Tidal Restriction Restoration at Wallace Shore Road

2016 Monitoring Report:
Year 2 of 5, Post-Project

Prepared For:

MAINE NATURAL RESOURCES CONSERVATION PROGRAM
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Casco Bay Estuary
PARTNERSHIP

Contents

1. Overview

Project Name:	Tidal Restriction Restoration at Wallace Shore Road
MNRCP ID:	2013-CIM-Wallace Shore Rd-CBEP
Project Location:	Appletree Marsh, Harpswell
Project Sponsor:	Casco Bay Estuary Partnership (CBEP)
Contractor and/or Consultant:	Shaw Brothers Construction; Wright Pierce
Start and Completion Dates:	12/15/2014 – 12/29/2014.
Corps and DEP Permit Numbers:	Corps Permit #: NAE-2014-01922; State ID#: NRPA/PBR #58778

1.1 Project Summary

The primary objective of this project was to reestablish natural hydrology, and specifically, to restore natural tidal variability into the Appletree Marsh adjacent to Wallace Shore Road in Harpswell (Fig. 2, following page). Two existing culverts were replaced according to amended designs provided with permit applications: A 3.3' box culvert was replaced with a 15' open bottom span concrete box culvert, and a 18" HDPE culvert was replaced with a 5' pre-cast concrete culvert (Fig. 1). At the 15' open bottom box, remnant slugs of fill from the original crossing structure were dredged from the channel immediately adjacent to the crossing in order to promote the free exchange of water into and out of the marsh.

Figure 1. Installation of open bottom concrete box culvert IN December 2014 at the lower site (9079, left) and embedded concrete round pipe at the upper site (9078, right).

Engineering services were provided by Wright Pierce, construction services were provided by Shaw Brothers, and the Cumberland County Soil and Water Conservation District administered the construction contract. The project was managed by the Casco Bay Estuary Partnership. Construction activities began on 12/15/14 at the north (secondary) culvert and concluded on 12/24/2014 at the primary crossing. Finishing road work was completed on 12/29/2014 following a break from 12/24 – 12/28/2014 over the holidays.

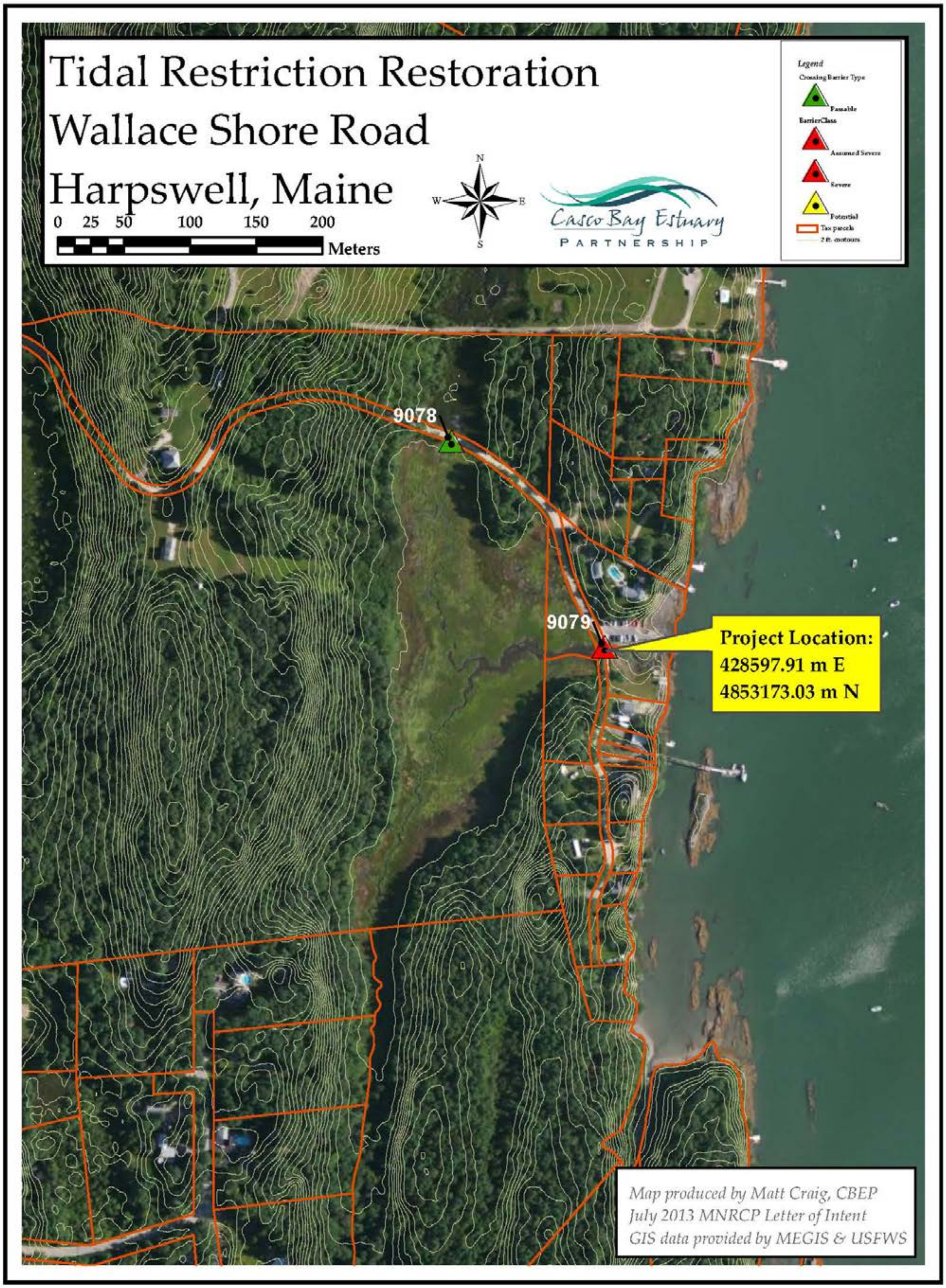


Figure 2. Map of project locations, parcels, and topography.

1.2 Project Monitoring

A monitoring plan was incorporated into the *Wallace Shore Road Restoration Work Plan.* CBEP is conducting pre- and post- project monitoring in the wetland adjacent to the project area (crossings 9079 and 9078). Following one season of collecting pre-project data, CBEP will collect five years of post-project data. CBEP, one of 28 National Estuary Programs nationwide, has focused on assessment, restoration, and monitoring at tidal marshes in Casco Bay since 1999.

The *Restoration Work Plan* summarizes the project goal to increase tidal exchange at two road/stream crossings where privately owned Wallace Shore Road crosses a tidal wetland in Harpswell. To monitor ecosystem change in response to the tidal restoration project, CBEP established 10 monitoring Stations at Appletree Marsh, spaced so that they were evenly distributed. Station 1 was located downstream of the primary crossing (9079), immediately to the north of Wallace Shore Road; Stations 2-9 are located in the marsh between the two road crossings, and Station 10 is located upstream of the secondary road crossing (9078; Fig. 3).

The *Restoration Work Plan* described the current (pre-construction) condition of the marsh and incorporated data on channel morphology, surface water hydrology and salinity, pore water salinity, vegetation, species of concern and other parameters. This report summarizes monitoring results from Year 2 post-project and where illustrative, provides a comparison with pre-construction data in the *Restoration Work Plan.* Monitored parameters include:

- Hydrology signal – using continuous water level recorders deployed upstream and downstream of Long Reach Lane.
- Pore water and surface water salinity.
- Vegetation – abundance (percent cover) of halophytic, brackish, freshwater, and invasive plant species.
- Channel morphology – cross sectional area.
- Erosion – post-project visual surveys within the construction area.
- Photo stations.

Monitoring is intended to document changes in the marsh following the restoration of tidal exchange at the two road crossings. Monitoring is designed to detect changes such as:

- Channel depth within the construction area compared with the longitudinal profile of the channel's gradient outside the area of impact.
- Halophytes as a percentage of overall species composition.
- Groundwater depth variability in response to tidal cycles.
- Pore water salinity variability in response to tidal cycles.
- Surface water salinity upstream of Wallace Shore Road variability in response to tidal cycles.

NOTE: This Year 2 Post-Project Monitoring Report updates the Year 1 Post-Project Monitoring Report dated March 2016 (herein referred to as, "Year 1 report"). Where practical, references to the Year 1 report are provided to minimize unnecessary redundancy and emphasize Year 2 results in the context of prior data.

Monitoring Stations
Tidal Restriction Restoration Project
Wallace Shore Road, Harpswell, Maine

Data available from:
Casco Bay Estuary Partnership
Matt Craig
(207) 228-8359
mcraig@usm.maine.edu

Figure 3. Map of monitoring stations.

2. Performance Standards/Requirements

The *Restoration Work Plan* defines performance standards for this project as follows (p. 26-7):

- Erosion control: All the constructed features such as slopes, soils, and substrates within the mitigation site will be stabilized and free from erosion, with erosion control materials removed once the site is stable.
- Invasive species: Invasive *Phragmites australis* is not introduced to the site, or if invasive *Phragmites australis* does colonize the project area, it is eliminated.
- Hydrology signal: Tidal restriction at the primary crossing, defined as the difference between highest observed water (HOW) downstream and upstream, will be less than or equal to .3' by the conclusion of the five year post-construction monitoring period.

3. Monitoring Results

This section describes the current conditions on the site focused on the condition of the mitigation project to replace two road crossings and restore tidal hydrology, as well as conditions in the marsh, in order to substantiate the success and/or potential challenges associated with the project. For full photo documentation, see Appendix A.

3.1 Monitoring Dates

This report summarizes data presented in the Year 1 report, as well as data gathered over the course of 14 distinct visits to the site during the 2016 field season. A 15th administrative site visit in January 2016 was noted in the Year 1 report.

Table 1. List of 2016 monitoring and site visits.

Date	Name*	Activity
4/25/2016	JM	Assess spring maintenance needs
5/25/2016	MC, KC	Pore water salinity samples; maintain monitoring stations
5/31/2016	KC, LW	Channel morphology (cross sections)
6/15/2016	KC	Pore water salinity samples
7/11/2016	CB, LW	Vegetation surveys
7/13/2016	CB, LW	Vegetation surveys
7/14/2016	KC, LW	Pore water salinity samples; channel morphology (longitudinal profiles)
7/26/2016	KC, LW	Invasive species meander survey
8/1/2016	KC, LW	Channel morphology (cross sections)
8/26/2016	KC, LW	Pore water salinity samples
9/8/2016	MC	Assess conditions, remove trash/debris, invasive plants management
9/22/2016	MC	Pore water salinity samples
10/24/2016	MC	Pore water salinity samples
11/15/2016	MC	Observe astronomic high tide
* JM = Joseph McLean, Project Engineer, Wright Pierce; MC = Matt Craig, CBEP Habitat Program Manager; KC = Kelsey Chenoweth, Bates College/CBEP Field Technician.; LW = Lisa Willey, CBEP Field Technician; CB = Curtis Bohlen, CBEP Director		

3.2 Erosion Control

For this project, all erosion control measures were temporarily installed before and during construction to minimize the potential for soil erosion while the crossings were being replaced. Shaw Brothers removed all temporary erosion control measures, as well as excavated fill, the temporary pedestrian bridge, stored materials/supplies, and miscellaneous equipment, by the conclusion of construction activity on 12/29/2014.

Year 2: On the morning of 4/25/2016, M. Craig CBEP was contacted by a representative from the Harpswell Conservation Commission about erosion adjacent to structure 9079. The information was provided to Project Engineer Joseph McLean of Wright Pierce, who visited the site on the afternoon of 4/25/16. In a memo dated 4/26/16 (Appendix E), McLean noted "piping" erosion of the roadway subgrade adjacent to the bridge, resulting from surficial road runoff conveyed by the roadway to the bridge site. The memo provided recommendations for addressing the erosion and redirecting runoff. Craig forwarded the memo to residents of the area who addressed the erosion using 2" crushed rock in accordance with McLean's recommendations. Routine spring road maintenance included regrading and crowning, resulting in redirected flow. The road is graded twice annually, according to landowners.

Ecosystem monitoring documented channel scour and sediment movement in response to the new road/stream crossings. The changes are consistent with the geomorphic response anticipated to result from increased tidal exchange and drainage. Results of Year 2 monitoring of channel response are presented in Section 3.9, Channel Morphology.

Erosion at 9079 documented on 4/25/16 (photo: Wright Pierce)

Repair by landowners, documented on 5/25/16 (photo: CBEP)

3.2.1 Status of Performance Standards

Table 2. Summary of Performance Standards and Monitoring Parameters

Performance Standard/ Monitoring Parameters	2016 Findings (Year 2 post-project)	Meet Standard?
Erosion control	*Slopes, soils, substrates within the mitigation site are stable. Erosion at crossing 9079 was identified and addressed.*	On-track
Invasive species	*Phragmites australis is not present in the Project Area*	On-track
Hydrology signal	*Tidal restriction at the primary crossing ≤ .3' at Highest Observed Water*	Yes
Pore water salinity*	*Mean pore water salinity levels and maximum pore water salinity increased at almost every station.*	On-track
Vegetation community*	*Changes in the plant community indicate adjustment to the new hydrology.*	On-track
Channel morphology*	*Channel cross sectional area increased throughout Project Area.*	On-track

* *Hydrology signal, invasive species, and erosion control are the three core performance standards defined by the Restoration Work Plan.*

3.3 Corrective Actions

A summary of corrective actions taken during the monitoring period is provided in Table 3.

Table 3. List of corrective actions taken during the monitoring period.

Date(s)	Observation	Corrective Action
4/25/16	CBEP notified of erosion adjacent to 9079. Wright Pierce Project Engineer visited site, and prepared a memo about piping erosion dated 4/26/16, which described the issue and recommended remedial response.	Local residents implemented Wright Pierce recommendation to address piping erosion, including application of 2" crushed rock and road grading/crowning, in late April/early May 2016.
5/25/16	Several ~6" sized rocks were observed in a partial linear arrangement at the 9079 inlet. The rocks appeared to have been placed by hand or to have fallen into the channel from adjacent armoring. There was no evident impact to movement of water or sediments.	CBEP hand removed ~10 x 6" rocks from the channel and hand placed them atop similarly sized rocks that function as armoring adjacent to the bridge abutment.
August 2016	(See description in Table 3 of Year 1 report). Over the course of multiple visits in 2015 and spring 2016, CBEP observed water pooling in the excavated channel outlet of crossing 9078 due to a lack of channel development/scour. Probing indicated that coarse grained sediments are present and not mobilizing – or mobilizing slowly - due to a lack of sufficient velocity. Anecdotes from abutters that the culvert blew out several years ago, depositing road fill downstream, supports this assessment.	In low flow conditions during a neap tide phase, CBEP used small hand tools to remove a minimal volume of sediment/fill (>.05 yard^3) from the channel immediately downstream of 9078, which lowered water levels at the outlet of 9078 by a few inches. This activity was proposed in alternative 2 of Section 4.2 of the Year 1 report, Adaptive Management, and conducted under the original project PBR that expired on 9/25/16. The action was taken based on feedback from MNRCP reviewers provided to CBEP by K. Jensen on 3/14/16. Sediments were transported offsite in two partially filled 5 gallon buckets as needed. CBEP will continue to monitor drainage and channel formation in this area.

