Chesapeake Bay Program
A Watershed Partnership

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

EXECUTIVE SUMMARY

This document presents a 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 30 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 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. Its adoption fulfills 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.*

The new Baywide SAV goal is to achieve 185,000 acres by 2010. By adopting this goal and strategy, the Chesapeake Bay Program partners commit to four major initiatives that must be successfully implemented to reach the new goal and sustain healthy levels of SAV in the Chesapeake Bay.

SAV Protection and Restoration Initiatives

1. *Meet jurisdictional water clarity criteria in areas designated for SAV use.* The impacts of excessive nutrients and sediments must be reduced significantly in order for the water clarity criteria and interim SAV restoration goals to be fulfilled. Sources of degradation to water clarity from upland sources, tidal shorelines, tidal resuspension and estuarine processes must all be successfully addressed. In order to meet current and future SAV restoration goals, it is essential to fulfill the 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 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. At a minimum, meeting these criteria in the Bay's shallow water SAV designated use areas will provide the water clarity conditions necessary to support 185,000 acres of SAV by 2010.
2. *Provide existing SAV beds greater protection from anthropogenic activities and invasive species.* To increase protection for existing SAV beds and to manage use conflicts as SAV populations increase, the CBP partners will:
   - Characterize direct and indirect threats to SAV including shoreline erosion and tidal resuspension, and develop and implement new best management practices and protection measures, as necessary.
   - Establish criteria for SAV protection areas. Sites may be formally designated by federal and state governments for the sole purpose of increasing protection and restoration of SAV or as components of more comprehensive conservation and restoration efforts.
   - Minimize the impact of invasive species.
   - Increase understanding of the potential effects of sea-level rise on SAV populations.
3. *Accelerate SAV restoration by planting 1,000 acres of new SAV beds by December 2008.* 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. Large-scale planting projects will require the development of significant sources of plant material and sufficient financial resources for monitoring the success of these projects. Improving the coordination of Baywide SAV restoration and protection activities will be necessary if we are to meet this goal.

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 Estimates

The estimated cost of fulfilling jurisdictional water clarity criteria has been estimated by the Chesapeake Bay Commission. In order to implement initiatives two, three and four to accelerate the protection and restoration of SAV's in the Chesapeake Bay and its tributaries, an estimated $32.26 million must be secured over five years (not including completion of the water clarity criteria). This will require the development of an extensive public and private partnership similar to that of the oyster restoration effort.

The following strategy describes the rationale for and actions associated with each of these initiatives and includes an estimated budget at several levels of funding.

Introduction

More than 30 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 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 dissolved oxygen problems. 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.

For the past 30 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). These management efforts depend upon our recognizing both the habitat value of SAV to many fish and shellfish 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 have been 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.

This strategy has four essential elements which are mutually complementary and will be pursued simultaneously: (1) for areas where SAV should grow, the CBP partners will complete the establishment of water quality criteria and water quality standards, and thereafter implement them to achieve the water quality necessary to provide for SAV recovery in areas designated for that use; (2) for

areas where SAV grows, protect existing SAV beds from destructive anthropogenic activities and invasive species; (3) for areas where water quality is suitable but where SAV does not yet grow, accelerate SAV restoration by planting 1,000 acres of new SAV beds by December 2008; and (4) strengthen the scientific and public support for SAV protection and restoration through enhanced SAV research, citizen involvement and education.

While the critical nature of the relationship between SAV water quality requirements and the new water quality criteria and standards and their implementation is described in general terms within this strategy, the details of the water quality initiative and the funding level required to implement those standards are not detailed. This document, instead, focuses more on the other three essential elements of the strategy, which will proceed simultaneously with the development, adoption, and implementation of water quality criteria and standards. Likewise, the budget presented with this strategy addresses only the estimated costs of the latter three essential strategic elements listed above.

