



The Use of Native Vegetation and Natural Materials in Shoreline Stabilization: A Case Study of Bubble Gum Beach, Rehoboth Beach, Delaware

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PURPOSE: This technical note is the fourth in a series about using native plant communities to achieve engineering and ecological purposes such as shoreline stabilization, structural enhancements, habitat creation, and ecosystem development. In this series, we demonstrate the utility of natural materials (specifically, native vegetation, oyster reefs, and coir logs) in living shoreline projects. Plant species and plant communities play critical roles in wave attenuation and sediment accretion in coastal areas. The application of vegetation in the coastal areas, especially on the East and Gulf Coasts, has focused heavily on the creation of living shorelines—serving both environmental and engineering purposes. This technical note documents the workshop conducted by the US Army Engineering Research and Development Center (ERDC) and hosted by the US Army Corps of Engineers’ (USACE) Philadelphia District (NAP) and Center for the Inland Bays. The goals of this technical note are (1) to demonstrate the application of native plant communities, oyster shells, and coir (coconut) materials and their installation techniques along shorelines to the engineering community; (2) to demonstrate how targeted vegetation establishment can facilitate ecosystem development along shorelines to improve engineering and environmental outcomes; and (3) to provide native vegetation installation techniques for living shorelines projects’ purposes.

BACKGROUND: Historically, engineering practices to stabilize shorelines encompass the use of rock structures (for example, stone revetment) (USACE 2002). However, recent advancements in the understanding of the properties of plants and their potential use to supplement or replace rock structures has led to greener or *softer* alternatives. These softer structures provide both stabilization properties as well as ecological value. Basic ecological studies show that wetland plants hold soil in place with their roots, absorb the energy of waves, and slow the flow of stream or river currents along the shore (Mitsch and Gosselink 2000). In addition, research has shown that vegetation provides important engineering functions, including restraining and protecting soil as well as increasing the strength and competence of the soil mass (Coppin and Richards 1990). Laboratory studies also show that both emergent and near-emergent vegetation can attenuate wave energy from stimulated coastal storms (Augustin et al. 2009). Furthermore, created *Sporobolus alterniflorus* salt marshes have proven to provide value to fisheries and nekton despite some not achieving full functionality of a natural marsh (Minello and Webb Jr. 1997). O’Donnell (2017) discussed the acceptance of living shorelines in the Northeast, as well as nationwide, with examples of completed projects from across the nation. O’Donnell further describes the various types of living shorelines and includes a thorough comparison of the pros and cons associated with each type. Many states have now published living shorelines guidelines for practitioners to follow, such as the New Jersey Department of Environmental Protection’s *Living Shorelines Engineering Guidelines* in 2015 (Miller et al. 2016). Furthermore, USACE created a nationwide permit for living shorelines in 2017 as a result of public demand and acceptance of living shorelines.

CASE STUDY: ERDC and the NAP conducted a field-based Engineering With Nature® (EWN®) workshop that was hosted by the NAP and Center for the Inland Bays 10–11 April, 2018. The EWN workshop took place both in the classroom and in the field, demonstrating how the application of native plant species, clean sand, oyster shells, and coir logs can enhance engineering objectives while also providing important wildlife habitat. The addition of vegetation to an existing revetment resulted in nature-based features that attenuate waves, build dunes, create wildlife habitat, and prevent erosion in areas located along Bubble Gum Beach, Indian River Inlet, Delaware Bay, and the surrounding ecosystems. The workshop offered an interagency group field experience in conducting living shoreline plantings while providing insights and instructions for incorporating EWN principles into existing projects. This workshop is the second of a series of field-based, EWN workshops facilitated by ERDC to train USACE engineers, scientists, and project managers on new techniques to manage existing engineering structures using native vegetation.

