processes modeling, and driven by management needs for the next generation of requirements, a group of scientists and managers were assembled in 1997 to produce a second technical synthesis (Batiuk et al. 2000). Simplified minimum light requirements for SAV survival and growth in different salinity regimes were determined (Table 1). Models were developed using water quality conditions, including dissolved inorganic nutrient levels, K_d, and suspended sediment concentrations, to estimate incident light reaching the SAV leaf surfaces through both the water column and also through projected periphyton growth on the leaves. Managers can apply this model to predict the potential for SAV growth at any depth using the predicted light levels. Also, by applying a simple diagnostic tool they can evaluate what reductions in total suspended solids or chlorophyll *a* (phytoplankton) would be needed to reduce water-column light attenuation to levels that allow SAV growth. Quantitative requirements for physical, geological and chemical factors affecting SAV habitat suitability were also established. An expanded set of tiered restoration goals was documented along with a more in-depth assessment of the applicability of midchannel monitoring for evaluating water quality in adjacent shallow-water habitats. Maryland, Virginia, Delaware and the District of Columbia adopted minimum SAV light requirements as the basis for specific water clarity standards for their portion of the tidal waters in 2003. Attainment of these goals is a critical first step toward meeting the revised SAV acreage restoration goals.

In addition to the efforts to promote the recovery of SAV, its importance as an essential habitat for the blue crab, *Callinectes sapidus*, was delineated in the *1997 Blue Crab Fisheries Management Plan* (FMP), which the Executive Council signed in 1997. As the first FMP that recognized the links among water quality, seagrass habitat and fishery yields, the plan recommended SAV restoration baywide, but particularly in areas that are the primary settlement sites for blue crab post-larval recruitment into the Chesapeake Bay.

The new water clarity goals set restoration depths for each of the 70 CBP segments, at which the minimum light requirements set in Batiuk *et al.* (2000) need to be met. The restoration depths were chosen based on the greatest documented depth at which SAV grew in that segment in recent and historical maps of SAV distribution, so their attainment should allow SAV to grow back to its historical depths. Guidelines for assessing attainment of the goals were based on the water clarity that was found in reference segments within each of the four salinity regimes. These reference segments were chosen to represent the best current conditions of SAV growth in each salinity regime.

Appendix II

Review of Existing SAV Protection Provisions

While many Chesapeake Bay Program policies underscore the need to protect and restore SAV, their implementation often requires the adoption of specific rules and regulations by federal and state agencies that have regulatory authority over the regions' natural resources (Chesapeake Bay Program 1995). These guidelines range from broad, over-arching federal guidelines such as the Clean Water Act, to individual state regulations controlling or limiting fishing activities in SAV beds.

Federal Agency Guidelines

SAV is afforded increased protection under Section 404 of the Clean Water Act (33 U. S. C. 1341-1987), which regulates the discharge of dredged or fill material into U.S. waters. The US EPA and Army Corps of Engineers (USACE) have the authority for administering the Clean Water Act. Section 10 of the Rivers and Harbors Act (33 U.S. C. 403), administered by the U.S. Army Corps of Engineers, regulates all activities in navigable waters, including dredging and placement of structures. SAV protection under these acts is provided by a federal permit. Potential impacts on Special Aquatic Sites, such as SAV, are considered in the permit review process.

Individual permit applications under the Clean Water Act and Rivers and Harbors Act are routinely reviewed by the USACE, the US EPA, the U. S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS). Comments from the agencies are provided to the USACE to recommend approval (often with recommended conditions or project modifications) or denial of individual permits. Consultations among agencies on environmental impacts of federal and other projects also are required through the provisions of the Fish and Wildlife Coordination Act (16 U. S. C. 661-667e) and the National Environmental Policy Act (42 U. S. C. 4231-4370a). Many permit applications are reviewed as national and regional permits, some of which do not require coordination with NOAA, MFFS, FWS and EPA, because the permits were coordinated with the federal agencies at the time they were developed.

In the permit review and approval processes, special consideration is made for the protection and preservation of SAV. Other than the permit process outlined above, the federal agencies have no written policies specific to SAV protection. Guidelines that the regulatory agency (USACE) and the commenting agencies (US EPA, USFWS and NMFS) use to make their decisions and recommendations are summarized in Table 3 (based on Chesapeake Bay Program 1995). These guidelines in most cases are specific to physical alterations accompanying dredging and direct impacts. They do not cover direct physical impacts from fisheries or boating activities, which, while regulated by state laws, may also be evaluated as indirect impacts through the federal and state regulatory permit process.