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

ACTION 1.1—*Establish and achieve the jurisdictional water clarity criteria. This is the most significant action necessary to protect and restore SAV in the Chesapeake Bay.*

The *Chesapeake 2000* Agreement committed the signatories to, "by 2001, define the water quality conditions necessary to protect aquatic living resources." These conditions are being defined through the development of Chesapeake Bay-specific water quality criteria for dissolved oxygen, water clarity and chlorophyll *a*. 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

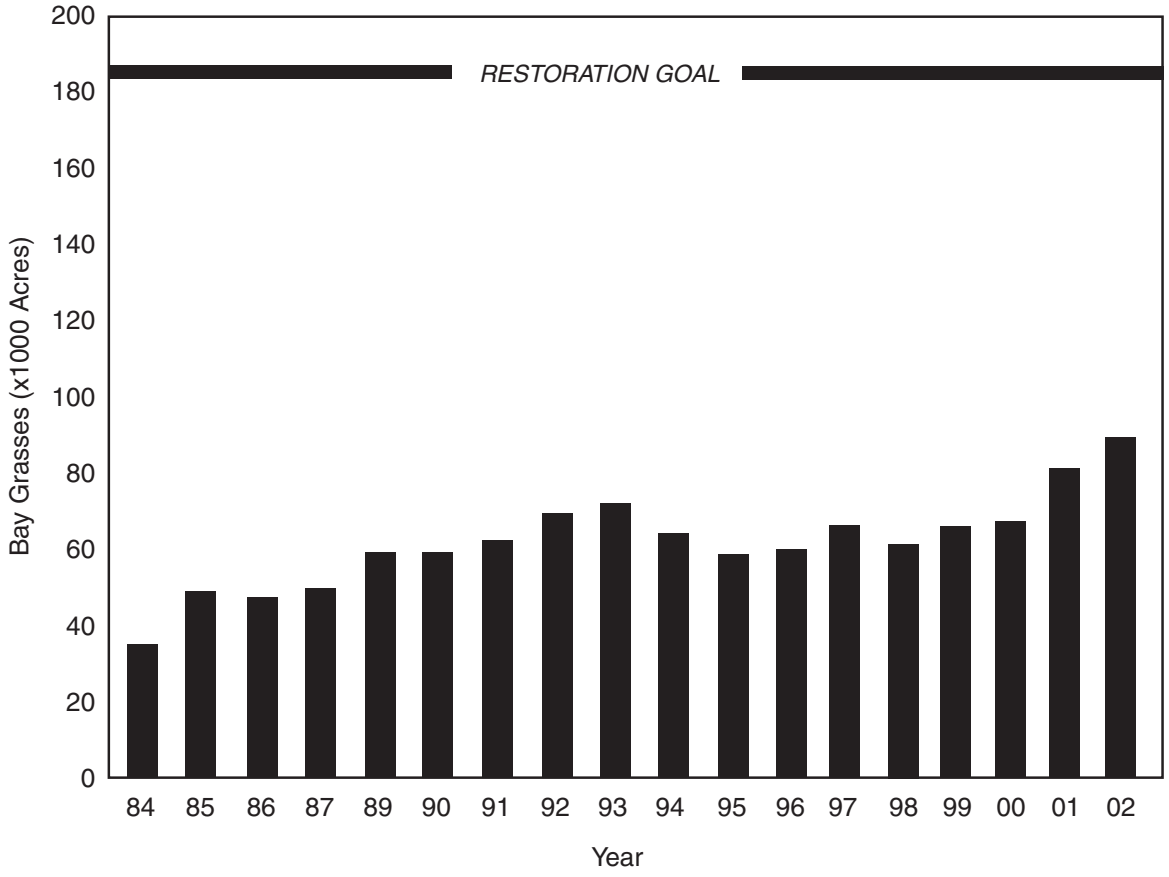

Figure 1. Total acres of SAV in Chesapeake Bay 1984–2002 as measured by the Virginia Institute of Marine Science's annual aerial surveys.

