Edisto Beach
Annual Beach & Inshore Survey

2021
MONITORING REPORT

Prepared for

Town of Edisto Beach
Edisto Island, South Carolina

COASTAL SCIENCE & ENGINEERING

2017 BEACH RESTORATION AND GROIN LENGTHENING PROJECT
Edisto Beach, Colleton County (SC)

SURVEY REPORT NO 4
Annual Beach and Inshore Surveys
Assessment of Beach and Groin Conditions

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[2485YR4 — Monitoring Year 4]

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SYNOPSIS

This report is the 4th in a series of annual monitoring reports initiated following the 2017 Edisto Beach Restoration and Groin Lengthening Project. It contains results and analysis of the most recent beach survey, including information on the history of shoreline stabilization projects at Edisto Beach.

The 2017 restoration project saw the largest volume of sand placed on Edisto Beach to date (1,006,072 cubic yards encompassing 19,300 feet of shoreline). There have been four beach nourishment projects along Edisto Beach since 1954. These projects have collectively placed 2,862,133 cubic yards (cy) of material on the beach.

Fill volumes for the 2017 project averaged ~30–70 cubic yards per foot (cy/ft), with the greatest volumes placed along the State Park and the northern end of the Town in anticipation of the sand moving south. As of July 2021, approximately 551,544 cy remain within the project area above the volumes measured in December 2016 (before the project began). Approximately 55 percent of the nourishment volume remains within the project area. Approximately 71 percent of the project volume remains on the beach along Edisto Island, including areas adjacent to the project area but not within the original fill template. Within the project area, reach-wide volumes still in place from the 2017 nourishment range from 28 percent to 70 percent.

Edisto Beach contains 37.7 cy/ft more sand in July 2021 than November 2005 (equivalent to ~1,080,900 cy) and 24.9 cy/ft more sand than December 2016 (equivalent to ~716,700 cy). The annualized erosion rate for the project area was –4.4 cubic yards per foot per year (cy/ft/yr) from July 2020 to July 2021. Annualized erosion rates within the project area have averaged –5.8 cy/ft/yr from April 2017 to July 2021.

At that rate, the project area beach will reach pre-project (December 2016) volumes within the next ~5 years. It is important to note the pre-project volume within the project area was ~70 to 90 cy/ft higher than the minimum target volume of 160 cy/ft throughout much of the project area. In the meantime, we expect localized hot spots to develop along particular groin cells, especially those that retain less than 50 percent of the nourishment received (see Table 4.2; page 29). Figure A shows the progressive growth in island-wide volumes along Edisto Beach from November 2005 (prior to the 2006 renourishment) through July 2021.

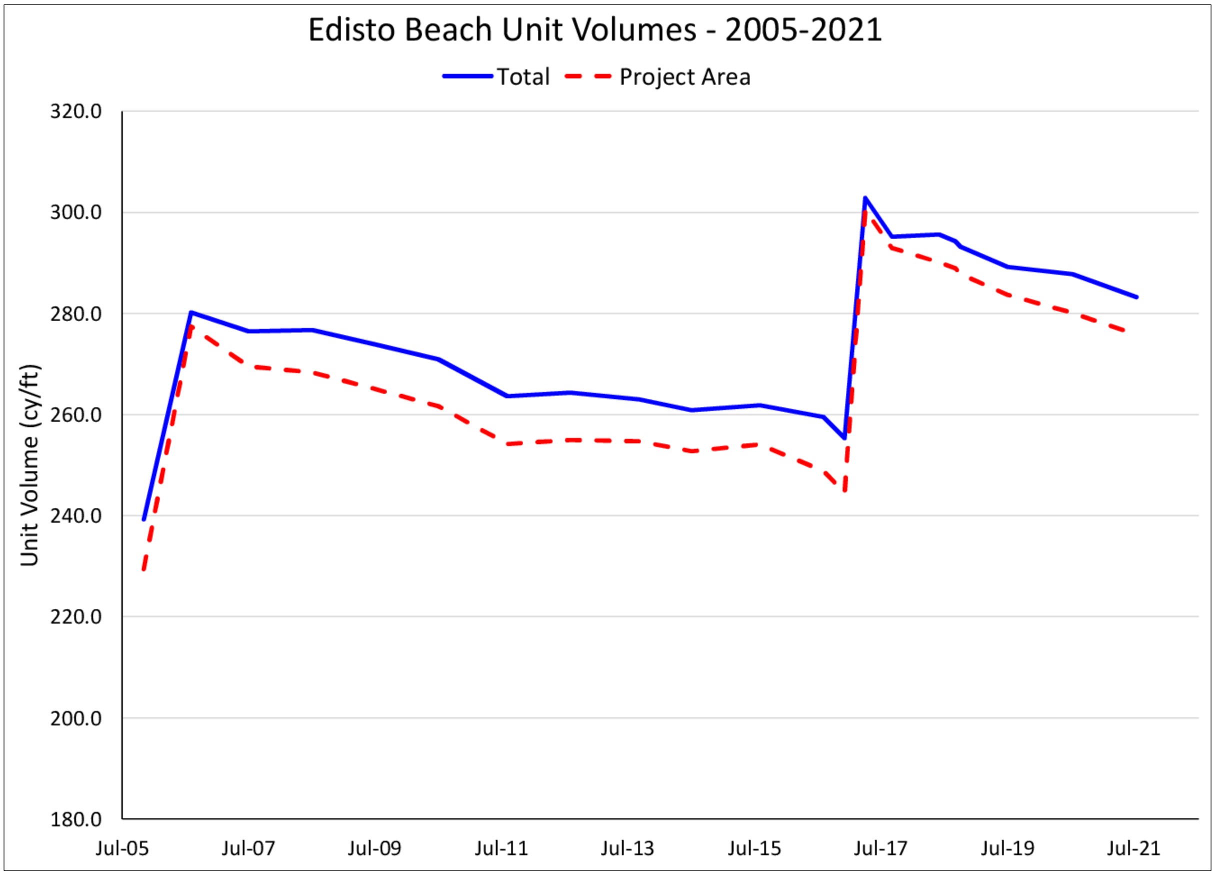

FIGURE A. Long-term island-wide changes in beach volume along Edisto Beach. The solid line accounts for the entire Island's beachfront, while the dashed line indicates changes within the project area alone. The past two nourishments have increased average beach volumes along Edisto Island by ~20 percent, and provided an excess volume of sand to help grow the beach seaward over time. The average unit volume across the entire project area was higher in July 2021 (more than three years following 2017 project completion) than in August 2006 (immediately following 2006 project completion). The steady increases in project area and island-wide beach volumes through multiple episodes of renourishment bodes well for the longevity of future projects along Edisto Island.

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1.0 INTRODUCTION

This report details the results of the fourth post-project monitoring survey of the 2017 Edisto Beach (Fig 1.1) nourishment and groin extension project, which placed over 1 million cubic yards (cy) of offshore sand on the beachfront and reinforced the existing groins. It presents volumes and photographs from post-project surveys collected in July 2021, referencing surveys collected in July 2020, April 2017 (post-project), and December 2016 (pre-project). The report includes a summary of the island's major processes and features, discussion of changes in sand volume compared to pre-nourishment and post-nourishment conditions, and environmental monitoring compliance efforts required by project permits.

FIGURE 1.1. Edisto Beach (SC) in February 2021. [Photo by D Giles]

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2.0 SETTING AND HISTORY

Edisto Beach is located on a ~5.8-mile-long barrier island with an additional one mile of beach fronting St. Helena Sound. Along with Edingsville Beach and Botany Bay Island, Edisto Beach sits on thin barriers between marshes flanking the larger Edisto Island and the Atlantic Ocean. The Town of Edisto Beach is situated between Jeremy Inlet and South Edisto River Inlet.

Beach width is strongly influenced by the tidal deltas of North Edisto Inlet and St. Helena Sound. The two deltas mark the limits of a littoral cell encompassing Botany Bay Island, Edingsville Beach, and Edisto Beach. Within this cell, sand is gradually drawn away from the center of the island and shifted north toward Deveaux Bank and south toward Edisto Beach (Fig 2.1).

The ~1.4 miles of oceanfront north of Hwy 174 is the site of Edisto Beach State Park, maintained by the South Carolina Department of Parks, Recreation and Tourism (SCPRT). The Town of Edisto Beach is responsible for the portion of oceanfront south of Hwy 174 (~4.4 miles). Along most of the island, there is one row of houses on relatively narrow lots seaward of Hwy 174. Towards South Edisto Inlet, the island widens to accommodate two rows of oceanside homes (see Fig 1.1). These homes are located on Point Street, between the Atlantic Ocean and Hwy 174.

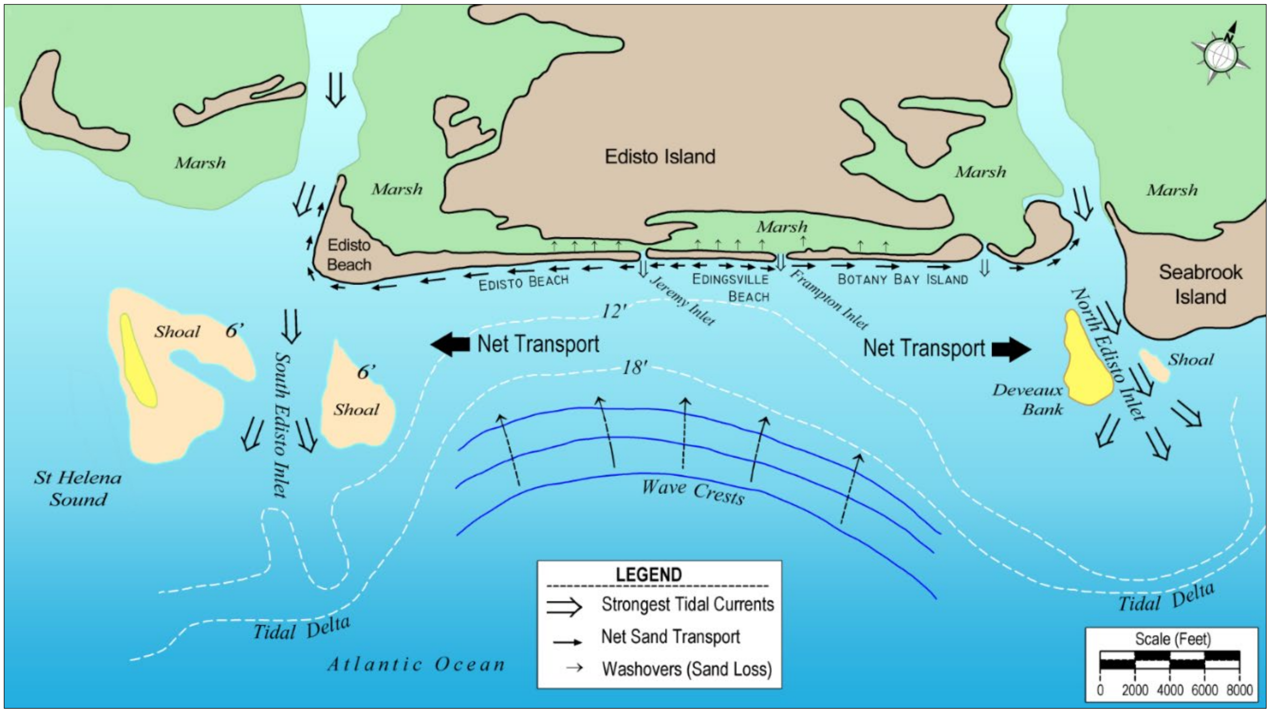

FIGURE 2.1. Regional setting of Edisto Beach between the North Edisto River Inlet and South Edisto River Inlet. Principal wave and current directions and net sand transport patterns are inferred from the shoreline morphology, spit development, shape of underwater contours, and site-specific measurements in similar settings. High background rates of erosion occur along Edingsville Beach and the north end of Edisto Beach due to washovers and limited sand availability around Jeremy Inlet. [After CSE 2001]

As sand is drawn from the center of the island towards the inlet shorelines, erosion along Edingsville Beach and Botany Bay Island reduces the volume of beach sand and exposes the marsh deposits underneath. Edingsville Beach has been retreating upward of 15 feet per year (ft/yr) for decades (Stephen et al 1975, CSE 2003). This erosion reduces the volume of sediment supplied downcoast to Edisto Beach (Fig 2.2). Furthermore, the sediments supplied to Edisto Beach tend to have a high proportion of mud and shells derived from the exposed marsh deposits.

The downcoast end of Edisto Beach at "The Point" and along St. Helena Sound has generally remained stable over the past century, but erosion further north along Edisto Beach spurred the construction of groins in 1948 near the Pavilion. By the 1950s, erosion near the Pavilion (Groin 1) on Edisto Beach reached upward of 10 ft/yr (Fig 2.3). During the next decade, 17 groins were built from north to south in an attempt to halt the loss of sand or at least to slow its southerly movement. However, erosion continued downcoast of the structures as each group of groins was built. This prompted the construction of more groins through 1975 (Table 2.1), eventually reaching all the way south to The Point (the southern tip of Edisto Beach; CSE 2001). Groin 34 (the last one built) is situated along the South Edisto River Inlet shoreline, about 3,000 feet (ft) from Big Bay Creek.

The sand-trapping capacity of individual groins impacts erosion rates along the beachfront. Gaps in deteriorating groins allow sand piping and leaking, which results in erosion within the groin cell and accretion downcoast. Conversely, when updrift groins are repaired, and their trapping capacity is restored, downcoast areas may erode (unless repairs are accompanied by nourishment). Sand volumes around The Point are mainly influenced by the condition of groins along the oceanfront (Kana et al 2004).

In the mid-1950s, erosion near the Pavilion had progressed such that groins alone were not sufficient to protect Palmetto Boulevard. The South Carolina Highway Department combined groin construction with the first nourishment of Edisto Beach in 1954 using sand, shells, and mud from the marsh behind the island (Fig 2.4). Excavations created the "boat basin" and reclaimed ~1.2 miles of shoreline between Groins 1 and 12. Much of the material was unsuitable for the beach and washed away quickly because it was too fine. The 1954 nourishment project placed ~830,000 cubic yards (cy) along 5,400 linear feet (lf) from the Pavilion south, allowing reclamation of beachfront property down to the "600" block (Kana 2012).

TABLE 2.1. Edisto Beach groin construction chronology. Groins are numbered from updrift to downdrift. [After Cubit 1981]

Groin #	Constructed
1	1948
2	1948
3-4	1949
5-8	1954
9-12	1953
13-17	1958
18-19	1962
20-21	1964
22-25	1969
26	1970
27-29	1972
30-33	1974
34	1975

FIGURE 2.2. Erosion along Edingsville Beach (distant in the center of this photo, taken 31 August 2021 by D Giles), and the northern reaches of Edisto Beach draws sand away from the rest of the beachfront and transports beach material landward in overwash deposits atop the marsh between Edisto Beach and Jeremy Cay. The noticeable arc in the shoreline exhibited in this photograph indicates shoreline recession due to overwash (notated with red circle).

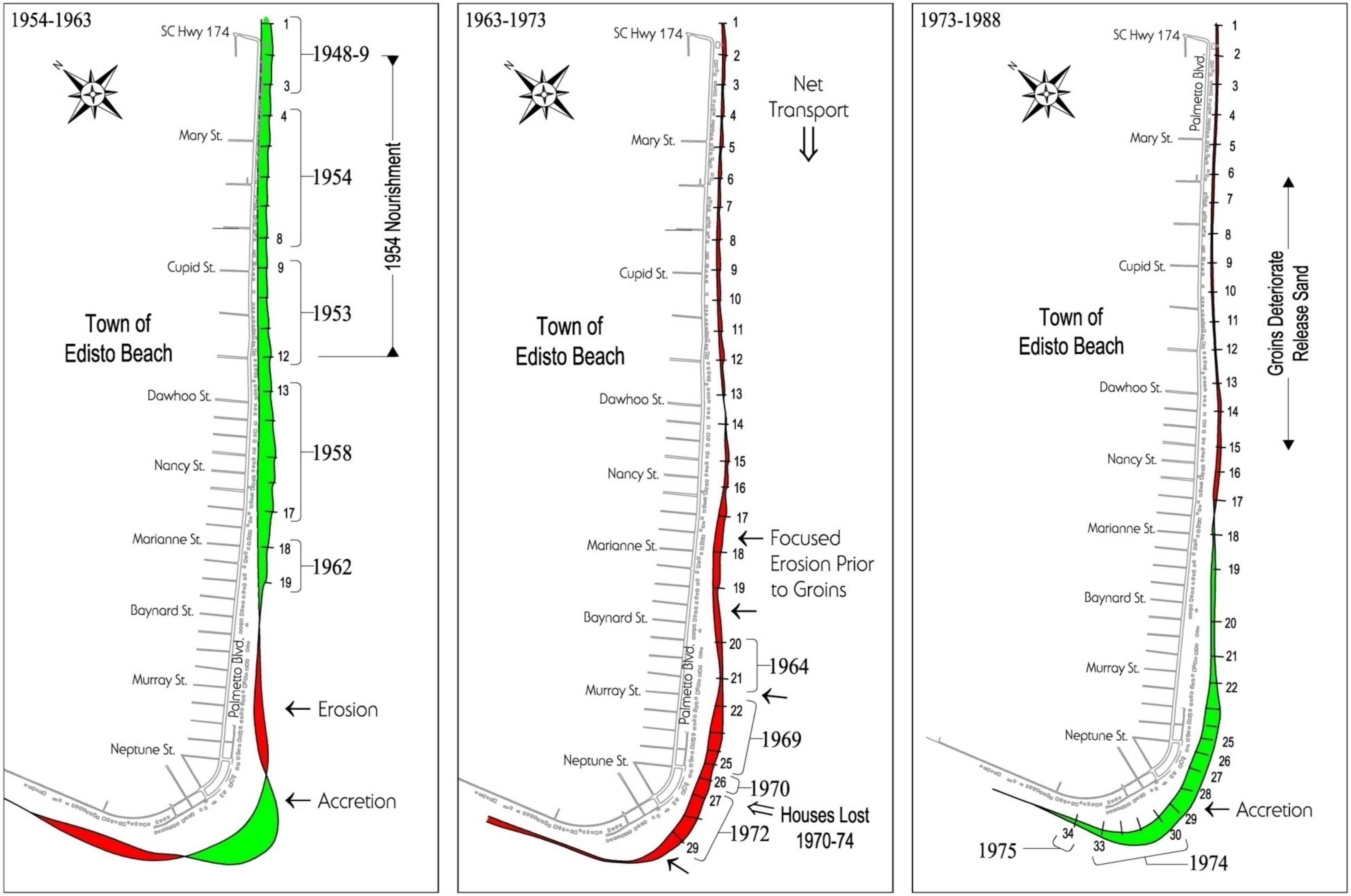

FIGURE 2.3a. Historical shoreline trends for representative time periods along Edisto Beach reflecting the negative sequencing of groin construction from updrift to downdrift (see Table 2.1) and the positive effect of nourishment in 1954. [After CSE 2001]

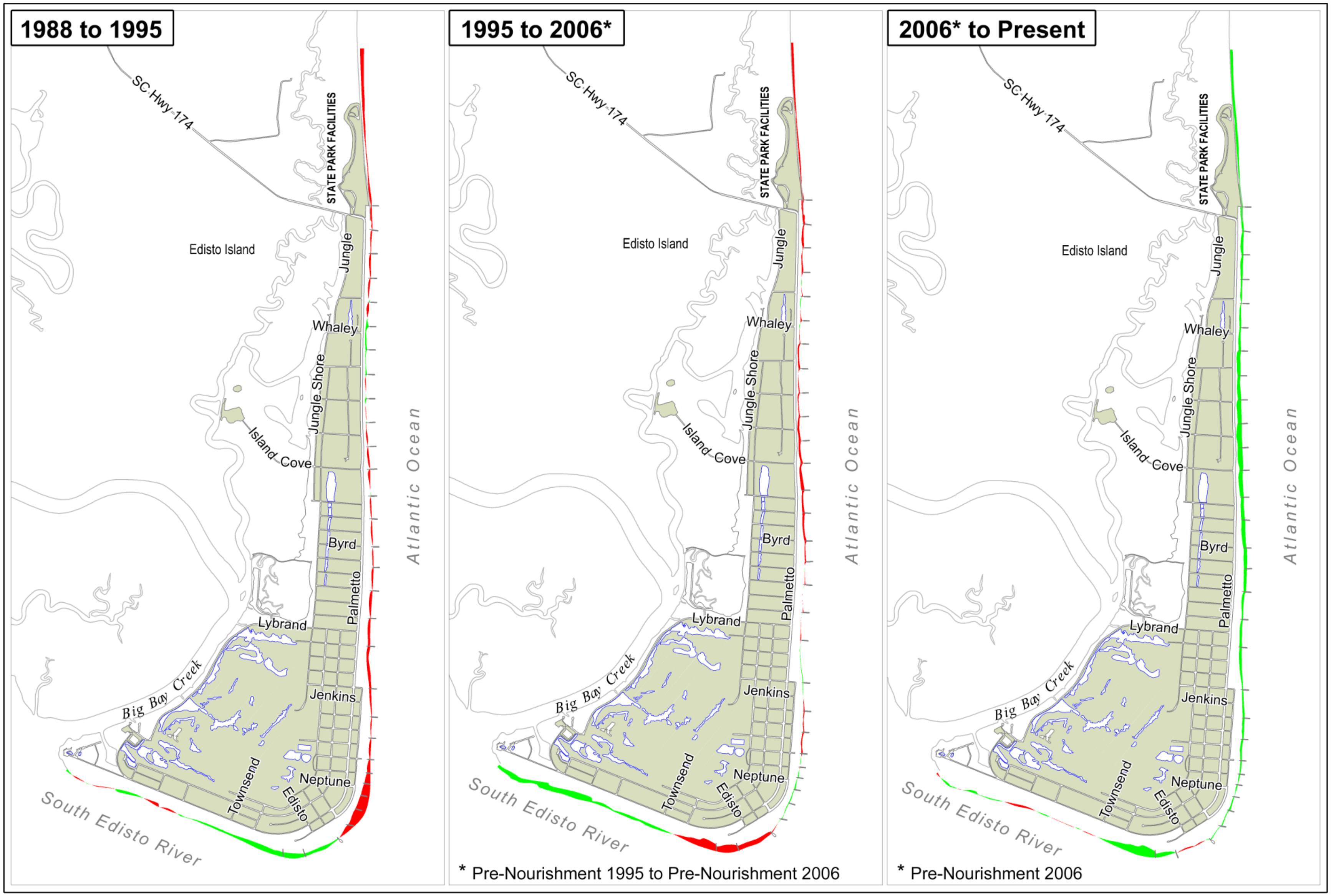

FIGURE 2.3b. Historical shoreline trends for representative time periods along Edisto Beach reflecting the positive effect of nourishment in 1995 and 2006. [After CSE 2001]

