Salt Marsh Creation in the York River

Final Report to the Maine Outdoor Heritage Fund, Grant #152-01-01

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Wells National Estuarine Research Reserve

Wells, Maine

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This project received additional funding through a grant from the National Fish and Wildlife Foundation and the Maine Coastal Program.

This project was also made possible through matching funds from partners, including the York Country Club, Civil Consultants, Laudholm Trust, Wells Reserve, Rachel Carson National Wildlife Refuge, York Rivers Association, and Mt. Agamenticus to the Sea Coalition.

Project Summary

This project resulted in the restoration of 5.5 acres of inter-tidal habitat in the York River Estuary through the upgrade of two tidal crossings located at the York Golf and Tennis Club.

Overall crossing span was increased from four to twelve feet at the first crossing, and from 3 to 9 feet at the second. The new culverts were installed at lower elevation than the existing pipes. The use of multiple round PVC culverts at each crossing increased the design span and lowered the cost of the project while still allowing for increased tidal exchange and enhanced tidal habitat.

Post construction monitoring confirms that significant tidal range has been restored in both ponds, resulting in improved water quality and access for aquatic organisms and other wildlife to utilize intertidal habitat.

This project represents a new public/private partnership between The York Golf and Tennis Club, the York Country Club, and community partners working toward long term conservation and sustainability of the York River watershed.

Local conservation efforts are enhanced by the presence of a successful habitat restoration project which supports conservation goals for the watershed and provides a demonstration site for infrastructure and tidal marsh resiliency.

New culverts improve tidal exchange between brackish ponds and the adjacent York River.

Project Background

In 2014 the York Tennis and Golf Club was planning for the replacement of two culverts that connected two small ponds with the tidal water of the York River estuary. The replacements were needed in order to eliminate the risk that the partially collapsed structures would fail in an extreme rainfall event, which would wash out a maintenance road into the main stem of the York River and potentially cause erosion of the adjacent banks and fairway. The Golf Club approached the Wells Reserve with the possibility of creating additional tidal habitat through the installation of appropriately sized and positioned culverts that would increase tidal exchange across 5.5 acres of ponded area.

Anticipated habitat benefits of the project included improve water quality with increased tidal flushing, improved access to habitat for aquatic species, and enhanced potential for tidal marsh migration to occur as a result of future sea level rise.

This project represented an opportunity to work with a private organization to enhance a routine culvert replacement project to include the creation of salt marsh habitat in the York River, a watershed that is the focus of ongoing local and national conservation efforts including designation under the National Park Service Wild and Scenic River Program in one of the fastest growing parts of Maine.

Implementation

After delays due to funding shortfall and unfavorable construction conditions, the installation of the culverts was completed during the last week in October and first week of November 2016. Three 36-inch culverts were installed connecting the York River to the first pond, in addition to the two existing 24-inch ones which were left in place. Two 36-inch culverts were added between the first and second ponds in addition to the existing 36 inch one which was also left in place.

Replacement of the culverts between the York River and the first pond commenced in late October 2016.

The addition of these five 36-inch culverts achieved the goal of enhancing tidal exchange between the ponds and the York River. The average daily tidal range of the first impoundment was increased by approximately 0.8 meters in the first pond and by approximately 0.9 meters in the second pond.

Fairway flooding

Two areas of the golf course were found to be experiencing inundation that were not anticipated, including an important portion of the fairway immediately adjacent to the lower pond, and a low area of the rough connected to the lower pond through a drainage pipe, both on Hole 12. The fairway area which did not previously flood experienced significant die-back of turf grass from new daily tidal flooding. In the rough area tidal flooding likely occurred periodically through the drainage pipe but the area stayed primarily fresh. With higher inundation and more frequent tidal flooding, it appears that the vegetation community is shifting to more salt tolerant plants such as *Spartina alternaflora.*

Grass die-back along Hole 12 in low area which is connected to the first pond through a drainage pipe.

A solution was reached for raising the fairway area above current flood levels through the construction of a vegetated berm. However an issue arose when Maine Department of Environmental Protection determined that once flooded the fairway area was now considered Critical Coastal Habitat and any activity to mitigate the flooding would require a full Natural Resource Protection Act (NRPA) application and additional approval from Army Corp of Engineers rather than a Permit by Rule, in addition to local approval from the Town. After several on-site meetings with the owners, engineering firm, Wells Reserve, Maine DEP and the Town of York, an acceptable solution and approach was agreed to. A NRPA application was submitted in March 2017 and Army Corp, Maine DEP and Town of York approvals were received in May and June 2017. The berm was finally constructed in 2018 and the seeded with salt tolerant plant species below the extent of tidal flooding. Fairway turf was subsequently reestablished returning full functionality to the affected area of the golf course.

