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Dredged Material Can Benefit Submerged Aquatic Vegetation (SAV) Habitats

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PURPOSE: This technical note (TN) was developed by the US Army Engineer Research and Development Center–Environmental Laboratory (ERDC-EL) to provide an overview of the ecosystem services delivered by submerged aquatic vegetation (SAV) to estuarine and coastal ecosystems and to describe potential methods for the beneficial use of dredged material (BUDM) to aid in SAV restoration. Although dredging tends to have a negative association with SAV habitats, BUDM may provide an opportunity to expand suitable SAV habitat to areas where depth is the primary limiting factor. Recent in situ observations have shown that SAV has opportunistically colonized several dredged-material placement sites. This TN provides context on BUDM for SAV habitat restoration to encourage increased strategic placement.

BACKGROUND AND PROBLEM: SAV are rooted and flowering plants found in shallow marine, estuarine, and freshwater habitats that provide a variety of critical ecosystem services (Table 1). Ecologically, SAV habitats are important sources of food, foraging grounds, and shelter from predators for a variety of species (Boström et al. 2006; Orth et al. 1984). SAV also provides chemical and physical services by cycling nutrients, sequestering carbon (Romero et al. 2006; Fourqurean et al. 2012), and preventing erosion through sediment stabilization and the attenuation of wave and current energy (Ward et al. 1984; Fonseca and Cahalan 1992). Quantitative analyses of these and other ecosystem services have demonstrated that seagrass (marine and estuarine SAV subset) habitats render services valued at US dollar (USD) 37,500 ha^{-1} y^{-1} (Costanza et al. 2014; adjusted to 2021 USD),[1] which rank SAV among the top three most economically valuable marine habitats and within the top five if terrestrial habitats are included (Costanza et al. 1997; Costanza et al. 2014). Because some benefits are poorly, if at all, quantified (Barbier 2015; Dewsbury et al. 2016), SAV ecosystems are likely undervalued.

Throughout the twentieth and twenty-first centuries, SAV habitats and their associated ecosystem services have declined globally because of increasing sea surface temperatures; rising water-column turbidity, which reduces light availability; declining water quality due to coastal development; and direct disturbance of SAV beds from humans, animals, wind and wave energy, and increasingly frequent and more severe storm events (Orth, Carruthers, et al. 2006; Waycott et al. 2009). SAV habitat decline can also cause further water-quality decline and sediment erosion, which creates a feedback loop that reinforces habitat loss (Maxwell et al. 2017; van der Heide et al. 2007) and reduces blue carbon storage potential (Fourqurean et al. 2011).

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[1] For a full list of the spelled-out forms of the units of measure used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 248–52, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

Table 1. Submerged aquatic vegetation (SAV) functions and associated ecosystem services. Citations of studies exemplifying these relationships are provided. Table adapted from Short et al. (2000) and Altman et al. (2023).

Function Performed	Services Provided	Supporting Citations
Addition of benthic structural complexity	Epiphyte and epifauna substratum	Duffy and Harvilicz 2001; Moore and Hovel 2010; Pettit et al. 2016
	Support fish and invertebrate (that is, secondary) production through the provision of habitat	Bertelli and Unsworth 2014; Boström et al. 2006; Orth et al. 1984
	Wave attenuation and current reduction, sediment resuspension reduction	Fonseca and Cahalan 1992; Fonseca and Fisher 1986; Hansen and Reidenbach 2013
Primary production	Oxygen production	Findlay et al. 2006; Y. Wang et al. 2021
	Carbon sequestration	Bao et al. 2022; Duarte et al. 2010; Fourqurean et al. 2012; Howard et al. 2018; Romero et al. 2006
	Food production for herbivores, directly supporting estuarine and coastal food webs and fisheries	Heck and Valentine 2006; Santos et al. 2022
	Organic matter production and export, indirectly supporting offshore food webs and fisheries	Heck et al. 2008; Nelson et al. 2013; Thresher et al. 1992
Nutrient filtration and cycling	Improve water quality	Desmet et al. 2011; Piehler and Smyth 2011; Thomas and Cornelisen 2003
	Support primary production and food webs	Jiménez-Ramos et al. 2017; Daudi et al. 2012
Contamination filtration	Improve water and sediment quality	Fry and Chumchal 2012
	Indicator of nutrient pollution	Lee et al. 2004
Sediment filtration, trapping, and stabilization	Reduce erosion and sediment resuspension	Fonseca and Fisher 1986; James et al. 2004; C. Wang et al. 2015
	Sediment and organic matter accumulation, counter sea-level rise (SLR)	Asaeda et al. 2010; Dumbauld et al. 2022; Silva et al. 2009; Potouroglou et al. 2017
	Improve water quality and reduce turbidity	Findlay et al. 2006; C. Wang et al. 2015; Ward et al. 1984