In June 2016, the NAP was selected as an EWN *Proving Ground*. This status was conferred on NAP on the basis of its pursuit of EWN practices. ERDC and the NAP subsequently explored the use of native vegetation on projects as part of an overall EWN approach. In March 2016, USACE and the National Oceanographic and Atmospheric Administration (NOAA)–National Ocean Service (NOS) conducted a collaborative workshop on natural and nature-based features (NNBF). During this workshop, participants identified several NNBF collaborative projects and the use of native vegetation on dredged material placement areas as a priority for the application of EWN principles and practices on a national scale. Currently, this concept is being expanded to other areas such as USACE dams, reservoirs, parks, and public and private lands.

This ERDC-NAP EWN demonstration workshop included 30 participants representing ERDC, Philadelphia District, St. Louis District, Norfolk District, the US Fish and Wildlife Service’s New Jersey and Delaware field offices, the US Department of Agriculture–Natural Resources Conservation Service, the Delaware Department of Natural Resources and Environmental Control, Texas A&M University, and the nonprofit organization the Center for the Inland Bays (CIB). The workshop brought together a diverse group consisting of engineers, wildlife biologists, marine biologists, soil scientists, and ecologists. The location of the workshop was at Bubble gum Beach in Delaware Seashore State Park in Rehoboth Beach, along the Indian River Inlet in Sussex County, Delaware (Figures 1 and 2). The project area and adjacent water are habitat to multiple fauna. Both Horseshoe crab and Diamondback terrapin were also observed on the project site during the planting workshop.

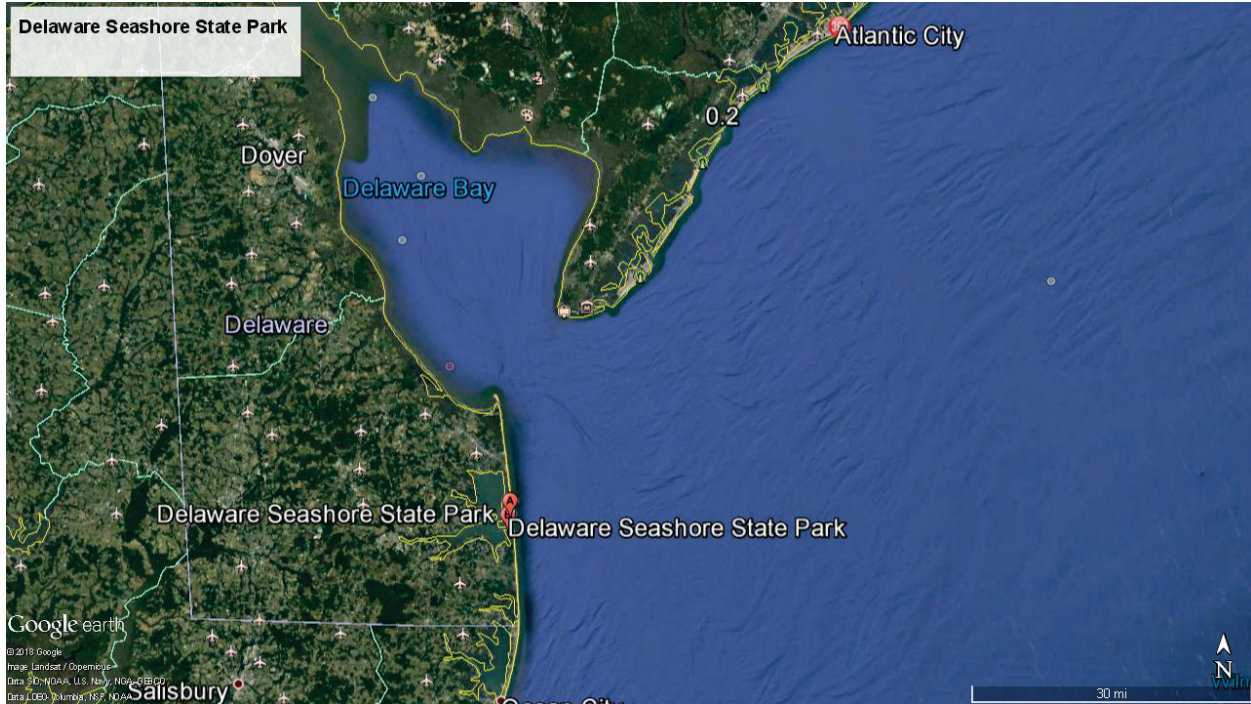


Figure 1. Delaware Seashore State Park, Delaware.