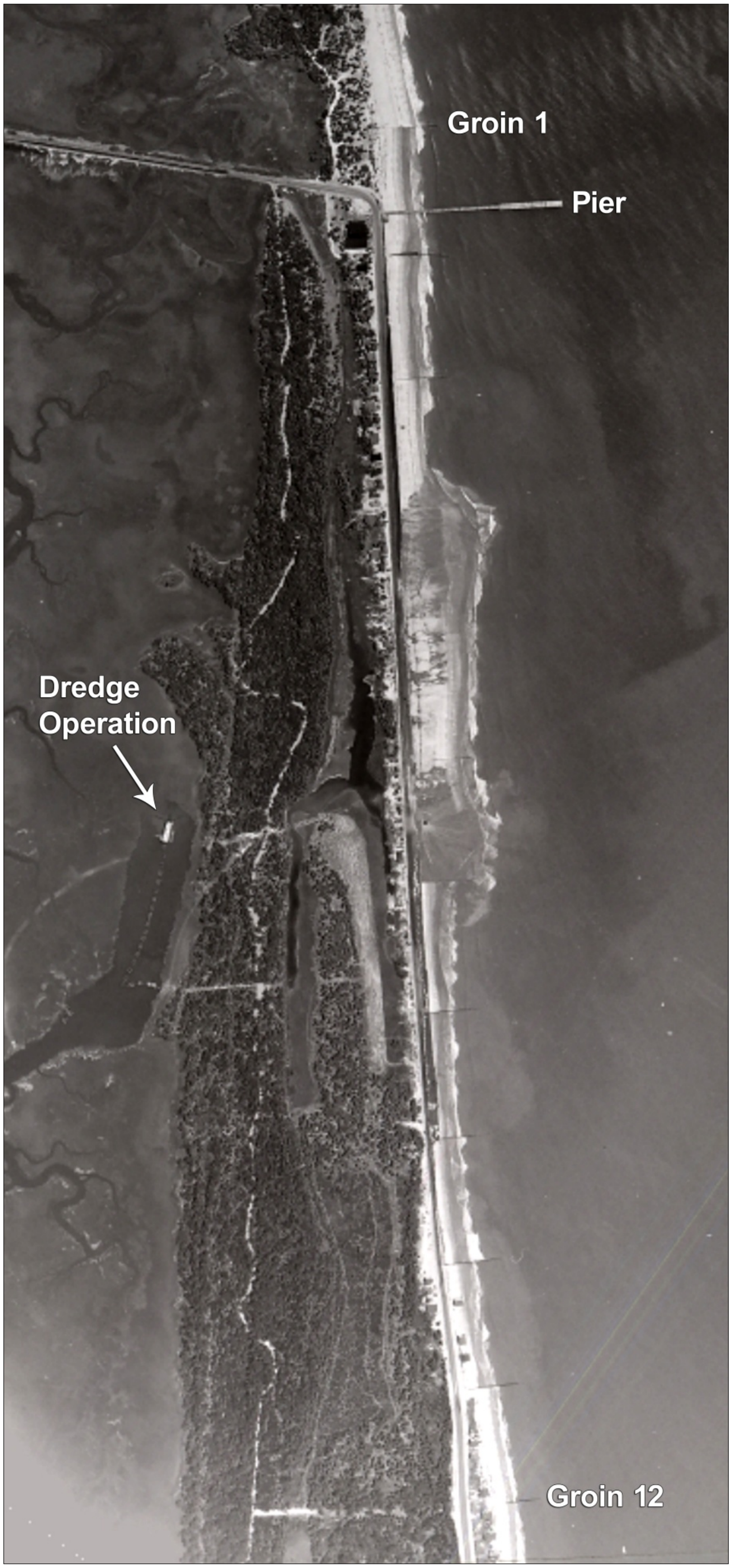

FIGURE 2.4.

May 1954 nourishment and groin construction at Edisto Beach which reclaimed oceanfront lots seaward of Palmetto Boulevard.

Note the source of "sand" for beach nourishment was marsh deposits (mud, shells, and sand) which partly accounts for the high shell content along Edisto Beach.

(After Kana et al 2004)
[Image is from USDA]

Following the initial beach reclamation in the 1950s, most oceanfront lots south of the Pavilion were developed, albeit with minimal setbacks from Palmetto Blvd or the ocean. Timber groins initially stabilized the beach and reduced sand losses but left little room for dune development north of Groin 15 (Byrd Street – "1000" block). The original timber groins terminated above the mean high water elevation, meaning they tended to be exposed more than six (6) feet around the ends at low tide. Over time, timbers rotted, and leaks developed, allowing sand to pass through the structures. This caused the active beach to drop in elevation (and recede landward), increasing exposure of the groins beyond their design limits. During the 1970s and 1980s, minor groin repairs were made to patch holes in the timber "sheets." But the principal repairs consisted of adding rip rap and larger armor stone along each structure. Kana et al (2004) discusses the limitations of this approach and the continued loss of trapping capacity due to settlement of the armor stone.

In 1995, the Town completed a major groin repair project whereby armor stone was added, and the groin profiles reshaped to include a sloping seaward section. The repaired sections were designed to follow the natural slope of the beach and were stabilized by injecting grout into the structures. By cementing the armor stone units, permeability decreased, and sand retention increased. The 1995 project included ~148,000 cy nourishment via offshore dredge and trucking to accommodate the increased sand trapping capacity of each repaired groin (Kana et al 2004). Because of budget limitations in 1995, only 21 groins were upgraded, and none could be lengthened beyond their original design per terms of state permits. The 1995 project restored a degree of stability to the north end of Edisto Beach, but the repaired groins remained shorter than optimal for maintaining a stable dune from the 100 block to the 1500 block. Most significantly, the groin profiles lacked a low relief seaward section which is necessary to hold the low tide beach in place (ASCE 1994; Kana et al 2004).

In 2006, the Town and SCPRT secured funds to renourish the beach, adding ~878,000 cy from an offshore borrow area in the north shoals of South Edisto River Inlet. That project encompassed over 18,200 lf of oceanfront and resulted in the near-complete burial of the groins (Fig 2.5). The 2006 nourishment matched the 1954 project in volume but exceeded its performance by introducing more beach-compatible sediment with a coarser sand size, typical for Edisto Beach. CSE (2015, 2006) monitored the project for 10 years and tracked the shift of sand out of the northern groin cells into the area of south Edisto Beach. Over time, the groins were re-exposed, and many cells reverted to their pre-nourishment condition. By 2015, the Town and SCPRT began planning for another renourishment project. The principal study effort was by the US Army Corps of Engineers (USACE), working under a cooperation agreement with the Town for a "50-year" storm damage reduction project (USACE 2013). The federal project called for periodic nourishment using the same shoal area of South Edisto River Inlet about 2,500–3,500 ft offshore of The Point, along with certain groin improvements. While the need for beach restoration was well established by the USACE (2013) and prior studies, there were no, or insufficient, federal funds to construct a project. By 2015, the Town elected to proceed with a "locally-sponsored" project until federal funds became available. This decision was also driven by the impacts of Hurricanes *Matthew* and *Joaquin* (NWS 2014, 2015), which caused extensive erosion and minor to moderate damages to beachfront property.

FIGURE 2.5. Aerial photographs showing the state of Edisto Beach before the 2006 renourishment (left, taken by T Kana 10 February 2006) and after project completion (right, T Kana, 9 June 2006). That project resulted in the placement of nearly 900,000 cy of beach-quality material along Edisto Island between the State Park and The Point. Notice the shoreline offset in the background of both images, highlighting the chronic erosion experienced along Edingsville Beach and between Jeremy Inlet and Edisto Beach State Park. This chronic erosion can cause sand deficits along the northern reaches of Edisto Beach itself.

2.1 2017 Beach Restoration and Groin Lengthening Project

The 2017 beach restoration was designed to address erosion along the Town's beachfront and help provide a longer-term solution by repairing and lengthening most of the groins. The project added up to 125 ft of dry sand between houses and the Atlantic Ocean. Coastal Science & Engineering (CSE 2018) prepared a nourishment plan encompassing much of the Edisto Beach State Park shoreline and the oceanfront shoreline within the Town's boundaries to The Point. Specific nourishment quantities varied according to the pre-nourishment deficit, the expected tendency for nourishment sand to shift south(west) over time, and allowable quantities based on storm losses. The 2017 project involved nourishment volumes about 25 percent greater than those placed during the 2006 project. Both of these nourishment projects filled the groins over their capacity and buried the structures. The most significant change in the project scope of the 2017 project was the groin repair and lengthening.

Engineered by CSE, the nourishment project was constructed between January and April of 2017 by Marinex Construction, Charleston, SC. The length of the project was ~19,000 lf, and average design fill volumes were ~30–70 cy/ft. The greatest volumes were added to the State Park and northern end of the Town in anticipation of sand moving south and storm damage repair. Post-project erosion rates along the north half of the project area were anticipated to be rapid during the first few years, while the groins remained buried and nonfunctional. Rates were expected to decrease as the groins became more exposed and functional. The erosion trend projected for the southern half of the beach is lower than that for the northern half in anticipation of sand from the upcoast reaches feeding downcoast areas. This is also consistent with historical erosion and accretion trends for the island.

The total volume of sand added during the 2017 restoration was 1,006,072 cy. Groins were extended between 40 and 100 linear feet with a total lengthening of 1,630 ft. The final cost of the nourishment was $12,198,780, of which $2,683,800 (22.0 percent) covered mobilization and demobilization. The groin lengthening and repair cost was $5,424,642. The Town of Edisto Beach and the South Carolina Department of Parks, Recreation and Tourism sponsored the project with a combination of local, county, and state funds. Details of the restoration project and nourishment volumes are given in the 2017 project final report (CSE 2018). Table 2.2 summarizes the nourishment events along Edisto Beach, including the 2017 project.

Table 2.2. Nourishment events along Edisto Beach. Sources: USACE 1965, Kana 2012, CSE 2018.

Year	Length (ft)	Volume (cy)	Fill Design (cy/ft)	Unadjusted Cost	Unit Cost (cy)
1954	5,400	830,000	153.7	$400,000	$0.48
1995	10,371	148,414	14.3	$1,100,000	$7.41
2006	18,258	877,647	48.1	$7,697,500	$8.77
2017	19,300	1,006,072	52.1	$12,198,780	$12.13
	Total Volume (cy)	2,862,133	**Total Cost (US$)**	$21,396,280	

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3.0 METHODOLOGY

This section describes the methodology CSE used to monitor erosion and accretion along the beach and the inshore zone and evaluate the condition of the groins.

3.1 Stationing

Several baselines and stationing systems have been used along Edisto Beach. Permanent monuments established by the State of South Carolina are situated from Big Bay Creek (OCRM 2110) to the State Park (OCRM 2270). CSE has monitored the shoreline for the Town of Edisto Beach since the early 1990s using the lines established by the South Carolina Office of Ocean and Coastal Resource Management (OCRM) as well as numerous intermediate profiles. Because of the presence of groins, typically, three profiles per groin cell are monitored (CSE 2001), which provides for better accounting of fillets (ie – wedges of sand that accumulate against each groin) as sand shifts north or south within each groin cell as a function of wave direction.

CSE's numbering system uses a combination of groin cell number and distance downcoast (south) from the nearest groin beginning at Cell 1. Groin cells are numbered consecutively from north to south, with Cell 1 being the length of the beach between Groins 1 and 2, Cell 2 being the length between Groins 2 and 3, and so on. Profile lines were established in 1995 at ~75 ft, 300 ft, and 525 ft (typical) downcoast of most groins. These lines have been resurveyed continuously since the 2006 nourishment project. The adopted station number is in the form of 1+75, 1+300, 1+525, 2+75, etc. For example, CSE 12+300 is a profile in Cell 12 (between Groins 12 and 13), 300 ft downcoast (south) of Groin 12. The "1995" profile series is referenced to the centerline of Palmetto Boulevard (distance = 0, where applicable). The locations, offsets, and distances between profiles (listed in Table 3.1) reference the beach monitoring baseline, which is the approximate centerline of Palmetto Boulevard for a majority of the stations.

Additional lines were surveyed in the State Park area before and after the 2006 project and have been resurveyed annually since 2005. These stations are named "Park number," where the number is the distance upcoast (north) of Groin 1 (ie – Park 900 is 900 ft north of Groin 1). Surveying these stations provides detail of the beach condition along the campground.

TABLE 3.1.

Stations and reaches along Edisto Beach used for measuring changes in sand volume.

Coordinates reference the landward control point along the beach monitoring baseline (typically the centerline of Palmetto Boulevard).

Stationing within Groin Cells 1–28 references the cell number followed by the distance (ft) downcoast of the respective updrift groin (see text for further explanation).

The "2000-series" stations are permanent OCRM survey lines.

Edisto Beach Profile Stations (North - South)

Station	Distance to Next (ft)	Northing	Easting
Upcoast 1			
2270	1,160	248,569	2,221,530
2250	1,380	247,834	2,220,635
Park 3300	300	246,957	2,219,572
Park 3000	300	246,767	2,219,341
Park 2700	20	246,576	2,219,109
Upcoast 2			
2230	280	246,560	2,219,091
Park 2400	300	246,365	2,218,896
Park 2100	110	246,152	2,218,685
2210	190	246,070	2,218,604
Park 1800	300	245,935	2,218,477
Park 1500	300	245,716	2,218,272
Park 1200	300	245,498	2,218,066
Park 900	300	245,279	2,217,861
Park 600	300	245,065	2,217,651
Park 300	300	244,852	2,217,440
Park 0	110	244,638	2,217,229
Reach 1			
1+75	225	244,574	2,217,181
1+300	225	244,443	2,217,003
1+525	143	244,295	2,216,826
2+75	225	244,206	2,216,715
2+300	225	244,068	2,216,539
2+525	145	243,928	2,216,361
3+75	225	243,838	2,216,248
3+300	225	243,699	2,216,072
3+525	155	243,559	2,215,894
4+75	225	243,461	2,215,768
4+300	225	243,314	2,215,582
4+525	153	243,182	2,215,415
5+75	225	243,089	2,215,297
5+300	225	242,950	2,215,120
5+525	145	242,811	2,214,944
6+75	225	242,730	2,214,841
6+300	225	242,591	2,214,663
6+525	155	242,452	2,214,487
7+75	225	242,359	2,214,369
7+300	225	242,220	2,214,191
7+525	150	242,064	2,214,008
8+75	225	241,963	2,213,897
8+300	225	241,811	2,213,731
8+525	158	241,660	2,213,565
9+75	225	241,558	2,213,452
9+300	225	241,406	2,213,285
9+525	150	241,258	2,213,122
10+75	225	241,159	2,213,012
10+300	225	241,007	2,212,845
10+525	155	240,855	2,212,678
Reach 2			
11+75	225	240,756	2,212,568
11+300	225	240,614	2,212,413
11+525	170	240,476	2,212,261
12+75	225	240,363	2,212,133
12+300	225	240,198	2,211,945
12+525	185	240,053	2,211,780
Reach 2 (cont)			
13+75	225	239,935	2,211,645
13+300	225	239,803	2,211,495
13+525	170	239,665	2,211,337
14+100	250	239,550	2,211,206
14+350	250	239,385	2,211,018
14+600	160	239,220	2,210,830
15+65	180	239,115	2,210,711
15+245	205	238,995	2,210,574
15+450	145	238,863	2,210,423
Reach 3			
16+75	225	238,767	2,210,313
16+300	225	238,642	2,210,159
16+525	175	238,508	2,209,980
17+75	225	238,404	2,209,839
17+300	225	238,257	2,209,642
17+525	200	238,111	2,209,445
18+75	225	237,991	2,209,284
18+300	225	237,844	2,209,087
18+525	200	237,697	2,208,888
19+100	425	237,570	2,208,734
19+525	430	237,284	2,208,416
19+955	200	236,998	2,208,098
20+100	250	236,864	2,207,949
20+350	250	236,696	2,207,763
20+600	185	236,527	2,207,574
21+75	190	236,409	2,207,443
21+265	165	236,284	2,207,305
21+430	165	236,174	2,207,176
22+75	193	236,069	2,207,045
22+268	192	235,965	2,206,881
22+460	190	235,862	2,206,719
23+100	120	235,761	2,206,560
23+220	205	235,699	2,206,471
Reach 4			
24+100	90	235,592	2,206,293
24+190	175	235,544	2,206,218
25+100	100	235,465	2,206,054
25+200	215	235,432	2,205,962
26+115	120	235,352	2,205,747
26+235	200	235,311	2,205,636
27+145	145	235,249	2,205,376
27+290	275	235,227	2,205,233
Downcoast 1			
28+130	147	235,184	2,204,955
28+277	725	235,163	2,204,811
2135	639	235,103	2,204,088
2130B	642	235,477	2,203,569
2130A	729	236,041	2,203,261
Downcoast 2			
2130	596	236,729	2,203,018
2120	1,298	237,299	2,202,841
2115	1,000	238,527	2,202,418
2113	1,145	239,476	2,202,101
2110	0	240,553	2,201,713

For the 1995 project, the beachfront was divided into four reaches encompassing Groin Cell 1 through Cell 27. CSE (1999, 2001) added updrift and downdrift reaches for purposes of tracking changes along the entire island (Fig 3.1). The present report uses the same upcoast and downcoast reaches along with the 1995 reaches. The reaches are defined as follows:

State Park	North of Campground (Upcoast 1)
	Groin 1 to Campground (Upcoast 2)
Town Oceanfront	Groin Cells 1–10 (Reach 1)
	Groin Cells 11–15 (Reach 2)
	Groin Cells 16–23 (Reach 3)
	Groin Cells 24–27 (Reach 4)
Town-Sound Shoreline	Downcoast of Groin 28 (Downcoast 1)
	Downcoast of OCRM monument 2130 (Downcoast 2)

The present survey was conducted in July 2021. Profiles along Edisto Beach were surveyed perpendicular to the local shoreline azimuth from the control points to a minimum of −13 ft NAVD* (the depth equal to the normal limit of sand movement).

> *[*NAVD: North American Vertical Datum of 1988, which is ~0.5 ft above present mean sea level. CSE's previous reports had referenced NGVD'29 which is ~1 ft lower than NAVD. NAVD has become the more common datum in the engineering field; therefore, CSE has updated profiles to represent elevation in NAVD. Volumes previously reported may differ slightly from those reported in the present report due to the conversion.]*

Surveys were conducted by combining a land-based survey and a bathymetric survey. Land surveys were accomplished using an RTK-GPS between the foredune and low-tide wading depth. In contrast, over-water work was performed via RTK–GPS (Applanix™ POS MV) combined with a precision echo sounder (Odom™ Echotrac CV100) mounted on CSE's shallow-draft research vessel (R/V *Southern Echo*) (Fig 3.2). Working around the tidal cycle, data collected on land were extended into shallow depths in the surf zone at low tide. Then data were collected from the boat at high tide such that overlap of the two surveys occurred close to shore. Appendix A includes profiles for selected dates (pre-nourishment and post-nourishment).

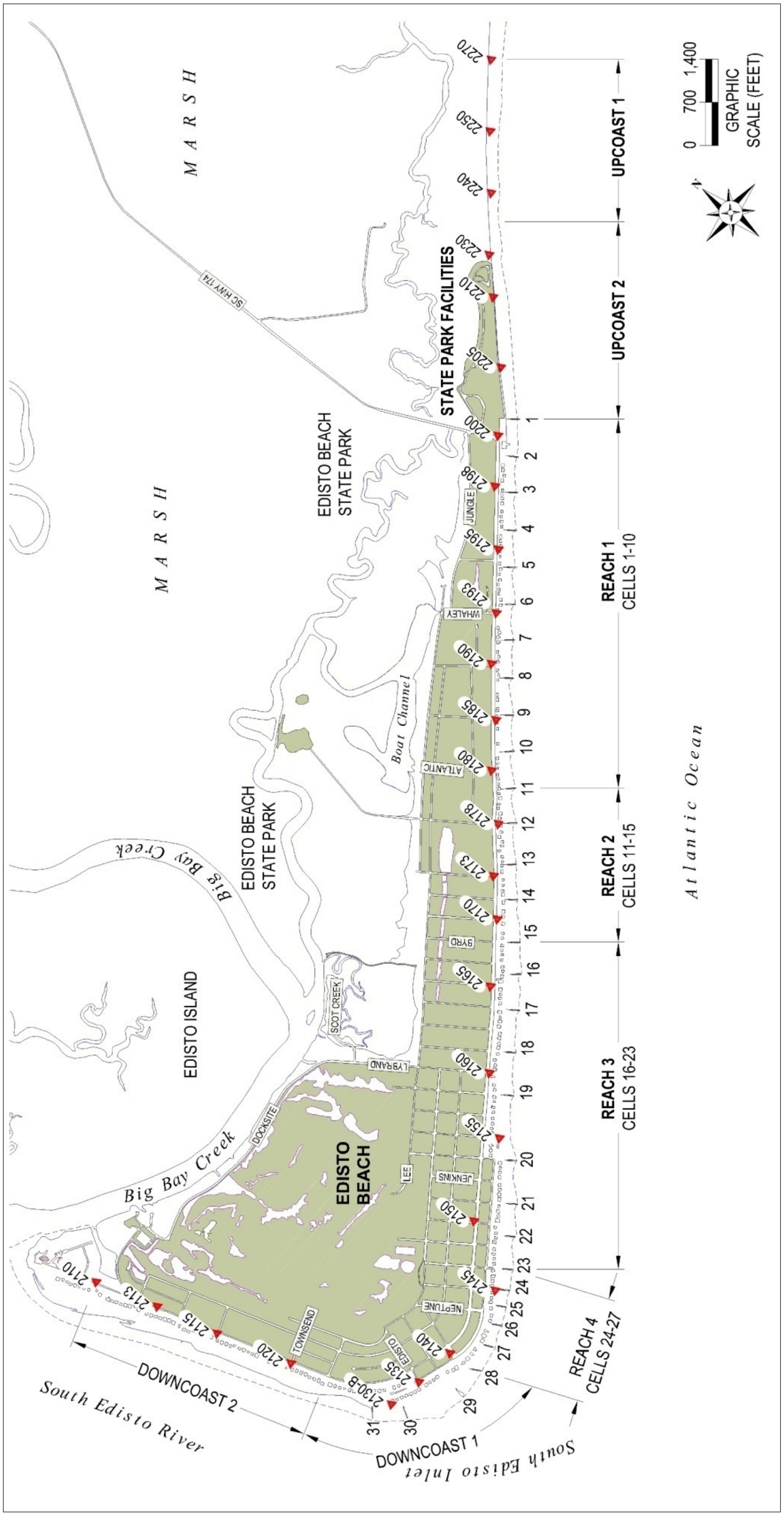

FIGURE 3.1. Edisto Beach (SC) reach limits for beach monitoring. The 2017 nourishment project encompassed Upcoast 2, Reaches 1–3, and Reach 4 to Groin 27. [From CSE 2007]

FIGURE 3.2. CSE beach monitoring methods include land-based data collection using Trimble™ RTK-GPS from the backshore to low-tide wading depth and over-water work using RTK-GPS linked to a precision echo sounder aboard CSE's survey boat (R/V *Southern Echo)*.