Fairway area experiencing significant die-back of turf due to tidal flooding, May 2017.

New fairway raised above tidal flooding and bank stabilized with salt tolerant species, Apr. 2019.

Monitoring

Salinity Monitoring

Water salinity in the ponds was expected to increase after the installation of new culverts and associated increase in tidal flooding. Loggers were deployed in each pond pre and post construction to monitor changes in salinity. Our salinity data show that the average salinity in both ponds has actually decreased as a result of the project. Pre-restoration salinity values stayed relatively constant with the exception of disturbances from periodic rain events. With the restoration of full tidal exchange, a low flow channel has emerged which is fresh water dominated at low tide. This change in daily salinity levels will allow usage of the habitat by a wider range of estuarine species particularly those that prefer lower salinity levels, and exposed mudflats will provide new foraging opportunities for wildlife.

Vegetation Monitoring

Vegetation was monitored using photo stations situated around the two ponds. Photographs were taken along the shoreline visible from each station. Photos were taken prior to replacement of the culverts on 11/5/15 and 8/25/16, and then after on 9/18/17 and 5/22/2019. Little change was detected in the shoreline vegetation from 2015 to 2017, however 2019 monitoring did begin to identify more significant change in shoreline vegetation around the first pond including primarily die-back of grass intolerant to saltwater. It may take longer to begin to see the effects on trees and shrubs that line the ponds. Our photos will provide a baseline to enable future monitoring comparisons.

Shoreline vegetation along Hole #6 pre-construction, Aug 25, 2016.

Shoreline vegetation die-back along Hole #6, May 22, 2019.

Tidal Hydrology

One season of enhanced tidal inundation monitoring was carried out to better characterize the new tidal regime in the ponds and relate tidal height to modeled sea level rise. In spring 2019 water level stations were deployed in each pond immediately upstream of the new culverts.

A temporary benchmark was established to provide a tie to the National Spatial Reference System (NSRS) for each of the water level sensors. The benchmark was occupied with survey grade GPS for approximately 4 hours and a network adjustment was calculated through the NOAA OPUS website (NOAA 2019). The orthometric height of each water level station was then measured with a real-time kinematic (RTK) GPS. Station heights were then applied to the pond depth data to generate vertically controlled water level data relative to the North American Vertical Datum of 1988 (NAVD88).

Tidal datums (e.g. mean sea level, mean high water) were calculated from the water level data with the NOAA CO-OPS Tidal Analysis Datum Calculator (NOAA 2019) using the Portland tide gauge as a control station and adjusting our local water level data to the National Tidal Datum Epoch 1983-2001 (NTDE). The Mean Higher High Water (MHHW), which is the average height of the highest high tide of each day, was calculated to be 1.32 meters (NAVD88). The Highest Annual Tide (HAT) height was not observed during our monitoring. A value of 1.89 meters (NAVD88) was obtained from the HAT layer on the Maine Sea Level and Storm Surge Viewer (MGS 2019).

A tide station monitors post-restoration tidal flooding in the first pond upstream of the York River.

