2008 BEACH RESTORATION PROJECT
ISLE OF PALMS SOUTH CAROLINA

Monitoring Report No 7
June 2016

Prepared for:

City of Isle of Palms

COASTAL SCIENCE & ENGINEERING

2008 Isle of Palms Restoration Project

YEAR 7 (2015) MONITORING REPORT

Annual Beach and Inshore Surveys

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[CSE 2447 YR1]

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COVER PHOTO: Aerial image of Isle of Palms (Reach 5) taken in January 2016.

EXECUTIVE SUMMARY

This report outlines beach changes occurring on Isle of Palms, focusing on changes occurring between September 2014 and August 2015. It also provides a summary of beach changes due to Hurricane *Joaquin*, which were detailed in a letter to the City submitted in October 2015. The August 2015 survey encompassed 118 monitoring stations along the island and additional lines covering the deltas of Dewees and Breach Inlets, similar to previous annual monitoring efforts for the City. Between the 2014 and 2015 surveys, the City completed another shoal management project, transferring ~240,000 cubic yards (cy) of sand from accretional areas at 53rd Avenue to 56th Avenue and the shoal attachment zone to the erosional hotspots along Beachwood East and near Seascape and Ocean Club.

Significant findings of the 2015 monitoring event include:

- Overall, the island gained 125,000 cy from 2014 to August 2015.
- Reach 5 (western portion of Wild Dunes) was the most erosional area, losing 65,500 cy (11 cubic yards per foot—cy/ft).
- Reach 6 (eastern portion of Wild Dunes) was the most accretional, gaining 110,000 cy (22.5 cy/ft).
- Reaches 1 and 2 (Breach Inlet to the Sea Cabins Pier) eroded 0.7 cy/ft and 7.1 cy/ft (respectively).
- Shoal attachment stalled between 2014 and August 2015 because the shoal remained off the beach but increased in elevation.
- Erosional hotspots remain around 6th Avenue and the area between the Wild Dunes Grand Pavilion and Dunecrest Lane.
- Hurricane *Joaquin* resulted in net accretion, adding ~124,000 cy of sand to the beach, although there was dune loss in the erosional hotspot areas. The storm pushed the main body of the shoal to the beach, resulting in attachment along the center and northern side of the shoal. Evidence of sand spreading to the north is apparent.
- As of October 2015 (post-*Joaquin*), the east end (2008 project area) contains 396,500 cy more sand than the pre-nourishment (2008) condition. Reach 6 has 528,000 cy more sand than in 2008, while Reach 5 has lost 268,000 cy since 2008.

The major events occurring between September 2014 and the end of 2015 were the shoal management project, shoal-induced erosion and accretion in the attachment area, and the passage of Hurricane *Joaquin*. The majority of the Isle of Palms beach remains healthy and properties are well protected; however, several properties in the erosional hotspots along Wild Dunes are threatened. The City is presently pursuing a permit for a large-scale nourishment project.

CSE recommends the City establish funding to implement a project once permits are issued. Alternatively, in the event the permit is delayed or the beach condition significantly improves, another shoal management project may be conducted to restore critically eroded areas. Any restoration alternative would require any emergency measures that are presently installed to be removed prior or during restoration. The next monitoring event will be completed in summer of 2016.

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1.0 INTRODUCTION

This monitoring report is submitted to the City of Isle of Palms, SC (IOP) by Coastal Science & Engineering (CSE) as part of an ongoing, beach-monitoring effort which began in 2007 as part of the planning effort for the 2008 Isle of Palms Beach Restoration Project (P/N 2007-02631-2IG) (CSE 2008). This report follows earlier monitoring reports submitted annually to the City as well as additional reports and engineering documents related to ongoing shoal management activities (P/N 2010-1041-2IG) occurring since 2010. The report details the beach condition as surveyed in August 2015 and compares this condition with selected earlier dates including the pre-2008 project condition.

Analyses in this report include detailed beach volume change along the ~7-mile beach which spans from Breach Inlet to Dewees Inlet. It also includes comparisons of earlier beach conditions with the present condition, calculation of annual erosion rates, and measurements of linear shoreline change. Large-scale morphologic changes occurring in Breach Inlet and Dewees Inlet are also discussed along with the anticipated impacts of these shifting shoals on the future beach condition. Ground and aerial photographs are included to provide visual representation of the beach condition and include identifying areas with dune escarpments, showing dry-beach width, and showing areas with existing or potential damage due to erosion.

This report also includes general information about the storm event occurring in early October 2015 associated with offshore passage of Hurricane *Joaquin* and beach condition changes occurring during the storm. Under a separate agreement with the City, CSE completed a post-storm beach survey following the storm and provided a summary letter to the City outlining beach-volume changes and identifying areas of beach damage. While the focus of this report will be changes occurring between 2014 and August 2015, volume change occurring during the storm will be presented so that the most up-to-date beach condition is also included. CSE is presently coordinating with the City and FEMA on potential disaster recovery measures.

Per requirements of the shoal management permit, a survey of the beach must be completed approximately one year after a shoal management project is constructed. The October 2015 survey will satisfy this permit requirement, and this report will be sent to permitting agencies for compliance.

1.1 Setting

Isle of Palms is an ~7-mile-long, southeast-facing, barrier island located ~8 miles east of Charleston, South Carolina. It is bounded by Dewees Inlet and Dewees Island to the northeast and Breach Inlet and Sullivan's Island to the southwest. A feature typical of the central South Carolina barrier islands is the "drumstick" shape (Hayes 1979) produced by the interaction of waves and tides, and formation of prominent ebb-tidal deltas at the inlets. Seaward shoals of each delta produce wave refraction and variable longshore transport rates, which lead to a wider upcoast (northern) end and a relatively narrow downcoast end (Fig 1.1).

The wider end of the island is influenced by shoal bypassing, a process whereby sand is periodically released from the inlet delta and moved onshore through wave action (Fig 1.2). This process occurs at somewhat regular intervals (average interval between events from 1941 to 1997 is 6.6 years) (Gaudiano 1998) and contributes to the overall health of the island. However, it also can cause focused erosion in areas adjacent to the shoal attachment zone (Kana et al 1985).

The long-term accretion trend at Isle of Palms is a direct result of shoal bypassing at Dewees Inlet (Fig 1.3). Numerous episodic events have deposited sand on the northeastern end of the island (Gaudiano 1998). The annual average sand gain from shoal-bypass events is ~100,000 cubic yards per year (cy/yr); however, ~120,000–130,000 cy/yr are typically lost to downcoast areas each year, leaving a net sand deficit of ~20,000–30,000 cy/yr at the northeastern end (CSE 2007). A more detailed explanation of the coastal processes and erosion history of Isle of Palms is provided in CSE (2007, 2008, 2009).

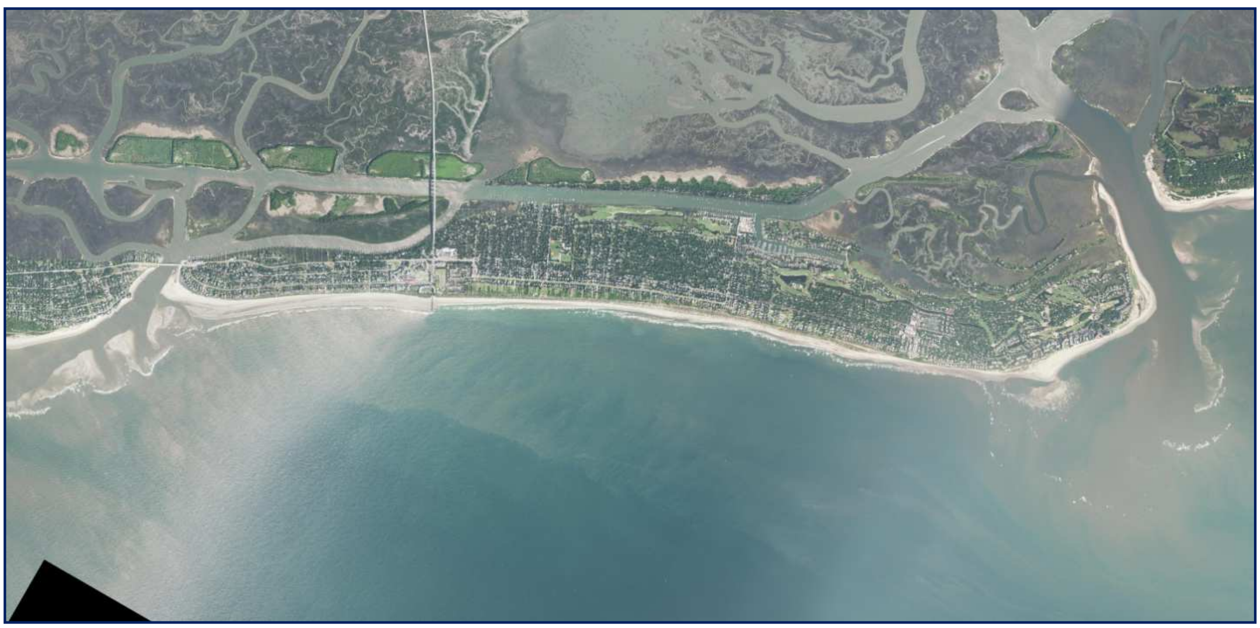

FIGURE 1.1. Isle of Palms, South Carolina. [Source: 2015 NAIP Imagery]

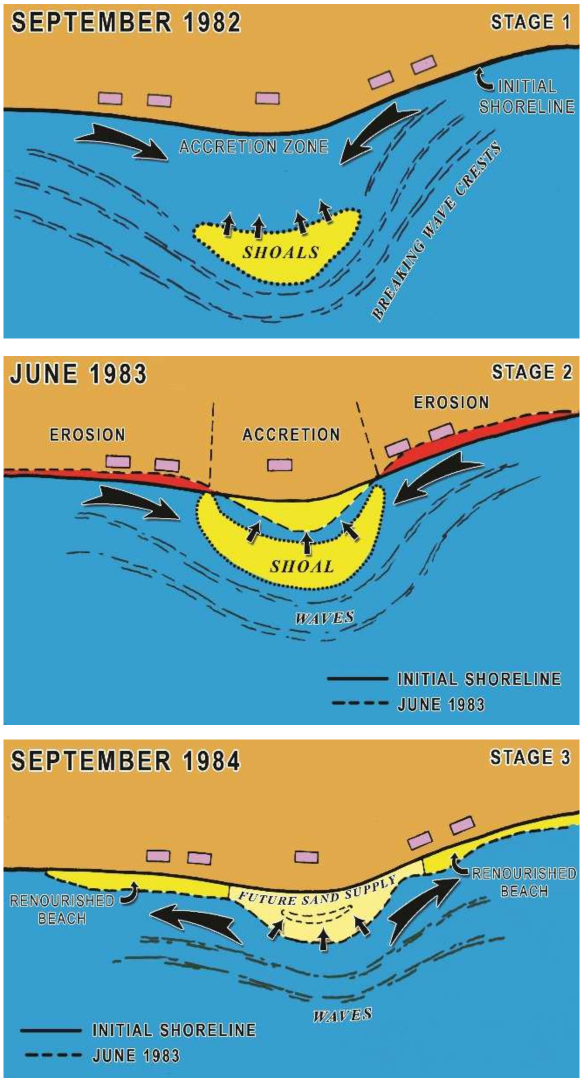

FIGURE 1.2. Shoal-bypassing at IOP.

[LEFT]
Schematic of the shoal-bypass cycle originally modeled from a bypass event at IOP. During Stages 1 and 2 of the cycle, accretion in the lee of the shoal is accompanied by erosion on either side of the attachment site. (After Kana et al 1985)

[RIGHT]
Shoal-bypass event at the northeastern end of IOP. The upper photo shows a shoal in Stage 1 of the bypass cycle in March 1996. The middle image, taken in 1997, shows that the shoal is beginning to attach to the beach and is in Stage 2 of the bypass cycle. The lower image (from December 1998) shows the shoal completely attached (Stage 3), and sand has spread to previously eroded areas.

FIGURE 1.3. Schematic of the sediment transport pathways at Isle of Palms (SC). The island is a typical "drumstick" barrier island (after Hayes 1979), where the upcoast end is wider due to sediment accumulation through shoal-bypass events, and the downcoast end usually forms a growing recurve spit. Other examples of drumstick barrier islands along South Carolina are Bull Island, Kiawah Island, and Fripp Island. Zones of sediment transport reversal generally occur in the lee of delta shoals which are situated offshore. Upon shoal attachment to the beach, transport directions in the vicinity of the shoal switch, spreading sand away from the attachment point (see for example Fig 1.2).

1.2 Erosion Mitigation Efforts

The earliest known, engineered erosion control efforts at Isle of Palms were installation of a seawall in the vicinity of the Citadel Beach House from 46th Avenue to 53rd Avenue and a series of groins from 42nd Avenue to 53rd Avenue. These were in place by 1973 in response to narrow setbacks in the area and are shown as they existed in 1984 in Figure 4. The structures remained visible through 1994 and were removed or buried by the late 1990s as the beach in this area accreted.

Around 1980, erosion along the Dewees Inlet shoreline was threatening portions of the Wild Dunes Links Course, and a groin was constructed of concrete-filled geotextile bags. The groin proved successful in stabilizing the stretch of shoreline near the 17th tee box and is currently exposed to varying degrees based on recent sediment transport magnitudes.

FIGURE 1.4. 1984 aerial image of Isle of Palms between 39th Avenue and 57th Avenue showing groins and a seawall installed along the beach. Groins are indicated by the arrows.

In the early 1980s, erosion associated with a shoal-bypass event resulted in several individual properties or condominium units installing armor-stone revetments seaward of the structures. In 1984, a nourishment project was conducted using sand dredged from the Isle of Palms marina basin adjacent to the Intracoastal Waterway. Approximately 350,000 cy of sand were placed in areas adjacent to the attaching shoal, restoring the dry-sand beach. By 1987, another shoal-bypass event was occurring which resulted in severe erosion along Beachwood East and Beach Club Villas. Approximately 50,000 cy of sand from an upland borrow source were added, and portions of the armor-stone revetment were extended.

Remedial sand scraping followed Hurricane *Hugo* in 1989 to mitigate storm induced erosion, which eliminated dunes but created a wide intertidal beach suitable for scraping and rebuilding the dune.

Another bypass event occurring in the mid-1990s led to critical erosion (see Fig 1.2), and sand was transferred from the attaching shoal to erosional areas (quantities are uncertain) in a similar fashion as recent shoal-management projects.

The event leading to the present monitoring effort was a large shoal-bypass event which began to impact the shoreline along Wild Dunes by 2003. This event was one of the largest observed shoal-bypassing events observed at Isle of Palms (Gaudiano & Kana 2001) and resulted in an extended period of extreme erosion on either side of the shoal. On the north side, erosion was so severe that all properties north of Mariners Walk had to place sandbags to prevent damage to structures (Fig 1.5). The 18th hole of the links course eroded after sandbags proved too costly to maintain. In 2007, CSE completed an erosion assessment and provided a feasibility study to the Wild Dunes Community Association recommending a nourishment project using an offshore sand deposit to restore the existing sand deficit and provide advanced nourishment for future erosion. The City then led the effort to implement an ~900,000 cy nourishment project in the late spring of 2008, which added sand to the erosional areas in three reaches as shown in Figure 1.6.

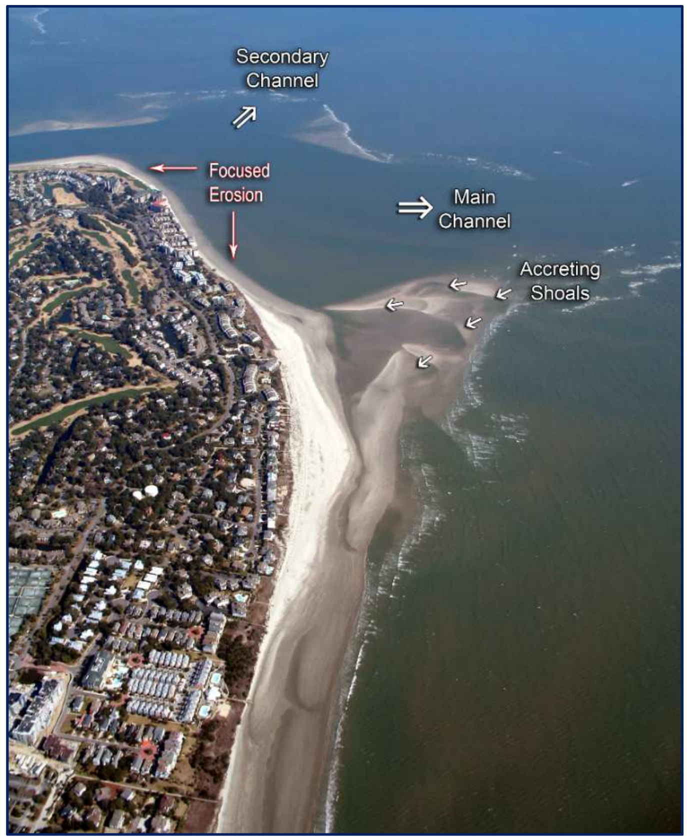

FIGURE 1.5. 2007 aerial image of the northeast end of Isle of Palms, showing a large shoal event attached to the beach.

The (~) $10 million nourishment project was effective in restoring a wide dry beach along the entire shoreline along the northeast end of the island. Following the project, two additional shoal-bypass events occurred, attaching to the beach in 2009 and 2010. These events, coupled with morphologic features such as the position of the Dewees Inlet channel, led to focused erosion along the northern end of the island centered at the Ocean Club unit. In anticipation of the potential need for remedial action, the City applied for a permit to allow harvesting sand from the accretional areas of the beach (shoal attachment zones). By 2012, the beach

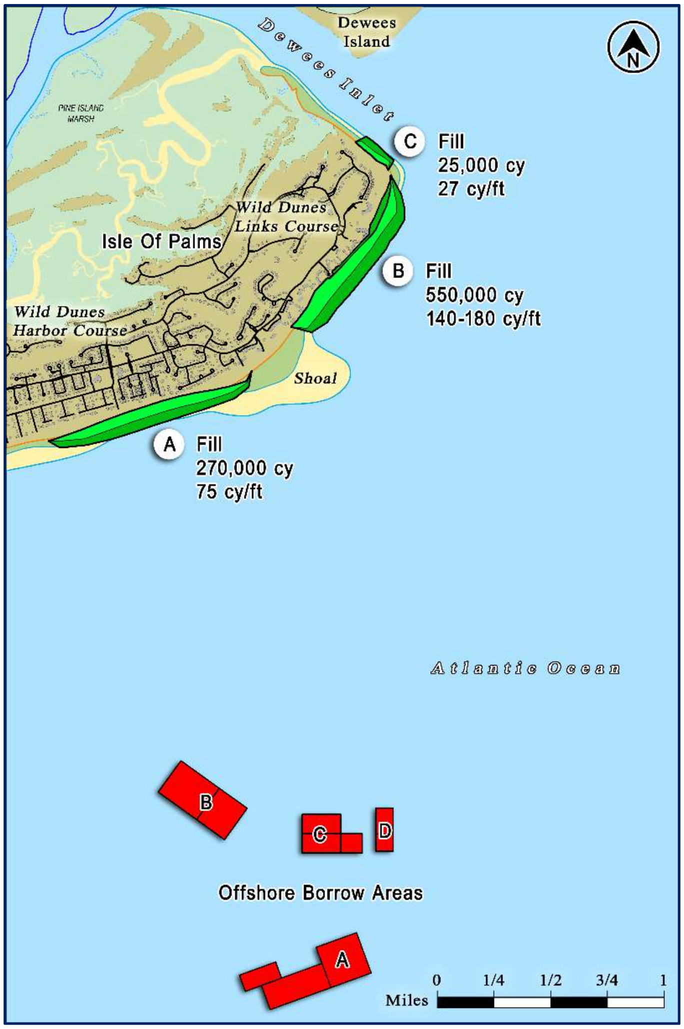

FIGURE 1.6. Diagram showing the 2008 beach nourishment project footprint.

condition in the area near Seascape, Ocean Club, and the 18th Hole reached the point where additional sand was needed. The City, working with RB Baker as contractor, transferred ~80,000 cy of sand from the beach landward of the attaching shoal (around Beach Club Villas and the Wild Dunes Property Owners Beach House) and placed it in eroded area. The volume of sand was limited by the availability in the harvest area. At the time of the project, there was not an active shoal attaching to the beach, therefore, all sand was harvested from the beach, which had excess sand from the previous bypass events.

The limited quantity of sand available to place during the 2012 project resulted in a relatively short project life (3–4 months). The same area continued to be a hotspot for erosion, and by 2014, additional emergency measures were in place fronting Seascape and Ocean Club. Erosion was also occurring on the western side of the shoal along Beachwood East and Dunecrest Lane.

By late 2014, an approaching shoal was nearing attachment to the beach, and a portion of the shoal was accessible to equipment for harvesting. The City implemented another shoal management project (Fig 1.7) which moved ~240,000 cy of sand to the two erosional areas: ~70,000 cy were placed in along the area between Seagrove and Dunecrest Lane, and 170,000 cy were placed between Port O Call and the 18th Hole. Near the time of the project, erosion accelerated along the western area and continued during and after the project, resulting in rapid loss of the sand placed along that length of beach. The eastern area performed much better, retaining a dry sand buffer until Hurricane *Joaquin* in early October 2015.

FIGURE 1.7. Post-construction photos of the 2014–2015 shoal management project. [LEFT] The area fronting Dunecrest Lane. [RIGHT] The area fronting Seascape and Ocean Club.

Following the 2014/2015 shoal management project, a Wave Dissipation System (WDS) was installed by homeowners along Beachwood East in hopes of preventing additional loss of upland sand (Fig 1.8). A system was also installed in front of Ocean Club. These systems and the permits allowing the systems were not coordinated by the City, but conditions of the permits prevent sand from being placed seaward of the structures. In a meeting with homeowners in the erosional areas, the homeowners indicated to the City that they preferred to leave the WDS systems in place rather than allow the City to attempt another shoal management project in the fall of 2015. Presently, the City is in the initial phases of obtaining a permit for another large-scale beach nourishment project using an offshore borrow source.

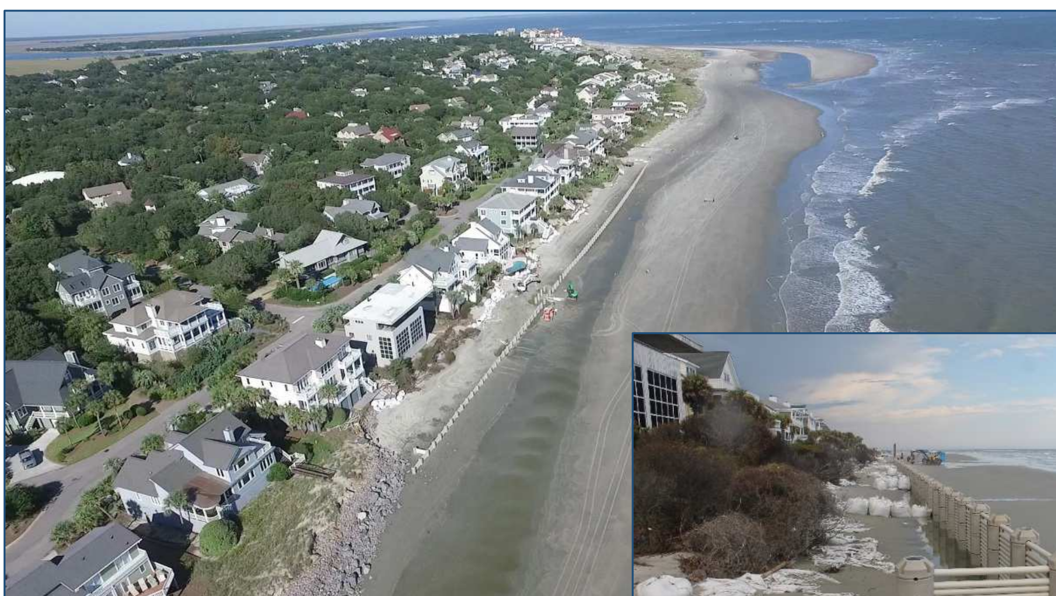

FIGURE 1.8. Photos of the wave-dissipation system installed in front of Beachwood East. A similar structure was installed in front of Seascape and Ocean Club.

2.0 METHODS

Monitoring efforts for the present report were performed in August 2015. Changes in the volume of sand in the active beach zone were evaluated by obtaining topographic and bathymetric data along shore-perpendicular transects at established locations along the beach (herein referred to as the baseline) (Fig 2.1). The present baseline spans from the center of the Breach Inlet Bridge (station 0+00) and continues to Cedar Creek spit at the northeastern end of the island (station 376+00). Stationing relates to the distance along the shore with the number before the "+" symbol representing 100 feet (ft). Therefore, station 36+00 is 3,600 ft from station 0+00. The baseline is generally set landward of the present active beach to allow for future erosion/accretion.

Topographic data were collected via RTK-GPS (Trimble™ R8 GNSS), which provides position and elevation measurements at centimeter accuracy. Beach profiles were obtained by collecting data at low tide along the dunes, berm, and active beach to low-tide wading depth. Overwater work was then performed at high tide to overlap the land-based work (Fig 2.2) and was collected with RTK-GPS coupled with an Odom CV100™ precision echosounder mounted on CSE's survey vessel, the RV *Southern Echo*.

Profiles were collected from the most landward accessible point in the dune system to a minimum of 1,500 ft from the baseline. Profiles along the northeast end of the island extended up to 6,000 ft offshore to encompass the shoals associated with Dewees Inlet. Alongshore spacing of the profiles ranged from 200 ft to 1,000 ft with the more closely spaced profiles north of 53rd Avenue and along Breach Inlet. Comparative profiles from CSE's monitoring efforts are shown in Appendix A. The complexity of areas impacted by inlets requires more detailed analysis (closer profile spacing) to fully incorporate volume changes associated with shoal-bypassing events and inlet migration.

To better understand regional sand volume changes, seven reaches were defined along Isle of Palms. By combining several profiles into a reach, it is easier to identify overall sediment gains and losses over large portions of the beach. In the project area, the reaches differ from reaches used during construction so as to encompass areas where no work was performed.

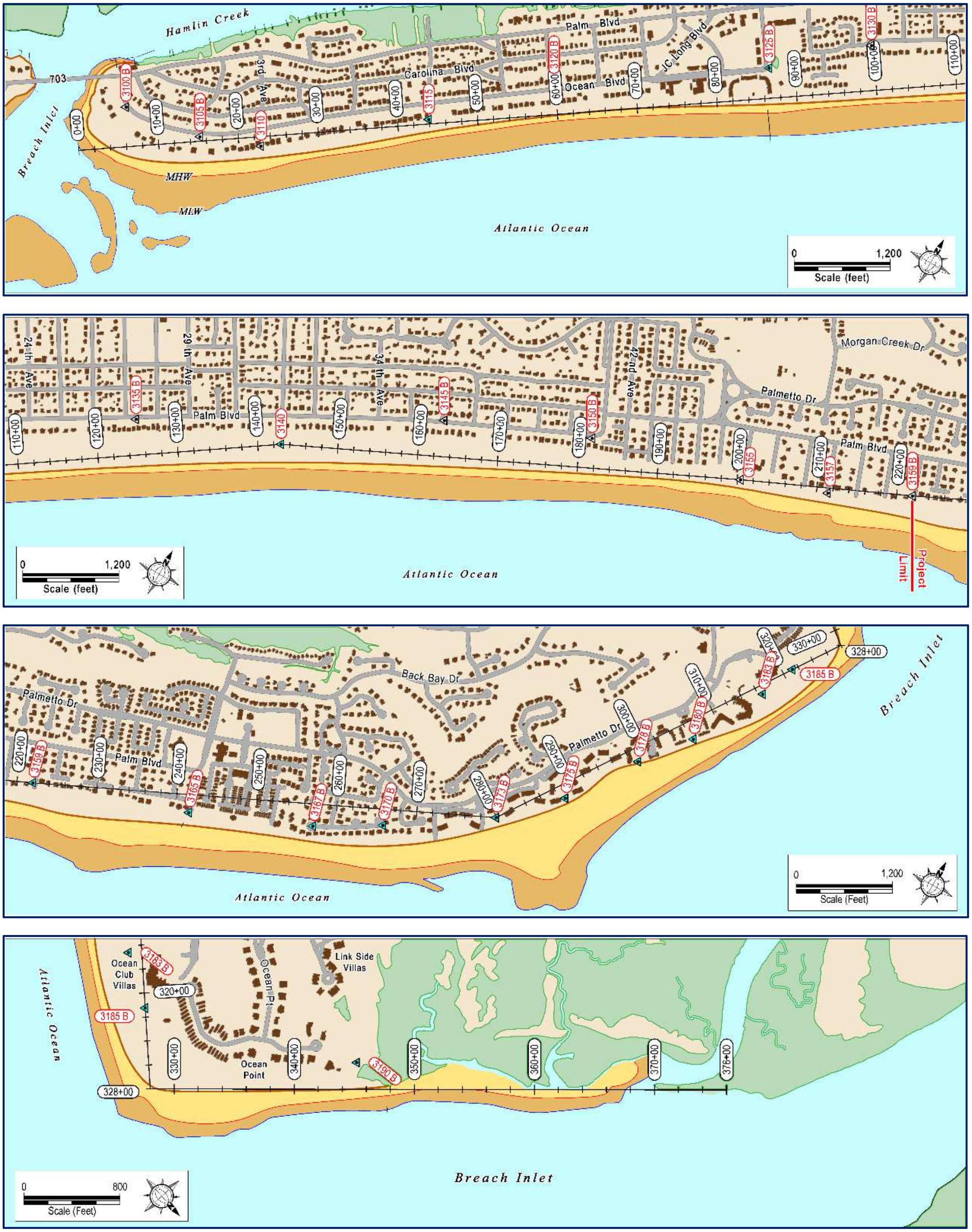

FIGURE 2.1. Baseline map of Isle of Palms showing the reference line used to establish monitoring profiles. Stationing increases to the north from Beach Inlet.

FIGURE 2.2.

Surveying beach profiles involves collection of land-based data at low-tide and hydrographic data collection overlapping the land-based work.

The reaches used for monitoring purposes are shown in Figure 2.3 and are defined as follows:

Reach 1	0+00 to OCRM 3115	Breach Inlet to 6th Avenue
Reach 2	OCRM 3115 to OCRM 3125	6th Avenue to Sea Cabins Pier
Reach 3	OCRM 3125 to OCRM 3140	Sea Cabins Pier to 31st Avenue
Reach 4	OCRM 3140 to 222+00	31st Avenue to 53rd Avenue
Reach 5	222+00 to 280+00	53rd Avenue to Wild Dunes Property Owners Beach House
Reach 6	280+00 to 328+00	Wild Dunes Property Owners Beach House to Dewees Inlet
Reach 7	330+00 to 370+00	Dewees Inlet Shoreline

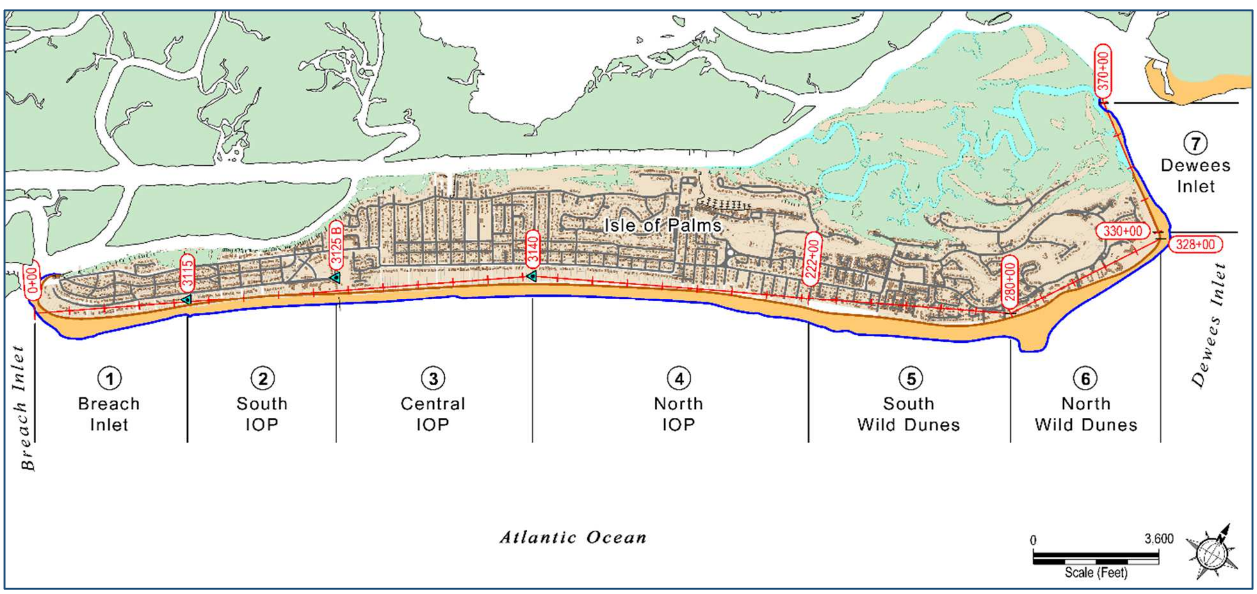

FIGURE 2.3. Reach limits used in the present monitoring report.

To determine changes in beach volume along Isle of Palms, beach profile data were entered into CSE's in-house custom software, Beach Profile Analysis System (BPAS), which converts 2D profile data in x–y (distance–elevation) format to 3D volumes. The software provides a quantitative and objective way of determining ideal minimum beach profiles and how the sand volume per unit length of shoreline compares with the desired condition. It also provides an accurate method of comparing historical profiles—as the volume method measures sand volumes in the active beach zone rather than extrapolating volumes based on single-contour shoreline position (ie – from aerial photography). Unit-volume calculations can distinguish the quantity of sediment in the dunes, on the dry beach, in the intertidal zone to wading depth, and in the remaining area offshore to the approximate limit of profile change (closure depth).

Figure 2.4 depicts the profile volume concept. The reference boundaries are site-specific, but ideally encompass the entire zone over which sand moves each year. Sand volume was calculated between the primary dune and between −10 ft and −18 ft NAVD. The lower calculation limit was site-specific, as profiles in the center of the island and along Dewees Inlet generally have deeper closure depths than areas in the unstable inlet/shoal zones. Comparative volumes and volume changes were computed using standard procedures (average-end-area method, in which the average of the area under the profiles computed at the ends of each cell is multiplied by the length of the cell to determine the cell's sand volume). Certain adjustments were made to account for changes in the baseline direction and for volumes at the turn in the baseline at Dewees Inlet.

Note that for the present report, several adjustments were made to the calculation limits for profiles showing significant erosion in recent years. The erosion has resulted in the active beach moving landward into areas which were not previously included in volume measures. Profile volumes for all previous surveys were recomputed using these new limits to provide accurate comparisons. This results in report volumes for a given year being slightly different than volumes reported in earlier reports.

Sand volumes for offshore areas were calculated from digital terrain models (DTMs) produced from MATLAB® and AutoCAD® Civil 3D®. DTMs are digital 3D representations of the topography and bathymetry of an area and are useful for calculating changes in contour positions and calculating sediment volumes. Position data were entered into software as x–y–z coordinates and were processed to provide cross-section profiles and volumes. DTMs from the 2015 data collections were compared with earlier collections to determine changes in shoal positions and volumes. Color contour maps were also produced from the DTMs.

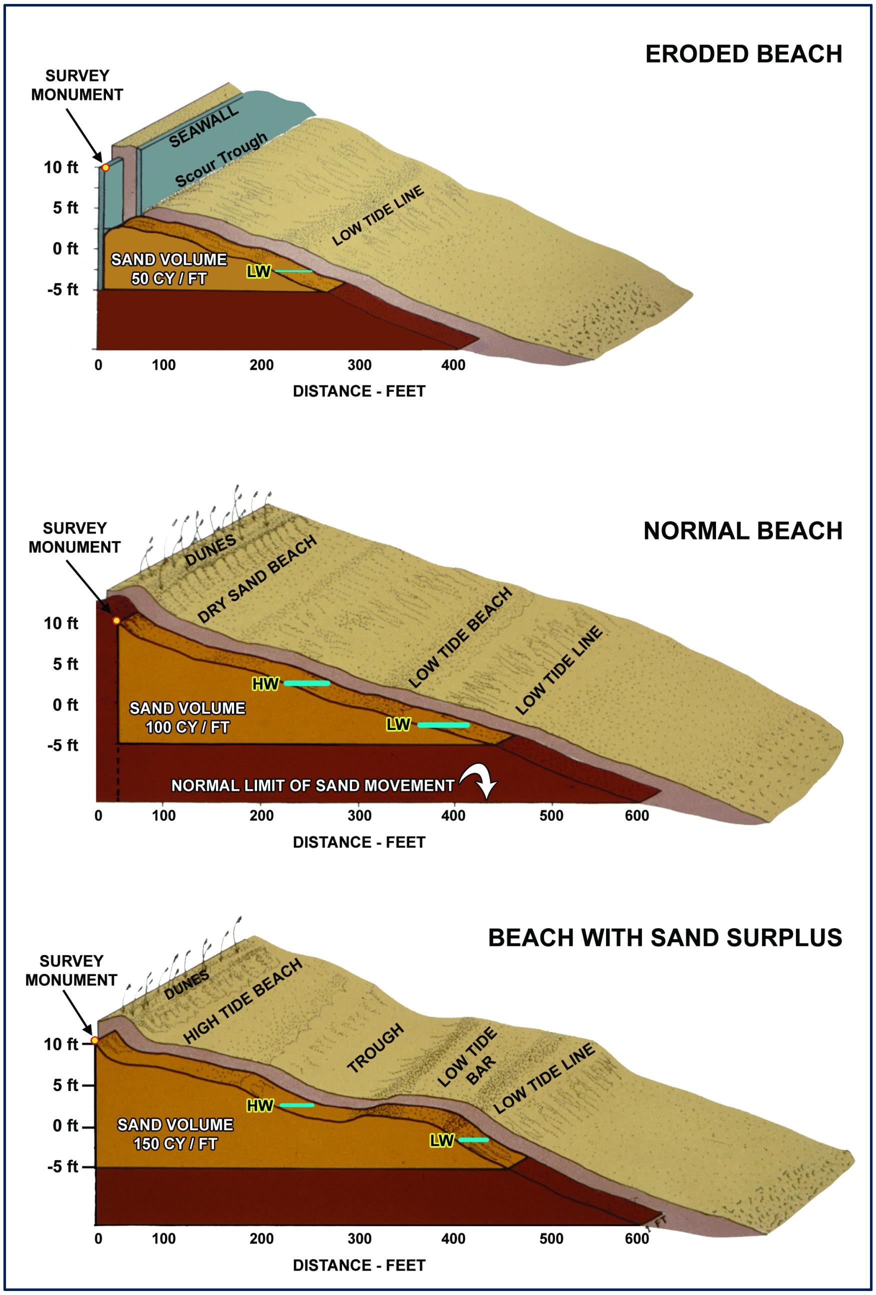

FIGURE 2.4. Illustration of the profile volume concept.

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3.0 RESULTS

Results of the beach monitoring effort presented in the following sections will focus on changes occurring since 2014, but will also address the condition relative to earlier periods, such as the post-2008 project condition. CSE attempts to simplify the discussion of beach changes by focusing on larger reaches or areas rather than change occurring at a single profile; however, individual profiles are useful in visualizing how the shape of the beach changes over time, how shoals migrate onshore, and how the beach condition exists in front of specific properties or features. Volume change will first be reported for the entire island and will identify overall trends occurring between 2014 and 2015. The next sections will focus on changes occurring in Dewees and Breach Inlets followed by localized changes in Reaches 1–7.

3.1 Island-Wide Changes

Isle of Palms gained 125,000 cy of sand between September 2014 and August 2015 (Fig 3.1). Accretion was observed along the central portion of the island between 14th and 53rd Avenues (Reaches 3 and 4) and east of the Wild Dunes Property Owners Beach House (Reaches 6 and 7). Erosion was observed in the area between 4th Avenue and the Sea Cabins Pier (Reach 2), and from 53rd Avenue to the Wild Dunes Property Owners Beach House (Reach 5). Figure 3.2 shows the general volume change trends along the island between September 2014 and August 2015—with green and blue colors showing areas which accreted, and red and orange hues showing areas that eroded.

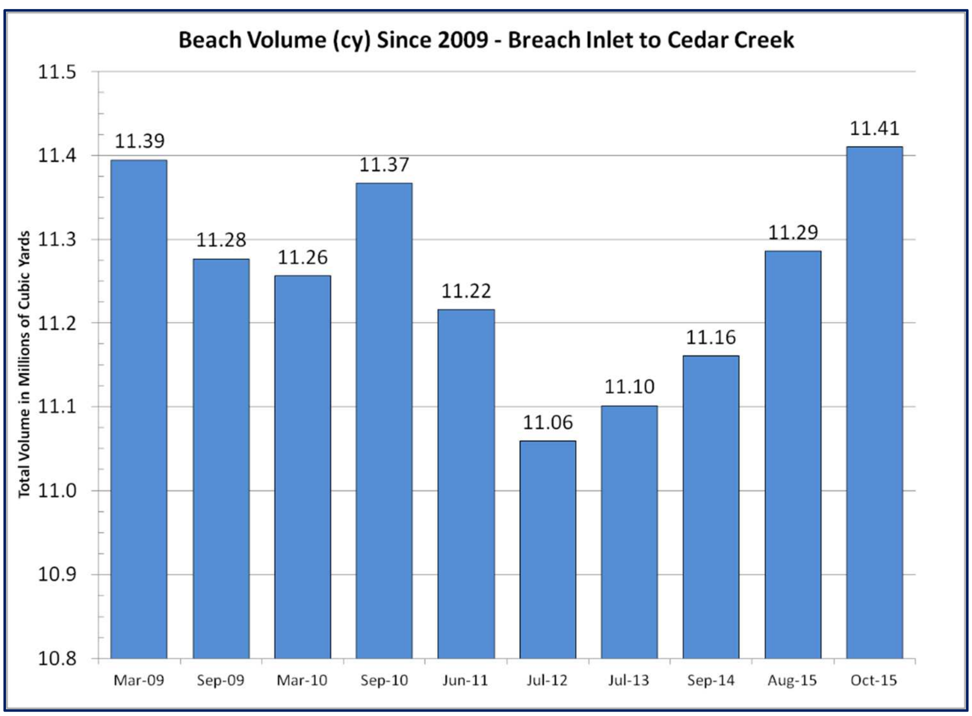


FIGURE 3.1. Total beach volume along Isle of Palms for the period 2009–2015.

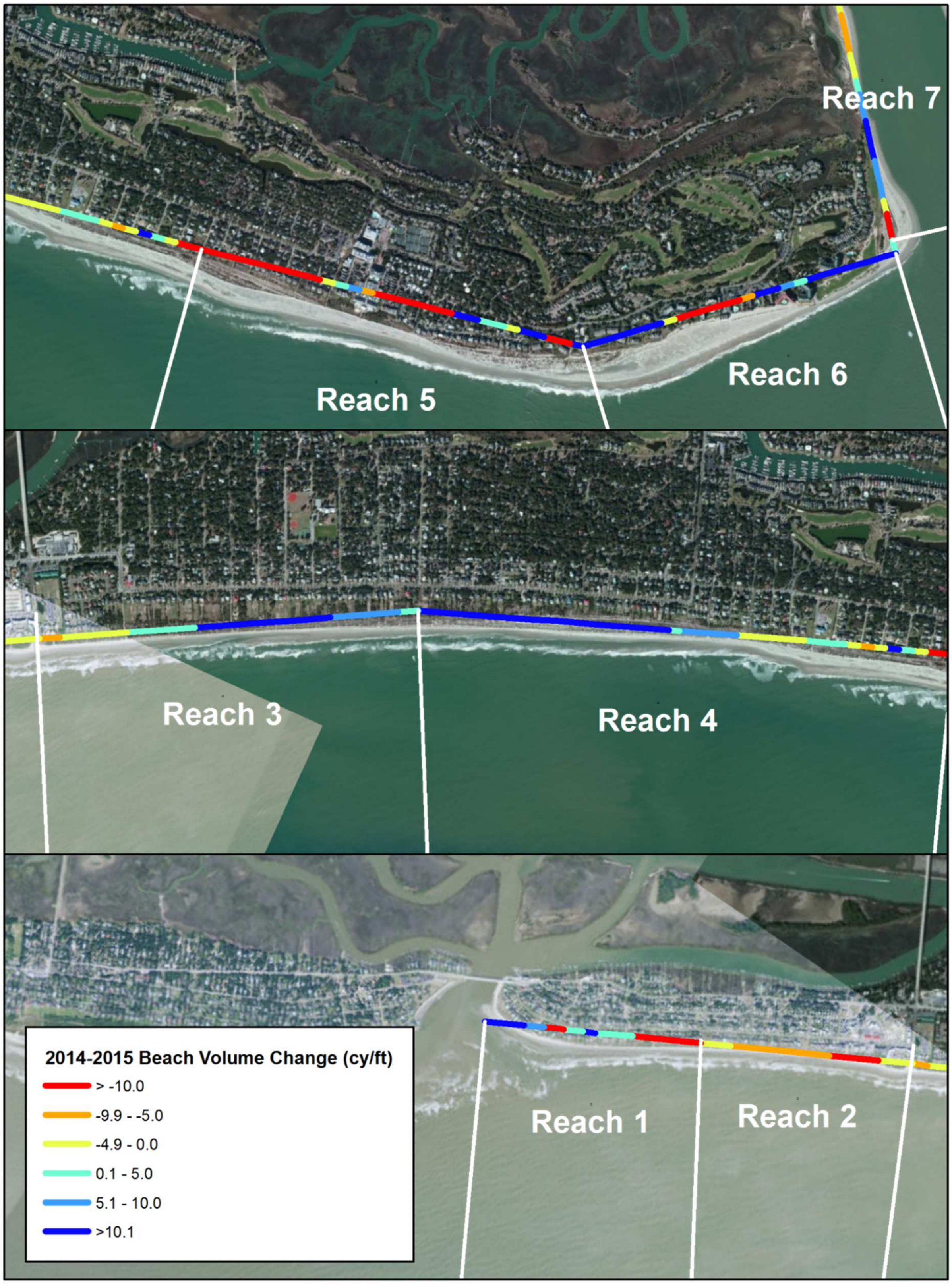


FIGURE 3.2. Erosion values along Isle of Palms between September 2014 and August 2015.

Figure 3.3 shows the unit volume change and linear change in the dry beach (measured at the +6 ft NAVD contour which is the typical toe of the dune) for each monitoring station on the island. Generally, areas which lost sand volume also lost dune width, and areas gaining volume gained dune width. Spikes in the dune erosion data usually resulted from creation or loss of a foredune, causing the 6ft elevation contour to quickly shift a large distance. Of note in the figure is the area near stations 280+00 through 300+00, which shows dune recession despite increasing volume. The volume increase is due to sand gains in the lower beach profile from shoal attachment while the dune erosion is mostly likely a result of sand harvesting in the winter of 2015-2016 eliminating small foredunes in the area.

Table 3.1 provides unit volumes for each profile for select dates spanning to the pre-2008 project condition. Profiles nourished during the 2008 project are colored. Volumes for the post-Hurricane *Joaquin* (October 2015) condition are included. Unit volume changed ranged from −44.8 cy/ft near Breach Inlet to +84.5 cy/ft near Mariners Walk. In each of these areas, the volume change was associated with sand moving below the mid-tide line as inlet shoals moved onshore or offshore.

Table 3.2 provides volumes and volume change values for each monitoring reach. Reach 5 was the most erosional, losing 10.9 cy/ft from September 2014 to August 2015, while Reach 6 was the most accretional, gaining 22.5 cy/ft over the same period. Compared to the pre-2008 nourishment condition, Reaches 5–7 contain ~376,000 cy (35.3 cy/ft) more sand as of August 2015. Overall, the island lost 308,000 cy between September 2010 and July 2012, but has gained 351,500 cy since 2012.

The October 2015 storm event resulted in significant onshore migration of the shoal at the east end of the island, leading to a net gain of 20,000 cy of sand in Reaches 5–7 between August and October 2015. Most of the gain was in Reach 6 and was a result of the attaching shoal. The central reaches (2–4) also accreted during the storm, gaining 61,000 cy. While the net volume change was positive over most of the island, the storm resulted in significant dune erosion in some areas, including up to 80 ft of recession along the eastern end of the Wild Dunes Grand Pavilion. Areas along Breach Inlet and 49th Avenue to 53rd Avenue also lost a significant amount of dunes. Overall, the island gained 124,300 cy between August and October 2015, the majority of which is assumed to be due to the storm. Erosion of the high beach and growth along the lower beach are the typical beach responses to a storm event as higher water levels and wave energy tend to flatten the slope of the profile. Calmer wave conditions tend to push sand up the beach and restore the dune.

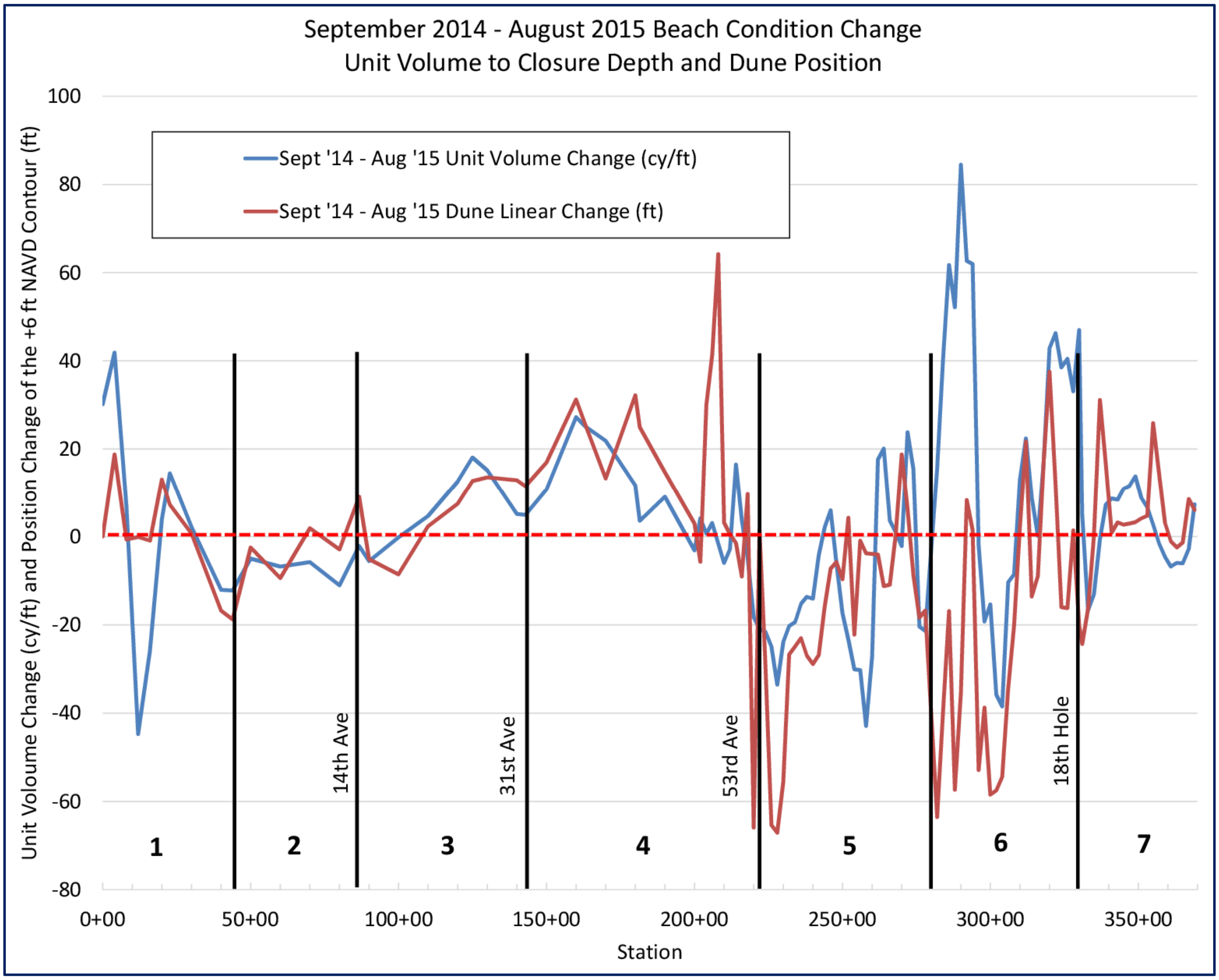


FIGURE 3.3. Erosion values (cy/ft) and linear change in the dune position (measured at the +6 ft NAVD contour) along Isle of Palms between September 2014 and August 2015.

TABLE 3.1. Unit volumes for monitoring stations at Isle of Palms. Profiles within the limits of the 2008 project fill areas are colored.

Reach	Line	Elevation Lens (ft NAVD)	Distance to Next (ft)	Unit Volume (cy/ft) Mar-08	Jul-08	Sep-09	Jun-11	Jul-13	Sep-14	Aug-15	Oct-15
Reach 1	3100	-10	0			249.6	193.5	259.3	257.0	304.8	314.2
	3105	-10	0			472.5	446.4	418.5	439.4	398.2	412.4
	0	-10	400			141.0	227.1	147.5	188.5	218.6	211.2
	4	-10	400			309.3	314.9	259.2	277.6	319.4	370.5
	8	-10	400			344.8	340.3	283.9	320.3	327.2	311.2
	12	-10	400			432.5	396.7	380.7	399.1	354.4	368.0
	16	-10	400			389.4	357.8	331.6	357.2	331.4	328.4
	20	-10	270			317.3	303.1	244.6	283.8	287.8	292.2
	3110	-12	730			354.8	361.4	314.0	329.4	343.8	355.4
	30	-12	1000			276.9	301.8	276.9	280.2	282.5	292.8
	40	-12	390			292.9	302.2	297.5	283.8	271.8	282.1
Reach 2	3115	-12	610			288.1	300.5	297.3	279.5	267.2	281.0
	50	-12	1000			296.7	298.7	302.4	283.6	278.6	291.5
	60	-12	1000			269.5	274.7	287.9	279.5	272.8	284.6
	70	-12	1000			282.7	284.9	307.9	302.5	296.7	296.2
	80	-12	670			265.7	270.5	298.5	300.5	289.5	304.9
Reach 3	3125	-12	330			308.1	320.2	333.9	347.9	345.7	347.6
	90	-13	1000			292.5	303.1	322.3	336.5	330.9	346.3
	100	-13	1000			304.4	315.0	329.9	342.9	342.7	351.4
	110	-13	1000			306.8	309.6	331.5	332.3	337.0	340.1
	120	-13	500			323.6	330.6	355.1	349.9	362.4	369.4
	3135	-13	500			351.4	349.6	379.7	364.6	382.7	374.4
	130	-13	1000			294.1	297.5	324.3	306.9	322.0	328.7
	140	-13	290			367.3	376.6	397.6	399.7	404.8	392.2
Reach 4	3140	-13	710			329.1	335.6	349.9	357.4	362.4	353.0
	150	-13	1000			299.5	311.3	330.1	337.9	348.7	345.6
	160	-13	290			284.6	291.6	316.3	328.2	355.4	358.6
	3145	-13	710			298.1	298.0	324.0	342.5	367.8	369.8
	170	-13	1000			291.8	289.8	335.4	339.3	361.1	358.6
	180	-12	150			275.7	295.4	331.2	332.8	344.5	334.8
	3150	-12	850			295.3	303.2	349.5	346.6	350.2	350.6
	190	-12	1000			275.9	310.8	331.5	324.0	333.1	326.0
	200	-12	200			307.9	337.7	356.6	355.5	352.4	371.8
	202	-12	200		280.5	325.0	341.0	360.3	356.9	361.0	384.1
	204	-12	200		286.8	333.0	344.8	360.5	357.7	358.4	389.7
	206	-12	200		288.7	336.4	346.4	363.7	361.7	364.9	381.3
	208	-11	200		255.9	294.1	311.9	343.2	332.7	331.2	341.1
	210	-11	200		287.8	328.2	346.6	367.7	373.4	367.5	370.6
	212	-11	200		258.0	298.1	316.0	335.8	335.8	333.0	327.9
	214	-11	200		251.7	305.3	321.3	340.3	315.7	332.2	320.5
	216	-11	200		253.4	302.3	317.0	344.0	320.3	324.1	313.3
	218	-11	200		274.5	312.9	332.6	352.5	344.5	339.8	325.7
	220	-11	200		269.5	309.1	327.8	357.0	358.7	340.4	333.4
Reach 5	222	-10	200	252.0	261.0	295.7	322.4	339.2	346.5	325.6	337.2
	224	-10	200	221.5	233.5	273.0	288.3	306.5	310.4	288.8	311.2
	226	-10	200	217.6	225.3	286.8	281.8	294.0	301.3	276.4	305.1
	228	-10	200	222.6	252.1	299.8	285.6	287.7	296.3	262.8	274.0
	230	-10	200	233.0	284.4	307.4	296.5	293.6	287.1	263.2	270.6
	232	-10	200	273.9	316.6	336.8	327.2	307.8	300.0	279.7	290.1
	234	-10	200	245.9	320.5	327.9	317.6	298.1	282.1	262.8	268.1
	236	-10	200	214.2	295.1	300.6	294.7	267.4	252.3	237.1	241.4
	238	-10	200	204.8	294.6	299.6	296.4	269.7	249.4	235.7	236.2
	240	-10	200	184.3	277.6	285.8	285.9	250.1	232.1	218.0	219.0
	242	-10	200	182.6	273.6	283.8	280.0	241.0	223.2	219.0	212.6
	244	-10	200	172.0	265.0	279.1	262.5	227.9	213.7	215.8	200.7
	246	-10	200	181.8	271.0	271.4	262.6	214.6	211.7	217.7	196.9
	248	-10	200	188.7	272.2	267.2	255.9	218.3	217.5	211.4	190.0
	250	-10	200	188.5	282.2	261.2	248.6	223.7	217.8	200.4	176.5
	252	-10	200	228.9	322.8	294.0	276.8	276.5	228.0	204.7	170.2
Reach 5 (continued)	254	-10	200	212.3	312.9	282.0	250.7	257.9	187.8	157.7	146.9
	256	-10	200	212.3	313.2	273.8	233.6	230.9	164.1	133.8	137.4
	258	-10	200	222.9	318.5	273.5	237.6	206.3	172.5	129.6	132.1
	260	-10	200	286.7	362.9	314.5	274.2	227.9	189.1	161.9	168.8
	262	-10	200	341.9	404.9	356.1	310.2	266.1	170.2	187.8	181.8
	264	-10	200	392.7	452.8	404.1	300.6	254.7	201.4	221.5	207.6
	266	-10	200	422.4	493.4	421.7	345.7	274.9	248.5	252.2	243.0
	268	-10	200	391.5	436.7	363.7	330.3	199.2	236.7	237.8	232.8
	270	-10	200	404.8	435.0	353.0	307.8	225.5	261.2	259.1	257.6
	272	-10	200	407.3	420.9	352.7	322.9	191.5	266.9	290.7	270.8
	274	-10	200	359.3	362.1	307.2	311.5	178.1	233.7	249.2	236.0
	276	-10	200	461.8	459.1	399.1	417.3	320.3	367.1	346.7	341.5
	278	-10	400	463.2	415.2	371.7	426.2	296.9	345.9	324.5	305.9
Reach 6	280	-10	200	498.6	474.3	641.6	495.9	461.5	477.6	493.1	507.0
	282	-10	200	501.0	440.4	634.9	411.5	400.3	449.7	489.8	481.0
	284	-10	200	515.3	522.2	679.5	497.6	466.7	541.2	602.9	585.8
	286	-10	200	484.3	510.8	628.0	493.3	479.5	585.8	638.0	619.3
	288	-10	200	333.0	423.8	453.8	442.6	389.3	453.6	538.1	554.4
	290	-10	200	255.4	357.3	390.9	412.7	385.9	429.5	492.1	517.9
	292	-10	200	246.8	355.6	389.3	423.4	418.7	453.9	515.8	539.0
	294	-10	200	235.7	363.0	380.7	395.9	416.5	426.3	424.4	469.7
	296	-10	200	213.5	354.7	353.7	375.0	374.6	369.4	350.1	400.5
	298	-10	200	191.1	354.1	339.4	356.5	343.0	318.6	303.2	371.5
	300	-10	200	173.6	347.5	323.6	339.7	316.1	289.4	253.6	289.1
	302	-10	200	149.8	339.3	306.7	317.6	306.1	271.6	233.1	257.9
	304	-10	200	141.5	333.2	289.8	292.3	273.6	236.4	226.0	241.6
	306	-10	200	171.7	372.6	312.2	310.8	298.8	275.4	266.9	269.1
	308	-10	200	155.4	341.0	287.0	260.9	230.0	200.7	213.8	219.4
	310	-10	200	152.6	312.9	241.6	245.9	188.2	149.5	171.9	165.2
	312	-10	200	111.2	281.0	215.2	192.6	169.9	115.2	124.1	121.1
	314	-10	200	86.9	246.1	169.0	156.0	110.6	100.2	100.4	99.3
	316	-10	200	136.4	309.3	252.7	235.4	210.9	173.8	190.8	181.2
	318	-10	200	128.2	312.0	256.8	229.4	182.4	162.4	205.2	184.2
	320	-10	200	140.9	324.5	271.8	238.8	212.0	186.4	232.6	211.5
	322	-10	200	205.4	368.5	318.2	267.3	247.9	225.7	264.2	267.5
	324	-10	200	212.3	361.7	331.6	270.8	265.0	252.2	292.7	312.8
	326	-10	200	174.1	291.2	309.9	258.3	253.8	251.1	284.1	296.3
	328	-10	100	241.0	285.3	321.5	257.9	324.6	284.4	331.4	339.0
Reach 7	330	-18	200	228.2	262.4	297.0	374.3	372.3	352.8	357.7	347.9
	332	-18	200	286.9	333.6	344.8	389.5	409.6	424.5	407.8	397.8
	334	-18	200	252.6	295.8	328.5	357.5	391.7	406.4	393.3	381.3
	336	-18	200	232.8	284.0	291.3	319.1	343.4	362.8	362.2	357.7
	338	-18	200	214.7	261.2	240.3	252.3	280.9	304.9	312.2	313.7
	340	-18	200	204.6	244.6	216.1	218.4	233.3	246.4	255.1	259.7
	342	-18	200	227.6	246.4	232.7	232.4	253.5	264.2	272.6	271.5
	344	-18	200	201.1	209.5	205.0	198.6	215.3	222.2	233.1	228.5
	346	-18	200	198.4	198.1	197.7	193.5	199.7	203.8	215.3	213.1
	348	-15	200	150.9	147.2	149.0	147.2	146.2	150.7	164.4	166.8
	350	-15	200	170.1	169.7	167.5	165.1	173.7	181.4	190.2	191.9
	352	-15	200	159.8	160.4	153.3	158.9	169.6	174.2	180.9	176.2
	354	-15	200	170.1	171.1	165.0	174.2	184.0	185.4	188.1	185.8
	356	-15	200	186.5	185.6	177.9	189.1	195.4	190.9	189.4	186.6
	358	-15	200	175.3	171.9	163.8	180.0	175.2	164.8	160.2	157.0
	360	-15	200	177.2	172.0	164.2	181.8	170.8	155.4	148.6	146.8
	362	-15	200	173.3	167.4	164.5	174.4	154.9	143.6	137.6	135.9
	364	-15	200	146.2	141.2	139.7	136.3	117.6	108.4	102.3	102.8
	366	-13	200	137.4	131.6	138.9	136.8	132.9	138.6	135.8	133.5
	368	-13	200	168.9	174.2	178.5	174.2	188.4	209.1	216.4	216.6
	370	-13	0	109.8		176.0		162.0	214.1	230.5	238.8

TABLE 3.2. Reach volumes for monitoring reaches at Isle of Palms.

			Total Volume (cy)									
Reach	Limits	Length (ft)	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Oct-15
Reach 1	0-3115	4,390	-	-	1,401,558	1,456,764	1,421,289	1,333,323	1,274,808	1,333,286	1,330,359	1,373,162
Reach 2	3115-3125	4,280	-	-	1,204,057	1,224,707	1,224,861	1,270,043	1,290,942	1,263,051	1,232,810	1,272,060
Reach 3	3125-3140	5,620	-	-	1,780,093	1,846,220	1,816,402	1,869,050	1,937,399	1,940,822	1,975,150	1,994,132
Reach 4	3140-222	7,910	-	-	2,359,540	2,427,588	2,475,177	2,569,776	2,683,865	2,692,639	2,764,360	2,767,297
Reach 5	222-280	6,000	1,719,106	2,037,256	1,964,517	1,919,966	1,839,781	1,637,605	1,534,013	1,538,355	1,472,855	1,450,624
Reach 6	280-328	4,900	1,121,276	1,748,938	1,755,674	1,659,225	1,586,025	1,521,769	1,499,036	1,488,251	1,598,368	1,649,559
Reach 7	330-370	4,000	766,568	816,758	811,009	832,184	852,642	857,028	880,657	904,217	911,968	903,294
Reaches 2-4	3115-222	17,810	-	-	5,343,690	5,498,515	5,516,439	5,708,869	5,912,206	5,896,512	5,972,320	6,033,490
Reaches 5-7	222-370	14,900	3,606,951	4,602,952	4,531,200	4,411,375	4,278,448	4,016,402	3,913,706	3,930,823	3,983,191	4,003,477
Reaches 1-7	0-370	37,100	-	-	11,276,447	11,366,653	11,216,176	11,058,594	11,100,719	11,160,621	11,285,870	11,410,129

	Average unit Volume (cy/ft)									
Reach	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Oct-15
Reach 1	-	-	319.3	331.8	323.8	303.7	290.4	303.7	303.0	312.8
Reach 2	-	-	281.3	286.1	286.2	296.7	301.6	295.1	288.0	297.2
Reach 3	-	-	316.7	328.5	323.2	332.6	344.7	345.3	351.5	354.8
Reach 4	-	-	298.3	306.9	312.9	324.9	339.3	340.4	349.5	349.8
Reach 5	286.5	339.5	327.4	320.0	306.6	272.9	255.7	256.4	245.5	241.8
Reach 6	228.8	356.9	358.3	338.6	323.7	310.6	305.9	303.7	326.2	336.6
Reach 7	191.6	204.2	202.8	208.0	213.2	214.3	220.2	226.1	228.0	225.8
Reaches 2-4			300.0	308.7	309.7	320.5	332.0	331.1	335.3	338.8
Reaches 5-7	242.1	308.9	304.1	296.1	287.1	269.6	262.7	263.8	267.3	268.7
Reaches 1-7			303.9	306.4	302.3	298.1	299.2	300.8	304.2	307.6

			Net Change Since Previous									
Reach	Limits	Length (ft)		Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Oct-15
Reach 1	0-3115	4,390				55,206	-35,474	-87,966	-58,515	58,479	-2,928	42,804
Reach 2	3115-3125	4,280				20,651	153	45,183	20,899	-27,891	-30,241	39,250
Reach 3	3125-3140	5,620				66,126	-29,818	52,648	68,349	3,423	34,328	18,983
Reach 4	3140-222	7,910				68,048	47,589	94,599	114,089	8,774	71,721	2,937
Reach 5	222-280	6,000		318,150	-72,740	-44,551	-80,185	-202,175	-103,592	4,342	-65,500	-22,231
Reach 6	280-328	4,900		627,662	6,736	-96,449	-73,200	-64,256	-22,733	-10,785	110,117	51,191
Reach 7	330-370	4,000		50,190	-5,749	21,175	20,459	4,385	23,629	23,560	7,751	-8,674
Reaches 2-4	3115-222	14,900				154,825	17,924	192,430	203,337	-15,694	75,808	61,170
Reaches 5-7	222-370	4,900		996,001	-71,753	-119,825	-132,927	-262,046	-102,696	17,116	52,369	20,286
Reaches 1-7	0-370	37,100				90,206	-150,477	-157,582	42,125	59,902	125,249	124,259

	Unit Change Since Previous (cy/ft)									
Reach	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Oct-15
Reach 1	-	-	7.8	3.0	-8.1	-20.0	-13.3	13.3	-0.7	9.8
Reach 2	-	-	-1.6	3.4	0.0	10.6	4.9	-6.5	-7.1	9.2
Reach 3	-	-	-4.6	3.3	-5.3	9.4	12.2	0.6	6.1	3.4
Reach 4	-	-	-0.1	7.6	6.0	12.0	14.4	1.1	9.1	0.4
Reach 5	-13.1	53.0	-11.8	2.7	-13.4	-33.7	-17.3	0.7	-10.9	-3.7
Reach 6	29.8	128.1	-7.6	-3.6	-14.9	-13.1	-4.6	-2.2	22.5	10.4
Reach 7	1.1	12.5	-3.0	1.5	5.1	1.1	5.9	5.9	1.9	-2.2
Reaches 2-4				8.7	1.0	10.8	11.4	-0.9	4.3	3.4
Reaches 5-7		66.8	-4.8	-8.0	-8.9	-17.6	-6.9	1.1	3.5	1.4
Reaches 1-7				2.4	-4.1	-4.2	1.1	1.6	3.4	3.3

			Net Change Since Prenourishment (cy)									
Reach	Limits	Length (ft)	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Oct-15
Reach 5	222-280	6,000	-	318,150	245,411	200,859	120,675	-81,501	-185,093	-180,751	-246,251	-268,482
Reach 6	280-328	4,900	-	627,662	634,398	537,949	464,749	400,493	377,760	366,974	477,092	528,283
Reach 7	330-370	4,000	-	50,190	44,441	65,615	86,074	90,459	114,089	137,648	145,400	136,726
5-7 Total Change Since Prenourishment			-	996,001	924,249	804,424	671,497	409,452	306,755	323,872	376,241	396,526

	Unit Change Since Prenourishment (cy/ft)									
Reach	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Oct-15
Reach 5	-	53.0	40.9	33.5	20.1	-13.6	-30.8	-30.1	-41.0	-44.7
Reach 6	-	128.1	129.5	109.8	94.8	81.7	77.1	74.9	97.4	107.8
Reach 7	-	12.5	11.1	16.4	21.5	22.6	28.5	34.4	36.3	34.2
5-7 Total Change Since Prenourishment	-	66.8	62.0	54.0	45.1	27.5	20.6	21.7	25.3	26.6

3.2 Inlet Dynamics

Before discussing the beach condition along individual profiles or reaches, it is important to identify the large-scale processes occurring in the deltas of Dewees Inlet and Breach Inlet. Changes occurring in the inlets have a direct effect on the beach condition and, ultimately, are responsible for the short- and long-term erosion or accretion signature along the island. Movement of inlet shoals can impact wave and sediment transport direction, create or close minor channels, and cause highly localized and significant changes to the beach condition.

Since 2007, CSE has completed comprehensive surveys of Dewees Inlet, covering the majority of the delta at least on an annual basis. At the time of the first survey (July 2007), the system had a defined channel (C1) extending to the south about 4,000 ft from Dewees Inlet, then turning to the southeast (Fig 3.4). A large shoal was attached to the Isle of Palms beach, centered at the Wild Dunes Property Owners Beach House (labeled S1 in Fig 3.4). A large area of shallow water extended seaward form the shoal, terminating adjacent to the inlet channel. On the north side of the inlet throat, a shoal extended off of Dewees Island to the southeast, paralleling the inlet channel. A secondary channel (C2), much shallower than the primary channel, was present in line with the axis of Dewees Inlet, and another isolated shoal (S2) was positioned between the secondary and primary channels.

Ongoing monitoring efforts revealed that the 2007 condition was the beginning of a channel avulsion event, which would see the original main channel close and the secondary channel become the dominant channel. The complete series of surveys are provided in Appendix B. Figure 3.4 shows the condition as of June 2015. Note in the graphic that the shoal which was attached in 2007 (S1) has completely merged with the beach, while the offshore shoal (S2) migrated southwest, closing the original main channel (C1). The 2007 secondary channel (C2) was the new main channel by 2011. The shallow platform extending off the beach was still present and had produced two additional small incipient shoals in 2009 and 2010 which quickly attached to the beach. An area of higher sand along the seaward end of the platform (southwest of S2) remained offshore and was beginning to migrate toward the beach.

The remnants of the sand platform merged with the offshore shoal by 2013 and, together, totaled ~1.6 million cubic yards of sand above the −10-ft NAVD contour (CSE 2013). At this time, the shoal was beginning to impact the beach with the leeward beach accreting and the adjacent areas eroding. The September 2014 condition is shown in Figure 3.4. By then, the offshore shoal (S2) was attaching to the beach at the western end, but remained ~300 ft offshore at the eastern end. The western flank of the shoal remained low in the profile, just beneath the low waterline. In the fall of 2014, the beach along Beachwood East and Dunecrest Lane had eroded significantly, and emergency protection measures were installed by several property owners.

A new feature called a trailing ebb spit began to develop around 2012 at the eastern tip of the island (T), extending on the landward side of the main channel. This feature has been observed on past aerial photography, but was not surveyed prior to 2007. It has continued to accumulate sand since 2012, extending further south and increasing in elevation. This feature acts as an inshore breakwater to northeast waves, providing increased sheltering along the golf course and Ocean Club area.

Between the 2014 and 2015 beach monitoring efforts, the major change occurring in Dewees Inlet was continued onshore migration of the attaching shoal (Fig 3.5). The center of the shoal (at station 290+00, Fig 3.6) did not migrate landward between September 2014 and August 2015, but increased in elevation up to 5 ft along the leading edge. The beach landward of the shoal grew nearly 100 ft. Note that a shoal management project was completed between the two surveys, so the observed accretion was despite the removal of ~180,000 cy of sand from the shoal and the leeward beach. The channel separating the shoal and the beach also filled in, reducing the depth from ~8 ft at low tide to ~1 ft at low tide.

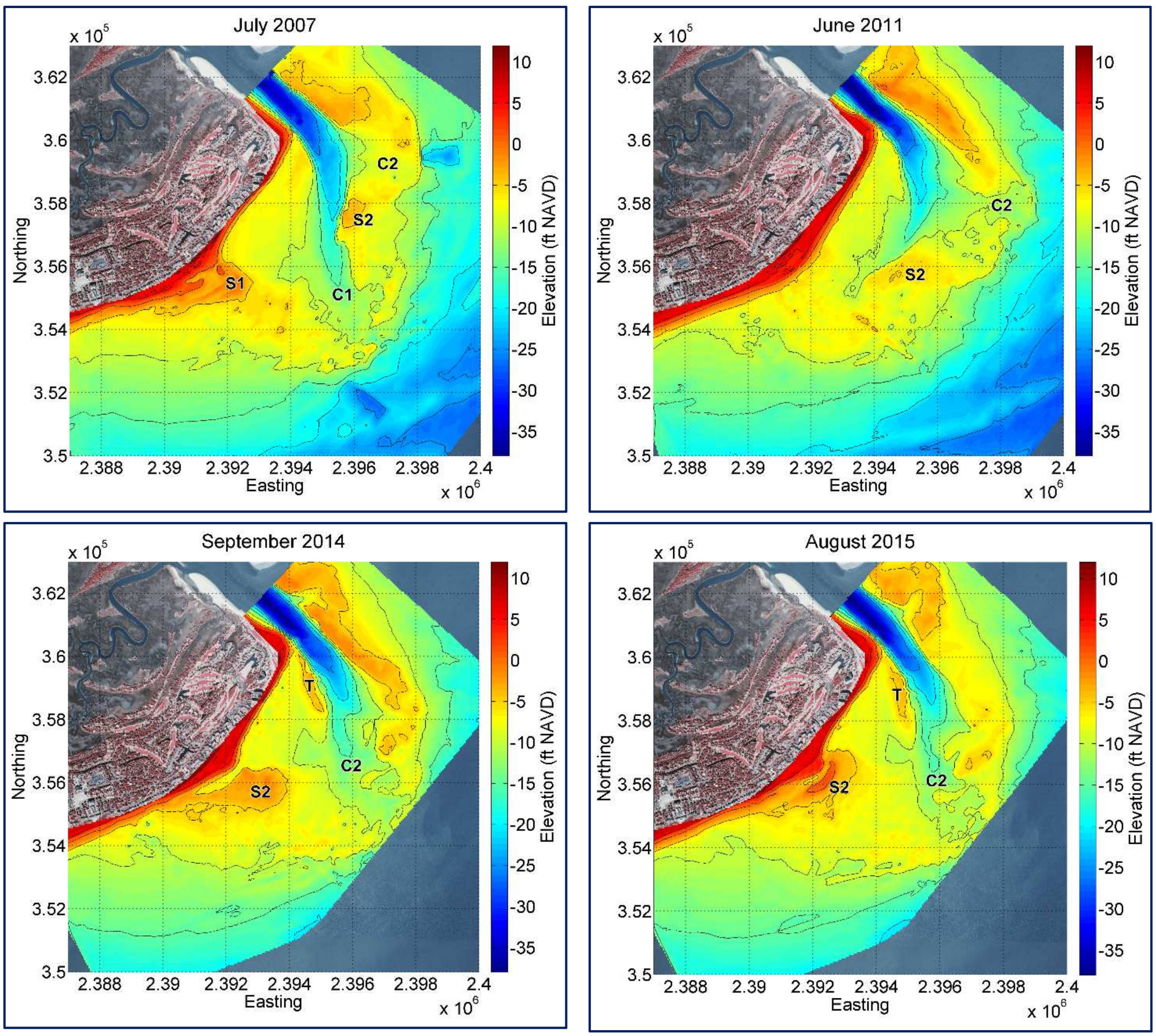


FIGURE 3.4. Digital terrain models (DTMs) of the bathymetry around Dewees Inlet showing a new channel (C2) forming and migrating between 2007 and 2015 accompanied by a large shoal-bypass event.

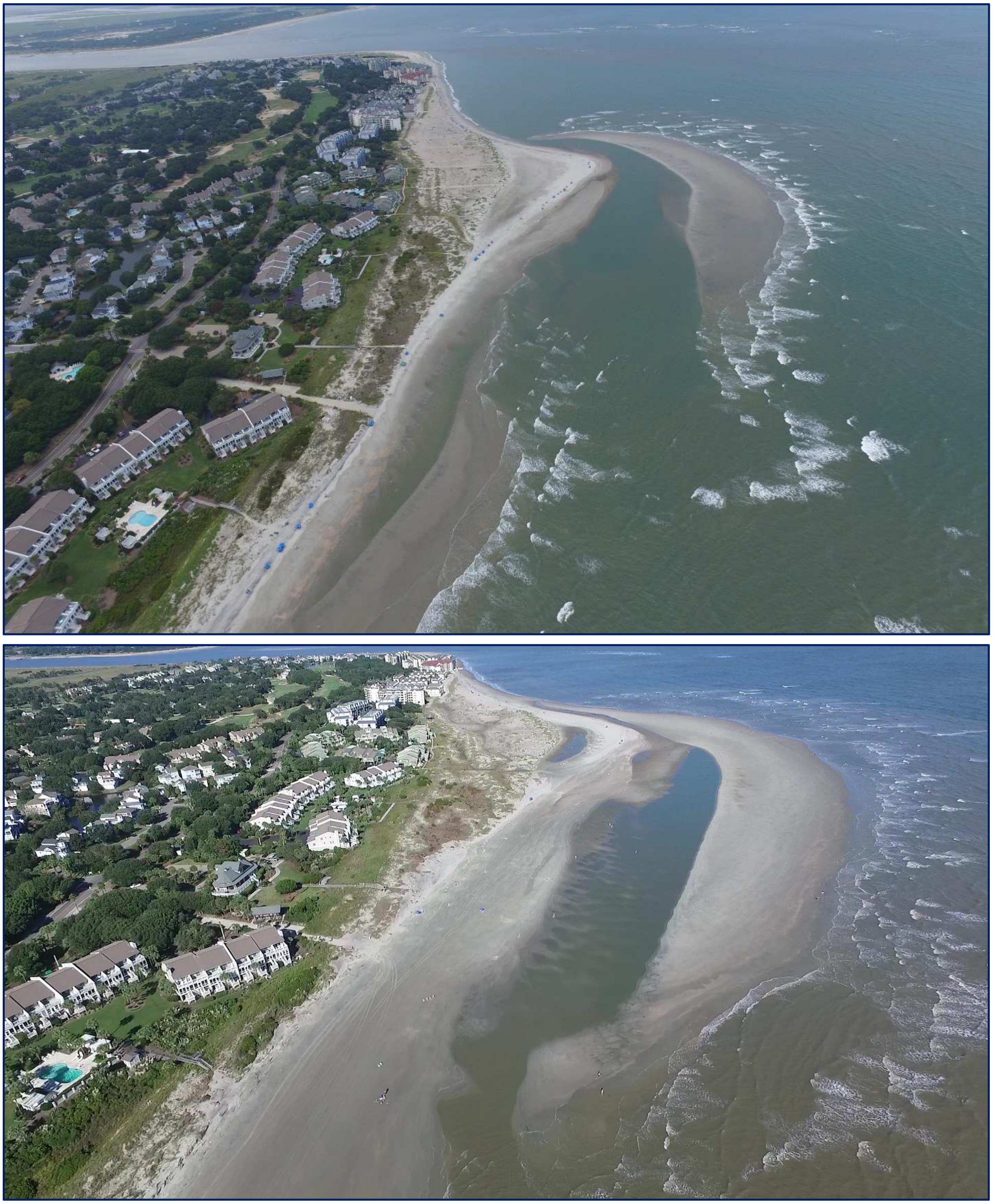


FIGURE 3.5. August 2015 (upper) and October 2015 (lower) aerial images of the attaching shoal at the northeast end of Isle of Palms. The center of the shoal (top of images) stalled between 2014 and August 2015, but moved onshore during Hurricane *Joaquin*.

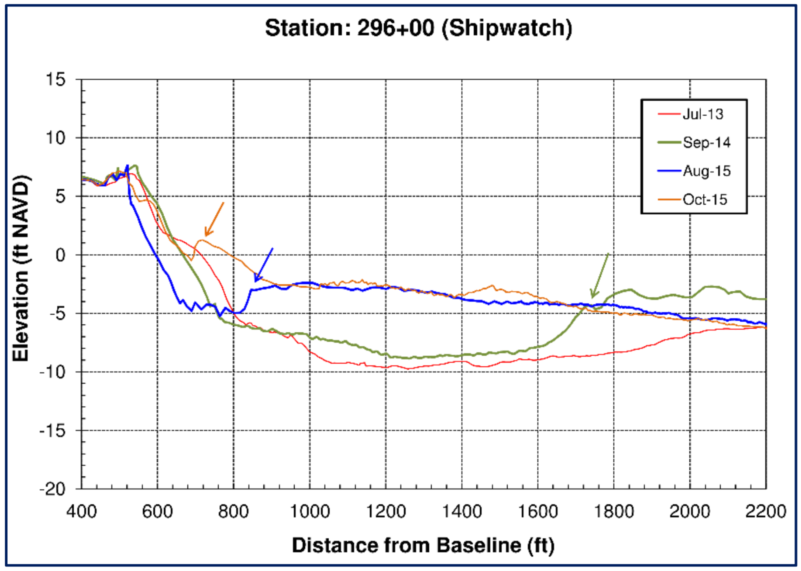
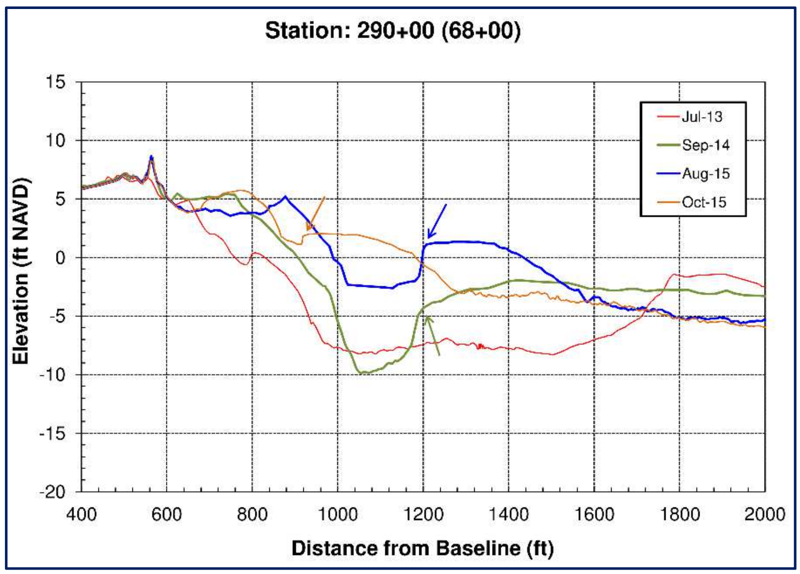


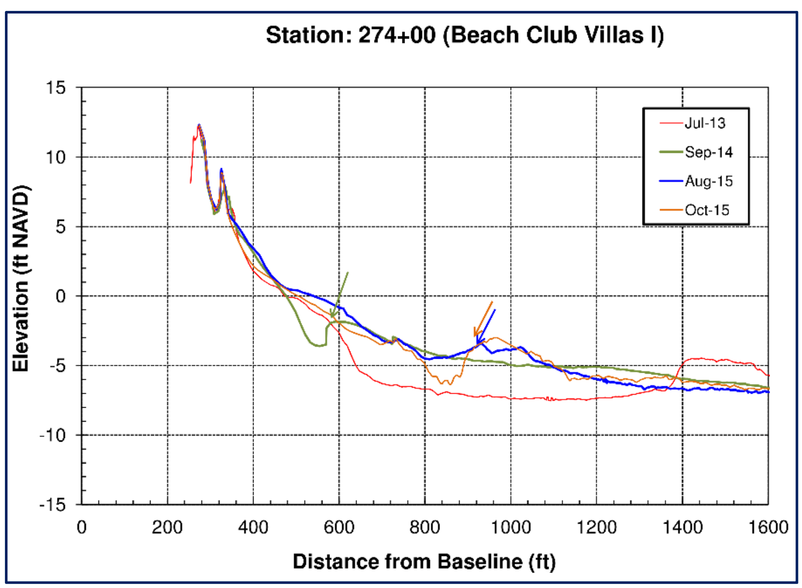
FIGURE 3.6.

Profiles from the shoal attachment area showing landward migration of the shoal since 2013.

The center of the shoal (station 290+00) stalled between 2014 and 2015, but increased in elevation. The October storm completed the attachment along the center and eastern ends of the shoal.

At the western end of the attachment area (station 274+00), a series of low-tide bars have merged with the beach but have not significantly restored the upper beach.





While the center of the shoal did not migrate much between 2014 and August 2015, the eastern portion showed significant landward migration. At station 296+00 (Shipwatch), the leading edge moved ~850 ft landward. The sand gain was a result of onshore migration (sand moving landward) and spreading of sand from the center of the shoal (sand moving to the east). The elevation of the attaching sand remained just below the low-tide line (which is about -1 ft NAVD). As of August 2015, the shoal sand was positioned ~200 ft from the beach with a small channel reaching to low-tide wading depth, separating the beach from the shoal. On the west side of the shoal, periodic attachment events have occurred since 2014, but have not resulted in significant accretion (see Fig 3.5). The welding sand has remained low in the profile and is spreading quickly to adjacent areas. Based on the lack of accretion observed at Beachwood East, CSE assumes most of the sand attaching along the western edge is moving to the east, building the beach behind the center of the shoal.

Further offshore, the main channel of the inlet shifted to the southwest, and a new distinct offshore shoal appears to be developing and shifting with the inlet channel. The August 2015 configuration of the delta channel and shoals is very similar to the 2007 condition, although CSE expects that in another year or two, the condition will be even closer to the 2007. Hurricane *Joaquin* shifted the shoal landward up to 200 ft along the main body of the shoal, leading to attachment along the mid beach (see Fig 3.5). It also led to westward extension of the western arm of the shoal and landward migration of the low-tide bar in front of the Wild Dunes Property Owners Beach House (WDPOBH). Larger waves and increased water levels associated with storms can expedite migration of shoals that have stalled under normal wave and tide conditions. Once the shoal elevation reaches a certain height, normal waves are incapable of overtopping the shoal frequently or with enough energy to move significant volumes of sand. In some cases, shoals grow so large that they stall while still offshore, creating a new "mini" barrier island with a dry beach and dune (the east end of Kiawah Island is a recent example).

As of October 2015, the active body of the shoal (defined as the area above the -4 ft NAVD contour – Fig 3.7) contains ~450,000 cy of sand above -10 ft NAVD (the normal ocean depth in the absence of shoals in this setting). Of this volume, CSE estimates ~225,000 cy will be available to attach to the beach over the next two years. This is the volume above – 6 ft NAVD. The remainder will continue to be held in the shallow sand platform associated with the delta. Additional sand from offshore will be added continuously, either adding to the existing shoal volume or developing new distinct shoal events.

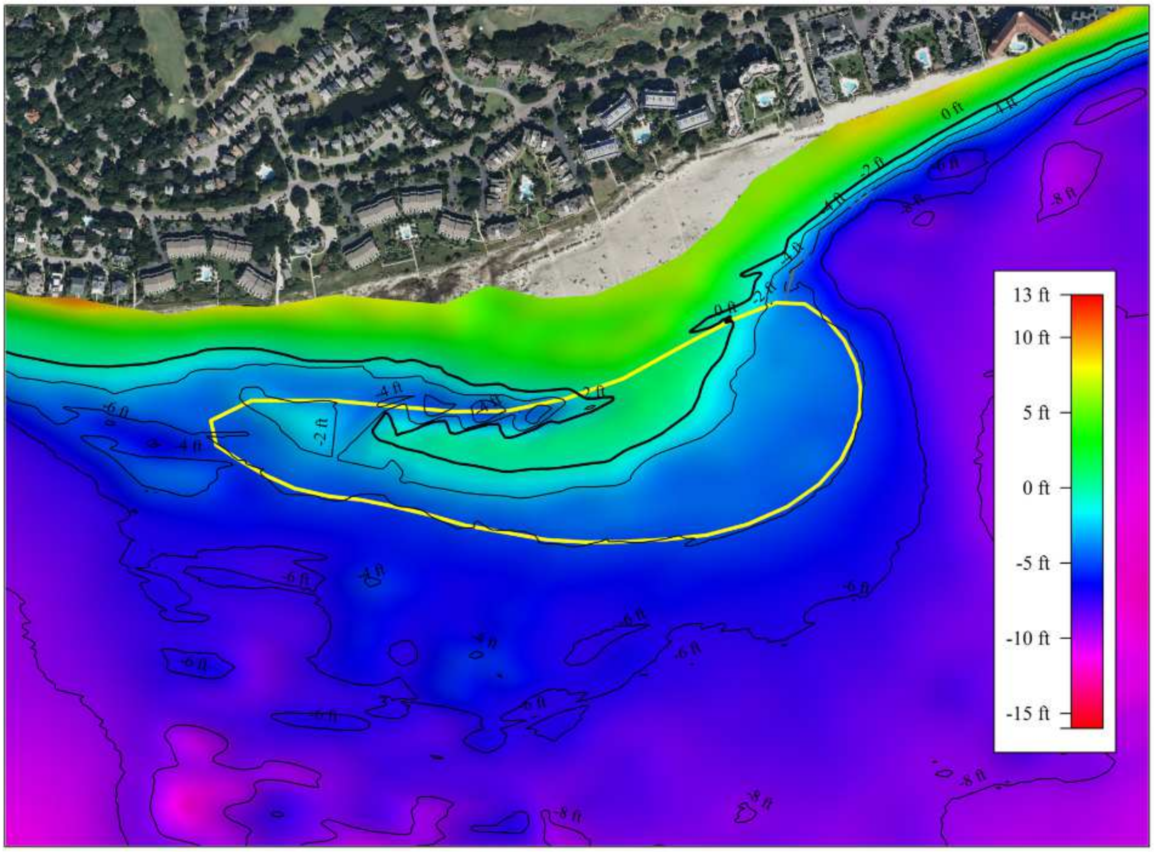
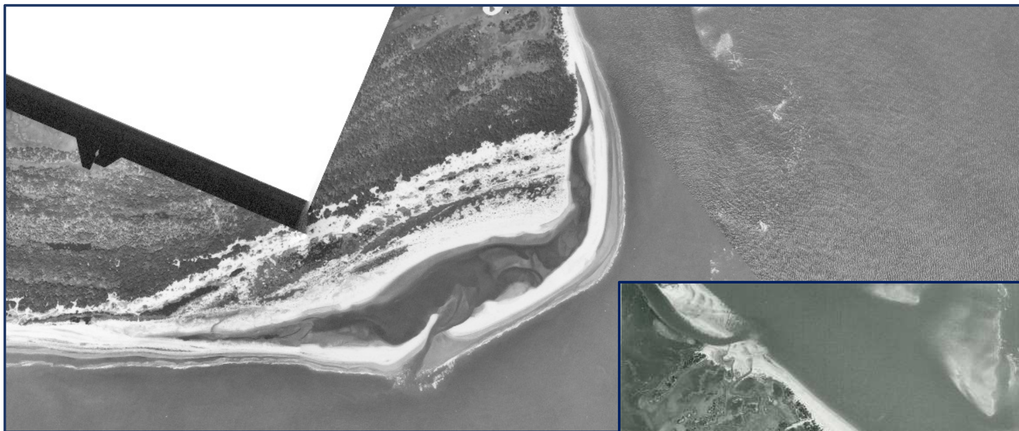


FIGURE 3.7. Elevation model of the shoal attachment area in October 2015, following Hurricane *Joaquin*. The yellow line shows the approximate −4 ft NAVD contour, which CSE used to determine the sand volume of the shoal.

The most significant difference between the 2007 and 2015 condition is the presence and magnitude of the trailing ebb spit on the landward side of the main channel. This feature is much larger in 2015 and extends further into the delta. It remains possible that if this feature continues to grow, it will eventually merge with attaching shoals and create a large shoal attachment event, similar to one that occurred between 1949 and 1965 (Fig 3.8). The significance of this is that the monitoring efforts of the City have now nearly captured a complete cycle of a major channel relocation event. By the time the inlet channel completely returns to the 2007 position, it will have taken 9–10 years for the cycle to complete. Over the course of the channel relocation and associated shoal bypassing, CSE estimates over 1 million cubic yards of sand will be added to the Isle of Palms beach.

Changes at Breach Inlet — The beach condition near Breach Inlet is heavily influenced by currents and shoals. Net sediment transport to the west causes the main channel to migrate west, over-extending along the eastern portion of Sullivan's Island. Much like Dewees Inlet at the eastern end of Isle of Palms, periodic breaks in the delta shoals allow the main channel to relocate further east, starting the migration process over again (Fig 3.9).



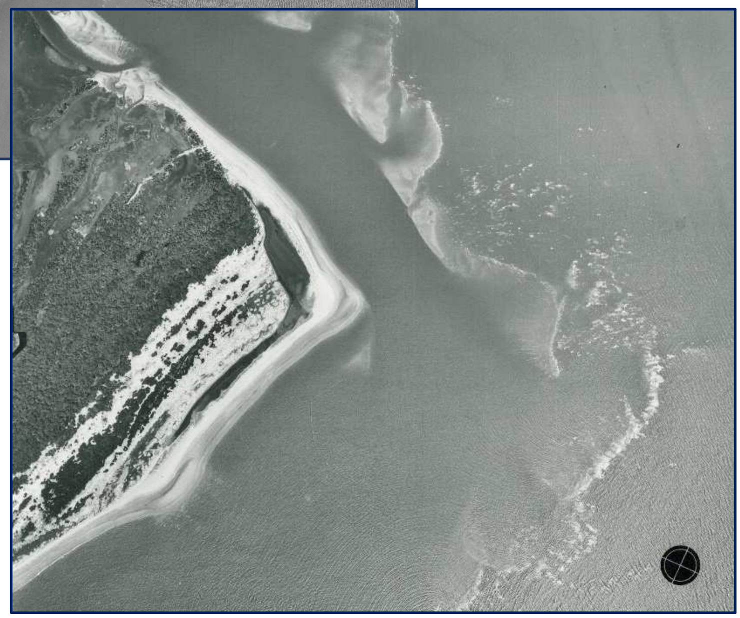


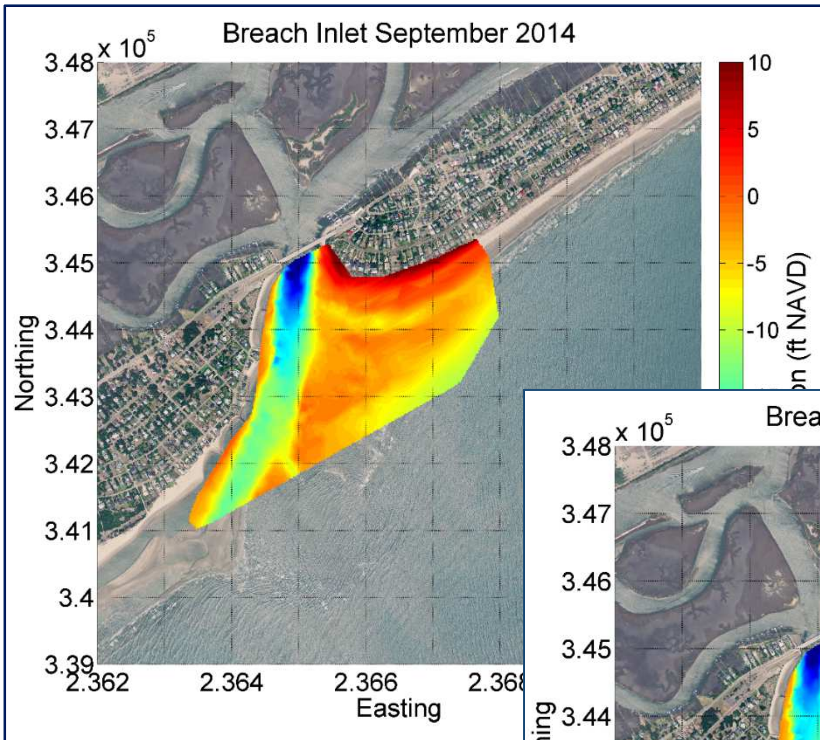
FIGURE 3.8.

[UPPER] 1949 aerial image of the northeast end of Isle of Palms showing a large-scale shoal bypass event, which produced an incipient barrier ridge wrapping the northern end of the island.

[RIGHT] 1957 image showing that the 1949 event was still merging with the beach nearly 10 years after attaching. A large-scale event like this is possible if an offshore shoal from the inlet merges with a shoal closer to the beach, such as a trailing ebb spit.

FIGURE 3.9. October 2015 aerial image of Breach Inlet. Arrows show the main (adjacent to Sullivan's Island) and secondary channels.

A realignment event occurred between 2009 and 2011. Between 2013 and 2014, the seaward end of the inlet migrated away from Isle of Palms which caused the delta shoals to shift southwest, likely drawing off sand from the beach near Breach Inlet. Between 2013 and 2014, the Isle of Palms side of the Breach Inlet delta was fairly stable. The marginal flood channel was also relatively stable, which is favorable for stability of the beach. From 2014 to 2015, the major change observed in the delta was the formation of a new secondary channel in the center of the northern shoal, positioned ~2,500 ft south of the center of the bridge (Fig 3.10).



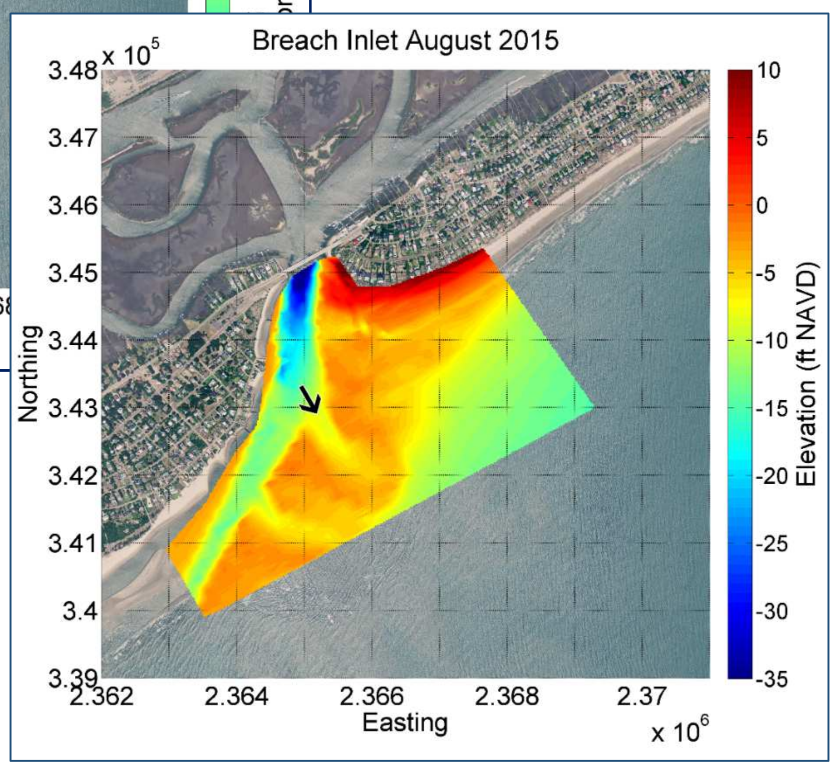


FIGURE 3.10. Elevation models of the Breach Inlet delta in 2014 (left) and 2015 (right). The arrow in the 2015 model shows the location of a new secondary channel in the delta.

This new channel may grow and become the dominant channel in the near future, forcing a new shoal-bypass event on Sullivan's Island. It will also lead to the buildup of the delta closer to Isle of Palms, which may shift the erosional arc between the inlet and the pier to the north. The main channel remained in a similar position as 2014, running adjacent to Sullivan's Island. The marginal flood channel along the north side of the inlet (the yellow hues just off the tip of Isle of Palms) was stable over the past year. Movement of this channel onshore or offshore can impact the local beach condition near Breach Inlet. The full series of elevation models are provided in Appendix B.

The changes observed near Breach Inlet highlight the dynamic nature of barrier-island shorelines adjacent to inlets. Often, beach condition is driven by short-term events associated with inlet changes rather than long-term erosional patterns. As evidenced by recent changes, decades' worth of accretion can be lost rapidly due to inlet effects. Similarly, a shoal-bypass event may restore a beach which has suffered long-term erosion (eg – Fripp Island, CSE 2013b). While local beach changes due to inlet effects are difficult to predict several years in advance, regular monitoring provides the best method to plan for potential issues and project near-future changes.

3.3 Reach Volume Change

Volume change for individual reaches is presented next, beginning at the northern end of the island.

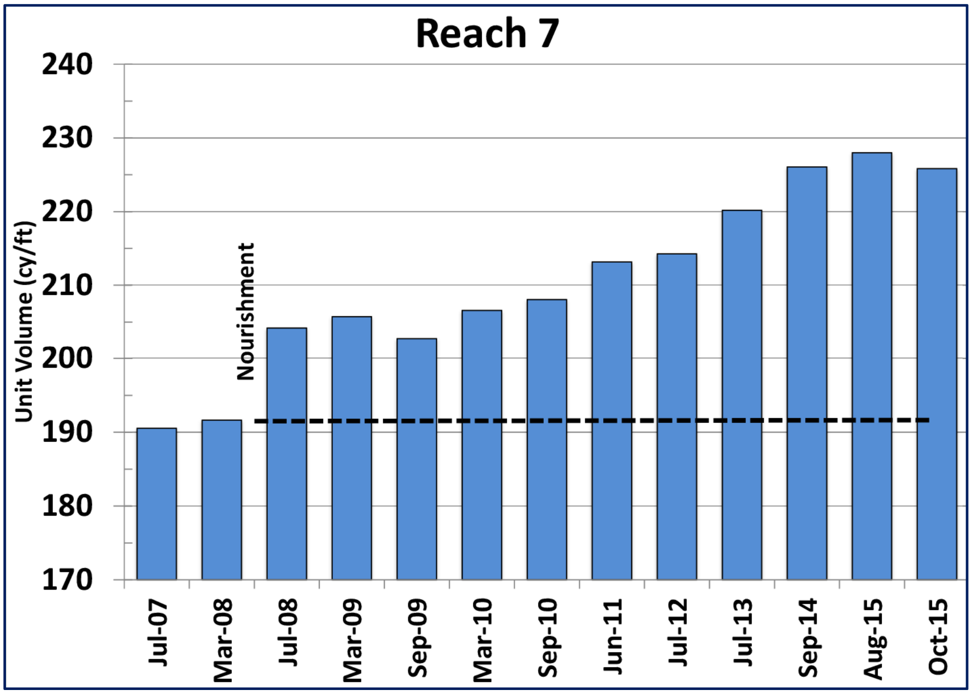
3.3.1 Reach 7

Reach 7 encompasses the shoreline adjacent to Dewees Inlet and includes stations 330+00 through 370+00. The profile along this stretch of beach is narrower and steeper than the ocean-facing shoreline due to the sheltering effects of the Dewees Inlet shoals and the lower wave energy reaching the shoreline. This stretch of beach has experienced localized in the past, resulting from wave focusing through breaks in the delta shoals or reduced sediment supply coming from the front beach. A low-profile groin was built in 1981 near the 17th tee box to mitigate chronic erosion in that area. Approximately 25,000 cy were added during the 2008 nourishment project to the seaward end of the reach (stations 330+00 to 340+00).

FIGURE 3.11. Reach 7 encompasses the shoreline bordering Dewees Inlet. The reach limits are shown by the orange bar.

Figure 3.12 shows the total reach volume and the volume for each station since 2007. Overall, the reach has been accretional since 2007, increasing in volume by ~150,000 cy, including the 25,000 cy gained during nourishment. The majority of the gain since nourishment has been at the seaward end of the reach, between stations 330+00 and 342+00, which have gained an average of 61.9 cy/ft (or 1.5 times the quantity added during nourishment). The accretion has led to some areas gaining over 100 ft of beach width since the project and has shifted the margin of the Dewees Inlet channel to the east. Vegetation has propagated across the constructed berm, and wind-blown sand has accumulated to create natural dunes seaward of the pre-project escarpment. Stations 358+00 through 364+00 along Cedar Creek Spit all show lower unit volumes compared to the 2008 condition, despite having developed a stable dune over that time.

Between September 2014 and August 2015, Reach 7 gained 7,750 cy of sand (1.9 cy/ft). The majority of the gain occurred between stations 338+00 and 352+00 (between the 17th fairway and the boardwalk for the Seagrass Lane properties). The seaward end of the reach eroded with stations 332+00 and 334+00 losing ~15 cy/ft; however, this area remains much healthier than the post-project condition (Fig 3.13). The landward end of the reach near Cedar Creek spit also eroded moderately, although most of the sand loss occurred beneath the low waterline. Dunes in the area appeared stable despite the narrow and steep beach (Fig 3.14).