for water quality measures that directly influence Bay aquatic living resources, including fish, crabs and SAV. Loading caps will be established to help address the causes of reduced water quality conditions, including excessive nitrogen, phosphorus and sediment. Bay models enable the partners effectively to translate the desired dissolved oxygen, water clarity and chlorophyll *a* conditions back 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 water quality criteria propose that such criteria should apply 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) would be 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 was published by the EPA in April 2003. These criteria will be applied to a tidal water designated use (i.e., shallow water SAV habitat). The shallow water SAV habitat designated use, along with the jurisdictional water clarity criteria, will be adopted by Maryland, Virginia, Delaware and the District of Columbia into their state water quality standards. In turn, these standards will be 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 shallow water SAV habitat designated use is applied by the jurisdictions.

Once the Bay water clarity criteria and the refined shallow water SAV habitat designated use are adopted in state water quality standards, these tailored sets of standards will apply to similar habitats across all jurisdictions. Each of the state jurisdictions and the District of Columbia will be responsible for protecting and restoring SAV habitat in those areas through the development and implementation of tributary strategies to manage of nutrient and sediment loadings that affect water clarity within the designated use areas.

2. Track Progress Toward the 185,000 Acre Goal

On April 15th, 2003, the Chesapeake Bay Program's Principals' Staff Committee approved the new bay grass restoration goal of 185,000 acres by 2010. The partner states of the Bay Program have adopted the new goal, consistent with the *Chesapeake 2000* agreement. Progress toward the new 185,000-acre SAV 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 by means of aerial photography and groundtruthing. Aerial photographs are digitized for analysis and combined with groundtruthing data in a central SAV distribution database, which is available through the CBP website. The SAV distribution database to date includes data from aerial photographs taken in the following years: 1938, 1952, 1964, 1978, 1986–1991, and 1996–2001.

The new bay-wide SAV goal, 185,000 acres, 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 baywide 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.

3. Strategy to Accelerate Protection of Existing SAV Beds

For purposes of this section, "protection of existing SAV beds" includes avoiding or minimizing the direct physical disruption of SAV through anthropogenic activities (e.g., dredging, propeller scarring or aquaculture facilities) and invasive species (such as the mute swan and water chestnut), as well as the indirect effects of localized water quality degradation generated by these activities (e.g., sedimentation resulting from clam dredging). 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 continued increases.

3.1. Characterize threats to SAV

ACTION 3.1.1—*By Dec. 2003, characterize direct and localized indirect threats to existing SAV beds on a Bay Program segment-specific basis.*

ACTION 3.1.2—*Annually, perform aerial monitoring of SAV beds to detect damage to existing SAV beds and to monitor the status of previously impacted areas.*

Although many impacts to SAV are acknowledged, such as shoreline erosion and sediment resuspension, and although some have been studied directly, the full extent of these effects is unknown. Annual SAV losses are due to direct and localized indirect impacts such as dredging and shoreline alterations, destructive commercial and recreational boating and fishing practices, aquaculture and the influx of exotic species of birds, fish and plants. The annual aerial survey will continue to be the primary tool to detect the effects of damaging activities.

3.2. Manage the regulatory program effectively

ACTION 3.2.1—*By December 2004, Maryland, Virginia, the District of Columbia, and the Army Corps of Engineers will contribute data annually to a centralized database on SAV loss and damage, the amount and type of mitigation being planned or performed and mitigation success rates and the long-term effects of these projects upon SAV.*

ACTION 3.2.2—*By December 2004, Maryland, Virginia, the District of Columbia and federal agencies will develop tributary-specific guidelines for protecting SAV from threats characterized in Action 3.1, 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.*

The CBP Living Resource Subcommittee 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 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.

3.3. Establish SAV protected areas (PAs)

ACTION 3.3.1—*By December 2004, the SAV Task Group will propose to the jurisdictions 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.*

ACTION 3.3.2*—By December 2005, the jurisdictions will initiate a public review process to consider protection for the PAs identified in Action 3.3.1.*

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.

