2021 South Amelia Island, FL Beach Nourishment Project

FDEP Permit No. 0187721-013-JC
USACE Permit No. SAJ-2001-03870 (SP-PRJ)

Year 2 Post-Construction Monitoring Report

Prepared for:
SAISSA
Nassau County, FL
Florida Park Service

Submitted to:
Florida Department of Environmental Protection

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September 2023

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YEAR TWO POST-CONSTRUCTION MONITORING REPORT

September 2023

EXECUTIVE SUMMARY

The report summarizes the Year Two monitoring data and second year performance of the 2021 South Amelia Island, FL Dredging and Beach Nourishment Project. The project was constructed between July 27, 2021 and January 16, 2022 and was the fourth nourishment of the project shoreline (1994, 2002, 2011, and 2021). The fill limits of the 2021 project span roughly 3.1 miles of the Atlantic Ocean shoreline of southern Amelia Island, FL from south of Burney Park southward into the Amelia Island State Park, from FDEP reference monument R-59.5 to R-76.5 (AP-25). The beach fill project resulted in the placement of a pay volume of +1,800,000 cubic yards (cy) of sand at a total cost of $14,597,000.00.

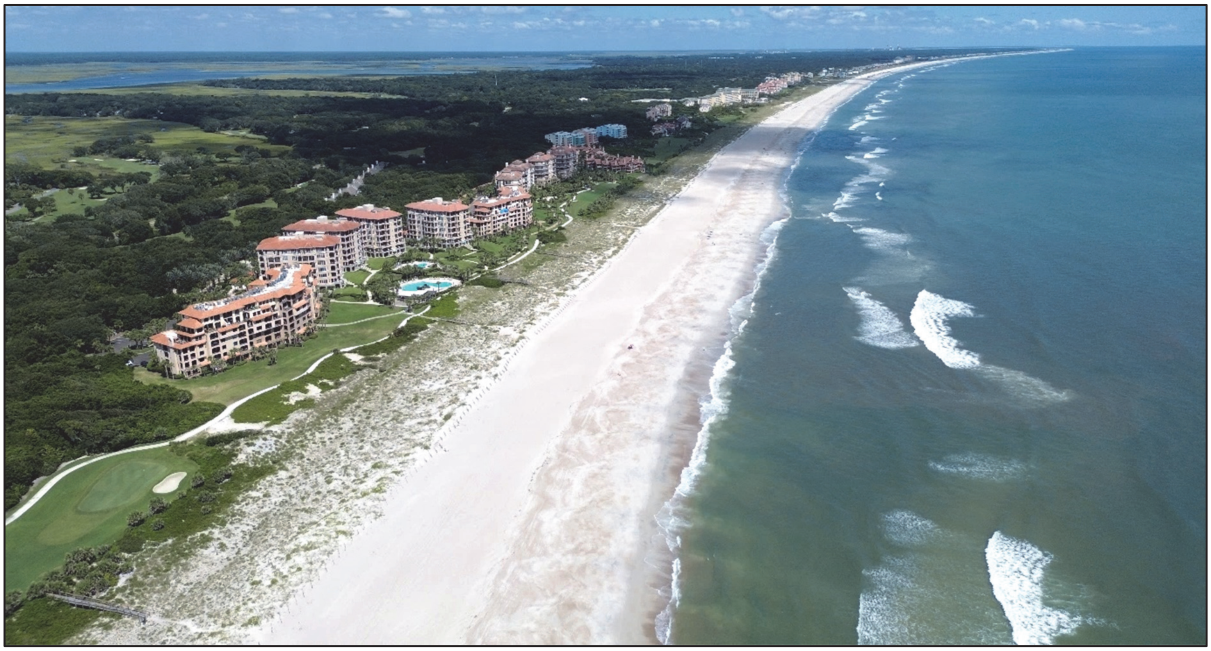
Consistent with the project permits and physical monitoring plan, data collected in June 2023 included a pre-tropical storm season beach profile survey, a bathymetric survey of the borrow area and Nassau Sound, and orthorectified aerial photography. Supplemental oblique drone aerial photography was flown at various dates (see **Photos EX-1** and **EX-2**).

<u>Beach Project Changes.</u> As of the Year-2 Post-Construction survey of June 2023, the 2021 beach nourishment project, and the long-term project as a whole, has experienced the following shoreline and volumetric changes since January 2022:

- -55 ft of shoreline retreat since 01/22, measured at Mean High Water (+2.0ft-NAVD)
  - -92 ft of retreat of the upper fill berm elevation of +6.5ft-NAVD
- -230,000 cy lost, as measured from the dunes to MHW (+2.0ft-NAVD)
  - 12.4% of the 2021 overall placement volume
  - 30.3% of the sand placed above MHW in the 2021 project
- -534,500 cy lost, measured from the dunes to -10 ft-NAVD
  - 28.7% of the 2021 overall placement volume
  - 32.4% of the sand placed above -10ft NAVD
- -60,300 cy lost overall, measured from the dunes seaward out to -20 ft-NAVD
  - 3.2% of the 2021 overall placement volume

Since May 1994:

- The beach project remains an average of 265 ft wider than the May 1994 condition
- An additional 4.7 to 5.2 million cubic yards of sand exist along the monitored beaches



Photograph EX.1: Northward looking view at R-69 (Sea Dunes) on 27-August-2023.

Photograph EX.2: Southward looking view toward the detached breakwater from The Sanctuary (AP-20) on 27-August-2023.

Comparison of the post-construction (January 2022), one-year (July 2022) and two-year post-construction (June 2023) surveys indicates continued post-fill beach equilibration effects and the severe impacts of Hurricanes Ian (September 2022) and Nicole (November 2022). The two storms eroded a significant volume of sand from the upper beach, transporting it offshore as well as alongshore out of the project limits. The significant difference listed above between losses to -10ft and losses to -20 ft reveal this impact and the equilibration effects, where an estimated 474,200 cubic yards of sand has been deposited in the area offshore of the primary nearshore bar (see **FIGURE EX-1**). The sand deposited in this area does provide a solid foundation for the upper beach profile, and it also provides some level of storm protection despite the depths in which that sand now lies.

As mentioned, Hurricanes Ian and Nicole impacted the project area in 2022. A post-Nicole survey of the SAISSA project limits in January 2023 revealed a storm-related loss of 301,850 cy above -20 ft NAVD. The June 2023 surveys suggest that some level of recovery may have occurred since that time, although the recovery appears to be concentrated in the offshore portions of the profile. It is recognized that a) storm erosion affected the entire Amelia Island shoreline, hence some of the measured accretion may be the result of sand migrating into the project limits from the north, and b) the offshore areas of the survey carry the most uncertainty in calculation, due to the limited transect data used to characterize the broad offshore areas of the beach profiles. Future surveys will assist in further refining the offshore volume changes.

Borrow Area Changes – Surveys of the project borrow since January 2022 reveal areas of both deposition and erosion as the channel-like feature responds to sand inputs from the surrounding shoals, storm effects from Ian and Nicole (among other), and the shifts in the two main tidal channels through Nassau Sound. As of June 2023, an estimated 993,000 cubic yards of sand lies within the permitted borrow area limits.

Nassau Sound Changes – Updated surveys of the ebb shoal complex of Nassau Sound, and portions of the flood shoal, illustrate the slowly migrating thalwegs of the northern and southern primary tidal channels through the Sound and the extremely dynamic shifts in smaller ebb shoal features. The southern tidal channel continues to migrate toward Big Talbot and Little Talbot Island, putting significant erosional stress on those shorelines. Recent volume changes across the Sound indicate a minor level of accretion, consistent with the historical trend of ebb shoal growth. Surveys indicate the coalescing of emergent or semi-emergent shoal features between the two channels, in the general area where ephemeral "Bird Island" shoals form, shift, and dissipate over time.

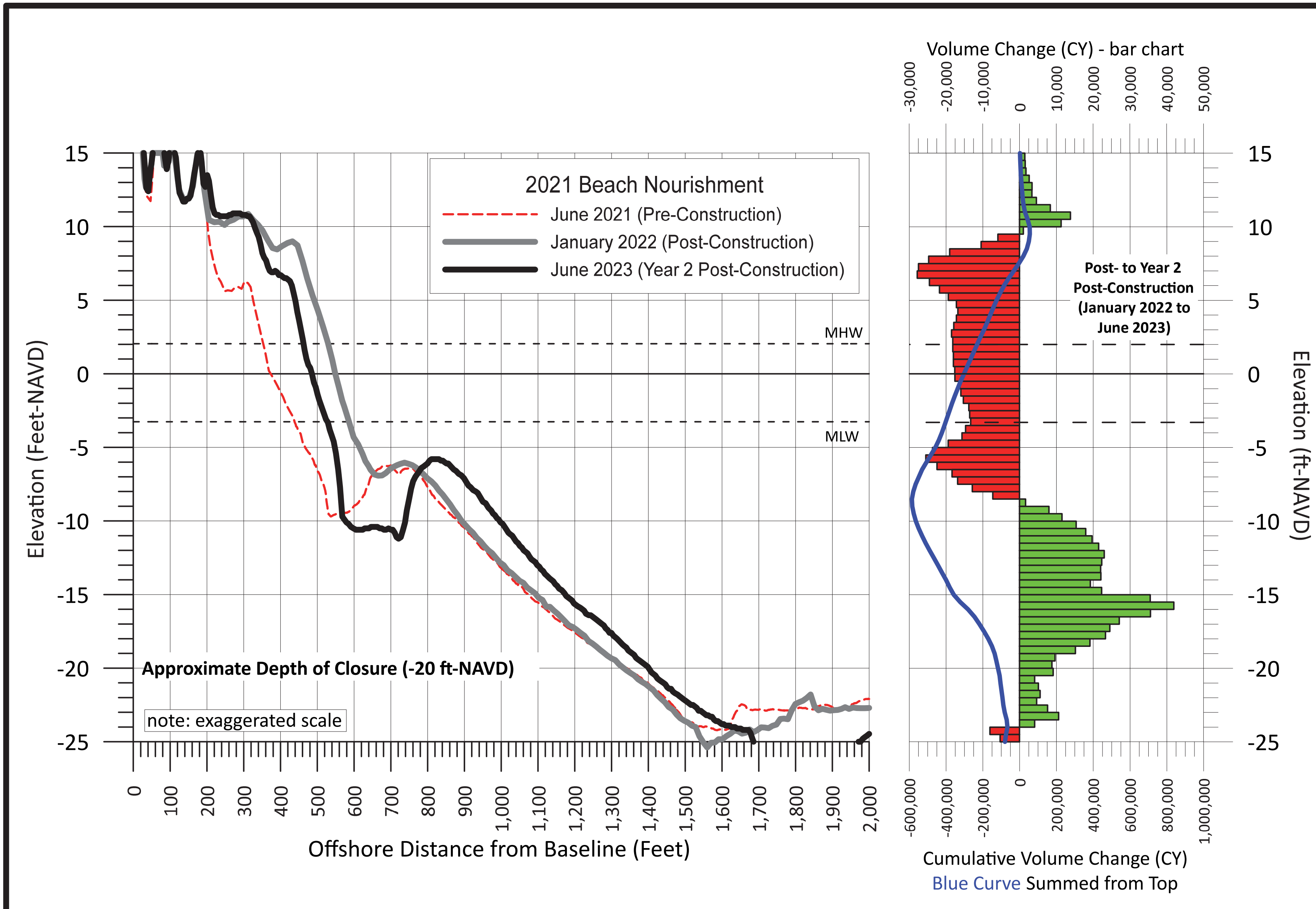


Figure EX-1: Vertical distribution of the volume changes **post-construction** of the 2021 beach nourishment along south Amelia Island from **Jan. 2022 to June 2023** between R-59.5 and AP-25 (fill limits). The graph on the right depicts the volume changes measured at half foot vertical intervals (bar chart), as well as a summation of the total volume change measured from the dunes seaward to survey closure (blue curve).

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YEAR TWO POST-CONSTRUCTION MONITORING REPORT

September 2023

1.0 INTRODUCTION

1.1 Scope and Authorization of Study

This engineering report presents the "Year Two" post-construction monitoring for the fourth nourishment of the South Amelia Island Shore Stabilization Project (SAISSP), constructed between July 27, 2021 and January 16, 2022. Specifically, the report seeks to summarize and discuss the Year Two monitoring data and performance of the beach fill to date. The project placed approximately 1.8 million cubic yards (Mcy) of beach quality sand along roughly 3.1 miles of the Atlantic Ocean shoreline of Amelia Island in Nassau County, FL. The fill area spanned FDEP reference monuments R-59.5 to AP-25 (~R-76.5).

This report is submitted in compliance with FDEP Joint Coastal Permit No. 0187721-013-JC and the associated Physical Monitoring Plan, which requires the submission of an engineering report following completion of the initial annual monitoring survey. A copy of the FDEP permit and Physical Monitoring Plan were included in the *Post-Construction Documentation Report* (Olsen 2022a). This report is also submitted in compliance with Department of the Army permit No. SAJ-2001-03870 (SP-PRJ).

The project was constructed with funds provided from several sources. The local sponsor, the South Amelia Island Shore Stabilization Municipal Services Benefit Unit (SAISS-MSBU), administered by the Nassau County Board of County Commissioners (a co-permittee), paid all contractor invoices, and was subsequently reimbursed by grants from the Florida Department of Environmental Protection, the Federal Emergency Management Agency (FEMA), and the Florida Division of Emergency Management (FDEM). The FEMA and FDEM reimbursements were provided to make repairs stemming from Hurricanes Matthew and Irma. In total, grant reimbursements covered more than 56% of the construction cost. The Florida Park Service was a partner and co-permittee in the overall project on behalf of Amelia Island State Park, located at the south end of the project limits.

1.2 Project Location and Physical Setting

Amelia Island is a sandy barrier island located along the Atlantic Ocean in Nassau County in Northeast Florida (**Figure 1.1**). The island has approximately 14.5 miles of sandy shoreline, bordered to the north by the entrance to the St. Mary's River, and to the south by Nassau Sound. Neighboring islands include Cumberland Island, GA, to the north, and Little Talbot Island to the south.

The 2021 project nourishment area is located along the southern Atlantic Ocean fronting portion of Amelia Island, between FDEP reference monuments R-59.5 and AP-25 (~R-76.5). The project borrow area is located approximately 0.5 to 1.2 miles east/southeast of the southern end of the project area.

The astronomical tides in the vicinity of the project area are semi-diurnal and have average mean and spring ranges of approximately 5.1 ft and 5.7 ft, respectively. Tidal datums at the south end of Amelia Island are listed in **Table 1.1.** The predicted astronomical tides during the Year-2 monitoring period (June 2022 to July 2023) are provided as **Figure 1.2** with the highest tides occurring in the fall season.

Table 1.1: Tidal datums at the south end of Amelia Island[1].

Datum	Elevation (ft-NAVD 88[2])
Mean Higher High Water (MHHW)	+2.4
Mean High Water (MHW)	+2.0
NAVD 1988	0.0
Mean Tide Level (MTL)	-0.5
NGVD 1929	-1.2
Mean Low Water (MLW)	-3.1
Mean Lower Low Water (MLLW)	-3.3

[1] Approximations based upon NOS Tidal Station 8720135, Nassau River Entrance, Nassau River.
[2] NAVD 88: North American Vertical Datum of 1988. **All elevations in this report are referenced in FEET to NAVD 88 unless otherwise noted.**

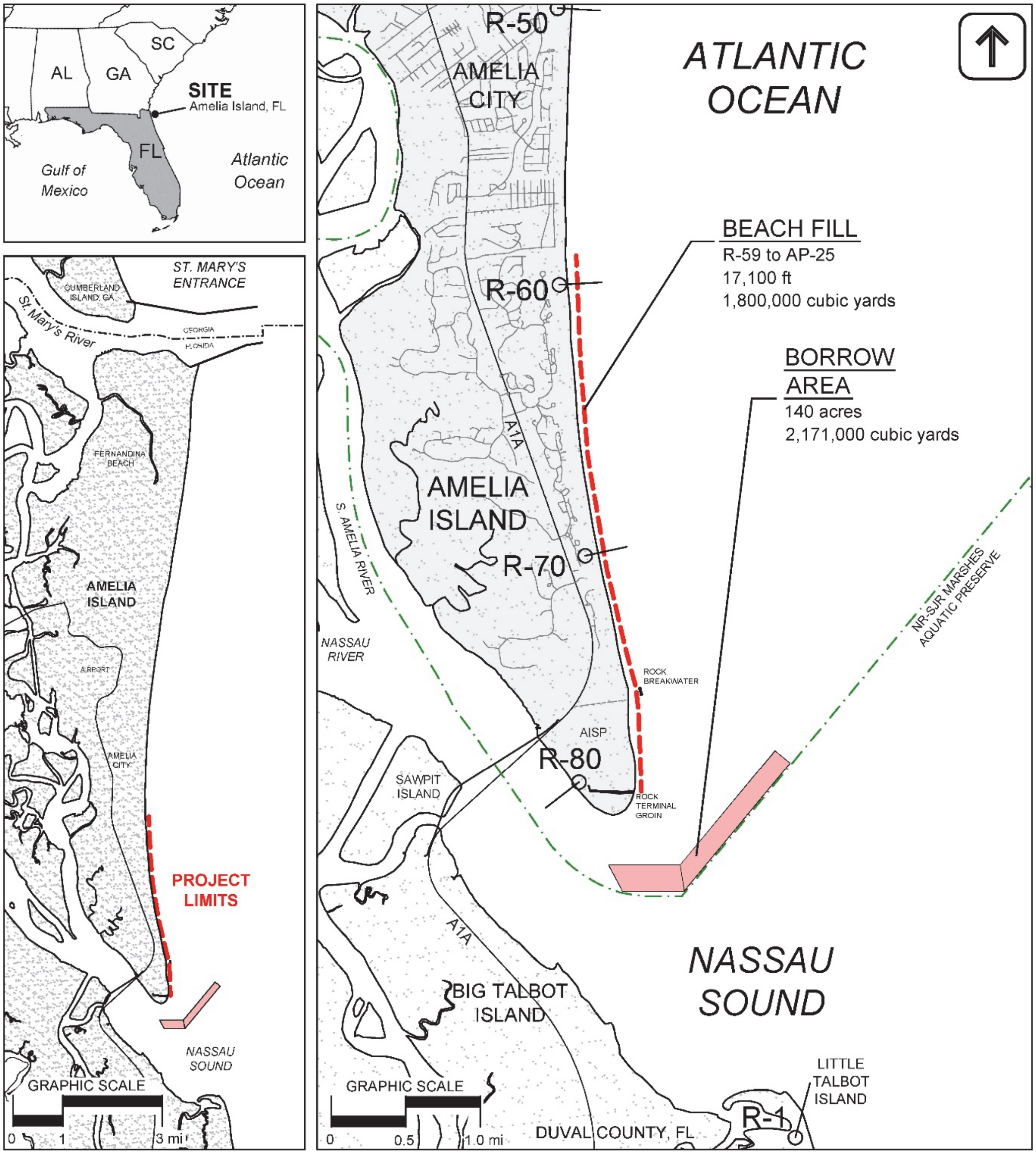

Figure 1.1: General location of the 2021 South Amelia Island Dredge and Beach Nourishment Project.

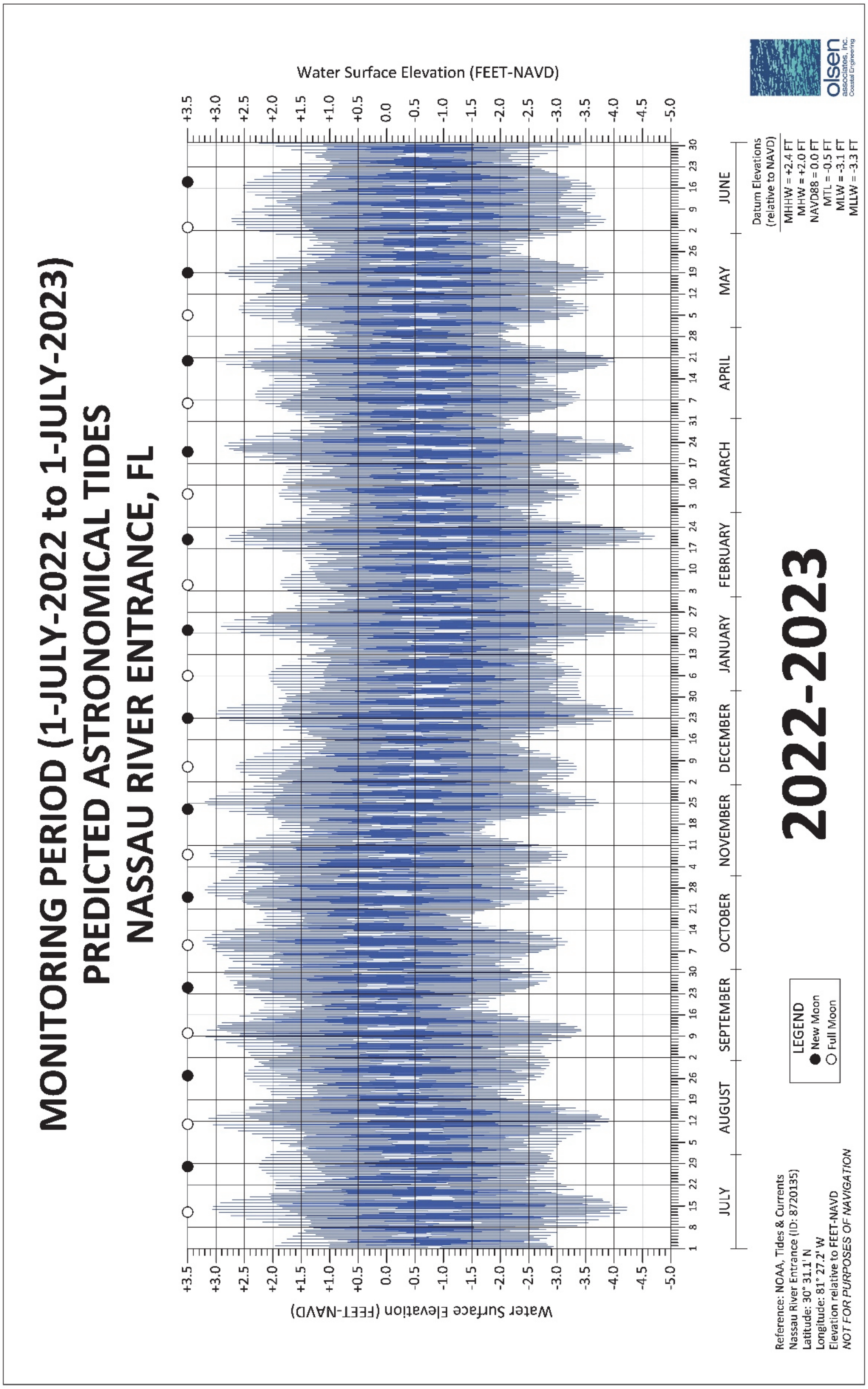

Figure 1.2: Predicted astronomical tides at the Nassau River Entrance for the 2022-2023 monitoring period.

1.3 Project Area Background

Over the last 60+ years, numerous actions have been implemented in an attempt to offset the effects of erosional stress along the southern end of Amelia Island. Major engineering activities since 1964 are summarized in **Table 1.2** (updated from OAI 2022b). Since 1984, over 10.7 Mcy of sand have been placed as beach fill or dune enhancement along the south end of the island (R-48 to R-79).

In 1993, a large group of property owners collectively founded the South Amelia Island Shore Stabilization Association, Inc. (SAISSA) for the purpose of combatting the severe erosion that threatened the south Amelia Island shorefront. Ultimately, SAISSA sponsored the design and construction of a 2.6 Mcy beach restoration project (SAISSA Project) along a 3.1 mile reach of the southernmost shoreline (R-60 to R-78). This project was designed and permitted by Olsen Associates, Inc. and constructed through an MSBU in the summer of 1994.

In the summer of 2002, a 1.8 Mcy beach renourishment of the 1994 project was constructed between R-60 and R-79.5. The 2002 beach fill constituted Phase I of the SAISSA project, which was co-sponsored by the Florida Park Service (FPS). As a result, the project limits were extended to include the Amelia Island State Park as well as privately owned properties located north of the park.

In August 2003, approximately one year following completion of the Phase I Beach Fill, permits for a Phase II Structural Stabilization project were issued by the FDEP. Three rock structures were permitted with the intention of a.) stabilizing the severely eroded Park oceanfront shoreline at a more seaward position for purposes of restoring recreational beach and protecting a unique maritime forest and related Sea Island ecosystem; b.) increasing the overall performance (*i.e.* longevity) of the 3.5 mile beach restoration project and in particular the Park shoreline segment lying in close proximity to Nassau Sound; and c.) to assist in fostering the stability of the Park east-west shoreline which borders a relatively deep Nassau Sound marginal tidal channel. Construction of the three structures was initiated in July 2004 with substantial completion of the project in December 2004.

In the summer of 2011, approximately 2.1 Mcy of sand was placed between R-59.5 and R-79. This project was the second scheduled maintenance nourishment of the SAISSA Project and the first maintenance nourishment following completion of the Phase II structural stabilization project (2004).

During the summer of 2013, the U.S. Army Corps of Engineers (USACE) placed approximately 581,000 CY of material hydraulically from the Atlantic Intracoastal Waterway (AIWW) onto the south Amelia Island beaches between the detached breakwater and the terminal groin (R-76 to R-79). In the winter of 2018/19, the USACE placed an additional 570,000 CY of AIWW disposal material along this reach.

Table 1.2a: Historical shoreline protection efforts, South Amelia Island, 1964-2022.

DATE	ACTION
1964	In response to erosion damage suffered during Hurricane Dora in 1964, emergency Federal funds were appropriated for the construction of granite stone revetments along approximately 1.1 miles of American Beach. This revetment is currently buried by both beach fill and natural dunes.
1970's	Amelia Island Plantation (AIP) conducted beach scraping along its shoreline. The effort consisted of seasonal scraping of sand from the intertidal beach zone and subsequent placement at the dune toe.
1980	Permitted beach scraping of approximately 32,000 cy of material was conducted between monuments R-64 and R-68. The project was undertaken by the AIP and constructed in a manner consistent with previous scraping efforts.
1984	Between January and March, AIP placed approximately 76,000 cy of material via truck haul from the Atlantic Intracoastal Waterway (AIWW) dredge spoil disposal site within the Amelia Island State Recreation Area (AISRA) located at the southern end of Amelia Island. The material was placed as dune enhancement along 7,200 feet of AIP shoreline. As an emergency response to the Thanksgiving Day Storm of 1984, an additional 5,500 cy of sand were trucked in from the aforementioned spoil pile and placed at various locations where breaching of the AIP dune system was considered to be imminent.
1987	As part of a larger island-wide 1.42 Mcy beach fill project, 515,000 cy of material were placed by the USACE along a 1.3-mile reach of shoreline between R-48 and R-55. The material was obtained from new-work dredging of the St. Mary's Entrance required to provide navigational access for the U.S. Navy's Trident-class submarines. The disposal project was undertaken as a result of a 1986 Memorandum of Understanding (MOU) between the U.S. Navy and the State of Florida.
1987	USACE placed 2.13 Mcy of material in a nearshore disposal site located between R-33 and R-55. The material placed at this site was obtained from the aforementioned new work dredging of the St. Mary's Entrance. The material was placed seaward of the –18 ft (MLW) contour, and primarily in deeper water (-20 to –35 ft, MLW).
1988	Under the conditions of the 1986 State/Navy MOU, USACE reportedly placed 750,000 cy of material along approximately 1 mile of shoreline between R-55 and R-60. The material was originally placed in the USACE nearshore disposal site by hopper dredge and later moved onshore by means of a cutterhead dredge. The volume actually placed on the beach is a matter of dispute. The dredging contractor was paid for the placement of 1.083 Mcy of fill, intended to extend over the 12,000-ft reach of shoreline between R-54 and R-65. Actual placement of material occurred along approximately 5,000 ft of shoreline between R-55 and R-60. This resulted in an approximate 60% shortfall in project length relative to the original design. Anecdotal visual inspection indicated that much of the material was fine sands and clay, which in all probability resulted from over-dredging of the specified nearshore rehandling site.
1989	AIP placed about 50,000 cy of beach fill material along its shoreline. The material was trucked in from an AIWW dredge spoil disposal site located west of the Amelia River.
1991	AIP placed approximately 12,000 cy of beach fill, from an upland source, along its shoreline as a part of a continuing dune protection effort.
1993	USACE beach fill along South American Beach~300,000 cy extending south to about R-62.
1994	SAISS-MSBU funded the design and construction of a comprehensive beach restoration project along the southernmost 17,000 feet of Amelia Island's shoreline. The project placed approximately 2.6 Mcy of fill between monuments R-60 and R-78. The borrow area for the site was 800-ft wide by 7,500-ft long and located between 3,000 and 3,900 feet offshore of the southern end of the island on the margins of the Nassau Sound ebb shoal platform.
1995	A temporary terminal groin field was constructed between August and November consisting of four groins placed perpendicular to the shoreline, spaced about 500 ft apart in a tapered configuration. The groins were constructed of 70-inch diameter, sand-filled geotextile tubes (LONGARD™) and numerous smaller support tubes. The landward terminus of each groin was installed below grade within the 1994 beach fill.

(table continued on next page)

Table 1.2b: Historical shoreline protection efforts, South Amelia Island, 1964-2022.

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DATE	ACTION
1996	The southernmost groin, G-4, was first vandalized in October, resulting in deflation of a 50-ft section of the geotextile groin. The gap was closed through the placement of several small tube sections.
1997	Between May and September, USACE placed about 300,000 cy of sand along 4,500 ft of shoreline between monuments R-77.5 and R-73.5 The sand was obtained from maintenance dredging of the AIWW through Nassau Sound. Fill was placed within the groin field as well as along the beach 1,000 ft to the north and 2,000 ft to the south of the structures.
2000	All four of the geotextile groins have been routinely vandalized resulting in substantial structural damage and sand loss. The seaward terminus of each groin required major reconstruction during which the decision was made by SAISS-MSBU to truncate each structure, thereby creating the current groin configuration. Additional stabilizing bags were also added to groin G-4 at this time. In October, groin G-3 essentially was rendered ineffective.
2000	In November/December, approximately 2,000 ft of shore-parallel sand-filled geotextile tubes were placed along segments of the AISRA to reduce flooding of the maritime forest in areas where the dune had been lost to chronic erosion. During the same time period, the USACE initiated a second beach disposal project derived from material maintenance-dredged from the AIWW. With participation from FDEP, the total volume is expected to reach as much 300,000 cy, to be placed at the southern terminus of the island.
2001	Between May and September, USACE placed about 300,000 cy of sand along 4,500 ft of shoreline between monuments R-77.5 and R-73.5 The sand was obtained from maintenance dredging of the AIWW through Nassau Sound. Fill was placed within the groin field as well as along the beach 1,000 ft to the north and 2,000 ft to the south of the structures.
2002	Phase I of the South Amelia Island Shore Stabilization Project was constructed between monuments R-79 and R-60 along Amelia Island State Park and northward thereof.; approximately 1.8 Mcy of sand were placed. Prior to construction, all shore-parallel and shore-perpendicular geotextile structures were removed.
2004/05	Phase II of the South Amelia Island Shore Stabilization Project was constructed consisting of The project consisted of three engineered rubble mound erosion control structures, a detached breakwater and two groins, including a "leaky" terminal groin at the south end of the island in an east-west orientation
2006	Approximately 400,000 cy of material from the AIWW was hydraulically placed by U.S. Army Corps of Engineers onto the south Amelia Island beaches between the detached breakwater and the terminal groin, or between monuments R-76 to R-79
2011	The 2011 South Amelia Island Shore Stabilization Project was constructed between R-60 and R-76 along the southern 3.8 miles of the Atlantic Ocean shoreline of Amelia Island, FL. Approximately 2.1 million cubic yards of sand were placed.
2013	Approximately ±581,000 cy of material from the AIWW was hydraulically placed by U.S. Army Corps of Engineers onto the south Amelia Island beaches between the detached breakwater and the terminal groin, or between monuments R-76 to R-79
2018/19	Approximately ±570,000 cy of material from the AIWW was hydraulically placed by U.S. Army Corps of Engineers onto the south Amelia Island beaches between the detached breakwater and the terminal groin, or between monuments R-76 to R-79.
2021/22	The 2021 South Amelia Island Beach Nourishment Project was constructed between R-59 and R-76.5 (AP-25) along the southern 3.1 miles of the Atlantic Ocean shoreline of Amelia Island, FL. Approximately 1.8 Mcy of sand were placed.

***2016** Hurricane Matthew impacted the engineered beach fill project area in October 2016.
***2017** Hurricane Irma impacted the engineered beach fill project area in September 2017.

1.4 2021 South Amelia Island Beach Nourishment Project Implementation

The various elements of planning and construction associated with the 2021 South Amelia Island Beach Nourishment Project are documented in greater detail in the *Post-Construction Documentation Report* (Olsen, 2022).

The project was constructed between July 27, 2021 and January 16, 2022 by S.J. Hamill / Marinex Construction, Inc. The Contractor employed the 24-inch cutterhead-suction pipeline dredge *Savannah*. The *Savannah* was also used for the 2011 nourishment. The fill limits of the 2021 renourishment of the South Amelia Island Beach Nourishment Project covered approximately 17,100 feet (3.2 miles) of the Atlantic Ocean shoreline (**Figure 1.1**). The project placed 1,858,000 cubic yards of beach quality sand (approximate total volume) from roughly R-59.5 southward to AP-25 (~R-76.5), approximately 2,300 feet north of the existing rock terminal groin. Fill tapers were constructed at both ends of the project to transition the fill to the existing shoreline. **Photograph 1.1** shows construction activities in the vicinity of The Residence (~R-72) on August 11, 2021.

Photograph 1.1: Southward view of the beach fill construction progress at The Residence on 11 Aug, 2021 near Station 65+00 (R-72).

Sand for the project was excavated from a 140-acre (56.6 hectare) borrow area located south-southeast of the southern tip of Amelia Island on the Nassau Sound ebb shoal. The borrow area connects one of the main tidal channels through Nassau Sound to the Atlantic Ocean in a fashion that mimics historic marginal tidal channels through the ebb shoal. A supplementary borrow area located on the outer contours of the ebb shoal was designed to be utilized in the event of a volume shortfall during a future project or for use immediately following a severe storm event. The supplemental borrow area was not utilized during the 2021 project. The permitted design depth of the borrow area varied between -17.0 and -18.0 ft-NAVD. **Photograph 1.2** shows dredging activities at the borrow area on December 30, 2021.

Photograph 1.2: View northward toward South Amelia Island of the Dredge Savannah excavating the shoal borrow area in Nassau Sound. (30 Dec. 2021)

Figure 1.3 depicts the "typical" design beach fill template for the 2021 beach nourishment project. The landward section of the upper beach berm is flat and built to an elevation +10 ft-NAVD. The seaward portion of the upper berm slopes from +10 ft-NAVD to +6.5 ft-NAVD over a constant width of 192.5 ft (1:55 slope). Seaward of the sloping berm, the fill template dips at a 1:15 slope to the intersection with the existing seabed. The design fill densities ranged between 55 and 152 cy/ft, not including the northern and southern fill tapers (±500 ft). The average design fill density for the entire 17,100 ft project shoreline was 105 cy/ft.

The shape of the beach fill template was intended to reduce post-construction scarping of the beach fill, reduce ponding of water on the new beach berm and assist in the crawl direction of sea turtle hatchlings following emergence from nests. The occurrence of beach scarps is generally dictated by the composition of the fill material and the amount of compaction resulting from the hydraulic fill process. Past projects at Amelia Island have exhibited significant scarping due to the coarse nature of the fill material placed. The lowering of the seaward edge of the berm in the 2021 project has thus far reduced the degree of scarping.

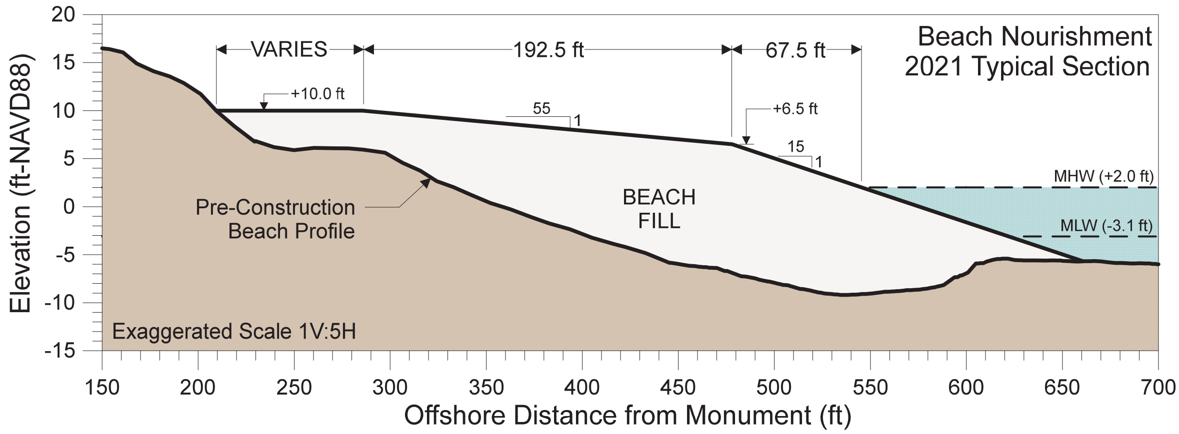

Figure 1.3: Typical beach fill construction template utilized in the 2021 SAI Project.

<u>November 2021 Nor'easter</u>

The largest recorded significant wave height over the construction period, -12.4 ft, occurred during the November 6, 2021 nor'easter. During this storm, waves exceeding 6 ft persisted for about 60 hours, and waves exceeding 10 ft persisted for about 11 hours. The maximum water level recorded during the nor'easter was approximately +5.66 ft-NAVD88 on November 7, 2021, the highest water level recorded at the Fernandina Beach tide station during the construction period. This surge level was 3.66 ft above MHW at the project area, although the measurement at the interior gauge is not wholly representative of the surge levels experienced on the beach. It should be noted that the nor'easter coincided with the highest astronomical tides of the year.

Beach fill operations stopped for approximately one week as a result of the storm (November 3rd to 10th). At the time of the storm, the Contractor had reached the vicinity of Beach Walker (R-66). The filled portions of the beach provided a storm buffer, the primary purpose of the project. The nor'easter contributed to accelerated profile equilibration and some post-storm erosion and scarping of the seaward edge of the fill berm was experienced along the filled portions. After the storm the Contractor graded down any scarps that formed along the already filled areas. In the unfilled areas north of R-66, the storm contributed additional erosion and scarping of the primary dunes.

1.5 Year Two Post-Construction – Wave & Water Level Climate

Figure 1.4 displays a time series of significant wave heights[3] measured at NOAA Buoy 41112[4] from July 2022 through June 2023. **Figure 1.5** presents the time series of water elevations recorded at the Fernandina Beach tide gauge (NOAA ID: 8729840)[5] during this period.

The average significant wave height at the Fernandina buoy during the Year Two post-construction period was 3.10 feet. This value is approximately 6.9% greater than the full buoy record average of 2.90 feet (March 2006 through June 2023). During this period, 5.0 percent of the recorded wave heights were over 6 ft, 2.7 percent over 8 ft, and 1.2 percent over 10 ft. All three percentages are greater than those of the full record averages of 4.1 percent (>6 ft), 1.0 percent (>8 ft), and 0.2 percent (>10 ft).

The largest wave heights recorded during Year Two occurred on September 30, 2022 and November 10, 2022 with peaks of 15.4 ft and 14.9 ft, respectively. These two peak wave heights were generated by Hurricane Ian in September and Hurricane Nicole in November. **Figure 1.6** depicts the storm tracks of Hurricanes Ian and Nicole. The passage of both tropical systems coincided with the seasonal high tides of the year, which typically occur in the fall from September to November. The third largest wave height was recorded on April 10, 2023 during a strong nor'easter with a peak wave height of 11.2 ft. For comparison, during Hurricanes Matthew (2016) and Irma (2017), wave heights at the buoy reached 19.6 ft and 21.0 ft, respectively.

The highest peak water levels recorded at the Fernandina Beach tide station during Year Two were also generated by Hurricanes Ian and Nicole with peaks of +6.1 ft-NAVD and +6.5 ft-NAVD, respectively. These water levels correspond to 3.7 ft and 4.1 ft above MHHW. For comparison, during Hurricanes Matthew and Irma, water levels reached +6.91 ft and +6.34 ft, respectively.

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[3] The significant wave height (H_s) is the average of the highest 1/3 of all the wave heights measured by the buoy instrument in a 20-minute sampling period. For that reason, individual waves in that 20-minute period may be much higher than the reported significant wave height, perhaps by a factor of up to two times. The gage lies in 51 ft of water, eight miles offshore. At that depth, depth-limited waves would break at a height of roughly 40 ft. It is not known specifically what was the highest wave height in that record.

[4] NOAA Buoy 41112 is located roughly 8 miles offshore of Fernandina Beach, FL in roughly 50 feet of water and approximately 16 miles northeast of the project area. The buoy was deployed in February 2006 and has since been collecting data nearly continuously for 16+ years. The data collected by the buoy include significant wave height (average of the highest one-third of all waves in a 20-minute sampling period), wave period, wave direction, wind speed and other standard meteorological data.

[5] The Fernandina Beach tide station is located on the Amelia River, approximately 10 miles north of the project area. The station collects readings of water level, wind speed, gust speed, atmospheric pressure, and other meteorological data. It is noted that the tide station is not located on the open coast but in a sheltered area. As such, water levels reported at the gage are likely to be somewhat lower than those experienced along the open coastline of Amelia Island.

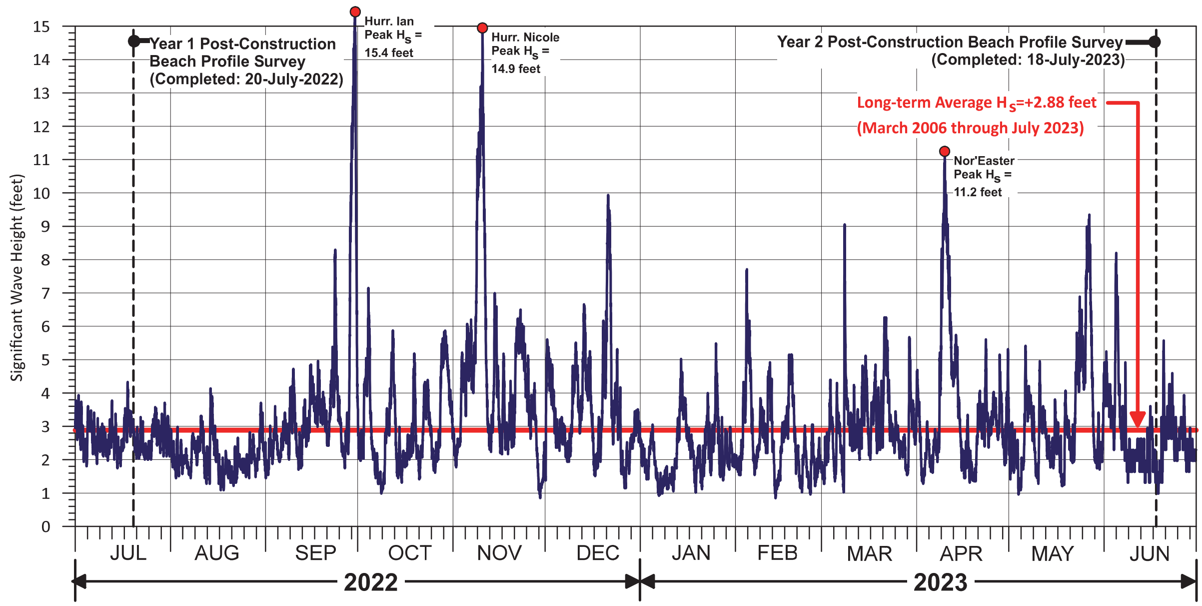

Figure 1.4: Offshore wave conditions measured during Year Two post-construction of the 2021 South Amelia Island Beach Nourishment Project. Wave data were obtained from NOAA at offshore data buoy 41112 (Fernandina).