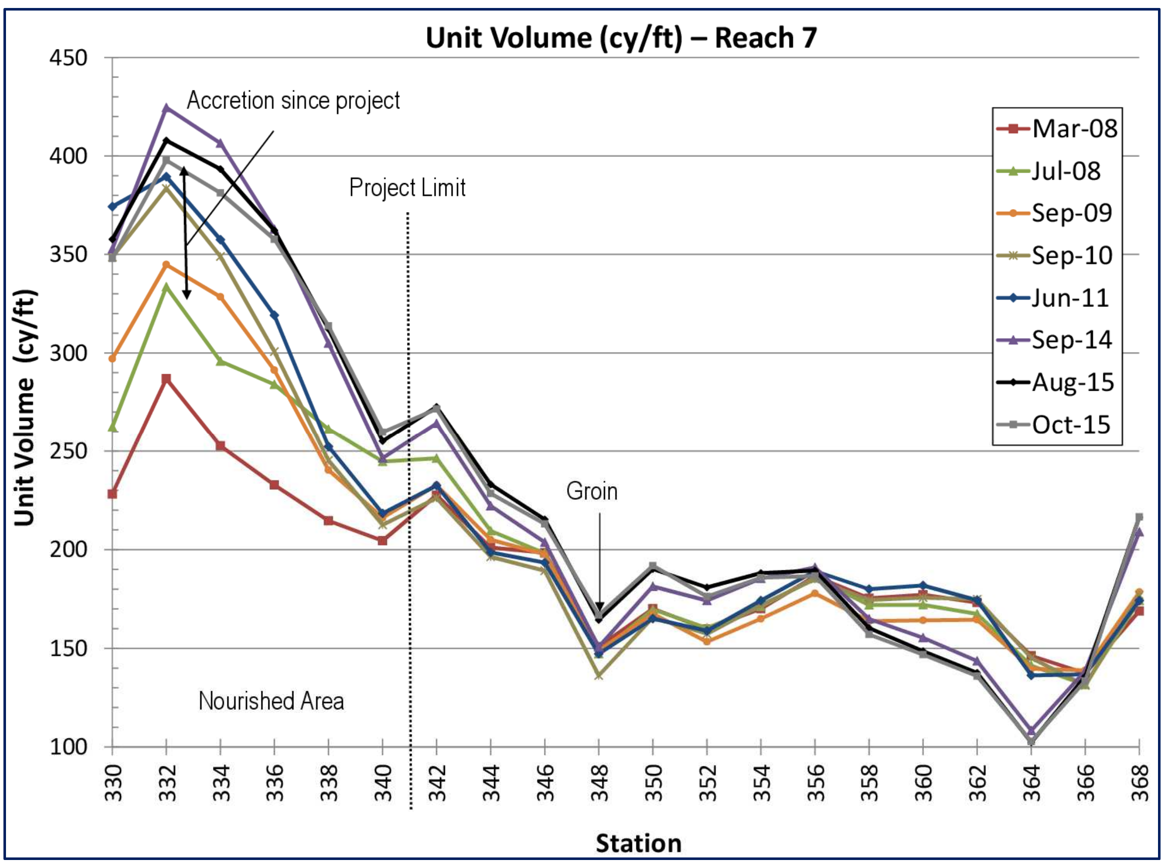
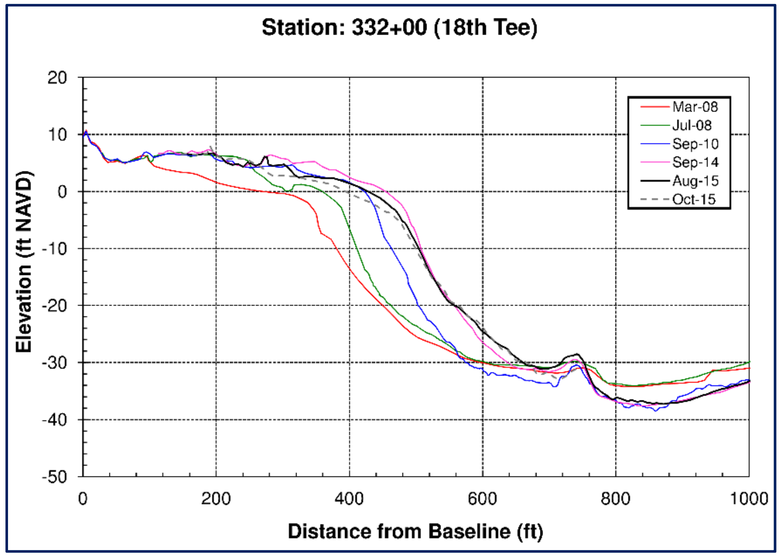
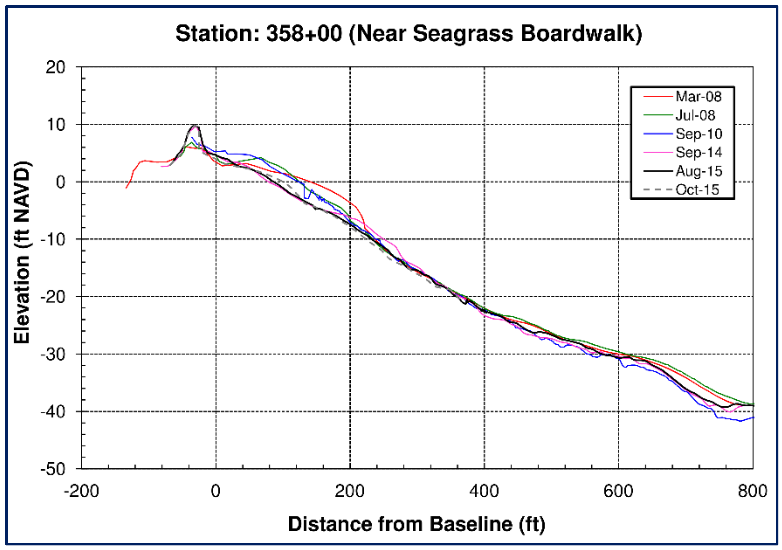


FIGURE 3.12. Beach volumes for Reach 7 showing overall volume change (upper) and change for each line (lower).





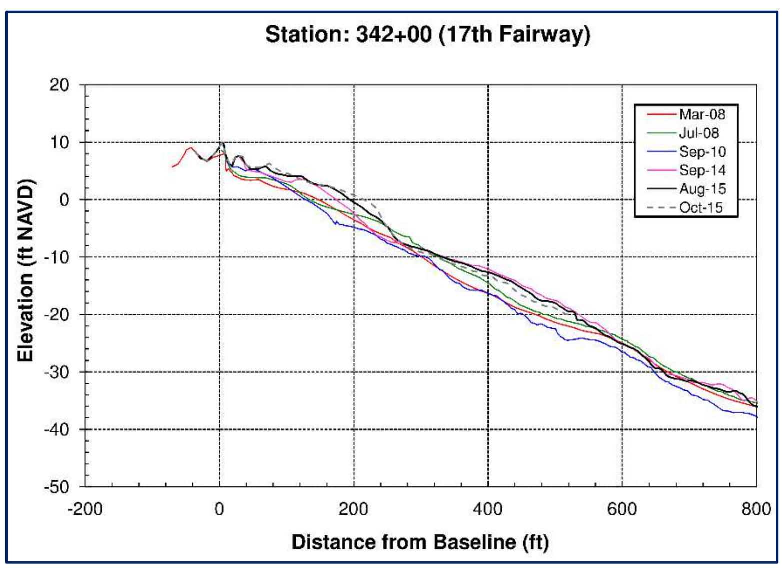


FIGURE 3.14.

August 2015 ground photos of Reach 7: upper photo is station 336+00; lower photo is station 356+00.

Profiles are shown for stations 332+00, 358+00, and 342+00.

FIGURE 3.15. October 2015 aerial image of Reach 7 showing the nourished area in the foreground.

3.3.2 Reach 6

Reach 6 encompasses ~4,900 ft of beach between the Wild Dunes Property Owners Beach House (station 280+00) and the 18th Hole of the Links Course, where the shoreline turns to Dewees Inlet (station 328+00–Fig 3.15). Along with Reach 5, shoal-bypass events have directly impacted this length of beach since the island's formation. Depending on the location of bypass events, the shoreline can change hundreds of feet over a period of several months (Kana et al 1985, Gaudiano 1998). The waterline has periodically encroached on properties since this area of the island was developed.

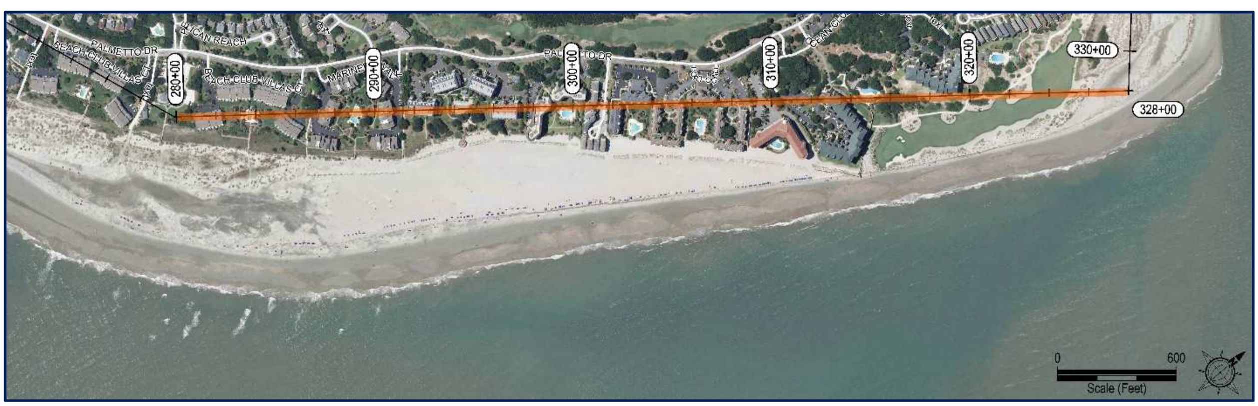


FIGURE 3.16. Baseline stationing along Reach 6 indicated by the orange bar.

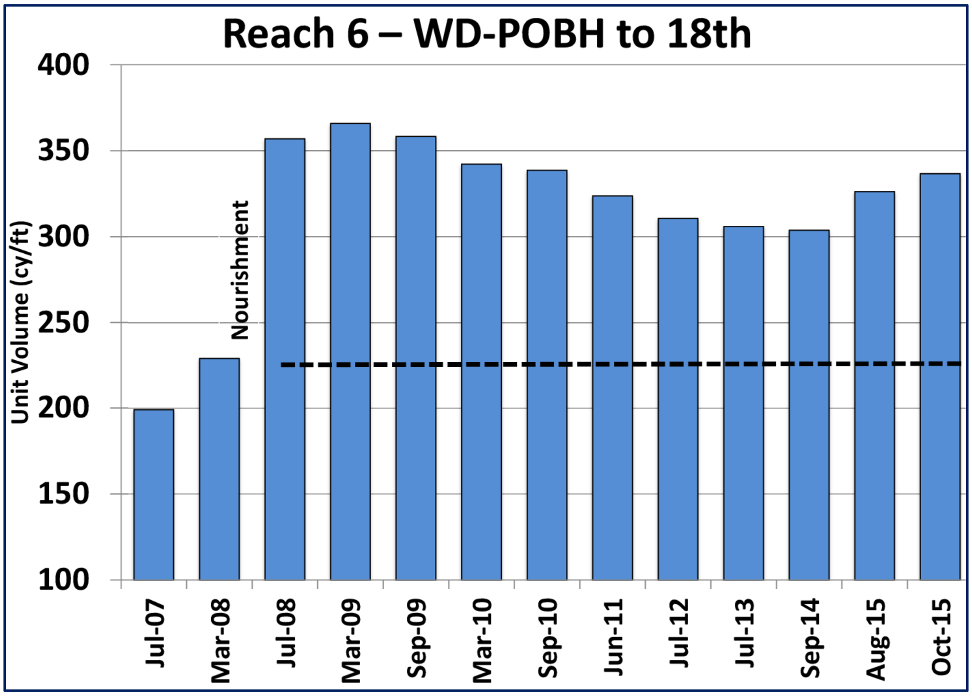
In 2007, The central and eastern ends of Reach 6 were critically eroded due to a very large shoal-bypass event, which was attaching at the western end of the reach. A temporary sandbag revetment was in place, extending from Summer House to the 18th Hole (Fig 3.16). A significant portion of the reach had no dry beach fronting condominium structures and a very narrow wet-sand beach. Approximately 628,000 cy of sand were added via nourishment in 2008, which was the highest fill density of any area during that project. The largest fill sections received nearly 200 cy/ft of sand, which increased the beach width by up to 350 ft. Additional details of the pre- and post-project condition are provided in the nourishment project final report (CSE 2008) and in the previous monitoring report (CSE 2014).

FIGURE 3.17. Sandbags were installed in front of most of the condominium units prior to the 2008 restoration project.

Following nourishment in 2008, Reach 6 continued to gain sand through late 2009 due to continued attachment and spreading of the 2007 shoal event. From 2009 to 2014 the reach eroded, losing a total of ~305,000 cy. Most of the erosion occurred along the eastern half of the reach with the most severe erosion centered near station 314+00 (Ocean Club building). A shoal management project was conducted in fall of 2012, transferring ~80,000 cy of sand from the western end of Reach 6 to the area between stations 308+00 and 320+00 (Seascape, Ocean Club, and 18th Hole). This sand was relatively short-lived, and erosion continued to affect the area.

Another shoal management project was conducted in winter of 2014–2015, moving a total of ~170,000 cy to the erosional area. This sand lasted longer, maintaining a dry-sand beach along the fill area through the following summer. With passage of Hurricane *Joaquin* in October 2015, most of the fill eroded and the beach critically eroded in front of Ocean Club. The condominium owners elected to install an experimental wave-dissipation device in the summer to act as a preventative against potential erosion, although erosion during the storm still damaged some of the building's structure.

As the large shoal-bypass event approached the beach, the western end of the reach began to build as sand was deposited in the lee (sheltered area landward) of the shoal. By 2014–2015, the reach was showing a net gain of sand, gaining ~110,000 cy (22.5 cy/ft, Fig 3.17). Some of this volume was the result of the last shoal management event, which expedited sand movement from the shoal to the eastern end of the reach; however, most of the accretion is attributed to attachment of the shoal. Figure 3.17 shows the beach volume along the reach for selected surveys dating to 2008.



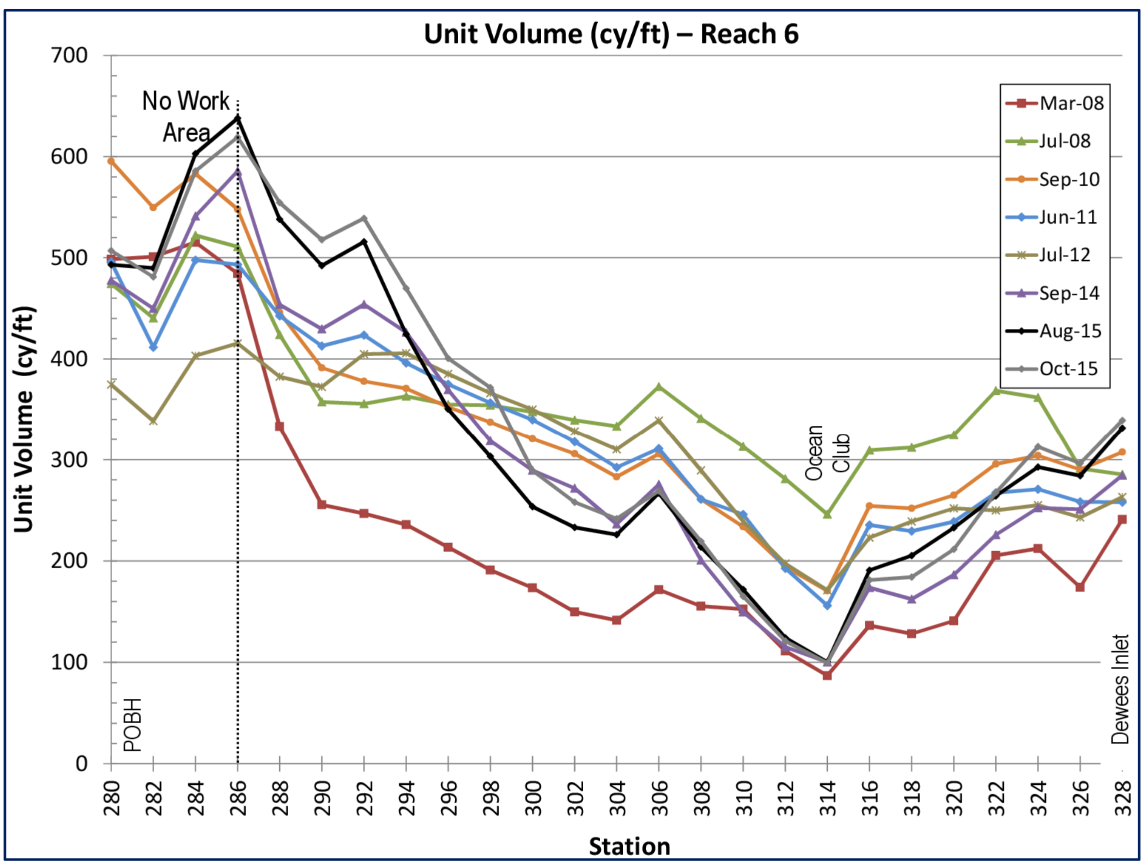


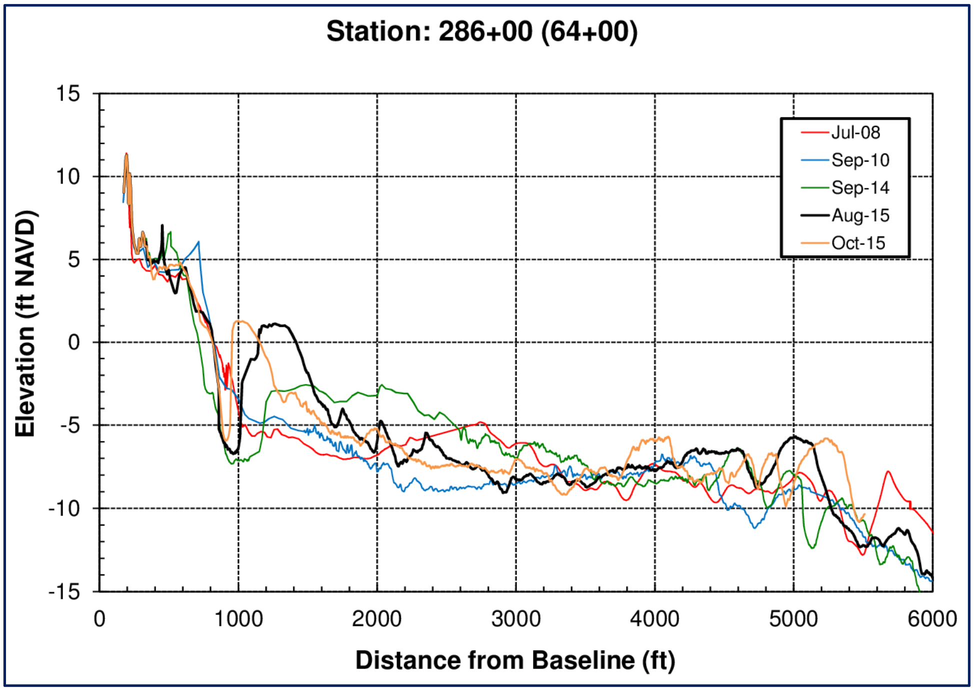
FIGURE 3.18. Beach volumes for Reach 6.

Changes from 2014 to 2015 are visible in the difference between the 2014 (purple line) and August 2015 (black line) data. Note that the black line is higher than the purple along the western end of the reach (left side of plot) and along the eastern end of the reach (right side of plot). Stations 296+00 through 304+00 were the most erosional between the 2014 and August 2015 surveys, losing an average of 21.3 cy/ft.

Profiles from Reach 6 tend to have a steeper beach face than the remainder of the front beach due to the sheltering effects of the inlet delta. Beaches receiving lower wave energy can maintain steeper slopes along the intertidal and shallow subtidal beach. Along the western end of the reach, attaching sand and active wave-breaking create shallow and variable topography, which extends the shallow profile several thousand feet offshore. For example, at station 286+00 (Beach Club Villas II), a platform of sand extends nearly a mile from the dune line, only reaching depths of −7 ft to −8 ft NAVD (Fig 3.18).

At the eastern end of the reach, the offshore profile is more consistent, but still much shallower than the central portion of the island. Changes occur in the bottom topography further offshore, where the Dewees Inlet channel migrates through the delta, but little sand is exchanged with the beach. At Port O'Call, the beach has lost about 225 ft of width since the 2008 project, but remains ~135 ft wider than the pre-nourishment condition (Fig 3.18).

Overall, the western third of the reach (west of Summer House) has been accretional since 2008 (compare black and green lines). As of August 2015, all stations held more sand than the pre-2008 nourishment condition, although the span from stations 310+00 through 314+00 are very close to the pre-nourishment condition. The reach presently containss 477,092 cy more sand than the March 2008 condition. Aerial photos in Figure 3.19 show the condition of Reach 6 at various periods over the past year.



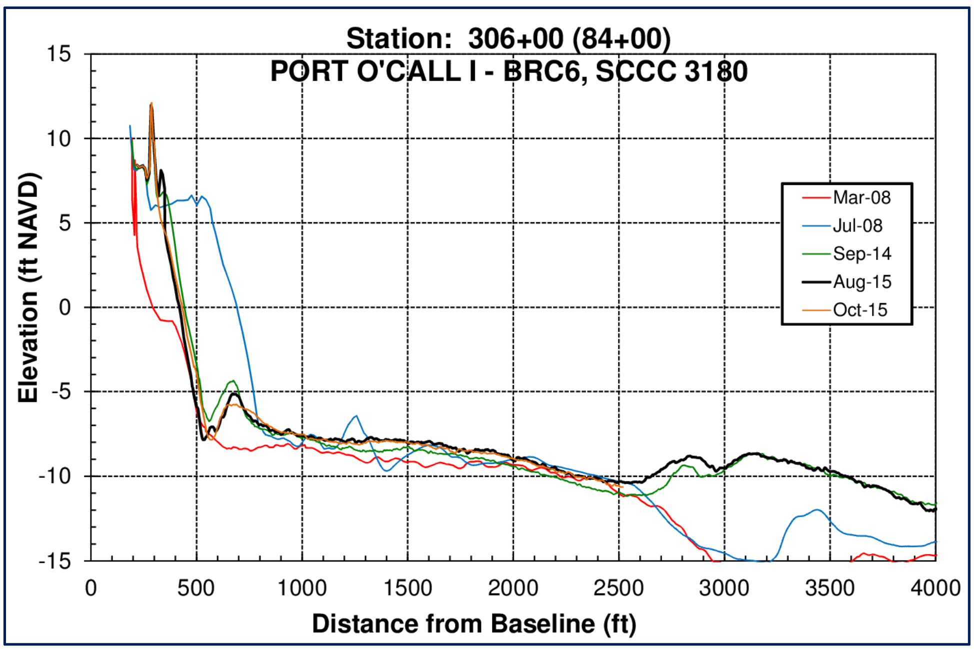


FIGURE 3.19. Profiles from Reach 6 showing beach profile changes since 2008. Station 286+00 is near the shoal attachment site and shows the shallow sand platform extending nearly a mile from the dune. Infilling of the old Dewees Inlet channel is evident at the seaward end of the profile from station 306+00.

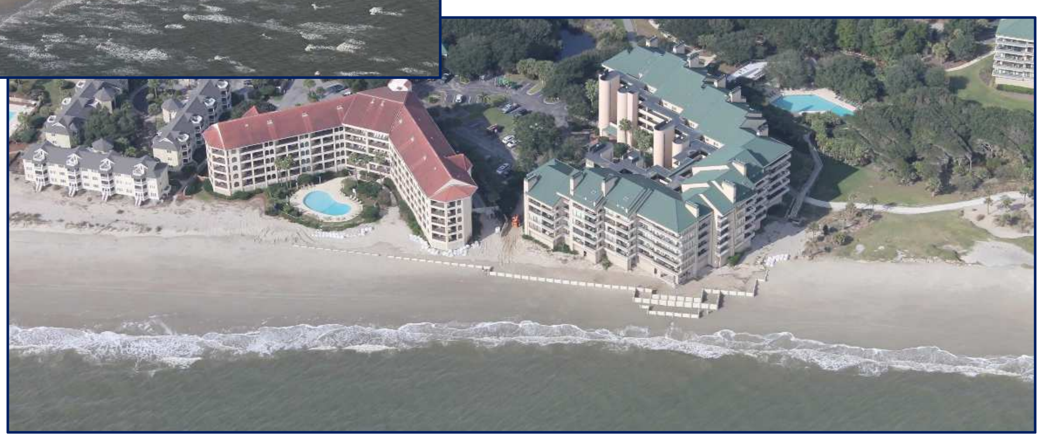
FIGURE 3.20.

Aerial images of Reach 6.

[UPPER RIGHT]
January 2016 during the latest shoal management project.

[UPPER LEFT AND MIDDLE RIGHT]
March 2015.

[LOWER LEFT AND LOWER RIGHT]
January 2016.



3.3.3 Reach 5

Reach 5 includes the area of beach between 53rd Avenue and the Wild Dunes Property Owners Beach House (stations 222+00 through 280+00 – Fig 3.20). Like Reach 6, this area is greatly influenced by shoal-bypass events, especially along the central and eastern ends of the reach. Prior to nourishment in 2008, the large shoal-bypass event impacting the eastern shoreline had created a pronounced bulge at the eastern end of the reach, and an erosional arc extended along the central portion of the reach, centered along the Wild Dunes Grand Pavilion (Fig 3.21, upper). The 2008 nourishment added ~318,000 cy of sand to the reach, increasing the beach width by up to 225 ft.

FIGURE 3.21. Baseline stationing for Reach 5, indicated by the orange bar.

Since 2008, Reach 5 has been the most erosional area of the island. Most of the erosion occurred between 2008 and 2012, and was due to spreading of the bulge created by the 2007 shoal. Between 2008 and 2012, the reach lost nearly 400,000 cy (Fig 3.22, upper). Since 2012, erosion has continued, but has been the result of wave refraction around the new shoal-bypass event. The reach has lost ~187,000 cy since 2012, most of which was lost along the eastern half of the reach. The new shoal event is attaching to the beach further east than the 2007 event, which is causing the western erosional arc to form further east than the 2007 event (Fig 3.23).

Figure 3.22(lower) shows the beach volume along Reach 5 and highlights the erosional trends since 2008. The eastern half of the reach has been highly erosional since the post-project condition (green line). As of August 2015, the area between station 248+00 and station 278+00 has lost an average of 156 cy/ft since nourishment with a maximum of 250 cy/ft at station 266+00. The western end of the reach has lost an average of 20.6 cy/ft over the same time with the erosion rate decreasing to the west. Stations 222+00-228+00 still contains more sand than the post-project condition, and stations 222+00 through 250+00 held more sand than the pre-project condition (as of August 2015).

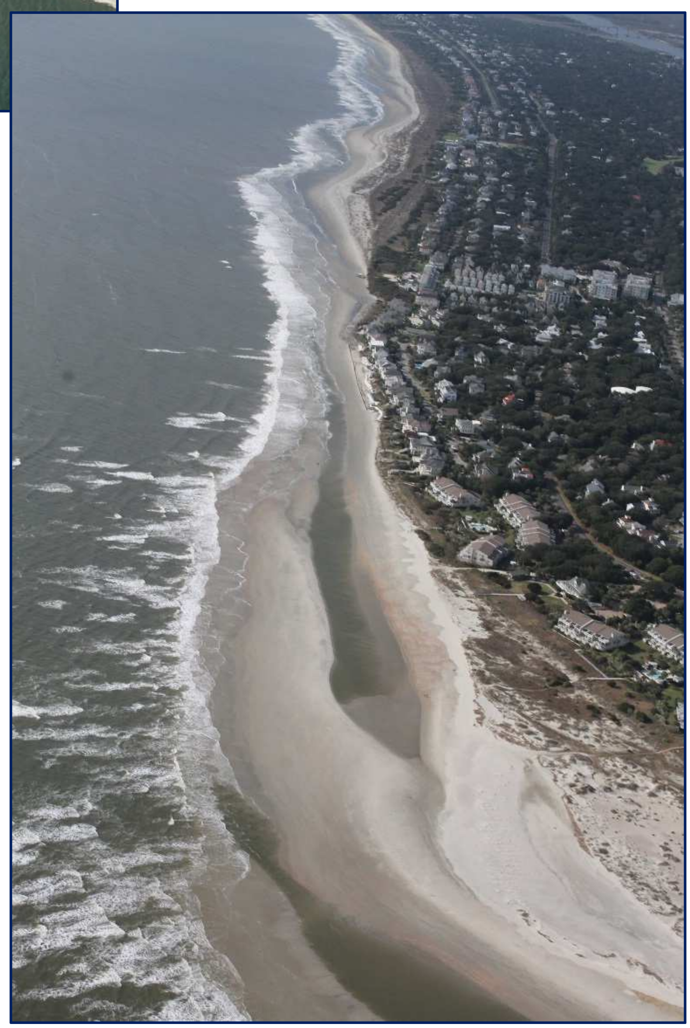
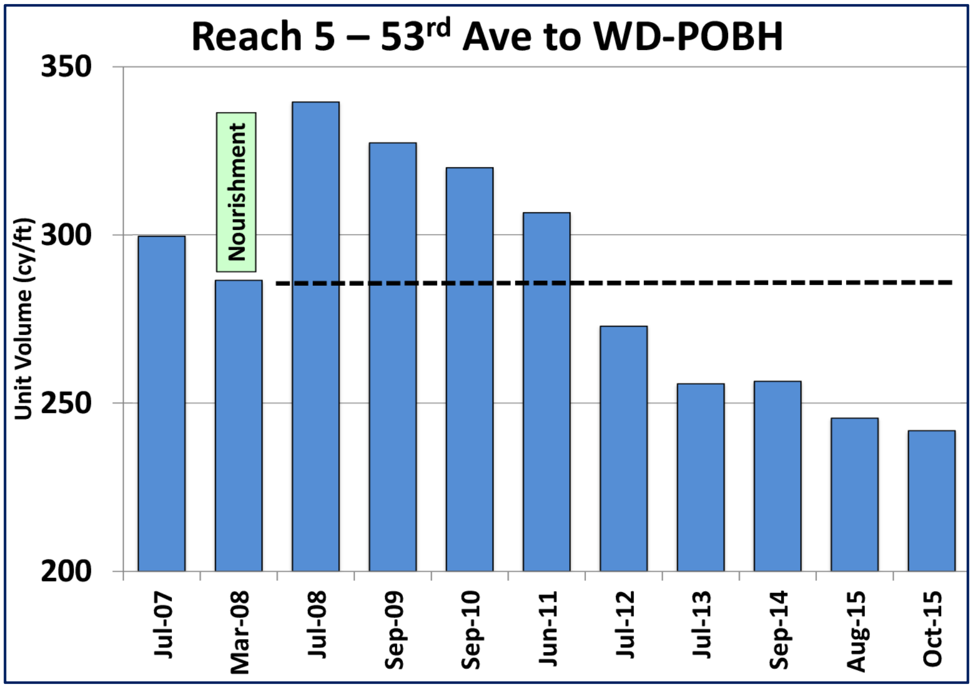


FIGURE 3.22.

[UPPER] Reach 5 in 2007 showing the bulge created from the recent shoal attachment and an erosional arc downdrift (center of photo).

[LOWER] January 2016 aerial view of Reach 5.



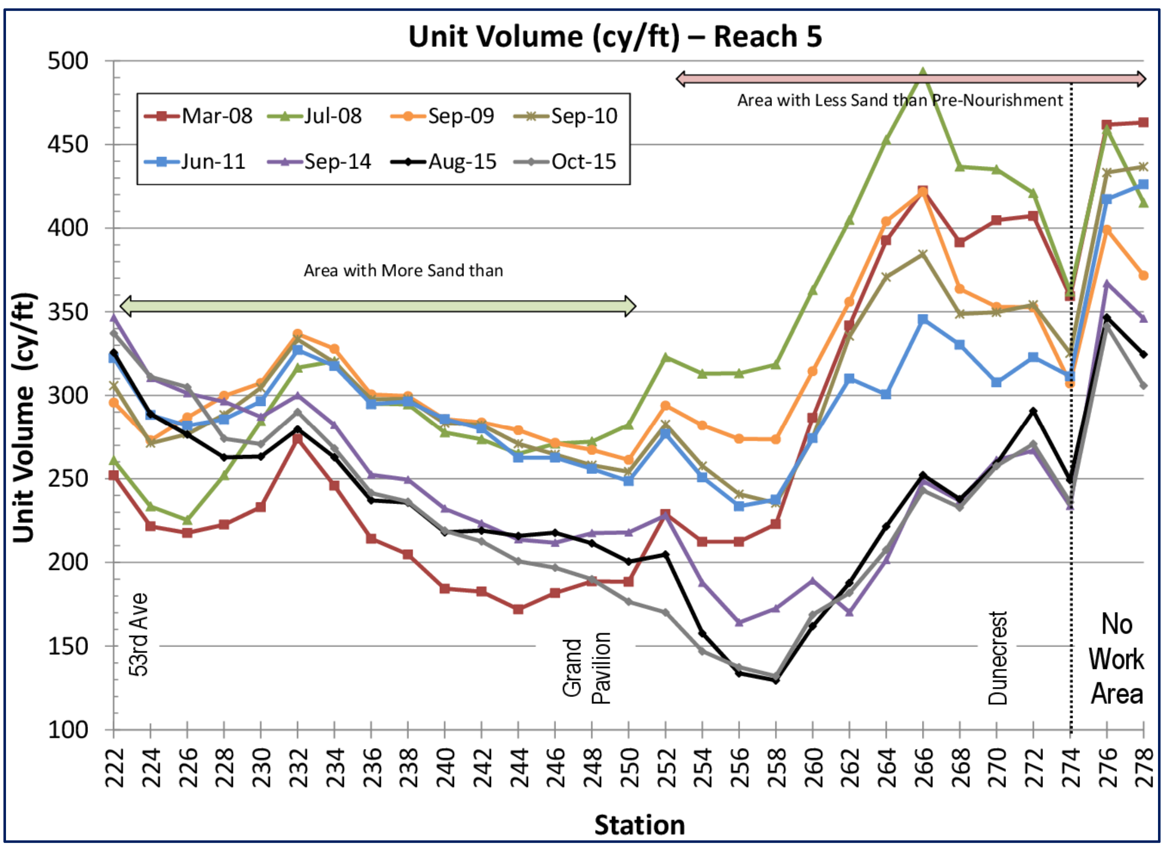


FIGURE 3.22. Beach volumes for Reach 5.

FIGURE 3.24. Aerial images of shoal attachments from 2007 and 2015. The 2015 event is attaching further east than the 2007 event, resulting in different portions of the beachfront experiencing focused erosion. [Upper image by IMC, Charlotte NC and lower image via ESRI World Imagery]

From September 2014 to August 2015, Reach 5 lost 65,600 cy (10.9 cy/ft) of sand, despite the addition of ~60,000 cy during the 2014–2015 shoal management project. It has lost a total of 586,600 cy (98 cy/ft) since nourishment, equivalent to an average loss of 80,860 cy/yr. Profiles from the reach show the variation in beach condition from one end of the reach to the other (Fig 3.25) with the western end having a wide and stable dune field and the eastern portion presently having no dry-sand beach fronting structures. Along Beachwood East, properties owners have installed an experimental "wave dissipation device" which is intended to reduce wave energy reaching the dune area and maintain sand in place (Fig 3.25).

Photos from Reach 5 show the impacts of the accelerated erosion, including loss of the sand berm placed during the latest shoal management project (Fig 3.26). As of the August 2015 survey, the area near Dunecrest Lane and the western Beach Club Villas building was stable or accreting; however, sand from the attaching shoal remained low in the beach profile and was not restoring the upper beach.

Visual observations following the survey show that periodic gains and losses occurred along the eastern end of Beachwood, likely triggered by shifts in the wave climate. Waves from the north will tend to push sand to the south, feeding the eroded area, while southerly waves will move that sand back to the north.

Eventually, shoal sand is expected to reverse the erosional trend and restore much of the eroded area; however, the volume of sand spreading to the north or south cannot be predicted with certainty. As of October 2015 (after Hurricane *Joaquin*), there were ~450,000 cy of sand in the portion of the shoal presently attaching to the beach (see Fig 3.7). If all of this volume attached to the beach, it would be a sufficient quantity to restore the erosional areas on both sides of the shoal and provide a dry beach along the entire northern end. However, only a portion of this volume will actually attach to the beach, as some percentage will still be trapped in the inlet delta.

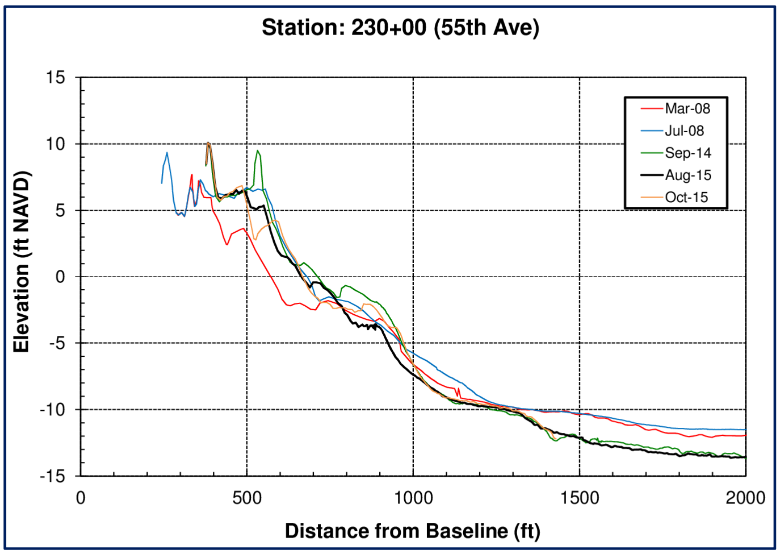


FIGURE 3.24.

Profiles from Reach 5 showing the variation in beach condition from one end of the reach to the other.

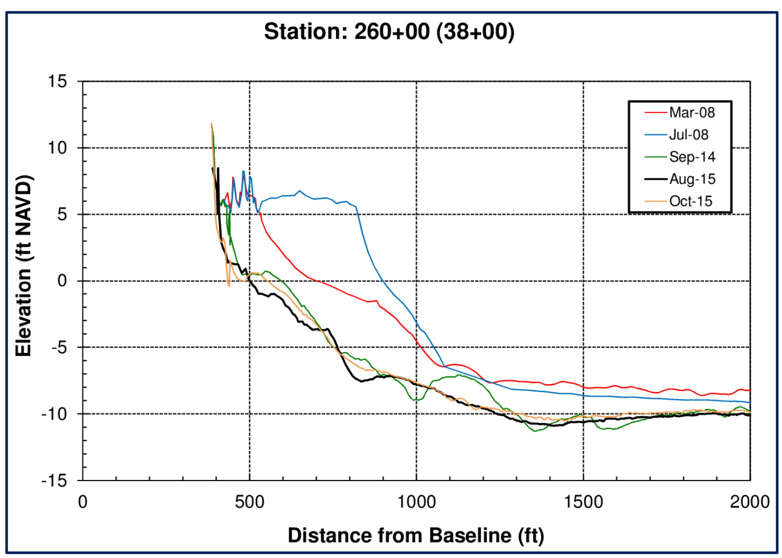


Figure 3.25.

Photos of the experimental wave dissipation system installed in front of properties along Beachwood East. Another installation fronts two condos in Reach 6.

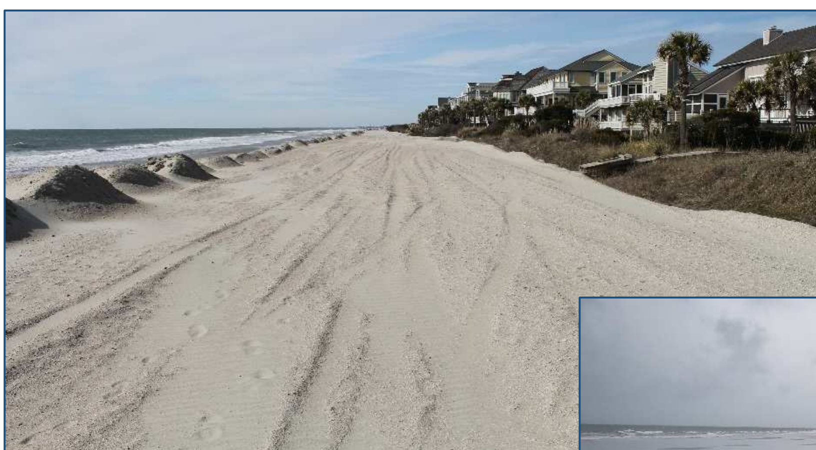


FIGURE 3.26.

Images of Reach 5, near station 270+00 from February 2015 following the shoal management project (left) and in August 2015 (right).

3.4 Summary of East End Changes

Overall, the east end of the island (Reaches 5-7) gained 20,300 cy of sand between September 2014 and August 2015 (Fig 3.27). This continues the accretional trend observed over the last year, when the three reaches gained 52,000 cy. Previously, the reaches lost 480,000 cy between 2010 and 2014. Volumetrically, accretion due to attaching sand near the shoal is compensating for losses along the Grand Pavilion, Beachwood, and Ocean Club areas. CSE expects the net accretional trend to continue through 2016, as additional shoal sand merges with the beach.

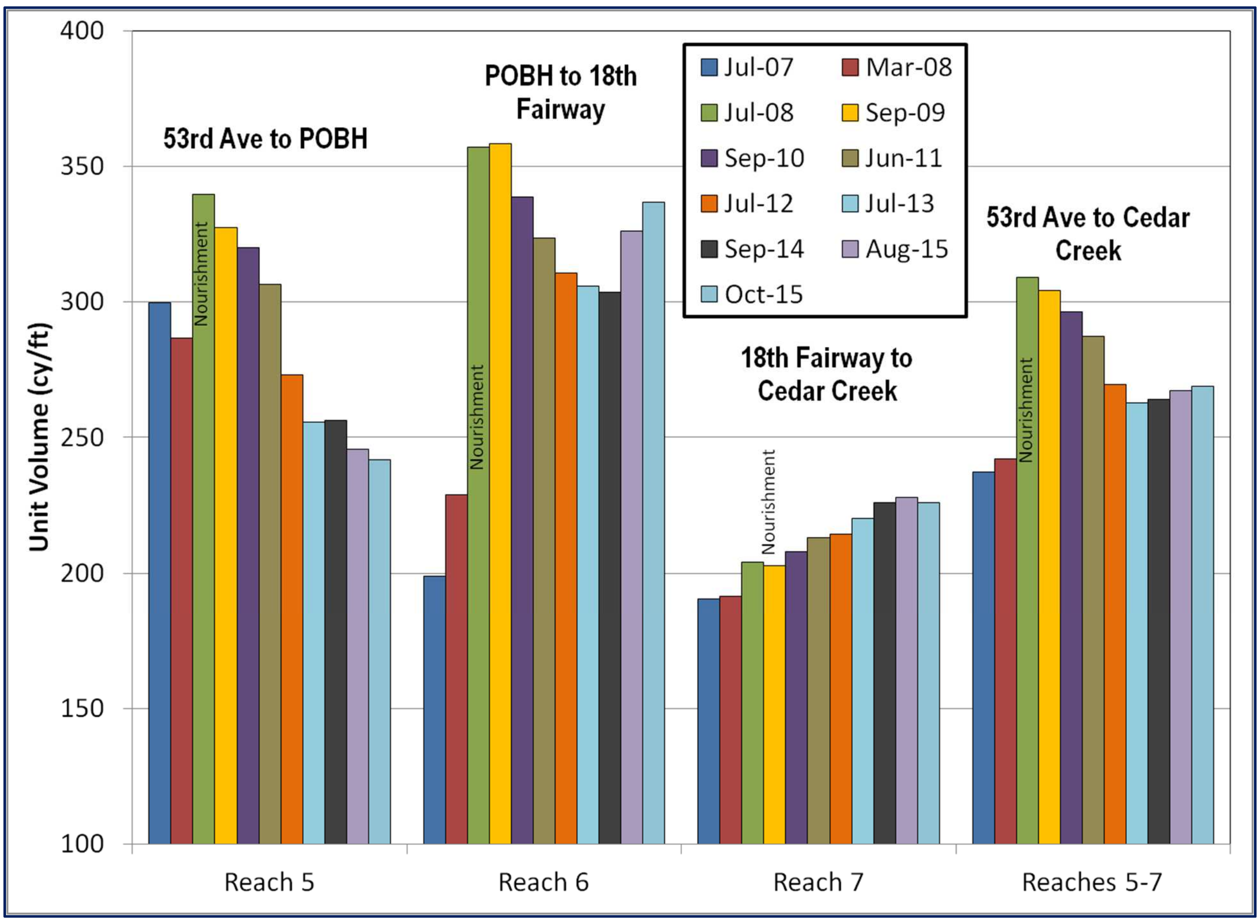


FIGURE 3.27. Reach unit volumes for the east end reaches from 2007 to 2015.

3.5 Downcoast Reaches

Overall volume change for the downcoast reaches is shown in Figure 3.28.

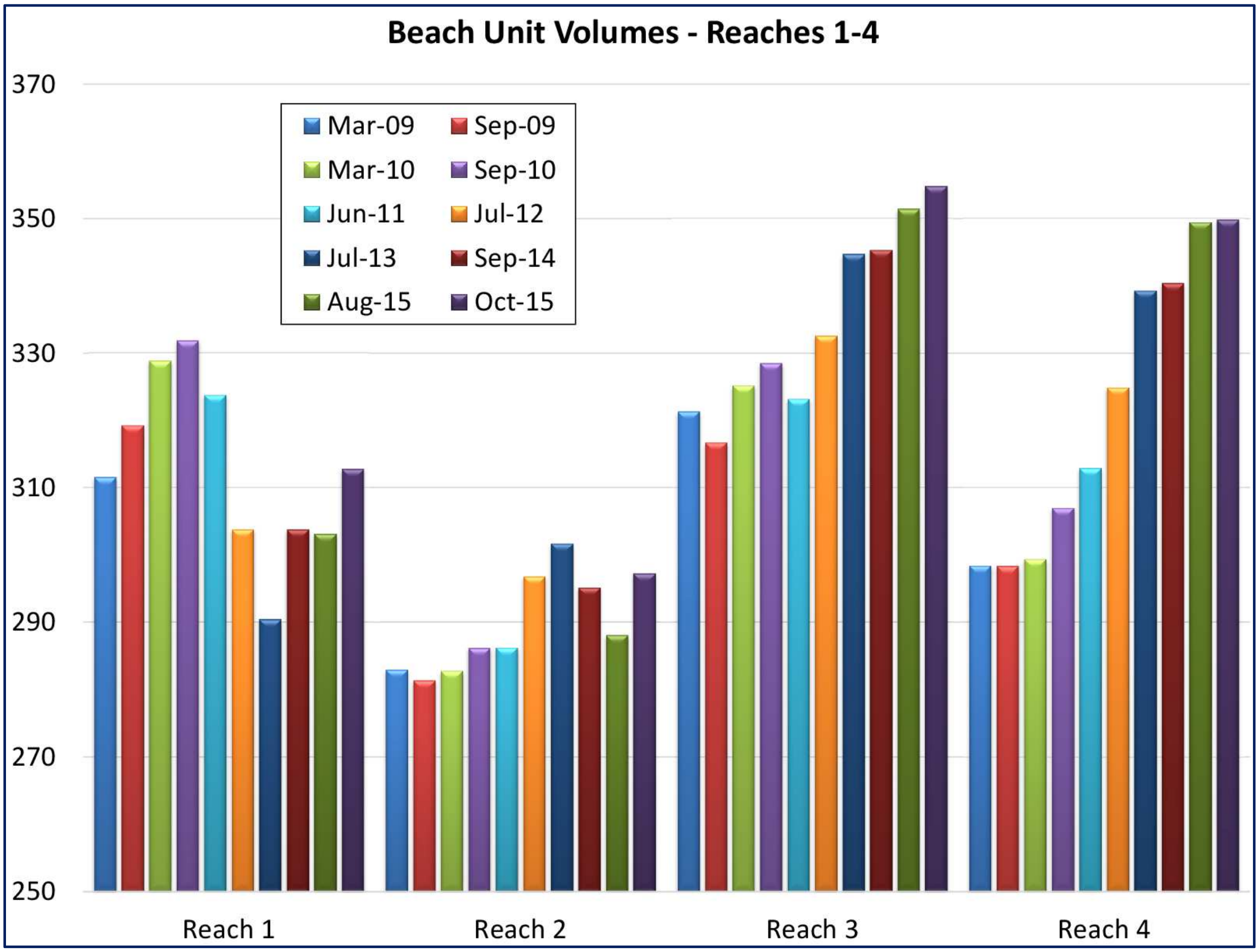


FIGURE 3.28. Beach unit volumes for Reaches 1-4 since March 2009.

3.5.1 Reach 4

Reach 4 includes the length of beach between 31st Avenue and 53rd Avenue (stations OCRM 3140 to CSE 222+00 – Fig 3.29). This reach is ~7,910 ft long and immediately downdrift of the 2008 project area. It is also outside of the direct influence of Dewees Inlet and maintains a more typical and consistent beach profile shape. By being positioned downdrift of the 2008 project area, it receives nourishment sand spreading from the placement area as well as spreading shoal sand. The reach has gained sand every year since 2009.

FIGURE 3.29. Baseline stationing map of Reach 4. Limits of Reach 4 are shown by the orange bar.

Over the past year, the reach gained 71,700 cy (9.1 cy/ft) of sand, increasing from 1.1 cy/ft over the previous year. Accretion was most pronounced at the western end of the reach with the area between stations 150+00 to 180+00 gaining an average of 19.3 cy/ft (Fig 3.30). The central area of the reach was more stable with profiles eroded or accreting between -6.0 cy/ft and +9.0 cy/ft. The very eastern end of the reach near 52nd Avenue was erosional, continuing the erosional trend from the western end of Reach 5. Despite minor volumetric erosion at a few stations, most areas of the reach increased in dune width between 2014 and 2015.

Since 2009, all stations in the reach have gained at least ~30 cy/ft of sand with a maximum gain of 68.6 cy/ft. Overall, the reach has gained 407,000 cy (51.1 cy/ft) of sand since 2009, which is an average annual accretion rate of ~8 cy/ft/yr. Profiles show the beach along Reach 4 has increased in width by 100–150 ft, and dunes have continued to grow in elevation and expand seaward (Fig 3.31). In front of the Citadel Beach Club, a new dune line has formed, reaching an elevation of +12 ft NAVD (~6 ft above the normal dry beach) and is nearly 80 ft wide at the base (Fig 3.32). This amount of accretion significantly increases the level of storm protection in the area by providing a greater buffer between the ocean and properties. CSE expects portions of the reach to continue to gain sand over the next year; however, increased erosion is likely along the eastern end of the reach as the erosional wave presently impacting Reach 5 will continue to move to the west, reducing the sediment supply into Reach 4.

Reach 4 was fairly stable overall during Hurricane *Joaquin*, gaining ~3,000 cy (0.4 cy/ft) of sand during the storm. Erosion occurred at the eastern end of the reach, between stations 210+00 and 220+00 (50th to 53rd Avenues), while the area just west accreted (47th to 49th Avenues). The remainder of the reach showed variable erosion or accretion with maximum losses of ~10 cy/ft. The storm modified the beach topography from a gently sloping profile to one with a distinct ridge-and-runnel system along the intertidal beach and sandbar just below the low-tide line.

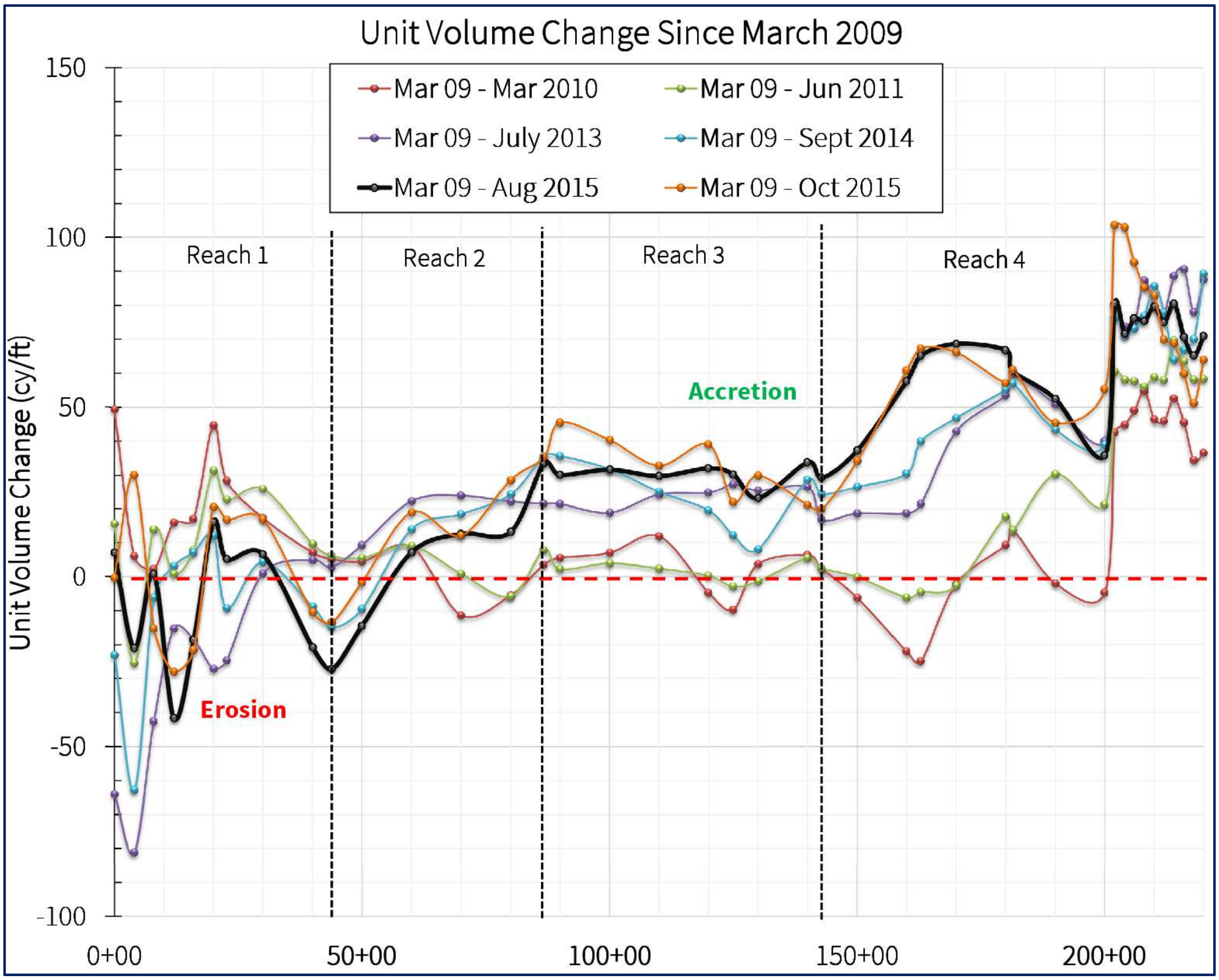


FIGURE 3.30. Unit volume change since 2009 for each station in Reaches 1–4. Positive values indicate accretion and negative values equal erosion. The black line represents the 2015 condition.

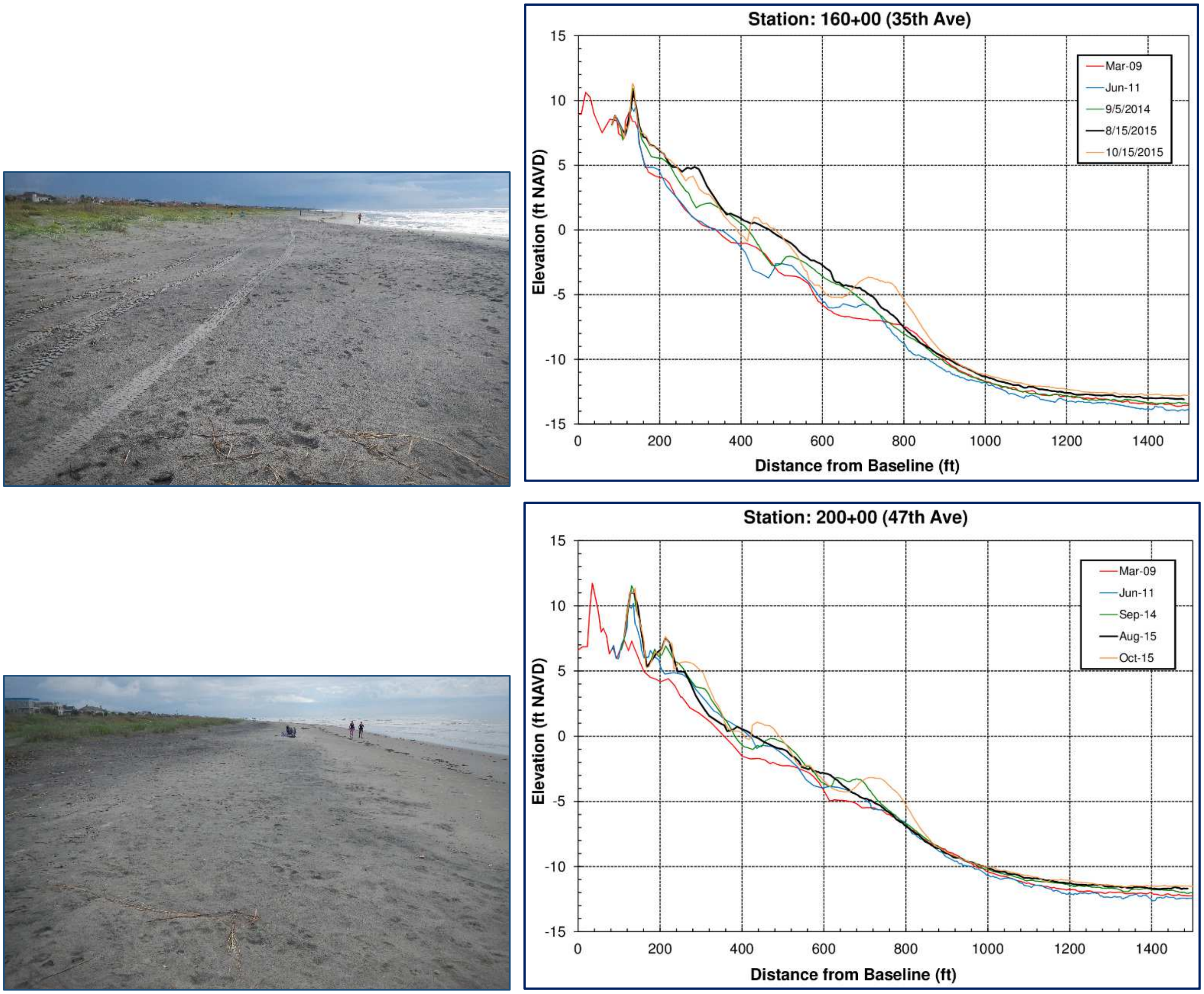


FIGURE 3.31. Profiles show the beach along Reach 4 has increased in width by 100–150 ft, and dunes have continued to grow in elevation and expand seaward.

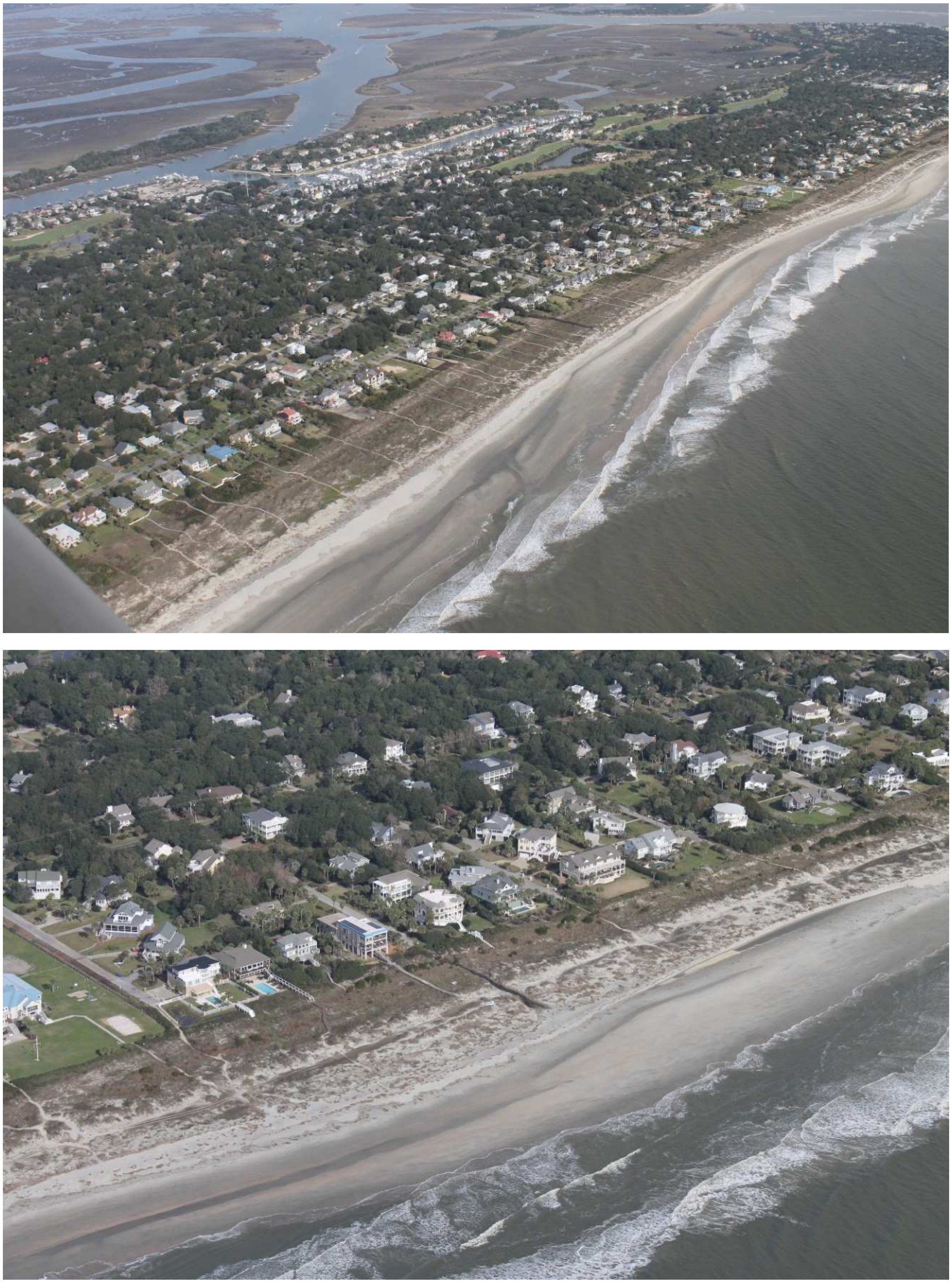


FIGURE 3.32. January 2016 photos of Reach 4. The lower photo shows the 49th Avenue beach access which was washed out during Hurricane *Joaquin*. The waviness of the dry-beach line reflects natural variations in the orientation, position, and width of intertidal sand bars. Sediment tends to move downcoast (right to left as viewed here) in "packages" rather than at a steady rate which would yield a straighter shoreline.

3.5.2 Reach 3

Reach 3 extends from the Sea Cabins Pier to 31st Avenue (OCRM monuments 3125 to 3140 – Fig 3.33). Like Reach 4, the long-term trend in this area is stable to accretional. Dwellings in the reach are generally well set back from the beach, generally between 400 ft and 500 ft except at the western end where Sand Dune Lane and the county park are set back ~150 ft. The reach has shown periods of erosion and accretion since CSE began island-wide monitoring in 2009. This is typical for stable to moderately accretional beaches as variations in wave conditions from year to year and temporary changes in sediment supply lead to minor fluctuations in yearly volume change. Over the long term, the trend is accretion. Profiles from stations within the reach show that the beach gained up to 50 ft of dune width between 2009 and 2015.

FIGURE 3.33. Baseline and stationing for Reach 3.

Over the past year (September 2014 to August 2015), Reach 3 gained 34,300 cy of sand (6.1 cy/ft). This compares to a gain of only 3,400 cy the previous year. Since 2009, the September 2010-June 2011 period is the only interval with measured erosion. Erosion was measured at the western end of the reach (stations 3125 through 100+00) over the past year with profiles losing up to 5.5 cy/ft (see Fig 3.30). The central and eastern portions of the reach accreted an average of 11.1 cy/ft. Profiles in Reach 3 have gained between 23.1 cy/ft and 33.8 cy/ft of sand since 2009. Photos show that along the western end of the reach, the primary dune has continued to grow in elevation and width since 2009, while a new dune line is forming along the eastern half of the reach (Fig 3.34).

Overall, Reach 3 has gained 169,000 cy (30.1 cy/ft) of sand since 2009, which is an average annual accretion rate of 4.7 cy/ft/yr (through August 2015). An additional 19,000 cy (3.4 cy/ft) of sand accreted during Hurricane *Joaquin*, although most of the accretion was in the lower portion of the profile (Fig 3.35). During the storm, the toe of the dune eroded and sand moved to an intertidal ridge and subtidal sandbar just below the low-tide line. This process is the classic beach response to a storm event, which brings larger waves and more energy to the system and tends to flatten the total profile by moving sand from the dunes to the inshore zone.

FIGURE 3.35. January 2016 aerial images of Reach 3. [UPPER] The area from the County Park to 22nd Avenue. [LOWER] Area between 27th Avenue and 33rd Avenue.

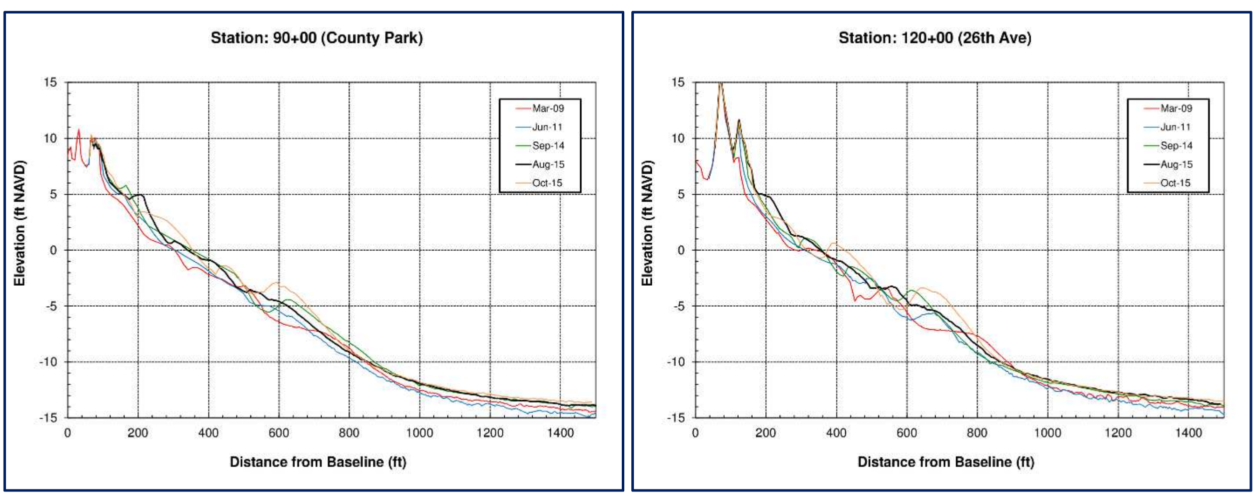


FIGURE 3.34. Example profiles from Reach 3 showing accretion since 2009.

3.5.3 Reach 2

Reach 2 spans 4,280 ft between 6th Avenue and the Sea Cabins Pier (OCRM monuments 3115-2125 – Fig 3.36). It includes the Front Beach commercial area at the eastern end of the reach. Reach 2 shows an erosion/accretion pattern similar to Reach 3 with intermittent periods of accretion and erosion, and a long-term trend of accretion. Since monitoring began in 2009, Reach 2 has been the most stable reach, typically showing lower magnitudes of volume change compared to the other reaches.

FIGURE 3.36. Baseline and stationing for Reach 2.

Reach 2 lost ~30,200 cy (7.1 cy/ft) of sand between 2014 and 2015. This is the largest documented volume loss since monitoring began in 2009 and continues higher than normal erosion first observed in 2014 (when the reach lost 6.5 cy/ft). All five stations eroded during the monitoring interval, varying between 5.0 cy/ft and 12.2 cy/ft (see Fig 3.30). Along the western end of the reach, near 6th and 7th Avenues, erosion occurred to the dune, especially at station 50+00 which lost ~10 ft of dune between September 2014 and August 2015, and another 10 ft during Hurricane *Joaquin*.

Erosion along the central and eastern portions of the reach was mainly in the wet-sand beach and subtidal profile. Hurricane *Joaquin* resulted in accretion along the reach with each profile except 70+00 gaining at least 10 cy/ft. Accretion was generally limited to the intertidal and subtidal portions of the profile with the dune stable except at the west end of the reach (Fig 3.37). The total accretion during the storm was 39,000 cy (9.2 cy/ft), resulting in a net volume change from September 2014 to October 2015 of +9,000 cy.

Overall, Reach 2 has gained 21,900 cy (5.1 cy/ft) since 2009, which is an average annual accretion rate of 0.8 cy/ft/yr. Erosion occurring over the past two years has eliminated much of the accretion observed between 2009 and 2013 (Fig 3.38). As of August 2015, OCRM station 3115 and station 50+00 (near 6th Avenue) have less sand than the March 2009 condition (and a narrower dune). The remaining stations have a net increase in sand volume and dune width compared to 2009.

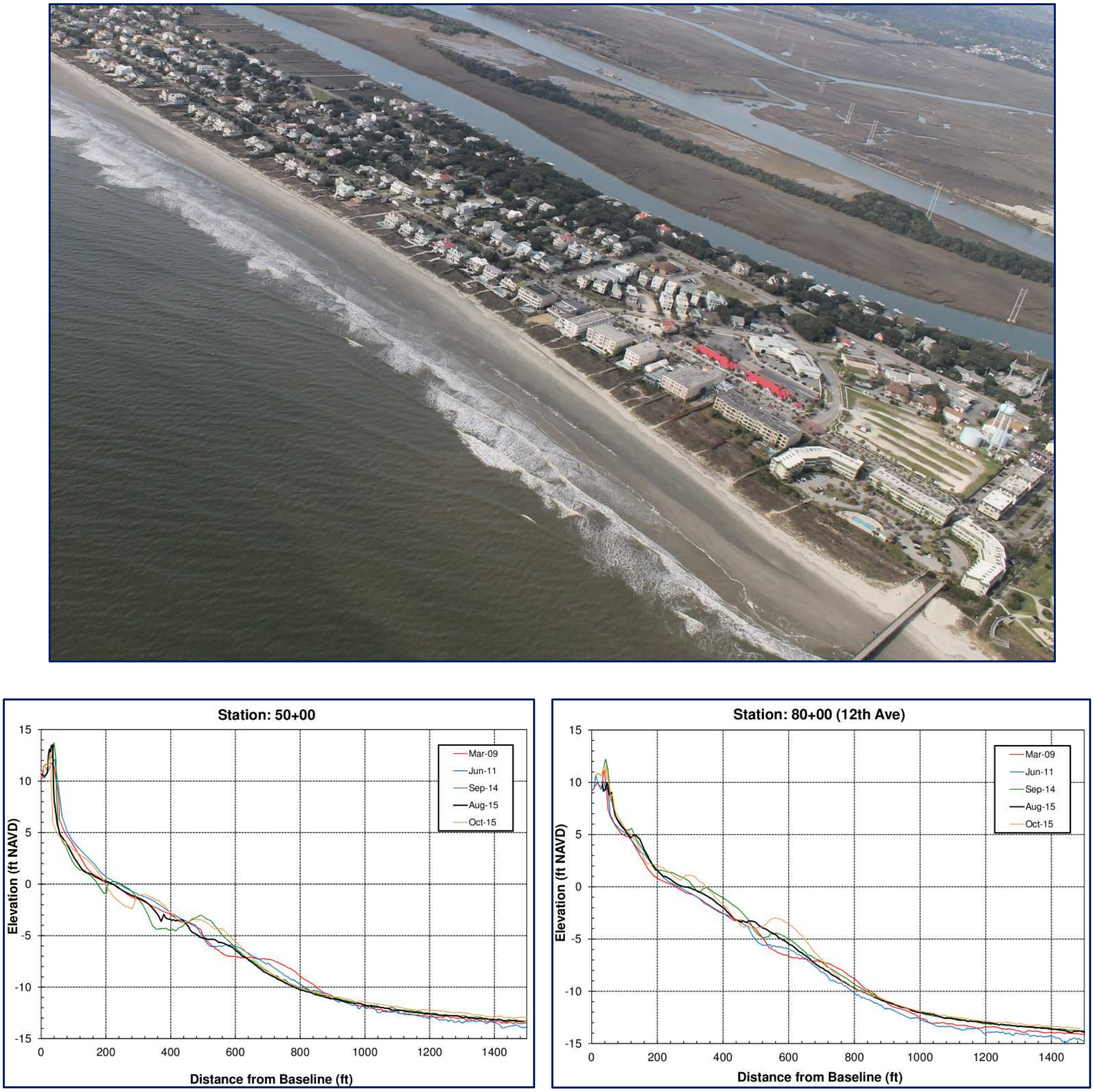


FIGURE 3.37. [UPPER] January 2016 aerial image of Reach 2. [LOWER] Profiles from Reach 2. This reach lost sand along the dune during Hurricane *Joaquin*, but has accreted overall since 2009.

FIGURE 3.38.

Ground photos from Reach 2 on 23 October 2015, following Hurricane Joaquin.

[UPPER LEFT] View north from 6th Avenue.

[UPPER RIGHT] View north of the dunes landward of the escarpment at 6th Avenue.

[LOWER RIGHT] The beach in front of the commercial area in October 2015.

3.5.4 Reach 1

Reach 1 encompasses the beach between Breach Inlet and 6th Avenue (Fig 3.39), and is classified as an unstabilized inlet erosion zone due to the dynamic nature of the shoals associated with the inlet delta. The long-term trend in the reach is accretion, evidenced by a new row of houses being built seaward of the original "beachfront" row in the 1980s. Sand supply originates from shoal-bypass events at Dewees Inlet and longshore sand transport from north to south over the length of Isle of Palms. Excess sand is deposited along the southern spit of the island and in the Breach Inlet ebb-tidal delta. Shoals of Breach Inlet form a protuberance in the shoreline, which backs sand up along the oceanfront much like a terminal groin traps sand. Changes in this area are related to bars from the inlet delta migrating onto the beach or marginal flood channels moving landward or seaward. Such natural processes lead to rapid changes in the beach volume compared to the central Isle of Palms reaches.

Reach 1 lost ~182,000 cy of sand from September 2010 to July 2013, which led to loss of dunes, damaged walkovers, and generally the most eroded beach condition in that area in recent memory. Some areas lost over 100 ft of dune and dry-beach width from 2011 to 2013. The erosion was atypical for the reach, which has historically accreted, and generated concerns form property owners. CSE predicted the erosional trend would reverse based on the amount of sand moving in from upcoast reaches; however, additional monitoring was conducted to more closely track the conditions.

FIGURE 3.39. Baseline and stationing for Reach 1.

The reach gained ~58,800 cy between 2013 and 2014, and much of the eroded area began to rebuild a dry sand beach (especially near the southern tip of the island). Despite the overall accretion, an escarpment persisted along the eastern end of the reach. Over the past year, the reach was fairly stable with a measured loss of only 3,000 cy (0.7 cy/ft).

Despite the net erosion, most of Reach 1 showed increasing dry beach width between 2014 and 2015. Except for station 40+00 near 6th Avenue, erosion was mostly confined to the underwater area near Breach Inlet, and was a function of changing topography in the sandbars along the south end of the reach (Fig 3.40). For example, at station 16+00, the measured volume eroded was 25.8 cy/ft; however, the dry beach area gained ~50 ft of width over the same time. Profiles from that station suggest that an intertidal ridge present in 2014 migrated up the beach and built up the high-tide beach area in 2015. At the same time, the offshore area seaward of the nearshore bar decreased in elevation, leading to the net volume loss in the profile.

Station 40+00 continued an erosional trend observed since 2012, losing between 11.3 cy/ft and 13.7 cy/ft each year. The dune in this area has eroded ~60 ft since 2011. Fortunately, properties in this area are set back from the beach and are not presently threatened. In the 2014 monitoring report, CSE anticipated that erosion was likely in Reach 1 this year due to observed erosion in Reach 2. This proved to be the case with the low accretion rate. CSE continues to expect the erosional trend to reverse before structures are threatened due to the sand surplus in the upcoast reaches. Overall, the reach lost ~37,000 cy of sand between 2009 and August 2015; however, Hurricane *Joaquin* resulted in a gain of 42,800 cy for a total net change since 2009 of +5,800 cy.

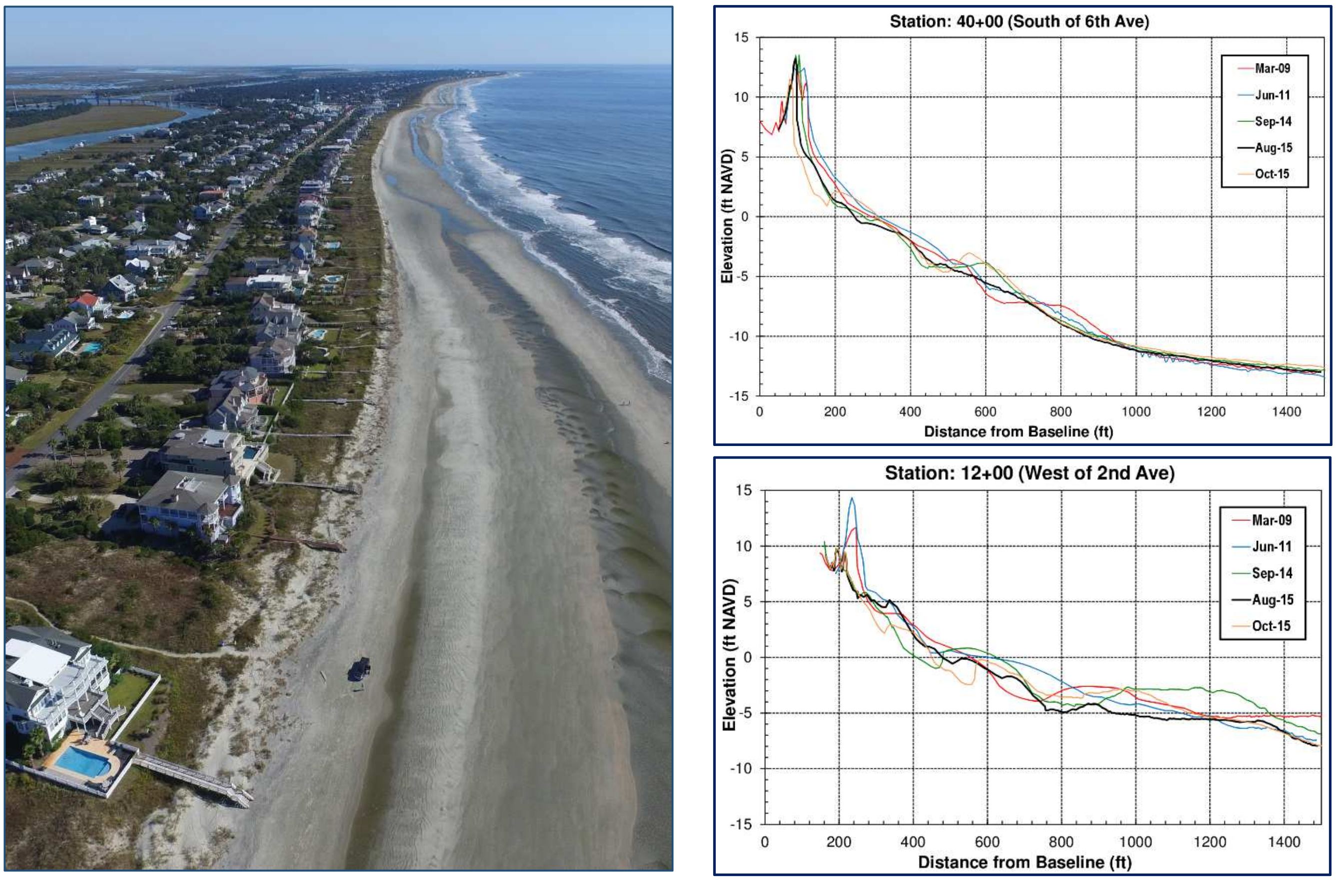


FIGURE 3.40. [LEFT] October 2015 aerial image of Reach 1 shortly after Hurricane *Joaquin*. [RIGHT] Profiles from Reach 1.

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4.0 SUMMARY AND RECOMMENDATIONS

The most significant beach changes occurring at Isle of Palms in 2014–2015 were due to (1) the 2014-2015 shoal management project at the east end, (2) continued erosion and accretion associated with the ongoing shoal bypass event, and (3) impacts of Hurricane *Joaquin*. The shoal management project redistributed ~240,000 cy of sand along the east end, transferring sand from accretional areas to the areas most impacted by erosion. The larger fill volume proved more effective than the 2012 shoal project, which was limited to ~80,000 cy of sand, and some sand remained in front of the Ocean Club and Seascape area until Hurricane *Joaquin*. All sand placed along Beachwood eroded fairly rapidly, as that area was the hotspot for erosion at that time.

As noted in the preceding sections, migration of the main body of the shoal stalled between September 2014 and August 2015; however, Hurricane *Joaquin* resulted in merging of the central and eastern portions of the shoal. The beach between the WDPOBH and Shipwatch accreted substantially with the attachment, and evidence of spreading to the north is clear. The erosion pressure is still impacting the area west of the shoal, leading to severe loss of beach between the Grand Pavilion and Dunecrest.

Significant findings of the monitoring discussed herein include:

- Island-wide gain of 125,000 cy from September 2014 to August 2015.
- Additional gain of 124,000 cy from August to October 2015 during Hurricane *Joaquin.*
- Reach 6 was the most accretional area due to shoal attachment centered near Mariners Walk.
- Reach 5 was the most erosional area likely due to the western arm of the shoal remaining offshore.
- The present configuration of Dewees Inlet is similar to the 2007 condition with the main channel deflected to the south and a small secondary channel beginning to form to the northeast.
- Hurricane *Joaquin* resulted in net accretion along the island, although most of the volume gain was in the lower portion of the beach profile. As is typical with storms, the dune eroded and a subtidal sand bar developed during the event. Calmer conditions will move this sandbar up the beach and restore the dry-sand beach.
- The central and western portions of Isle of Palms are generally accretional with the exception being near 6th Avenue.

The City is presently pursuing a permit application for a large-scale nourishment project using an offshore sand source. CSE recommends that the City establish the funding scheme for the project so that it may be implemented once permits are issued. In the event permits are not obtained in time to complete a nourishment project in the winter/spring of 2016–2017, it may be advantageous to complete another shoal-management project to restore the beach in heavily eroded areas this upcoming winter. The present shoal configuration will likely lead to improved performance of any fill placed compared to the previous two projects. The City should also continue to coordinate with FEMA for reimbursement for beach volume losses due to Hurricane *Joaquin*. Losses were detailed in several letters to the City and FEMA following the storm.

Overall, the beach condition at the end of 2015 is beginning to become more favorable for the entire island. The attaching shoal is nearing complete attachment and is beginning to restore some of the eroded areas, especially to the east. Downcoast reaches are gaining sand and generally held up well during Hurricane *Joaquin*. Erosional hotspots are still present near 6th Avenue and portions of Wild Dunes near the Grand Pavilion and Beachwood East.

The results of this report provide the City with an updated condition of the beach and offer guidance for beach maintenance activities. The City's commitment to regular, detailed monitoring of the beach is a model for other coastal communities looking to protect their most valuable physical asset. CSE will complete another annual monitoring effort in the summer of 2016.

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6.0 ACKNOWLEDGMENTS

This report is prepared under an agreement between the City of Isle of Palms and CSE. It is the seventh in a series of annual reports following the 2008 beach restoration project at the northeastern end of the island.

CSE thanks the Isle of Palms City Council (Mayor Dick Cronin), Linda Lovvorn Tucker (city administrator), and Emily Dziuban (assistant to the administrator) for their continued support and coordination of this project.

SCDHEC–Office of Coastal Resource Management (c/o Bill Eiser) provided historical profiles collected by Coastal Carolina University, which were incorporated into CSE's island-wide analysis.

CSE's data collection and analyses were directed by Steven Traynum with assistance by Drew Giles, Luke Fleniken, Trey Hair, and Tim Kana. Graphics were prepared by Trey Hair and Steven Traynum using AutoCAD® Civil 3D®, MATLAB®, and Global Mapper® for digital terrain models. The report was written by Steven Traynum and Dr. Timothy Kana (SC PG 564) with production assistance by Diana Sangster and Trey Hair.

APPENDIX A

Representative Profiles

October 2015

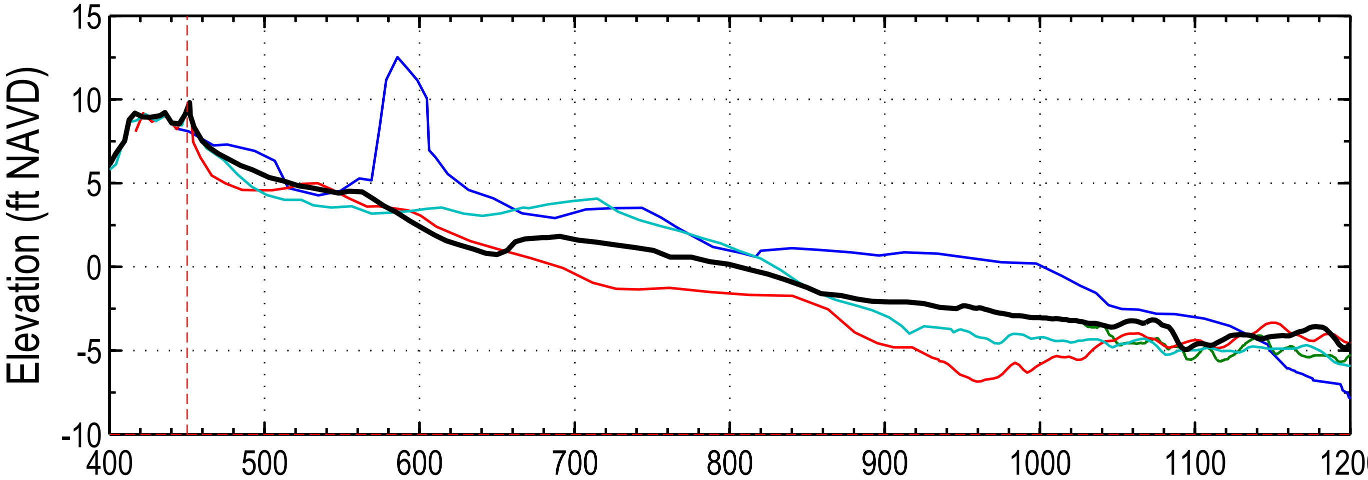
[Isle of Palms – Year 7 Monitoring]

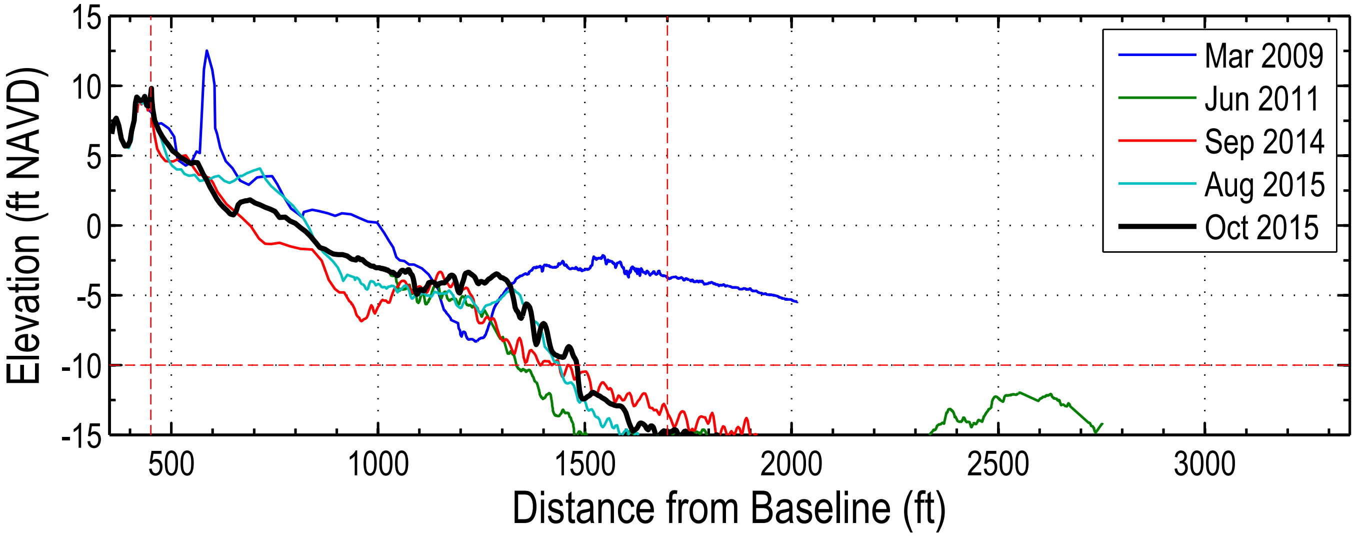
APPENDIX B

DIGITAL TERRAIN MODELS

[Isle of Palms – Year 7 Monitoring]

Station: OCRM 3100b

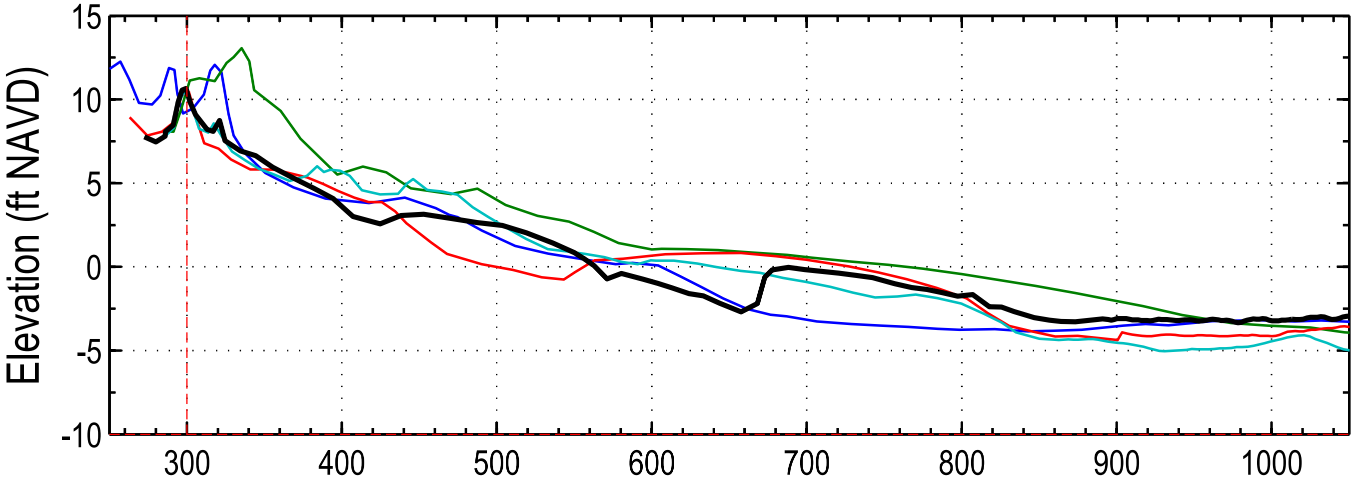


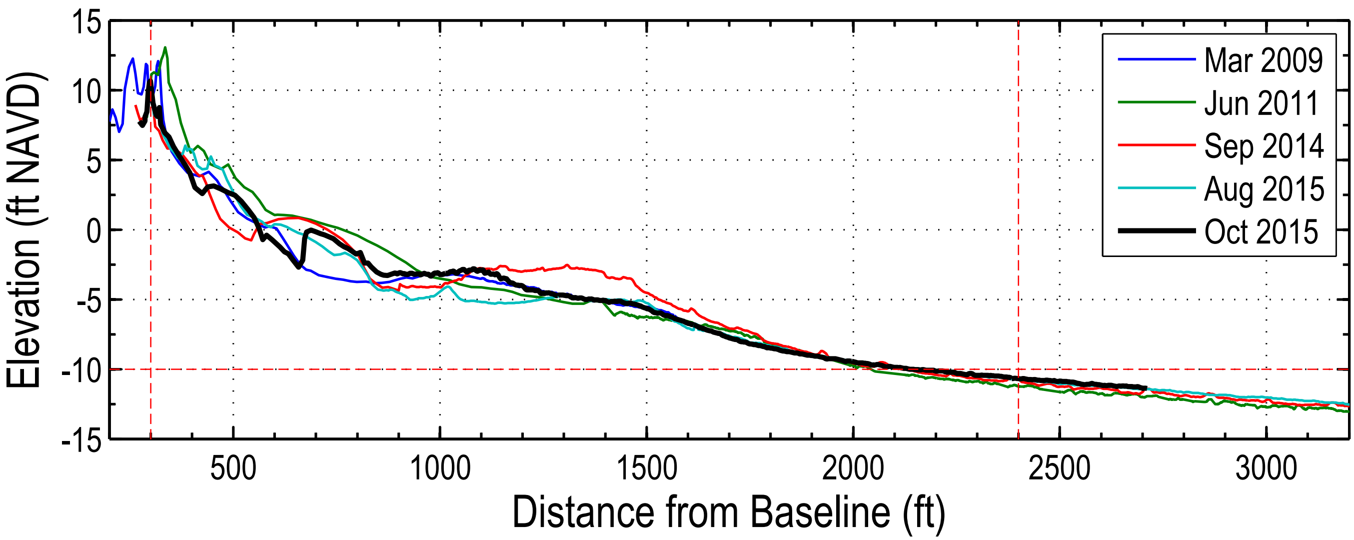


Date	Unit Vol (cy/ft)
Mar 2009	432.7
Sep 2009	249.6
Mar 2010	315.1
Sep 2010	285.1
Jun 2011	193.5
Jul 2012	265.2
Jul 2013	259.3
Sep 2014	257.0
Aug 2015	304.8
Oct 2015	314.2

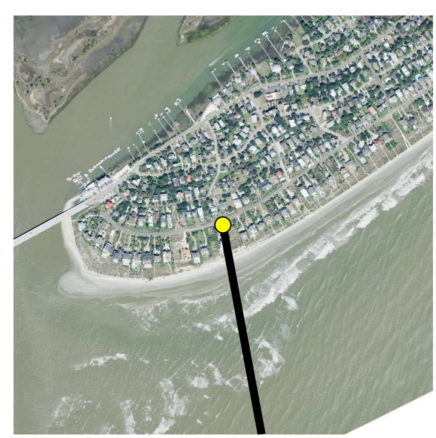
X: 2365850.59
Y: 345201.78

Station: OCRM 3105b



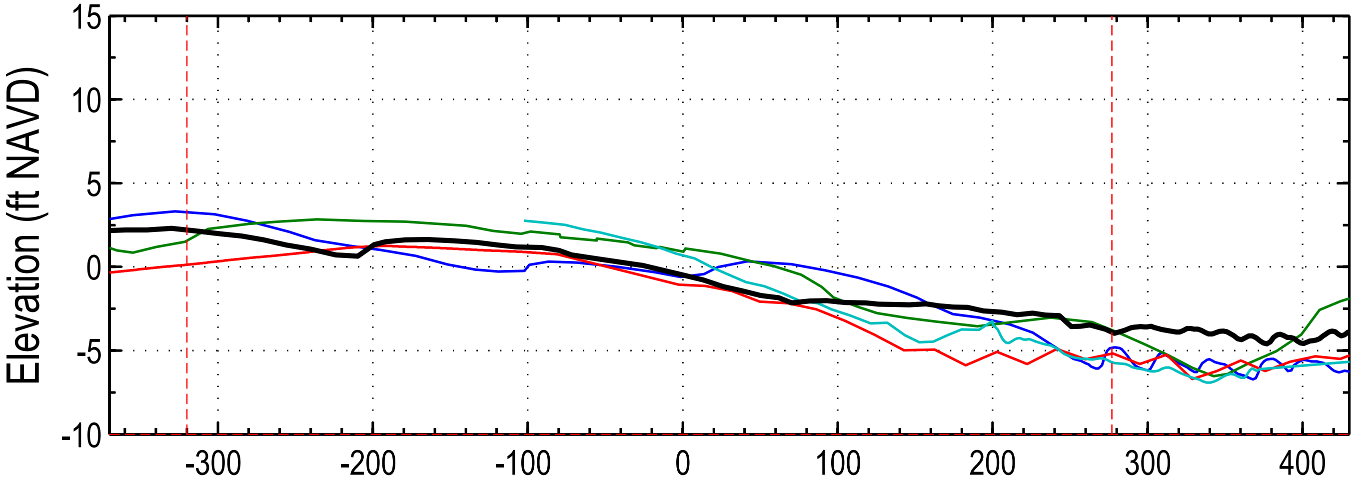


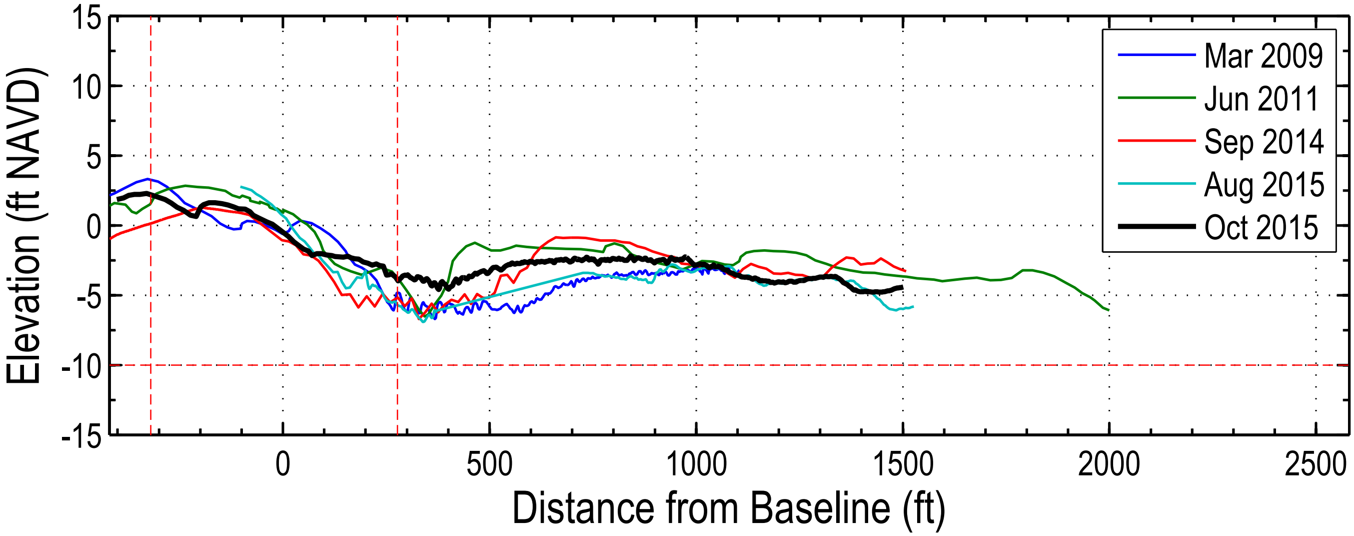
Date	Unit Vol (cy/ft)
Mar 2009	374.3
Sep 2009	472.5
Mar 2010	465.0
Sep 2010	476.7
Jun 2011	446.4
Jul 2012	394.2
Jul 2013	418.5
Sep 2014	439.4
Aug 2015	398.2
Oct 2015	412.4



X: 2366847.09
Y: 345256.9

Station: 0+00

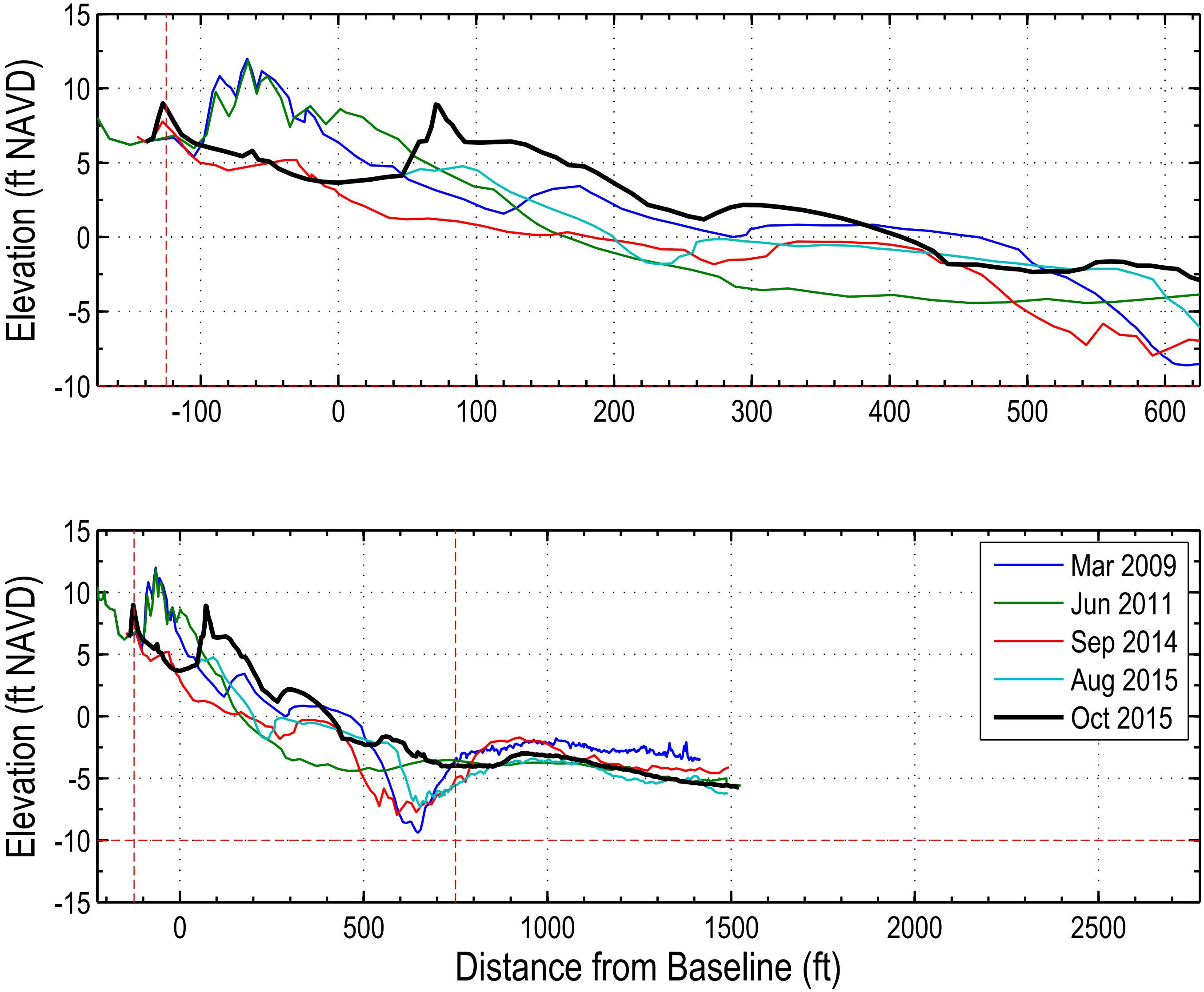




Date	Unit Vol (cy/ft)
Mar 2009	211.6
Sep 2009	141.0
Mar 2010	260.9
Sep 2010	212.3
Jun 2011	227.1
Jul 2012	224.2
Jul 2013	147.5
Sep 2014	188.5
Aug 2015	218.6
Oct 2015	211.2

X: 2365547.46
Y: 344462.21

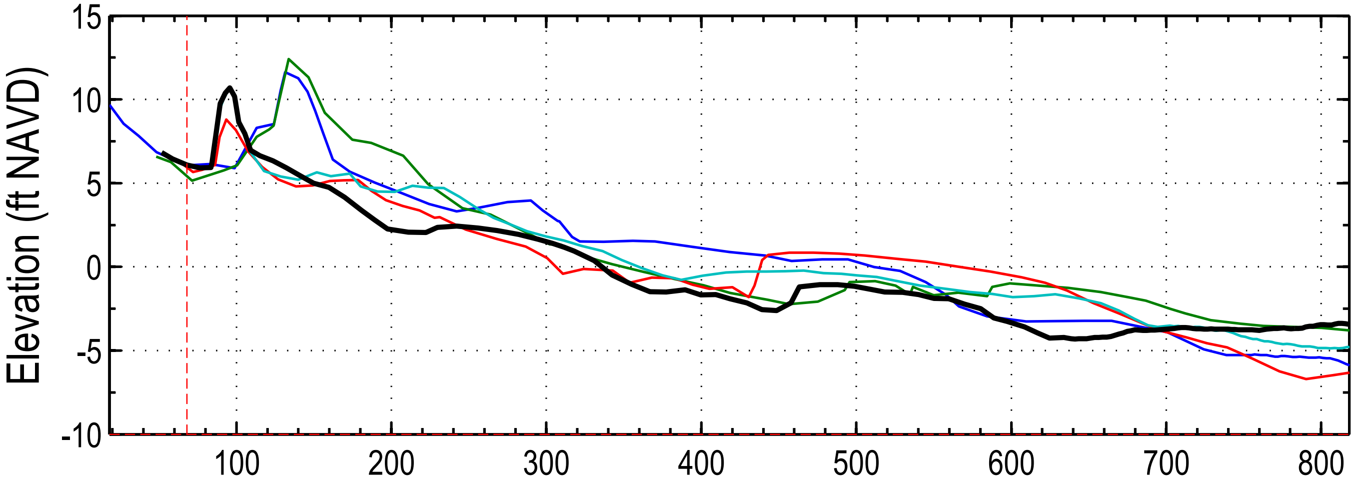
Station: 4+00 (Breach Inlet)

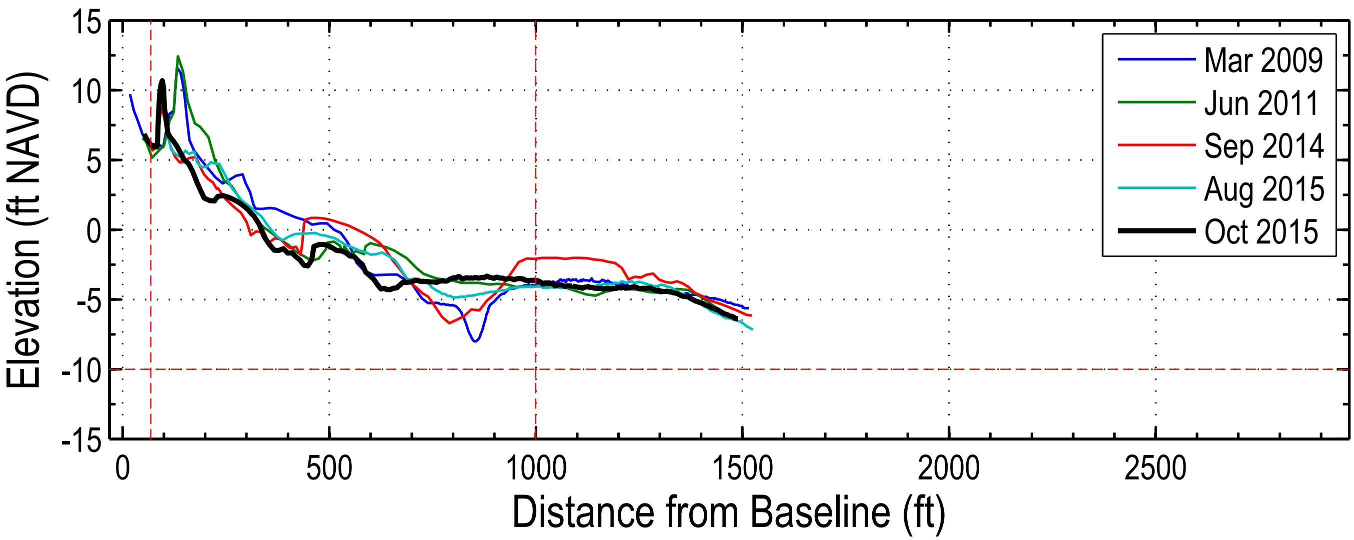


Date	Unit Vol (cy/ft)
Mar 2009	340.5
Sep 2009	309.3
Mar 2010	346.5
Sep 2010	343.4
Jun 2011	314.9
Jul 2012	296.7
Jul 2013	259.2
Sep 2014	277.6
Aug 2015	319.4
Oct 2015	370.5

X: 2365896.3
Y: 344657.95

Station: 8+00 (Near Breach Inlet)