Figure 2. Bubble gum Beach, adjacent to Delaware Seashore State Park, the Engineering With Nature® (EWN®) is the workshop location.

The existing condition of the site consisted of an eroding beach dune located behind a previously constructed stone revetment (Figure 3). Despite the revetment, the upper beach area continued to erode (Figure 4).



Figure 3. Existing conditions of Bubble gum Beach showing severe escarpment behind the existing riprap (November 2017). (Photo credit: Mark Eberle.)



Figure 4. Existing condition of the site showing upper beach erosion landward of the shoreline (November 2017). (Photo credit: Mark Eberle.)

In 2017, ERDC developed a conceptual design for Bubble gum Beach (see Figure 5). The conceptual design called for a living shoreline approach, using both sand and native vegetation, behind the existing revetment. In addition to the sand and vegetation, oyster shells were also used during design implementation.

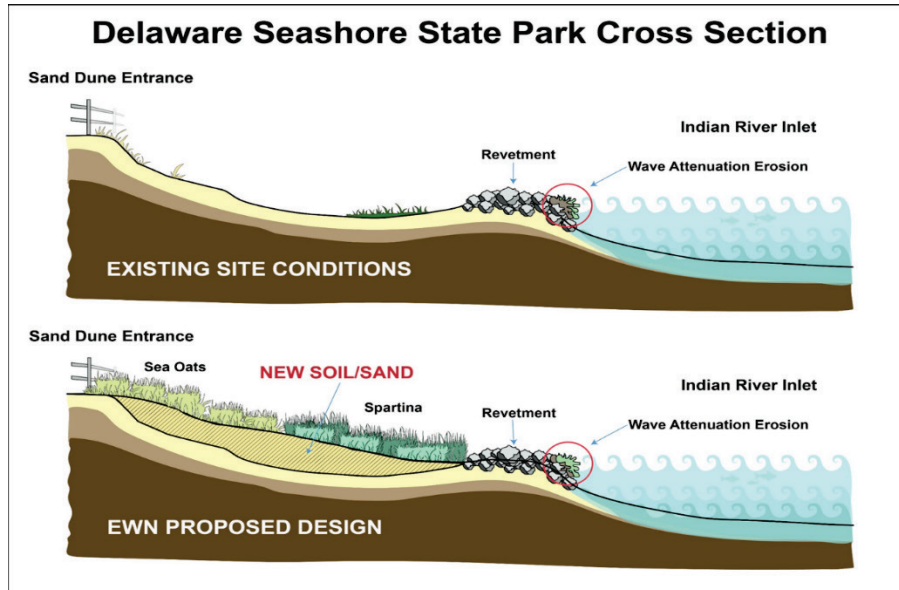


Figure 5. Conceptual design for Bubble gum Beach EWN site. (Design, Drawing, and Illustration credit: Brian Durham).

As part of the design implementation, 40 yd³ (30.6 m³) of beach grade sand was placed on the dune in March 2018 (Figure 6), before planting with native vegetation.

VEGETATIVE SURVEY: Prior to project implementation, a vegetative survey was completed in February 2018. Plant species found on the site included smooth cordgrass (*Sporobolus alterniflorus*), saltmeadow cordgrass (*Spartina patens*), saltwort (*Salicornia virginica*), little blue stem (*Schizachyrium scoparium*), and Maryland golden aster (*Chrysopsis mariana*) (Figure 7). Two native species, wild black cherry (*Prunus serotina*) and groundsel tree (*Baccharis halimifolia*), also commonly occur within this community in the upland zones.

USE OF NATURAL MATERIAL: The workshop participants used natural materials in lieu of hard structures for shoreline erosion control. These natural materials included native vegetation and coir logs. Historical information indicated that the Delaware Department of Natural Resources and Environmental Control (DNREC) deployed 18,000 sandbags to the site (Figure 8) as a temporary erosion control in 2006 prior to the construction of the new stone revetment.