3.2 Volume Calculations

To determine changes in the sand volume present along Edisto Beach, survey data were entered into CSE's in-house custom software, Beach Profile Analysis System (BPAS), which converts 2-D profile data from an x-z format to 3-D volumes. The software provides a more quantitative and objective way of determining ideal minimum beach profiles (Kana 1993) and how the sand volume per unit length of shoreline compares with a desired or design condition. It also provides a more accurate method of comparing historical profiles—as the volume method measures sand volumes in the active beach zone rather than extrapolating volumes based on a single-contour shoreline position.

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. Figure 3.3 depicts the profile volume concept. The reference boundaries are site-specific but ideally encompass the entire zone over which sand moves each year.

For the present survey, sand volume was calculated between the primary dune and −15 ft NAVD'88 (roughly equal to −14 ft NGVD'29, which was the reference datum used in earlier reports). 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 cell's length to determine the cell's sand volume. Volumes at each profile line were extrapolated to the next line and to each groin. Net volumes were calculated for each groin cell as well as for project reaches defined during the nourishment (CSE 2006).

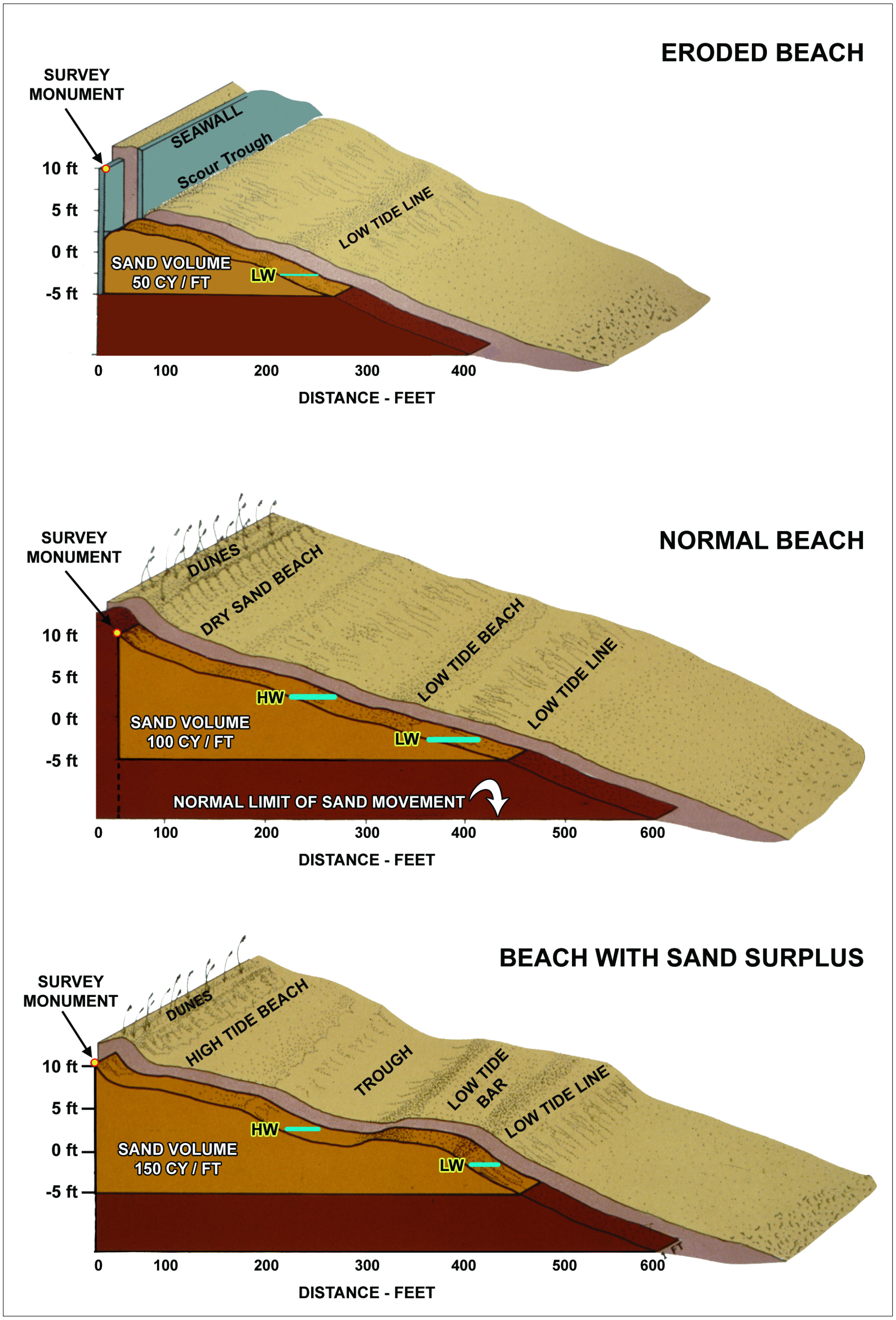

FIGURE 3.3. Calculation of unit-width profile volumes is a means of comparing the condition of one section of beach with another. Profile volumes are the amount of sand contained in a one-foot length of beach between specified elevations. [After Kana 1990]

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4.0 RESULTS

The results of the July 2021 monitoring survey are presented in Table 4.1 and Appendix B. The data are listed as individual profiles identified in Section 3.1 (cf – Fig 3.1). The results are further divided by groin cells (as listed in Table 4.2). There have been eight beach surveys since project completion in 2017; April 2017, September 2017, June 2018, September 2018, October 2018, July 2019, July 2020, and July 2021. The April 2017 results served as a post-project survey, while September 2017, September 2018, and October 2018 surveys were collected following hurricane impacts. This report will focus on erosion rates derived from volumes surveyed in July 2021 to those surveyed in April 2017 (post-project survey) and July 2020 (previous survey).

Edisto Beach lost ~362,500 cy (–12.6 cy/ft) of sand between April 2017 and July 2021. Within the project area (Reaches 1–4 and Upcoast Reach 2), the beach lost ~471,900 cy (–24.8 cy/ft) from April 2017 to July 2021. Compared to the pre-construction volumes surveyed in December 2016, as of July 2021, the project area retained ~551,544 cy (28.9 cy/ft) more material on the beach than before construction.

Following any nourishment project, an adjustment period will occur in which erosion rates are relatively high and gradually decrease as the template adopts a more "natural" profile. Erosion rates have diminished somewhat since July 2019. Between April 2017 and July 2020, annualized erosion rates along the project area measured –6.2 cy/ft/yr and have since improved to –4.4 cy/ft/yr (July 2020 to July 2021).

The volume changes have increased along the entire island from an average of –2.4 cy/ft/yr (April 2017 to July 2020) to –4.7 cy/ft/yr (July 2020 to July 2021). The 2017 to 2020 rates are equivalent to the entire island losing ~225,700 cy (–7.8 cy/ft) and the project area losing ~386,300 cy (–6.2 cy/ft) over the same period. Between July 2020 and July 2021, however, the entire island lost ~136,800 cy (–4.8 cy/ft) while the project area lost ~85,500 cy (–4.4 cy/ft). Most of the losses along the island outside the project area occurred in Upcoast reaches 1 and 2, where sand is drawn away from the State Park towards Edingsville Beach (see Fig 2.2).

As of July 2021, ~55 percent of the nourishment volume placed in 2017 remained within the project boundaries, and ~71 percent of the nourishment material is accounted for across the entire island. As mentioned above, the rate of loss in the first 2 to 3 years following project completion is typically higher than in subsequent survey periods. Details of the volume changes for individual reaches and groin cells are presented in the following sections.

TABLE 4.1a. Beach profile volumes and percent nourishment sand remaining as of July 2021.

Station	Unit Volume (cy/ft)											Unit Volume Change (cy/ft)						Nourishment Remaining
	Aug-15	Aug-16	Dec-16	Apr-17	Sep-17	Jun-18	Sep-18	Oct-18	Jul-19	Jul-20	Jul-21	'15 - '16	'16 - '17	'17-'18	'18-'19	'19-'20	'20-'21	%
SCCC 2270	305.5	296.8	282.3	280.2		274.2	275.6	271.5	273.4	266.5	**252.5**	-8.7	-16.5	-8.8	1.9	-6.9	**-14.0**	-
SCCC 2250	267.9	255.0	243.1	243.3	253.6	252.5	261.2	258.8	256.9	254.2	**240.5**	-12.9	-11.7	15.5	-1.9	-2.7	**-13.7**	-
Park 3600	224.4	270.1	249.3	267.0	268.7	282.7	285.3	280.1	288.2	280.5	**268.4**	45.6	-3.1	13.1	8.1	-7.7	**-12.1**	-
Park 3300	261.2	251.6	234.5	265.9	266.6	275.6	277.5	277.1	279.8	273.0	**257.0**	-9.6	14.2	11.3	2.7	-6.9	**-16.0**	-
Park 3000	259.9	244.8	223.6	278.7	277.5	274.1	278.4	268.6	280.1	274.3	**257.4**	-15.1	33.8	-10.0	11.5	-5.8	**-17.0**	-
Park 2700	252.6	238.1	218.4	286.7	275.5	273.1	273.2	270.7	270.9	263.8	**256.2**	-14.4	48.6	-16.1	0.2	-7.1	**-7.6**	-
SCCC 2230	270.3	263.7	236.5	308.6		289.7	292.5	285.7	290.3	281.2	**270.7**	-6.6	45.0	-22.9	4.6	-9.2	**-10.5**	-
Park 2400	276.5	270.5	257.0	343.7	319.5	312.3	310.6	308.6	297.4	290.2	**279.9**	-6.0	73.2	-35.1	-11.1	-7.2	**-10.3**	-
Park 2100	281.4	273.2	268.7	348.3	316.3	312.3	313.0	311.0	306.1	295.5	**284.6**	-8.3	75.2	-37.3	-4.9	-10.7	**-10.9**	-
SCCC 2210	285.7	275.5	271.6	353.6		318.9	316.9	315.2	304.5	294.8	**283.5**	-10.2	78.2	-38.4	-10.8	-9.7	**-11.4**	-
Park 1800	270.5	266.4	264.9	342.5	320.3	309.7	308.4	305.8	294.2	282.1	**278.6**	-4.0	76.1	-36.8	-11.6	-12.1	**-3.5**	-
Park 1500	273.6	271.2	268.9	339.1	311.9	312.8	300.9	297.7	290.3	285.0	**280.7**	-2.4	67.9	-41.4	-7.3	-5.3	**-4.3**	-
Park 1200	268.3	268.5	266.2	333.5	308.6	312.3	301.2	298.2	288.5	280.2	**273.9**	0.2	65.0	-35.3	-9.8	-8.3	**-6.3**	-
Park 900	248.5	252.0	262.1	325.8	300.7	310.1	295.8	295.5	284.9	282.8	**274.6**	3.4	73.8	-30.3	-10.6	-2.1	**-8.2**	-
Park 600	229.5	227.3	241.4	302.3	284.9	288.4	273.8	278.6	262.6	261.7	**255.9**	-2.2	75.0	-23.7	-16.0	-1.0	**-5.7**	-
Park 300	208.2	207.0	235.6	287.0	280.8	275.6	261.7	271.4	242.7	251.0	**248.9**	-1.2	80.0	-15.6	-28.7	8.3	**-2.1**	-
Park 0	254.0	254.6	206.4	287.2		275.6	277.0	278.8	264.2	261.4	**262.8**	0.6	32.6	-8.4	-14.6	-2.8	**1.4**	-
1+75	224.6	236.0	211.3	275.1	275.2	266.3	259.1	262.2	262.9	265.9	**268.2**	11.4	39.0	-12.8	0.7	3.0	**2.4**	89.3
1+300	220.8	219.2	213.3	283.4	256.0	256.2	251.1	250.6	249.6	243.8	**245.3**	-1.6	64.2	-32.8	-0.9	-5.8	**1.4**	45.6
1+525	218.9	209.7	221.8	305.7	268.3	260.4	266.5	260.2	254.7	242.0	**252.2**	-9.2	96.0	-45.5	-5.4	-12.8	**10.2**	36.2
2+75	229.5	226.7	208.6	319.9	289.7	277.4	266.9	270.6	265.2	262.7	**260.0**	-2.7	93.2	-49.3	-5.4	-2.5	**-2.7**	46.2
2+300	215.9	210.9	216.2	299.7	281.8	274.1	264.5	264.9	257.4	249.7	**256.8**	-5.0	88.8	-34.8	-7.5	-7.7	**7.1**	48.7
2+525	218.6	201.6	211.7	275.5	278.0	272.6	283.3	278.4	275.0	254.5	**262.1**	-17.0	73.8	2.9	-3.4	-20.5	**7.6**	79.0
3+75	215.4	214.4	190.9	255.4	259.9	261.5	254.6	253.3	251.0	249.4	**245.5**	-1.1	41.0	-2.0	-2.4	-1.5	**-3.9**	84.8
3+300	207.6	200.2	209.3	265.1	255.3	258.2	254.0	248.9	241.6	233.7	**235.1**	-7.5	65.0	-16.2	-7.4	-7.9	**1.4**	46.2
3+525	207.8	195.4	212.4	259.2	263.5	255.8	263.9	261.7	253.9	246.1	**252.9**	-12.4	63.8	2.6	-7.8	-7.8	**6.8**	86.5
4+75	211.6	211.9	194.3	247.9	252.5	255.4	256.4	247.3	246.6	249.1	**245.3**	0.3	36.0	-0.6	-0.7	2.5	**-3.8**	95.2
4+300	215.7	209.1	198.9	253.4	248.1	259.6	258.3	255.5	251.6	255.7	**252.7**	-6.6	44.3	2.0	-3.9	4.2	**-3.0**	98.6
4+525	217.9	205.2	225.6	270.3	277.2	273.0	271.3	276.9	272.6	259.7	**267.3**	-12.7	65.0	6.6	-4.2	-12.9	**7.6**	93.4
5+75	226.0	235.4	205.9	270.7	283.7	283.8	273.4	276.0	271.1	269.2	**260.3**	9.3	35.3	5.3	-4.9	-1.8	**-9.0**	83.9
5+300	225.1	218.4	216.0	278.9	276.3	273.3	274.2	268.5	263.9	259.5	**252.6**	-6.7	60.5	-10.4	-4.7	-4.4	**-6.9**	58.2
5+525	214.7	212.5	222.3	292.1	283.6	280.2	288.3	282.5	274.2	266.3	**271.5**	-2.1	79.5	-9.5	-8.3	-7.8	**5.2**	70.6
6+75	218.1	222.1	200.0	279.9	283.3	280.7	275.4	277.7	276.7	269.4	**261.2**	4.0	57.9	-2.2	-1.0	-7.4	**-8.1**	76.6
6+300	234.0	223.0	215.9	294.7	286.9	272.9	273.6	271.5	269.9	266.1	**259.4**	-11.1	71.7	-23.2	-1.6	-3.7	**-6.7**	55.2
6+525	236.0	216.8	231.9	309.6	298.1	278.5	289.1	285.5	284.2	268.1	**271.1**	-19.2	92.8	-24.1	-1.3	-16.1	**3.0**	50.4
7+75	234.2	239.2	211.4	304.8	288.9	277.8	269.7	270.9	271.2	266.8	**260.8**	5.0	65.5	-33.9	0.3	-4.3	**-6.1**	52.8
7+300	224.8	211.8	208.9	289.5	274.9	261.4	264.6	262.5	265.3	251.2	**250.1**	-13.0	77.8	-27.1	2.9	-14.2	**-1.1**	51.0
7+525	246.2	234.8	249.9	322.0	314.6	296.4	303.3	303.9	298.8	277.7	**280.0**	-11.4	87.3	-18.1	-5.1	-21.1	**2.4**	41.8
8+75	257.2	253.6	224.2	300.4	308.0	299.3	297.1	294.5	296.3	293.7	**275.2**	-3.5	46.8	-6.0	1.8	-2.6	**-18.4**	66.9
8+300	247.2	230.8	227.3	299.4	302.2	293.3	297.5	292.3	294.0	288.5	**273.4**	-16.4	68.6	-7.2	1.7	-5.4	**-15.1**	64.0
8+525	265.9	244.9	266.7	336.2	341.8	323.5	334.0	328.9	331.7	315.1	**308.2**	-21.0	91.3	-7.3	2.8	-16.6	**-6.9**	59.7
9+75	287.7	292.7	262.0	328.2	341.7	333.7	334.7	331.5	331.7	325.4	**312.7**	5.0	35.5	3.2	0.2	-6.3	**-12.7**	76.6
9+300	271.4	261.1	256.7	304.8	313.0	308.1	310.7	311.8	306.9	309.8	**302.9**	-10.3	43.8	7.0	-4.9	2.9	**-6.9**	96.0
9+525	274.5	262.1	275.3	328.8	334.5	334.9	336.6	336.6	335.0	321.1	**317.8**	-12.5	66.7	7.8	-1.6	-13.9	**-3.3**	79.5
10+75	260.3	277.4	262.7	321.9	327.1	338.6	335.0	333.8	327.5	322.7	**307.0**	17.1	44.5	11.8	-6.2	-4.8	**-15.7**	74.8
10+300	255.1	248.8	251.6	311.5	307.2	323.4	323.6	325.3	316.4	319.8	**306.6**	-6.3	62.8	13.8	-8.9	3.4	**-13.2**	91.8
10+525	258.1	235.5	248.3	298.9	302.1	310.2	316.9	319.9	317.7	311.4	**303.0**	-22.6	63.4	21.0	-2.2	-6.3	**-8.4**	108.1
11+75	258.2	277.6	246.0	307.9	307.1	305.3	307.8	306.1	310.9	310.9	**303.2**	19.4	30.3	-1.8	4.8	-0.1	**-7.7**	92.4
11+300	260.9	258.1	266.3	322.5	302.8	310.8	305.1	303.4	300.7	294.9	**286.8**	-2.8	64.4	-19.1	-2.7	-5.8	**-8.1**	36.5
11+525	253.3	238.1	253.0	310.3	295.6	302.6	306.6	309.4	302.6	286.5	**283.2**	-15.2	72.2	-0.9	-6.8	-16.1	**-3.2**	52.8
12+75	251.0	254.8	223.8	298.2	293.5	295.9	292.0	294.0	292.6	291.3	**277.8**	3.8	43.4	-4.2	-1.4	-1.3	**-13.5**	72.6
12+300	244.3	233.6	232.9	293.5	303.6	297.5	293.6	292.6	279.9	287.5	**274.4**	-10.7	59.9	-0.8	-12.8	7.7	**-13.2**	68.5
12+525	235.6	220.1	233.1	284.4	297.5	298.6	304.1	304.5	297.2	288.6	**285.5**	-15.5	64.4	20.1	-7.3	-8.6	**-3.1**	102.1
13+75	234.5	243.0	214.2	270.9	281.2	283.1	280.3	282.1	276.8	286.3	**280.0**	8.5	27.9	11.2	-5.3	9.4	**-6.3**	116.0
13+300	239.6	228.1	231.0	283.9	280.2	280.3	274.8	278.0	273.9	275.7	**269.5**	-11.5	55.8	-5.9	-4.1	1.8	**-6.2**	72.7
13+525	230.8	218.3	227.9	277.3	278.7	272.0	278.6	277.3	277.4	263.8	**264.1**	-12.5	58.9	0.0	0.1	-13.6	**0.3**	73.4
14+100	242.9	246.8	214.2	275.7	269.3	270.6	267.7	268.5	265.8	274.1	**260.0**	4.0	28.9	-7.2	-2.7	8.2	**-14.1**	74.4
14+350	255.4	248.5	244.5	286.4	286.0	281.9	278.5	278.6	271.2	265.8	**264.0**	-6.8	37.9	-7.9	-7.3	-5.4	**-1.8**	46.4
14+600	261.8	248.4	267.3	308.6	309.6	303.1	308.8	308.0	308.1	287.4	**283.8**	-13.4	60.1	-0.5	0.0	-20.6	**-3.6**	39.9
15+65	278.5	290.0	266.3	312.4	310.3	315.1	307.4	310.3	301.4	316.5	**301.7**	11.5	22.3	-2.1	-8.9	15.1	**-14.8**	76.8
15+245	289.7	285.7	279.3	316.7	304.2	307.3	306.6	304.8	301.8	308.2	**302.9**	-4.0	31.0	-11.9	-3.1	6.5	**-5.4**	63.0
15+450	290.9	278.9	282.8	319.3	309.4	302.8	310.0	308.8	302.6	298.6	**298.3**	-12.0	40.4	-10.5	-6.2	-4.1	**-0.3**	42.5

TABLE 4.1b. Beach profile volumes and percent nourishment sand remaining as of July 2021.