Increasing rates of climate change and anthropogenic pressures will also likely affect future SAV growth, distribution, and resilience. Short and Neckles (1999) reviewed the potential effects climate change may have on seagrasses, ranging from enhanced growth to habitat loss, because of increased temperature, sea levels, CO_2 concentrations,[2] and UVB radiation. The overall impact of climate change on SAV is expected to be negative when paired with rapid human population growth in coastal areas (Duarte 2002; Freeman et al. 2008; Holon et al. 2015). Although much uncertainty surrounding the possible outcomes remains, numerical models have proven essential tools to better capture potential impacts of climate change on SAV habitats (for example, DeMarco et al. 2018; Dumbauld et al. 2022; Pearson et al. 2021). Many models predict that seagrass beds will migrate shoreward into shallower waters because of decreased light penetration at the deeper habitat limits under rising sea level scenarios (Saunders et al. 2013). However, shoreward migration may be restricted by coastal development, causing an overall loss of SAV habitat (Scalpone et al. 2020) (Figure 1). This process describes *coastal squeeze*, a term initially coined to describe saltmarsh transgression and decline due to the combination of sea-level rise (SLR) and coastal development (Doody 2004) but which also applies to numerous coastal marine habitats, including SAV (Silva et al. 2020).

SUBMERGED AQUATIC VEGETATION (SAV) LOSS AND MITIGATION THROUGH RESTORATION EFFORTS: Multiple restoration efforts have been implemented to mitigate SAV habitat loss, usually at a high cost (Bayraktarov et al. 2016). Overall, restoration-project success rates have been relatively low, with the greatest survival rates occurring in large-scale planting projects (for example, Orth, Luckenbach, et al. 2006; 2010). In these cases, exposure to greater degrees of environmental variability and higher planting densities promote SAV self-sustaining feedbacks (Katwijk et al. 2015). However, restoration science and applications in SAV systems are still in an early stage as compared to terrestrial and freshwater systems. Continued investment in this research will likely enhance rates of future project success.

HISTORICAL DREDGING IMPACTS ON SAV: Open-water placement of dredged material in denuded areas, which, apart from inappropriate depths, are otherwise suitable for SAV habitat, is a BUDM restoration opportunity that has not been widely pursued, largely because of regulatory restrictions in place to ensure minimal water-quality and habitat degradation. Dredging and dredged material placement have historically had a negative association near SAV habitats because of the removal of plants (direct impact), if located within the dredging footprint, and temporary water-quality degradation (indirect impact). Most of the approximately 21,000 ha seagrass loss that has been attributed to dredging since the 1950s resulted from direct impacts from using outdated and discontinued practices (Erftemeijer and Lewis 2006).

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[2] For a full list of the spelled-out forms of the chemical elements used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 265, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