3.4 Vegetation

Although the vegetative community is not a performance standard, CBEP will monitor vegetation throughout the five year post-project period. Vegetation transects were established and surveyed on 7/15 and 7/17/14, on 7/14 and 7/16/15, and on 7/11 and 7/13/16. A total of approximately 110 plots are sampled annually (12 plots along Station 1a and 1b, and 98 plots along transects at Stations 2-10). Plot locations are at identical distances along each transect for most stations. The transect at Station 2 was not identical in 2014 and 2015, but was replicated from 2015 to 2016. The number of plots at Station 10 was 12 in 2014, 10 in 2015, and 12 in 2016.

Selected photos from vegetation monitoring are included with the appendices.

A combined total of 81 plant species were identified across all Stations over the three years of monitoring. Species richness within the monitored plots across all stations decreased markedly in 2016. Sixty-one (61) species were observed in 2014, 67 in 2015, and 35 in 2016. Four species were observed in 2016 that were not recorded in prior years: *Eleocharis sp.*, *Glyceria candadensis*, *Taraxacum officinale*, and *Toxicodendron radicans*. Thirty-seven (37) species were observed in 2015 but not in 2016 (Tale 4); of these, 27 are glycophytic, and 8 are brackish.

Table 4. Plant species observations and community type. Groupings based on Verrill 2016 and Tiner 2009.

Latin Name	Common Name	Community Group	2014	2015	2016
Acer rubrum	Red Maple	Fresh	✓	✓	✓
Agrostis stolonifera	Creeping Bent Grass	Brackish	✓	✓	✓
Alnus incana	Speckled Alder	Fresh	✓	✓	✓
Argentia anserina	Common Silverweed	Brackish	✓	✓	✓
Atriplex prostrata	Orach	Brackish	✓	✓	✓
Betula populifolia	Gray birch	Fresh	✓		✓
Bolboschoenus maritimus	Alkali Bulrush	Brackish	✓	✓	✓
Calamagrostis Canadensis	Bluejoint Grass	Fresh		✓	✓
Calla palustris	Wild Calla	Fresh	✓	✓	
Carex hystericina	Bottlebrush Sedge	Fresh	✓		
Carex lacustris	Lake Sedge	Fresh	✓	✓	
Carex scoparia	Broom Sedge	Fresh	✓	✓	✓
Carex trisperma	Three-Seeded Sedge	Fresh	✓	✓	
Carex utriculata	Common Beaked Sedge	Fresh		✓	
Carex spp.	Unk. Sedge	Fresh	✓	✓	
Drosera rotundifolia	Sundew	Fresh	✓		
Dryopteris cristata	Crested Wood Fern	Fresh		✓	
Eleocharis sp.	Sedge	Brackish			✓
Elymus pycnanthus	Tick Quackgrass	Fresh	✓	✓	
Elymus repens	Creeping Wild Rye	Fresh	✓	✓	✓
Epilobium leptophyllum	American Marsh Willow-Herb	Fresh	✓	✓	
Festuca rubra	Red Fescue	Brackish	✓	✓	✓
Galium asprellum	Rough Bedstraw	Fresh			
Galium palustre	Marsh Bedstraw	Brackish	✓	✓	
Galium trifidum	Threepetal Bedstraw	Fresh	✓	✓	
Glaux maritima	Milkwort	Brackish		✓	
Glyceria canadensis	Rattlesnake Mannagrass	Fresh			✓
Glyceria grandis	American Manna Grass	Fresh	✓	✓	
Hypericum mutilum	St. John's Wort	Fresh	✓	✓	
Ilex verticillata	Winterberry	Fresh	✓	✓	✓
Impatens capensis	Jewelweed	Fresh	✓	✓	
Juncus arcticus	Arctic Rush	Brackish	✓	✓	✓
Juncus gerardii	Black Grass	Salt	✓	✓	✓
Juniperus communus	Common Juniper	Fresh	✓	✓	
Lemna minor	Duckweed	Fresh	✓		
Limonium carolinianum	Sea Lavender	Salt	✓	✓	✓
Lycopus americanus	American Water Horehound	Fresh	✓		
Lycopus uniflorus	Northern Bugleweed	Fresh	✓	✓	
Lysimachia terrestris	Swamp Candle	Fresh	✓	✓	✓
Lythrum salicaria	Purple Loosestrife	Fresh	✓	✓	
Onoclea sensibilius	Sensitive Fern	Fresh	✓	✓	
Osmunda regalis	Royal Fern	Fresh	✓	✓	
Persicaria sagittata	Tearthumb	Fresh	✓		

Phragmites americanus	American Reed	Brackish	✓		
Picea glauca	White Spruce	Fresh	✓	✓	
Picea rubens	Red Spruce	Fresh		✓	
Pinus strobus	White pine	Fresh		✓	
Populus grondidentata	Poplar	Fresh		✓	✓
Populus tremuloides	Quaking Aspen	Fresh	✓	✓	✓
Proserpinaca palustris	Marsh Mermaidweed	Fresh	✓	✓	
Puccinellia tenella	Alkali Grass	Brackish		✓	
Quercus rubra	Northern Red Oak	Fresh	✓	✓	✓
Rosa palustris	Swamp Rose	Fresh		✓	
Rubus hispidus	Bristly Blackberry	Fresh	✓	✓	
Rubus sp.	Blackberry	Fresh		✓	
Rumex pallidus	Seabeach Dock	Brackish	✓	✓	
Ruppia maritima	Widgeon Grass	Salt	✓	✓	
Salicornia depressa	Common Glaswort	Salt		✓	✓
Schoenoplectus pungens	Three-Square Bulrush	Fresh	✓	✓	✓
Scirpus cyperinus	Woolgrass	Fresh	✓		
Scirpus sp.	Sedge	Brackish		✓	
Scutellaria galericulata	Hooded Skullcap	Fresh	✓	✓	
Solidago altissima	Tall Goldenrod	Fresh	✓	✓	
Solidago sempervirens	Seaside Goldenrod	Brackish	✓	✓	✓
Sparganium americanum	American Bur-Reed	Fresh	✓	✓	
Spartina alterniflora	Smooth Cordgrass	Salt	✓	✓	✓
Spartina patens	Salt Hay	Salt	✓	✓	✓
Spartina pectinata	Freshwater Cordgrass	Brackish	✓	✓	✓
Spirea tomentosa	Steeplebush	Fresh			
Sphagnum spp.	Unk. Sphagnum moss	Fresh		✓	
Spirea alba var. latifolia	White Meadowsweet	Fresh	✓	✓	✓
Suaeda maritima	Herbacious Seepweed	Salt	✓	✓	✓
Symphyotricum novi-belgii	Aster	Brackish	✓	✓	✓
Taraxacum officinale	Common Dandelion	Fresh			✓
Thelypteris palustris	Eastern Marsh fern	Brackish		✓	
Toxicodendron radicans	Poison Ivy	Brackish			✓
Triglochin maritimum	Seaside Arrowgrass	Salt	✓	✓	✓
Typha angustifolia	Narrow-Leaf Cattail	Brackish	✓	✓	✓
Typha latifolia	Broad-Leaf Cattail	Fresh	✓	✓	✓
Typha x glauca	Hybrid Cattail	Brackish		✓	
Vaccinium corymbosum	High Bush Blueberry	Fresh	✓		
Vaccinium macrocarpon	Large Cranberry	Brackish	✓	✓	
Viola pallens	Smooth White Violet	Fresh		✓	
Total species N			**61**	**67**	**35**

3.4.1 Percent Cover

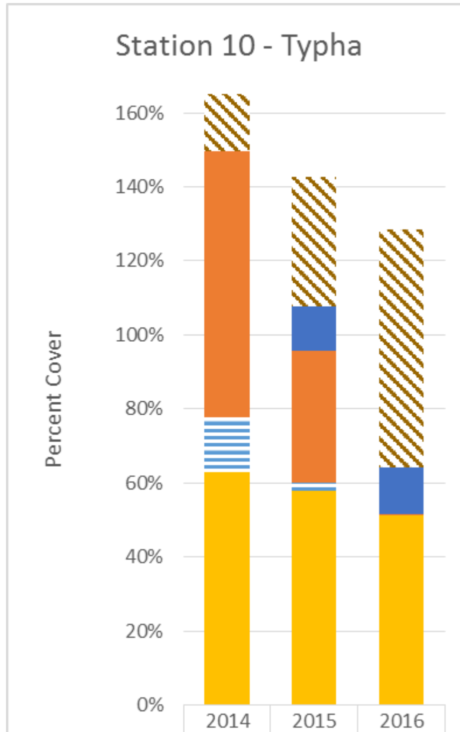
<u>Stations 1-8</u>

Figure 5 illustrates community type abundance (mean percent cover across all plots at a given station) at Stations 1 through 10 (all station plots combined) in 2014, 2015, and 2016. Overhanging tree canopy was recorded, but is not displayed. The presentation of this graphic has changed from the Year 1 Report to more consistently show differences in cover across stations. Percent cover is presented here as cumulative (with totals exceeding 160% cover at some stations), whereas in the Year 1 Report, percent cover was shown as proportional to 100%.

Looking at the 2016 data compared with 2014 and 2015, patterns appear. In 2016, the relative abundance of litter increased over prior years across all stations including Station 1, the reference site downstream of crossing 9079. Also in 2016, across all stations upstream of crossing 9079, the relative abundance of glycophytic vegetation decreased compared with prior years. At three Stations – 5, 6 and 9 - an abrupt loss of glycophytic vegetation was observed. In comparison, the relative abundance of halophytic vegetation appeared somewhat constant by comparison.

Distinct changes were also observed at a subset of the stations in 2016 compared with prior years. At Station 2, relative abundance of glycophytic and brackish vegetation decreased from prior years, consistent with observations that a community of freshwater and brackish species at the upland transect end had died. At Station 7, the furthest transect in the marsh's southern lobe from tidewater, the relative abundance of halophytic vegetation has increased post-project, while the relative abundance of glycophytes may be decreasing slightly.

Immediately upstream of Station 9 at the outlet of 9078 (see photos, Appendix A), individual cattails were extremely stressed or dead in 2016, consistent with the absence of glycophytes at Station 9. An abrupt transition in community composition remains evident between Stations 9 downstream of 9078, which has an abundance of halophytic vegetation, and 10 upstream of 9079, which lacks halophytes. However, the relative abundance of glycophytes decreased from 63% in 2015 to just 11% in 2016. This shift was accompanied by a decline in species richness within the surveyed plots from 27 species in 2014 and 2015 to 5 in 2016. This shift in species composition is illustrated in Figure 4 (right), which breaks out Typha species from other glycophytic and brackish species observed within the 2016 plots. The graph illustrates that diversity in this area has been lost, and the vast majority of remaining plants are cattails.



	2014	2015	2016
Litter	15.4%	35.0%	64.6%
Wrack			
Water		12.0%	12.5%
Bare			
Panne			
Non-Typha Glycophytic	72.0%	35.7%	0.3%
Non-Typha Brackish	14.7%	2.0%	
Typha spp.	62.9%	58.0%	51.3%

Figure 4. Percent cover of Typha and non-Typha glycophytic and brackish vegetation.

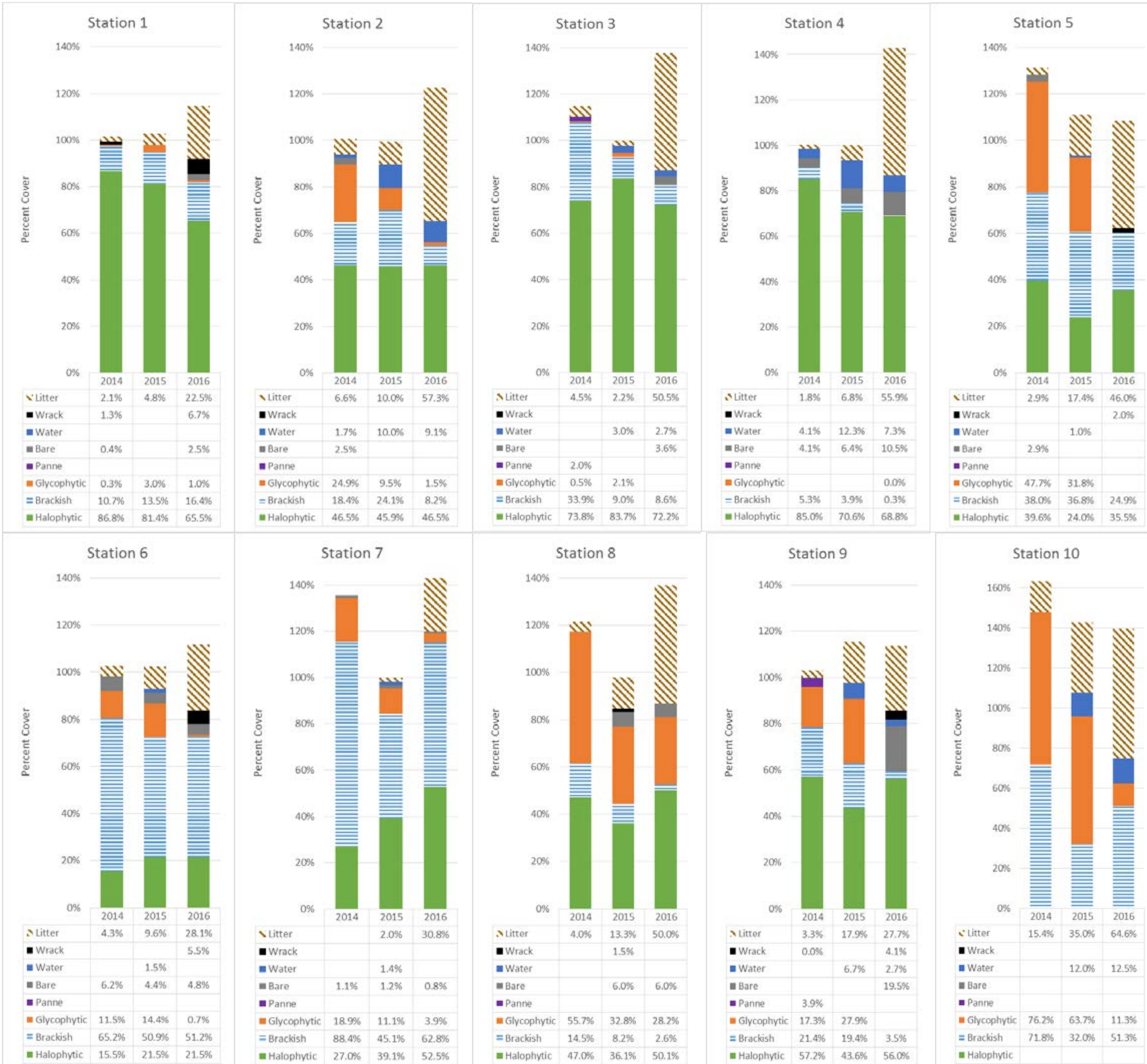


Figure 5. Change in community type, 2014-2016, for Stations 1-10.