3.4. Minimize impacts of invasive exotic species

ACTION 3.4: *In accordance with the Chesapeake 2000 commitments for exotic species, work with the Invasive Species Workgroup to develop and implement plans to manage invasive species that have the potential to affect SAV abundance.*

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 and hydrilla). We must identify species with such potential and take appropriate actions to minimize their impact on SAV.

3.5. Anticipate effects of climate change and sea level rise on SAV protection strategies

ACTION 3.5*—The CBP SAV Task Group will continue to evaluate the best available information concerning anticipated effects of climate change on SAV in the Bay and will forward their recommendations to the CBP community.*

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 increased water turbidity 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. 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.

4. Strategy to Accelerate Restoration through the Planting and Transplanting of New 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. Estimates of the funding levels required for the completion of this section is presented in Tables 1, 2 and 3.

4.1. Strategic targeting of restoration projects

ACTION 4.1.1*—Continue water quality assessment via fixed-station water quality monitoring, and expand efforts to use spatially intensive monitoring in shallow areas to more fully characterize SAV habitat conditions.*

ACTION 4.1.2*—By December 2003, develop and implement a baywide 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 large-scale restoration. 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.

4.2. Develop sources of plant material

ACTION 4.2*—By December 2003, identify, evaluate and recommend techniques and facilities capable of producing adequate quantities of seeds and plants for planting.*

One of the current obstacles to SAV restoration is the lack of plants, propagules and seeds. 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 to be taken into consideration.

4.3. Perform large-scale planting and follow-up monitoring

ACTION 4.3.1*—By 2004, develop and publish on the web proven 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.*

ACTION 4.3.2*—By December 2003, Maryland, Virginia and the District of Columbia will offer coordinated on-line databases that will allow individuals, groups and agencies to enter the design and results of new projects and to view ongoing and completed projects.*

ACTION 4.3.3*—By December 2008, to have planted at least 1,000 acres of SAV at multiple sites in suitable areas within the tidal waters of the Chesapeake Bay. Conduct appropriate follow-up monitoring and inclusion in SAV restoration web databases.*

Investments in planting and transplanting projects will focus on species and techniques with a documented history of success based on the past 20 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. 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, and to better understand parameters other than light that may limit SAV growth. Research needs are addressed in detail in Section 7.

5. Strategy to Improve Coordination of 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.

5.1. Conduct regular meetings to discuss restoration activities

ACTION 5.1.1*—The SAV Task Group will hold frequent (bimonthly) conference calls among interested parties to discuss ongoing and planned projects.*

ACTION 5.1.2—*The SAV Task Group 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 5.1.3*—Regulatory agencies will hold regular meetings to address SAV protection issues.*

To be successful in restoring Chesapeake Bay SAV communities, communication among all involved parties is essential. The SAV Task Group 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 in late fall or early winter, after eelgrass planting has been done. 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. Finally, there should be coordinated enforcement of protected areas and an annual meeting of regulatory agencies to address issues.

6. 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 experi-

ences, 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.

6.1 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 large-scale success.

ACTION 6.1.1*—By December 2003, the SAV Task Group will coordinate with the Communication and Education Subcommittee (CESC) to consider ways to educate the public about the importance of protection and restoration of SAV and will continue to work with the CESC to implement and expand public education and outreach programs.*

ACTION 6.1.2*—By December 2003, the SAV Task Group 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 Task Group will continue to work with the relevant webmasters to maintain SAV-related web pages with updated information aimed at Bay restoration managers, tributary teams and the general public.*

ACTION 6.1.3*—Continue to involve students and citizens in SAV restoration activities (i.e., grow-out programs in schools, homes and businesses), groundtruthing for the annual aerial survey and water quality monitoring.*

ACTION 6.1.4*—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.*

7. Strategy to Conduct Research to Support Protection and Restoration

Although much SAV restoration work is under way, little research in SAV restoration takes place due to a lack of discretionary funding. Fundamental primary research directed at determining SAV protection and restoration needs has been practically nonexistent in the Chesapeake Bay over the past 10 years. Although restoration methods have substantially improved, significant investments in research must be made to improve the body of knowledge surrounding restoration techniques. Recent updates to the SAV Technical Synthesis relied primarily upon old data, because little new research was available. While sufficient light and water quality data are available to establish target zones for SAV restoration, other possible parameters limiting SAV must be investigated.

