Submerged Aquatic Vegetation Mitigation and Monitoring Guidance for the Chesapeake and Atlantic Coastal Bays

Developed by the
Chesapeake Bay Program's SAV Workgroup
for
Regulatory Agencies Overseeing SAV Mitigation in the Chesapeake and Atlantic Coastal Bays

2026

About the Chesapeake Bay Program's SAV Workgroup:

The Chesapeake Bay Program's SAV Workgroup serves the broader Chesapeake Bay community by guiding managers on the protection and restoration of SAV. The workgroup carries out its mission by providing technical expertise and applying research findings to issues impacting SAV in the Bay.

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Background

Submerged aquatic vegetation (SAV) in the Chesapeake and Atlantic Coastal Bays is a vitally important habitat that provides numerous ecosystem services, including the provision of habitat and refuge for ecologically and commercially important finfish and shellfish, carbon sequestration and pH buffering, shoreline erosion control, and nutrient cycling. Regardless, due to their confinement to shallow, nearshore waters, they are immediately susceptible to the direct and indirect impacts of shoreline construction and coastal development. In recent years, Bay jurisdictions have documented a steady rise in shoreline alteration, dredging, and other near-shore activities that have resulted in measurable SAV losses, with impacts varying by region depending on development pressure and regulatory frameworks. It is anticipated that these shallow water use conflicts will only increase over time as sea level rise continues and SAV recovers with improvements in water quality associated with the Chesapeake Bay Total Maximum Daily Load (TMDL).

In the context of these increasing pressures, mitigation refers to the process of avoiding and minimizing impacts to SAV to the maximum extent practicable, then compensating for any remaining, unavoidable loss of SAV habitat through restoration or other approved mitigation mechanisms. Compensatory mitigation for aquatic resources—including SAV—is grounded in federal and state regulatory authorities such as the Clean Water Act Section 404(b)(1) Guidelines, the Rivers and Harbors Act, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) and United States Army Corps of Engineers (USACE) habitat protection mandates, and state tidal wetlands laws and permitting programs. Chesapeake and Atlantic Coastal Bays jurisdictions currently employ several mitigation mechanisms, including permittee-responsible mitigation, mitigation banking, and in-lieu fee (ILF) programs. However, SAV-specific guidance has been limited, resulting in inconsistent mitigation requirements, variable ecological outcomes, and uncertainty among regulators and permittees.

On January 30, 2025, the Chesapeake Bay Program's SAV Workgroup hosted a compensatory SAV Mitigation Workshop. The purpose of the workshop was to respond to the rising number of near-shore projects and activities (i.e., shoreline alteration and stabilization, dredging, marina expansion) that impact SAV in the Chesapeake and Atlantic Coastal Bays and to develop standardized guidance to regulatory agencies on compensatory SAV mitigation and monitoring.

This document explains the compensatory SAV mitigation and monitoring recommendations developed during the SAV Mitigation and Monitoring Workshop. The intent is to ensure that when SAV habitat is lost due to permitted activities, it is mitigated appropriately, meaningfully, and with the greatest chance of ecological success. The guidance emphasizes avoidance and minimization first and foremost; *it is not our intent to promote or facilitate the allowance of additional SAV impacts*. Rather, the intent is to clarify expectations, improve consistency across jurisdictions, and strengthen ecological outcomes when mitigation is required.

Chesapeake Bay SAV Restoration Guidance

In 2019, the Chesapeake Bay Program's SAV Workgroup published ***Small-scale SAV Restoration in Chesapeake Bay: A Guide to the Restoration of SAV in Chesapeake Bay and its Tidal Tributaries***. This guidance document includes the latest available information and guidance on

- What native species should be used for restoration in each of the Bay's salinity zones
- When and how to harvest seeds from each species recommended for restoration
- How to process and store the SAV seeds collected
- How to test viability and germination rates
- How to select sites appropriate for restoration
- SAV monitoring basics

Compensatory SAV mitigation projects required in the Chesapeake and Atlantic Coastal Bays should follow the guidance provided in this document or other approved methods. Although the Small-scale Restoration guidance document includes guidelines for transplanting mature plants for SAV restoration, only SAV seeds are recommended for mitigation purposes to minimize additional impacts to the Bay's SAV populations.