3.4.2 Plant Survival

If applicable, by species planted, describe the general health and vigor of the surviving plants, the prognosis for their future survival, and a diagnosis of the cause(s) of morbidity or mortality. Outline any plans for replanting if recommended.

Not applicable. No vegetation was planted as part of this project.

3.5 Fish and Wildlife

CBEP incidentally recorded use of the marsh and immediate vicinity (marsh perimeter) by fish and wildlife when on site for other monitoring tasks. Species observed are listed in Table 5. Note: additional data about bird use may be available from Project SHARP (Saltmarsh Habitat Avian Research Program) based at the University of Maine, which has a long-term monitoring station in the middle of the marsh.

Table 5. Fish and wildlife observed at the site during the monitoring period.

Common name	Scientific name	Uses/notes
Great blue heron	*Ardea herodias*	Feeding in pools
Snowy egret	*Egretta thula*	Feeding in pools
Pileated woodpecker	*Hylatomus pileatus*	Feeding at snag
Osprey	*Pandion haliaetus*	Soaring
Greater yellowlegs	*Tringa melanoleuca*	Feeding in pools
Turkey vulture	*Cathartes aura*	
Black duck	*Anas rubripes*	Creek channel
Mallard	*Anas platyrhynchos*	Creek channel
Canada goose	*Branta canadensis*	Creek channel; marsh surface
Salt marsh sparrow	*Ammodramus caudacutus*	
Mink	*Neovison vison*	Feeding in channel
Coyote	*Canis latrans*	Sign (bones)
Soft shell clam	*Mya arenaria*	Upstream flats
Silverside	*Menidia menidia*	Creek channel
Mummichog	*Fundulus heteroclitus*	Creek channel
Green crab	*Carcinus maenas*	Creek channel
American eel	*Anguilla rostrate*	Creek channel
Red-winged blackbird	*Agelaius phoeniceus*	Roosting in cattails
White-tailed deer	*Odocoileus virginianus borealis*	

3.6 Soils Data

If applicable, soils data, commensurate with the requirements of the soils portion of the Corps Wetlands Delineation Manual (Technical Report Y-87-1 and approved regional supplements) New England District data form, should be collected after construction and every alternate year throughout the monitoring period.

Not applicable for this project.

3.7 Hydrology

CBEP collected continuous data on water levels, salinity, and other parameters at the site using In Situ AquaTroll 200 data loggers with vented cables in order to monitor tidal hydrology, which defines a specific performance standard for the project. CBEP has collected four hydrology data sets to date (Table 6). Pre-project data were collected in 2013, and again from 7/9/15 – 7/25/14. The 2013 data were used by the project engineer to characterize local hydrology. Results of the 2014 data are included in this report for comparison of pre- and post- restoration data. Post-project water level data were collected between 4/30/15 – 6/30/15. (An additional data set was collected between 8/18/15 – and 10/18/15, but is not included in this report).

Table 6. Hydrology monitoring deployments.

Dates	St. 1 (Surface Water)	St. 2 (Surface Water)	St. 3 (Groundwater)	St. 10 (Groundwater)
2013 (pre)	5/21 – 6/17*	5/21 – 6/17*		
2014 (pre)	7/9 – 8/26	7/9 – 8/26	7/9 – 8/26*	7/9 – 8/26
2015 (post)	4/30 – 6/30 8/8 – 10/15*	4/30 – 6/30 8/8 – 10/15*		5/8 – 6/30 8/18 – 9/25*

* Data sets not covered in this report.

3.7.1 Stage Height

Pre- and post- project water levels are plotted in Figures 6 and 7, with Station 1 downstream of the primary crossing #9079, Station 2 upstream of 9079, and Station 10 upstream of the secondary crossing #9078. Station 1 and Station 2 plot surface water elevations, and Station 10 plots groundwater/surface water elevations through a piezometer due to the lack of a channel. Both graphs clearly show spring/neap tide cycles.

Figure 6 illustrates the effect of tidal restriction upstream of 9079 (St. 2), with lower maximum height during spring tides and impounded water during low tide. At Station 10, water levels were generally flat and unaffected by tides, with exception of a peak associated with a > 2.5” rain event over two days in mid-August. Salinity data recorded simultaneously (see Table 8; Figure 14) confirm that tidal water did not reach the Station 10 logger during the 2014 peak.

Figure 7 illustrates the effect of the two new crossings on site hydrology and water levels. At high tide, surface water elevations are virtually identical at St. 1 and St. 2, while the surface water level upstream of 9079 fell by over 1.5 feet, allowing for complete drainage of the upstream marsh at low tide. Groundwater levels at Station 10 fell by about .5 feet, indicating improved drainage through the new embedded round pipe at 9078. The new culvert is also providing two-way flow into the upstream wetland for likely the first time in several decades. During a spring tide event in May 2015, water levels at Station 10 clearly rose and fell with the tides, confirming that tide water is now accessing the cattail stand upstream of 9078 during astronomical high tides.

Figures 8 and 9 illustrate the instantaneous difference in water levels upstream and downstream of 9079 in 2014 (Fig. 8) and 2015 (Fig. 9). The difference is calculated as the water elevation at St. 1 – the elevation at St. 2, so that a positive number would indicate tidal restriction. In 2014, instantaneous water levels differed by as much as .85 feet during a spring tide, with a difference in range of approximately 4 feet over a single spring tide cycle due to water levels at low tide typically at least 3 feet higher upstream than downstream.

In 2015, the instantaneous difference in water level at high tide was negligible, with a maximum difference of .093 feet during a spring tide event. This affirms that the project has met its hydrological performance standard: *Tidal restriction at the primary crossing ≤ .3’ at Highest Observed Water.* The remaining difference in instantaneous water level at low tide is a result of the higher channel bottom elevations at Station 2 and grade controls formed by the movement of coarse grained sediments out of the system in response to the new hydrology.

Figures 10 and 11 illustrate that the effect of tidal restriction on the timing of hydrology has been eliminated as well. The obvious lag in upstream water levels in 2014 (60 minutes to reach high water, Fig. 9) is no longer evident in 2015

(Fig. 10). Figure 10 also illustrates the increase in water levels at Station 10, that are clearly associated with the diurnal high tide during the May spring tide cycle.

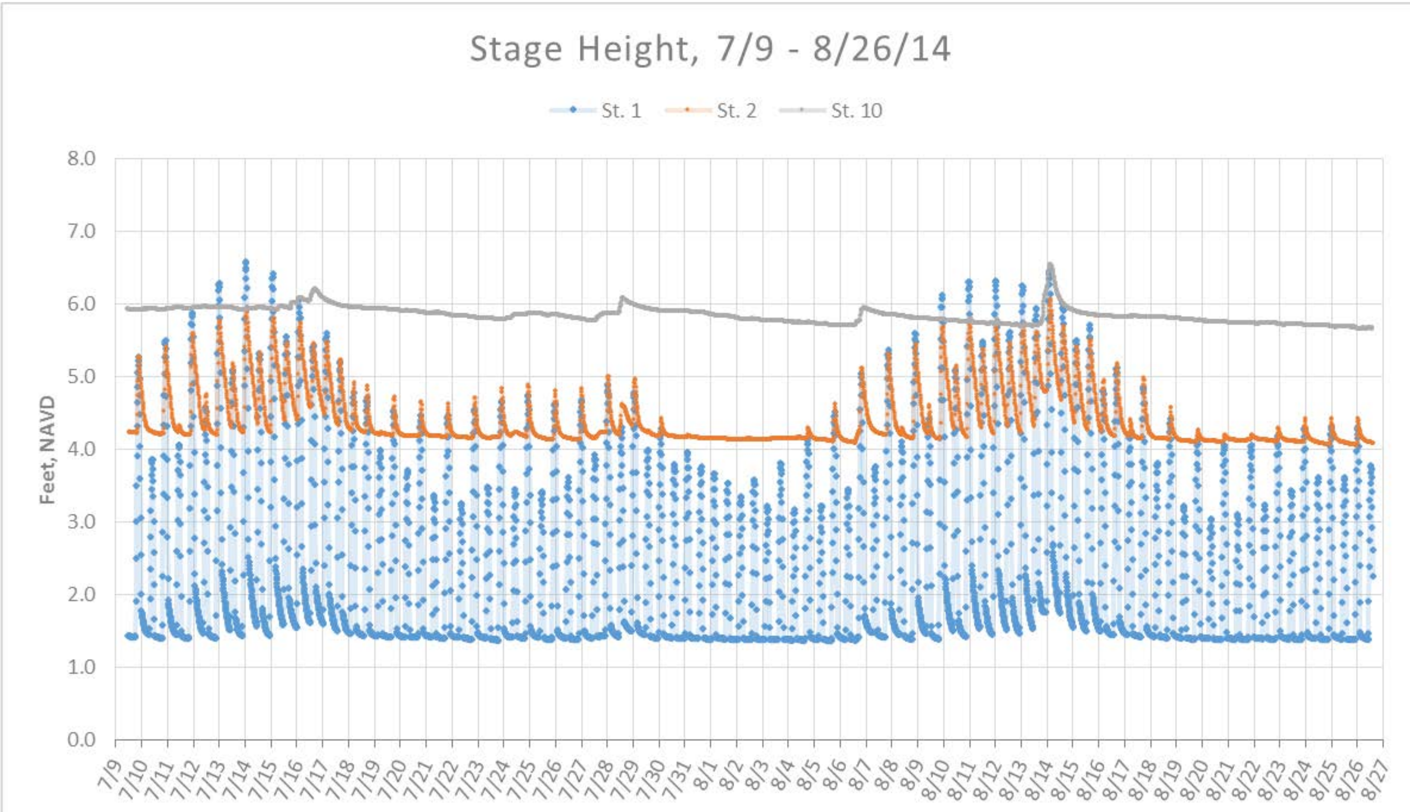


Figure 6. Pre-project water levels (2014).

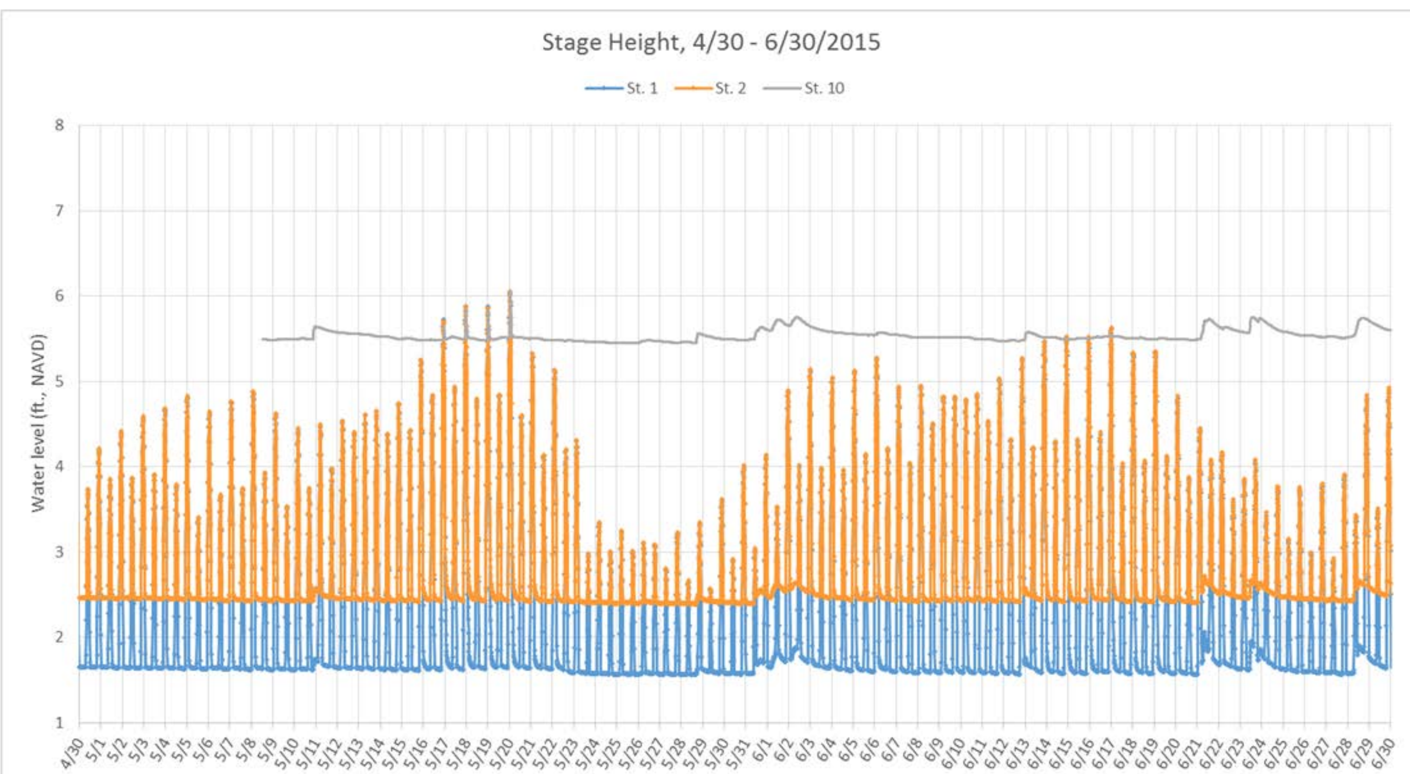


Figure 7. Post-project water levels (2015).