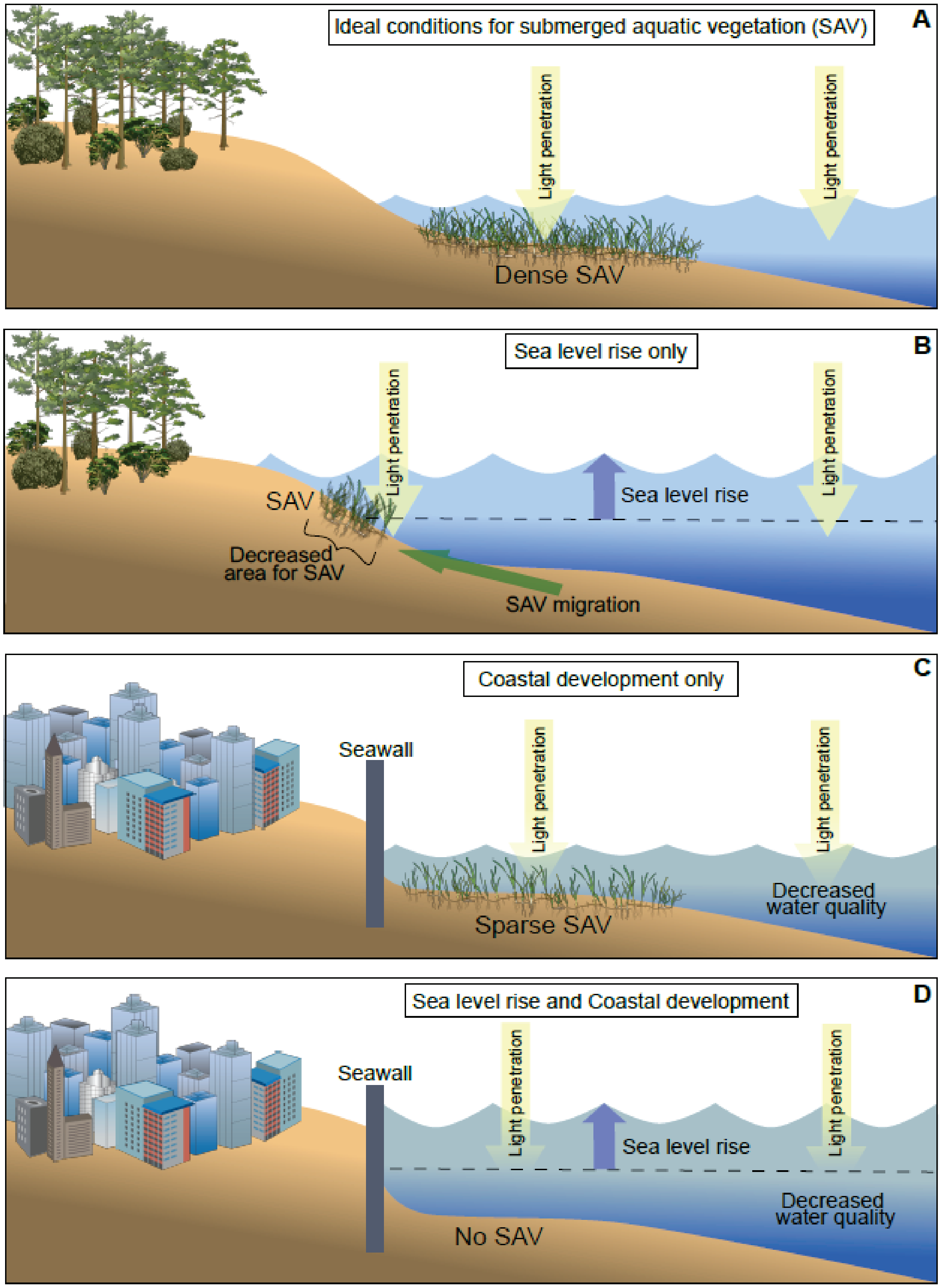

Figure 1. Four scenarios illustrating how submerged aquatic vegetation (SAV) habitat may thrive in (*A*) ideal conditions or how SAV habitat may decline because of (*B*) sea-level rise (SLR) only; (*C*) coastal development only; and (*D*) SLR paired with coastal development, termed *coastal squeeze*.