Figure 6. Bubble gum Beach after sand placement was completed in March 2018. (Photo credit: Wayne Marston.)

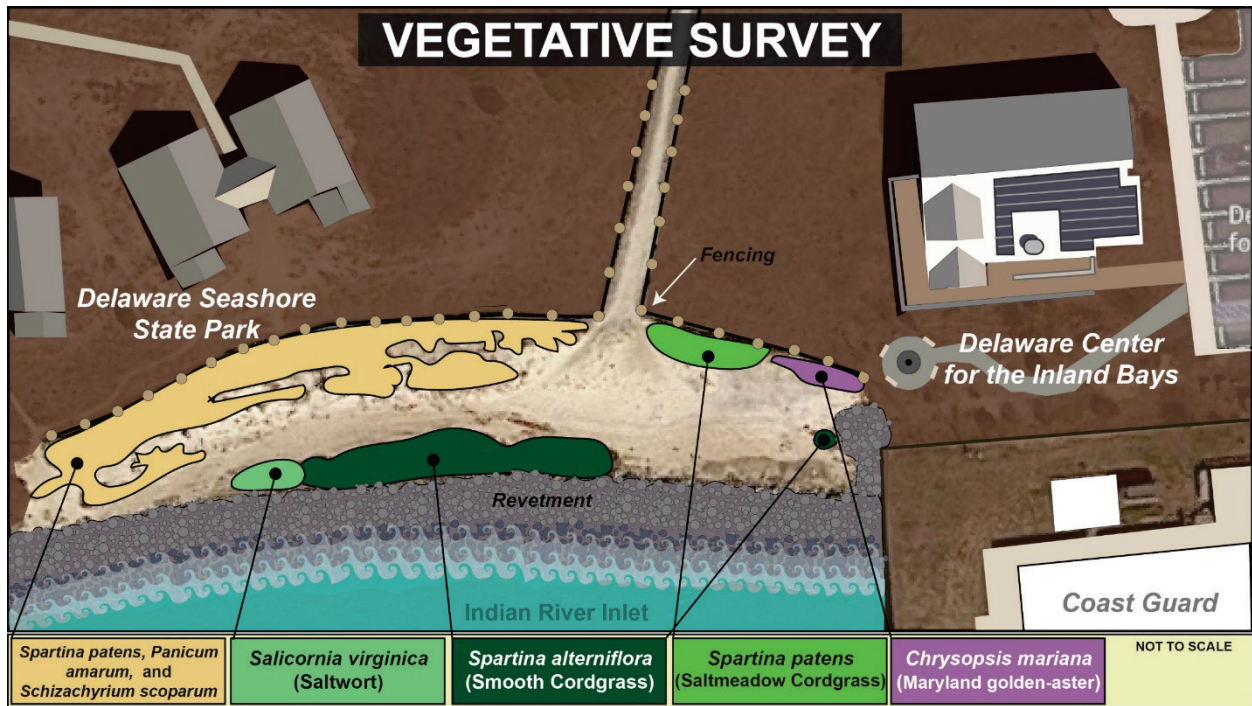


Figure 7. Preproject vegetative survey as completed in February. (Drawing by Brian Durham, 2018).



Figure 8. The deployment of sandbags along the shoreline in Bubble gum Beach in 2006. (Photo credit: Mark Eberle.)

During the 2018 workshop, natural materials used on the site included vegetation, coir fiber logs, and oyster shell bags. Vegetation using native plants stabilized the site, while a 10 ft coir fiber log was used to secure an area of the existing stone revetment (Figure 9). In addition, the team placed approximately eight oyster-shell bags within crevices of the existing revetment to facilitate movement of both diamondback terrapins and horseshoe crabs to Bubble gum Beach (Figure 10).



Figure 9. Coir fiber log installed during the April 2018 workshop within the project location. (Photo credit: Danielle McCulloch.)



Figure 10. Workshop participants with oyster shell bags. Oyster shells were part of nature-based features. (Photo credit: Mark Eberle.)