3.7.2 Instantaneous Difference in Stage Height

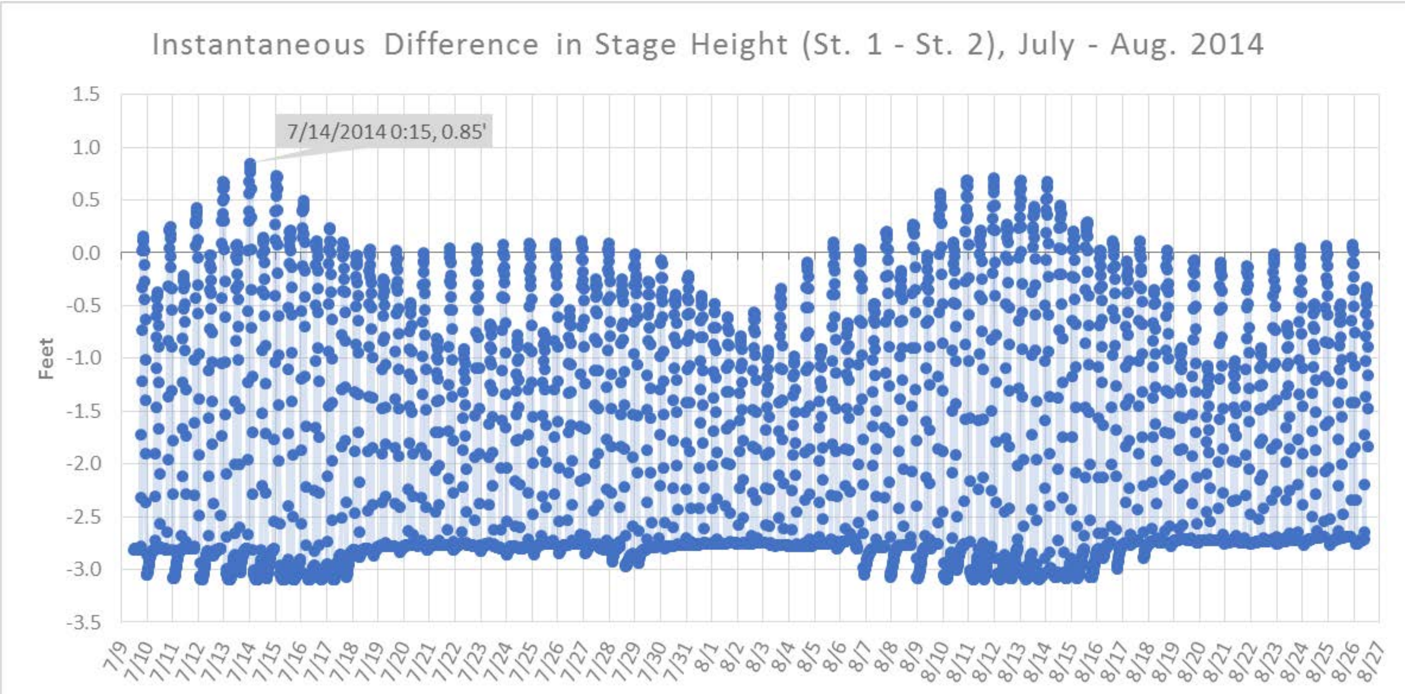


Figure 8. Instantaneous difference in stage height, pre-project (2014).

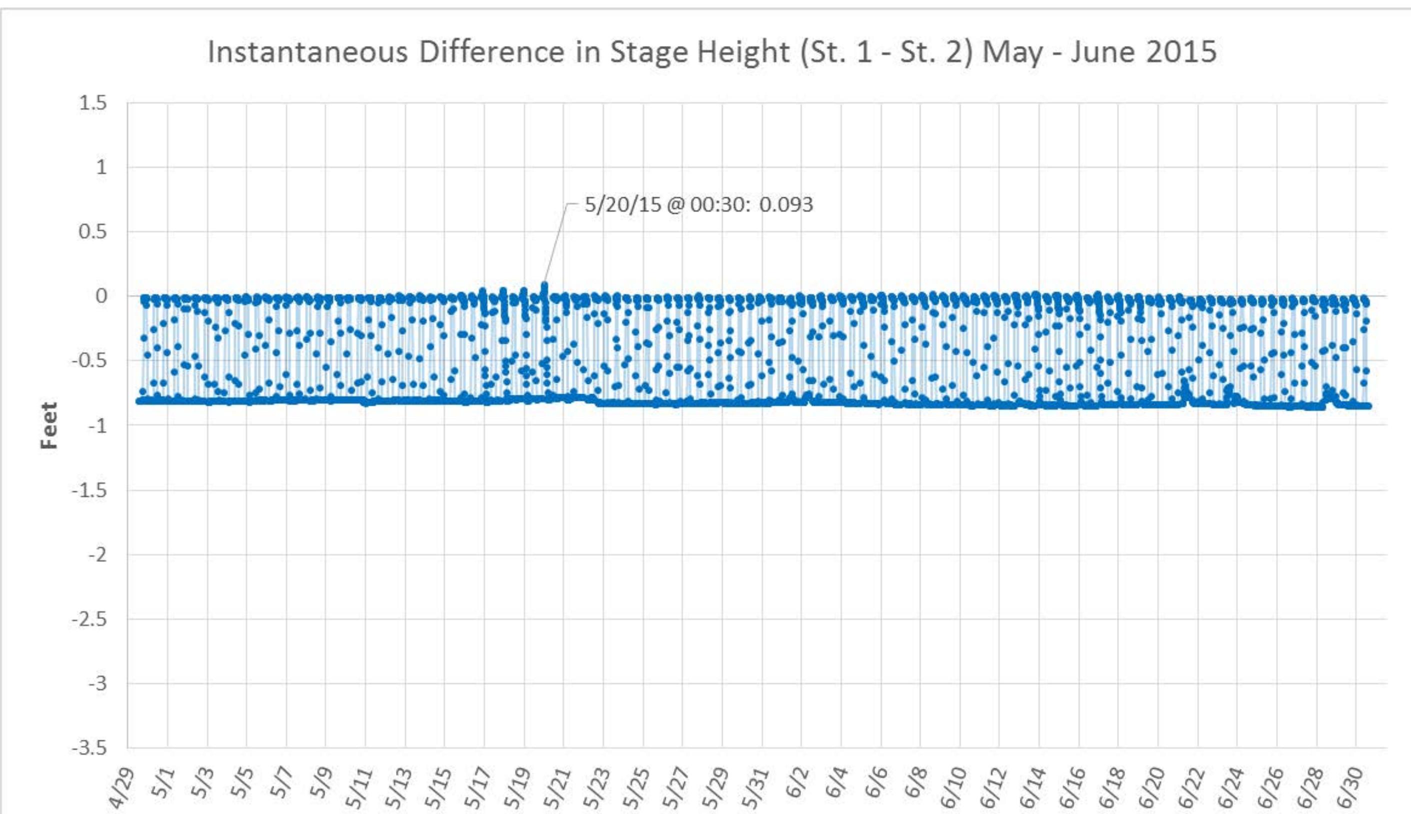


Figure 9. Instantaneous difference in stage height, post-project (2015).

3.7.3 Tidal Metrics

Tidal metrics were developed for the surface water hydrology data sets, as well as for the Portland Tide Station data during the deployment period presented for reference. Tables 7 and 8 summarize pre- and post-project tidal metrics at Station 1 and Station 2 for Mean Water Level (MWL), Highest Observed Water (HOW), Mean Higher High Water (MHHW), and Mean High Water (MHW). (Low-tide metrics were not evaluated due to the fact that the site sits in the upper end of the tide range and the wetland is primarily influenced by inundation at the upper end of the tide cycle). Elevations are provided in NAVD. NOTE: the tables summarize tidal metrics for the deployment period and should not be interpreted as datums for the site.

Over 4,600 data points were collected for the 2014 data set, and over 5,900 data points for the 2015 data set. Despite the longer deployment in 2015, the observed tidal metrics were lower across each elevation. The lower observations for MWL, MHHW, MHW, and HOW in 2015 are partially explained by the fact that the 2014 and 2015 data sets captured quite different spring tide events, based on comparison with Portland data. Another cause for this difference may be that fewer data points were collected during the neap tide phase in 2014, skewing the metrics higher. Other regional/Gulf of Maine circulation changes may also be at play.

For the pre-project data set, HOW was 6.584 at Station 1 (7/14/14), and 60 minutes later, HOW was 5.911 at Station 2, a difference of .673'. Post-project, HOW for the data set was observed to be 6.052 feet at Station 1 on 5/20/15, and 6.045 feet at Station2, with HOW occurring simultaneously. Based on the data, the project appears to have relieved the tidal restriction at the primary crossing (9079).

Portland's tide data is useful as a reference. Comparison of the 2014 and 2015 Portland Tide Station data shows that HOW was 6.783 feet during the 2014 deployment period, but just 6.203 feet during the 2015 deployment period. The 2014 data set captured unusually high tides that happened to occur during the deployment period. Comparison with epochal elevations on the Portland Tide Station Datum suggest that the 2015 data set is more representative of typical elevations at the Portland Tide Gauge, with the epochal datum MHW of 4.21 feet NAVD (compared with 4.365 at Portland, 4.245 at St. 1, and 4.262 at St. 2 for the 2015 deployment period). In contrast, MHW was 4.778' at Portland for the 2014 deployment period and 4.532 at St. 1, considerably higher than normal.

Table 7. Pre-restoration tidal metrics for the 7/9 – 8/26/2014 data set (elevations in NAVD).

7/9 – 8/26/14 (4,617 obs.)	Portland	St. 1	St. 2	Difference (St.1 - St. 2)	Difference (Portland – St. 1)
Mean water level	-0.060	2.296	4.410	-2.113	-2.357
HOW	6.783	6.584	5.911	0.673	0.199
MHHW	5.234	4.957	4.967	-0.010	0.276
MHW	4.778	4.532	4.734	-0.202	0.246

Table 8. Post-restoration tidal metrics for the 4/30 – 6/30/2015 data set.

4/30 – 6/30/2015 (5,955 obs.)	Portland	St. 1	St. 2	Difference (St.1 - St. 2)	Difference (Portland – St.1)
Mean water level	-0.290	2.281	2.841	-0.560	-2.571
HOW	6.203	6.052	6.045	0.007	0.151
MHHW	4.748	4.618	4.633	-0.015	0.131
MHW	4.365	4.245	4.262	-0.017	0.120

3.7.4 Highest Observed Water

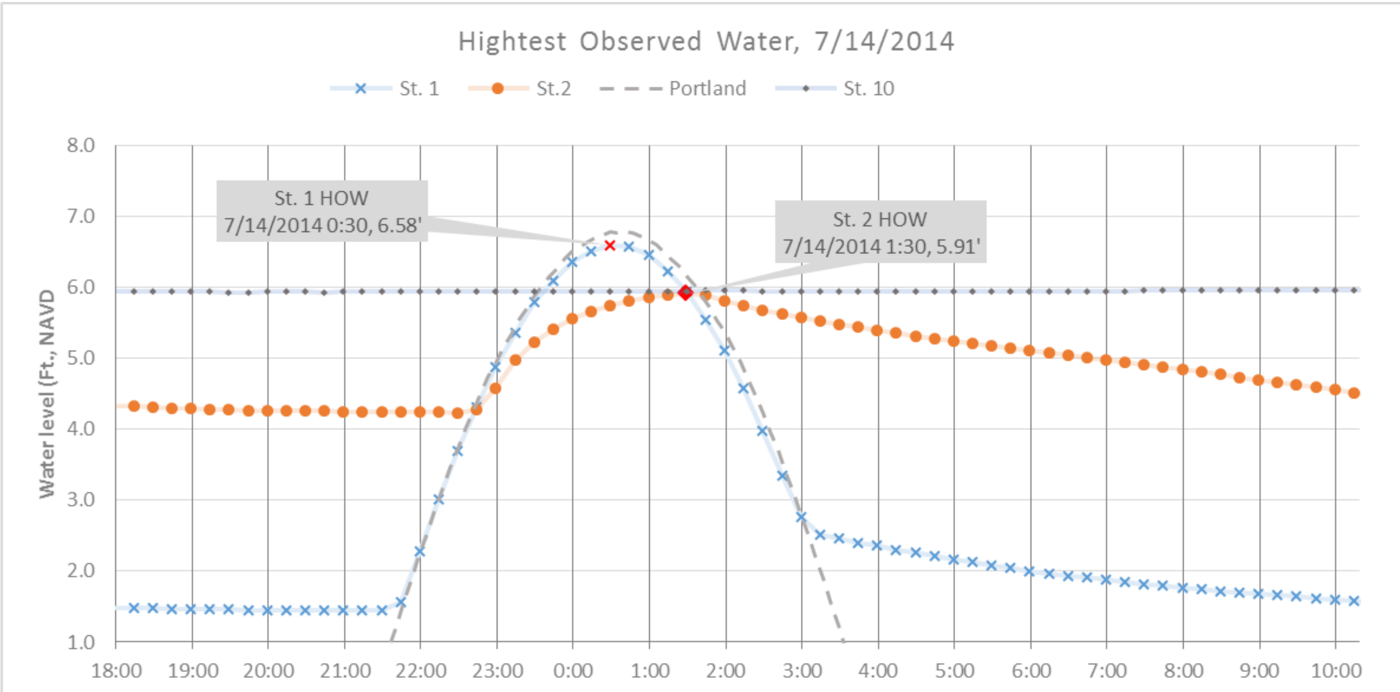


Figure 10. Highest observed water for the 2014 deployment period.