Station	Unit Volume (cy/ft)											Unit Volume Change (cy/ft)						Nourishment Remaining
16+75	287.4	293.3	271.0	322.5	305.1	301.2	294.4	297.1	289.8	298.9	**289.4**	5.9	29.2	-25.3	-7.4	9.2	**-9.6**	35.7
16+300	297.5	290.1	279.6	322.0	312.3	318.3	310.4	310.3	298.5	304.9	**293.7**	-7.4	31.9	-11.7	-11.8	6.4	**-11.1**	33.3
16+525	277.7	262.3	272.6	309.5	299.1	302.4	308.3	307.0	303.8	297.4	**297.3**	-15.4	47.2	-2.6	-3.2	-6.4	**-0.1**	66.9
17+75	266.0	270.1	243.2	295.3	289.5	293.4	281.8	280.7	283.2	287.5	**281.0**	4.1	25.2	-14.6	2.5	4.3	**-6.5**	72.6
17+300	250.4	241.0	237.2	281.3	275.0	274.5	270.1	267.1	269.3	275.8	**265.1**	-9.4	40.3	-14.2	2.2	6.5	**-10.8**	63.2
17+525	263.1	245.8	257.5	303.5	293.3	289.9	295.0	291.2	290.1	284.6	**284.1**	-17.4	57.7	-12.3	-1.1	-5.5	**-0.4**	57.9
18+75	266.2	263.5	243.0	284.7	286.2	282.1	280.7	274.5	273.7	267.3	**262.6**	-2.6	21.1	-10.2	-0.8	-6.4	**-4.7**	47.1
18+300	272.0	257.2	256.2	288.7	287.6	282.6	283.5	279.0	271.2	259.7	**255.4**	-14.8	31.5	-9.8	-7.7	-11.5	**-4.4**	-2.6
18+525	291.1	266.9	279.0	308.8	304.6	297.3	310.6	305.9	301.0	279.0	**274.4**	-24.2	42.0	-2.9	-4.9	-22.1	**-4.5**	-15.5
19+100	283.8	293.8	262.2	315.2	305.6	305.8	302.6	297.9	294.0	297.2	**287.5**	10.0	21.5	-17.3	-4.0	3.2	**-9.6**	47.7
19+525	317.9	291.3	291.5	337.1	339.3	335.5	340.8	337.0	323.4	322.3	**305.2**	-26.6	45.8	-0.1	-13.6	-1.1	**-17.1**	30.1
19+955	264.1	250.1	273.7	313.3	319.5	302.6	311.4	310.6	297.5	291.5	**296.1**	-13.9	63.2	-2.8	-13.1	-6.0	**4.7**	56.6
20+100	244.3	250.5	237.0	268.9	272.7	271.7	271.4	268.1	261.7	267.8	**264.4**	6.1	18.5	-0.9	-6.4	6.1	**-3.4**	85.8
20+350	247.5	245.6	248.3	276.5	275.7	276.0	270.6	271.9	261.1	261.2	**264.9**	-2.0	31.0	-4.7	-10.7	0.1	**3.6**	58.8
20+600	272.4	257.1	270.4	303.8	301.3	295.9	303.0	302.1	293.0	288.2	**292.4**	-15.2	46.7	-1.7	-9.1	-4.8	**4.2**	65.9
21+75	285.3	277.4	266.6	298.6	302.4	300.9	297.3	297.7	293.5	301.0	**298.5**	-7.9	21.2	-0.8	-4.3	7.5	**-2.5**	99.8
21+265	284.5	275.0	272.7	306.9	313.7	301.5	302.3	303.8	301.1	304.8	**304.1**	-9.5	31.9	-3.1	-2.7	3.6	**-0.7**	91.6
21+430	305.4	289.7	287.9	320.7	319.3	308.8	317.2	315.4	316.4	303.1	**305.6**	-15.7	31.0	-5.2	1.0	-13.4	**2.5**	53.9
22+75	292.2	292.4	281.7	324.9	317.2	316.4	307.2	307.8	306.6	319.2	**309.5**	0.2	32.5	-17.1	-1.2	12.6	**-9.6**	64.4
22+268	301.7	298.8	286.6	326.3	325.4	315.8	308.2	306.8	306.3	320.5	**312.6**	-2.9	27.6	-19.5	-0.5	14.2	**-7.9**	65.4
22+460	293.8	279.8	296.1	326.4	321.0	307.4	314.9	313.9	309.4	304.1	**301.9**	-14.0	46.5	-12.5	-4.5	-5.3	**-2.2**	19.1
23+100	289.2	294.0	279.2	324.1	308.1	308.6	296.4	298.7	298.3	300.2	**291.7**	4.8	30.1	-25.4	-0.4	1.9	**-8.5**	27.9
23+220	298.6	285.5	281.1	321.6	317.8	306.4	300.1	300.4	302.2	313.2	**303.2**	-13.1	36.1	-21.1	1.8	11.0	**-10.0**	54.7
24+100	262.1	263.2	262.4	309.2	293.0	293.2	293.2	286.4	284.8	285.7	**279.9**	1.1	46.0	-22.8	-1.6	0.9	**-5.8**	37.4
24+190	259.8	255.7	259.6	303.4	280.9	283.2	285.3	282.9	276.1	276.5	**274.2**	-4.1	47.6	-20.4	-6.8	0.4	**-2.3**	33.3
25+100	238.4	233.5	238.6	289.3	255.9	258.5	253.1	250.6	252.0	250.3	**250.4**	-4.9	55.7	-38.6	1.4	-1.7	**0.1**	23.2
25+200	232.7	226.0	236.4	277.5	242.5	249.6	247.2	244.0	242.0	240.8	**244.2**	-6.7	51.4	-33.5	-2.0	-1.2	**3.3**	18.8
26+115	194.3	196.4	194.8	251.8	216.8	220.8	214.6	215.4	214.1	211.5	**210.7**	2.1	55.4	-36.4	-1.3	-2.6	**-0.8**	27.8
26+235	212.2	204.8	199.8	247.2	220.5	227.3	221.0	221.7	225.2	223.4	**220.4**	-7.4	42.4	-25.5	3.5	-1.7	**-3.0**	43.5
27+145	228.4	241.2	214.7	259.6	243.6	236.3	233.4	230.6	235.0	228.1	**237.8**	12.8	18.4	-29.0	4.3	-6.8	**9.6**	51.4
27+290	293.2	291.3	278.1	302.3	314.7	285.8	290.9	283.1	301.1	288.2	**288.1**	-1.9	11.0	-19.3	18.1	-12.9	**-0.1**	41.1
28+130	388.1	362.4	396.2	426.5	419.0	406.7	406.3	415.8	397.7	397.4	**374.1**	-25.7	64.1	-10.6	-18.1	-0.3	**-23.3**	-
28+277	413.4	389.0	383.3	431.1	441.7	420.1	417.6	435.5	399.9	417.0	**409.4**	-24.4	42.0	4.4	-35.5	17.1	**-7.6**	-
29+75		377.2	370.5	402.4	449.0	359.2	341.7	340.4	344.1	353.2	**371.0**		25.2	-62.0	3.7	9.0	**17.9**	-
29+340		350.9	345.3	362.1	388.0	338.1	333.0	330.7	325.2	345.2	**354.8**		11.2	-31.4	-5.5	20.0	**9.6**	-
2135	364.6	336.2	332.2	320.0								-28.4	-16.2	-320.0	0.0	0.0	**0.0**	-
30+85		309.2	300.6	297.2	335.1	296.8	284.0	275.8	272.7	294.5	**307.9**		-12.1	-21.4	-3.1	21.8	**13.4**	-
30+345		299.0	292.9	291.9	308.1	297.6	292.6	288.0	291.6	318.2	**317.6**		-7.1	-3.9	3.6	26.5	**-0.6**	-
2130B	150.9	144.6	144.8	136.1	166.4	256.5	242.1	234.2	206.5	199.1	**162.5**	-6.3	-8.5	98.1	-27.7	-7.4	**-36.6**	-
2130A	240.8	226.3	235.7	225.9	207.9	359.9	361.2	368.1	356.5	394.6	**368.3**	-14.5	-0.4	142.1	-11.5	38.0	**-26.3**	-
2130	295.3	296.6	296.3	296.0	286.9	254.9	245.2	247.4	282.6	314.9	**333.0**	1.3	-0.7	-48.5	35.2	32.4	**18.0**	-
2120	337.5	328.3	330.8	333.8		340.6	332.0	330.2	319.5	322.4	**320.0**	-9.2	5.5	-3.6	-10.7	2.9	**-2.4**	-
		323.2	331.1	334.5		335.6	337.7	338.5	347.4	345.5	**345.9**		11.3	4.0	8.9	-1.9	**0.4**	-
2115	321.4	314.5	325.6	315.3		322.3	325.9	325.7	333.6	337.9	**339.6**	-6.9	0.8	10.4	7.9	4.3	**1.7**	-
2113	309.8	305.0	303.3	304.5		303.7	307.3	308.2	307.3	314.0	**321.6**	-4.8	-0.5	3.6	-0.8	6.7	**7.6**	-
2110	463.8	459.4	463.0	463.4		468.8	470.6	470.3	433.2	458.4	**456.6**	-4.3	3.9	6.9	-37.1	25.2	**-1.8**	-

TABLE 4.2. Groin cell volumes and percent nourishment sand remaining as of July 2021.

		Cell Unit Volume (cy/ft)													Unit Vol Change (cy/ft)
Cell	Length (ft)	Aug-12	Sep-13	Jul-14	Aug-15	Aug-16	Dec-16	Apr-17	Sep-17	Jun-18	Sep-18	Oct-18	Jul-19	Jul-20	Jul 2019 - Jul 2020
1	598	214.4	218.3	217.2	219.4	219.6	213.3	285.0	263.4	258.3	256.0	254.9	253.1	248.0	-5.1
2	593	224.3	221.2	221.9	221.8	213.8	213.1	299.6	284.1	275.6	271.9	271.8	266.1	256.1	-10.0
3	603	214.3	212.7	210.1	210.9	203.8	205.3	261.2	260.3	259.4	258.3	255.3	249.3	243.4	-5.9
4	605	225.3	219.4	212.5	214.4	208.1	205.3	256.2	257.9	261.7	261.0	258.8	255.8	254.1	-1.7
5	590	227.3	228.5	224.0	224.0	223.8	216.5	282.6	283.2	281.0	280.5	277.4	271.5	266.8	-4.7
6	591	239.8	237.6	237.6	235.3	226.1	221.3	302.0	296.4	283.8	285.9	284.6	283.3	274.3	-9.0
7	616	230.0	224.2	225.5	228.2	221.5	216.6	296.3	283.9	270.1	270.9	270.6	270.2	257.3	-12.9
8	601	258.0	258.8	259.2	259.3	245.2	241.8	315.2	320.4	308.4	312.7	308.3	310.4	302.1	-8.3
9	596	281.3	277.4	275.7	279.3	273.1	265.9	321.8	330.9	326.6	328.5	327.9	325.6	320.3	-5.3
10	599	269.3	268.8	260.2	260.1	255.8	256.3	313.6	314.6	327.0	328.0	329.2	323.2	321.0	-2.3
11	575	282.9	280.6	272.5	277.8	277.6	275.8	338.8	325.5	330.5	330.5	330.4	328.4	320.3	-8.1
12	645	250.7	250.3	239.5	239.5	231.5	226.7	287.2	293.9	292.8	292.3	292.6	285.2	284.6	-0.7
13	586	262.3	256.1	248.5	248.7	242.6	237.9	293.8	296.2	294.4	293.7	295.1	291.9	290.8	-1.1
14	667	263.1	258.0	254.5	250.9	245.3	239.9	287.1	285.3	282.1	281.8	281.8	278.2	272.2	-6.0
15	530	297.1	289.0	289.8	286.4	284.6	276.2	315.9	307.5	308.0	307.7	307.5	301.6	307.4	5.7
16	587	308.0	311.7	307.9	306.4	299.9	292.4	338.5	325.5	327.7	324.7	325.0	317.0	320.1	3.1
17	678	251.0	258.4	254.2	248.7	240.6	236.0	281.2	273.9	273.6	270.7	268.1	269.2	270.6	1.4
18	694	254.0	259.4	257.1	259.8	246.0	244.3	276.3	274.9	269.7	274.2	269.4	265.0	252.0	-13.0
19	1055	287.7	288.2	287.8	291.3	278.7	277.8	323.5	323.7	316.8	320.9	317.8	307.0	305.5	-1.5
20	693	252.3	253.6	249.3	252.2	248.1	249.7	280.4	280.3	278.3	278.7	277.9	269.1	269.3	0.2
21	528	289.2	277.9	278.7	287.2	276.3	271.5	304.0	307.1	299.1	300.9	301.0	299.0	298.3	-0.7
22	564	298.0	297.1	295.4	301.6	295.4	294.1	332.1	327.4	318.8	316.2	315.6	313.3	320.0	6.7
23	311	307.1	298.3	298.1	307.4	302.9	293.0	337.6	327.3	321.5	311.9	313.3	314.0	320.9	6.8
24	280	251.5	246.5	245.8	247.4	246.2	247.4	290.5	272.4	273.5	274.5	269.9	266.1	266.8	0.6
25	303	223.8	224.8	228.0	233.0	227.3	235.0	280.3	246.5	251.3	247.5	244.6	244.3	242.9	-1.5
26	366	152.8	152.0	159.5	159.4	158.1	155.7	197.8	172.7	176.8	171.8	172.5	172.9	171.1	-1.8
27	429	295.3	301.7	300.8	305.3	311.7	288.5	328.9	326.8	305.6	306.9	300.7	313.8	302.2	-11.6

		Total Volume (cy)							Nourishment Remaining (%)						
Cell	Length (ft)	Aug-06	Dec-16	Apr-17	Jul-19	Jul-20	Dec 2016 - July 2020	July 2019 - July 2020	Apr-17	Sep-17	Jun-18	Sep-18	Oct-18	Jul-19	Jul-20
1	598	153,195	127,655	170,516	151,446	148,391	20,736	-3,055	100.0	69.9	62.8	59.5	58.0	55.5	48.4
2	593	147,299	126,391	177,691	157,822	151,879	25,488	-5,943	100.0	82.0	72.2	68.0	67.7	61.3	49.7
3	603	144,715	123,764	157,431	150,284	146,708	22,944	-3,576	100.0	98.4	96.8	94.9	89.5	78.8	68.2
4	605	153,703	124,160	154,985	154,766	153,708	29,548	-1,058	100.0	103.3	110.8	109.4	105.2	99.3	95.9
5	590	157,743	127,774	166,814	160,234	157,479	29,705	-2,756	100.0	100.8	97.5	96.8	92.1	83.1	76.1
6	591	164,573	130,708	178,404	167,317	161,998	31,290	-5,319	100.0	93.0	77.4	80.0	78.4	76.8	65.6
7	616	158,741	133,502	182,669	166,579	158,614	25,111	-7,965	100.0	84.4	67.1	68.1	67.8	67.3	51.1
8	601	167,629	145,323	189,434	186,536	181,578	36,255	-4,959	100.0	107.1	90.7	96.6	90.6	93.4	82.2
9	596	173,052	158,490	191,773	194,066	190,920	32,430	-3,146	100.0	116.3	108.8	112.1	111.0	106.9	97.4
10	599	163,000	153,655	187,987	193,766	192,410	38,755	-1,356	100.0	101.8	123.3	125.1	127.3	116.8	112.9
11	575	174,223	158,529	194,691	188,748	184,085	25,556	-4,663	100.0	78.9	86.9	86.9	86.7	83.6	70.7
12	645	182,184	146,229	185,220	183,962	183,530	37,301	-0,432	100.0	111.1	109.4	108.4	109.0	96.8	95.7
13	586	169,668	139,424	172,205	171,094	170,447	31,022	-0,647	100.0	104.3	101.2	99.9	102.4	96.6	94.6
14	667	181,397	160,116	191,560	185,667	181,631	21,515	-4,037	100.0	96.3	89.5	88.8	88.8	81.3	68.4
15	530	160,017	146,502	167,592	160,018	163,061	16,559	3,043	100.0	78.8	80.1	79.2	78.9	64.1	78.5
16	587	194,156	171,641	198,694	186,046	187,847	16,206	1,801	100.0	71.7	76.6	69.9	70.7	53.2	59.9
17	678	188,653	160,120	190,756	182,597	183,556	23,435	958	100.0	83.8	83.3	76.9	71.0	73.4	76.5
18	694	191,910	169,474	191,689	183,839	174,805	5,331	-9,034	100.0	95.7	79.3	93.3	78.4	64.7	24.0
19	1055	324,940	293,057	341,275	323,898	322,325	29,267	-1,573	100.0	100.5	85.4	94.3	87.6	64.0	60.7
20	693	183,766	173,008	194,319	186,474	186,604	13,596	130	100.0	99.7	93.3	94.4	91.8	63.2	63.8
21	528	151,427	143,384	160,550	157,925	157,536	14,152	-0,389	100.0	109.5	84.9	90.5	90.7	84.7	82.4
22	564	169,668	165,950	187,409	176,813	180,596	14,645	3,783	100.0	87.7	65.1	58.2	56.5	50.6	68.2
23	311	96,463	91,040	104,910	97,590	99,718	8,677	2,128	100.0	77.0	64.0	42.5	45.6	47.2	62.6
24	280	69,677	69,200	81,236	74,431	74,610	5,410	179	100.0	58.0	60.7	62.8	52.2	43.5	44.9
25	303	72,020	71,258	85,010	74,107	73,666	2,408	-0,441	100.0	25.4	36.0	27.6	21.4	20.7	17.5
26	366	65,806	57,069	72,490	63,360	62,705	5,635	-0,655	100.0	40.4	49.9	38.3	39.7	40.8	36.5
27	429	146,816	123,698	141,048	134,559	129,599	5,901	-4,960	100.0	94.8	42.4	45.6	30.2	62.6	34.0

4.1 Volume Changes

Volume changes by reach, groin cell, and station are discussed in this section. Groin cells showing a significant change in volume relative to the previous condition are highlighted. Volume changes for individual reaches are shown in Figure 4.1. Individual stations within groin cells (Fig 4.2), which help identify sediment transport patterns near the time of the survey, will also be discussed. Unit volumes for each station are shown in Figure 4.3.

To compare the present condition of the beach with the volume added during the 2017 project, "nourishment" quantities were estimated from the total volume change to −15 ft NAVD between the December 2016 and April 2017 surveys. This includes the volume change due to nourishment as well as natural changes (background erosion/accretion) between these dates.

