Management Strategy: Marsh Migration Buffer Zones

Marshes globally are being threatened by rapid sea level rise, which was on average 4.1 mm yr^{-1} in 2014 for the Chesapeake Bay and continues to accelerate[1]. When marshes are not able to accumulate enough sediment to keep up with sea-level rise, marshes respond by either migrating upland or drowning. Drowning of marshes, or "coastal squeeze" results when there are barriers or coastal development that inhibits marsh from migrating inland[2]. A healthy marsh migration is key for the conservation of these vulnerable ecosystems and their ecosystem services for coastal communities. Landscape characteristics, marsh fragmentation, and biophysical processes influence marshes' ability to migrate, however, some modifications may facilitate marsh migration in areas that are more vulnerable to drowning. Examples of marsh migration buffer zones techniques include land protection, removal of barriers, upland space conversion, ditch remediation, and contouring of adjacent slopes.

- **Land protection (Easements and Purchases)**

Conservation easements are voluntary legal agreements designed to ensure the long-term viability and protection of the natural resources within a surveyed and recorded boundary. The easement planning process establishes allowances and restrictions that are beneficial to the landowner, the easement holder, and the environment. Conservation easements are perpetual or 30-year term and remain in place with each change in land ownership. The Prince George tract in South Carolina is an example of conservation easement, which protects 1,065 acres of saltmarsh from future development[3]. Stewardship of a conservation easement generally includes initial costs (e.g., documentation and signs), annual monitoring, landowner communications, legal, easement enforcement, amendments, and indirect costs. According to reports of land trusts, the annual stewardship costs ranges from $431 to $1500 per easement (excluding costs to resolve major violations)[4].

Figure 1. The Blackwater National Wildlife Refuge in Maryland is an example of land protection. Credits: Will Parson/Chesapeake Bay Program

Purchased land protection refers to land that is purchased from the owner and is publicly owned or managed by a government agency. There are not agreements or restrictions in this type of land protection (may allow resource extraction, subdivision/sale). Typically, purchased land protection later becomes public conservation land (such as State Park, or Wildlife Management Area), whereas a conservation easement protects land that remains private property[5]. The Blackwater National Wildlife Refuge in Maryland is an example of purchased land protection and is currently managed by the U.S. Fish and Wildlife Service. The first 8,241 acres were acquired from Delmarvia Fur Farms in 1933, to provide sanctuary for the migrating birds.

- **Convert upland space (e.g., farmland to marsh)**

Many coastal marshes are bordered inland by agricultural fields. As sea levels rise, agricultural fields are becoming inundated with salt water, limiting the land available for farmers to grow the crops that they grew previously. Conversion of upland space to marsh is an opportunity for farmers to both protect their future finances and create space for inland marsh migration. Allowing marshes to migrate into salt-impacted farms can protect crops further inland by absorbing flooding events and preventing salt-water intrusion of cropland, allowing farmers to continue to farm some of their land as sea level rises. This management approach requires collaborative work with farmers, farmer compensation, and technical support to prevent invasive species from encroaching on land[6].

Figure 2. Marsh migration into agricultural fields in Dorchester county, Maryland. Credits: Jay Fleming

An example of this management technique is a project of the U.S. Department of Agriculture's Natural Resource Conservation Service conducted in the Chesapeake and Delaware Bay starting in 2017. This project pays landowners to create American black duck habitat that will also serve as migration buffer for the marsh[6].

- **Removal of infrastructure/barriers**

This management type focuses on enhancing adaptation in marshes, by removing infrastructure or topographical barriers to inland migration[7]. One example of barriers for marsh migration are "aquatic barriers", which are human-made structures that impede flow, fluvial, and coastal processes (e.g., dams, coastal stabilization structures)[8]. Other barriers can be natural topographic barriers, hardened shorelines, roads, and other infrastructure. The cost of removal of infrastructure/barriers varies widely as it depends on the economic value of the infrastructure/barrier in addition to design/construction costs.

- **Ditch remediation**

In addition to altering hydrological connectivity, ditches in saltmarshes represent a barrier to marsh migration. Ditch remediation is the natural regenerative process that uses hydrology and vegetation to mend ditches from the bottom up, restoring natural marsh function[9]. The remediation process involves placing layers of organic growing medium and vegetation (can also be collected from higher areas of the marsh), raking it into the low ditches and holding the grasses in place with twine, resulting in 5 to 10 cm of elevation to the ditch floor each growing season[10]. An example of ditch remediation is the project at the Parker National Wildlife Refuge in Massachusetts, where they started implementing ditch remediation in 2014, observing increases in elevations of 5-20 cm in the treated ditches in just six months[10,11].

Figure 3. Ditch after remediation project at Parker River Refuge, Massachsetts. Credits: Margie Brenner/USFWS

- **Contour adjacent slopes**

Marsh migration potential is influenced, among other factors, by slope of the land perpendicular to the marsh-forest boundary as that is the direction of migration, as steep terrain limits marsh migration inland. Where appropriate, contouring adjacent slopes in migration buffer zones can be a way to facilitate migration by modifying topographic barriers.

References:

1. Beckett, L. H., Baldwin, A. H. & Kearney, M. S. Tidal marshes across a chesapeake bay subestuary are not keeping up with sea-level rise. *PLoS One* **11**, (2016).
2. Borchert, S. M., Osland, M. J., Enwright, N. M. & Griffith, K. T. Coastal wetland adaptation to sea level rise: Quantifying potential for landward migration and coastal squeeze. *Journal of Applied Ecology* **55**, 2876–2887 (2018).
3. Swenson, C. Easement provides permanent protection for Prince George tract. *Coastal Observer* (2021).
4. WeConservePA. Costs of Conservation Easement Stewardship. https://conservationtools.org/guides/86-costs-of-conservation-easement-stewardship#heading_7.
5. TennGreen Land Conservancy. Land Conservation: Public vs. Private Options. https://tenngreen.org/land-conservation-public-vs-private-options/#:~:text=Typically%2C%20purchased%20land%20later%20becomes,land%20that%20remains%20private%20property. (2022).
6. Gewin, V. Turning Salt-Damaged Fields into Marshes Could Save Maryland Farmland—and The Chesapeake Bay. *CivilEats* (2019).
7. NERRA. *Best Management Options for Enhancing Tidal Marsh Resiliency*. https://www.nerra.org/wp-content/uploads/2021/03/Management-options-for-marsh-resiliency-FINAL.xlsx.
8. Shaw, K. *Great Marsh Barrier Mitigation*. https://www.mass.gov/doc/great-marsh-barriers-mitigation/download.
9. Dittbrenner, C. How sea level rise is affecting our coastal salt marshes and what we can do about it. Preprint at https://massland.org/sites/default/files/files/seal_level_rise_what_to_do_mar26_9a.pdf (2022).
10. Kelley, H. Helping nature heal itself at the Great Marsh. *U.S. Fish and Wildlife Service Northeast Region*.
11. PIE- Rivers Partnership. Saltmarsh Ditch Restoration. https://pie-rivers.org/portfolio-item/id_41/.