Submerged Aquatic Vegetation Review

Purpose and Definition

The goal of this brief literature review is to lay the foundation for research on the barriers and benefits that individuals face to engaging in behaviors that protect submerged aquatic vegetation (SAV). SAV includes aquatic grasses and other flowering plants that root into the sediment of the Chesapeake Bay (Bay).[1] SAV is highly valuable habitat since it provides numerous important ecological functions that are difficult to replace, including shelter, food, and reproductive space for animals.[2] SAV also binds sediment together, adds oxygen to the water, absorbs nutrient pollution, and reduces erosion.[3] Approximately 20 SAV species exist in the Chesapeake Bay, based on the major salinity zones, and have different tolerances to light and sediment quality.[4] As part of the Chesapeake Bay Watershed Agreement, the Chesapeake Bay Program partners have committed to the goal of achieving and sustaining 185,000 acres of SAV in the Bay, with a target of 130,000 acres by 2025. In 2018, there were an estimated 91,559 acres of SAV in the Bay.[5]

Background

There are many ecosystem factors that affect the abundance of SAV in the Bay. Three of the most influential factors are: changes in watershed land use and increased shoreline development; climate change; and decreased water quality (nitrogen, phosphorus, sediment).[6] These factors will have long-term impacts on SAV in the Bay, from decreasing populations of SAV species that are less resilient to changes in temperature, storm frequency, and salinity, to declining viable areas for growth due to poor water quality and habitat reductions. These factors affect different SAV species in the Bay to varying

---

[1] Chesapeake Environmental Communications. (2017). Submerged Aquatic Vegetation. Retrieved from http://www.chesapeakedata.com/changingchesapeake/

[2] NOAA Southeast Regional Office (2018) Why Is Submerged Aquatic Vegetation Designated As Essential Fish Habitat? NOAA. Retrieved from www.fisheries.noaa.gov/content/why-submerged-aquatic-vegetation-designated-essential-fish-habitat

[3] Chesapeake Bay Program. (2020) Underwater Grasses. Retrieved from: https://www.chesapeakebay.net/issues/bay_grasses

[4] NCCOS. (2016) Hardened Shorelines Associated with Seagrass Decline in Southern Chesapeake Bay. NOAA. Retrieved from https://coastalscience.noaa.gov/news/researchers-associate-hardened-shorelines-declines-seagrasses-southern-chesapeake-bay/; Dennison, W.C. ; Orth, R.J; Moore, K.A.; Stevenson, J.C.; Carter, V.; Kollar, S.; Bergstrom, P.W.; & Batiuk, R.A (1993). Assessing Water Quality with Submersed Aquatic Vegetation. *BioScience, 43*:2.pp. 86-94.

[5] Chesapeake Bay Program. (2020) Underwater Grasses. Retrieved from: https://www.chesapeakebay.net/issues/bay_grasses

[6] Chesapeake Environmental Communications. (2017). Submerged Aquatic Vegetation. Retrieved from http://www.chesapeakedata.com/changingchesapeake/

degrees, with the previously mentioned effects related to human activities generally having the most significant impact.[7] However, while all three are critical factors to consider for achieving the goal of increased SAV quality and quantity, these factors are generally beyond the current scope of this project. This work seeks to change behavior that has a direct physical effect on SAV populations, as opposed to a secondary effect via improved water quality or reduced climate change impacts. There are numerous research efforts focused on behaviors that impact water quality and climate change. However, there is limited existing work exploring direct human effects on SAV. This work acknowledges that water quality, development, and climate change are critical factors of concern for SAV's future prosperity. However, the primary focus of this work is to prioritize and understand direct human impacts on SAV quality and quantity. The review does also look at some indirect effects on SAV through shoreline modification.

Direct Human Impacts on SAV

As human populations have grown in the Chesapeake Bay region, they have had an increasing negative impact on the shoreline and associated SAV populations. There are also two primary audiences who can have a direct negative impact on SAV populations – boaters and shoreline property owners.