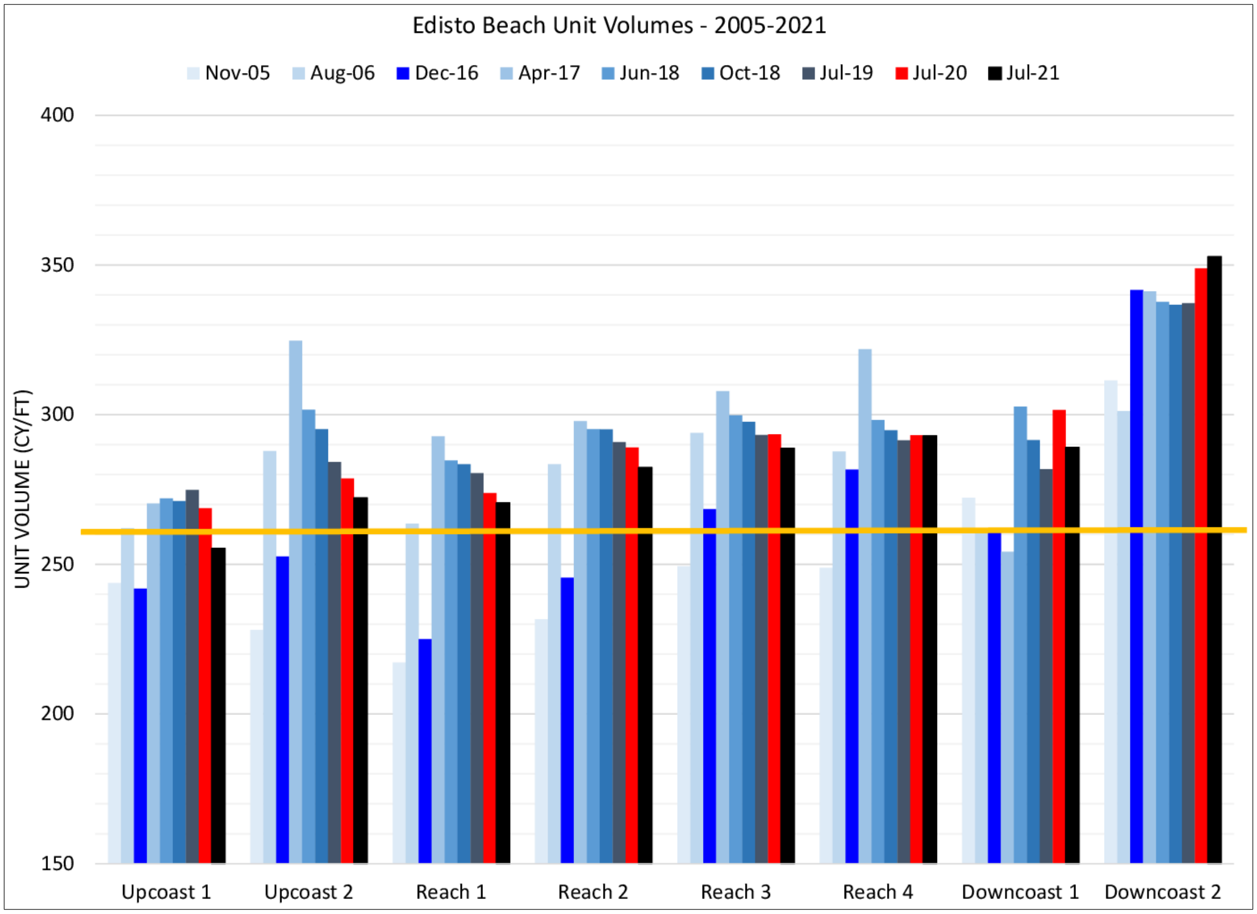
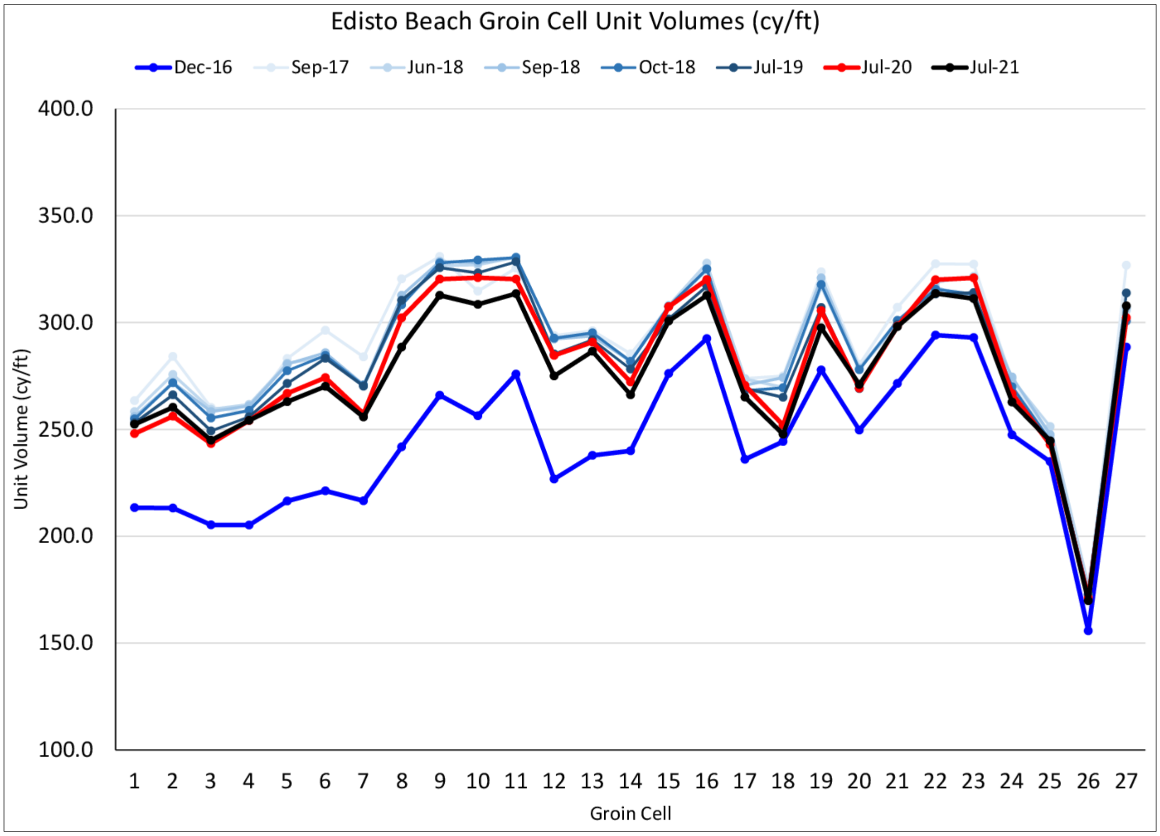


FIGURE 4.1. Unit volume for each reach at Edisto Beach for selected dates from 2005 to 2021. Volumes are calculated to −15 ft NAVD.



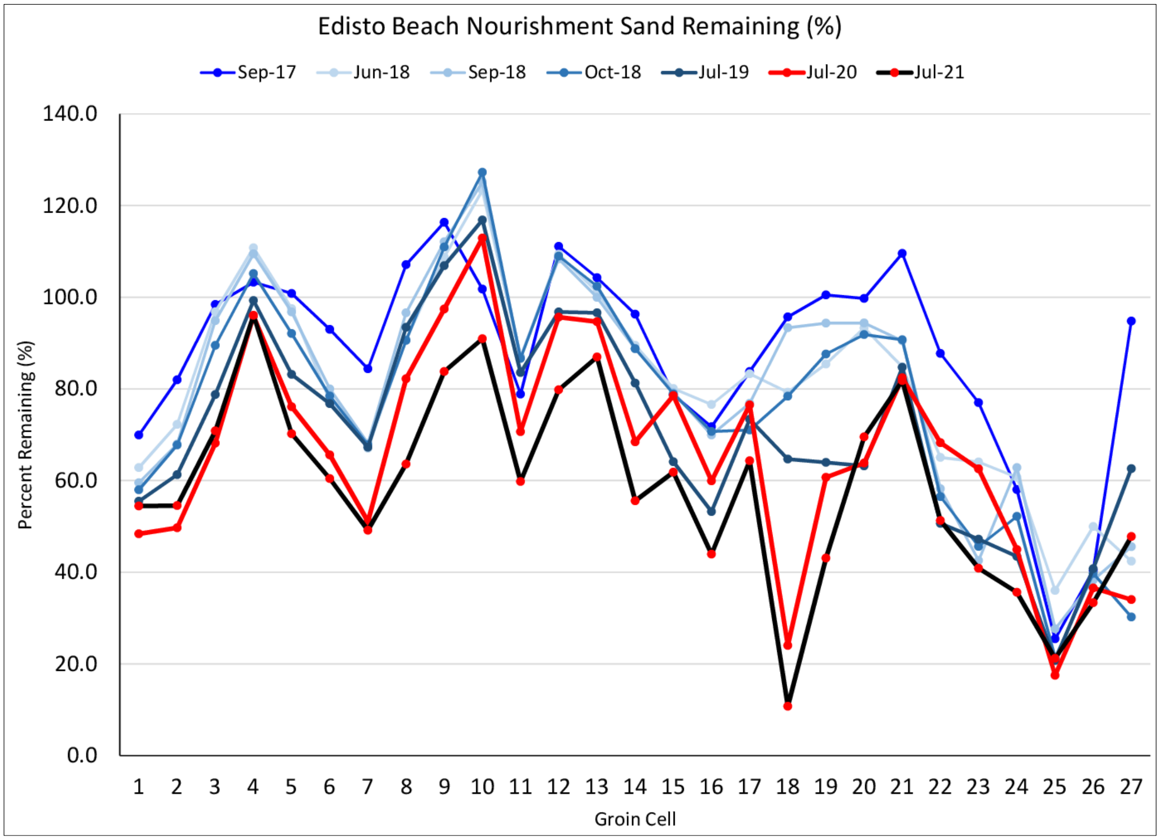
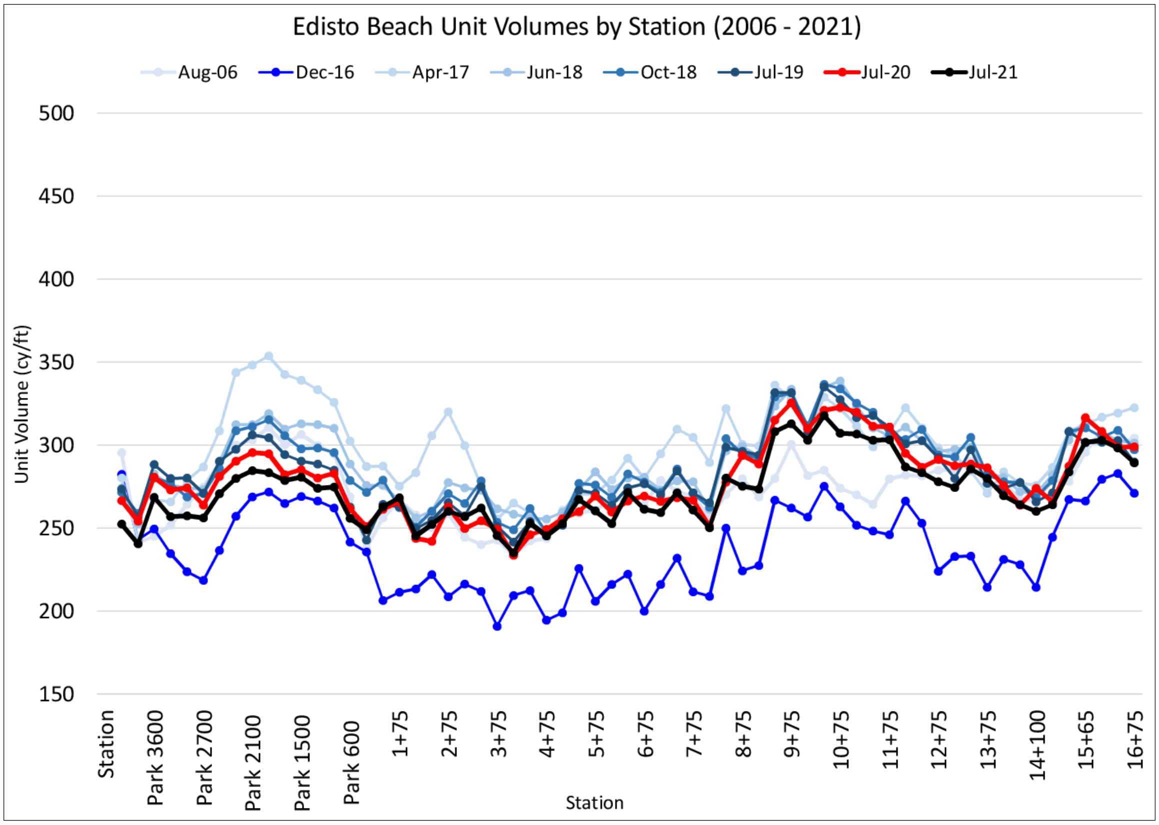


FIGURE 4.2. [UPPER] Variation in unit volume (cy/ft) for each groin cell for each year (2016–2021). [LOWER] Percent of nourishment (volume change between December 2016 and April 2017 survey) remaining in each groin cell.



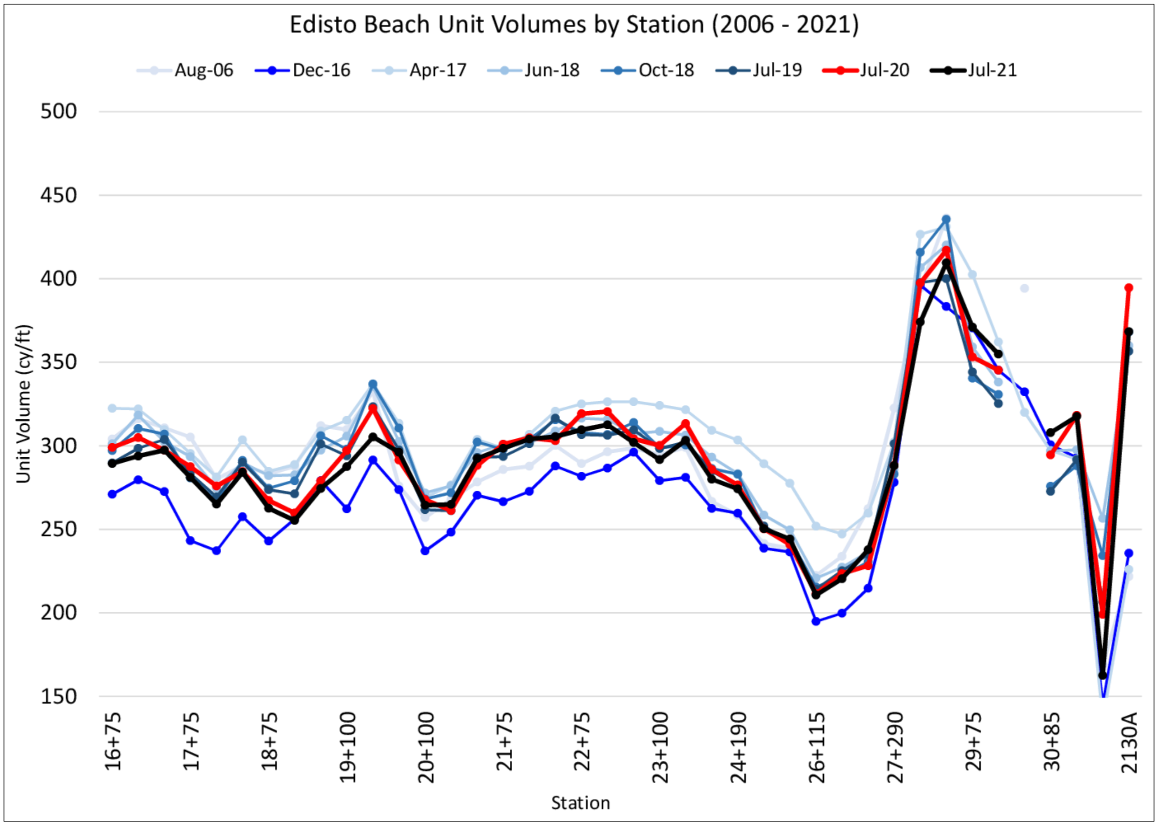


FIGURE 4.3. Unit volume for each survey station at Edisto Beach for selected dates from 2006 to 2021. Volumes are calculated to −15 ft NAVD.

4.1.1 *Upcoast Reaches*

Upcoast 1 (the beach north of the campground area) saw a large influx of sand from December 2016 to April 2017 as sand spread from the 2017 nourishment, although this reach was not nourished during the 2017 project. Overall, the reach gained ~49,000 cy (15.5 cy/ft) over that four-month period.

From April 2017 to July 2019, the reach gained a total of ~27,600 cy (3.9 cy/ft/yr). However, since July 2019, the upcoast reaches have steadily lost sand – from July 2019 to July 2020, the reach lost ~17,300 cy (–5.4 cy/ft/yr), and erosion increased again from July 2020 to July 2021 (~42,900 cy, or –13.4 cy/ft/yr).

Since July 2019, Upcoast 1 has lost ~60,200 cy (19.1 cy/ft). The recent switch from accretion (from April 2017 to July 2019) to erosion (since July 2019) along Upcoast 1 is likely related to beach recession and overwash observed along Edingsville Beach in recent years. Since Hurricane *Matthew*, that portion of Edisto Island has moved landward by well over 100 ft. When dramatic beach recession occurs, adjacent portions of the shoreline are left more exposed to erosive waves and tend to lose volume. The alongshore movement of erosion rates as observed along Reach 1 and Edingsville Beach is analogous to a zipper closing – as more sand is lost from Edingsville, more losses are incurred closer to Edisto Beach. So long as the beach recession around Edingsville continues, Edisto Beach State Park will experience some erosion along Upcoast 1.

Upcoast 2 gained ~197,000 cy of sand from December 2016 to April 2017 (nourishment at 181,728 cy plus natural changes). Between April 2017 and July 2020, the reach lost ~127,700 cy (~14.0 cy/ft/yr). A significant portion of this change occurred between June 2018 and October 2018, when the annualized erosion rate was 21.8 cy/ft/yr. During that period, the reach lost ~20,000 cy (7.3 cy/ft) in just four months while hurricanes *Michael* and *Florence* impacted Edisto Beach. From July 2020 to July 2021, the annualized rate of loss was lower (~16,800 cy, or –5.9 cy/ft/yr). The reach still holds ~52,500 cy (18.8 cy/ft) more sand than the before-nourishment condition in December 2016.

FIGURE 4.4. **[UPPER]** Upcoast 1 in July 2021. This reach has accreted since nourishment in 2006, transitioning from a washover barrier to a stable beach with a growing dune ridge. **[LOWER]** Upcoast 2, taken from just north of the Pavilion in July 2021.

FIGURE 4.5. **[UPPER]** View north from State Park station –600 in October 2016, just after Hurricane *Matthew.* **[MIDDLE]** View north from State Park station −600 in July 2019. **[LOWER]** View north from State Park station −600 in July 2021. Since Hurricane *Michael*, relatively calm conditions have allowed dune vegetation to begin expanding seaward beyond the sand fencing established in conjunction with the beach renourishment project. As of July 2021, a ~3 to 4-ft-high foredune had accreted amongst maturing stands of sea oat and bitter panicum. This indicates the dune is stabilizing.

4.1.2 Reach 1

Reach 1 encompasses Groin Cells 1–10 (near the Pavilion to approximately Atlantic Street) with a total length of ~6,000 ft (Fig 4.6–4.7). Before nourishment, erosion led to waves reaching house pilings and scarping the remaining dunes along the northern end of the beach. Following nourishment in 2016, over 100 ft of dry beach was present along most of the reach. Since nourishment, the northern half of the reach has eroded while the southern half has been more stable (see Fig 4.2). Compared to the other project reaches (with survey data back to 2005), the northern half of Reach 1 has consistently experienced more erosion than other portions of the beach. Potential solutions for this chronic erosion include redesigning the groins to improve sand-trapping capacity and placing extra fill material during the next nourishment project to provide a surplus buffer.

The reach lost ~73,800 cy between April 2017 and July 2019, which included impacts from hurricanes *Irma* (2017), *Florence* (2018), and *Michael* (2018). This is equivalent to an annualized erosion rate of –5.5 cy/ft/yr. From July 2019 to July 2020, the annualized erosion rate increased to –6.4 cy/ft/yr as Hurricane *Dorian* impacted Edisto Beach. From July 2020 to July 2021, erosion decreased to ~3.4 cy/ft/yr (or ~20,700 cy). Over the past few years, there have been noticeable hot spots of erosion along Groin Cells 1 through 7 (particularly Cells 1, 2, 3, 6, 7, and 8 – see Fig 4.2). At these locations, losses approached or exceeded 20 cy/ft, and the amount of nourishment sand remaining is as low as 48.4 percent (Groin Cell 1 – see Table 4.2). Due to the 2016 renourishment project, Reach 1 still has 272,364 cy more sand on the beach than during pre-project surveys in December 2016 (equivalent to 45.3 cy/ft). Cells 1–10 retain between ~50 and 100+ percent of the nourishment volume. As of July 2021, Cells 1, 2, and 7 have experienced the most erosion since December 2016 and only contain ~55, ~55, and ~49 percent of the nourishment volume, respectively (see Fig 4.2). All other groin cells in Reach 1 contain at least 60 percent of the nourishment volume more than four years after project completion. Across the entire reach, the beach retained 67.2 percent of the nourishment fill as of July 2021.

Within individual groin cells, the southern-most profiles tended to lose the most volume between July 2020 and July 2021. The average losses along the southern-most profiles were ~7.8 cy/ft, while the central profiles in each groin cell lost an average of ~4.3 and the northern profile gained ~2.4 cy/ft, respectively. This is because prevailing summertime winds and waves along Edisto Island are from the south resulting in localized sand deficits on the north side of individual groin cells. If surveys are completed in the winter months, the opposite effect would be expected wherein the northward-directed drift would accumulate on the south side of each groin cell. Groin Cells 1, 2, 6, 7, and 8 lost the most volume from July 2020 to July 2021, with Groin Cells 2 and 7 losing more than 10.0 cy/ft. These cells were all included in the January-February 2021 dune restoration project.

FIGURE 4.6. [UPPER] Aerial image of Reach 1 in January 2019. Cells 1–4 near the top of the image have the narrowest post-nourishment beach with less of a buffer between houses and the water. [LOWER] Aerial image of Reach 1 in August 2021. A dune restoration project completed in January-February 2021 is visible, along with re-established dune grasses between properties and the beach. The red arrow highlights the same property in both images. [Photos by D Giles]

FIGURE 4.7. [UPPER] Cell 3 in July 2020 — the 2017 project was followed by sand fencing and vegetation plantings, which helped spur the initial stages of dune growth (seen on the right side of the frame). The wrack line located along the dune toe is evidence of high-water conditions reaching the dune ridge recently. **[LOWER]** Cell 3 in August 2021 — the darker-colored material on the right-hand side of the image is from the January-February 2021 dune restoration project, which used upland material to re-establish a protective storm berm and foredune. [Photos by D Giles]

4.1.3 Reach 2

Reach 2 spans ~3,000 ft and includes Cells 11–15 (Fig 4.8). This reach lost ~20,700 cy between July 2020 and July 2021 but retained ~109,500 cy (35.7 cy/ft) more than was surveyed in December 2016. Similar to Reach 1, little dry beach was present along Reach 2 at high tide before nourishment, offering no storm protection and little recreational area at high tide (Fig 4.9). The present condition remains similar to the post-nourishment condition with a wider dry beach than the pre-nourishment condition in most cells. This is a transitional zone between areas of the beach with relatively little dune protection and an area with relatively substantial vegetated dunes between houses and the beach.

Reach 2 has been the least erosive section of the project area since the post-dredge survey in April 2017 (–3.8 cy/ft/yr from April 2017 to July 2021). Its location, which is close to the center of the project rather than along the tapered ends, means there is more material to feed this portion of the beach on either side. As a result, erosion rates are significantly lower here than in the other project reaches and across the entire island. The lone exception to this pattern is along the South Edisto River Inlet shoreline (Downcoast 1 and Downcoast 2 reaches), where a southwest-facing beach encounters a different set of conditions influencing dry sand volumes.

Erosion rates along Reach 2 were lower from April 2017 to July 2019 (–3.6 cy/ft/yr) than from July 2019 to July 2020 (–4.5 cy/ft/yr) and increased again to –6.6 cy/ft/yr from July 2020 to July 2021. This trend likely reflects post-project adjustment of the fill template more than background chronic erosion or storm-related impacts. To that point, profiles in Reach 2 generally contain sufficient sand volume to maintain a vegetative buffer and adequate berm width (Fig 4.8). Sand remaining from the 2017 project within Reach 2 constitutes ~70 percent of the project volume placed in that renourishment.

Again, the southern-most profiles tended to lose the most volume between July 2020 and July 2021. The average losses along the southern-most profiles were ~11.3 cy/ft, while the northern and central profiles in each groin cell gained an average of ~2.0 and ~6.9 cy/ft, respectively. This is because prevailing winds and waves along Edisto Island are from the south during the summer months, resulting in localized sand deficits on the northern side of individual groin cells. A winter-time survey would probably show the opposite effect with accumulations of sand on the southern side of each groin cell. Groin Cells 11 and 15 lost the most volume from July 2020 to July 2021.