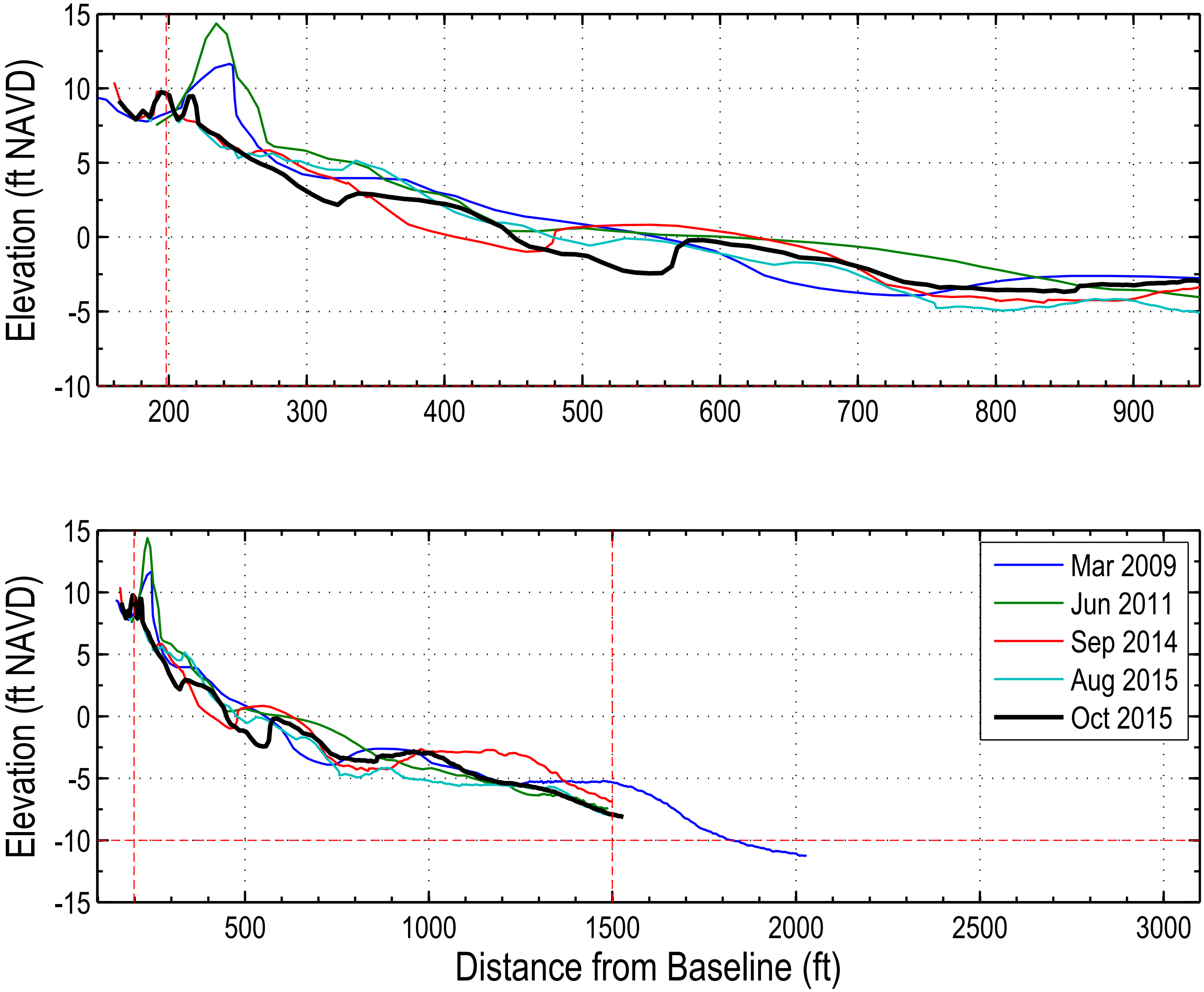




Date	Unit Vol (cy/ft)
Mar 2009	326.5
Sep 2009	344.8
Mar 2010	328.7
Sep 2010	333.1
Jun 2011	340.3
Jul 2012	306.9
Jul 2013	283.9
Sep 2014	320.3
Aug 2015	327.2
Oct 2015	311.2

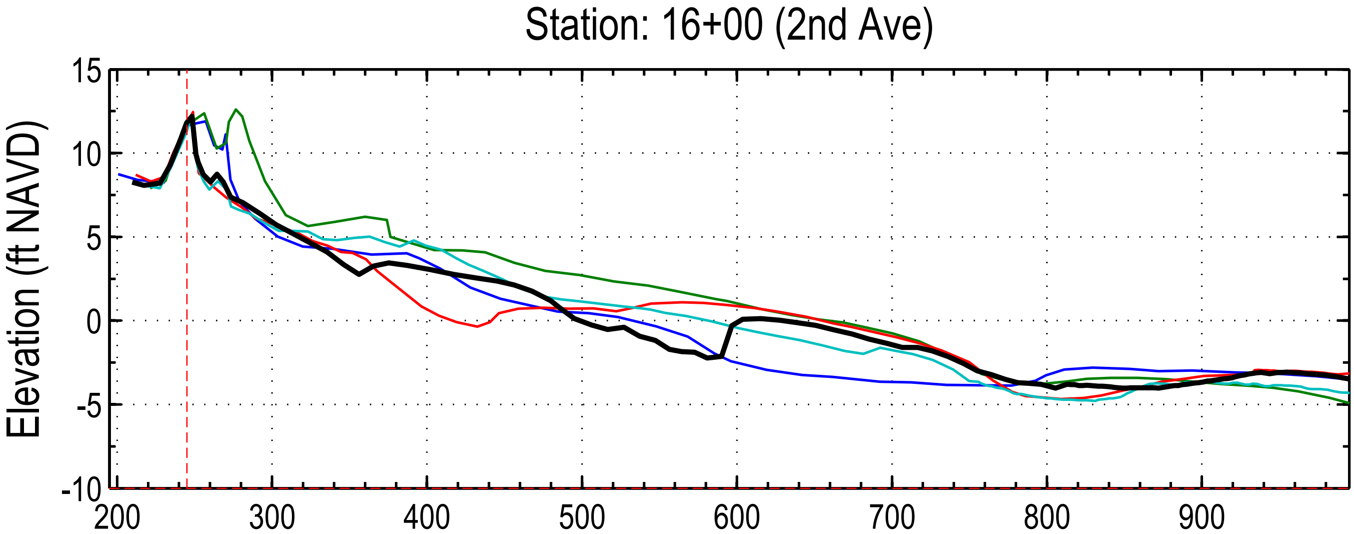
X: 2366245.13
Y: 344853.69

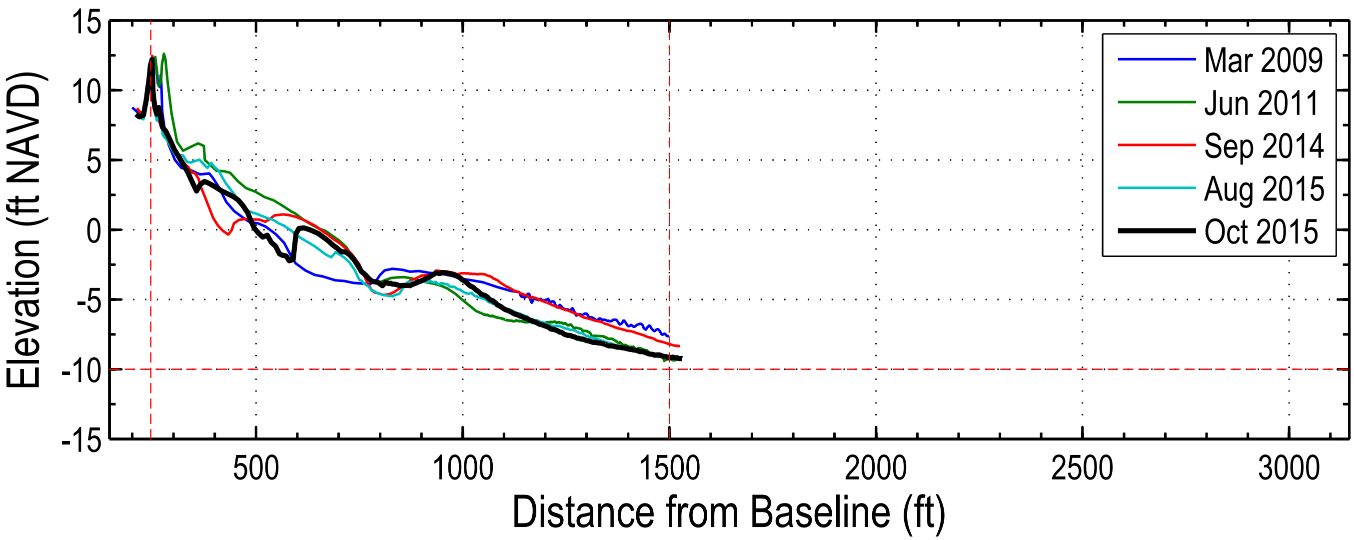
Station: 12+00 (West of 2nd Ave)



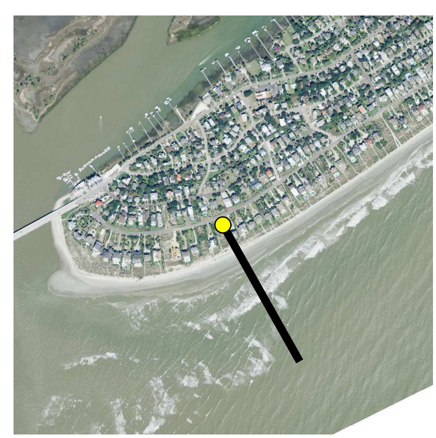
Date	Unit Vol (cy/ft)
Mar 2009	396.0
Sep 2009	432.5
Mar 2010	411.9
Sep 2010	430.4
Jun 2011	396.7
Jul 2012	358.7
Jul 2013	380.7
Sep 2014	399.1
Aug 2015	354.4
Oct 2015	368.0

X: 2366593.96
Y: 345049.44



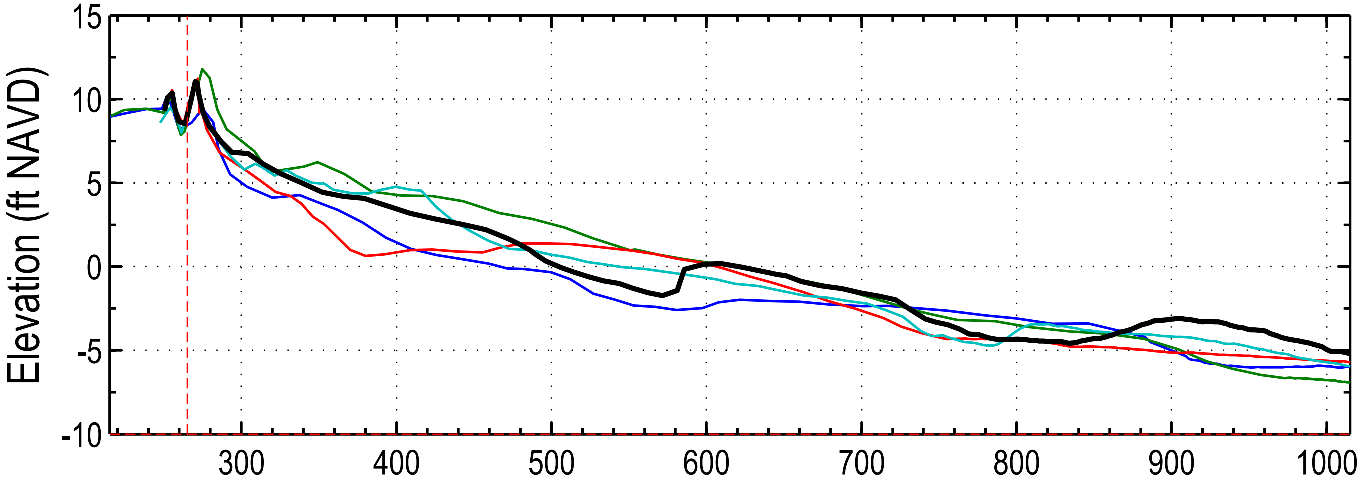


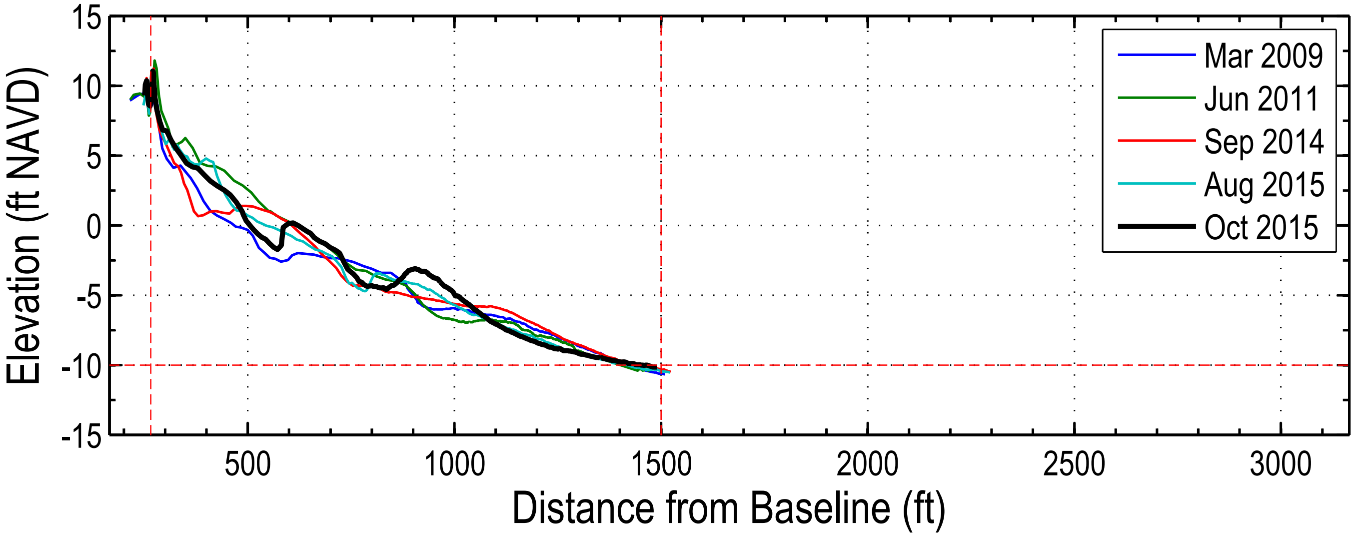
Date	Unit Vol (cy/ft)
Mar 2009	350.0
Sep 2009	389.4
Mar 2010	367.0
Sep 2010	382.6
Jun 2011	357.8
Jul 2012	300.9
Jul 2013	331.6
Sep 2014	357.2
Aug 2015	331.4
Oct 2015	328.4



X: 2366942.8
Y: 345245.18

Station: 20+00

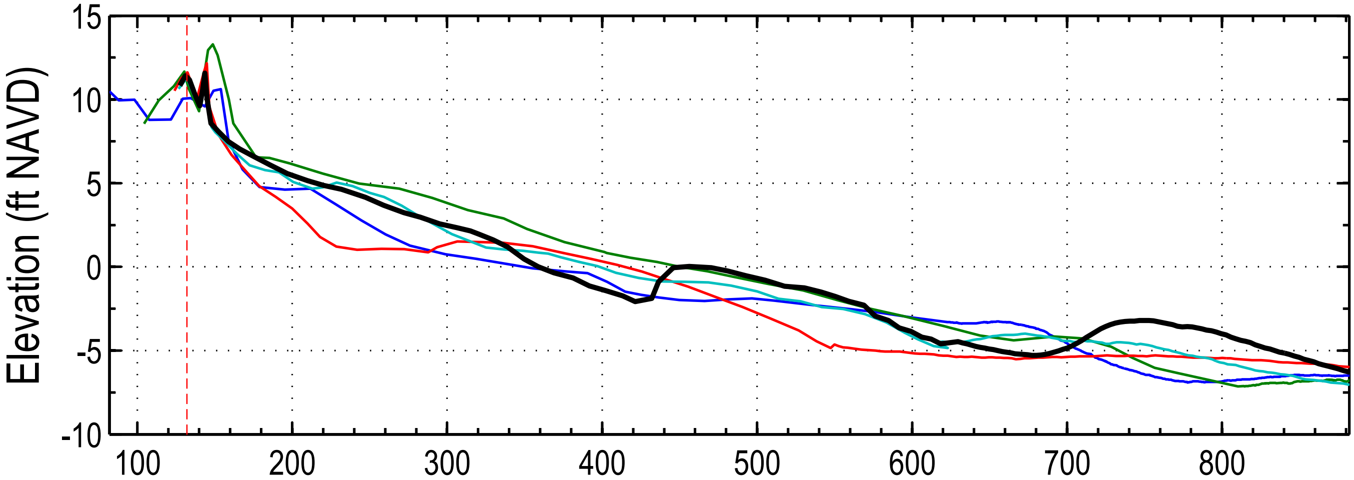


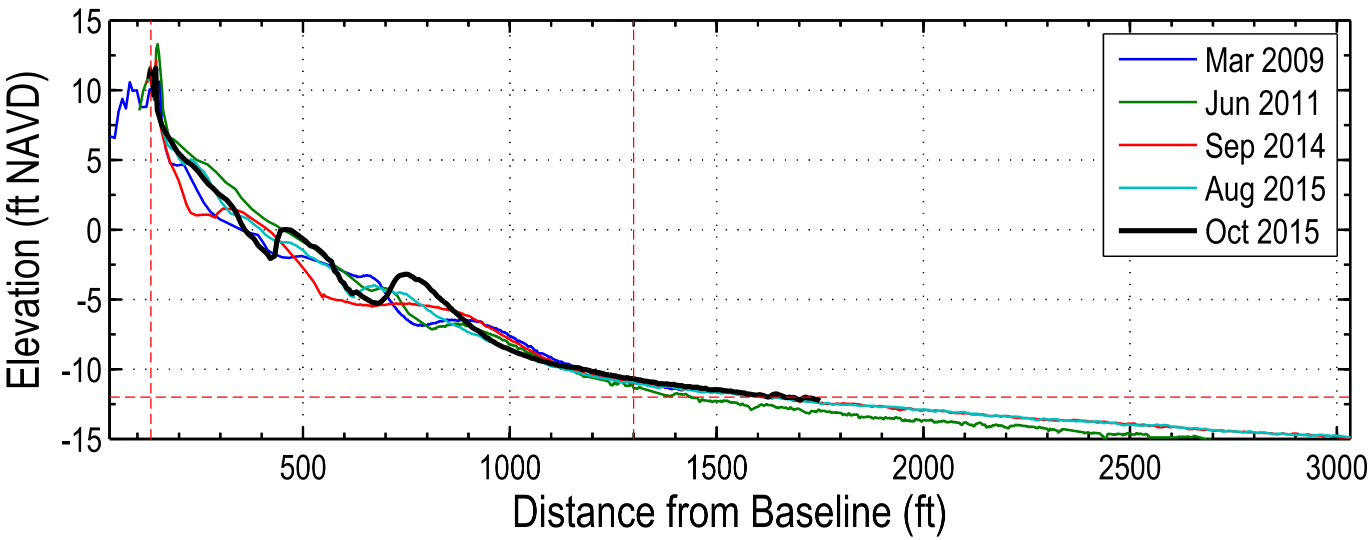


Date	Unit Vol (cy/ft)
Mar 2009	271.7
Sep 2009	317.3
Mar 2010	316.4
Sep 2010	317.4
Jun 2011	303.1
Jul 2012	265.7
Jul 2013	244.6
Sep 2014	283.8
Aug 2015	287.8
Oct 2015	292.2

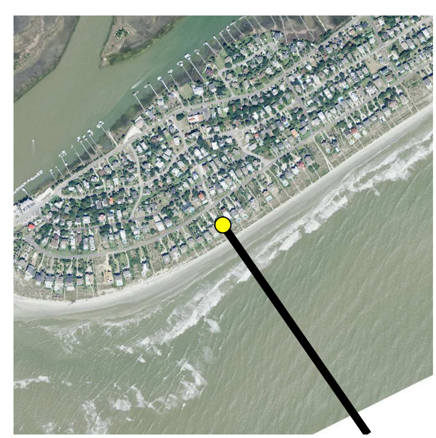
X: 2367291.63
Y: 345440.92

Station: OCRM 3110a



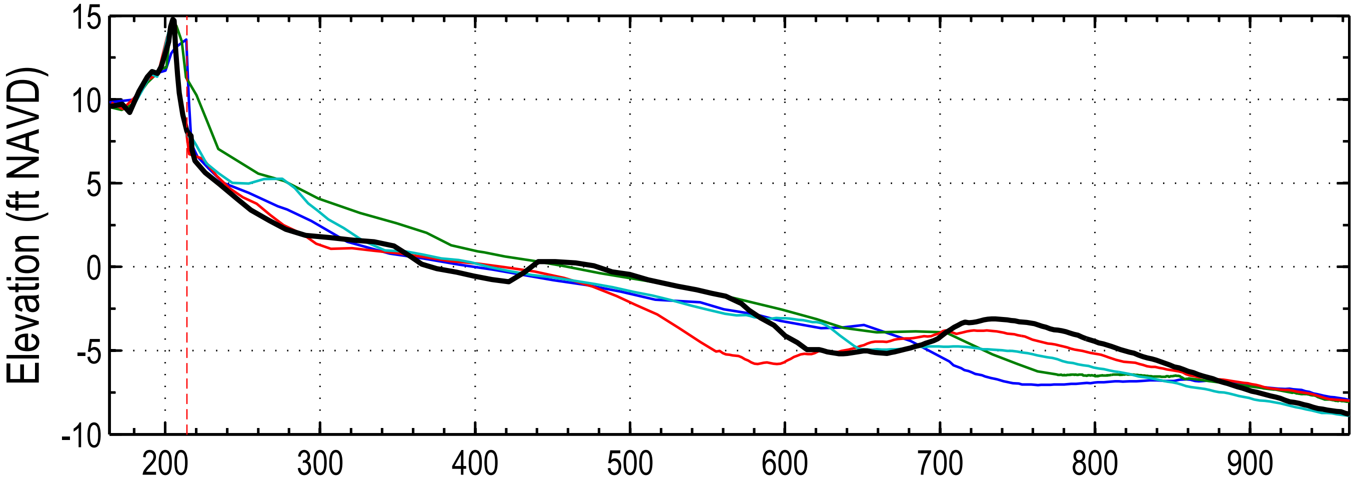


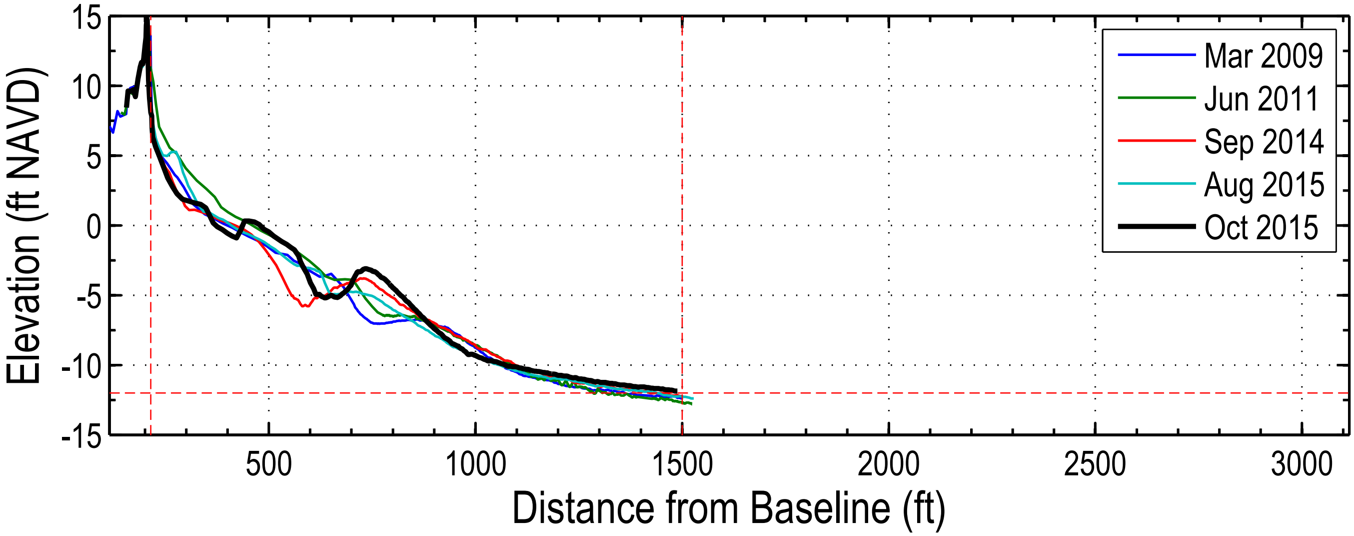
Date	Unit Vol (cy/ft)
Mar 2009	338.7
Sep 2009	354.8
Mar 2010	367.0
Sep 2010	366.7
Jun 2011	361.4
Jul 2012	335.7
Jul 2013	314.0
Sep 2014	329.4
Aug 2015	343.8
Oct 2015	355.4



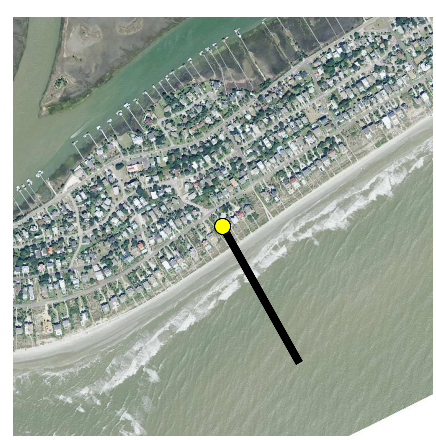
X: 2367587.5
Y: 345473.68

Station: 30+00 (4th Ave)



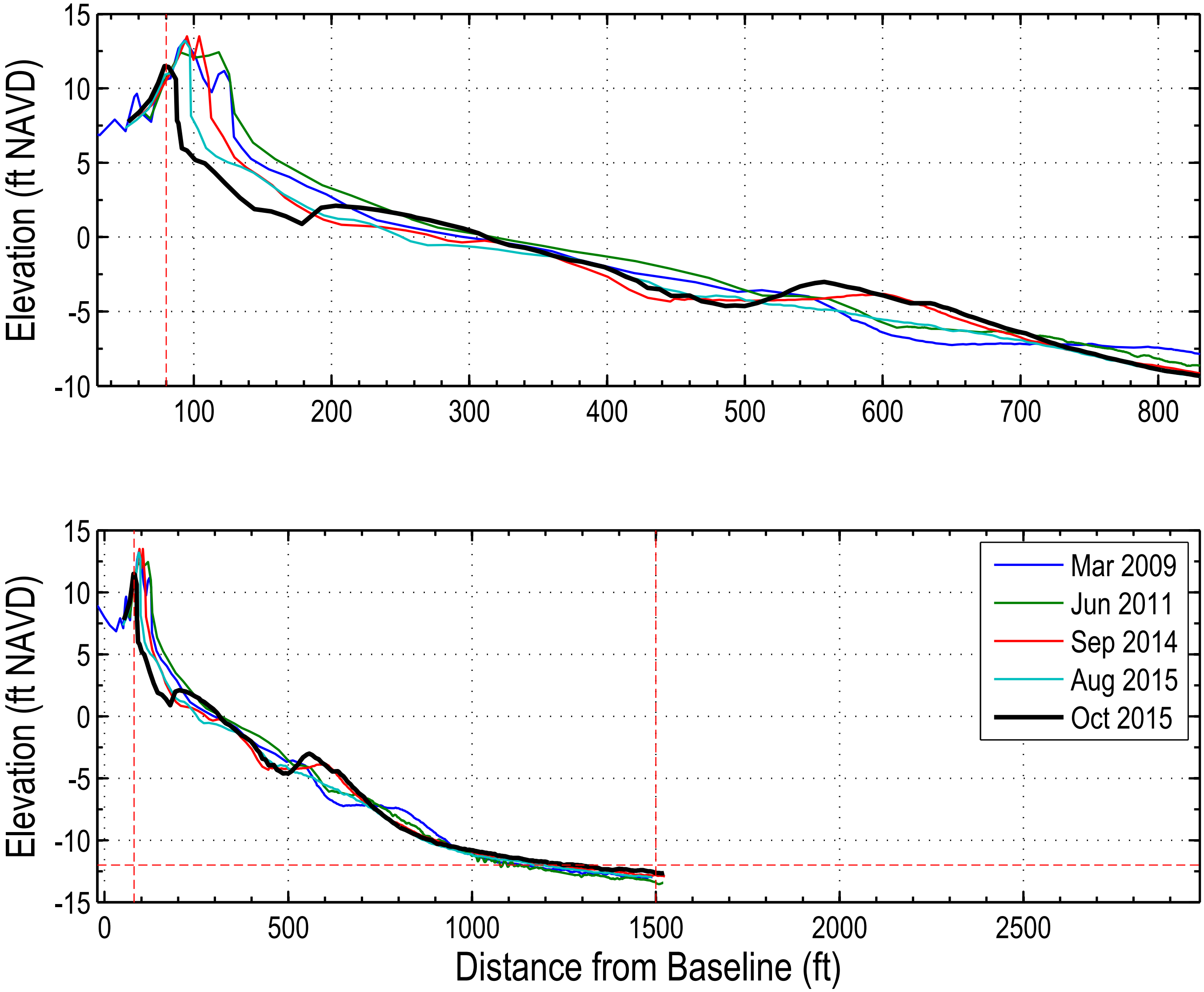


Date	Unit Vol (cy/ft)
Mar 2009	275.9
Sep 2009	276.9
Mar 2010	293.2
Sep 2010	300.9
Jun 2011	301.8
Jul 2012	290.9
Jul 2013	276.9
Sep 2014	280.2
Aug 2015	282.5
Oct 2015	292.8

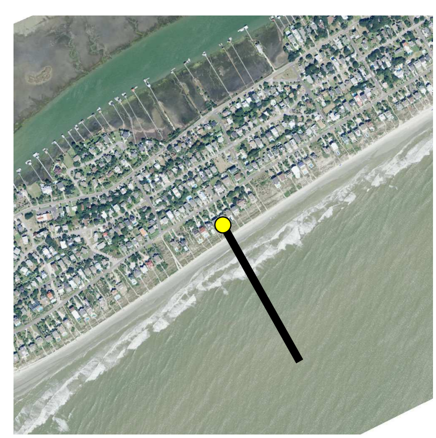


X: 2368163.71
Y: 345930.28

Station: 40+00

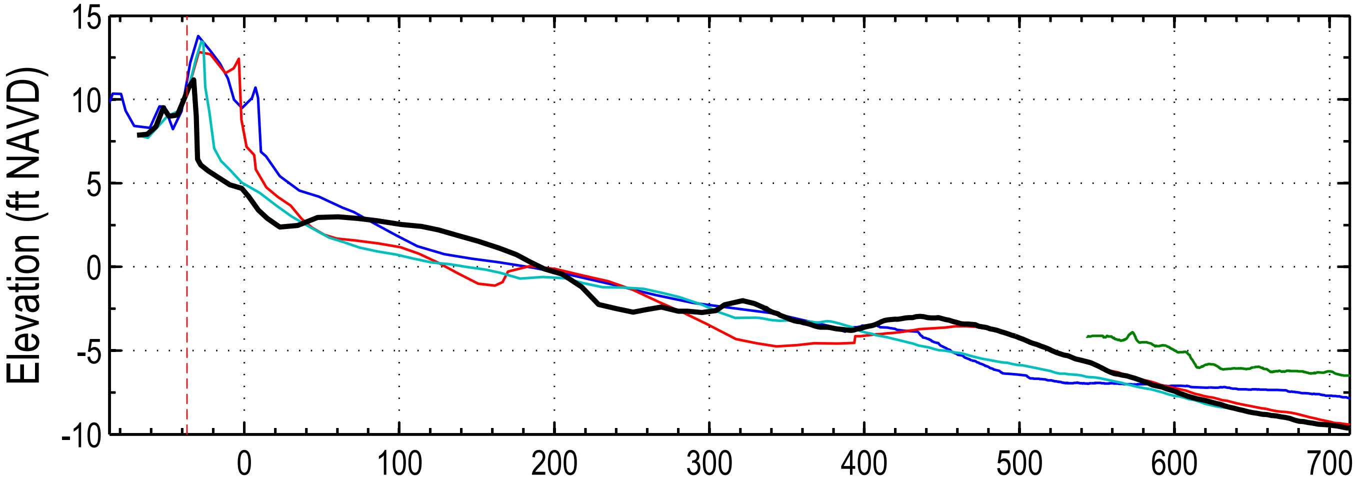


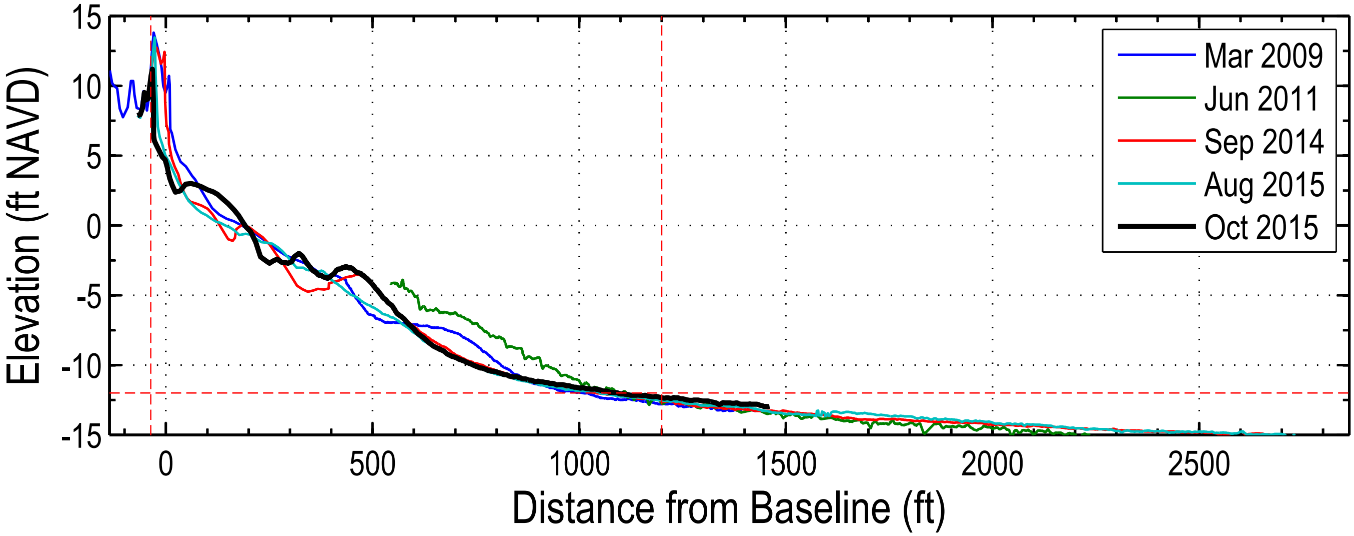
Date	Unit Vol (cy/ft)
Mar 2009	292.6
Sep 2009	292.9
Mar 2010	299.7
Sep 2010	304.2
Jun 2011	302.2
Jul 2012	308.8
Jul 2013	297.5
Sep 2014	283.8
Aug 2015	271.8
Oct 2015	282.1



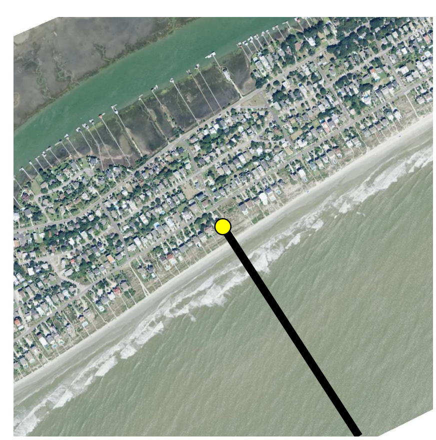
X: 2369035.8
Y: 346419.63

Station: OCRM 3115a



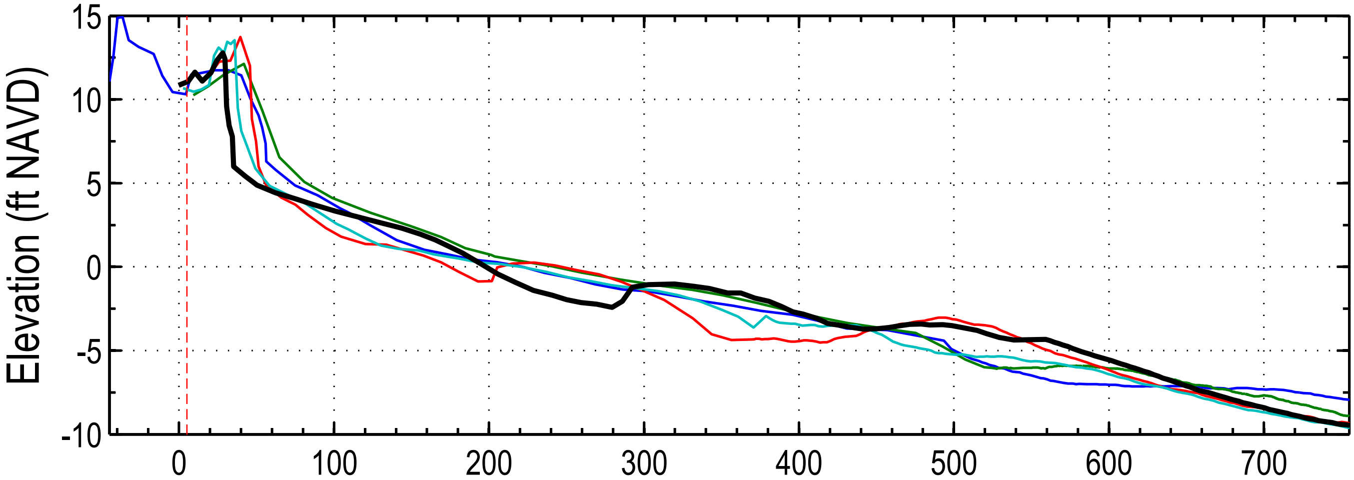


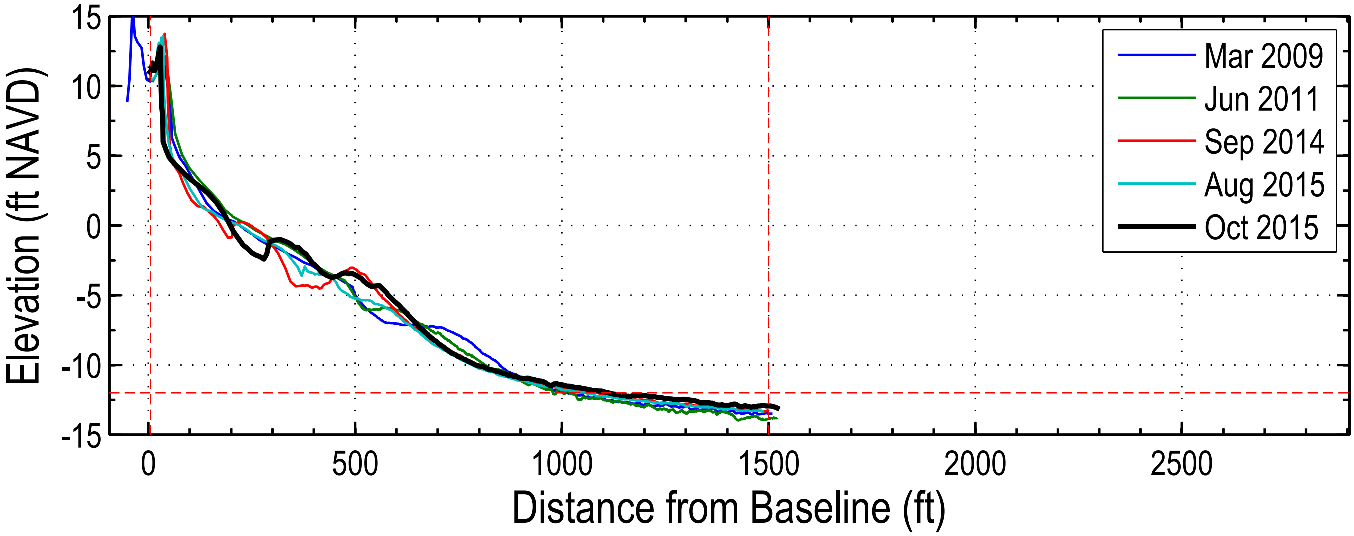
Date	Unit Vol (cy/ft)
Mar 2009	294.4
Sep 2009	288.1
Mar 2010	299.6
Sep 2010	293.0
Jun 2011	242.8
Jul 2012	308.0
Jul 2013	297.3
Sep 2014	279.5
Aug 2015	267.2
Oct 2015	281.0



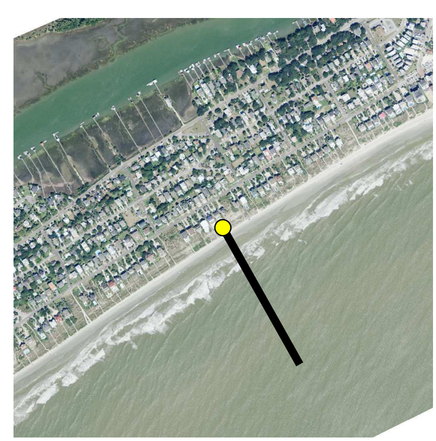
X: 2369349.5
Y: 346659.88

Station: 50+00



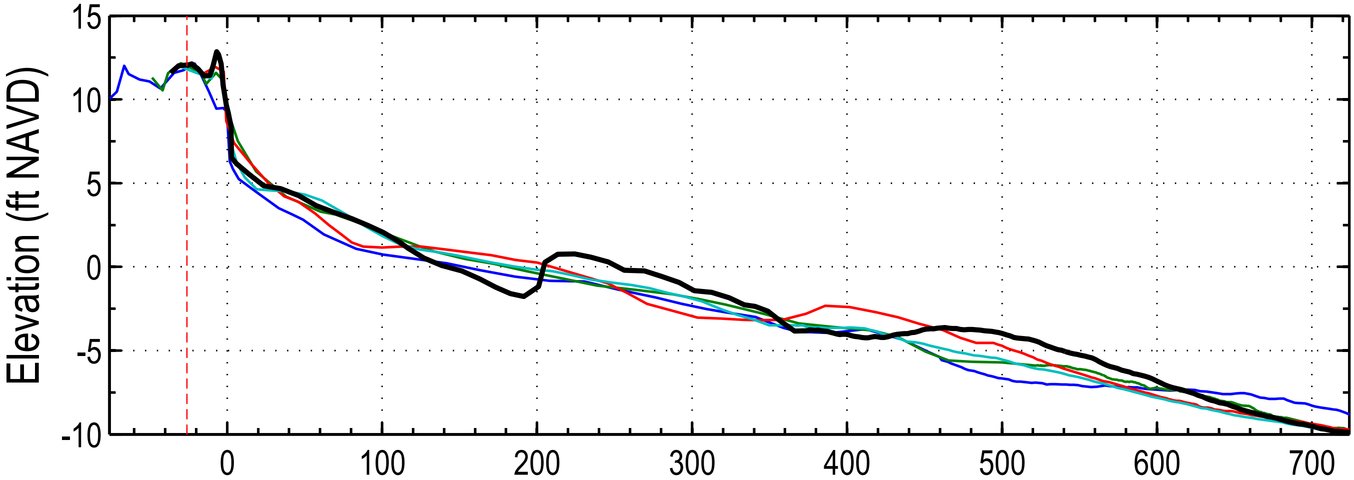


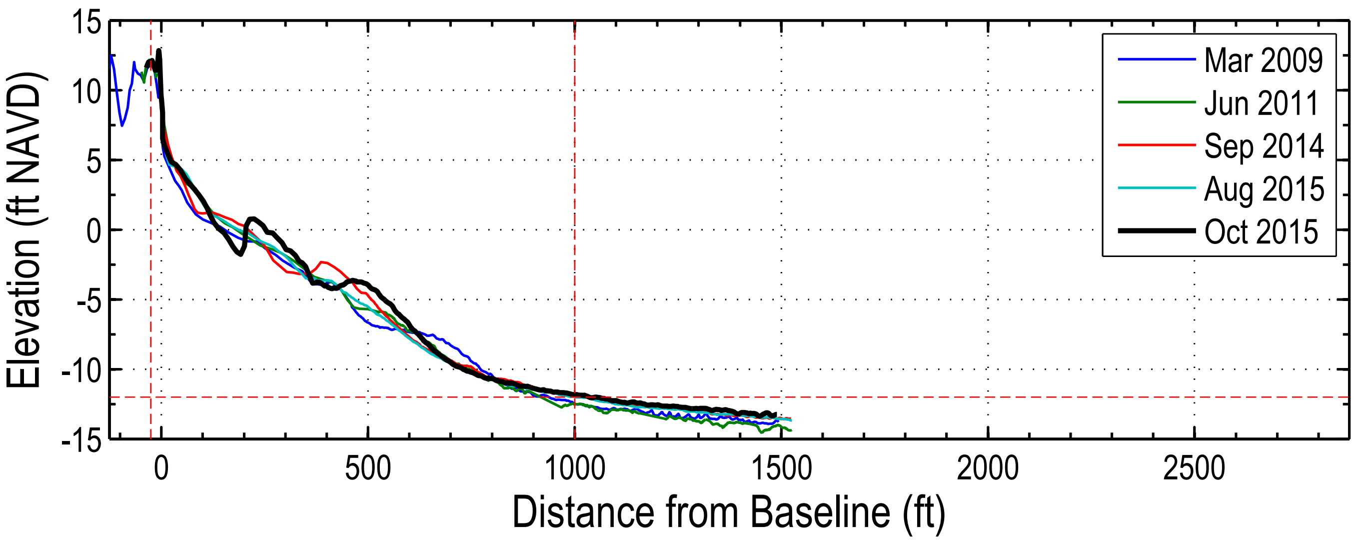
Date	Unit Vol (cy/ft)
Mar 2009	293.2
Sep 2009	296.7
Mar 2010	297.6
Sep 2010	305.3
Jun 2011	298.7
Jul 2012	307.0
Jul 2013	302.4
Sep 2014	283.6
Aug 2015	278.6
Oct 2015	291.5



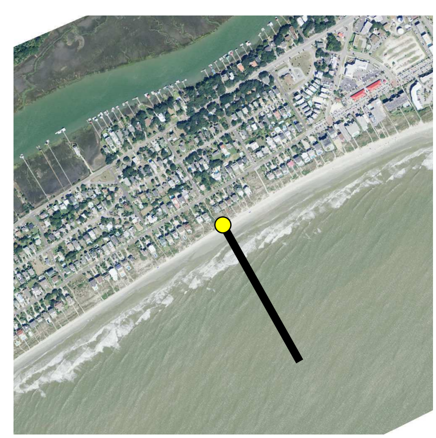
X: 2369907.88
Y: 346908.99

Station: 60+00 (8th Ave)



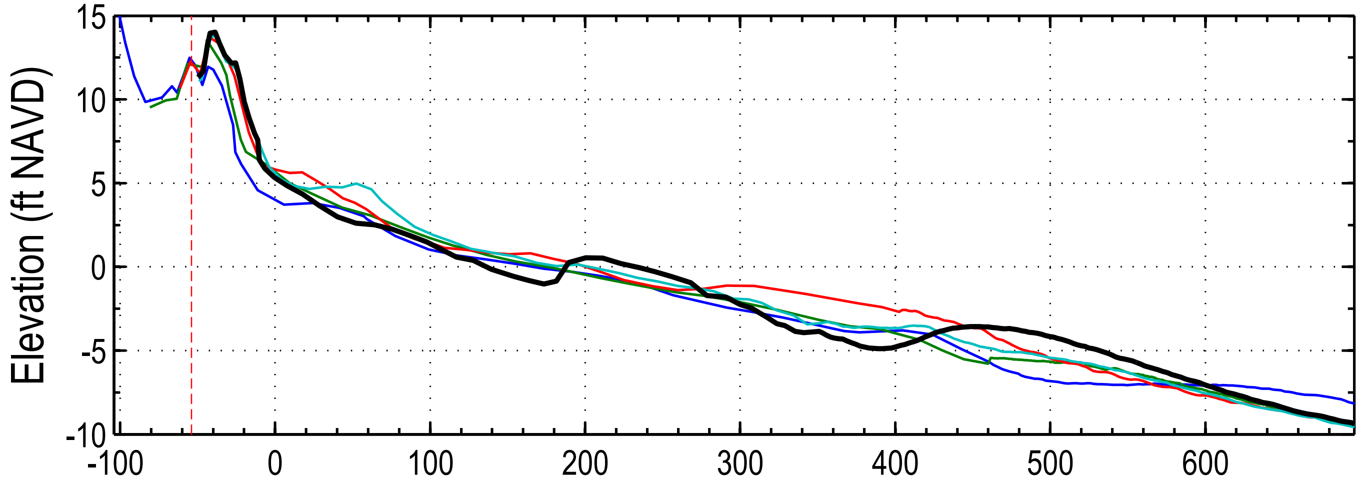


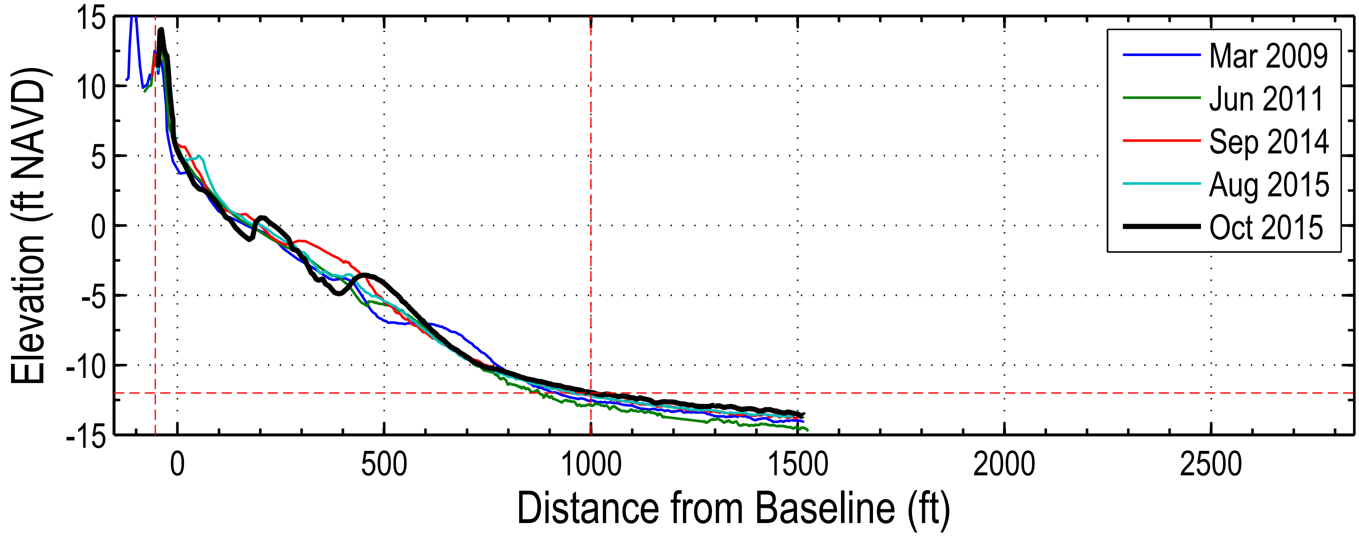
Date	**Unit Vol (cy/ft)**
Mar 2009	265.6
Sep 2009	269.5
Mar 2010	274.4
Sep 2010	274.7
Jun 2011	274.7
Jul 2012	286.2
Jul 2013	287.9
Sep 2014	279.5
Aug 2015	272.8
Oct 2015	284.6



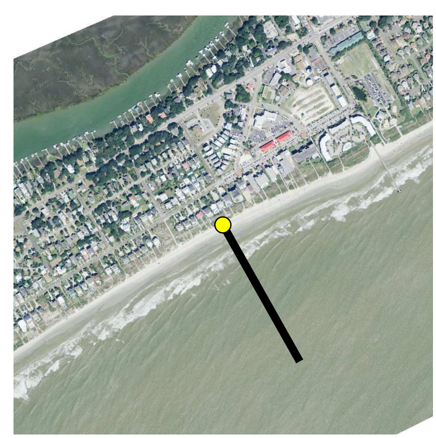
X: 2370779.97
Y: 347398.34

Station: 70+00



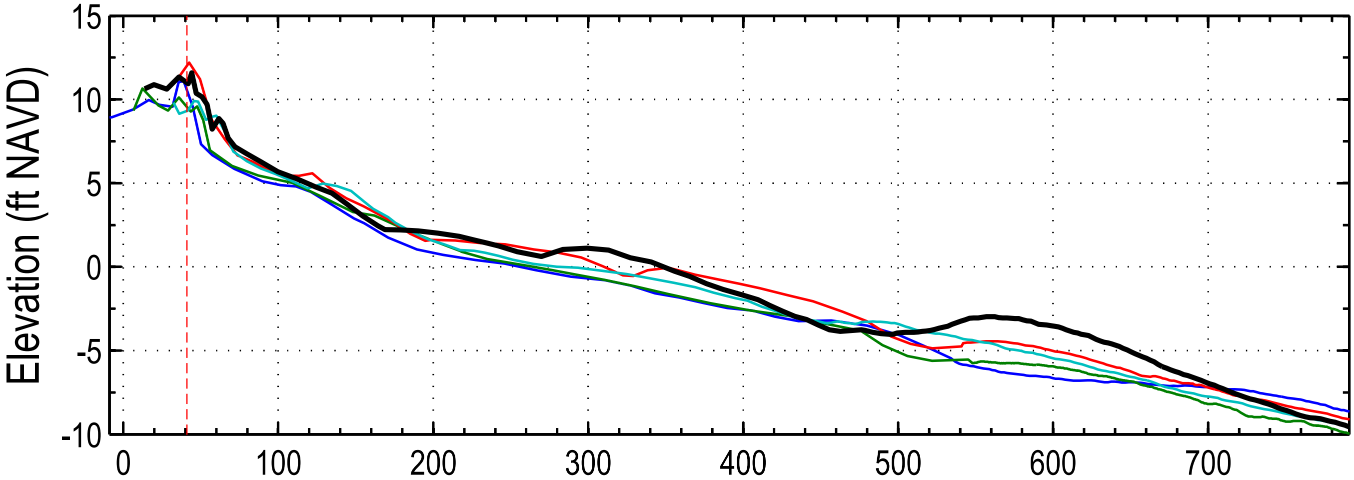


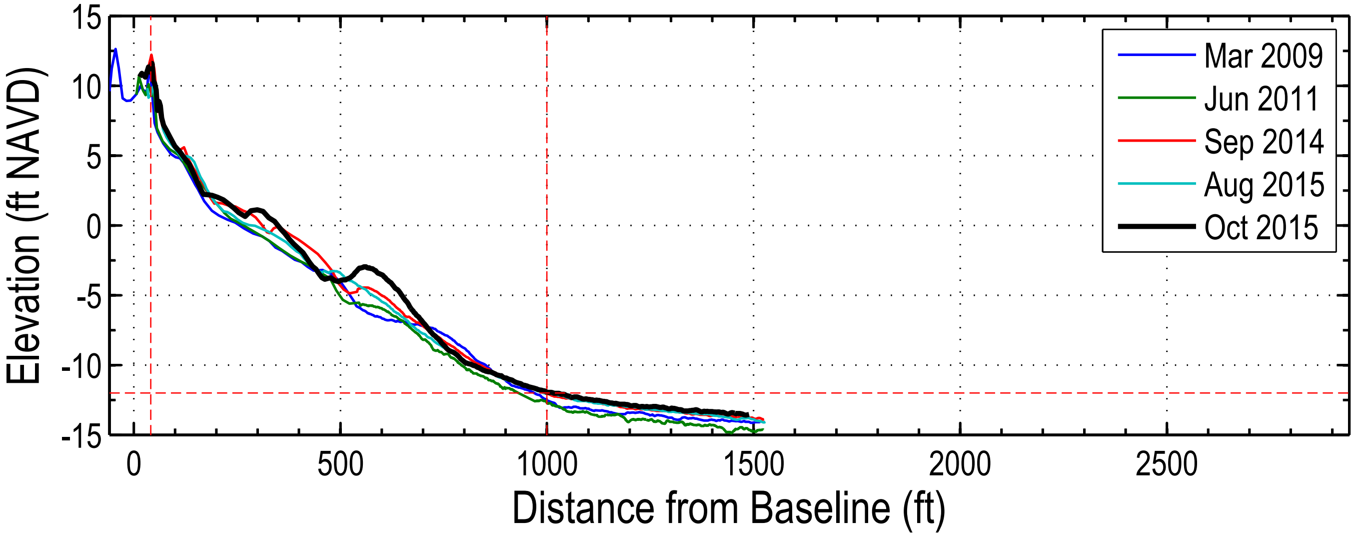
Date	Unit Vol (cy/ft)
Mar 2009	284.1
Sep 2009	282.7
Mar 2010	272.7
Sep 2010	280.1
Jun 2011	284.9
Jul 2012	297.0
Jul 2013	307.9
Sep 2014	302.5
Aug 2015	296.7
Oct 2015	296.2



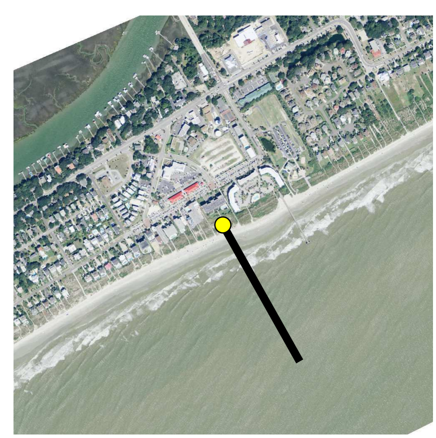
X: 2371652.05
Y: 347887.7

Station: 80+00 (12th Ave)



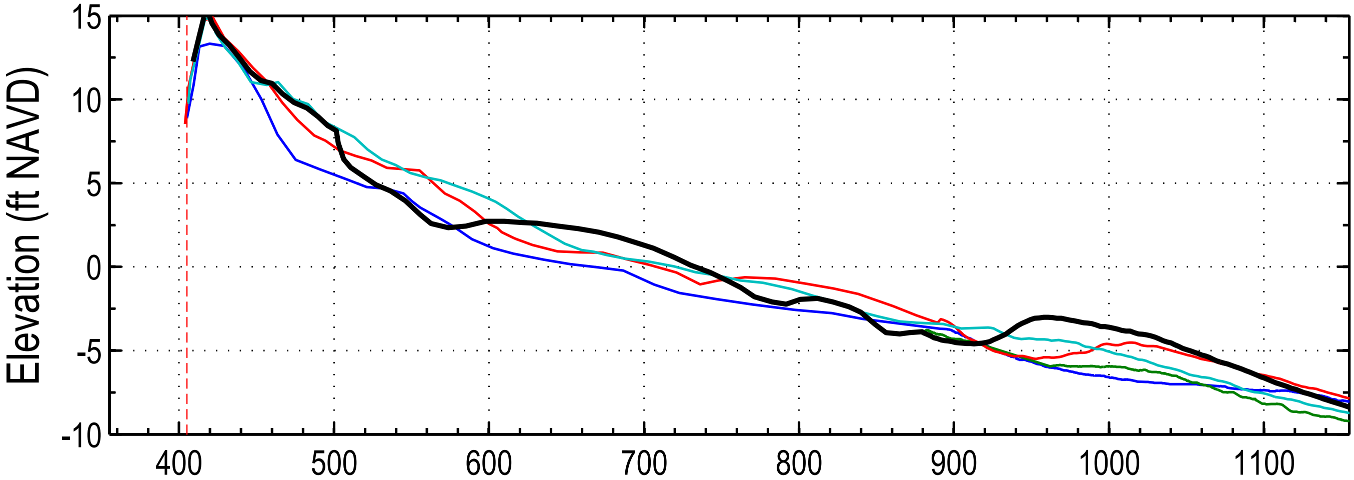


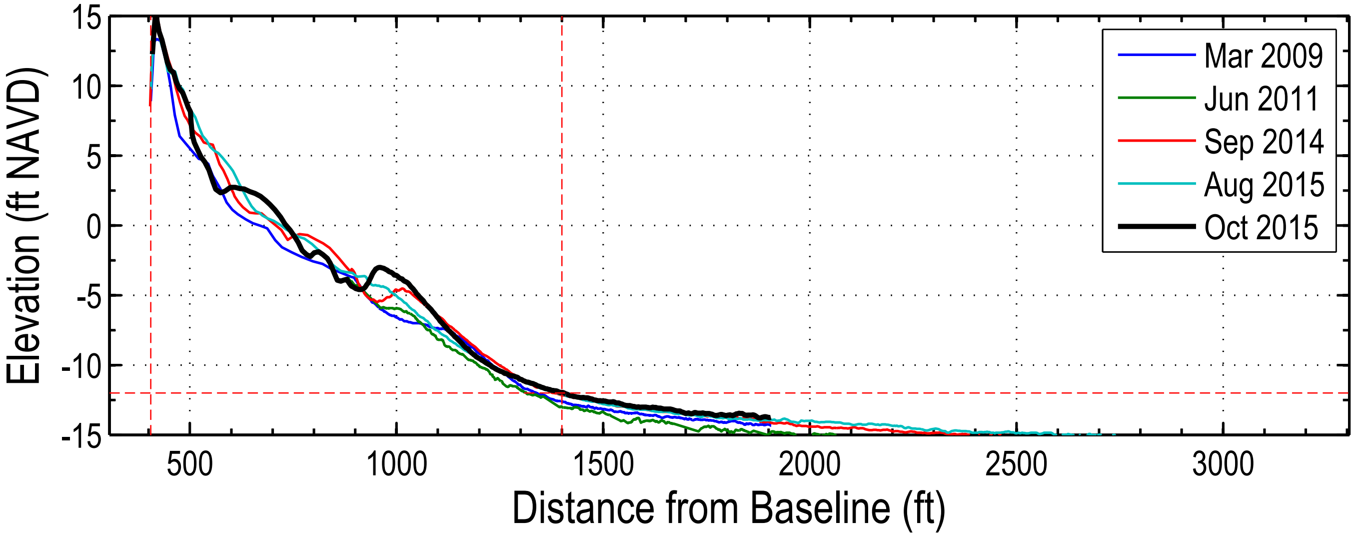
Date	**Unit Vol (cy/ft)**
Mar 2009	276.3
Sep 2009	265.7
Mar 2010	270.8
Sep 2010	274.9
Jun 2011	270.5
Jul 2012	283.2
Jul 2013	298.5
Sep 2014	300.5
Aug 2015	289.5
Oct 2015	304.9



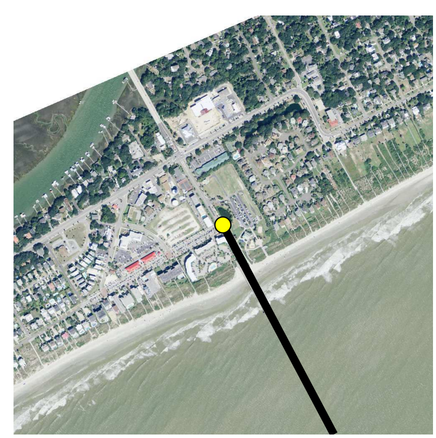
X: 2372524.13
Y: 348377.06

Station: OCRM 3125b



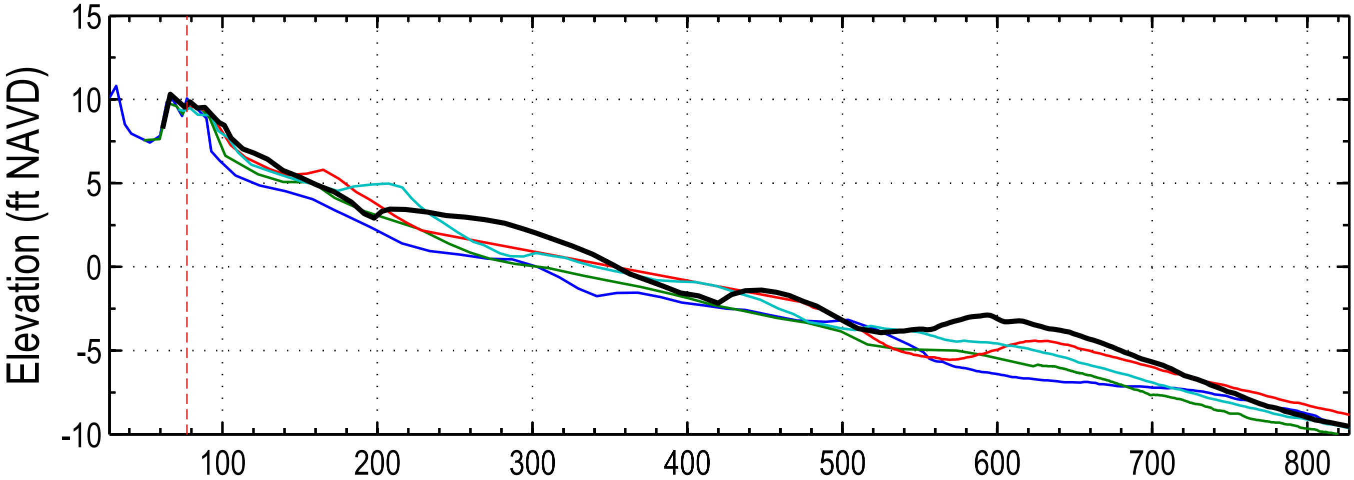


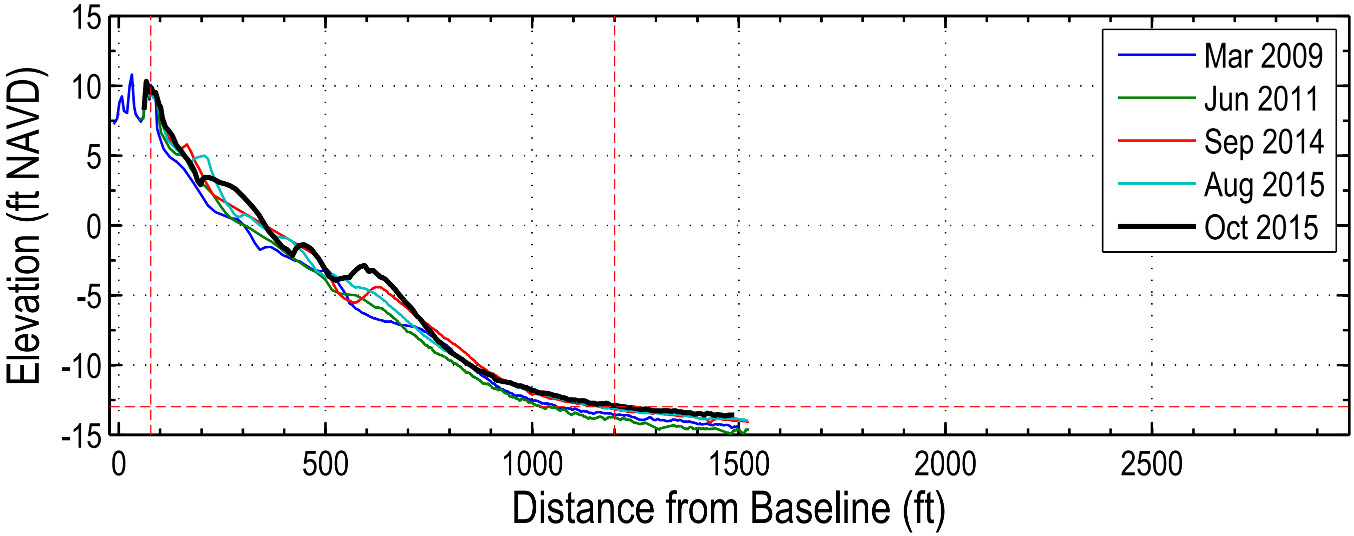
Date	**Unit Vol (cy/ft)**
Mar 2009	312.4
Sep 2009	308.1
Mar 2010	315.8
Sep 2010	314.0
Jun 2011	205.9
Jul 2012	326.3
Jul 2013	333.9
Sep 2014	347.9
Aug 2015	345.7
Oct 2015	347.6



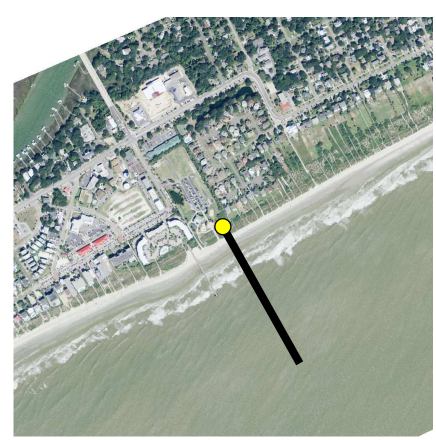
X: 2372935.25
Y: 349041.14

Station: 90+00 (County Park)



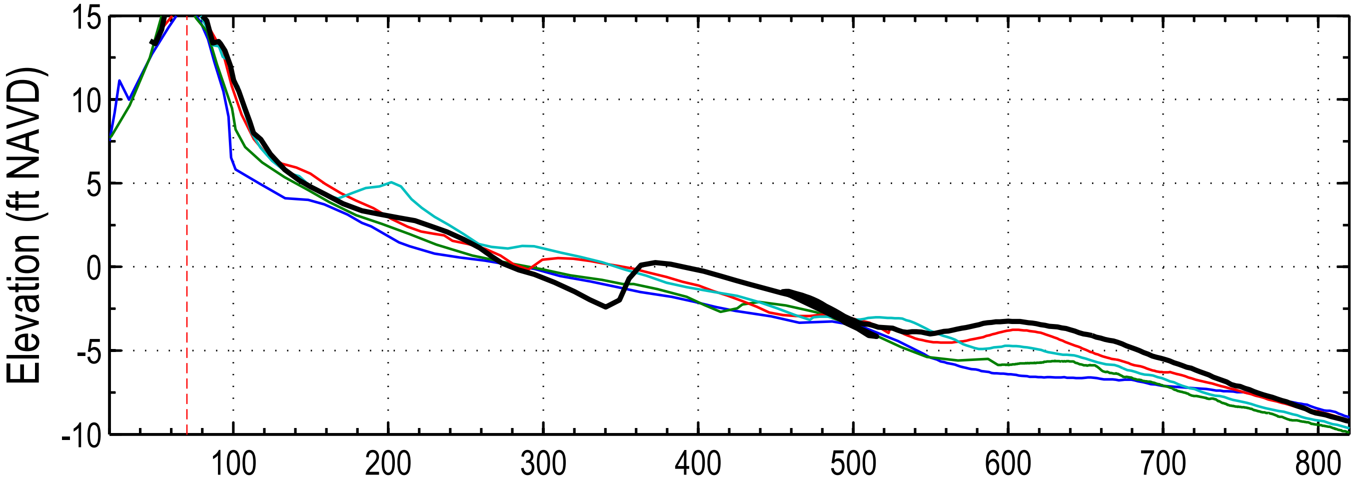


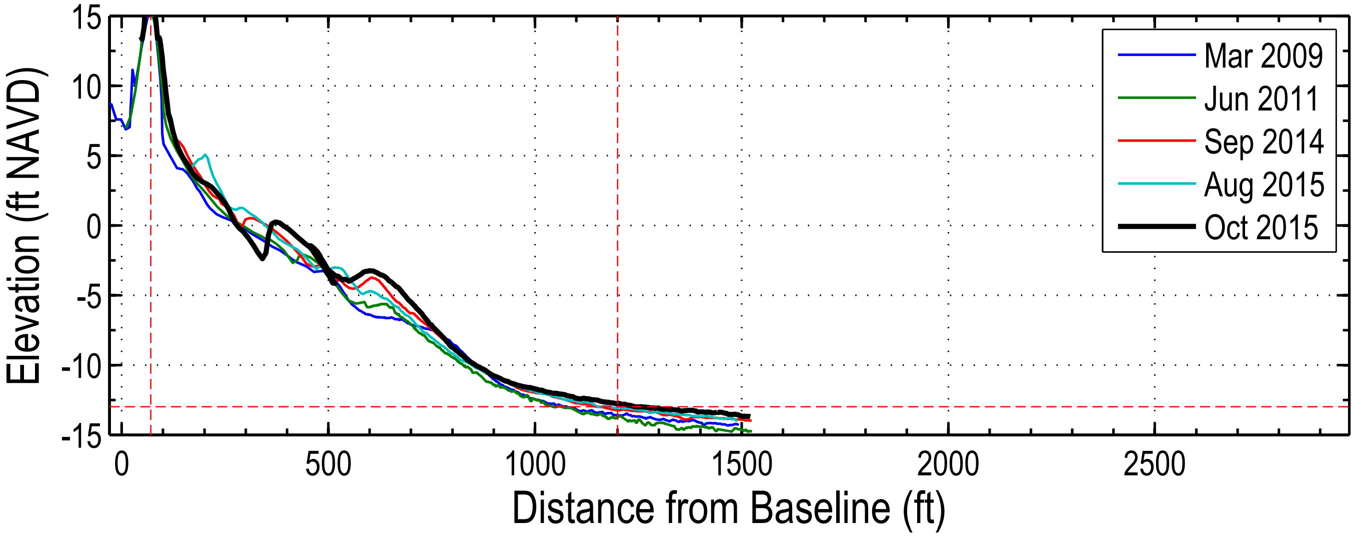
Date	Unit Vol (cy/ft)
Mar 2009	300.9
Sep 2009	292.5
Mar 2010	306.4
Sep 2010	302.0
Jun 2011	303.1
Jul 2012	316.4
Jul 2013	322.3
Sep 2014	336.5
Aug 2015	330.9
Oct 2015	346.3



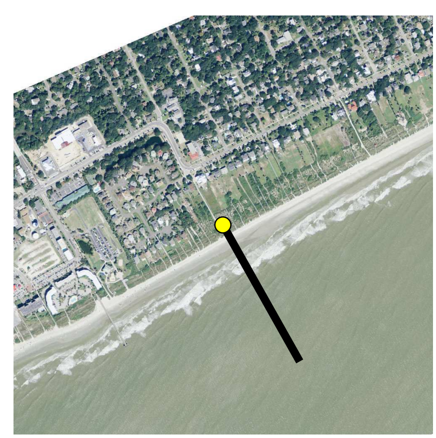
X: 2373396.22
Y: 348866.41

Station: 100+00



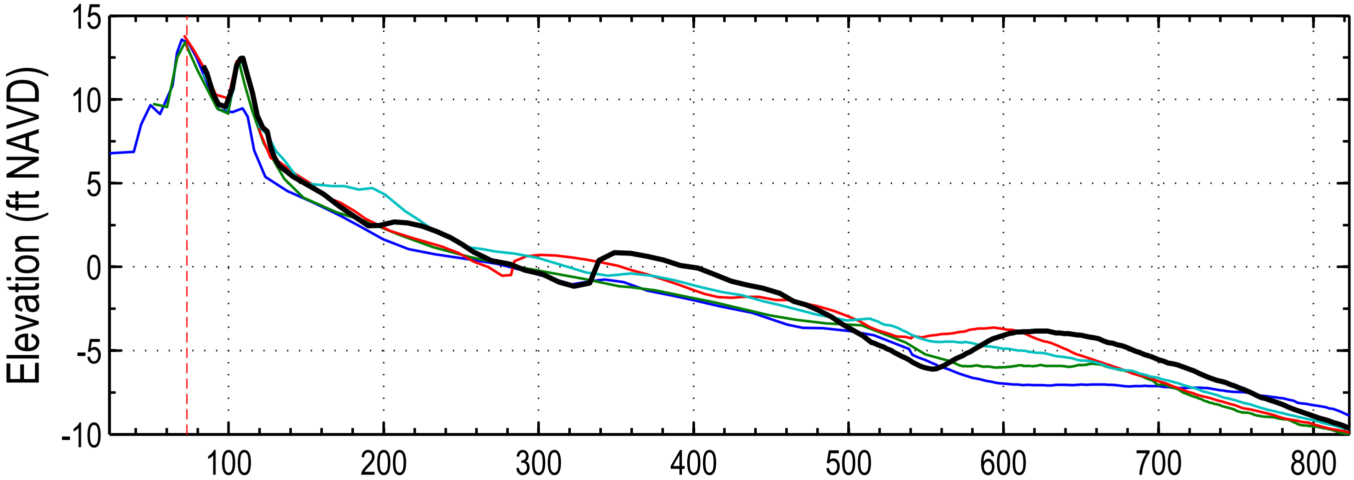


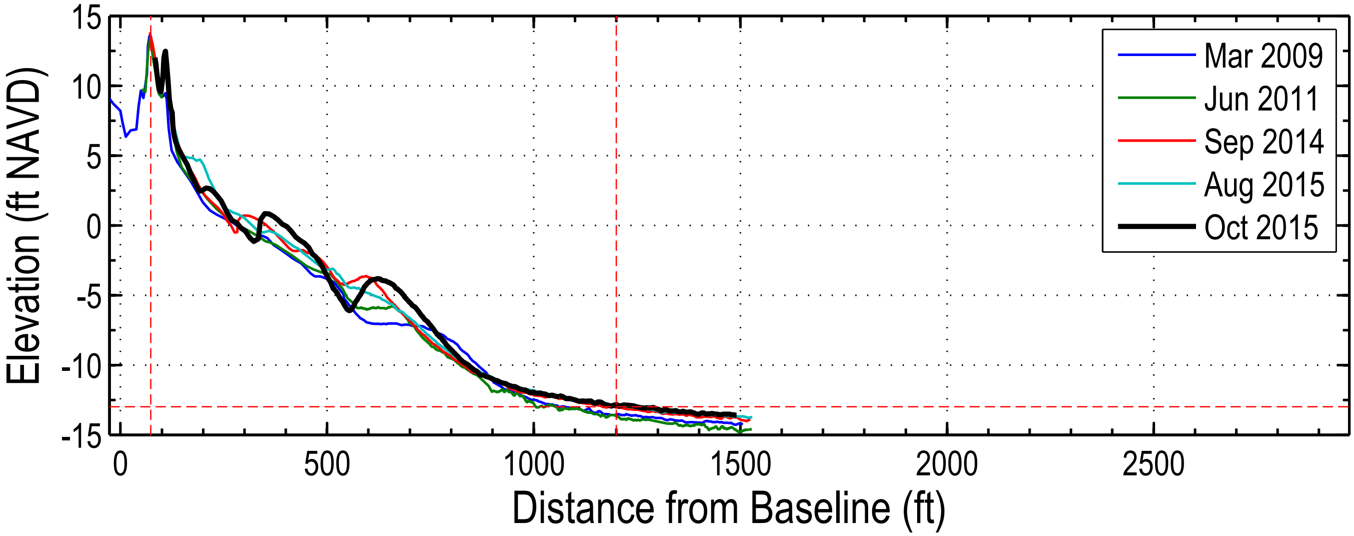
Date	Unit Vol (cy/ft)
Mar 2009	311.1
Sep 2009	304.4
Mar 2010	318.1
Sep 2010	324.0
Jun 2011	315.0
Jul 2012	320.8
Jul 2013	329.9
Sep 2014	342.9
Aug 2015	342.7
Oct 2015	351.4



X: 2374268.3
Y: 349355.77

Station: 110+00 (24th Ave)

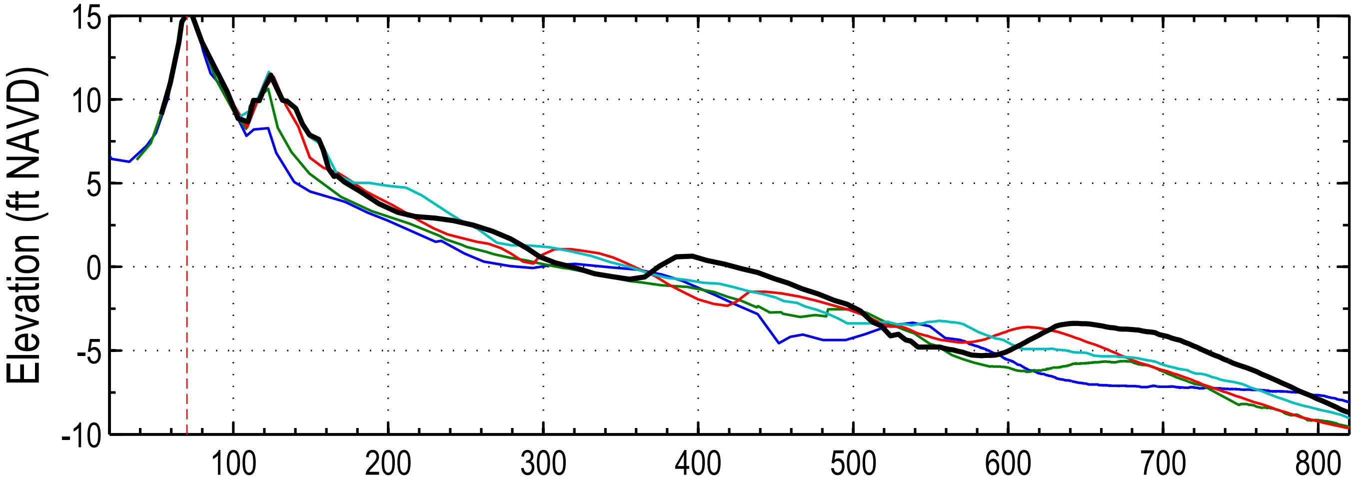


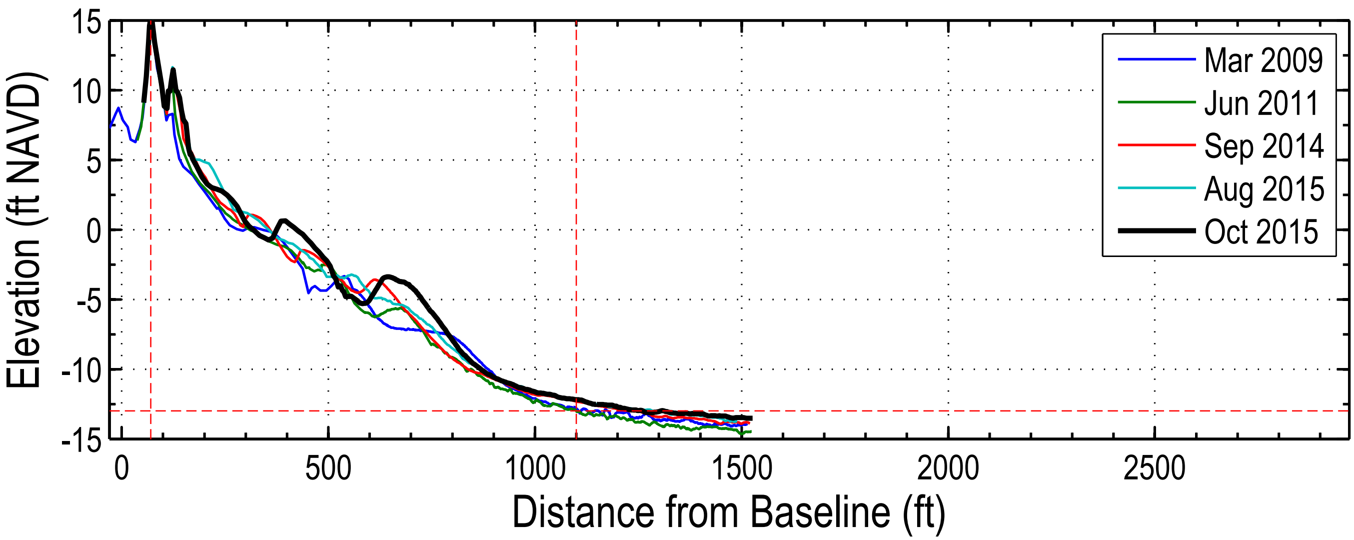


Date	**Unit Vol (cy/ft)**
Mar 2009	307.2
Sep 2009	306.8
Mar 2010	319.1
Sep 2010	316.5
Jun 2011	309.6
Jul 2012	321.6
Jul 2013	331.5
Sep 2014	332.3
Aug 2015	337.0
Oct 2015	340.1

X: 2375140.39
Y: 349845.12

Station: 120+00

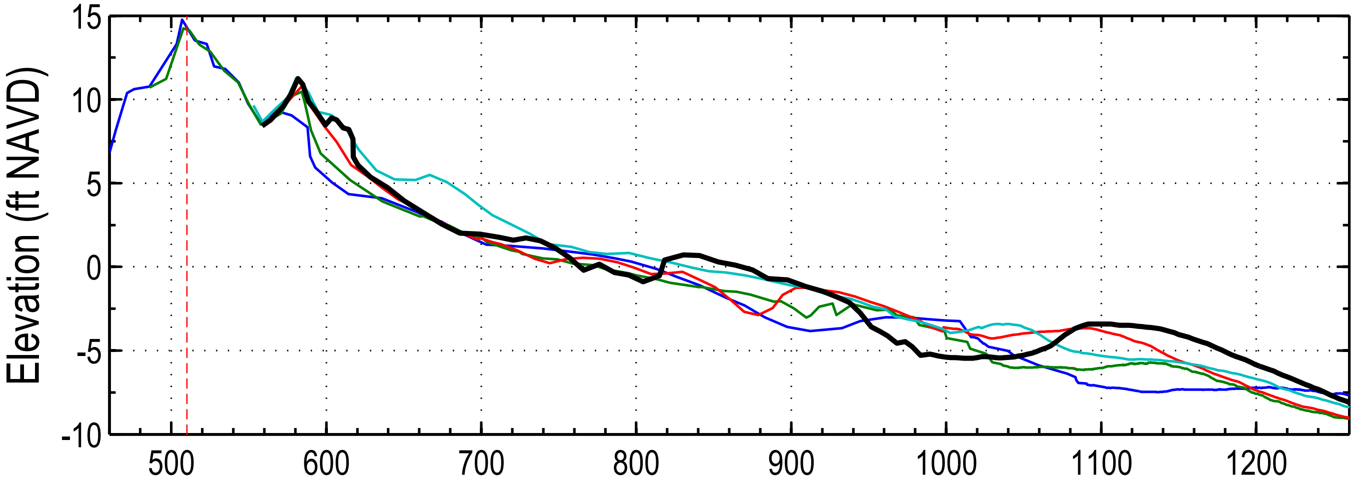


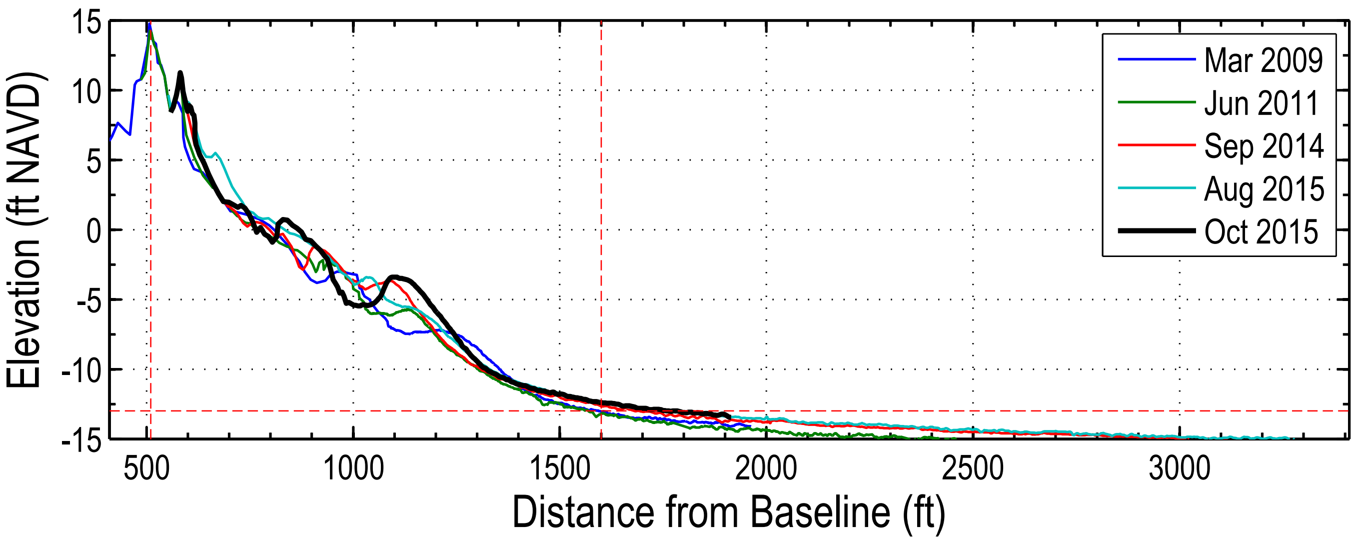


Date	Unit Vol (cy/ft)
Mar 2009	330.4
Sep 2009	323.6
Mar 2010	325.6
Sep 2010	336.6
Jun 2011	330.6
Jul 2012	349.0
Jul 2013	355.1
Sep 2014	349.9
Aug 2015	362.4
Oct 2015	369.4

X: 2376012.47
Y: 350334.48

Station: OCRM 3135b - 27th Ave

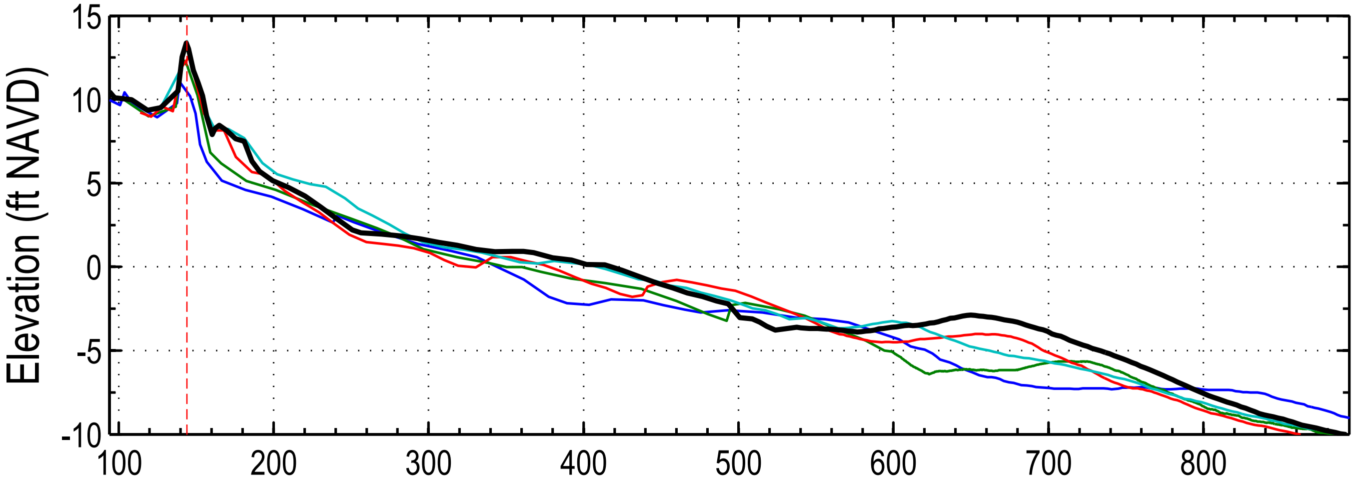


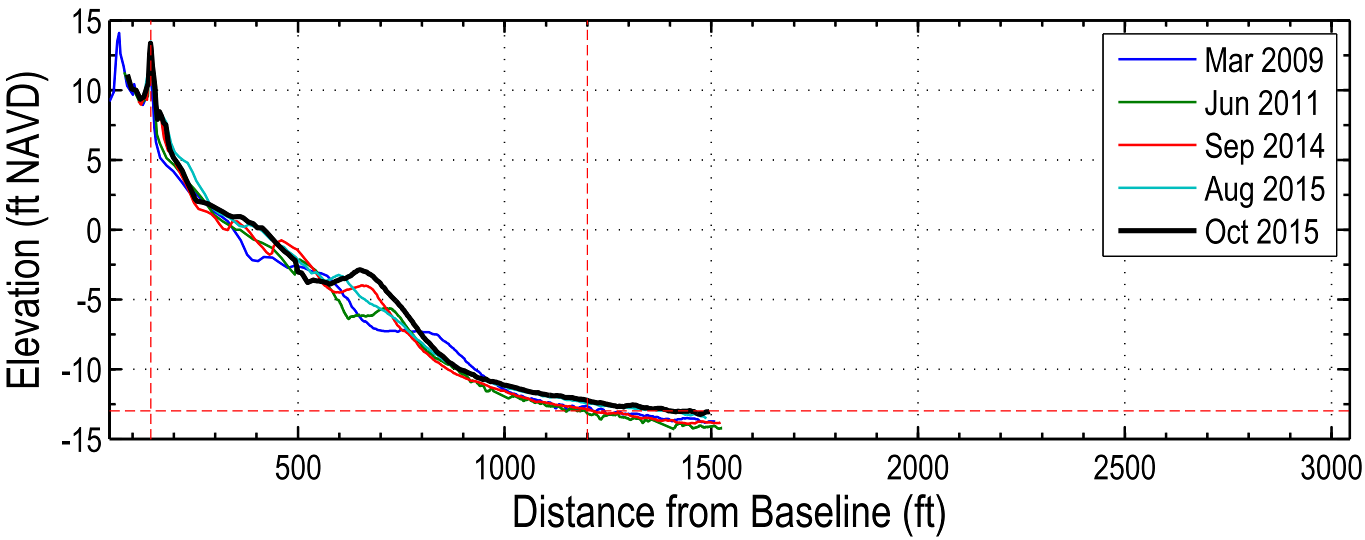


Date	Unit Vol (cy/ft)
Mar 2009	352.5
Sep 2009	351.4
Mar 2010	342.7
Sep 2010	355.8
Jun 2011	349.6
Jul 2012	360.9
Jul 2013	379.7
Sep 2014	364.6
Aug 2015	382.7
Oct 2015	374.4

X: 2376236.65
Y: 350971.98

Station: 130+00

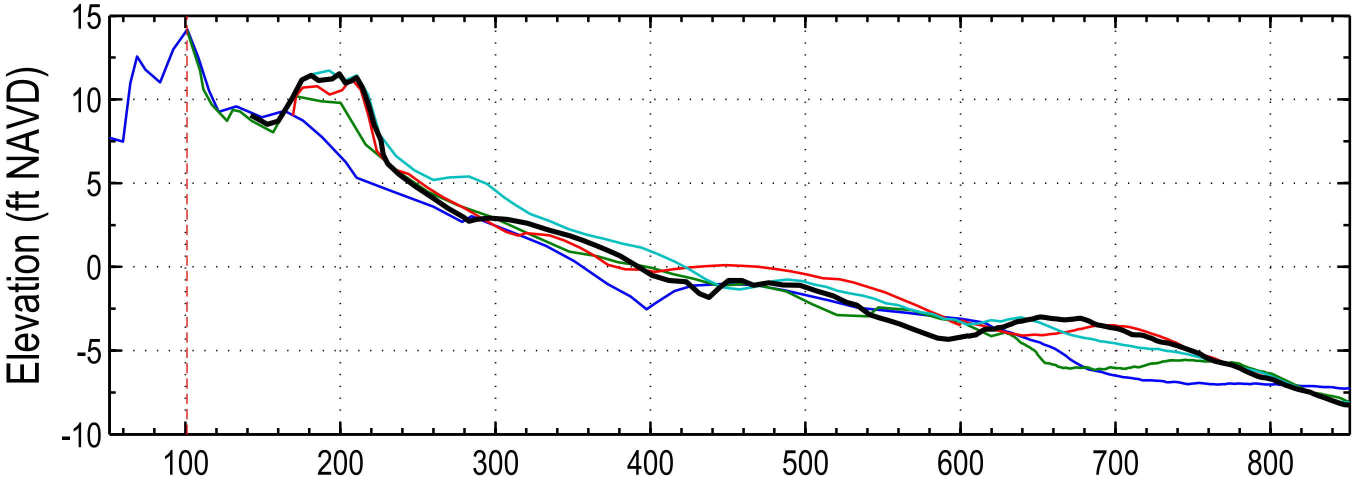


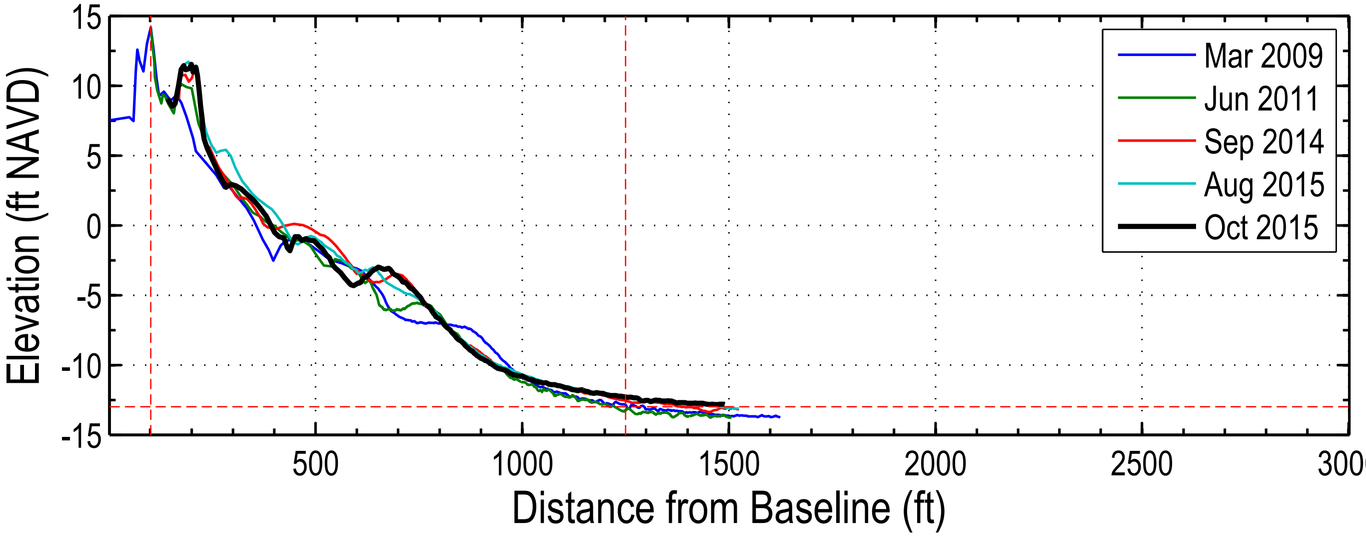


Date	Unit Vol (cy/ft)
Mar 2009	298.9
Sep 2009	294.1
Mar 2010	302.6
Sep 2010	300.9
Jun 2011	297.5
Jul 2012	299.7
Jul 2013	324.3
Sep 2014	306.9
Aug 2015	322.0
Oct 2015	328.7

X: 2376884.55
Y: 350823.84

Station: 140+00

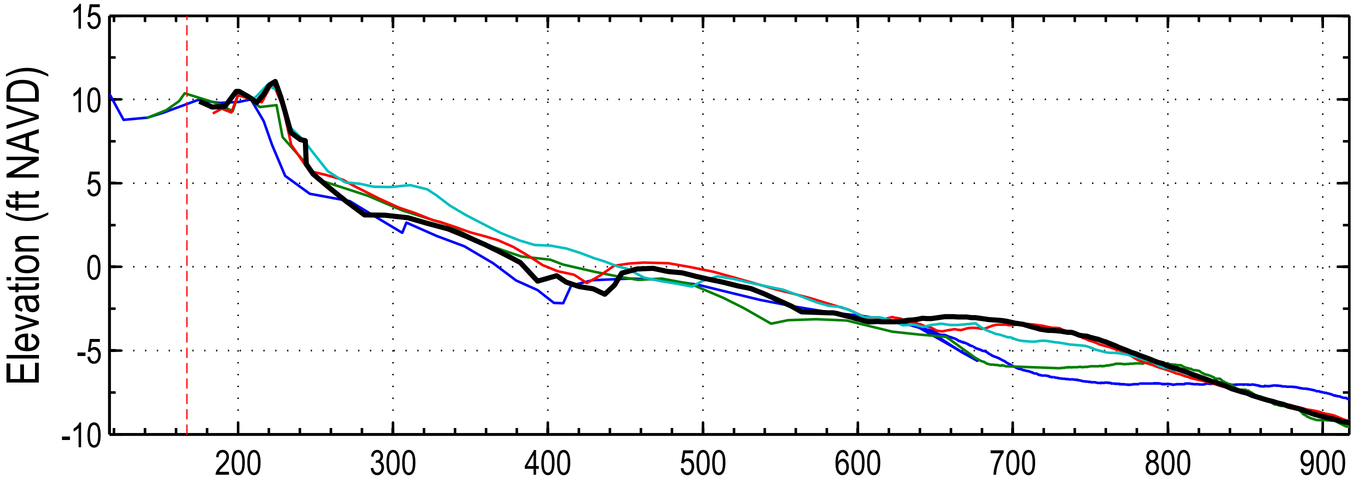


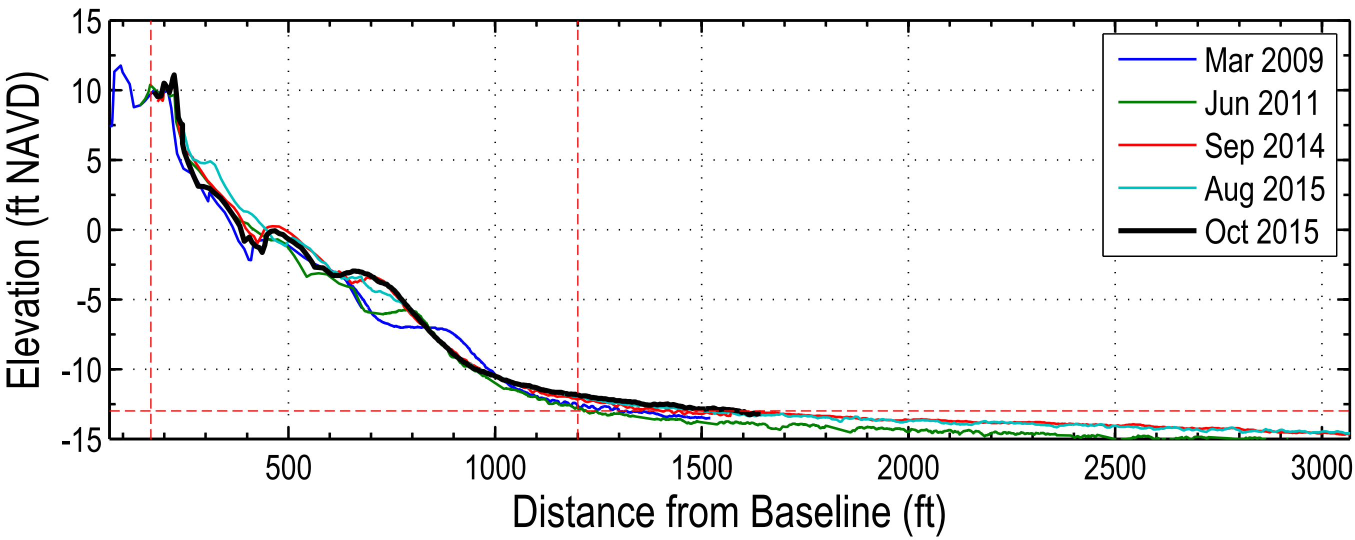


Date	Unit Vol (cy/ft)
Mar 2009	371.1
Sep 2009	367.3
Mar 2010	377.4
Sep 2010	383.5
Jun 2011	376.6
Jul 2012	382.5
Jul 2013	397.6
Sep 2014	399.7
Aug 2015	404.8
Oct 2015	392.2

X: 2377756.64
Y: 351313.19

Station: OCRM 3140a

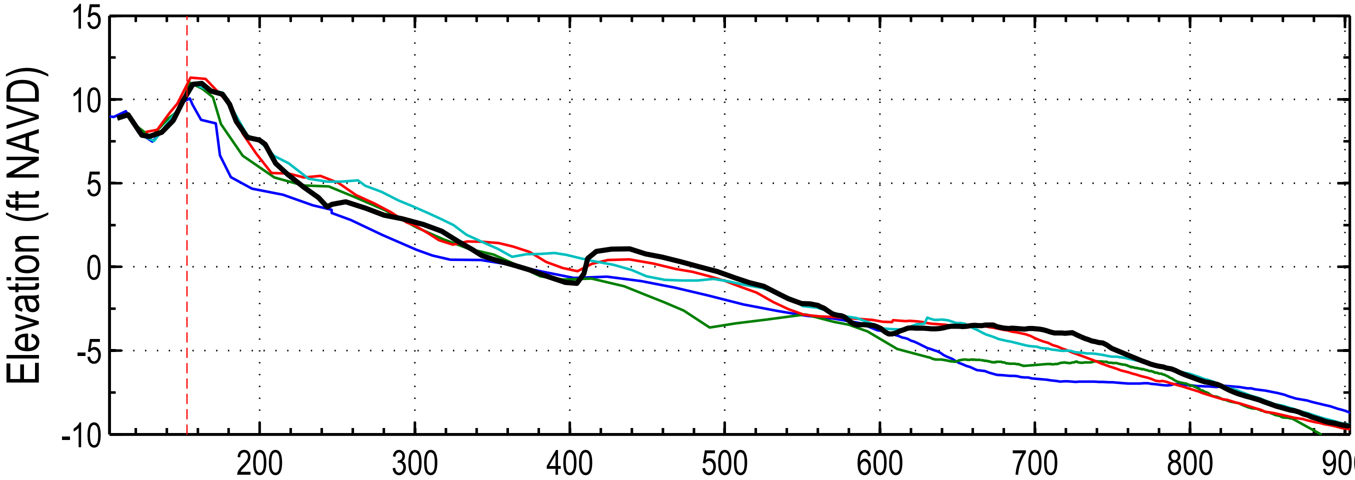


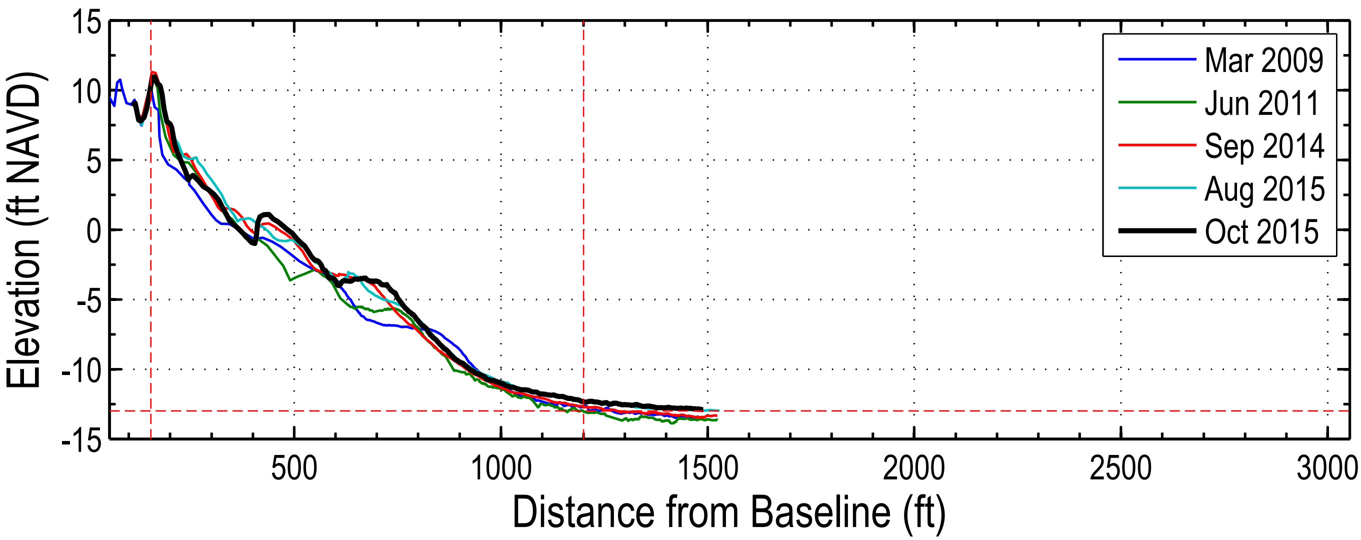


Date	Unit Vol (cy/ft)
Mar 2009	333.1
Sep 2009	329.1
Mar 2010	335.5
Sep 2010	342.7
Jun 2011	335.6
Jul 2012	335.8
Jul 2013	349.9
Sep 2014	357.4
Aug 2015	362.4
Oct 2015	353.0