Recreational and Commercial Boaters

When individuals and organizations operate boats in the Chesapeake Bay, the boats can cause significant damage to SAV. When commercial and recreational boats run aground while docking, scrape their boat along the bank, fail to follow speed limits and no-wake laws, or move carelessly through shallow waterways (such as by revving their motor), they can damage and even kill SAV.[8] For example, shellfish dredges and boat propellers can pull underwater grasses up from the bottom of rivers, streams, and the Bay, leaving visible marks across grass beds in shallow waters.[9] SAV can also get wrapped around propellers and cause damage to boats, leading to negative attitudes about SAV. Boaters present a challenge as it is difficult to enforce regulations on such a diverse and large population, and passing regulations may lack public support.[10] While recreational and commercial boaters are meaningful audiences that influence the health of SAV, there are already significant efforts to directly target these audiences. These efforts include state regulations and behavior change outreach from organizations such as the Ocean Foundation and ShoreRivers, with funding from the Chesapeake Bay Trust. Consequently, this project will focus on the ways that shoreline property owners affect SAV populations.

---

[7] Patrick, C.J., Weller, D.E., Orth, R.J., Wilcox, D.J., & Hannam, M.P. (2017) Land Use and Salinity Drive Changes in SAV Abundance and Community Composition. *Estuaries and Coasts, 40:*2.

[8] Murphy, R., Valauri-Orton, A., & Hildt, A. (2018) Changing Boater Behavior: A Case Study in Using a Social Marketing Toolkit to Prevent SAV Damage. ShoreRivers and Ocean Foundation for Chesapeake Bay Trust. Retrieved from https://www.chesapeakebay.net/channel_files/27574/tof_shorerivers_cbt_workshop_presentation.pdf

[9] Chesapeake Bay Program. (2020) Underwater Grasses. Retrieved from: https://www.chesapeakebay.net/issues/bay_grasses

[10] Chesapeake Bay Program (U.S.). Living Resources Subcommittee. Submerged Aquatic Vegetation Workgroup. (1995). Guidance for Protecting Submerged Aquatic Vegetation in Chesapeake Bay from Physical Disruption.

The effectiveness of these efforts has not been evaluated within the scope of this work, but this project seeks to prioritize audiences and behaviors that have not already been addressed.

Shoreline Property Owners

Shoreline property owners across the Chesapeake Bay can have significant direct and indirect effects on SAV populations, including through direct removal and hardening of shoreline.

Shoreline Hardening

A common concern reported by many shoreline property owners in the Bay is reduced property size and harm to infrastructure resulting from shoreline erosion. There are several actions that a property owner can take to reduce shoreline erosion each having a unique impact on SAV populations. A common activity for reducing shoreline erosion is to construct armor to harden the shoreline. Shoreline hardening stabilizes coastal land and protects infrastructure through the construction of bulkheads, riprap, or other similar structures.[11] When shorelines are hardened, the SAV environment may be disrupted or destroyed due to changes in natural wave energies and sediment transport.[12] Comparisons of SAV beds show reduced coverage, diversity, species richness, and evenness in the distribution of SAV species in beds adjacent to hardened shorelines compared to natural shorelines.[13] SAV beds adjacent to hardened shorelines also have inhibited recovery times after storms.[14] As climate change leads to sea level rise and increased weather events, shoreline owners may increasingly seek to harden their property, potentially leading to further reductions in SAV populations.[15]

Removing Current Armoring. For properties with current armoring, they may be able to remove the current armoring, even if no further work is done. While armoring a few small sections of shoreline may have only small-scale adverse impacts, armoring larger areas of shoreline causes changes to occur to the coastal ecosystem and services they provided.[16] For example, installing bulkheads usually increases nearshore erosion, and can increase erosion on adjoining properties (Nutrient Subcommittee Sediment Workgroup's Tidal Sediment Task Force, 2005). Therefore, landowners can improve the health of the Bay by removing their property's armoring, if their property has low to moderate erosion potential.

---

[11] NCCOS. (2016) Hardened Shorelines Associated with Seagrass Decline in Southern Chesapeake Bay. NOAA. https://coastalscience.noaa.gov/news/researchers-associate-hardened-shorelines-declines-seagrasses-southern-chesapeake-bay/

[12] Koch, E.W. (2001) Beyond light: physical, geological and geochemical parameters as possible submersed aquatic vegetation habitat requirements. Estuaries 24: 1–17.