Because SAV habitats have high light irradiance requirements relative to other macrophytes, they are highly sensitive to decreased light availability (Duarte 1991). Therefore, the elevated turbidity, increased light attenuation, and enhanced sedimentation that occurs during dredging and placement activities are major concerns in these habitats (Sabol et al. 2005; Shafer et al. 2016). However, dredge-induced turbidity plumes are generally short lived and often within the range of natural turbidity fluctuations in coastal areas (Shafer et al. 2016; Fall et al. 2021). Although dredging has been associated with seagrass loss because of persistent increased turbidity, this association is likely because of the placement of fine-grained material, which is highly prone to resuspension within a dynamic environment (Onuf 1994). In the United States, more recent dredging actions (since the early 2000s) implement environmental-management techniques, including sediment-plume modeling to help forecast dredge-induced turbidity and water-quality monitoring to help track in situ conditions during dredging activities, which have resulted in dredging practices with minimal or no impacts to seagrass beds (Erftemeijer and Lewis 2006; CWA Section 404).[3]

Dredging activity impacts on SAV depend on (i) dredged-material-specific factors such as volume, duration, frequency, and material-placement methods; (ii) environmental factors such as sediment grain size, water depth, and hydrodynamics; and (iii) plant-specific factors such as their tolerance to suboptimal light conditions and sedimentation rates, which vary considerably by species (Erftemeijer and Lewis 2006, Fraser et al. 2017). Although few published studies have tracked SAV habitat recovery following dredging, SAV habitats showed significant recovery within two to three years following an initial decline (Sheridan 2004b; Sabol et al. 2005). However, these habitats are naturally dynamic, and dredging may not be the only factor that affects their coverage (Sabol et al. 2005; Long et al. 1996). There have also been a few attempts to vegetate dredged deposits through seagrass transplantation, but these have been unsuccessful because of lower light levels caused by wind-driven sediment resuspension and elevated ammonium concentrations relative to the native environment (Kaldy et al. 2004).

BENEFICIAL USE OF DREDGED MATERIAL (BUDM) IN SAV RESTORATION: SAV habitats continue to face a variety of natural and anthropogenic threats that are expected to be exacerbated by climate change and increasing human population growth. Despite efforts to protect and conserve existing beds, additional restoration of these habitats is imperative to slow or reverse the current trajectory and reclaim valuable ecosystem services. Using clean dredged material to elevate barren areas (as described through guidance from USACE 2015) to depths that can support SAV is a restoration technique that can both expand suitable SAV habitat to recently or historically unvegetated areas and keep sediment in the littoral system and out of navigation channels. These BUDM opportunities will provide both environmental and economic benefits. Using open-water placement to create and expand SAV habitats (and support their various ecosystem services) will allow SAV beds to keep pace with SLR while also lowering material transport costs by not having to place sediment offshore or in upland confined disposal facilities. And open-water placement will help maximize BUDM (currently 40%; Esri et al. 2022) in accordance with the Water

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[3] Federal Water Pollution Control Act of 1948 § 404. 2021. 33 U.S.C. § 1344 (as amended in 2016 by Pub. L. No. 114-322). https://www.govinfo.gov/content/pkg/USCODE-2021-title33/pdf/USCODE-2021-title33-chap26-subchapIV-sec1344.pdf.

Resources Development Act of 2022[4] and LTG[5] Spellmon's 70/30 Goal to increase BUDM to 70% by 2030 (Coleman 2022; see also Brutsché 2022 for more information on the 70/30 Goal).

SAV has proven to be resilient to short-term dredging impacts, especially with improvements in modeling and monitoring techniques to help minimize impacts to sensitive habitats (Sheridan et al. 2004a; Shafer et al. 2016). However, there is a dearth of information regarding long-term outcomes of dredging near SAV habitats because there are few examples of postdredging SAV monitoring, which severely limits our understanding of potential benefits and caveats (Erftemeijer and Lewis 2006, Sabol et al. 2005; Sheridan 2004b).

Many of the regulatory restrictions (that is, CWA Section 404[6]) that preclude innovative dredging and placement activities surrounding SAV habitats may be unnecessarily prohibitive because the focus has been skewed towards the temporary, potentially negative impacts rather than the longer-term results. Therefore, field-based demonstrations need to be developed and monitored to showcase both positive and negative dredging effects on SAV habitats over both short and long timescales. A robust, long-term monitoring program is imperative to maximize our understanding of how BUDM can promote and enhance SAV sustainability. Proof-of-concept studies like the examples presented in this technical note will further help determine the future of similar BUDM opportunities by documenting best practices to optimize favorable results.