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, 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.

7.1. Develop, implement and disseminate results from a Chesapeake Bay SAV protection and restoration research agenda

ACTION 7.1.1*—By June 2003, develop a research agenda that identifies specific research to advance SAV protection and restoration to achieve the 185,000-acre SAV goal.*

ACTION 7.1.2*—Develop successful and cost-effective, efficient restoration methods. Specific objectives for restoration and protection research should include:*

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

- *Size. Define the ideal size of restoration plots to maximize success.*
- *Density. Determine at what density SAV should be planted to maximize success and restoration of ecological functions.*
- *Pattern. Determine whether the spatial arrangement of the plants matters, and whether checkered patterns or homogeneous plantings are more successful.*
- *Exclosures. Determine whether the 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 Estimates

The actions called for in this strategy—particularly the 1,000 acre planting goal—are admittedly bold and exceed current technology and resources. 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 progress simultaneously with the actual large-scale planting. 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, what capabilities have been developed (e.g., private SAV propagation for planting) and how much further we must go to reach our goals

TABLE 1. $32,261,000 five year budget estimate for completion of strategy to accelerate restoration of SAV through the planting and transplanting of new beds.

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 one full-time equivalent position in MD, VA and DC and associated travel and software costs.	3.1, 3.2.1, 3.2.2, 3.3.1, 3.3.2, 3.4, 3.5, 4.1.2, 4.3.1, 4.3.2, 5.1.1, 5.1.3, 6.1.1, 6.1.3, 6.1.4, 7.1.1	$210,000	$210,000	$210,000	$210,000	$210,000	$1,050,000
Targeting Restoration Sites	Equipment and implementation costs to carry out intensive, shallow water monitoring of 10 medium-sized tributaries 2X/month during the SAV growing season. Costs also include expenses for 2 continuous monitors of each system.	3.1.2, 4.1.1, 4.1.2	$746,420	$746,420	$746,420	$746,420	$746,420	$3,732,100
Developing large-scale SAV propagation capabilities	Develop techniques for large-scale propagation of plants. Production of sufficient material to plant 1,000 acres.	4.2	$2,380,916	$2,380,916	$2,380,916			$7,142,750
Implementing large-scale plantings	Plant a total of 1,000 acres of SAV in multiple sites baywide.	4.3.3			$5,238,017	$5,238,017	$5,238,017	$15,714,050
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.	5.1.2	$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	6.1.1	$285,710	$285,710	$285,710	$285,710	$285,710	$1,428,550
Citizen- and school-based restoration	Involve citizens, students, watershed organizations, businesses and other groups in SAV restoration activities.	6.1.3	$100,000	$100,000	$100,000	$100,000	$100,000	$500,000
Research and technology development	Conduct intensive research into species-specific habitat requirements of SAV in Chesapeake Bay and develop planting protocols.	7.1.1, 7.1.2	$535,710	$535,710	$535,710	$535,710	$535,710	$2,678,550
		Total	**$4,261,756**	**$4,261,756**	**$9,499,773**	**$7,118,857**	**$7,118,857**	**$32,261,000**

TABLE 2. $18,231,875 five year budget estimate for completion of strategy to accelerate restoration of SAV through the planting and transplanting of new beds.