For locations of SAV Beds in the Chesapeake and Atlantic Coastal Bays, refer to the Virginia Institute of Marine Science Interactive SAV Map: https://www.vims.edu/research/units/programs/sav/access/maps/

Purpose and Scope

This guidance document recommends standard expectations established by the Chesapeake Bay Program's SAV Workgroup for when and how in-kind compensatory SAV mitigation should be implemented in the Chesapeake and Atlantic Coastal Bays and their tidal tributaries. It is intended for regulatory agencies, permit applicants and permittees, and restoration practitioners. The guidance builds upon recommendations from the SAV Workgroup's 2025 SAV Mitigation and Monitoring Workshop and Workshop Report.

Applicability

This guidance should apply to all permitted activities in the Chesapeake and Atlantic Coastal Bays that present unavoidable impacts to SAV. It provides a consistent yet flexible framework for evaluating mitigation needs and ensuring successful SAV restoration. Permittees developing SAV Mitigation Plans for projects that incur SAV impacts should follow the guidance within for successful mitigation plan development.

SAV Mitigation and Monitoring Guidance

SAV impact size trigger for in-kind SAV mitigation

- First and foremost, the federal mitigation hierarchy should be followed:
    - Avoid → Minimize → Mitigate

- Any size impact to SAV should result in compensation to ensure that all SAV losses and loss of habitat function are discouraged and accounted for if unavoidable.

- SAV restoration efforts in the Chesapeake and Atlantic Coastal Bays have ranged in size from several square meters to acres. Either end of the spectrum has resulted in both successes and failures, and there is practicality in restoring SAV at both small and larger scales. Relatively small impacts can still be meaningfully mitigated, particularly when considering mitigation ratio requirements to account for loss of function.

- The SAV Workgroup recommends that any SAV impact greater than 300 square feet require in-kind SAV mitigation.

Determining if in-kind SAV mitigation is appropriate at the time

- If an SAV impact triggers compensatory mitigation efforts, considering if in-kind SAV mitigation is appropriate is an important first step in this process. Local, regional, or Bay-wide habitat conditions may be such that SAV restoration success is not likely at the time. In this case, our limited SAV resources should not be wasted.

- If SAV habitat conditions are declining in the tributary where the impact will occur, such that a loss in SAV acreage has been documented over the most recent three years of data, SAV mitigation should take place outside of the tributary and in the broader region/salinity zone.

- If region-wide conditions are in decline and SAV restoration success is unlikely even in the broader area, the regulatory agency should require another form of compensatory mitigation.

Characteristics of a suitable compensatory SAV mitigation project site

- The mitigation site is the site where the SAV restoration effort will take place.

- Ideal mitigation sites should meet or exceed SAV habitat requirements (e.g., light availability, low chlorophyll-a – refer to *Chesapeake Bay Submerged Aquatic Vegetation Water Quality and Habitat-Based Requirements and Restoration Targets: A Second Technical Synthesis* Table 1, copied below, for SAV Habitat Requirements), have low wave energy, limited boat traffic, suitable adjacent land use (i.e., avoid urban areas with hardened shorelines), and historical SAV presence.

TABLE 1. Recommended habitat requirements for growth and survival of submerged aquatic vegetation (SAV) in Chesapeake Bay and its tidal tributaries.