X: 2378011.62
Y: 351456.27

Station: 150+00 - Near 33rd Ave

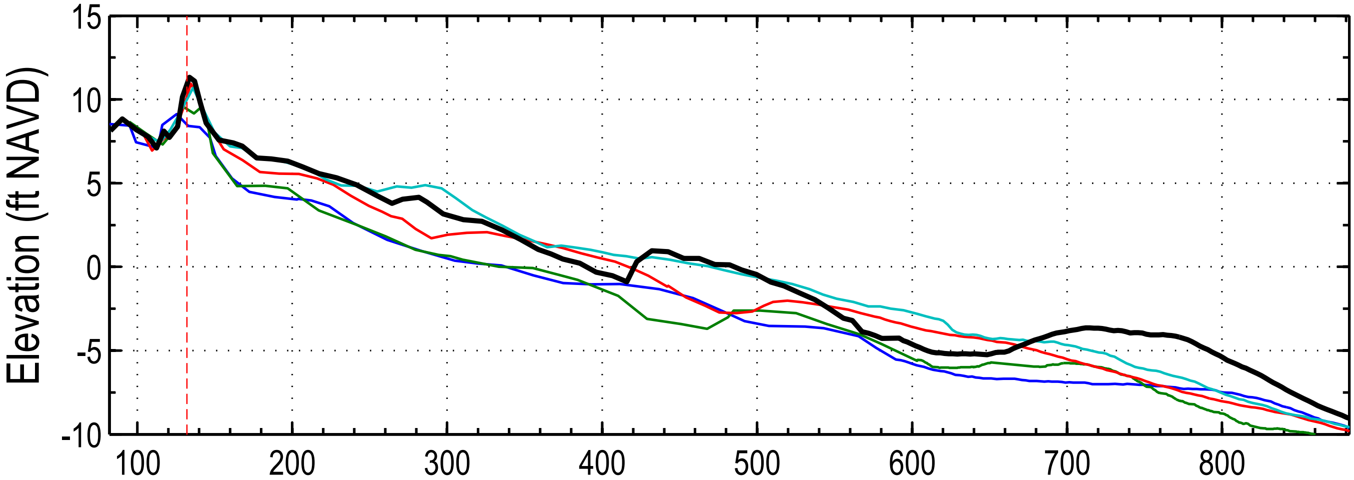


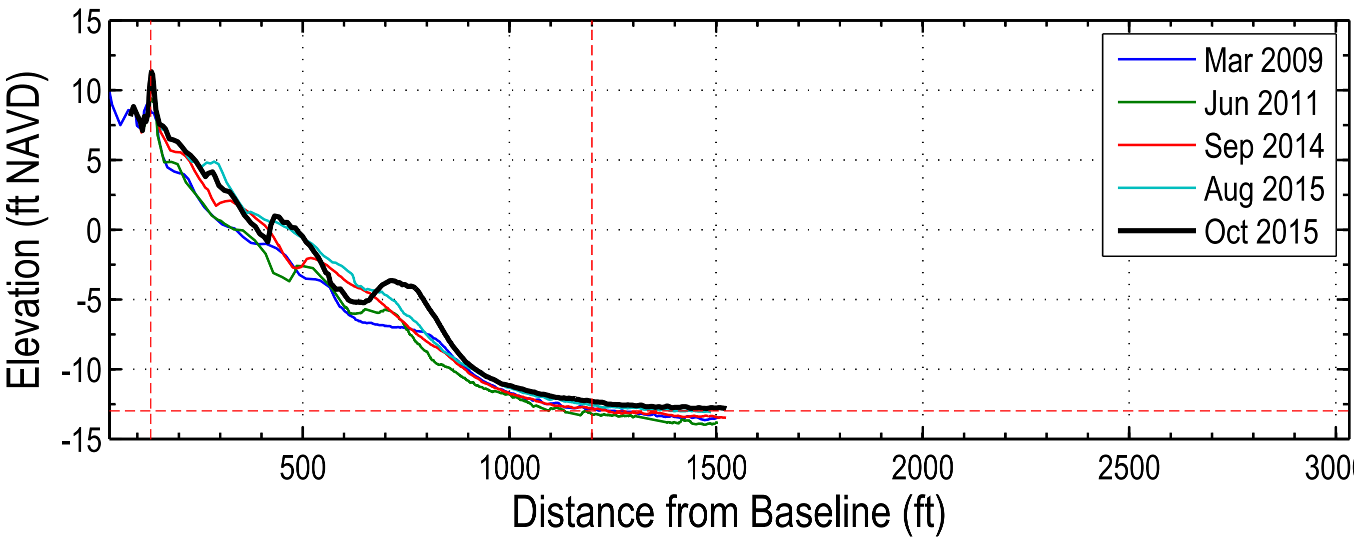


Date	Unit Vol (cy/ft)
Mar 2009	311.4
Sep 2009	299.5
Mar 2010	305.2
Sep 2010	309.7
Jun 2011	311.3
Jul 2012	313.0
Jul 2013	330.1
Sep 2014	337.9
Aug 2015	348.7
Oct 2015	345.6

X: 2378674.05
Y: 351705.08

Station: 160+00

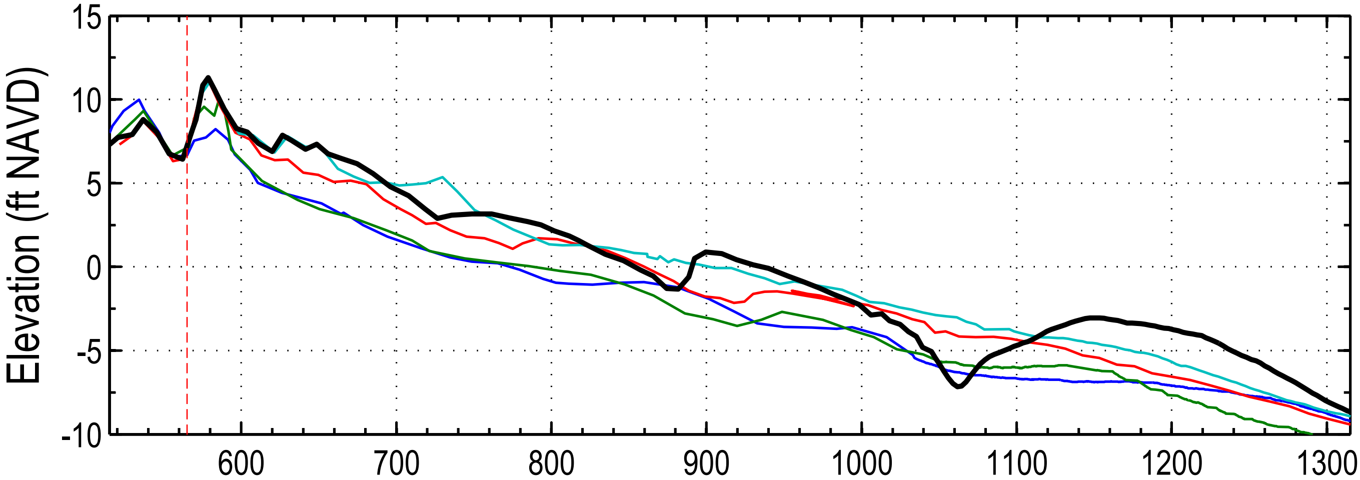


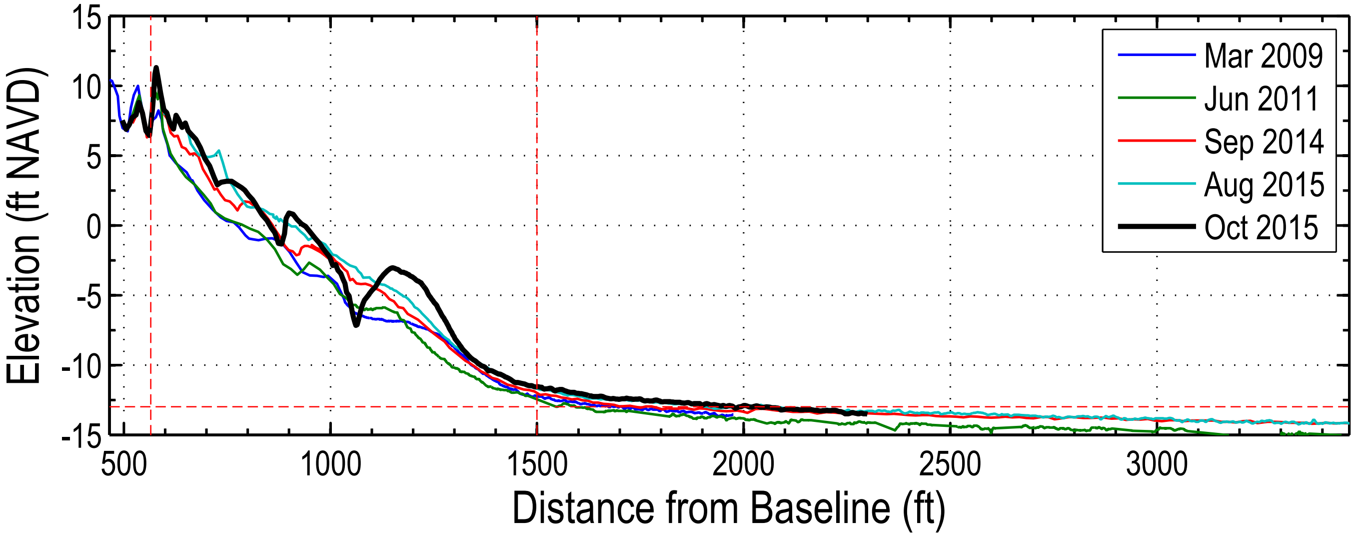


Date	Unit Vol (cy/ft)
Mar 2009	297.8
Sep 2009	284.6
Mar 2010	275.8
Sep 2010	283.1
Jun 2011	291.6
Jul 2012	305.0
Jul 2013	316.3
Sep 2014	328.2
Aug 2015	355.4
Oct 2015	358.6

X: 2379610.2
Y: 352056.69

Station: OCRM 3145b - 36th Avenue

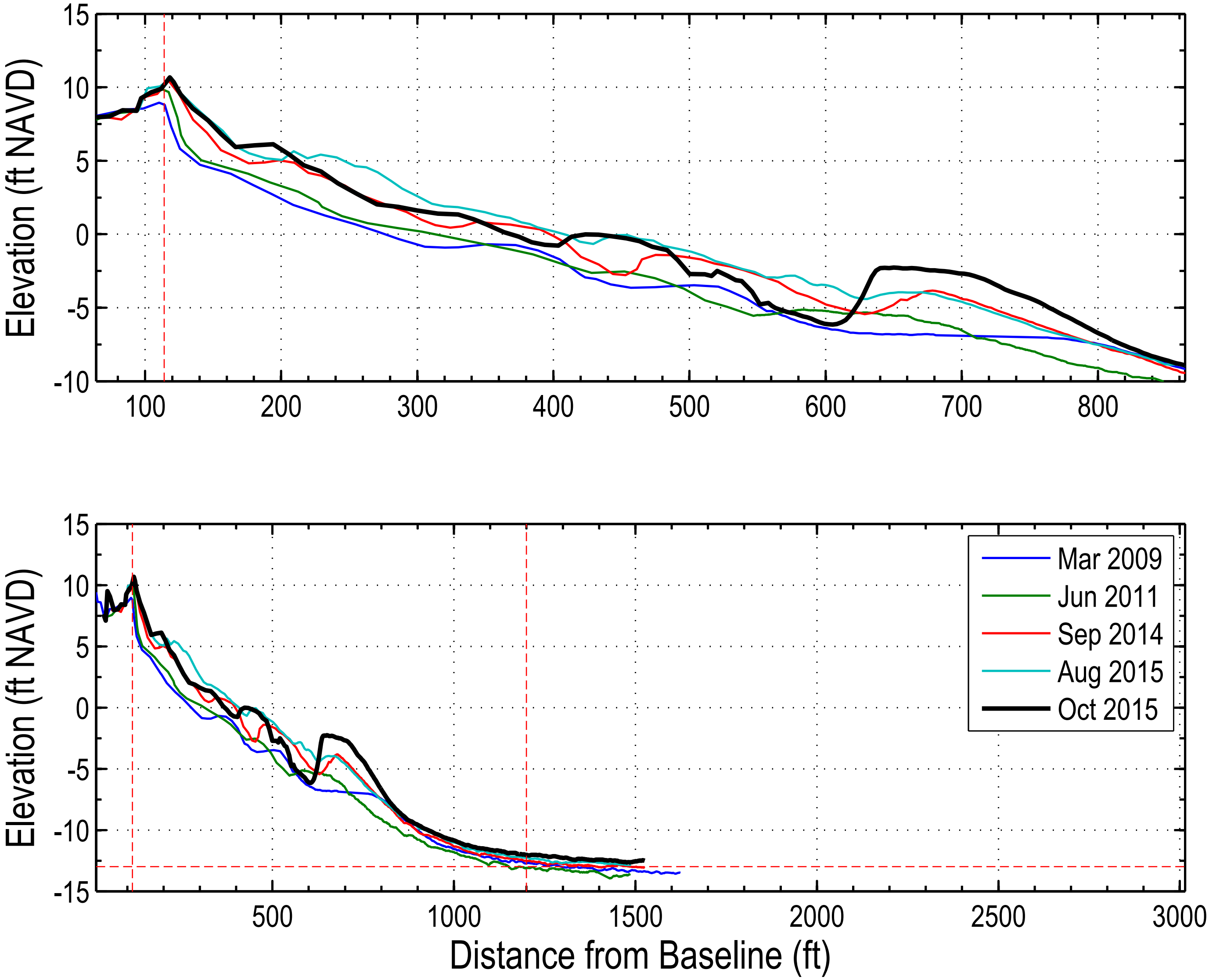




Date	Unit Vol (cy/ft)
Mar 2009	302.6
Sep 2009	298.1
Mar 2010	277.7
Sep 2010	283.4
Jun 2011	298.0
Jul 2012	319.2
Jul 2013	324.0
Sep 2014	342.5
Aug 2015	367.8
Oct 2015	369.8

X: 2379730.46
Y: 352585.1

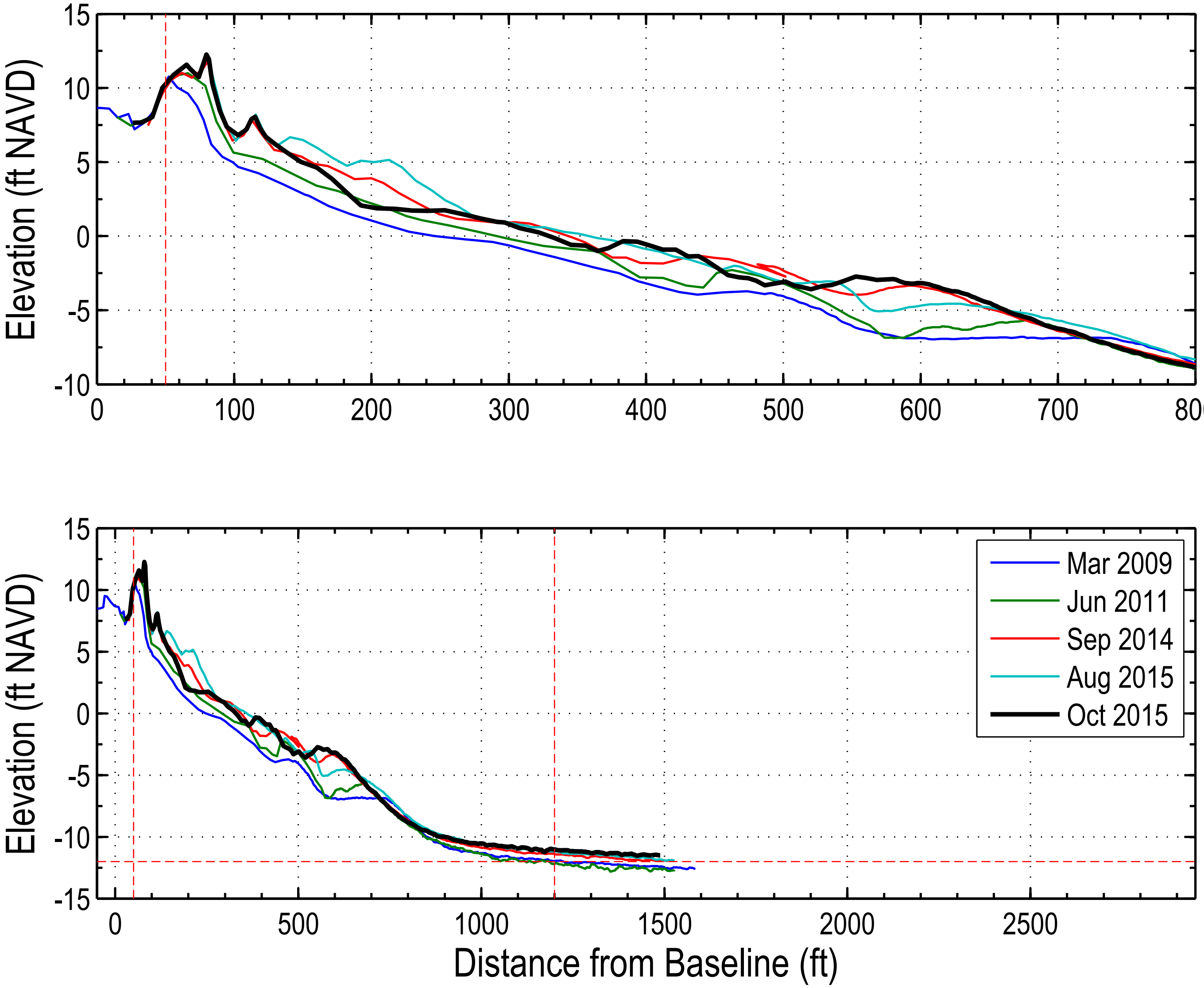
Station: 170+00



Date	Unit Vol (cy/ft)
Mar 2009	292.5
Sep 2009	291.8
Mar 2010	290.3
Sep 2010	293.4
Jun 2011	289.8
Jul 2012	317.0
Jul 2013	335.4
Sep 2014	339.3
Aug 2015	361.1
Oct 2015	358.6

X: 2380546.35
Y: 352408.3

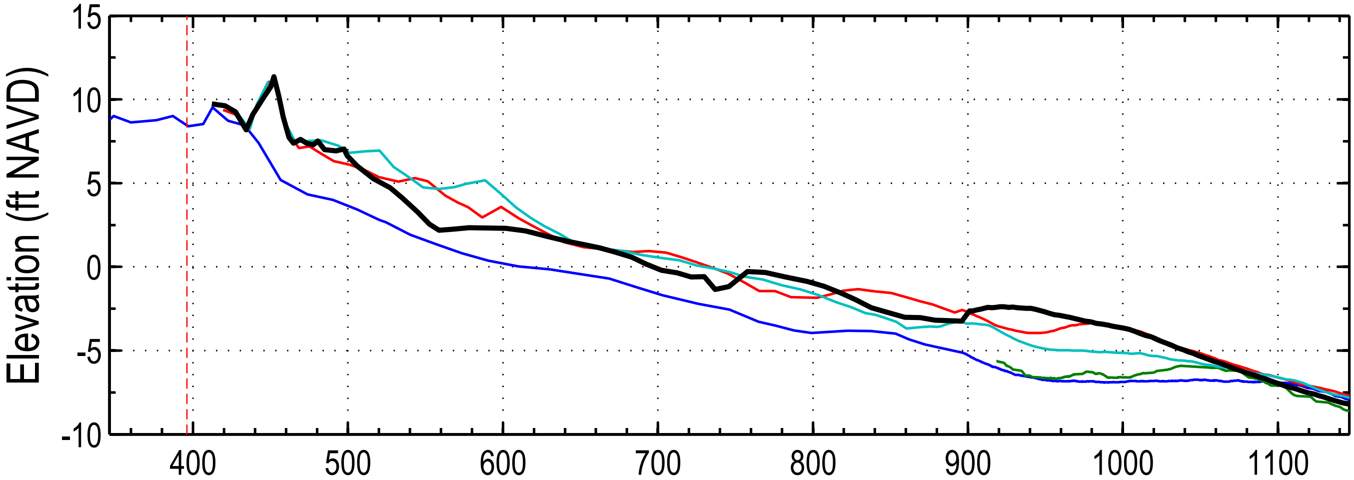
Station: 180+00 (40th Ave)

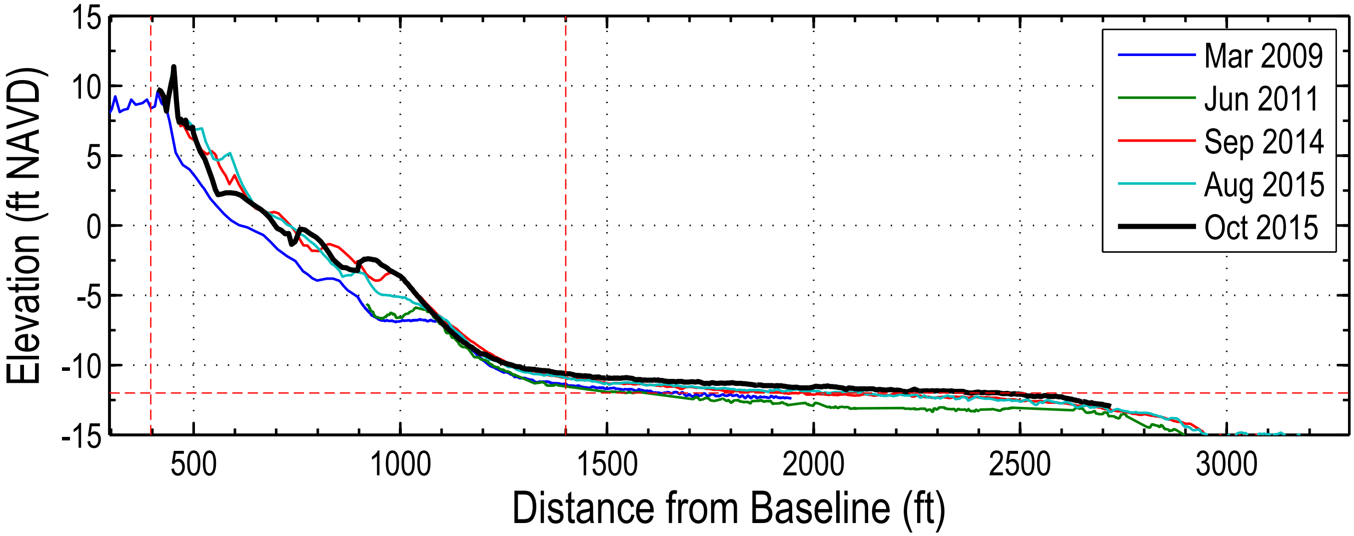


Date	Unit Vol (cy/ft)
Mar 2009	277.7
Sep 2009	275.7
Mar 2010	287.0
Sep 2010	293.6
Jun 2011	295.4
Jul 2012	312.0
Jul 2013	331.2
Sep 2014	332.8
Aug 2015	344.5
Oct 2015	334.8

X: 2381482.49
Y: 352759.91

Station: OCRM 3150b

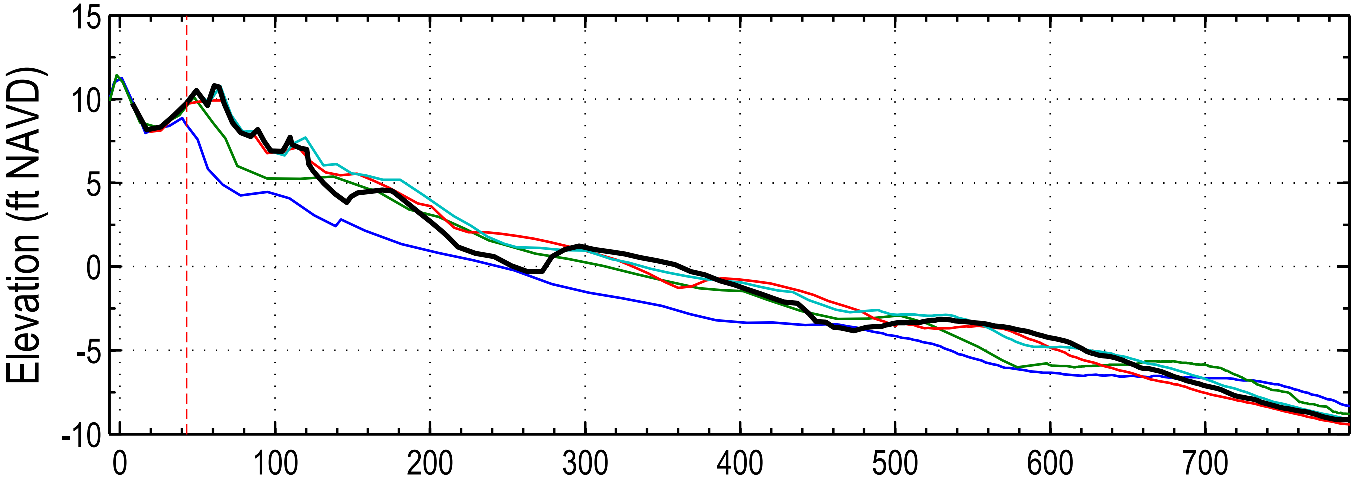


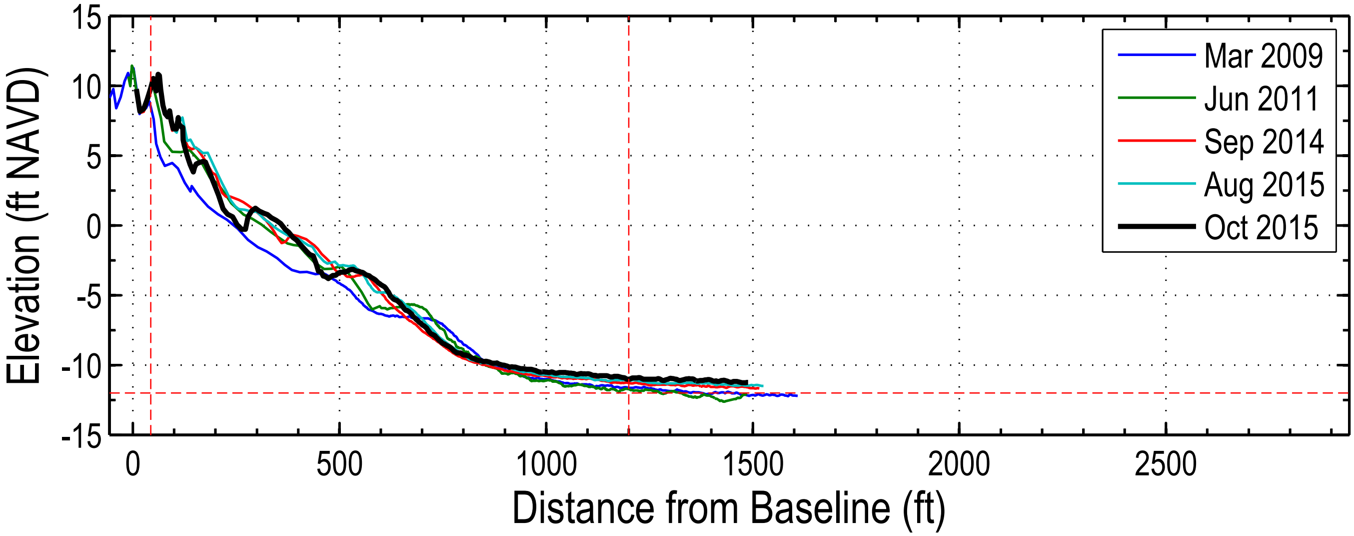


Date	Unit Vol (cy/ft)
Mar 2009	289.6
Sep 2009	295.3
Mar 2010	303.2
Sep 2010	237.3
Jun 2011	182.4
Jul 2012	287.9
Jul 2013	349.5
Sep 2014	356.4
Aug 2015	350.2
Oct 2015	350.6

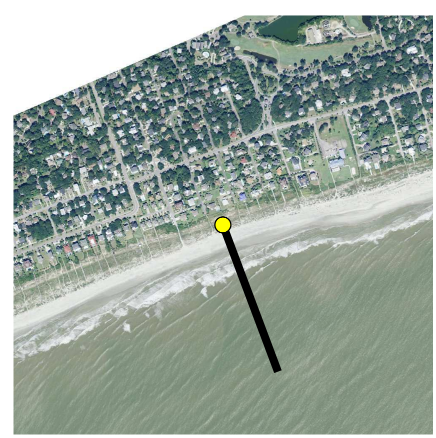
X: 2381498.08
Y: 353164.03

Station: 190+00



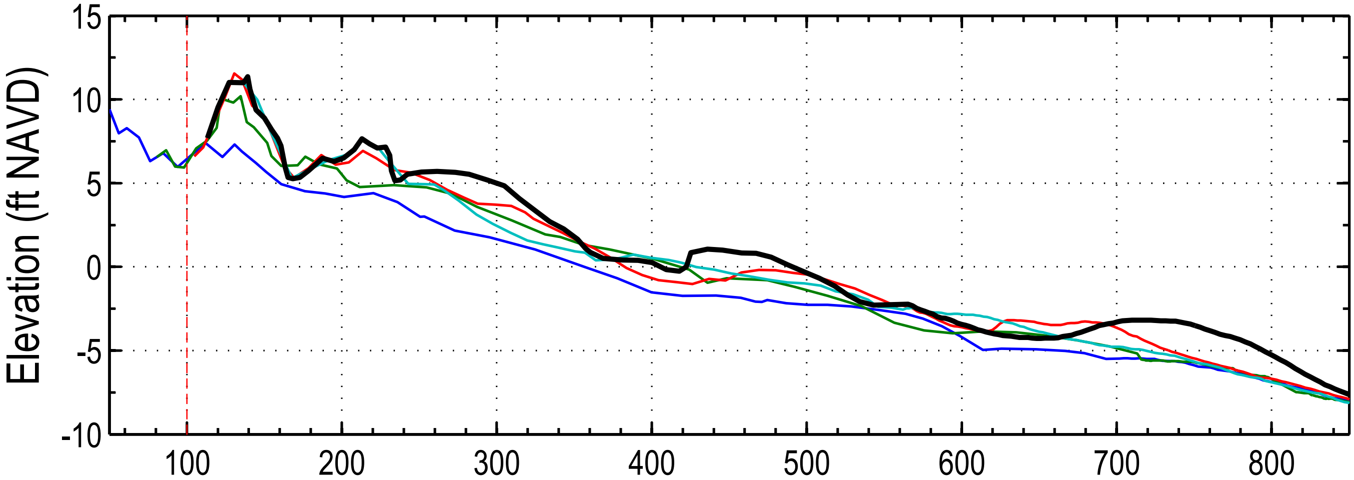


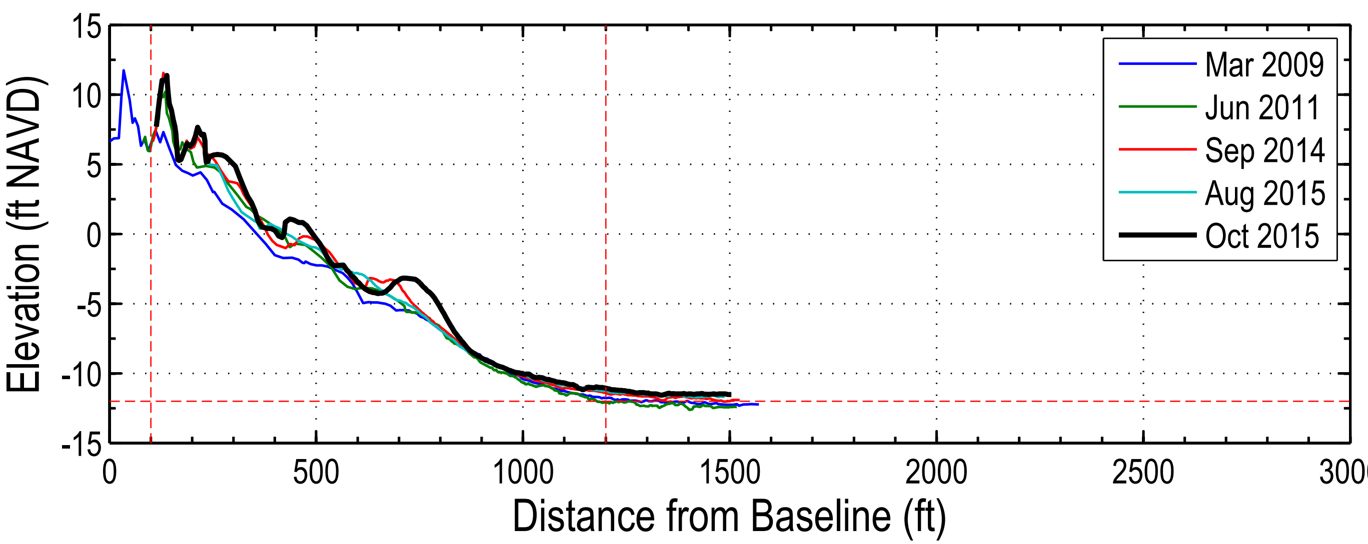
Date	Unit Vol (cy/ft)
Mar 2009	280.6
Sep 2009	275.9
Mar 2010	278.6
Sep 2010	293.7
Jun 2011	310.8
Jul 2012	327.7
Jul 2013	331.5
Sep 2014	324.0
Aug 2015	333.1
Oct 2015	326.0



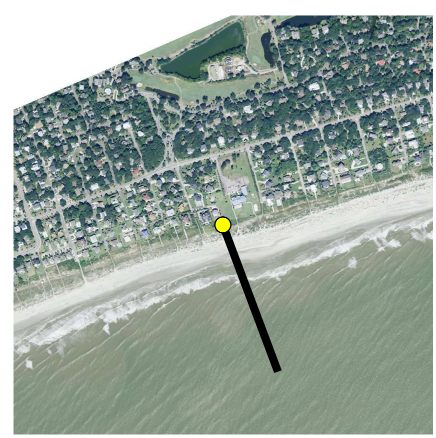
X: 2382418.64
Y: 353111.53

Station: 200+00



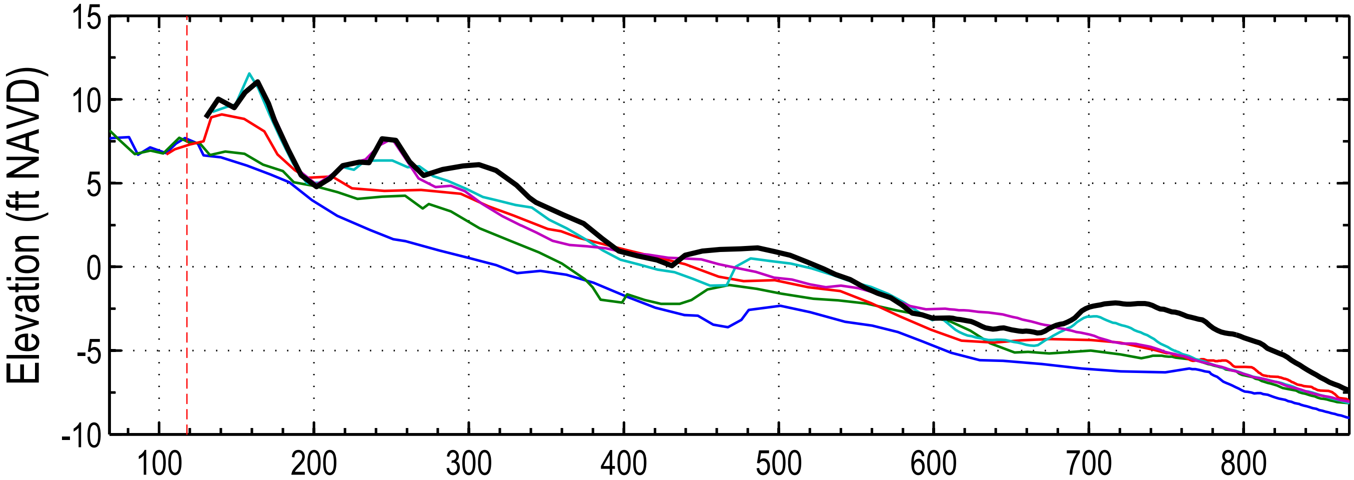


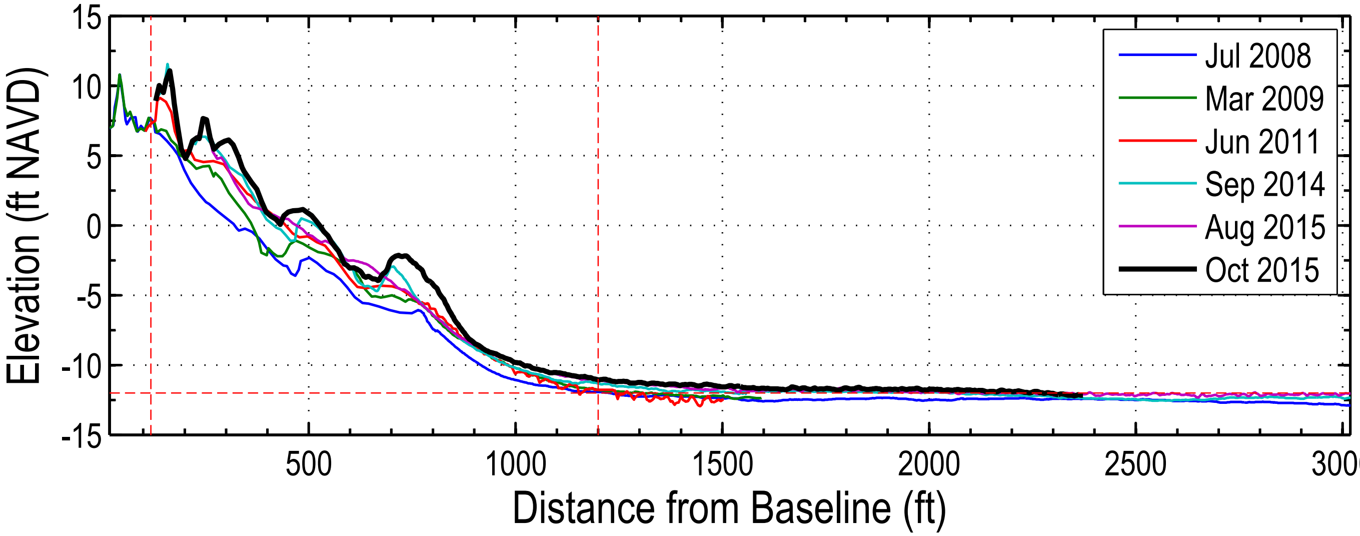
Date	Unit Vol (cy/ft)
Mar 2009	316.5
Sep 2009	307.9
Mar 2010	311.9
Sep 2010	328.9
Jun 2011	337.7
Jul 2012	349.7
Jul 2013	356.6
Sep 2014	355.5
Aug 2015	352.4
Oct 2015	371.8



X: 2383354.78
Y: 353463.14

Station: 202+00 - Citadel Beach Club

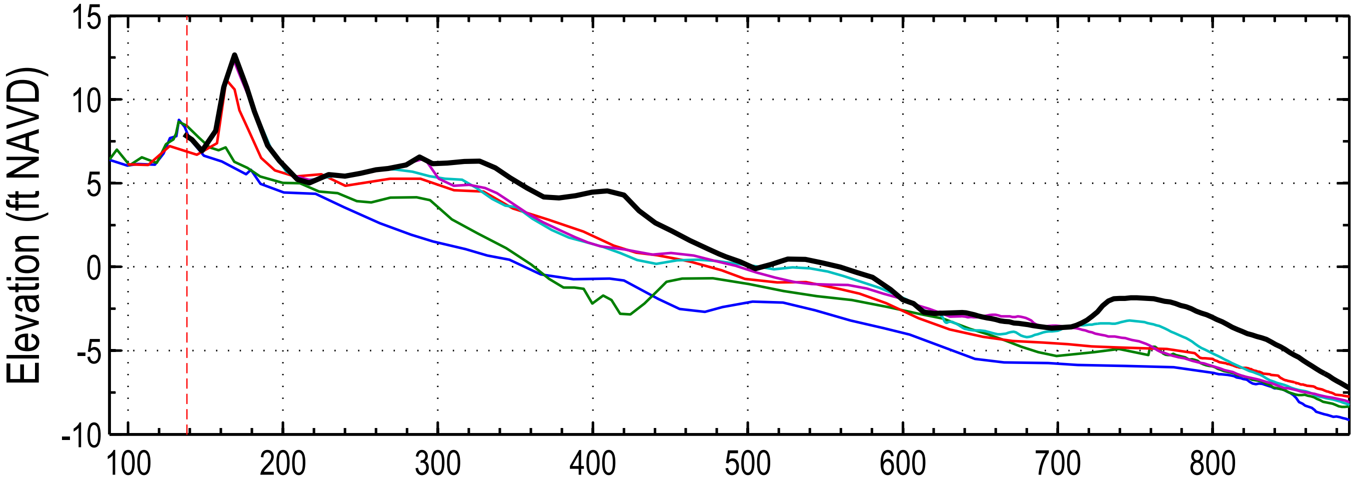


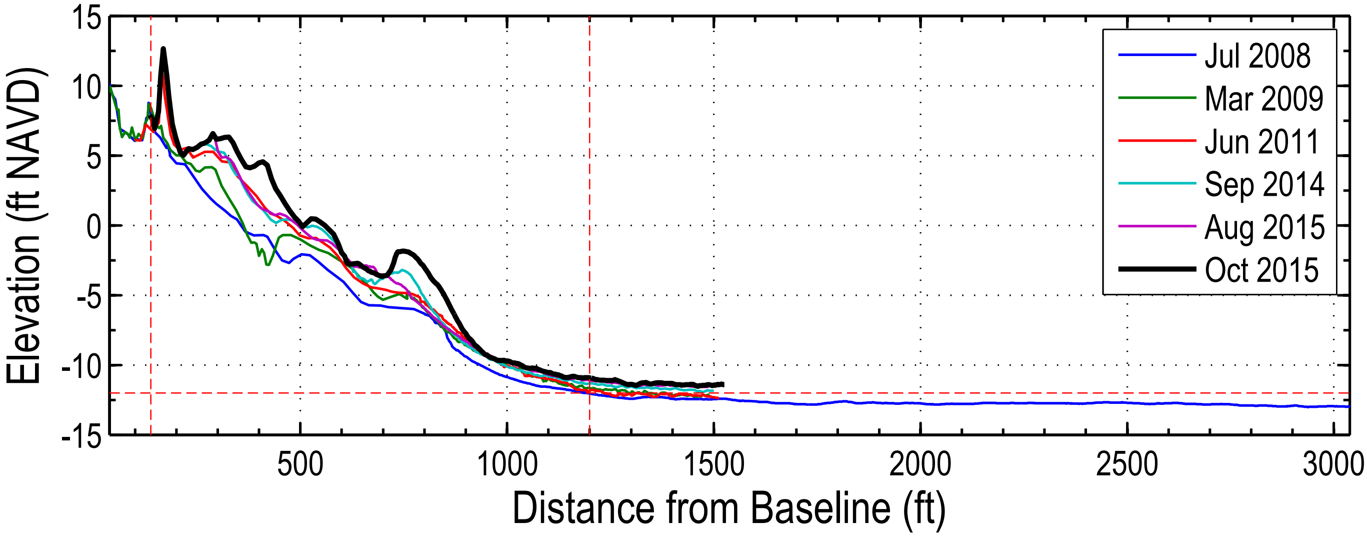


Date	Unit Vol (cy/ft)
Jul 2008	280.5
Mar 2009	317.7
Sep 2009	325.0
Mar 2010	323.1
Sep 2010	337.3
Jun 2011	341.0
Jul 2012	351.3
Jul 2013	360.3
Sep 2014	356.9
Aug 2015	361.0
Oct 2015	384.1

X: 2383542.9
Y: 353531.03

Station: 204+00 (-18+00)

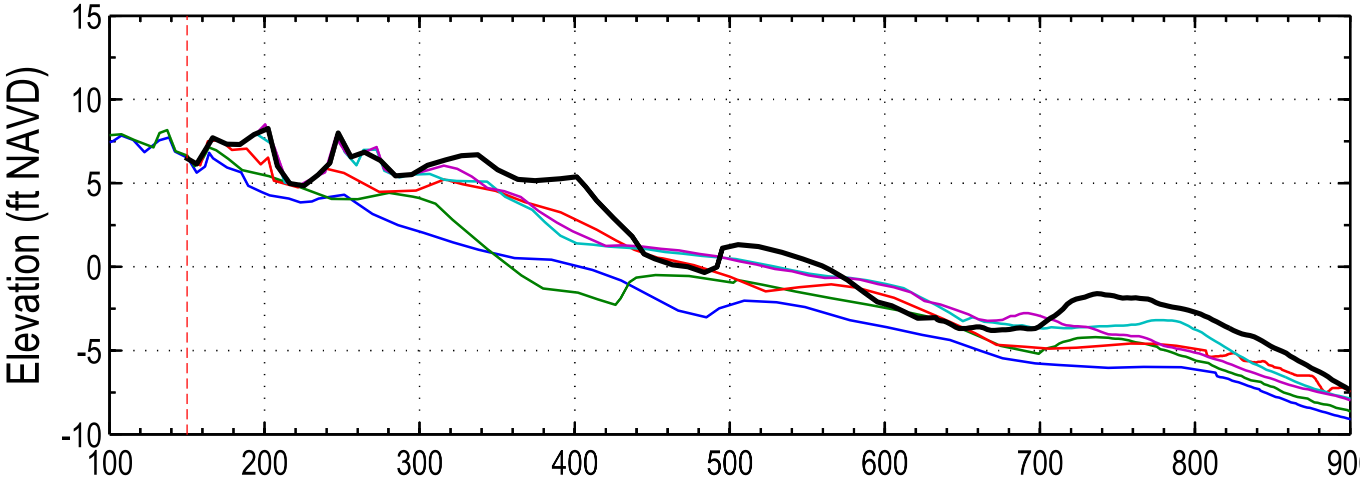


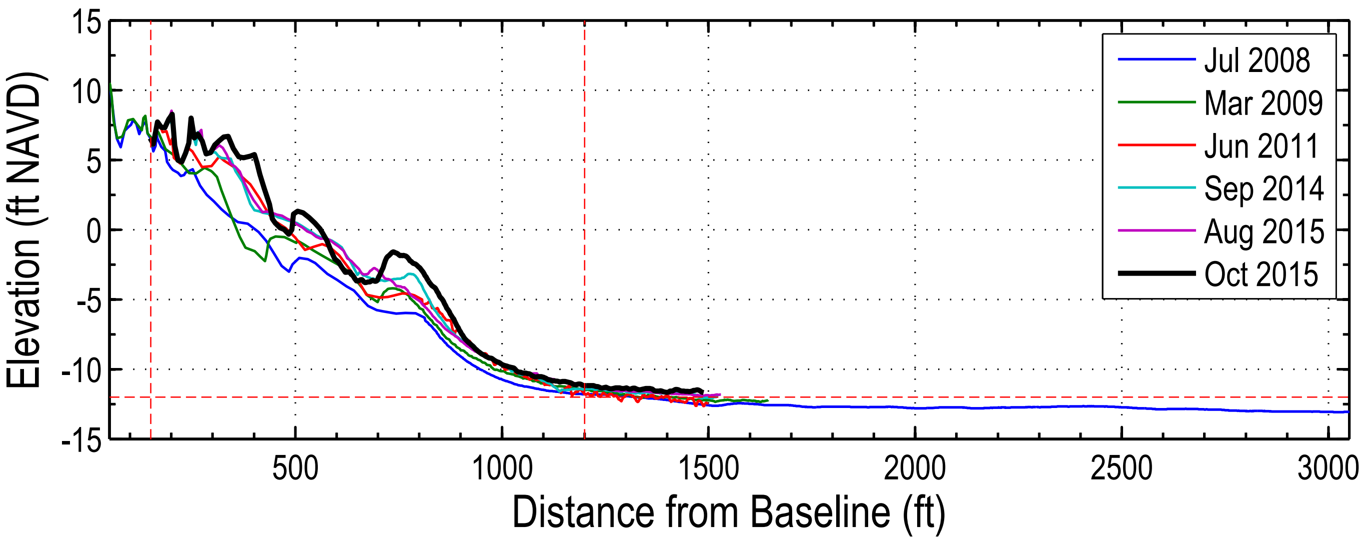


Date	Unit Vol (cy/ft)
Jul 2008	286.8
Mar 2009	315.9
Sep 2009	333.0
Mar 2010	331.6
Sep 2010	343.5
Jun 2011	344.8
Jul 2012	352.8
Jul 2013	360.5
Sep 2014	357.7
Aug 2015	358.4
Oct 2015	389.7

X: 2383731.27
Y: 353598.25

Station: 206+00 (-16+00)

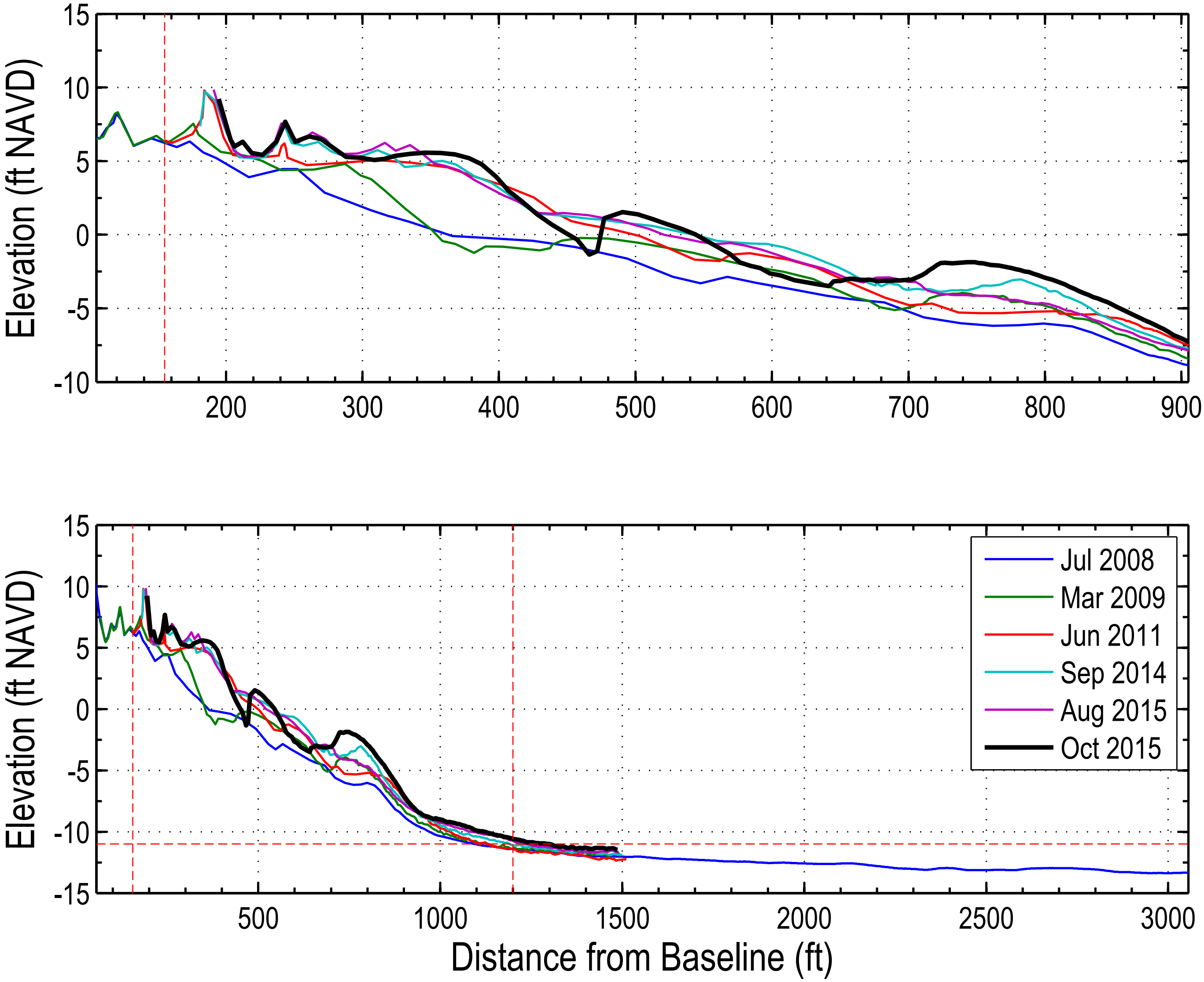




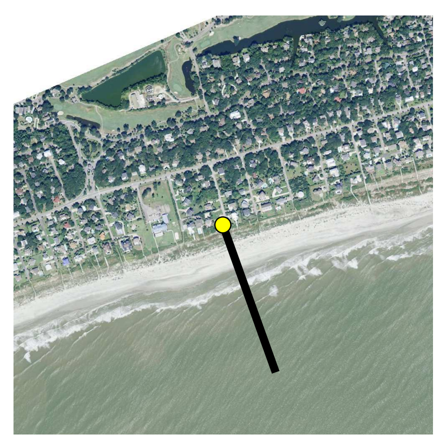
Date	Unit Vol (cy/ft)
Jul 2008	288.7
Mar 2009	314.3
Sep 2009	336.4
Mar 2010	337.7
Sep 2010	344.8
Jun 2011	346.4
Jul 2012	353.4
Jul 2013	363.7
Sep 2014	361.7
Aug 2015	364.9
Oct 2015	381.3

X: 2383919.64
Y: 353665.47

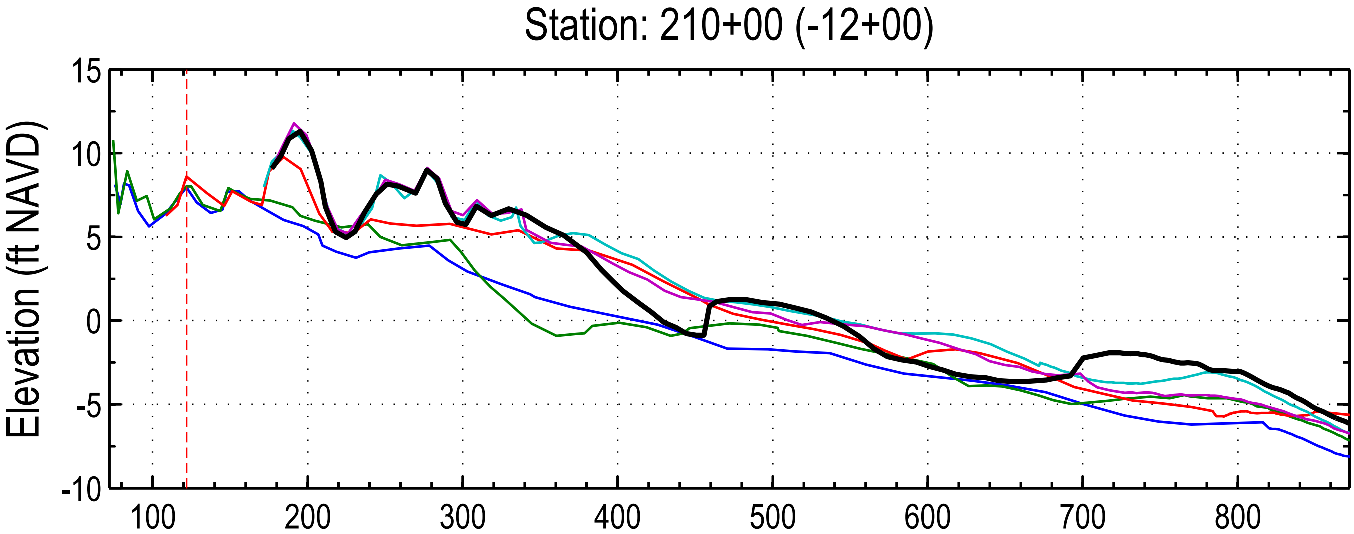
Station: 208+00 (-14+00)

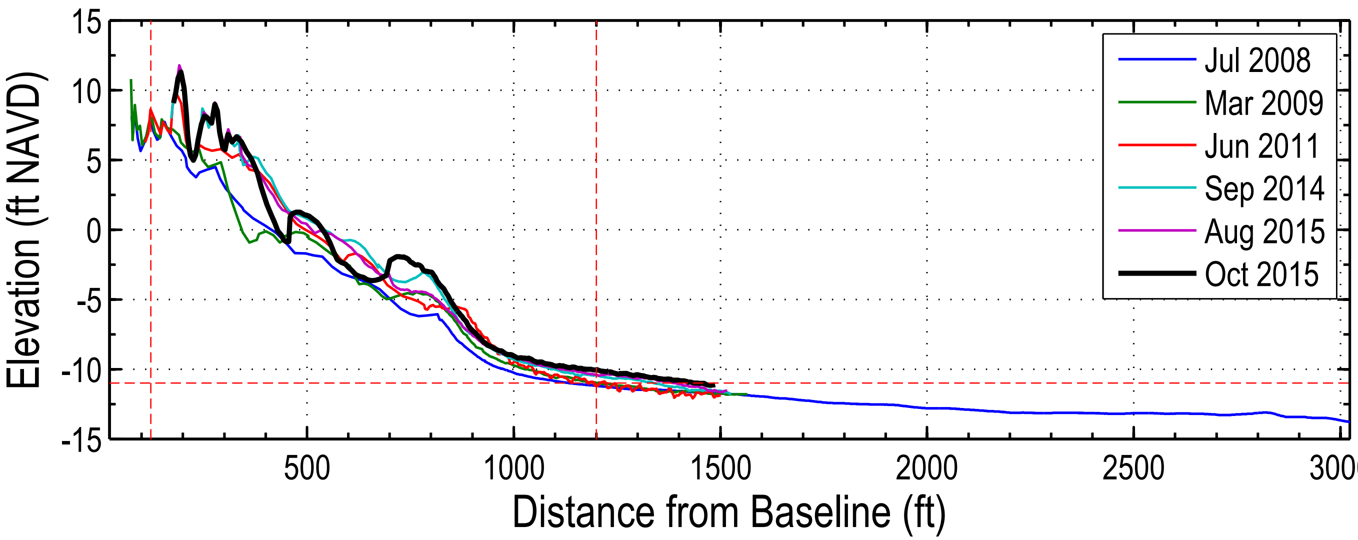


Date	Unit Vol (cy/ft)
Jul 2008	255.9
Mar 2009	281.6
Sep 2009	294.1
Mar 2010	310.6
Sep 2010	308.8
Jun 2011	311.9
Jul 2012	327.0
Jul 2013	343.2
Sep 2014	332.7
Aug 2015	331.2
Oct 2015	341.1

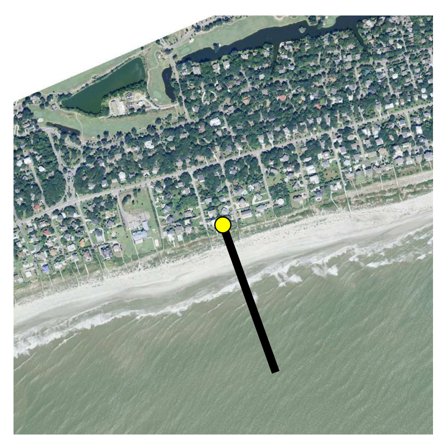


X: 2384108
Y: 353732.68



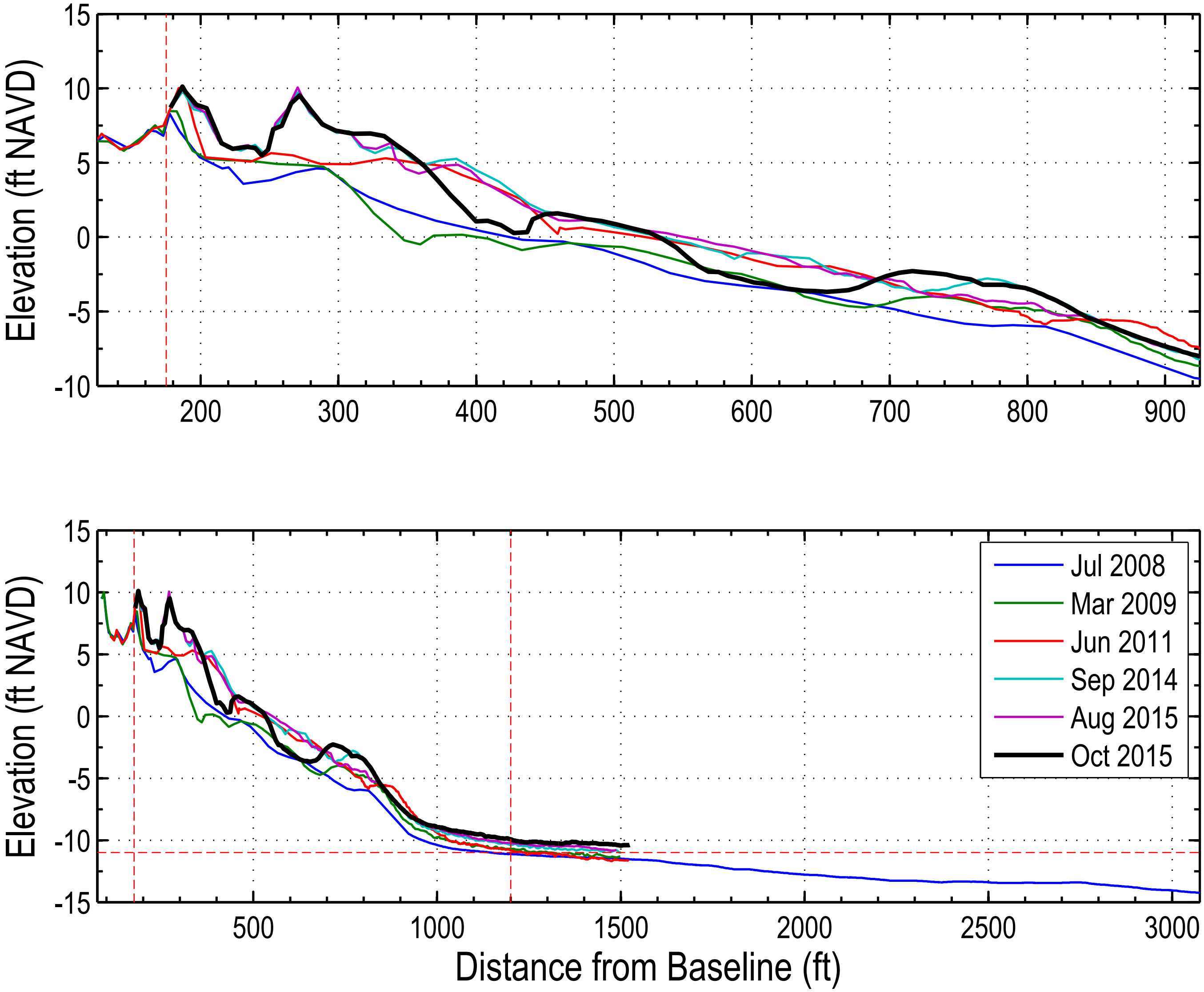


Date	Unit Vol (cy/ft)
Jul 2008	287.8
Mar 2009	306.7
Sep 2009	328.2
Mar 2010	334.2
Sep 2010	341.7
Jun 2011	346.6
Jul 2012	354.9
Jul 2013	367.7
Sep 2014	373.4
Aug 2015	367.5
Oct 2015	370.6



X: 2384296.37
Y: 353799.9

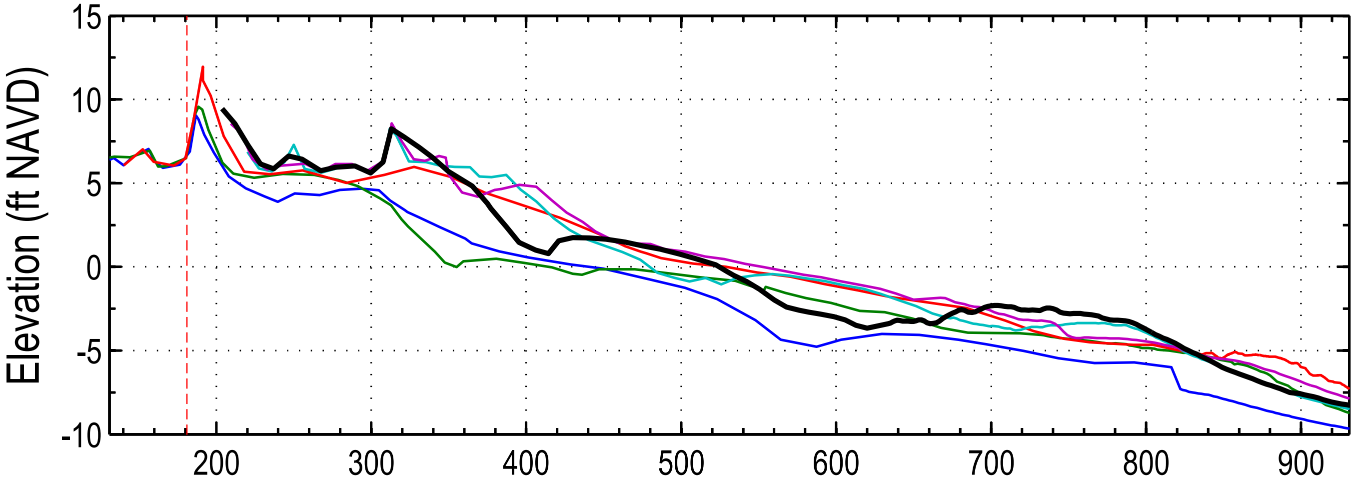
Station: 212+00 (-10+00)

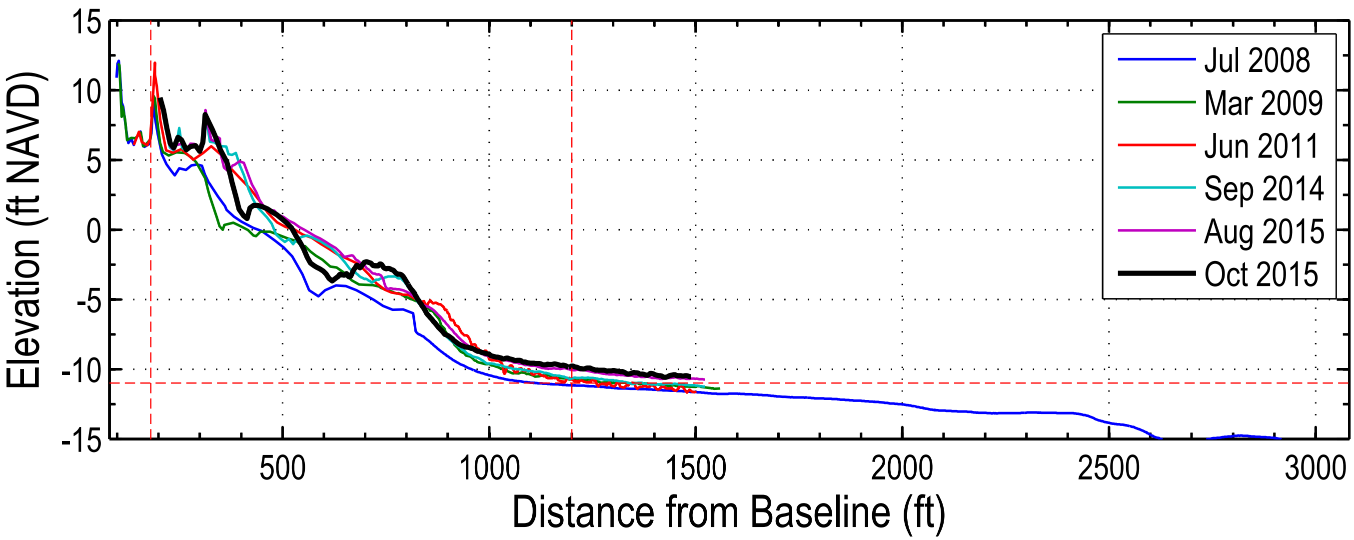


Date	Unit Vol (cy/ft)
Jul 2008	258.0
Mar 2009	274.0
Sep 2009	298.1
Mar 2010	303.9
Sep 2010	310.7
Jun 2011	316.0
Jul 2012	335.2
Jul 2013	335.8
Sep 2014	335.8
Aug 2015	333.0
Oct 2015	327.9

X: 2384484.73
Y: 353867.12

Station: 214+00 (-8+00)

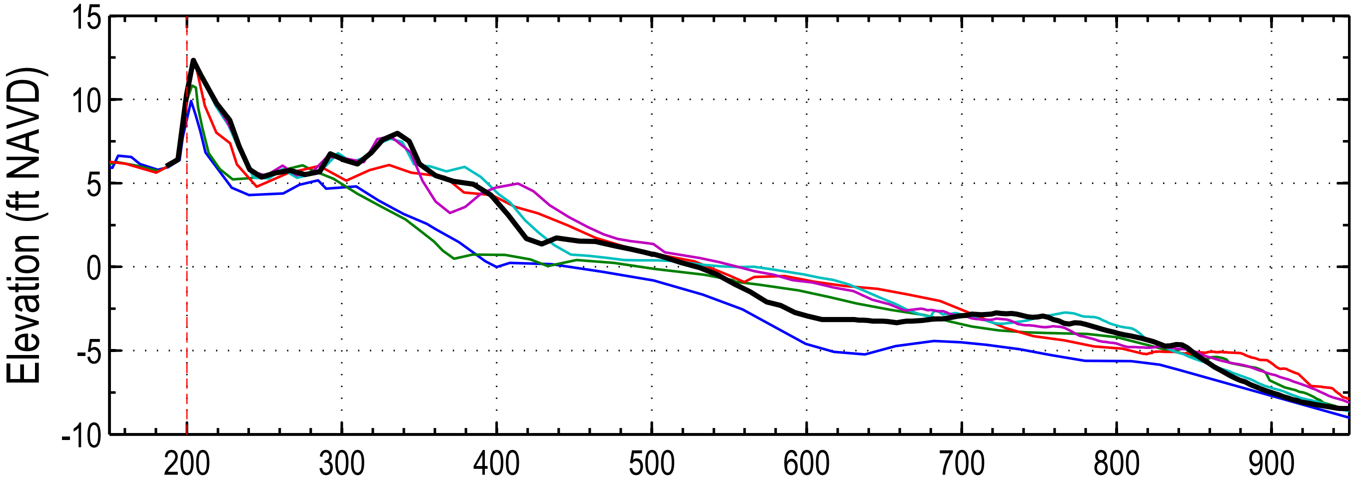


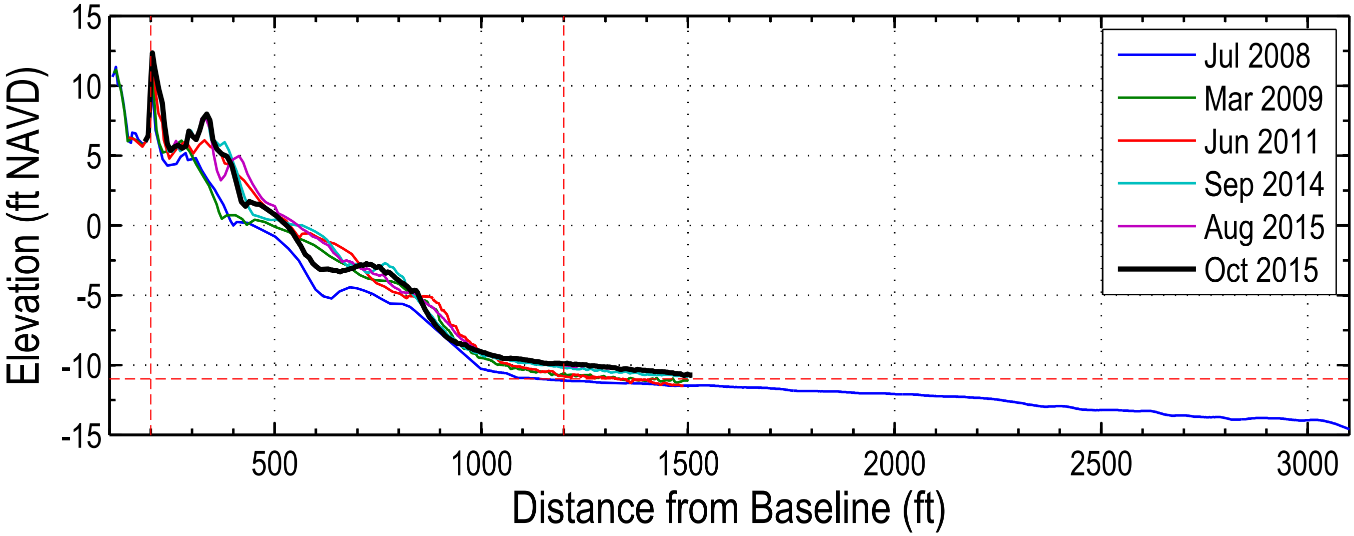


Date	Unit Vol (cy/ft)
Jul 2008	251.7
Mar 2009	281.8
Sep 2009	305.3
Mar 2010	304.3
Sep 2010	306.3
Jun 2011	321.3
Jul 2012	334.9
Jul 2013	340.3
Sep 2014	315.7
Aug 2015	332.2
Oct 2015	320.5

X: 2384673.1
Y: 353934.34

Station: 216+00 (-6+00)

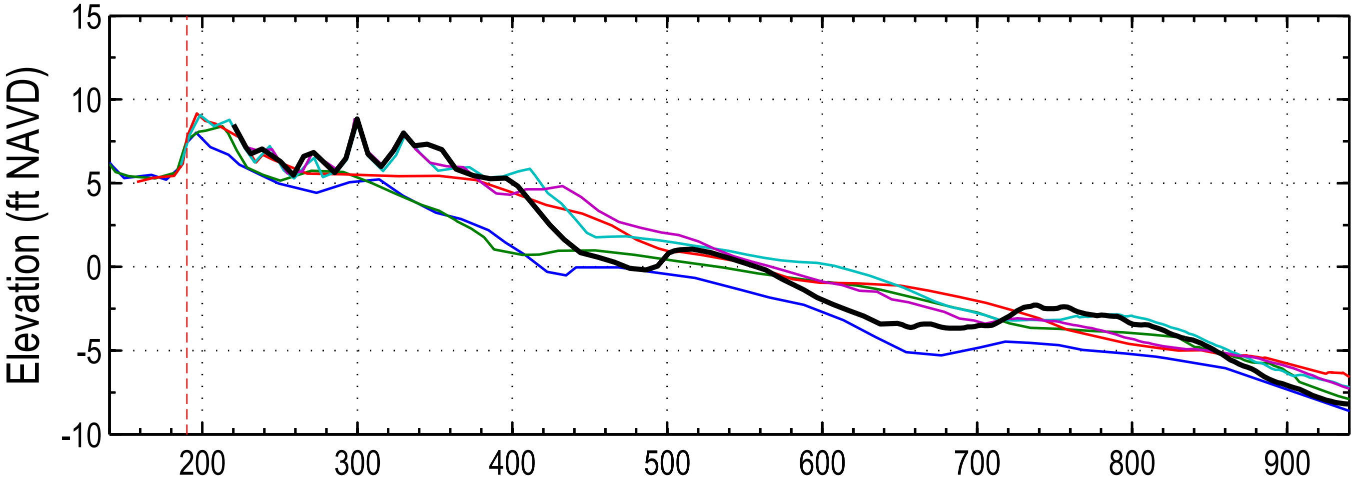


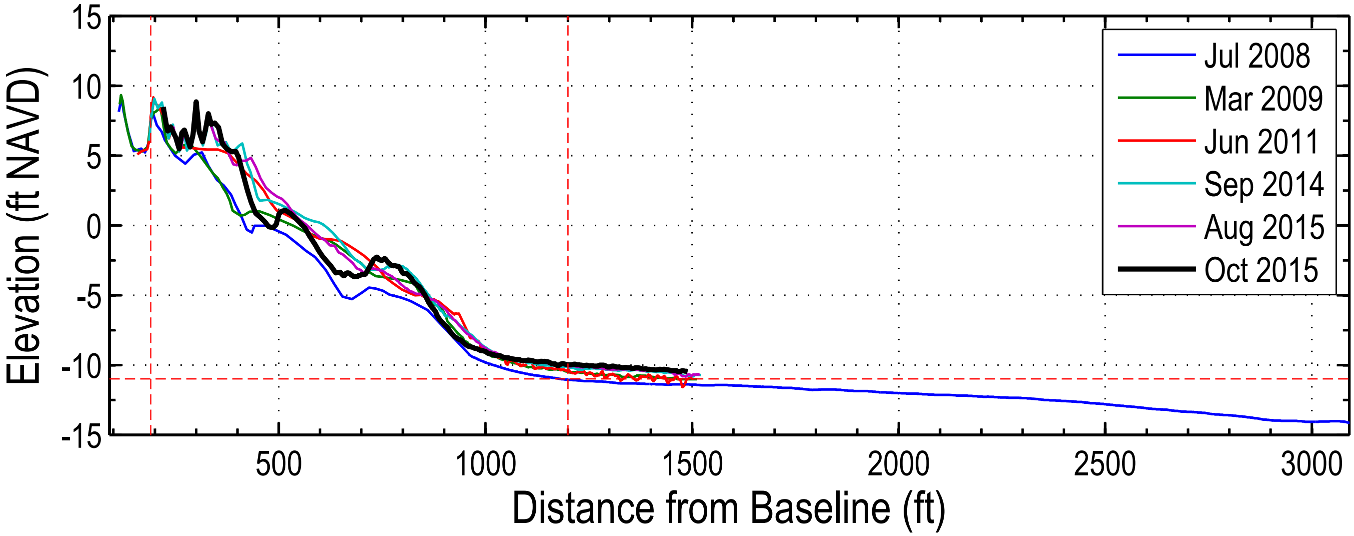


Date	Unit Vol (cy/ft)
Jul 2008	253.4
Mar 2009	286.8
Sep 2009	302.3
Mar 2010	298.9
Sep 2010	303.1
Jun 2011	317.0
Jul 2012	332.4
Jul 2013	344.0
Sep 2014	320.3
Aug 2015	324.1
Oct 2015	313.3

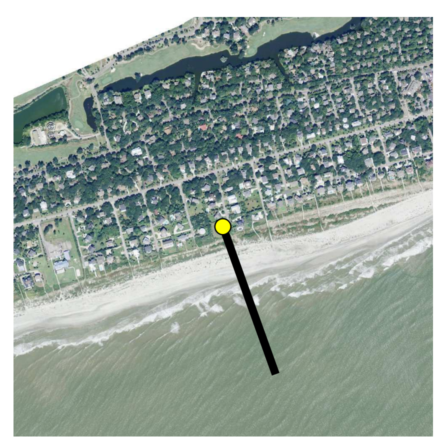
X: 2384861.47
Y: 354001.55

Station: 218+00 (-4+00)



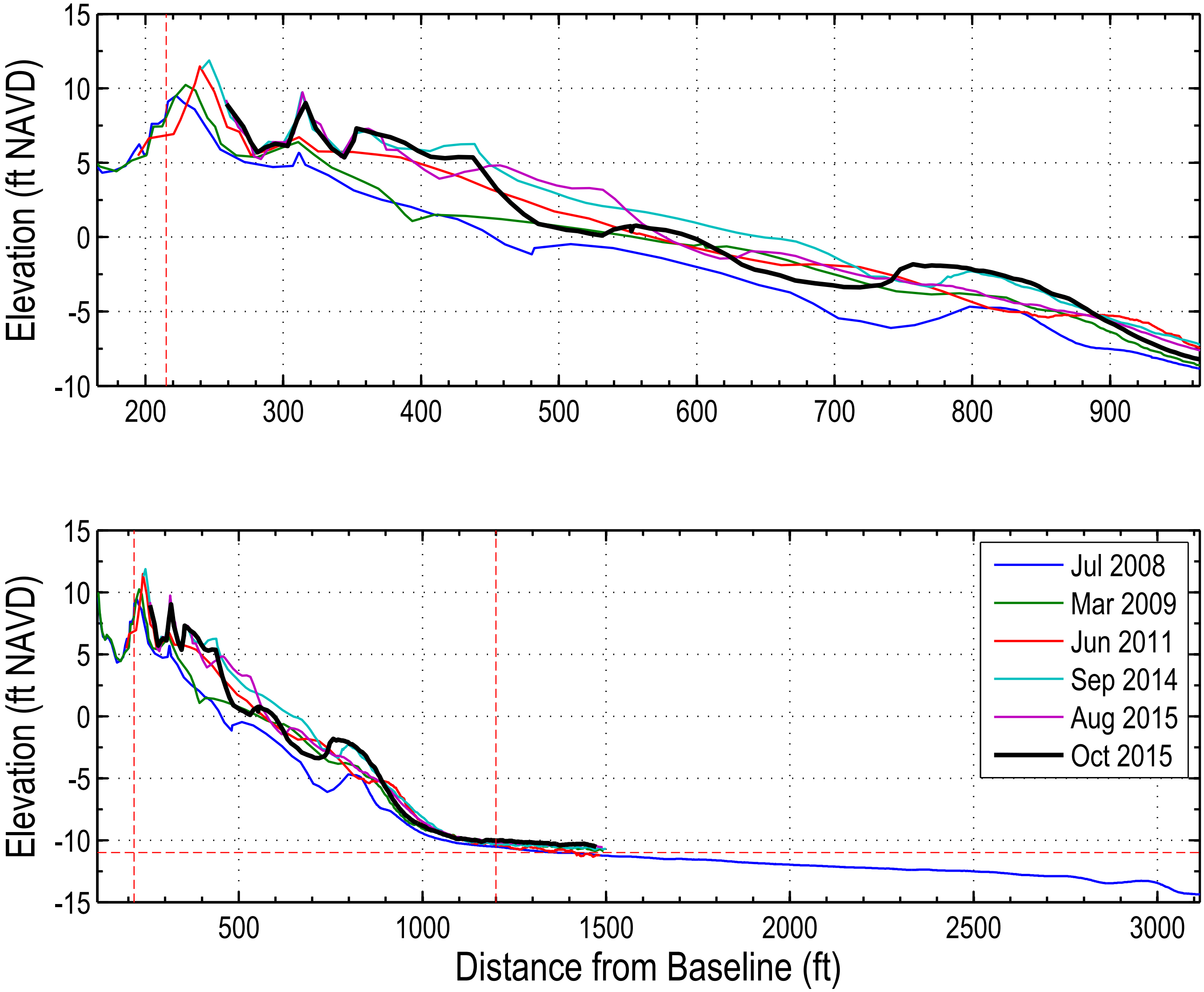


Date	Unit Vol (cy/ft)
Jul 2008	274.5
Mar 2009	309.6
Sep 2009	312.9
Mar 2010	308.9
Sep 2010	318.8
Jun 2011	332.6
Jul 2012	342.8
Jul 2013	352.5
Sep 2014	344.5
Aug 2015	339.8
Oct 2015	325.7



X: 2385049.83
Y: 354068.77

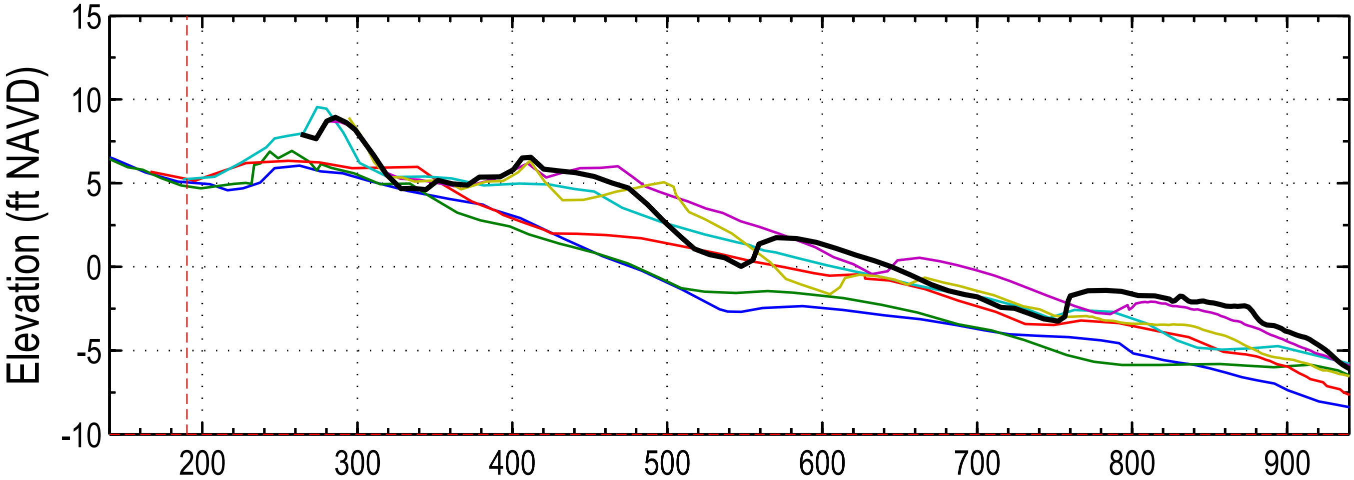
Station: 220+00 (-2+00)

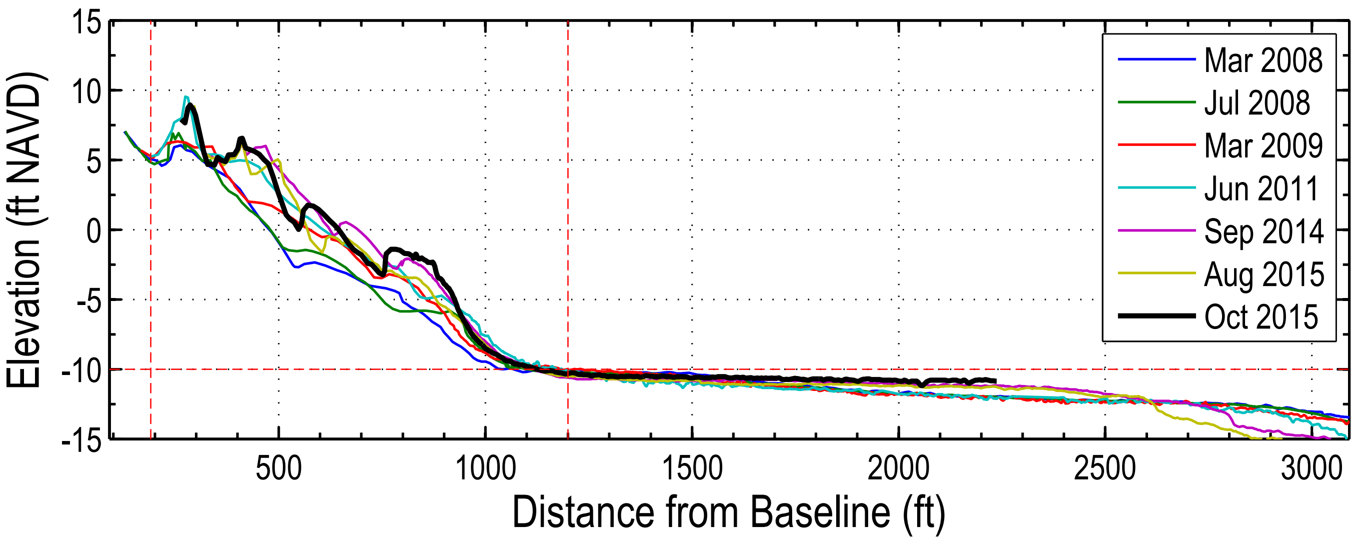


Date	Unit Vol (cy/ft)
Jul 2008	269.5
Mar 2009	305.9
Sep 2009	309.1
Mar 2010	306.1
Sep 2010	315.1
Jun 2011	327.8
Jul 2012	343.5
Jul 2013	357.0
Sep 2014	358.7
Aug 2015	340.4
Oct 2015	333.4

X: 2385238.2
Y: 354135.99

Station: 222+00 (0+00) 53RD AVENUE - SCCC 3159

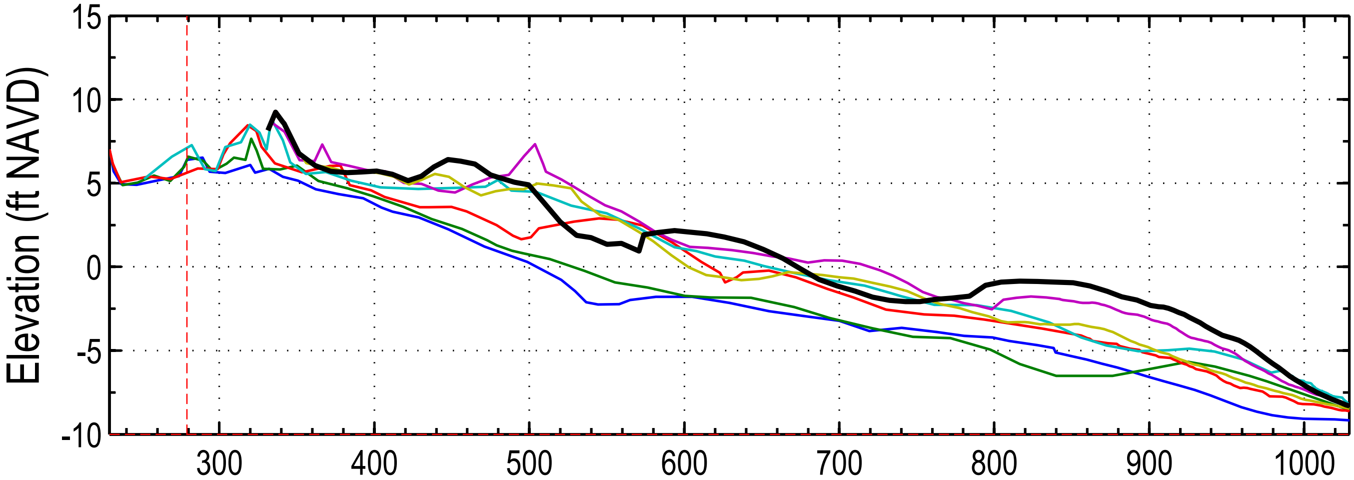


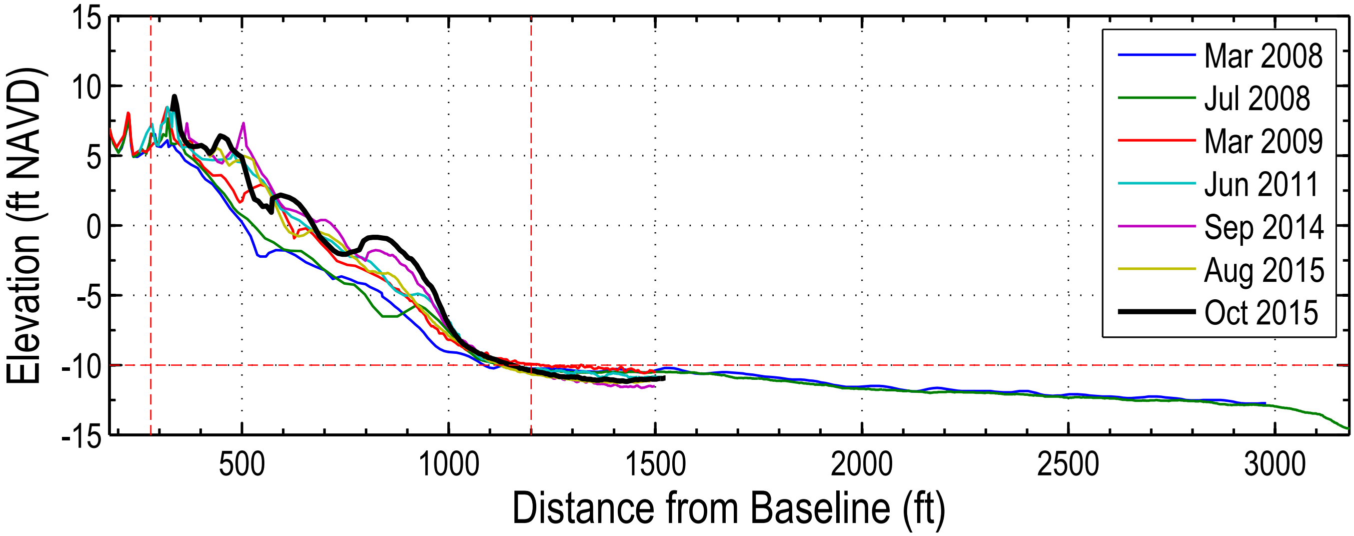


Date	Unit Vol (cy/ft)
Jul 2007	243.8
Mar 2008	252.0
Jul 2008	261.0
Mar 2009	292.6
Sep 2009	295.7
Mar 2010	295.6
Sep 2010	305.9
Jun 2011	322.4
Jul 2012	337.3
Jul 2013	339.2
Sep 2014	346.5
Aug 2015	325.6
Oct 2015	337.2

X: 2385426.56
Y: 354203.21

Station: 224+00 (2+00)

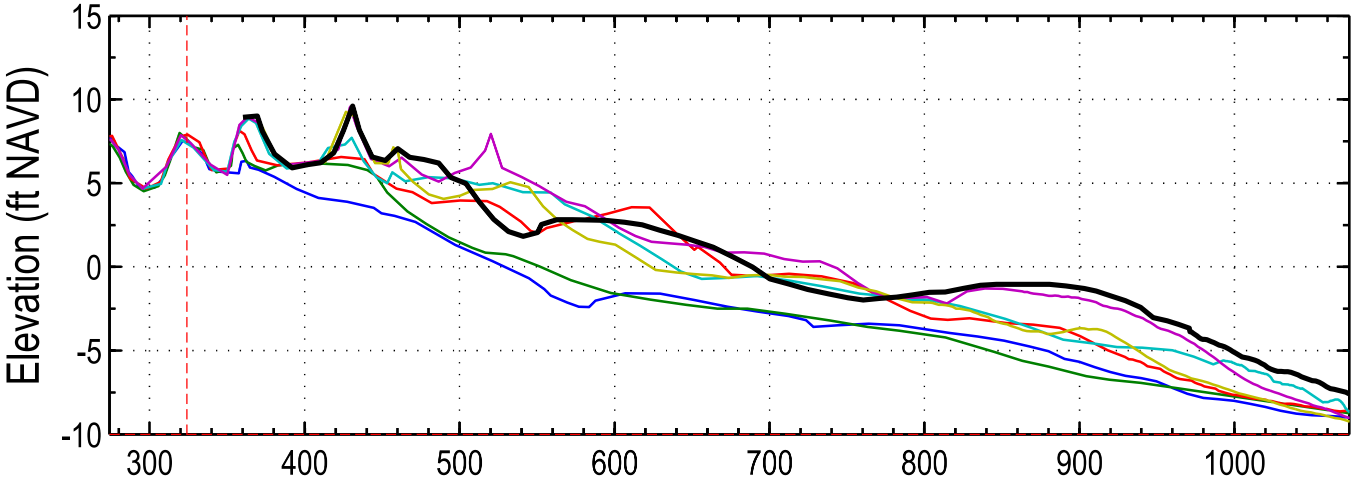


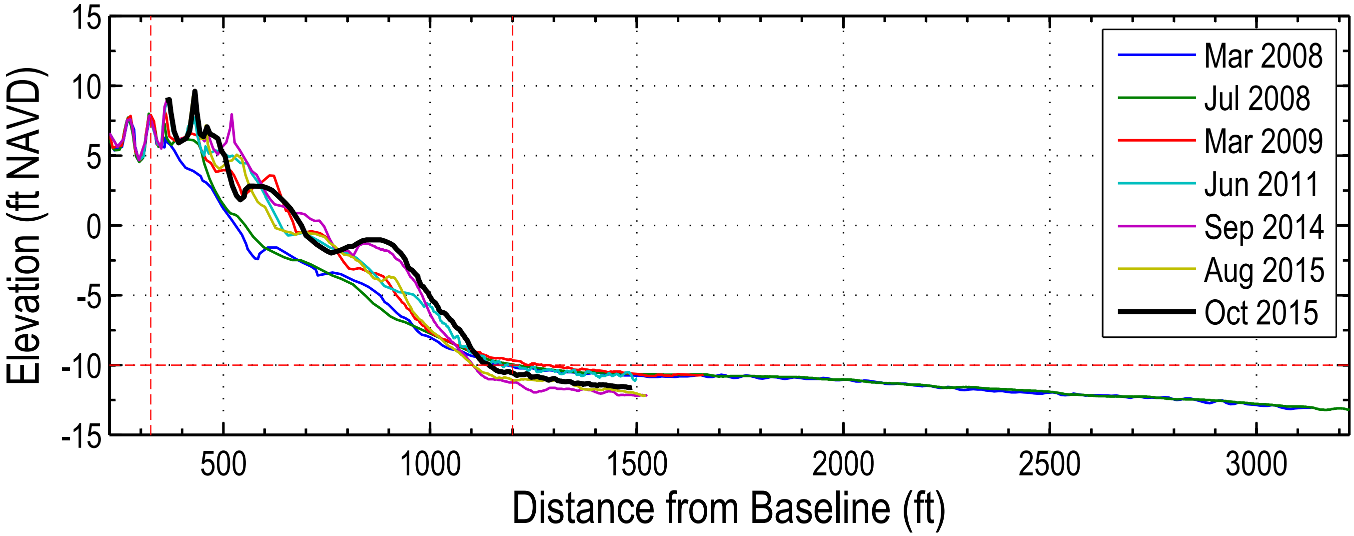


Date	Unit Vol (cy/ft)
Jul 2007	214.0
Mar 2008	221.5
Jul 2008	233.5
Mar 2009	269.0
Sep 2009	273.0
Mar 2010	269.1
Sep 2010	271.3
Jun 2011	288.3
Jul 2012	309.0
Jul 2013	306.5
Sep 2014	310.4
Aug 2015	288.8
Oct 2015	311.2

X: 2385613.66
Y: 354273.87

Station: 226+00 (4+00)

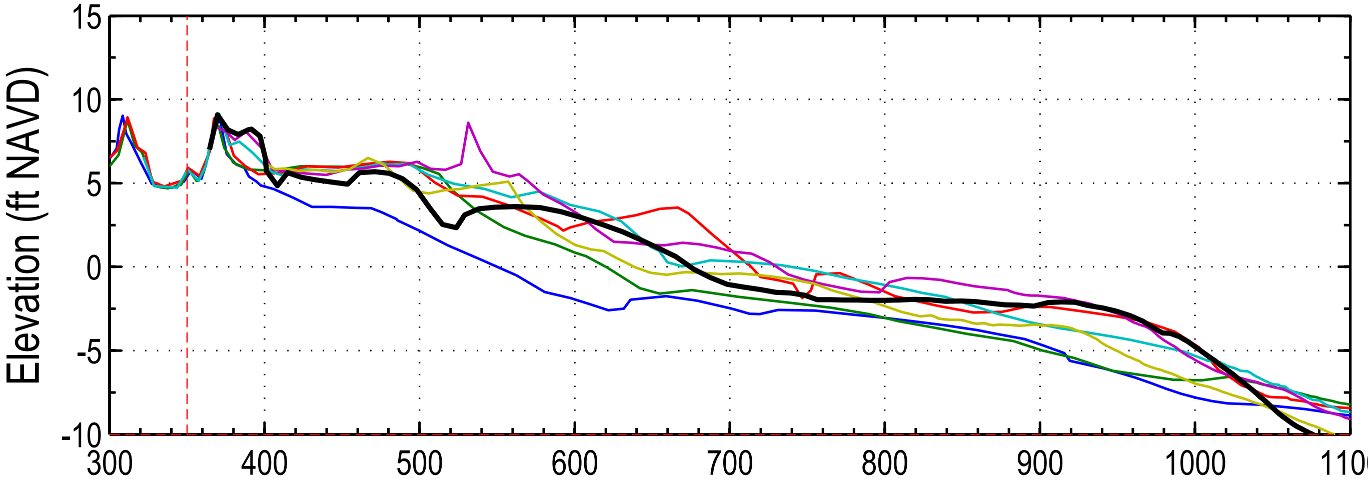


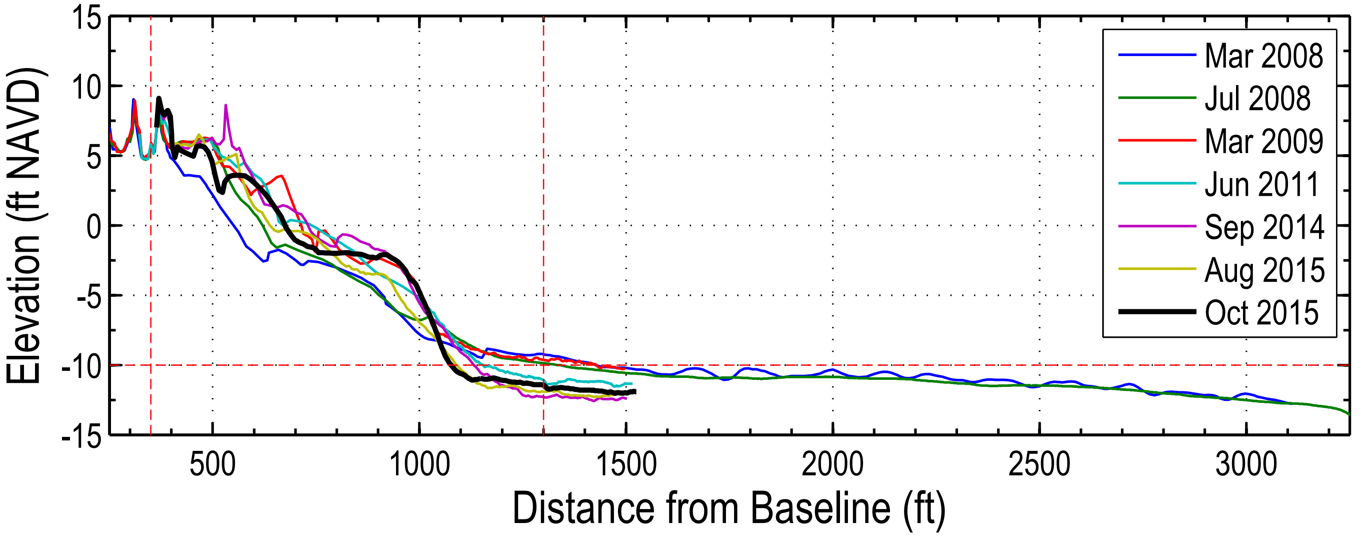


Date	Unit Vol (cy/ft)
Jul 2007	214.0
Mar 2008	217.6
Jul 2008	225.3
Mar 2009	274.0
Sep 2009	286.8
Mar 2010	276.0
Sep 2010	276.8
Jun 2011	281.8
Jul 2012	300.8
Jul 2013	294.0
Sep 2014	301.3
Aug 2015	276.4
Oct 2015	305.1

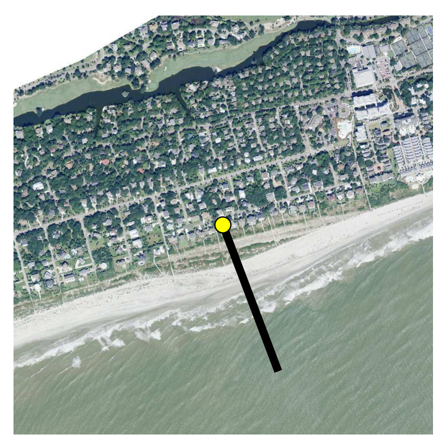
X: 2385800.77
Y: 354344.54

Station: 228+00 (6+00)



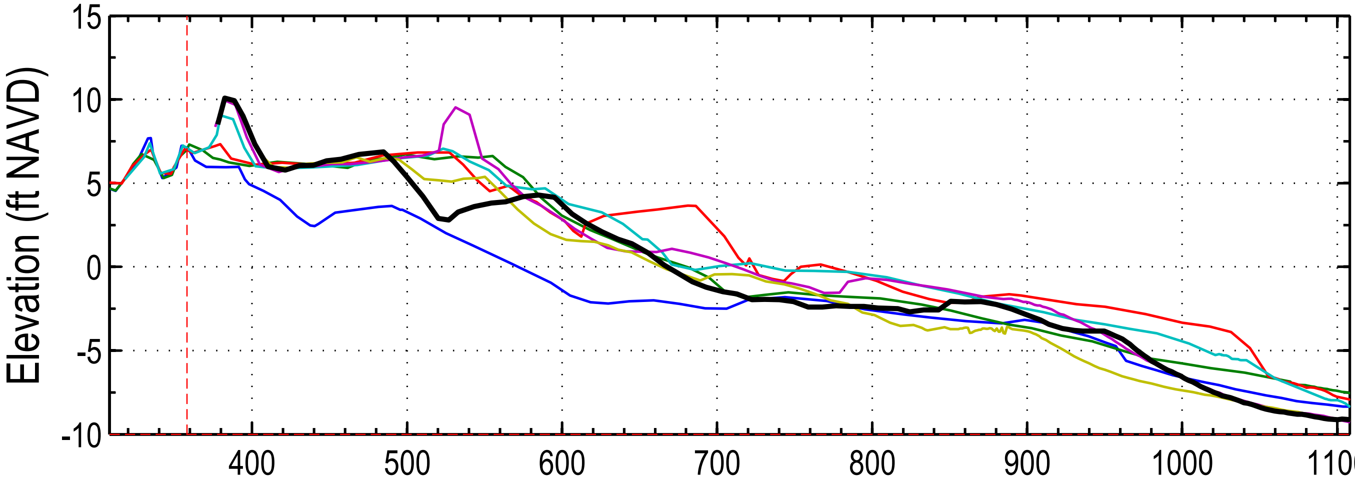


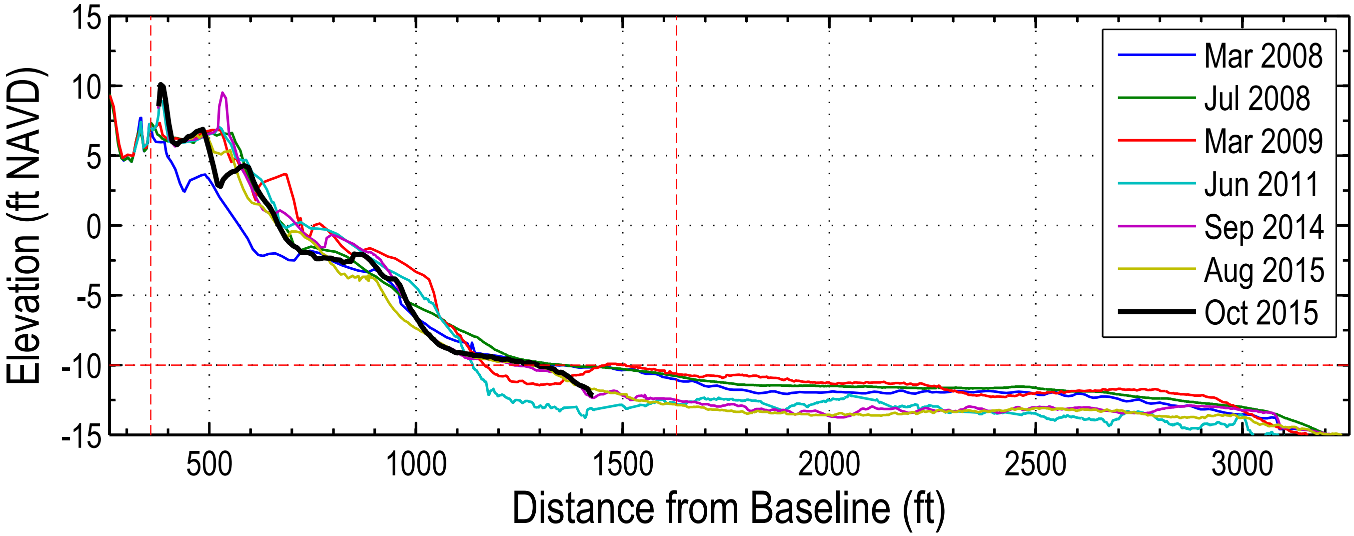
Date	Unit Vol (cy/ft)
Jul 2007	224.6
Mar 2008	222.6
Jul 2008	252.1
Mar 2009	292.2
Sep 2009	299.8
Mar 2010	275.3
Sep 2010	288.4
Jun 2011	285.6
Jul 2012	296.4
Jul 2013	287.7
Sep 2014	296.3
Aug 2015	262.8
Oct 2015	274.0



X: 2385987.87
Y: 354415.2

Station: 230+00 (55th Ave)

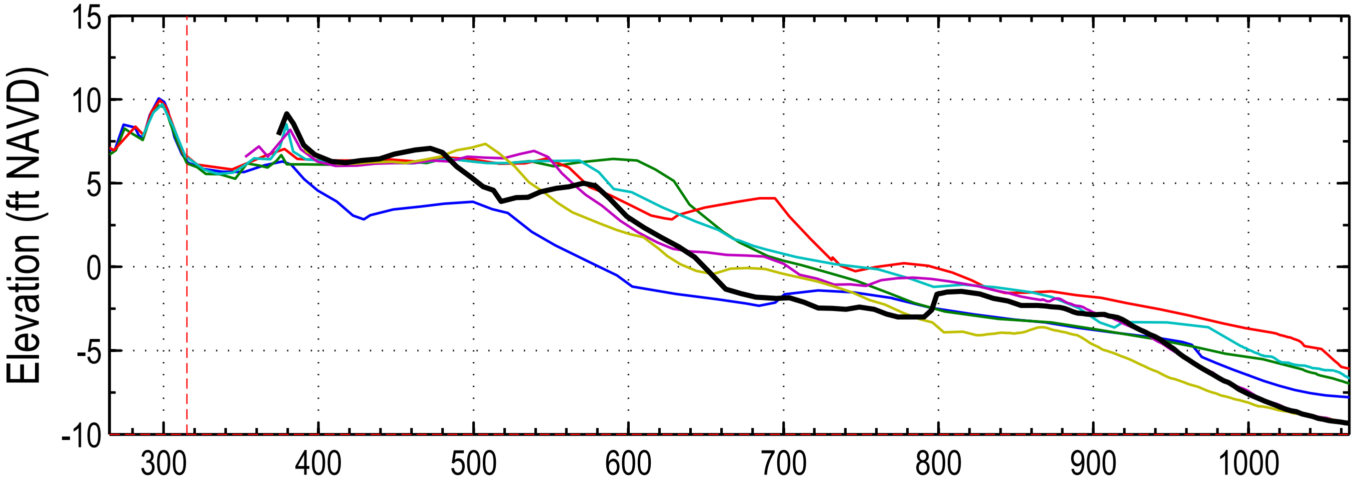


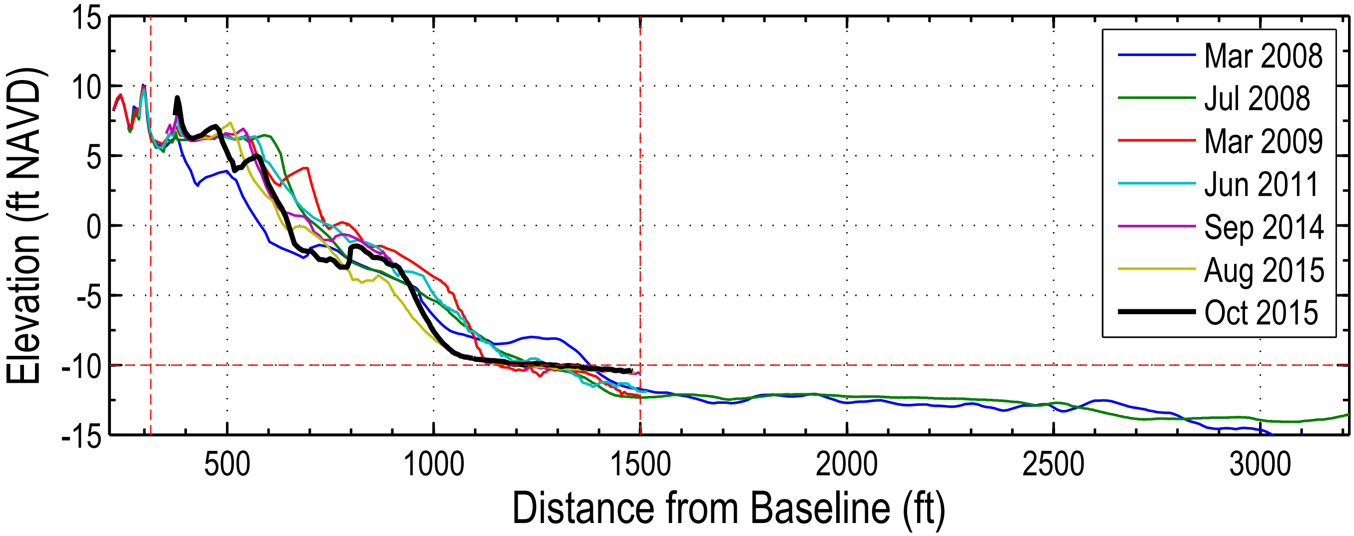


Date	Unit Vol (cy/ft)
Jul 2007	249.4
Mar 2008	233.0
Jul 2008	284.4
Mar 2009	306.3
Sep 2009	307.4
Mar 2010	298.8
Sep 2010	304.6
Jun 2011	296.5
Jul 2012	293.8
Jul 2013	293.6
Sep 2014	287.1
Aug 2015	261.9
Oct 2015	270.6