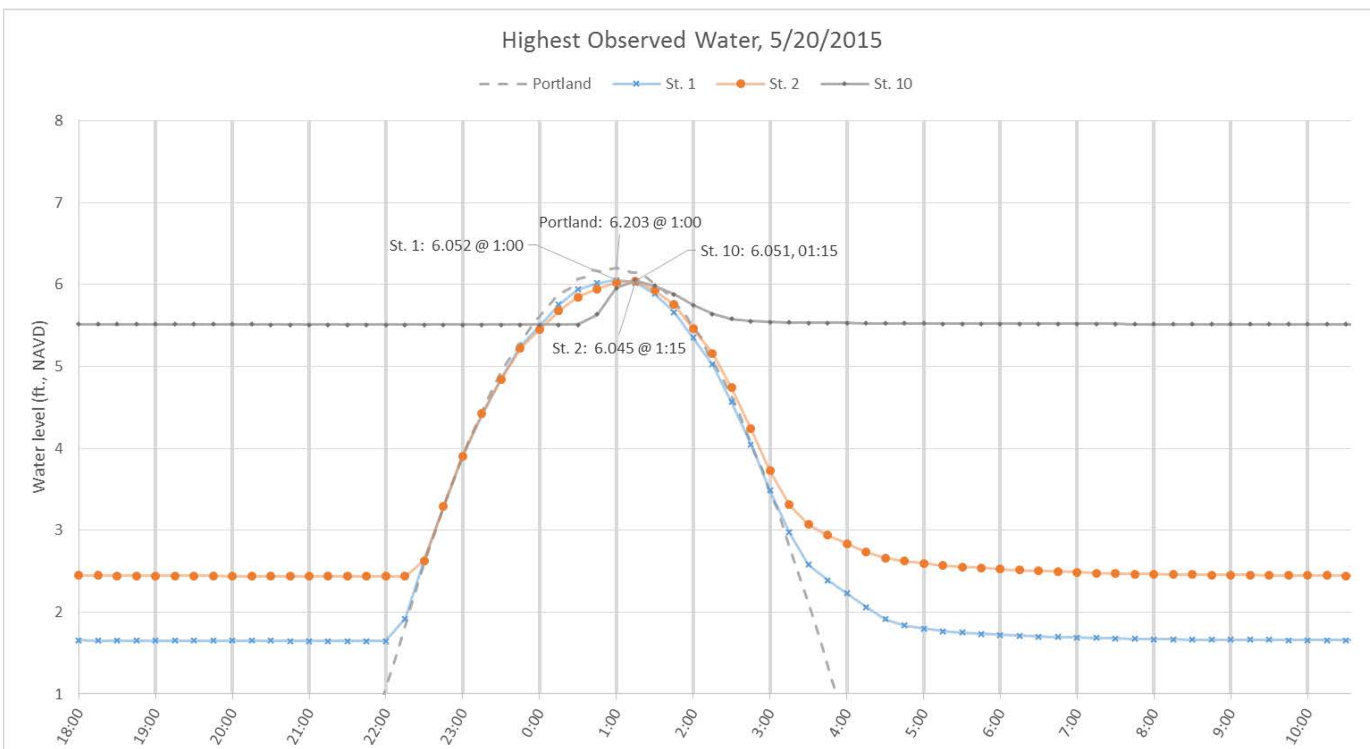


Figure 11. Highest observed water for the 2015 deployment period.

3.7.5 Corresponding High Tide Heights

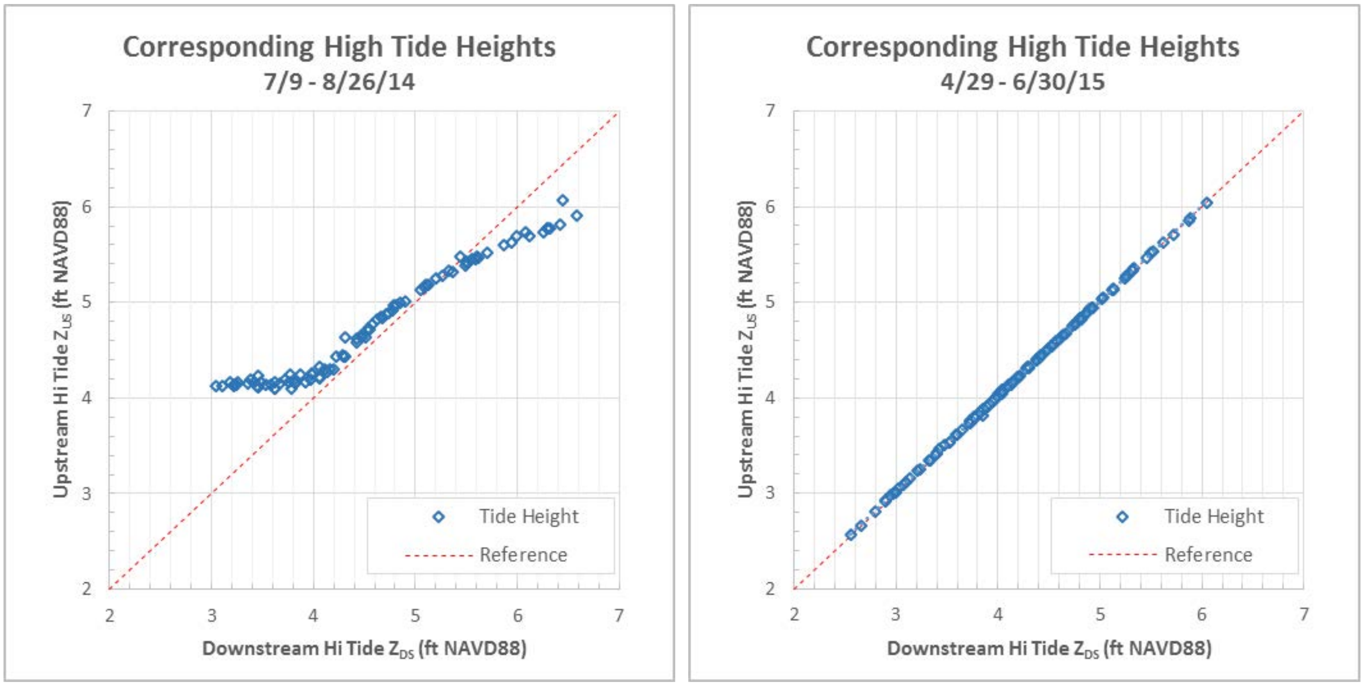


Figure 12. Plotted high tide heights upstream and downstream of 9079 pre- (L) and post- (R) project.

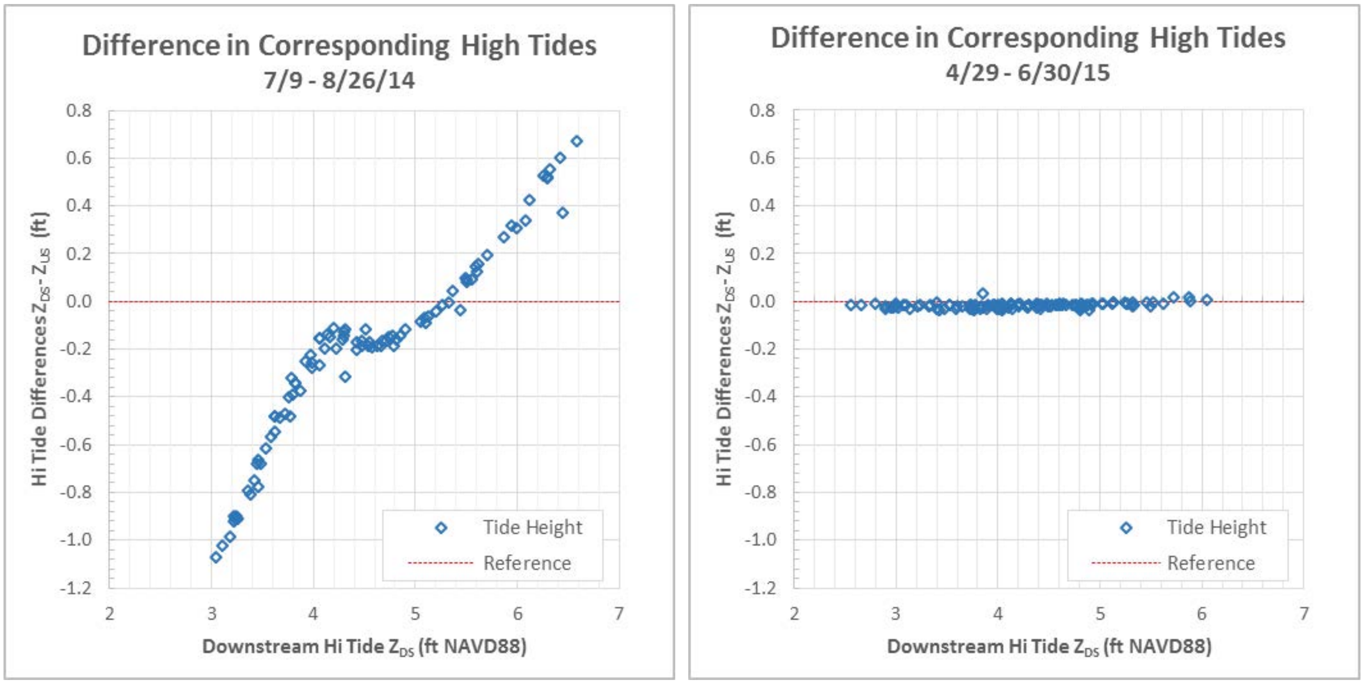


Figure 13. Difference in corresponding high tide heights pre- (L) and post- (R) project.

3.8 Salinity

CBEP monitored surface water salinity at Stations 1 and 2, groundwater salinity at Station 10, and pore water salinity at Stations 1, 3, 4, 6, 7, 8, 9, and 10.

3.8.1 Surface water salinity

Continuous surface salinity data was recorded using In Situ AquaTroll 200 loggers in conjunction with water level monitoring at Station 1 and Station 2. Fig. 14 illustrates the effect of the original crossing on salinity in the upstream surface water, which was much less variable than the surface water downstream except during rain storms. This may be explained by a combination of factors including impoundment of high salinity water upstream, stratification of water in the impoundment, and the fact that at low tide, enough groundwater was seeping into the channel to temporarily affect salinity levels in the shallow remnant pool. Fig. 15 illustrates that the new structure at 9079 has resulted in a similar level of variability in surface water salinity upstream and downstream of the crossing. [Note: manufacturer recommendations for salinity sensor calibration every three weeks were not performed in order to maintain continuous water level monitoring. Both data sets appear to show drift downward in salinity over the deployment].

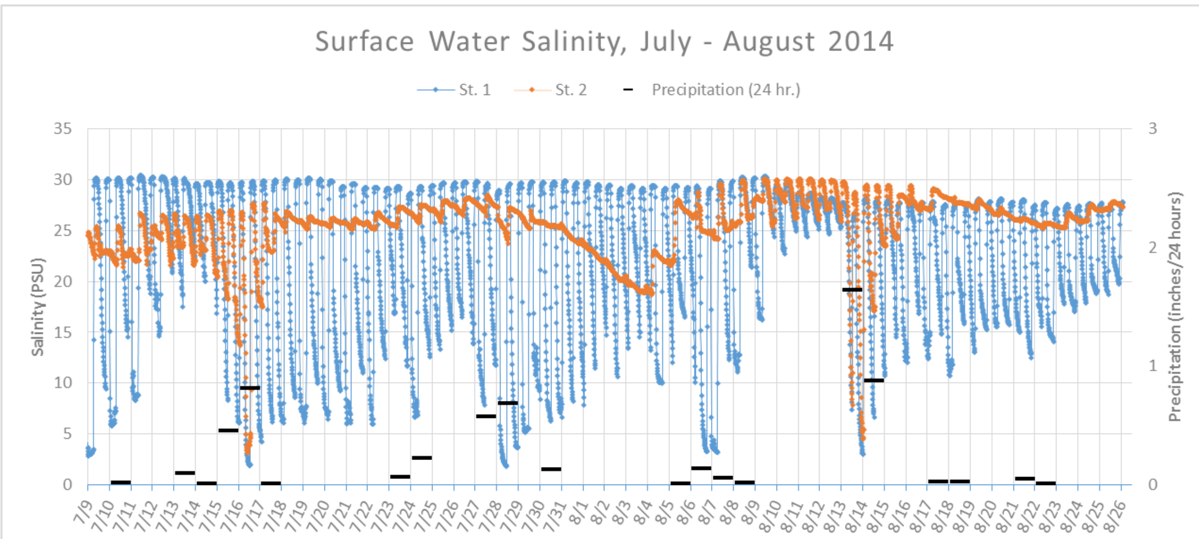


Figure 14. Pre-project surface water salinity, 2014.

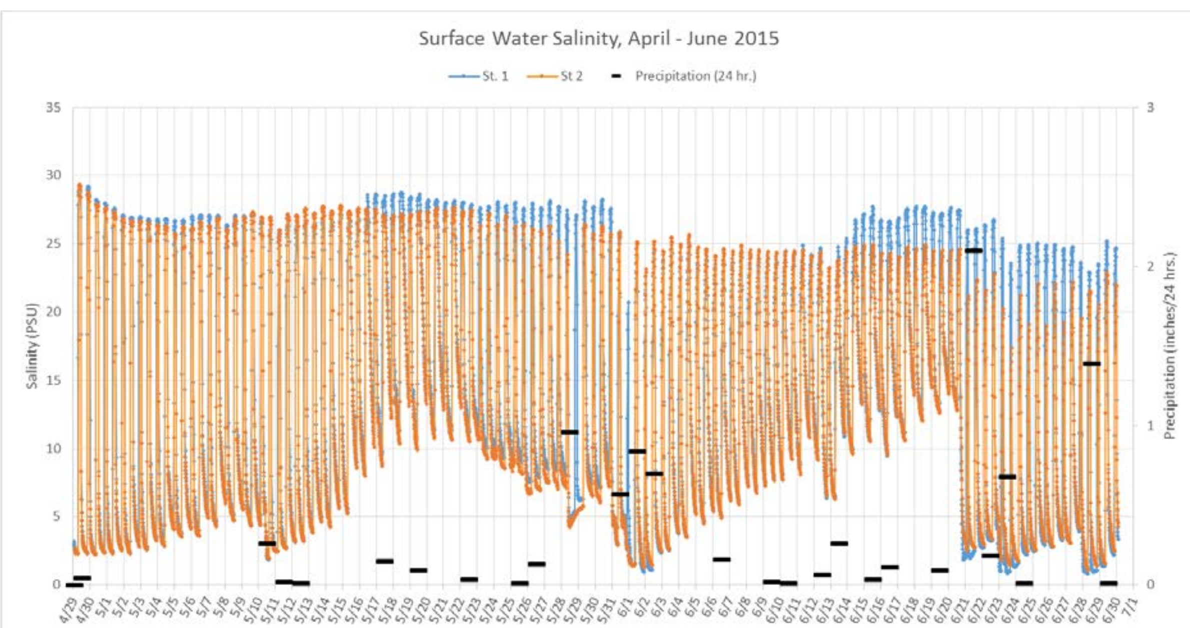


Figure 15. Post-project surface water salinity, 2015.

Tables 9 and 10 summarize the mean, minimum, and maximum salinity levels for surface water at Stations 1 and 2, and groundwater at Station 10. Mean salinity levels were higher at Stations 1 and 2 in 2014 (Table 9) than at the same locations in 2015 (Table 10). In 2014, salinity levels at Station 10 were near zero for the deployment period, but in 2015, salinity levels reached a high of 10.1 PSU (standard salinity units), despite the fact that overall site salinity was lower downstream, and there was a much lower documented HOW in 2015 than in 2014 (see Section 3.8.3). Figure 16 plots pre- and post- project salinity at Station 10 with water levels at Station 2 to illustrate the effect of high water levels on salinity upstream. Spring tides did not affect salinity levels at Station 10 in 2014, but did in 2015, indicating that tidal water moved upstream of 9078.

Table 9. Pre-project summary statistics for salinity (2014).