In general, all four federal agencies involved in permit review use similar guidelines (Table 3). All consider it desirable to avoid dredging in or near existing SAV beds, in areas that historically supported SAV and in potential shallow habitat, especially where there is no documented boat access. Unfortunately, the majority of requests for new and maintenance dredging are proposed within these areas. This has made it increasingly difficult to allow dredging and still protect SAV and its habitat. The line of priority for protection is first to protect SAV beds, then historic SAV beds and finally potential SAV habitat. All agencies generally recommend avoiding dredging during the SAV growing season, but specific dates vary. Most of the agencies recommend a minimum of a 1-meter horizontal buffer around existing SAV for each vertical 0.3 meter of material removed. Most agencies also recommend against depositing dredged material on SAV and often suggest project modifications or alternatives when marine-related developments are proposed near SAV beds. The agencies sometimes differ over whether to recommend dredging through SAV beds and shallow areas. The definition of maintenance dredging used by the Chesapeake Bay Program (1995) is dredging to maintain existing navigation channels with documented historic boat use. In some circumstances, this may include areas not previously dredged.

SAV beds are considered one of several Essential Fish Habitats (EFH, Fluharty 2000) identified by the NMFS, i.e., habitats necessary to fish for spawning, breeding, feeding or growth to maturity. The Atlantic States Marine Fisheries Commission (ASMFC), a council of 15 Atlantic States with responsibility to conserve and enhance interjurisdictional fisheries of the Atlantic coast of the United States, adopted an SAV Policy in 1997 (ASMFC 1997). The policy recognized the importance of SAV as habitat for ASMFC managed species, and encourages the implementation of its policy by state, federal, local and cooperative programs which influence and regulate fish habitat and areas impacting fish habitat.

Virginia and Maryland Agency Guidelines

The state of Maryland and the commonwealth of Virginia, which are the only two regions that contain tidal waters of Chesapeake Bay and its tributaries, each have separate regulatory agencies to oversee activities that could be injurious to SAV populations (Table 3). Both Maryland and Virginia are committed to protecting SAV habitat, while maintaining viable commercial fisheries and aquaculture operations.

Maryland State Code COMAR 4-213 specifically prohibits damage to SAV for any reason except for commercial fishing activities and certain specific situations such as clearing SAV from docks, piers and navigable waters. If SAV could be adversely affected, a permit is required, which includes a plan showing the proposed activity site, a dated map of current SAV and the extent of SAV to be removed. The Maryland Department of the Environment (MDE) and Natural Resources (MD DNR) are responsible for issuance of the permit. Maryland does prohibit one type of commercial fishing activity hydraulic clam dredging in specific regions of its state waters. Hydraulic clam dredging is prohibited both within a specified distance from shore, which varies by political boundaries (NRA 4-1038), as well as in existing SAV beds (NR4-1006.1) as determined by annual aerial mapping surveys. In 2002 the Maryland legislature passed legislation (Senate Bill 195) creating SAV protection zones from hydraulic clam dredging based on a composite distribution of grass beds from three successive years of SAV monitoring, specifically from the annual survey, rather than a single-year specified in previous legislation.

In Virginia, permits to use state-owned submerged lands now include SAV presence as a factor to be considered in the application process (Code 28.2-1205 [A] [6], amended in 1996). Shellfish aquaculture activities requiring structures are now prohibited from being placed on existing SAV (4 VAC 20 335-10, effective January 1998). In 1999, the Virginia Marine Resources Commission (VMRC) was directed (Code 28.2-1204.1) to develop guidelines with criteria to define existing beds of SAV and to delineate potential restoration areas. Dredging for clams (hard and soft) in Virginia is prohibited in waters less than 1.2 meters. A special regulation was passed for SAV in the Virginia portion of Chincoteague Bay (4-VAC 20-1010), a coastal bay of Virginia and Maryland, where clam and crab dredging is prohibited within 200 meters of SAV beds. However, as a result of the violations, following a series of meetings among managers, scientists and watermen, a new regulation (4 VAC 20-70-10 seq.) was approved in October, 2001, which authorized the placement of distinct marker posts that, along with existing aids to navigation, outlined a revised SAV protection zone for Virginia coastal bays, using straight lines instead of buffers.