FIGURE 4.8. **[UPPER]** Ground image of Reach 2 in July 2021, taken just south of Groin 15 (Byrd St.). **[LOWER]** Looking north from Groin Cell 11. This is the northern limit of the densely-vegetated dunes which extend to The Point and along the Inlet shoreline to the west. Since project completion, sand fencing has helped trap sand and encourage plant growth. With a wide dry beach remaining, further dune growth is expected over the next couple years along this portion of the beach. [Photos by D Giles]

FIGURE 4.9. **[UPPER]** Although Cell 12 has lacked significant dunes in many of the recent surveys (particularly since 2015), there is now a small dune ridge growing with vegetation; some pioneering grass species have even begun to colonize the upper dry beach (highlight), indicating a healthy sandy supply and elevation. The beach remains wider than before construction. **[LOWER]** Cell 15 has larger dunes, so houses are sufficiently set back from the beach. [Photos by D Giles]

4.1.4 Reach 3

Reach 3 includes Cells 16–23 and covers ~5,100 ft of the southern oceanfront portion of the island (Fig 4.10). Houses in this reach are generally better protected due to greater setbacks and an established dune field. Reach 3 received ~202,500 cy of sand between December 2016 and April 2017 (nourishment and natural changes), adding ~30–55 cy/ft in each cell (Figs 4.11–4.12).

Erosion trends along Reach 3 since the 2017 project have mirrored those in Reach 2, with the higher volume losses (~75,400 cy, or 6.5 cy/ft/yr) between April 2017 and July 2019 and lower volume losses from July 2019 to July 2020 (losing only ~1,300 cy, or –0.2 cy/ft/yr). However, from July 2020 to July 2021, erosion increased to ~25,520 cy (–4.9 cy/ft/yr). Earlier losses (pre-July 2019) may have been related to adjustment of the fill template following project completion, similar to the trends observed elsewhere along the project area. Most of the groin cells within Reach 3 lost sand between July 2020 and July 2021. However, Groin Cell 20 gained ~1,200 cy (+1.8 cy/ft) over that period. No other groin cell gained volume from July 2020 to July 2021 (see Fig 2.3a).

Despite recent erosion, on average Reach 3 contains 20.0 cy/ft more sand than the pre-nourishment condition (December 2016), which translates to the cells retaining between ~11 and ~82 percent of the nourishment fill. Retention is greater along the southern portion of the reach (Cells 19–23), although these cells lost more volume than others between July 2020 and July 2021. Overall, the reach has lost a total of 100,900 cy (–19.8 cy/ft) of sand since nourishment in 2017 and contains ~101,600 cy (20.0 cy/ft) more sand than the pre-nourishment condition. This is equivalent to ~52 percent of the nourishment volume remaining on the beach above –15 ft NAVD. Photos (Figs 4.11–4.12) show that all properties maintain a vegetative buffer between houses and the active beach.

FIGURE 4.10. **[UPPER]** January 2019 aerial showing Reach 3, which has the greatest setbacks and vegetated buffers of any ocean-facing area along Edisto. Groin 25 is in the foreground. **[LOWER]** As of August 2021, Reach 3 has remained one of the healthiest portions of Edisto Beach since project completion. Groin 24 is in the foreground [Photos by D Giles]

FIGURE 4.11. **[UPPER]** Cell 20 looking north in August 2015, before nourishment. **[LOWER]** Cell 20 looking north in July 2021. Although the dune is not fully visible in the lower photograph, the relative positions of the wrack line in each photo highlight the expansion in dry beach area since project completion. [Photos by D Giles]

FIGURE 4.12. Reach 3 — July 2021.
All cells in Reach 3 have adequate widths of vegetated buffers; however, dune elevations remain low. **[UPPER]** Cell 17 looking west. **[MIDDLE]** Cell 19 looking west. **[LOWER]** Cell 23 looking east. [Photos by D Giles]

4.1.5 Reach 4

Reach 4 represents the southern taper section of the 2017 nourishment project and includes Cells 24–27 (Fig 4.13). This area is often referred to as "The Point" because it encompasses the southern tip of Edisto Beach, where the beach turns toward the north-northwest. Houses located in Cells 26 and 27 have narrower and lower dunes compared to other homes in the area (Figs 4.14–4.15), especially those further around The Point. This places houses in Cells 26 and 27 closer to the beach and increases their risk of storm or erosion damage. The 2017 nourishment represented an increase of ~25–60 cy/ft for each cell.

Reach 4 eroded rapidly immediately after the nourishment project, losing ~32,000 cy (15.1 cy/ft) of sand between April 2017 and June 2018. Between June 2018 and October 2018, the reach lost ~4,600 cy. When annualized, these two erosion rates represent 13.0 and 6.6 cy/ft/yr, respectively. Both of these annualized erosion rates represent the highest loss rates within the groin field (Reaches 1–4) over those time periods.

As in the other project reaches, the erosion rate of Reach 4 has slowed relative to observations made before July 2019. From April 2017 to July 2019, the reach lost ~34,600 cy (–7.3 cy/ft/yr). However, between July 2019 and July 2020, Reach 4 lost ~5,600 cy (–4.1 cy/ft/yr). Between July 2020 and July 2021, Reach 4 lost just ~1,900 cy (~1.3 cy/ft/yr). This shift is likely related to sand transport from adjacent portions of the project area into Reach 4. Because of its position at the downdrift end of Edisto Beach, Reach 4 is the recipient of much of the nourishment sand over time as wave action and tidal currents push the material southward.

The reach still retains ~15,700 cy (11.3 cy/ft) more sand than the pre-nourishment condition surveyed in December 2016. This is equivalent to ~11 percent of the nourishment fill remaining in the project area above closure depth (–15 ft NAVD).

FIGURE 4.13. **[UPPER]** Aerial view of Reach 4 in January 2019. Groin 28 is in the foreground. **[LOWER]** The same section of shoreline in August 2021. The beach has equilibrated since the 2017 project with a wider dry sand beach than before construction. The sand used for the dune restoration project is visible. [Photos by D Giles]

FIGURE 4.14. Representative photos of Reach 4 in July 2021 showing (upper) Cell 24 and (lower) Cell 26. [Photos by D Giles]

FIGURE 4.15. Representative photos of Reach 4 in July 2021 showing (upper) Cell 27 and (lower) Cell 28. [Photos by D Giles]

4.1.6 Downcoast Reaches

The downcoast reaches extend 7,200 ft beyond Reach 4 along the St. Helena Sound shoreline of Edisto Beach (Fig 4.16). Downcoast 1 and Downcoast 2 areas generally receive less wave energy than the oceanfront due to sheltering by offshore shoals and the predominant wave direction coming from the northeast. Historical erosion in these reaches has been significant during some periods, as evidenced by the scalloped vegetation line between Groin 28 and Groin 31; the seawall at Groin 31 was re-exposed in late 2020 for the first time since 2016. However, the area has generally been healthy over the past several decades, with seawalls buried behind a wide dune field (CSE 2001; see Fig 4.17).

From April 2017 to July 2021, the downcoast reaches have gained ~142,000 cy (19.5 cy/ft). Between April 2017 and June 2018, the reaches gained ~80,000 cy, followed by a loss of ~15,000 cy from June to October 2018. From October 2018 to July 2019, the downcoast reaches lost an additional ~44,458 cy. From July 2019 to July 2020, the reaches gained ~102,900 cy. Most recently, the reaches lost ~8,400 cy from July 2020 to July 2021. The oscillations between accretion and erosion (or relatively large and small changes in consecutive survey periods) are probably related to sand migrating away from the project area and onto the South Edisto Inlet shoreline. This portion of Edisto Beach will often behave independently from the main project reaches and the upcoast portions of the island.

Erosion rates along The Point (discussed in the previous section) also influence change rates along the downcoast reaches. For example, a local increase in beach volumes, such as the accretion between April 2017 and June 2018, can make this portion of the island grow significantly in dry-beach width while the remainder of the island erodes. From June 2018 to July 2019, Downcoast 1 eroded consistently while Downcoast 2 remained relatively static in volume. Over time, as the project area fill template equilibrates, these oscillations may be expected to decrease in magnitude.

One recent notable change along the Downcoast Reaches has been the increased exposure of Groins 31 and 32 (Figs 4.16 and 4.17). Waves of sand moving downshore from the project reaches have provided excess volume for the Downcoast Reaches, but these temporary increases in volume can also create erosional hot spots that may be exacerbated when hardened structures become exposed. A bulkhead just south of Groin 31 was exposed by ~3 to 4 ft in July 2021, and Groin 32 is no longer buried in beach sand. The combination of an exposed bulkhead and groin in close proximity may lead to enhanced erosion during high-water or storm events; however, this is somewhat difficult to predict with very much precision. What is guaranteed is that as Groin 32 becomes more exposed, it will begin trapping beach sand from moving downshore along South Edisto Inlet.

FIGURE 4.16. **[UPPER]** The downcoast reaches in July 2019. A considerable volume of nourishment sand has made its way around the corner of the shoreline and created a bulge in the beach around the western end of Point St. **[LOWER]** Reach 4 and downcoast reaches in July 2021. Nourishment sand has continued to move through the groin field to the downcoast reaches, maintaining the prominent bulge along the inlet shoreline, however an erosional arc at groin 31 (highlighted) has resulted in a narrower beach and exposure of a protective wall. [Photos by D Giles]

FIGURE 4.17. **[UPPER]** View west from Groin 29 in July 2020. **[LOWER]** The same area in July 2021. The erosional arc extending inland on the downdrift side of Groin 31, is more pronounced this year such that a low timber revetment is now exposed to wave action at high water conditions. [Photos by D Giles]

4.2 Summary of Volume Changes

Figure 4.18 summarizes unit beach volumes (in cubic yards per foot) by groin cell compared to the 2016 pre-nourishment condition. The effects of the 2017 nourishment project are easily visible in the graphic. All profiles contain more sand than was present following the 2016 renourishment.

Project reaches presently retain between ~28 and ~70 percent of the nourishment volume, and as a whole, the 2017 project area contains ~55 percent of the nourishment sand over four years after project completion. Including adjacent areas which were not nourished, ~72 percent of the nourishment volume remains on Edisto Beach between Jeremy Inlet and Big Bay Creek. As of July 2021, the beach has ~716,702 cy more sand than the December 2016 pre-nourishment survey. CSE believes that the beach has been negatively affected by recent storms, including hurricanes *Irma* (2017), *Michael* (2018), *Florence* (2018), and *Dorian* (2019), all of which have impacted beach volume since the project was completed.

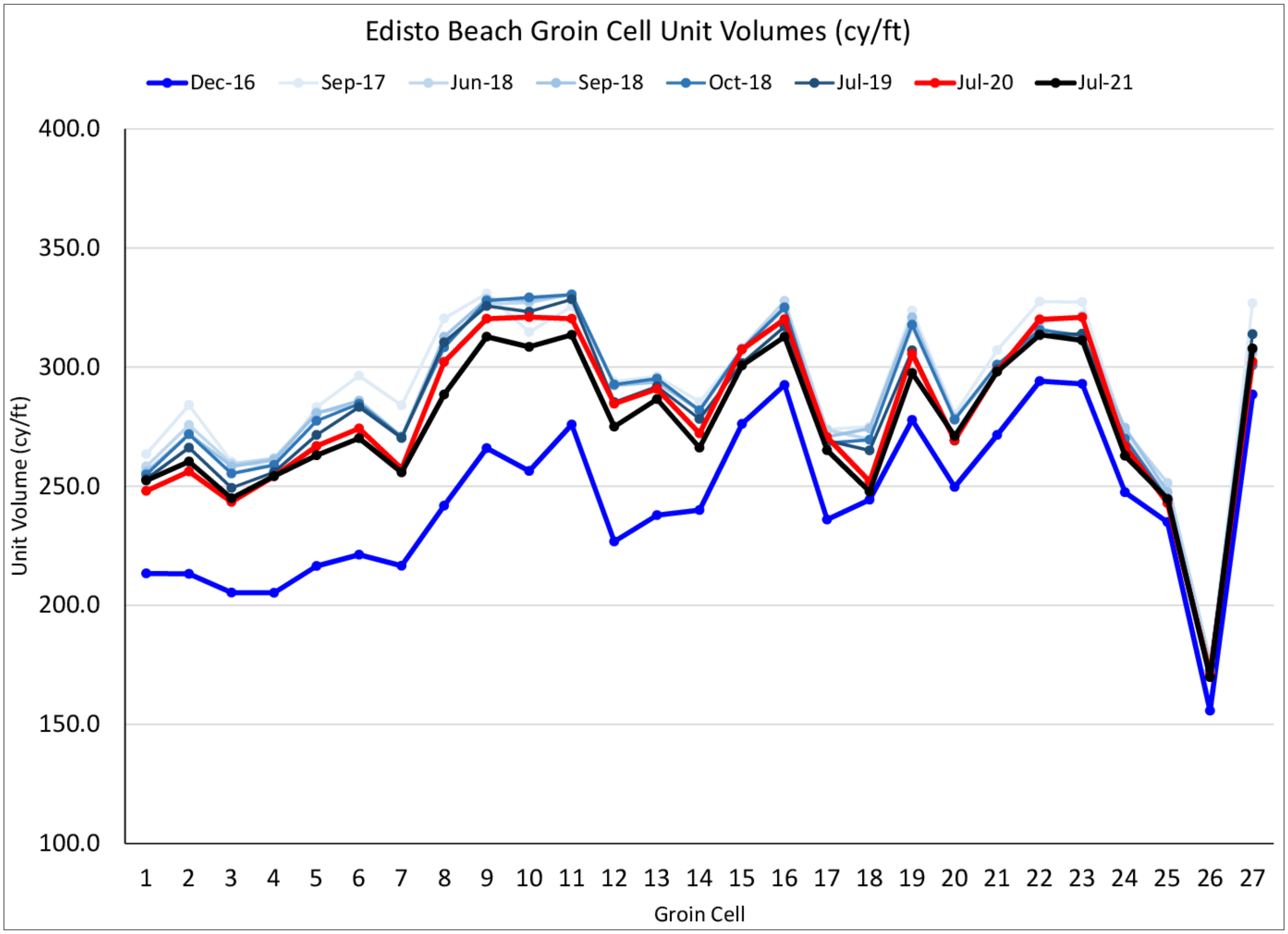


FIGURE 4.18. Groin cell unit volumes by reach from December 2016 to July 2021. Nourishment preceded the April 2017 survey.

4.3 Target Minimum Volumes

One final measure that is useful for design purposes is the comparison of profile volumes with some target minimum volume after the method of Kana (1990) or Verhagen (1992). Dutch coastal engineers, for many years, have established specific dimensions for their sea dikes and protective beaches. These dimensions are maintained by periodic additions of sand in order to keep pace with erosion, meaning that when the volume of the beach falls below some target value, it is time to renourish. This concept has been utilized for Edisto Beach and other Carolina beaches (eg – CSE 1999). CSE has observed at many sites that there will be an average unit volume to some defined depth limit, which represents a normal, healthy profile (see Fig 3.3, which illustrates the concept). Communities may adopt a particular target unit volume appropriate for local conditions then seek to maintain sand levels at or above the minimum target volume.

Along Edisto Beach, a target volume of 260 cy/ft is desired, which is close to the average beach condition along the State Park in 2004 and 2005. Target profile volumes provide a point of comparison to track the condition of the beach and to determine when renourishment may be required (if the goal is to maintain at least the minimum-target beach volume).

Every station within the project area is above its minimum volume as of July 2021, and most reaches are ~15 to 35 cy/ft greater than this target minimum (see Fig 4.18, previous page). The project area unit volume averages 281.3 cy/ft as of July 2021, and the annualized erosion rate for the project area was –5.8 cy/ft/yr from April 2017 to July 2021. This suggests approximately four years remain before the project area drops below the target minimum volume. This would be similar to the time elapsed between the 2006 and 2017 projects.

CSE plans to accumulate data from several more post-project surveys then evaluate the effect of groin lengthening on the profile. The past ~5 years have complicated analysis because of the high frequency of damaging storms along the South Carolina coast, particularly hurricanes *Irma* (2017), *Michael* (2018), and *Dorian* (2019). As more sand is lost within each groin cell, the groins will become more exposed and, therefore, effectively hold the remaining sand in place. The key question is: how much more sand do the longer structures retain compared with the original groins? Excess sand remaining on the beach above the groin trapping capacity continues to freely move between cells and alongshore. Thus, it is too early to verify the improved trapping capabilities of the lengthened groins.

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5.0 COASTAL RESILIENCY UPDATE

5.1 Wind and Waves

CSE gathered weather and climate data from outside sources (all NOAA-supported) to evaluate observed changes to the beach with respect to environmental conditions. Wind and wave data reported here cover the time period from 22 July 2020 to 28 July 2021 (the same as the survey data presented herein). Wind data are compared to historical data covering the period from 1945 to 2021. Real-time and historical hourly wind data from across the United States are aggregated by the Midwestern Regional Climate Center (MRCC), a cooperative program between offices of the National Oceanic and Atmospheric Administration (NOAA) and Illinois State Water Survey (MRCC 2020, http://mrcc.isws.illinois.edu/). The closest operational station is Charleston International Airport (FAA Identifier – CHS) in North Charleston, ~30 miles north northeast of Edisto Island.

The average wind speed and direction* was ~13.0 miles per hour (mph) from ~125° (approximately east-southeast, Fig 5.1). The peak observed wind speed was a gust to 44.3 mph from ~23° (approximately north-northwest) on 21 March 2021 during the passage of a low-pressure trough. According to data from MRCC-NOAA, wind data over the study period were similar to the long-term trends. The proportion of winds from the southeast (90°–180°) and southwest (180°–270°) quadrants represent ~45.0 percent of the total from 1949 to 2020; between April 2020 and June 2021, these have represented ~49.5 percent of the total incoming winds. Northerly winds were consistent with long-term trends, as well.

Wave data are recorded by the National Data Buoy Center (NDBC) Station 41004 ('Edisto'), 71 nautical miles (nm) east of Edisto Beach. However, no wave data were recorded at Station 41004 from February to May 2021, so we have elected to use data from Station 41008 ('Grays Reef'), ~81 nm south-southwest of Edisto Beach. Station 41008 has a similar exposure to north and northeasterly winds as Edisto Beach (NOAA 2021, http://www.ndbc.noaa.gov/station_page.php?station=41008). The average wave height at Station 41008 was ~3.1 ft with an average wave period of ~7.3 seconds. The maximum observed wave height was ~10.3 ft on 31 March 2021 during the passage of the same low-pressure system that triggered the highest-speed wind gust. The average wave direction** was ~120° (approximately southeast).

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* Herein, wind and wave direction is either given in degrees north or in terms of the direction from which it propagates.

** The direction from which waves propagate toward NDBC Station 41004.

*** The beach cycle refers to the natural buildup of a beach during fair weather (eg summer season) and erosion of the dry beach during storms (or winter season). When the onshore-offshore transport of sand balances, the beach is in dynamic equilibrium. More storms or higher water levels than normal interrupt this balance and lead to more erosion.

From July 2020 to July 2021, Station 41008 experienced relatively calm wave conditions compared to recent years. Data from Station 41008 have been collected nearly continuously since December 2009, and in the period from then until June 2021, wave height exceeded 10 ft 269 times and 15 ft 32 times. Wave height exceeded 10 ft just once from July 2020 to July 2021 and did not exceed 15 ft over the same period.

Similarly, atmospheric pressure dropped below 1000 millibars (mb) 211 times from 2009 to 2021 but did not drop below 1000 mb once from 2020 to 2021 (Fig 5.3). This metric is used because most Category 1 hurricanes have a central pressure of ~980–990 mb, and many nor'easter-type storms will feature central pressures below 1000 mb. Similarly, wave height is an easy parameter for the relative intensity of storm events. However, atmospheric pressure and wave height are imperfect measures because these are simply proxies for the physical processes that result in beach erosion (eg – a more energetic surf zone with alongshore transport in a particular direction occurring in phase with high tide).

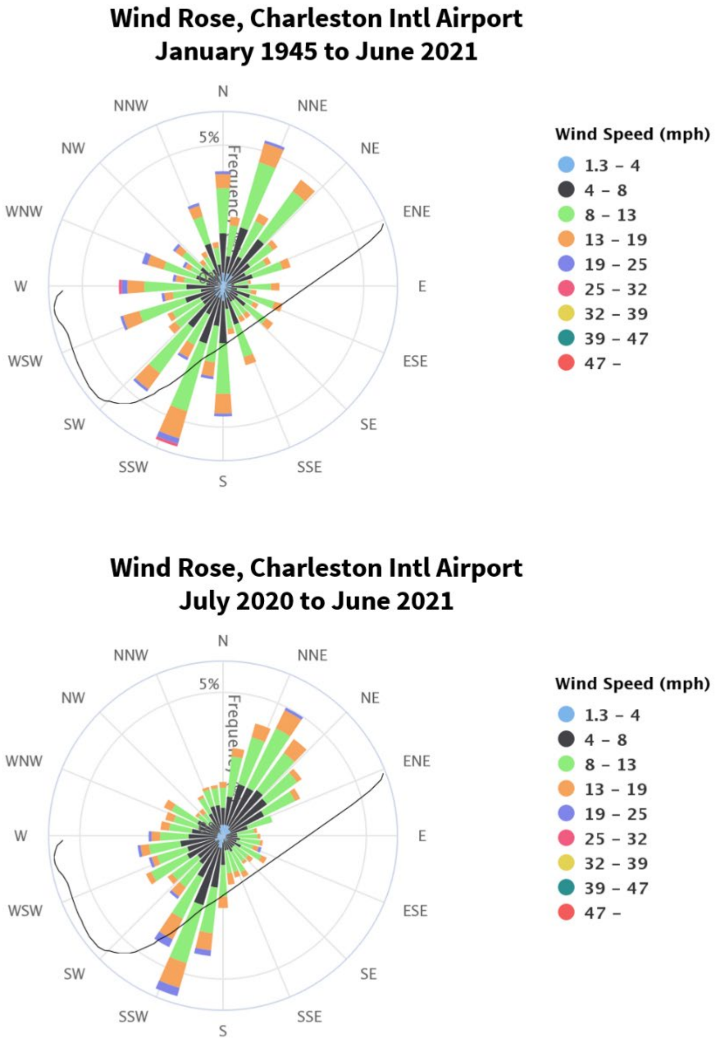


FIGURE 5.1. Wind roses showing direction and magnitude of winds measured at Charleston International Airport from January 1945 to July 2021 [UPPER] and from July 2020 to July 2021 [LOWER]. The curve across the wind rose indicates the shoreline position of Edisto Beach between the mouth of Big Bay Creek and Jeremy Inlet.