Location	MIN	MAX	MEAN
St. 1	1.9	30.4	21.4
St. 2	3.1	30.0	25.4
St. 10	0.0	0.7	0.2

Table 10. Post-project summary statistics for salinity (2015).

Location	MIN	MAX	MEAN
St. 1	0.8	29.2	13.7
St. 2	1.1	29.3	12.5
St. 10	0.0	10.1	4.2

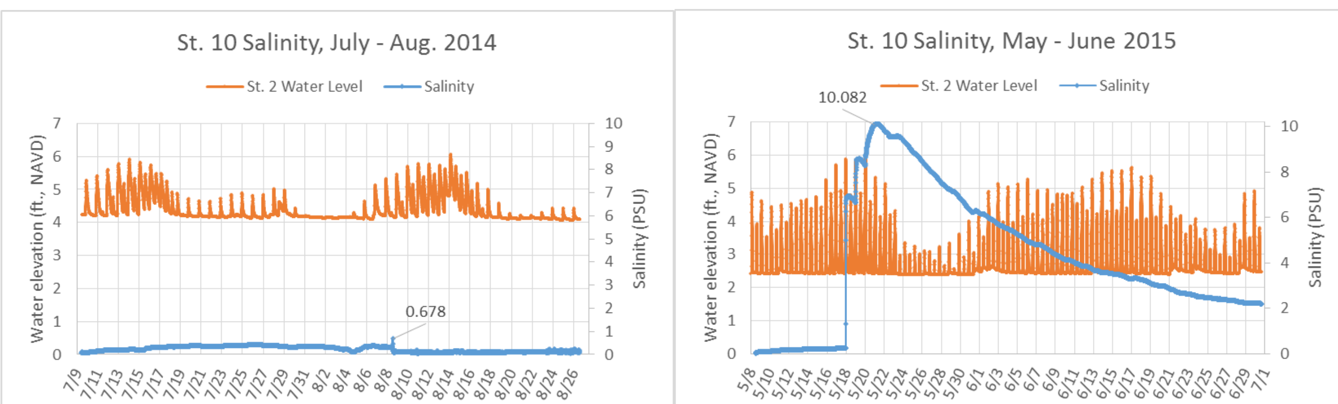


Figure 16. Comparison of pre- and post- project salinity levels at St. 10 with water levels at St. 2.

3.8.2 Pore water salinity

CBEP collected pre- and post-project pore water salinity samples from using wells constructed with PVC piping consistent with specifications provided in the *Restoration Work Plan*, which allow for samples in the root zone of salt marsh vegetation of 15-25 cm below the marsh surface. Sampling protocols call for samples to be collected at least once per month during the growing season (April – October), with samples collected using a catheter and surgical tubing, and measurements made using a calibrated hand-held refractometer. At Stations 3, 4, 6, 8, and 9, multiple wells were installed along the vegetation transect to document pore water salinity levels at various distances from the creek channel and upland edge, with lower alphabetical order (e.g., 3a, 3b) generally associated with closer proximity to the channel

With the exception of Station 8, where a freshwater seep from the adjacent upland is evident, pore water salinity observations (Fig. 17) were generally higher across each station throughout the 2016 monitoring season. This trend is consistent with what would be expected from the combination of increased delivery of salt water into the marsh post-project and the moderate to severe drought conditions that persisted throughout the region over the spring, summer and fall. Fig. 18 illustrates mean, minimum, and maximum pore water salinity levels at each well. Mean and maximum observed pore water salinity were higher at every station in 2016 than in 2014 or 2015, including at Station 1, the downstream reference. Minimum salinity levels were higher at each station except for 6a and 7 at the southern lobe. The influence of groundwater seepages from upslope is clearly evident at 6b and 8b, which lie at the foot of a steep hill, and at St. 10, which drains an area that includes several houses upslope. At Station 10 upstream of the second road crossing, a marked increase in the mean pore water salinity from 1.7 PPT in 2015 to 7.3 PPT in 2016 was observed.

Figure 17. Graphs of pre- and post- project pore water salinity levels at individual wells.

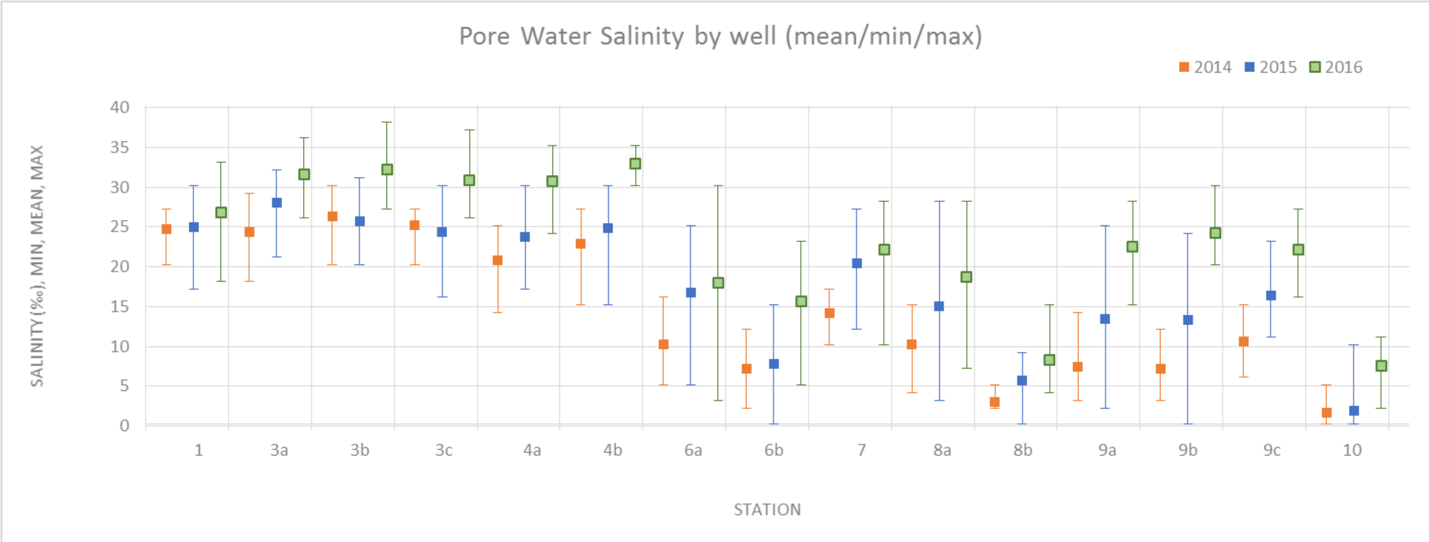


Figure 18. Box and whisker illustration of mean, minimum, and maximum pore water salinity levels pre- and post-project.

3.9 Channel Morphology

CBEP staff surveyed channel cross sections at Stations 1-9, as well as longitudinal profile through the construction areas, pre-project and again in 2015 and 2016. Data were entered into the *Reference Reach Spreadsheet*[1] for comparison. Fig. 19 plots the longitudinal profile of 9079 based on data collected in 2012. The profile illustrates the perched crossing (9079) at 200 feet, with accumulated sediment 50 feet upstream of the culvert outlet functioning as a grade control that impounded surface water upstream. Fig. 20 plots the profile of the channel approaching 9078 from downstream.

The 2015 longitudinal profile of the tidal creek from the bay through both project areas (9079 and 9078) is shown in Fig. 21, with elevations in feet, NAVD based on benchmark data provided by Wright Pierce. Mean high water (MHW, 4.12' NAVD) for the Portland datum is shown for context.

The channel bottom at 9079 is consistent with the channel grade upstream and downstream, and the accumulated sediment upstream is no longer evident. A series of shallow pools remains immediately downstream of 9079, and has formed immediately upstream in response to gradual movement of sediment. A small head cut was observed a little more than 400' upstream from the bay, with the channel bottom relatively flat until getting shallower between Station 8 and 9. The channel bottom at 800' (Fig. 21) has dropped by approximately 1' from the 2012 survey (50', Fig. 20). Further upstream, the channel becomes extremely shallow approaching 9078, where the slug of coarse-grained sediments (evident in both Fig. 20 and 21) sits on the marsh surface, resulting in a very shallow braided channel below the outlet of 9078. The sand is believed to have been deposited in this location during a culvert blow-out prior to any discussions about a restoration project. Local residents described a portion of the road bed washing onto the downstream marsh along with the culvert. Immediately upstream of the slug, and immediately downstream of the culvert outlet, is the area excavated during culvert installation. Here, water is pooled behind this grade control through the culvert into the excavated area upstream, above which a defined channel is no longer visible. This issue is discussed further in Section 4.2. The 2015 profile ends at the next culvert upstream (9076) beneath Shore Road.

A 2016 longitudinal profile was surveyed by seasonal CBEP field staff, but errors are evident in the data set and cannot be verified or corrected. The plot is necessarily omitted from this report. A longitudinal profile will be surveyed in 2017.

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[1] Mecklenburg, D. 2006. *The Reference Reach Spreadsheet*. Ohio Department of Natural Resources. http://water.ohiodnr.gov/portals/soilwater/data/xls/Example_of_Reference_Reach_Survey_4_0_T.xls

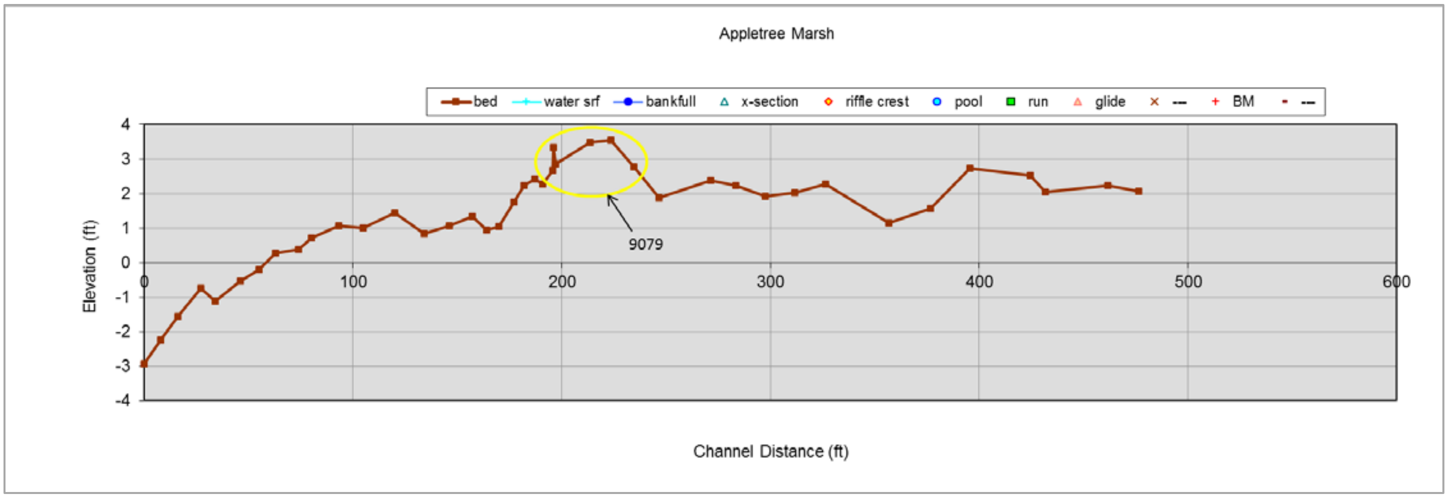


Figure 19. Pre-project longitudinal profile of 9079 (2012). Mecklenburg 2006.

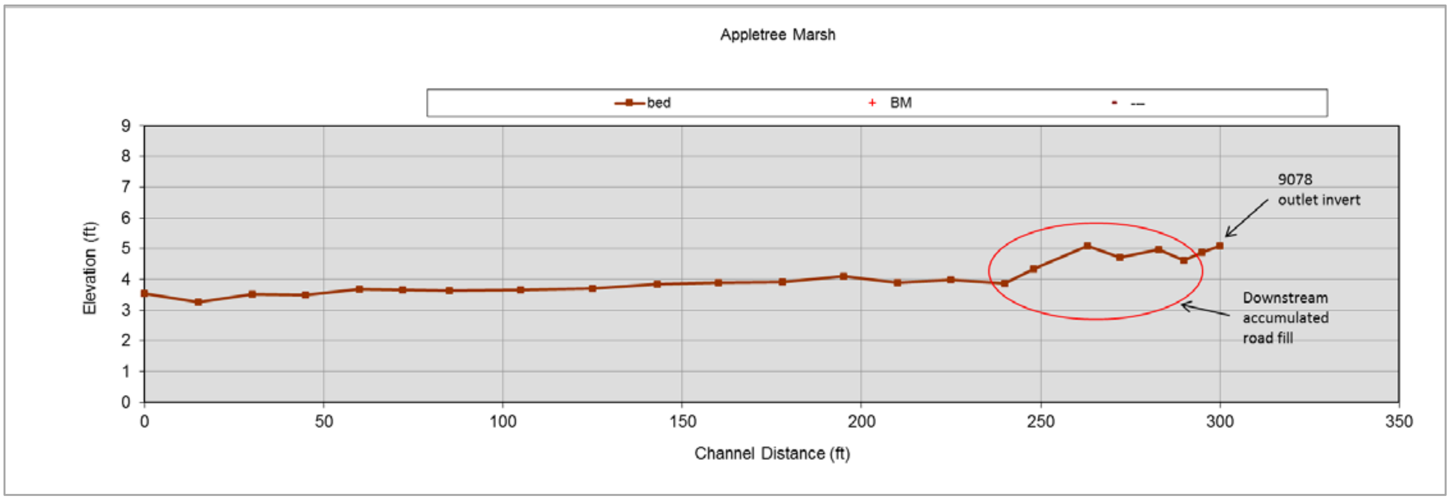


Figure 20. Pre-project longitudinal profile of 9078 (2012, downstream only). Mecklenburg 2006.