[13] Landry, J.B. & Golden, R.R. (2018) In Situ Effects of Shoreline Type and Watershed Land Use on Submerged Aquatic Vegetation Habitat Quality in the Chesapeake and Mid-Atlantic Coastal Bays. *Estuaries and Coasts 41:*S101-S113.

[14] Ibid.

[15] Orth, R.J. et al, (2017). Submersed Aquatic Vegetation in Chesapeake Bay: Sentinel Species in a Changing World. *BioScience, 67*:8, Pg 698‑712, https://doi.org/10.1093/biosci/bix058

[16] NOAA. (2015) Guidance for Considering the Use of Living Shorelines. Living Shorelines Workgroup. Retrieved from https://www.habitatblueprint.noaa.gov/wp-content/uploads/2018/01/NOAA-Guidance-for-Considering-the-Use-of-Living-Shorelines_2015.pdf

Property owners may be unnecessarily hardening their shoreline as they do not realize their shoreline does not need that level of erosion protection or believe their shoreline has unique characteristics that requires armor. In addition, they may need financial incentives to overcome the cost of removal. Shoreline property owners have reported that they have a desire to learn customized information about their shorelines, learn from other shoreline property owners, tend to make decisions about shoreline management after an erosion event, and want to do the right thing.[17]

Direct Removal of SAV

Shoreline property owners may also have direct and specific concerns about SAV itself, and ultimately seek to remove it. Property owners cite multiple reasons for seeking to remove SAV from shoreline property including: navigational pathways for boats; swimming (either for perceived entanglement risk or for discomfort with plants touching skin); hydrodynamics (impaired water flow); fishing; property value; and aesthetic preferences.[18] SAV is more likely to be considered a nuisance if it has a high growth rate, tall height, high coverage, high biomass, and/or is a monoculture, with height and coverage most highly related to a negative perception. [19] Other cited reasons for a negative attitude toward SAV included perceived health risks and unpleasant odors.[20] However, the presence of SAV is positively linked to many types of recreational activities, such as fishing, hunting, and bird watching, as it provides food, shelter, and habitat for species. [21]

Types of Direct Removal

There are two common methods property owners may use to remove SAV: (1) by hand or (2) with larger equipment/machinery. Anecdotal evidence from members of the SAV goal implementation team also suggests that herbicides, which are widely available for use in removing SAV in lakes or ponds, may also be used in some capacity in the Bay.

Hand Removal. Hand removal involves removing the entire plant by hand or with hand tools such as by pulling, cutting, or raking. These methods are labor-intensive and would typically be employed in a

[17] Colehour + Cohen, Applied Research Northwest, Social Marketing Services, Futurewise and Coastal Geologic Services (2014) Shore Friendly Final Report. WA Department of Fish and Wildlife and WA State Department of Natural Resources

[18] Verhofstad, M.J.J.M., & Bakker, E.S. (2019) Classifying nuisance submerged vegetation depending on ecosystem services. Limnology 20:55–68.

[19] Verhofstad, M.J.J.M., & Bakker, E.S. (2019) Classifying nuisance submerged vegetation depending on ecosystem services. Limnology 20:55–68.

[20] Dodds WK, Bouska WW, Eitzmann JL, Pilger TJ, Pitts KL, Riley AJ, Schloesser JT, Thornbrugh DJ (2009) Eutrophication of US freshwaters: analysis of potential economic damages. *EnvironSci Technol 43*:12–19

[21] Verhofstad, M.J.J.M., & Bakker, E.S. (2019) Classifying nuisance submerged vegetation depending on ecosystem services. Limnology 20:55–68.

smaller context. Property owners may use this method on their own, or by hiring a company. A company may utilize powered- or non-powered hand tools specifically designed to remove SAV. [22]