		Primary Requirements†	Secondary Requirements** (Diagnostic Tools)				
Salinity Regime#	SAV Growing Season*	Minimum Light Requirement (%)	Water Column Light Requirement (%)	Total Suspended Solids (mg/l)	Plankton Chlorophyll-*a* (μg/l)	Dissolved Inorganic Nitrogen (mg/l)	Dissolved Inorganic Phosphorus (mg/l)
Tidal Fresh	April-October	>9	>13	<15	<15	—	<0.02
Oligohaline	April-October	>9	>13	<15	<15	—	<0.02
Mesohaline	April-October	>15	>22	<15	<15	<0.15	<0.01
Polyhaline	March-May Sept.-Nov.	>15	<22	<15	<15	<0.15	<0.02

\# Regions of the estuary defined by salinity regime, where tidal fresh = <0.5 ppt, oligohaline = 0.5-5 ppt, mesohaline = >5-18 ppt and polyhaline = >18 ppt.

- To maximize the use of limited SAV seeds, the mitigation site should not currently have any SAV present.

- Follow restoration site selection guidance in *Small-scale SAV Restoration in Chesapeake Bay: A Guide to the Restoration of SAV in Chesapeake Bay and its Tidal Tributaries*.

- For locations of SAV Beds in the Chesapeake and Atlantic Coastal Bays, refer to the Virginia Institute of Marine Science Interactive SAV Map: https://www.vims.edu/research/units/programs/sav/access/maps/

- For additional assurance that the site is appropriate for SAV restoration, the applicant should consider using *GrassLight*. *GrassLight* is a coupled model of 2-flow radiative transfer and photosynthesis in submerged plant canopies frequently used to determine if the water column light environment in a given area will support SAV productivity. *GrassLight* is available at no cost on GitHub at https://github.com/BORG-ODU/GrassLight.

Allowable distance from the impact site to the mitigation site

- The purpose of an SAV mitigation project is to offset unavoidable SAV loss and to reestablish the lost ecosystem services. Therefore, to restore ecosystem services locally, an SAV mitigation site should be as close as possible to the impact site without risk of impact from the project.

- Prioritize proximity: at site → near site → same tributary* → adjacent tributary → within salinity zone. Justification should be provided if the mitigation site is outside of the sub-watershed where the impact occurred.

  *Some tributaries are large enough that they have multiple salinity zones (i.e., the Potomac River extends from tidal fresh to upper mesohaline salinity). A mitigation site should remain in the same salinity zone even if outside of the tributary to maintain similar ecosystem functions to the impact site.

Identifying an SAV seed donor bed

- A donor bed is defined as an SAV bed where SAV seeds are collected for use in SAV restoration or mitigation efforts.

- SAV donor beds for seed harvest should be large beds (relative to the size of the SAV beds in the tributary in question) that are at least 5 years old, have a cover/density class 4 (70-100%) on the VIMS aerial survey map, and approximately 75% of plants should be reproductive based on a visual assessment while scouting for seed maturity.

- Though there are instances when it may be advantageous for SAV seeds from populations far away from the impact site to be used in mitigation, in most cases, SAV donor beds should be as close as possible to the impact and mitigation sites. Using seeds from nearby populations ensures genetic adaptation to local conditions.

- Permittees must obtain a permit to harvest SAV seeds and/or plant material.
  - In Maryland, refer to Maryland DNR's SAV regulations webpage at: https://dnr.maryland.gov/waters/bay/pages/sav/sav-permits-and-regulations.aspx ;
  - In Virginia, refer to the Virginia Marine Resources Commission subaqueous permit information here: https://www.mrc.virginia.gov/regulations/hm-permits.shtm
  - In Washington, D.C., refer to the SAV regulations here: https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/submergedaquaticveg.pdf