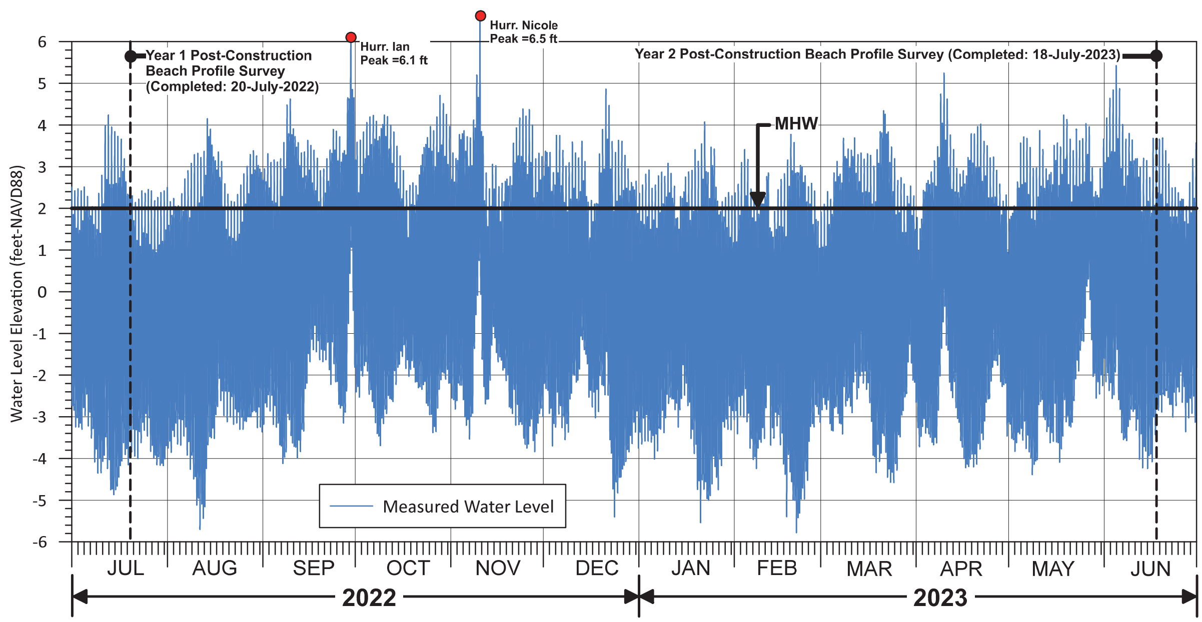

Figure 1.5: Water levels measured during Year Two post-construction of the 2021 South Amelia Island Beach Nourishment Project. Water level data were obtained from the Fernandina Beach tide station (8729840). Note that this tide station does not directly indicate the water levels along the open coast of south Amelia Island during the height of the storm.

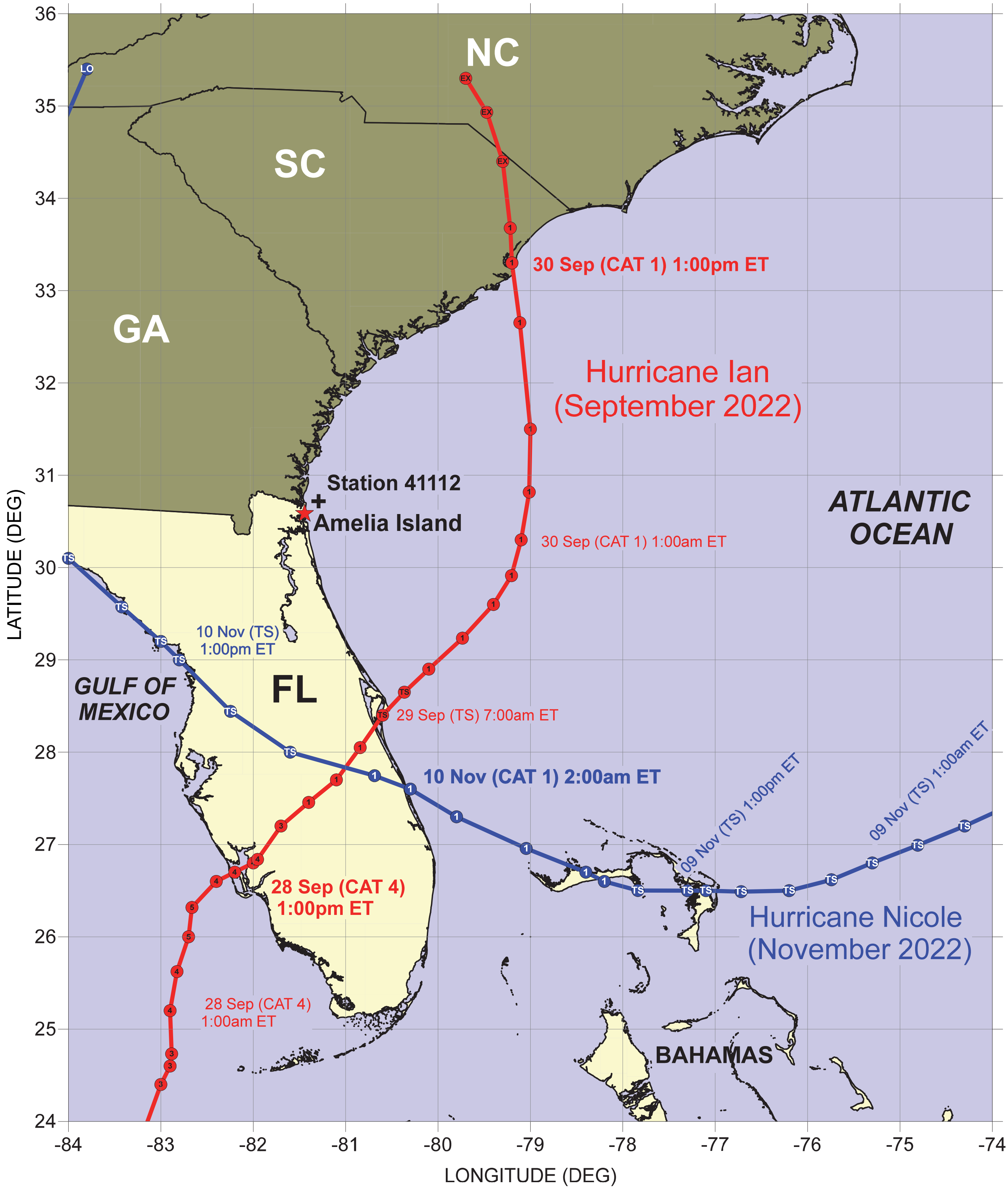

Figure 1.6: Storm Tracks of Hurricane Ian (Sept. 2022) and Hurricane Nicole (Nov. 2022).

2.0 Year Two Post-Construction Monitoring (Beach & Borrow Area)

2.1 Post-Construction Physical Monitoring Program

As specified in the project permit, the Permittee is required to perform post-construction physical monitoring as detailed in the *South Amelia Island Shoreline Stabilization Project Periodic Beach Renourishment – Physical Monitoring Plan*, dated October 26, 2020. The standards for all relevant data acquisition and submission requirements are published by the Department. Specific data requirements of the Plan include, at a minimum, topographic and bathymetric surveys of Nassau Sound, the borrow area and beach (onshore and offshore), borrow area sand sampling, orthorectified aerial photography, oblique drone imagery, and engineering analysis. The anticipated schedule of data collection and analysis for the first 5 years following project completion is provided in the Plan documentation referenced above and summarized in **Figure 2.1**. It is noted that the Plan can be revised at any later time by written request of the Permittee and with the written approval of the Department.

The monitoring data is necessary in order for both the project sponsor and the Department to regularly observe and quantitatively assess the performance of the project. The monitoring process will also provide the information necessary to plan, design and optimize future projects, potentially reducing the need for and costs of unnecessary work and potentially reducing environmental impacts. Additionally, the monitoring data aids in fulfilling the requirements of FEMA with respect to disaster relief eligibility by documentation beach conditions prior to a major storm event.

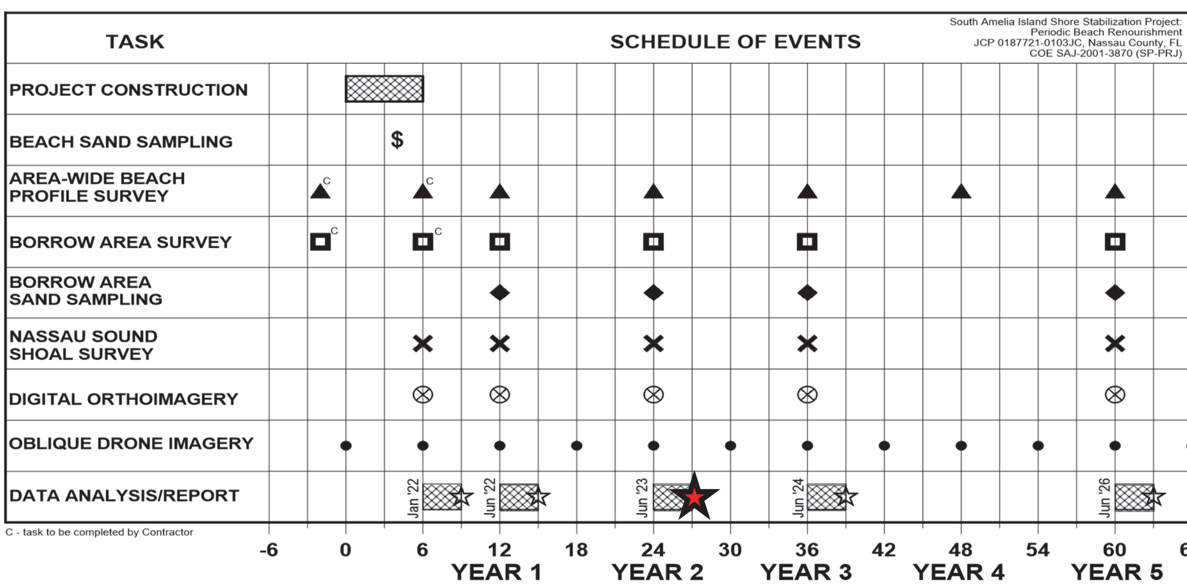

Figure 2.1: Schedule of monitoring events for the first five years following construction of the 2021 Beach Nourishment Project. This report represents the "Year 2" report submittal (red star).

2.2 Year Two Monitoring Data

In compliance with project permit conditions, the project QA/QC control plan and the post-construction physical monitoring program (see **Section 4.2**), the following physical data were collected for the "Year Two" post-construction monitoring effort:

Beach Profile Surveys

The Year Two Post-Construction beach profile survey was completed on June 09, 2023 by Arc Surveying & Mapping, Inc.[6] along roughly 28,210 feet of shoreline at approximate 1,000 feet intervals, utilizing the existing FDEP R-monuments (R-55 to R-82). Additional intermediate profiles at 500 feet intervals were surveyed along the southern portion of the project, beginning at R-73/AP-19 and extending to R-82. At R-79, additional profiles were surveyed at different azimuths to better document the shoreline condition of the curved sand spit south of the rock terminal groin. In all, forty-one (41) beach profiles were surveyed. See **Appendix A** for the survey drawings and **Appendices B & C** for profile plots. The locations of the survey monuments are listed in **Appendix B** in **Table B.1** and graphically depicted as **Figure B.1**. All beach profile surveys extend seaward from the R-monument to an approximate depth of -30.0 ft-NAVD (or consistent survey closure depth).

In this report, the Year Two post-construction survey is compared to the post-construction (January 2022) and the Year One (July 2022) beach profile surveys performed by Gahagan & Bryant Associates, Inc. (GBA)[7] and Arc Surveying & Mapping, Inc., respectively. All three beach profile surveys were performed utilizing the FDEP standards for survey data collection.

Borrow Area & Nassau Sound Bathymetric Surveys

The Year Two Post-Construction bathymetric survey of the 2021 Beach Nourishment Project borrow area and Nassau Sound was completed on June 6, 2023 by Arc Surveying & Mapping, Inc. See **Appendix F** for bathymetric plots of the Nassau Sound surveys conducted to date, including the Year Two survey.

Hydrographic soundings were collected via a Teledyne CV-100 single-beam sounder and topographic elevations (above the waterline) were generated with aerial LIDAR survey methods utilizing a Rock R2A LiDAR system mounted to a DJI M300 unmanned aerial vehicle (UAV). Vertical positioning was referenced to the NAVD88 vertical datum, and the horizontal measurements were referenced to the Florida State Plane System, East Zone, North American Datum of 1983 (NAD83).

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[6] Arc Surveying & Mapping, Inc.; 5202 San Juan Avenue, Jacksonville, FL 32210

[7] Gahagan & Bryant Assoc, Inc.; 3802 West Bay to Bay Blvd., Ste. B-22; Tampa, FL 33629. Tel: 813.831.4408, Web: www.gba-inc.com

For the borrow area analysis, the Year Two post-construction bathymetric survey is compared to the pre-construction (July 2021) and post-construction (January 2022) borrow area only surveys performed by Gahagan & Bryant Associates, Inc. (GBA). All three bathymetric surveys were performed utilizing the FDEP standards for survey data collection.

Orthorectified Aerial Photography

The Year Two Post-Construction orthorectified aerial photography of South Amelia Island and Nassau Sound was collected on June 25, 2023 by Kucera International, Inc[8]. at approximately low-tide. The photography was collected and processed per FDEP BIPP specifications. A copy of the flight report and metadata are included at the end of **Appendix E**. Future photography will be collected following the schedule shown in **Figure 2.1**, approximately concurrent with the corresponding beach profile monitoring surveys.

Oblique Aerial Drone Photography

In order to monitor project performance and the effects of the existing rock structures, low-altitude oblique aerial drone photography was acquired during the Year Two monitoring period. Olsen Associates, Inc. acquired eight photosets that reflect the conditions during this period (July 2022 - June 2022). These photosets are as follows.

- August 27, 2022
- October 01, 2022 (Post-Ian)
- November 11, 2022 (Post-Nicole)
- March 30, 2023
- April 12, 2023 (Pre-Tilling)
- April 14, 2023 (Post-Tilling)
- May 31, 2023
- August 27, 2023

Photosets from June 4, 2022 and August 8, 2022 were provided in the Year 1 monitoring report (Olsen 2022). Selected examples of the photography from each of these photosets are included in **Appendix D**.

[8] Kucera International, Inc.; 38133 Western Parkway; Willoughby, OH 44094

2.3 Volume and Shoreline Change Analysis Methodology

For purposes of analysis and discussion, the south Amelia Island monitoring shoreline is qualitatively broken into four shoreline segments (**Figure 2.2**), or zones of interest, each with significantly varying physiographic characteristics. The four zones are as follows:

- **"SAISS Project Area" (15,840 ft):** R-59 to Detached Breakwater (R-75 + 250ft)
- **"AISP Atlantic Shoreline" (3,420 ft):** Detached Breakwater to Terminal Groin (R-79D)
- **"AISP Sound Shoreline" (4,750 ft):** Terminal Groin (R-79D) to R-82
- **"North of Project Area" (4,200 ft):** R-55 to R-59 (Northern Limit of 2011 project)

Additionally, the area that received direct placement of sand during the 2021 Dredging & Beach Nourishment Project was examined (R-59.5 to AP-25).

Alongshore **volume changes** were calculated using an average end-area method, where the cross-sectional areas are determined by comparing beach profiles at each beach monitoring station above several different vertical datums. This approach allows evaluation of beach changes at different elevations along the project in addition to the total profile. For this analysis volume changes were calculated in 0.5 ft vertical increments from +15.0 ft-NAVD to -30 ft-NAVD. Volume changes above the MHWL (+2.0 ft-NAVD), the approximate toe of fill (-10 ft-NAVD) and the typical depth of survey closure (-20 ft-NAVD) are summarized in tabular form in **Table 2.1** (Year-1 to Year 2) and **Table 2.2** (Post-construction to Year-2).

Shoreline position changes were computed at the nominal fill berm elevation of +6.5 ft-NAVD, and the MHWL (+2.0 ft-NAVD). The average shoreline changes along given reaches were calculated by spatially weighting the changes at individual monuments based upon the variable distance between monuments. Please note that at the southern end of the island, in the vicinity of R-79, berm location measurements are incomplete for some survey dates and profiles due to upland beach access restrictions related to nearby nesting and roosting shorebirds. The shoreline changes since construction completion are summarized in tabular form in **Table 2.3.**

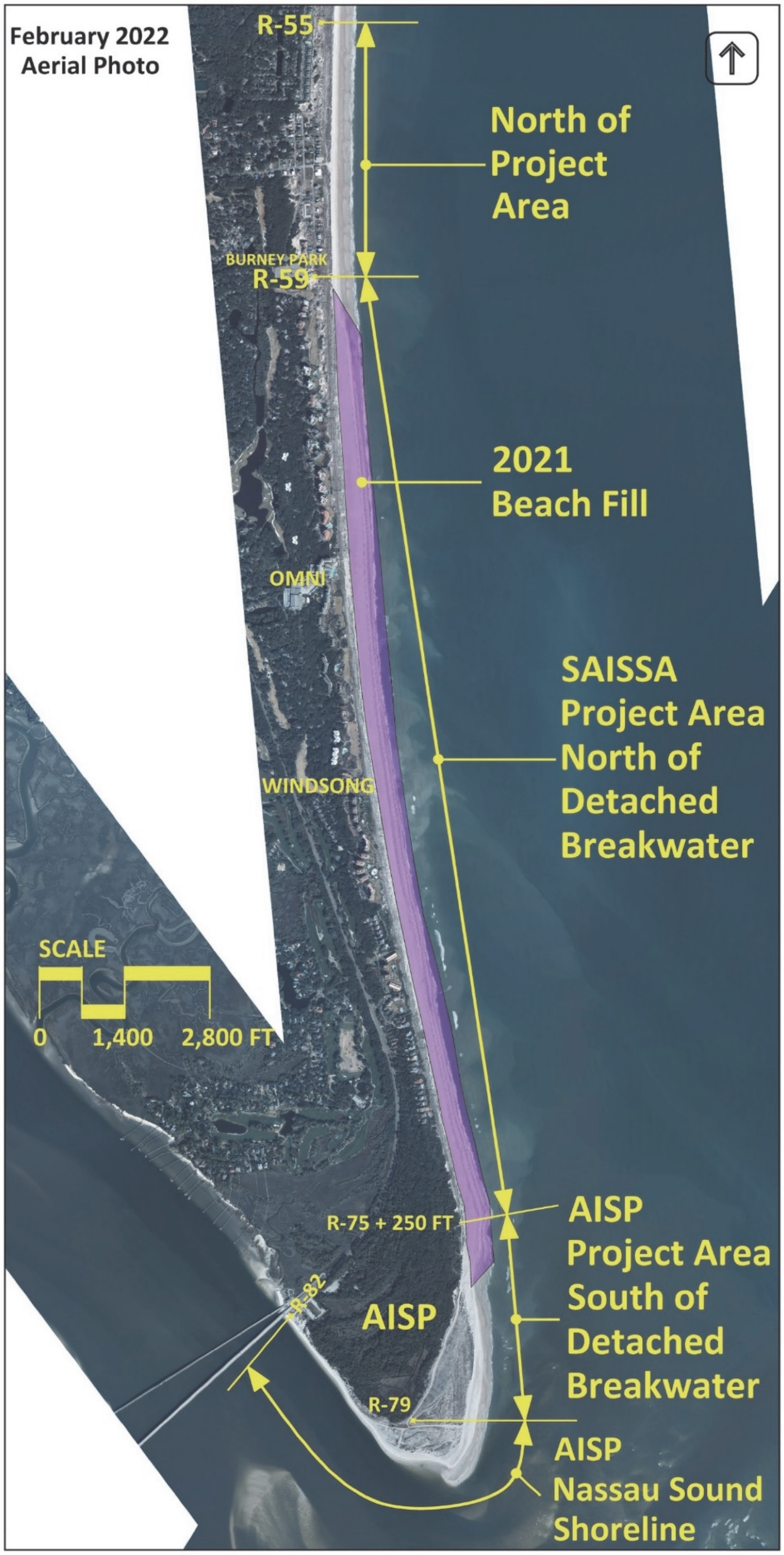


Figure 2.2: Locations of South Amelia Island monitoring zones of shoreline analysis.

Table 2.1: Volume changes during the most recent intersurvey period
from Year 1 to Year 2 (July 2022 to June 2023), 2021 Beach Nourishment Project.

Start Mon.	End Mon.	Reach (ft)	Volume Change Above Datum (cy)			
			MHWL	-10 ft-NAVD	-20 ft-NAVD	MHWL to -20 ft
R-55	R-56	1,190	-5,400	-35,200	+2,300	+7,700
R-56	R-57	1,060	-4,300	-23,500	+14,100	+18,400
R-57	R-58	990	-2,300	-17,800	+19,200	+21,500
R-58	R-59	960	+1,100	-17,100	+18,600	+17,500
North of Project Area (R-55 to R-59):		**4,200**	**-10,900**	**-93,600**	**+54,200**	**+65,100**
R-59	R-60	1,020	-11,000	-35,700	+7,200	+18,200
R-60	R-61	940	-24,000	-44,800	+1,300	+25,300
R-61	R-62	1,080	-26,400	-42,100	+10,100	+36,500
R-62	R-63	910	-21,900	-39,600	-2,800	+19,100
R-63	R-64	950	-22,800	-44,900	-8,500	+14,300
R-64	R-65	940	-15,000	-33,200	+4,000	+19,000
R-65	R-66	920	-8,500	-32,700	-100	+8,400
R-66	R-67	930	-4,900	-28,100	+8,400	+13,300
R-67	R-68	990	-6,900	-19,900	+21,000	+27,900
R-68	R-69	1,050	-3,700	-14,600	+22,500	+26,200
R-69	R-70	970	+1,200	-11,800	+16,200	+15,000
R-70	R-71	1,000	-2,000	-21,800	+2,400	+4,400
R-71	R-72	900	-800	-17,300	+3,000	+3,800
R-72	A-19	990	-4,200	-9,200	+29,700	+33,900
A-19	A-20	490	-3,800	-3,300	+21,700	+25,500
A-20	A-21	540	-2,600	-5,100	+16,600	+19,200
A-21	A-22	510	-1,200	-5,000	+5,800	+7,000
A-22	R-75	460	-1,100	-5,300	-5,300	-4,200
R-75	Detached Breakwater	250	-1,700	-3,400	-2,500	-800
SAISS Project Area (R-59 to DB):		**15,840**	**-161,300**	**-417,800**	**+150,700**	**+312,000**
Detached Breakwater	A-23	260	-2,500	-2,900	+300	+2,800
A-23	A-24	430	-3,200	-5,300	-3,600	-400
A-24	A-25 [1]	410	-3,100	-10,100	-13,100	-10,000
A-25 [1]	R-77 [1]	470	-7,000	-20,700	-23,400	-16,400
R-77 [1]	R-77.5	510	-6,900	-20,600	-23,400	-16,500
R-77.5	R-78	480	-300	+2,800	+2,000	+2,300
R-78	R-78.5	410	+3,200	+13,700	+15,100	+11,900
R-78.5	R-79D	360	+3,400	+13,200	+13,200	+9,800
R-79D	TG	90	+800	+4,100	+4,100	+3,300
Subtotal (DB to Terminal Groin)		**3,420**	**-15,600**	**-25,800**	**-28,800**	**-13,200**
TG	R-79	560	+2,800	+6,100	+6,300	+3,500
R-79	R-79B	400	+5,800	+44,100	+48,500	+42,700
R-79B	R-79C	400	+3,700	+39,800	+44,100	+40,400
R-79C	R-79A	480	-1,900	-4,900	-3,800	-1,900
R-79A	R-79.5	390	-500	+1,600	+1,300	+1,800
R-79.5	R-80	560	+100	+7,500	+5,700	+5,600
R-80	R-80.5	490	+500	+3,000	+1,100	+600
R-80.5	R-81	470	+600	+1,500	-500	-1,100
R-81	R-81.5	500	+300	+1,000	+300	+0
R-81.5	R-82	500	-200	+300	-100	+100
Subtotal (Terminal Groin to R-82)		**4,750**	**+11,200**	**+100,000**	**+102,900**	**+91,700**
Total Monitored Area (R-55 to R-82)		**28,210**	**-176,600**	**-437,200**	**+279,000**	**+455,600**

(1) June 2022 profiles extended landward by inspection of adjacent and recent profiles to approximate landward closure.

Table 2.2: Volume changes since construction of the 2021 Beach Nourishment Project **from Post-construction to Year 2** (January 2022 to June 2023).

Start Mon.	End Mon.	Reach (ft)	Volume Change Above Datum (cy)			
			MHWL	-10 ft-NAVD	-20 ft-NAVD	MHWL to -20 ft
R-55	R-56	1,190	-1,000	-26,900	+400	+1,400
R-56	R-57	1,060	+100	-12,500	+16,100	+16,000
R-57	R-58	990	+3,400	-2,400	+26,400	+23,000
R-58	R-59	960	+8,800	+8,200	+37,600	+28,800
North of Project Area (R-55 to R-59):		**4,200**	**+11,300**	**-33,600**	**+80,500**	**+69,200**
R-59	R-60	1,020	-9,100	-17,900	+21,000	+30,100
R-60	R-61	940	-24,500	-41,600	+1,300	+25,800
R-61	R-62	1,080	-27,300	-48,900	-2,300	+25,000
R-62	R-63	910	-27,200	-57,400	-25,000	+2,200
R-63	R-64	950	-27,400	-62,100	-29,500	-2,100
R-64	R-65	940	-19,100	-43,200	-11,600	+7,500
R-65	R-66	920	-13,900	-38,400	-10,900	+3,000
R-66	R-67	930	-11,000	-33,600	-4,100	+6,900
R-67	R-68	990	-10,400	-23,900	+9,700	+20,100
R-68	R-69	1,050	-6,600	-15,200	+14,400	+21,000
R-69	R-70	970	-3,200	-17,800	+2,500	+5,700
R-70	R-71	1,000	-5,000	-30,300	-7,600	-2,600
R-71	R-72	900	-2,200	-16,300	+1,600	+3,800
R-72	A-19	990	-9,400	-11,700	+16,300	+25,700
A-19	A-20	490	-7,800	-11,400	+5,400	+13,200
A-20	A-21	540	-7,900	-18,500	-3,100	+4,800
A-21	A-22	510	-7,200	-17,200	-8,800	-1,600
A-22	R-75	460	-6,700	-16,600	-16,900	-10,200
R-75	Detached Breakwater	250	-4,200	-12,500	-12,700	-8,500
SAISS Project Area (R-59 to DB):		**15,840**	**-230,100**	**-534,500**	**-60,300**	**+169,800**
Detached Breakwater	A-23	260	-4,500	-14,300	-14,100	-9,700
A-23	A-24	430	-3,000	-17,900	-20,000	-17,000
A-24	A-25	410	+1,700	-6,400	-12,700	-14,400
A-25	R-77	470	-800	-12,600	-17,400	-16,600
R-77	R-77.5	510	-2,500	-29,300	-33,400	-30,900
R-77.5	R-78	480	+2,000	-16,200	-18,100	-20,100
R-78	R-78.5	410	+4,600	+4,200	+5,800	+1,200
R-78.5	R-79D	360	-100	+5,000	+5,000	+5,100
R-79D	TG	90	-1,200	+400	+400	+1,600
Subtotal (DB to Terminal Groin)		**3,420**	**-3,800**	**-87,100**	**-104,500**	**-100,800**
TG	R-79	560	+6,200	-4,100	-5,800	-12,000
R-79	R-79B	400	+8,300	+43,100	+49,300	+41,000
R-79B	R-79C	400	+4,900	+41,000	+47,900	+43,000
R-79C	R-79A	480	-900	-13,400	-14,800	-13,900
R-79A	R-79.5	390	+1,000	-3,300	-5,100	-6,100
R-79.5	R-80	560	+500	+7,300	+6,400	+5,900
R-80	R-80.5	490	+0	+300	-300	-300
R-80.5	R-81	470	+600	+0	-600	-1,200
R-81	R-81.5	500	+300	+1,000	+800	+500
R-81.5	R-82	500	+0	+600	+300	+300
Subtotal (Terminal Groin to R-82)		**4,750**	**+20,900**	**+72,500**	**+78,100**	**+57,200**
Total Monitored Area (R-55 to R-82)		**28,210**	**-201,700**	**-582,700**	**-6,200**	**+195,400**

Table 2.3: Shoreline changes **from Year 1 to Year 2** (January 2022 to June 2022), and **from Post-construction to Year 2** (January 2022 to June 2023).

Reach	R-Mon	Shoreline Change between Year 1 & Year 2 Monitoring Surveys (ft) July 2022 to June 2023		Shoreline Change between Post-Construction & Year 2 Monitoring Surveys (ft) January 2022 to June 2023	
		Berm (+6.5 ft-NAVD)[1]	MHWL (+2.0 ft-NAVD)	Berm (+6.5 ft-NAVD)[1]	MHWL (+2.0 ft-NAVD)
North of 2021 Fill Area	R-55	-12.7	+29.3	-13.4	+45.5
	R-56	-9.3	+18.6	-6.5	+44.2
	R-57	-8.4	+8.3	-7.7	+21.0
	R-58	+2.3	+18.1	+5.6	+69.4
	R-59	+10.4	-11.2	+3.3	+109.0
2021 Fill Area	R-60	-160.4	-59.0	-152.2	-68.3
	R-61	-158.2	-59.9	-131.9	-59.8
	R-62	-137.7	-62.1	-151.3	-101.7
	R-63	-139.8	-86.2	-149.7	-123.9
	R-64	-113.5	-56.8	-131.7	-82.7
	R-65	-82.4	-50.9	-95.8	-72.0
	R-66	-41.0	-27.9	-56.5	-67.0
	R-67	-24.0	-16.2	-40.5	-50.8
	R-68	-38.2	-25.3	-47.5	-41.7
	R-69	-59.0	-25.0	-74.9	-31.7
	R-70	-55.8	-24.9	-59.5	-57.3
	R-71	-28.6	-12.6	-17.7	-22.3
	R-72	-67.0	+9.0	-63.8	+2.8
	A-19	-95.7	-11.6	-117.6	-47.1
	A-20	-80.1	-21.5	-98.3	-58.4
	A-21	-88.6	-17.8	-121.6	-65.5
	A-22	-65.5	-12.0	-107.6	-71.8
	R-75	-85.7	-4.3	-142.4	-87.5
	A-23	-44.8	-17.3	-25.9	-109.7
	A-24	-70.9	-72.5	+35.8	-63.0
	A-25	-115.0	-70.6	+36.8	-20.2
South of 2021 Fill Area	R-77	NA	-126.8	+15.8	-80.5
	R-77.5	+6.4	-57.2	+14.4	-86.0
	R-78	+71.3	+7.1	+75.8	-16.9
	R-78.5	+79.7	-13.7	NA	-54.8
	R-79D	+118.3	+51.7	+118.9	-63.3
	R-79	-34.1	+61.0	NA	+97.0
	R-79B	-4.7	+302.5	NA	+367.8
	R-79C	-17.7	-34.2	NA	-100.9
	R-79A	+24.7	-46.5	NA	-73.5
	R-79.5	+1.0	-1.5	-2.1	-0.4
	R-80	-6.0	+16.1	-7.4	+6.8
	R-80.5	+1.3	+3.7	+0.4	-2.6
	R-81	-0.2	+6.8	-1.4	+4.0
	R-81.5	+0.0	+3.3	-2.2	+1.6
	R-82	-1.4	+2.8	+1.0	+2.6

(1) Values of "NA" indicate areas where upland beach access was limited by the Park for either the post-or Yr-1 or Yr-2 post-construction surveys due to concerns regarding potential impacts to nearby nesting shorebirds.

2.4 Year-2 Shoreline & Volume Changes (July 2022 to June 2023)

This section details the shoreline and volume changes during the Year-2 post-construction monitoring period. This most recent intersurvey period between the Year-1 and Year-2 monitoring surveys spans 11 months from July 2022 to June 2023. This period includes the impacts of Hurricanes Ian (September 2022) and Nicole (November 2022).

Figure 2.3 graphically presents the alongshore distribution and cumulative summation of volume changes along the entire monitored shoreline (i.e. R-55 to R-82). **Figures 2.4** and **2.5**, graphically depict the positions at each R-monument during this period at the berm and MHWL locations, respectively. The position of the post-construction berm and MHWL are included for reference.

2.4.1 Entire Monitored Shoreline (R-55 to R-82)

Beach profile surveys from July 2022 to June 2023 indicate that the entire monitored shoreline (R-55 in American Beach to R-82 at the A1A bridge) experienced a volume loss of -176,600 cy above MHW and a volume gain of +455,600 cy below MHW which yields a net positive volume change of +279,000 cy during this period. Changes within the four primary monitoring zones of interest are discussed in the following subsections.

2.4.2 2021 Project Area (R-59.5 to AP-25)

The Year-1 and Year-2 post-construction monitoring surveys indicate that the 2021 beach fill area lost approximately -164,600 cy above the MHWL and gained +295,300 cy below the MHWL for a total change of +130,700 cy above -20 ft-NAVD. Measured above -10 ft-NAVD (roughly the offshore limit of fill placement), the project area lost -418,300 cy.

Figure 2.6 depicts the measured volume changes during Year-2 in 0.5 ft vertical increments along the 2021 project area. Volume gain (green bars) of +71,800 cy above +9.5 ft-NAVD signals dune growth attributed to windblown sand accumulating mostly along the dune toe. Between +9.5 and -7.5 ft-NAVD the beach experienced a volume loss (red bars) of -585,300 cy. Below -7.5 ft-NAVD the beach gained +644,200. In keeping with the expected beach equilibrium processes, all of the measured “losses” along the upper beach were offset by “gains” in the nearshore zone, principally between -7.5 ft and -20 ft-NAVD. Contributing to the equilibration process were the effects of Hurricanes Ian, Nicole and a few strong nor’easter events during the monitoring period.

On weighted average, the berm and MHWL receded by about -84.4 ft and -35.3 ft, respectively. The largest overall shoreline recession was observed near the northern end of the fill (**Figures 2.4** and **2.5**). The largest berm recession occurred at R-60 (-160.4 ft), located at the old 16th fairway and the largest MHWL recession occurred at R-63 (-86.2 ft), located at Sand Castles.

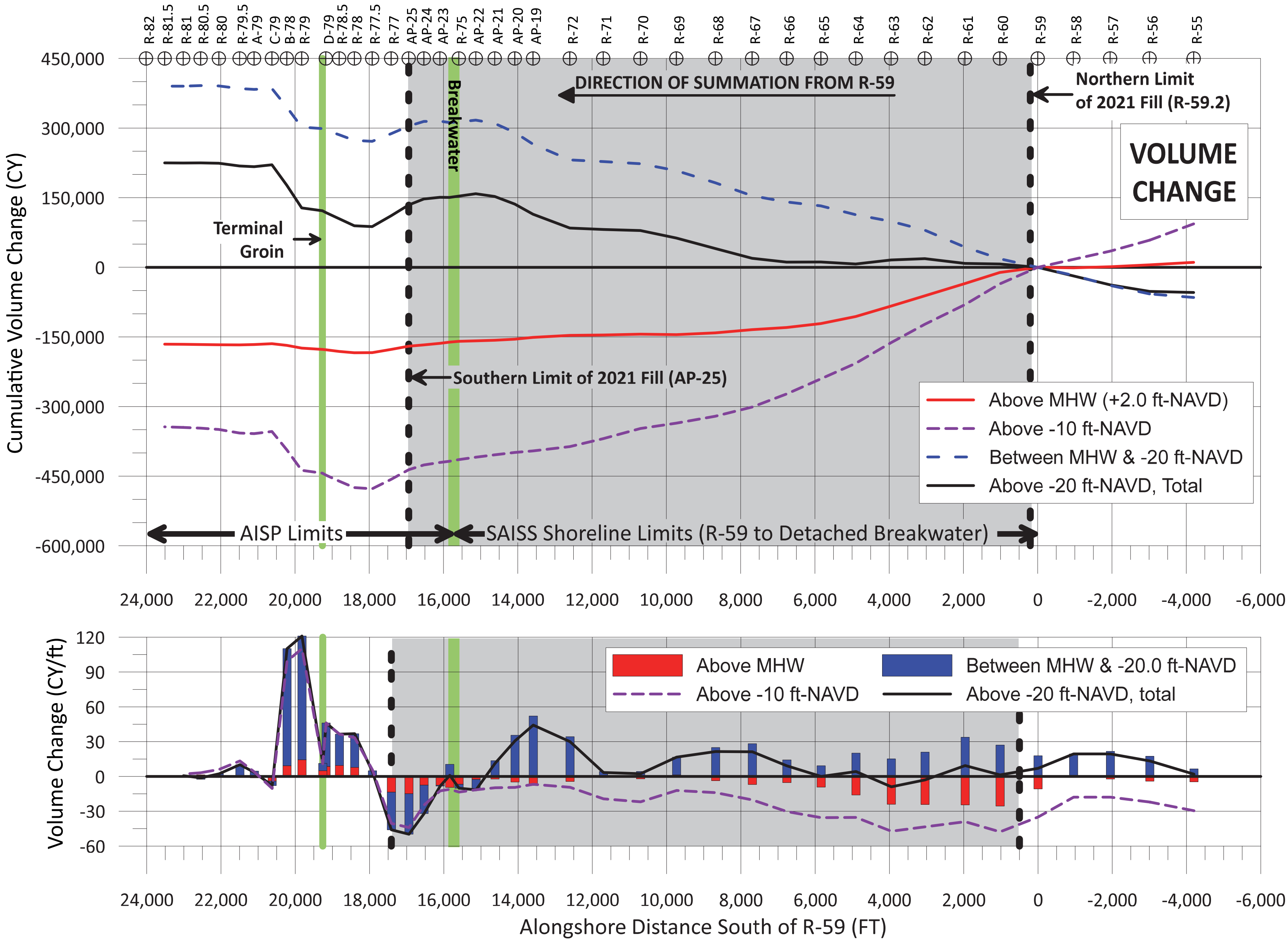


Figure 2.3: Recent intersurvey beach volume changes (July 2022 to June 2023), South Amelia Island, FL.

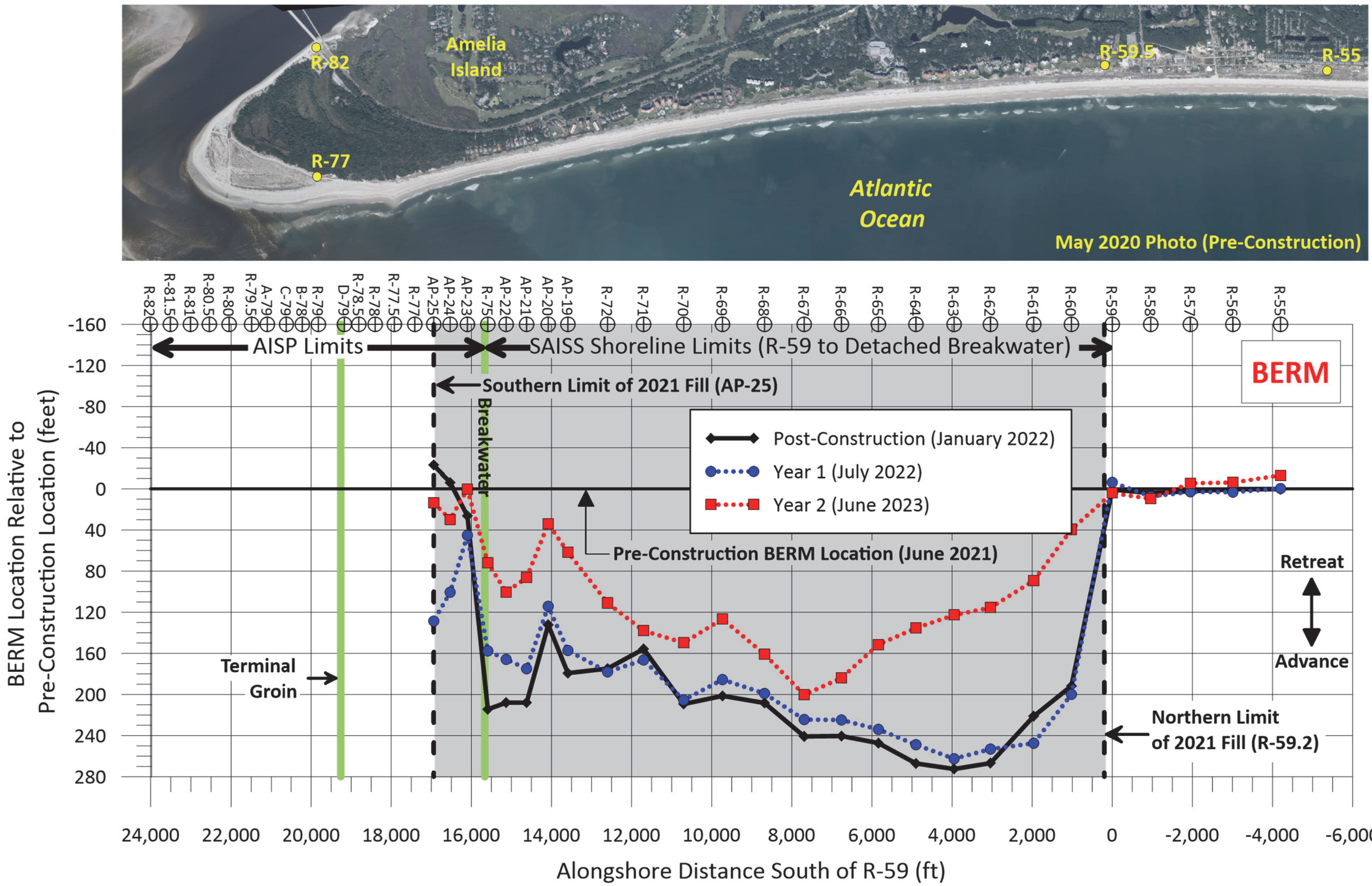


Figure 2.4: Post-, Year-1 and Year-2 post-construction BERM locations changes relative to June 2021 pre-construction location.
Note: Upland beach access is limited by the park due to concerns regarding potential impacts to nesting shorebirds resulting in some profile surveys not extending up to the berm elevation.