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 one full-time equivalent position in MD, VA and DC and associated travel and software costs.	3.1, 3.2.1, 3.2.2, 3.3.1, 3.3.2, 3.4, 3.5, 4.1.2, 4.3.1, 4.3.2, 5.1.1, 5.1.3, 6.1.1, 6.1.3, 6.1.4, 7.1.1	$100,000	$100,000	$100,000	$100,000	$100,000	$500,000
Targeting Restoration Sites	Equipment and implementation costs to carry out intensive, shallow water monitoring of 6 medium-sized tributaries 2X/month during the SAV growing season. Costs also include expenses for 2 continuous monitors of each system.	3.1.2, 4.1.1, 4.1.2	$450,000	$450,000	$450,000	$450,000	$450,000	$2,375,000
Developing large-scale SAV propagation capabilities	Develop techniques for large-scale propagation of plants. Production of sufficient material to plant 500 acres.	4.2	$1,380,916	$1,380,916	$1,380,916			$4,142,748
Implementing large-scale plantings	Plant a total of 500 acres SAV in multiple sites baywide.	4.3.3			$2,619,009	$2,619,009	$2,619,009	$7,857,027
Public education	Implement education and outreach programs to generate public interest and concern for SAV restoration	6.1.1	$85,710	$85,710	$85,710	$85,710	$85,710	$428,550
Citizen- and school-based restoration	Involve citizens, students, watershed organizations, businesses and other groups in SAV restoration activities.	6.1.3	$50,000	$50,000	$50,000	$50,000	$50,000	$250,000
Research and technology development	Conduct intensive research into species-specific habitat requirements of SAV in Chesapeake Bay and develop planting protocols.	7.1.1, 7.1.2	$535,710	$535,710	$535,710	$535,710	$535,710	$2,678,550
		Total	**$2,627,336**	**$2,627,336**	**$5,246,345**	**$3,865,429**	**$3,865,429**	**$18,231,875**

TABLE 3. $8,624,889 five year budget estimate for completion of strategy to accelerate restoration of SAV through the planting and transplanting of new beds.

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 one full-time equivalent position in MD, VA and DC and associated travel and software costs. (Cut from original budget)	3.1, 3.2.1, 3.2.2, 3.3.1, 3.3.2, 3.4, 3.5, 4.1.2, 4.3.1, 4.3.2, 5.1.1, 5.1.3, 6.1.1, 6.1.3, 6.1.4, 7.1.1						
Targeting Restoration Sites	Equipment and implementation costs to carry out intensive, shallow water monitoring of 3 medium-sized tributaries 2X/month during the SAV growing season. Costs also include expenses for 1 continuous monitor of each system.	3.1.2, 4.1.1, 4.1.2	$325,000	$325,000	$325,000	$325,000	$325,000	$1,625,000
Developing large-scale SAV propagation capabilities	Develop techniques for large-scale propagation of plants. Production of sufficient material to plant 125 acres.	4.2	$690,458	$690,458	$690,458			$2,071,374
Implementing large-scale plantings	Plant a total of 125 acres SAV in multiple sites baywide.	4.3.3			$1,309,505	$1,309,505	$1,309,505	$3,928,515
Public education	Implement education and outreach programs to generate public interest and concern for SAV restoration (cut from original funding table)	6.1.1						
Citizen- and school-based restoration	Involve citizens, students, watershed organizations, businesses and other groups in SAV restoration activities. (cut from original funding table)	6.1.3						
Research and technology development	Conduct intensive research into species-specific habitat requirements of SAV in Chesapeake Bay and develop planting protocols.	7.1.1, 7.1.2	$200,000	$200,000	$200,000	$200,000	$200,000	$1,000,000
		Total	**$1,215,458**	**$1,215,458**	**$2,524,963**	**$1,834,505**	**$1,834,505**	**$ 8,624,889**

* At levels below this funding projection, although restoration activities would still be possible, it is likely that economies of scale would result in disproportionate decreases in acreage planted per dollar allocated.

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 baywide 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."

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 are committed to adopting the minimum SAV light requirements as the basis for specific water clarity standards for their portion of the tidal waters by 2003 (Chesapeake Executive Council 2000).

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.

Most recently, the *Chesapeake 2000* agreement (Chesapeake Executive Council 2000) committed the signatory partners to revising the tiered restoration targets into a set of SAV acreage goals reflecting historical SAV distribution levels from the 1930s through the present. The partners also committed to set and attain water clarity goals. Attainment of these goals is a critical first step toward meeting the revised SAV acreage restoration goals.