EFFECTIVE USES OF DREDGED MATERIAL FOR SAV RESTORATION: Numerous previous studies that examine the short-term negative influences of active dredging on SAV provide insight into nonideal conditions for SAV growth and survival. However, less is known about possible long-term positive influences dredged-material placement has on SAV restoration, expansion, or novel colonization. Therefore, combining previously published work and more recent in situ observations, we suggest several conditions and scenarios that merit further exploration to determine whether dredged material can be strategically placed to promote SAV coverage expansion.

According to conditions in which SAV most often thrives and systems in which navigation-channel dredging regularly occurs, BUDM in SAV restoration efforts should be pursued in shallow coastal and estuarine systems that are experiencing benthic elevation loss because of SLR but are otherwise mostly optimal for SAV growth and survival. Systems experiencing SLR without heavy coastal development represent the potential for shoreward expansion of benthos available to SAV. Areas that were previously fully or partially aerially exposed during the tidal cycle may become ideal for SAV colonization through SLR-related water-depth increases (Dumbauld et al. 2022; Figure 1*B*). The BUDM may supplement these systems to maintain or expand SAV in deeper areas, farther from shore, where SLR would otherwise outpace SAV depth and light irradiance requirements. Furthermore, areas that historically had SAV but are now barren, or historically

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[4] Water Resources Development Act of 2022, Pub. L. No. 117-263, 136 Stat. 3691–3857. https://www.govinfo.gov/content/pkg/PLAW-117publ263/pdf/PLAW-117publ263.pdf.

[5] For a full list of the spelled-out forms of the title abbreviations used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 227–30, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

[6] 33 U.S.C. § 1344.

unvegetated areas down current of existing SAV beds that are otherwise suited to SAV aside from depth conditions, are ideal BUDM sites.

In cases where SAV habitat exists but will soon be outpaced because of SLR, thin-layer placement (TLP) of dredged material may be considered to assist SAV sediment-accretion rates and maintain optimal benthic depth. Although widely used in marsh-restoration projects (Ray 2007), TLP applications in SAV habitats will likely face many regulatory challenges since they involve intentionally adding sediment to SAV beds. However, TLP may be justifiable if the SAV habitat would likely disappear without intervention because of SLR. Future research and field-based case studies are needed to help constrain TLP timing and volumes to achieve optimal SAV benefits.

There are likely many novel opportunities to create natural and nature-based features (NNBF), which often use BUDM (see, for example, Bridges et al. 2015), to restore and expand SAV habitats. For example, BUDM can be used in part to build longshore bars that act as breakwaters and encourage SAV development in the more quiescent region behind the built structure (Greening et al. 2011). However, this type of structure is more likely to be included as part of a large-scale restoration project rather than be considered as a cost-effective material-placement alternative, relative to the federal standard, because of planning and constructions costs.

Systems with heavy coastal development or persistent water-quality issues such as high input of nutrient runoff from agriculture or point sources (Li et al. 2019), or high water-column turbidity due to wave energy or bioturbation (Stevens and Lacy 2012; Townsend and Fonseca 1998; Kaldy et al. 2004) should not be chosen as BUDM-SAV restoration sites. Therefore, these factors need to be analyzed prior to site selection to maximize project success. In addition, dredged sediments should be allowed to settle (that is, become compact and stable) potentially for several years prior to the initiation of SAV restoration efforts (see Kaldy et al. 2004). Otherwise, the system chosen should have low wind, wave, and current energy. This low-energy system will help prevent seeds or transplanted plants from being buried to suboptimal sprouting depths or scoured from the site prior to root establishment.