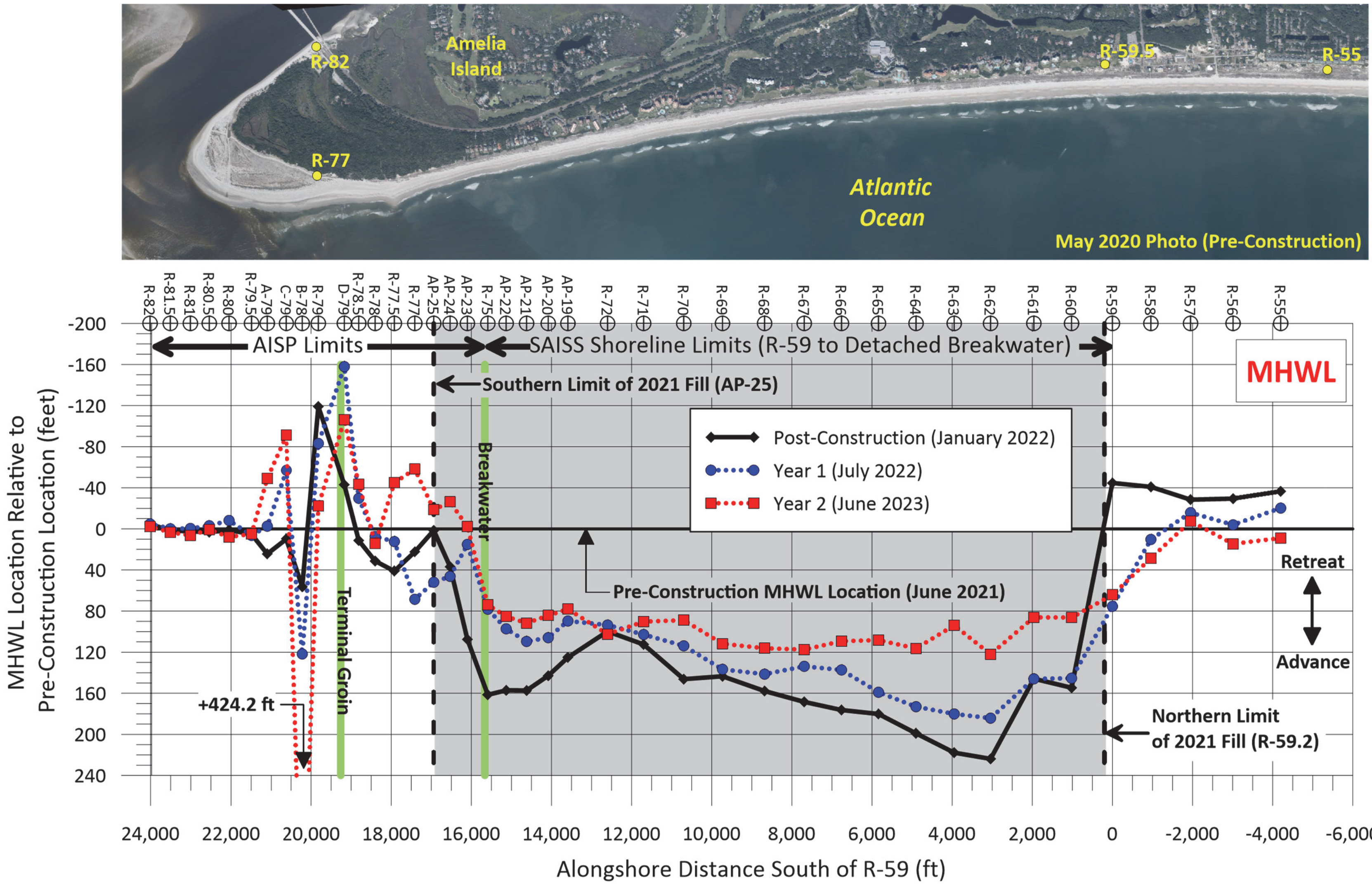


Figure 2.5: Post-, Year-1 and Year-2 post-construction MHWL locations changes relative to June 2021 pre-construction location.

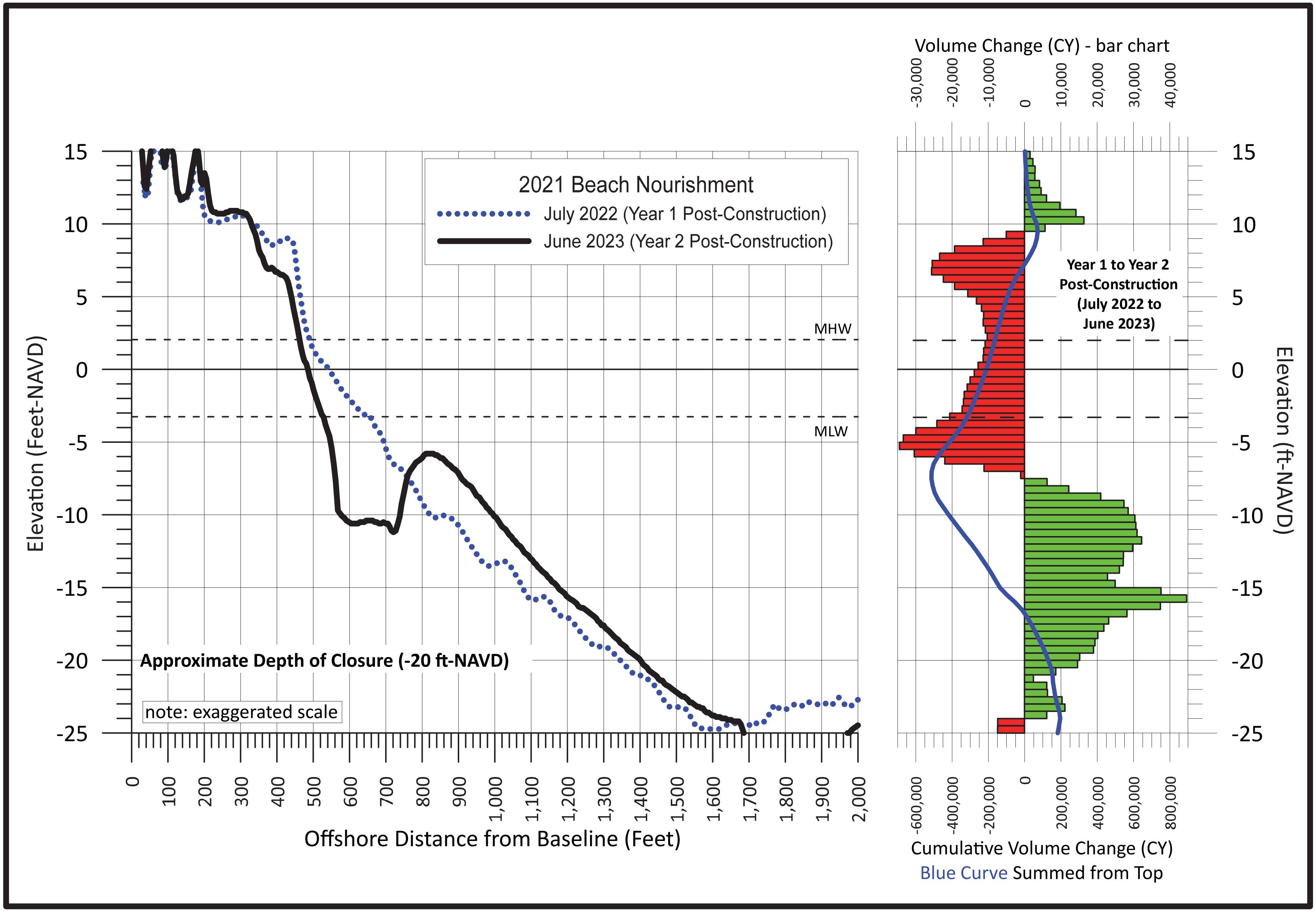


Figure 2.6: Vertical distribution of the volume changes for the 2021 beach nourishment along south Amelia Island from during the **most recent intersurvey period from July 2022 to June 2023** between R-59.5 and AP-25 (fill limits). The graph on the right depicts the volume changes measured at half foot vertical intervals (bar chart), as well as a summation of the total volume change measured from the dunes seaward to survey closure (blue curve).

As mentioned, Hurricanes Ian and Nicole impacted the project area in 2022. A post-Nicole survey of the SAISSA project limits in January 2023 revealed a storm-related loss of 301,850 cy above -20 ft NAVD. The June 2023 surveys suggest that some level of recovery may have occurred since that time, although the recovery appears to be concentrated in the offshore portions of the profile. It is recognized that a) storm erosion affected the entire Amelia Island shoreline, hence some of the measured accretion may be the result of sand migrating into the project limits from the north, and b) the offshore areas of the survey carry the most uncertainty in calculation, due to the limited transect data used to characterize the broad offshore areas of the beach profiles. Future surveys will assist in further refining the offshore volume changes.

2.4.3 Monitoring Sub-Reaches

Table 2.3 summarizes the volume changes and **Table 2.4** the shoreline changes by monitoring sub-reach. The most recent intersurvey period changes along each reach are described below.

North of the project area (R-55 to R-59), the 4,200 ft of shoreline experienced a loss of -10,900 cy (-2.6 cy/ft) above the MHWL and a gain of +65,100 cy (+15.5 cy/ft) below the MHWL for a net gain of +54,200 cy (+12.9 cy/ft) above -20 ft-NAVD. During this period the berm receded by a weighted average of -4.5 ft while the MHWL advanced by +13.9 ft. The volume gains and advance of the MHWL observed here may be attributed to the spreading of beach fill northward toward the adjacent shoreline. The retreat of the berm and erosion above the MHWL in this segment are the result of storm waves which eroded some of the dune during this period. **Photograph 2.1** shows the shoreline conditions looking north at R-59 (Burney Park) on August 27, 2023.

Photograph 2.1: Northward looking view at R-59 (Burney Park) on 27-August-2023.

Table 2.4: South Amelia Island volume changes during the most recent intersurvey period (July 2022 to June 2023).

Description:	North of Project Area	SAISS Project Area	AISP Atlantic Shoreline	AISP Sound Shoreline	Entire Monitored Area
R-Mons:	R-55 to R-59	R-59 to DB[1]	DB to TG[2]	TG to R-82	R-55 to R-82
Reach:	4,200 ft	15,840 ft	3,420 ft	4,750 ft	28,210 ft
Datum	Measured Volume Change (cy)				
Above MHWL	-10,900	-161,300	-15,600	+11,200	-176,600
Above -10 ft-NAVD	-93,600	-417,800	-25,800	+100,000	-437,200
MHWL to -20 ft-NAVD	+65,100	+312,000	-13,200	+91,700	+455,600
Total above -20 ft-NAVD	**+54,200**	**+150,700**	**-28,800**	**+102,900**	**+279,000**

[1] Detached Breakwater located at R-75 + 250 feet

[2] Terminal Groin located at R-79D

Table 2.5: South Amelia Island shoreline changes during the most recent intersurvey period (July 2022 to June 2023).

Description:	North of Project Area	SAISS Project Area	AISP Atlantic Shoreline	AISP Sound Shoreline	Entire Monitored Area
R-Mons:	R-55 to R-59	R-59 to DB[1]	DB to TG[2]	TG to R-82	R-55 to R-82
Reach:	4,200 ft	15,840 ft	3,420 ft	4,750 ft	28,210 ft
Datum	Weighted Average Shoreline Change (ft)				
BERM	-4.5	-82.0	NA	-45.8	NA
MHWL	+13.9	-33.1	-43.4	+31.0	-16.5

[1] Detached Breakwater located at R-75 + 250 feet

[2] Terminal Groin located at R-79D

[3] Values of "NA" indicate areas where upland beach access was limited by the Park for either the pre- or post-construction surveys due to concerns regarding potential impacts to nearby nesting shorebirds.

Along the SAISS project area (R-59 to the detached breakwater), the 15,840 ft of shoreline lost roughly -161,300 cy (-10.2 cy/ft) above the MHWL and gained +312,000 cy (+19.7 cy/ft) below the MHWL for a net gain of +150,700 cy (+9.5 cy/ft) above -20 ft-NAVD. Above the approximate toe of fill (-10 ft-NAVD), the shoreline lost -417,800 cy during Year-2 or approximately -23.4 percent of the estimated +1,786,431 cy placed along this project reach (BD/AD total placed estimate). The overall net volume gain suggests the lost volume remains on the project shoreline in the submerged nearshore, principally between depths of 10 to 20 ft, offshore of the primary bar in the profile. During this period, the berm and MHWL receded by weighted averages of -82.0 ft and -33.1 ft, respectively. **Photograph 2.2** shows the shoreline conditions looking southward looking view at R-69 (Sea Dunes) on 27-August-2023

Photograph 2.2: Northward looking view at R-69 (Sea Dunes) on 27-August-2023.

Along the AISP Atlantic shoreline (detached breakwater to terminal groin), the 3,420 ft of shoreline experienced a loss of roughly -15,600 cy (-4.6 cy/ft) above the MHWL and -13,200 cy (-3.8 cy/ft) below the MHWL for a net loss of -28,800 cy (-8.4 cy/ft) above -20 ft-NAVD. During project construction, approximately 71,645 cy (BD/AD total placement estimate) was placed between the detached breakwater (R-75+250 ft) to AP-25. Along this reach, the shoreline lost -18,300 cy during Year-2 above the approximate toe of fill (-10 ft-NAVD), or approximately 25.6 percent of the placed volume. During this period, the MHWL receded by a weighted average -43.4 ft. The weighted berm change was unable to be calculated along this reach as upland survey beach access was limited by the Park at one of the monuments for the post-construction survey due to concerns regarding impacts to nearby nesting shorebirds. **Photograph 2.3** shows the shoreline conditions looking southward from The Sanctuary (AP-20) and **Photograph 2.4** looking northward from the south end of Amelia Island on August 27, 2023.

Photograph 2.3: Southward looking view toward the detached breakwater from The Sanctuary (AP-20) on 27-August-2023.

Photograph 2.4: Northward looking view from the south end of Amelia Island on 27-August-2023.

The 4,750 ft of AISP shoreline south of the terminal groin (terminal groin to R-82), gained +11,200 cy (+2.4 cy/ft) above the MHWL and +91,700 cy (+19.3 cy/ft) below the MHWL for a net gain of +102,900 cy (+21.7 cy/ft) above -20 ft-NAVD. During this period, the berm receded by a weighted average of -45.8 ft and the MHWL advanced by weighted average of +31.0 ft. These changes are indicative of the accretion occurring primarily due to the southward sand migration from the project shoreline. The aerial view in **Photograph 2.4** depicts this sand accretion as a "lobe" of sand south of the terminal groin and around the tip of the Island.

2.5 Post-Construction to Year-2: Shoreline & Volume Changes

This section details the shoreline and volume changes since the post-construction survey of January 2022. The 17-month monitoring period immediately follows the placement of +1,800,000 cy (pay volume) of beach fill between R-59.2 and AP-25 (~R-76.5).

Figure 2.7 graphically presents the alongshore distribution and cumulative summation of volume changes along the entire monitored shoreline (i.e. R-55 to R-82) during this period. Refer to **Figures 2.4** and **2.5** for a graphical depiction of the berm and MHWL shoreline positions at each R-monument for the post-construction (January 2022), Year 1 (July 2022), and Year-2 (June 2023) relative to the pre-construction shoreline (June 2021).

2.5.1 Entire Monitored Shoreline (R-55 to R-82)

Beach profile surveys from January 2022 to June 2023 indicate that the entire monitored shoreline (R-55 in American Beach to R-82 at the A1A bridge) experienced a volume loss of -201,700 cy above MHW and a volume gain of +113,600 cy below MHW which yields a net loss of -88,100 cy since post-construction. Changes within the four primary monitoring zones of interest are discussed in the following subsections.

2.5.2 2021 Project Area (R-59.5 to AP-25)

The post-construction and Year-2 surveys indicate that the 2021 beach fill area lost approximately -231,400 cy above the MHWL and gained +113,700 cy below the MHWL for a total change of -117,700 cy above -20 ft-NAVD. Measured above -10 ft-NAVD (roughly the offshore limit of fill placement), the placement area lost -534,500 cy.

Figure 2.8 depicts the measured volume changes during Year-2 in 0.5 ft vertical increments along the 2021 project area. The project area experienced a volume gain (green bars) of +55,200 cy above +9.5 ft-NAVD, a volume loss (red bars) of -640,700 cy between +9.5 and -8.5 ft-NAVD, and a volume gain of +467,800 cy below thereof. As previously discussed, this volume change pattern indicates some dune growth and the exchange of sand from the placement fill to the submerged nearshore. The fill losses observed during this period include the typical beach equilibration process, the effects of Hurricanes Ian (Sep 2022), Hurricane Nicole (Nov 2022), and a few strong nor'easters.

On weighted average, the berm and MHWL receded by about -92.0 ft and -54.9 ft, respectively. The largest shoreline recession was observed toward the north end of the fill (**Figures 2.4** and **2.5**). During this period, the largest berm recession occurred at R-60 (-152.2 ft), located at the 16th fairway and the largest MHWL recession occurred at R-63 (-123.9 ft), located at Sand Castles. Only three profiles (AP-23 through AP-25, around the breakwater and into the AISP property) exhibited a MHW position landward of the pre-constriction MHWL. Overall, the beach remains roughly 106 ft (berm) and 89 ft (MHWL) seaward of the June 2021 pre-construction location.

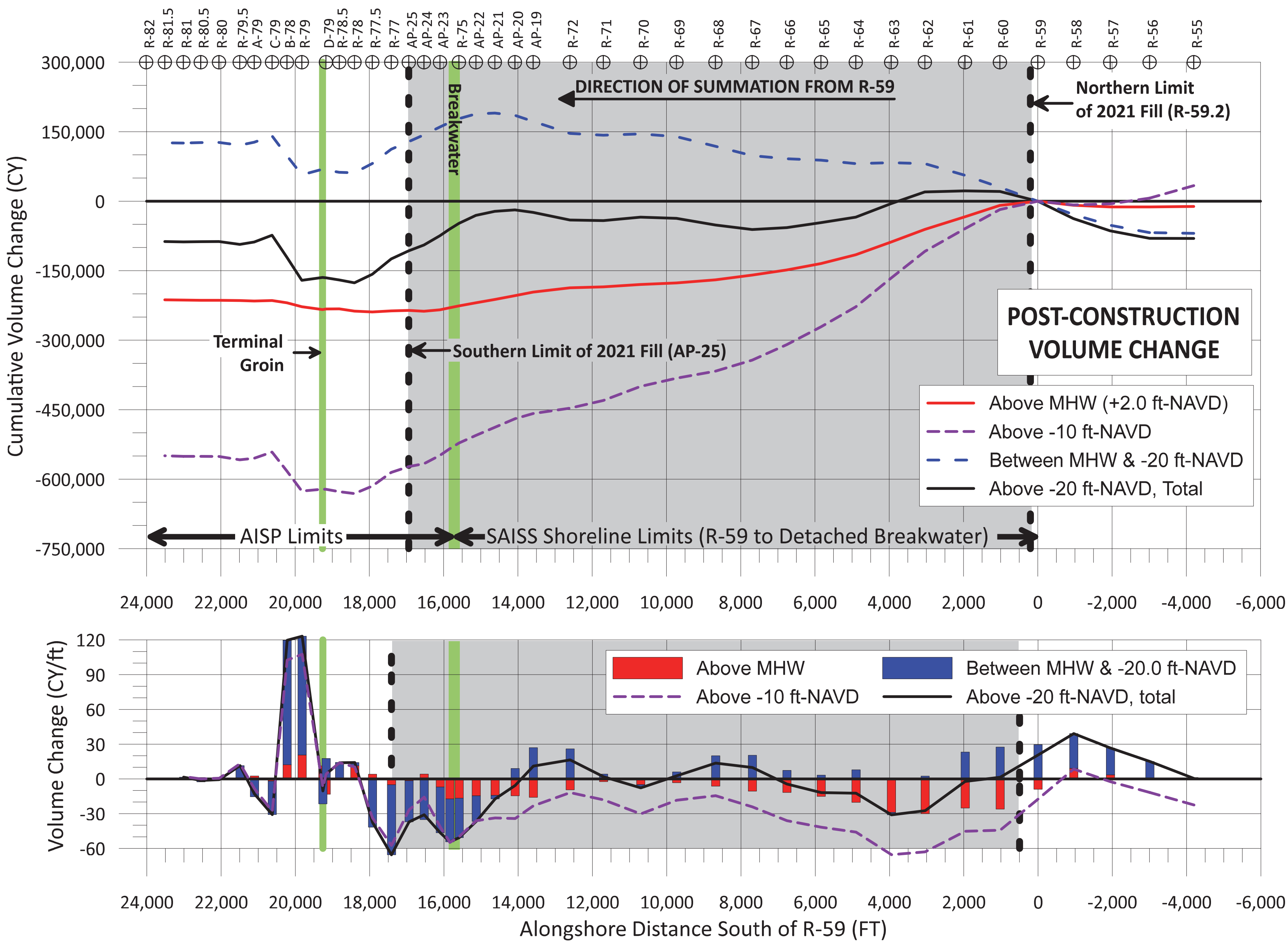


Figure 2.7: **Post-construction** beach volume changes (**January 2022 to June 2023**), South Amelia Island, FL.

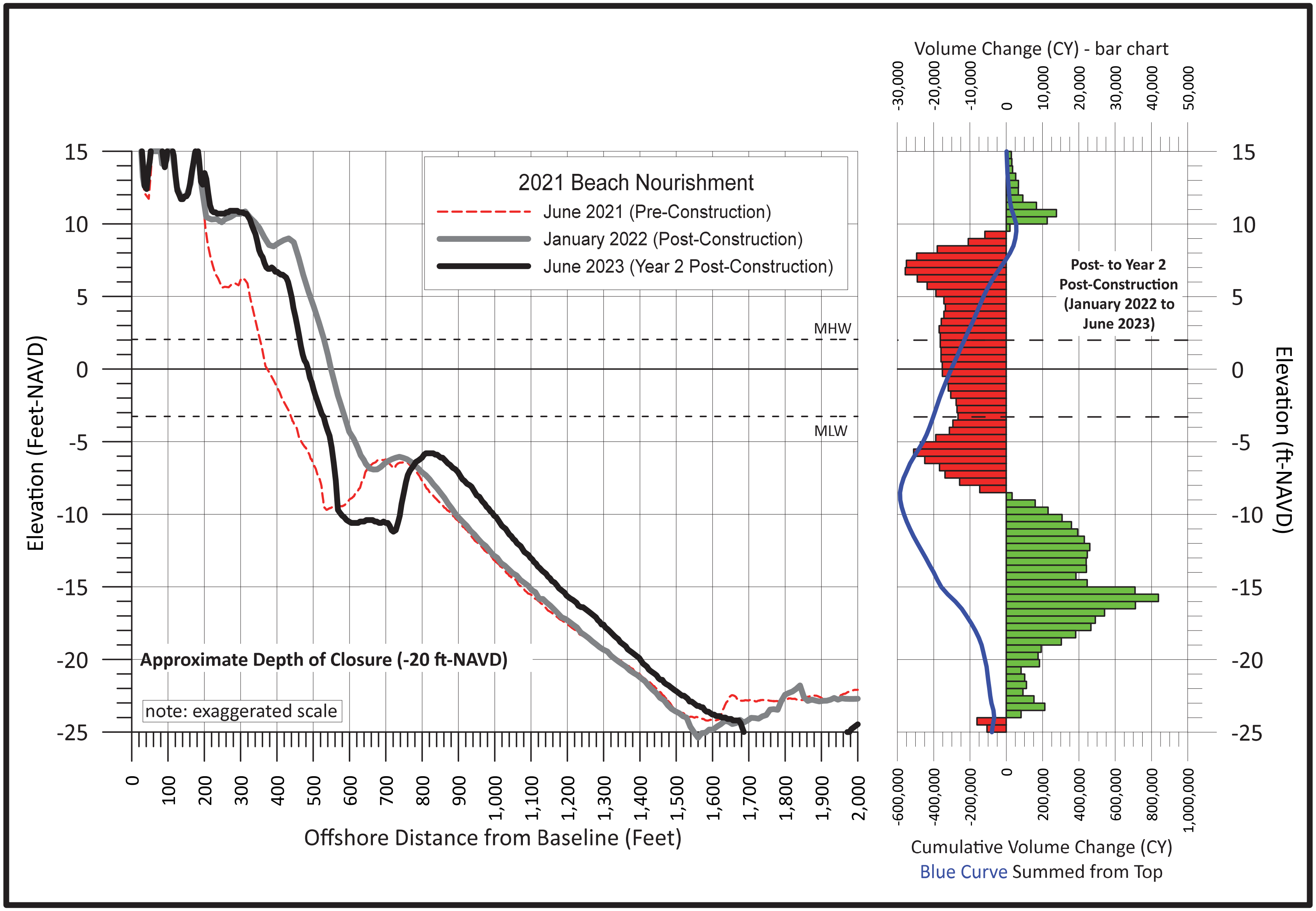


Figure 2.8: Vertical distribution of the volume changes **post-construction** of the 2021 beach nourishment along south Amelia Island from **Jan. 2022 to June 2023** between R-59.5 and AP-25 (fill limits). The graph on the right depicts the volume changes measured at half foot vertical intervals (bar chart), as well as a summation of the total volume change measured from the dunes seaward to survey closure (blue curve).

2.5.3 Monitoring Sub-Reaches

Table 2.6 summarizes the volume changes and **Table 2.7** the shoreline changes by monitoring sub-reach. The intersurvey period changes from January 2022 to June 2023 along each reach are described below.

North of the project area (R-55 to R-59), the 4,200 ft of shoreline experienced a gain of +11,300 cy (+2.7 cy/ft) above the MHWL and a gain of +69,200 cy (+16.1 cy/ft) below the MHWL for a net gain of +80,500 cy (+19.1 cy/ft) above -20 ft-NAVD. During this period the berm receded by a weighted average of -3.8 ft while the MHWL advanced by +52.4 ft. The volume gains and advance of the MHWL are attributed largely to the northward spread of beach fill toward the adjacent shoreline.

Along the SAISS project area (R-59 to the detached breakwater), the 15,840 ft of shoreline lost roughly -230,100 cy (-14.5 cy/ft) above the MHWL and gained +169,800 cy (+10.7 cy/ft) below the MHWL for a net loss of -60,300 cy (-3.8 cy/ft) above -20 ft-NAVD. Above the approximate toe of fill (-10 ft-NAVD), the shoreline lost -534,500 cy or approximately -29.9 percent of the estimated +1,786,431 cy placed along this project reach (BD/AD total placed estimate). Since the post-construction survey, the berm and MHWL receded by weighted averages of -92.0 ft and -54.9 ft, respectively.

Along the AISP Atlantic shoreline (detached breakwater to terminal groin), the 3,420 ft of shoreline experienced a loss of roughly -3,800 cy (-1.1 cy/ft) above the MHWL and -100,800 cy (-29.5 cy/ft) below the MHWL for a net loss of -104,500 cy (-30.6 cy/ft) above -20 ft-NAVD. During project construction, approximately +71,645 cy (BD/AD total placed estimate) was placed between the detached breakwater (R-75+250 ft) to AP-25. During the most recent intersurvey period roughly -51,200 cy above the approximate toe of fill (-10 ft-NAVD), or approximately 71 percent of the placed volume. During this period, the MHWL receded by a weighted average -62.9 ft. The weighted berm change was unable to be calculated along this reach as upland survey beach access was limited by the Park at one of the monuments for the post-construction survey due to concerns regarding impacts to nearby nesting shorebirds.

The 4,750 ft of AISP shoreline south of the terminal groin (terminal groin to R-82), gained +20,900 cy (+4.4 cy/ft) above the MHWL and +57,200 cy (+12.0 cy/ft) below the MHWL for a net gain of +78,100 cy (+16.4 cy/ft) above -20 ft-NAVD. During this period, the MHWL advanced by weighted average of +31.6 ft. As previously stated, the changes observed along this part of the shoreline are primarily due to the southern drift of sand from the southern end of the fill.

Table 2.6: South Amelia Island post-construction to Year 2 volume changes (January 2022 to June 2023).

Description:	North of Project Area	SAISS Project Area	AISP Atlantic Shoreline	AISP Sound Shoreline	Entire Monitored Area
R-Mons:	R-55 to R-59	R-59 to DB[1]	DB to TG[2]	TG to R-82	R-55 to R-82
Reach:	4,200 ft	15,840 ft	3,420 ft	4,750 ft	28,210 ft
Datum	**Measured Volume Change (cy)**				
Above MHWL	+11,300	-230,100	-3,800	+20,900	-201,700
Above -10 ft-NAVD	-33,600	-534,500	-87,100	+72,500	-582,700
MHWL to -20 ft-NAVD	+69,200	+169,800	-100,800	+57,200	+195,400
Total above -20 ft-NAVD	**+80,500**	**-60,300**	**-104,500**	**+78,100**	**-6,200**

[1] Detached Breakwater located at R-75 + 250 feet

[2] Terminal Groin located at R-79D

Table 2.7: South Amelia Island post- to two-years post-construction shoreline changes (January 2022 to June 2023).

Description:	North of Project Area	SAISS Project Area	AISP Atlantic Shoreline	AISP Sound Shoreline	Entire Monitored Area
R-Mons:	R-55 to R-59	R-59 to DB[1]	DB to TG[2]	TG to R-82	R-55 to R-82
Reach:	4,200 ft	15,840 ft	3,420 ft	4,750 ft	28,210 ft
Datum	**Weighted Average Shoreline Change (ft)**				
BERM	-3.8	-92.0	NA	NA	NA
MHWL	+52.4	-54.9	-62.9	+31.6	-25.3

[1] Detached Breakwater located at R-75 + 250 feet

[2] Terminal Groin located at R-79D

[3] Values of "NA" indicate areas where upland beach access was limited by the Park for either survey due to concerns regarding potential impacts to nearby nesting shorebirds.

2.5.4 Long-term SAISS Beach Project Performance (since 1994)

The SAISS project area (R-59 to the detached breakwater) long-term volume changes above -20 ft-NAVD, as quantified by monitoring surveys since pre-construction of the 1994 project (May 1994) to the June 2023 Year-2 post-construction 2021 project monitoring survey, are graphically depicted in **Figure 2.9**. Apparent in the volume trend data depicted by the figure is the fact that initial "losses" during the first one to two years after initial placement are generally the greatest. Such apparent large net losses are often offset by periods of gain or low annual loss. The non-linearity of the trend lines over the life of each fill demonstrates the effects of equilibration (initially), periods of high wave energy due to storms, as well as potential periods of low wave energy. Also of significance is the fact that the first renourishment interval (1994-2002) was 8 years, while the second renourishment interval was extended to 9 years (2002-2011) and the third renourishment interval extended to 10 years (2011-2021).

As of June 2023, the SAISS project shoreline has approximately +3,659,700 cy more sand relative to the pre-1994 project condition. Additionally, based upon an analysis of available survey data and aerial photography, the area immediately south of the fill area between the detached breakwater to R-82 is estimated to currently contain between 700,000 to 1,200,000 cy more sand than in May 1994. Similarly, the area immediately north of the project area between R-55 and the R-59, including American Beach and into Summer Beach, gained roughly +347,600 cy between May 1994 and June 2023.

In total, within the entire monitored area (R-55 to R-82), the shoreline has between 4.7 Mcy and 5.2 Mcy more sand as of June 2023 than in the May 1994 condition. During this same period, approximately 10.45 Mcy of sand was placed along this shoreline as part of the SAISS project or USACE beach disposal projects. Therefore between 45 to 50 percent of the sand placed since 1994 along the Amelia Island shoreline south of R-55 remains on the beach within the monitored area.

Figure 2.10 presents the long term MHWL locations after the 1994, 2002, 2011, and 2021 projects relative to the May 1994, pre-project condition along with the June 2023 location. **Figure 2.11** presents these MHWL locations superimposed upon the June 2023 aerial photography along the SAISS project shoreline. As of June 2023, within the SAISS project area the MHWL remains on average, 265 feet seaward of the May 1994, pre-project condition.

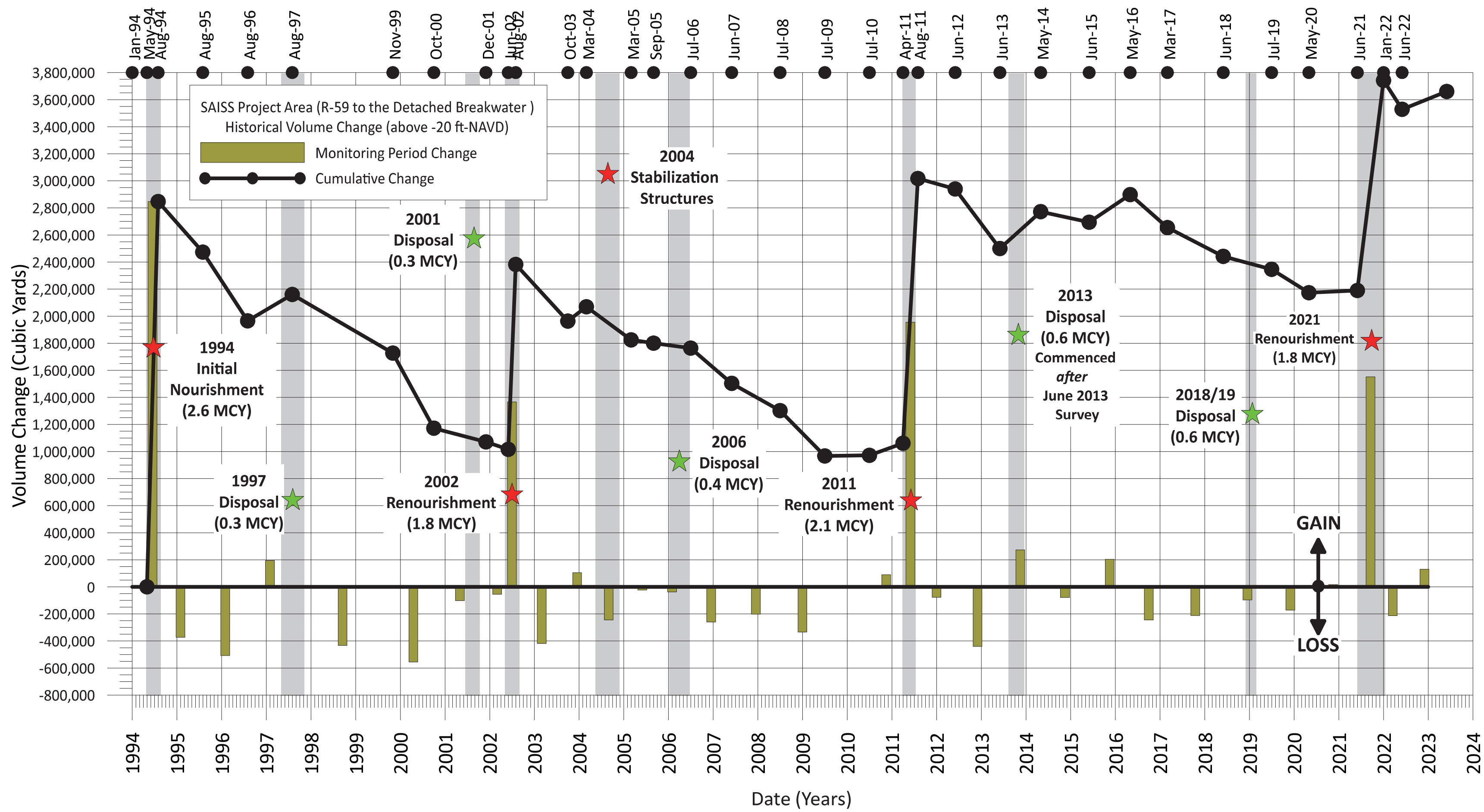


Figure 2.9: Historical volume change within the SAISS project area (R-59 to the detached breakwater), South Amelia Island, FL. Volume changes measured above -20 ft-NAVD

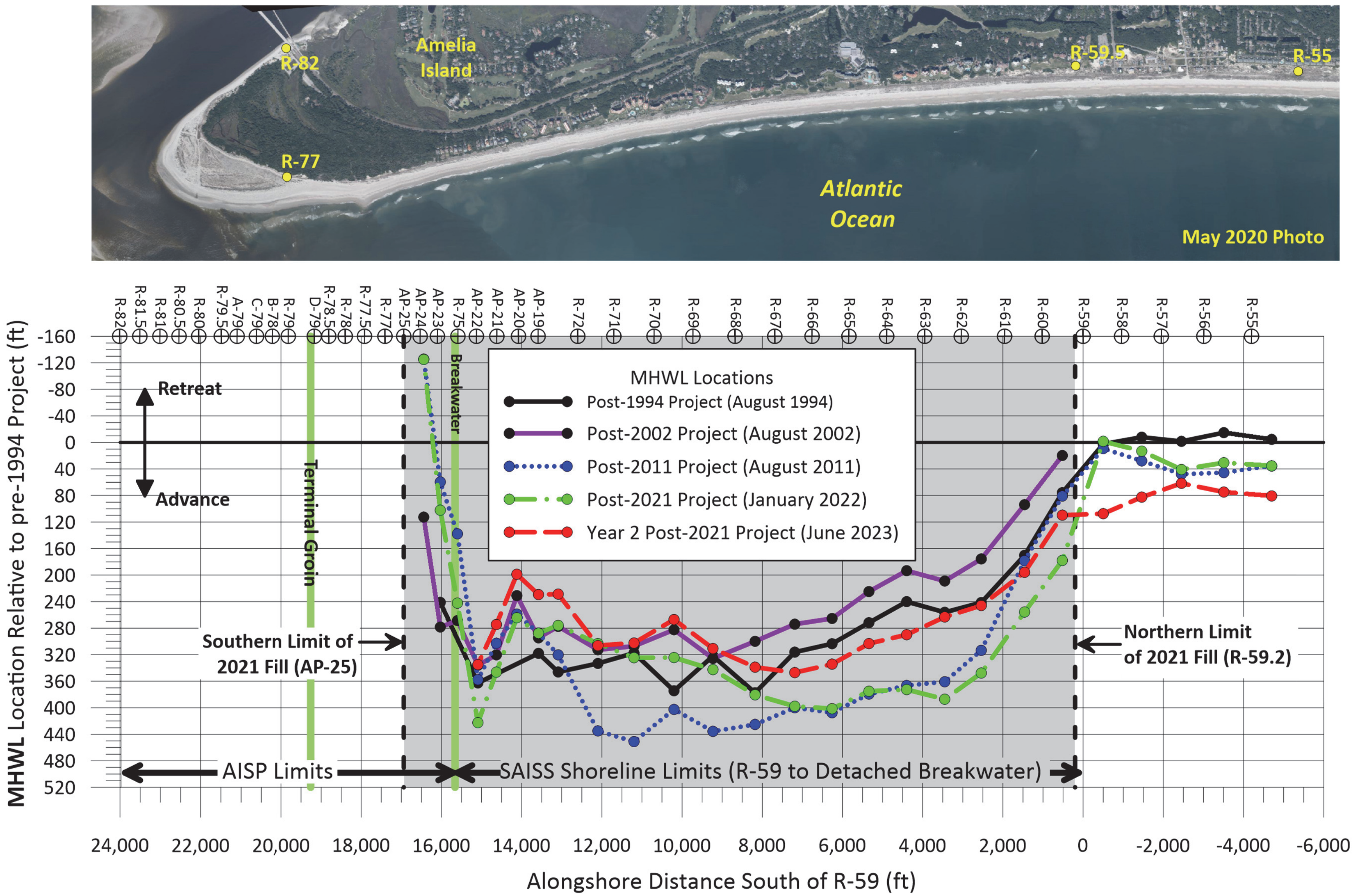


Figure 2.10: Long-term post-project MHWL positions relative to pre-1994 project location (May 1994), South Amelia Island, FL.

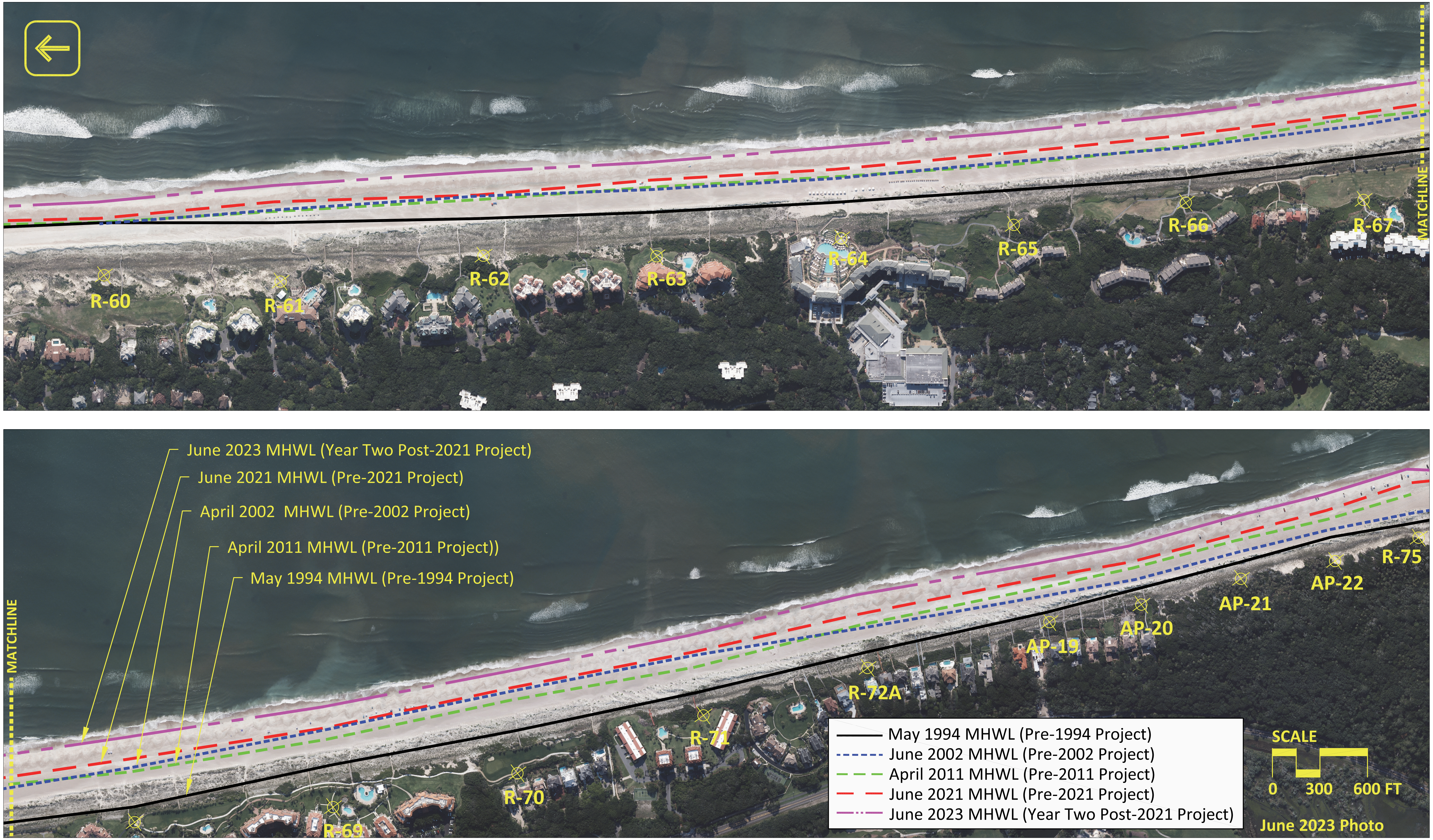


Figure 2.11: MHWL shorelines within the SAISS project limits (R-59 to R-75)

2.6 Borrow Area Monitoring Survey Results

2.6.1 2021 Borrow Area

The Year-2 post-construction bathymetric survey of the 2021 borrow area was conducted per permit requirement concurrent with the beach profile surveys. The survey was completed on June 6, 2023 and was part of a larger survey of Nassau Sound. The Year-2 survey was completed approximately 10 months after the Year-1 survey (August 2, 2022), 17 months after the post-construction survey (January 15-20, 2022) and 23 months after the pre-construction survey (July 13, 2021). The pre- and post-constructions surveys included only the borrow area and an approximate 200 ft buffer area.