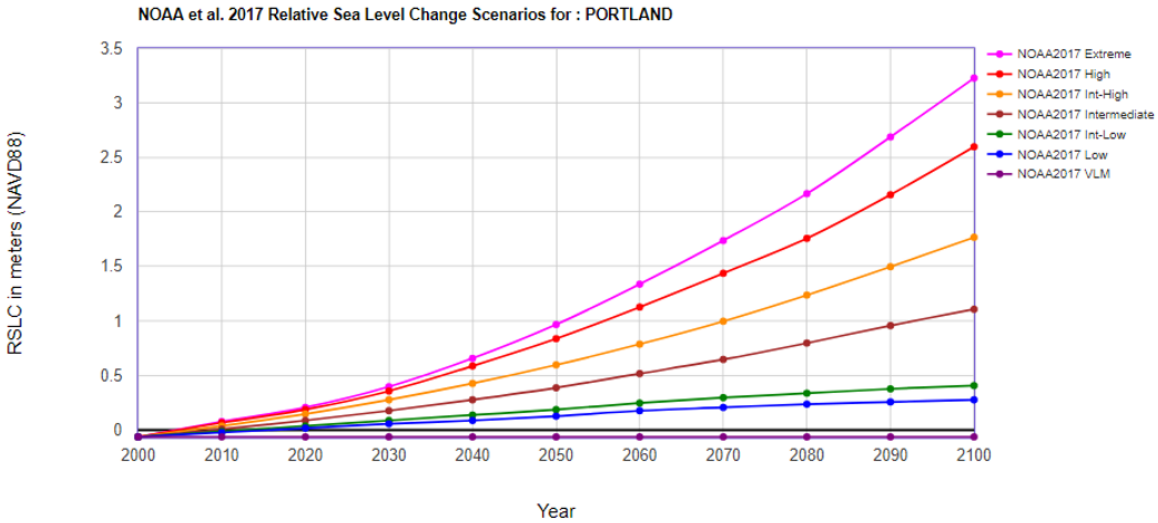
Inundation Mapping

Tidal inundation layers were then created in GIS using a digital elevation model (DEM) obtained from the NOAA Digital Coast website (NOAA 2019). The DEM was developed from 2017 LiDAR data collected by the Town of York and has a vertical accuracy of 0.08m. Areas of tidal inundation were mapped for the current MHHW and HAT. To each of these base elevations was then added modeled increases in sea level at years 2030, 2050, and 2080 (Table 1). Sea level increases were calculated using the online Sea-Level Change Curve Calculator (USACE 2019) for NOAA 2017 Intermediate-Low (Int-Low) and Intermediate-High (Int-High) scenarios (Figure 1). The resulting SLR tidal heights were then used to map future inundation of the surrounding landscape. Orthometric height was also measured at the inlets (upstream end) of each new culvert as well as the newly constructed fairway berm, and low point of the cart path adjacent to the lower culvert and the York River. These ortho heights were compared to the heights of the current MHHW and HAT and future sea level rise scenarios.

The current MHHW and the highest water level (HWL) in the first and second ponds only differ by approximately 0.03 meters. The HWL is delayed in the upstream pond by approximately 20-30 minutes indicating that a head differential exists at high tide which likely reduces flooding in the upstream pond. While this differential is not currently significant it is expected to become more pronounced with increased sea level. Aerial photos show that the second pond does not drain completely at low tide (Figure 2).

The height of the cart path closest to the York River and the new fairway are both roughly 2.2 meters (NAVD88). Both areas are higher than the current MHHW and the HAT. However, the NOAA sea level rise models indicate that these areas will become inundated during extreme tides and storm surges by 2030 under the Int-Low scenario, and during daily high tides by 2060 under the Int-High scenario. Also based on the DEM there appears to be an area of the cart path along Hole #12 which could be inundated by the current HAT. These estimates do not account for additional height that can occur from storm surge events.

Project: York Salt Marsh Creation
Gauge/Grid Selected: PORTLAND
NOAA2017 VLM: 0.00000 meters/yr
Adjustment to MSL(83-01) Datum: 0.032 meters applied
Adjustment to NAVD88 Datum: -0.09 meters applied
All values expressed in meters
Lines shown are the result of interpolation between values plotted



York Salt Marsh Creation
Scenarios for PORTLAND
NOAA2017 VLM: 0.00000 meters/yr
All values are expressed in meters

Year	NOAA2017 VLM	NOAA2017 Low	NOAA2017 Int-Low	NOAA2017 Intermediate	NOAA2017 Int-High	NOAA2017 High	NOAA2017 Extreme
2000	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
2010	-0.06	-0.02	-0.01	0.01	0.04	0.07	0.08
2020	-0.06	0.02	0.04	0.09	0.15	0.19	0.21
2030	-0.06	0.06	0.09	0.18	0.28	0.36	0.40
2040	-0.06	0.09	0.14	0.28	0.43	0.59	0.66
2050	-0.06	0.13	0.19	0.39	0.60	0.84	0.97
2060	-0.06	0.18	0.25	0.52	0.79	1.13	1.34
2070	-0.06	0.21	0.30	0.65	1.00	1.44	1.74
2080	-0.06	0.24	0.34	0.80	1.24	1.76	2.17
2090	-0.06	0.26	0.38	0.96	1.50	2.16	2.69
2100	-0.06	0.28	0.41	1.11	1.77	2.60	3.23

Figure 1. Modeled sea level rise for Portland, ME from the USACE Sea-Level Change Curve Calculator.

	Int-Low	Int-High
MHHW	1.32	1.32
2030	1.41	1.60
2050	1.51	1.92
2080	1.66	2.56
	Int-Low	**Int-High**
HAT	1.89	1.89
2030	1.98	2.17
2050	2.08	2.49
2080	2.23	3.13

Table 1. Measured tidal heights (NAVD88 meters) for MHHW and HAT, plus modeled sea level rise by year 2080.

