Management Strategy: Improving Hydrological Connectivity

Marsh management techniques to improve hydrological connectivity aim to restore physical, chemical, and biological components of the marsh that have been altered due to construction of human settlements, roads, or negative impacts from previous filling and diking of the marsh. Examples of these techniques are culvert sizing for tidal passage, ditch plug removal, creek extension, conversion of impoundments to saltmarsh, and runneling or tidal channel restoration.

- **Culvert sizing for tidal passage**

Expansion of culvert size in saltmarshes is used to restore hydrology of aquatic habitats that have partial or completely restricted tidal flow. Construction of dikes, causeways, and coastal development has inevitably resulted in loss of saltmarsh habitat, species, and primary productivity. Therefore, culvert expansion can improve marsh health by enhancing hydrological connection and allowing marsh ecological functions to be enhanced[1]. For marsh health, sizing should also consider placement of the culvert to be aligned as much as possible with the natural stream to avoid turbulence and allow fish migration, type of culvert (open-box culverts as opposed to pipe culverts are preferred for fish), including bank-edge areas that weak-swimming organisms can use, as well as internal habitat provision[2].

An example where culvert expansion was used to enhance tidal flow is a project in Egery Flats, Texas. Egery Flats has lost significant area of saltmarsh habitat due to road construction since 1945[3]. Following the construction of the new culverts, they planted marsh grass to impulse the recovery of the vegetation. The cost to replace culverts can differ by location and restoration objectives, but on average planning, construction, and monitoring can range from $20,000 to $5,000,000. Anticipated effort to apply this type of management technique can be categorized as 4, based on the time and construction work required to complete a replacement of culverts. Is it important to consider that restoration of ecological functions in a marsh can take from years to decades and monitoring should be included as a part of the management strategies post-construction.

Figure 1. Culverts before and after expansion for tidal passage in Egery Flats saltmarsh, Texas. Source: Building Conservation Trust.

- **Ditch plug removal**

Ditch plugs are small earthen dams across a drainage ditch, that were used previously in farming practices. Removing ditch plugs in marshes is a technique used to restore the tidal flow and drain the excess of water, reducing flooding and inundation in high marshes. It consists of using small excavators to remove the sediment blocking the ditch, carefully creating a channel to improve hydrological connection. The Parker Wildlife refuge on Plum Island in New England removed a total of 23 ditch plugs in 2019. This project resulted in tidal flow restoration and improved re-vegetation on the marsh[4]. Cost of this technique is low compared to other restoration projects as small excavators can be rented at $200-$500 per day, in addition to labor costs.

Figure 2. Ditch plug removal at the Parker Wildlife Refuge in New England. Source:

- **Creek extension**

This restoration practice consists of constructing, extending, or modifying areas of the marsh to connect it with the nearest creek. This technique could also involve, modifications in the length of a creek, bed, channel, or bank with the goal of reducing ponding in the marsh transition zone. Creek extension is achieved by connecting the wettest part of the marsh to a network of already existing creeks and then to open water. Farm Creek Marsh in Maryland is a case example where creek extension was implemented in 2018. This project had a cost of $475,000 and constructed a 500-foot (150 m) extension to connect the deteriorating marsh with the nearby creek, using a low ground pressure excavator[5].

- **Convert impoundments to saltmarsh**

Marsh impoundment was a technique used in the early 1970s to control mosquitoes, by flooding areas of the marsh. However, impoundments also alter or prevent natural tidal exchange, which can result in less sediment and nutrient supplies to the marsh[6]. The process of converting

impoundments to saltmarsh includes the construction of multiple culverts to allow for free movement of tidal flow in the system[7]. Implementation of culverts requires on average $20,000 to $5 million dollars and can be considered a high effort project due to the machinery and construction materials required.

Figure 3.Marsh impoundments at Seatuck National Wildlife Refuge, New York. Photo credit: Keith Shannon/USFWS

- **Runneling/ Tidal channel restoration**

Runnels are a narrow channel in the ground to drain water off the marsh surface, enhancing sub-surface drainage that can extend across the marsh platform and encourage revegetation. These channels tend to be very shallow and follow natural hydrology of the marsh, as opposed to mosquito ditches that are usually deeper with linear of gridded features. The construction of runnels (usually 0.15- 0.3 m wide and in depth) is designed to mimic the natural processes of channel capture that occurs in tidal marshes and can be an important technique to counteract marsh drowning[8]. One example where tidal channel restoration was implemented is the Pettaquamscutt River Estuary in Rhode Island. In this project, a total of 605 m of runnels were constructed during 2015 and 2016, resulting in an improved groundwater and surface flow and vegetation reestablishment in the next two to three years[8]. Runnels can be created by hand or with a low-ground pressure excavator, making it a low-cost technique depending on the area of marsh to restore.

Figure 4. Digging of runnel by hand at Winnapaug Pond. Credits: Karlo Berger/Save The Bay

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