ECOLOGICAL CONSIDERATIONS: Ecological considerations included soil, elevation, slope, existing plant species, and wetlands. Forty cubic yards of sand was imported to the site from a local sand quarry. The sand consisted of median grain size of 0.3 mm to 0.7 mm. The sand was graded to an approximately 2:1 slope prior to planting. In addition, the tidal regime was an important factor in selecting suitable native species for the site. Additional information on plant selection can be found in the Species Selection section below.

REGULATORY CONSIDERATIONS: The project was coordinated with the landowner, DNREC–State Parks, USACE Regulatory Office, the National Marine Fisheries Service, and DNREC–Wetlands and Subaqueous Land Section, prior to the workshop. The project qualified for Nationwide Permit (NWP) #54 (Living Shoreline), and a Delaware State Subaqueous Lands/Shore Stabilization Permit was issued for the project in March 2018.

In addition, numerous National Environmental Policy Act (NEPA) documents have been prepared over the years for the project area. USACE–Philadelphia District completed a NEPA document in 2006 for extension of the original stone revetment project located adjacent to Bubble gum Beach. In addition, the US Coast Guard completed a NEPA document in 2009 for repair work on an adjacent bulkhead immediately adjacent to the project site. Furthermore, NWP #54 has a completed national NEPA document to cover potential impacts associated with the permitted activity; therefore, additional NEPA documentation was not needed for this project.

PLANTING METHODOLOGY: The planting area was designated into three different zones according to elevation and tidal inundation (Figure 11). Zone 1 and Zone 2, with the most inundation, were planted with smooth cordgrass (approximately 1 ft on center). Zone 2 was also a transition zone and so was planted with Bitter panicum (*Panicum amarum*) (approximately 2 ft. on center). Zone 3 was the top of the dune and highest elevation. This zone was planted with

seaside goldenrod (*Solidago sempervirens*), yellow wild indigo (*Baptisia tinctoria*), beach plum (*Prunus maritima*), winged sumac (*Rhus copallinum*), northern bayberry (*Morella pennsylvanica*), and eastern red cedar (*Juniperus virginiana*).