The work of erosion is fundamentally a sand transport problem. An increase in erosion indicates more sand is being transported away from a location than being transported to replace lost volume. Sand transport increases exponentially with current velocity, and wave energy increases by the square of the wave height. So in tidal channels, a doubling of velocity will result in an eight-fold increase in net transport, while a doubling of wave heights produces a four-fold increase in erosive force. This helps explain why even minor storms can do significant damage along the coast. A four-foot wave impacting a structure or the foredune will be much more impactful than a normal two-foot wave.

Measurements of wave properties like height, wavelength, and speed translate the magnitude of energy exerted by a wave striking the beach. The estimate is expressed as 'wave power' in kilowatts per meter of crest length (kW/m). Because sand can migrate either way along a beach, wave power must be adjusted so that waves resulting in southerly transport (ie – north to south) and northerly transport (ie – south to north) can be differentiated. To accomplish this, wave power can be calculated so that northerly transport is measured above zero (positive) while southerly transport is measured below zero (negative). Wave power at Station 41008 was greater from August to November 2020 during the passage of cyclonic storms during the fall and winter (Fig 5.3). In the spring and summer, lower-magnitude positive values tend to dominate, except for the aforementioned 21 March nor'easter (strong southerly-directed energy from northerly winds) and the passage of tropical storm *Elsa* the first week of July 2021 (strong northerly-directed energy from southerly winds).

The most powerful waves from July 2020 to July 2021 exhibited ~8 kW/m in a southerly direction, while the most powerful northerly-directed wave was ~6 kW/m (Fig 5.3). The average power of a northerly-directed wave from July 2020 to July 2021 was 0.6 kW/m, while the average southerly-directed wave power was 0.9 kW/m. These values are nearly identical to those observed from 2009 to 2021. This suggests sediment transport rates during the survey period from July 2020 to July 2021 were near average compared to the previous decade – a conclusion corroborated by the volume results presented herein.

Calculating the sum of all wave power indicates more individual waves moved in a southerly direction (~4,500 kW/m) than in a northerly direction (~2,900 kW/m) over the same period. Using this metric suggests a *predominant* southerly-directed transport from July 2020 to July 2021. Since 2010, a similar pattern has been observed wherein approximately twice as much energy is expended moving waves in a southerly direction than a northerly direction. This result corroborates long-term observations along Edisto Beach documenting southerly-directed drift. It is important to note that Station 41008 is significantly more exposed to northeasterly waves than the Lowcountry. Thus, the net total wave power exhibited at Station 41008 may be somewhat different from Edisto Beach itself.

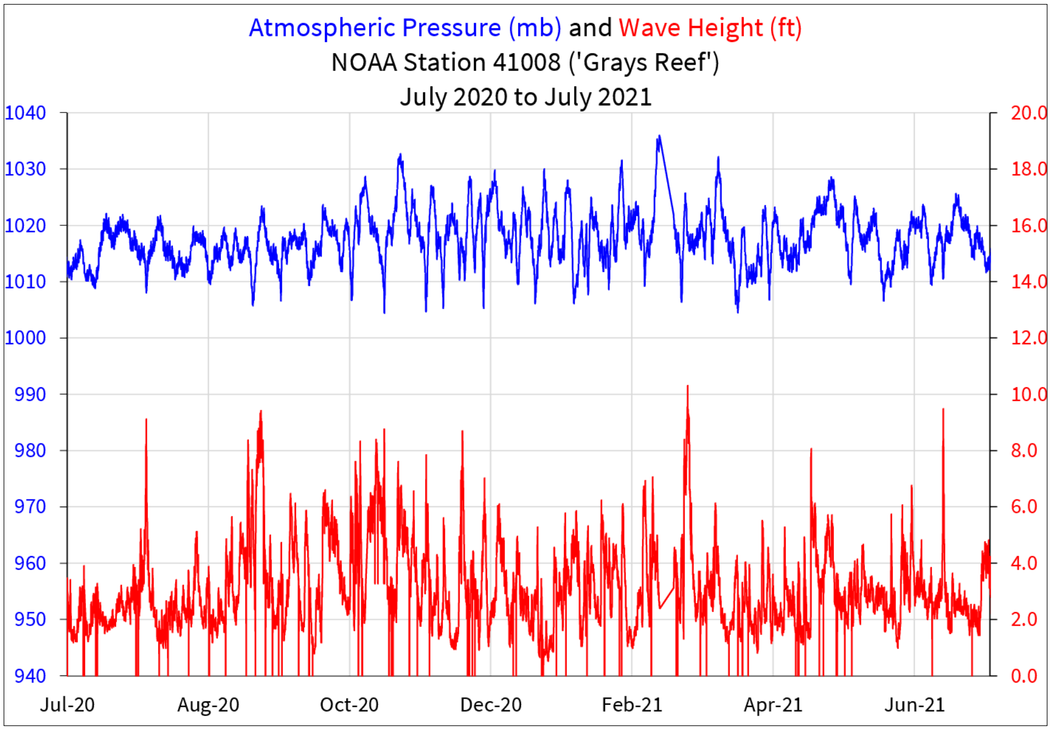


FIGURE 5.2. Atmospheric pressure and wave height at NDBC 41008 from July 2020 to July 2021. Wave heights exceeded 10 ft only once during the study period – far below the annual average since 2010 – and atmospheric pressure did not go below 1000 mb. These two data points indicate conditions have been relatively calm over the past year.

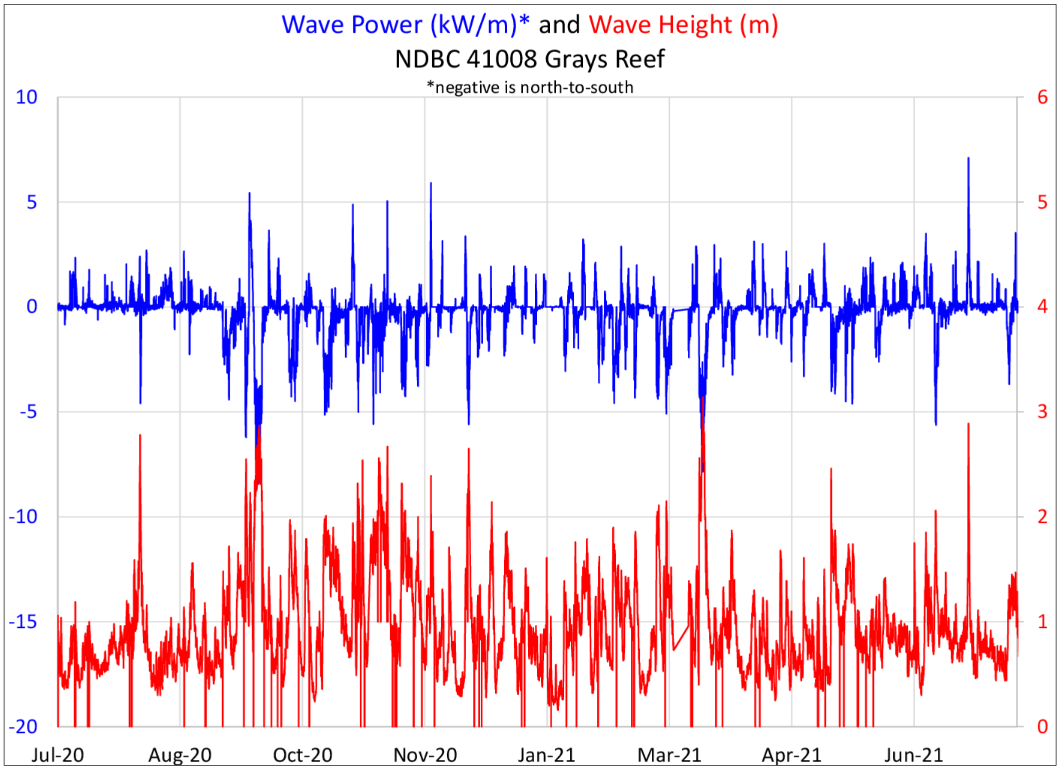


FIGURE 5.3. Wave power (in kW/m) and wave height (in m) for NDBC 41008 from July 2020 to July 2021. Wave power is a useful parameter for determining the relative magnitude and direction of wave energy in an alongshore direction along a beach. Positive values indicate waves move from south to north (ie – northerly transport), while negative values indicate predominance of north-to-south (ie – southerly) transport.

5.2 Flood Vulnerability

While analyzing past sea level trends is useful for predicting changes in the short-term (eg – years to decades), longer-term future sea level trends are more useful for strategic planning within coastal communities. To that end, NOAA and several national and international organizations regularly update future sea levels through the end of this century. Regional projections of average sea level rise (SLR) within the Southeast US range from ~1 ft to ~10 ft (Sweet et al 2017). These projections are based on six modeled values of future emissions, shifts in ocean circulation, vertical movements in the Earth's crust, and changes to Earth's gravitational field and rotation. They range from 'Low' – ~1 ft by 2100 to 'Extreme' – ~10 ft by 2100, with a 'High' scenario at 8 ft and three 'Intermediate' values averaging ~4 ft (Fig 5.6; NOAA 2021). For reference, the highest astronomical tide (aka 'King Tide') expected at Edisto Beach would bring water levels ~3 ft above mean sea level (MSL). So, the water levels observed during those King Tide events represent the higher range of projected MSL by ~2060 and the lower-intermediate projected MSL by ~2100 (Fig 5.6).

Relative to 1995–2014 conditions, the likely global mean sea level rise by 2100 is ~1 to 2 ft under the lowest scenario. This scenario calls for warming to be held at or below 1.5 °C by 2100 compared to 1900 and for 'net-zero' CO2 emissions by 2050. 'Net-zero' emissions represent the condition under which removals of atmospheric carbon exceed emissions. The 'intermediate' scenario is approximately in line with the upper end of reduced emissions, while the 'very high' scenario assumes no policy changes.

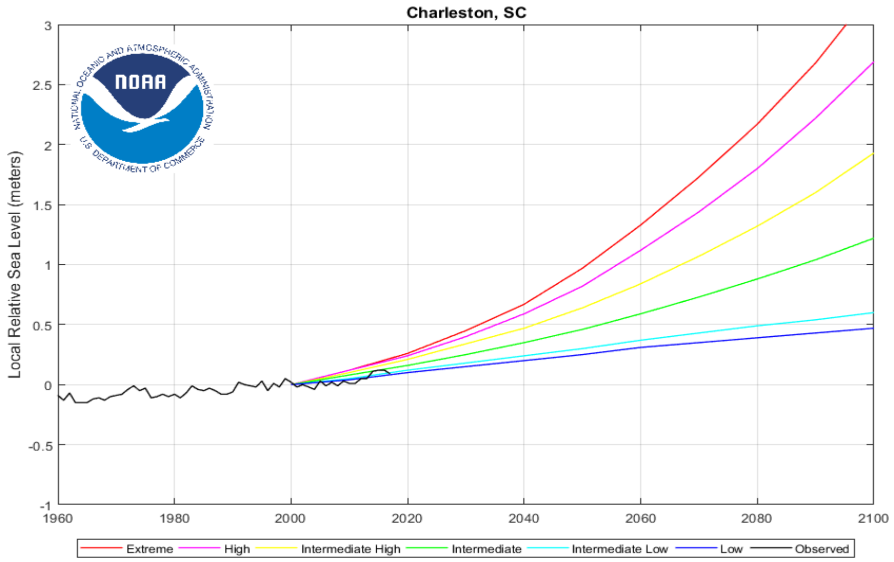


FIGURE 5.4. Projected MSL values at Charleston average ~2 ft by 2060, and ~4 ft by 2100. These projections are adapted global-scale predictions of future water levels (based largely on emissions) to the Lowcountry by accounting for regional and localized changes in ocean circulation, vertical movement in the ground surface, and changes to the planet's gravitational field and rotation.

Keep in mind that any rise in *mean* sea level in the future is accompanied by a corresponding rise in mean high tide. So in simple terms, today's high tide level would become a future mean tide level, and a future normal high tide level could be the equivalent of the storm tides Edisto Beach experienced during Hurricane *Matthew*.

Coastal communities are becoming more aware of the subtle differences in these impacts as they begin to feel pressure from sunny-day 'nuisance' floods (see Sweet et al 2018, Sweet et al 2020). Such floods will tend to impact low-lying sheltered shorelines, including causeways over the marsh or backyards fronting sheltered estuaries. Just a small super-elevation of the tide can quickly overtop a road that is barely above normal spring tide levels. On the other hand, locations on the open ocean generally don't experience nuisance floods the same way. This is because dunes accumulate vertically just inland from the beach, leading to relatively high elevations than the 'back side' of barrier islands, where the shoreline transitions more gradually into marsh and creek habitats.

NOAA provides a 'Sea Level Rise Viewer' (SLRV; see https://coast.noaa.gov/digitalcoast/tools/slr.html) to help people identify local variations in flood impacts under different SLR scenarios. This tool allows users to specify water levels and generate inundation maps showing MSL and depth in previously dry areas. Figure 5.5b shows example results for scenarios of MHHW plus 1 ft, 2 ft, 3 ft, and 4 ft SLR for Edisto Island and surrounding areas using data gathered from the SLRV website. The NOAA viewer is a handy tool to see what SLR scenarios start to impact a particular property.

Figure 5.5b shows a series of maps featuring a range of SLR scenarios between 1 ft and 4 ft above MHHW. MHHW is presently 2.87 ft above 0 ft NAVD at Edisto Beach. So, ~3 feet of SLR – well within the highest-probability forecasts of SLR by 2100 – would bring MSL up to present-day MHHW and likewise move MHHW upwards. Storm tides would be superimposed even higher, depending on wind direction and magnitude. These visualizations do not distinguish between MSL and MHWW; however, they indicate the water level at 1, 2, 3, and 4 ft above MHHW. This means the maps show where the highest astronomical tide would flood under these scenarios. It is apparent that with increasing SLR, flooding will be more impactful along the backside of Edisto Island.

At present, all properties on the island remain above MHHW. Under a SLR scenario of 1 ft, some of the marsh edge along Jungle Shore Drive and Jungle Road could be inundated, and the road could be threatened by nuisance flooding on a more frequent basis than at present. This is particularly true for the portions of the roads between Dawhoo Street and Nancy Street. Additional marsh creep may occur along the Edisto Beach causeway and between Scott Creek Drive and Jungle Road. This scenario is equivalent to projected MHHW in ~2040 under an 'Intermediate' scenario (see Fig 5.4).

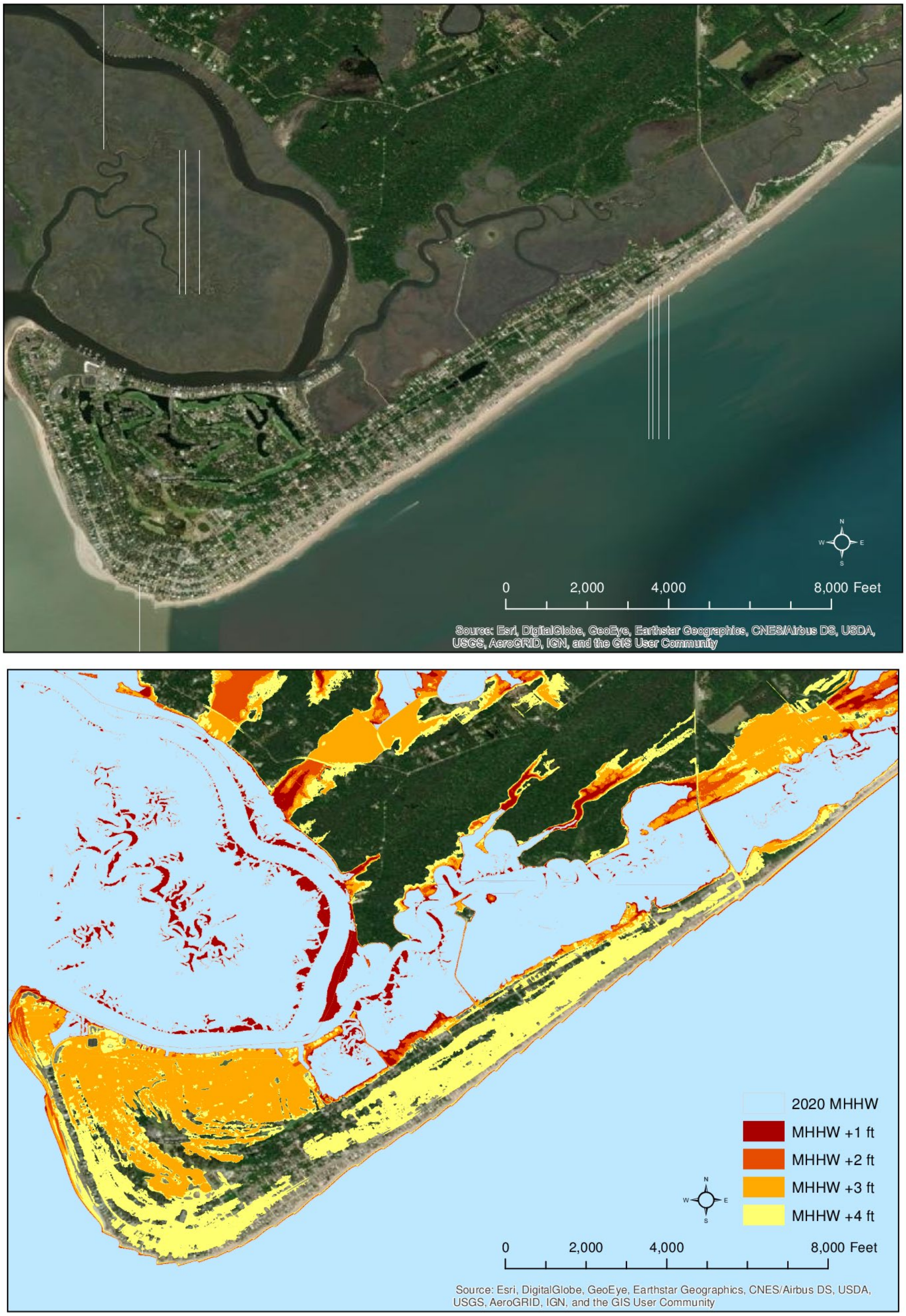
A 2-ft increase in MHHW would lead to the inundation of several properties along Jungle Shores Road and the inundation of Island Cove and Scott Creek Drive (Fig 5.5b). Further encroachment of marsh into present-day uplands is possible around the Marina and the Yacht Club and some properties on Docksite Road. According to NOAA projections under an 'Intermediate' scenario, this increase would occur by ~2070 (see Fig 5.4).

The SLRV indicates that the most significant changes could occur when MHHW increases from 2 ft to >3 ft above present (Fig 5.5b). Many properties along Jungle Shores Drive and Docksite Road would be permanently inundated, along with a significant portion of the golf course, Marina, and Yacht Club. At 4 ft of SLR, the causeway is permanently inundated along with a large portion of the developed parcels within Town limits. On the oceanfront, SLR of 3 ft and 4 ft could trigger a mixture of impacts. Most first- or second-row beachfront homes would likely remain high and dry, even with a 3-ft rise in MHHW. However, large portions of the golf course would flood, and an increased overwash hazard would likely exist near the Pavilion and State Park. This could present drainage and flooding issues following even minor storm impacts.

A 3 ft increase in MHHW is possible under the 'Intermediate' scenario by ~2090 (see Fig 5.4), whereas a 4 ft SLR under the same scenario is not expected until after 2100. Folly Beach plans to adapt to SLR of 3 ft by ~2060 (see SC Sea Grant 2017). Given the elevation around most of Edisto Island, it is likely many properties can be adequately protected for the next several decades (see darker shades of orange and red, Fig 5.5).

State Highway 174 (SC 174) is the main thoroughfare connecting Edisto Beach to US Highway 17 (US 17) and the mainland. Because SC 174 traverses multiple marshes and creeks between Edisto Beach and US 17, it will likely be vulnerable to frequent inundation before the Town of Edisto Beach. Highlighting the path of SC 174 over the SLRV visualizations (Fig 5.5c) begins to show the level of impacts possible under projected SLR conditions. Using the SLRV elevation values, a vertical profile of SC 174 between Edisto Beach and Adams Run was developed to identify vulnerable locations along the roadway. There are 10 marshes, creeks, and rivers that are already at or below MHHW (Fig 5.5d). Each stepwise increase in MSL will increase the flood hazard along SC 174 at these locations.

Some locations have been improved with higher causeways or bridges like Store Creek, Russell Creek, Sand Creek, and Dawhoo River. However, several of the other low spots along SC 174 are particularly vulnerable to nuisance flooding and persistent high water following flood events due to decreased drainage capacity.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 5.5a,b. Sea level inundation models around Edisto Beach generated using data from NOAA (https://coast.noaa.gov/digitalcoast/tools/slr.html). Shades of maroon, red, orange, and yellow are used to signify SLR of 1, 2, 3, and 4 ft above present-day MHHW.