Figure 2.12 presents the Year-2 (June 2023) seabed elevation contours. **Figures 2.13** and **2.14** depict Year-1 to Year-2 (August 2022 to June 2023) and post- to Year-2 (January 2022 to June 2023) seabed elevation changes, respectively. In the plots, the full permitted borrow area limits are shown. The permitted limits are further subdivided into two areas, Area 1 and Area 2. Area 1 had a design depth of -18.0 ft and Area 2 a design depth of -17.0 ft.

Table 2.8 summarizes the volume changes within the sub-areas and overall permitted borrow area limits since the pre-construction survey. **Table 2.9** summarizes the average seabed elevations for each borrow area survey conducted to date. During the Year-2 monitoring period, the 2021 borrow area gained approximately +645,800 cy within the permitted limits. During this period, the average seabed elevation increased from -15.9 ft-NAVD to -13.1 ft-NAVD within the permitted limits. As of the Year-2 survey (June 2023), there are approximately 992,800 cy of sand available within the permitted limits above the design depth.

The greatest decreases in seabed elevation during the first two years following construction (up to -12 ft) occurred along the westernmost subarea of Area 1, immediately adjacent to one of the main tidal channels through Nassau Sound to the Atlantic Ocean (see **Figure 2.12**). This relatively small subarea (12.1 acres) lost approximately -103,800 cy during Year-1 and -6,700 cy during Year-2. This subarea was not fully dredged during the 2021 project resulting in the borrow area not completely connecting to the tidal channel at the time of the post-construction survey (January 2022). However, as of the Year-2 survey (June 2023) a channel connecting the borrow area to the tidal channel has begun to form.

The borrow area, buffer zone, and the entirety of Nassau Sound will be surveyed again in the summer of 2024, to assess the evolution of the borrow area.

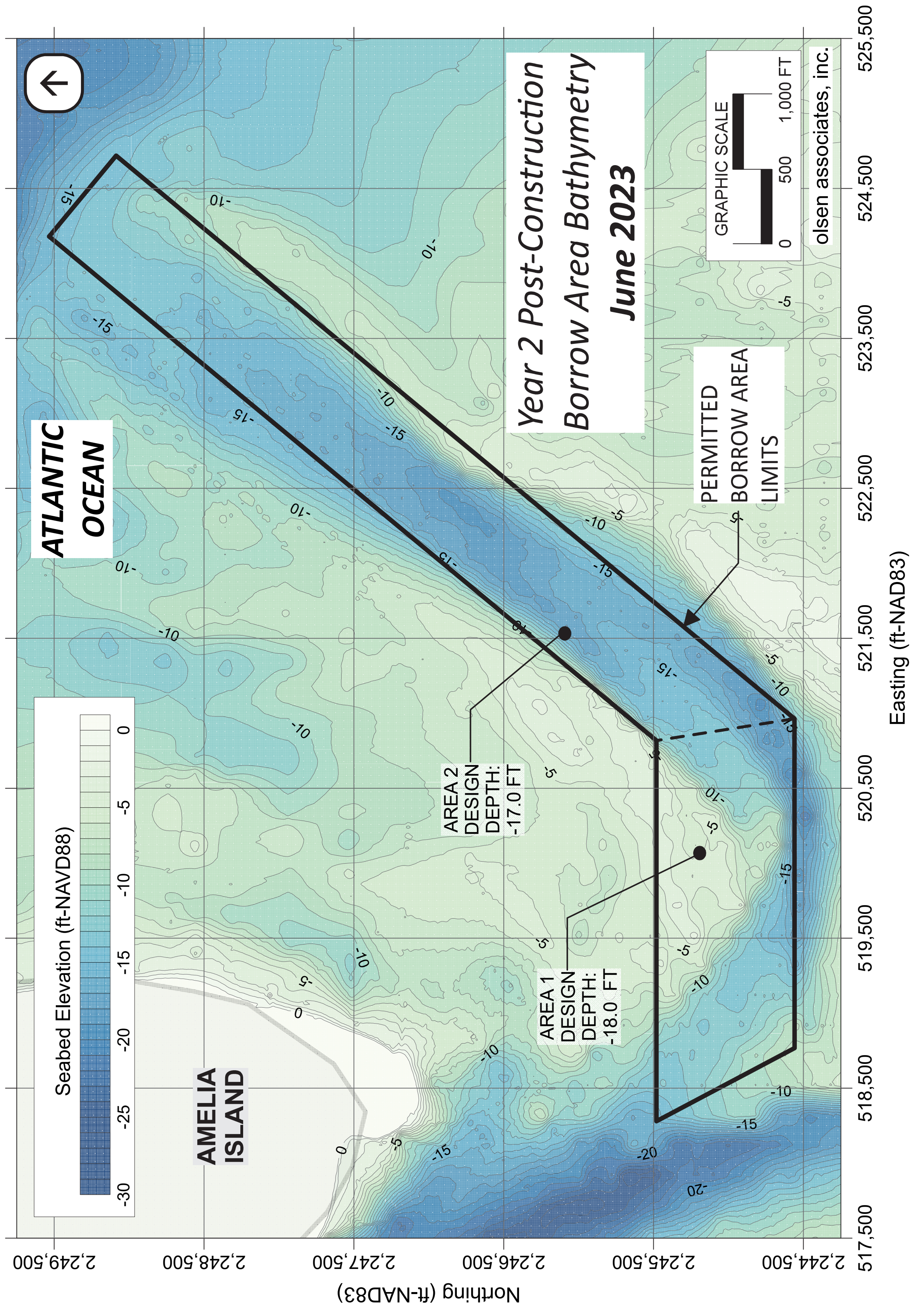


Figure 2.12: Year-2 post-construction borrow area bathymetry (June 2023), 2021 SAI Beach Nourishment Project.

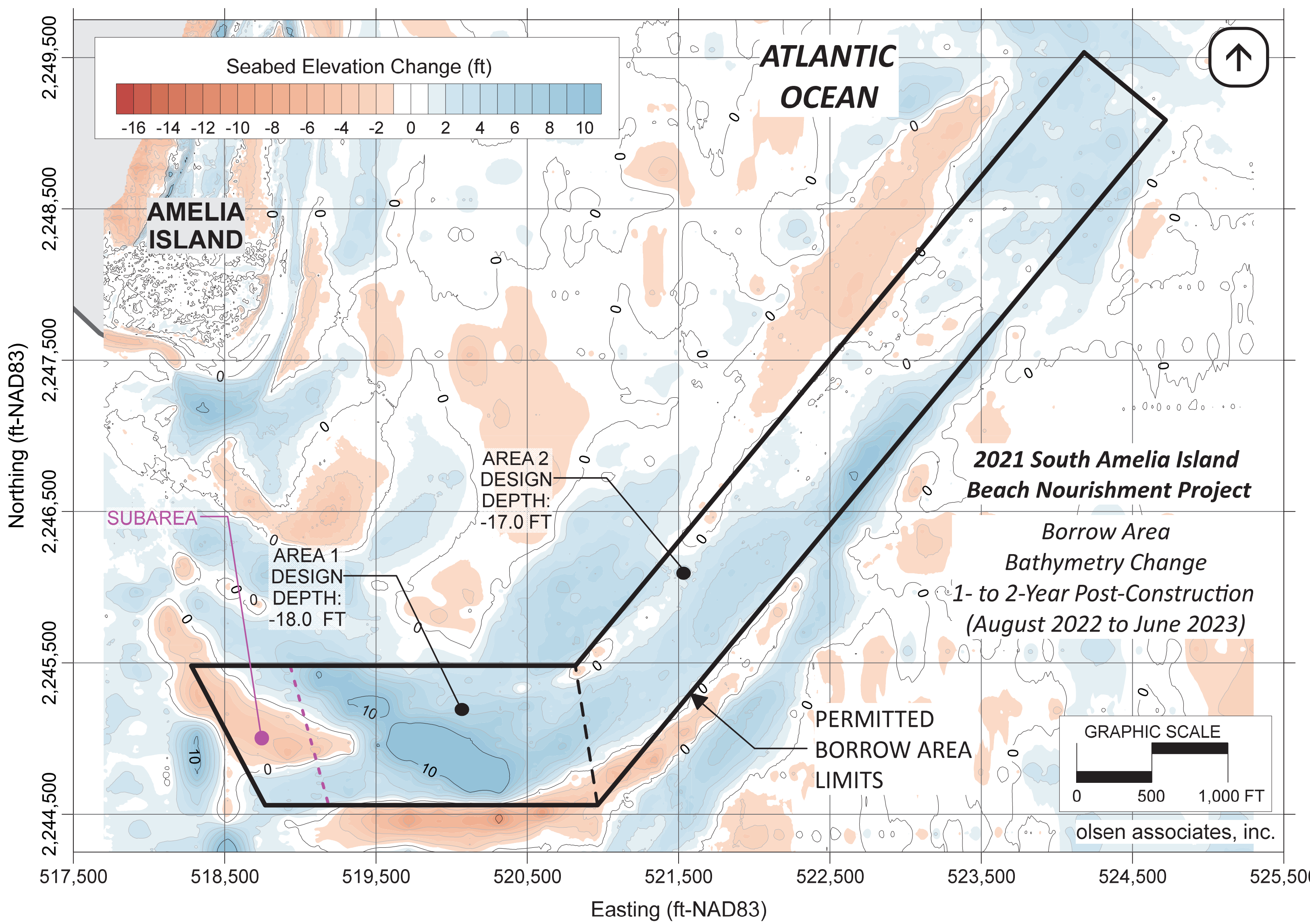


Figure 2.13: One to two years post-construction borrow area seabed elevation changes, 2021 SAI Beach Nourishment Project.

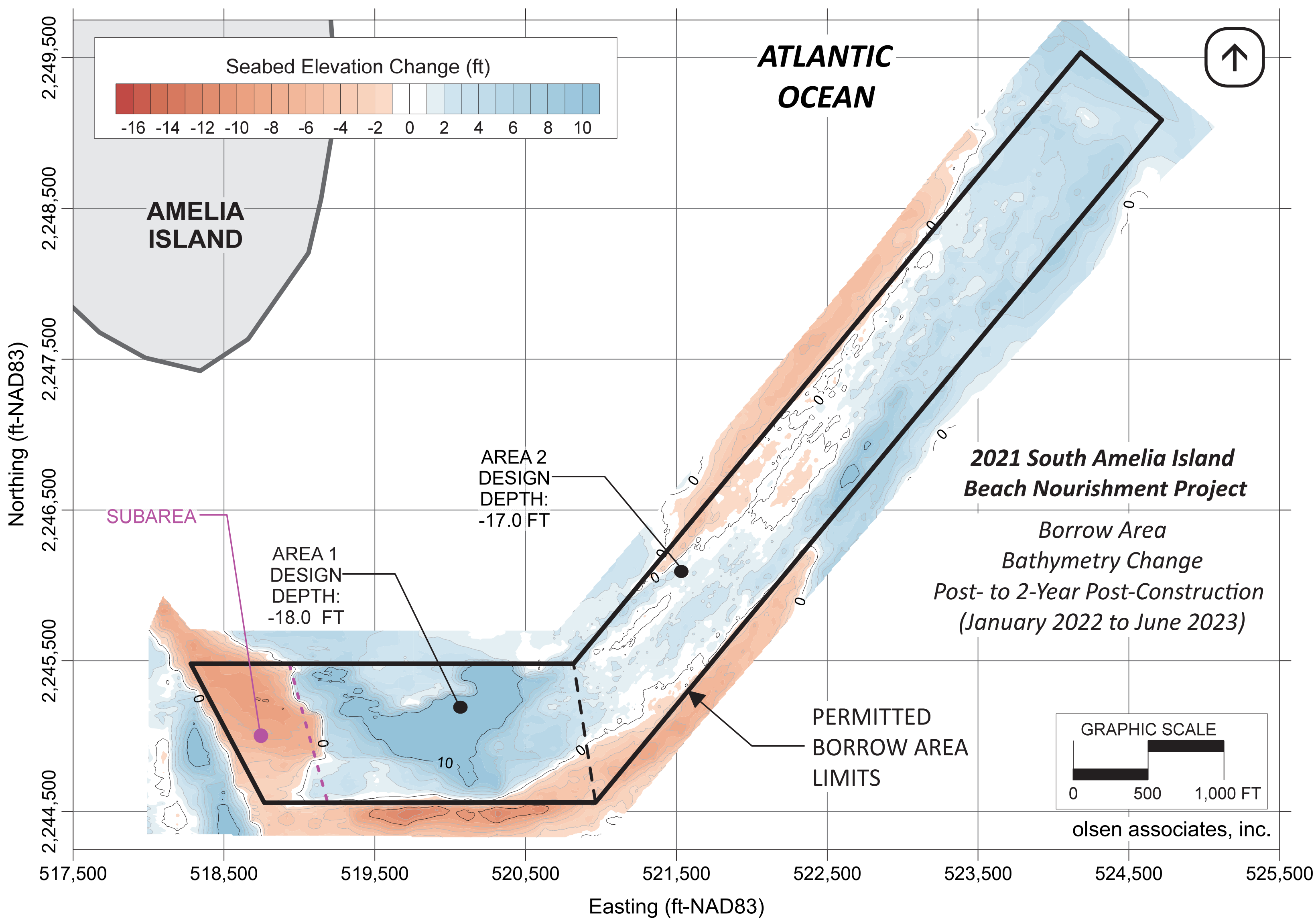


Figure 2.14: Post- to Year-2 post-construction borrow area seabed elevation changes, 2021 SAI Beach Nourishment Project.

Table 2.8: Borrow area volume changes within permitted limits.

Area	Gain/Loss/Net	Volume Change (CY)			
		Pre- to Post-Construction (Jul. 2021 to Jan. 2022)	Year-1 Post-Construction (Jan. 2022 to Aug. 2022)	Year-2 Post-Construction (Aug. 2022 to June. 2023)	Total Since Construction (Jan. 2022 to June 2023)
Area 1	Gross Gain:	+11,700	+90,000	+377,100	+467,100
	Gross Loss:	-619,500	-183,200	-38,500	-221,700
	Net Change:	-607,800	-93,200	+338,600	+245,400
Area 2	Gross Gain:	18,500	116,000	+320,400	+436,400
	Gross Loss:	-1,072,200	-131,000	-13,200	-144,200
	Net Change:	-1,053,700	-15,000	+307,200	+292,200
Borrow Area Total	**Gross Gain:**	**30,200**	**206,000**	**+697,500**	**+903,500**
	Gross Loss:	**-1,691,700**	**-314,200**	**-51,700**	**-365,900**
	Net Change:	**-1,661,500**	**-108,200**	**+645,800**	**+537,600**

Table 2.9: Borrow area average seabed elevations (permitted limits).

Survey	Average Seabed Elevation (ft-NAVD)		
	Area 1	Area 2	Total
Pre-Construction (July 2021)	-5.6 ft	-9.5 ft	-8.1 ft
Post-Construction (January 2022)	-13.1 ft	-16.8 ft	-15.5 ft
Year One (August 2022)	-14.3 ft	-16.9 ft	-15.9 ft
Year Two (June 2023)	-10.1 ft	-14.8 ft	-13.1 ft

2.6.2 2011 Borrow Area

As part of the Year-2 survey of Nassau Sound, the borrow area utilized in the 2011 project was surveyed. This survey was not required by permit and is included in this report for informative purposes only.

The 2011 borrow area is located adjacent to the 2021 borrow area (**Figure 1.1**) and comprised of approximately 141 acres. Roughly 2,071,500 CY of sand was excavated from the borrow area during 2011 project construction.

As of June 2023, the total volume gain within the 2011 borrow area limits over the 12 years since project completion (August 2011 to June 2023) is +865,000 CY.

3.0 NASSAU SOUND SURVEY RESULTS

Per the requirements of the 2004 Phase II stabilization structures FDEP Permit, surveying of Nassau Sound was initiated. Permit required surveys were completed pre- and post-construction as well as during the first and second year following the structures construction in 2004. Per the requirements of the 2021 Beach Nourishment Project FDEP Permit, a survey was completed during the Year 2 monitoring effort (June 6, 2023). The most recent survey was conducted in June 2023 and represents the Year 19 post-2004 structures construction monitoring event. Future surveys of Nassau Sound will be conducted following the schedule described in the 2021 Beach Nourishment Project permit (**Figure 2.1**).

Table 3.1 lists the large-scale bathymetric surveys of the Nassau Sound ebb-shoal complex conducted to date. **Figure 3.1** presents the seabed elevation contours for the most recent survey (June 2023). Plots of previous bathymetric surveys are provided in **Appendix F**. Specific points of interest within Nassau Sound illustrated by the bathymetric survey plots in **Appendix F** include:

- Evolution and migration of tidal channels including the effect of the 2021 borrow area,
- Evolution and migration of sand shoals,
- Spatial and volumetric variations in the Bird Island shoal complex and the ebb tidal delta, as well as,
- Impoundment processes in the immediate vicinity of the stabilizing structures constructed on S. Amelia Island in 2004.

Figure 3.2 presents the seabed changes between May 2021 (pre-2021 project) and June 2023. A clearer picture of long-term major sediment gains or losses measured throughout Nassau Sound, and the associated physical phenomena resulting in same, is provided by **Figure 3.3**. This figure depicts seabed change for the entire period of record – March 2003 to June 2023 (approximately 244 months). Hence, the predominant depth change trends (magnitude and direction) are much stronger and easier to visualize.

Table 3.1: Nassau Sound large-scale bathymetric surveys.

Survey Date	Comment	Figure Number
1991	3 Years Pre-1994 Project	Appendix F.2
March 2003	Pre-Construction (2004 Stabilization Structures)	Appendix F.3
March 2004	Post-Construction (2004 Stabilization Structures)	Appendix F.4
March 2005	1^{st} Year Post-2004 Construction	Appendix F.5
July 2006	2^{nd} Year Post-2004 Construction	Appendix F.6
July 2008	4^{th} Year Post-2004 Construction	Appendix F.7
July 2010	6^{th} Year Post-2004 Construction	Appendix F.8
June 2013	9^{th} Year Post-2004 Construction	Appendix F.9
June 2016	12^{th} Year Post-2004 Construction	Appendix F.10
June 2018	14^{th} Year Post-2004 Construction	Appendix F.11
June 2020	16^{th} Year Post-2004 Construction	Appendix F.12
May 2021	17^{th} Year Post-2004 Construction	Appendix F.13
August 2022	18^{th} Year Post-2004 Construction 1^{st} Year Post-2021 Beach Project	Appendix F.14
June 2023	19^{th} Year Post-2004 Construction 2^{nd} Year Post-2021 Beach Project	Appendix F.15 / Figure 3.1

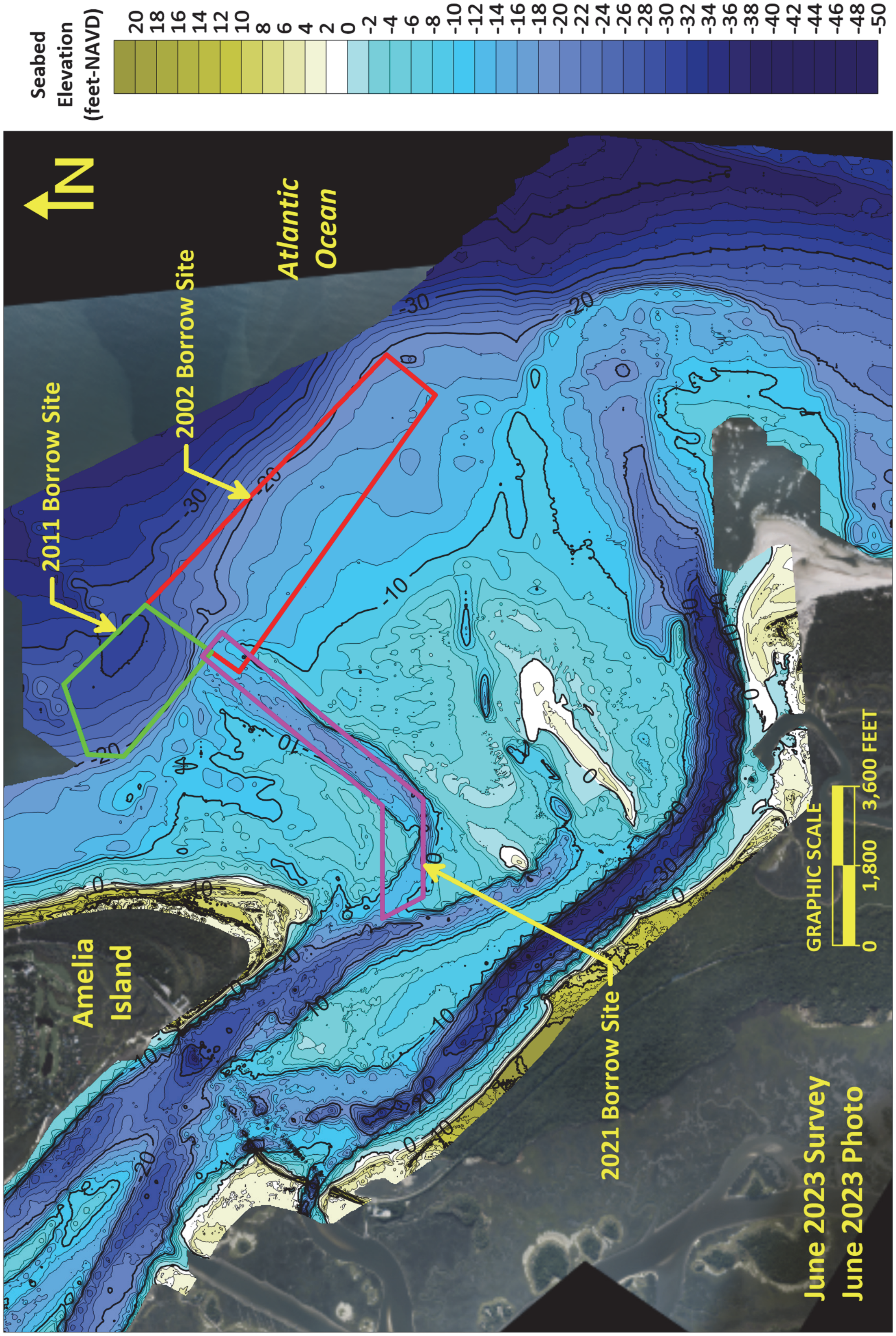
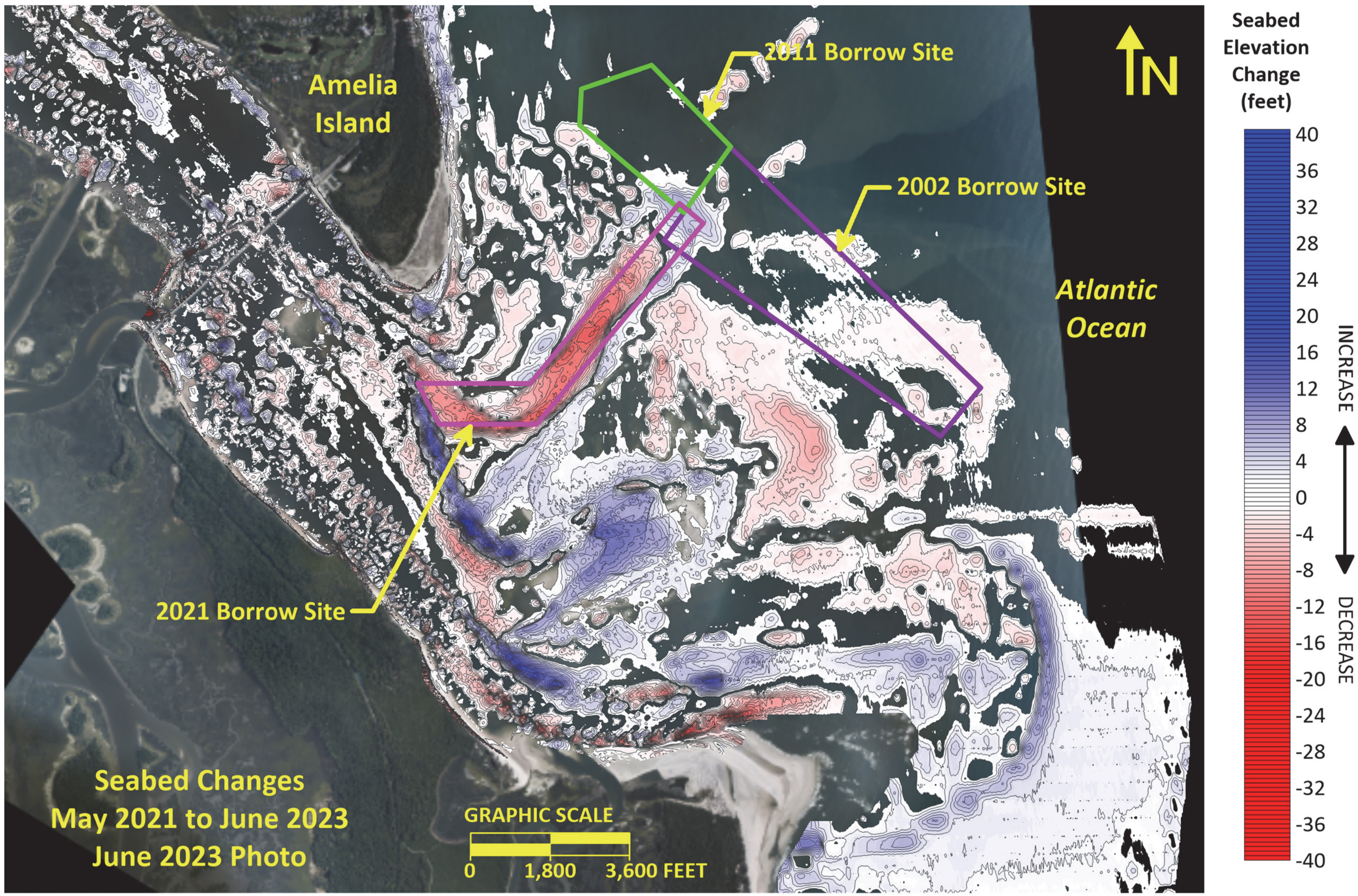
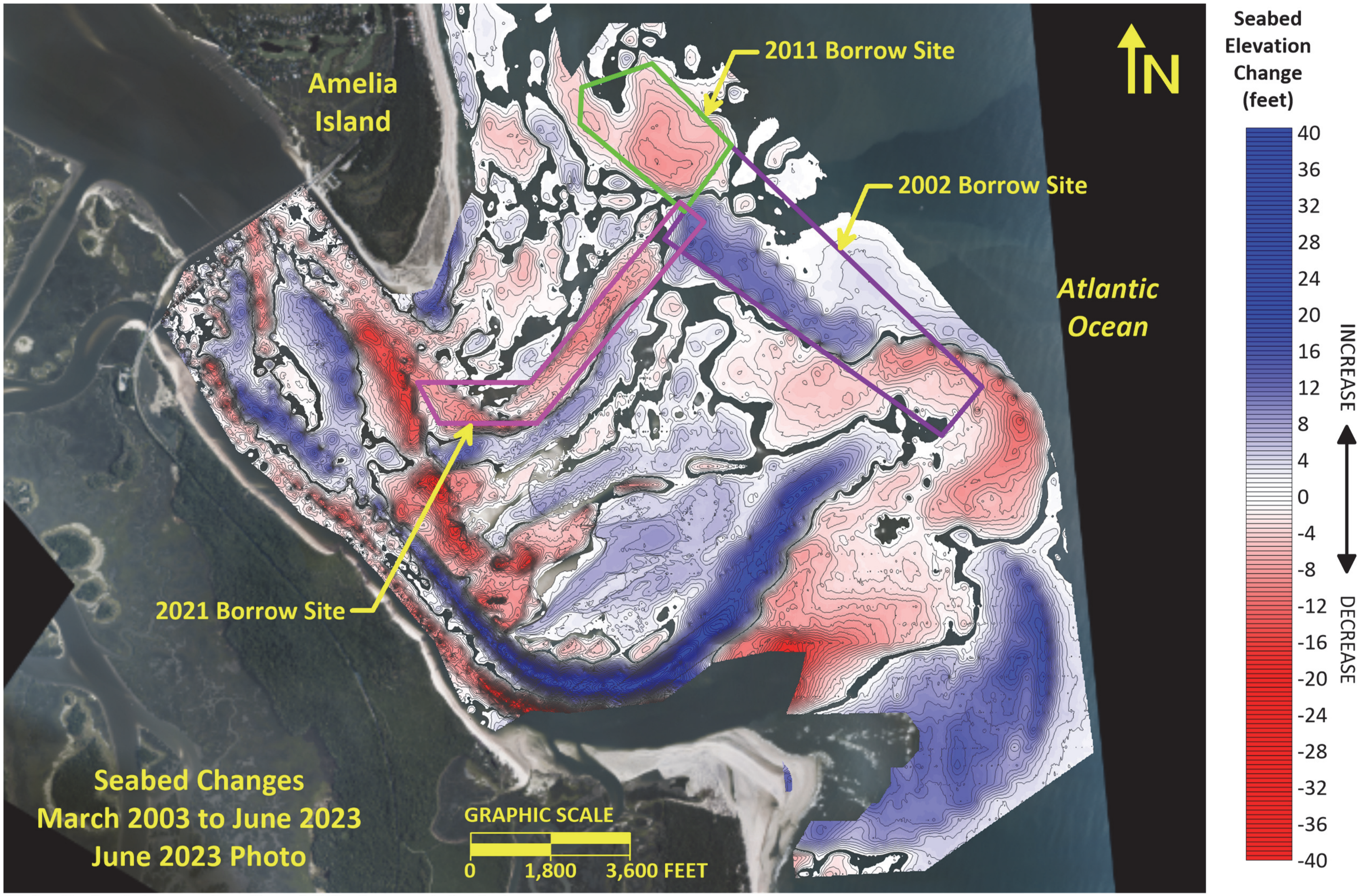


Figure 3.1: Nassau Sound bathymetry (June 2023).



Note: Seabed changes less than 0.5 feet are not shaded.

Figure 3.2: Nassau Sound seabed elevations changes (May 2021 to June 2023).



Note: Seabed changes less than 0.5 feet are not shaded.

Figure 3.3: Nassau Sound seabed elevation changes (March 2003 to June 2023).

Evident in **Figure 3.3** is the major shift in the southern channel through Nassau Sound, just north of the northern terminus of Little Talbot Island. This is evidenced by the consistent parallel blue and red tracks of that channel, formed as sand shoaled the channel from the north (blue track) and pushed the southern channel roughly 800 ft southward to erode into the banks of both Big and Little Talbot Islands (red track). Inspection of aerial photography reveals that in the winter of 2013, this shoaling pressure and channel migration from north to south elongated the southern channel to the point that it broke through the long linear shoal off the NE end of Little Talbot Island and out to the Atlantic Ocean. Since that breakthrough in 2013, the new channel has formed its own localized depositional ebb shoal at the SE corner of Nassau Sound (the blue semi-circular area east of Little Talbot Island).

Similarly, the northern channel through the Sound has shifted southward as sand has migrated into Nassau Sound and shoaled southward. The pattern of deposition in **Figure 3.3** does indicate a similar 1,700 ft southward migration of the thalweg of the northern channel. This southerly migration and erosion pressure likewise affects the shoal features in the Sound, particularly those between the northern and southern channels, including the ephemeral Bird Island shoal complex. Off the Big Talbot Island shoreline, the presence of the island limits the channel migration, thus compressing the area between channels and eroding those shoals in between.

For purposes of tracking the changes in the Bird Island shoal complex, a spatial analysis was performed of the land mass above the mean lower low water line (MLLW), as defined by the -3.3 ft contour, for each survey of the emergent portion of Bird Island shoal (see **Figure 3.4ab**). The measured acreages above the MLLW contour for each survey date are presented in **Table 3.2**.

Over the approximate 244-month period of analysis, the size, location and shape of the shoal has changed significantly (see **Figure 3.4ab**). These changes in the shoal configurations, including changes to the Bird Island shoal complex, are expected to continue as the channels in the Sound continue to migrate southward. Recently a major northerly shift of the channels occurred. With the major shift of the northern channel to the north, shoal features can potentially re-form in the broader area between channels. This cyclical pattern has been observed in the past at Nassau Sound. **Figure 3.5** depicts a similar history of migration and changes in shoal size and location migration within the Sound, based upon aerial photography dating back to the 1940's.

Table 3.2: Emergent acreage of the Bird Island Shoal complex by survey date.

Survey Date	Shoal Acreage above MLLW (-3.3 ft-NAVD)
March 2003	220.0 acres
March 2004	195.5 acres
March 2005	219.3 acres
July 2006	216.2 acres
July 2008	181.3 acres
July 2010	144.0 acres
June 2013	82.6 acres
June 2016	66.9 acres
June 2018	42.2 acres
June 2020	202.1 acres
May 2021	88.3 acres
August 2022	213.9 acres
June 2023	327.3 acres

Table 3.2 and **Figure 3.4b** do indicate recent aggregation of sand above MLLW, both north and south of the northern primary tidal channel. From **Figure 3.1**, as of June 2023, approximately 69.3 acres has risen above Mean Tide Level to provide additional ephemeral habitat.

Figure 3.4a: Bird Island Shoal location (March 2003 to June 2020).

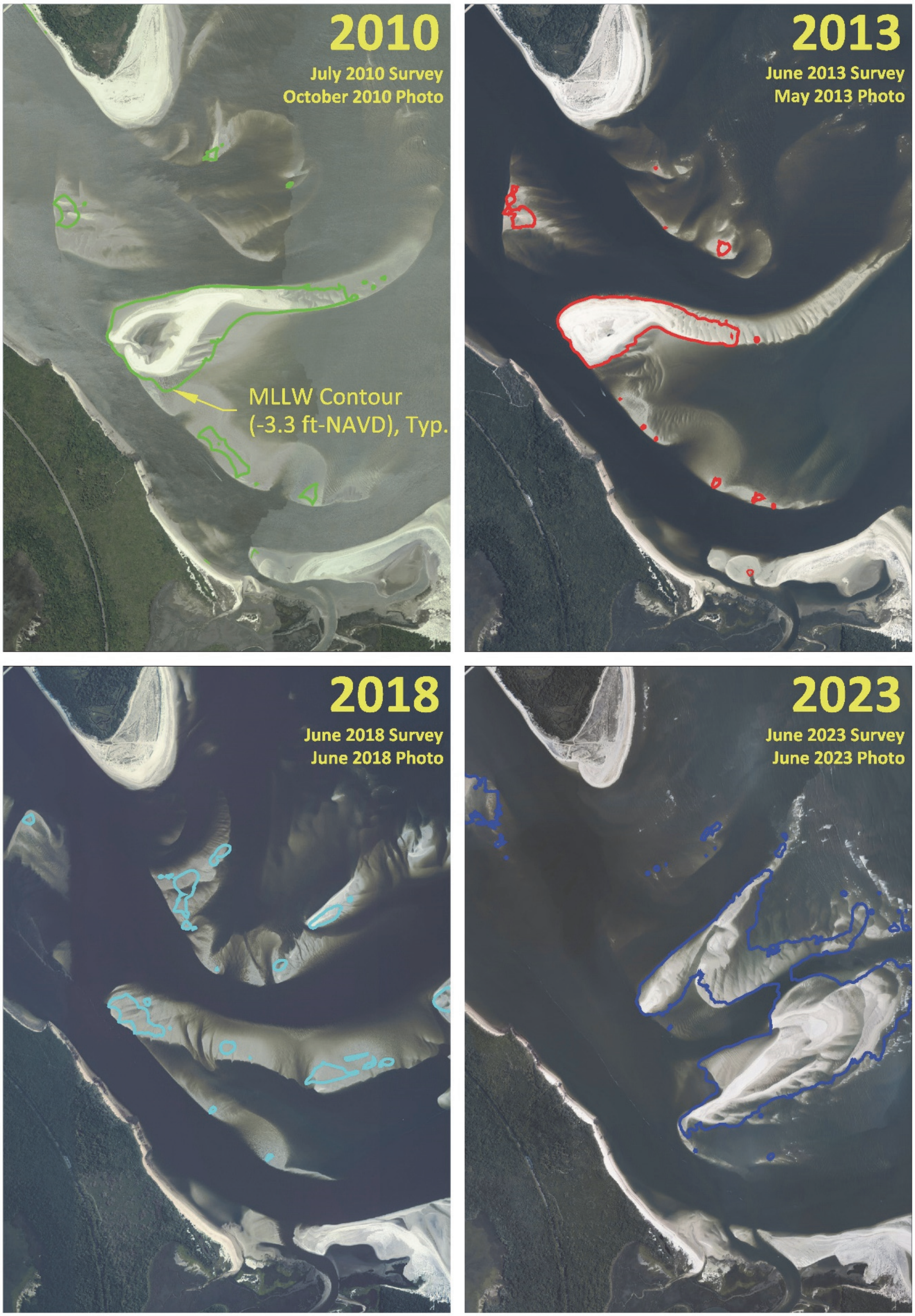


Figure 3.4b: Bird Island Shoal location (March 2003 to June 2023).

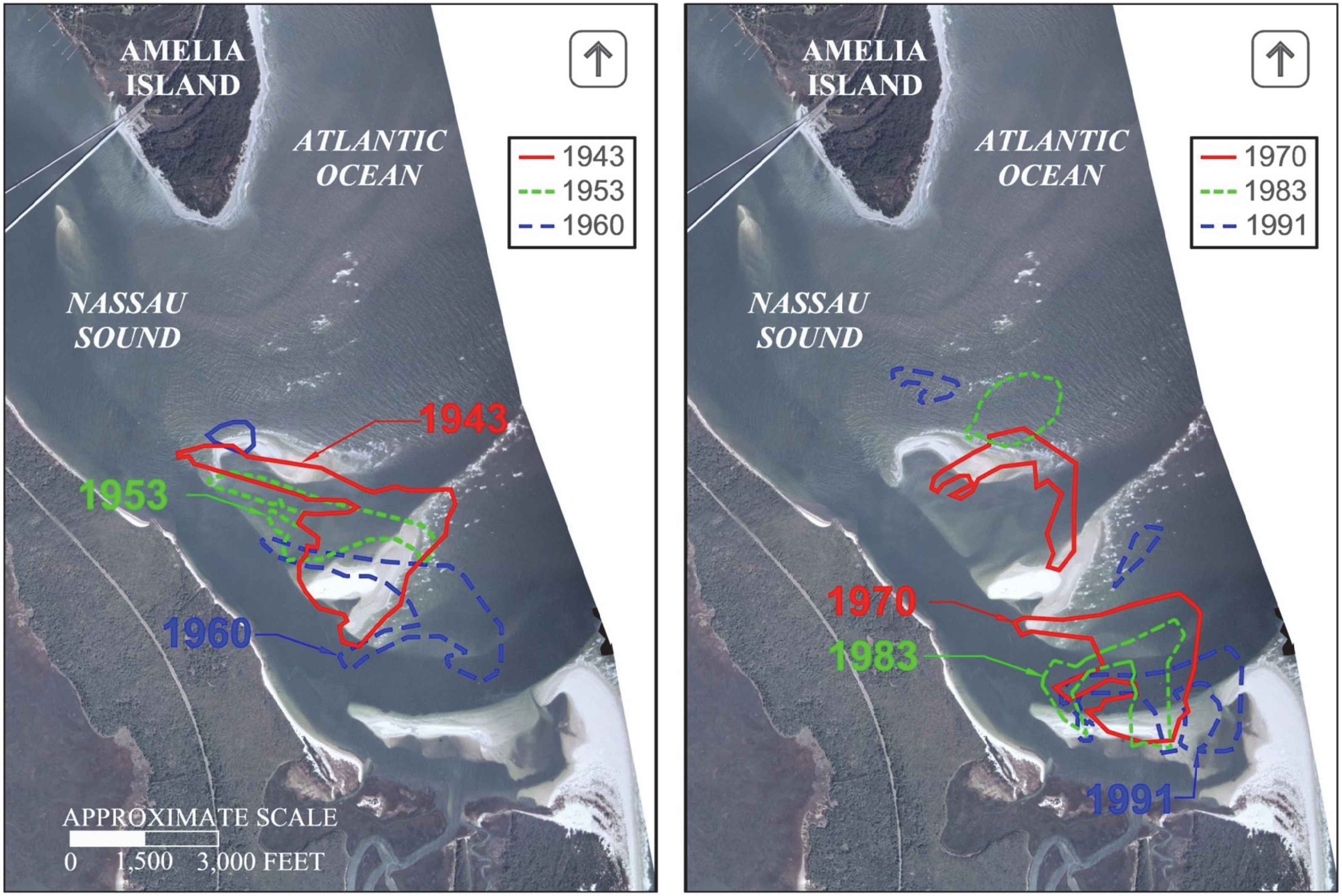


Figure 3.5: Historic location of the primary emergent ebb tidal shoal complex in Nassau Sound, Florida (2000 Photograph). This feature is referred to as the Bird Island Shoal complex.

4.0 REFERENCES

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APPENDIX A: Year 2 Post-Construction Survey Drawings for Beach (June 2023) & Borrow Site (June 2023)

This appendix contains reduced versions of the Year-2 post-construction beach profile and borrow site survey drawings produced by Arc Surveying & Mapping, Inc.[1] for the 2021 South Amelia Island, FL Beach Nourishment Project. The surveyor's report is included at the end of the appendix.