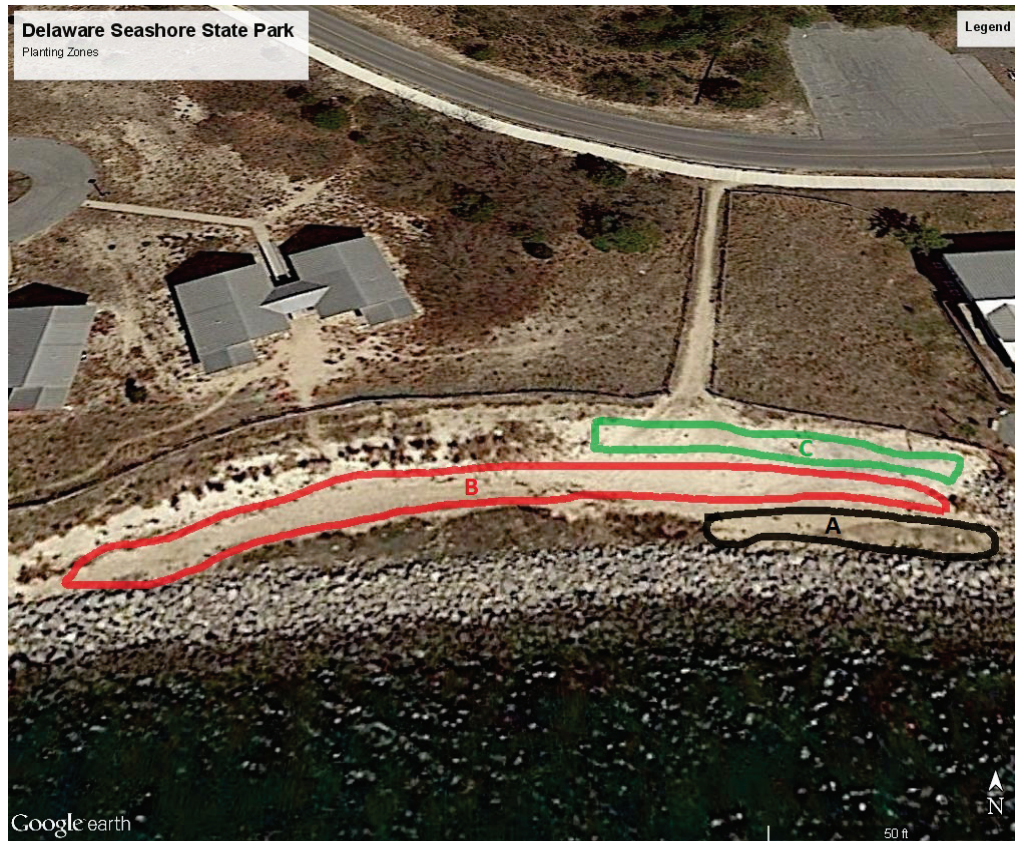


Figure 11. Three planting zones established for Bubble gum Beach EWN® Workshop.

SPECIES SELECTION: Coordination with biologists from USACE-NAP, ERDC, DNREC, and CIB ensured that species selected for the site would be native to Delaware and appropriate for growing conditions at Bubble Gum Beach. Species selected for planting are listed in Table 1.

Species were selected for this site according to their ability to colonize the eroding beach area and thrive in the tidal regime. Their hardiness and suitability for the site were also considered for their ecological value. Smooth cordgrass provides food and cover to a variety of marsh birds and mammals (NRCS 2016). Bitter panicum, or panic grass, is a native warm-season grass that provides cover and habitat for songbirds, waterfowl, and small mammals (NRCS 2006). Seaside goldenrod and yellow wild indigo are important plants for pollinators (bees, butterflies), with goldenrod blooming in late summer, early fall and indigo blooming in the summer. Goldenrod is also a key food source for migrating monarch butterflies (NRCS 2012). Beach plum is a coastal species useful for stabilizing dunes and used by coastal wildlife (NRCS 2009). Winged sumac is a pioneer species that is great winter food for over 300 species of songbirds and many mammals (NRCS 2016). Northern bayberry is a midsized shrub that provides stabilization and year-round cover for wildlife in dune areas of the mid-Atlantic region. The berries of this plant provide a key food source for migrating birds and other resident wildlife (NRCS 2002). As an evergreen, eastern red cedar provides important winter food and cover for numerous birds and mammals (NRCS 2002).

Table 1. Plant species for Bubble gum Beach.

Common name	Scientific name	Planting zone*	% composition of plantings	Spacing on center (ft)	Total plants	Form
Smooth cordgrass	<i>Sporobolus alterniflorus</i>	A*	100%	1	364	2" plug
Bitter panicum	<i>Panicum amarum</i>	B*	100%	2	485	2" plug
Seaside goldenrod	<i>Solidago sempervirens</i>	C*	60% groundcover	2	100	2" plug
Yellow wild indigo	<i>Baptisia tinctoria</i>	C*	40% groundcover	2	74	2" plug
Beach plum	<i>Prunus maritima</i>	C*	30% shrub layer	6	10	#2 container
Winged sumac	<i>Rhus copallinum</i>	C*	25% shrub layer	6	8	#2 container
Northern bayberry	<i>Morella pennsylvanica</i>	C*	25% shrub layer	6	8	#2 container
Eastern red cedar	<i>Juniperus virginiana</i>	C*	20% shrub layer	12	8	#5 container

Participants planted over 1,000 plants in their respective zones (Figure 12 and see planting plan, Figure 13). As a way to protect the newly planted area from foot traffic, approximately 350 linear feet of sand fence was erected around the planted areas (Figure 14).



Figure 12. Photo showing project area immediately after planting occurred in April 2018. (Photo credit: Michael T. Boyle.)