Habitat-restoration protocols emphasize that site selection is one of the most important steps in restoration efforts (Short et al. 2002; Katwijk et al. 2009), and the BUDM for SAV restoration is no exception. If initial SAV colonization of dredged placement sites is successful, several positive feedback loops may be initiated and lead to further growth and restoration success. Established SAV populations can improve water clarity and quality, stabilize sediments, and form the foundation for coastal ecosystems, all of which can positively affect the further expansion of SAV beds and prevent shoaling of sediments back into navigation channels (Maxwell et al. 2017; van der Heide et al. 2007). Further, established SAV habitats may have the ability to keep pace with SLR, self-maintain, and expand in coverage (Dumbauld et al. 2022), therefore reducing the need for repeat placements in the future.

CASE STUDIES: The accumulation and examination of case studies where (1) SAV has naturally recovered from dredging activity and (2) dredged-material placement sites have been opportunistically colonized by SAV are paramount to improving dredging regulations and BUDM protocols. Through the synthesis of such case studies, we can better understand the dredging activity and placement specifications, timing, locations, hydrodynamics, water-quality parameters, and material compositions that are most ideal for SAV recovery and opportunistic colonization.

Furthermore, we can use findings from natural opportunistic colonization events to (i) devise thresholds and benchmarks for water-quality and sediment-composition parameters, (ii) determine ideal system hydrodynamics and sedimentation conditions, and (iii) identify SAV species most suited for dredged-material colonization, all of which will inform the design of protocols for purposeful BUDM in SAV recovery and restoration efforts.

Several recorded instances exist where dredging within or nearby SAV has imposed short-term negative impacts on SAV coverage, yet over longer timescales SAV has recovered within the footprint of the initial dredging's direct and indirect impacts. Case studies also show opportunistic SAV colonization of dredged-material placement sites. Recovery and opportunistic colonization cases are described in brief below.

1. Wood Island Harbor, Maine—In 1990 the US Army Corps of Engineers–New England District (NAE) dredged the Biddeford federal navigation channel through a 610 × 30 m section of eelgrass (*Zostera marina*) (Figure 2). Surveys of the channel in 2016 indicated eelgrass recovery in several portions of the channel, with full recovery apparent in some areas. The channel was dredged again during the winter of 2020, directly affecting (via vegetation removal) an estimated 1.2 ha of eelgrass. By the summer of 2021, preliminary surveys again showed eelgrass recovery along the slope of the newly dredged channel (Altman et al. 2023, 14; USACE-NAE 2020; Sabol et al. 2005).[7]
2. Scituate Harbor, Massachusetts–During the winter of 2002, NAE dredged the harbor at ship anchorage and navigation channel locations. During this dredging event, direct impacts to SAV included removal of eelgrass within the anchorage dredging area footprint. In addition, indirect impacts on SAV, due to silt-screen failure, resulted in siltation of eelgrass outside the footprints of both the anchorage and channel-dredging areas. Overall, eelgrass in the Scituate Harbor experienced a 34% decline in coverage from immediately pre- to postdredging, followed by an 8% relative increase in coverage from 1 to 2 years postdredging, all within the indirectly affected zones. Notably, nearby undisturbed sites showed normal interannual variation in seagrass coverage similar to those areas indirectly affected by dredging (Sabol et al. 2005; Sabol and Shafer 2005). Additional SAV recovery beyond two years postdredging was not assessed.
3. Laguna Madre, Texas–Between 1994 and 1995, 6 out of 13 dredged-material placement sites chosen along the Gulf Intracoastal Waterway resulted in benthos within the depth range suitable for seagrass, and each site had existing fringing seagrass partially or completely surrounding the placement locations. After dredged-material placement completion, within 3 years 75% of nonvegetated areas were either colonized by seagrass or lost sediments at rapid rates because of wind and wave action. Areas within 5 m of existing seagrass exhibited rapid seagrass colonization and had full seagrass coverage within 1.5 years. Placement area centers exhibited slower colonization yet reached 48% coverage within 3 years and near full coverage in 3–5 years (Sheridan 2004a, 2004b).

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[7] See also USACE-NAE (US Army Corps of Engineers–New England District), *Island Harbor and the Pool at Biddeford Federal Navigation Maintenance Project, Biddeford, Maine: Eelgrass Damage Assessment and Mitigation Plan (DAMP)*, Working Draft – Not for Further Release (Concord, MA: US Army Corps of Engineers–New England District, 2020), https://www.biddefordmaine.org/DocumentCenter/View/7481/USACE-Eelgrass-Damage-Assessment-and-Management-Plan.