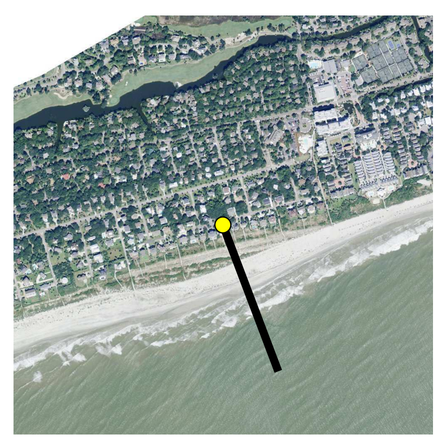
X: 2386174.97
Y: 354485.86

Station: 232+00 (10+00)



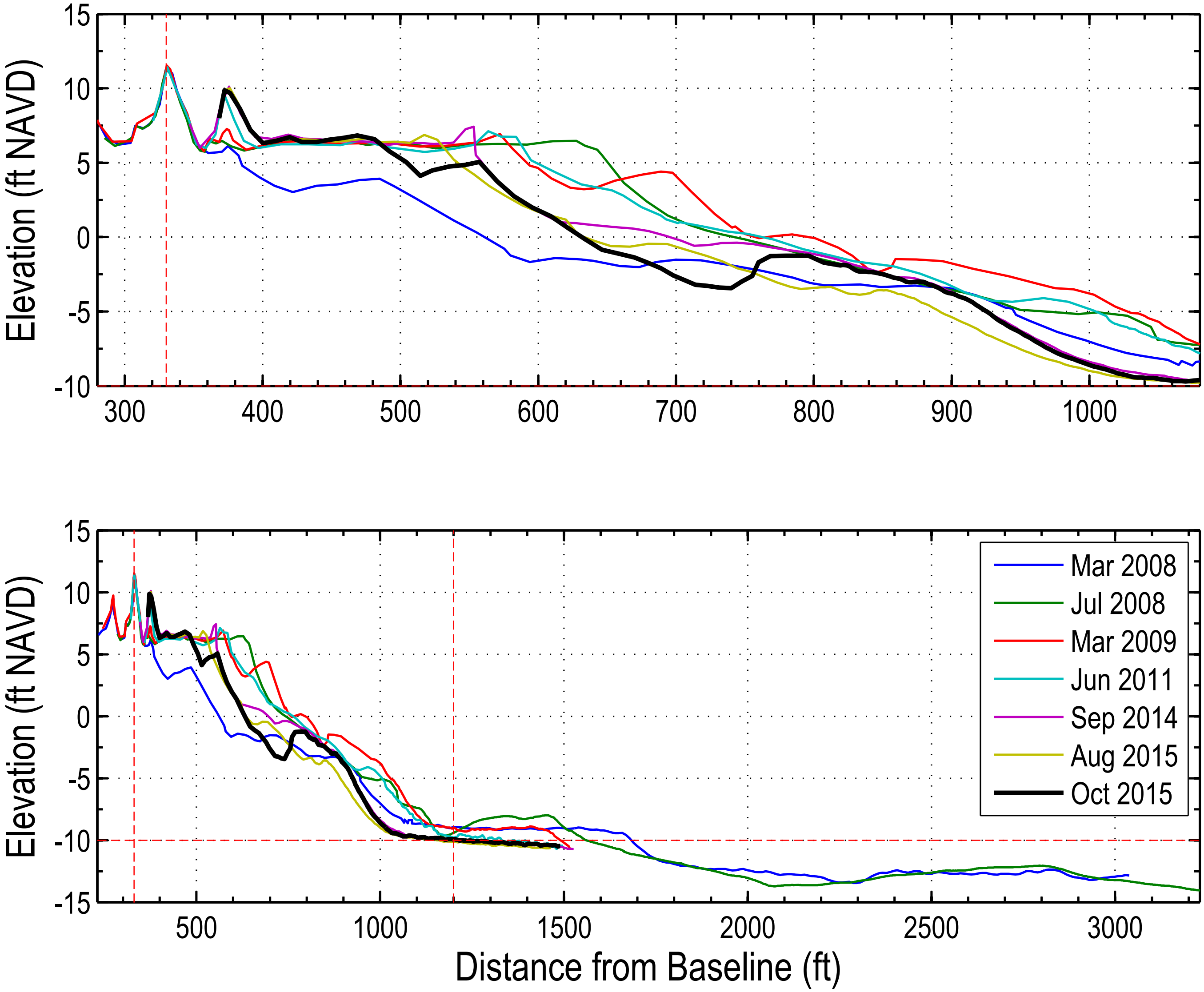


Date	Unit Vol (cy/ft)
Jul 2007	257.4
Mar 2008	273.9
Jul 2008	316.6
Mar 2009	336.9
Sep 2009	336.8
Mar 2010	333.9
Sep 2010	333.6
Jun 2011	327.2
Jul 2012	318.1
Jul 2013	307.8
Sep 2014	300.0
Aug 2015	279.7
Oct 2015	290.1

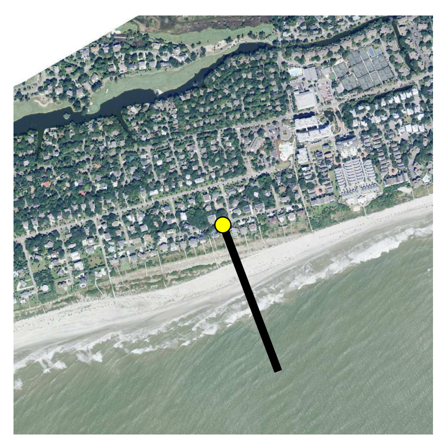


X: 2386362.07
Y: 354556.53

Station: 234+00 (12+00)

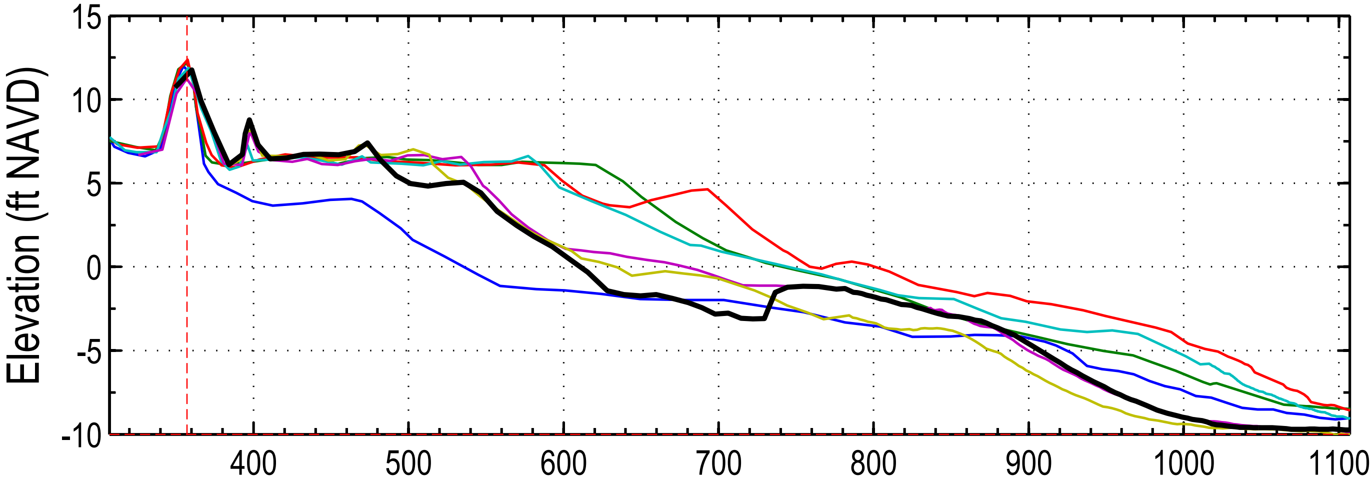


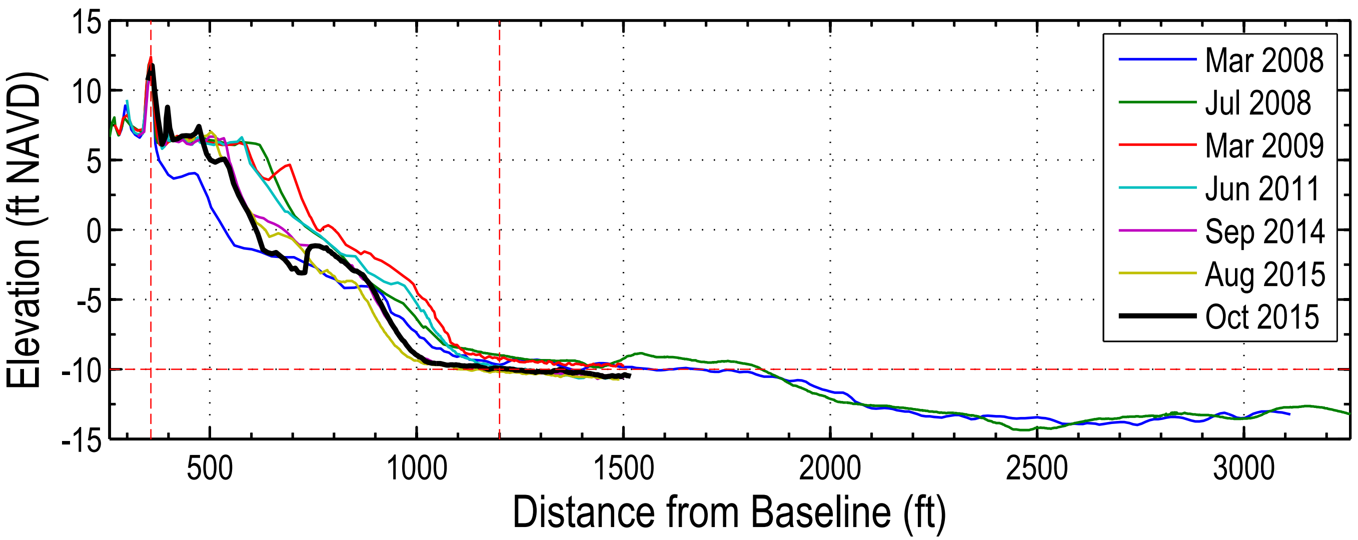
Date	Unit Vol (cy/ft)
Jul 2007	228.7
Mar 2008	245.9
Jul 2008	320.5
Mar 2009	335.1
Sep 2009	327.9
Mar 2010	321.9
Sep 2010	319.7
Jun 2011	317.6
Jul 2012	301.7
Jul 2013	298.1
Sep 2014	282.1
Aug 2015	262.8
Oct 2015	268.1



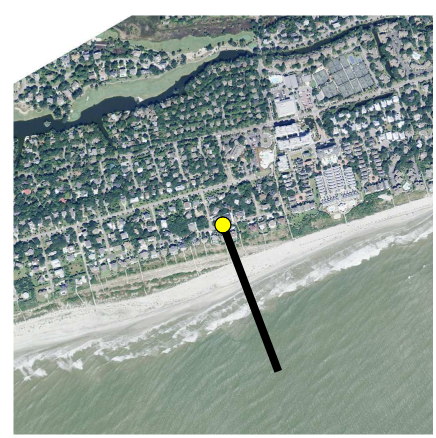
X: 2386549.17
Y: 354627.19

Station: 236+00 (14+00)



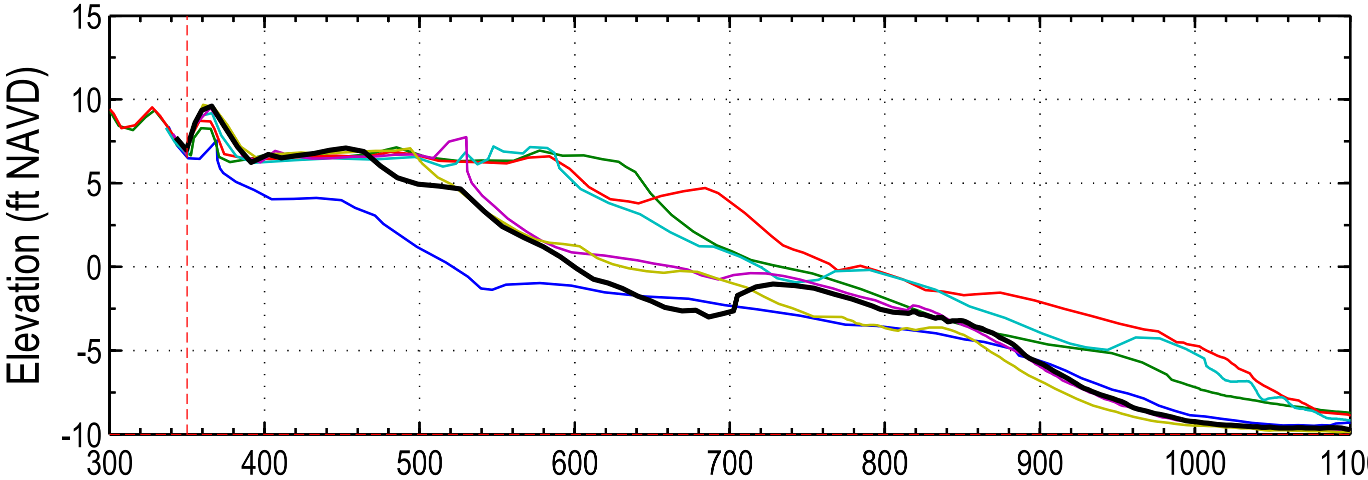


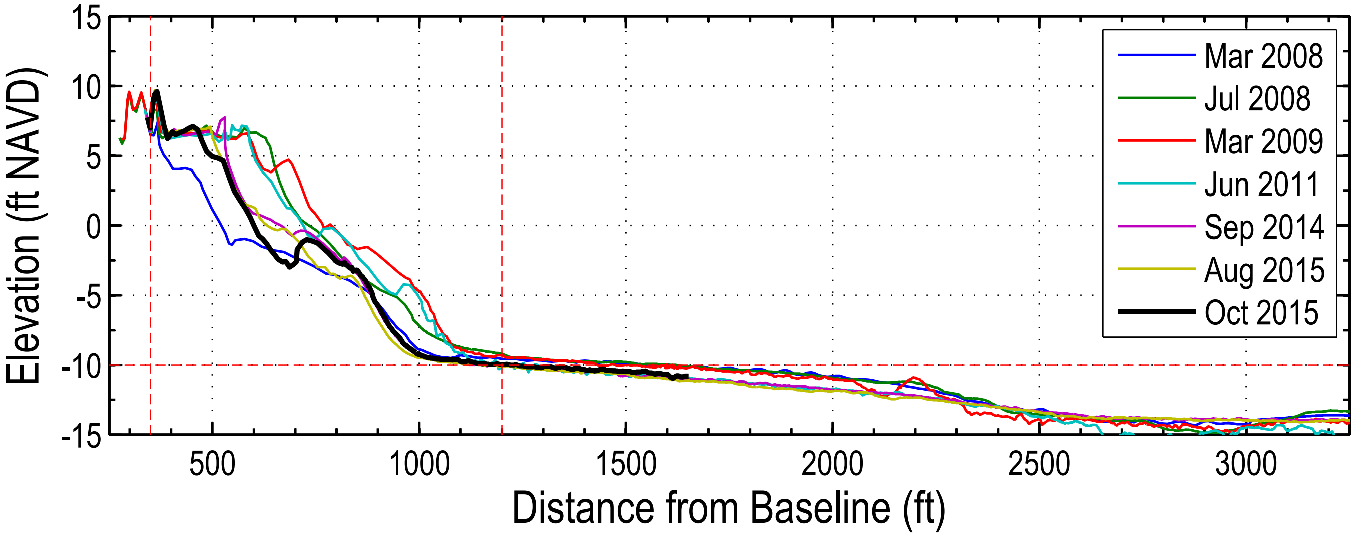
Date	Unit Vol (cy/ft)
Jul 2007	204.0
Mar 2008	214.2
Jul 2008	295.1
Mar 2009	317.1
Sep 2009	300.6
Mar 2010	301.7
Sep 2010	297.7
Jun 2011	294.7
Jul 2012	284.6
Jul 2013	267.4
Sep 2014	252.3
Aug 2015	237.1
Oct 2015	241.4



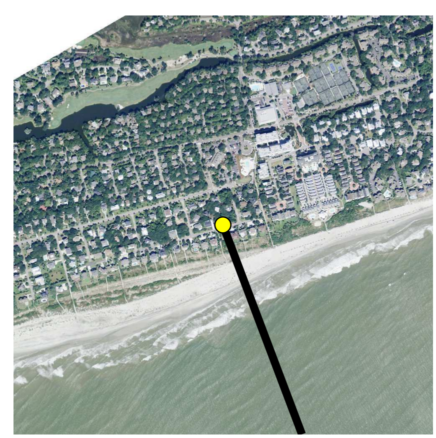
X: 2386736.27
Y: 354697.85

Station: 238+00 (16+00)



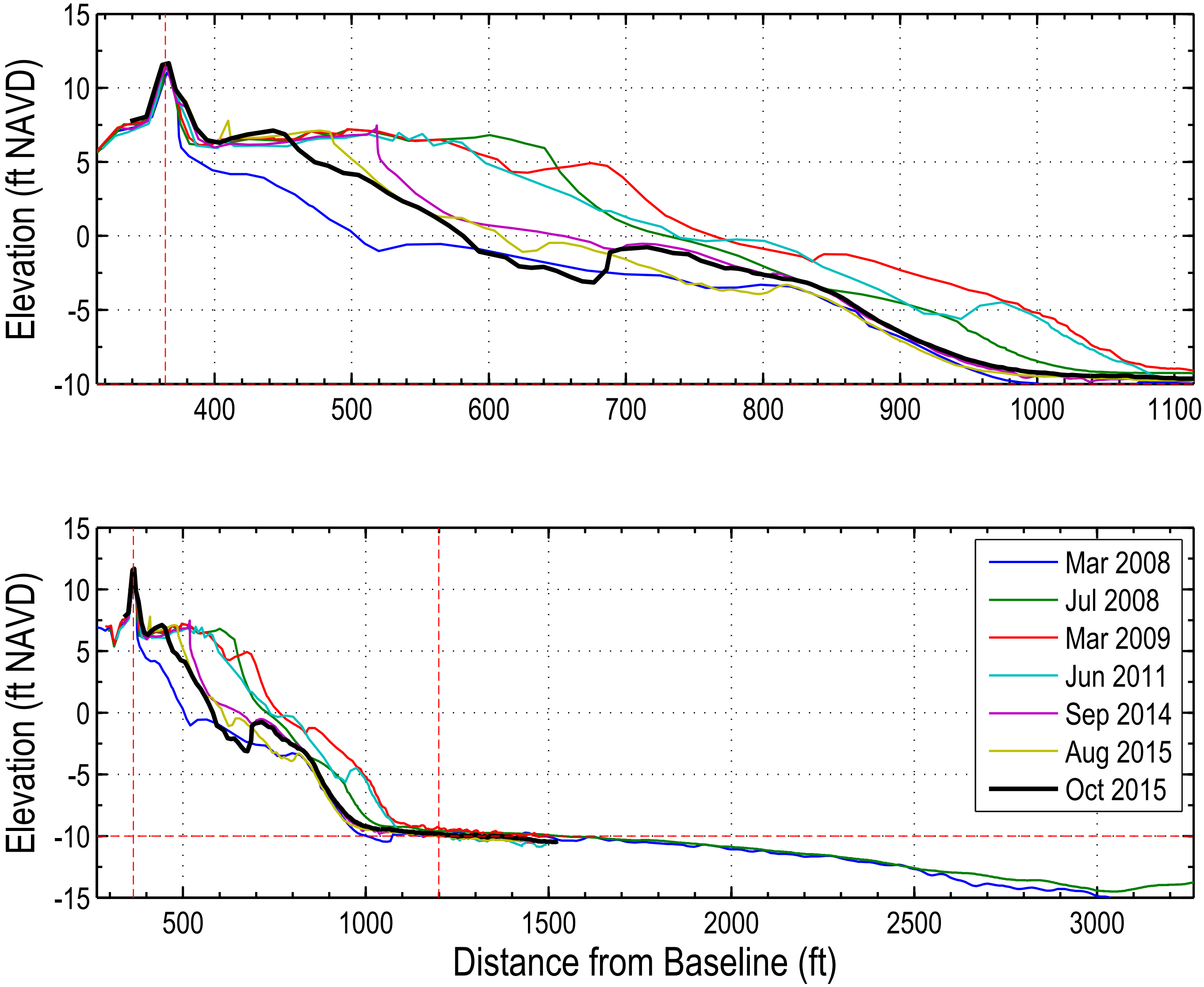


Date	Unit Vol (cy/ft)
Jul 2007	204.7
Mar 2008	204.8
Jul 2008	294.6
Mar 2009	318.1
Sep 2009	299.6
Mar 2010	303.7
Sep 2010	297.9
Jun 2011	296.4
Jul 2012	279.9
Jul 2013	269.7
Sep 2014	249.4
Aug 2015	235.7
Oct 2015	236.2



X: 2386923.37
Y: 354768.52

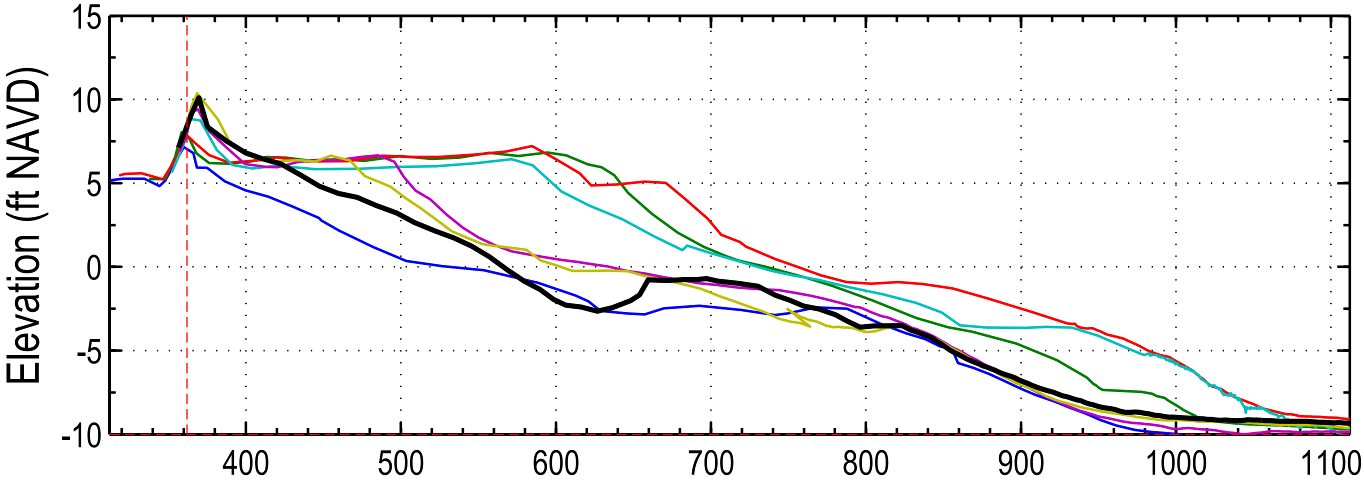
Station: 240+00 (18+00)

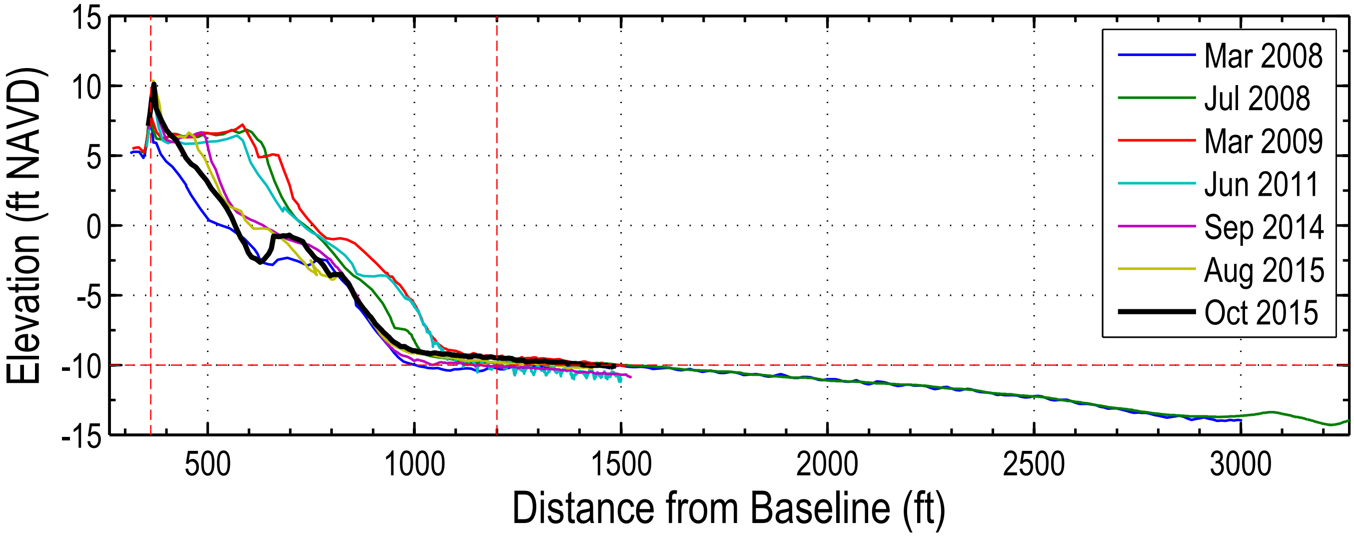


Date	Unit Vol (cy/ft)
Jul 2007	189.0
Mar 2008	184.3
Jul 2008	277.6
Mar 2009	307.6
Sep 2009	285.8
Mar 2010	288.9
Sep 2010	283.3
Jun 2011	285.9
Jul 2012	269.5
Jul 2013	250.1
Sep 2014	232.1
Aug 2015	218.0
Oct 2015	219.0

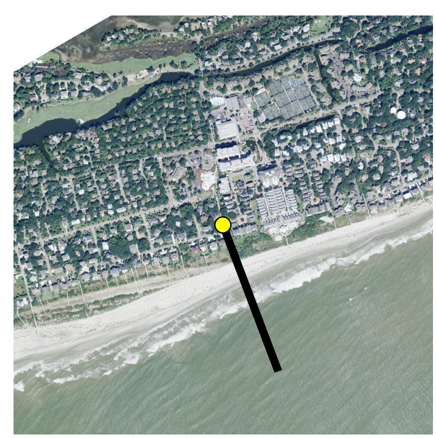
X: 2387110.47
Y: 354839.18

Station: 242+00 (20+00) BEACHCLUB CABANA - BRC1, SCCC 3165



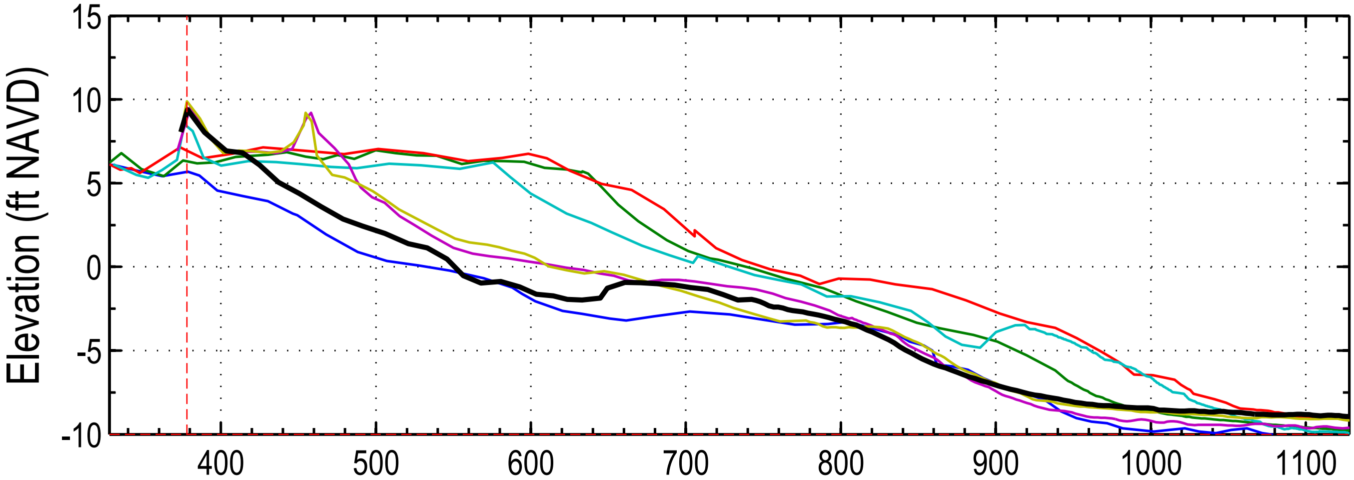


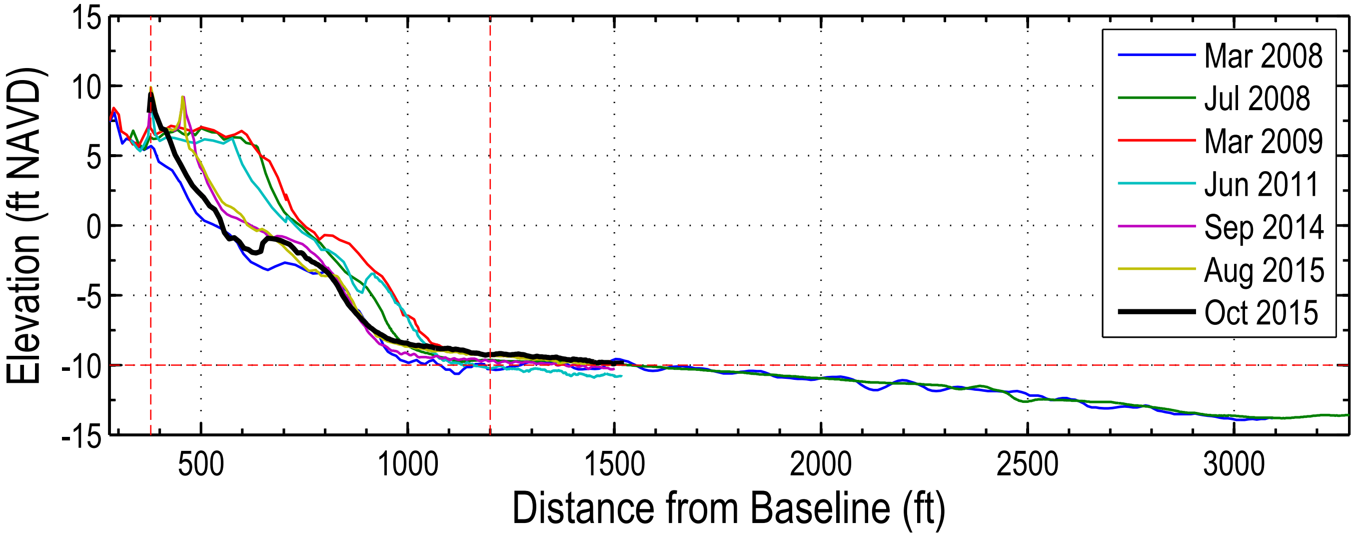
Date	Unit Vol (cy/ft)
Jul 2007	175.6
Mar 2008	182.6
Jul 2008	273.6
Mar 2009	304.3
Sep 2009	283.8
Mar 2010	283.5
Sep 2010	282.3
Jun 2011	280.0
Jul 2012	260.6
Jul 2013	241.0
Sep 2014	223.2
Aug 2015	219.0
Oct 2015	212.6



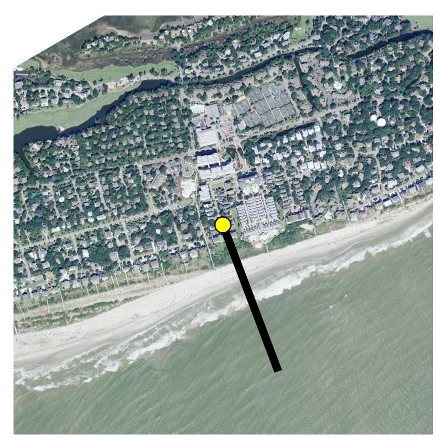
X: 2387297.57
Y: 354909.85

Station: 244+00 (22+00)



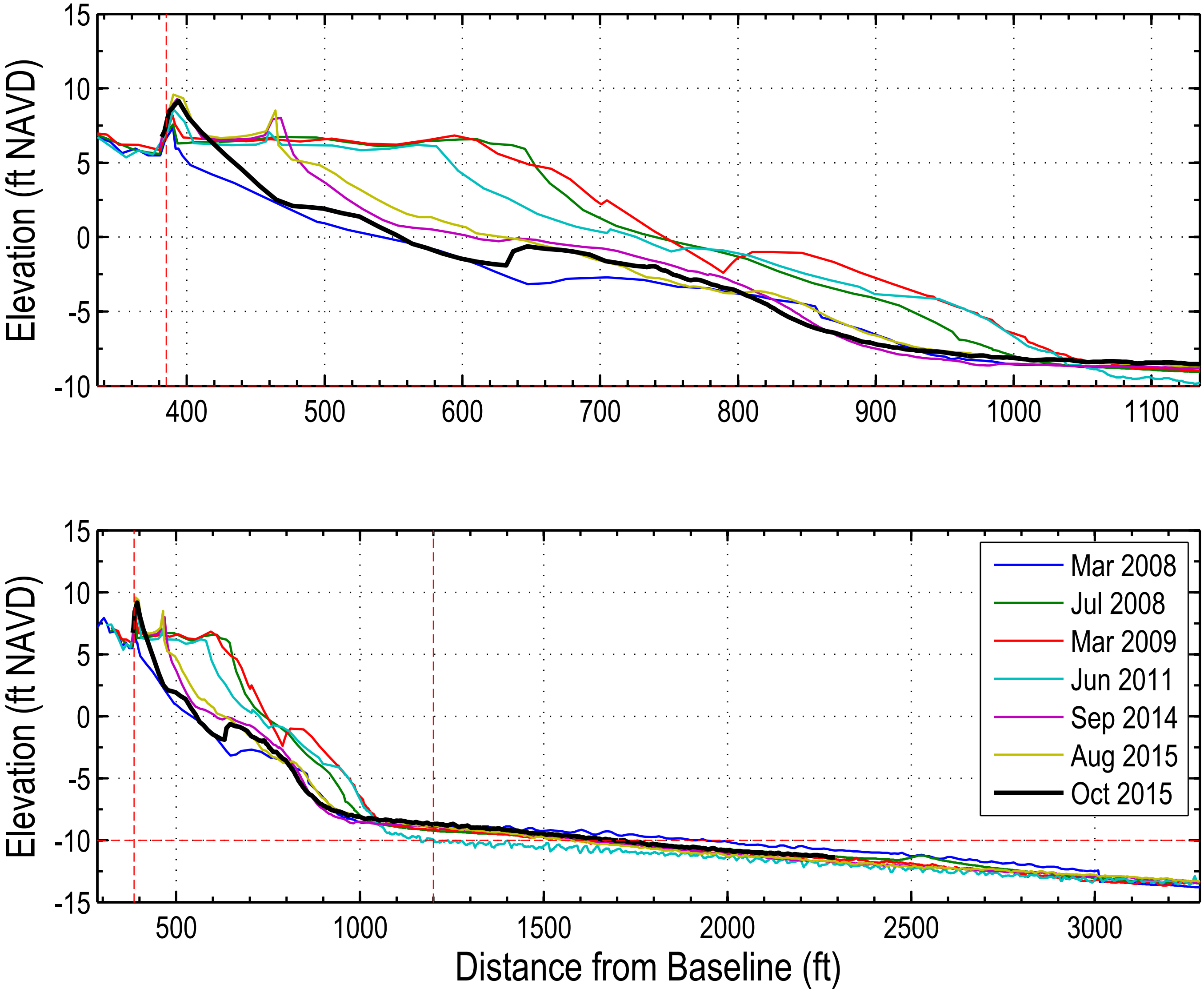


Date	Unit Vol (cy/ft)
Jul 2007	175.8
Mar 2008	172.0
Jul 2008	265.0
Mar 2009	294.1
Sep 2009	279.1
Mar 2010	270.9
Sep 2010	270.9
Jun 2011	262.5
Jul 2012	249.3
Jul 2013	227.9
Sep 2014	213.7
Aug 2015	215.8
Oct 2015	200.7

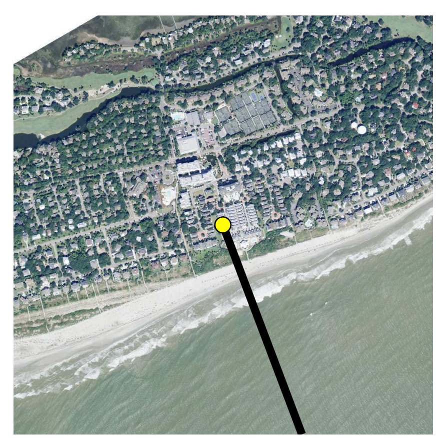


X: 2387484.67
Y: 354980.51

Station: 246+00 (24+00)

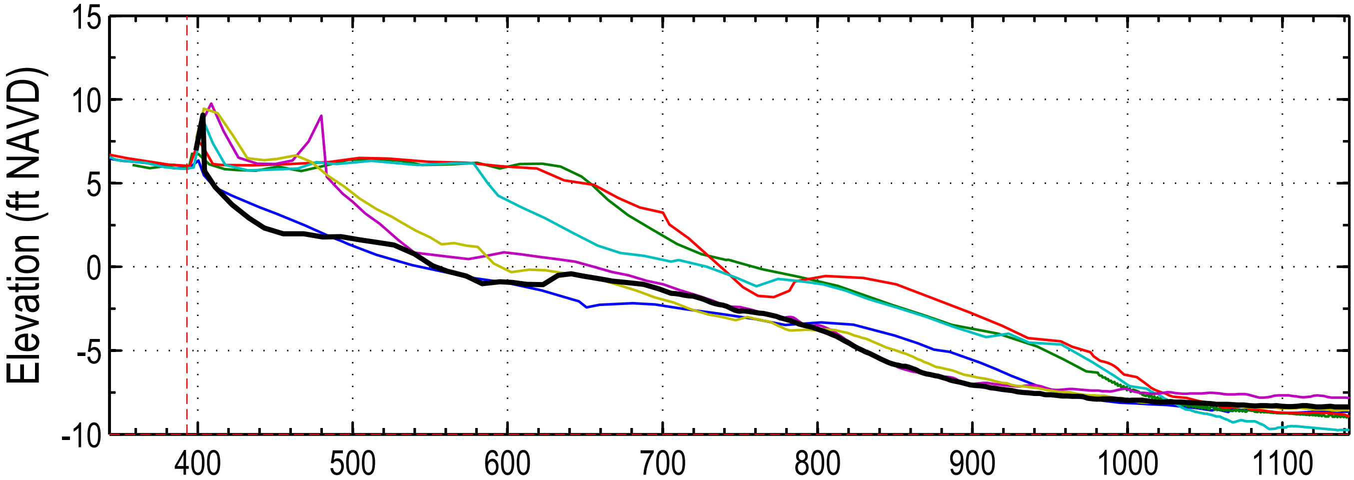


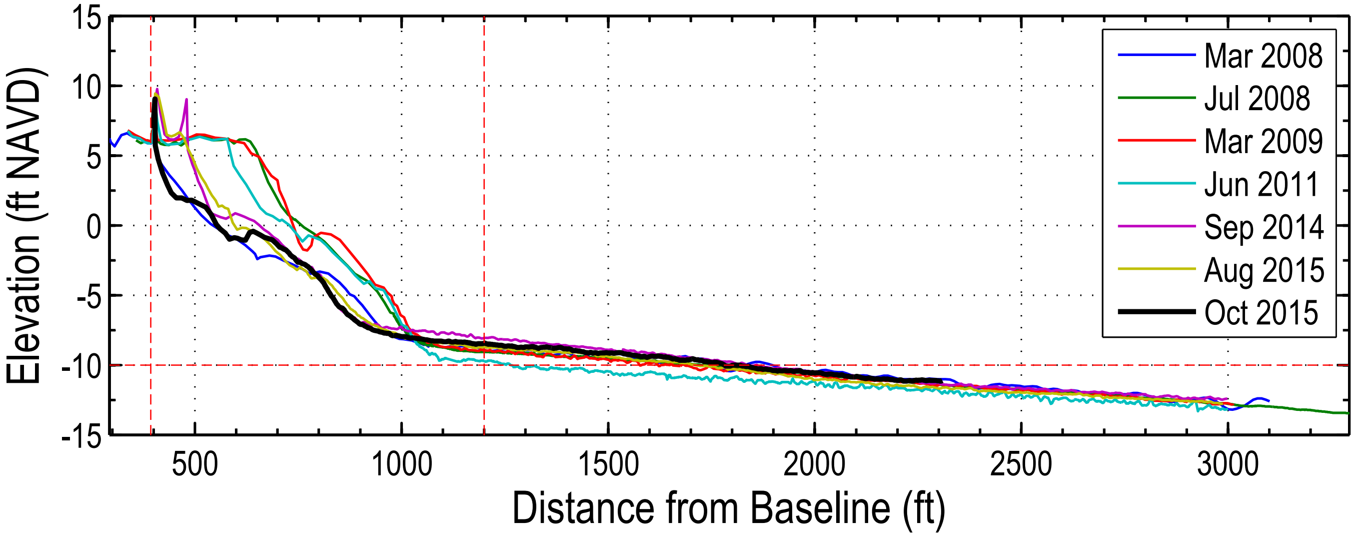
Date	Unit Vol (cy/ft)
Jul 2007	185.1
Mar 2008	181.8
Jul 2008	271.0
Mar 2009	286.4
Sep 2009	271.4
Mar 2010	263.5
Sep 2010	264.5
Jun 2011	262.6
Jul 2012	239.8
Jul 2013	214.6
Sep 2014	211.7
Aug 2015	217.7
Oct 2015	196.9



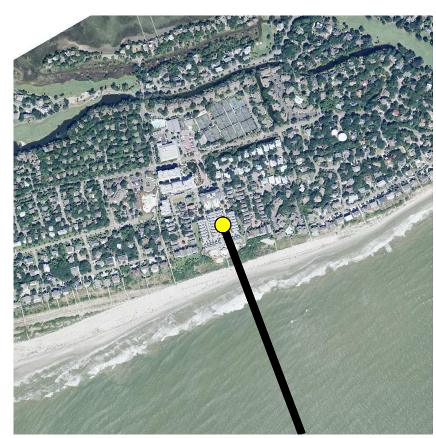
X: 2387671.77
Y: 355051.17

Station: 248+00 (26+00)



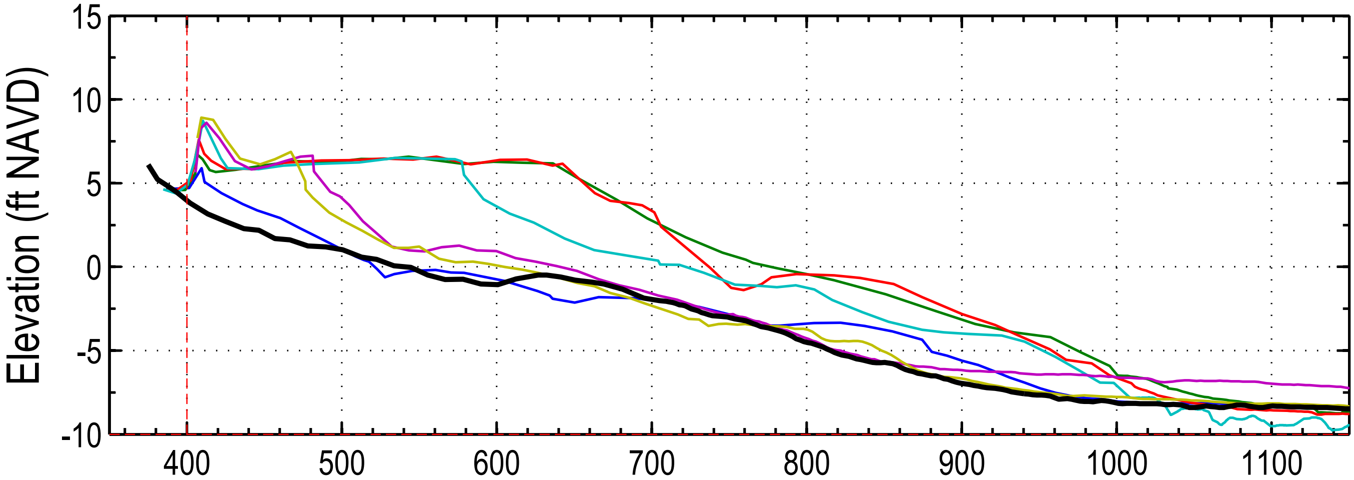


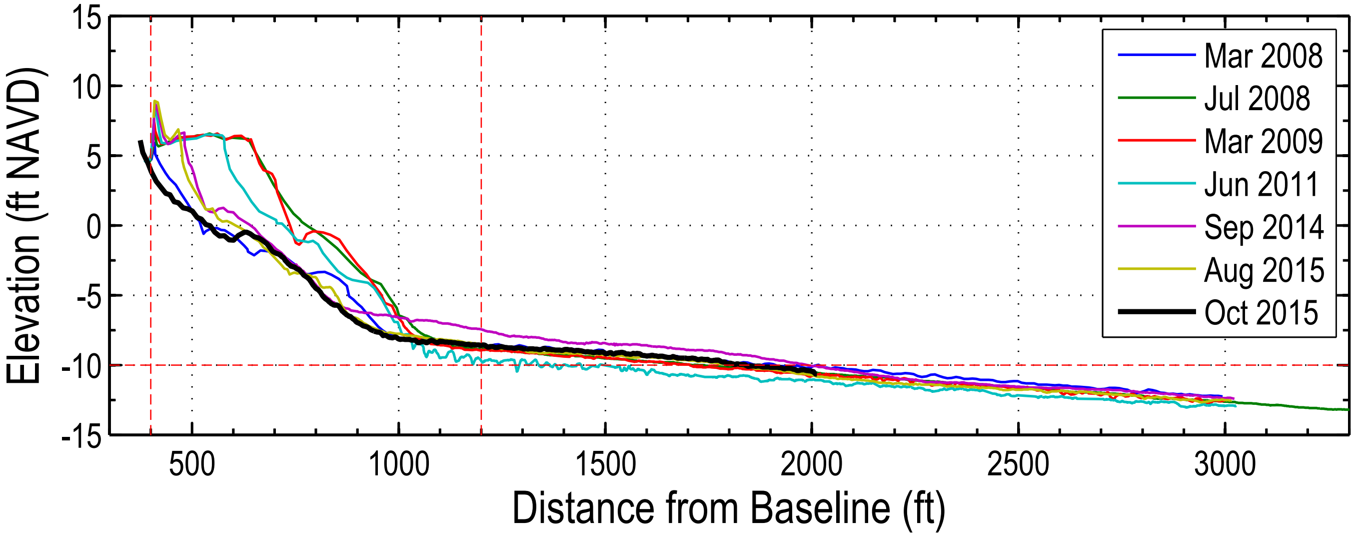
Date	Unit Vol (cy/ft)
Jul 2007	182.0
Mar 2008	188.7
Jul 2008	272.2
Mar 2009	280.5
Sep 2009	267.2
Mar 2010	255.5
Sep 2010	258.1
Jun 2011	255.9
Jul 2012	230.1
Jul 2013	218.3
Sep 2014	217.5
Aug 2015	211.4
Oct 2015	190.0



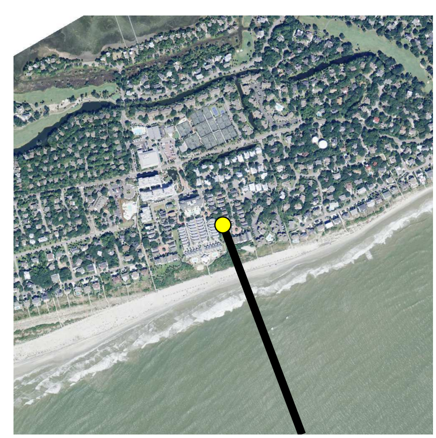
X: 2387858.87
Y: 355121.84

Station: 250+00 (28+00)



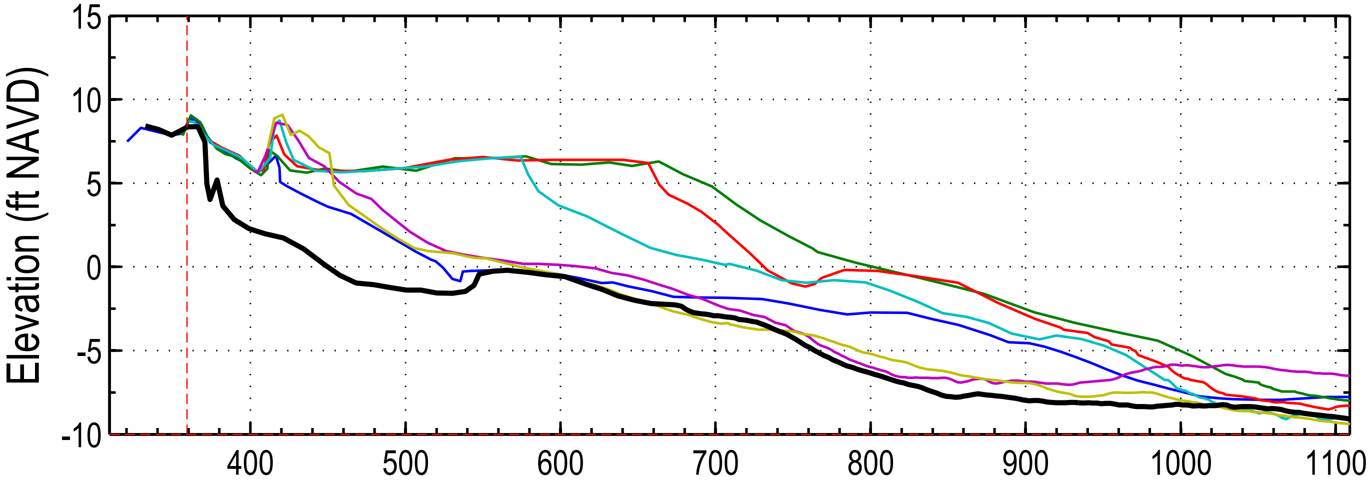


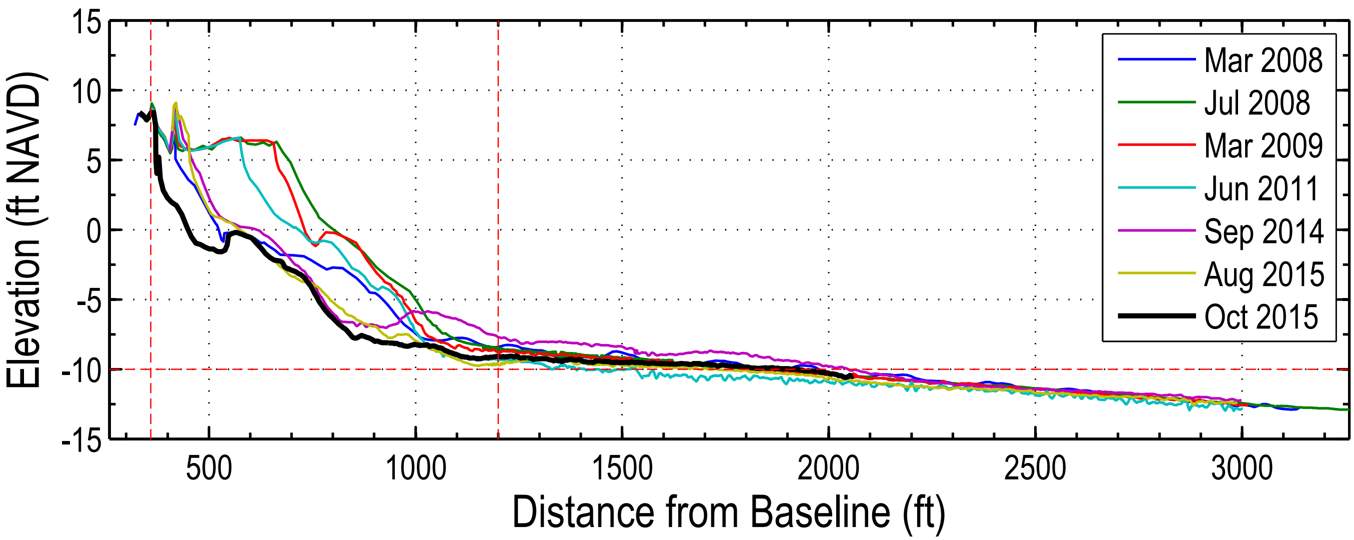
Date	Unit Vol (cy/ft)
Jul 2007	186.2
Mar 2008	188.5
Jul 2008	282.2
Mar 2009	278.3
Sep 2009	261.2
Mar 2010	253.7
Sep 2010	254.2
Jun 2011	248.6
Jul 2012	220.9
Jul 2013	223.7
Sep 2014	217.8
Aug 2015	200.3
Oct 2015	176.5



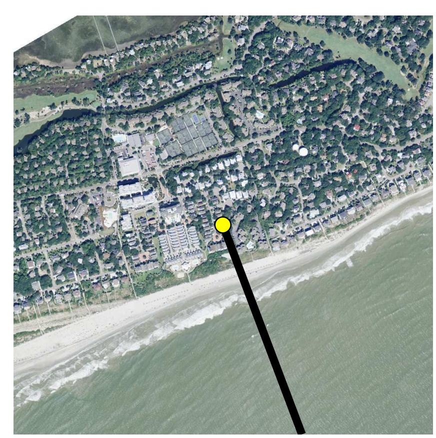
X: 2388045.97
Y: 355192.5

Station: 252+00 (30+00)



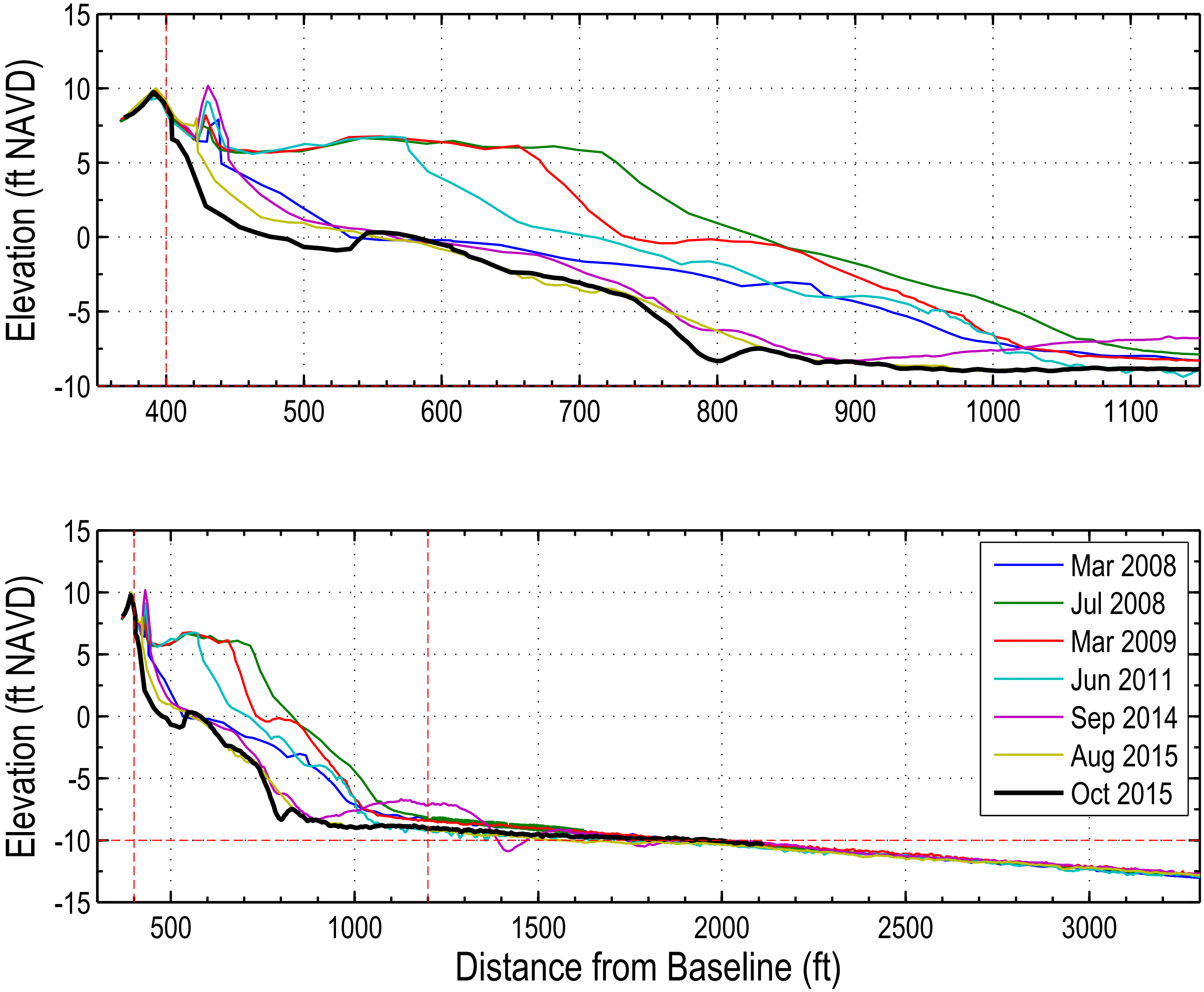


Date	Unit Vol (cy/ft)
Jul 2007	232.0
Mar 2008	228.9
Jul 2008	322.8
Mar 2009	306.5
Sep 2009	294.0
Mar 2010	284.2
Sep 2010	282.6
Jun 2011	276.8
Jul 2012	256.1
Jul 2013	276.5
Sep 2014	228.0
Aug 2015	204.7
Oct 2015	170.2

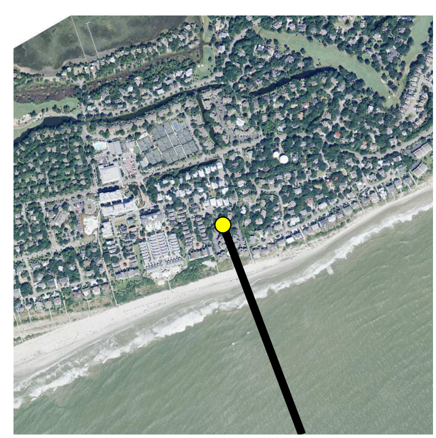


X: 2388233.07
Y: 355263.16

Station: 254+00 (32+00) (Seagrove Villas)

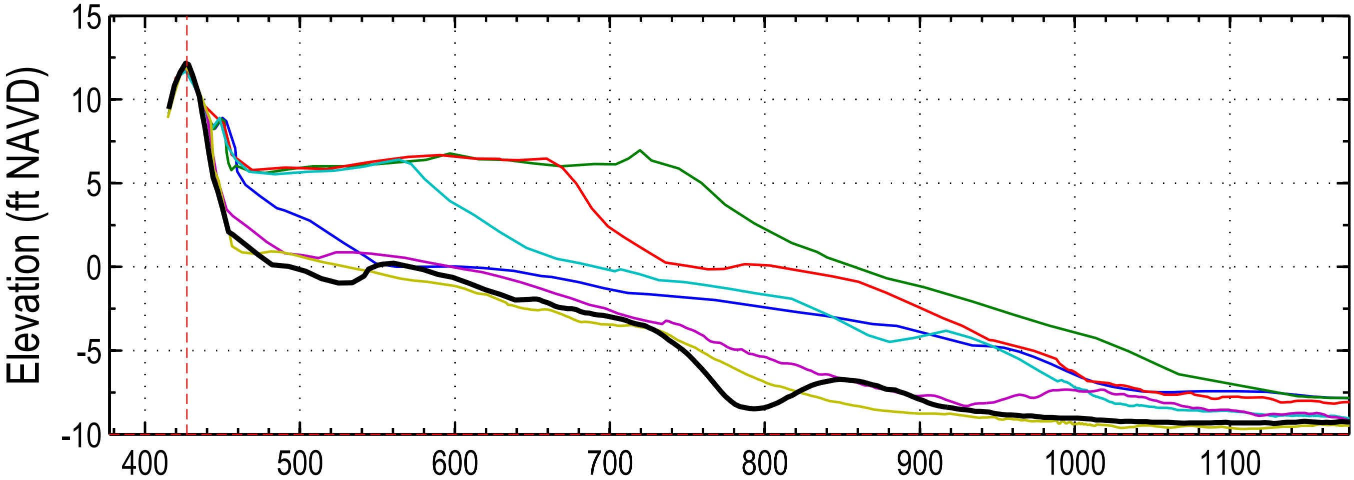


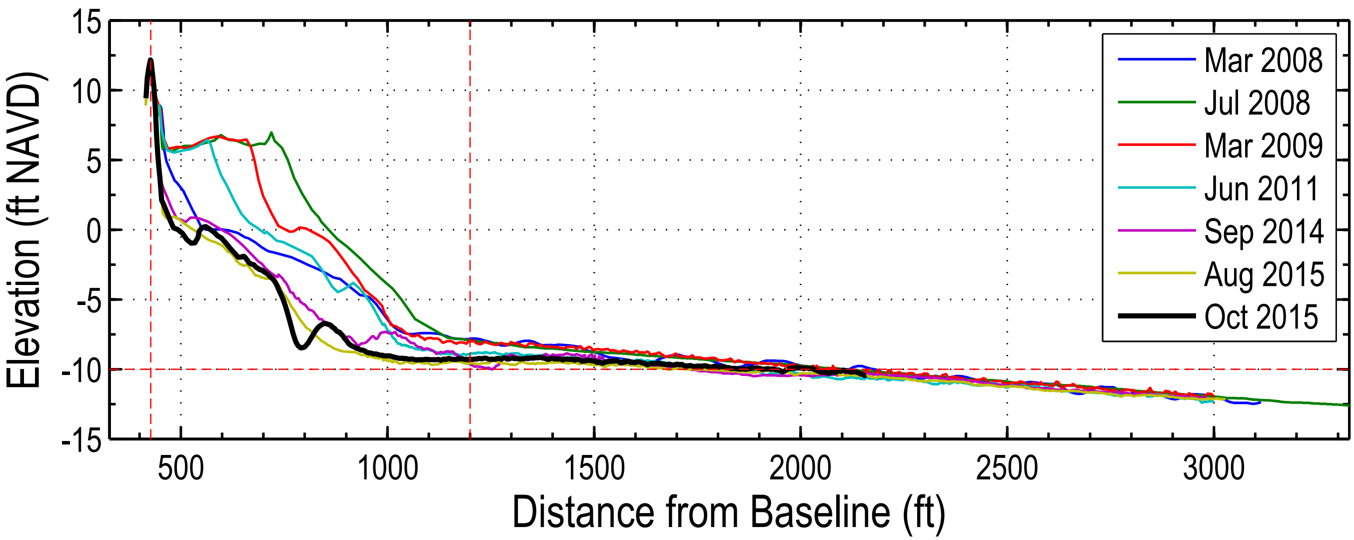
Date	Unit Vol (cy/ft)
Jul 2007	232.4
Mar 2008	212.3
Jul 2008	312.9
Mar 2009	285.3
Sep 2009	282.0
Mar 2010	262.5
Sep 2010	257.6
Jun 2011	250.7
Jul 2012	237.4
Jul 2013	257.9
Sep 2014	187.8
Aug 2015	157.7
Oct 2015	146.9



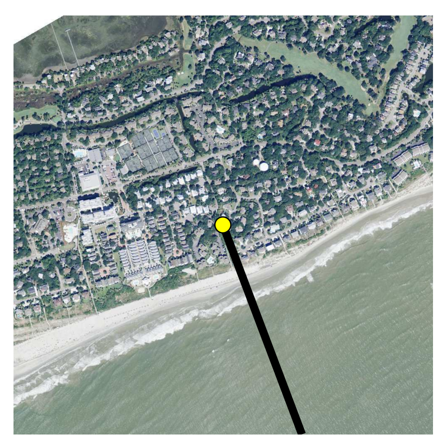
X: 2388420.17
Y: 355333.83

Station: 256+00 (34+00)



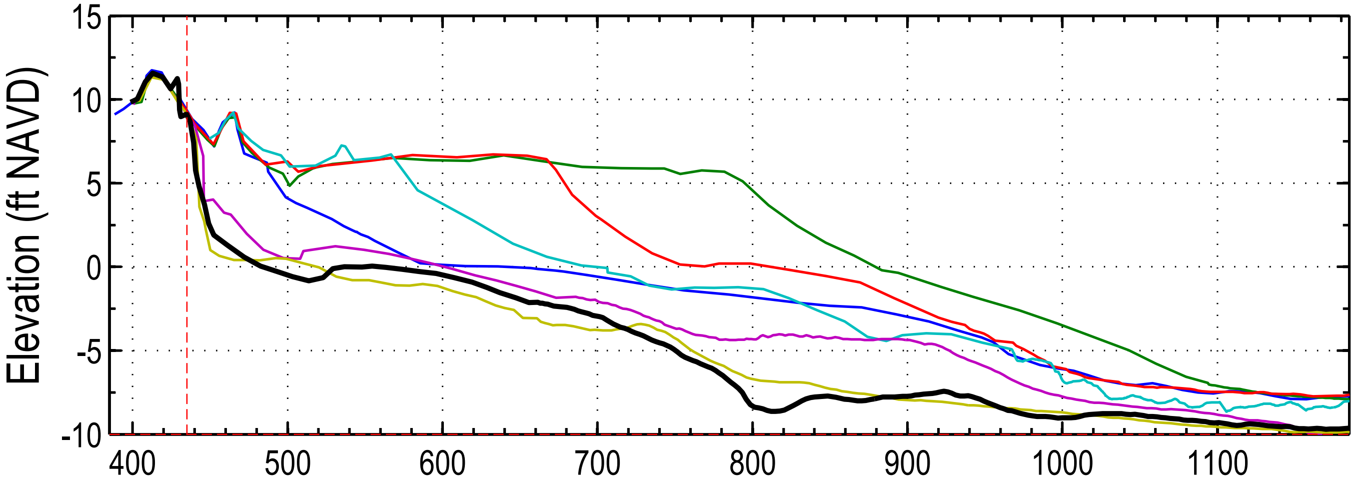


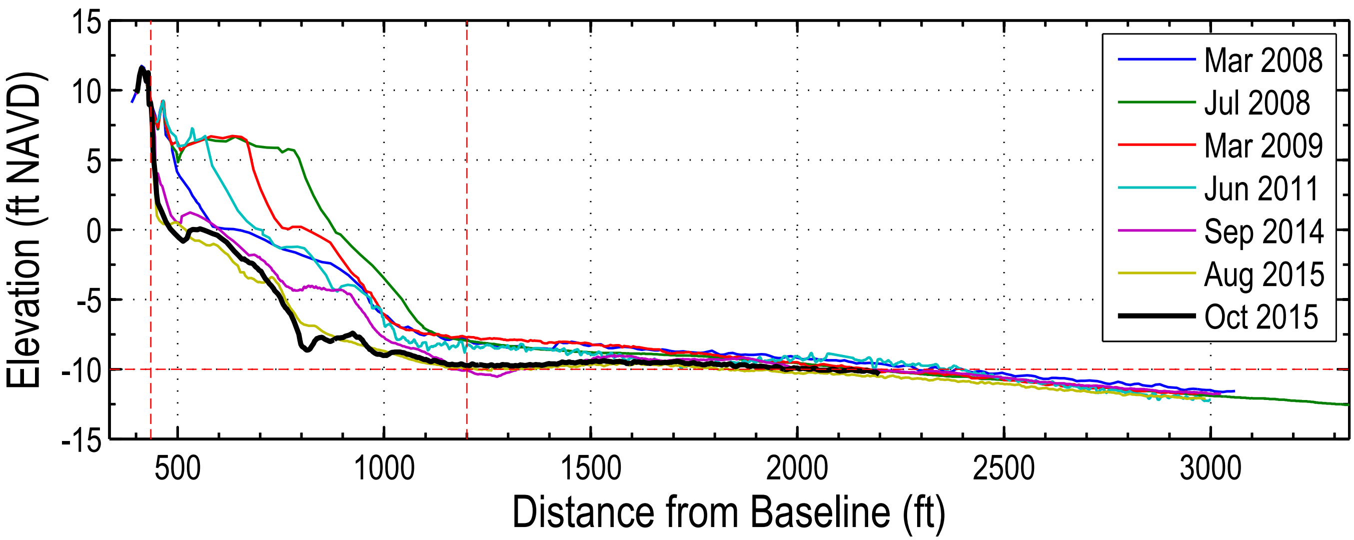
Date	Unit Vol (cy/ft)
Jul 2007	249.2
Mar 2008	212.3
Jul 2008	313.2
Mar 2009	276.2
Sep 2009	273.8
Mar 2010	248.0
Sep 2010	240.7
Jun 2011	233.6
Jul 2012	234.1
Jul 2013	230.9
Sep 2014	164.1
Aug 2015	133.8
Oct 2015	137.4



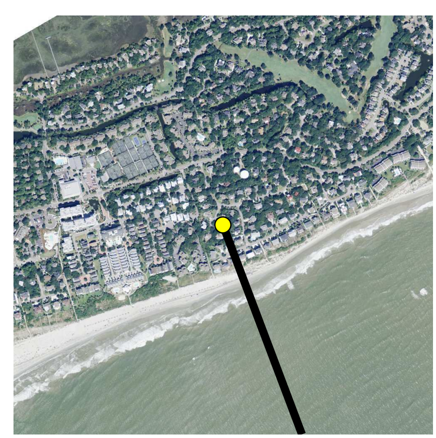
X: 2388607.27
Y: 355404.49

Station: 258+00 (36+00) BEACHWOOD EAST (SOUTH) - SCCC 3167



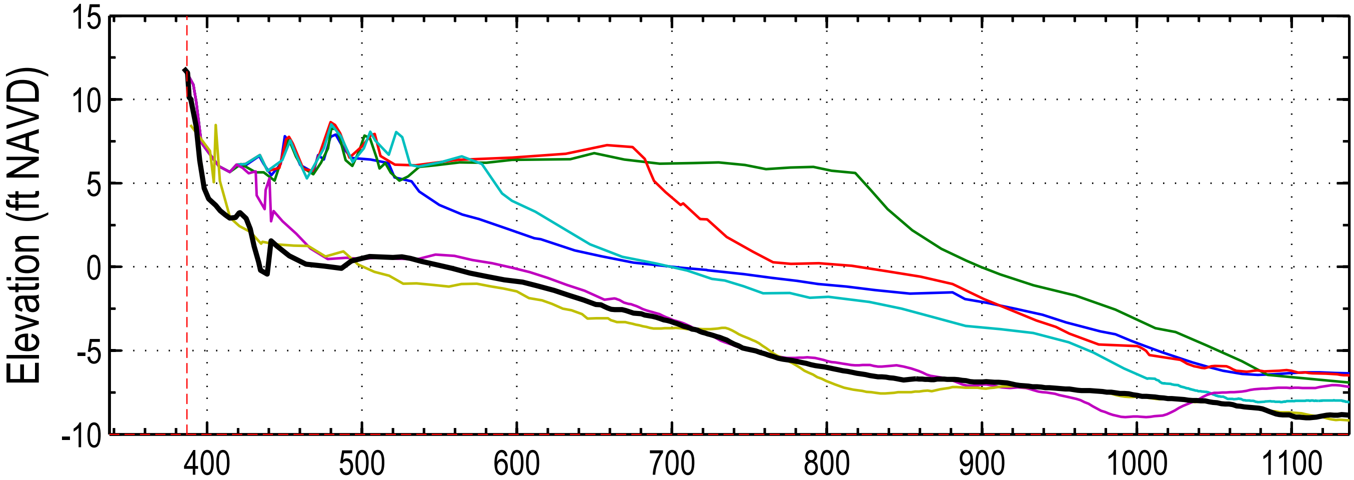


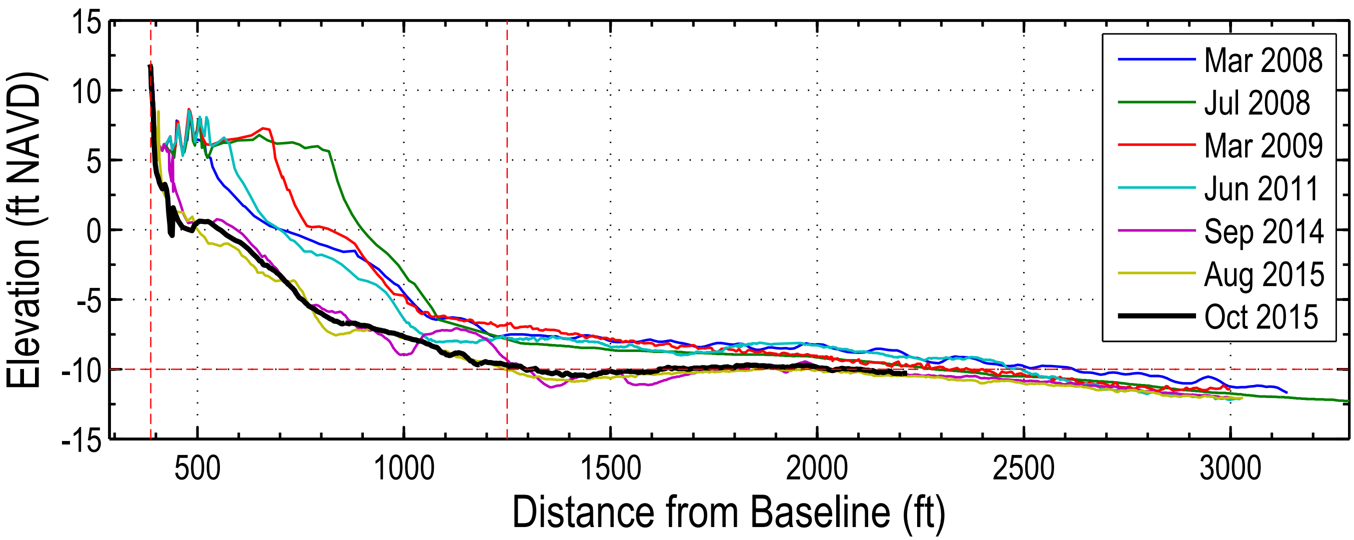
Date	Unit Vol (cy/ft)
Jul 2007	263.5
Mar 2008	222.9
Jul 2008	318.5
Mar 2009	277.9
Sep 2009	273.5
Mar 2010	240.6
Sep 2010	235.4
Jun 2011	237.6
Jul 2012	239.1
Jul 2013	206.3
Sep 2014	172.5
Aug 2015	129.6
Oct 2015	132.1



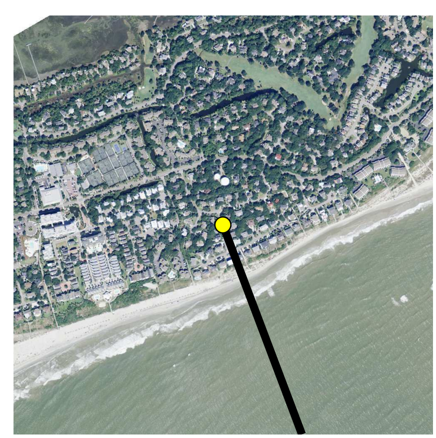
X: 2388794.38
Y: 355475.15

Station: 260+00 (38+00)



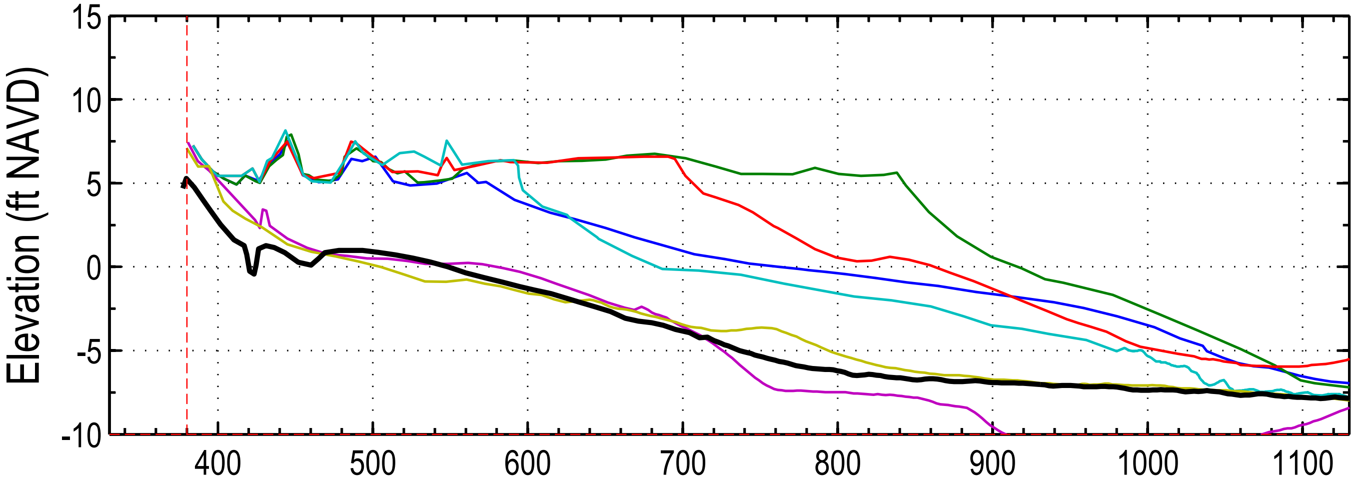


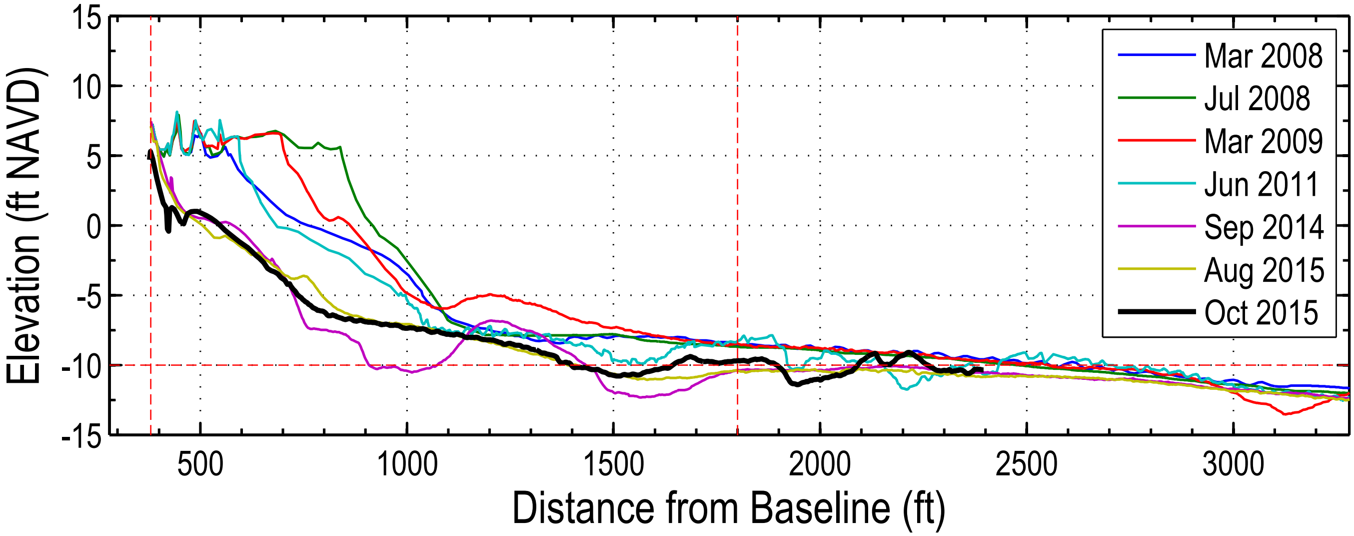
Date	Unit Vol (cy/ft)
Jul 2007	308.3
Mar 2008	286.7
Jul 2008	362.9
Mar 2009	328.4
Sep 2009	314.5
Mar 2010	274.8
Sep 2010	274.5
Jun 2011	274.2
Jul 2012	280.4
Jul 2013	227.9
Sep 2014	189.1
Aug 2015	161.9
Oct 2015	168.8



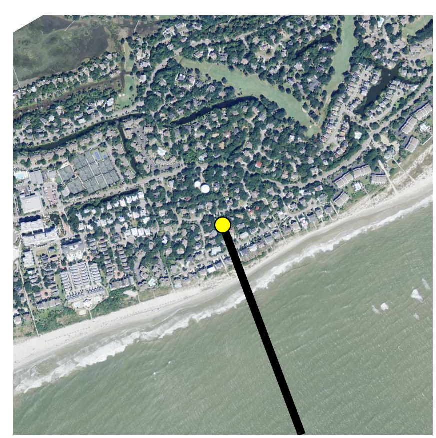
X: 2388981.48
Y: 355545.82

Station: 262+00 (40+00)

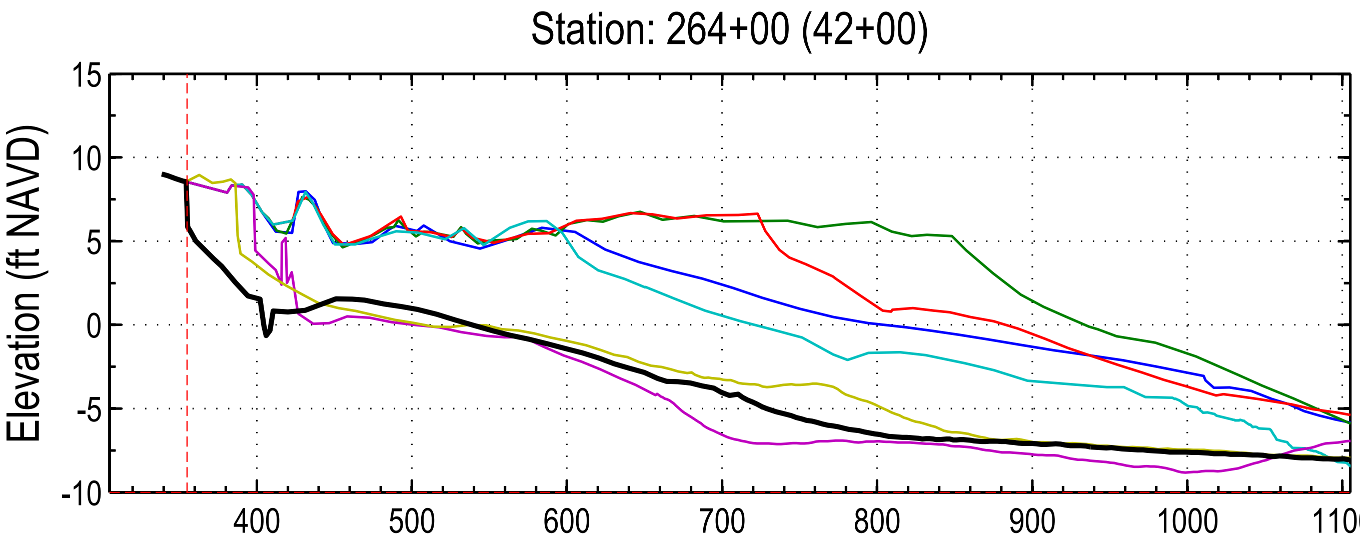


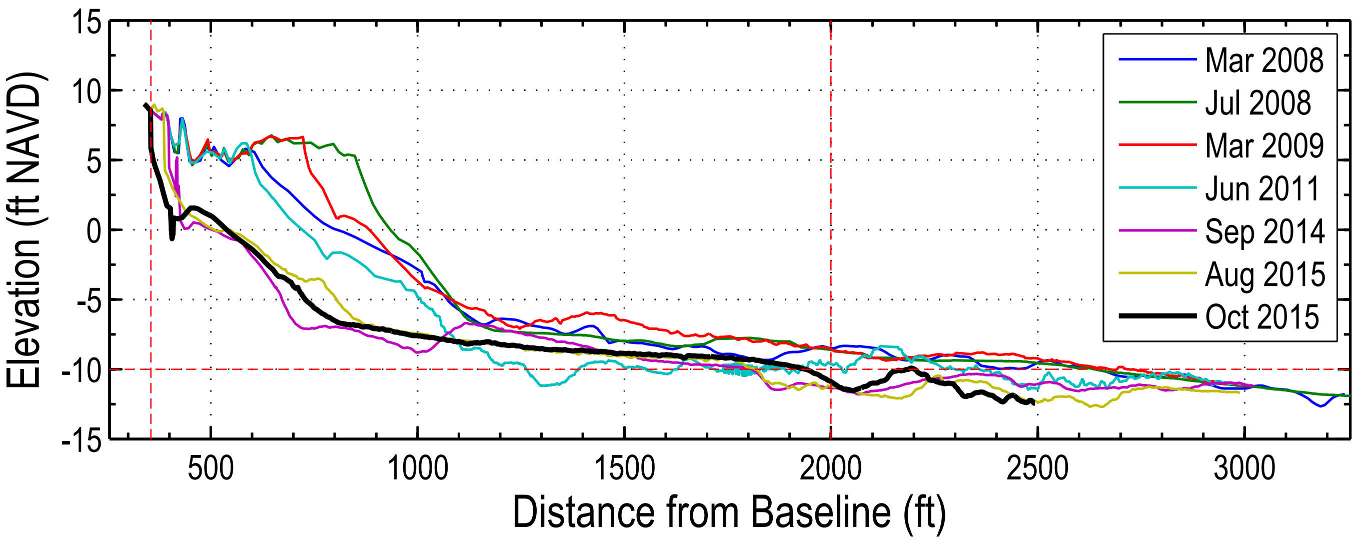


Date	Unit Vol (cy/ft)
Jul 2007	382.4
Mar 2008	341.9
Jul 2008	404.9
Mar 2009	399.8
Sep 2009	356.1
Mar 2010	322.7
Sep 2010	335.5
Jun 2011	310.2
Jul 2012	300.8
Jul 2013	266.1
Sep 2014	170.2
Aug 2015	187.8
Oct 2015	181.8

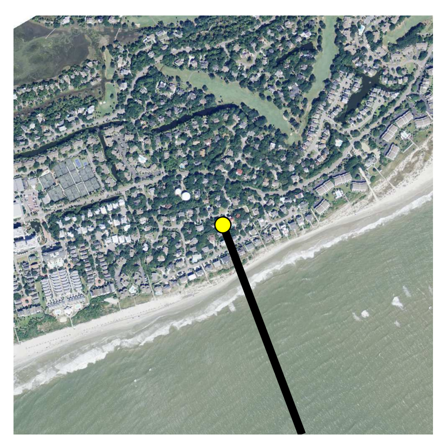


X: 2389168.58
Y: 355616.48



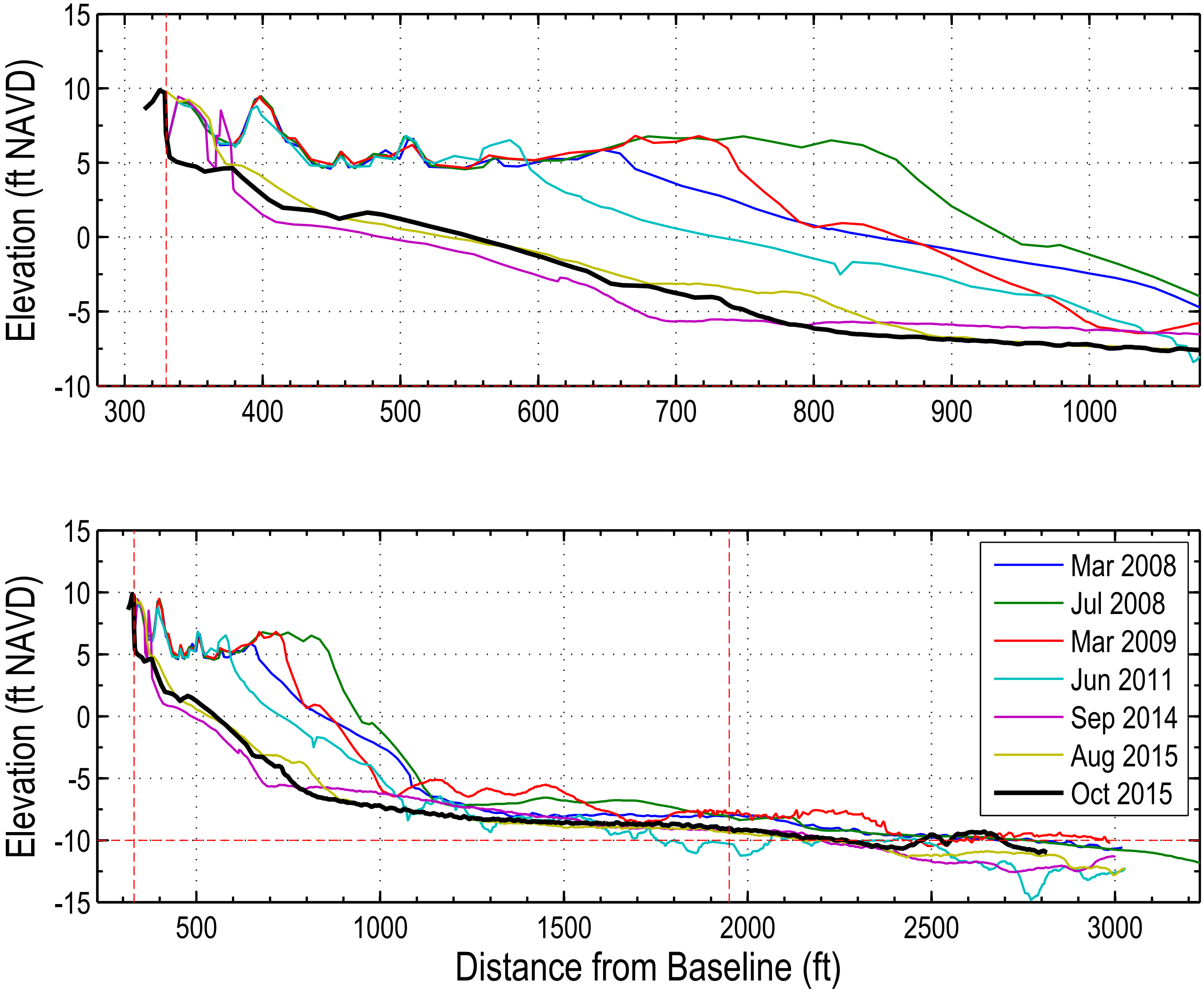


Date	Unit Vol (cy/ft)
Jul 2007	428.3
Mar 2008	392.7
Jul 2008	452.8
Mar 2009	444.8
Sep 2009	404.1
Mar 2010	374.3
Sep 2010	370.8
Jun 2011	300.6
Jul 2012	302.8
Jul 2013	254.7
Sep 2014	201.4
Aug 2015	221.5
Oct 2015	207.6

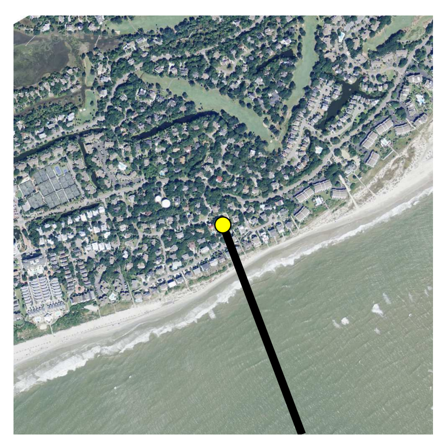


X: 2389355.68
Y: 355687.15

Station: 266+00 (44+00) BEACHWOOD EAST, BRC2, SCCC 3170

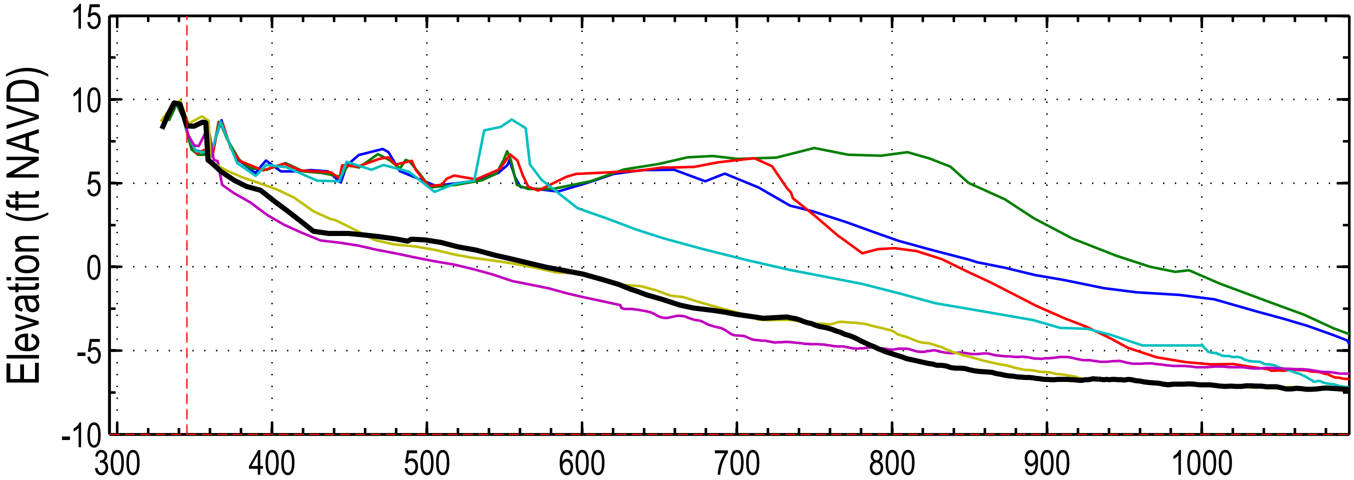


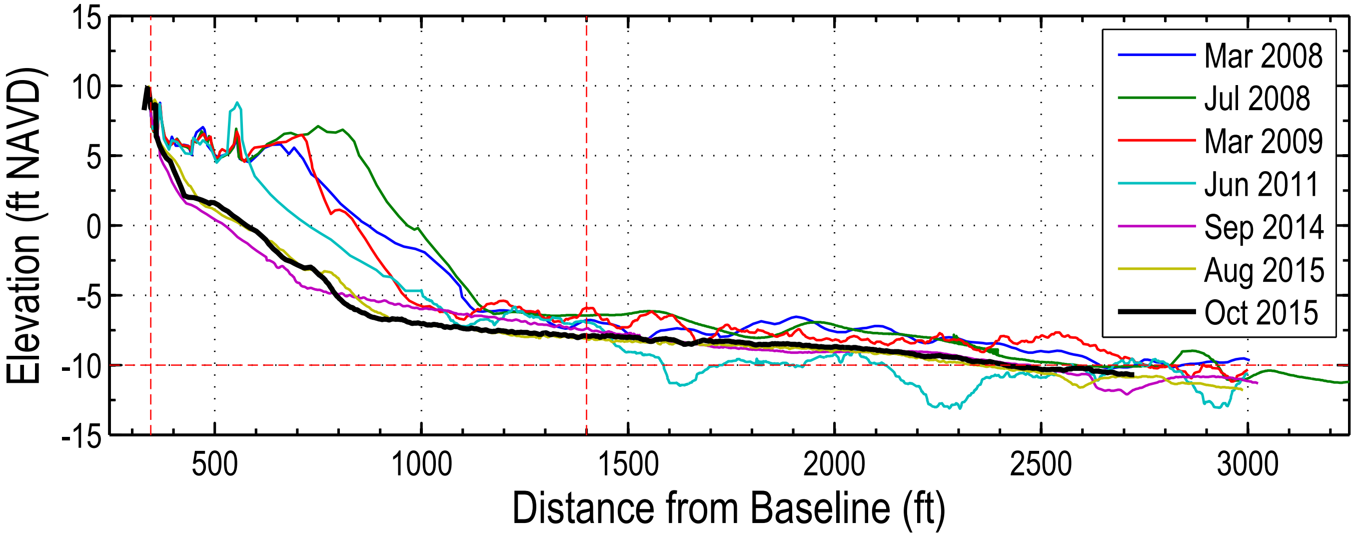
Date	Unit Vol (cy/ft)
Jul 2007	465.8
Mar 2008	422.4
Jul 2008	493.4
Mar 2009	448.1
Sep 2009	421.7
Mar 2010	362.1
Sep 2010	384.4
Jun 2011	345.7
Jul 2012	322.3
Jul 2013	274.9
Sep 2014	248.5
Aug 2015	252.2
Oct 2015	243.0



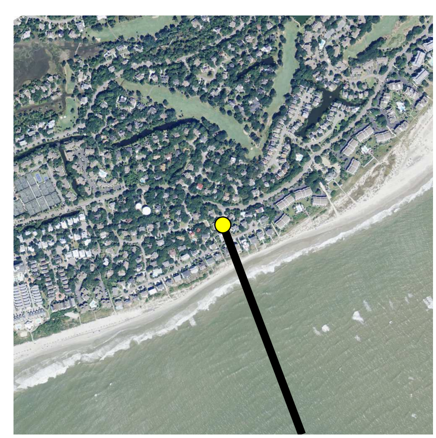
X: 2389542.78
Y: 355757.81

Station: 268+00 (46+00)



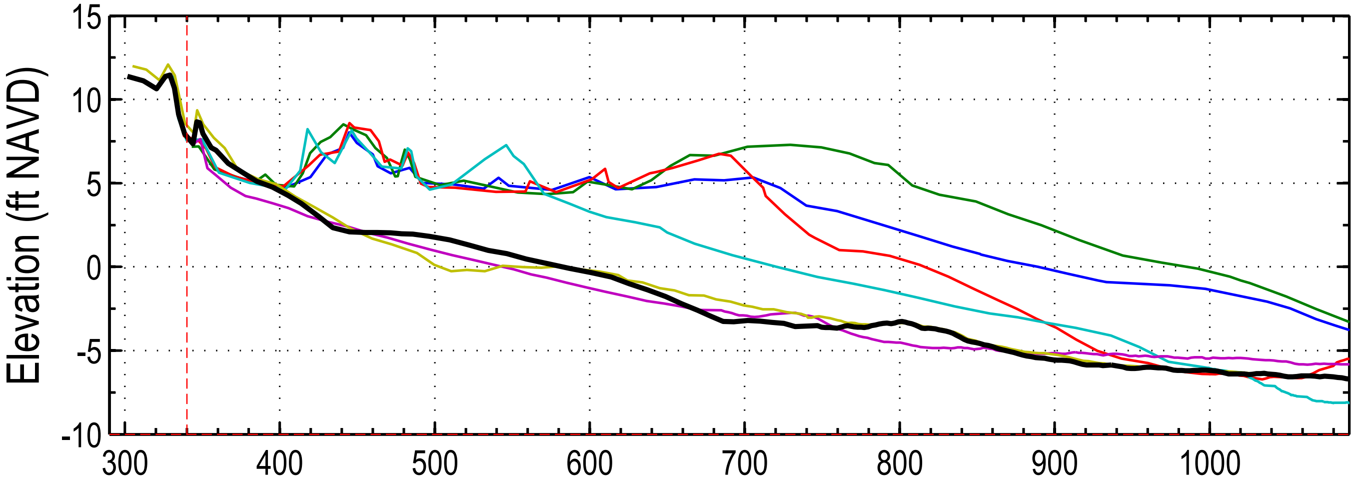


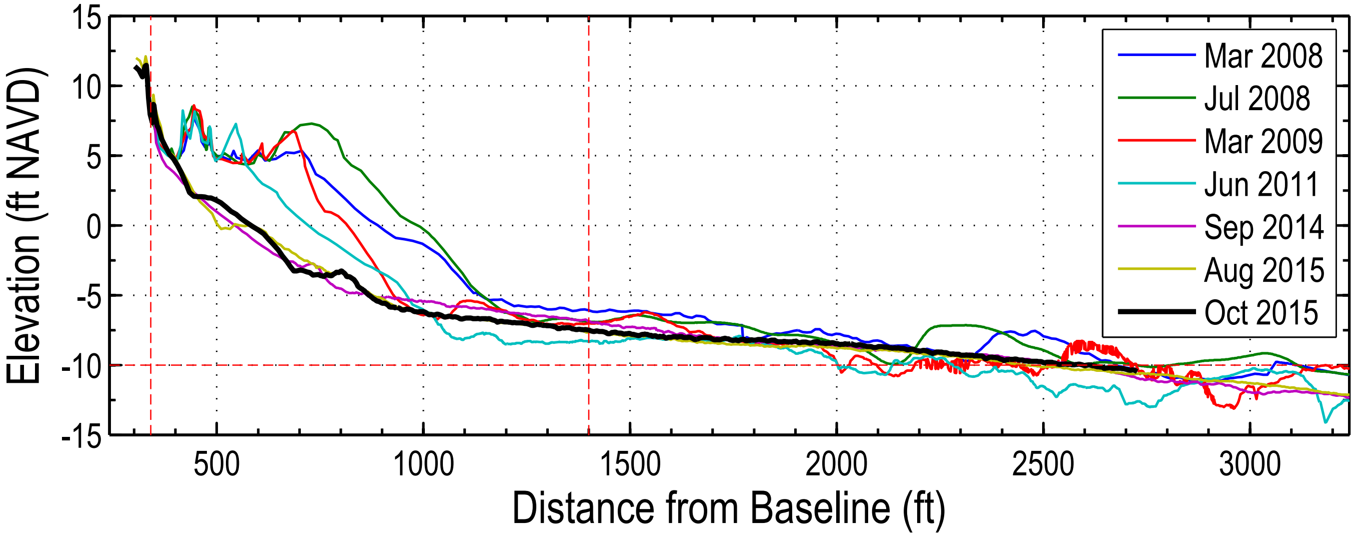
Date	Unit Vol (cy/ft)
Jul 2007	396.3
Mar 2008	391.5
Jul 2008	436.7
Mar 2009	370.9
Sep 2009	363.7
Mar 2010	335.5
Sep 2010	348.7
Jun 2011	330.3
Jul 2012	308.8
Jul 2013	199.2
Sep 2014	236.7
Aug 2015	237.8
Oct 2015	232.8



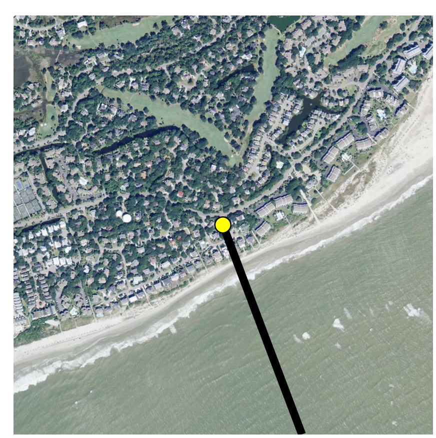
X: 2389729.88
Y: 355828.47

Station: 270+00 (48+00)



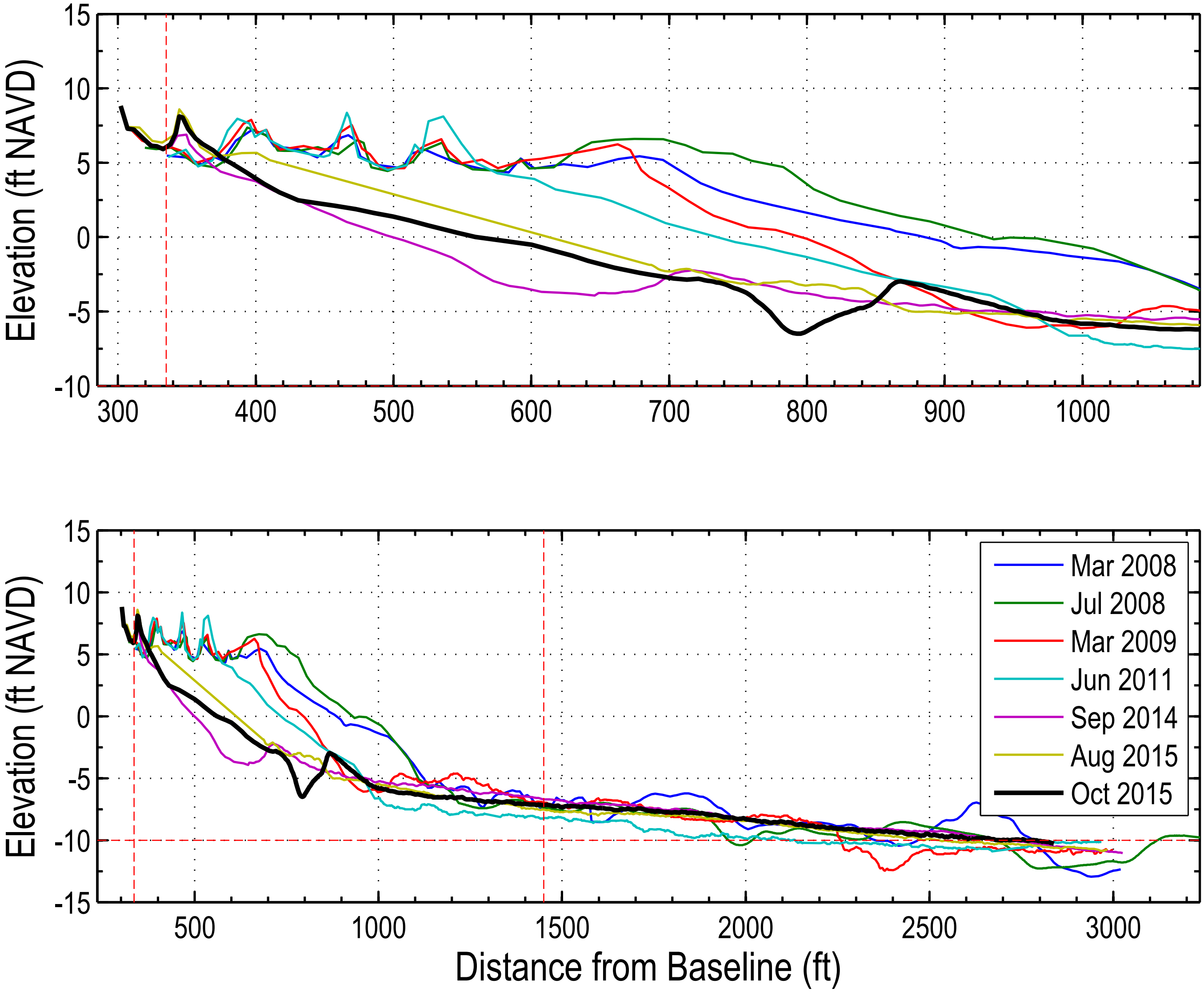


Date	**Unit Vol (cy/ft)**
Jul 2007	409.3
Mar 2008	404.8
Jul 2008	435.0
Mar 2009	355.7
Sep 2009	353.0
Mar 2010	332.4
Sep 2010	349.8
Jun 2011	307.8
Jul 2012	252.9
Jul 2013	225.5
Sep 2014	261.2
Aug 2015	259.1
Oct 2015	257.6

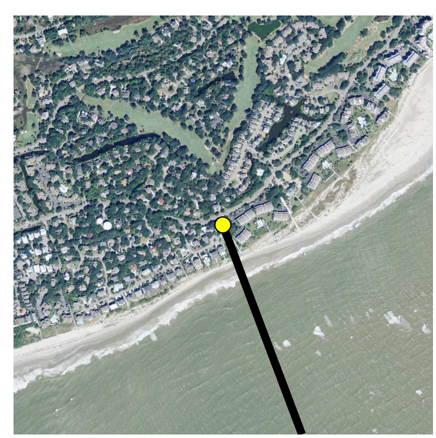


X: 2389916.98
Y: 355899.14

Station: 272+00 (50+00)