Sea level rise mapping shows the shoreline of the ponds will become increasingly inundated. These vegetated areas have the potential to allow for landward migration of salt marshes in the future. With the exception of a few hardened surfaces virtually all of the low elevation landscape adjacent to the ponds has the potential to

Figure 2. Location of the cart path and new fairway adjacent to the first pond upstream of the York River.

allow future migration of salt marsh habitat as sea level increases. The extent to which this may occur in managed areas will depend on priorities for the Golf Club. The maps in Figures 3-6 compare current inundation during the MHHW and HAT with the modeled sea level rise for 2080 under the Int-Low and Int-High scenarios.

Figure 3. Mapped inundation under the Int-Low sea level rise scenario. Current MHHW in blue, 2080 MHHW in pink.

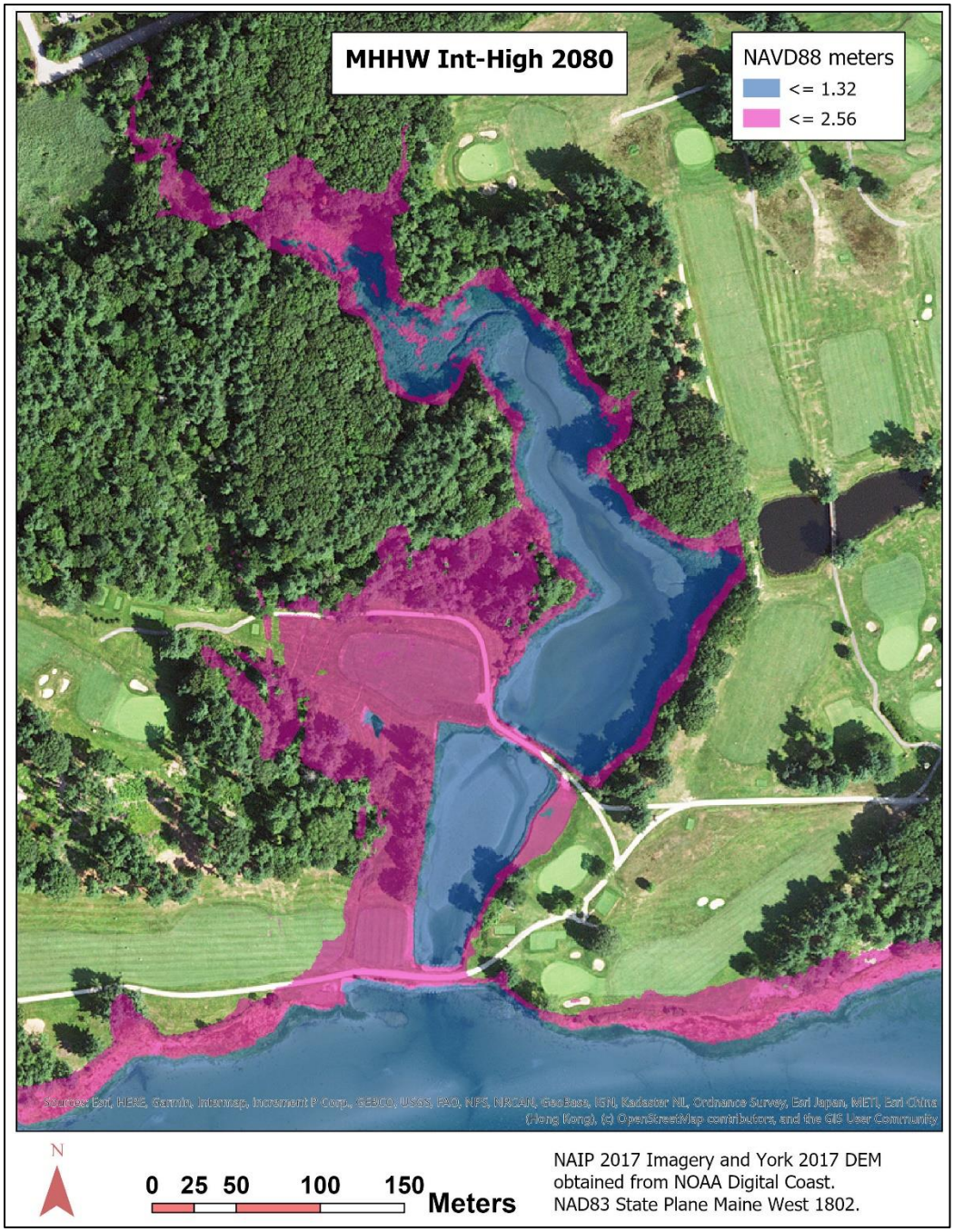


Figure 4. Mapped inundation under the Int-High sea level rise scenario. Current MHHW in blue, 2080 MHHW in pink.