4. Barnegat Bay, New Jersey–A dredged-material placement site, 26B, used 16 times from 1981 to 2017 in the lower Barnegat Bay, west of Island Beach State Park, resulted in an emergent island and a decrease in benthic depth in the surrounding area. Although initially unvegetated when open-water placement began, SAV, primarily composed of eelgrass, opportunistically colonized the area surrounding the island, first documented in aerial imagery in 1995. In the following decades the SAV bed continued to expand, with minimal retraction in some areas, forming a contiguous meadow surrounding the island by 2015 (Figure 3). This new seagrass bed will continue to be monitored through aerial imagery and field surveys to compare with seagrass colonization on a new, adjacent open-water placement site.

This relatively low number of case studies exemplifying dredging-related SAV recovery and colonization is likely due to the lack of long-term, postdredging SAV monitoring. Further, the SAV recovery examples show that monitoring-timescale length can produce different results. Although Wood Island Harbor showed more extensive SAV recovery after the 1990 dredging event than the modest recovery following the 2002 dredging activity in Scituate Harbor, Scituate Harbor was only monitored for 2 years after dredging, while Wood Island monitoring captured the cumulative results over a 30-year period. Current and future efforts should consider monitoring SAV around dredging activity for much longer time periods to capture SAV recovery over numerous growing seasons.

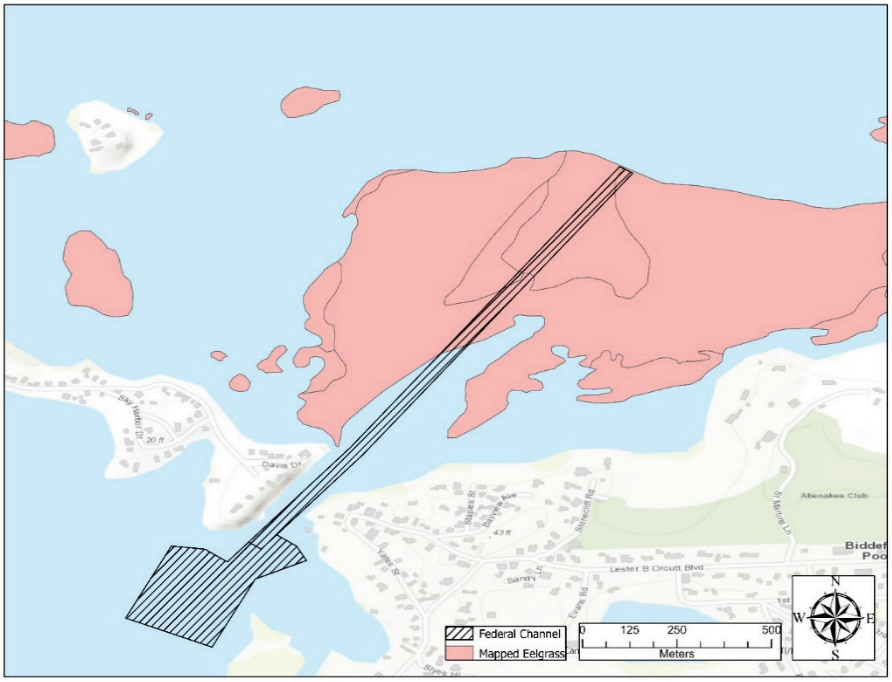
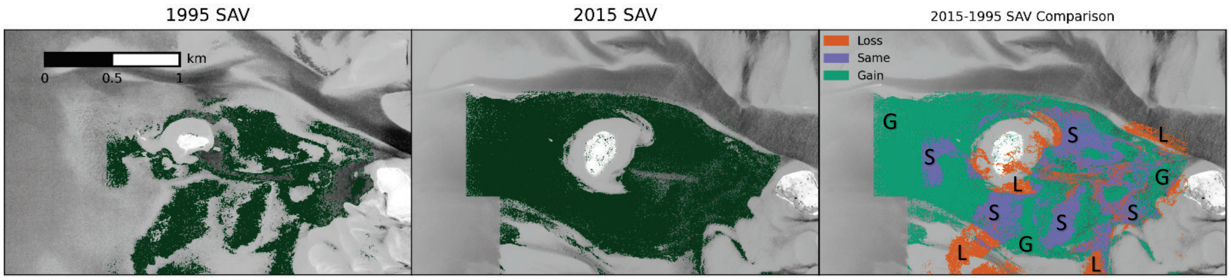