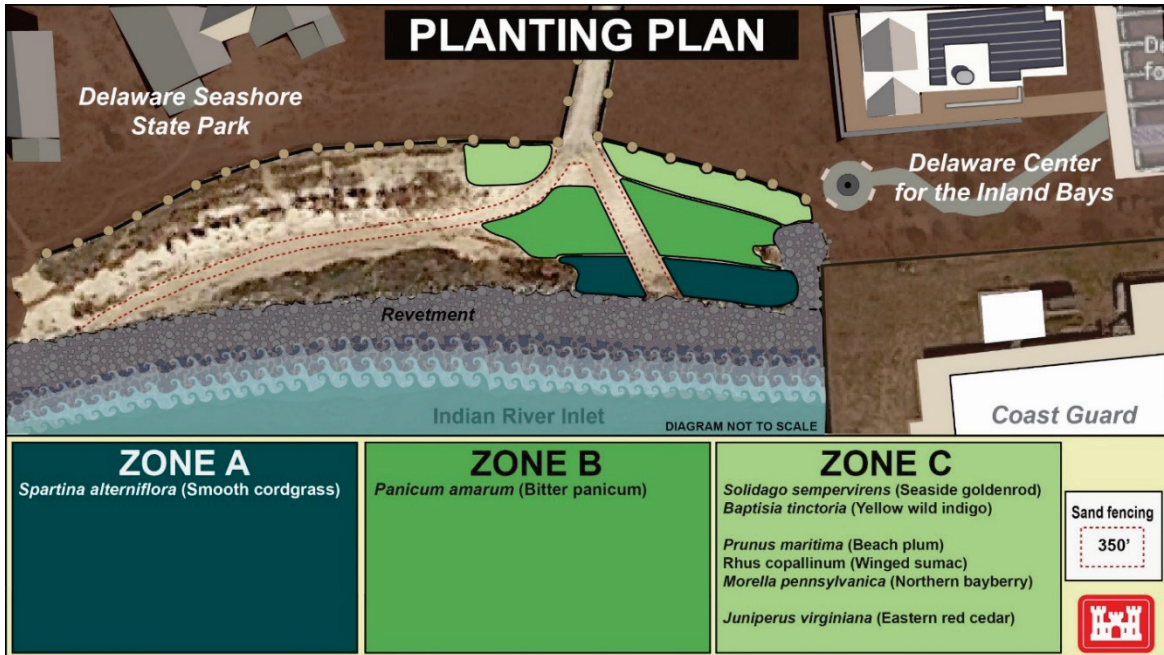


Figure 13. A schematic of the final planting that occurred during the workshop. The site was divided into three zones from the shoreline landward. *Deep green* is Zone A, *intermediate green* is Zone B, and *light green* is Zone C.



Figure 14. Planted area with protective fence installed on edges, serving as walking path. (Photo credit: Bob Collins.)

EARLY RESULTS: A coastal storm occurred approximately one week after the workshop with minimal damage to the vegetation (Figure 15).



Figure 15. Site a during coastal storm on 16 April 2018. The plant species are submerged. (Photo credit: Bob Collins.)

Early indications show the planted vegetation survived the storm and are becoming established on the beach.

As part of an adaptive management plan, additional planting was conducted in October 2018 at the midsection because of susceptibility to erosion (Figure 16). In addition, an erosion control blanket was installed in the midbeach section.



Figure 16. Midbeach loss of plants as of June 2018. Erosion observed in the midsection. (Photo credit: Bob Collins.)

MONITORING: Monitoring of Bubble gum Beach will be completed by staff from CIB. Monitoring will include plant success rate (percent cover) and species composition.

SUMMARY AND LESSONS LEARNED: The majority of the vegetation at Bubble gum Beach appears to be healthy, becoming established within the first six months while also providing some immediate structural stabilization for the newly placed sand on-site. As plants establish, a long-term stability of Bubble Gum Beach will be ensured. The mature ecosystem will then continually improve the habitat for migrating and local wildlife populations. The use of native vegetation and natural engineering features (coir fiber log, erosion control mat), demonstrates that EWN can work in a highly dynamic environment like Indian River Bay, Delaware.