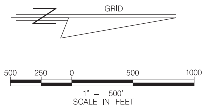
[1] Arc Surveying & Mapping, Inc.; 5202 San Juan Avenue, Jacksonville, FL 32210

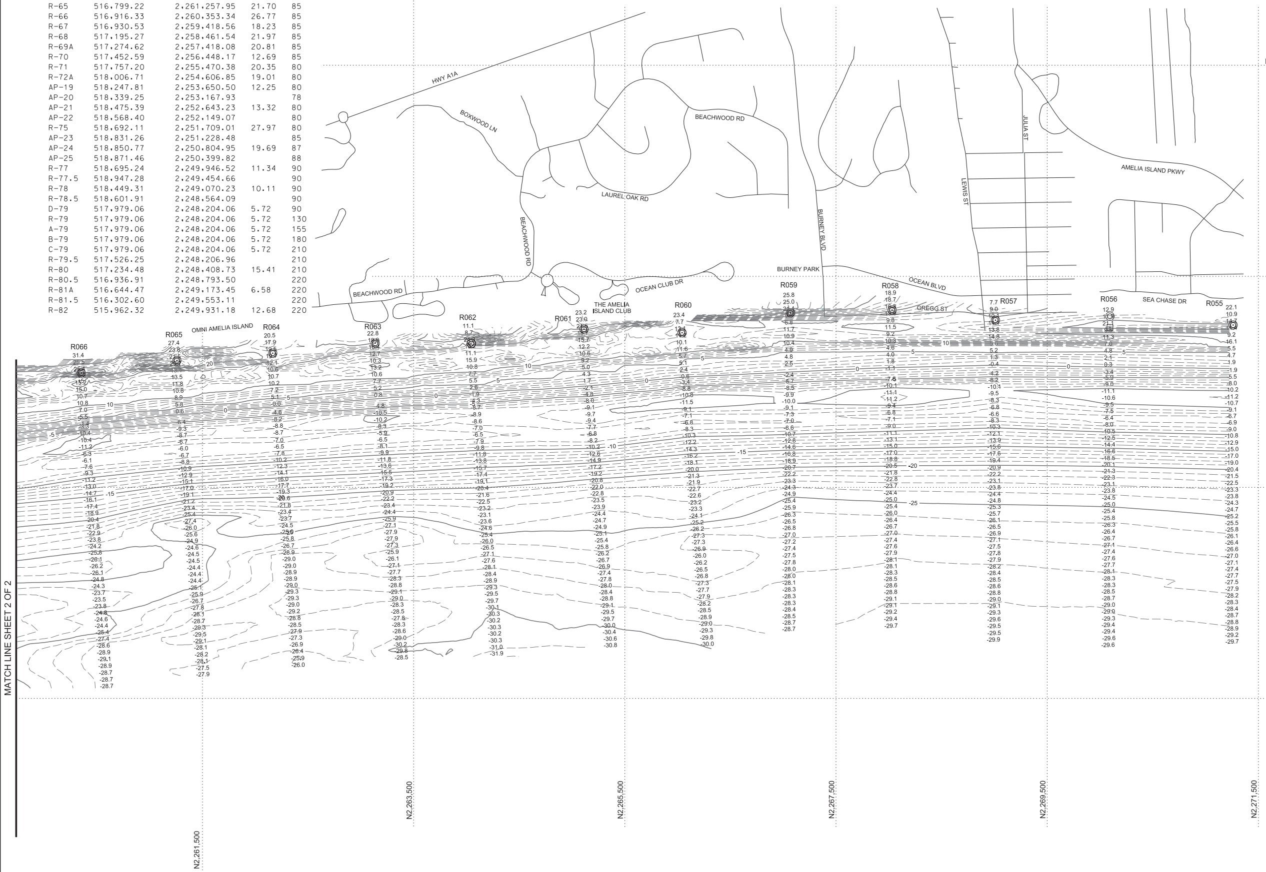
MAP SHOWING A HYDROGRAPHIC AND TOPOGRAPHIC SURVEY OF

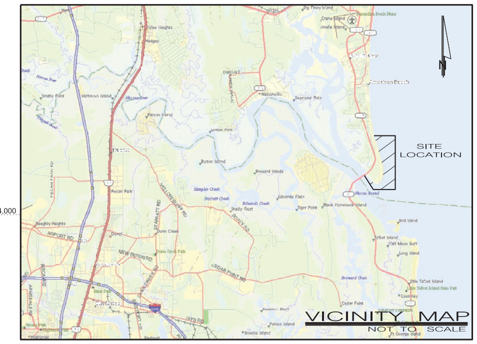
BEACH MONITORING PROFILES ALONG THE ATLANTIC OCEAN COASTLINE AND SOUTH AMELIA ISLAND AND INCLUDING A PORTION OF NASSAU SOUND, NASSAU COUNTY, FLORIDA

MONITORING PROFILE TABULATION

ID	EASTING	NORTHING	ELEV.	AZ.
R-55	516,461.72	2,271,261.62	20.37	90
R-56	516,484.07	2,270,094.50	15.36	90
R-57	516,415.29	2,269,010.55	12.38	90
R-58	516,319.72	2,268,031.52	14.62	90
R-59	516,345.38	2,267,069.14	23.94	90
R-60	516,534.13	2,266,042.64	14.71	85
R-61	516,500.82	2,265,113.72	20.50	85
R-62	516,637.16	2,264,046.90	26.91	85
R-63	516,633.98	2,263,136.71	18.48	85
R-64	516,728.41	2,262,165.79	18.90	85
R-65	516,799.22	2,261,257.95	21.70	85
R-66	516,916.33	2,260,353.34	26.77	85
R-67	516,930.53	2,259,418.56	18.23	85
R-68	517,195.27	2,258,461.54	21.97	85
R-69A	517,274.62	2,257,418.08	20.81	85
R-70	517,452.59	2,256,448.17	12.69	85
R-71	517,757.20	2,255,470.38	20.35	80
R-72A	518,006.71	2,254,606.85	19.01	80
AP-19	518,247.81	2,253,650.50	12.25	80
AP-20	518,339.25	2,253,167.93		78
AP-21	518,475.39	2,252,643.23	13.32	80
AP-22	518,568.40	2,252,149.07		80
R-75	518,692.11	2,251,709.01	27.97	80
AP-23	518,831.26	2,251,228.48		85
AP-24	518,850.77	2,250,804.95	19.69	87
AP-25	518,871.46	2,250,399.82		88
R-77	518,695.24	2,249,946.52	11.34	90
R-77.5	518,947.28	2,249,454.66		90
R-78	518,449.31	2,249,070.23	10.11	90
R-78.5	518,601.91	2,248,564.09		90
D-79	517,979.06	2,248,204.06	5.72	90
R-79	517,979.06	2,248,204.06	5.72	130
A-79	517,979.06	2,248,204.06	5.72	155
B-79	517,979.06	2,248,204.06	5.72	180
C-79	517,979.06	2,248,204.06	5.72	210
R-79.5	517,526.25	2,248,206.96		210
R-80	517,234.48	2,248,408.73	15.41	210
R-80.5	516,936.91	2,248,793.50		220
R-81A	516,644.47	2,249,173.45	6.58	220
R-81.5	516,302.60	2,249,553.11		220
R-82	515,962.32	2,249,931.18	12.68	220







SURVEYORS NOTES:

1. ALL ELEVATIONS SHOWN ARE REFERENCED TO NAVD88.
2. PLANE COORDINATES ARE BASED ON THE FLORIDA STATE PLANE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983(NAD83), TRANVERSE MERCATOR PROJECTION.
3. BEARING STRUCTURE NOTED HEREON IS REFERENCED TO GRID AS DETERMINED BY THE RECORD STATE PLANE COORDINATES (NAD83 FL EAST).
4. ALL MEASUREMENTS AND POSITIONS ARE IN U.S. SURVEY FEET AND WAS PERFORMED UTILIZING RTK GPS POSITIONING REFERENCED TO A FLORIDA VRS NETWORK.
5. SUBAQUEOUS MEASUREMENTS WERE MADE WITH AN TELEDYNE CV100 ECHOSOUNDER OPERATING AT A FREQUENCY OF 200 kHz, VESSEL HEAVE WAS MEASURED AND RECORDED UTILIZING A POS MV WAVE MASTER MOTION REFERENCE UNIT.
6. THE TOPOGRAPHIC COMPONENT WAS MEASURED UTILIZING REAL TIME KINEMATIC (RTK) SURVEYING PROCEDURES. VECTOR CORRECTIONS WERE GENERATED FROM PRIMARY SITE CONTROL DNR CONTROL STATIONS "R-55" ELEV. 20.37, "R-80" ELEV. 15.41 AND "N-326" ELEV.12.48.
7. THE FIELD WORK WAS COMPLETED ON JUNE 9, 2023.
8. THIS SURVEY MAP DOES NOT REFLECT OR DETERMINE OWNERSHIP.
9. THIS SURVEY IS NOT VALID WITHOUT THE SIGNATURE AND THE ORIGINAL RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.
10. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING GENERAL CONDITIONS EXISTING AT THAT TIME.
11. PREPARED FOR OLSEN ASSOCIATES, INC.

MAP NOTES:

1. Elevations shown are depicted at a 60- foot spacing interval for clarity.
2. Contours generated from a 60 - ft X 60 -ft grid matrix for graphical illustration only.
3. Contours may vary slightly from the original dtm.

Richard J Sawyer, PSM

Digitally signed by Richard J Sawyer, PSM
Date: 2023.07.05 16:14:57 -04'00'

Richard J. Sawyer
Professional Surveyor and Mapper No. 6131
NOT VALID WITHOUT THE SIGNATURE AND THE ORIGINAL RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER

Arc Surveying & Mapping, Inc.
Professional Hydrographers • Surveyors • Mappers
5202 San Juan Avenue
Jacksonville, Florida 32210
904.384.8377

Prepared For:
olsen associates, inc.
Jacksonville, Florida

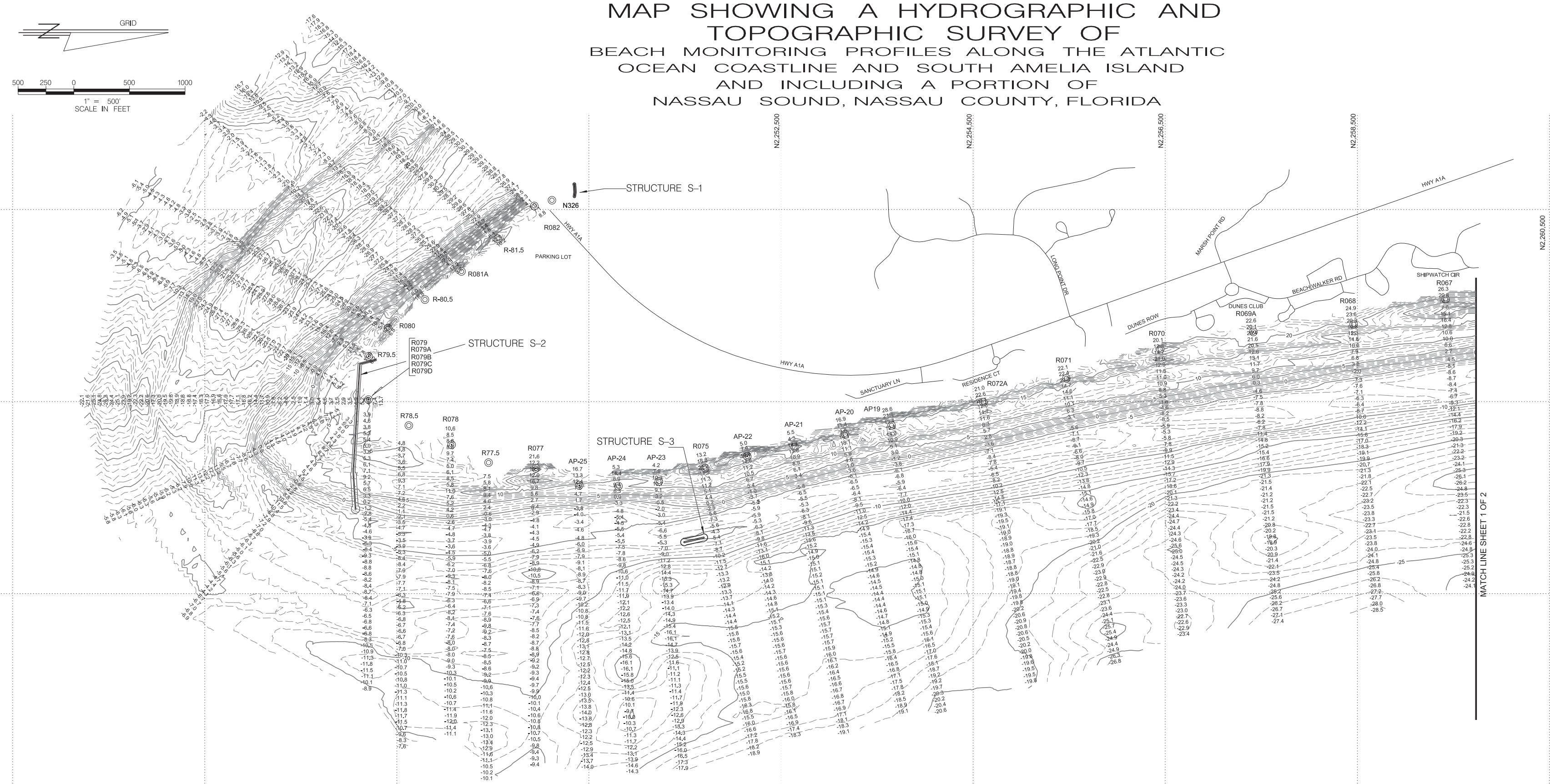
Project:
South Amelia Island
June 2023 Beach Monitoring Survey
R55 - R82

LB No. 6487
Drawn By: M. SAWYER
Scale: 1" = 500'
Plot Date: 06/16/23
Checked by: RJS
Field Book: NA
ARC Project No.: 23-020
SHEET: 1 OF: 2

23-020_Bch_sh1.dgn 6/16/2023 11:25:24 AM

MAP SHOWING A HYDROGRAPHIC AND TOPOGRAPHIC SURVEY OF

BEACH MONITORING PROFILES ALONG THE ATLANTIC OCEAN COASTLINE AND SOUTH AMELIA ISLAND AND INCLUDING A PORTION OF NASSAU SOUND, NASSAU COUNTY, FLORIDA



MAP NOTES:

1. Elevations shown are depicted at a 60ft spacing interval for clarity.
2. Contours generated from a 60ft X 60ft grid matrix for graphical illustration only.
3. Contours may vary slightly from the original dtm.
4. Refer to sheet 1 for Survey Notes.

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Scale:	1" = 500'
Plot Date:	06/16/23
Checked By:	RJS
Field Book:	NA
ARC Project No.:	23-020
SHEET: 2	OF: 2

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904.384.8377

Prepared For:

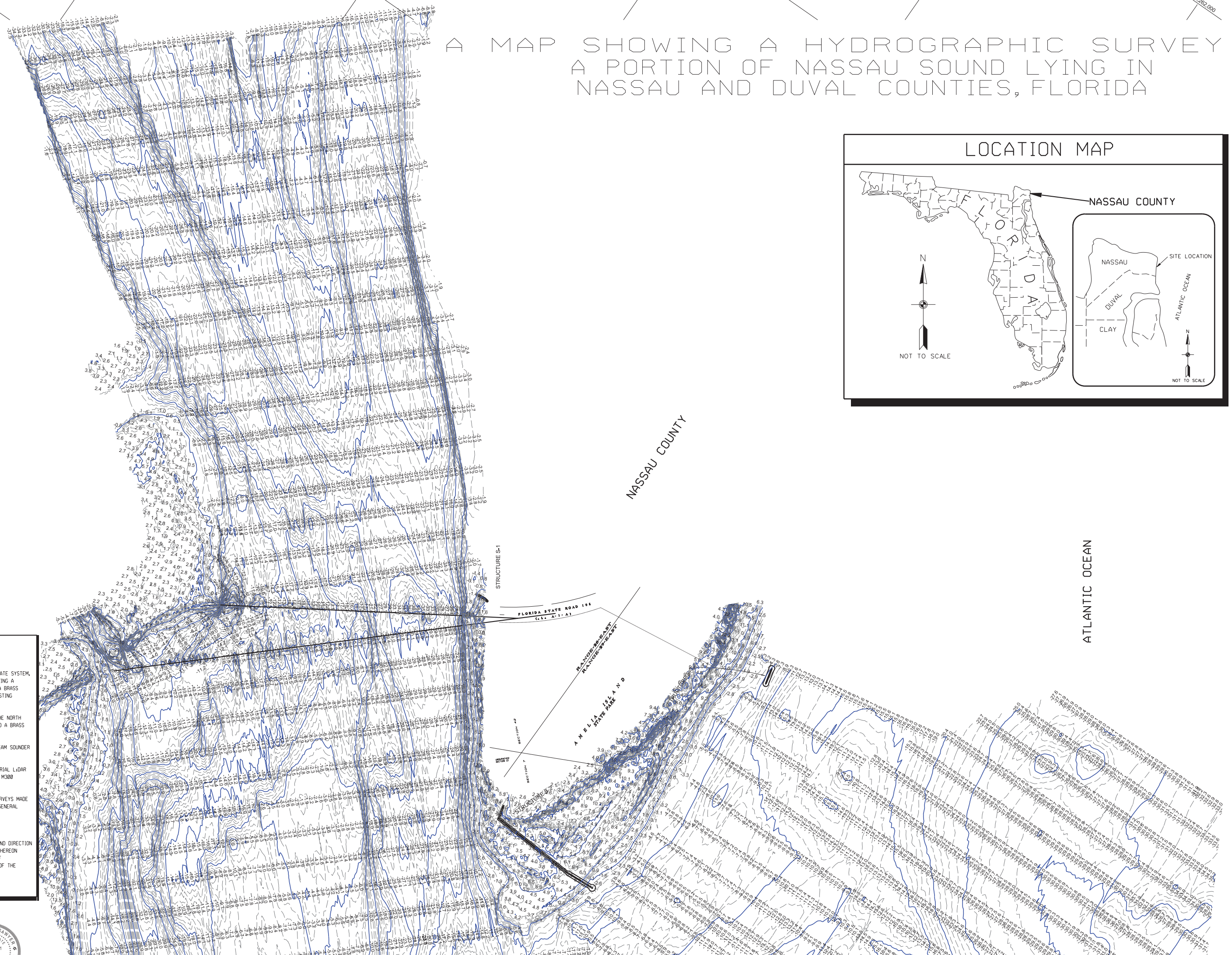
olsen associates, inc.
Jacksonville, Florida

Project:

South Amelia Island
June 2023 Beach Monitoring Survey
R55 - R82

23-020_Bch_sh2.dgn 6/16/2023 11:27:55 AM

A MAP SHOWING A HYDROGRAPHIC SURVEY OF A PORTION OF NASSAU SOUND LYING IN NASSAU AND DUVAL COUNTIES, FLORIDA



GRID N

600 300 0 600 1200

SCALE IN FEET
1" = 600'

SURVEYORS NOTES:

1. ALL DIMENSIONS, UNLESS OTHERWISE NOTED, ARE IN US SURVEY FEET.
2. HORIZONTAL DATUM IS REFERENCED TO THE FLORIDA STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83), BEING DERIVED UTILIZING A TRIMBLE VIRTUAL REFERENCE SYSTEM (VRS) REFERENCED AND VERIFIED TO A BRASS DISK STAMPED "N326", HAVING COORDINATES OF NORTHING 2,205,113.28 & EASTING 515,903.50
3. ELEVATIONS SHOWN HEREON ARE IN US SURVEY FEET AND ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), REFERENCED AND VERIFIED TO A BRASS DISK STAMPED "N326", HAVING AN ELEVATION OF 12.48 (NAVD88).
4. HYDROGRAPHIC SOUNDINGS WERE MADE WITH AN TELEDYNE CV-100 SINGLE-BEAM SOUNDER OPERATING AT A FREQUENCY OF 200 kHz.
5. TOPOGRAPHIC ELEVATIONS ABOVE THE WATERLINE WERE GENERATED WITH AERIAL LiDAR SURVEY METHODS UTILIZING A ROCK R2A LiDAR SYSTEM MOUNTED TO A DJI M300 UNMANNED AERIAL VEHICLE (UAV).
6. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES LISTED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THE TIME OF ACQUISITION.
7. THIS SURVEY WAS COMPLETED IN FIELD FROM MARCH 27 TO JUNE 6, 2023.
8. THE ABOVE LANDS WERE SURVEYED UNDER THE RESPONSIBLE SUPERVISION AND DIRECTION OF THE SIGNING PROFESSIONAL SURVEYOR AND MAPPER. THE SURVEY SHOWN HEREON MEETS THE STANDARDS OF PRACTICE SET FORTH BY THE FLORIDA BOARD OF PROFESSIONAL SURVEYORS AND MAPPERS PURSUANT TO CHAPTER 5J-17.052 OF THE FLORIDA ADMINISTRATIVE CODE.

Richard J. Sawyer Date:
Professional Surveyor and Mapper No. 6131
NOT VALID WITHOUT THE SIGNATURE, DATE AND THE ORIGINAL SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER

RICHARD J. SAWYER CERTIFICATE No. 6131 STATE OF FLORIDA

MATCH LINE SEE SHEET 2 OF 3

MAP NOTES:

1. Elevations shown are depicted at a 60 - foot spacing interval for clarity.
2. Contours generated from a 30 - ft X 30 -ft grid matrix for graphical illustration only.
3. Contours may vary slightly from the original dtm.

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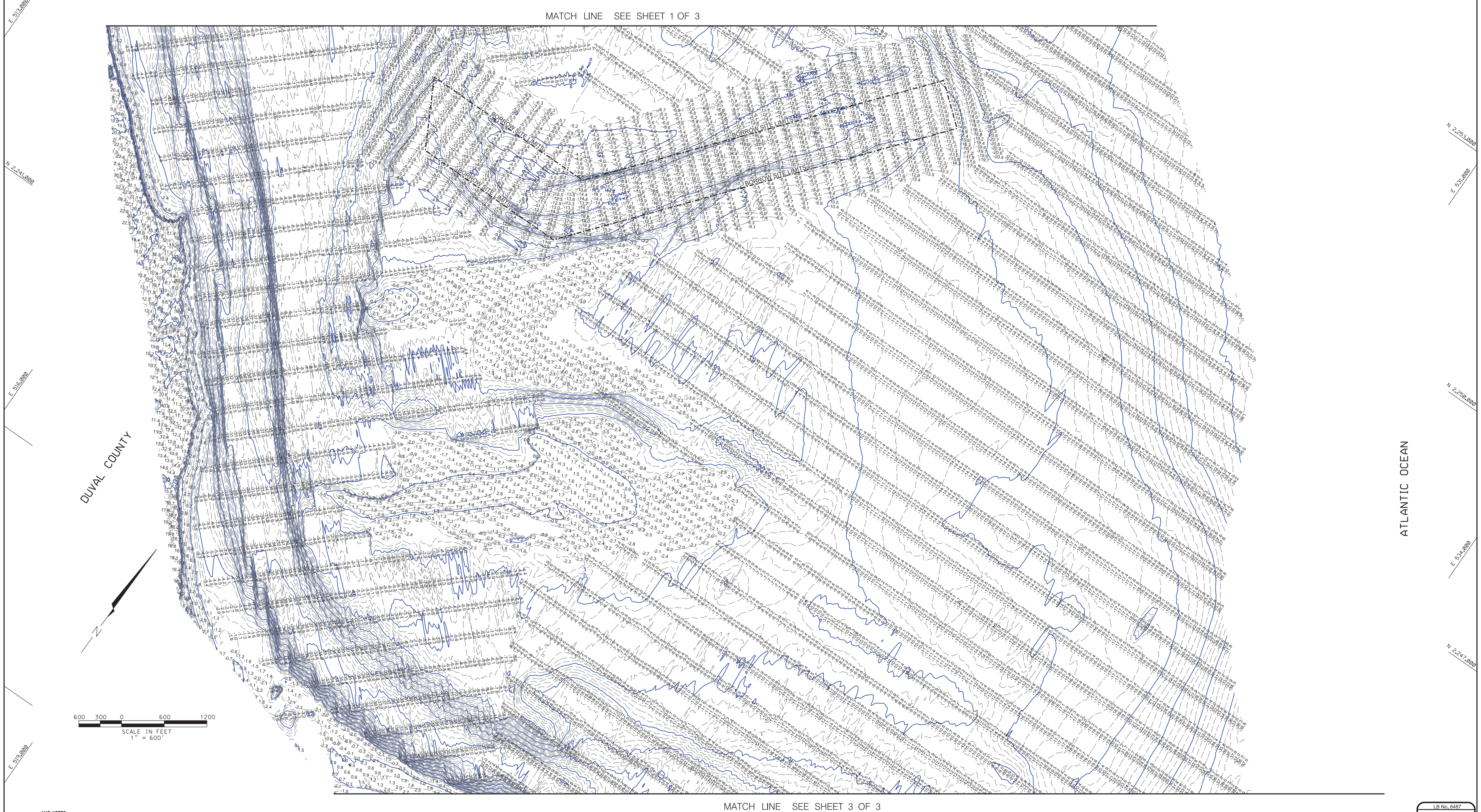
Jacksonville, Florida

Project:
South Amelia Island
Nassau Sound Bathymetry
March - June 2023

LB No. 6487
Drawn By: M. SAWYER
Scale: 1" = 600'
Plot Date: 06/14/23
Checked By: R. SAWYER
Fld Bk: NA
ARC Project No.: 23-019
SHEET: 01 OF: 03

23-019_nassau_sht1.dgn 6/14/2023 1:22:15 PM

A MAP SHOWING A HYDROGRAPHIC SURVEY OF A PORTION OF NASSAU SOUND LYING IN NASSAU AND DUVAL COUNTY, FLORIDA



MAP NOTES:

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Jacksonville, Florida

Project:
South Amelia Island
Nassau Sound Bathymetry
March - June 2023

LB No. 6487	
Drawn By:	M. SAWYER
Scale:	1" = 600'
Plot Date:	06/14/23
Checked By:	R. SAWYER
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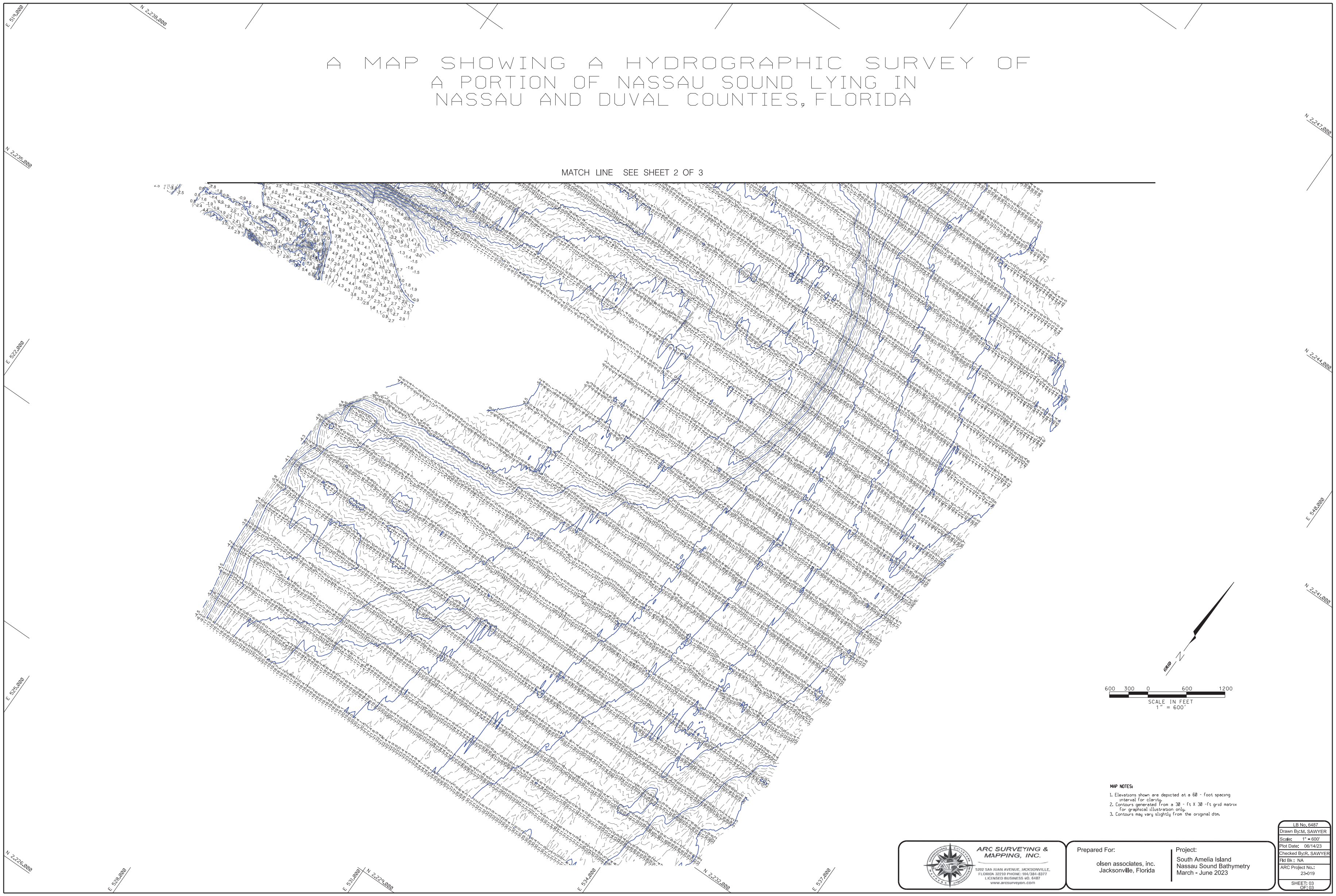
ARC Project No.:	23-019
SHEET: 02	OF: 03

23-019_nassau_sht2.dgn 7/11/2023 3:39:47 PM

A MAP SHOWING A HYDROGRAPHIC SURVEY OF A PORTION OF NASSAU SOUND LYING IN NASSAU AND DUVAL COUNTIES, FLORIDA



MAP NOTES:

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2. Contours generated from a 30 - ft X 30 -ft grid matrix for graphical illustration only.
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Prepared For:
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Jacksonville, Florida

Project:
South Amelia Island
Nassau Sound Bathymetry
March - June 2023

LB No. 6487	
Drawn By:	M. SAWYER
Scale:	1" = 600'
Plot Date:	06/14/23
Checked By:	R. SAWYER
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SHEET: 03	OF: 03

23-019_nassau_sht3.dgn 6/14/2023 1:29:00 PM

Surveyor’s Report

Arc Surveying & Mapping, Inc.
5202 San Juan Avenue
Jacksonville, Florida 32210

REPORT OF TOPOGRAPHIC AND BATHYMETRIC SURVEY
SOUTH AMELIA ISLAND, NASSUA COUNTY, FLORIDA
June 2023

In support of:

SOUTH AMELIA ISLAND SHORE STABLIZATION PROJECT
YEAR 5 PHASE I BEACH FILL MONITORING
Project No. 01NA2

Report of Survey: Richard J. Sawyer, PSM, ACSM Certified Hydrographer, Arc Surveying and Mapping, Inc., 5202 San Jun Ave., Jacksonville, Florida - 32210.

Project: South Amelia Island Beach Profile Monitoring

Location: Nassau County, Florida

Dates of Survey: June 9, 2023

Right of Access: There were no issues of access for this project.

Datum: Horizontal coordinates are referenced to the State Plane Coordinate System, Florida East Zone 0901, North American Datum of 1983 (NAD83). Vertical Datum referenced to North American Vertical Datum of 1988 (NAVD88).

Survey Site Control:

Designation	Northing	Easting	Elev.
R80	2248408.73	517234.48	15.41
N326	2250113.28	515906.50	12.48

Field Procedures:

- **Topographic Component:** The survey was performed utilizing Real-Time Kinematic (RTK) GPS surveying procedures. Corrections were obtained from Trimble VRS Network. Positional accuracy verification was documented at the beginning and end of each day of survey data acquisition. Topographic data resolution did not exceed 25-feet and included all breaks along each profile range. Data was collected beginning at the approximate high water line and extended seaward along the historic grid bearing of each profile to a depth obtainable by wading.
- **LiDAR Component:** Upland LiDAR topographic data acquisition was performed along the reach of the survey limits which includes all the Atlantic Coastline lying in Nassau County between profiles R-55 through R-82. Corridor data was collected at a width to capture the complete dune system and extend to the edge of water at a low tidal condition. LiDAR acquisition included a point density of not less than 25 points per square meter to support a compete digital terrain model of the existing beach condition. In addition, high resolution digital imagery was captured suitable for production of three-inch pixel resolution and adequate to assure successful production of accurate ortho digital imagery.
- **Hydrographic Component:** Hydrographic data acquisition was performed utilizing a Odom Echo Trac Sounder operating at 200 kHz, Applanix Wavemaster Positioning and IMU. Bathymetric survey data collection was conducted during high tide periods. Offshore profiles extended to a minimum of 3000 feet offshore from the most landward offshore data point or to –30 feet (NAVD88), whichever was reached first.

Survey Accuracy: The vertical accuracy meets and/or exceeds GPS – derived heights (5cm) standard and was documented and verified through a check back to on site controlling reference monuments. The horizontal accuracy of the data meets and/or exceeds the Geospatial Positioning Accuracy Standards, Range X, (maximum of 3 feet) and was documented and verified through a check back to on site controlling reference monuments.

SURVEYOR CERTIFICATION: This survey meets the State of Florida's Department of Environmental Protection, Office of Beaches and Coastal Systems, Regional Data Collection and Processing Plan (Section 2.01) and the Florida Standards of Practice for Surveying and Mapping (Chapter 472.027, Florida Administrative Code).

____

Richard J. Sawyer, ACSM Certified Hydrographer No. 194
Professional Surveyor and Mapper No. 6131
NOT VALID WITHOUT THE SIGNATURE AND THE ORIGINAL RAISED
SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER

South Amelia Island Beach

LiDAR Survey

Job Number: 23-020

LiDAR Survey Date: May 30, 2023

Survey Performed for: Olsen Associates, Inc

Arc Surveying & Mapping, Inc.
5202 San Juan Avenue
Jacksonville, FL 32210
(904) 384-8377
www.arcsurvevors.com

Index

Background

Arc Surveying and Mapping, Inc (Arc) was issued a contract by Olsen & Associates, Inc to perform aerial lidar mapping for the survey area. Utilizing a combination of data acquisition procedures including conventional survey collection, drone-based LiDAR and photogrammetry, and Real Time Kinematic (RTK) GPS. The procedures utilized result in high resolution spatial data, which provide accurate control and feature data acquisition

Preparation

Special care and attention to weather conditions were taken into consideration during survey operations. To improve survey data accuracies. Ideal conditions were utilized for data acquisition. Careful consideration was taken during the planning to ensure safety of crew and equipment.

Weather Conditions: General weather conditions were sunny during all survey acquisition days.

Personnel:

Project Manager: Rick Sawyer, P.L.S.
Data Processor: John Maffett, P.S.M.
Drone Pilot/Data Processor: Alex Sinardi, S.I.T.
Visual Observer: Cole Baker, S.I.T.
Crew Chief: Nick Enman
Instrument Man: Kevin Ameye

Equipment

- *Emlid Reach RS2+:* The Reach RS2+ gets a fixed solution in just seconds and maintains robust performance even in challenging conditions. Centimeter accuracy can be achieved on distances up to 60 km in RTK, and 100 km in PPK mode

- *Trimble™ S3 2" Robotic Total Station:* An accurate and reliable instrument, integrated robotic radio and popular Trimble TSC3 controller optimized for Trimble Access fld software, integrated high-capacity battery and dual charger.

- *DJI™ M300 RTK Commercial Quadcopter:* An absolute workhorse for public safety, utility, construction, inspection and many more applications. 50+ minutes of flight time, maximum transmission range of 9+ miles, and the ability to carry up to three payload cameras or sensors.

- *ROCK™ R2A: A* Livox™ Avia lidar sensor capable of collecting over 240,000 points per second, with three returns, coupled with a military grade, Inertial Labs™ IMU. A Sony™ A5100 24 mega-pixel sensor is mounted for image acquisition allowing RGB overlay for full color point clouds, and seamless ortho imagery.

Geodetic Control Summary

Horizontal Control:
Florida State Plane Coordinate System, East Zone, North American Datum of 1983 (NAD83 2011).

Vertical Control:
North American Vertical Datum of 1988 (NAVD88).

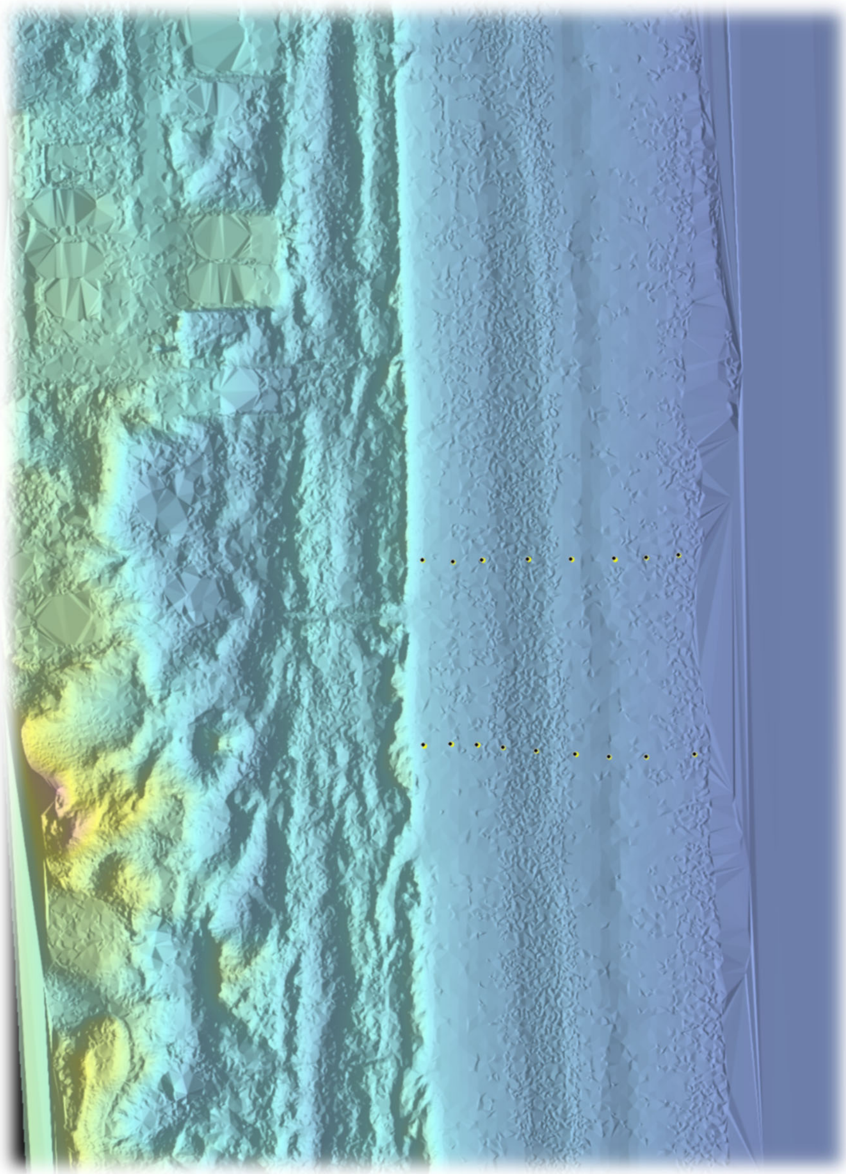
***NGS Benchmark*:** **N326** is the primary control point for this project.

Northing	***Easting***	***Elevation (ft)***
2,250,114.040	*515,903.217*	*12.48*

Positioning is provided from a reference base station located at the above reference benchmark. Both the base station and M300 quadcopter are logging simultaneous GPS corrections during lidar and photogrammetry acquisition. The data is then processed utilizing PPK (Post Processed Kinematic) techniques for further analysis, editing, and processing.

Lidar Ground Control Points and Accuracies

Data is processed and referenced in Blue Marble Global Mapper



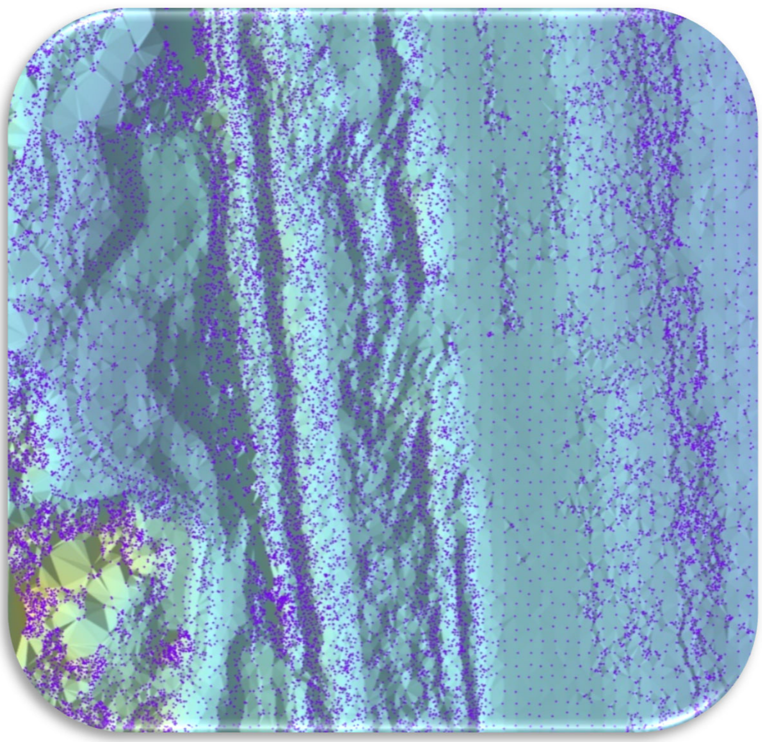
Elev.	LiDAR Elev.	Elev. Diff	Abs. Elev. Diff	RMSE
2.767	2.600	-0.167	0.167	0.167
2.107	1.949	-0.158	0.158	0.158
5.271	5.119	-0.152	0.152	0.152
6.743	6.641	-0.102	0.102	0.102
-1.889	-1.990	-0.101	0.101	0.101
9.352	9.265	-0.087	0.087	0.087
-1.697	-1.666	0.031	0.031	0.031
0.269	0.315	0.046	0.046	0.046
Avg.		**-0.086**	**0.106**	**0.106**

Key Point Extraction Used for Final Surface

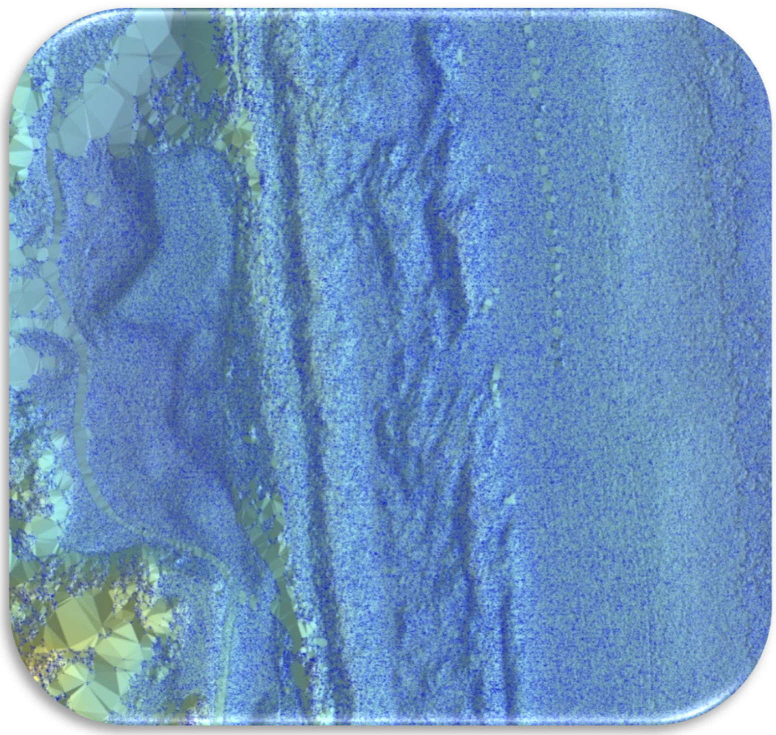
After ground is classified from the whole LiDAR point cloud, it is further classified into Model Key Points, which is a method in which points are classified into a rough grid based on input desired grid spacing, along with more points classified during changes in elevation, all done with custom input parameters. Both above and below tolerance for elevation changes can be modified to suit the needs for an induvial site. This allows it to be used directly as the Civil 3D surface while keeping the CAD file small and manageable.