Mitigation site monitoring

- Mitigation site monitoring is essential to determine if the mitigation effort is successful or not. Monitoring should be non-destructive and in-situ (on site/in water). Measured parameters should include SAV species composition*, SAV percent cover, SAV shoot count, and restored bed size. *SAV restoration sites frequently encourage settlement of SAV seeds of other species from nearby populations. It is important to include both the species planted and any additional species observed while monitoring.
- In advance of the first monitoring effort, the permittee should use mapping software such as ArcGIS to generate a grid matrix with approximately 30 grid cells over the restoration plot polygon (grid size changes based on the size of the mitigation site but the number of cells does not; tessellated hexagonal grid cells work best). Within each cell, generate a random point to survey.
- When conducting the survey, record SAV species composition, SAV percent cover, and conduct a shoot count within a 0.25 m^2 quadrat at each randomly generated point. Surveying at random points inside grid cells – rather than simply surveying at randomly generated points within the restoration area polygon – is a form of systematic random sampling that guarantees that the entire planted area will be surveyed.
- If possible, locate and map the edge of bed with a hand-help GPS device and determine the bed size. Edge of bed is where cover transitions from more than 10% cover to less than 5% cover. If SAV cover is too sparse to determine the edge of bed, disregard this step.
- At minimum, the mitigation site should be surveyed once annually during peak biomass for the restored species. More frequent monitoring may behoove the permittee to ensure SAV presence is captured. See the table below for peak biomass monitoring timeframes.
- Monitoring should occur for at least 5 years post-restoration.

Survey Timeframe	Months	SAV Community Peak Biomass
Early-summer	May/June	*Zostera/Zannichellia*
Mid-summer	July	Mesohaline/estuarine SAV community
Late-summer	August/September	Tidal Fresh/Oligohaline SAV community

- SAV monitoring should take place at a reference site as well as the mitigation site (see below).

Identifying an appropriate reference site

- A reference site serves as a reasonable benchmark for assessing mitigation success. It is defined as a site similar to the mitigation site that can be monitored in conjunction with the mitigation site to determine if success or failure of the mitigation effort is due to factors associated with the mitigation effort itself or due to regional trends that are beyond the permittee's control.

- A reference SAV bed should be similar in SAV species composition (if the permittee is planting wild celery, the reference bed should be dominated by wild celery), and physical and water quality characteristics (salinity, substrate, fetch, depth, water clarity, etc.).

Recommended distance from mitigation site to reference site

- Reference sites should be as close as possible to the mitigation site while maintaining independence and the reference bed characteristics described above.

- Prioritize proximity: near site → same tributary → adjacent tributary within same salinity zone.

Mitigation site monitoring responsibility and duration

- If financially feasible, mitigation and reference monitoring should be conducted by a qualified, third party and independent contractor for at least 5 years post-restoration.

- If not conducted by a third party, the responsible party should submit time-stamped pictures of the restoration and reference site(s) to the permitting agency to assure validity and accuracy of monitoring results.

- Required reports should document sampling methods, metrics, and include evaluation of results.

- Any monitoring conducted beyond 5 years should be the responsibility of the permitting agency.

Long-term mitigation site maintenance and monitoring responsibility

- The permittee should be responsible for long-term maintenance, defined as 5 years of monitoring and adaptive management actions.

- If the project is considered a success at year 5, the permittee should be free of obligation after that. If not successful after year 5, the mitigation requirements should be re-evaluated by the regulatory agencies and if deemed appropriate, a contingency plan determined by the regulatory agency should be enacted.

Determining success

- Success should be defined by the Threshold Value and Quality Ratio as described in *Seagrass Restoration Handbook UK & Ireland* by Gamble et al. (2021), p. 65.
- Gamble et al. compare restored beds to reference beds rather than to conditions at the impacted site. This takes into account regional trends and natural variability and also ensures that the trajectory of the compensatory mitigation project is interpreted in the context of regional conditions.
- Success each year should be determined using the Threshold Value and Quality Ratio, where:

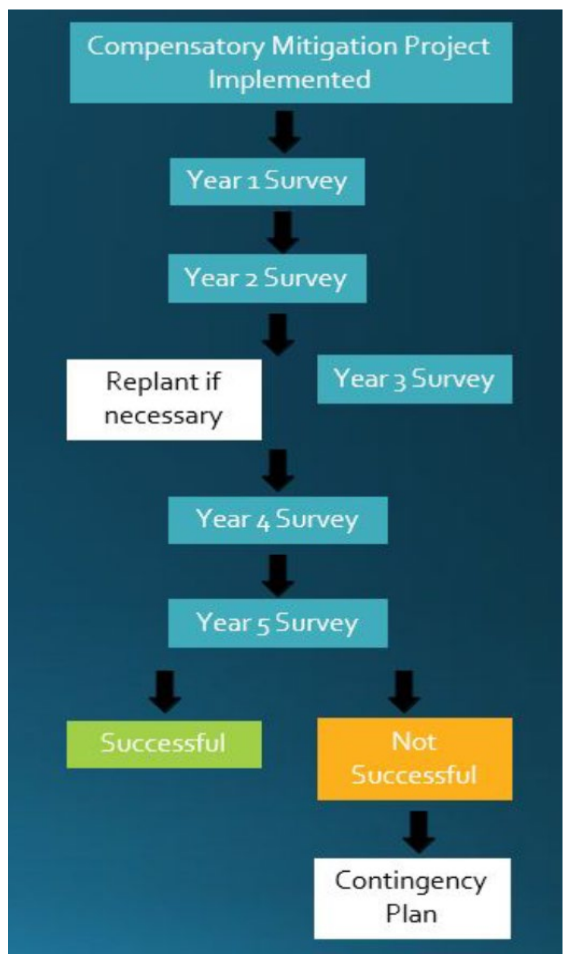
$$\textbf{Threshold Value} = \frac{(\text{average of parameter } \boldsymbol{\alpha} \text{ - 1SD in reference bed})}{(\text{average of parameter } \boldsymbol{\alpha} \text{ in reference bed})}$$

$$\textbf{Quality Value} = \frac{(\text{average of parameter } \boldsymbol{\alpha} \text{ in restored bed})}{(\text{average of parameter } \boldsymbol{\alpha} \text{ in reference bed})}$$

Success is defined if the Quality Ratio > Threshold Value

Note: 1SD is one standard deviation and parameter **α** can be any of the parameters measured (shoot count or SAV percent cover in this case).

- A threshold value is a point at which a significant change has occurred within a restored bed.
- Monitor both restoration and reference sites for 5 years
- If at Year 2 of monitoring the Quality Ratio is < the Threshold Value, the permittee should be required to re-seed during the spring of Year 3.
- After 5 years of monitoring:
    1. If the Quality Ratio > the Threshold Value, the project is successful and no further monitoring is required.
    2. If the Quality Ratio < the Threshold Value, the project is NOT successful, and the mitigation requirements should be re-evaluated by the regulatory agencies.



EXAMPLE OF HOW TO MEASURE SUCCESS USING A THRESHOLD VALUE AND QUALITY RATIO

Shoot density per m^2 in the restored bed can be compared with shoot density per m^2 in the reference bed using data from quadrats surveyed in each. Shoot density in the restored bed after five years was averaged to 515 shoots per m^2. The shoot density of the reference beds was measured at an average of 560 ± 102 (mean ± SD) shoots per m^2 .

Threshold value = (average of parameter α – 1 SD in reference beds) / (average of parameter α in reference beds).

Quality ratio = (average of parameter α in the restored bed) / (average of parameter α in the reference bed)

If the quality ratio is greater than the threshold value, the restoration project has been a success.

[Note: parameter α *can be any parameter (e.g. shoot count or cover) and 1SD is one standard deviation.]*

In this example, the quality ratio is 515/560 = 0.92.

Threshold value = (560-102) / 560 = 0.82.

Quality ratio > threshold value (0.92 > 0.82). This means that the restoration was successful.

- A threshold value is a point at which a significant change has occurred within the restored bed.
- The threshold value can also be used to determine whether there have been increases in other variables such as (i) biomass, (ii) maximum depth distribution, (iii) sediment variables, or (iv) the abundance and diversity of fish and invertebrates.

Updates

This document may be updated periodically to reflect advances in restoration science, regulatory needs, and ecosystem trends.

Contact

For questions, contact the Chesapeake Bay Program's SAV Workgroup Chair @ brooke.landry@maryland.gov