Figure 5. Mapped inundation under the Int-Low sea level rise scenario. Current HAT in blue, 2080 HAT in pink.

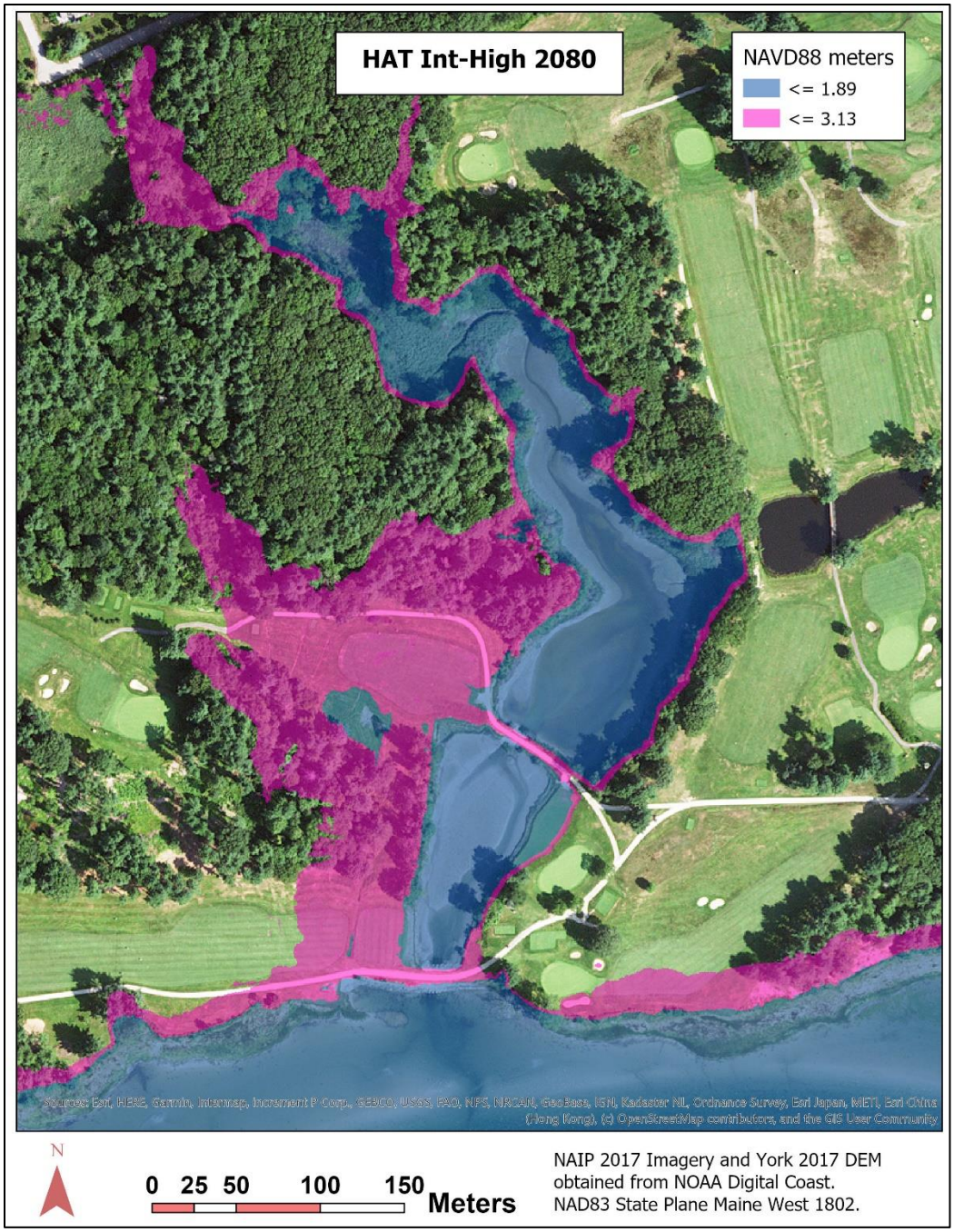


Figure 6. Mapped inundation under the Int-High sea level rise scenario. Current HAT in blue, 2080 HAT in pink.

Outreach

To date presentations have been given to the York Tennis and Golf Club Board of Directors, Laudholm Trust Board of Directors and one public presentation at the Wells Reserve's Lunch and Learn program. A project update was given to the York River Wild and Scenic Study Committee (representatives of the four watershed communities). A final project update was posted on the Wells Reserve website and distributed to partners.

References

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