Equipment/Machine Removal. Mechanical harvesters, weed rollers, and rotovators are equipment designed to remove aquatic plants at a much larger scale. They can cut out wide sections of SAV and cause significant disturbance to sediments, as well as to the animals that live in SAV. These activities would typically be taken on a residential property by a professional company, not by the property owner themselves. Similarly, ground-mowing equipment is available to mow wetland and shoreline vegetation, which does not remove the plant but does significantly damage the habitat. Mowing or harvesting would also typically be conducted by a professional company.[23]

Laws Covering Physical Removal of SAV

In Maryland, the Department of Natural Resources (DNR) requires an individual who wishes to remove SAV on their property to submit a permit application describing why the removal is necessary, the proposed method of removal, a site plan, and the amount of SAV to be removed. The statute excludes individuals harvesting fish, shellfish, or crabs. It also excludes individuals, organizations, and government agencies involved in the construction, operation, or maintenance of agricultural drainage channels. Furthermore, the statute permits individuals to remove a 60-foot strip of SAV for navigation/boating access purposes without prior DNR approval. Virginia and Washington, D.C. mandate obtaining a permit for SAV removal with similar policies and have policies about removal for navigable waters. Virginia has more specifics on the historical, environmental, and scientific context that allow for more policy guidance.[24] For our foundational research, it is important to keep in mind that the questionable legality of some SAV removal behaviors may influence survey respondents.

Conclusions

This project will explore the reasons that property owners remove SAV and what may motivate them to leave SAV in place, including recreational activities, aesthetics, shoreline use, and property value. There are many factors that influence SAV health and abundance, given that it exists within a complex ecosystem. However, reducing direct removal of SAV is a meaningful pathway to increased health and quantity of SAV, particularly as populations increase in areas where homeowners may be unfamiliar with it. Given the information in this literature review, we recommend that our foundational research focus on the following behaviors:

---

[22] Aquatic Ecosystem Restoration Foundation (2003). Best Management Practices Handbook for Aquatic Plant Management in Support of Fish and Wildlife Habitat

[23] Aquatic Ecosystem Restoration Foundation (2003). Best Management Practices Handbook for Aquatic Plant Management in Support of Fish and Wildlife Habitat

[24] Chesapeake Legal Alliance (2019). Existing Chesapeake Bay Watershed Statutes and Regulations Affecting Submerged Aquatic Vegetation. https://www.chesapeakelegal.org/wp-content/uploads/2019/07/Existing-Chesapeake-Bay-Watershed-Statutes-and-Regulations-Affecting-SAV-1.pdf

Behavior List

Behaviors to Encourage

- Leave SAV in place
- Leave shoreline unarmored
- Remove bulkheads/riprap

Behaviors to Discourage

- Physically hand remove SAV from residential property
- Hire a company to hand remove SAV from residential property
- Hire a company to use equipment to remove SAV from residential property
- Harden shoreline with riprap or bulkhead

An additional behavior of interest may be the use of herbicides to remove SAV – however, it is unclear at this time how frequent this behavior is, as there is no real data on this behavior. In addition, the questionable legality of such behaviors may present a challenge for research. Given advisement from the steering committee, this action will be included in a limited fashion as possible.

Next Steps

Based on the information collected in this document, the next step of this project will be to conduct research with shoreline property owners on the barriers and benefits they face to increasing the behaviors we seek to encourage and decreasing the behaviors we seek to discourage. We will also assess the current penetration (e.g., how many shoreline property owners are taking these actions) and probability (e.g., how willing are property owners to take these actions?) of those behaviors. Finally, we will collect information on the relevant attitudes and knowledge property owners have about SAV, as well as their communication preferences.

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CB96341401 to the Chesapeake Bay Trust. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

References

Aquatic Ecosystem Restoration Foundation (2003). Best Management Practices Handbook for Aquatic Plant Management in Support of Fish and Wildlife Habitat.

Bishop, J. (2020) Living Shorelines: An Environmentally Sensitive Alternative for Protecting your Property from Shoreline Erosion. Retrieved from: https://www.straughanenvironmental.com/living-shorelines-an-environmentally-sensitive-alternative-to-protecting-your-property-from-shoreline-erosion/

Chesapeake Bay Program (U.S.). Living Resources Subcommittee. Submerged Aquatic Vegetation Workgroup. (1995). Guidance for Protecting Submerged Aquatic Vegetation in Chesapeake Bay from Physical Disruption.