Grid Spacing:	***Above Tolerance***	***Below Tolerance***
10 ft	*0.25 ft*	*0.25 ft*

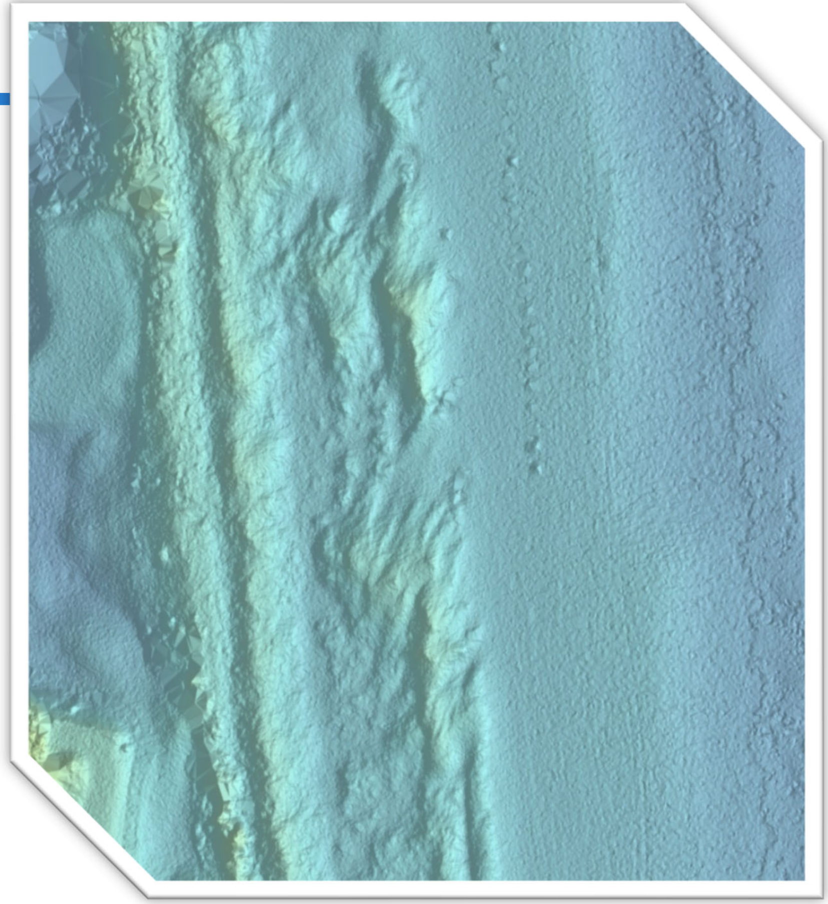
Classified Key Points



Classified Ground Points

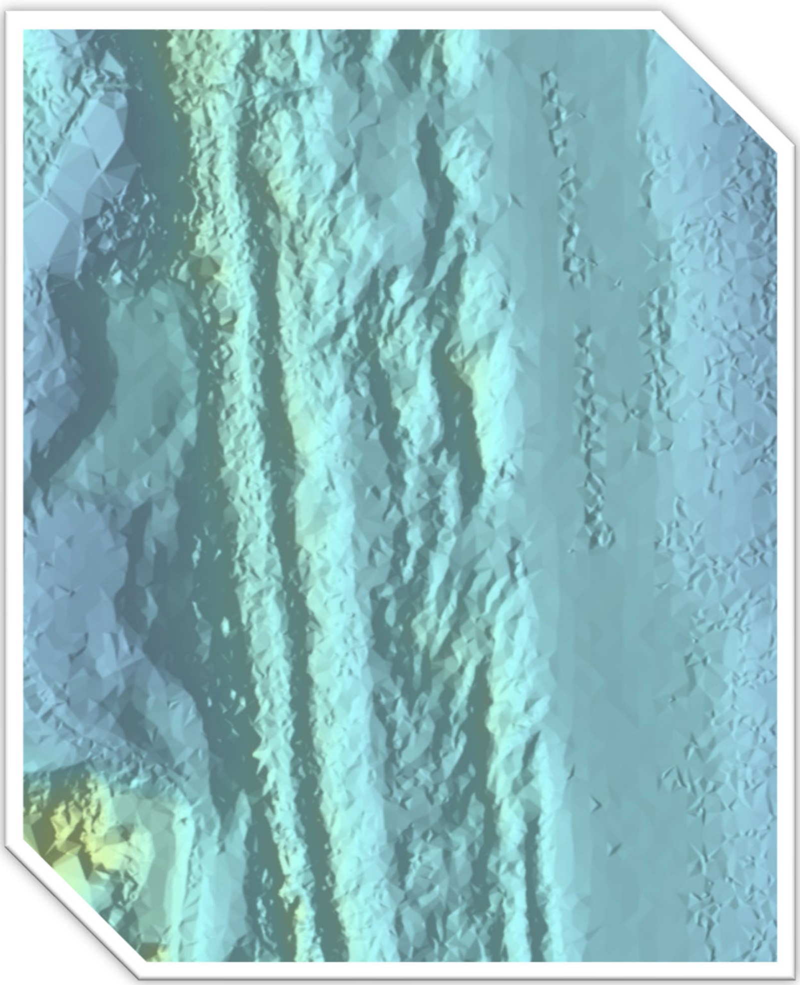


This Method makes the need for collection most breaklines, especially soft and miscellaneous, practically obsolete for the creation of a surface. See page 7 for the comparison of the full ground surface model to the model generated by Key Points.



Model of Ground Class

Notice the high resolution TIN model (13,568,974 points)



Model of Key Points

Notice the general lower resolution change of the TIN model, yet keeping the resolution high where there are changes in elevation. (908,928 points)

Deliverable Data Files

- Deliverable Digital CAD file w/ Surface
- .pdf of survey
- .xml surface file
- Geotiff / ECW Aerial Image files
- Survey Report

Surveyors Notes

1. Topographic digital terrain model (DTM) was generated from aerial lidar survey methods utilizing ROCK R2A LiDAR system mounted on a DJI M300 Unmanned Aerial Vehicle (UAV). The accuracy of the DTM ground surface in areas of high vegetation will vary and depend on the vegetation density. Conventionally surveyed cross sections and profiles were acquired to verify accuracies of DTM data.

2. Digital orthoimage shown here on was generated from aerial photogrammetric methods utilizing a SONY A5100 24 MP camera mounted on a DJI M300 unmanned aerial vehicle (UAV).

3. Horizontal and vertical positioning for both the aerial lidar and orthoimage are processed utilizing (PPK) post processed kinematic solutions. General accuracy for these solutions is 0.1 +/- of a foot.

Certification of Survey

This survey has been overseen and confirmed for compliance with State and Local Surveying Standards.

Signature: ____

John K. Maffett

This report was compiled by
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APPENDIX B:
2021 Project Beach Monitoring Profile Plots (R-55 to R-82)

This appendix contains plots of the 2021 Beach Nourishment Project pre-, post-, Year One, and Year Two post-construction survey beach profiles (June 2021, January 2022, July 2022 and June 2023 respectively). The limited beach survey following the impacts of Hurricanes Ian and Nicole (January 2023) are also included. **Table B.1** provides a summary of the beach profile surveys conducted since June 2021.

The location of the survey monuments (R-55 to R-82) are listed in **Table B.2** and graphically depicted as **Figure B.1**. Monument coordinates are referenced to the Florida State Plane Coordinate System – East Zone, North American Datum of 1983 (NAD83). Elevations are referenced to the National American Vertical Datum of 1988 (NGVD88). The available surveys listed by date and monument are summarized in **Table B.3**.

Plots of the beach profiles are provided as **Figures B.2** through **B.42**. Note that the pre- and post- construction beach monitoring profiles were surveyed several weeks before and after fill placement at a given monument and some level of the expected post-fill beach equilibration is apparent in the plotted beach profiles.

Table B.1: South Amelia Island beach profile surveys conducted since June 2021.

Description	Survey Date	Comments
Pre-construction	June 2021	Surveyor: Gahagan & Bryant Associates, Inc.
Post-construction	January 2022	Surveyor: Gahagan & Bryant Associates, Inc.
Year 1	July 2022	Surveyed approximately 7 months post-construction. Surveyor: ARC Surveying and Mapping
Post-Nicole	January 2023	Limited survey following storms Ian (~28 Sep.) and Nicole (~10 Nov.) Surveyor: ARC Surveying and Mapping
Year 2	June 2023	Surveyor: ARC Surveying and Mapping

Table B.2: South Amelia Island beach profile monument locations, Nassau County, FL.

Monument	Easting (FT-NAD83)	Northing (FT-NAD83)	Azimuth (GRID)
R-55	516,460.95	2,271,262.28	90
R-56	516,483.30	2,270,095.17	90
R-57	516,414.52	2,269,011.22	90
R-58	516,318.94	2,268,032.19	90
R-59	516,344.60	2,267,069.81	90
R-60	516,533.34	2,266,043.31	85
R-61	516,500.04	2,265,114.39	85
R-62	516,636.37	2,264,047.58	85
R-63	516,633.19	2,263,137.39	85
R-64	516,727.61	2,262,166.47	85
R-65	516,798.43	2,261,258.65	85
R-66	516,915.53	2,260,354.04	85
R-67	516,929.73	2,259,419.25	85
R-68	517,194.46	2,258,462.24	85
R-69	517,273.81	2,257,418.78	85
R-70	517,451.78	2,256,448.88	85
R-71	517,756.39	2,255,471.08	80
R-72A	518,005.90	2,254,607.56	80
AP-19 (R-73)	518,246.99	2,253,651.21	80
AP-20	518,339.25	2,253,167.93	78
AP-21 (R-74)	518,474.97	2,252,644.52	80
AP-22	518,568.40	2,252,149.07	80
R-75	518,691.29	2,251,709.72	80
AP-23	518,831.26	2,251,228.48	85
AP-24	518,850.77	2,250,804.95	87
AP-25	518,871.46	2,250,399.82	88
R-77	518,694.42	2,249,947.24	90
R-77.5	518,947.28	2,249,454.66	90
R-78	518,448.49	2,249,070.95	90
R-78.5	518,601.91	2,248,564.09	90
R-79D	517,978.22	2,248,204.80	90
R-79			130
R-79B			155
R-79C			180
R-79A			210
R-79.5	517,526.25	2,248,206.96	210
R-80	517,233.65	2,248,409.46	210
R-80.5	516,936.91	2,248,793.50	220
R-81A	516,643.65	2,249,174.18	220
R-81.5	516,302.60	2,249,553.11	220
R-82	515,961.50	2,249,931.91	220

Table B.3: South Amelia Island beach profile surveys since by monument since June 2021, Nassau County, FL. Surveys highlight in blue have limited upland coverage because beach access limitations by the Park due to concerns regarding impacts to nearby nesting shorebirds.

Mon.	**Pre-Construction** June 2021	**Post-Construction** January 2022	**Year 1** July 2022	**Post-Nicole** January 2023	**Year 2** June 2023
R-55	x	x	x	-	x
R-56	x	x	x	-	x
R-57	x	x	x	-	x
R-58	x	x	x	-	x
R-59	x	x	x	x	x
R-60	x	x	x	x	x
R-61	x	x	x	x	x
R-62	x	x	x	x	x
R-63	x	x	x	x	x
R-64	x	x	x	x	x
R-65	x	x	x	x	x
R-66	x	x	x	x	x
R-67	x	x	x	x	x
R-68	x	x	x	x	x
R-69	x	x	x	x	x
R-70	x	x	x	x	x
R-71	x	x	x	x	x
R-72A	x	x	x	x	x
AP-19	x	x	x	x	x
AP-20	x	x	x	-	x
AP-21	x	x	x	x	x
AP-22	x	x	x	-	x
R-75	x	x	x	x	x
AP-23	x	x	x	-	x
AP-24	x	x	x	x	x
AP-25	x	x	x	-	x
R-77	x	x	x	-	x
R-77.5	x	x	x	-	x
R-78	x	x	x	-	x
R-78.5	x	x	x	-	x
R-79D	x	x	x	-	x
R-79	x	x	x	-	x
R-79B	x	x	x	-	x
R-79C	x	x	x	-	x
R-79A	x	x	x	-	x
R-79.5	x	x	x	-	x
R-80	x	x	x	-	x
R-80.5	x	x	x	-	x
R-81A	x	x	x	-	x
R-81.5	x	x	x	-	x
R-82	x	x	x	-	x

Figure B.1: Amelia Island beach profile monument locations.

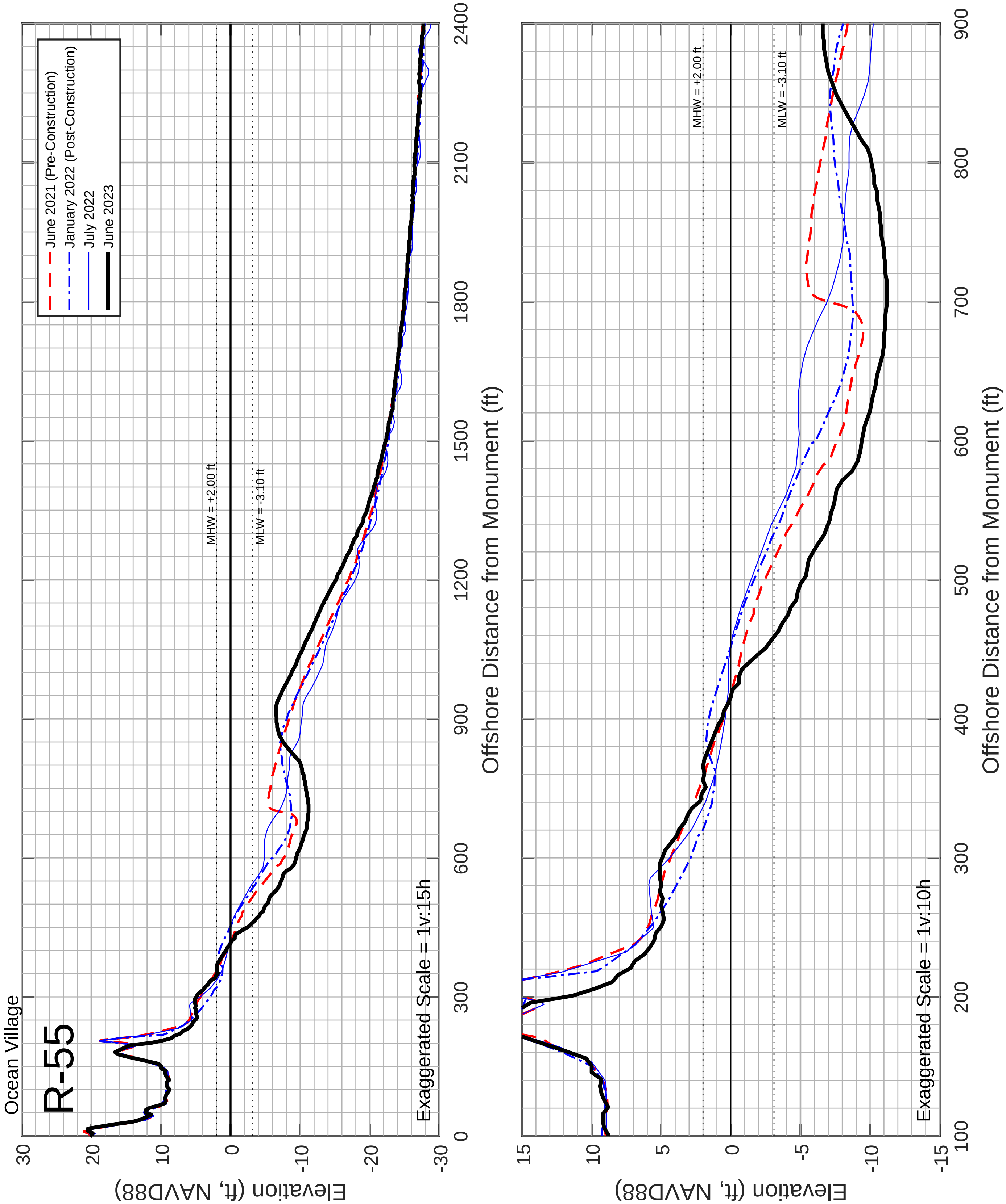


Figure B-01: Measured beach profiles at monument R-55 Amelia Island, Florida.

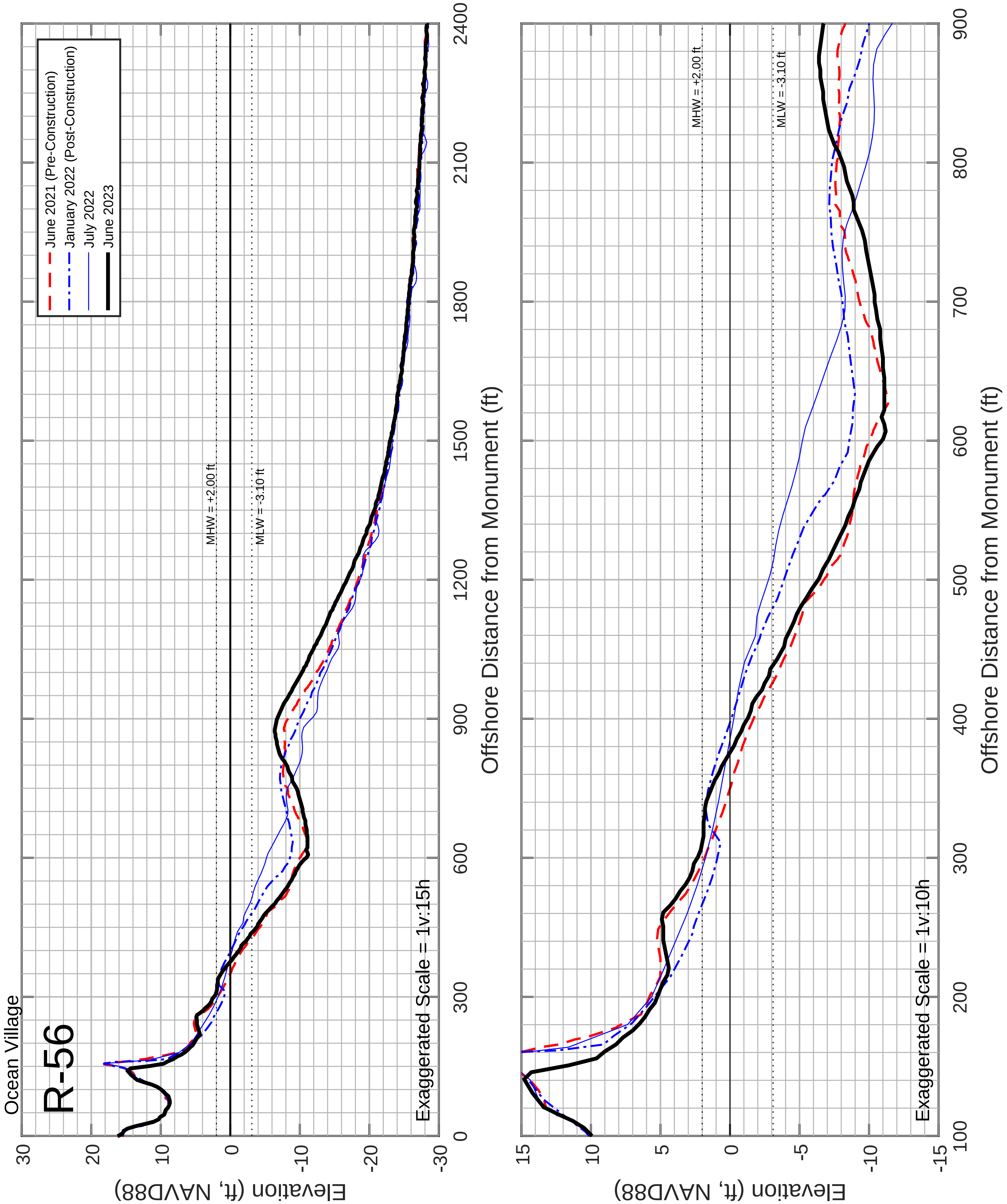


Figure B-02: Measured beach profiles at monument R-56 Amelia Island, Florida.

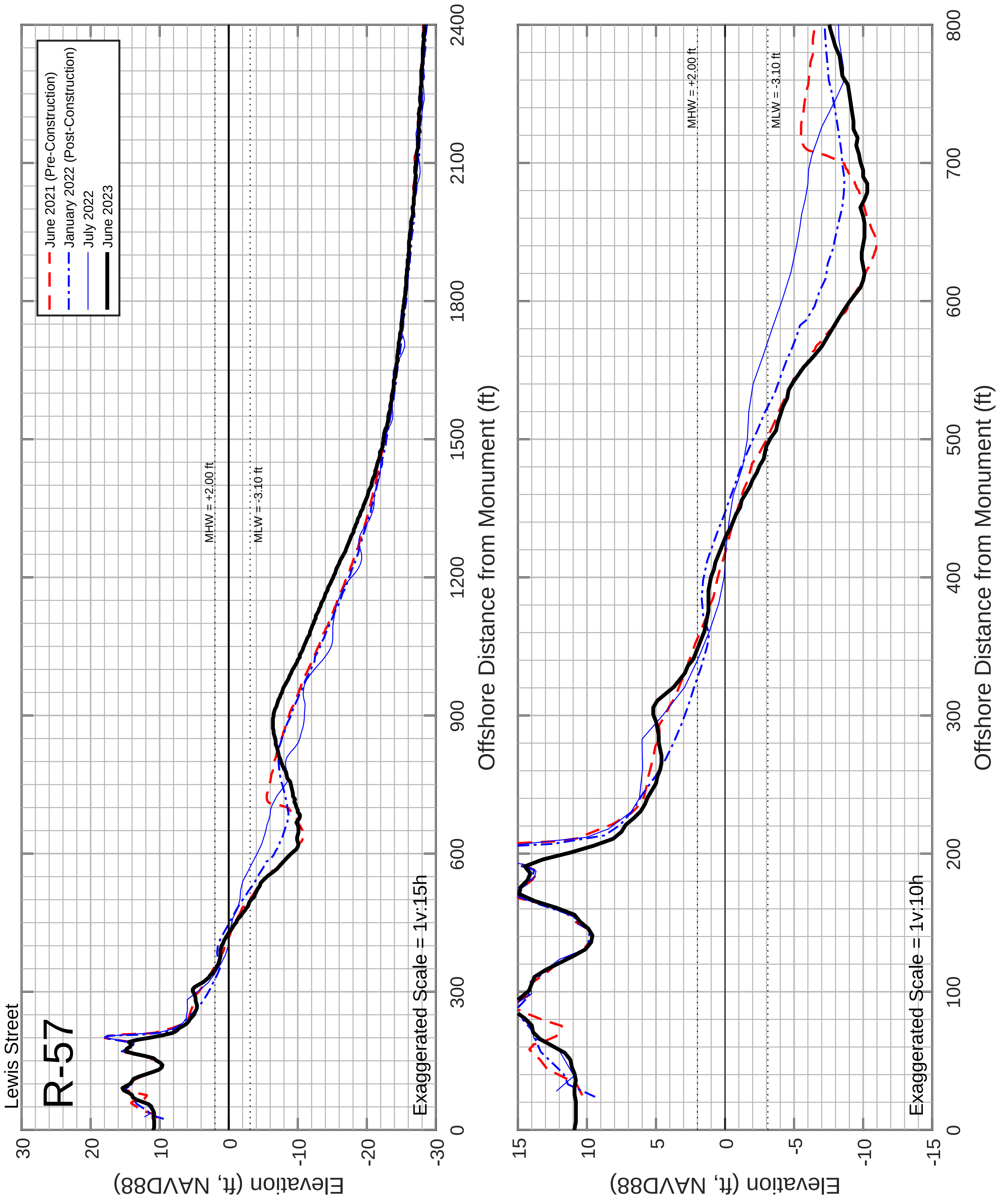


Figure B-03: Measured beach profiles at monument R-57 Amelia Island, Florida.

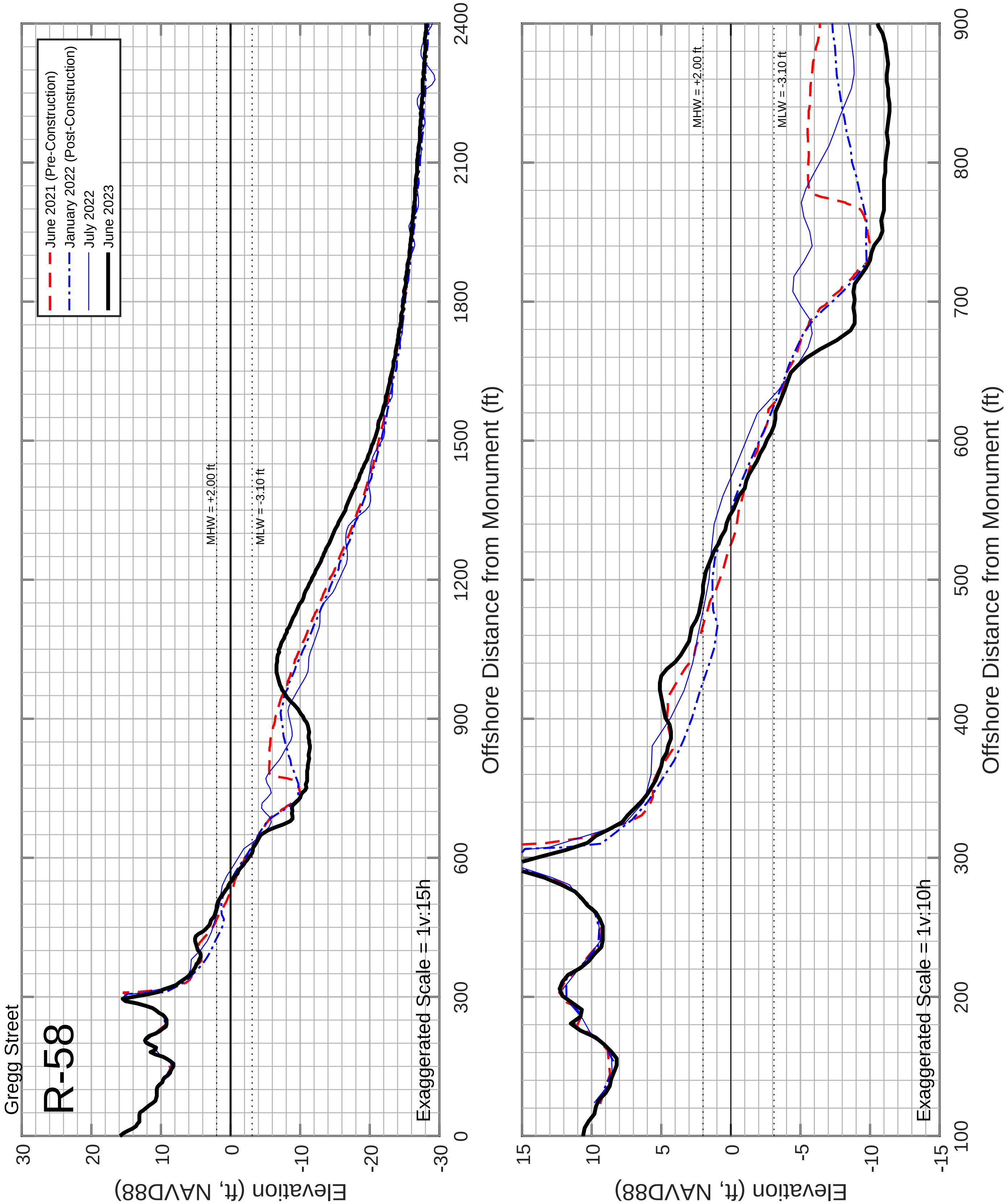


Figure B-04: Measured beach profiles at monument R-58 Amelia Island, Florida.

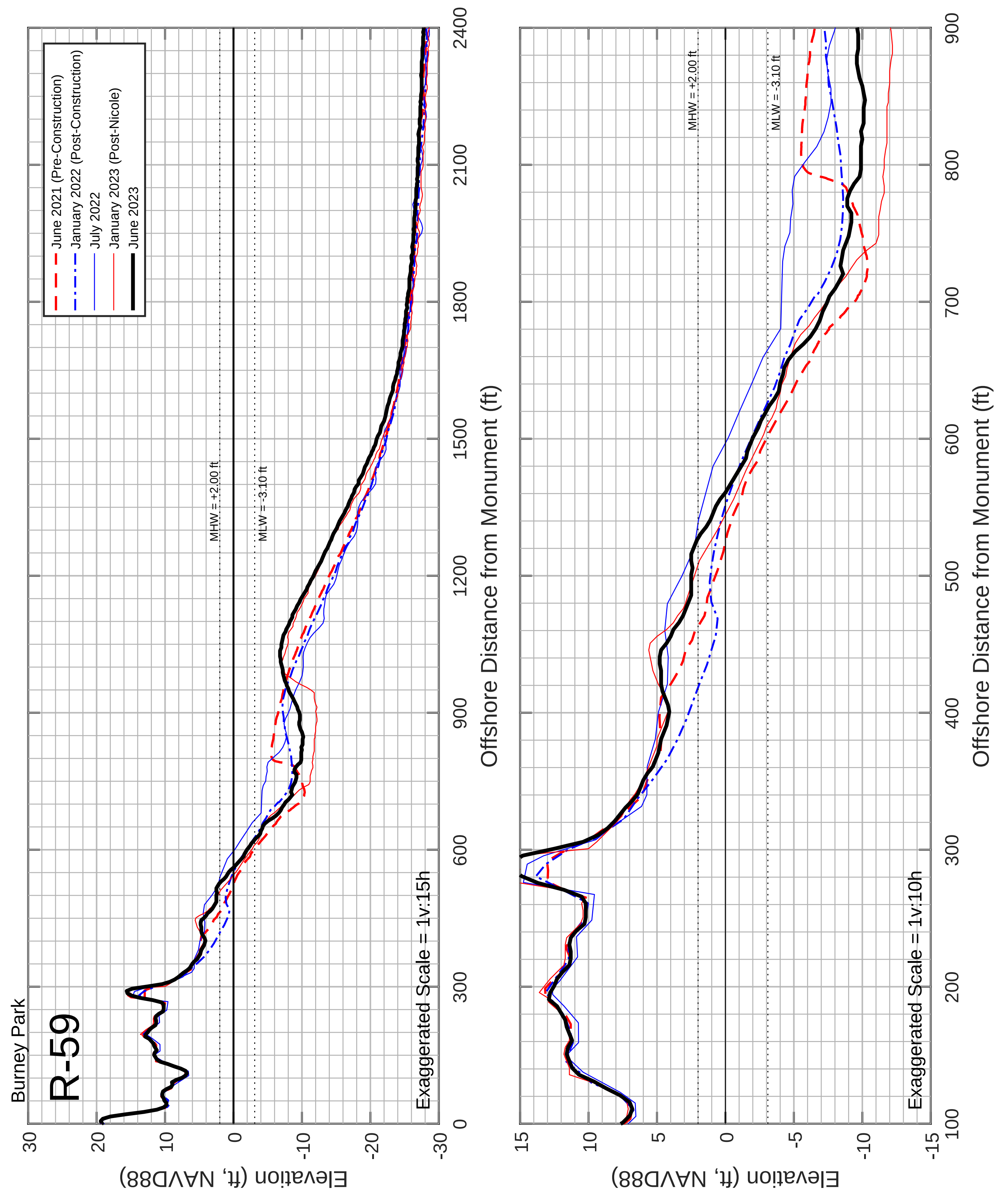


Figure B-05: Measured beach profiles at monument R-59 Amelia Island, Florida.

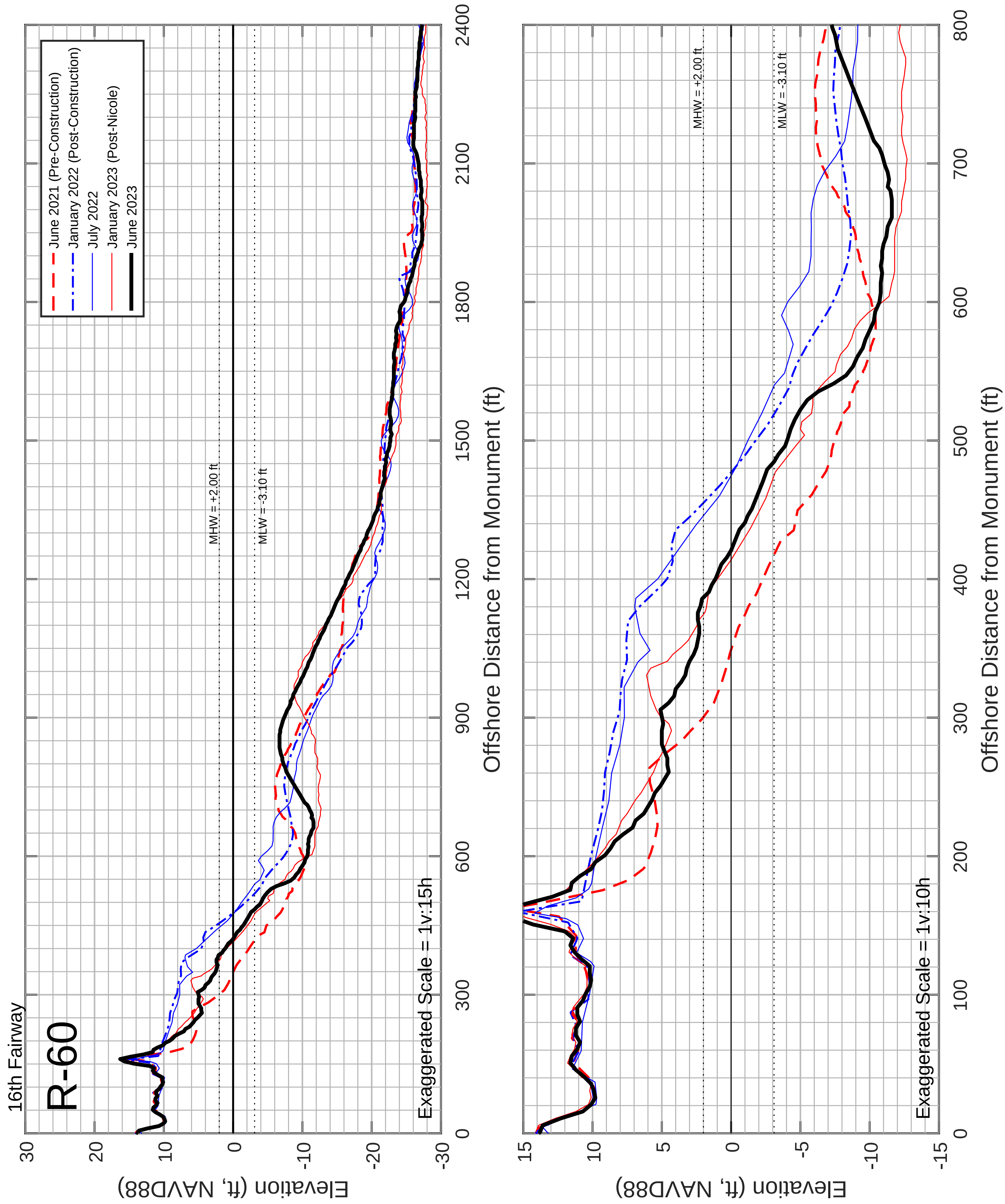


Figure B-06: Measured beach profiles at monument R-60 Amelia Island, Florida.

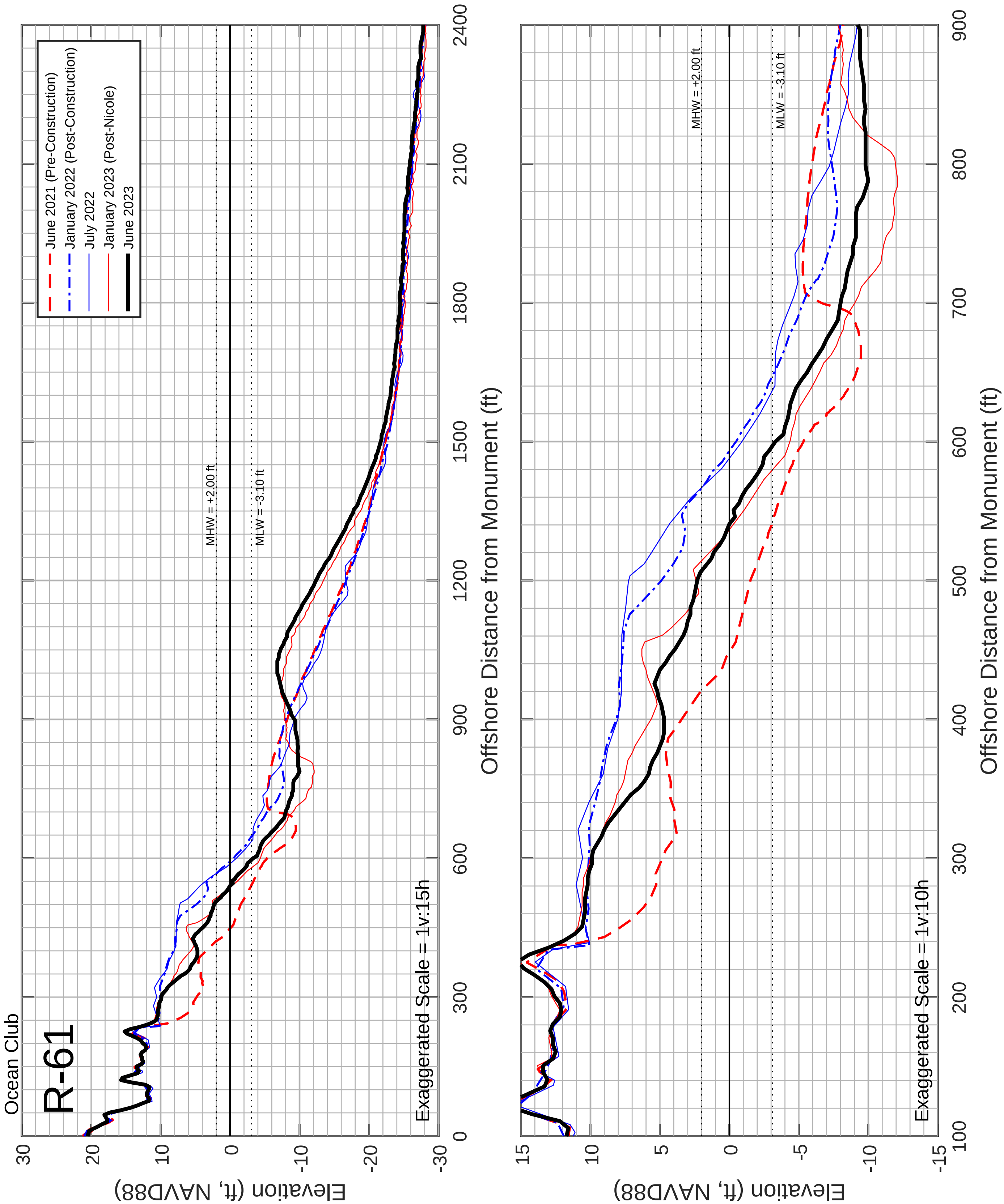


Figure B-07: Measured beach profiles at monument R-61 Amelia Island, Florida.

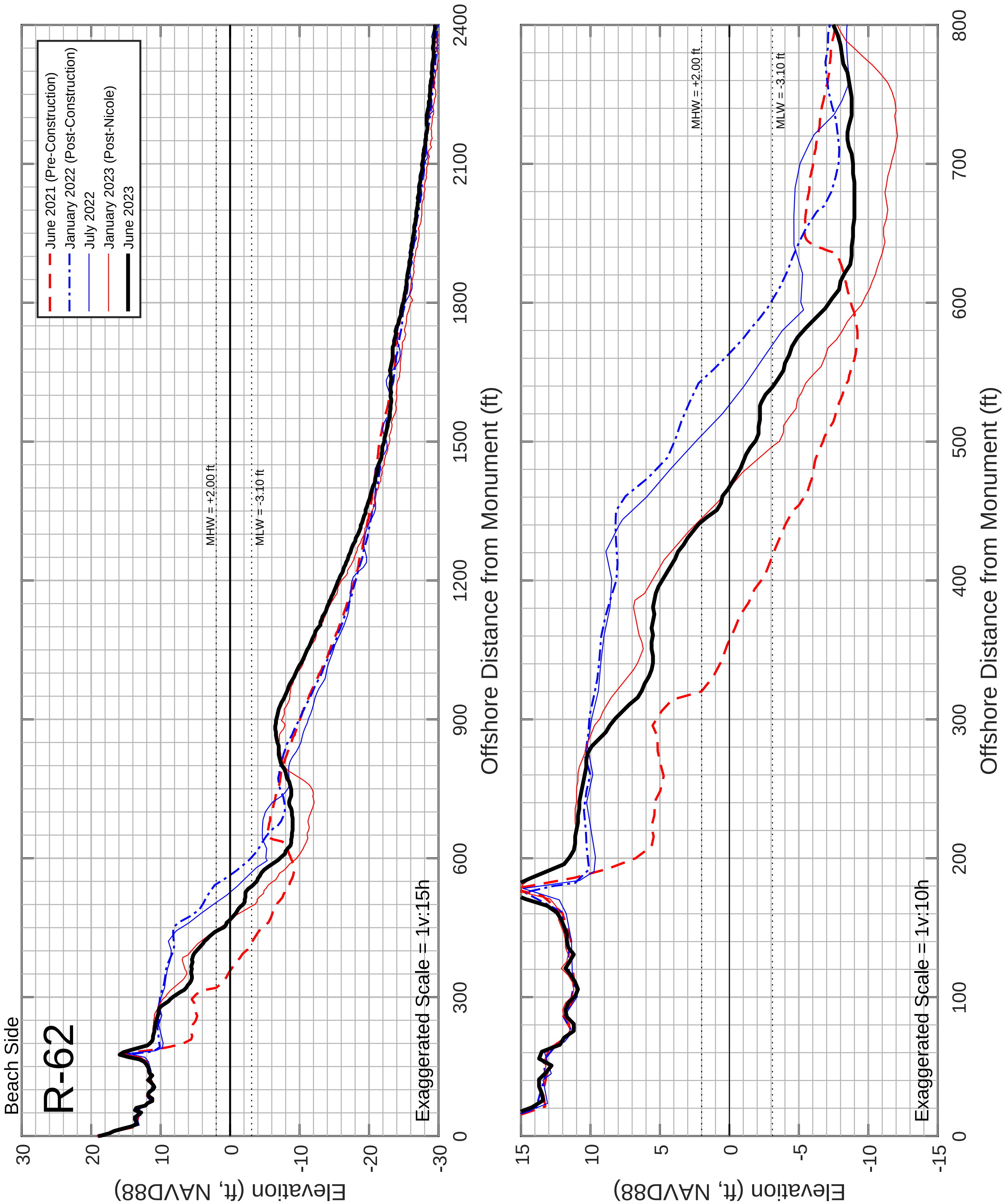


Figure B-08: Measured beach profiles at monument R-62 Amelia Island, Florida.