1995 Guidance document is available online through the CBP web site at:
http://www.chesapeakebay.net/pubs/SAVguidance.pdf

Appendix III

Current Status of Planting and Transplanting Capabilities

***Zostera marina* (Eelgrass).** This species has been planted at numerous sites in the lower Bay since 1978. Its salinity tolerance (approximately 10 ppt to full strength seawater) limits it to the lower Chesapeake Bay and tributaries. Various transplant techniques have been used with adult plants from sods, cores, bundled anchored shoots, to single and double anchored and unanchored shoots, all achieving some measure of short to long term success. Fertilizer additions were shown to have short-term positive benefits to plant growth. Most efforts have been conducted with manual labor although recently, mechanized planting has been attempted. Seeds have also been used successfully at some sites in the last few years with seeds being simply broadcast into unvegetated sites. There have been relatively few sites in Chesapeake Bay that have shown long term success (greater than 5 years). One of the longest successful sites established in 1984 (mouth of the East River in the Mobjack Bay) has persisted in concert with adjacent beds that expanded simultaneously. Several sites that had initially shown long term success (>10 years) have since died back (York River, Piankatank River). Currently, several sites planted in 1996-1998 (James River and Little Creek) have persisted through 2 recent warm water episodes (2005 and 2010) that have greatly reduced the overall abundance of eelgrass in Chesapeake Bay. One of the more significant restoration efforts is occurring in nearby VA coastal bays where, over 41 million seeds broadcast into 350 acres since 1998 which has now expanded into 4,372 acres from natural spreading by seeds produced from the seeded plots. There have been no successful attempts for micro-propagation. Eelgrass has been grown successfully in the laboratory but most projects have been short term (less than 1 year).

***Ruppia maritima* (Widgeon grass).** There has been no long-term success using these plants. A well-established lab propagation method exists and is currently being used in the Chesapeake Bay. Salinity range (about 5-50 ppt) could allow it to fill the gap between wild celery and eelgrass, if success could be increased. However, as a pioneer species, widgeon grass is often the first to disappear when conditions worsen, so it should be planted with other, more persistent SAV species.

***Stuckenia pectinata* (Sago pondweed).** There has been no long-term success using these plants. A well-established lab propagation method exists and is currently being used in the Chesapeake Bay. Its salinity range (about 5-15 ppt) could allow it to fill the gap between wild celery and eelgrass, if success could be increased.

***Potamogeton perfolaitus* (Redhead grass).** We have seen short-term success (two years) with this species, but no long-term success using tubers or plants. A well-established lab propagation method exists and plant cuttings have been successfully propagated in pots.

***Vallisneria americana* (Wild celery).** This is the most successful SAV species in the planting effort, using tubers and adult plants grown from seed. Techniques for raising plants from seeds are well-developed and are commonly used in schools and citizen volunteer programs. Range is limited to lower salinity areas, however (studies show it survives up to 12-15 ppt but grows best at 5 ppt and below).

***Heteranthra dubia* (Water stargrass).** This species is easy to grow and propagate, but has shown little documented success. It is not widely distributed in the Chesapeake Bay.

Summary of Propagation Methods and Planting Success for Selected Chesapeake Bay SAV Species.

Species	**Growth from Seed**	**Seed Collection**	**Possible Micro-propagation**	**Planting Success**
***Zostera marina*, Eelgrass**	Moderate	Moderate	No	From seed and adult plants- 5-20 year survival from adult plants, 10 years from seed
***Ruppia maritima*, Widgeon grass**	None	Difficult	Yes	None
***Stuckenia pectinata*, Sago pondweed**	unknown	Difficult	Yes	Low success rate
***Potamogeton perfolaitus*, Redhead grass**	Difficult	Difficult	Yes	Low success rate; 2 years from adult plants grown in lab
***Vallisneria americana*, Wild celery**	Easy	Easy	No	14 years from adult plants grown from seed
***Heteranthra dubia*, Water stargrass**	unknown	Difficult	Yes	none attempted