Figure 2. Wood Island federal navigation channel (*black hashed area*) and eelgrass coverage (*pink area*) according to a 2002 survey sourced from www.northeastoceandata.org. Figure reprinted from Altman et al. (2023), 15. Public domain.



1995 SAV

2015 SAV

2015-1995 SAV Comparison

Figure 3. Areal coverage of SAV determined using supervised classification of high-resolution (1 m) National Agriculture Imagery Program data at dredged-material placement site 26B in Barnegat Bay, New Jersey, in 1995 (*left*) and 2015 (*middle*). A comparison of the SAV coverage from 1995 to 2015 (*right*) revealed an overall gain (*green*, *G*) in SAV coverage, with a large portion of the area remaining the same (*purple*, *S*) in SAV coverage and a small proportion exhibiting loss (*orange*, *L*).

The dearth of examples of SAV colonization following dredged-material placement is also related to lack of monitoring, which may be because SAV monitoring is not considered for unvegetated open-water placement sites. Therefore, future efforts should monitor SAV if the altered placement-site characteristics are conducive to SAV colonization—especially if placement occurs near existing beds.

SAV recovery and opportunistic colonization are currently being monitored in recently completed and ongoing BUDM projects, which include (i) a second open-water placement site in Barnegat Bay (site 6), approximately 1 km west of 26B; (ii) the restoration of an eroding island in the Chesapeake Bay (Swan Island, Maryland), which is fringed by discontinuous SAV beds; and (iii) the restoration of a barrier island in Mississippi Sound (Ship Island, Mississippi) that was split into two segments following Hurricane Camille (1969), which supports patchy and reduced (relative to prebreach conditions) seagrass habitats in more-protected areas. These ongoing projects may present future case studies for analysis of seagrass colonization in real time. By further examining instances where dredged-material placement sites have naturally and successfully been colonized by SAV, we can strategically choose new placement locations where these ideal conditions are recreated to either encourage further natural SAV colonization events or more purposefully pair BUDM efforts with large-scale SAV habitat-restoration projects.

BUDM and SAV restoration can be paired to cobenefit coastal ecosystems and economies through improved secondary production of fishery species, shoreline stabilization, and wave attenuation. Further, strategic sediment placement to augment SAV beds will reduce long-term channel backfilling by minimizing sediment resuspension and erosion over time. This reduction will diminish the need for frequent and costly channel-dredging projects, leaving shipping channels and ports unhindered for extended periods. Finally, using dredged material as a component of SAV restoration practice has the potential to create and perpetuate positive feedback loops between sediment accretion and improved water clarity, which will facilitate continued SAV growth to help keep pace with SLR.

SUMMARY: SAV and its provided ecosystem services have experienced marked declines during the twentieth and twenty-first centuries. Efforts to restore these foundational coastal marine habitats are often highly expensive and have relatively low success rates. Navigation-channel dredging formerly had negative impacts on SAV habitat, by direct impacts (that is, SAV removal or burial) and indirect impacts (that is, increased water-column turbidity, reducing light availability). Since the early 2000s, dredge designs and protocols have been improved such that negative impacts on SAV are minimized. Further, recent observations of SAV recovery and colonization of dredged-material placement sites suggest burgeoning opportunities to leverage BUDM in SAV restoration efforts. This technical note provides background on SAV decline and former dredging impacts then further proposes several site-selection criteria for BUDM in SAV restoration efforts. This technical note also describes case studies of SAV that has recovered following dredging impacts or opportunistically colonized dredged-material placement sites, which provides context for future BUDM opportunities.

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