ADDITIONAL INFORMATION: This technical note was prepared by Tosin Sekoni, research ecologist, ERDC; Mark Eberle, biologist, USACE-Philadelphia District; Matthew Balazik, research ecologist, ERDC; Monica Chasten, hydraulic engineer, USACE-Philadelphia District; Bob Collins, program manager Center for Inland Bays; Brian Durham, research ecologist; Darrell Evans, wildlife biologist; and Kevin Philley, research biologist, ERDC. The study was conducted as an activity of the Engineering With Nature program. For more information, please visit www.EngineeringWithNature.org or contact the program managers, Dr. Todd Bridges and Dr. Jeff K. King, at Todd.S.Bridges@usace.army.mil and Jeffrey.K.King@usace.army.mil. This technical note should be cited as follows:

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BIBLIOGRAPHY

- Augustin, Lauren N., Jennifer L. Irish, and Patrick Lynett. 2009. "Laboratory and numerical studies of wave damping by emergent and near-emergent wetland vegetation." *Coastal Engineering* 56.3: 332-340.
- Collins, Bob. 2018. Email from Bob Collins to Mark Eberle dated May 10, 2018.
- Coppin, Nick J., and Ivor G. Richards, eds. 1990. *Use of vegetation in civil engineering*. London: Construction Industry Research and Information Association.
- Delaware Seashore State Park. 2018. Website. <http://www.destateparks.com/park/delaware-seashore/index.asp>.
- Kenneth G. Boykin, Nicole M. Harings, Virginia A. Seamster, N. Forrest East, Rachel K. Guy, and Mark C. Andersen 2016. Methods for Determining Biodiversity Metrics, Focal Species, and Conservation Practices for Multi-scale Analysis in Support of the Conservation Effects Assessment Project (CEAP) Informing Management for Grazing Lands in the Southwest Submitted to: United States Department of Agriculture Natural Resources Conservation Service (NRCS).
- Miller, Jon K., Andrew Rella, Amy Williams, and Erin Sproule. 2016. Living Shorelines Engineering Guidelines. Prepared for New Jersey Department of Environmental Protection by Stevens Institute.

- Minello, T.J., and J.W. Webb, Jr. 1997. Use of natural and created *Spartina alterniflora* salt marshes by fishery species and other aquatic fauna in Galveston Bay, Texas, USA.
- Mitsch, W.J. and J.G. Gosselink, J.G. 2000. *Wetlands*: Third Edition. John Wiley & Sons, Inc. New York.
- NOAA. 2018. Available at <https://tidesandcurrents.noaa.gov/waterlevels.html?id=8557380> Accessed 11/12/2019.
- O'Donnell, J.E.D., 2017. Living shorelines: A review of literature relevant to New England coasts. *Journal of Coastal Research*, 33(2), 435–451. Coconut Creek (Florida), ISSN 0749-0208.
- USACE. 2002. Coastal Engineering Manual. EM 1110-2-1100. April 30, 2002.
- USACE. 2009. Environmental Assessment for the Indian River Inlet and Bay Maintenance Dredging and Beneficial Use of Dredged Material Project. Philadelphia District. Philadelphia, PA.
- USDA - NRCS. 2002. *Juniperus virginiana* Fact Sheet. <https://plants.usda.gov/core/profile?symbol=JUVI>
- USDA - NRCS. 2002. *Morella pennsylvanica* Fact Sheet. <https://plants.usda.gov/core/profile?symbol=MOPE6>
- USDA - NRCS. 2006. *Panicum amarum* Fact Sheet. <https://plants.usda.gov/core/profile?symbol=PAAM2>
- USDA - NRCS. 2009. *Prunus maritima* Fact Sheet. <https://plants.usda.gov/core/profile?symbol=PRMA2>
- USDA - NRCS. 2012. *Baptisia tinctoria* Fact Sheet. <https://plants.usda.gov/core/profile?symbol=BATI>
- USDA - NRCS. 2012. *Solidago sempervirens* Fact Sheet. <https://plants.usda.gov/core/profile?symbol=SOSE>
- USDA - NRCS. 2016. *Rhus copallinum* Fact Sheet. <https://plants.usda.gov/core/profile?symbol=RHCO>
- USDA - NRCS. 2017. *Spartina alterniflora* Fact Sheet. <https://plants.usda.gov/core/profile?symbol=SPAL>