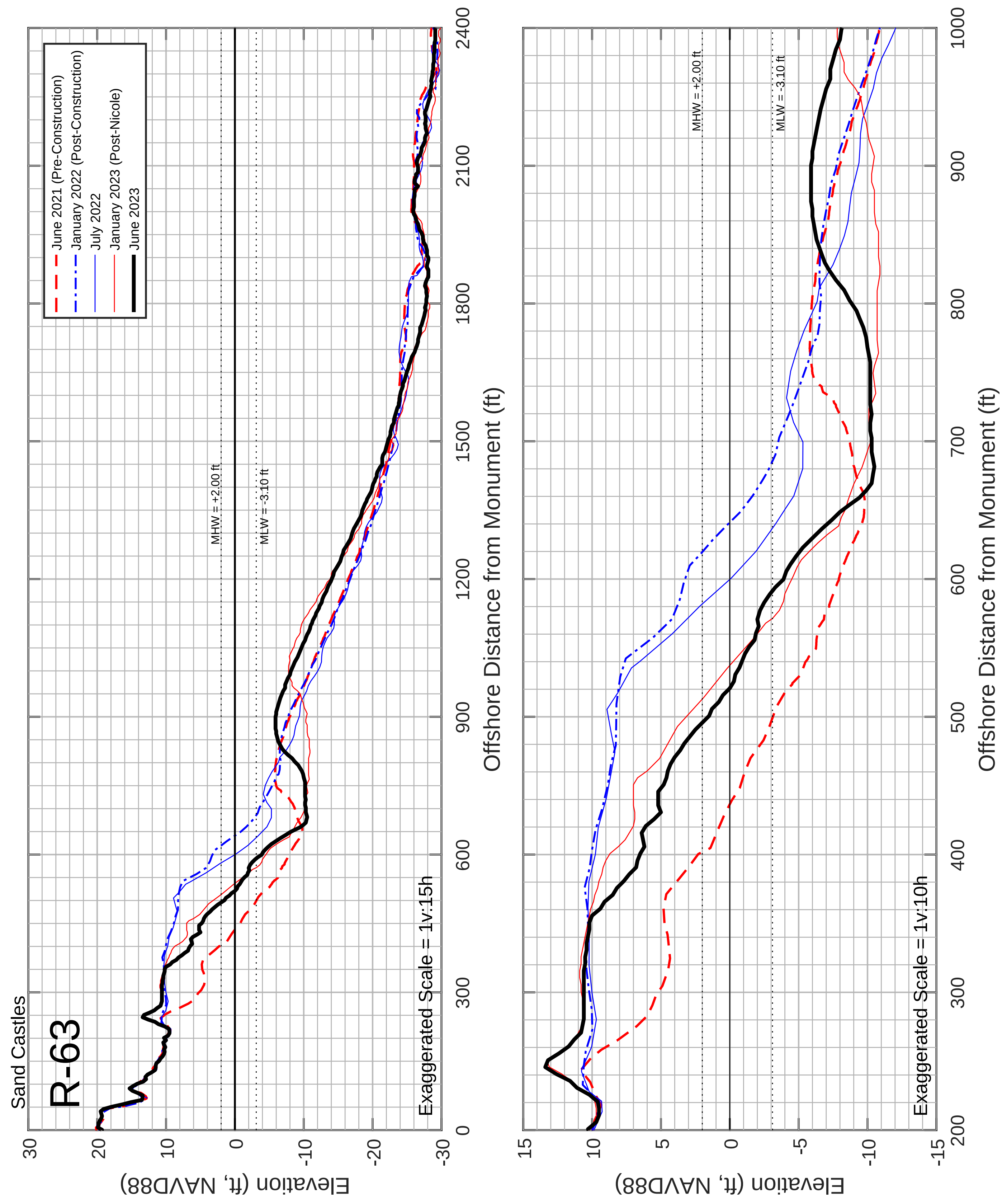


Figure B-09: Measured beach profiles at monument R-63 Amelia Island, Florida.

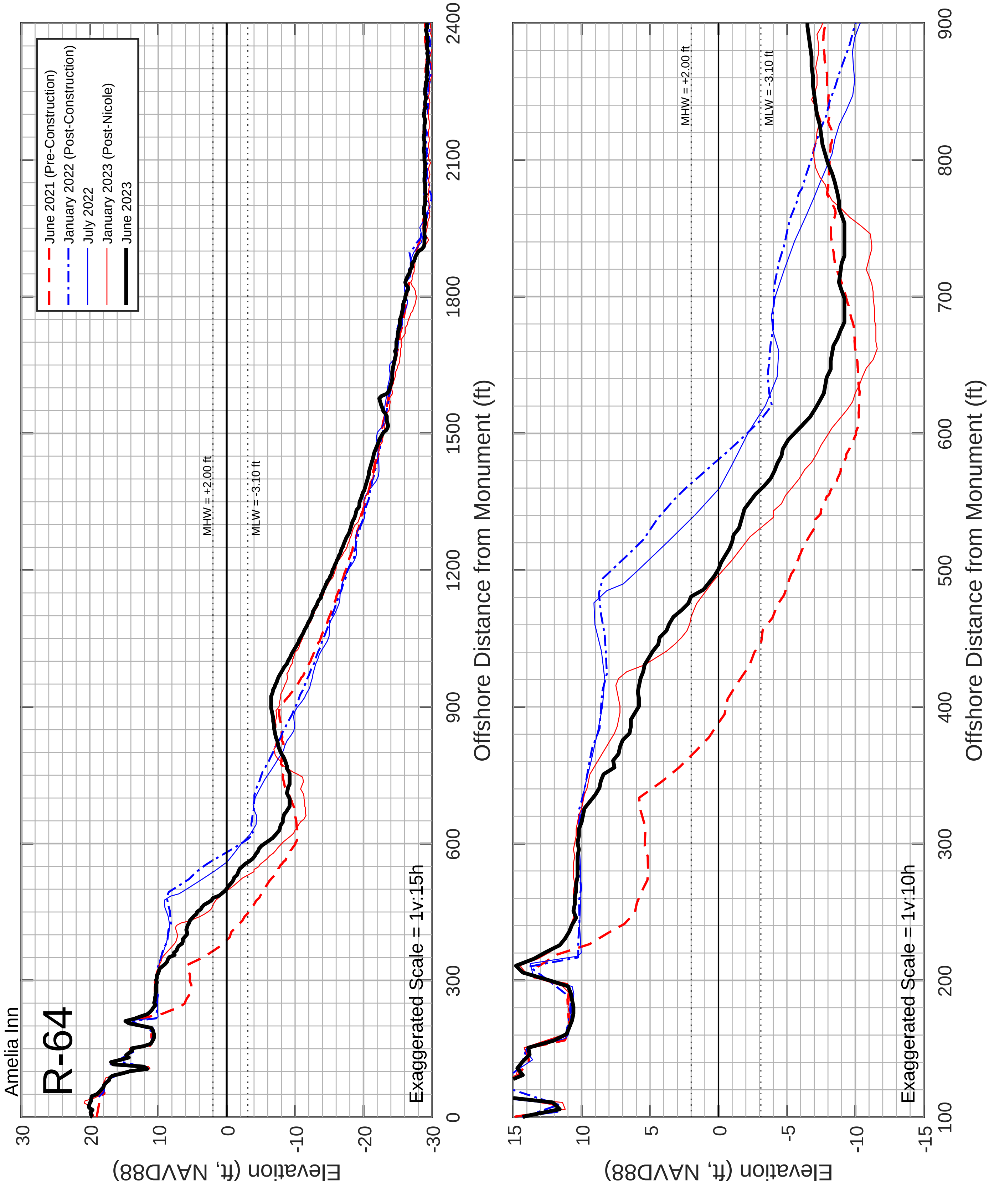


Figure B-10: Measured beach profiles at monument R-64 Amelia Island, Florida.

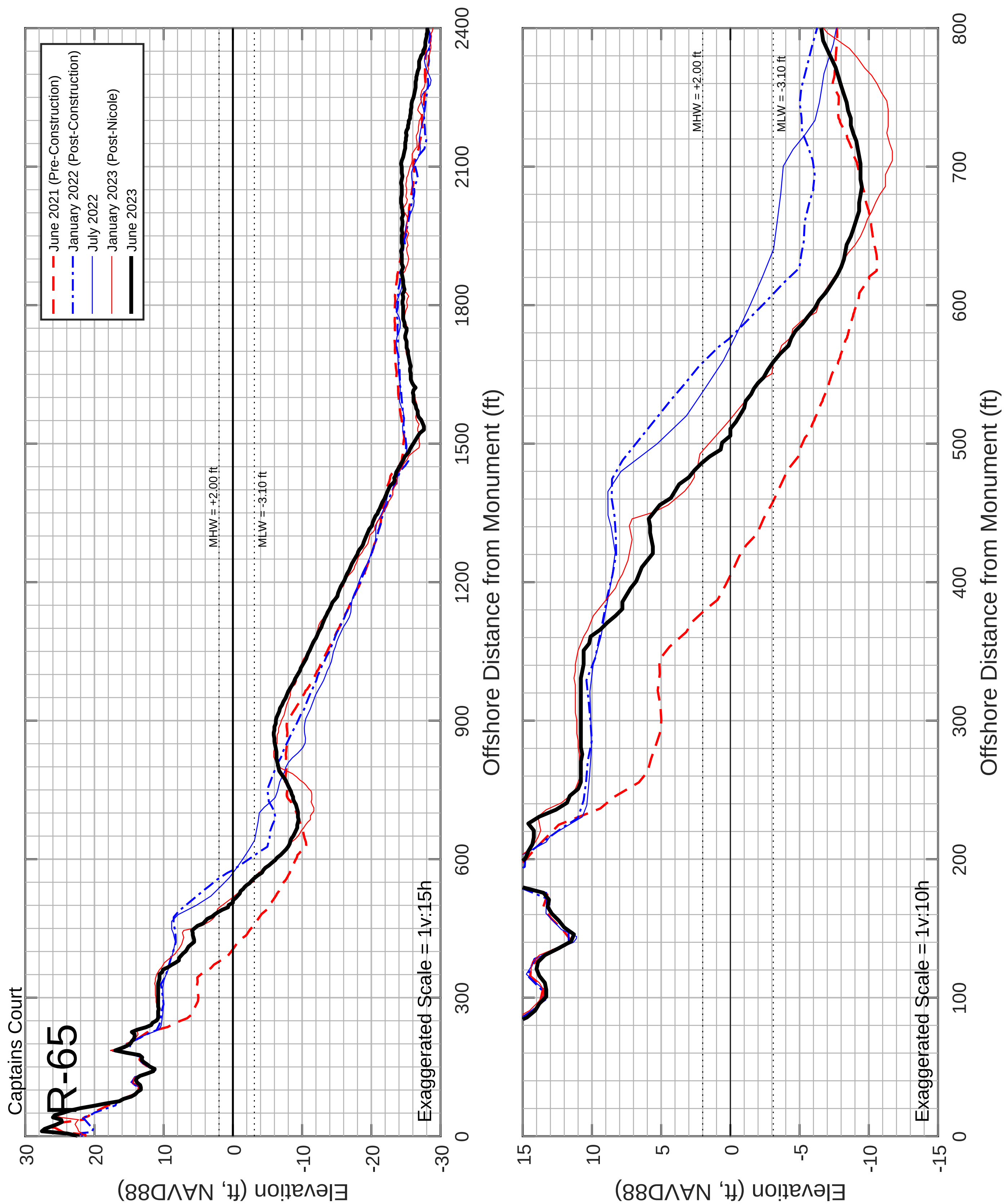


Figure B-11: Measured beach profiles at monument R-65 Amelia Island, Florida.

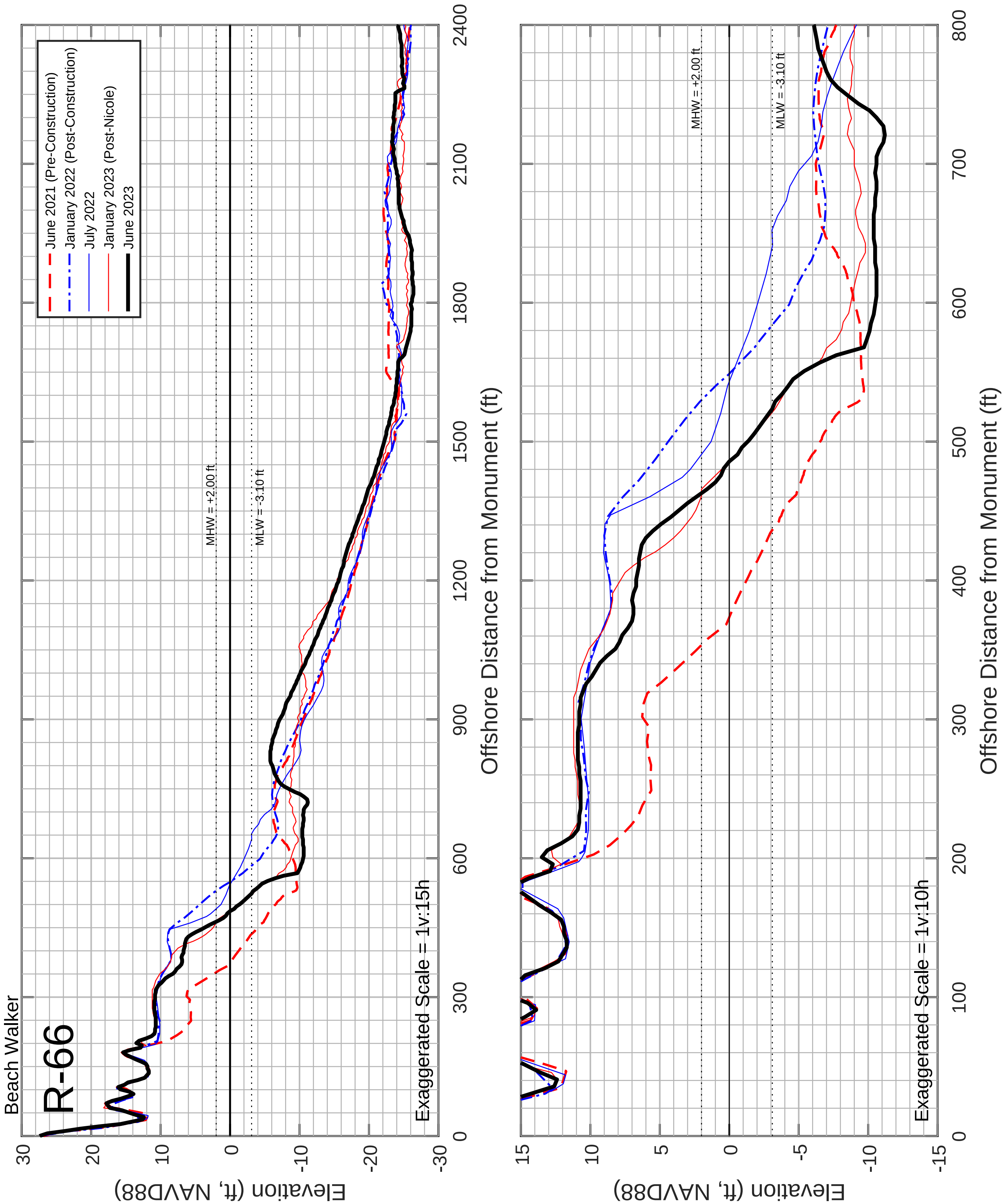


Figure B-12: Measured beach profiles at monument R-66 Amelia Island, Florida.

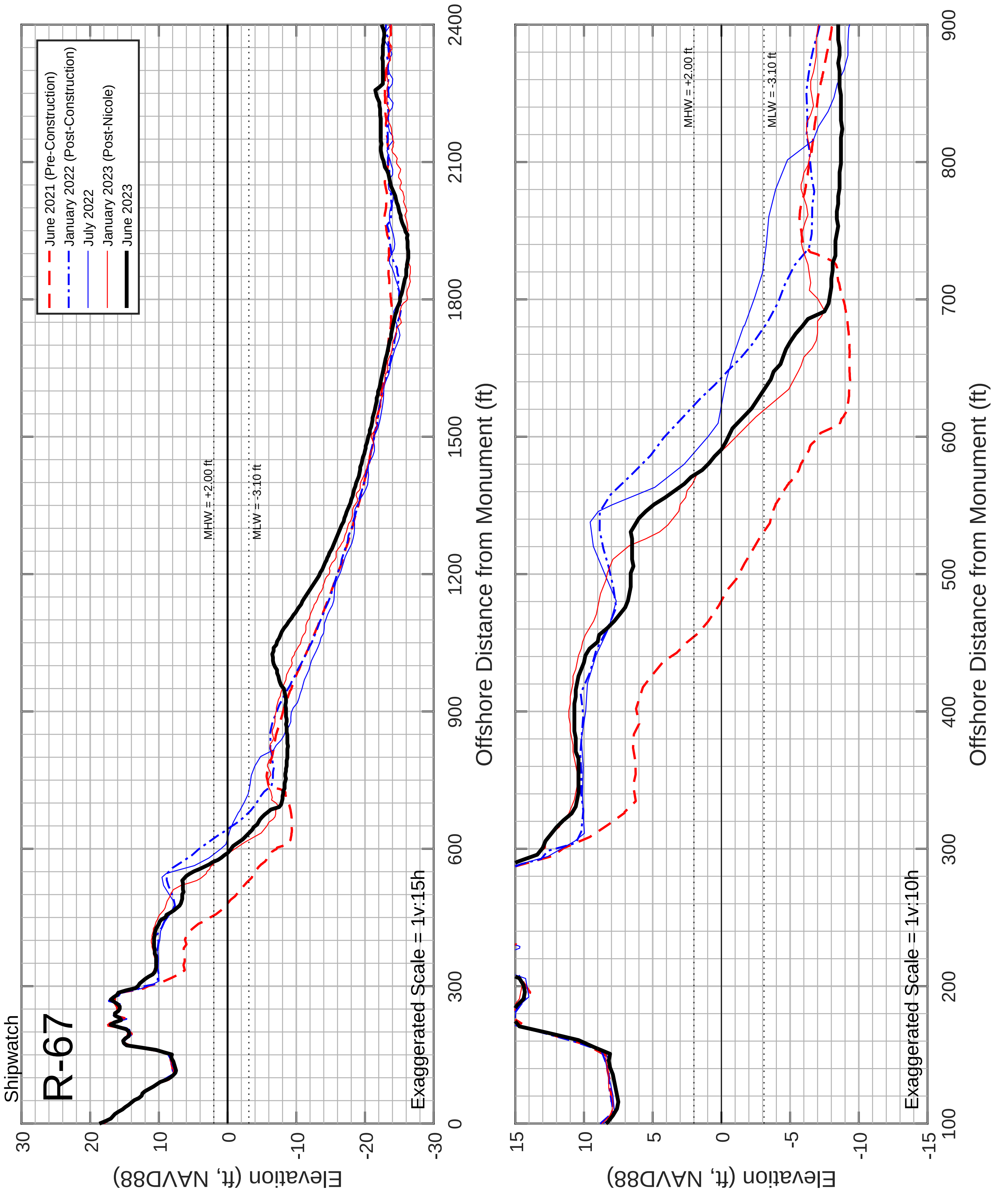


Figure B-13: Measured beach profiles at monument R-67 Amelia Island, Florida.

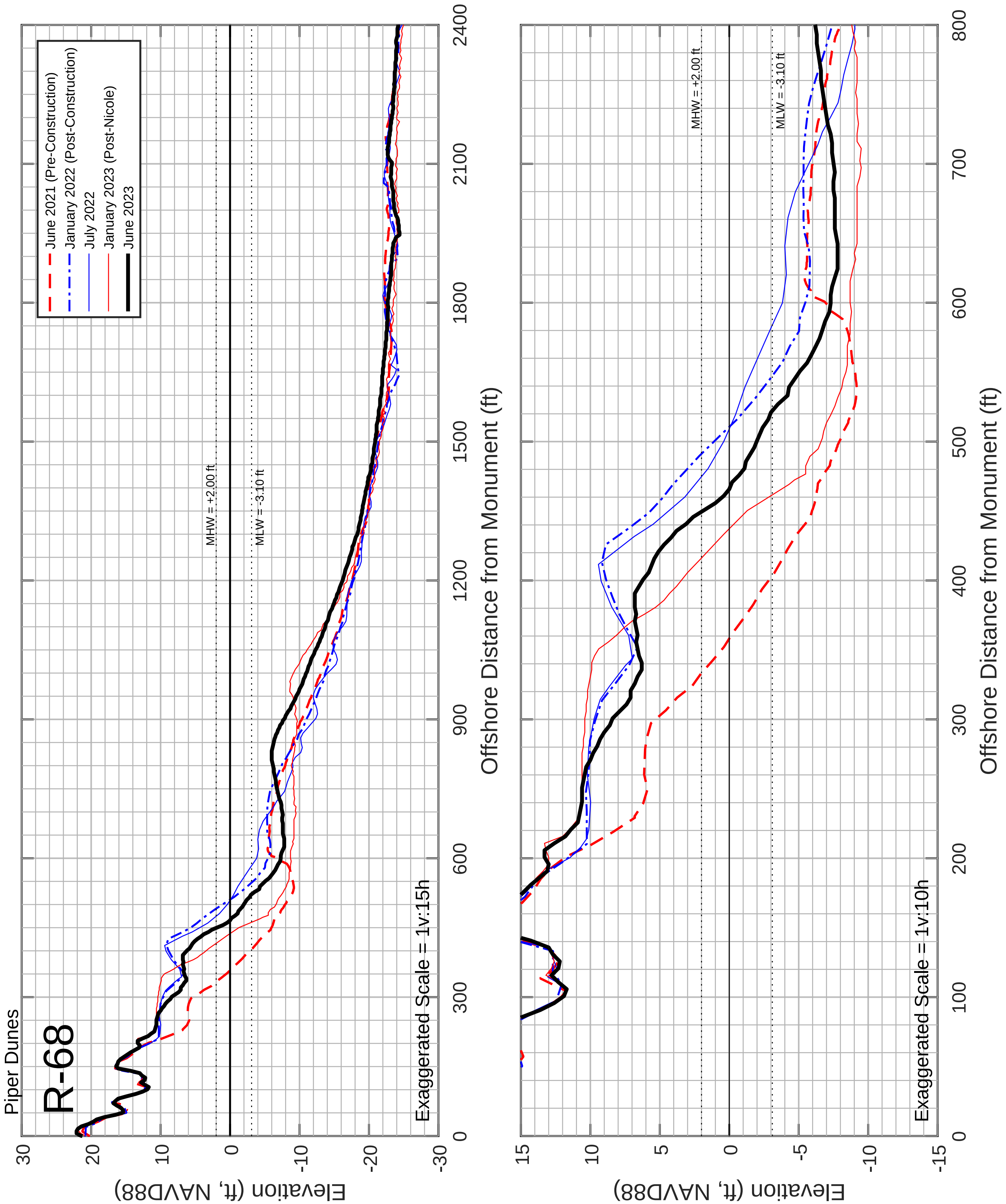


Figure B-14: Measured beach profiles at monument R-68 Amelia Island, Florida.

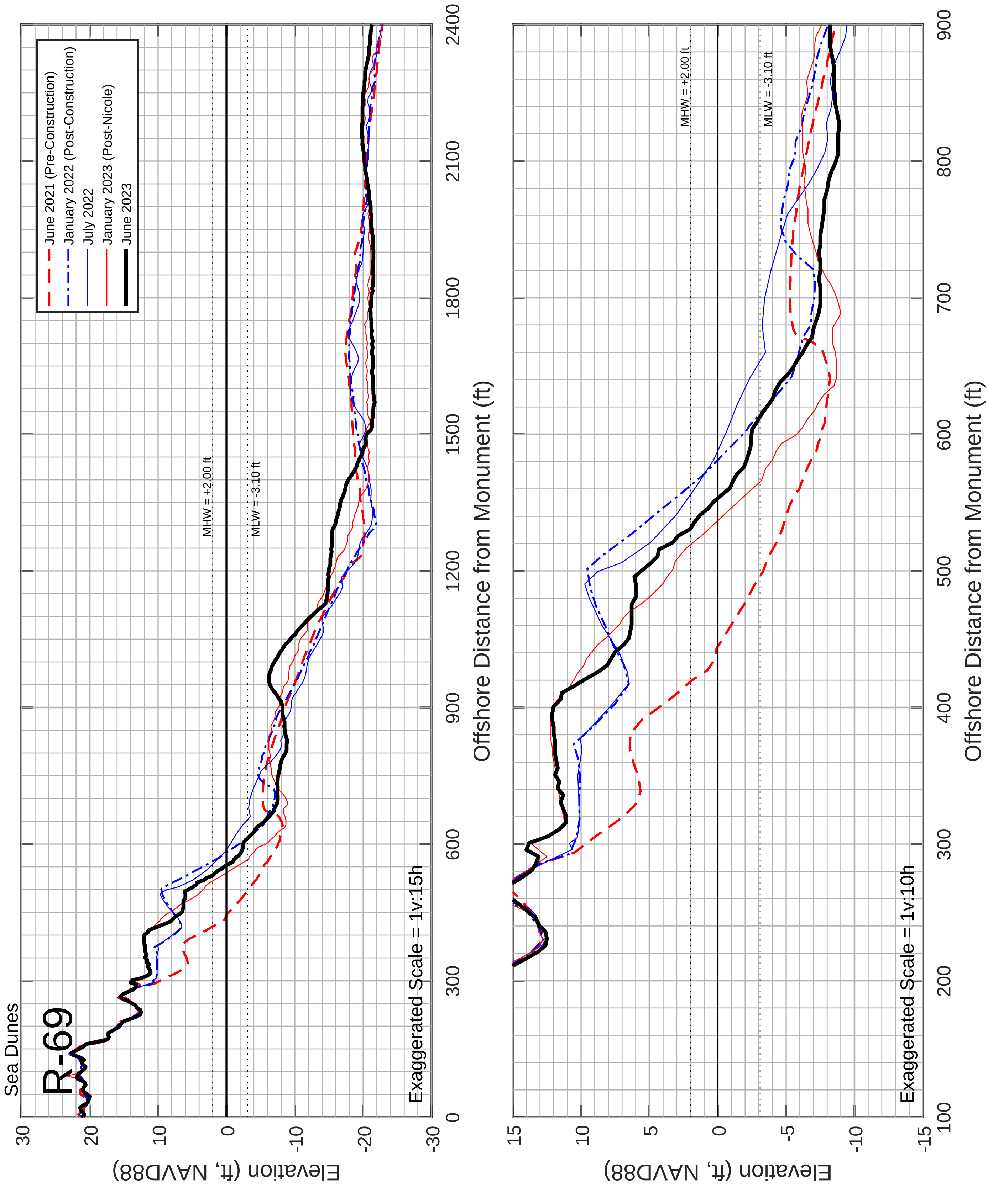


Figure B-15: Measured beach profiles at monument R-69 Amelia Island, Florida.

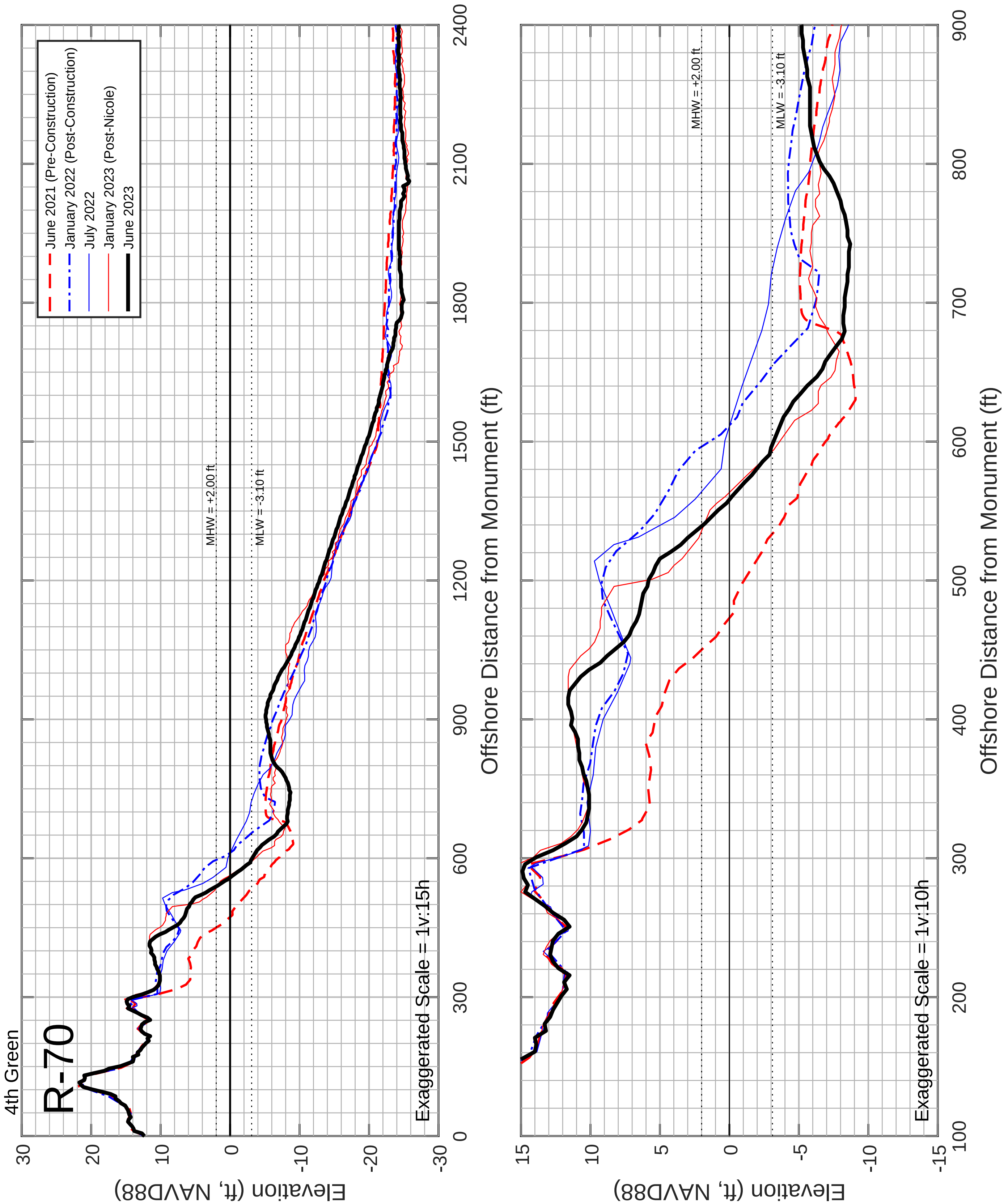


Figure B-16: Measured beach profiles at monument R-70 Amelia Island, Florida.

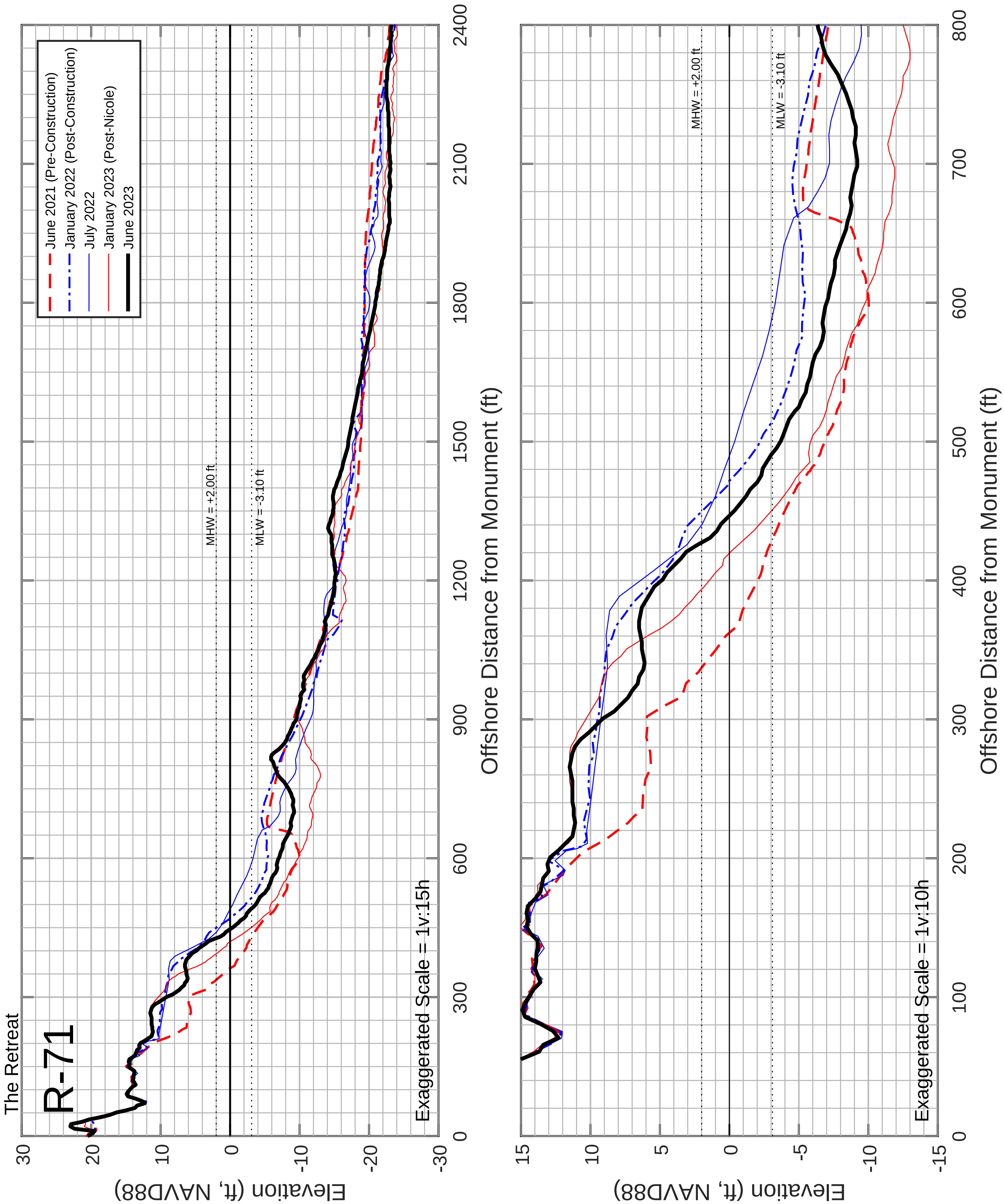


Figure B-17: Measured beach profiles at monument R-71 Amelia Island, Florida.

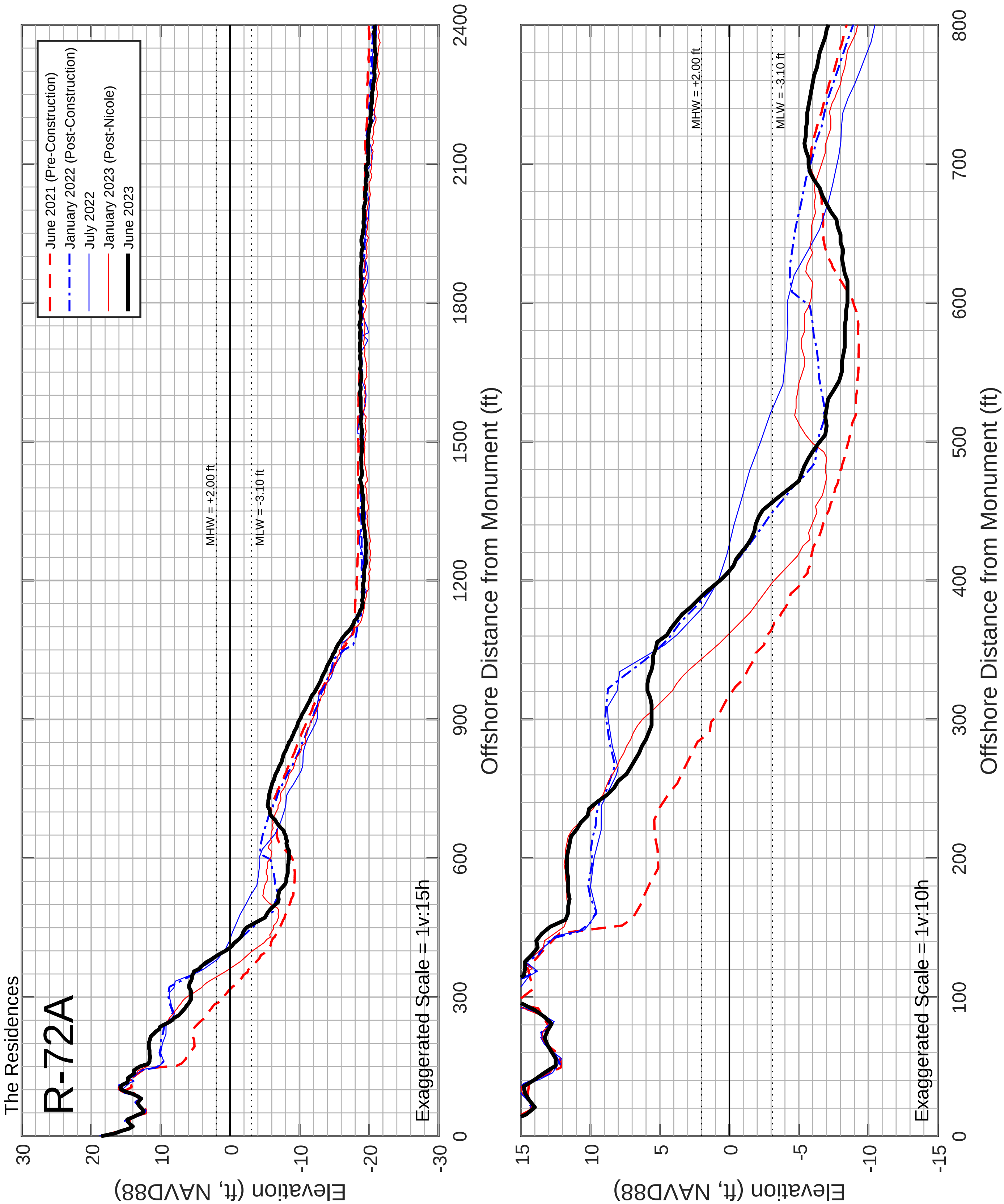


Figure B-18: Measured beach profiles at monument R-72A Amelia Island, Florida.

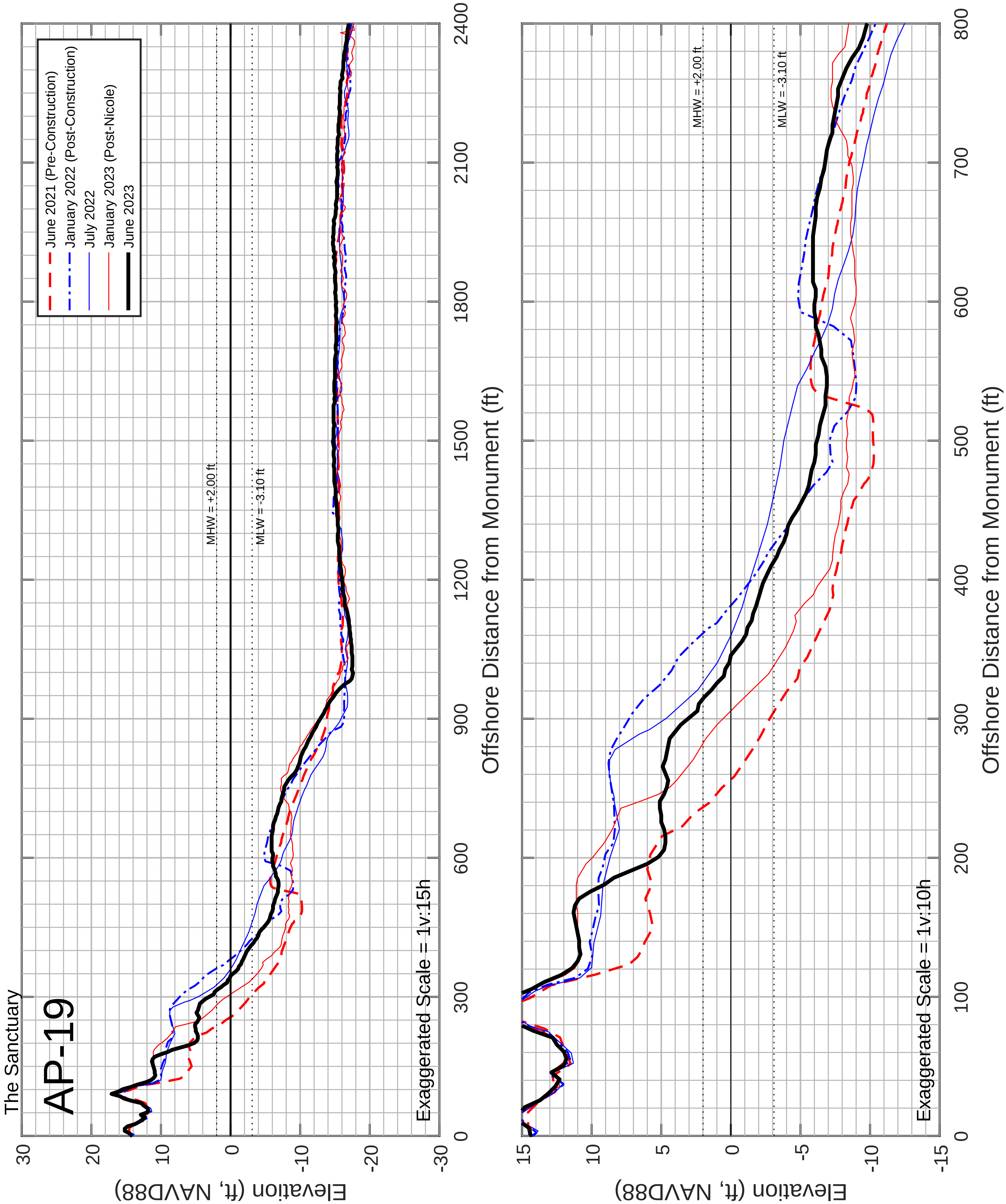


Figure B-19: Measured beach profiles at monument AP-19 Amelia Island, Florida.