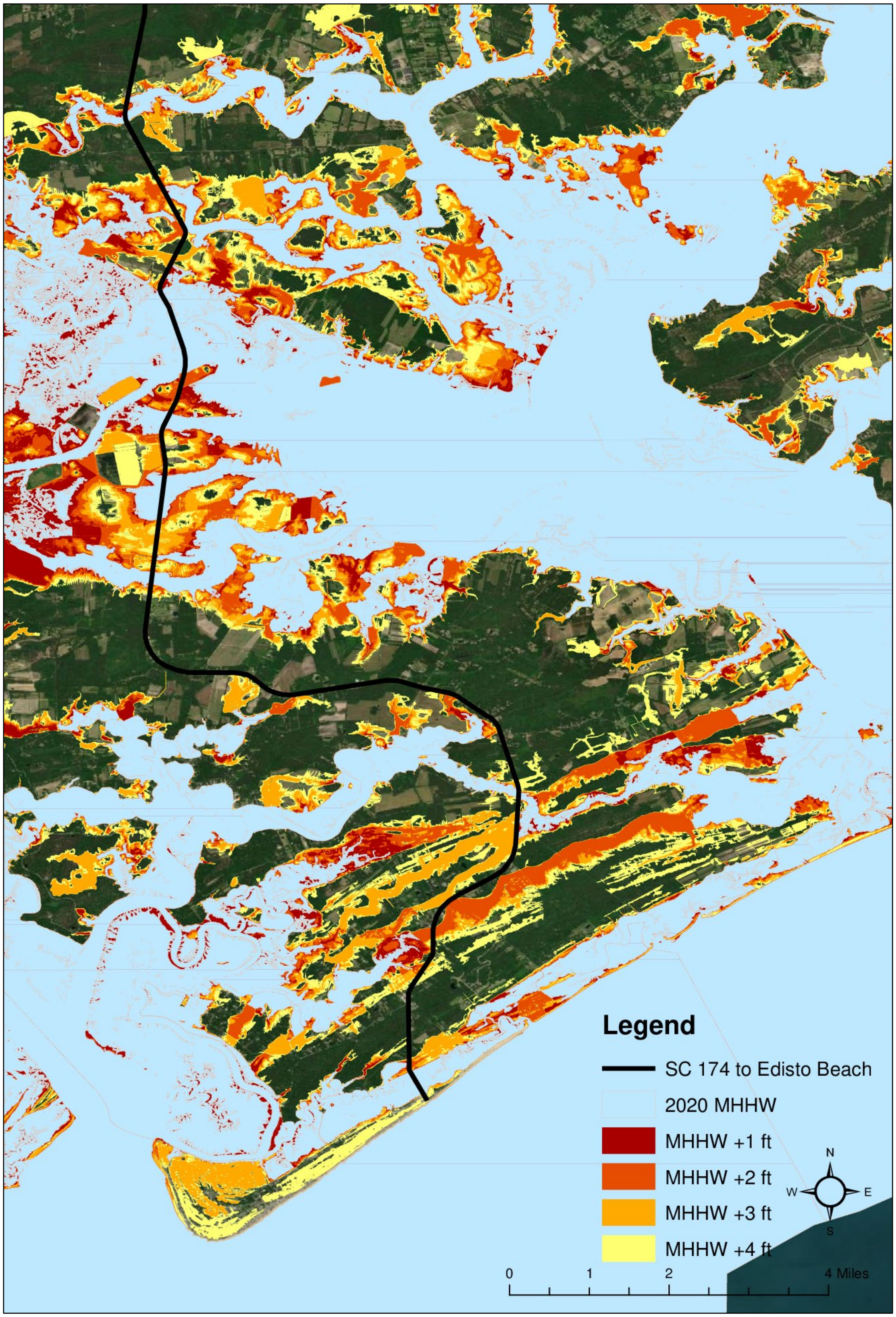


FIGURE 5.5c. Sea level inundation models following SC 174 from Edisto Beach to Adams Run, generated using data from NOAA (https://coast.noaa.gov/digitalcoast/tools/slr.html). Shades of yellow, orange, red, and maroon are used to signify SLR of 1, 2, 3, and 4 ft above present-day MHHW.

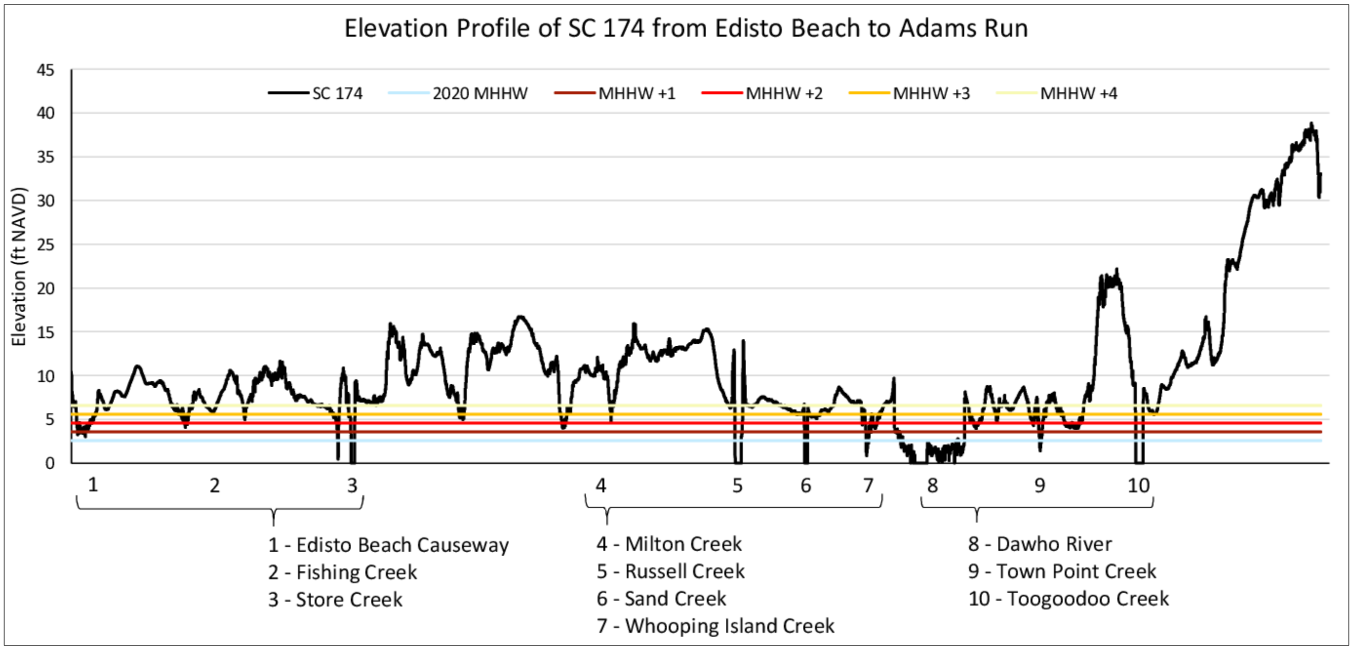


FIGURE 5.5d. Elevation profile following SC 174 from Edisto Beach to Adams Run, generated using data from NOAA (https://coast.noaa.gov/digitalcoast/tools/slr.html). Horizontal lines of blue, maroon, red, and orange are used to signify 2020 MHHW and SLR of 1, 2, 3, and 4 ft above 2020 MHHW.

While Edisto Beach will be relatively well-protected against high water for some time, the marsh edges along the inland side of Town, and SC 174, will likely need improvement sooner. Because many of these low spots are beyond Town limits, it is not under the direct purview of the Town to address these vulnerabilities. However, close consultation and coordination of efforts between the Town, Colleton County, Charleston County, and SCDOT should be maintained to preserve access to Edisto Beach for decades to come.

In most locations, road flooding can be avoided by simply elevating the surface. While this is an expensive proposition in most situations, SCDOT is more well-funded now than it has been in recent years. Moreover, FEMA and other federal agencies are issuing grants to states, counties, and municipalities to address precisely this type of issue.

5.3 Coastal Resiliency in the 21st Century

NOAA's Ocean Service defines coastal resiliency as the "ability of a community to 'bounce back' after hazardous events…rather than simply react to impacts" (NOAA 2021). NOAA recommendations for effectively preparing for hazardous situations, and improving coastal resiliency, include being "informed and prepared" for the impacts of SLR as a community.

As mentioned above, many communities around the nation, the world, and a handful of communities in South Carolina have begun strategic planning initiatives to address the impacts of projected SLR. The impacts of SLR are diverse and extensive, and conditions vary significantly from one community to another. Individualized plans developed at a community level help prepare for these impacts using various tools and adaptation strategies.

Other communities in South Carolina have categorized potential adaptation strategies according to their role and utility in mitigating impacts from future SLR. These include water infrastructure management, uplands management and/or conservation, transportation adaptation, and education/communication. The order of mitigation and adaptation strategies should be timed according to the vulnerability and capabilities of the community in question. Shorter-term goals (eg – 1 to 3 years) are focused on generating plans and taking inventory of the vulnerability of upland properties at a parcel scale. Medium- and long-term goals (eg – 3 to 5+ years) include implementing recommendations.

SLRV data indicate flooding along the marsh side of the Town and SC 174 will increase noticeably by mid-century under 'Intermediate' SLR scenarios. Mitigation and adaptation strategies should target improving drainage following rain events and elevating road surfaces above future MHHW. On a longer timescale ('Intermediate' scenarios as projected by the end of the century), developed properties along Jungle Shores Drive as well as near the golf course, Marina, and Yacht Club will be vulnerable to persistent flooding even during calm weather conditions.

The Town should continue ongoing work with SC Sea Grant and Carolinas Integrated Sciences & Assessments (CISA) to improve coastal resiliency and codify SLR adaptation plans. Adaptation plans are not unlike the Beachfront Management Plans prepared by many communities, although due to the broad array of SLR impacts, they can represent a more interdisciplinary effort. These plans contain recommendations and identify time horizons for specific priorities and goals. More importantly, they inform a community of the hazards presented by SLR and how to prepare adequately before those hazards negatively impact the community.

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6.0 BIG BAY CREEK SURVEY

CSE has occupied an established survey grid encompassing the mouth of Big Bay Creek to monitor possible shoaling associated with past and future nourishment sand being deposited in the mouth of the creek. The survey includes track-lines with 50-ft spacing perpendicular and parallel to the Big Bay Creek mouth, where that channel intersects South Edisto Inlet.

These data are used to create a Digital Terrain Model (DTM), which is a digital representation of the existing bathymetry. This figure can be used to determine the movement of sand into and out of the channel using bathymetric data. The mouth of Big Bay Creek has been surveyed three times following completion of the 2017 renourishment project, in April 2017, July 2019, and July 2021.

As is the case in many tidal creek mouths, there is a deep hole where the creek intersects the main channel of South Edisto Inlet. These holes are created by tidal currents moving through the channel. They can be scoured well below the typical creek bed depth, particularly if the channel bottom is made of unconsolidated 'soft' material. The balance between tidal scour and sand deposition in such a feature determines whether or not a hole will shift position or decrease in area over time.

There is a tidal scour hole at Big Bay Creek, wherein ~5 acres are located below –30 ft NAVD, with the deepest points exceeding –50 ft NAVD. The creek channel just to the east of the mouth is at elevations of –20 to 30 ft NAVD, and adjacent portions of the South Edisto Inlet are –25 to 35 ft NAVD.

The DTMs provided in Figure 6.1 demonstrate there was relatively little change in the hole's position, size, and depth at the mouth of Big Bay Creek, and likewise very little change to the inlet and creek channels on either side of the hole between 2017 and 2021.

Comparing the 2017 and 2021 elevation data in a profile along the deepest portion of the creek mouth reveals a slight northeastward deflection in the position of the scour hole since project completion (Fig 6.2). The bottom of the feature (eg below–50 ft NAVD) has shifted less than 100 ft northeast since completion of the 2017 project. However, approximately 5 acres remain below –30 ft NAVD, and there does not appear to be excess sand flowing into the mouth of Big Bay Creek as of July 2021.

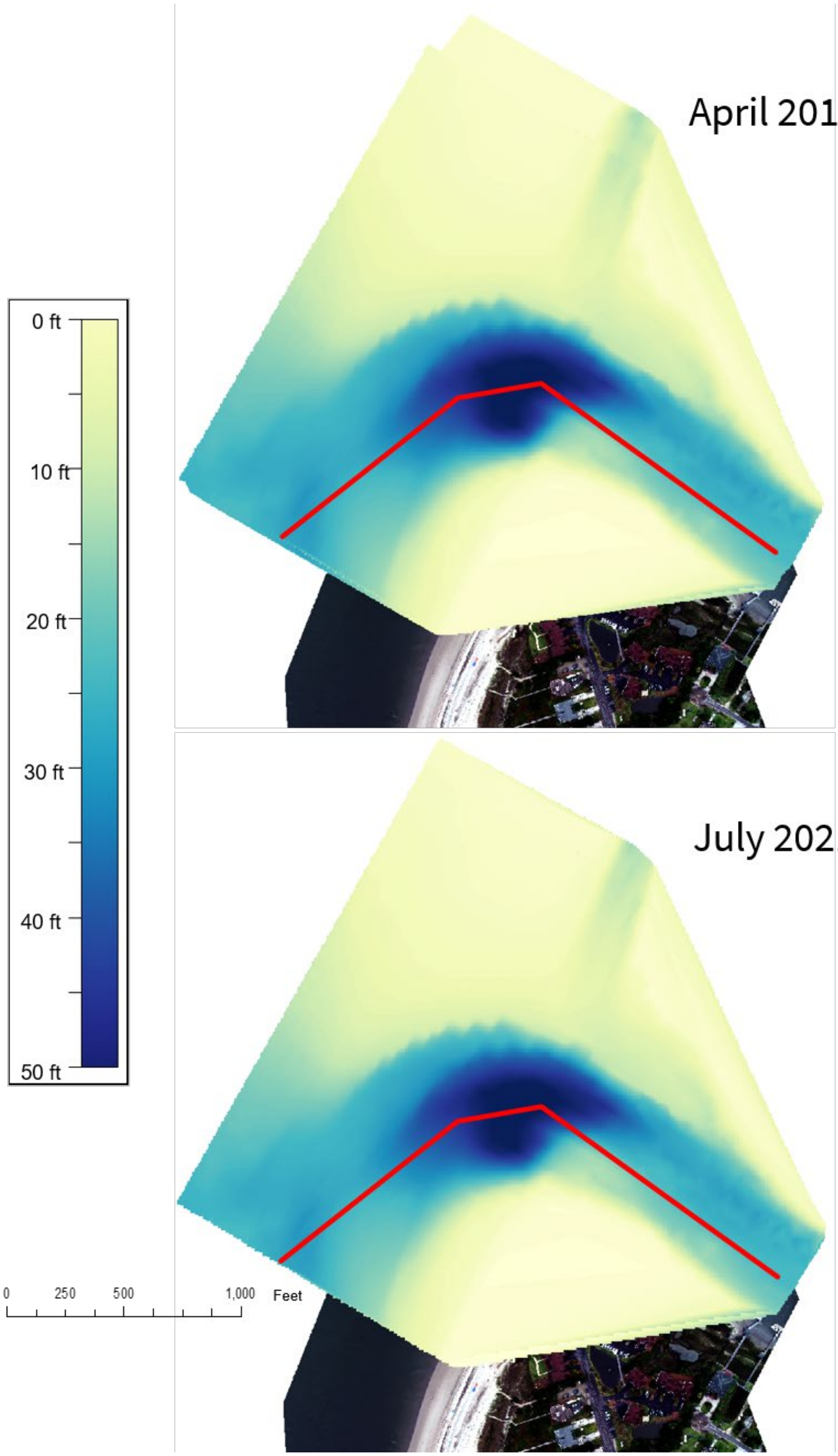

FIGURE 6.1. Changes in bathymetry at the mouth of Big Bay Creek between 2017 and 2021 were relatively minor. The darkest area near the center of each panel is a ~50-ft-deep hole where tidal scour has eroded the creek bed. This hole consists of approximately 5 acres of bottom below –30 ft NAVD. While the size of the hole has remained almost constant between surveys, the southwestern face has shifted ~100 ft northwest from 2017 to 2021. This change is not necessarily related to the 2017 project, and could just as easily be due to natural hydraulic shifts from year to year.

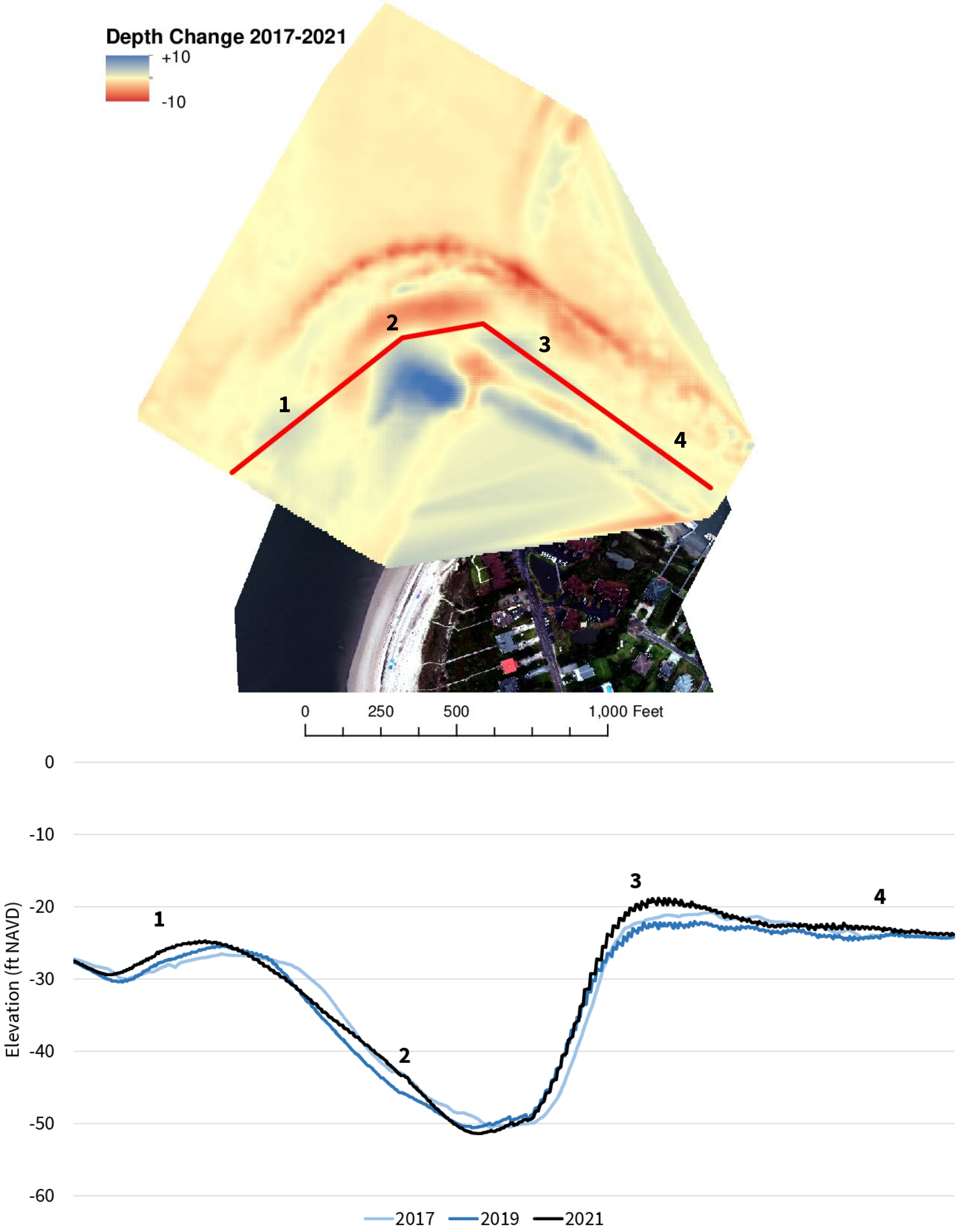

FIGURE 6.2. **[UPPER]** The difference in depth from 2017 and 2021 can be mapped similar to a DTM, so that red areas indicate erosion and blue areas indicate accretion. **[LOWER]** The bathymetric data collected along the red line can also be plotted against one another so that subtle changes in bottom elevation are easier to see. In general, there has been modest deposition along the southwestern face of the channel mouth hole ('2'), as well as at the channel mouth itself ('3'). Some erosion has also been measured along the northern edge of the channel (shown in red above).

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7.0 DISCUSSION AND RECOMMENDATIONS

The project area along Edisto Beach lost ~85,500 cy of sand between July 2020 and July 2021; however, erosion rates continue to generally decrease or hold steady following the busy hurricane seasons of 2016 through 2019. The most eroded portion of the beach within the project area is Upcoast 2, which lost ~144,500 cy between April 2017 and July 2021. Since project completion, across the entire island, the Downcoast 1 reach has performed the best since the 2017 renourishment with a gain of ~99,500 cy between April 2017 and July 2021.

The front beach retains an average of ~25 cy/ft more sand than the pre-nourishment condition. Following the same erosion patterns that have been in place since the 2006 renourishment, the most erosive reaches between July 2020 and July 2021 were between Upcoast 1 and Reaches 1 through 3. These reaches lost between ~20,700 and ~42,900 cy. Despite the recent losses, Reaches 1, 2, and 3 all retain more than 52 percent of the nourishment sand placed as part of the 2017 project.

Yearly monitoring efforts, such as this study, should be continued as planned to evaluate project performance and confirm sand volumes remaining within the project area and island-wide. Yearly surveys provide warnings of developing erosion problems and objective measures of the beach condition. Since the nourishment was funded through a combination of local, county, and state funds, it is considered an “engineered beach” as long as it is surveyed periodically and consistently. With proper design and engineering documents, it should qualify for FEMA Category G public assistance funds in the event of a federally declared disaster. The funds could be used to replace the volume of sand lost during a storm, which would be based on the most recent monitoring survey compared with a post-storm survey.

The Town should also continue its work with SC Sea Grant and the Carolinas Integrated Sciences & Assessments (CISA) teams to identify prudent measures for mitigating the impacts of sea level rise and nuisance flooding and follow the advice offered by these organizations. Edisto Beach and Edisto Island are generally vulnerable to SLR impacts in the next 20 to 30 years, including flooded roads, reduced vehicular access, and increased groundwater elevations. Collectively, mitigating these impacts will require a significant financial investment by the Town, County, and State. However, as with oceanfront nourishment projects, such improvements will occur in a piecemeal fashion along with – ideally – stepwise increases in the state and federal funding mechanisms.

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