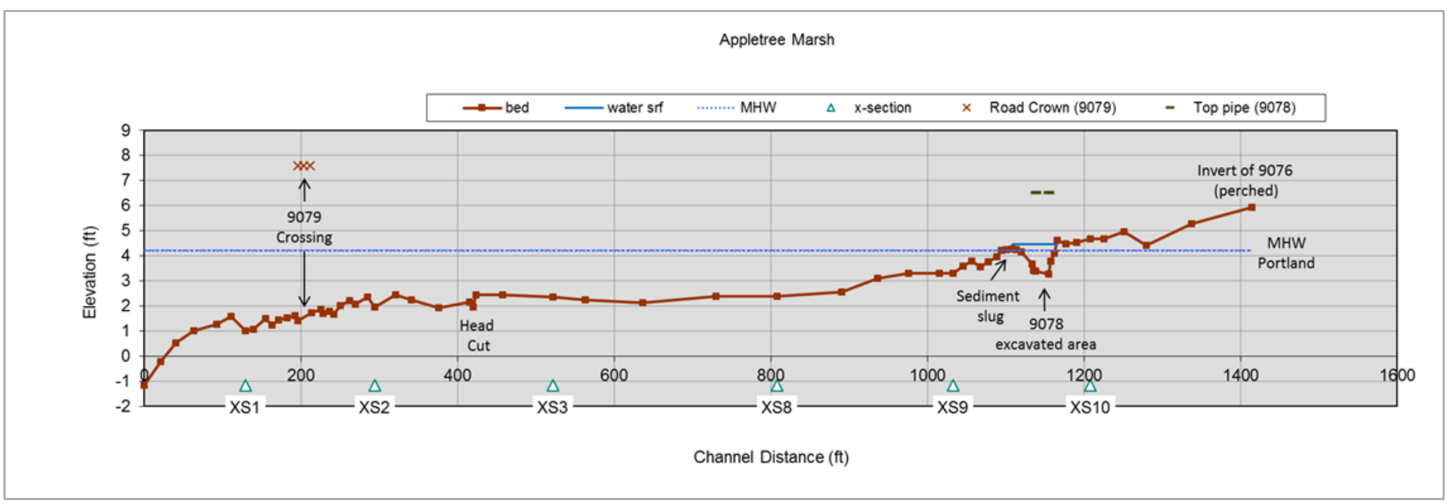


Figure 21. Post-project longitudinal profile of the tidal creek (2015). Mecklenburg 2006.

Fig. 22 plots pre- (2014) and post- (2016) project channel cross section profiles side by side using the *Reference Reach Spreadsheet* developed by Mecklenburg. Cross sections for St. 1, 9 and 10 are not shown.

Bank-full width (indicated by a blue line) was approximated using channel characteristics (elevation breaks, observations/notes) to calculate channel dimensions and cross sectional area, allowing for a roughly standardized year over year comparison of change in channel characteristics, which is useful for considering channel evolution in relation to increased inundation of the marsh surface. Elevations are approximate in feet relative to NAVD.

Generally, the plots illustrate dynamic ongoing changes to channel dimensions in response to increased tidal exchange and improved drainage out of the wetland. Cross sectional area has increased across all stations from pre-project levels, and at stations 2-9, the maximum channel depth has increased. At many stations, the channel has v-shaped angular shape, suggesting active scour and sediment mobility.

In 2015, the greatest percent increase in channel cross sectional area from pre-project occurred at Station 4 (57.6%). By volume, the greatest increase was measured at Station 3 (6.9 $ft.^2$). In 2016, although cross sectional area more than doubled at Stations 8 and 9, the northern lobe of the marsh, the channels were relatively small by comparison to begin with. The greatest total change in area was at Station 3, which increased by 7.4 $ft.^2$, indicating continued active channel response to the altered hydrology.

Selected photographs from the cross section surveys are included in the appendices. At most Stations, photographs were taken looking upstream, downstream, and from each channel bank, providing a visual record. At some Stations, additional photos were taken showing views to the upland edge.

Additional photos and cross section graphs for Stations 1, 2, and 10 are available upon request to CBEP.

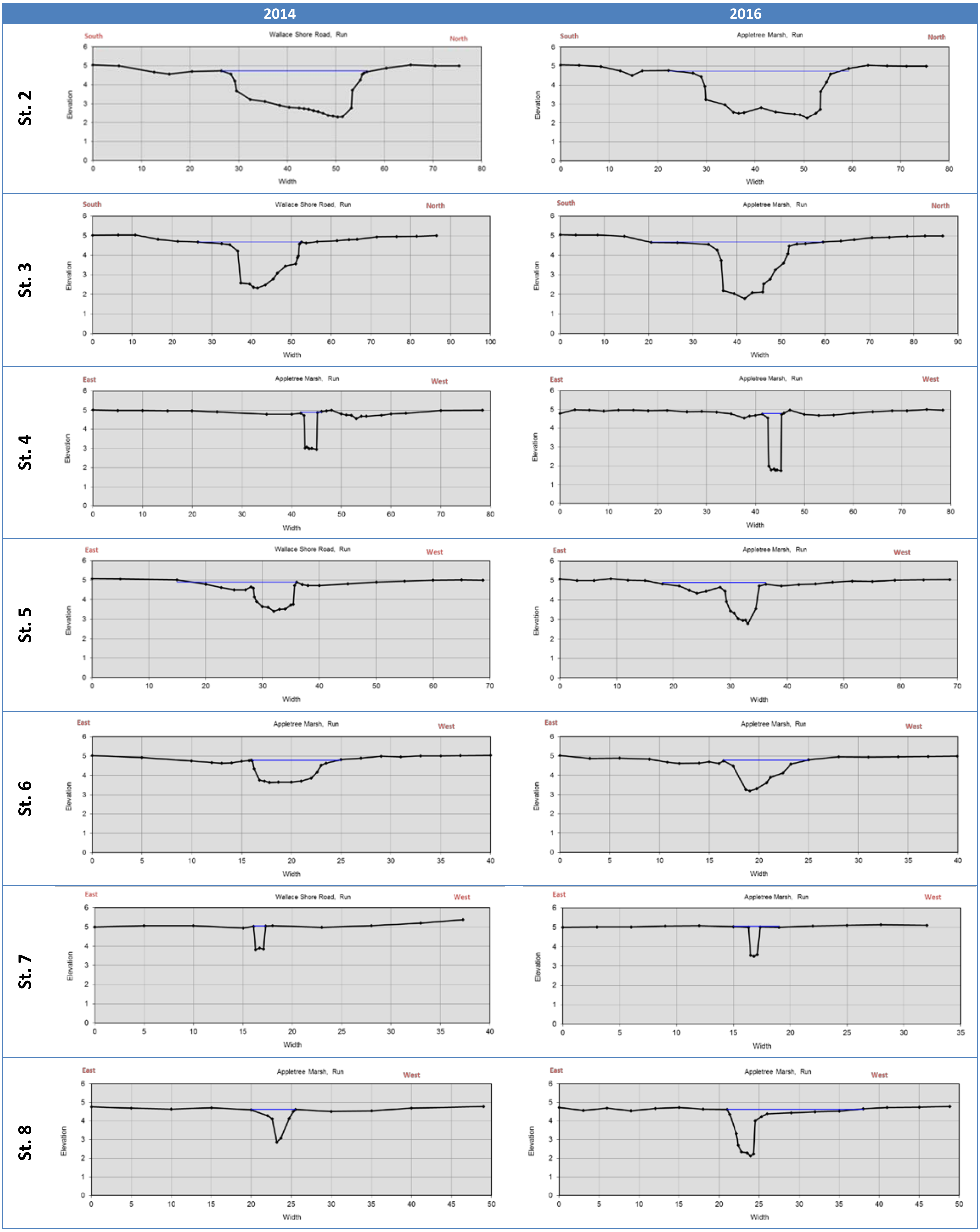


Figure 22. Comparison of pre- and year 1 post- project cross section profiles at Stations 2 - 8. Mecklenburg 2006.

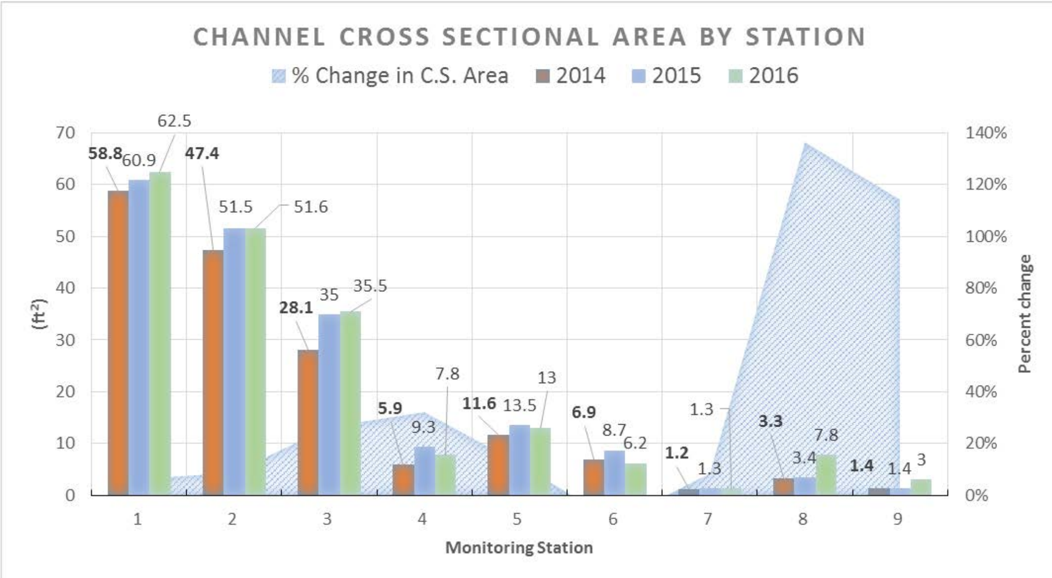


Figure 23. Comparison of channel cross sectional area pre- and year 1 post-project.

3.10 Plant Species of Concern

Plant species of concern are included in the monitoring plan. Observations were recorded during invasive species meander surveys of the marsh and its perimeter, during vegetation monitoring, and during incidental observations. CBEP did not document the presence of invasive plants in the forested area upslope of the upland edge, but they appear to be abundant under the forest canopy in some places. Neither did the surveys cover adjacent freshwater wetlands to the north and south of the wetland area influenced by the tidal restoration project.

The primary species of interest for performance standard monitoring, *Phragmites australis*, remains absent from the site. In 2015, the only invasive plant observed in the wetland footprint was Purple Loosestrife (*Lythrum salicaria*), which was found in several locations, typically in clusters of a few plants, along the perimeter (St. 2, St. 8, St. 10). Primarily, loosestrife was observed on or immediately adjacent to the road bank, and secondarily, in areas with obvious freshwater inputs (seeps or surface water). A large Japanese Barberry (*Berberis thunbergii*) was also observed on the road bank to the west of 9078 in 2014 and 2015 (Fig. 24), right at the wetland's delineated edge. CBEP staff manually cut back the Barberry to the ground in 2015 in order to promote native vegetation and limit the potential for expansion, and will monitor future growth and repeat manual cuts until the plant is dead.

In 2016, a meander survey through the project area for non-native plants was conducted on July 26 by CBEP's seasonal field crew. Similar to previous years, observations were limited to areas outside of, but immediately adjacent to, the project area, particularly along the edge of Wallace Shore Road. The number and distribution of loosestrife plants markedly declined since 2015. All *Lythrum* plants were carefully hand-pulled and rooted prior to going to seed, then bagged and destroyed offsite. The continued decline in plant species of concern is consistent with the drought, improved freshwater drainage out of the marsh, and increased salt delivery via tidal restoration. Monitoring for invasive plants will continue in 2017.

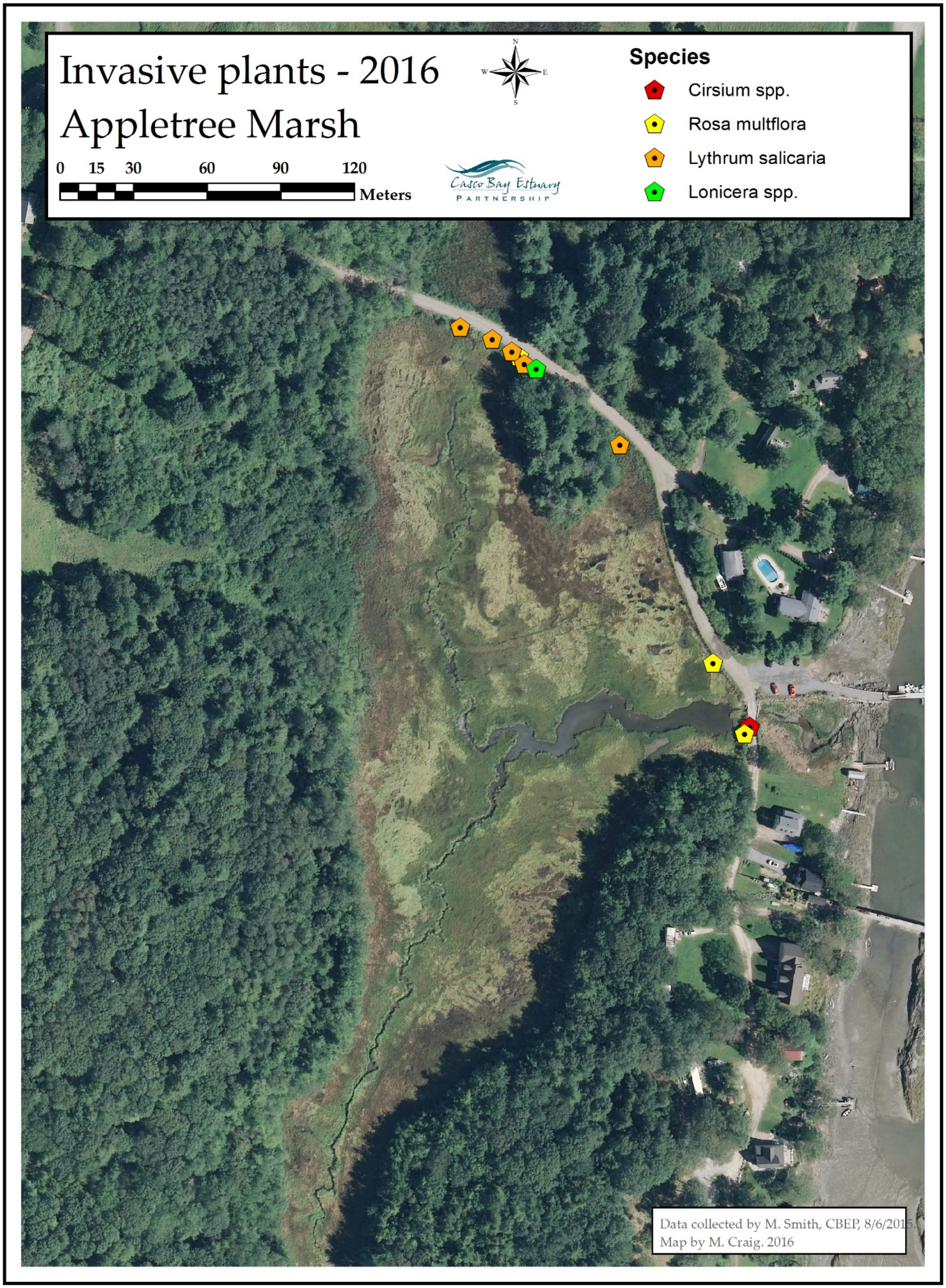


Figure 24. 2016 observations of plant species of concern.