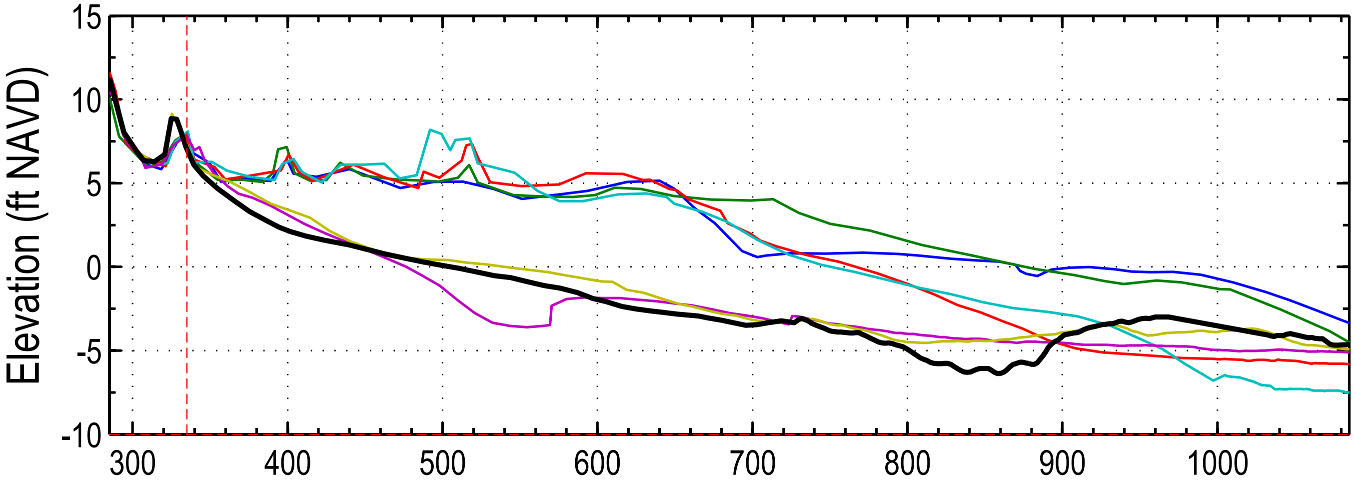


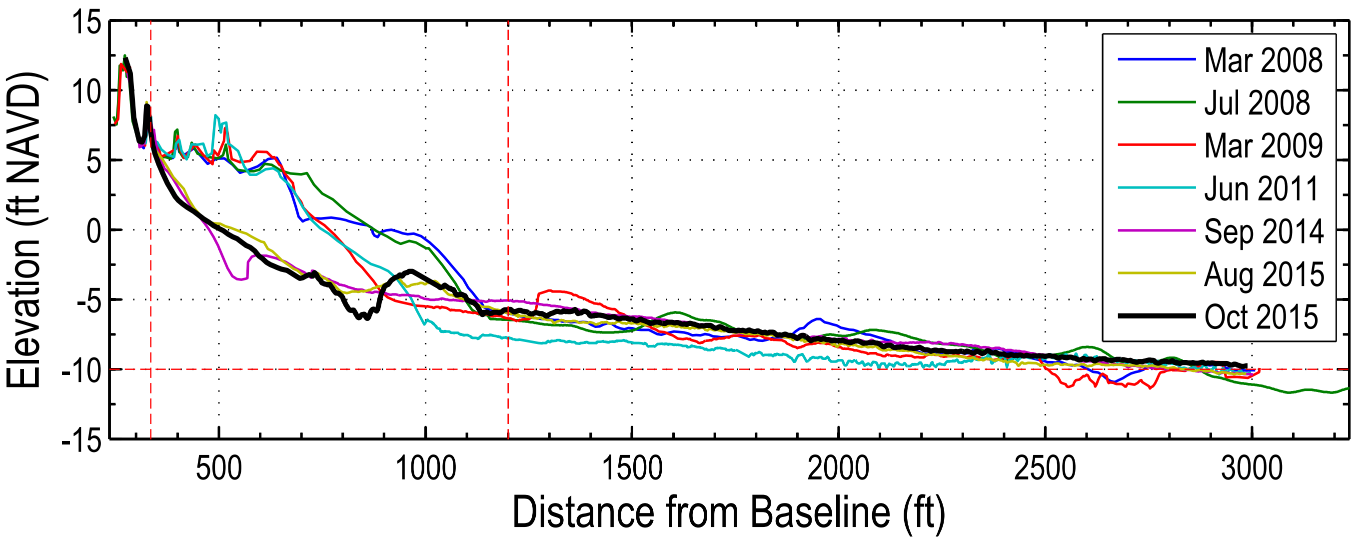
Date	Unit Vol (cy/ft)
Jul 2007	448.9
Mar 2008	407.3
Jul 2008	420.9
Mar 2009	371.0
Sep 2009	352.7
Mar 2010	333.0
Sep 2010	354.2
Jun 2011	322.9
Jul 2012	267.1
Jul 2013	191.5
Sep 2014	266.9
Aug 2015	290.7
Oct 2015	270.8



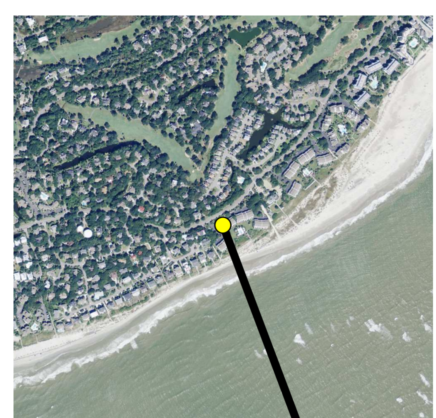
X: 2390104.08
Y: 355969.8

Station: 274+00 (Beach Club Villas I)



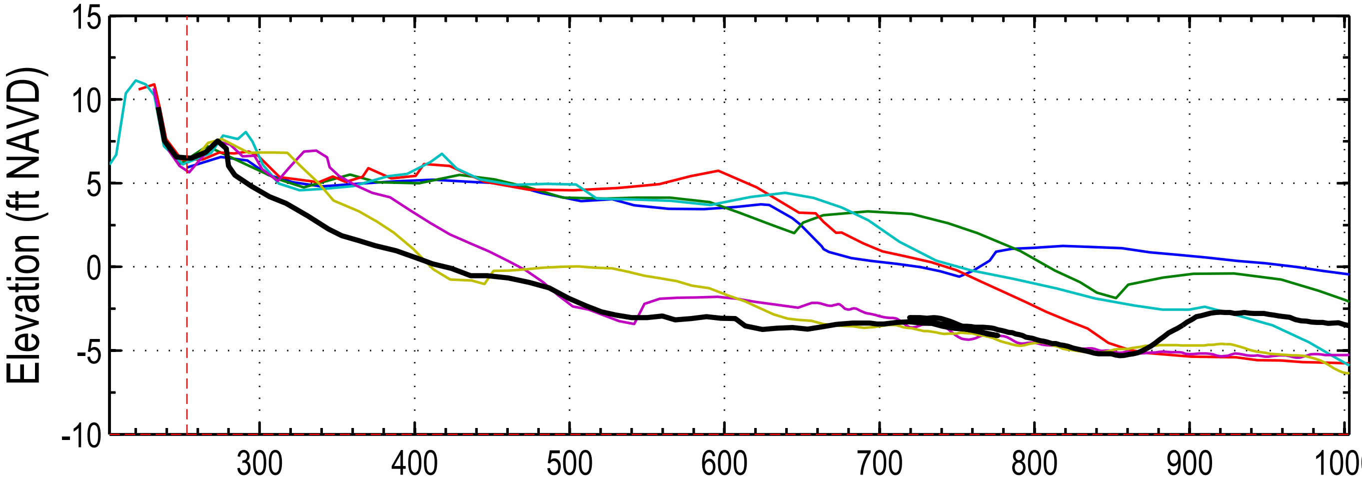


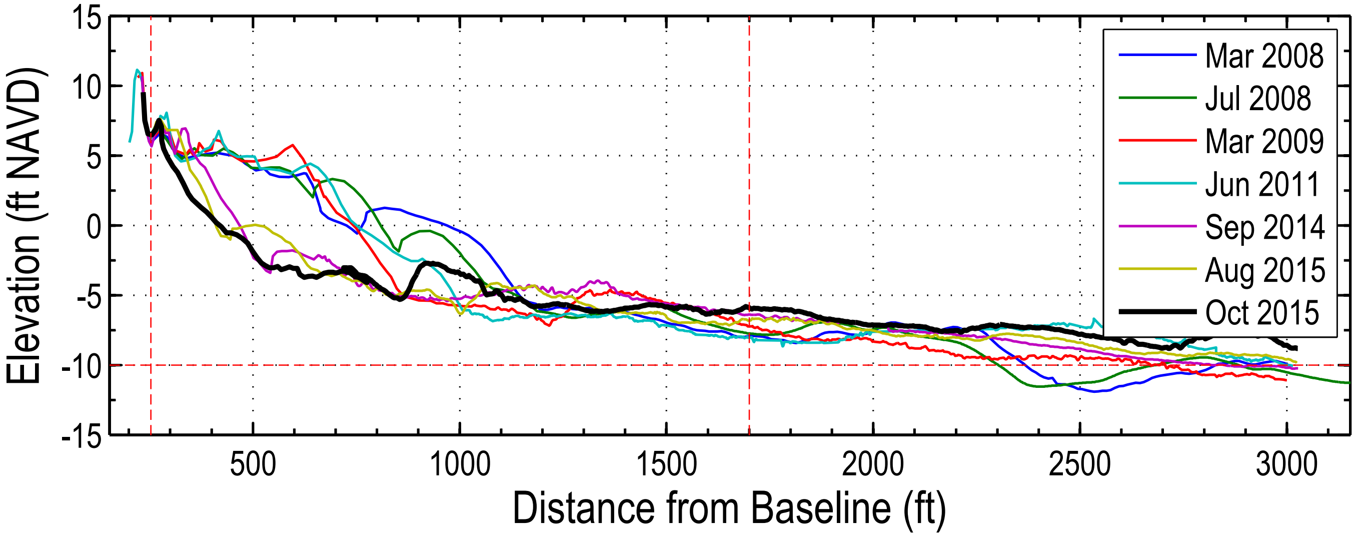
Date	Unit Vol (cy/ft)
Jul 2007	368.2
Mar 2008	359.3
Jul 2008	362.1
Mar 2009	318.5
Sep 2009	307.2
Mar 2010	315.8
Sep 2010	325.3
Jun 2011	311.5
Jul 2012	245.5
Jul 2013	178.1
Sep 2014	233.7
Aug 2015	249.2
Oct 2015	236.0



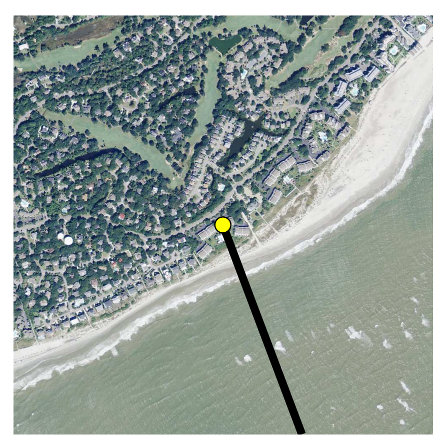
X: 2390291.18
Y: 356040.46

Station: 276+00 (54+00)



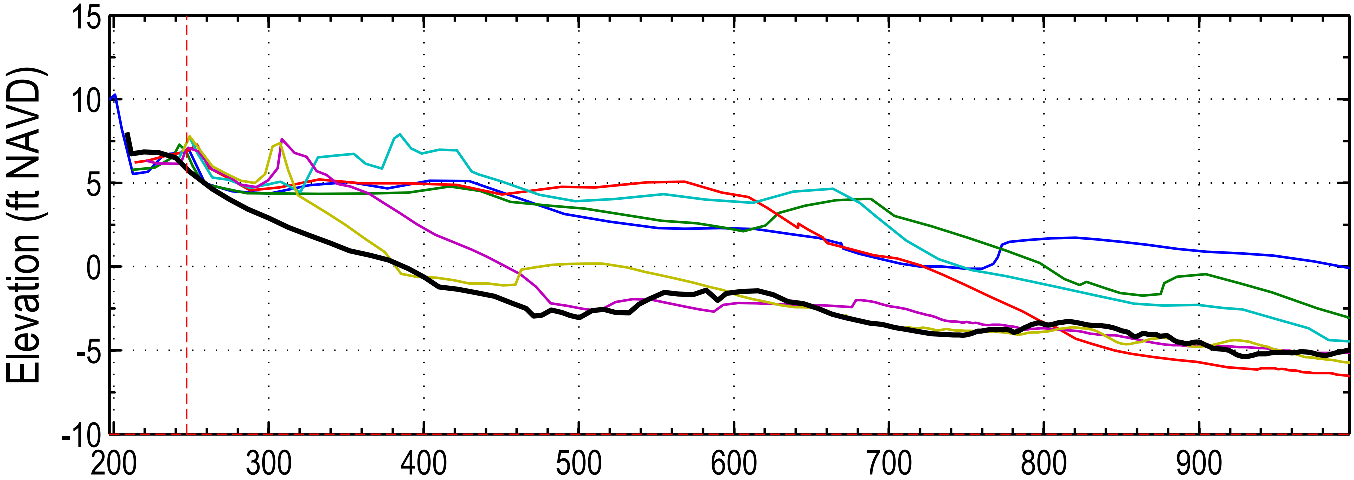


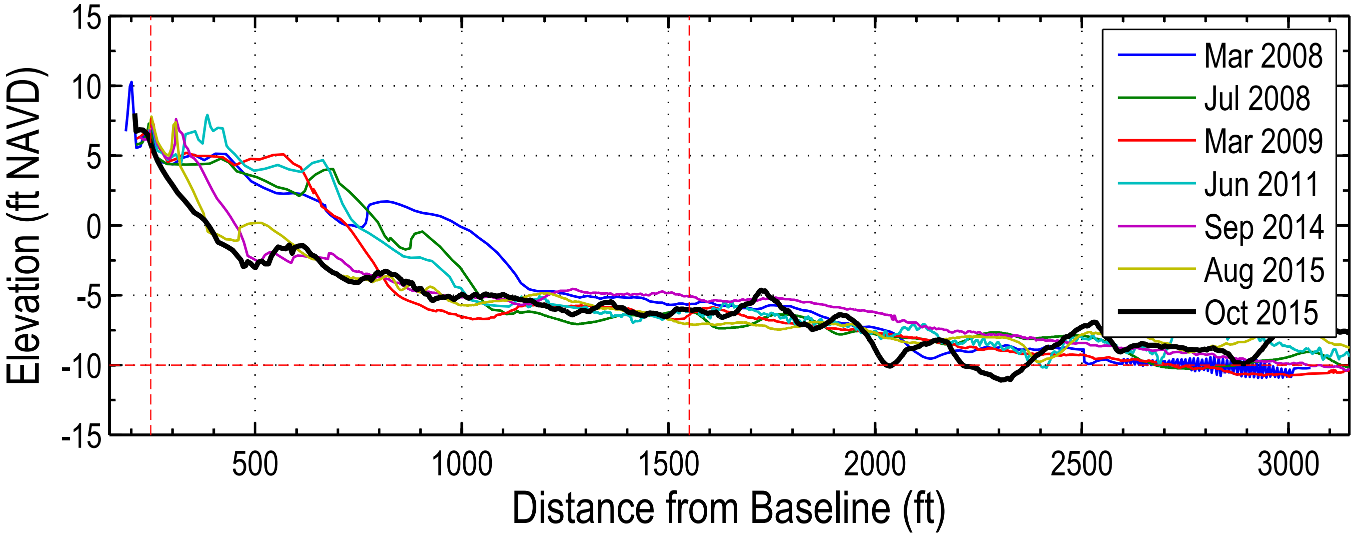
Date	Unit Vol (cy/ft)
Jul 2007	484.9
Mar 2008	461.8
Jul 2008	459.1
Mar 2009	427.9
Sep 2009	399.1
Mar 2010	439.8
Sep 2010	433.3
Jun 2011	417.3
Jul 2012	331.7
Jul 2013	320.3
Sep 2014	367.1
Aug 2015	346.7
Oct 2015	341.5



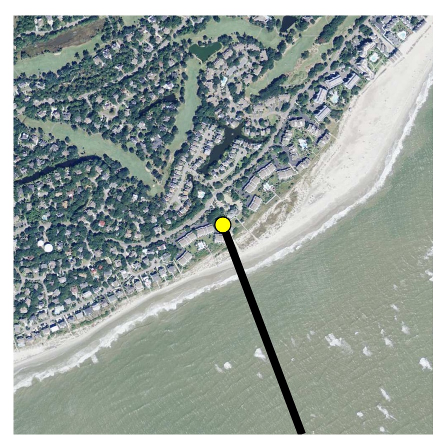
X: 2390478.28
Y: 356111.13

Station: 278+00 (56+00) BEACHCLUB VILLAS - BRC3



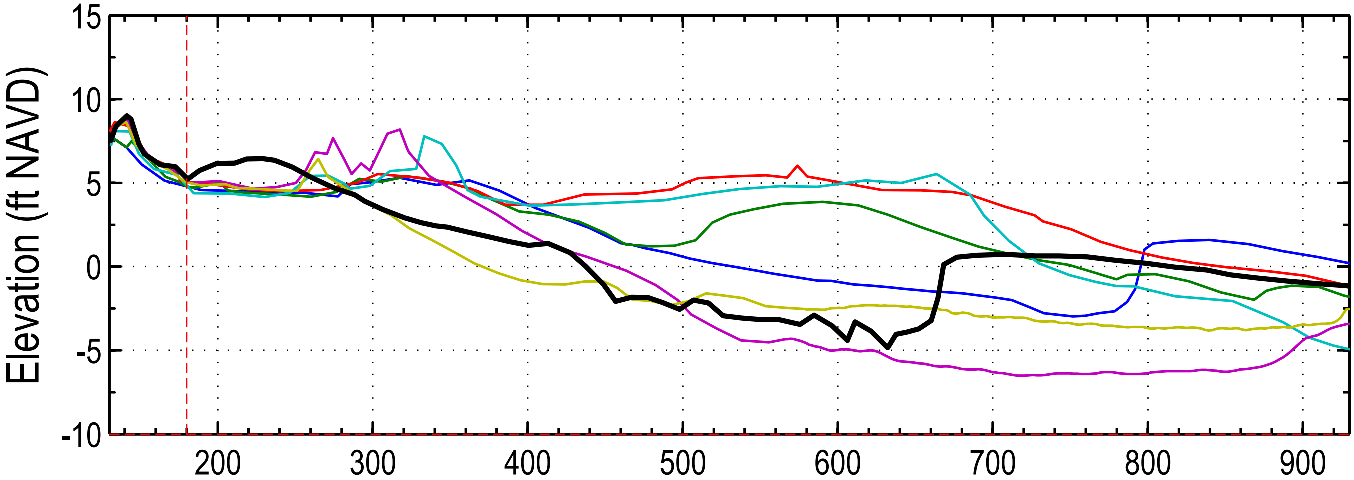


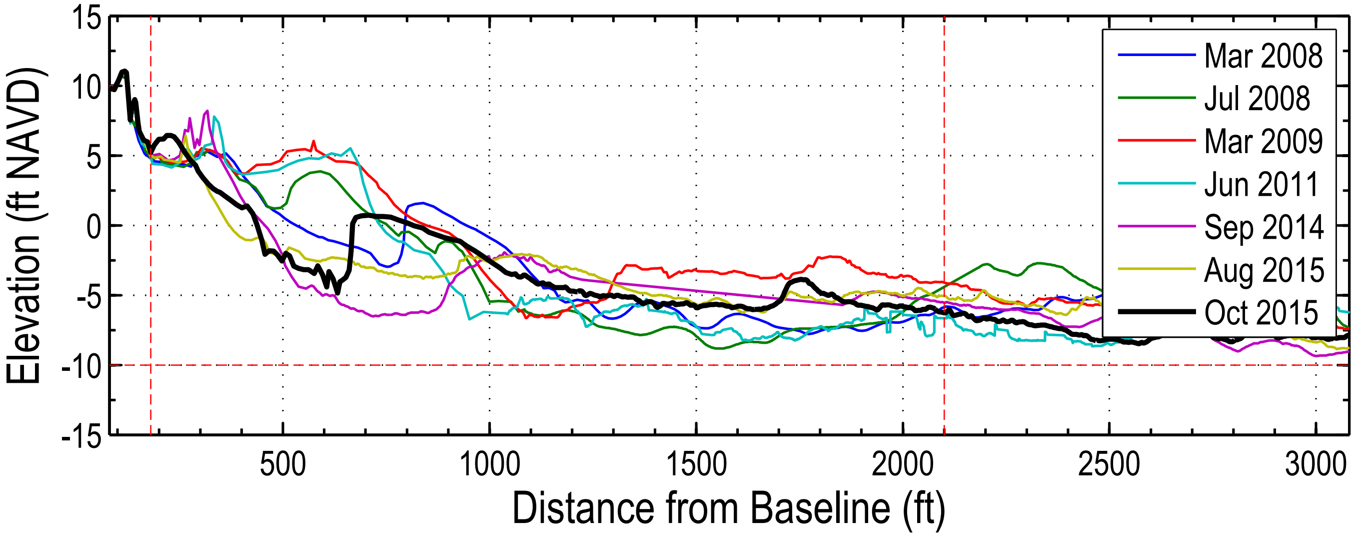
Date	Unit Vol (cy/ft)
Jul 2007	456.2
Mar 2008	463.2
Jul 2008	415.2
Mar 2009	384.9
Sep 2009	371.7
Mar 2010	450.2
Sep 2010	436.7
Jun 2011	426.2
Jul 2012	297.4
Jul 2013	296.9
Sep 2014	345.9
Aug 2015	324.5
Oct 2015	305.9



X: 2390665.38
Y: 356181.79

Station: 280+00 (58+00) BEACH CLUB VILLAS - SCCC 3173

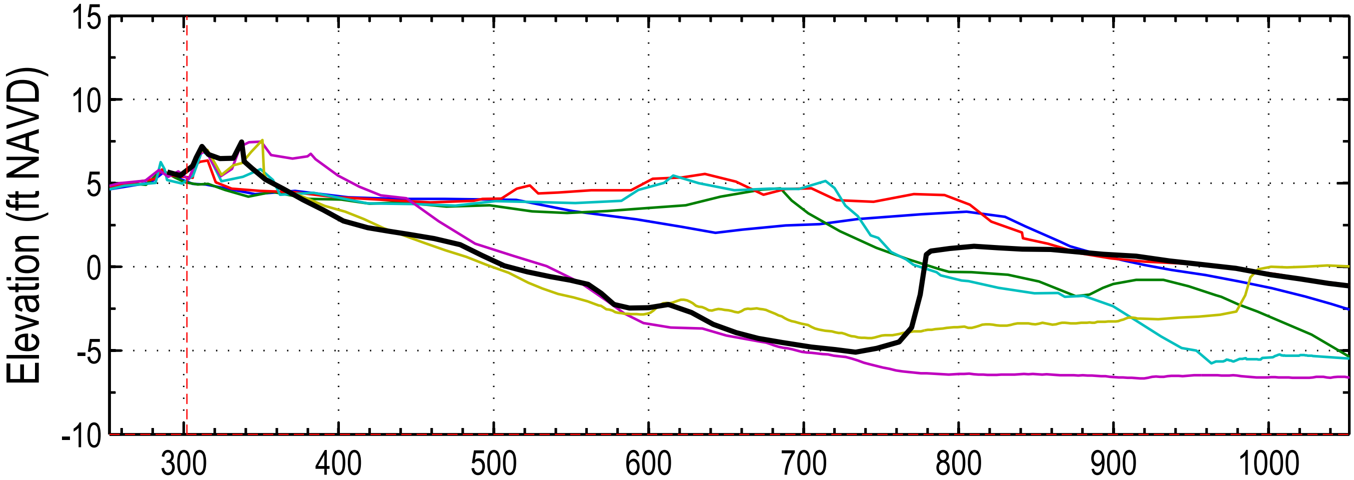


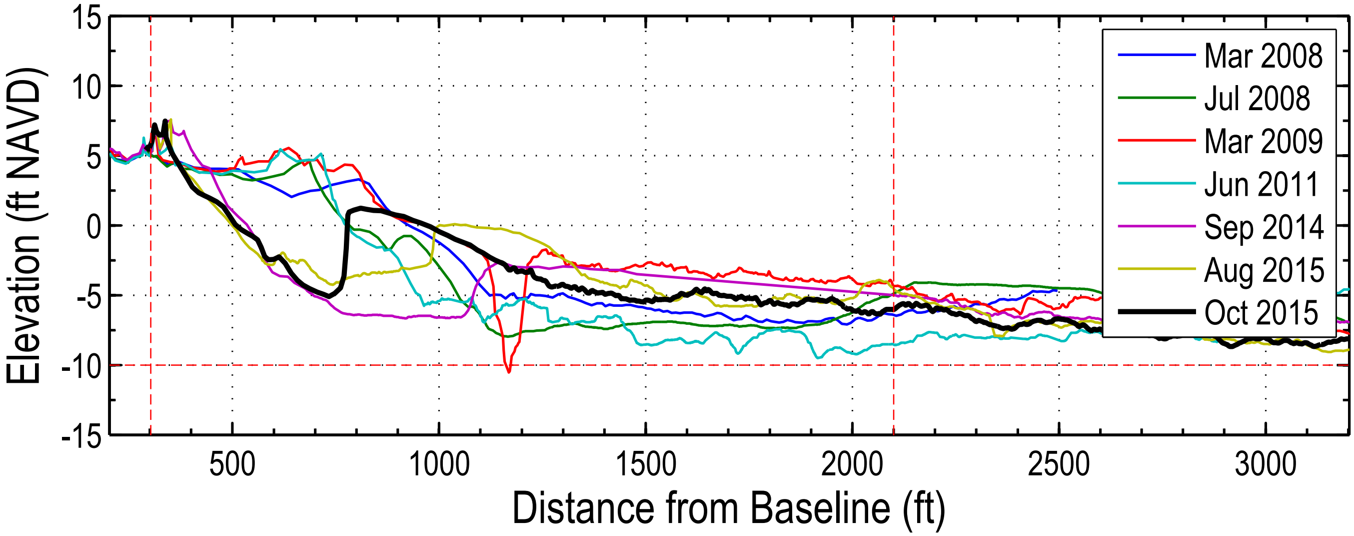


Date	Unit Vol (cy/ft)
Jul 2007	624.1
Mar 2008	498.6
Jul 2008	474.3
Mar 2009	640.5
Sep 2009	641.6
Mar 2010	573.2
Sep 2010	595.5
Jun 2011	495.9
Jul 2012	374.4
Jul 2013	461.5
Sep 2014	477.6
Aug 2015	493.1
Oct 2015	507.0

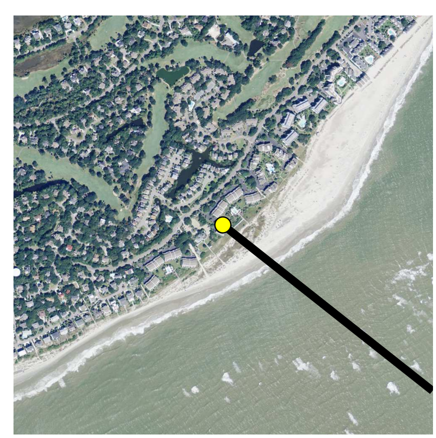
X: 2390849.49
Y: 356256.55

Station: 282+00 (60+00)



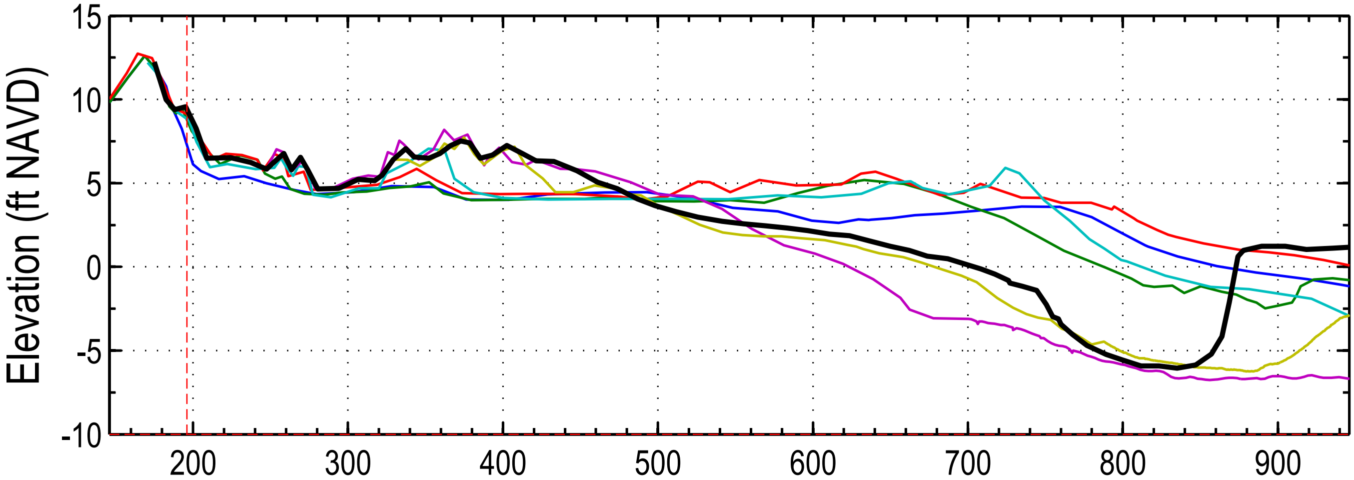


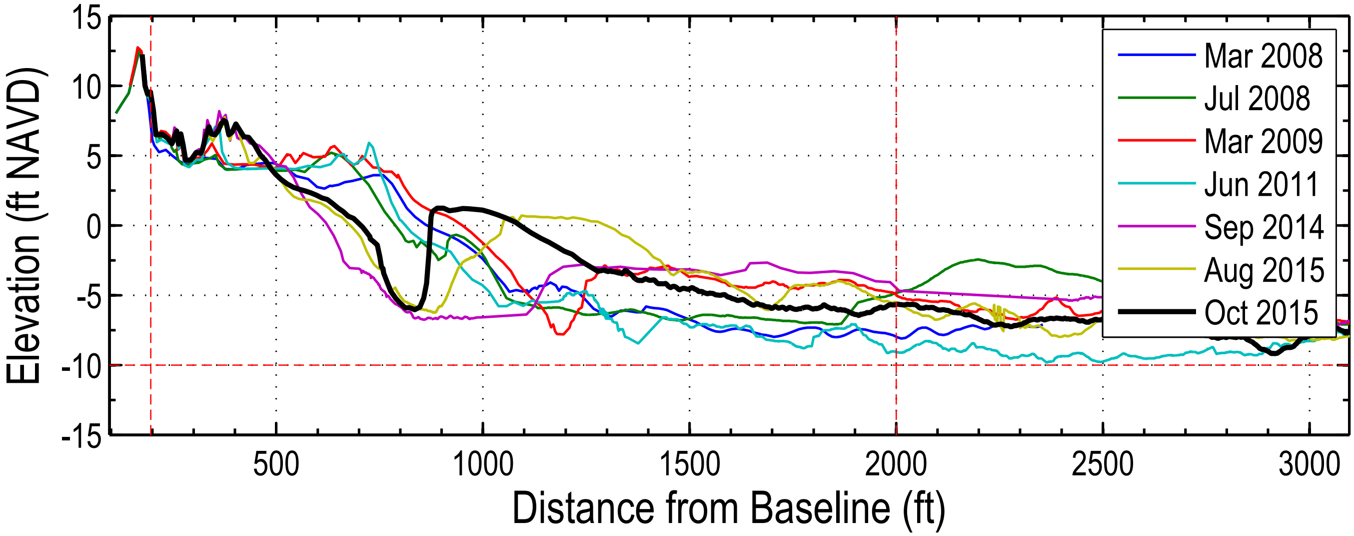
Date	Unit Vol (cy/ft)
Jul 2007	618.7
Mar 2008	501.0
Jul 2008	440.4
Mar 2009	615.9
Sep 2009	634.9
Mar 2010	521.9
Sep 2010	549.6
Jun 2011	411.5
Jul 2012	338.5
Jul 2013	400.3
Sep 2014	449.7
Aug 2015	489.8
Oct 2015	481.0



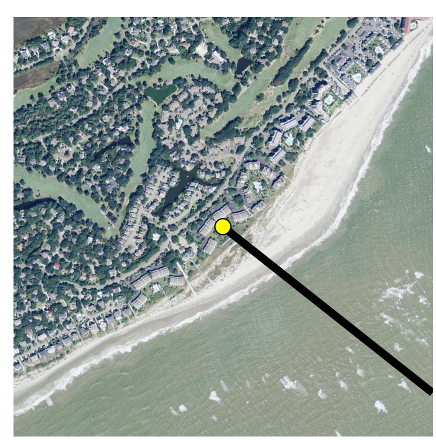
X: 2390973.85
Y: 356413.19

Station: 284+00 (Beach Club Villas II)



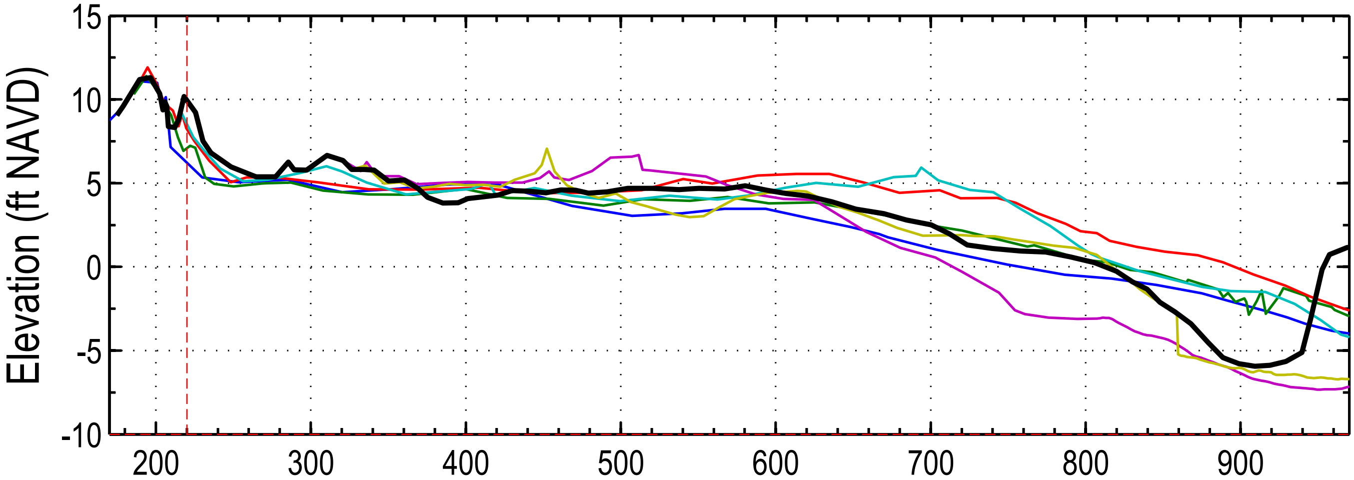


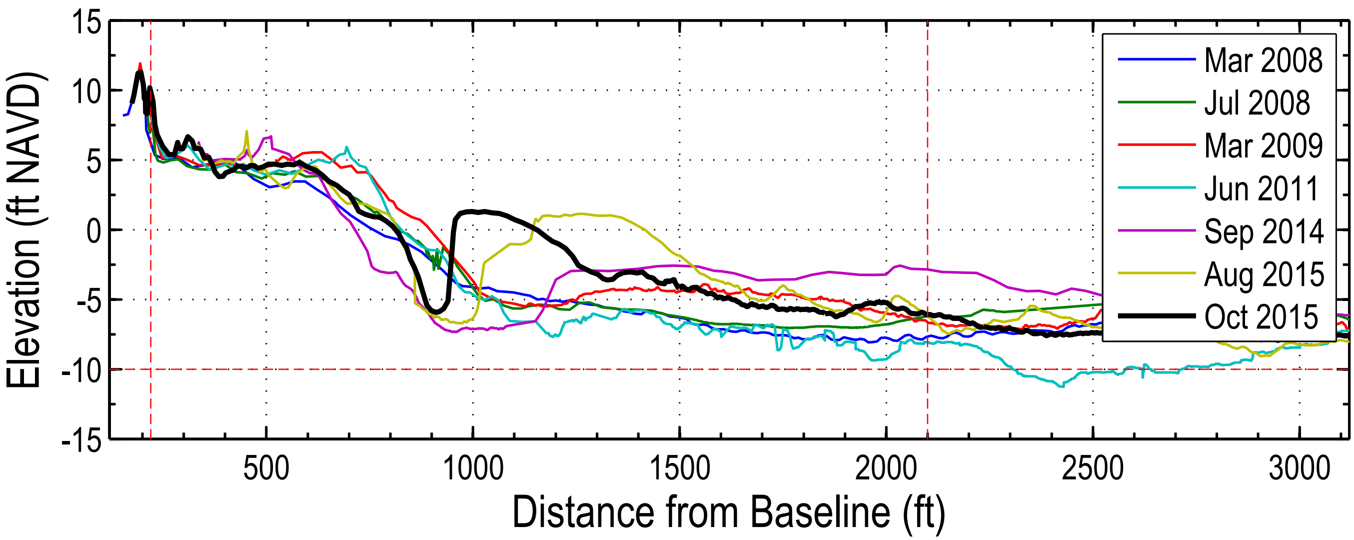
Date	Unit Vol (cy/ft)
Jul 2007	629.5
Mar 2008	515.3
Jul 2008	522.2
Mar 2009	627.9
Sep 2009	679.5
Mar 2010	567.3
Sep 2010	583.0
Jun 2011	497.6
Jul 2012	403.1
Jul 2013	466.7
Sep 2014	541.2
Aug 2015	602.9
Oct 2015	585.8



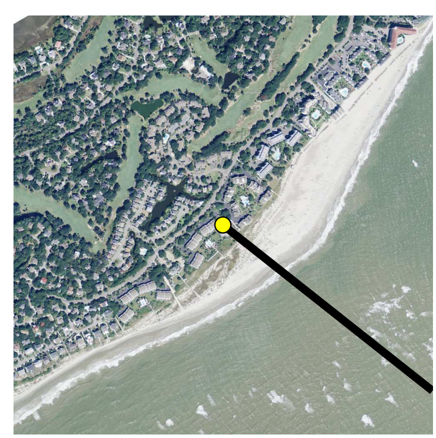
X: 2391098.21
Y: 356569.82

Station: 286+00 (64+00)



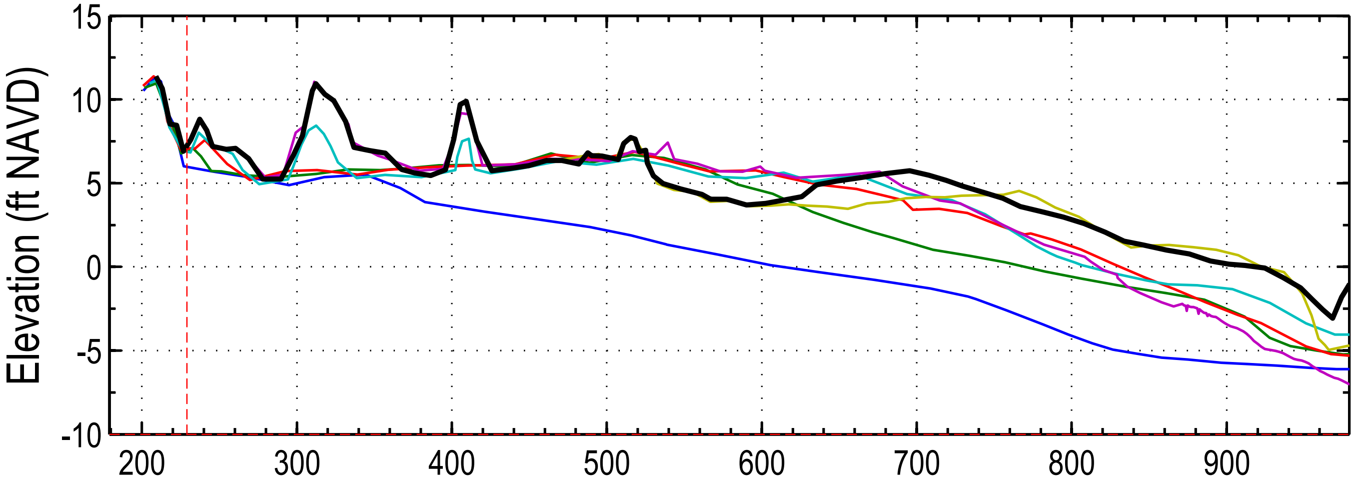


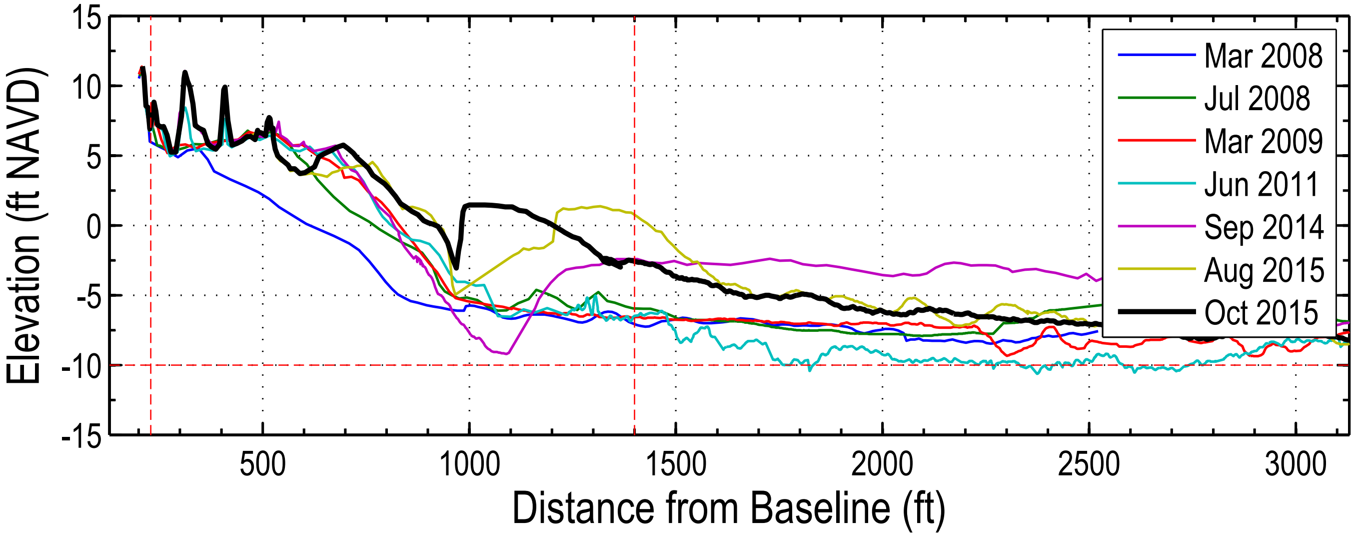
Date	Unit Vol (cy/ft)
Jul 2007	499.7
Mar 2008	484.3
Jul 2008	510.8
Mar 2009	593.5
Sep 2009	628.0
Mar 2010	542.5
Sep 2010	548.0
Jun 2011	493.3
Jul 2012	415.3
Jul 2013	479.5
Sep 2014	585.8
Aug 2015	638.0
Oct 2015	619.3



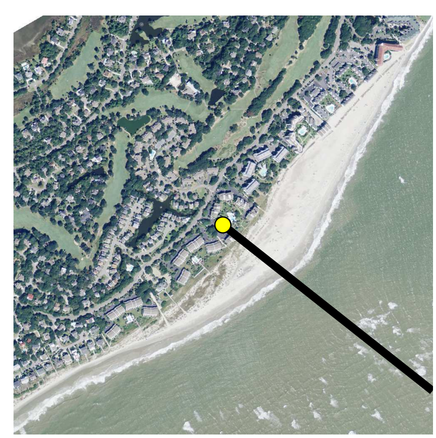
X: 2391222.57
Y: 356726.46

Station: 288+00 (66+00) MARINER'S WALK - BRC4, SCCC 3175



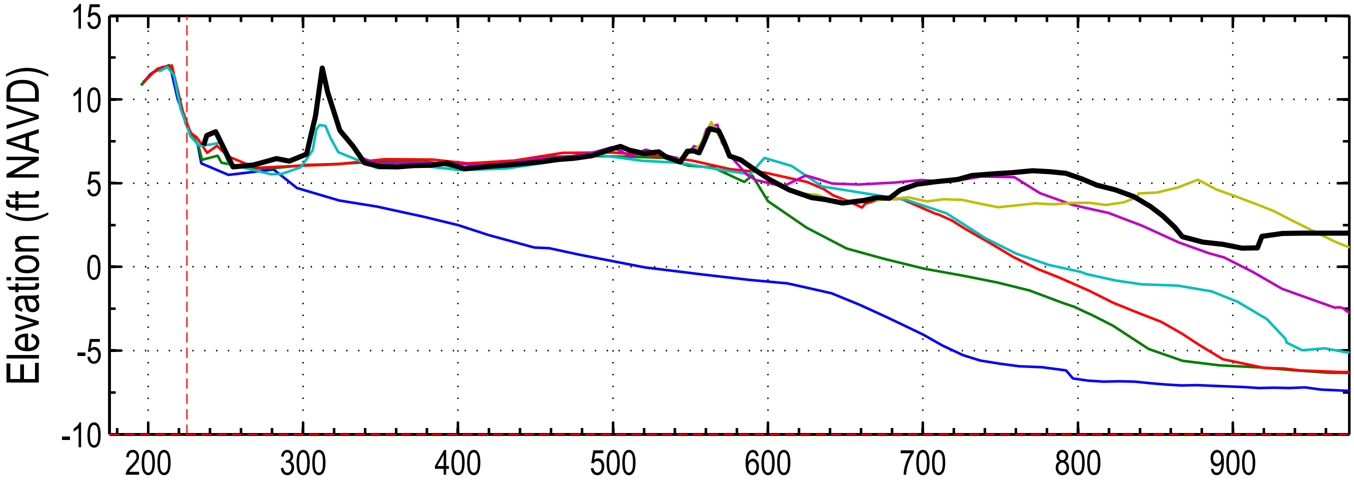


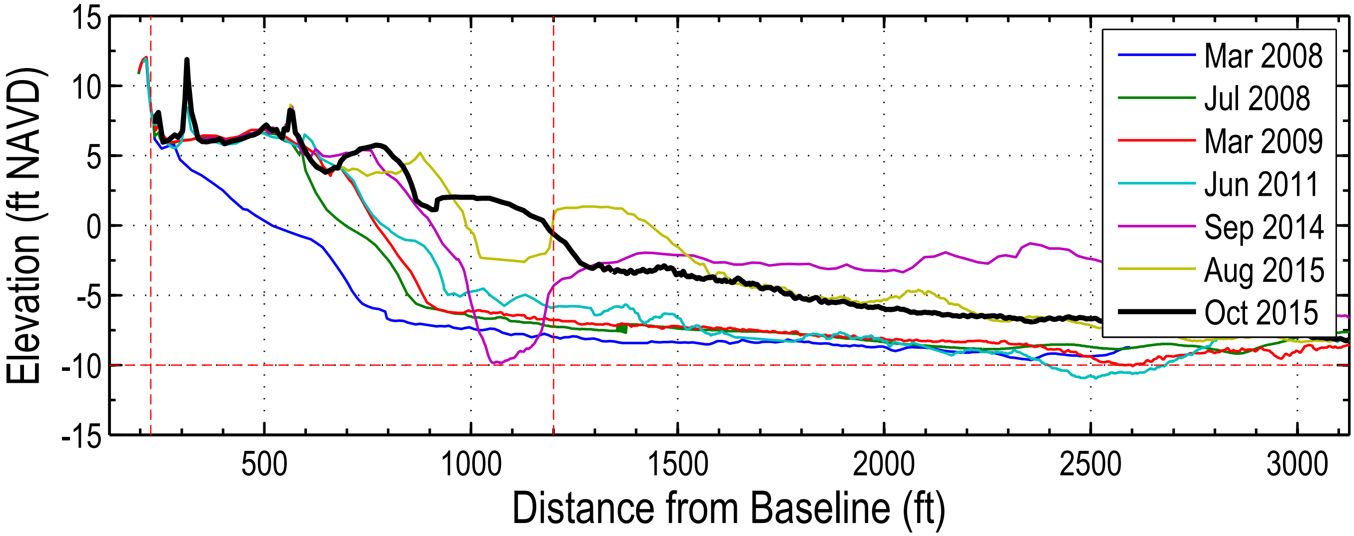
Date	Unit Vol (cy/ft)
Jul 2007	253.3
Mar 2008	333.0
Jul 2008	423.8
Mar 2009	433.6
Sep 2009	453.8
Mar 2010	447.5
Sep 2010	445.8
Jun 2011	442.6
Jul 2012	382.5
Jul 2013	389.3
Sep 2014	453.6
Aug 2015	538.1
Oct 2015	554.4



X: 2391346.93
Y: 356883.1

Station: 290+00 (Mariners Walk)

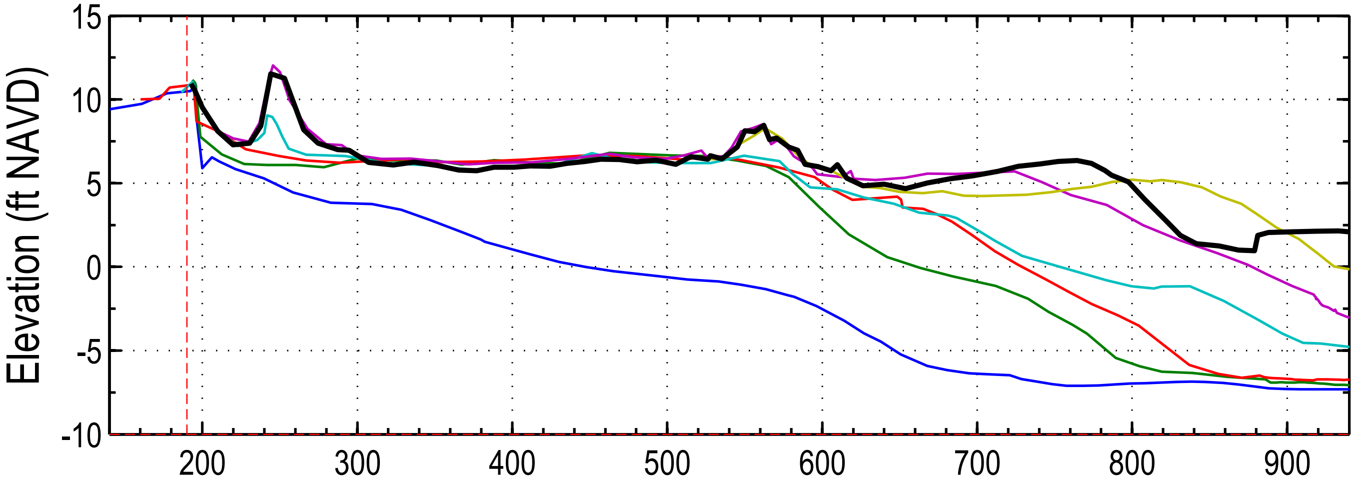


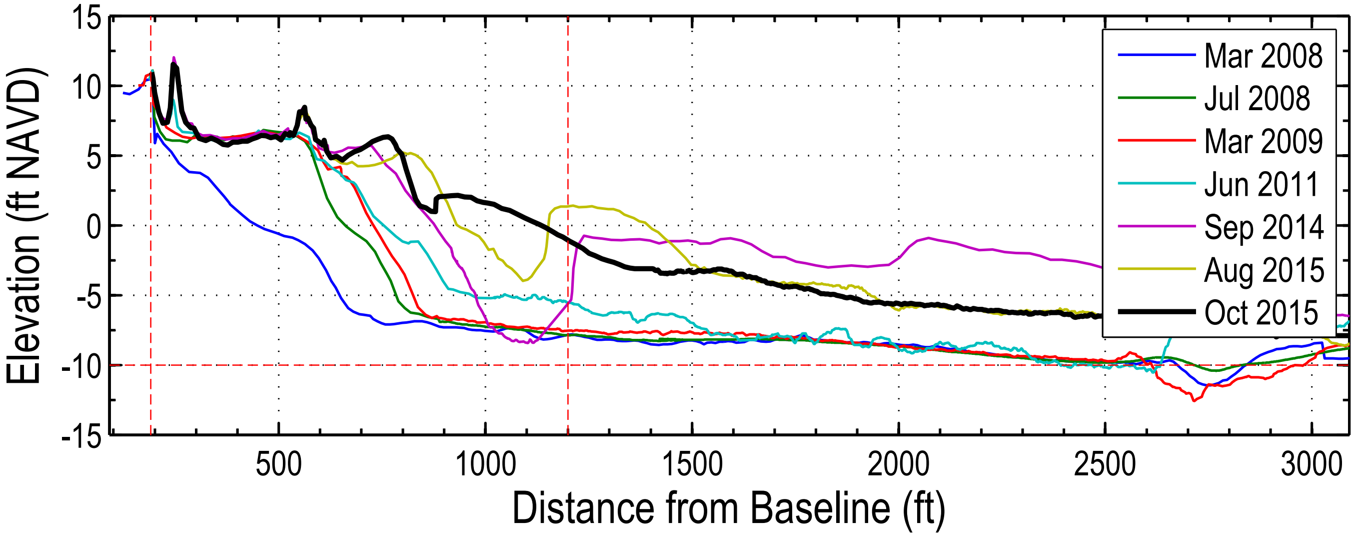


Date	Unit Vol (cy/ft)
Jul 2007	200.1
Mar 2008	255.4
Jul 2008	357.3
Mar 2009	387.9
Sep 2009	390.9
Mar 2010	398.7
Sep 2010	391.1
Jun 2011	412.7
Jul 2012	372.3
Jul 2013	385.9
Sep 2014	430.1
Aug 2015	492.1
Oct 2015	517.9

X: 2391471.29
Y: 357039.73

Station: 292+00 (Shipwatch)

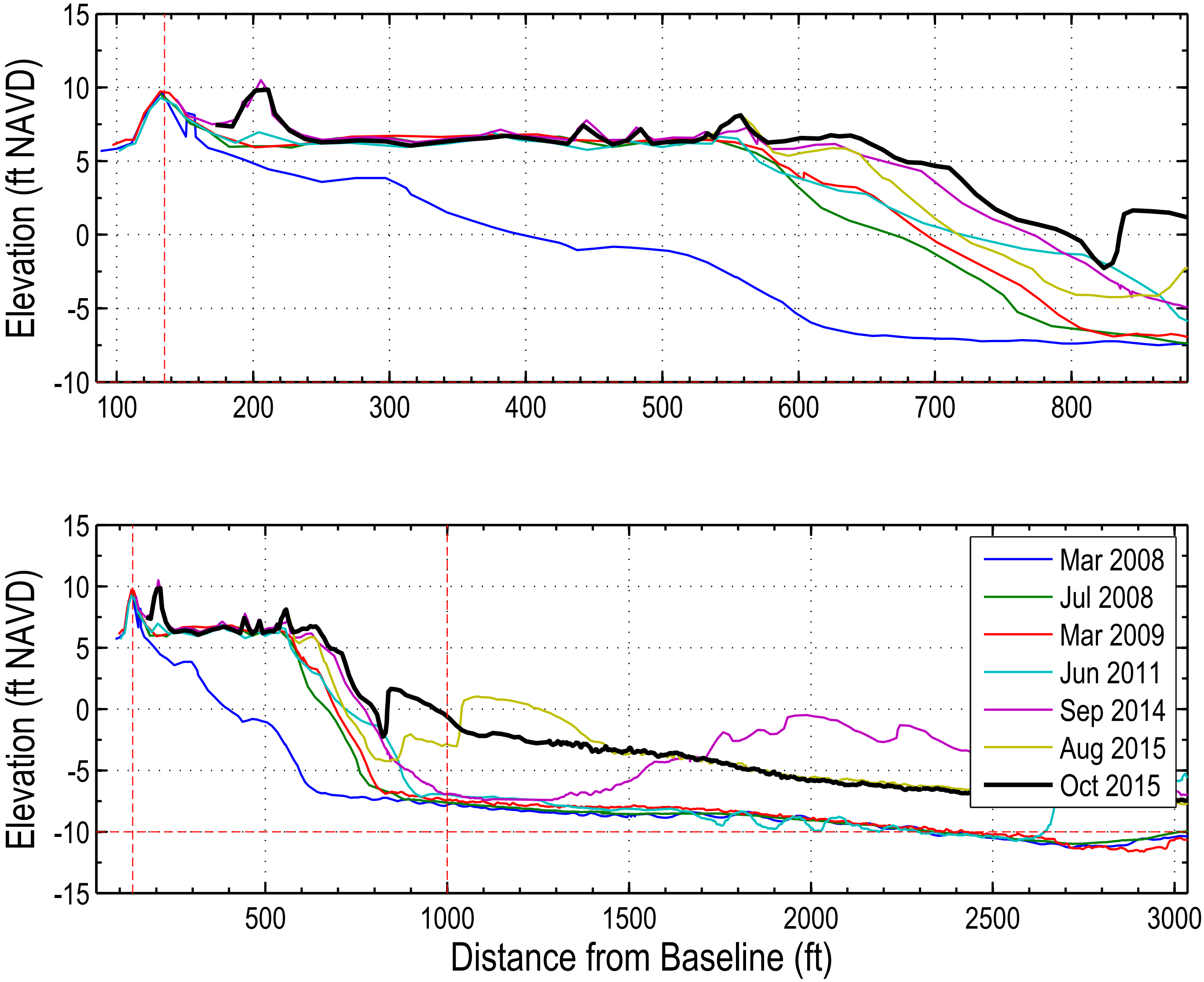




Date	Unit Vol (cy/ft)
Jul 2007	196.1
Mar 2008	246.8
Jul 2008	355.6
Mar 2009	382.7
Sep 2009	389.3
Mar 2010	400.7
Sep 2010	377.8
Jun 2011	423.4
Jul 2012	404.6
Jul 2013	418.7
Sep 2014	453.9
Aug 2015	515.8
Oct 2015	539.0

X: 2391595.64
Y: 357196.37

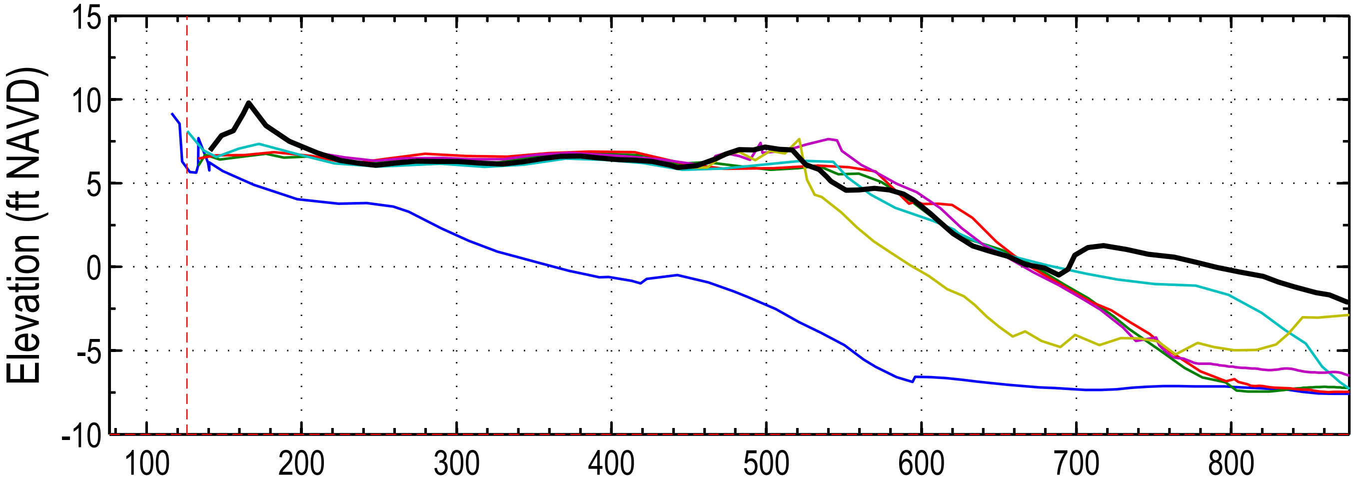
Station: 294+00 (72+00)

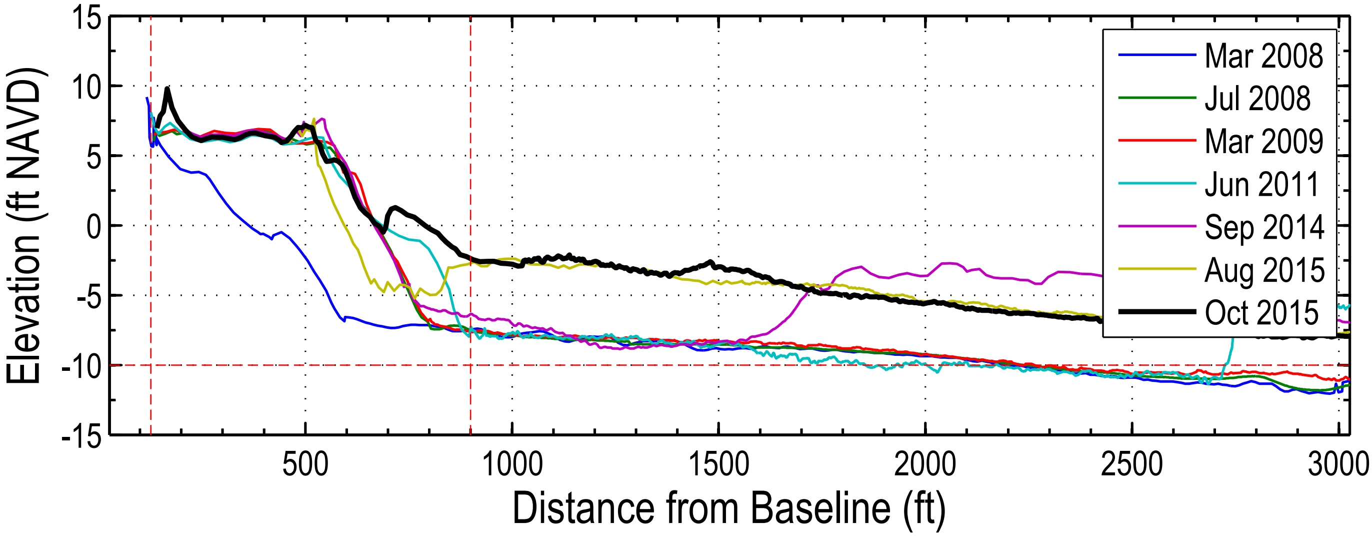


Date	Unit Vol (cy/ft)
Jul 2007	189.1
Mar 2008	235.7
Jul 2008	363.0
Mar 2009	378.1
Sep 2009	380.7
Mar 2010	397.9
Sep 2010	370.7
Jun 2011	395.9
Jul 2012	405.5
Jul 2013	416.5
Sep 2014	426.3
Aug 2015	424.4
Oct 2015	469.7

X: 2391720
Y: 357353.01

Station: 296+00 (Shipwatch)

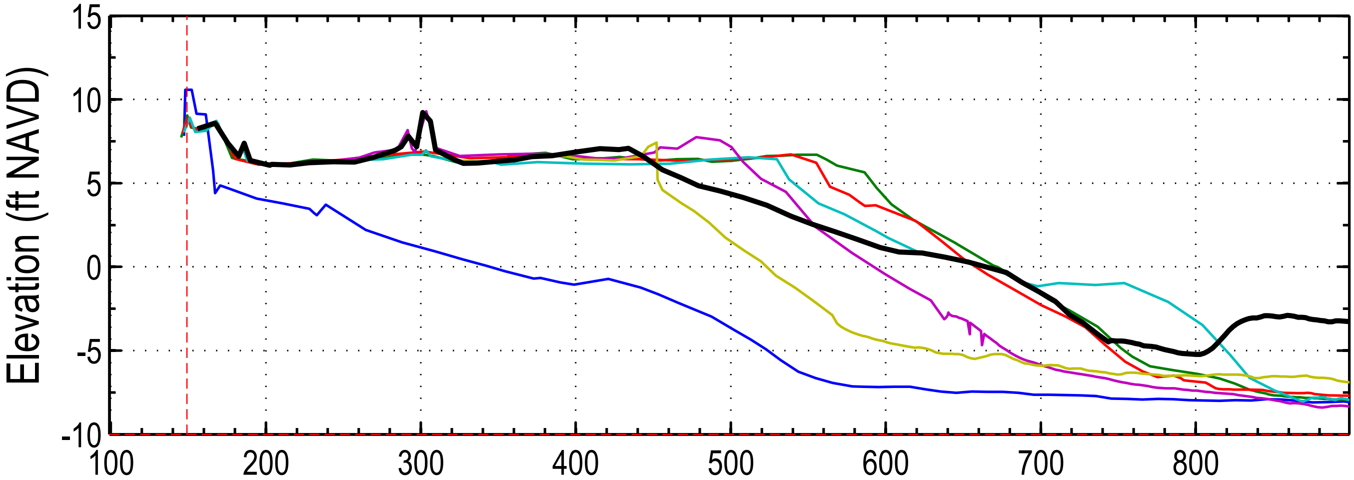


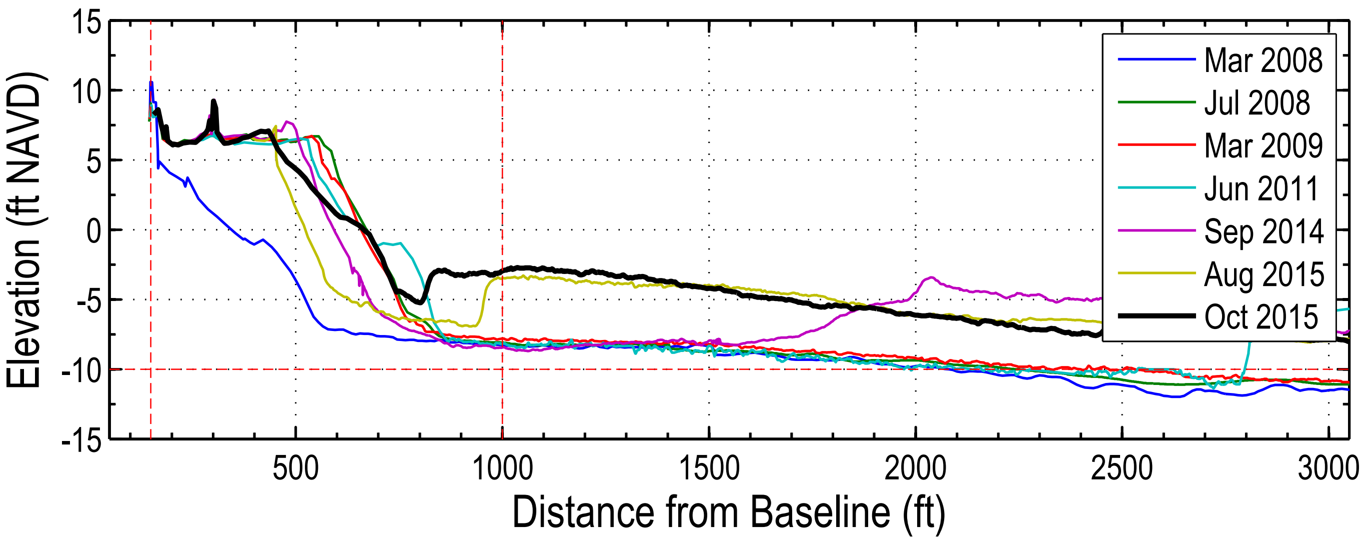


Date	Unit Vol (cy/ft)
Jul 2007	168.9
Mar 2008	213.5
Jul 2008	354.7
Mar 2009	359.8
Sep 2009	353.7
Mar 2010	378.9
Sep 2010	352.3
Jun 2011	375.0
Jul 2012	385.0
Jul 2013	374.6
Sep 2014	369.4
Aug 2015	350.1
Oct 2015	400.5

X: 2391844.36
Y: 357509.64

Station: 298+00 (76+00) Summer House - BRC5, SCCC 3178

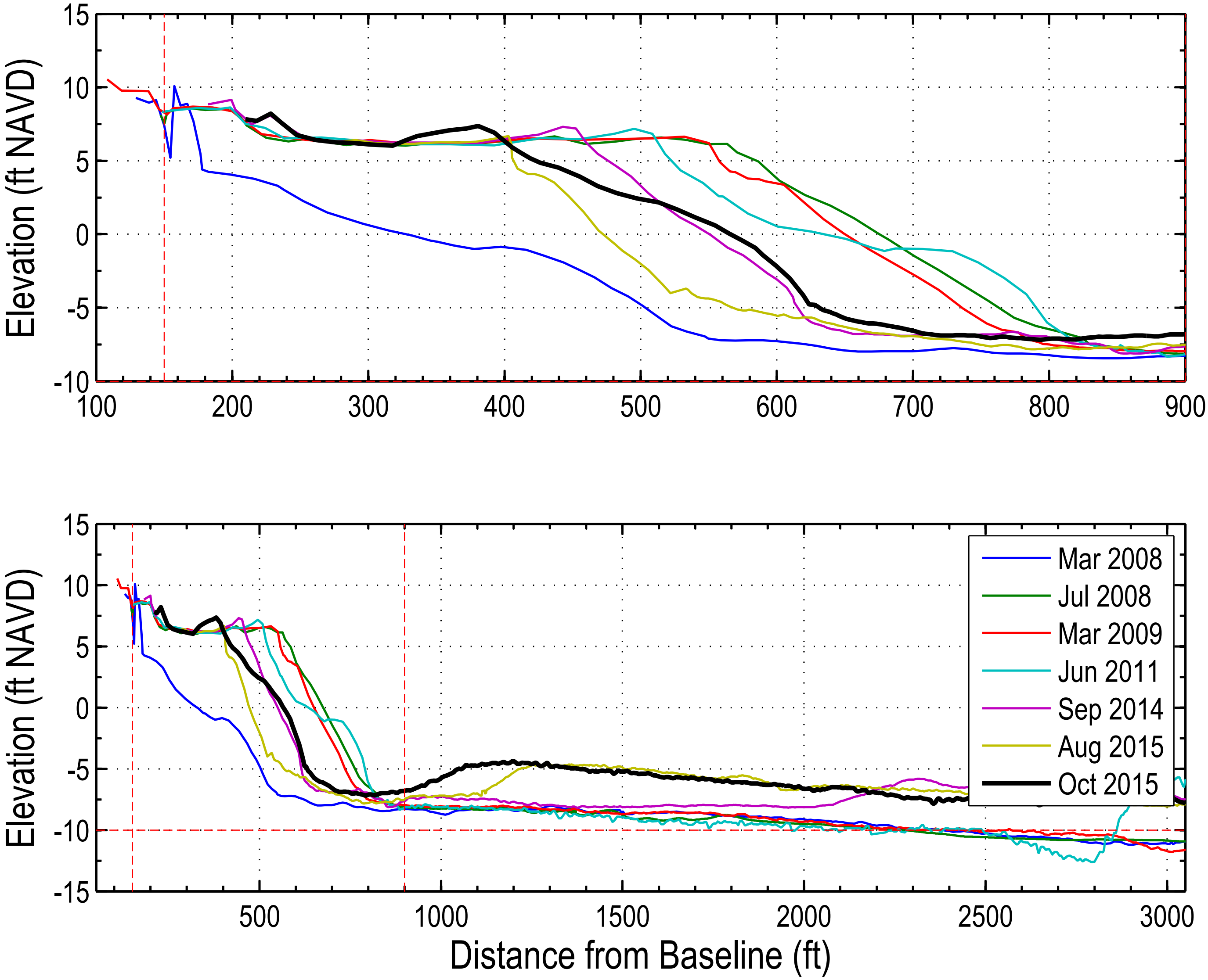




Date	Unit Vol (cy/ft)
Jul 2007	159.3
Mar 2008	191.1
Jul 2008	354.1
Mar 2009	349.5
Sep 2009	339.4
Mar 2010	360.0
Sep 2010	337.2
Jun 2011	356.5
Jul 2012	366.0
Jul 2013	343.0
Sep 2014	318.6
Aug 2015	303.2
Oct 2015	371.5

X: 2391968.72
Y: 357666.28

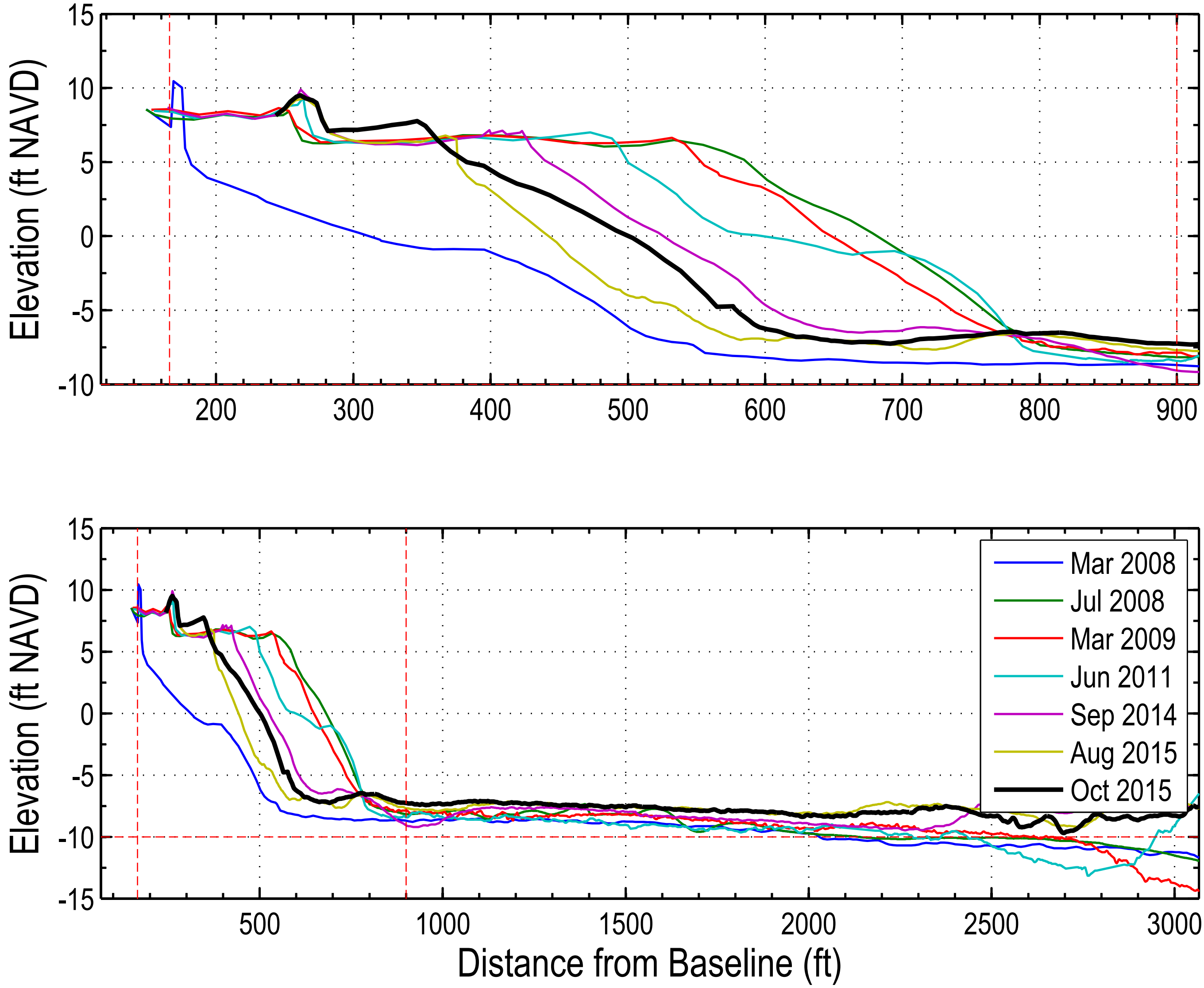
Station: 300+00 (78+00) Summer House Villas



Date	Unit Vol (cy/ft)
Jul 2007	147.9
Mar 2008	173.6
Jul 2008	347.5
Mar 2009	336.8
Sep 2009	323.6
Mar 2010	340.8
Sep 2010	320.5
Jun 2011	339.7
Jul 2012	349.9
Jul 2013	316.1
Sep 2014	289.4
Aug 2015	253.6
Oct 2015	289.1

X: 2392093.08
Y: 357822.91

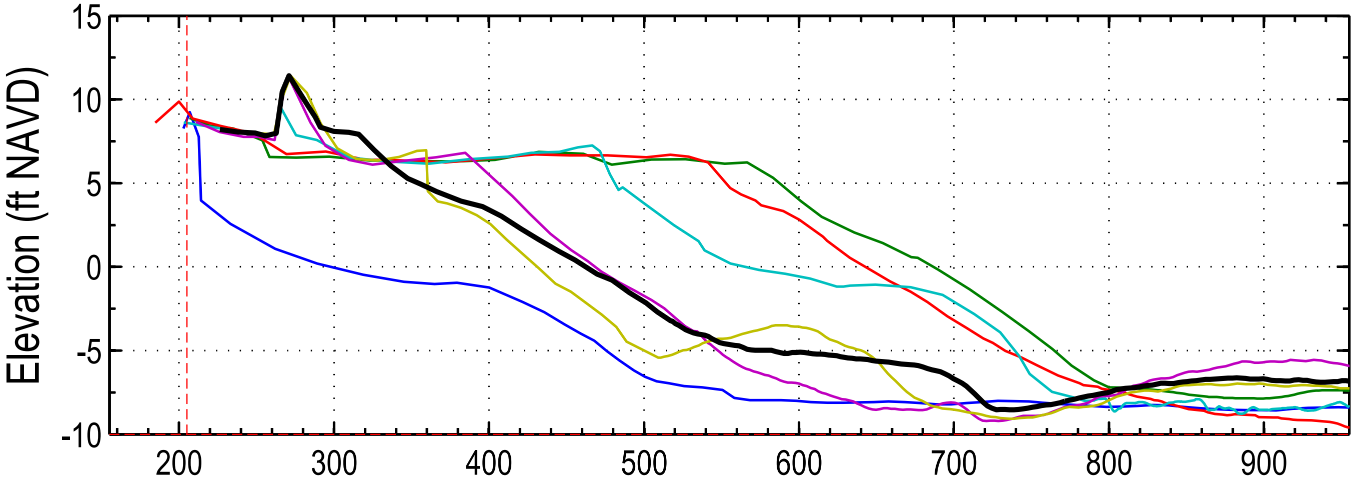
Station: 302+00 (80+00)

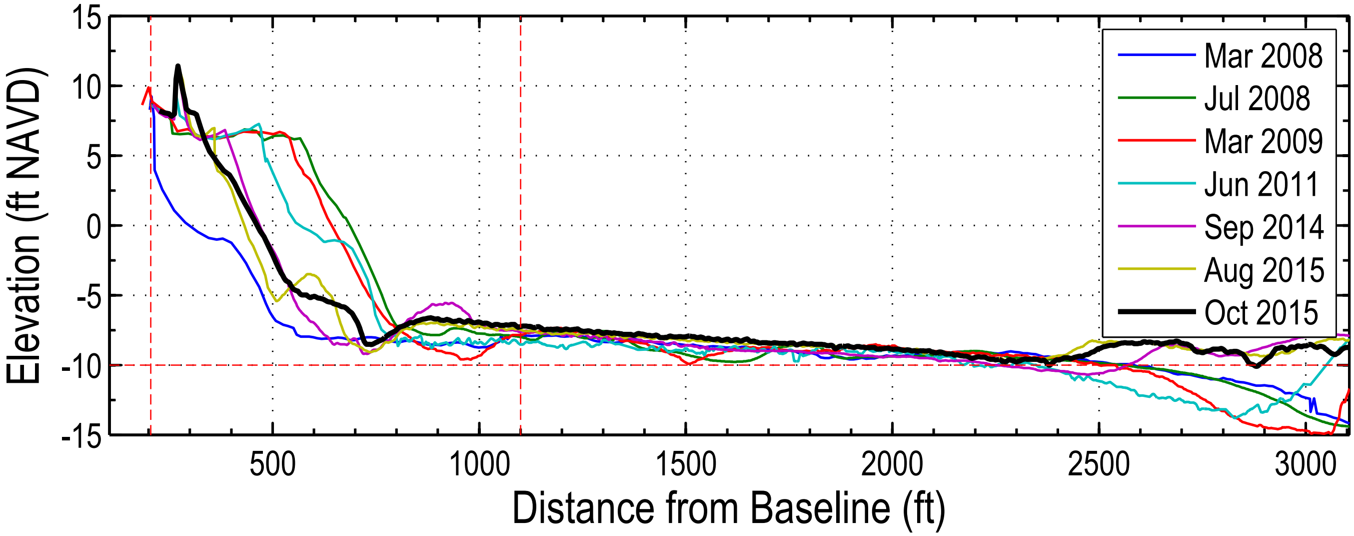


Date	Unit Vol (cy/ft)
Jul 2007	132.1
Mar 2008	149.8
Jul 2008	339.3
Mar 2009	329.5
Sep 2009	306.7
Mar 2010	319.0
Sep 2010	305.8
Jun 2011	317.6
Jul 2012	328.1
Jul 2013	306.1
Sep 2014	271.6
Aug 2015	233.1
Oct 2015	257.9

X: 2392217.44
Y: 357979.55

Station: 304+00 (82+00)

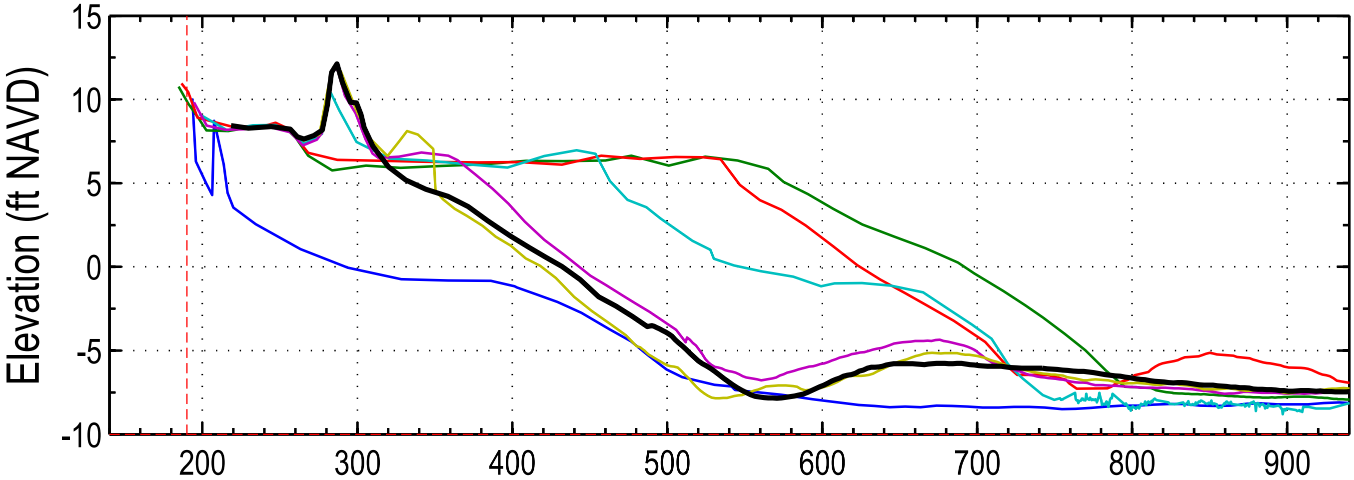


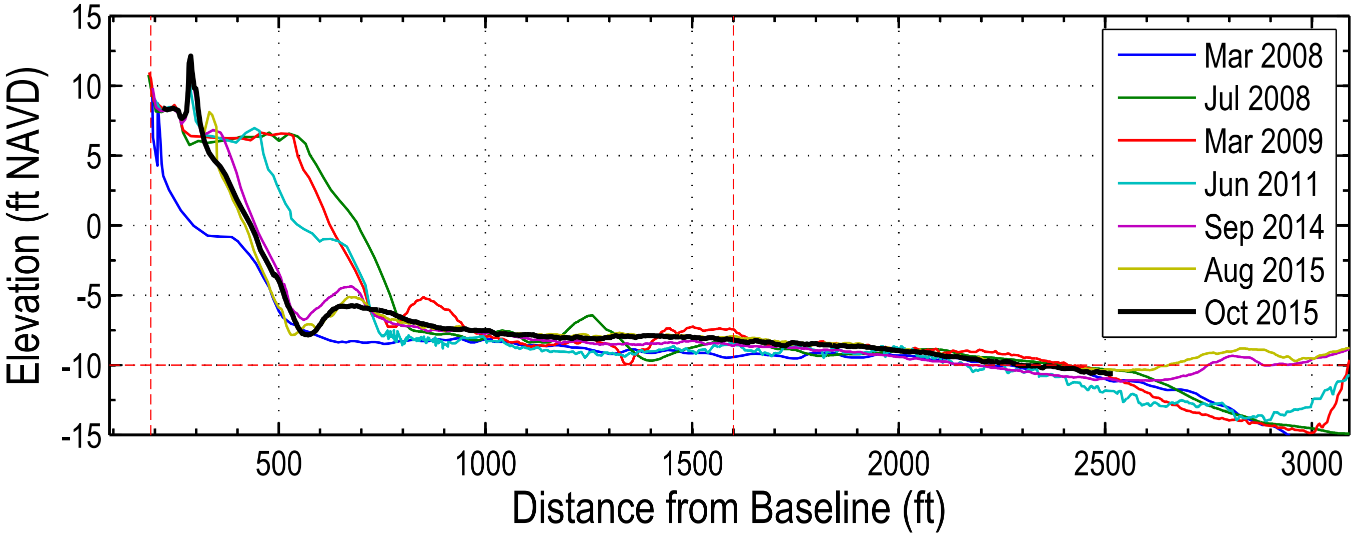


Date	Unit Vol (cy/ft)
Jul 2007	134.2
Mar 2008	141.5
Jul 2008	333.2
Mar 2009	307.5
Sep 2009	289.8
Mar 2010	293.3
Sep 2010	283.0
Jun 2011	292.3
Jul 2012	310.2
Jul 2013	273.6
Sep 2014	236.4
Aug 2015	226.0
Oct 2015	241.6

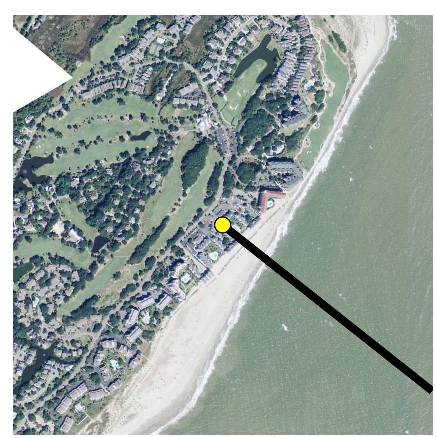
X: 2392341.8
Y: 358136.19

Station: 306+00 (84+00) PORT O'CALL I - BRC6, SCCC 3180



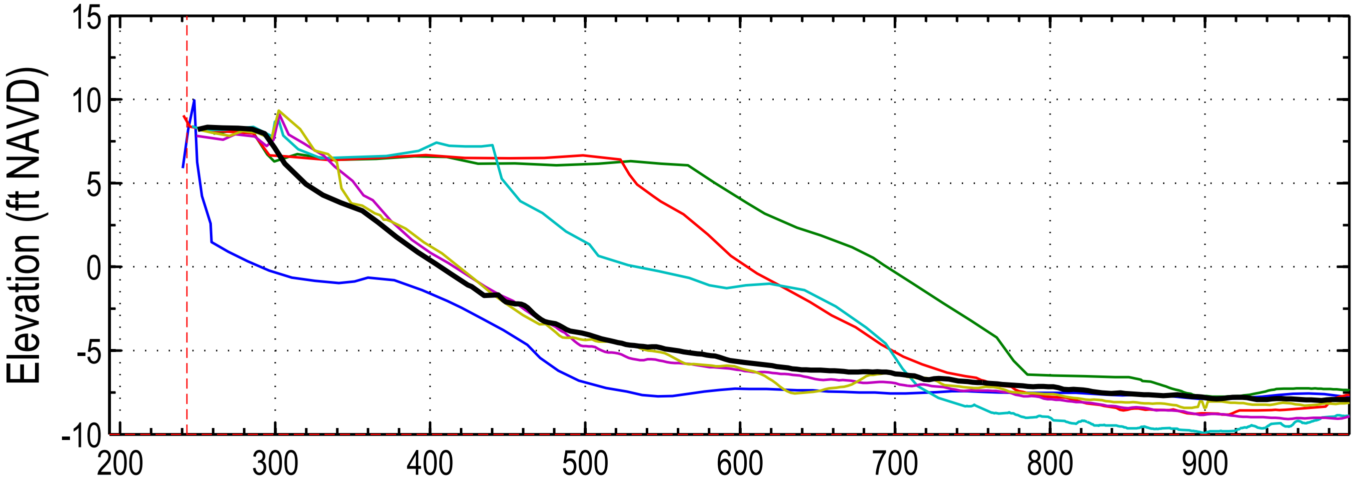


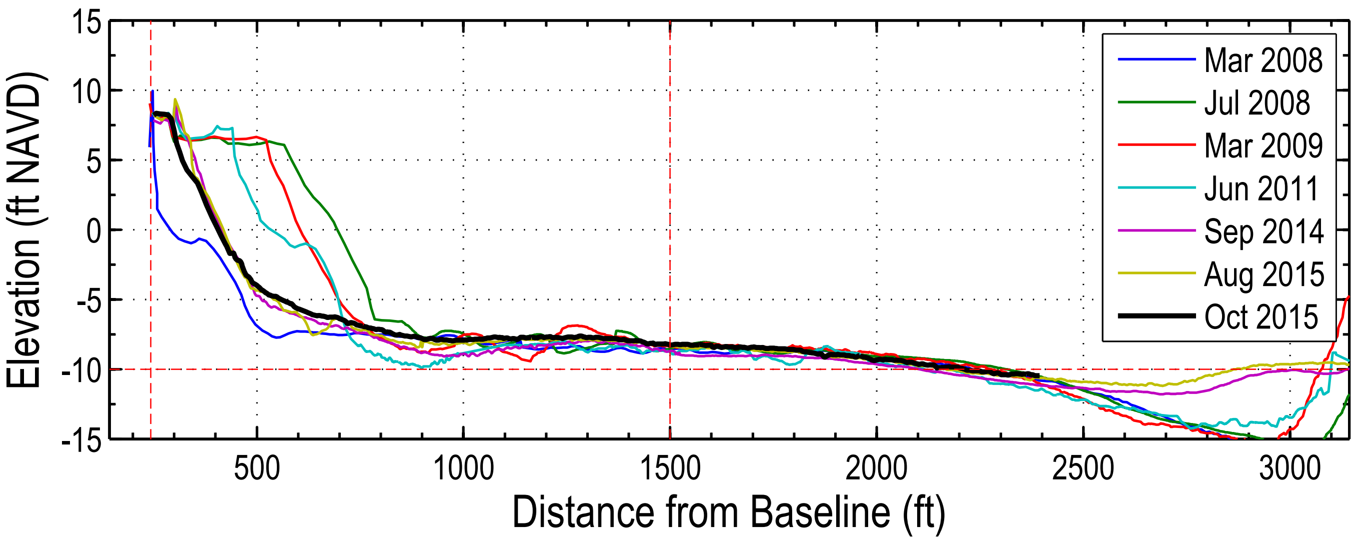
Date	Unit Vol (cy/ft)
Jul 2007	191.5
Mar 2008	171.7
Jul 2008	372.6
Mar 2009	359.8
Sep 2009	312.2
Mar 2010	316.7
Sep 2010	305.7
Jun 2011	310.8
Jul 2012	338.8
Jul 2013	298.8
Sep 2014	275.4
Aug 2015	266.9
Oct 2015	269.1



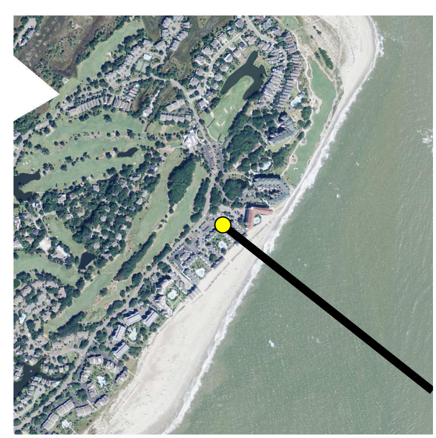
X: 2392466.15
Y: 358292.82

Station: 308+00 (86+00)



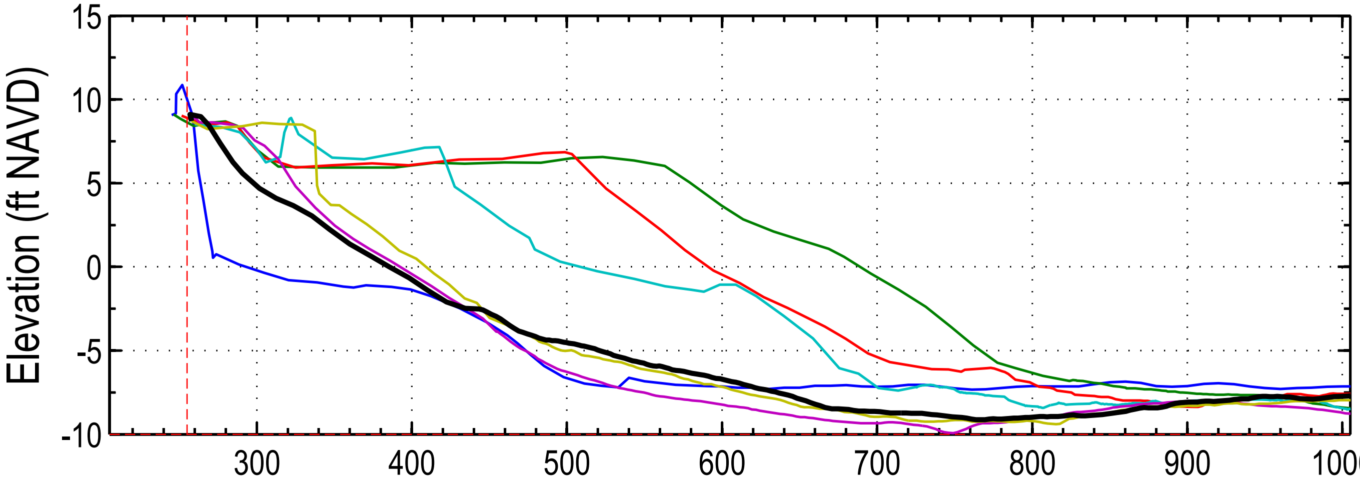


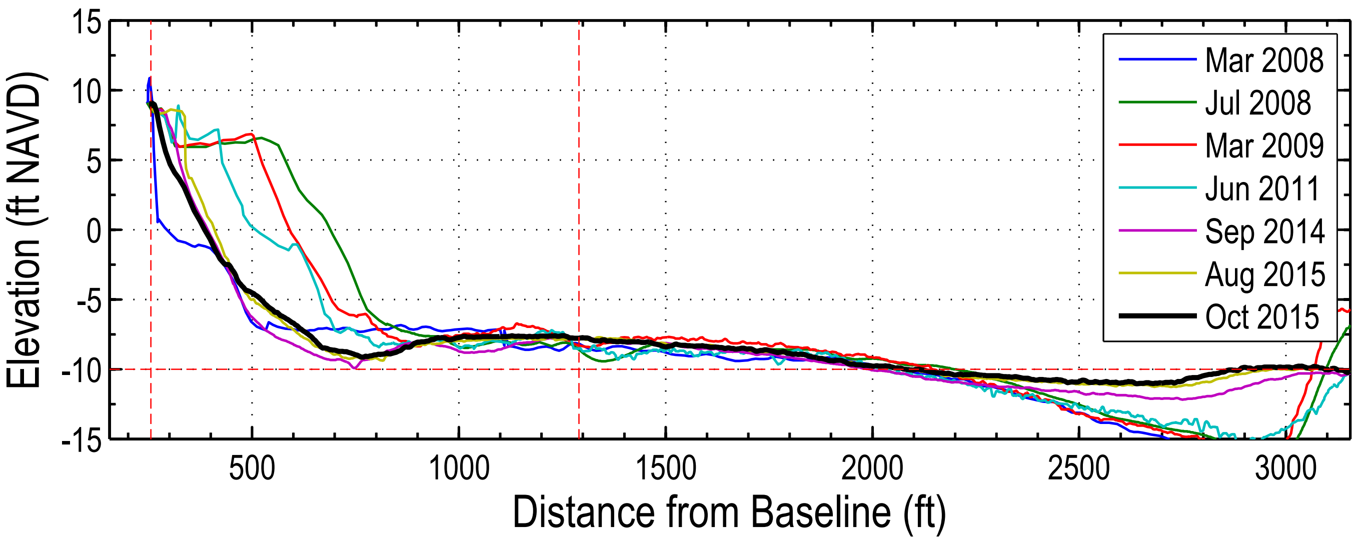
Date	Unit Vol (cy/ft)
Jul 2007	160.4
Mar 2008	155.4
Jul 2008	341.0
Mar 2009	301.7
Sep 2009	287.0
Mar 2010	275.9
Sep 2010	260.9
Jun 2011	260.9
Jul 2012	289.4
Jul 2013	230.0
Sep 2014	200.7
Aug 2015	213.8
Oct 2015	219.4



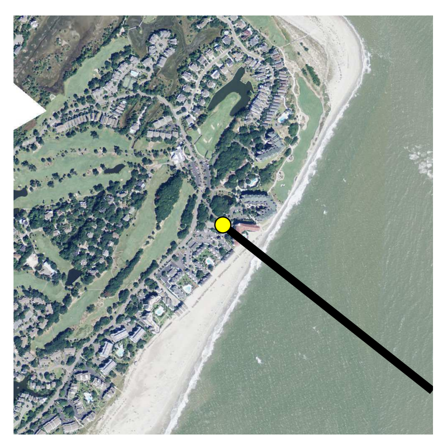
X: 2392590.51
Y: 358449.46

Station: 310+00



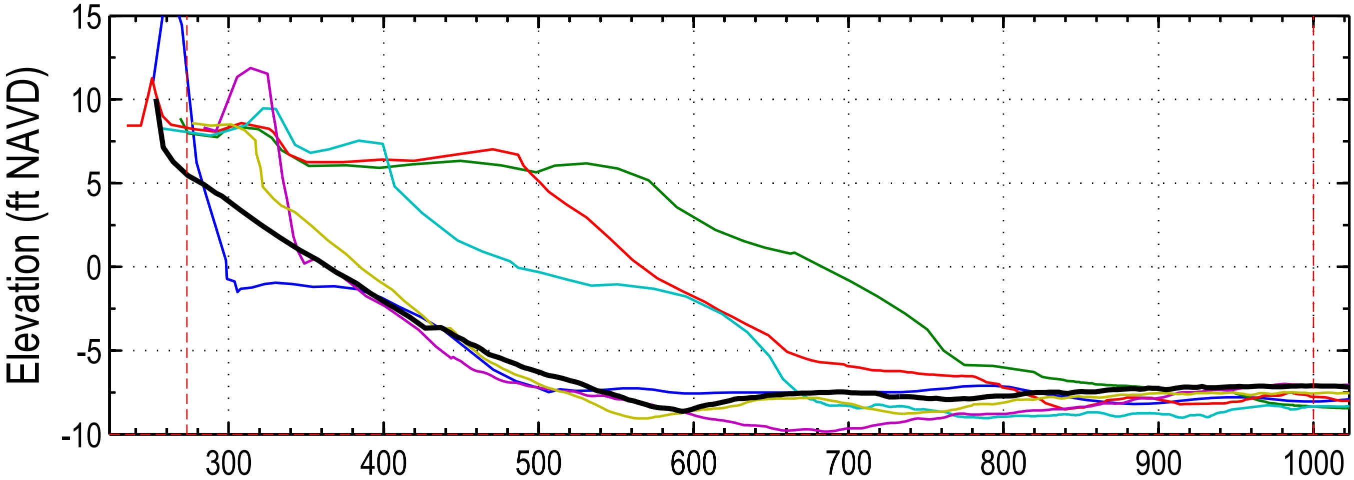


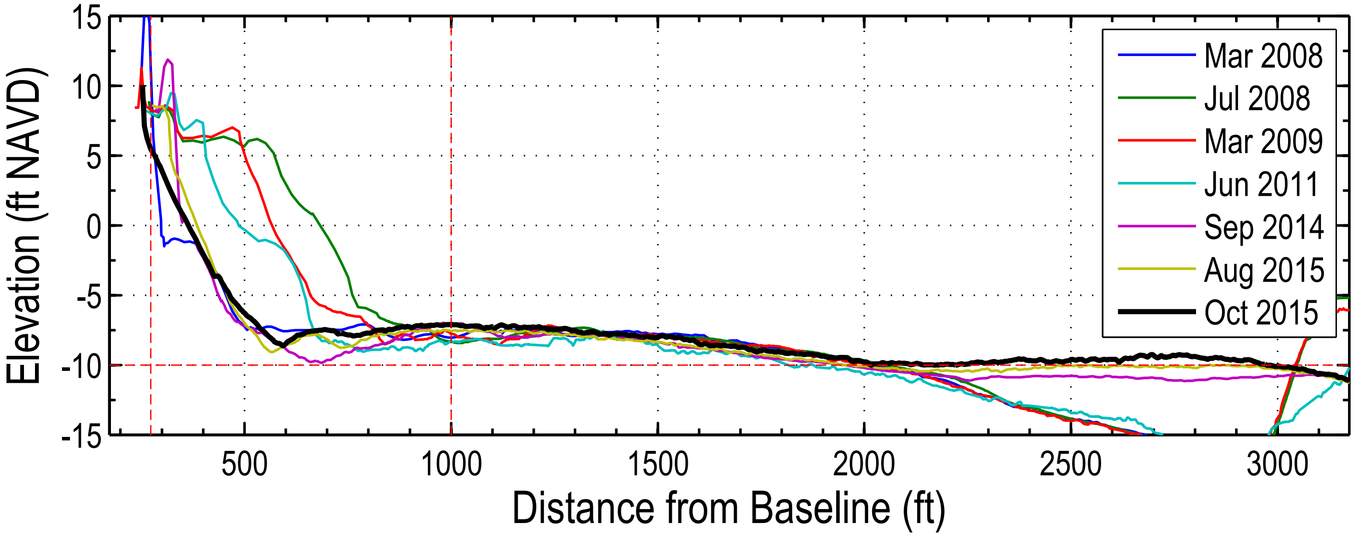
Date	Unit Vol (cy/ft)
Jul 2007	140.4
Mar 2008	152.6
Jul 2008	312.9
Mar 2009	284.6
Sep 2009	241.6
Mar 2010	236.1
Sep 2010	233.9
Jun 2011	245.9
Jul 2012	239.0
Jul 2013	188.2
Sep 2014	149.5
Aug 2015	171.9
Oct 2015	165.2



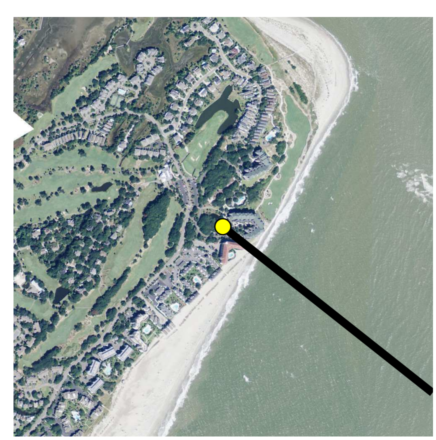
X: 2392714.87
Y: 358606.1

Station: 312+00 (90+00)



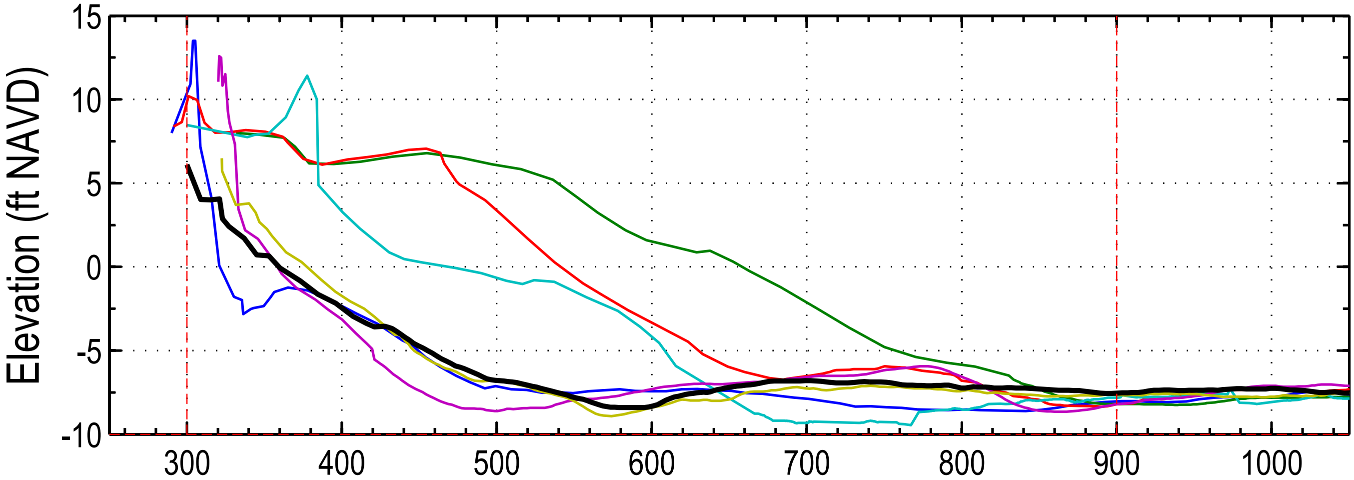


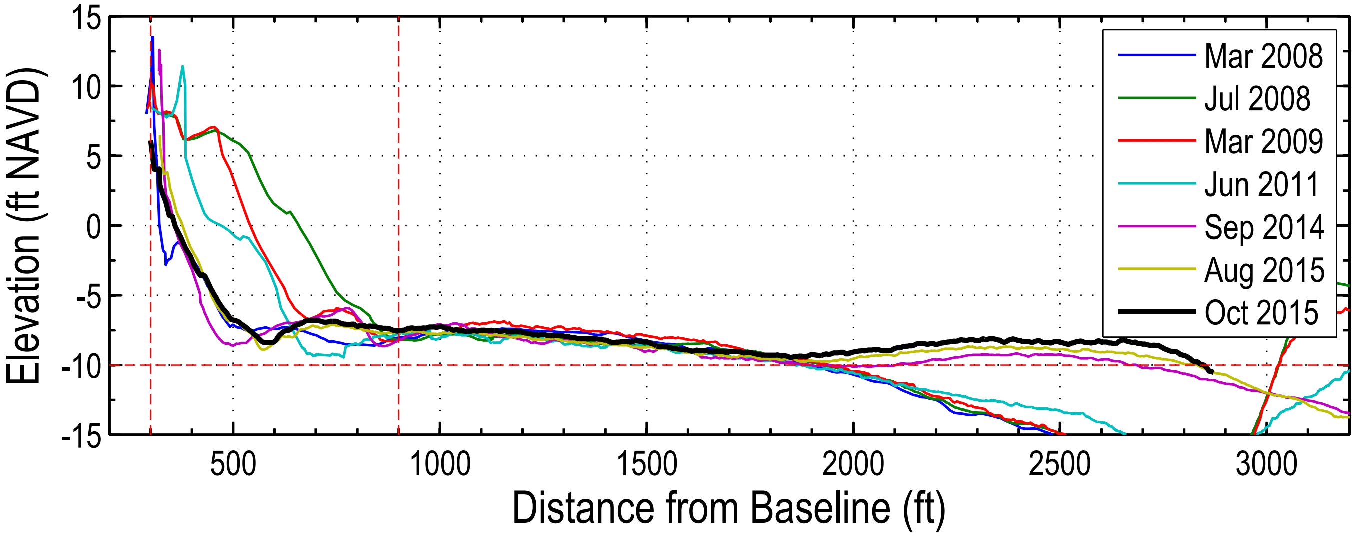
Date	Unit Vol (cy/ft)
Jul 2007	105.8
Mar 2008	111.2
Jul 2008	281.0
Mar 2009	234.7
Sep 2009	215.2
Mar 2010	205.2
Sep 2010	194.3
Jun 2011	192.6
Jul 2012	197.5
Jul 2013	169.9
Sep 2014	115.2
Aug 2015	124.1
Oct 2015	121.1