Chesapeake Bay Program. (2020) Underwater Grasses. Retrieved from: https://www.chesapeakebay.net/issues/bay_grasses

Chesapeake Bay Program. (2020). Despite record rainfall, underwater grass abundance remains strong. chesapeakebay.net/news/blog/despite_record_rainfall_underwater_grass_abundance_remains_strong; Patrick, CJ., Weller, D.E., Ryder, M. (2016). The relationship between shoreline armoring and adjacent submerged aquatic vegetation in Chesapeake Bay and nearby Atlantic Coastal Bays. Estuaries and Coasts 39: 158–170

Chesapeake Environmental Communications. (2017). Submerged Aquatic Vegetation. Retrieved from http://www.chesapeakedata.com/changingchesapeake/

Chesapeake Legal Alliance (2019). Existing Chesapeake Bay Watershed Statutes and Regulations Affecting Submerged Aquatic Vegetation. https://www.chesapeakelegal.org/wp-content/uploads/2019/07/Existing-Chesapeake-Bay-Watershed-Statutes-and-Regulations-Affecting-SAV-1.pdf

Colehour + Cohen, Applied Research Northwest, Social Marketing Services, Futurewise and Coastal Geologic Services. (2014) Shore Friendly Report. Retrieved from: https://wdfw.wa.gov/sites/default/files/2019-03/shorefriendly_finalreport.pdf

Dennison, W.C. ; Orth, R.J; Moore, K.A.; Stevenson, J.C.; Carter, V.; Kollar, S.; Bergstrom, P.W.; & Batiuk, R.A (1993). Assessing Water Quality with Submersed Aquatic Vegetation. *BioScience, 43*:2.pp. 86-94.

Koch, E.W. (2001) Beyond light: physical, geological and geochemical parameters as possible submersed aquatic vegetation habitat requirements. Estuaries 24: 1–17.

Landry, J.B. & Golden, R.R. (2018) In Situ Effects of Shoreline Type and Watershed Land Use on Submerged Aquatic Vegetation Habitat Quality in the Chesapeake and Mid-Atlantic Coastal Bays. *Estuaries and Coasts 41:*S101-S113.

Murphy, R., Valauri-Orton, A., & Hildt, A. (2018) Changing Boater Behavior: A Case Study in Using a Social Marketing Toolkit to Prevent SAV Damage. ShoreRivers and Ocean Foundation for Chesapeake Bay Trust. Retrieved from

https://www.chesapeakebay.net/channel_files/27574/tof_shorerivers_cbt_workshop_presentation.pdf

NCCOS. (2016) Hardened Shorelines Associated with Seagrass Decline in Southern Chesapeake Bay. NOAA. Retrieved from https://coastalscience.noaa.gov/news/researchers-associate-hardened-shorelines-declines-seagrasses-southern-chesapeake-bay/

NOAA. (2015) Guidance for Considering the Use of Living Shorelines. *Living Shorelines Workgroup.* Retrieved from https://www.habitatblueprint.noaa.gov/wp-content/uploads/2018/01/NOAA-Guidance-for-Considering-the-Use-of-Living-Shorelines_2015.pdf

NOAA Southeast Regional Office (2018) Why Is Submerged Aquatic Vegetation Designated As Essential Fish Habitat? NOAA. Retrieved from www.fisheries.noaa.gov/content/why-submerged-aquatic-vegetation-designated-essential-fish-habitat

Orth, R.J. et al, (2017). Submersed Aquatic Vegetation in Chesapeake Bay: Sentinel Species in a Changing World. BioScience, 67:8, Pg 698–712, https://doi.org/10.1093/biosci/bix058

Patrick, C.J., Weller, D.E., Orth, R.J., Wilcox, D.J., & Hannam, M.P. (2017) Land Use and Salinity Drive Changes in SAV Abundance and Community Composition. *Estuaries and Coasts, 40:*2.

Verhofstad, M.J.J.M., & Bakker, E.S. (2019) Classifying nuisance submerged vegetation depending on ecosystem services. *Limnology 20*:55–68.