4. Summary and Conclusions

4.1 General Site Conditions

The December 2014 project successfully replaced road/stream crossing infrastructure at two locations on Wallace Shore Road (site 9079 and 9078) with the goal, as stated in the *Restoration Work Plan*, of restoring tidal exchange and increasing freshwater drainage, thereby improving overall hydrology, at the adjacent E2EM1P estuarine and marine wetland. General site conditions are on track with the performance standards defined by the *Restoration Work Plan*:

- All the constructed features such as slopes, soils, and substrates within the mitigation site are stable and free from erosion during the monitoring period.
- Invasive *Phragmites australis* has not been introduced to the site.
- The tidal restriction at the primary crossing, defined as the difference between highest observed water (HOW) downstream and upstream, is less than or equal to .3' based on 2015 hydrology monitoring.

Based on review of hydrology data (Section 3.8), the overarching project goal has been achieved. Data collected through monitoring of other ecological parameters, including vegetation, channel morphology, and pore water salinity, indicates that the wetland has begun to adjust to the abrupt change in hydrology (Sections 3.5, 3.9, 3.10), which is presumed to be an ongoing process. Indications of improved bidirectional flow include channel scour, lower water levels, and higher pore water salinity levels. While some parameters, such as tidal hydrology and pore water salinity, show a short-term/immediate response to the new culverts, other parameters, particularly vegetation communities and channel morphology, are responding gradually and less abruptly. The ecological response to the new hydrology is an ongoing process that will be monitoring and reported for Years 3 – 5.

4.2 Recommendations for Adaptive Management

4.2.1 Year 1

As noted in Section 3.4, and described further in Section 3.10 (and illustrated in the 2015 longitudinal profile in Fig. 21), over the course of several monitoring visits, CBEP observed that surface water was pooling in the excavated channel outlet of crossing 9078 due to a lack of channel development/scour. Water flowing into the excavated area from upstream (north side of culvert) is impounded at the edge of the area excavated during installation, and backs up through the pipe into the excavated area upstream of the inlet, creating a standing pool of water that discharges in a braided network of channels before it reaches the downstream channel. Closer examination revealed that a sediment slug from a historic culvert failure is controlling the grade just downstream of the 9078 outlet. This may be maintaining water levels that allow for persistence of glycophytic species and slow the process of conversion to brackish and halophytic communities at Station 10. The issue is most obvious during low flow conditions that co-occur with a neap tide phase when the flow out of this pool becomes a trickle (Fig. 25). Shallow exploratory probing of the channel suggests that coarse-grained sediments are present on the marsh surface along the edge of the excavated area, and are not mobilizing, presumably due to a lack of velocity/volume combined with volume of sediments present. As previously mentioned, anecdotes from abutters confirm that several years ago (preceding the project), the culvert blew out at this location, washing road fill onto the downstream marsh. The pool, and the sediment slug, may be contributing to the presence of cattails immediately downstream (Fig. 25).

Although water levels in the cattail stand upstream (Station 10) have dropped following installation of the new culvert, and hydrology and pore water salinity data confirms that salt water is now accessing this area post-project, the sediments appear to be maintaining water levels higher than would be expected upstream, and further benefits to tidal exchange (bidirectional flow) could be achieved by removing sediments to assist channel evolution.

Three conceptual management responses could be considered to addressing the issue and enhancing flow at and downstream of 9078:

1. No action. In this approach, CBEP would continue to survey the channel, then re-evaluate the situation in the next report based on Year 2 data. This would allow for additional time to determine whether a direct remediation measure is warranted or whether the channel is slowly responding on its own. No additional cost would be associated with this option, which would occur within pre-determined monitoring and reporting tasks.

2. Remove sediments from the channel. Use hand tools (shovel, hoe) to carefully hand dig coarse-grained sand out of the narrow channel without damaging adjacent vegetation, and transport sediments offsite using a few five gallon buckets. Prior to implementation, additional sediment probes in the channel could be used to determine the extent and depth of coarse grained road fill in the channel. A simple plan could be drawn up in advance to determine channel elevations and width, based on the 2015 longitudinal profile, and survey equipment would be used to check elevations during field implementation. Implementation could be conducted in the summer of 2016. No cost is anticipated with this approach, which could be completed by two people in a couple hours. This is the preferred approach and is recommended out of the three options presented, provided that no additional permitting and approvals is required.

3. Remove sediments from the marsh and channel. Another approach would be to bring heavy equipment back to the site to excavate sediments from both the marsh surface and the channel. The purpose would be to not only improve flow out of the excavated area, and relieve the impoundment, but also to lower marsh surface elevations. A detailed topographic survey downstream of the 9078 outlet may be warranted, as well as a more expansive survey of sediments, to determine the extent and depth of coarse grain sediments downstream of 9078. Simple drawings may be warranted to guide excavation of sediments working with large equipment (presumably, a back hoe or excavator and a dump truck). This option is least preferred. Although this approach could realize additional benefits by removing fill from the marsh surface, use of an heavy equipment brings an inherent risk of doing more harm than good (damage to vegetation, digging out a larger or deeper channel than is suitable, etc.). For this reason, the approach is not recommended. Work could be conducted in late summer/early fall 2016 if funding was obtained, and permits were secured if necessary, but these are unknown considerations at this time.

Figure 25. Pooled water at the outlet of crossing 9078 (2015 (l) and 2016 (r)).

4.2.2 Year 2

CBEP removed small quantities of sediments adjacent to the excavated pool consistent with option 2, above. Water levels in the pool dropped by a few inches and based on subsequent observations, drainage was improved as a result. Drainage at this site will be monitored in the future to determine whether additional work is needed to improve drainage.

5.0 References

Mecklenburg, D., 2006. *The Reference Reach Spreadsheet: Version 4.3 L*. Ohio Department of Natural Resources.

Tiner, R. 2009. *Field Guide to Tidal Wetland Plants of the Northeastern United States and Neighboring Canada: Vegetation of Beaches, Tidal Flats, Rocky Shores, Marshes, Swamps, and Coastal Ponds.* University of Massachusetts Press, Amherst.

Verrill, S. 2017 (projected). *Shifting vegetation zones in response to culvert enlargement at a tidally restricted salt marsh in Harpswell, Maine.* (Unpublished master's thesis in progress). University of Southern Maine, Portland.

Appendix A – Photographs

Representative photos are required to support the findings and recommendations, for each restoration/enhancement site. Photos should be taken from the same locations for each monitoring event and must be dated and clearly labeled. A map, or maps, showing photo locations must be included and clearly labeled with the direction from which the photo was taken. Photos may be included in this appendix or in the body of the report.

CBEP staff photo-documented conditions on the marsh and at the two project areas (crossing #9079 & #9078) on multiple occasions pre-project, and at least once during years 1 and 2 post-project. A subset of these photos are organized in a set of three tables, which also include the subject, direction and date of each photo, within Appendix A. Maps showing the location of the photo stations, which include the project areas (sites 9079 and 9078), and the cross section and vegetation monitoring stations (Stations 1 – 10) are provided in the main body of the report.

Tables 11 and 12 compare pre-project and 2016 comparisons of conditions at the two project locations, 9079 and 9078. Additional photos (for example of the road approach, or certain details) are available upon request.

Table 13 presents pre/post photos at cross sections survey locations (Stations 1 – 9). Additional photos showing alternate views of the cross section surveys may be available. Photographs for Station 10 are presented in Table 14, for the vegetation surveys.

Table 14 presents pre/post photos along the transects at vegetation monitoring stations (Stations 1 – 10). Additional photos showing photos in the opposite direction (e.g., from the upland toward the channel) are available for each Station.

Table 11. Photos of project area, crossing #9079 (crossing nearest to bay). Photos reflect conditions at low tide.

Site 9079, Pre-Project	**Site 9079, Post-Project**
View Downstream (Est). Dates (L to R): 7/31/2012; 7/26/2016.	
	
View to Outlet (West). Dates (L to R): 7/31/2012; 7/26/2016	
	
View to Inlet (East). Dates (L to R): 7/31/2012; 7/26/2016	
	
View Upstream (West). Dates (L to R): 7/31/2012; 7/26/2016	
	

Table 12. Photos of project area, crossing #9078 (crossing nearest to upland). Photos reflect conditions at low tide.

Site 9078, Pre-Project	**Site 9078, Post-Project**
View Downstream (South). Dates (L to R): 7/23/2012; 9/8/2016	
	
View to Outlet (North). Dates (L to R): 7/28/2014; 9/8/2016	
	
View to Inlet (South). Dates (L to R): 7/28/2014; 9/8/2016	
	
View Upstream (North). Dates (L to R): 7/23/2012; 9/8/2016	
	

Table 13. Photos from cross section surveys. Photos reflect conditions at or near low tide.

<table>
<tr><th>Pre-Project</th><th>Post-Project</th></tr>
<tr><td colspan="2">Station 1 (L – 7/31/2012; R – 5/31/16); view to E/SE. Outlet to bay in the background.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 2 (L - 7/25/2014; R – 5/31/16); view to E. Inlet of 9079 in background.</td></tr>
<tr><td>
</td><td></td></tr>
<tr><td colspan="2">Station 3 (L – 7/9/2014; R – 5/31/16); view to W, looking upstream from 9079.</td></tr>
<tr><td>
</td><td></td></tr>
<tr><td colspan="2">Station 4 (L – 7/9/2014; R – 5/31/16); view to S, toward St. 5, 6, and 7.</td></tr>
<tr><td>
</td><td></td></tr>
</table>

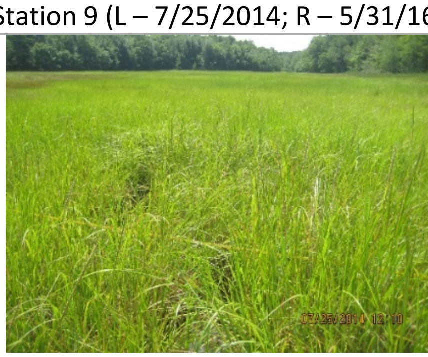
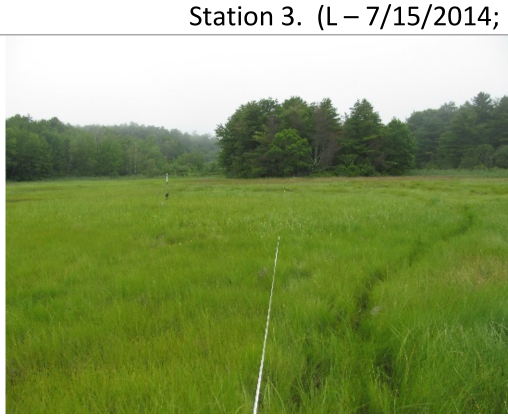
PRE-PROJECT	POST-PROJECT
Station 5 (L – 7/9/2014; R – 5/31/16); view to N, toward St. 4.	
	
Station 6 (L – 7/9/2014; R – 5/31/16); view to N, toward St. 4 & 5.	
	
Station 7 (L – 7/9/2014; R – 5/31/16); view to S. Channel obscured by vegetation.	
	
Station 8 (L – 7/25/2014; R – 5/31/16); view to S toward St. 4, 5.	
	
Station 9 (L – 7/25/2014; R – 5/31/16); view to S toward St. 8. Channel obscured by *S. alterniflora.*	
	

Table 14. Photos from vegetation surveys.

PRE-PROJECT	**POST-PROJECT**
Transect 1a. (L – 7/15/2014; R - 7/21/16); view S/SW from channel to upland.	
	
Station 1b. (L – 7/15/2014; R – 7/21/16); view N from channel to upland/gravel parking lot.	
	
Station 2. (L – 7/15/2014; R – 7/21/16); view N from channel toward upland.	
	
Station 3. (L – 7/15/2014; R – 7/21/16); view N from channel to upland.	
	

<table>
<tr><th>PRE-PROJECT</th><th>POST-PROJECT</th></tr>
<tr><td colspan="2">Transect 4. (L – 7/17/2014; 7/21/16); view E from channel to upland.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 5. (L – 7/17/2014; R – 7/21/16); view E from channel to upland.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 6. (L – 7/17/2014; R – 7/21/16); view E from channel to upland.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 7. (L – 7/17/2014; R – 7/21/16); view E from W end of transect.</td></tr>
<tr><td></td><td></td></tr>
</table>

<table>
<tr><th>Pre-Project</th><th>Post-Project</th></tr>
<tr><td colspan="2">Transect 8. (L – 7/15/2014; 7/21/16). L - view E from upland to channel; R - view W from channel to upland.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 9. (L – 7/15/2014; R – 7/21/16). View W from channel to upland.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 10. (L – 7/15/2014; R – 7/21/16). View E from W end of transect.</td></tr>
<tr><td></td><td></td></tr>
</table>

Appendix B – Maps

A map or maps should be attached to each monitoring report showing the boundaries of the restoration/enhancement area(s) relative to other landscape features on the site, habitat types, locations of photographic reference points, transects, sampling data points, and/or other features pertinent to the restoration/enhancement plan and monitoring events. Geographic coordinates are helpful in locating the site(s) for inspection purposes.

All maps are included within the main body of the report. Monitoring stations are georeferenced and GPS coordinates are available upon request to CBEP.

Appendix C – Plans

If alterations were made to the approved restoration/enhancement plan due to conditions found in the field, as-built plans showing appropriate topography for type of restoration, structures including any inlet/outlet structures, grading, etc. must be submitted. These need only be submitted once and may be included in future monitoring reports by reference. If plantings were part of the plan, location and extent of the designed plant community types (e.g., shrub swamp) should be included. Within each community type the plan shall show the species planted—but it is not necessary to illustrate the precise location of each individual plant. There should also be a soil profile description and the actual measured organic content of the topsoil. This should be included in the first monitoring report unless there is grading or soil modifications or additional plantings of different species in subsequent years.

No modifications were necessary due to unforeseen conditions in the field, so the project was constructed within the parameters of the final engineering designs as presented in the *Wallace Shore Road Restoration Work Plan.*

Appendix D – Plant List

As applicable, a vegetative species list of volunteers in each plant community type. The volunteer species list should, at a minimum, include those that cover at least 5% of their vegetative layer.

A comprehensive list of vegetation identified during vegetation surveys is provided in the main body of the report, and a list of invasive plant species observed is provided in Section 3.11. Since this project did not involve planting vegetation, and the community type is already present on the site, the monitoring plan was not designed to document volunteer species within each community type.

Appendix E – 4/26/16 Wright-Pierce Memorandum