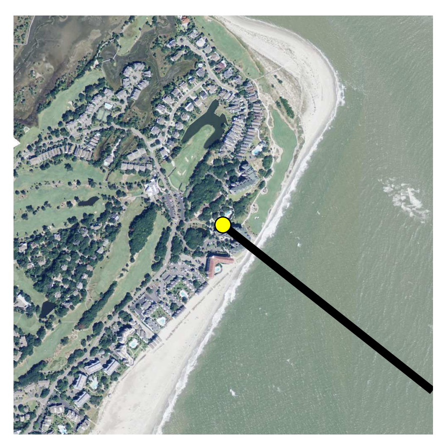
X: 2392839.23
Y: 358762.73

Station: 314+00 (Ocean Club)



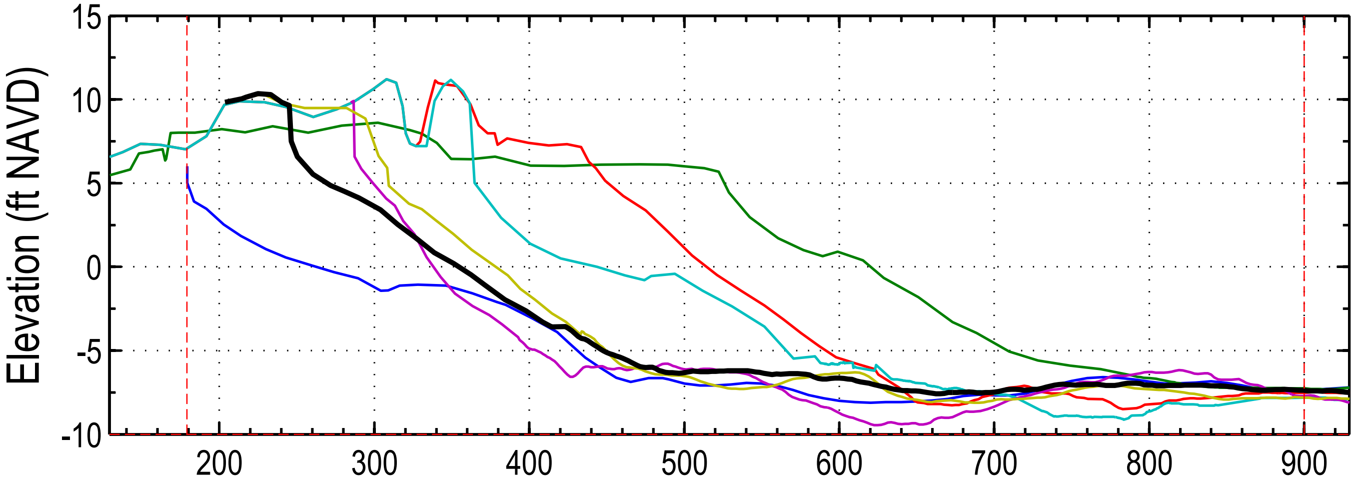


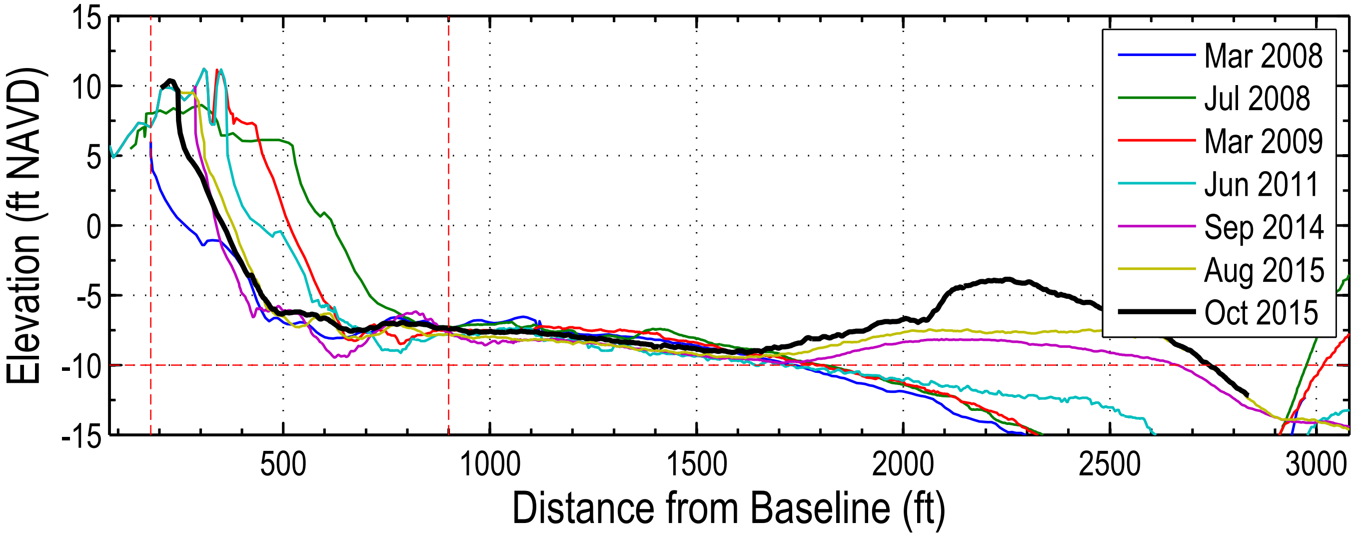
Date	Unit Vol (cy/ft)
Jul 2007	93.1
Mar 2008	86.9
Jul 2008	246.1
Mar 2009	198.9
Sep 2009	169.0
Mar 2010	163.7
Sep 2010	170.6
Jun 2011	156.0
Jul 2012	171.2
Jul 2013	110.6
Sep 2014	100.2
Aug 2015	100.4
Oct 2015	99.7



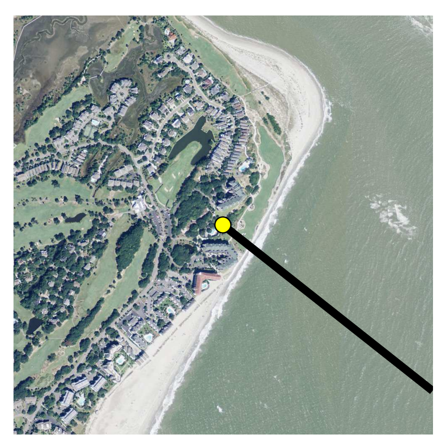
X: 2392963.59
Y: 358919.37

Station: 316 18TH GREEN - SCCC 3183 (94+00)



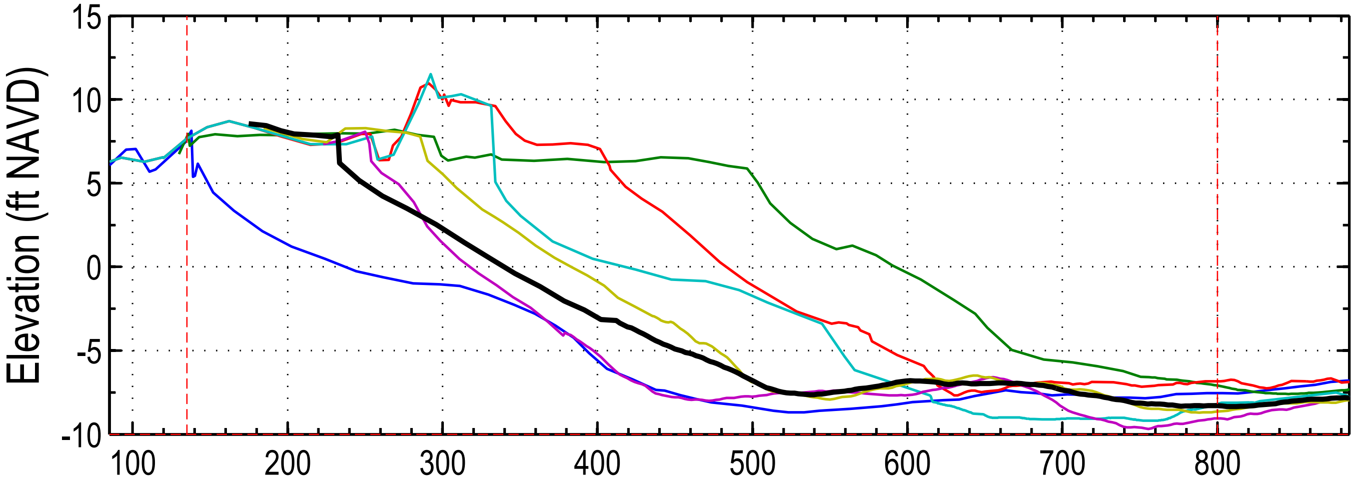


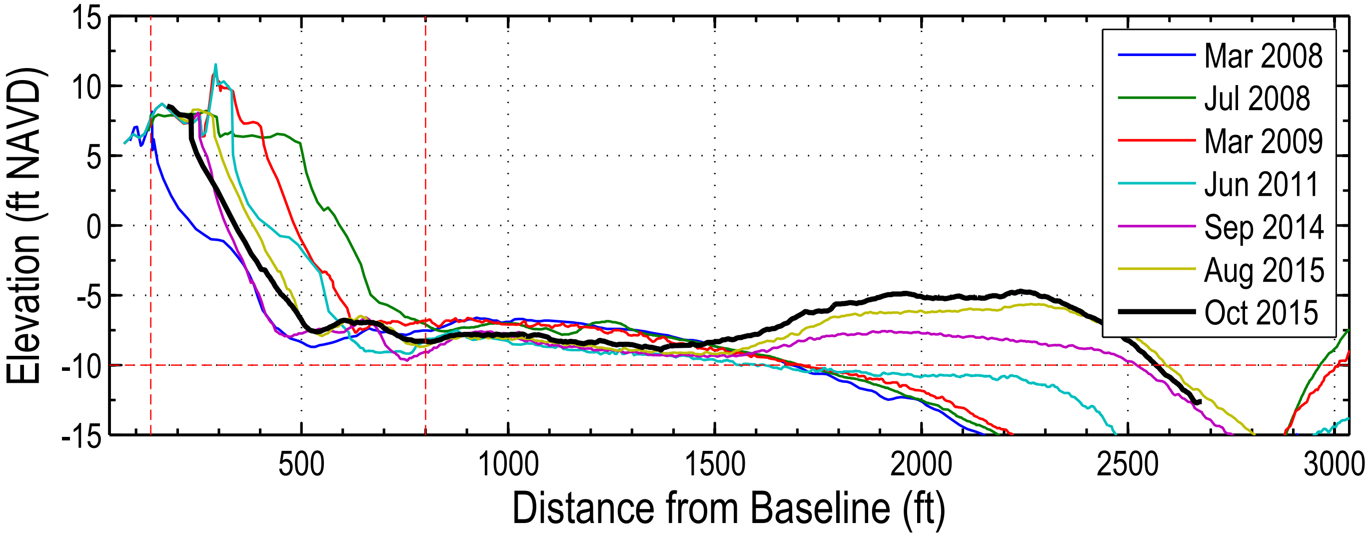
Date	Unit Vol (cy/ft)
Jul 2007	179.1
Mar 2008	136.4
Jul 2008	309.3
Mar 2009	268.6
Sep 2009	252.7
Mar 2010	245.7
Sep 2010	254.3
Jun 2011	235.4
Jul 2012	222.9
Jul 2013	210.9
Sep 2014	173.8
Aug 2015	190.8
Oct 2015	181.2



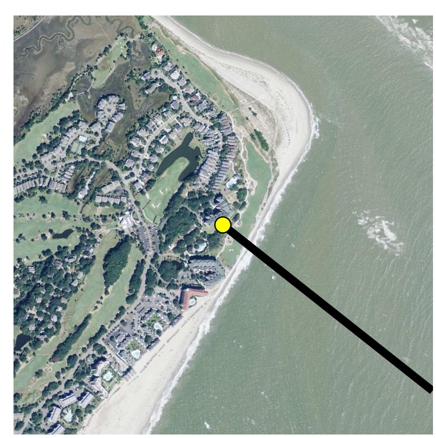
X: 2393087.95
Y: 359076.01

Station: 318+00 (96+00)



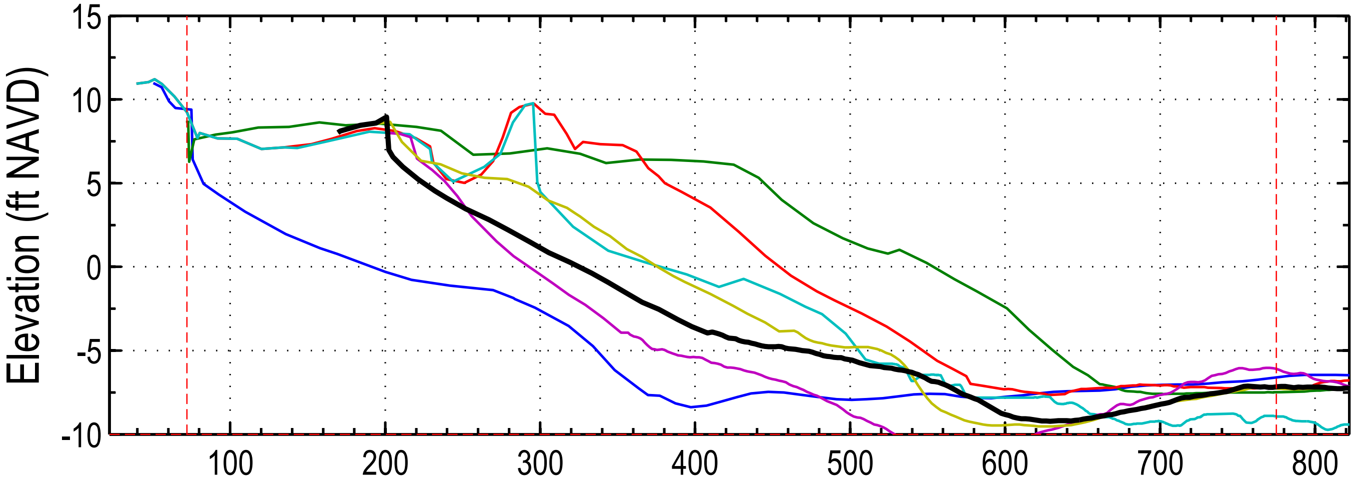


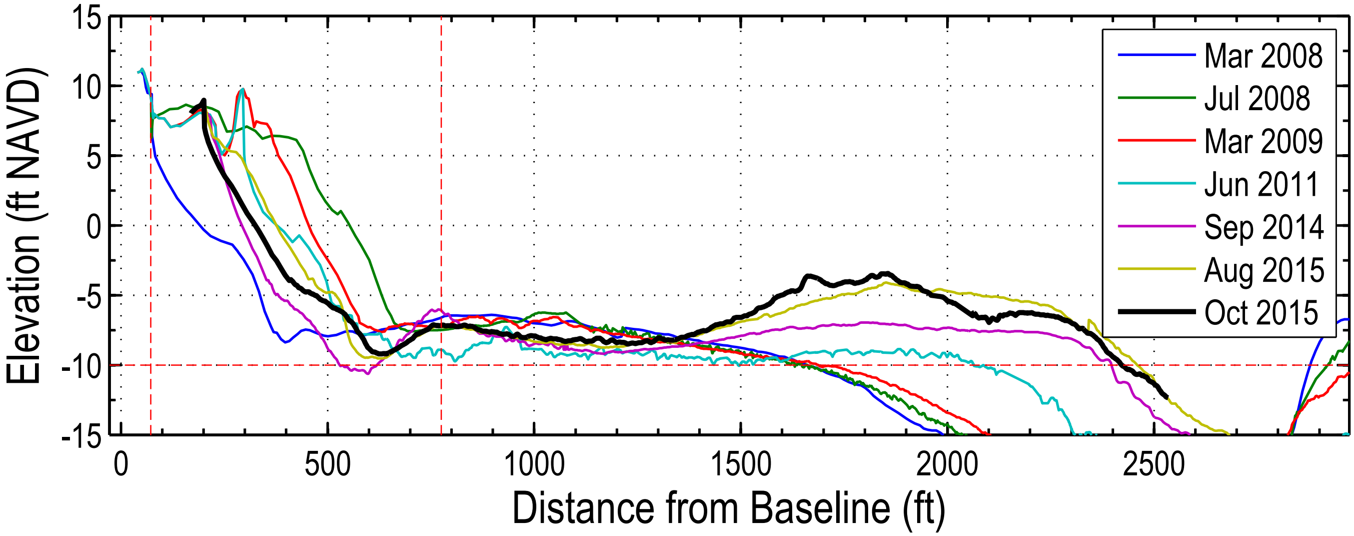
Date	Unit Vol (cy/ft)
Jul 2007	169.7
Mar 2008	128.2
Jul 2008	312.0
Mar 2009	272.7
Sep 2009	256.8
Mar 2010	241.4
Sep 2010	251.8
Jun 2011	229.4
Jul 2012	238.9
Jul 2013	182.4
Sep 2014	162.4
Aug 2015	205.2
Oct 2015	184.2



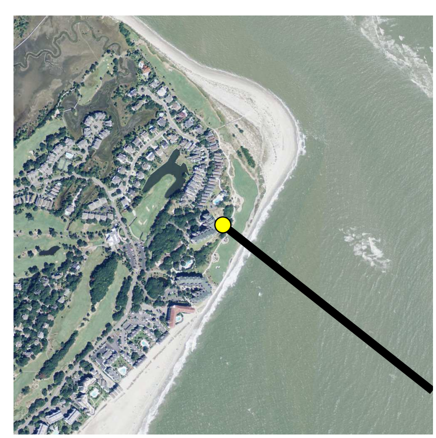
X: 2393212.31
Y: 359232.64

Station: 320+00 (98+00)



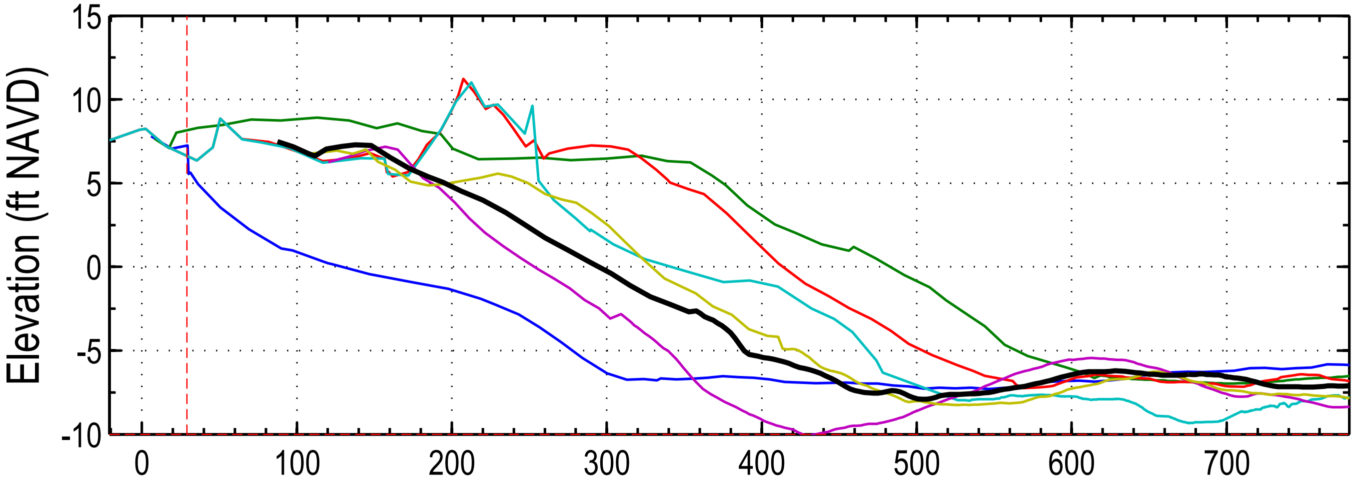


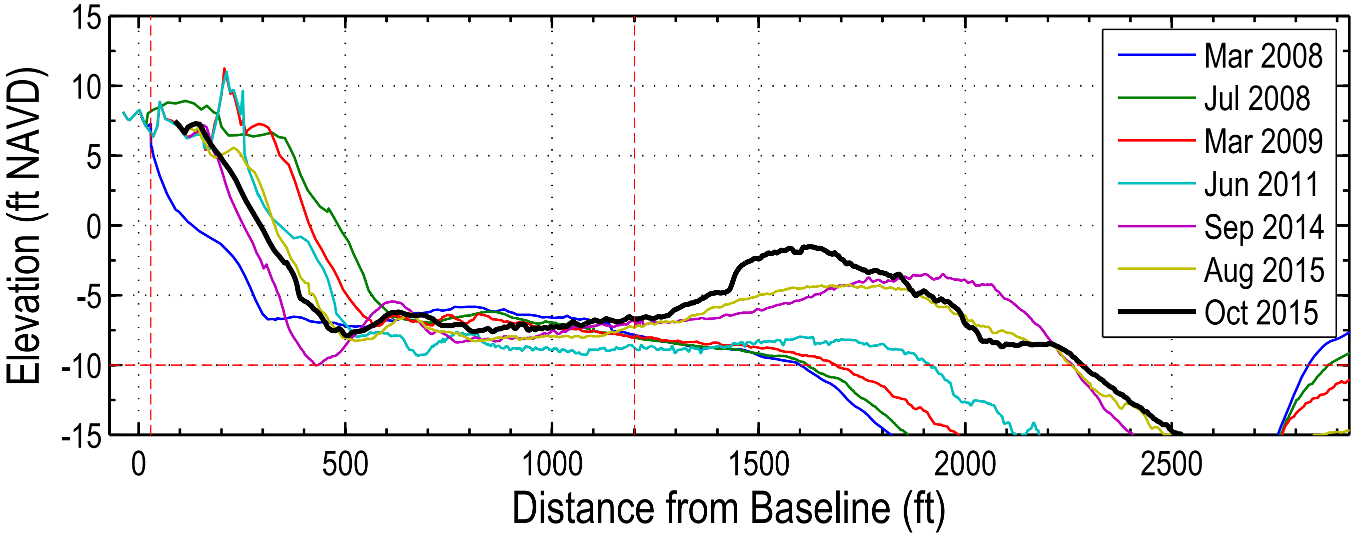
Date	Unit Vol (cy/ft)
Jul 2007	195.2
Mar 2008	140.9
Jul 2008	324.5
Mar 2009	284.3
Sep 2009	271.8
Mar 2010	260.8
Sep 2010	264.8
Jun 2011	238.8
Jul 2012	251.9
Jul 2013	212.0
Sep 2014	186.4
Aug 2015	232.6
Oct 2015	211.5



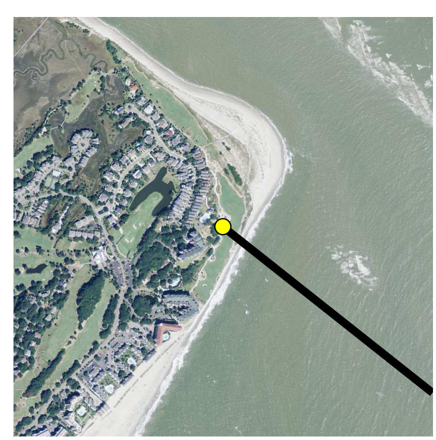
X: 2393336.66
Y: 359389.28

Station: 322+00 (100+00)



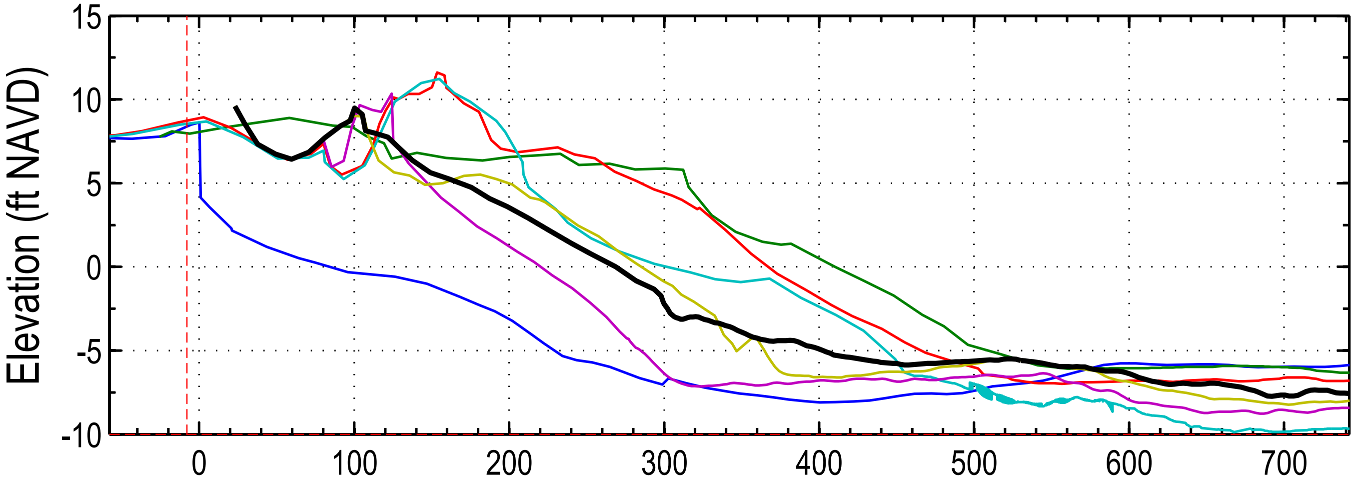


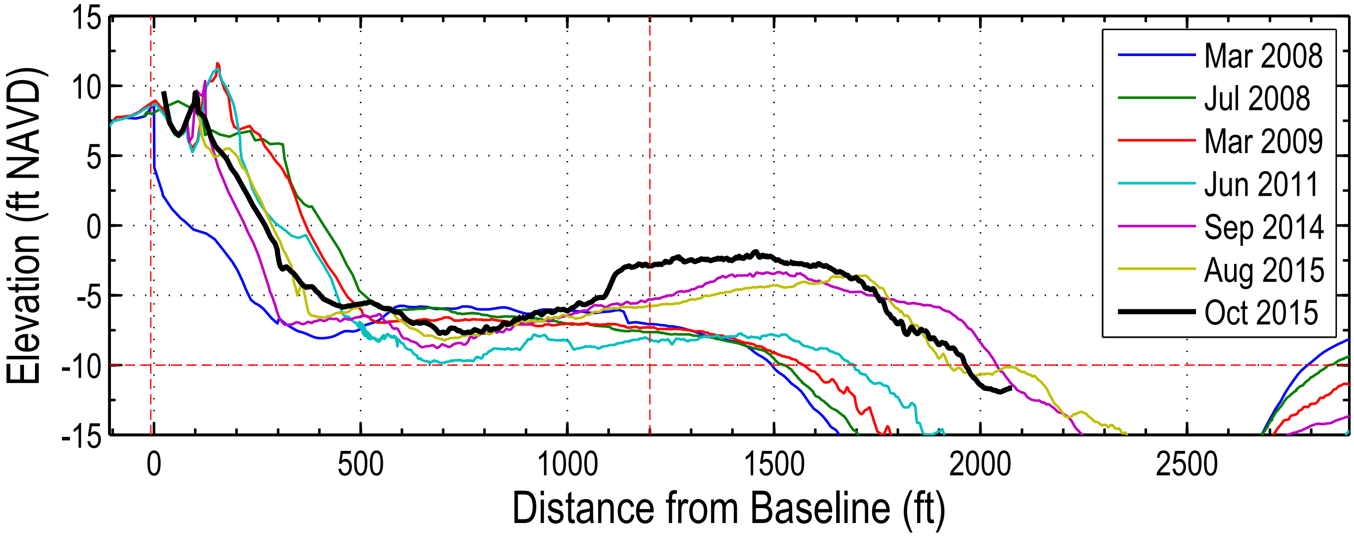
Date	Unit Vol (cy/ft)
Mar 2008	205.4
Jul 2008	368.5
Mar 2009	336.5
Sep 2009	318.2
Mar 2010	297.0
Sep 2010	295.5
Jun 2011	267.3
Jul 2012	249.9
Jul 2013	247.9
Sep 2014	225.7
Aug 2015	264.2
Oct 2015	267.5



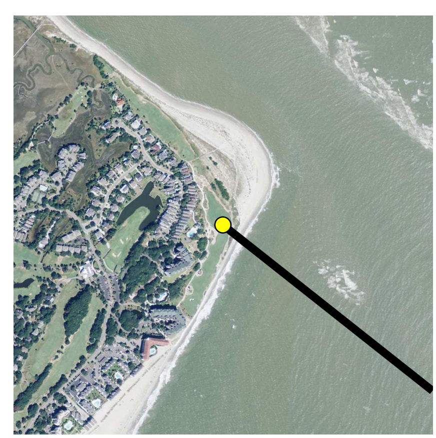
X: 2393461.02
Y: 359545.92

Station: 324+00 (102+00)



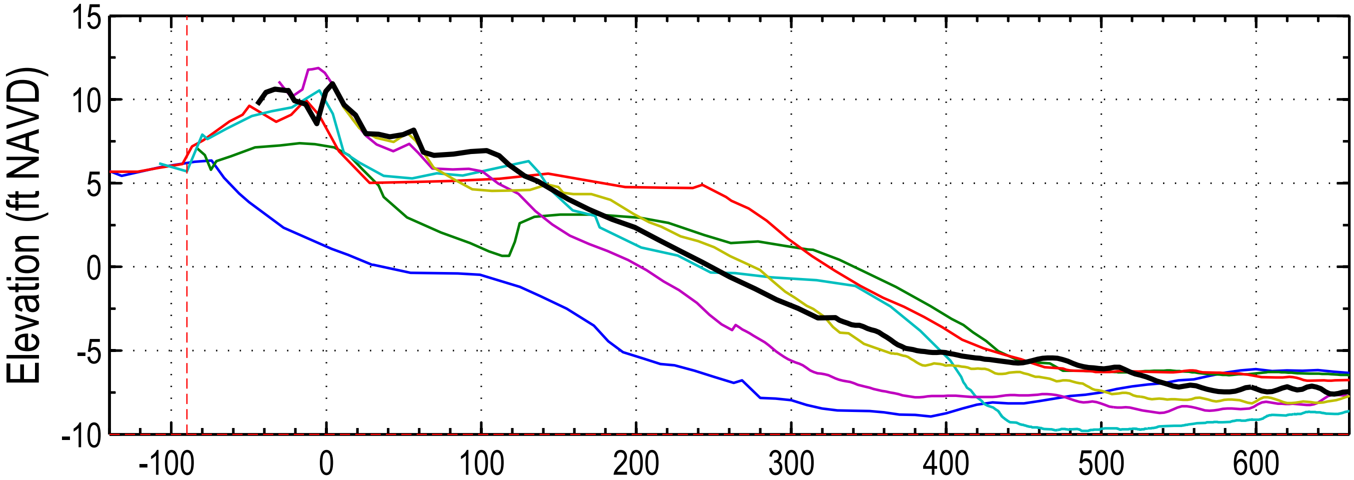


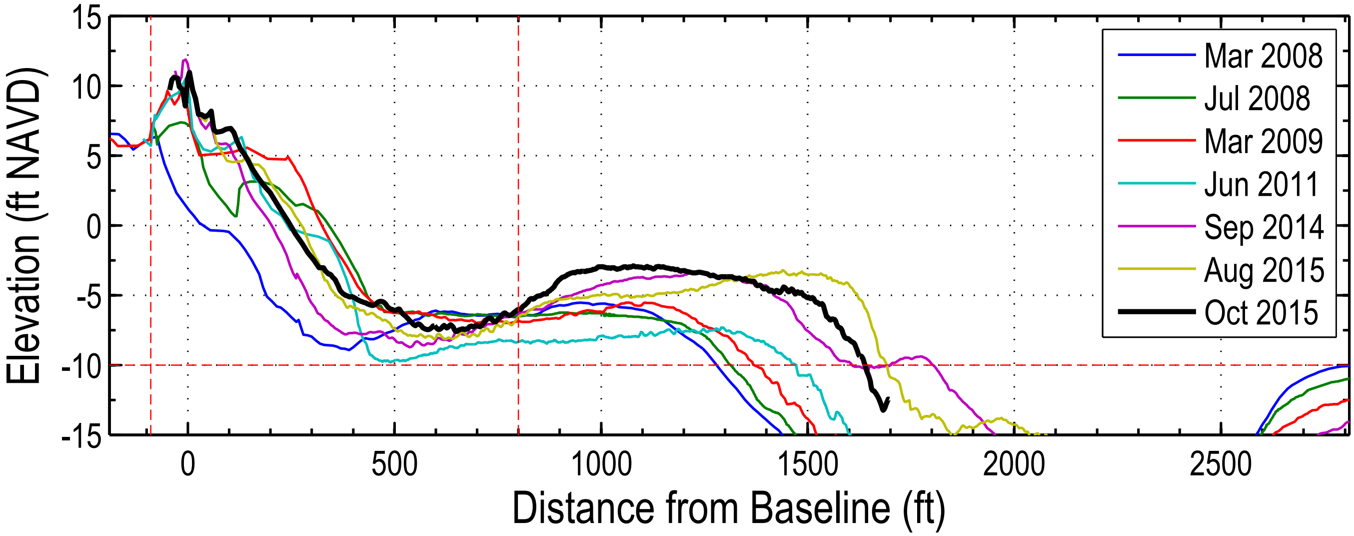
Date	Unit Vol (cy/ft)
Mar 2008	212.3
Jul 2008	361.7
Mar 2009	342.8
Sep 2009	331.6
Mar 2010	298.6
Sep 2010	304.0
Jun 2011	270.8
Jul 2012	255.0
Jul 2013	265.0
Sep 2014	252.2
Aug 2015	292.7
Oct 2015	312.8



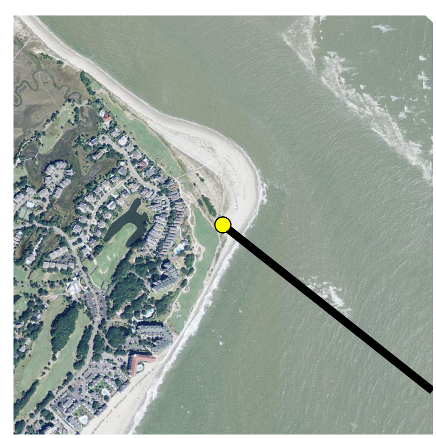
X: 2393585.38
Y: 359702.55

Station: 326+00 (104+00)



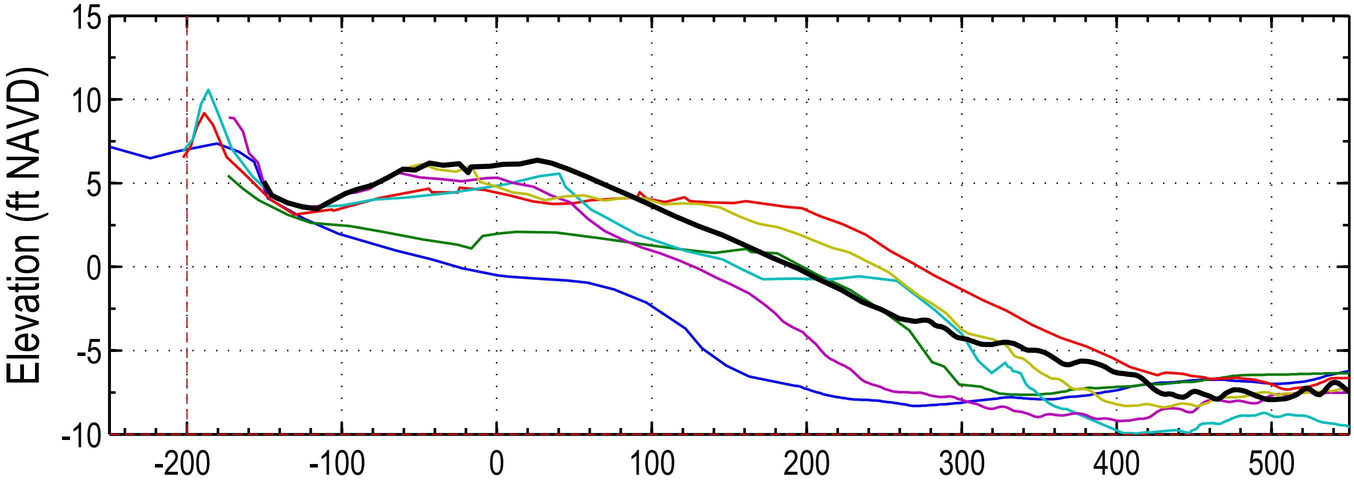


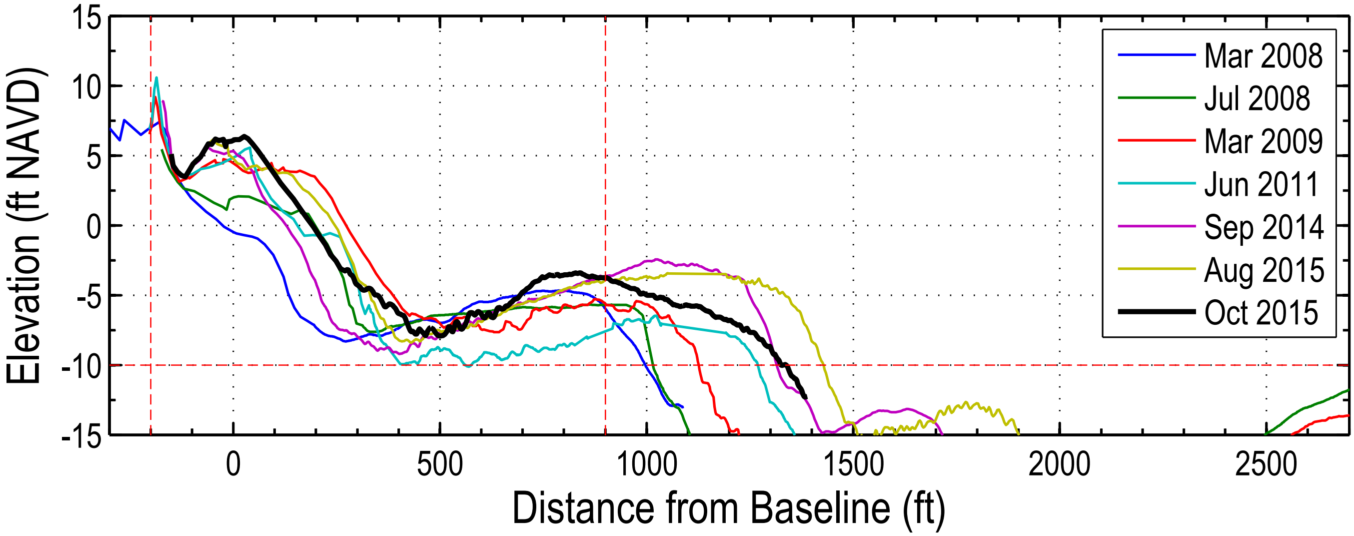
Date	Unit Vol (cy/ft)
Mar 2008	174.1
Jul 2008	291.2
Mar 2009	314.4
Sep 2009	309.9
Mar 2010	288.6
Sep 2010	290.1
Jun 2011	258.3
Jul 2012	243.0
Jul 2013	253.8
Sep 2014	251.1
Aug 2015	284.1
Oct 2015	296.3



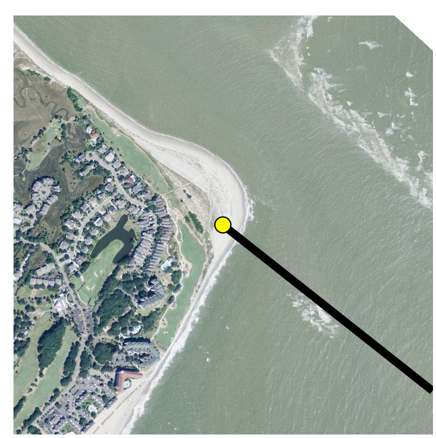
X: 2393709.74
Y: 359859.19

Station: 328+00 (106+00)



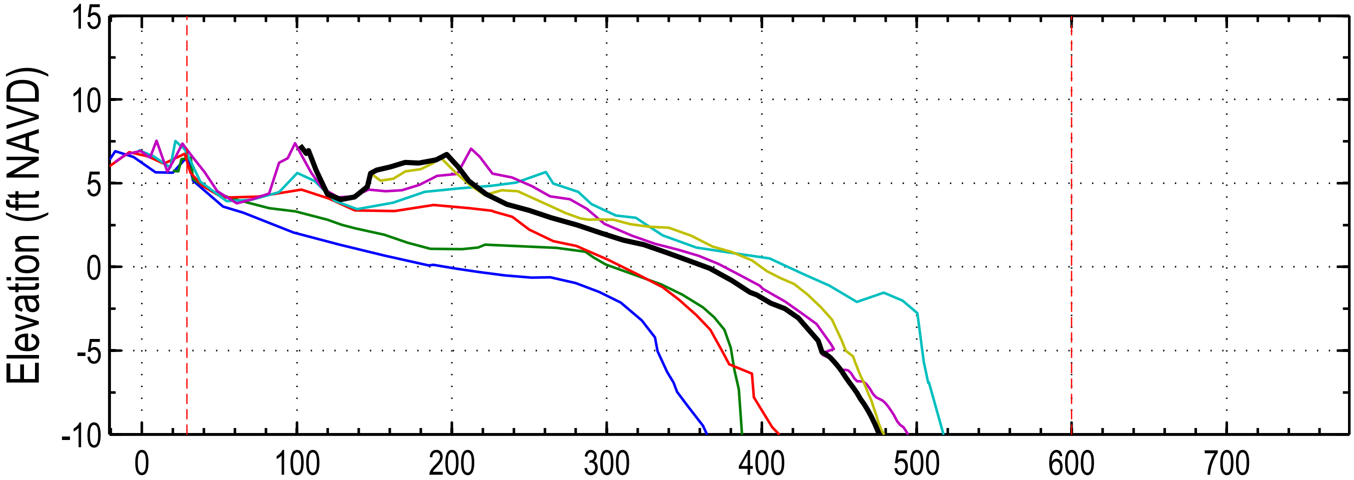


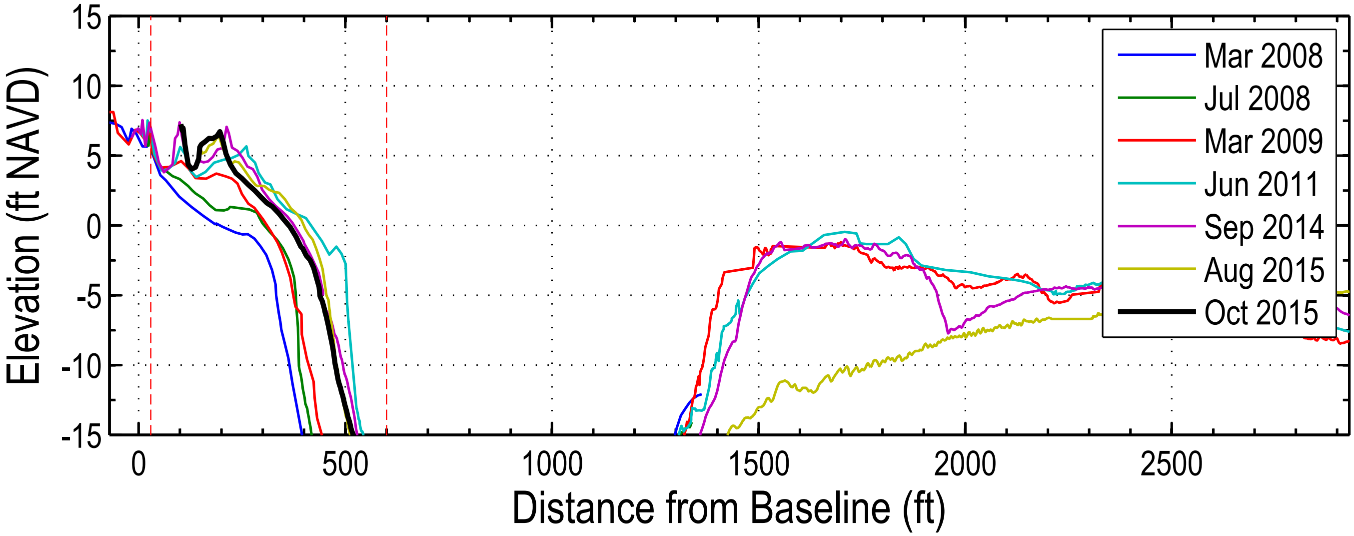
Date	Unit Vol (cy/ft)
Mar 2008	241.0
Jul 2008	285.3
Mar 2009	341.4
Sep 2009	321.5
Mar 2010	299.8
Sep 2010	307.5
Jun 2011	257.9
Jul 2012	263.1
Jul 2013	324.6
Sep 2014	284.4
Aug 2015	331.4
Oct 2015	339.0



X: 2393834.1
Y: 360015.82

Station: 330+00 (108+00)

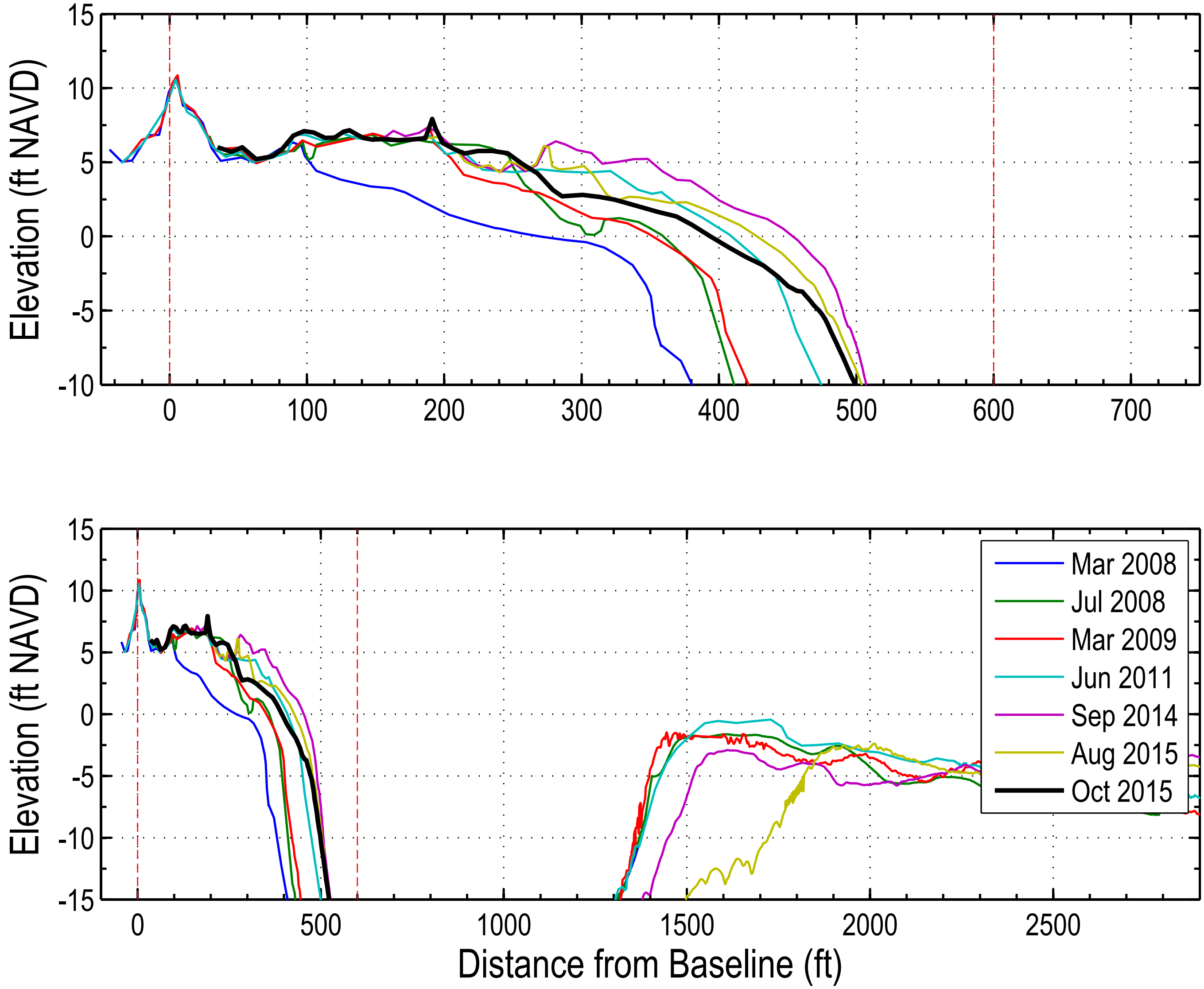




Date	Unit Vol (cy/ft)
Jul 2007	242.9
Mar 2008	228.2
Jul 2008	262.4
Mar 2009	281.7
Sep 2009	297.0
Mar 2010	329.3
Sep 2010	348.6
Jun 2011	374.3
Jul 2012	374.5
Jul 2013	372.3
Sep 2014	352.8
Aug 2015	357.7
Oct 2015	347.9

X: 2393685.82
Y: 360149.93

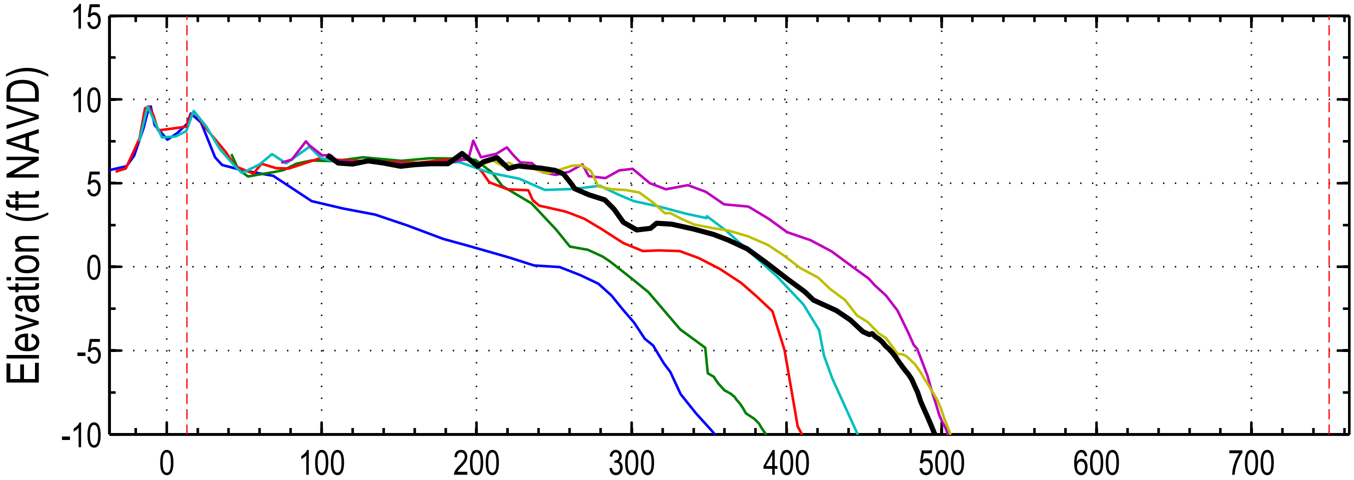
Station: 332+00 (18th Tee)

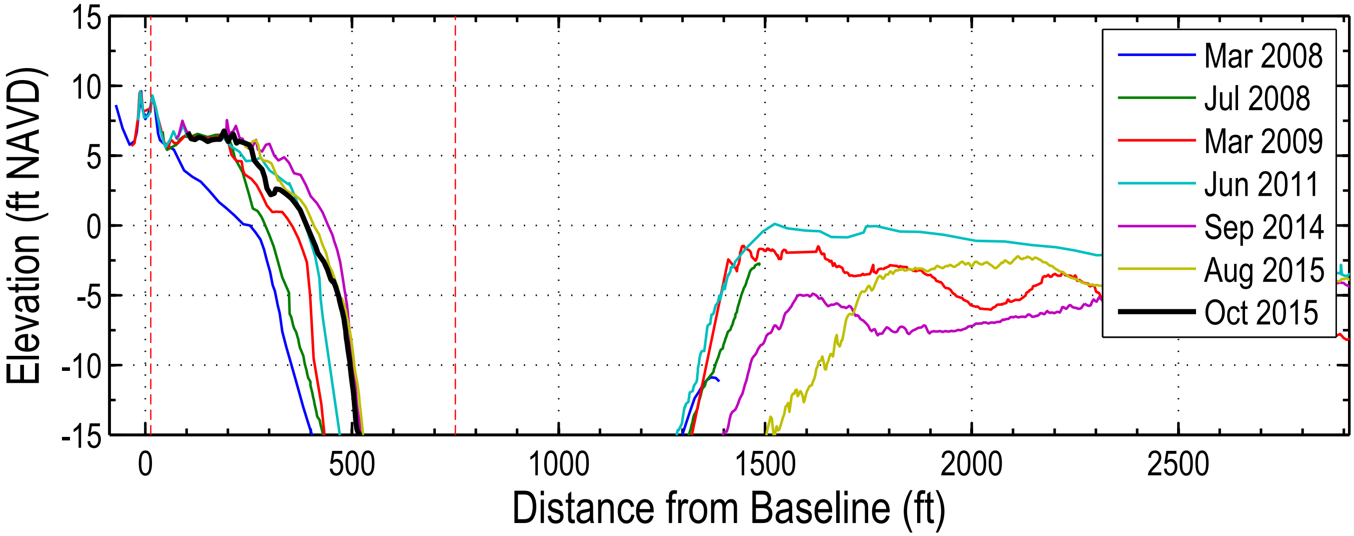


Date	Unit Vol (cy/ft)
Jul 2007	263.5
Mar 2008	286.9
Jul 2008	333.6
Mar 2009	340.5
Sep 2009	344.8
Mar 2010	367.4
Sep 2010	383.5
Jun 2011	389.5
Jul 2012	396.8
Jul 2013	409.6
Sep 2014	421.9
Aug 2015	405.9
Oct 2015	395.9

X: 2393537.44
Y: 360284.02

Station: 334+00 (112+00) 17TH HOLE - BRC9

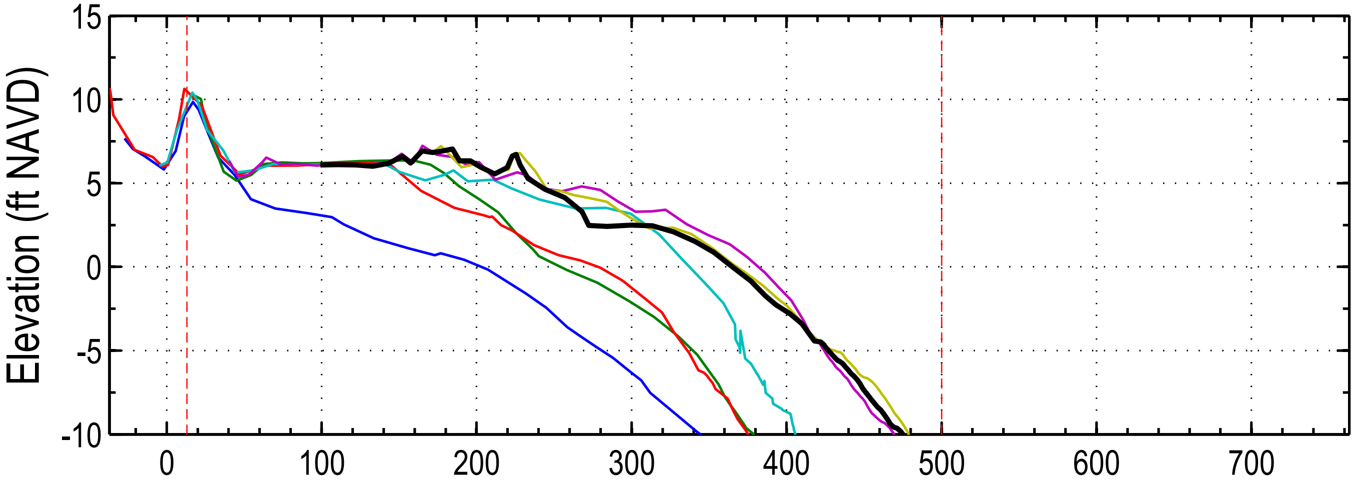


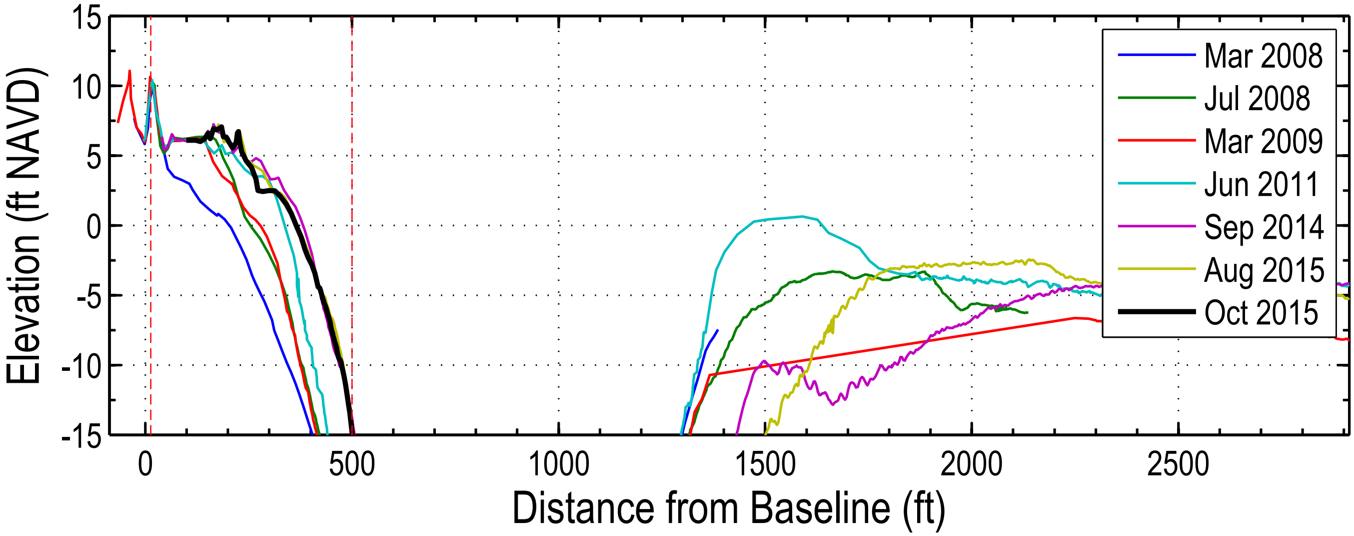


Date	Unit Vol (cy/ft)
Jul 2007	240.9
Mar 2008	252.6
Jul 2008	295.8
Mar 2009	324.2
Sep 2009	328.5
Mar 2010	338.6
Sep 2010	349.0
Jun 2011	357.5
Jul 2012	372.1
Jul 2013	391.7
Sep 2014	406.4
Aug 2015	393.3
Oct 2015	381.3

X: 2393389.05
Y: 360418.11

Station: 336+00 (114+00)

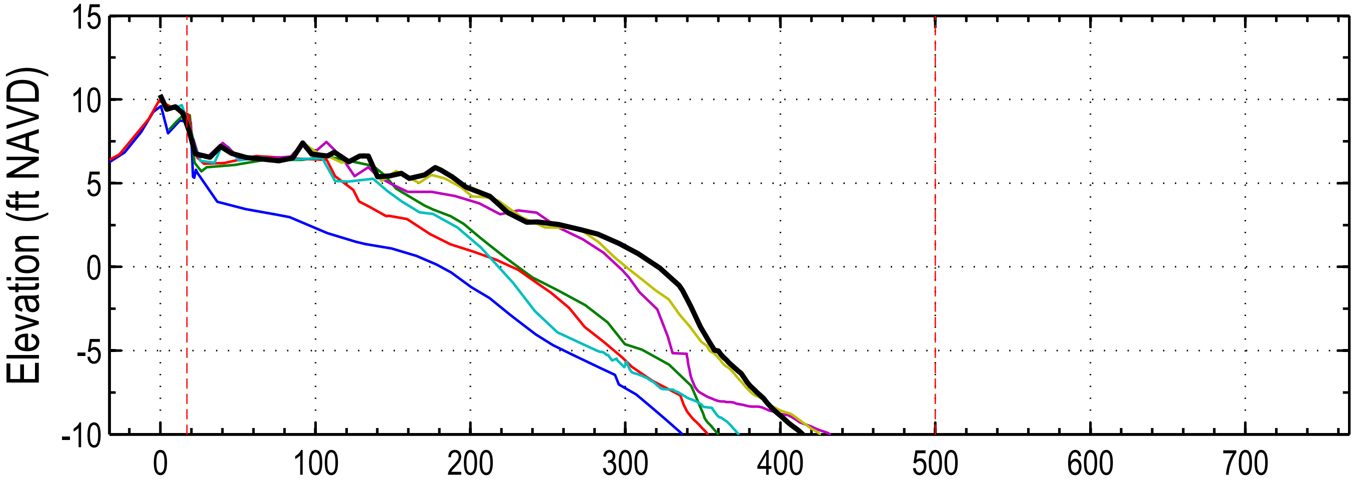


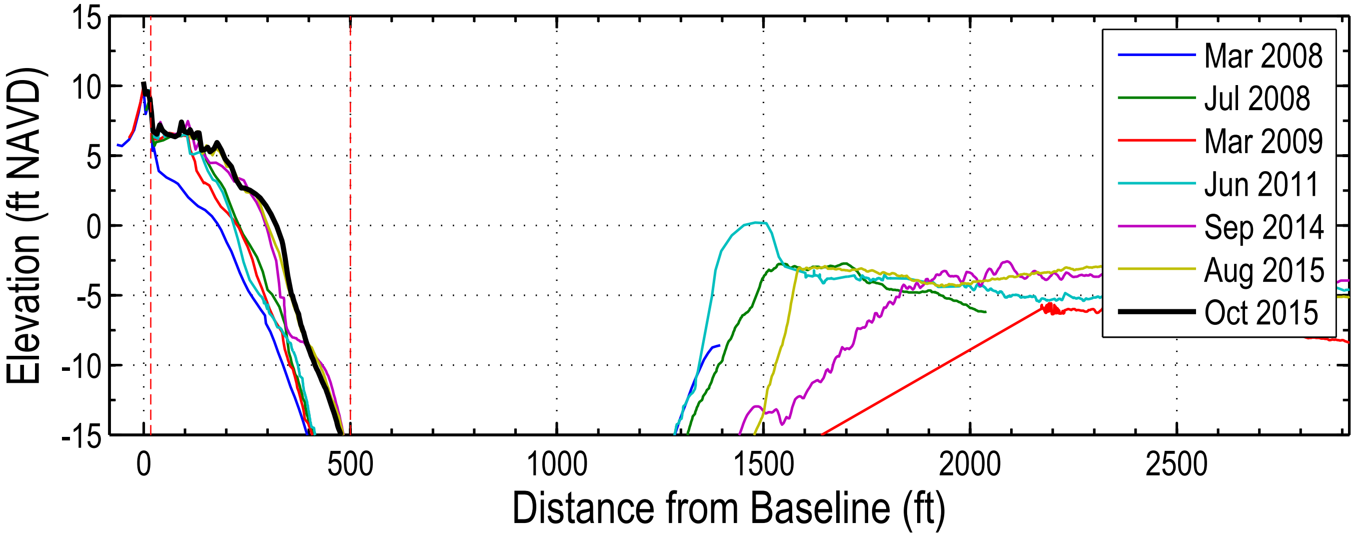


Date	Unit Vol (cy/ft)
Jul 2007	230.1
Mar 2008	232.8
Jul 2008	284.0
Mar 2009	281.2
Sep 2009	291.3
Mar 2010	298.3
Sep 2010	300.7
Jun 2011	319.1
Jul 2012	330.0
Jul 2013	343.4
Sep 2014	362.8
Aug 2015	362.2
Oct 2015	357.7

X: 2393240.66
Y: 360552.21

Station: 338+00 (116+00)

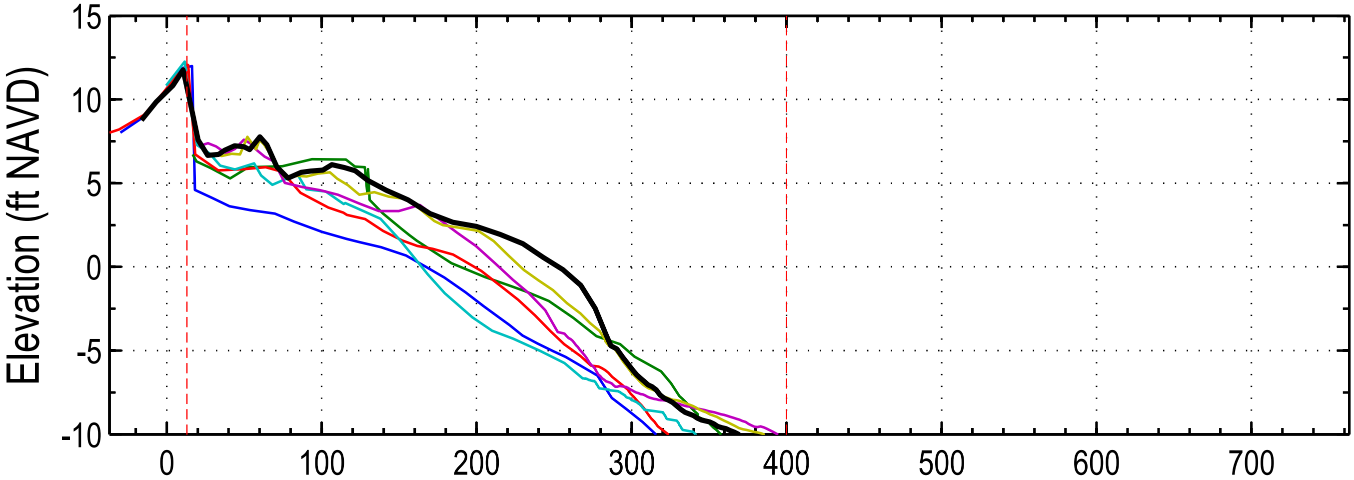


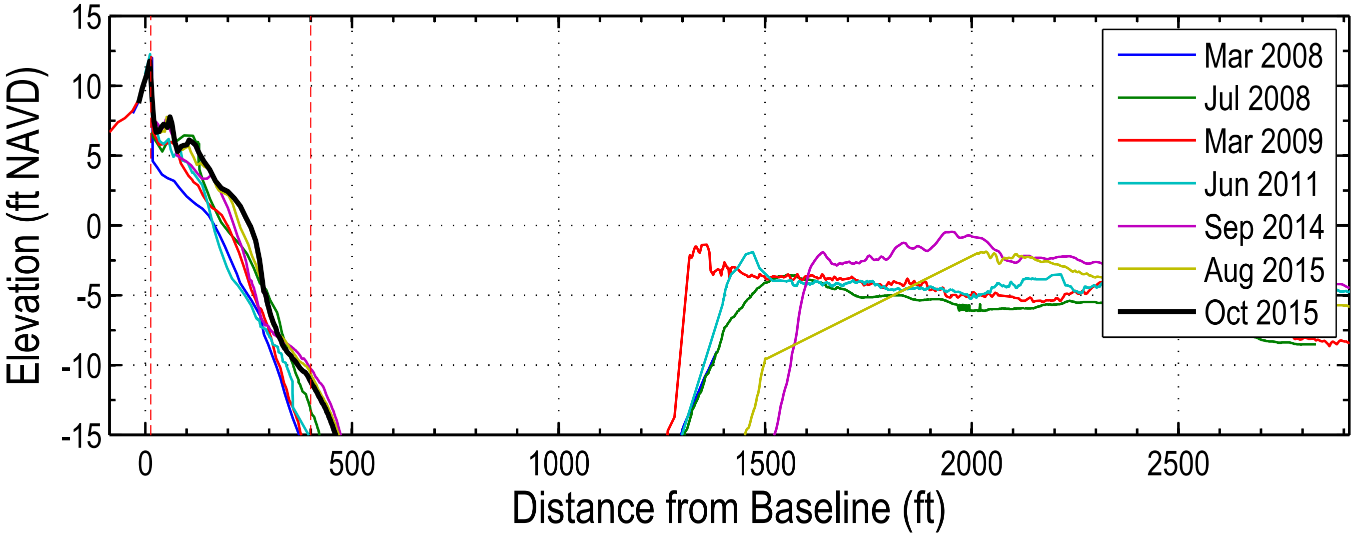


Date	Unit Vol (cy/ft)
Jul 2007	212.8
Mar 2008	214.7
Jul 2008	261.2
Mar 2009	247.8
Sep 2009	240.3
Mar 2010	240.1
Sep 2010	245.2
Jun 2011	252.3
Jul 2012	266.0
Jul 2013	280.9
Sep 2014	304.9
Aug 2015	312.2
Oct 2015	313.7

X: 2393092.27
Y: 360686.3

Station: 340+00 (118+00)

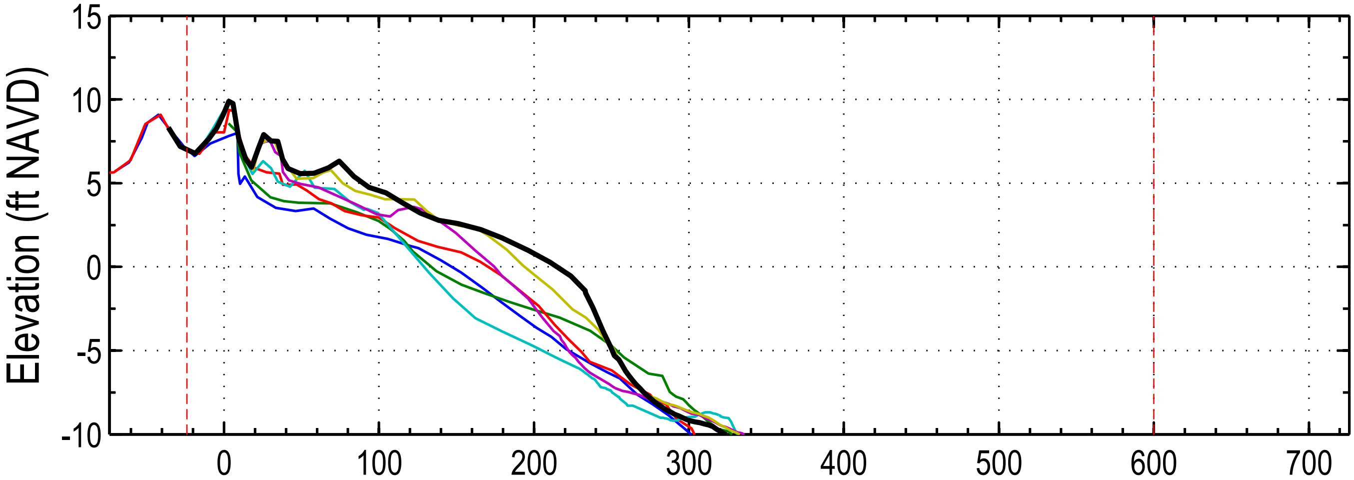


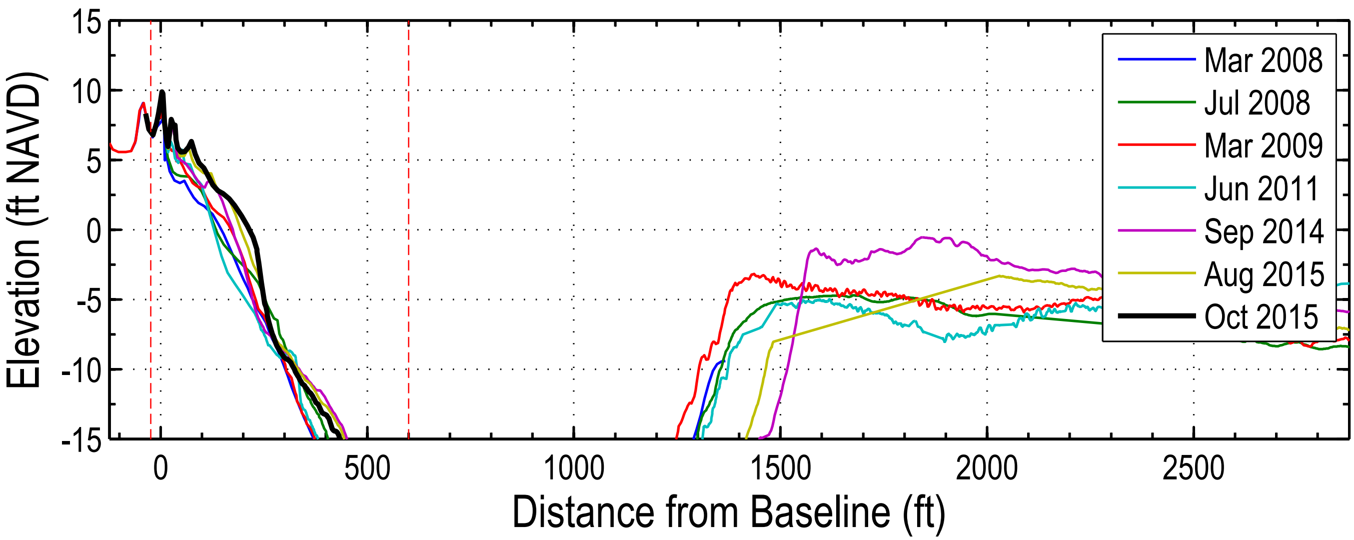


Date	Unit Vol (cy/ft)
Jul 2007	204.3
Mar 2008	204.6
Jul 2008	244.6
Mar 2009	223.2
Sep 2009	216.1
Mar 2010	209.4
Sep 2010	212.5
Jun 2011	218.4
Jul 2012	224.8
Jul 2013	233.3
Sep 2014	246.4
Aug 2015	255.1
Oct 2015	259.7

X: 2392943.88
Y: 360820.39

Station: 342+00 (17th Fairway)

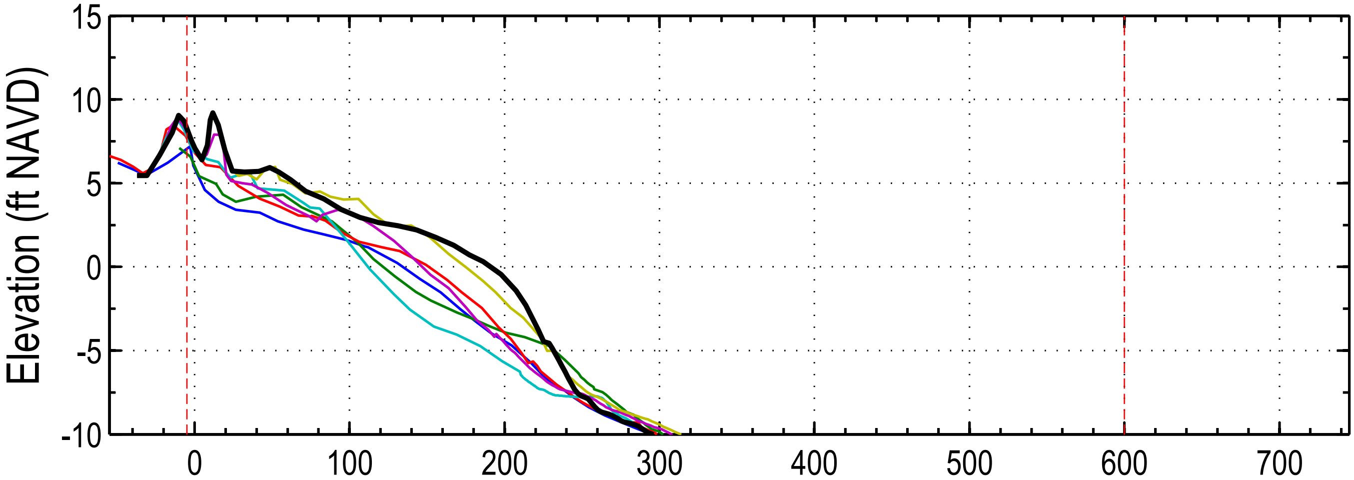


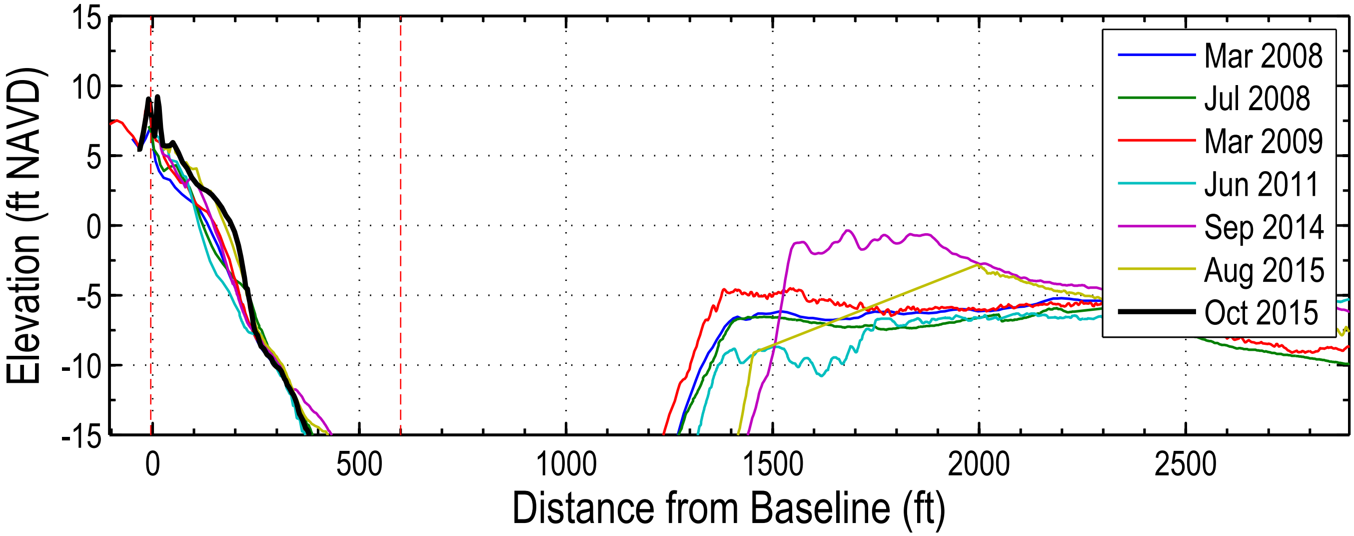


Date	Unit Vol (cy/ft)
Jul 2007	231.0
Mar 2008	227.6
Jul 2008	246.4
Mar 2009	239.2
Sep 2009	232.7
Mar 2010	226.1
Sep 2010	226.1
Jun 2011	232.4
Jul 2012	246.7
Jul 2013	253.5
Sep 2014	264.2
Aug 2015	272.6
Oct 2015	271.5

X: 2392795.49
Y: 360954.49

Station: 344+00 (122+00)

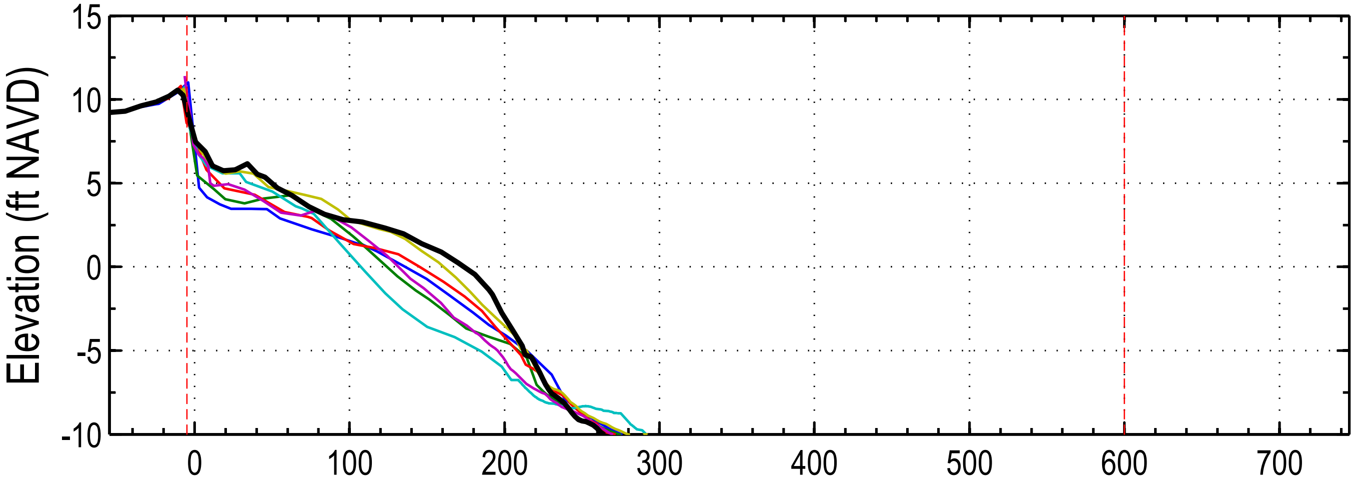


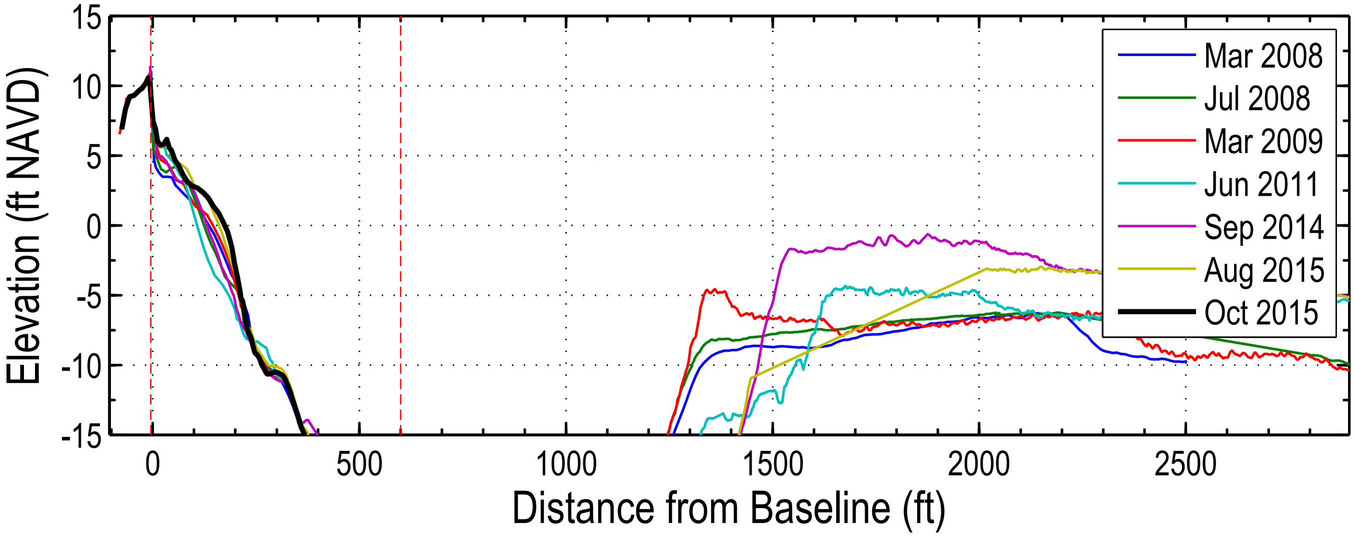


Date	Unit Vol (cy/ft)
Jul 2007	201.5
Mar 2008	201.1
Jul 2008	209.5
Mar 2009	208.3
Sep 2009	205.0
Mar 2010	196.9
Sep 2010	196.4
Jun 2011	198.6
Jul 2012	209.7
Jul 2013	215.3
Sep 2014	222.2
Aug 2015	233.1
Oct 2015	228.5

X: 2392647.11
Y: 361088.58

Station: 346+00 (124+00) UPDRIFT OF GROIN - BRC11, SCCC 3190

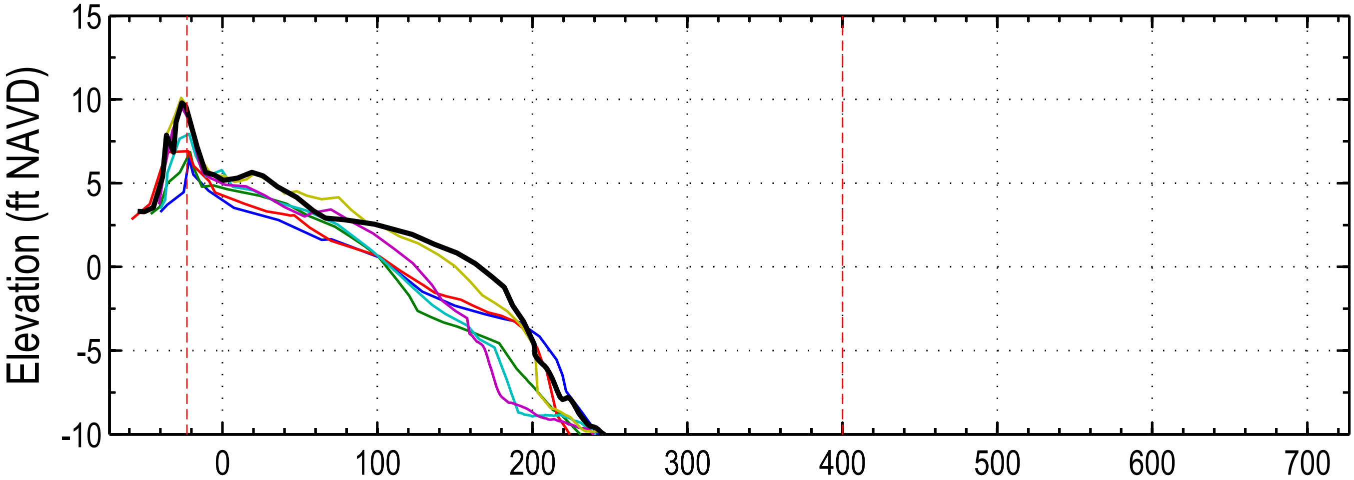


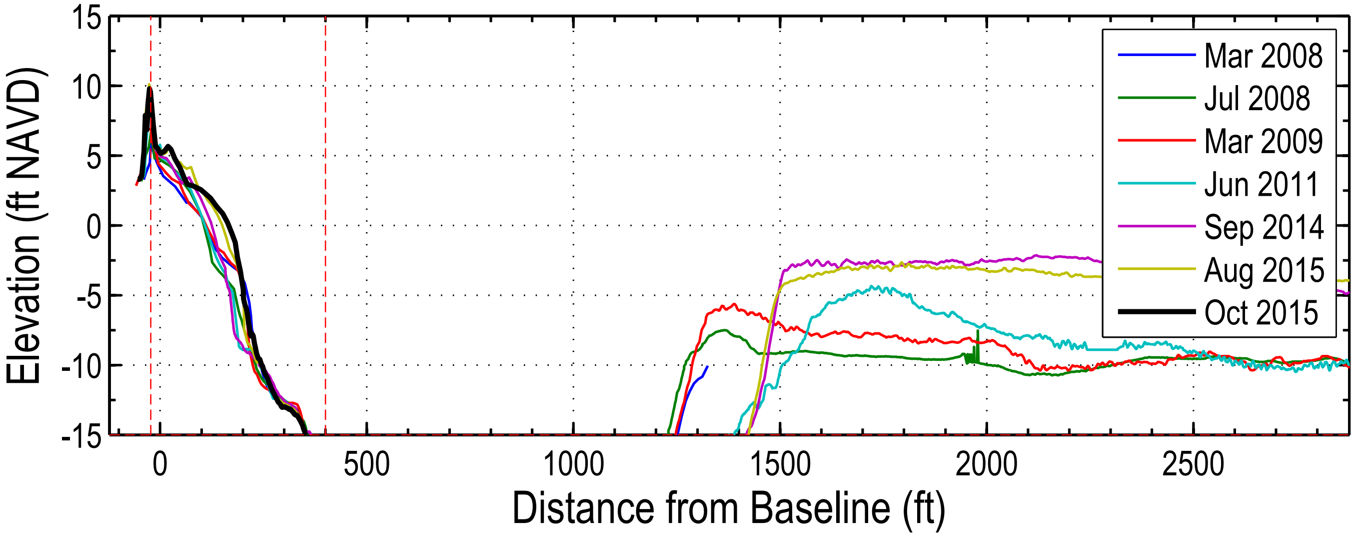


Date	Unit Vol (cy/ft)
Jul 2007	199.3
Mar 2008	198.4
Jul 2008	198.1
Mar 2009	201.8
Sep 2009	197.7
Mar 2010	190.0
Sep 2010	189.3
Jun 2011	193.5
Jul 2012	194.9
Jul 2013	199.7
Sep 2014	203.8
Aug 2015	215.3
Oct 2015	213.1

X: 2392498.72
Y: 361222.67

Station: 348+00 (126+00)

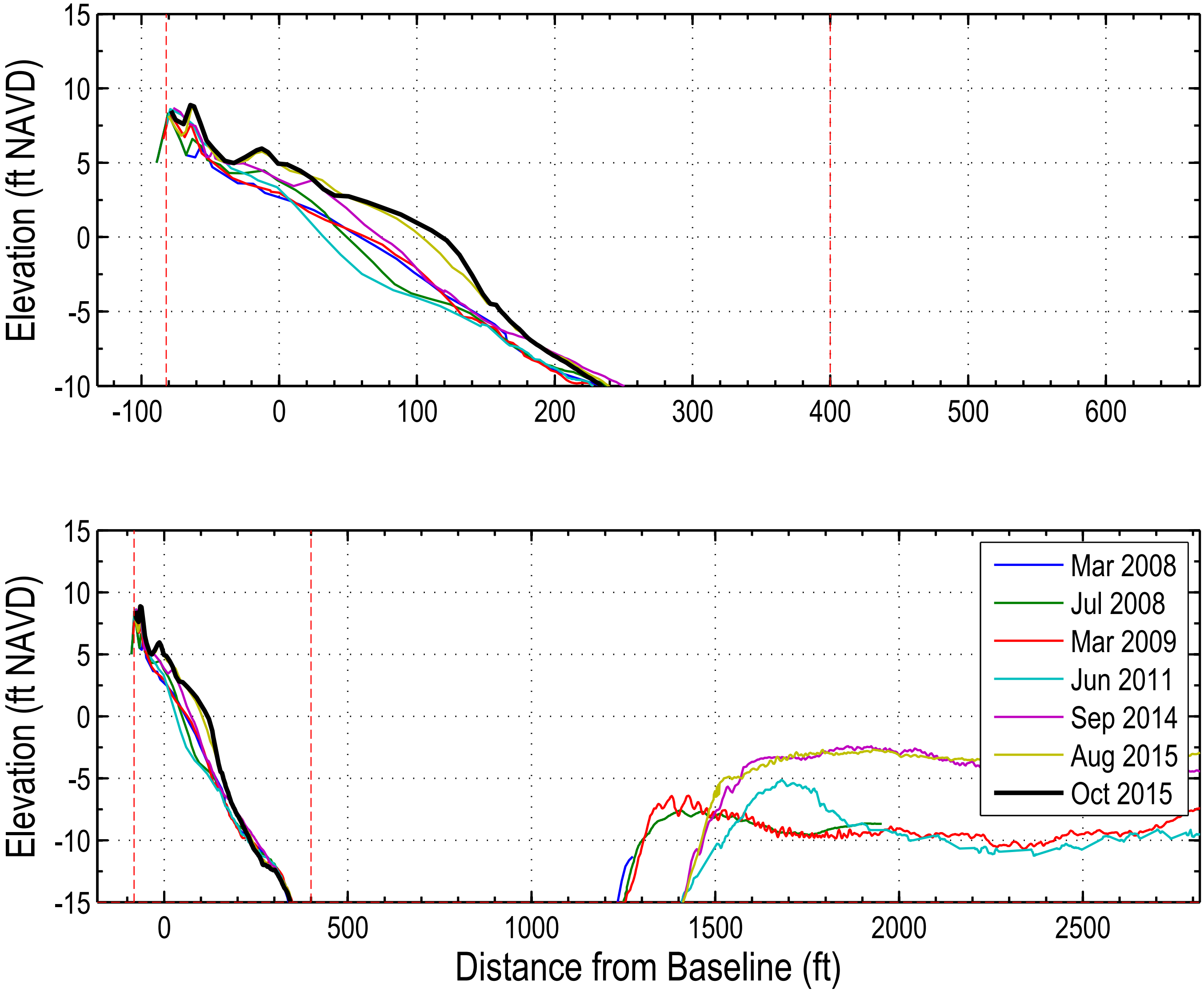




Date	Unit Vol (cy/ft)
Jul 2007	142.7
Mar 2008	150.9
Jul 2008	147.2
Mar 2009	150.7
Sep 2009	149.0
Mar 2010	141.8
Sep 2010	136.2
Jun 2011	147.2
Jul 2012	144.0
Jul 2013	146.2
Sep 2014	150.7
Aug 2015	164.4
Oct 2015	166.8

X: 2392350.33
Y: 361356.76

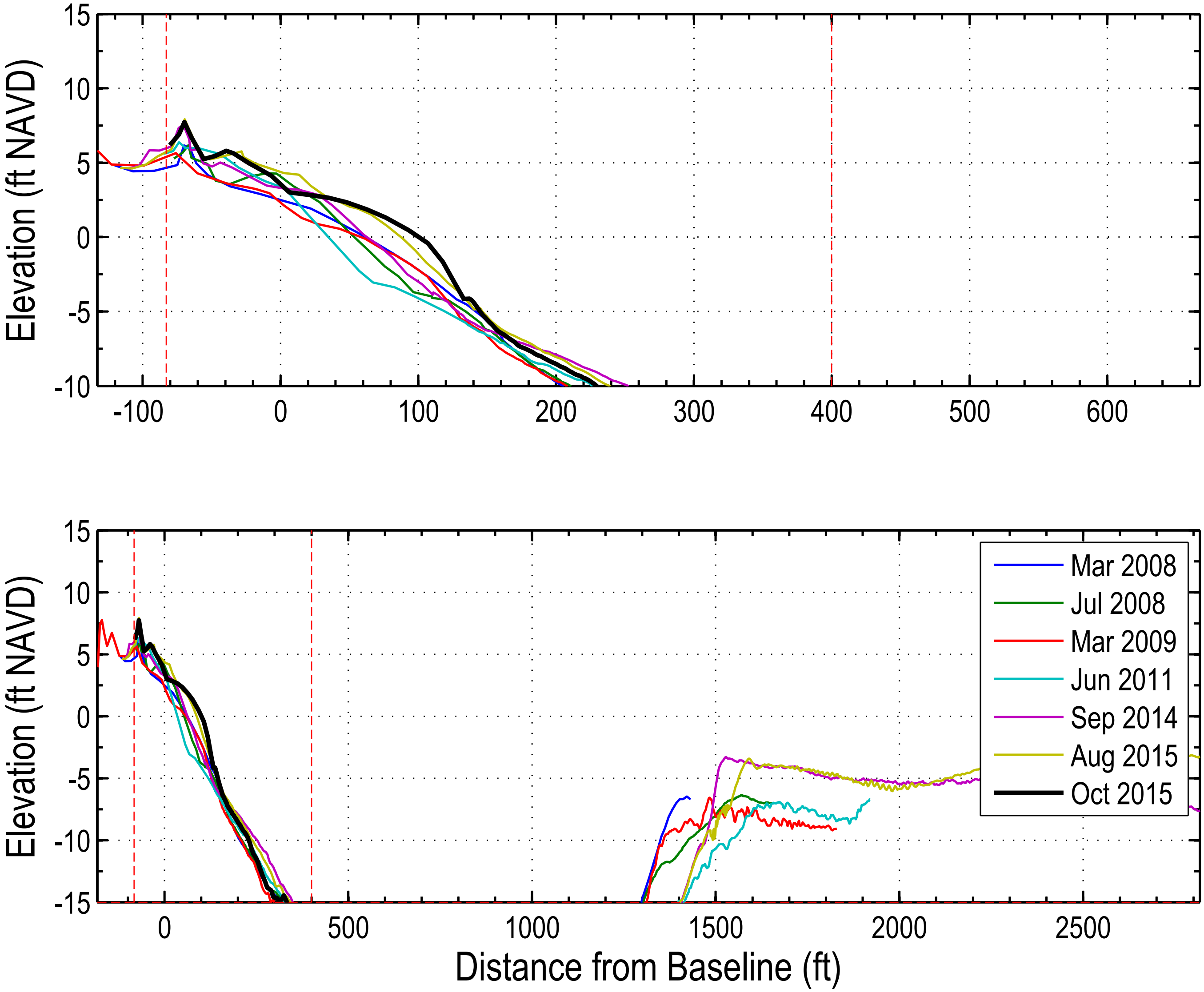
Station: 350+00 (128+00)



Date	Unit Vol (cy/ft)
Jul 2007	171.6
Mar 2008	170.1
Jul 2008	169.7
Mar 2009	170.7
Sep 2009	167.5
Mar 2010	167.2
Sep 2010	165.5
Jun 2011	165.1
Jul 2012	168.0
Jul 2013	173.7
Sep 2014	181.4
Aug 2015	190.2
Oct 2015	191.9

X: 2392201.94
Y: 361490.86

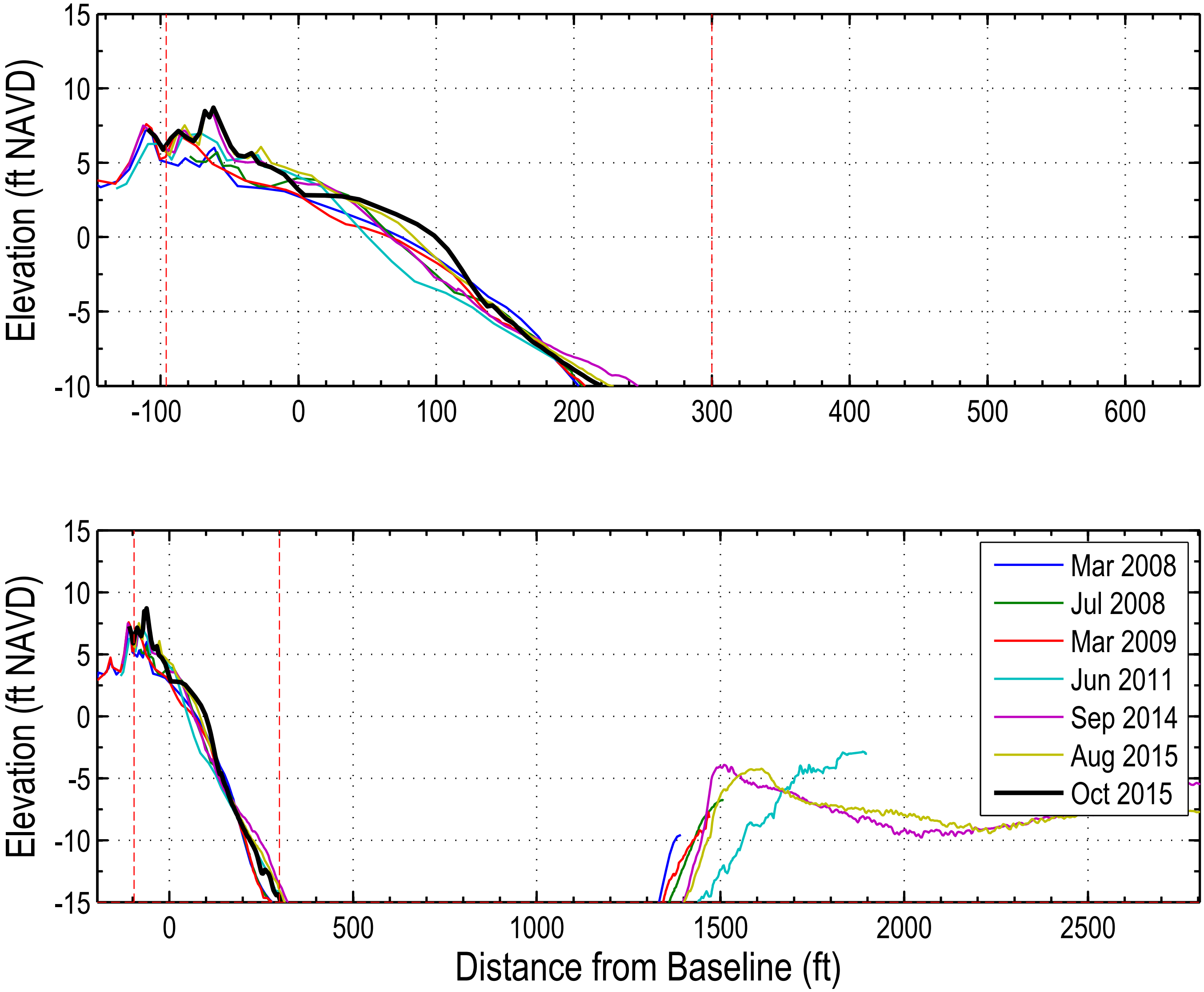
Station: 352+00 (130+00)



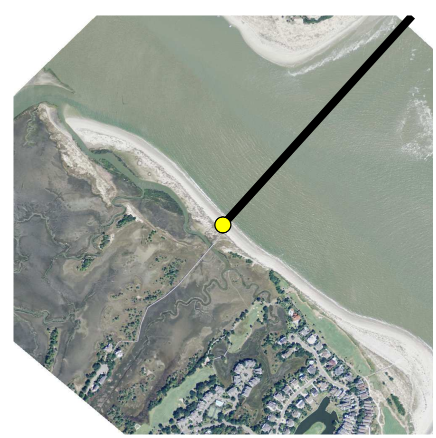
Date	Unit Vol (cy/ft)
Jul 2007	164.0
Mar 2008	159.8
Jul 2008	160.4
Mar 2009	155.2
Sep 2009	153.3
Mar 2010	155.4
Sep 2010	157.3
Jun 2011	158.9
Jul 2012	160.2
Jul 2013	169.6
Sep 2014	174.2
Aug 2015	180.9
Oct 2015	176.2

X: 2392053.55
Y: 361624.95

Station: 354+00 (132+00)

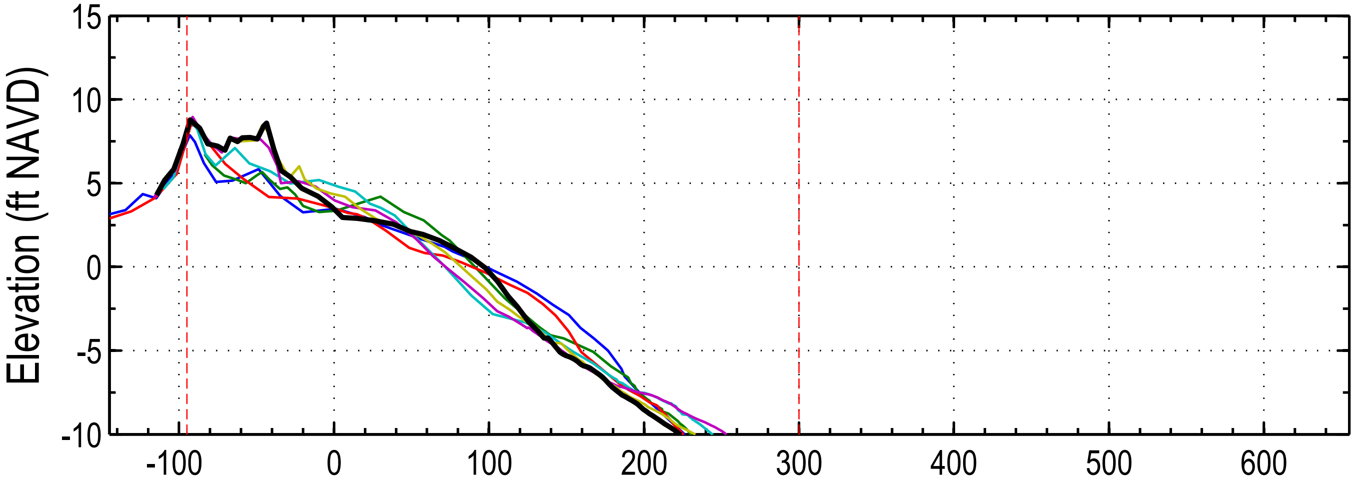


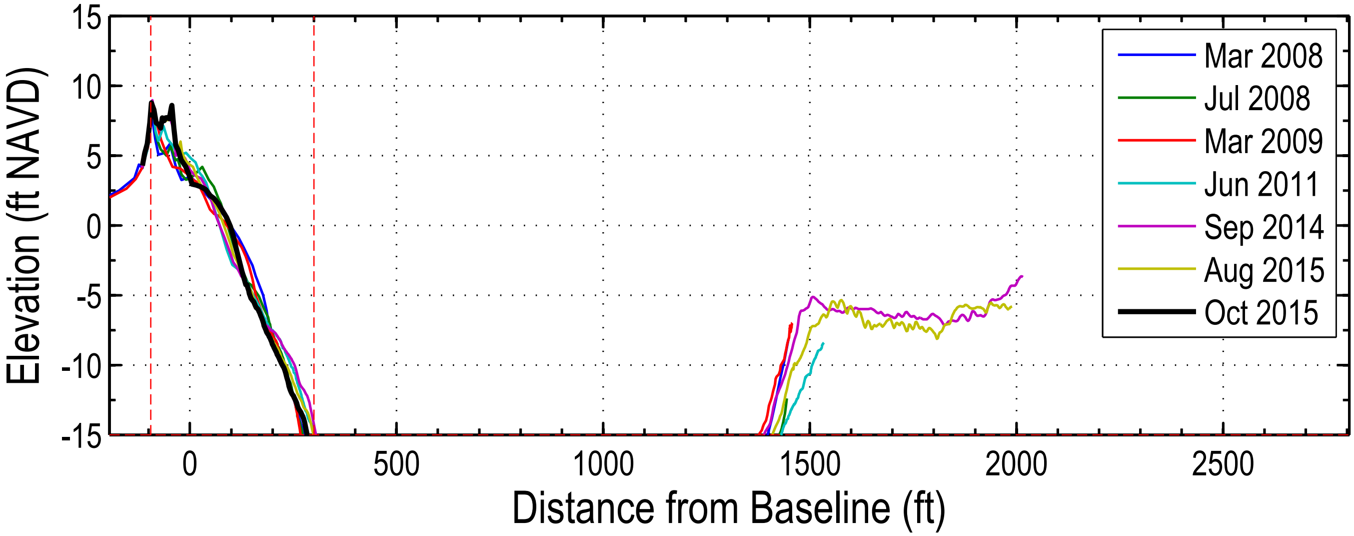
Date	Unit Vol (cy/ft)
Jul 2007	177.0
Mar 2008	170.1
Jul 2008	171.1
Mar 2009	168.1
Sep 2009	165.0
Mar 2010	167.0
Sep 2010	171.8
Jun 2011	174.2
Jul 2012	176.5
Jul 2013	184.0
Sep 2014	185.4
Aug 2015	188.1
Oct 2015	185.8



X: 2391905.17
Y: 361759.04

Station: 356+00 (134+00)