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 4 (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 4). All consider it desirable to avoid dredging in or near existing SAV beds, in areas that historically supported SAV and in potential shallow habitat, espe-

cially 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 4). 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

TABLE 4: Summary of existing regulations, guidelines and policies of regulatory and commenting agencies regarding activities affecting submerged aquatic vegetation.

Categories	Maryland	Virginia	US Army Corps of Engineers (Baltimore District)	US Environmental Protection Agency	US Fish and Wildlife Agency	National Marine Fisheries Service
Dredging of new channels	Not allowed in water ≤ 3′ at MLW	Limit channels to minimum dimensions necessary; avoid SAV	Not allowed in waters ≤ 2′ MLW in main channel, ≤ 1.5′ MLW in spurs; presence of SAV overrides these parameters	Generally opposed to new channel dredging	Avoid shallow water habitats; not recommended in areas without piers and historical deepwater access	Not recommended within existing SAV beds or adjacent shallows with potential for bed expansion
Dredging in SAV beds	Allowed in areas where there were historic channels	Usually not allowed	Prohibited upstream of 1.5-2′ contour and in existing beds (see text for exceptions); channel dimensions may be restricted where slumping occurs	Not recommended outside existing channels	Not recommended	Not recommended
Timing restrictions on dredging	Prohibited within 500 yards of SAV beds, April 15-October 15	Restrictions may be placed if in proximity to living resources	April 1-June 30; April 15- October 15 (species with two growing seasons)	March-June recommended 15	April-15 October (depending on species involved)	Species-dependent; April 15-October 15 for most species; April 1-June 30 for horned pondweed
Dredging in areas that historically supported SAV	Not recommended where SAV occurred during the previous growing season	Considered during the application review process	Depends on depths and why SAV disappeared. Check soils.	Not recommended	Not recommended	Not recommended where SAV has been documented during the past 2-3 growing seasons
Dredging near SAV beds/buffer zones	See timing restrictions on dredging above	Considered during the application review process	3′ buffer/1′ dredged below existing bottom; 15′ buffer from MHW & for SAV w. dense tuber mats	3′ buffer/1′ dredged	3′ buffer/ 1′ dredged below existing bottom	Recommended buffers around existing beds; no dredging in areas with potential bed expansion
Depositing dredged material on SAV	Prohibited	Locate to minimize impacts	Recommend against		Recommend against	Recommend against
Pier construction	Pier out to avoid dredging of SAV beds; minimize pier dimensions	Limit to minimum necessary for water access, locate to avoid SAV	Pier out, construct community piers or mooring piles to avoid dredging of SAV beds; maintain suitable pier height above SAV		Pier out to avoid dredging of SAV beds; construct community rather than multiple individual piers	Maintain 1:1 ratio of deck width to deck height above MLW
Marina development near SAV	Prohibited in areas ≥ 4.5′ unless dredged from upland and adverse impacts to SAV are minimized	Undesirable near SAV, or in waters < 3′ at MLW	Avoid historical SAV beds for new marina construction; maintain buffer for marina expansion	Avoidance of SAV recommended	Avoid	Recommend against new marinas or expansion in existing beds or adjacent shallows with potential for bed expansion
SAV harvest	Permit required	Permit required to harvest, transplant, or plant SAV plants				Limited harvest of Hydrilla in the Potomac

*Section 28.2-1205 of the Code of VA was amended in 1996 to include specific consideration impacts to SAV from a proposed project in the application review.

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. The longest successful planting site using whole plants has been in the lower York River. This site was planted with adult plants in 1982 and the East River in 1984, and these beds are still surviving. The second longest successful planting site was 10 years. However, most planting efforts have not yielded long term success of greater than 5 years. Since 1996, the number of successful sites planted with both adult plants and seeds has increased. The longest success to date that came from seeds has been 3 years. 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, 3 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	4 years from adult plants grown from seed
Heteranthra dubia, Water stargrass	unknown	Difficult	Yes	none attempted