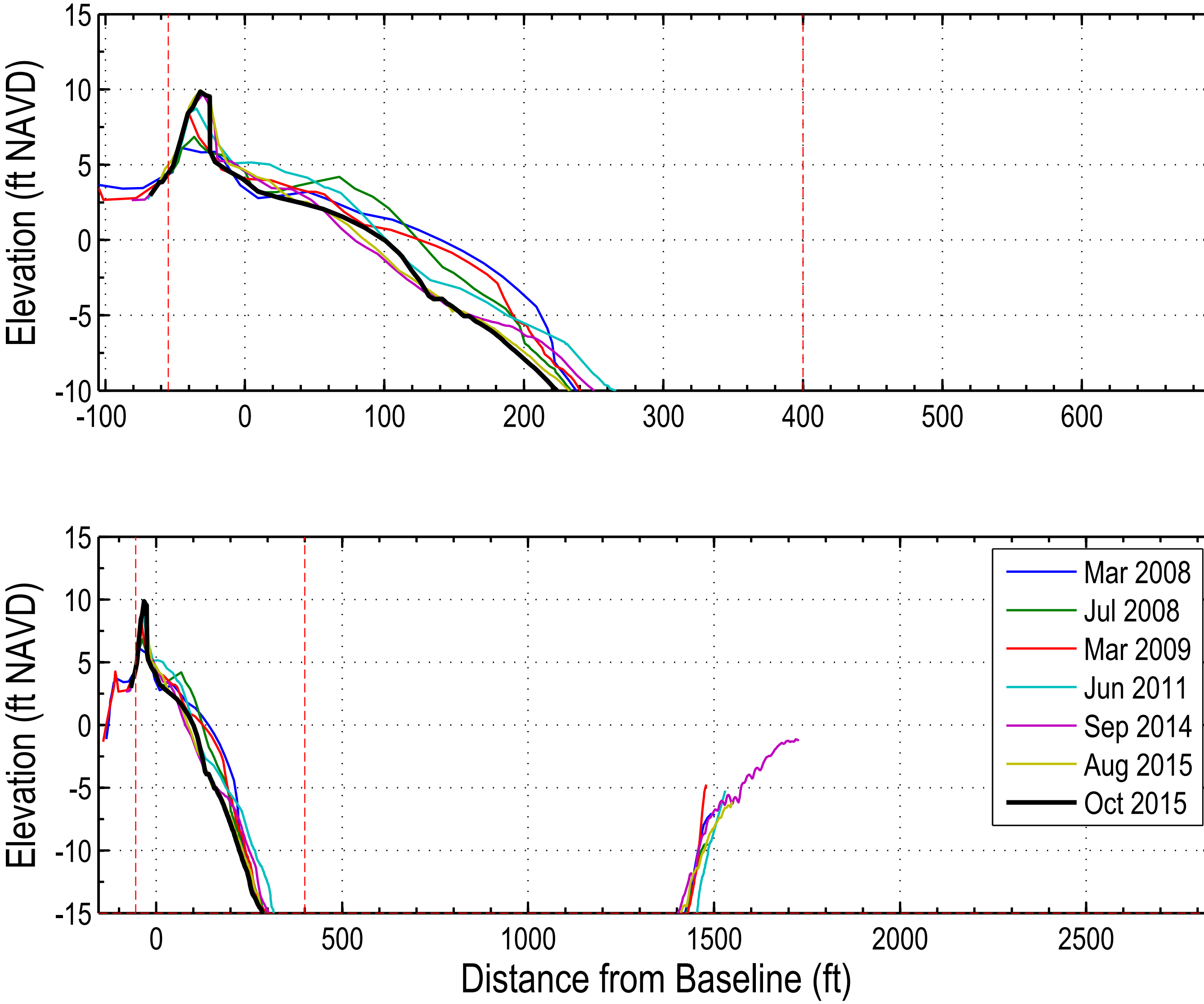




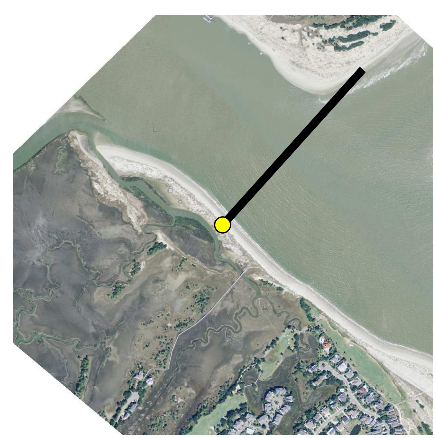
Date	Unit Vol (cy/ft)
Jul 2007	193.1
Mar 2008	186.5
Jul 2008	185.6
Mar 2009	183.1
Sep 2009	177.9
Mar 2010	183.7
Sep 2010	185.1
Jun 2011	189.1
Jul 2012	188.6
Jul 2013	195.4
Sep 2014	190.9
Aug 2015	189.4
Oct 2015	186.6

X: 2391756.78
Y: 361893.14

Station: 358+00 (Near Seagrass Boardwalk)

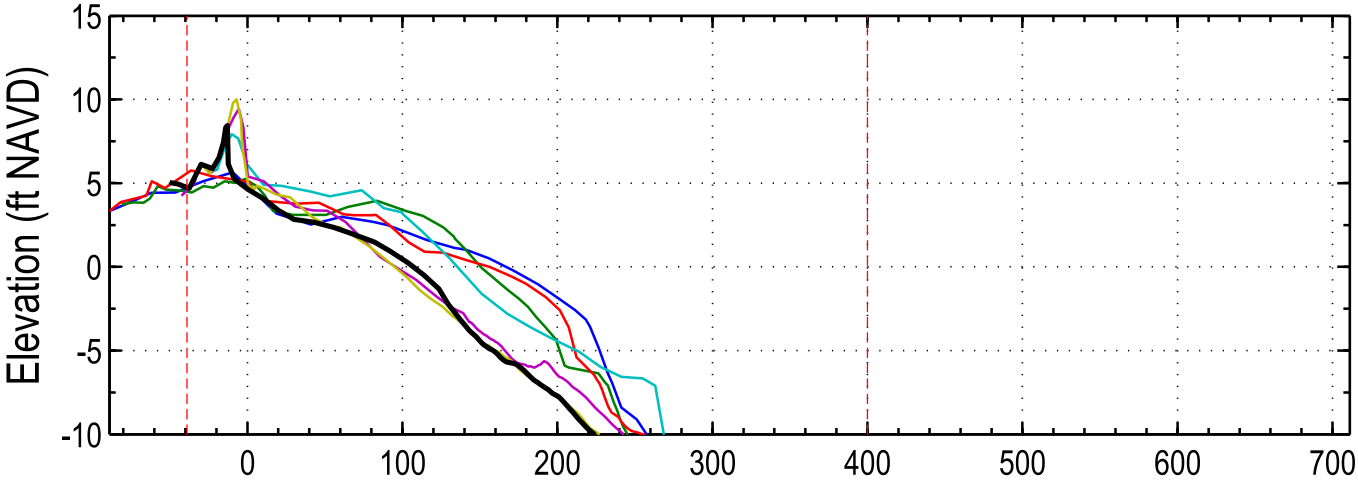


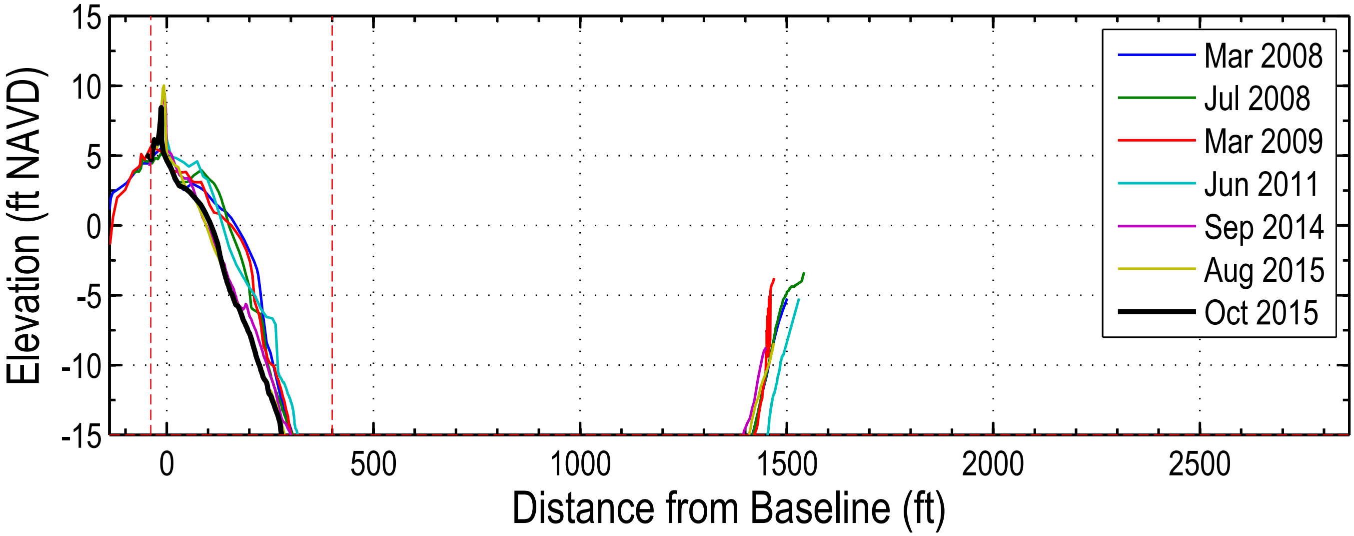
Date	Unit Vol (cy/ft)
Jul 2007	181.3
Mar 2008	175.3
Jul 2008	171.9
Mar 2009	173.1
Sep 2009	163.8
Mar 2010	173.4
Sep 2010	174.5
Jun 2011	180.0
Jul 2012	178.4
Jul 2013	175.2
Sep 2014	164.8
Aug 2015	160.2
Oct 2015	157.0



X: 2391608.39
Y: 362027.23

Station: 360+00 (138+00)

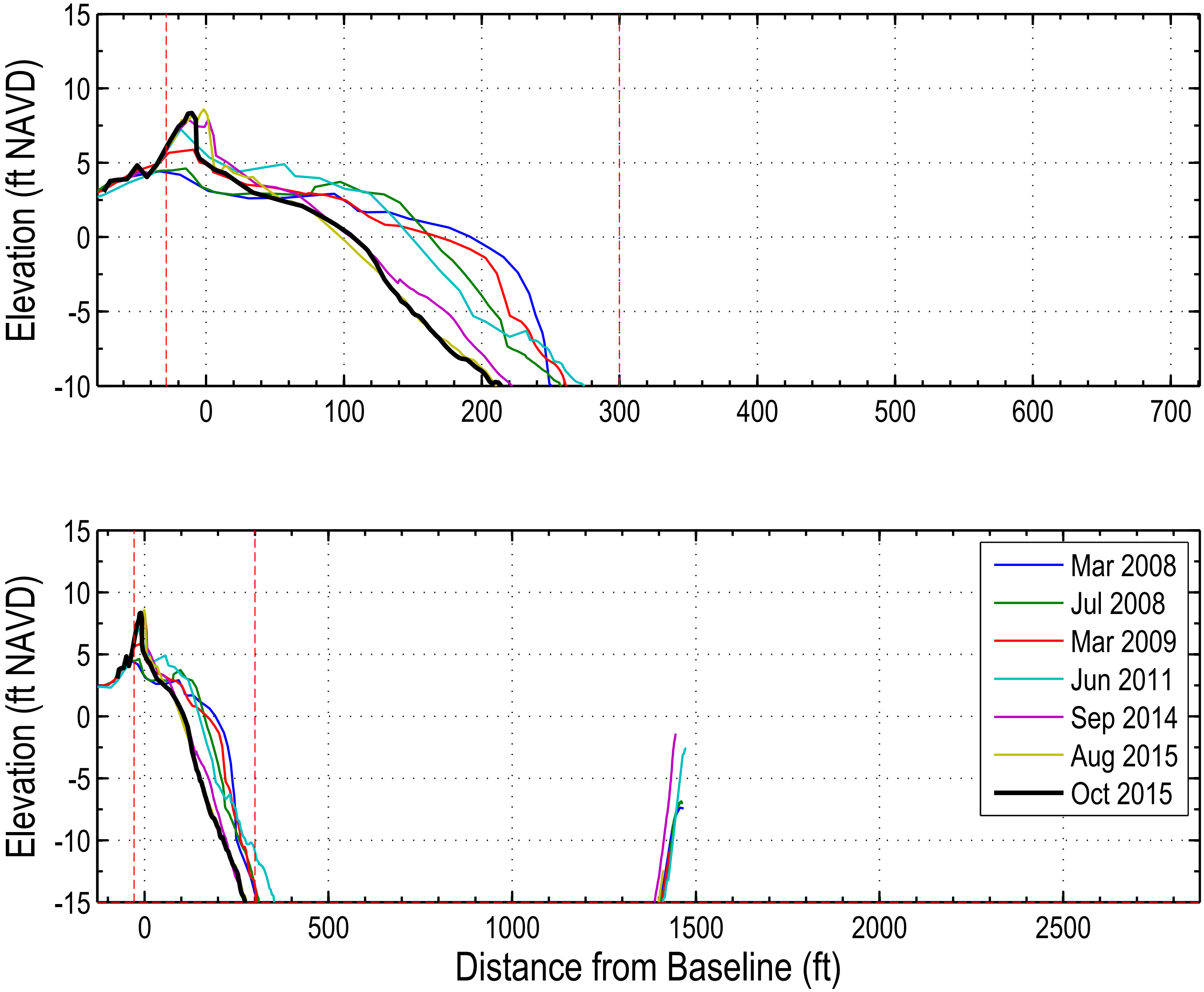




Date	Unit Vol (cy/ft)
Jul 2007	180.7
Mar 2008	177.2
Jul 2008	172.0
Mar 2009	174.4
Sep 2009	164.2
Mar 2010	179.7
Sep 2010	175.7
Jun 2011	181.8
Jul 2012	177.5
Jul 2013	170.8
Sep 2014	155.4
Aug 2015	148.6
Oct 2015	146.8

X: 2391460
Y: 362161.32

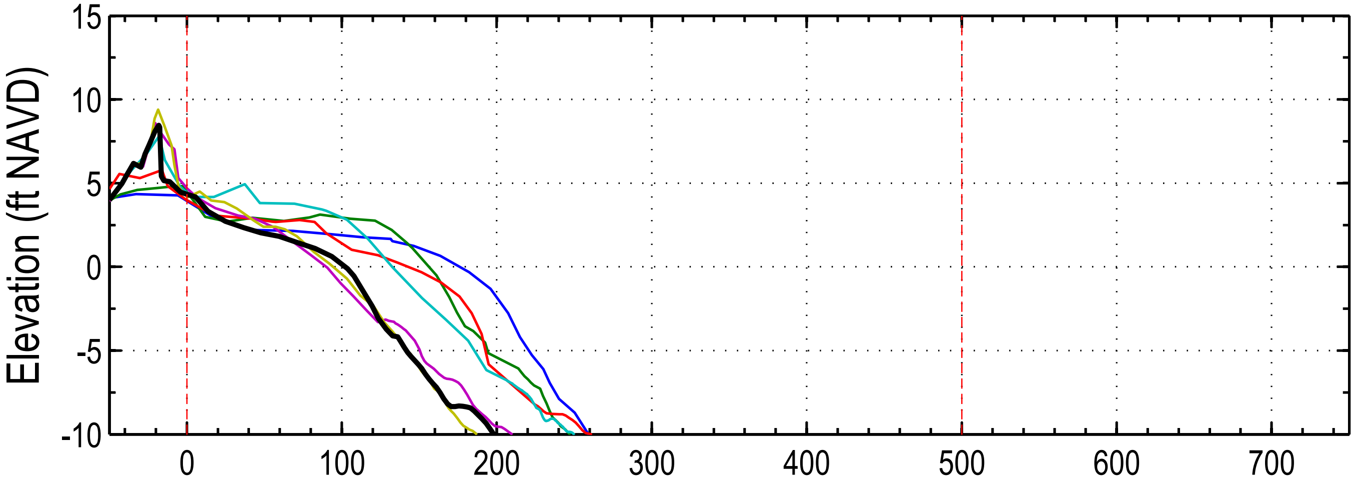
Station: 362+00 (140+00)

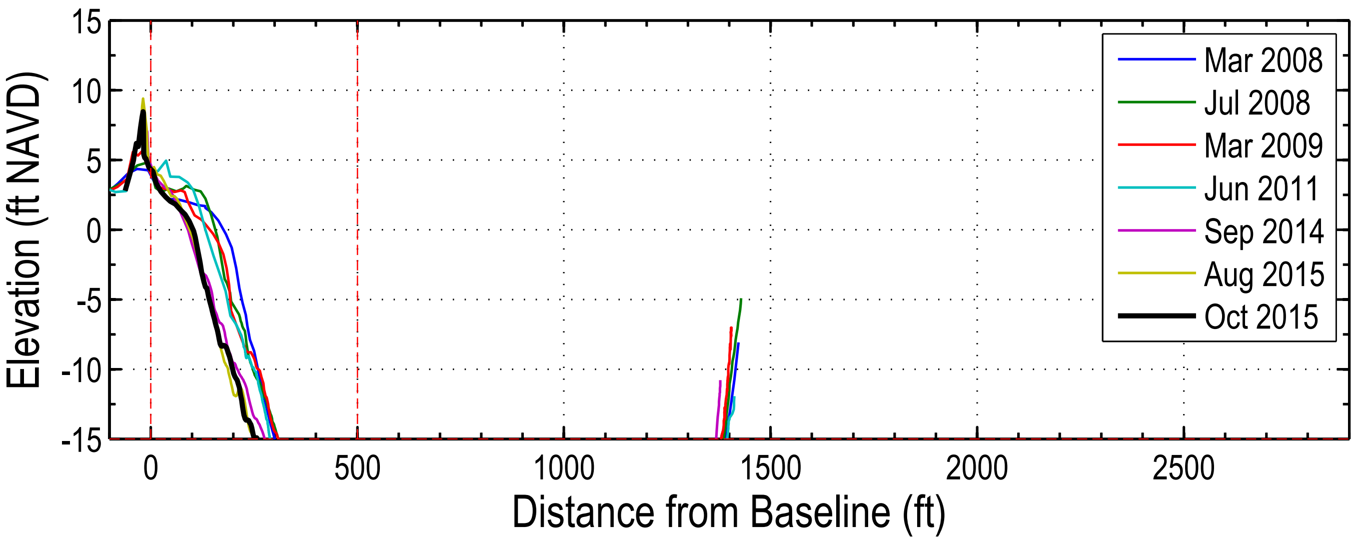


Date	Unit Vol (cy/ft)
Jul 2007	178.0
Mar 2008	173.3
Jul 2008	167.4
Mar 2009	173.1
Sep 2009	164.5
Mar 2010	172.4
Sep 2010	174.9
Jun 2011	174.4
Jul 2012	167.6
Jul 2013	154.9
Sep 2014	143.6
Aug 2015	137.6
Oct 2015	135.9

X: 2391311.61
Y: 362295.42

Station: 364+00 (142+00)

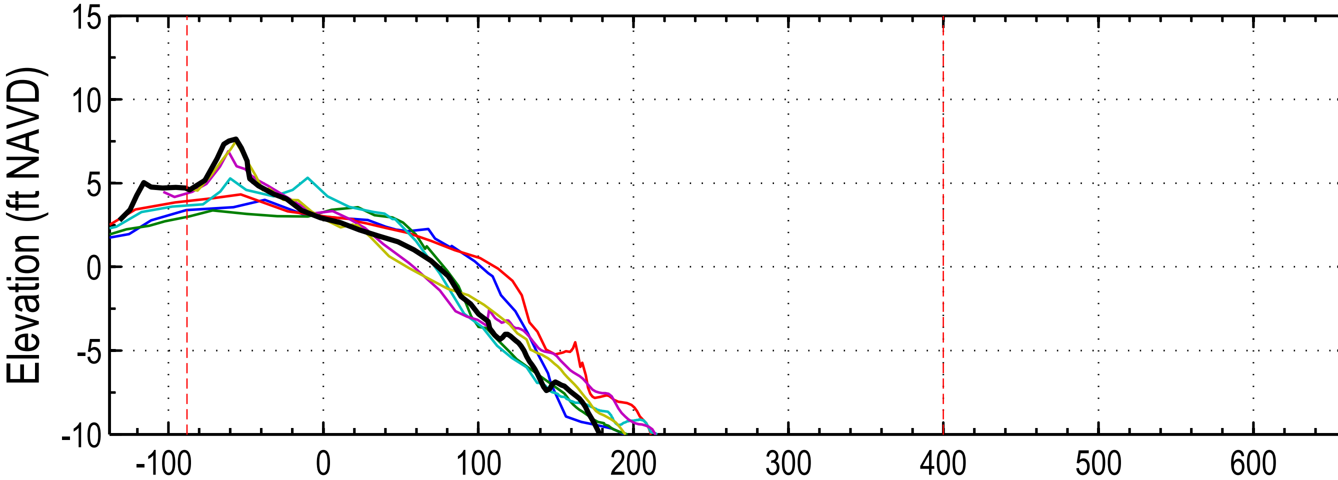


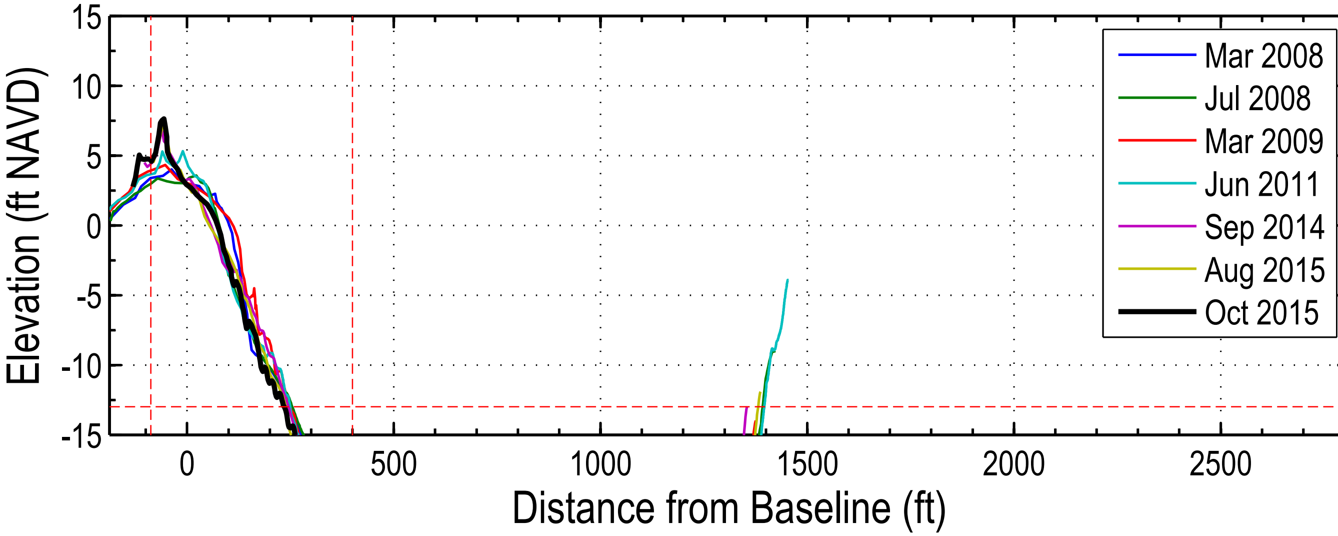


Date	Unit Vol (cy/ft)
Jul 2007	145.9
Mar 2008	146.2
Jul 2008	141.2
Mar 2009	137.5
Sep 2009	139.7
Mar 2010	136.3
Sep 2010	145.2
Jun 2011	136.3
Jul 2012	129.3
Jul 2013	117.6
Sep 2014	108.4
Aug 2015	102.3
Oct 2015	102.8

X: 2391163.23
Y: 362429.51

Station: 366+00 (144+00)

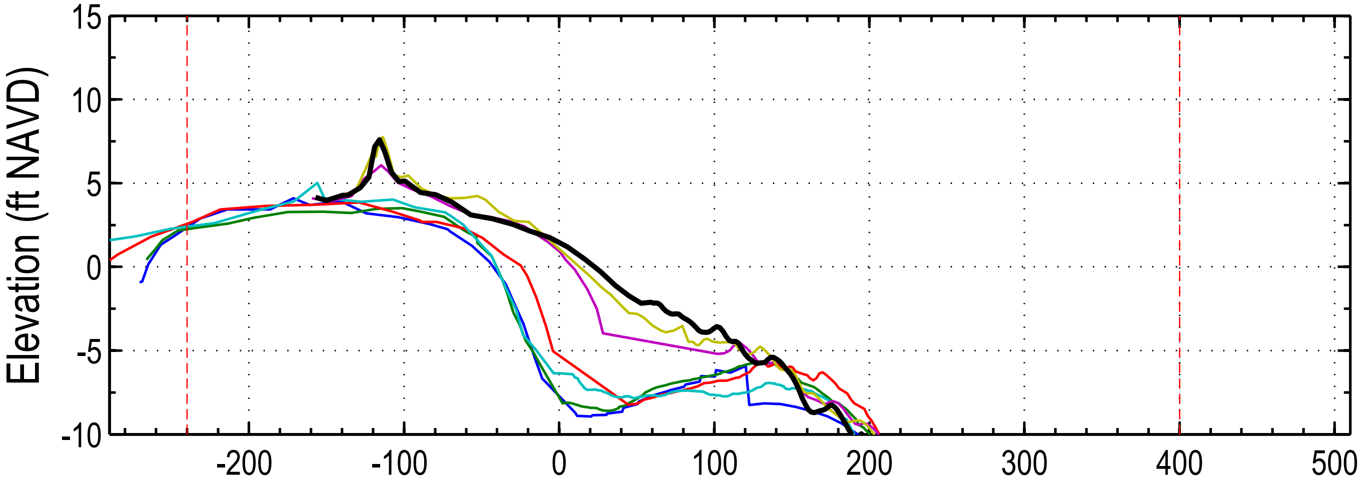


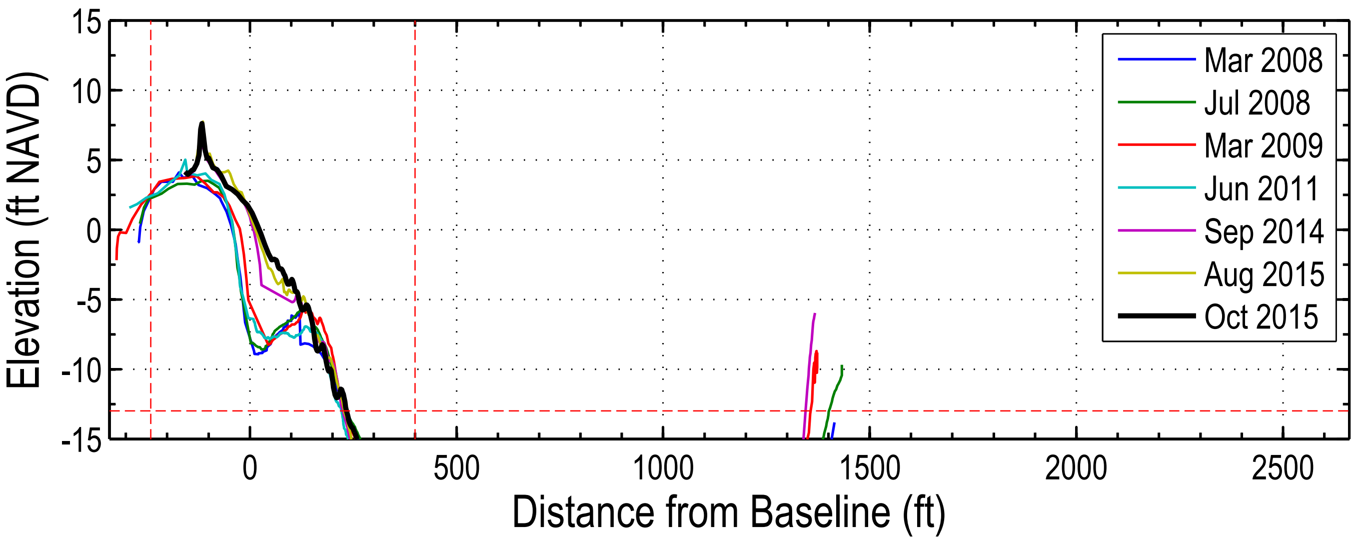


Date	Unit Vol (cy/ft)
Jul 2007	136.2
Mar 2008	137.4
Jul 2008	131.6
Mar 2009	146.1
Sep 2009	138.9
Mar 2010	135.0
Sep 2010	131.2
Jun 2011	136.8
Jul 2012	135.6
Jul 2013	132.9
Sep 2014	138.6
Aug 2015	135.8
Oct 2015	133.5

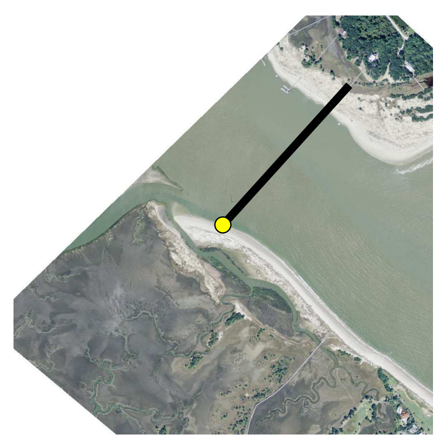
X: 2391014.84
Y: 362563.6

Station: 368+00 (146+00)



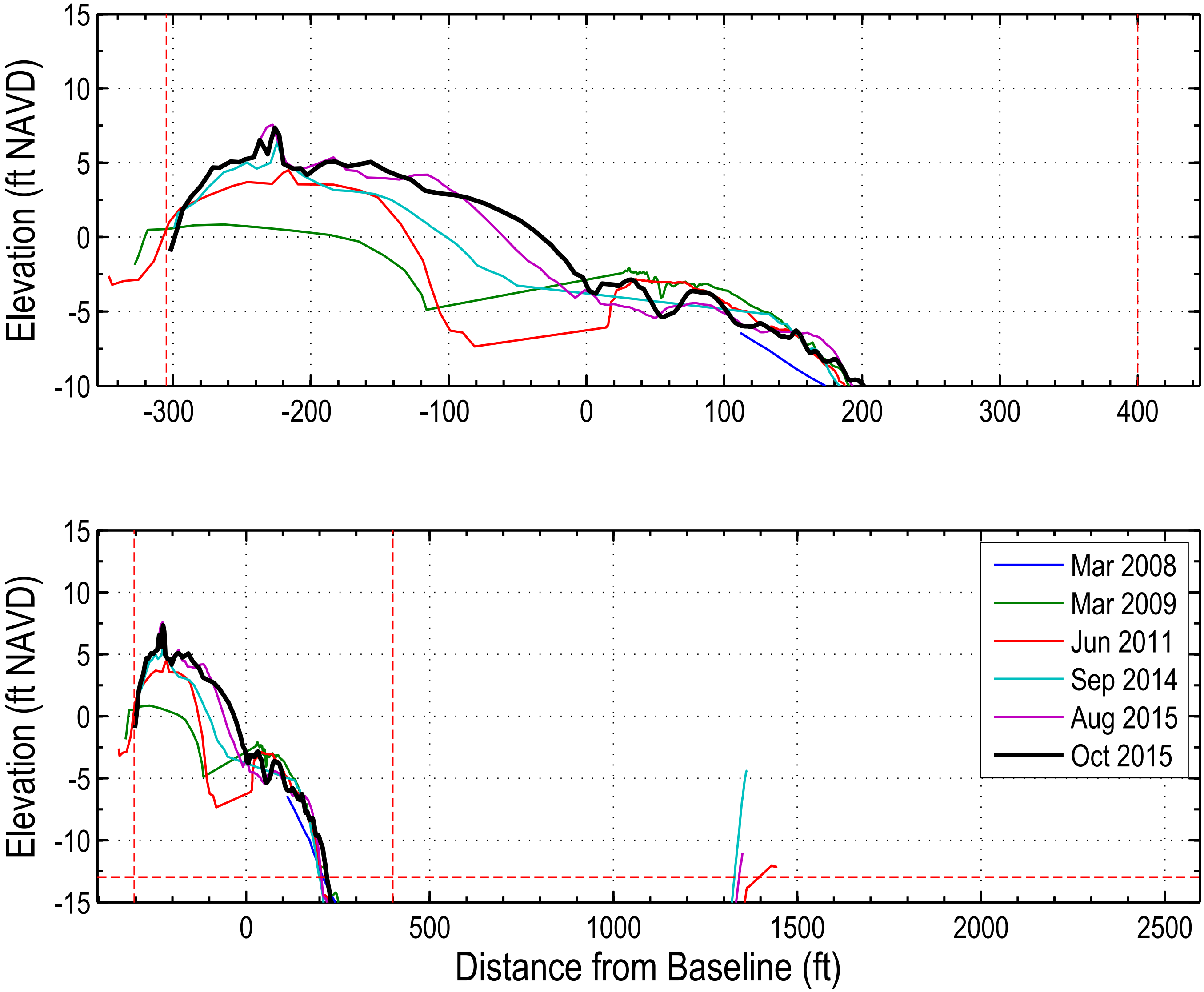


Date	Unit Vol (cy/ft)
Jul 2007	157.1
Mar 2008	168.9
Jul 2008	174.2
Mar 2009	183.7
Sep 2009	178.5
Mar 2010	187.0
Sep 2010	177.0
Jun 2011	174.2
Jul 2012	180.1
Jul 2013	188.4
Sep 2014	209.1
Aug 2015	216.4
Oct 2015	216.6



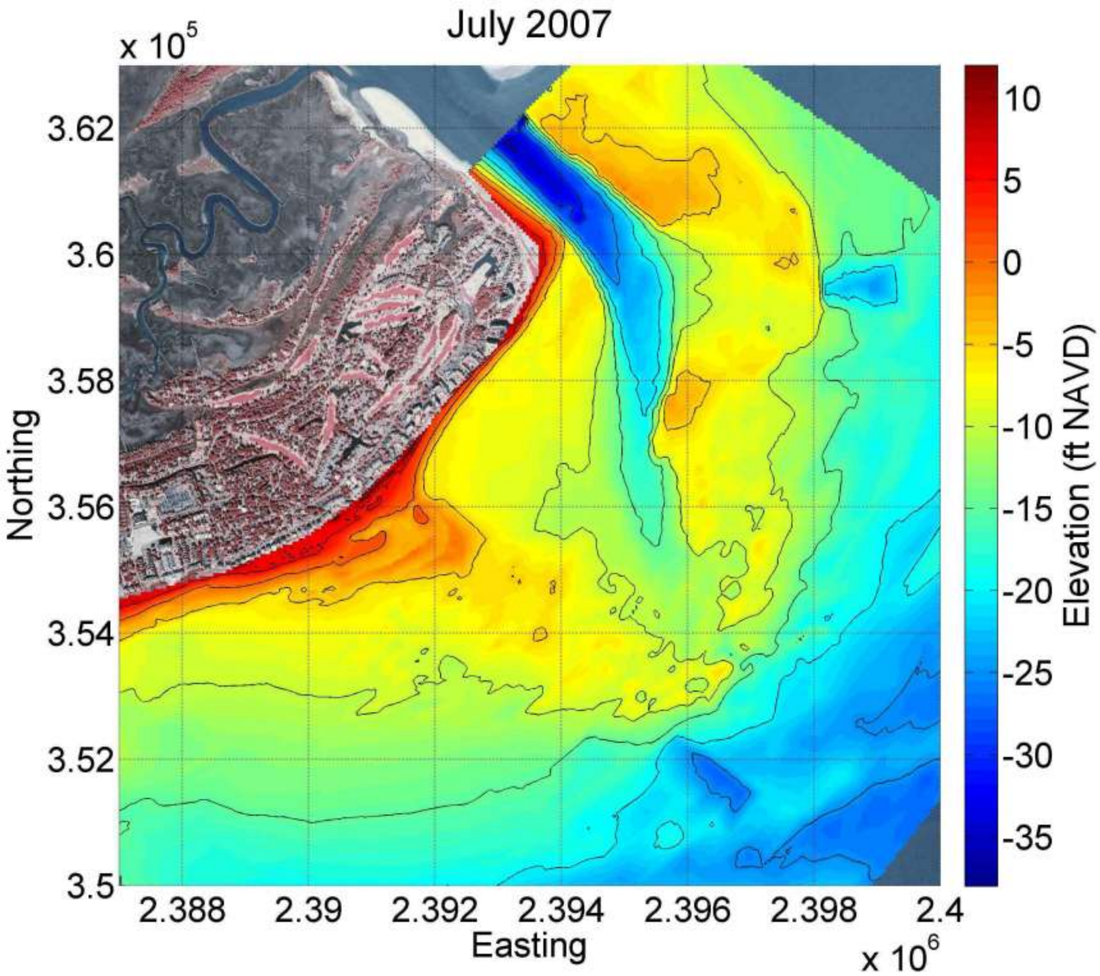
X: 2390866.45
Y: 362697.7

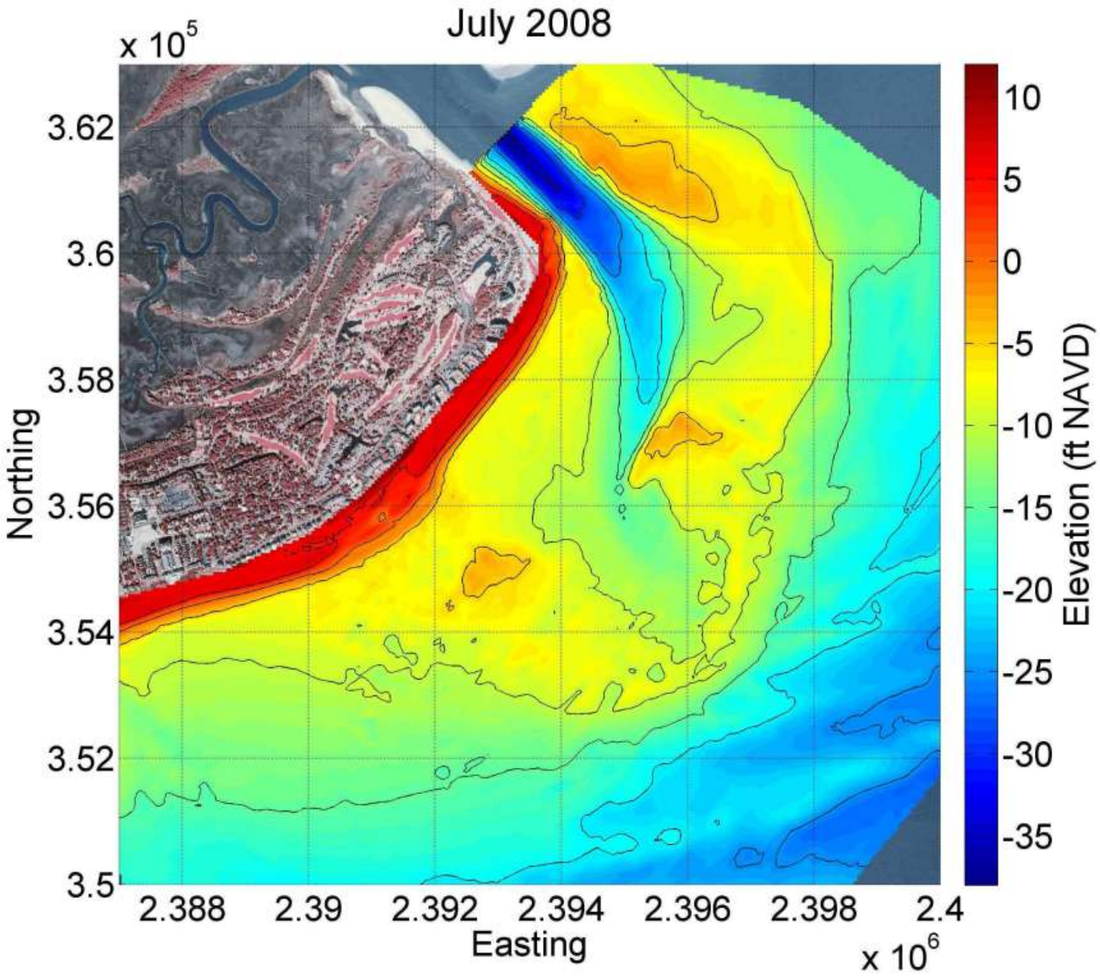
Station: 370+00 (148+00)

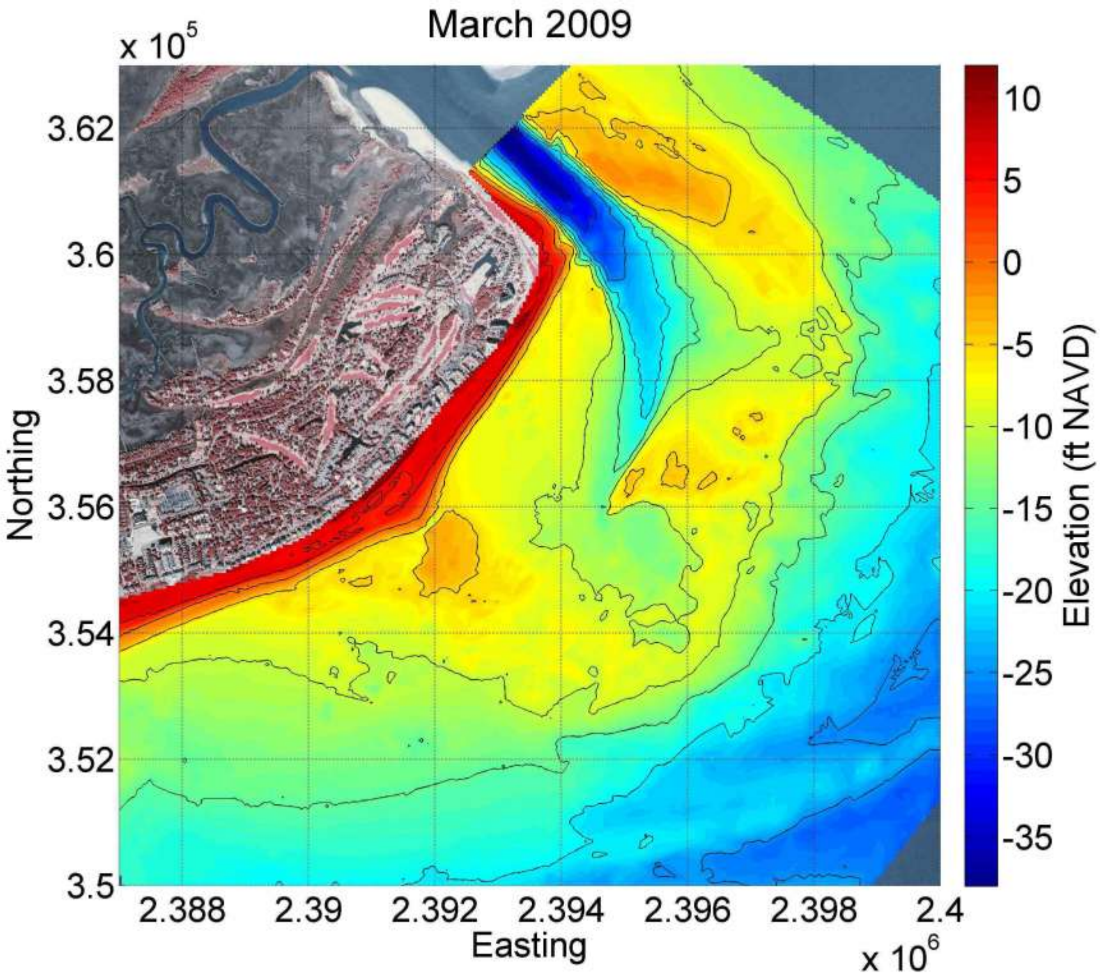


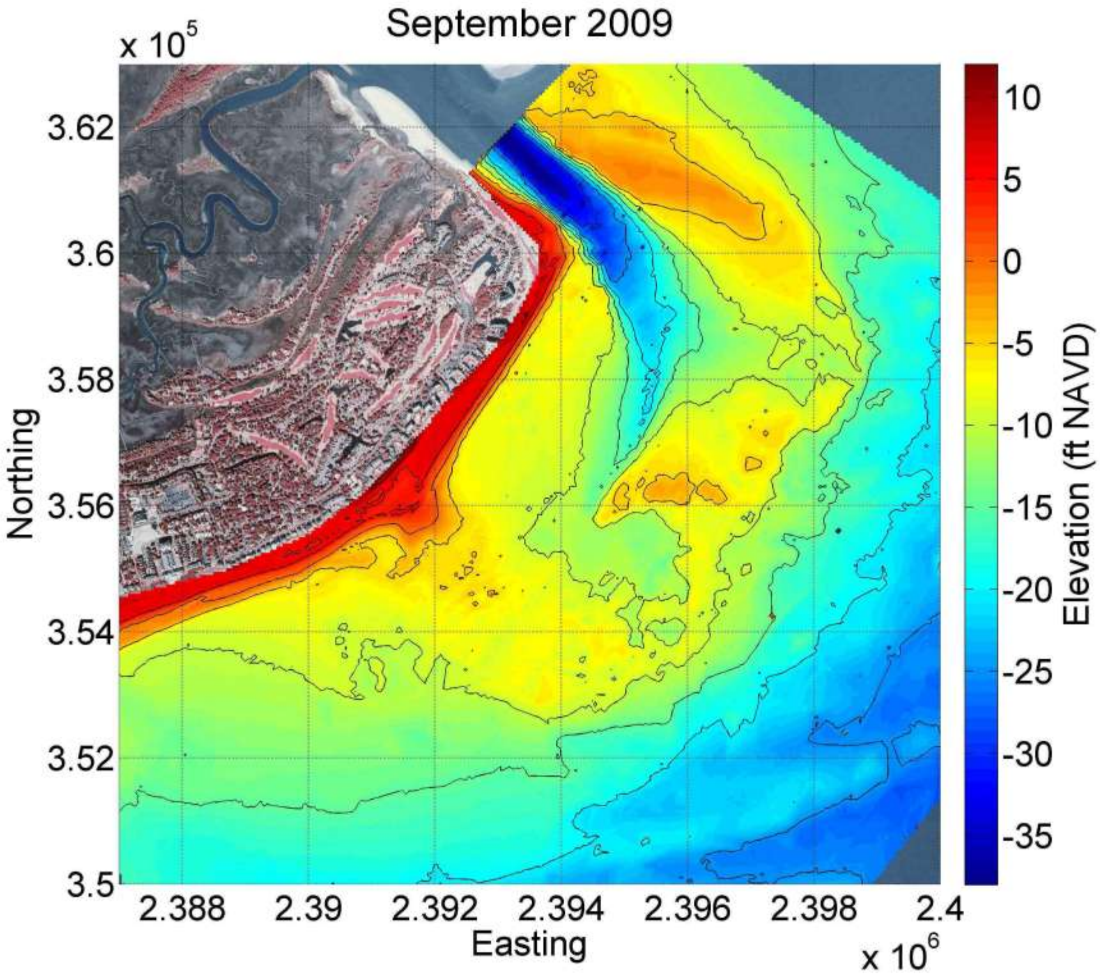
Date	Unit Vol (cy/ft)
Mar 2008	109.8
Mar 2009	190.6
Sep 2009	176.0
Mar 2010	202.5
Sep 2010	178.8
Jun 2011	193.5
Jul 2012	102.4
Jul 2013	162.0
Sep 2014	214.1
Aug 2015	230.5
Oct 2015	238.8

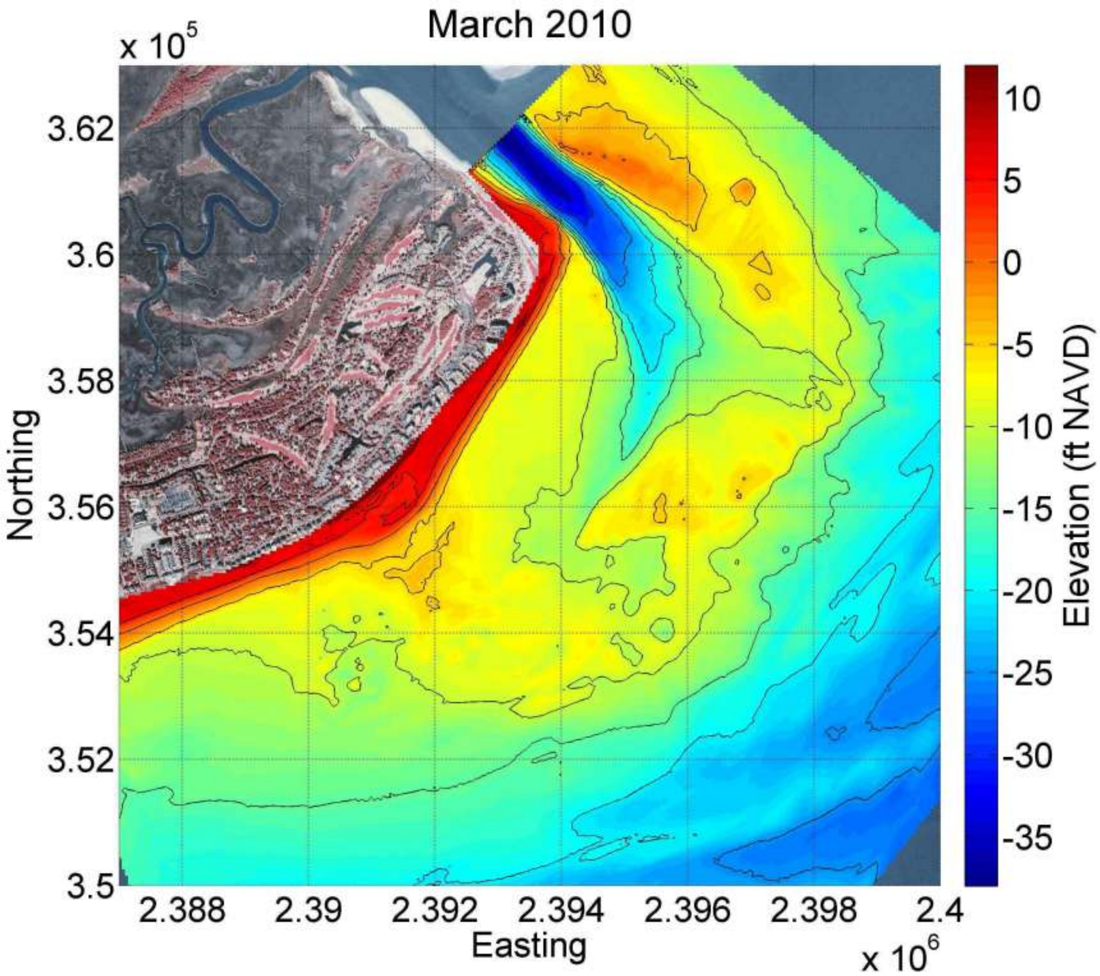
X: 2390718.06
Y: 362831.79

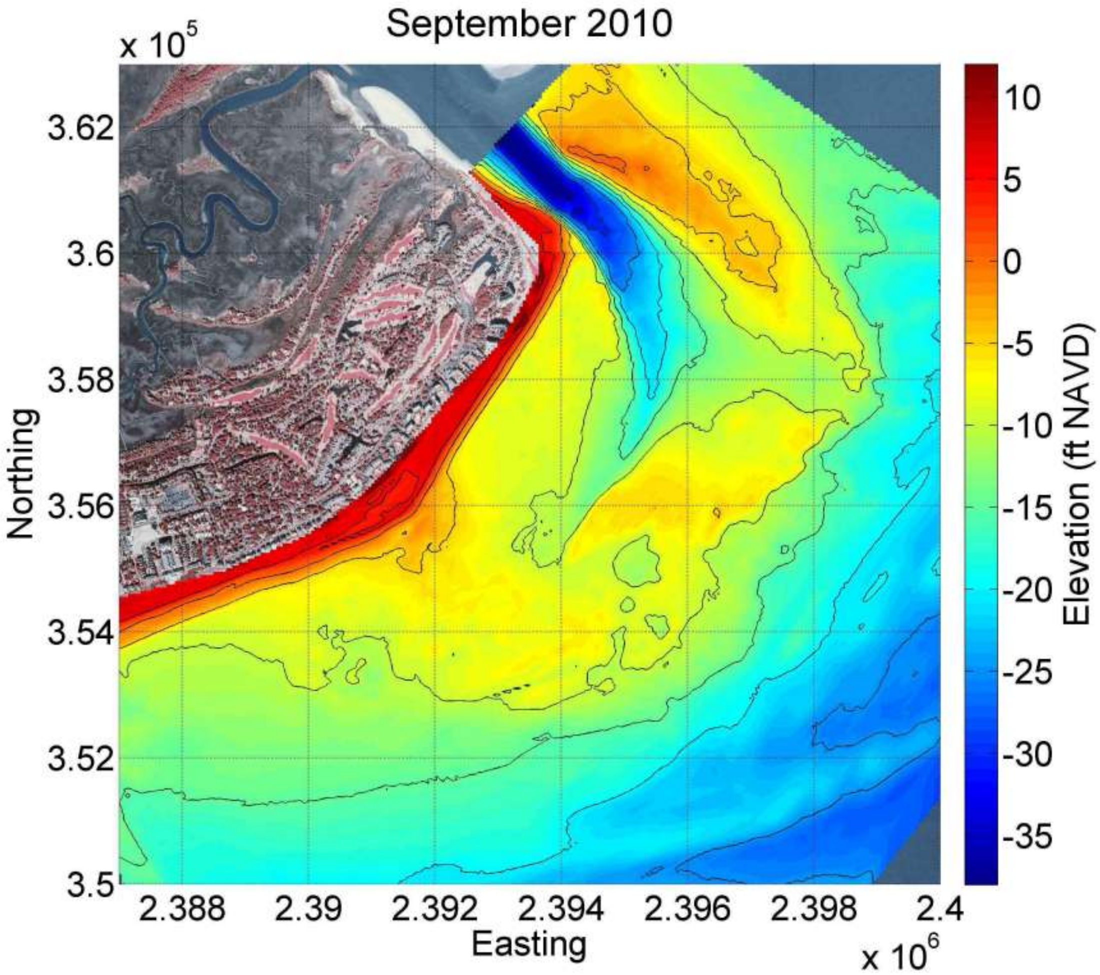

July 2007
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)

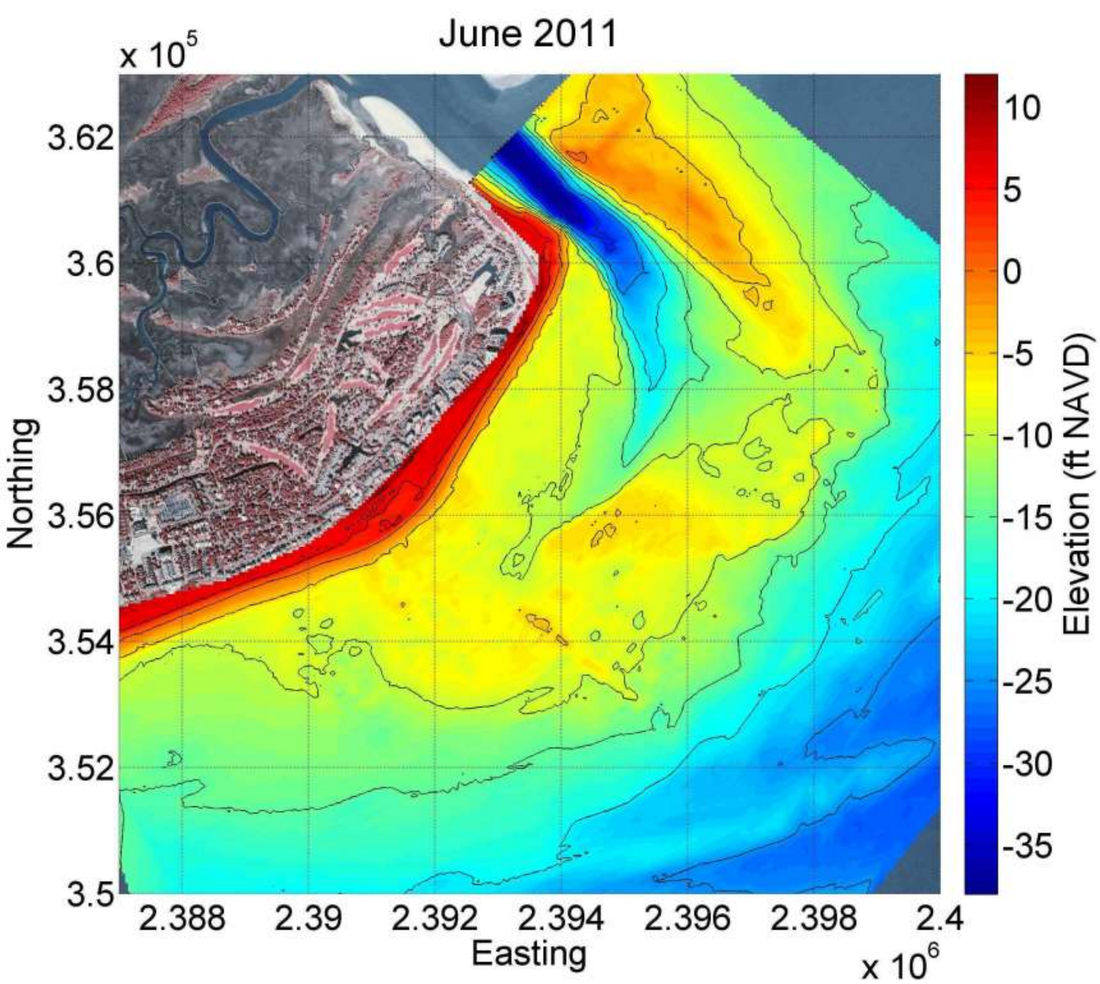

July 2008
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


March 2009
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


September 2009
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


March 2010
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


September 2010
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


June 2011
x 10^5
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3.6
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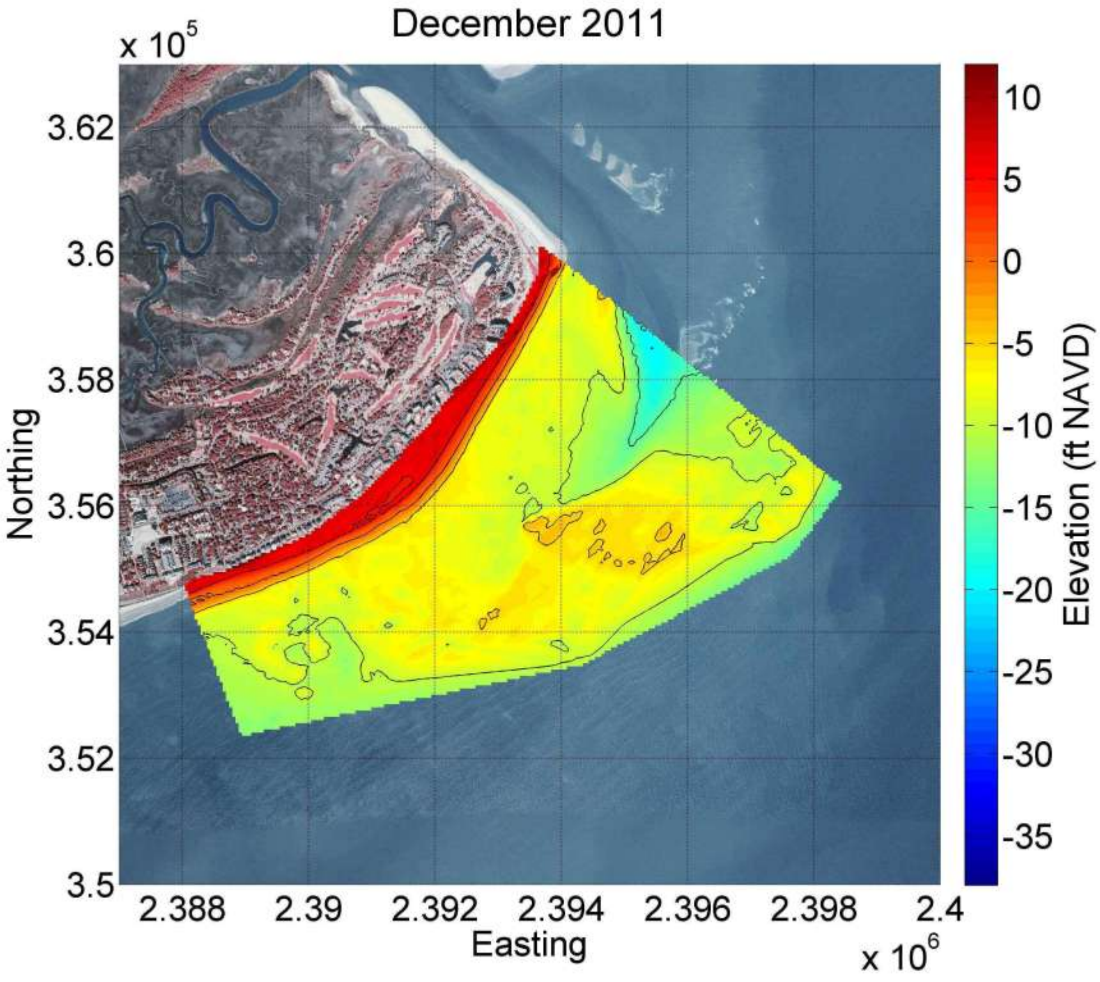
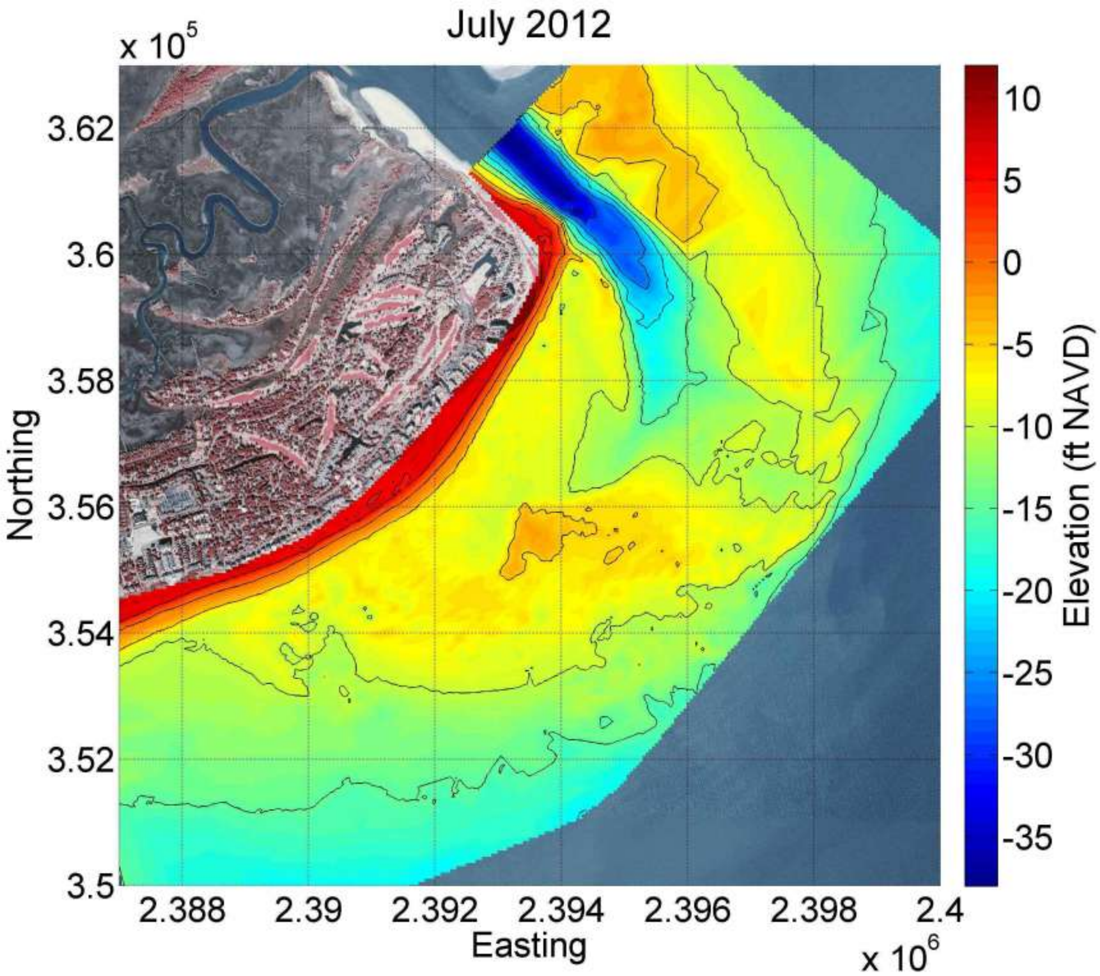
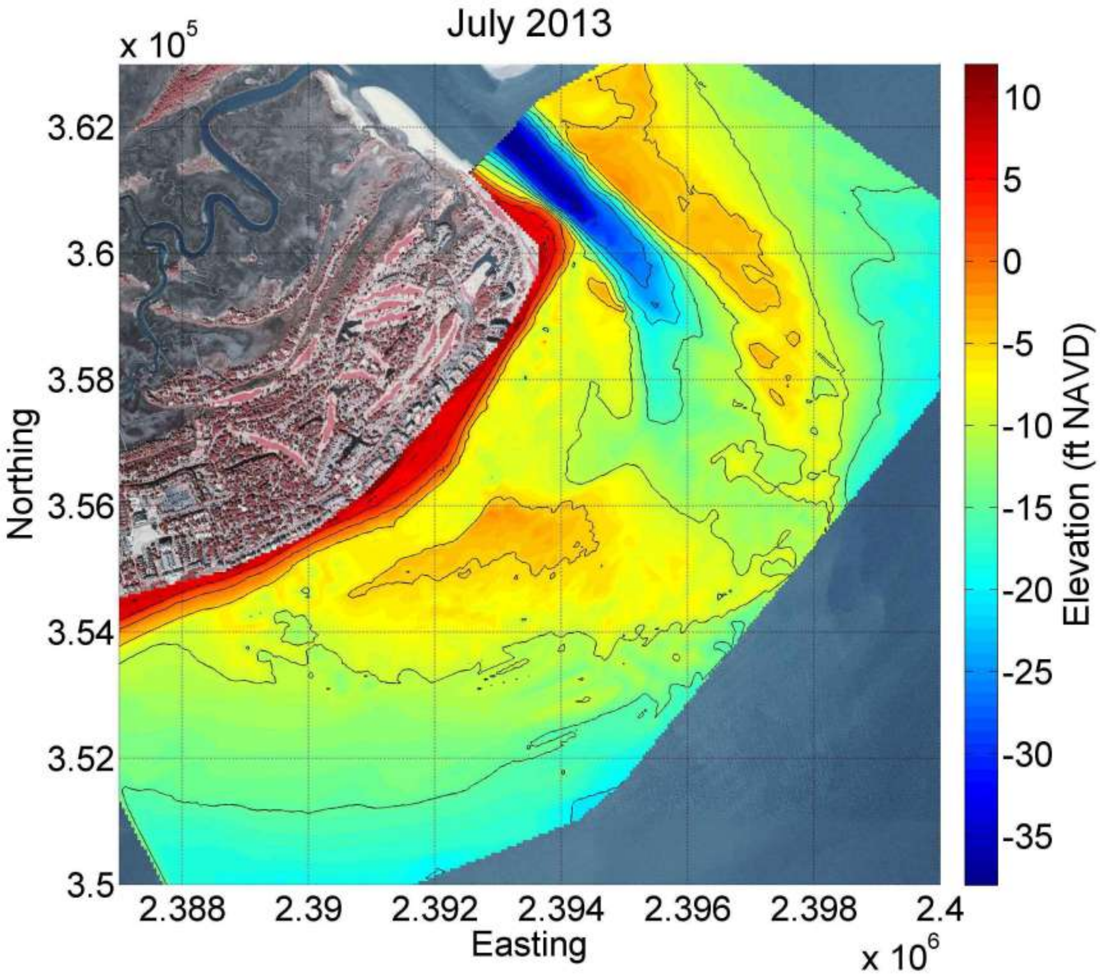
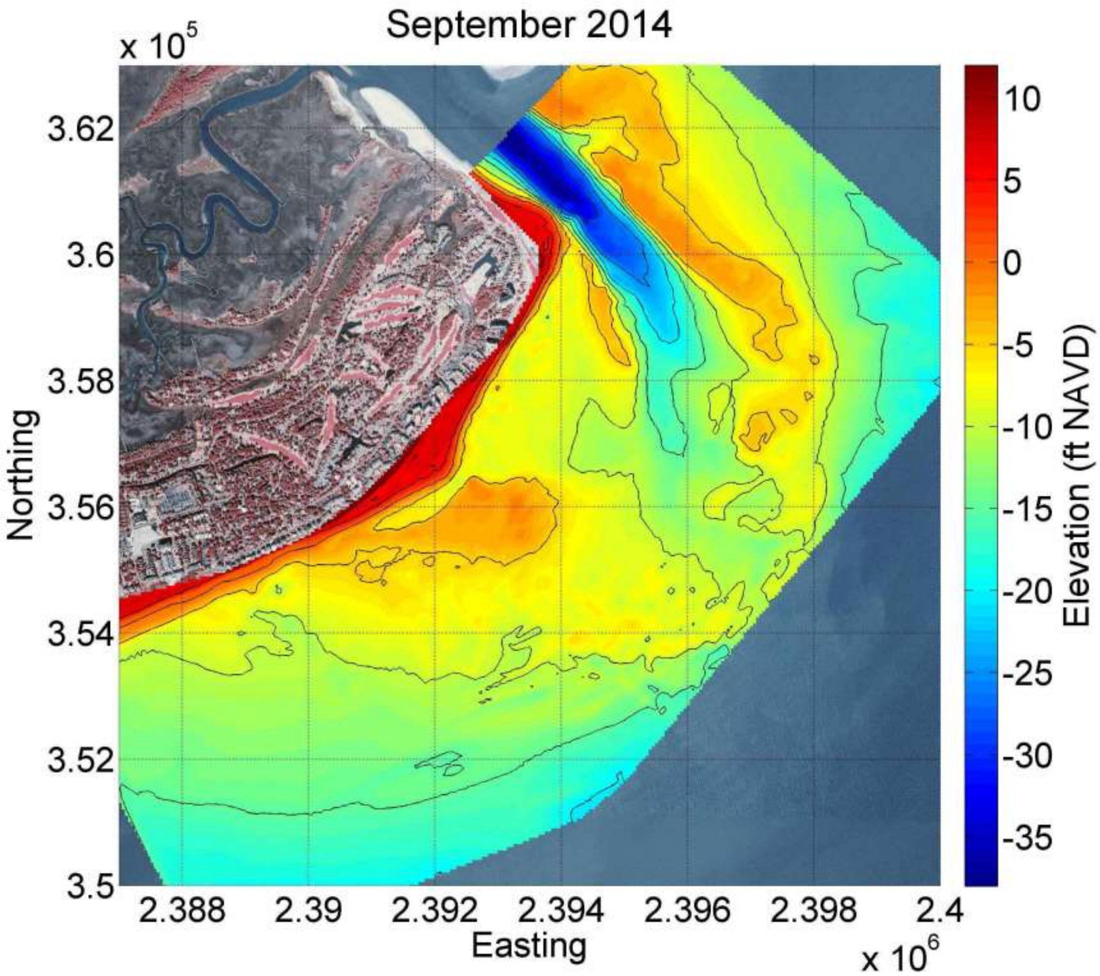
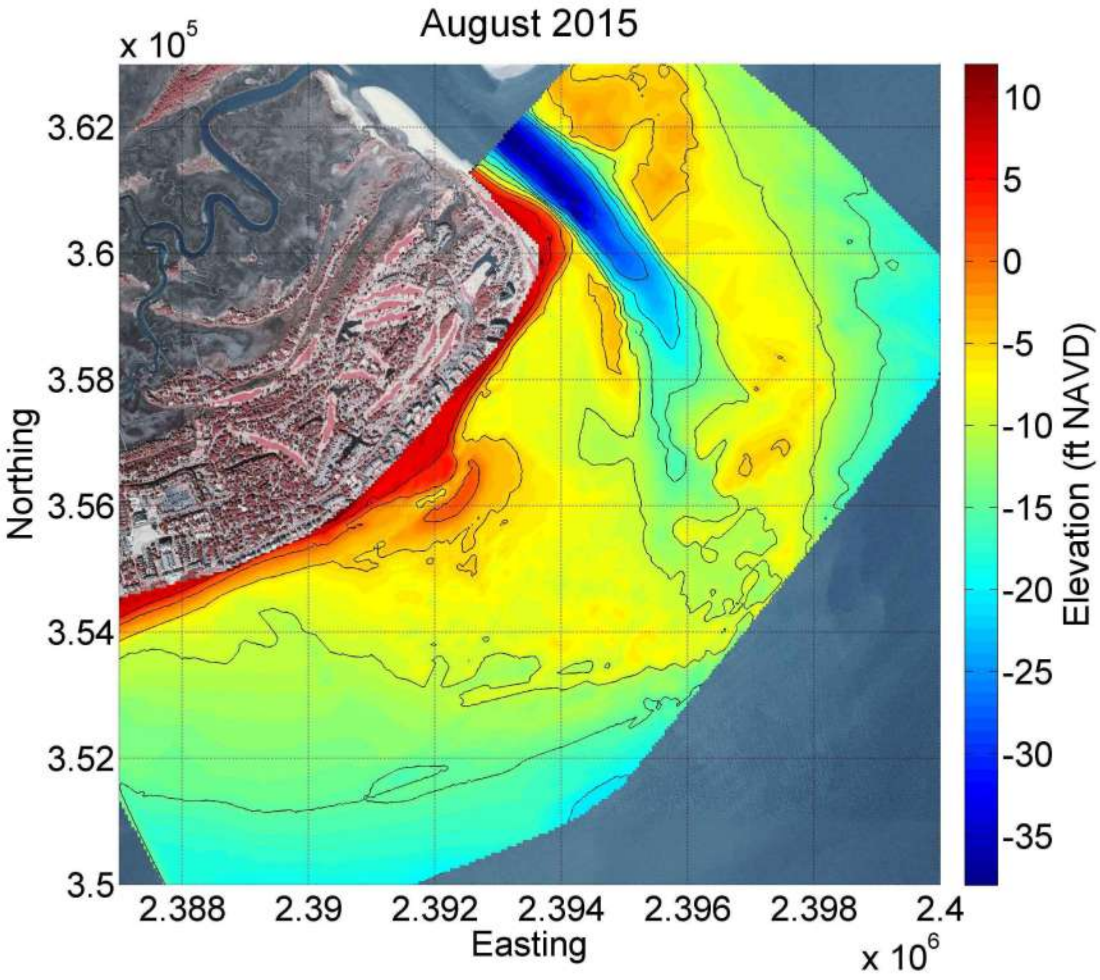
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)

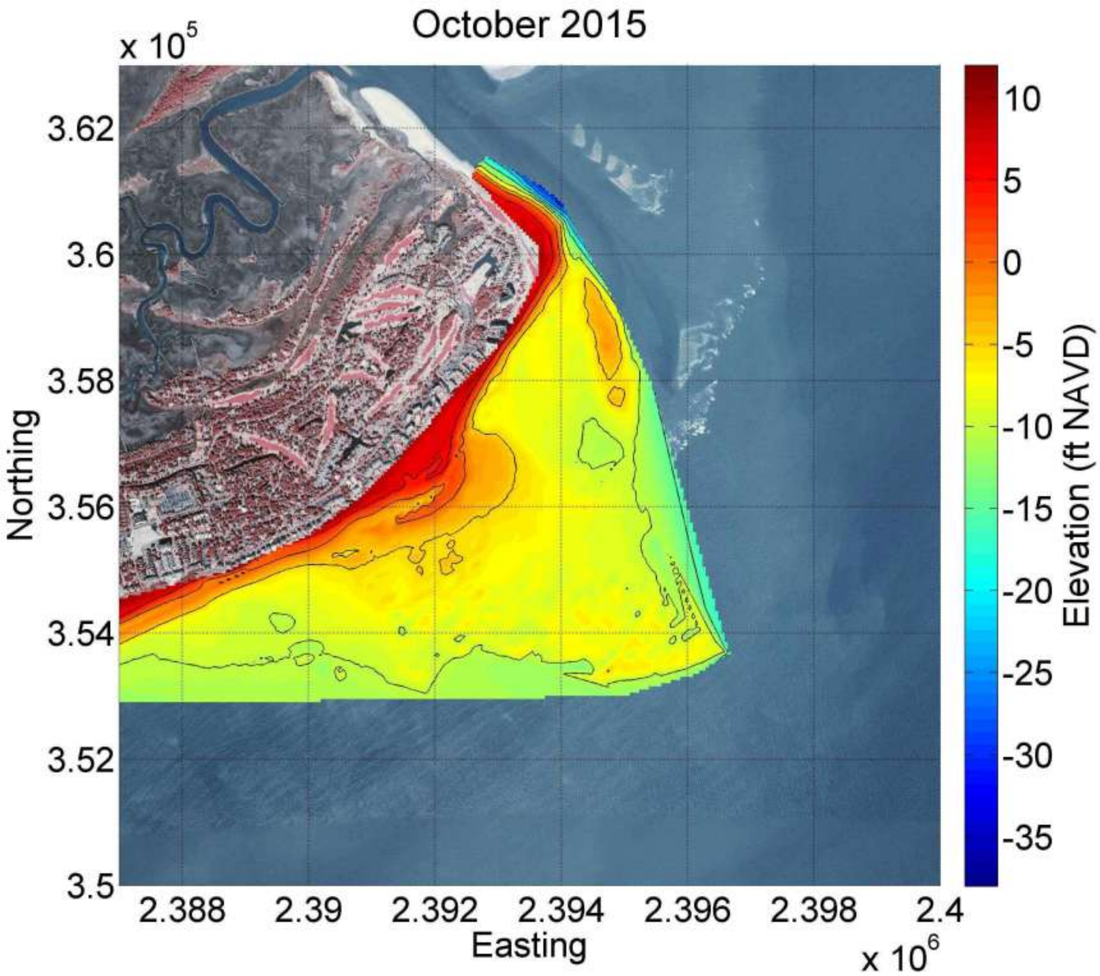

December 2011
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


July 2012
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


July 2013
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


September 2014
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


August 2015
x 10^5
3.62
3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)



October 2015
x 10^5
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3.6
3.58
3.56
3.54
3.52
3.5
Northing
2.388
2.39
2.392
2.394
2.396
2.398
2.4
Easting
x 10^6
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-5
-10
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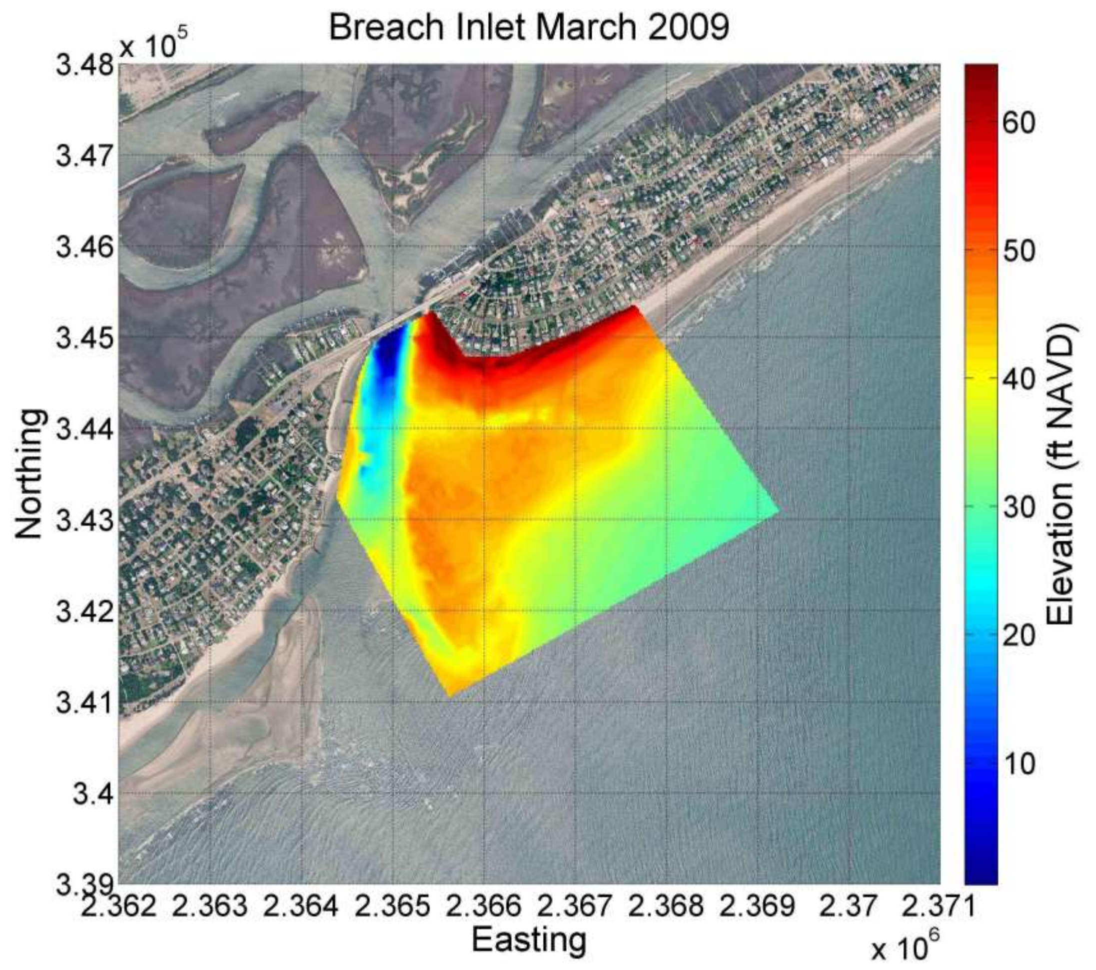
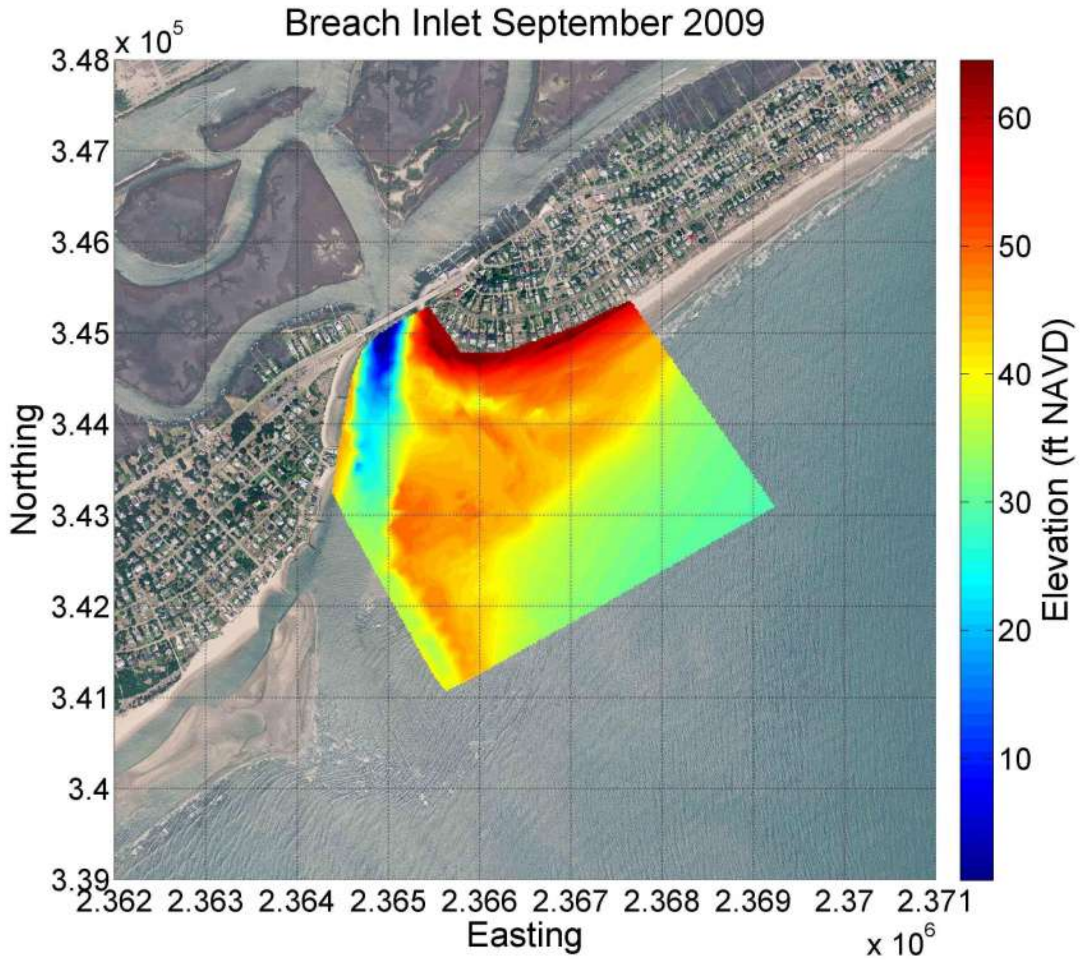
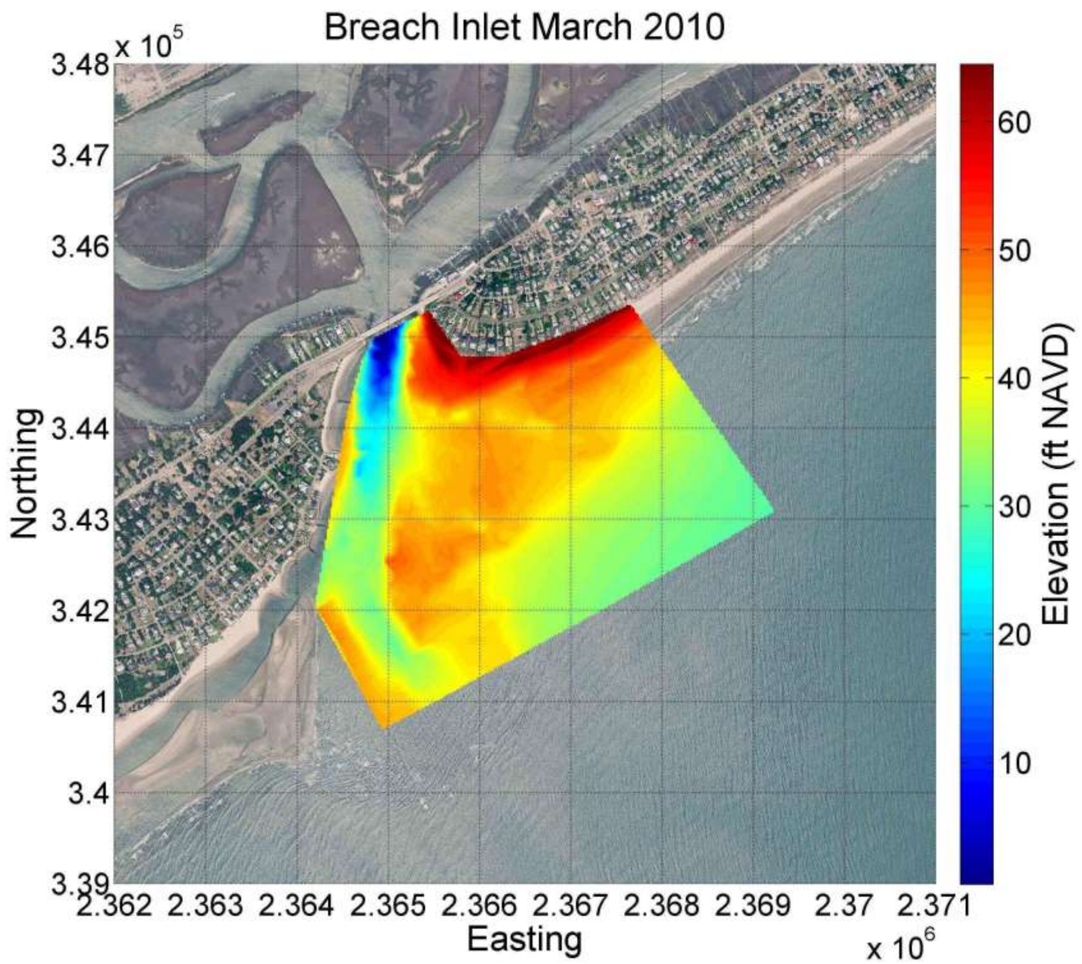
-20
-25
-30
-35
Elevation (ft NAVD)



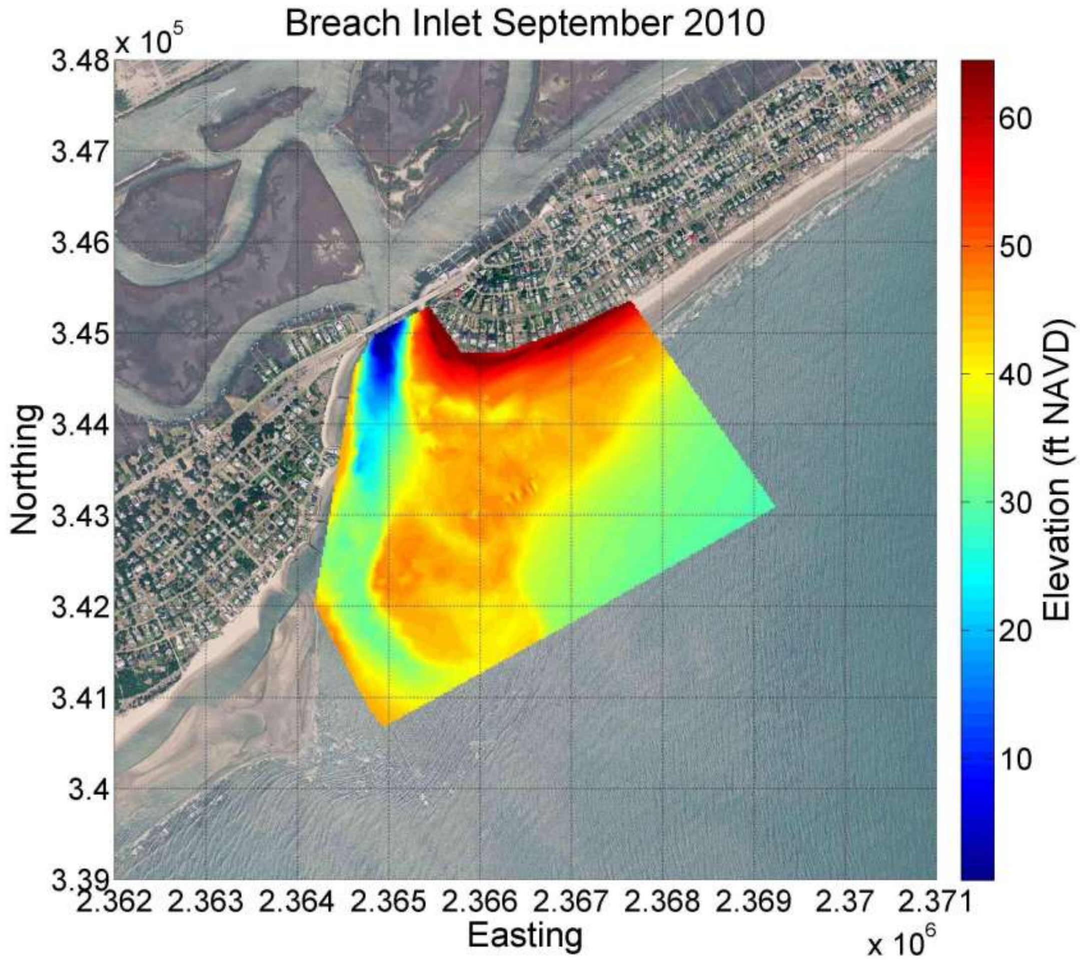
Breach Inlet March 2009
x 10^5
3.48
3.47
3.46
3.45
3.44
3.43
3.42
3.41
3.4
3.39
Northing
2.362
2.363
2.364
2.365
2.366
2.367
2.368
2.369
2.37
2.371
Easting
x 10^6
60
50
40
30
20
10
Elevation (ft NAVD)

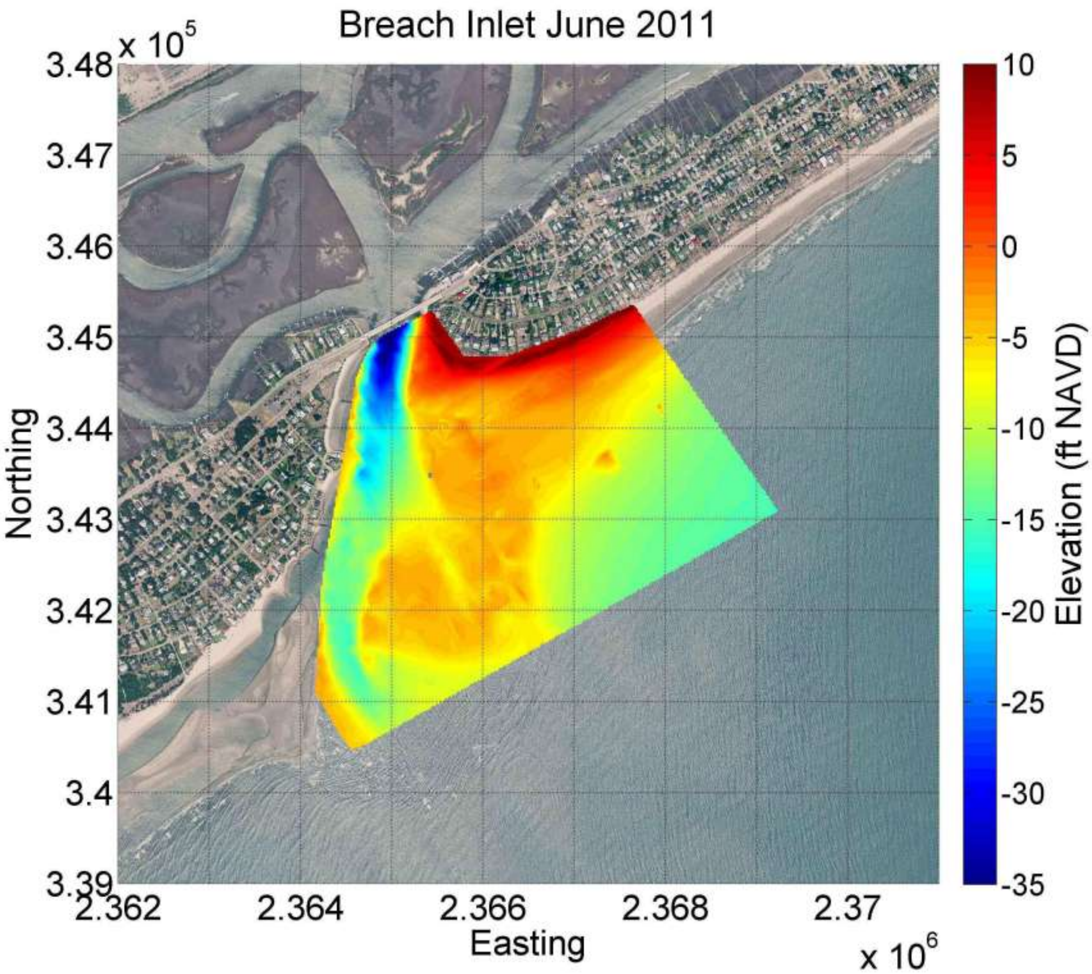


Breach Inlet September 2009
x 10^5
3.48
3.47
3.46
3.45
3.44
3.43
3.42
3.41
3.4
3.39
Northing
2.362 2.363 2.364 2.365 2.366 2.367 2.368 2.369 2.37 2.371
Easting
x 10^6
60
50
40
30
20
10
Elevation (ft NAVD)



Breach Inlet March 2010
x 10^5
3.48
3.47
3.46
3.45
3.44
3.43
3.42
3.41
3.4
3.39
Northing
2.362 2.363 2.364 2.365 2.366 2.367 2.368 2.369 2.37 2.371
Easting
x 10^6
60
50
40
30
20
10
Elevation (ft NAVD)


Breach Inlet September 2010
x 10^5
3.48
3.47
3.46
3.45
3.44
3.43
3.42
3.41
3.4
3.39
Northing
2.362 2.363 2.364 2.365 2.366 2.367 2.368 2.369 2.37 2.371
Easting
x 10^6
60
50
40
30
20
10
Elevation (ft NAVD)


Breach Inlet June 2011
x 10^5
3.48
3.47
3.46
3.45
3.44
3.43
3.42
3.41
3.4
3.39
Northing
2.362 2.364 2.366 2.368 2.37
Easting
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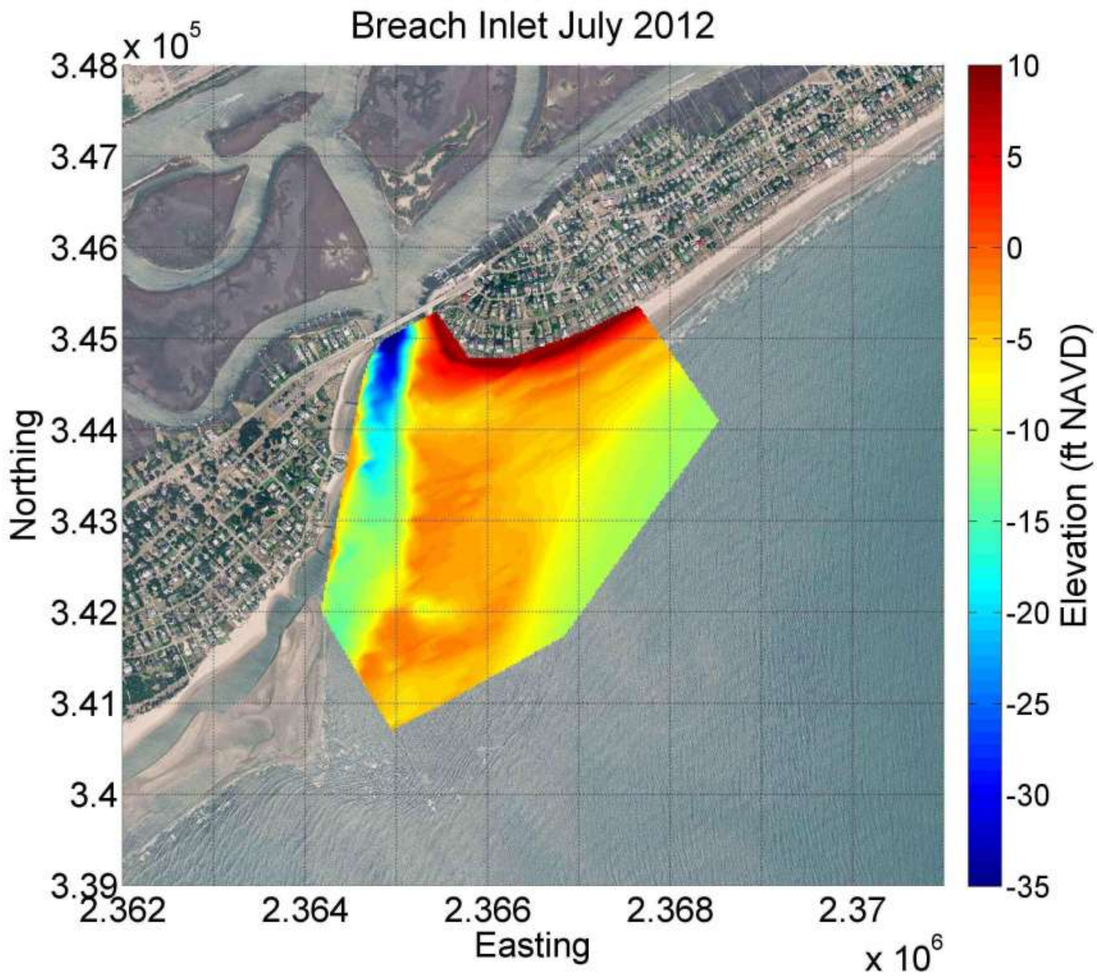
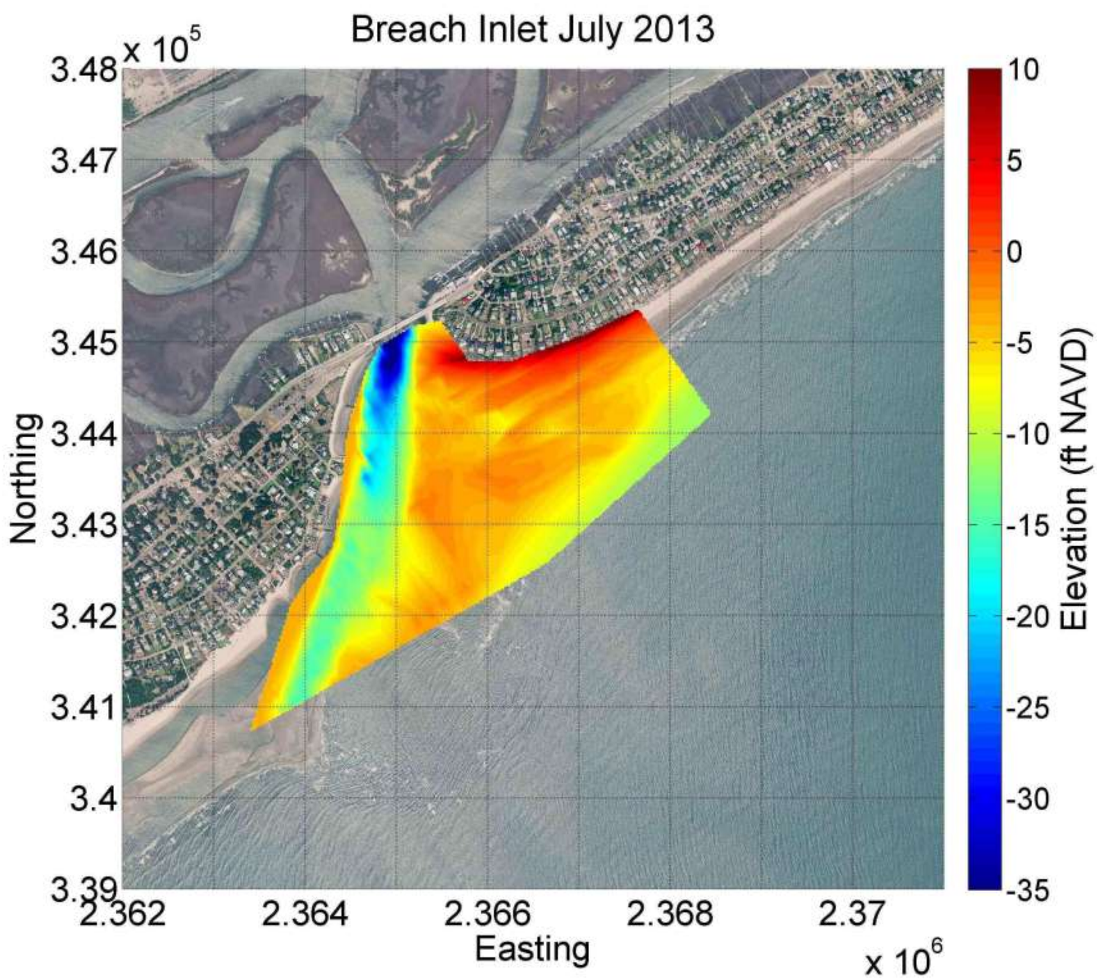
-30
-35
Elevation (ft NAVD)


Breach Inlet July 2012
x 10^5
3.48
3.47
3.46
3.45
3.44
3.43
3.42
3.41
3.4
3.39
Northing
2.362
2.364
2.366
2.368
2.37
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


Breach Inlet July 2013
x 10^5
3.48
3.47
3.46
3.45
3.44
3.43
3.42
3.41
3.4
3.39
Northing
2.362
2.364
2.366
2.368
2.37
Easting
x 10^6
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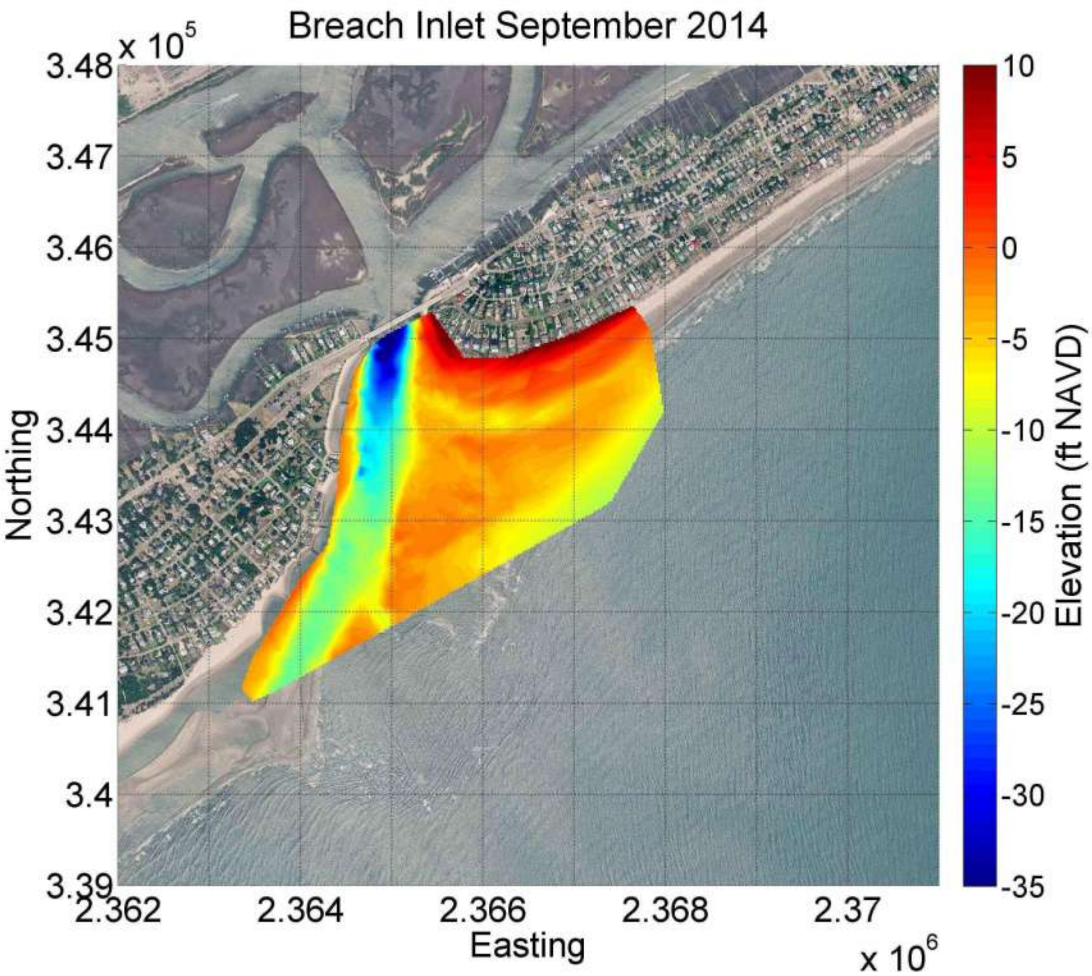
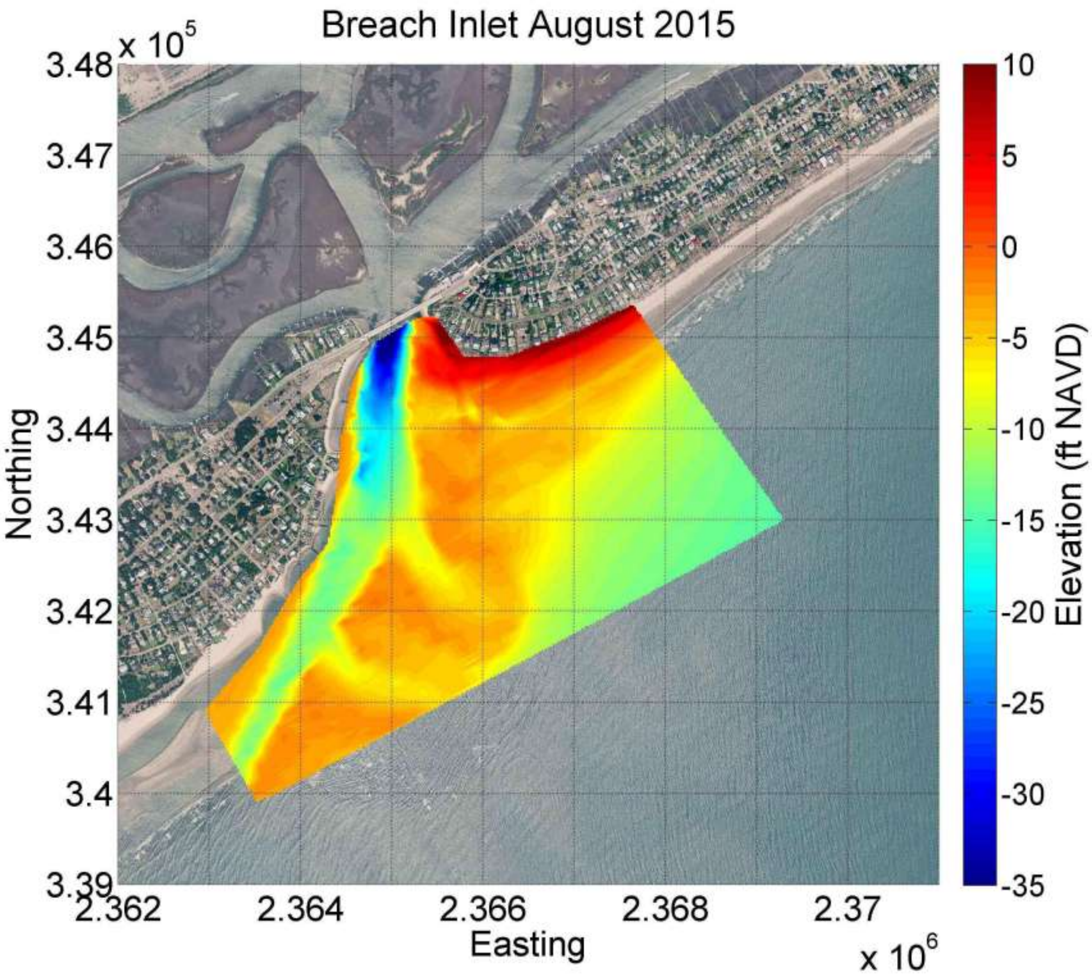
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


Breach Inlet September 2014
x 10^5
3.48
3.47
3.46
3.45
3.44
3.43
3.42
3.41
3.4
3.39
Northing
2.362
2.364
2.366
2.368
2.37
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)


Breach Inlet August 2015
x 10^5
3.48
3.47
3.46
3.45
3.44
3.43
3.42
3.41
3.4
3.39
Northing
2.362
2.364
2.366
2.368
2.37
Easting
x 10^6
10
5
0
-5
-10
-15
-20
-25
-30
-35
Elevation (ft NAVD)