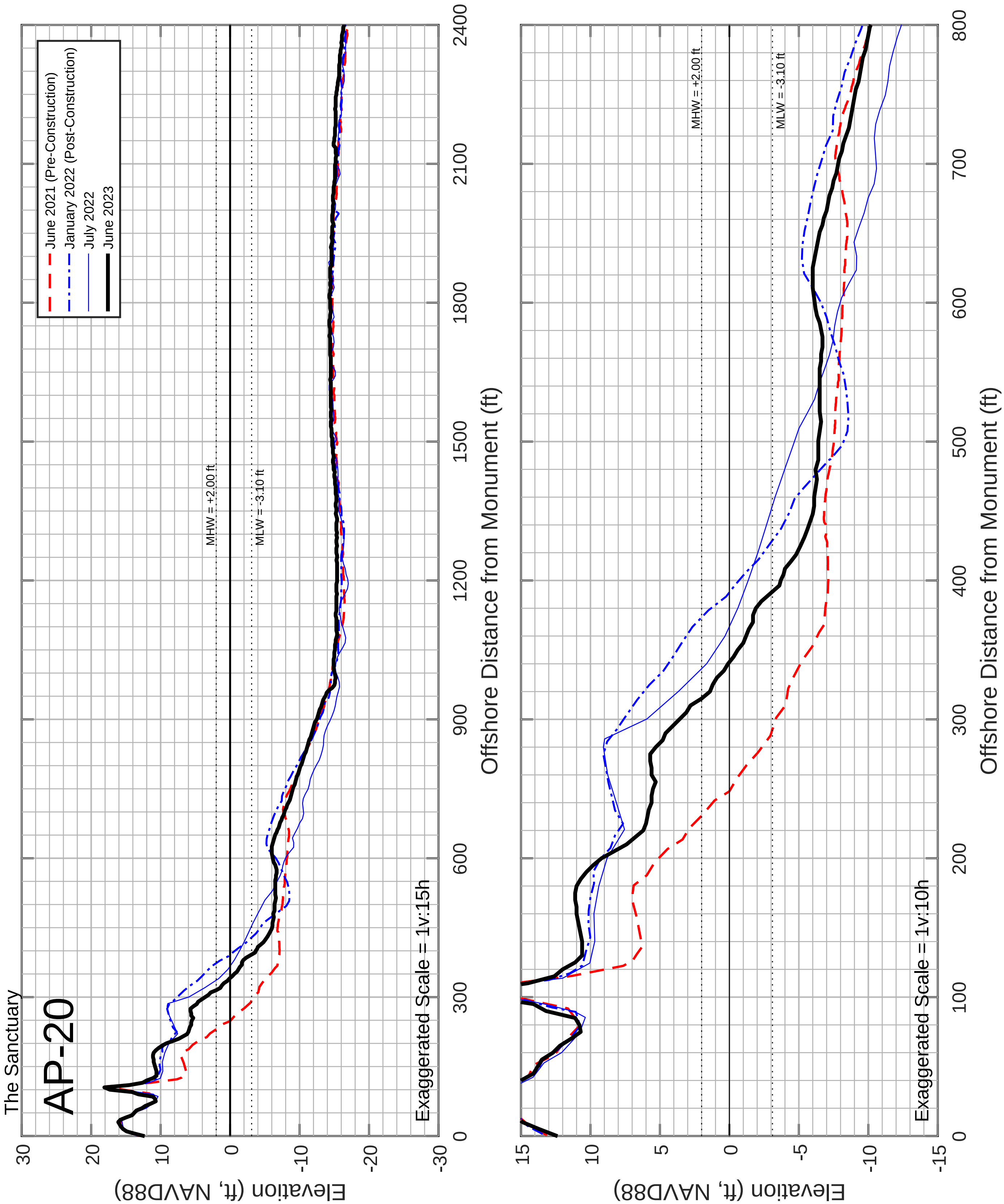


Figure B-20: Measured beach profiles at monument AP-20 Amelia Island, Florida.

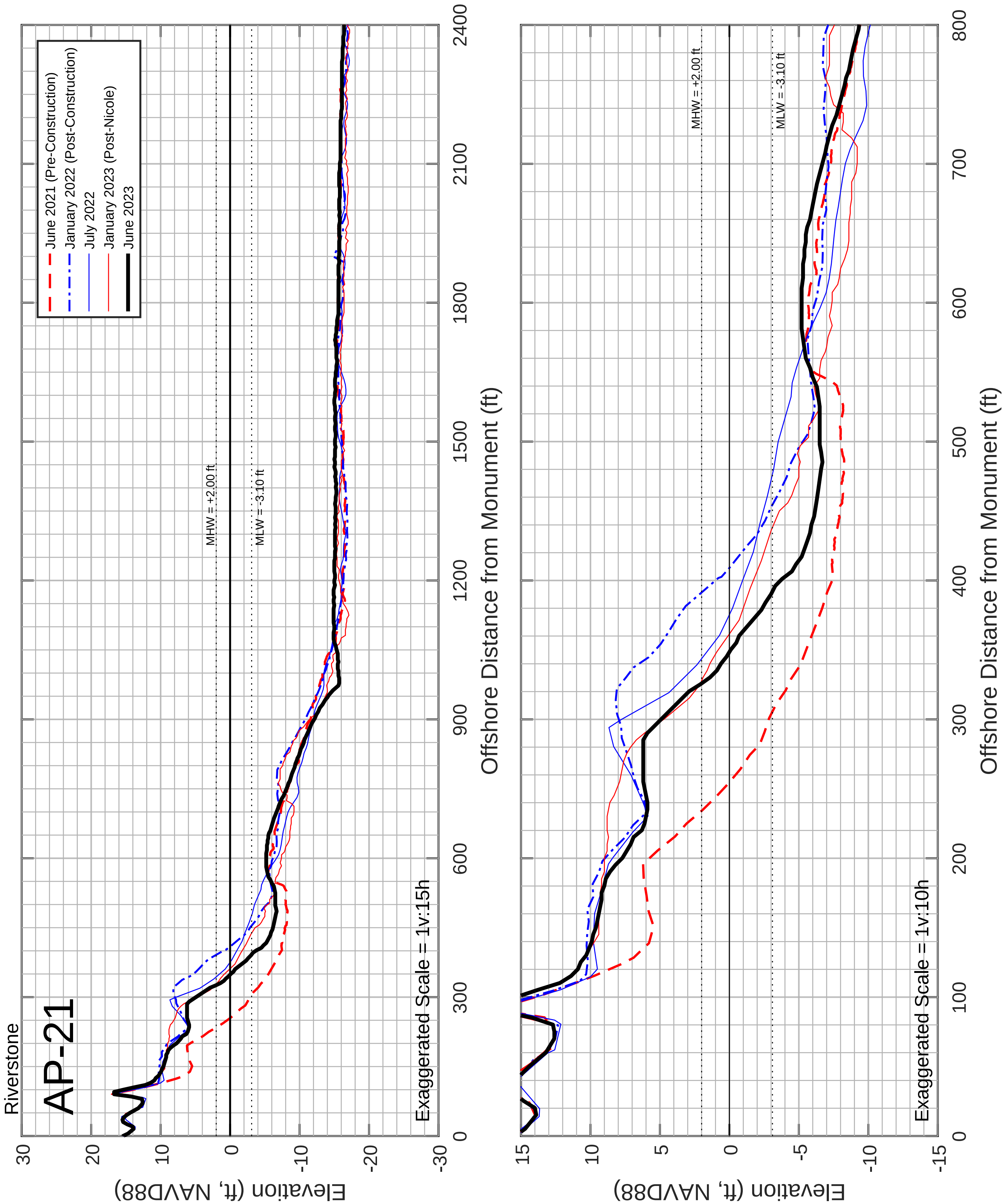


Figure B-21: Measured beach profiles at monument AP-21 Amelia Island, Florida.

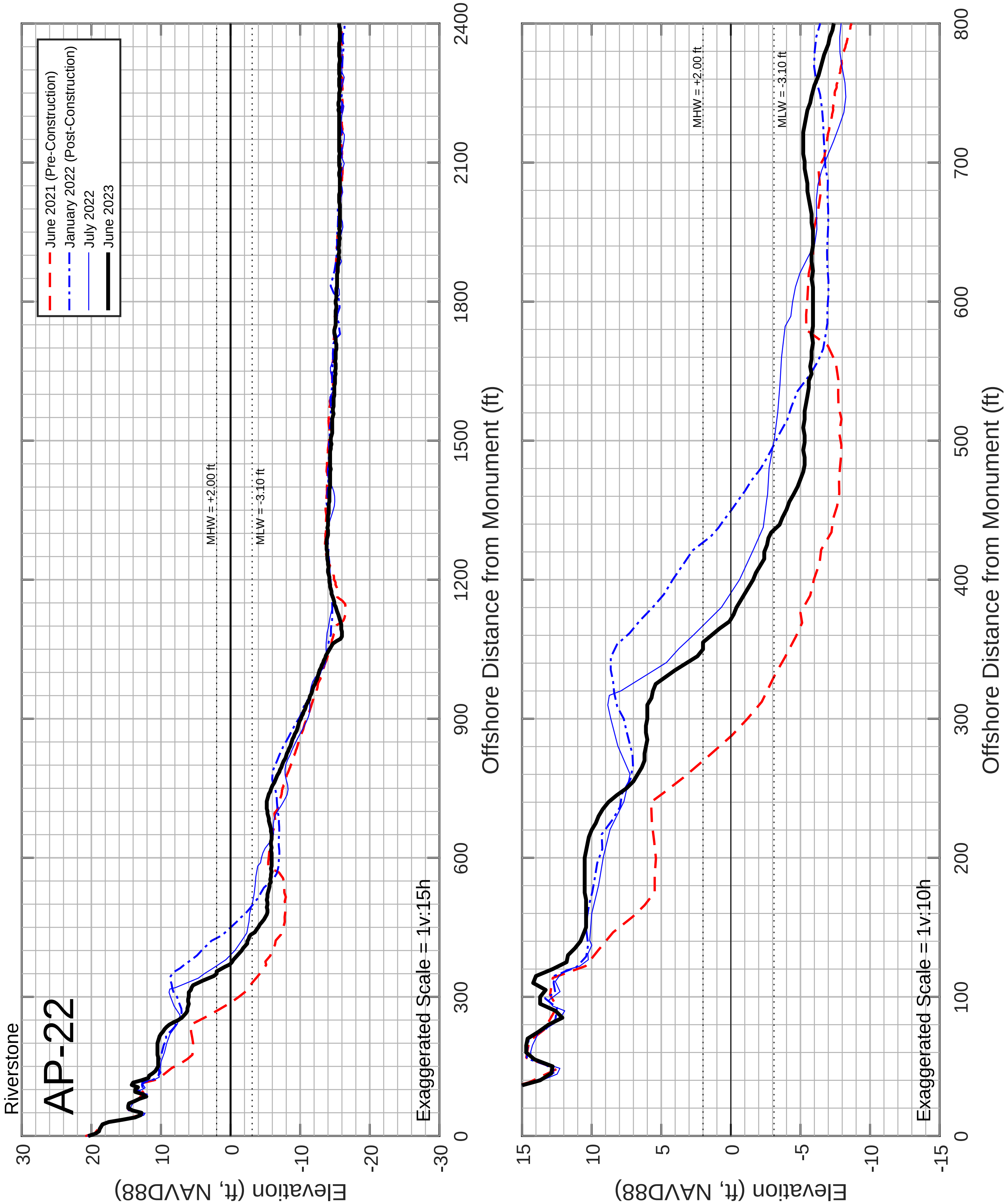


Figure B-22: Measured beach profiles at monument AP-22 Amelia Island, Florida.

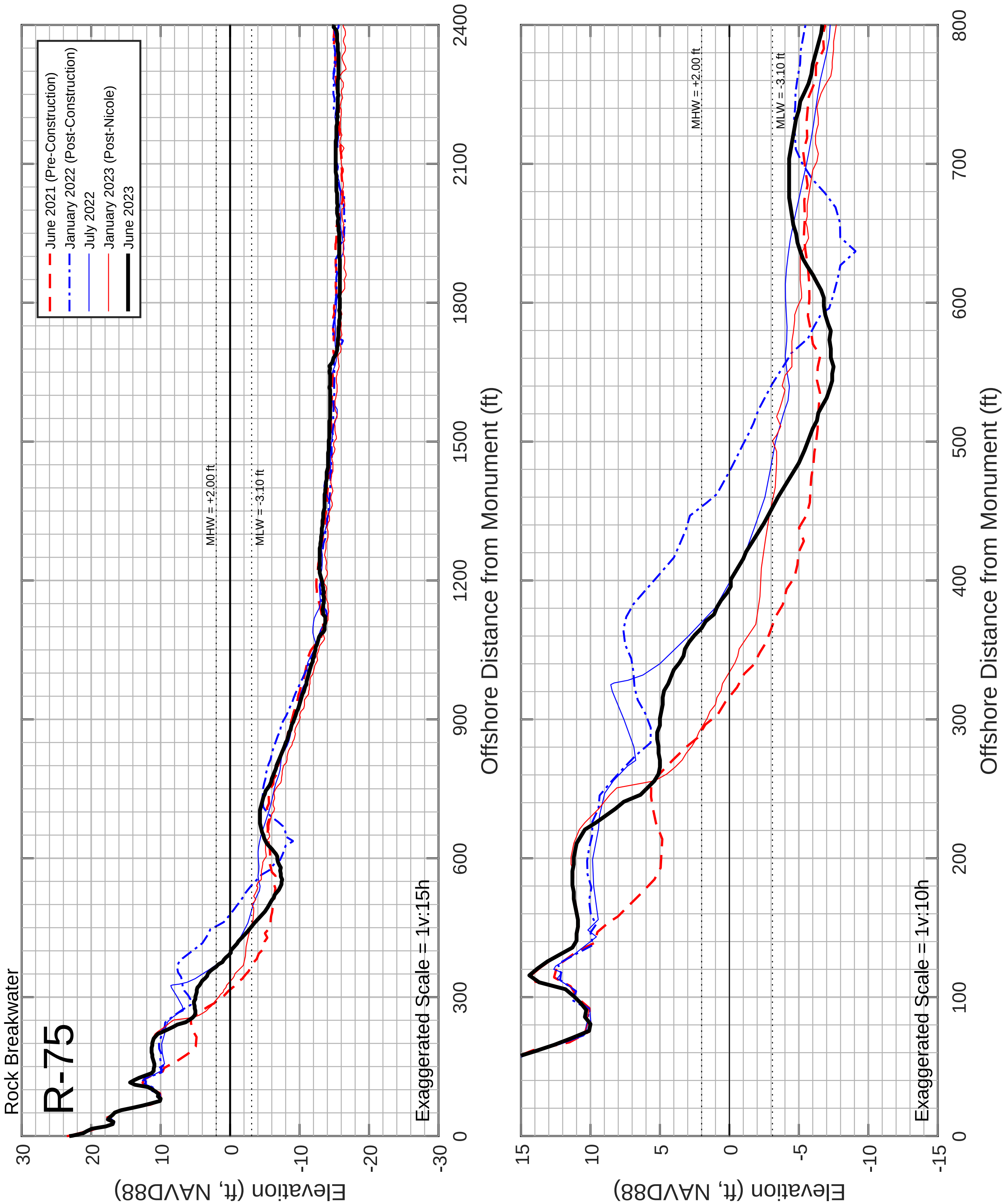


Figure B-23: Measured beach profiles at monument R-75 Amelia Island, Florida.

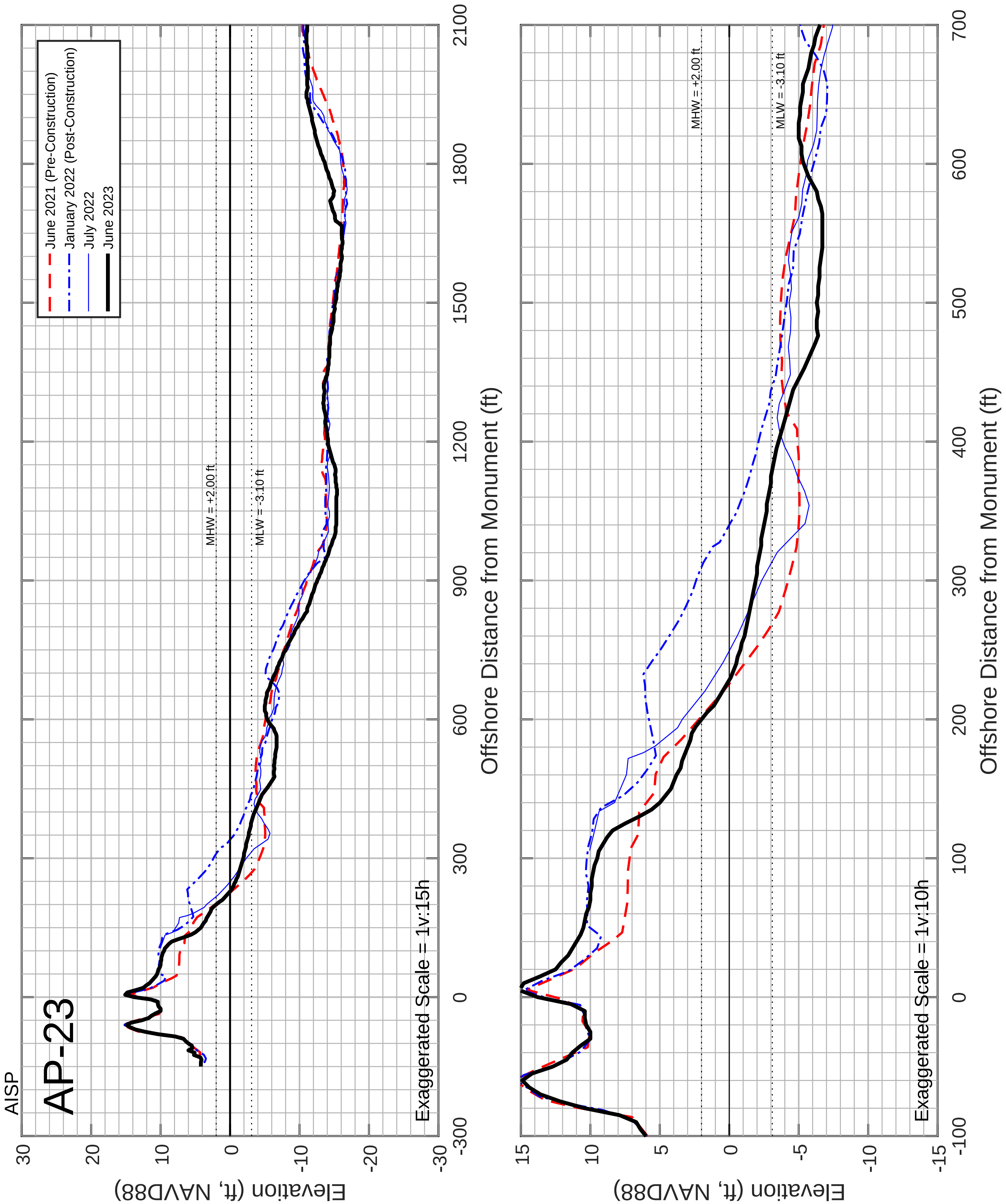


Figure B-24: Measured beach profiles at monument AP-23 Amelia Island, Florida.

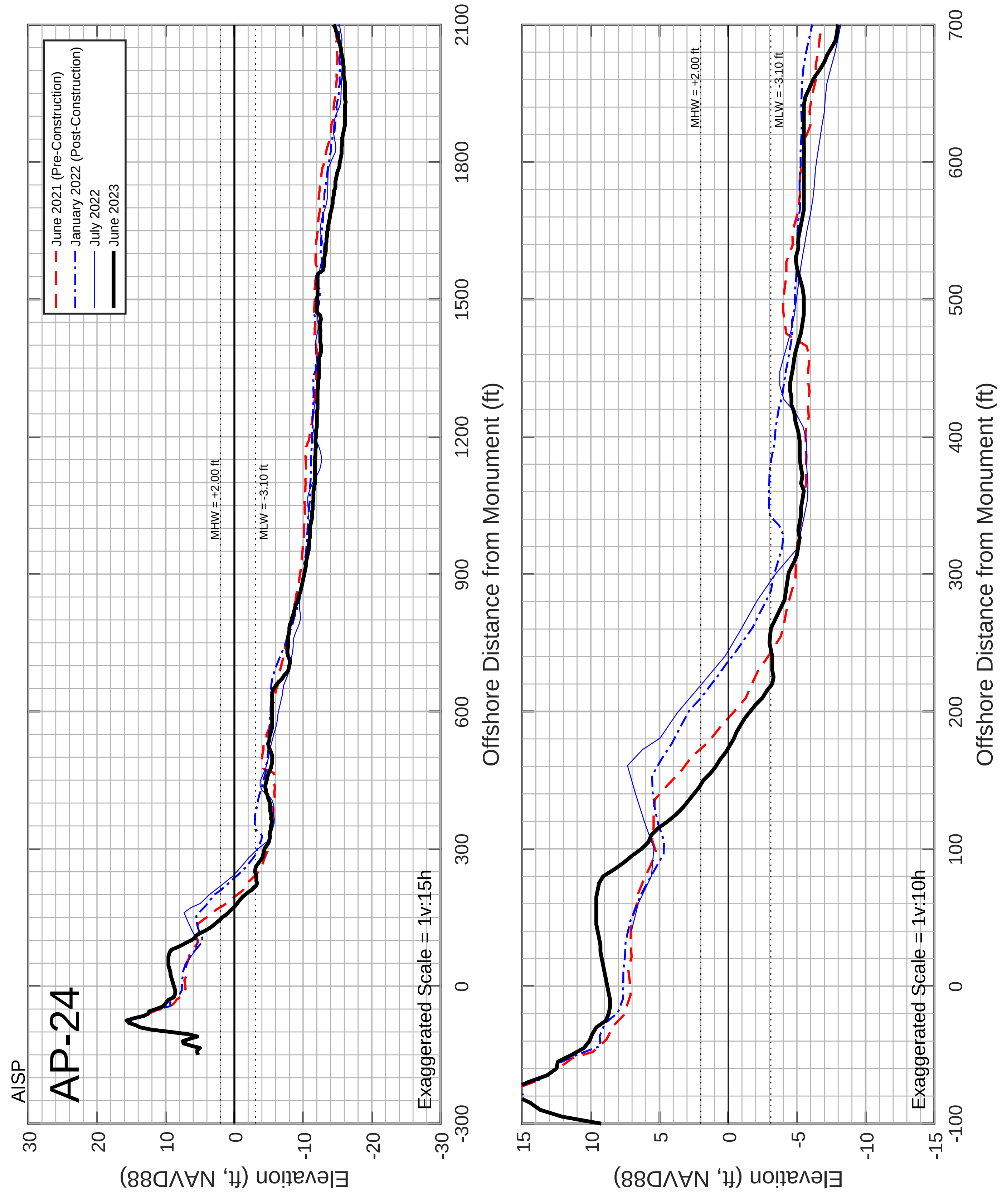


Figure B-25: Measured beach profiles at monument AP-24 Amelia Island, Florida.

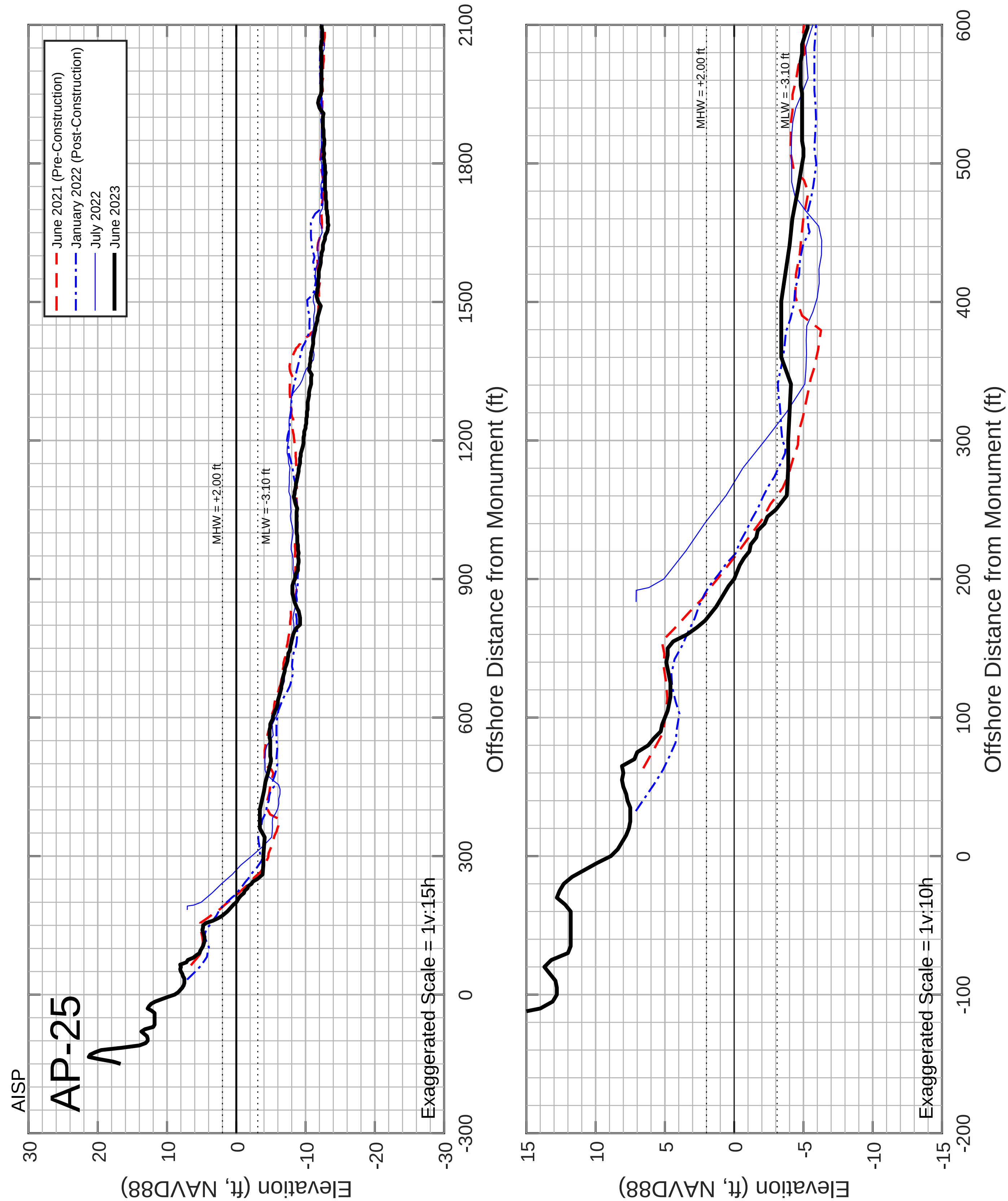


Figure B-26: Measured beach profiles at monument AP-25 Amelia Island, Florida.

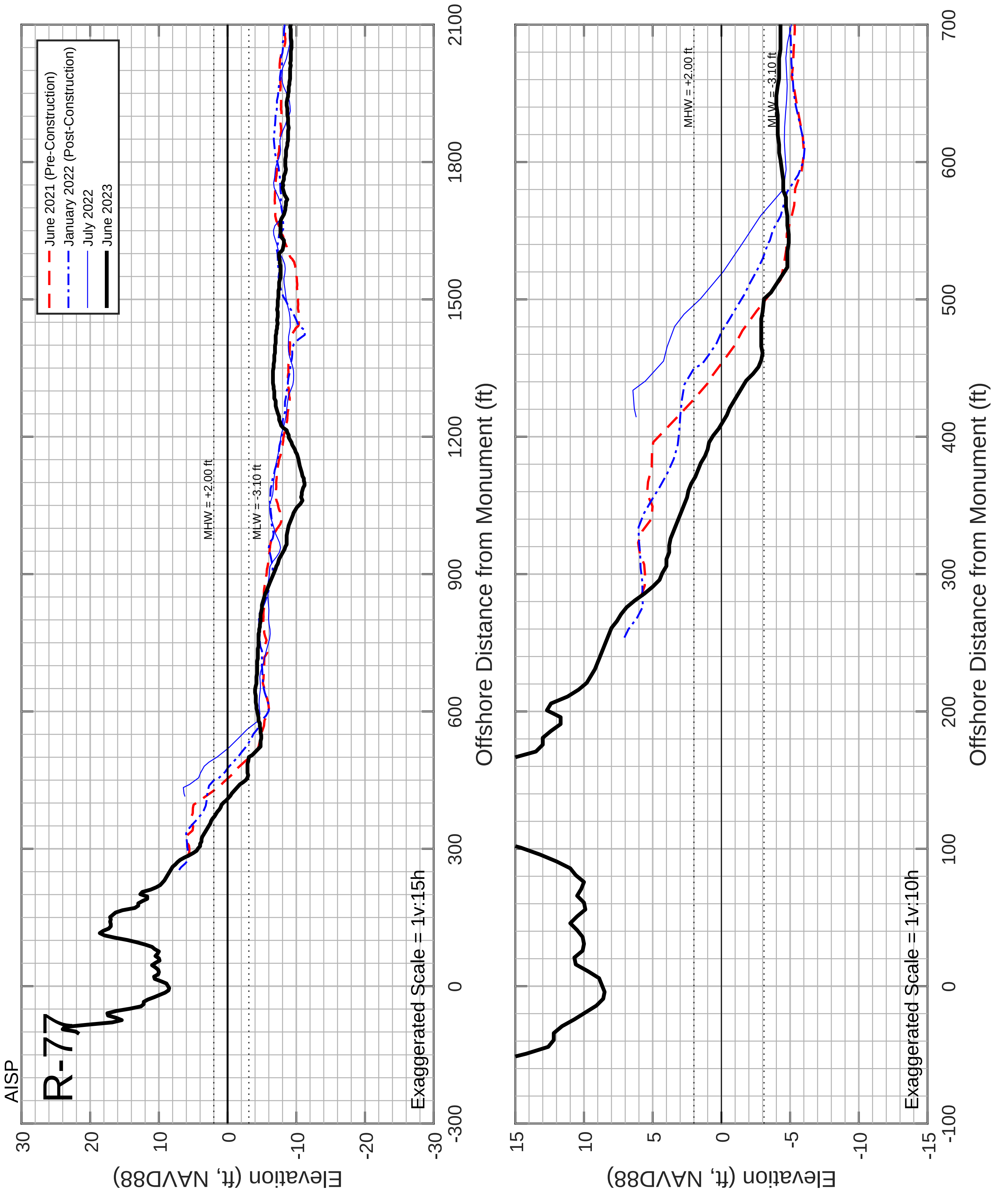


Figure B-27: Measured beach profiles at monument R-77 Amelia Island, Florida.

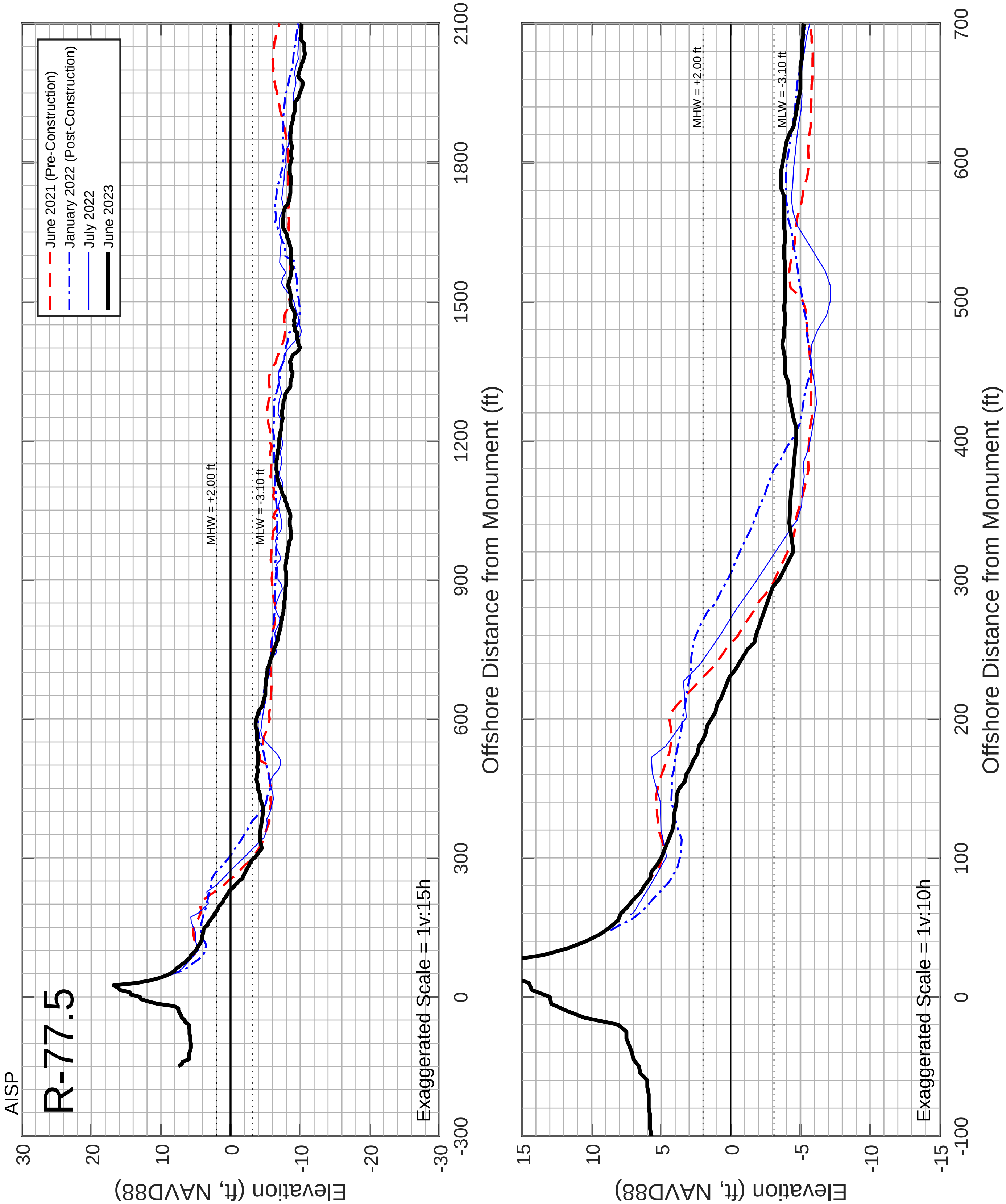


Figure B-28: Measured beach profiles at monument R-77.5 Amelia Island, Florida.

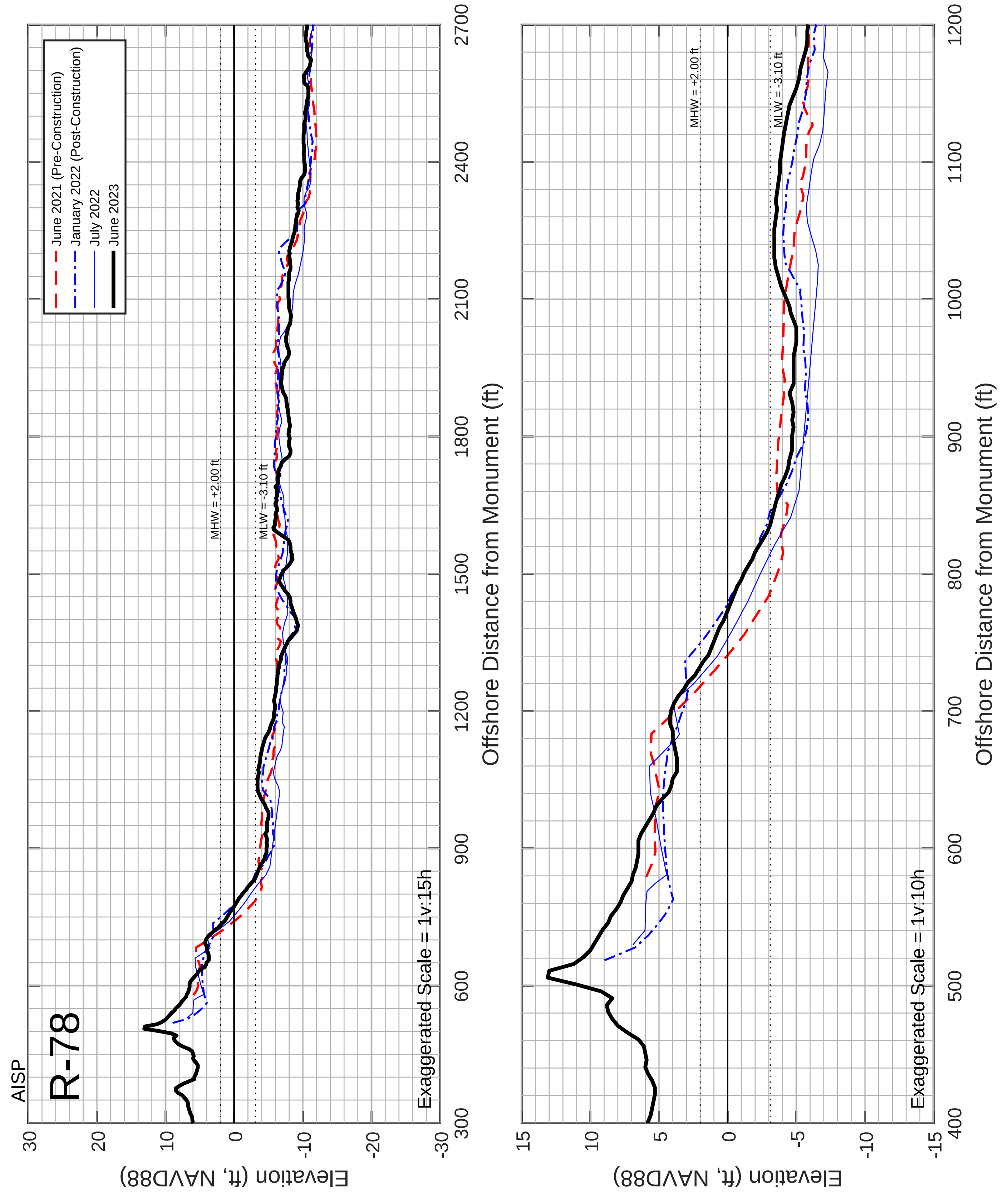


Figure B-29: Measured beach profiles at monument R-78 Amelia Island, Florida.

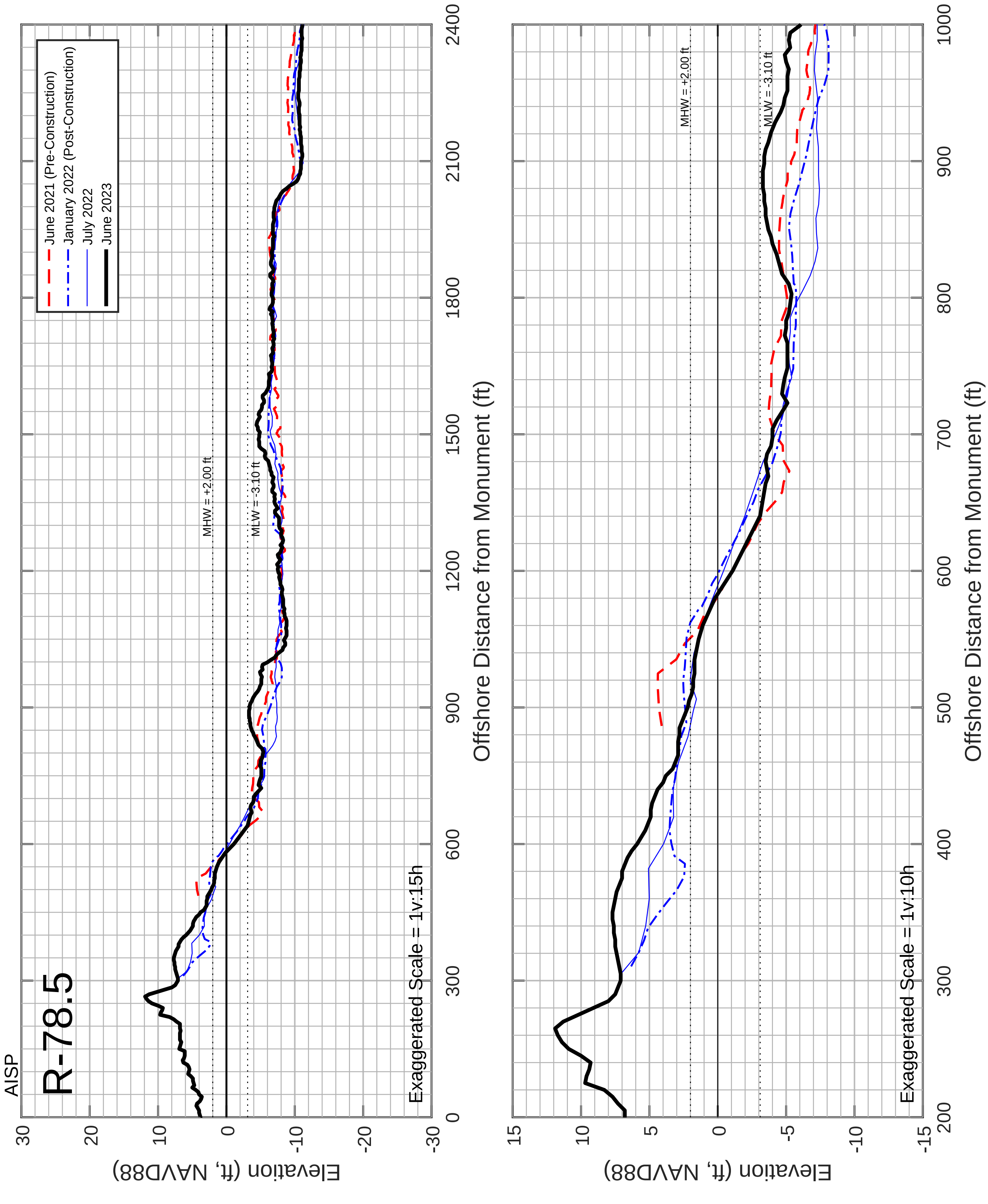


Figure B-30: Measured beach profiles at monument R-78.5 Amelia Island, Florida.

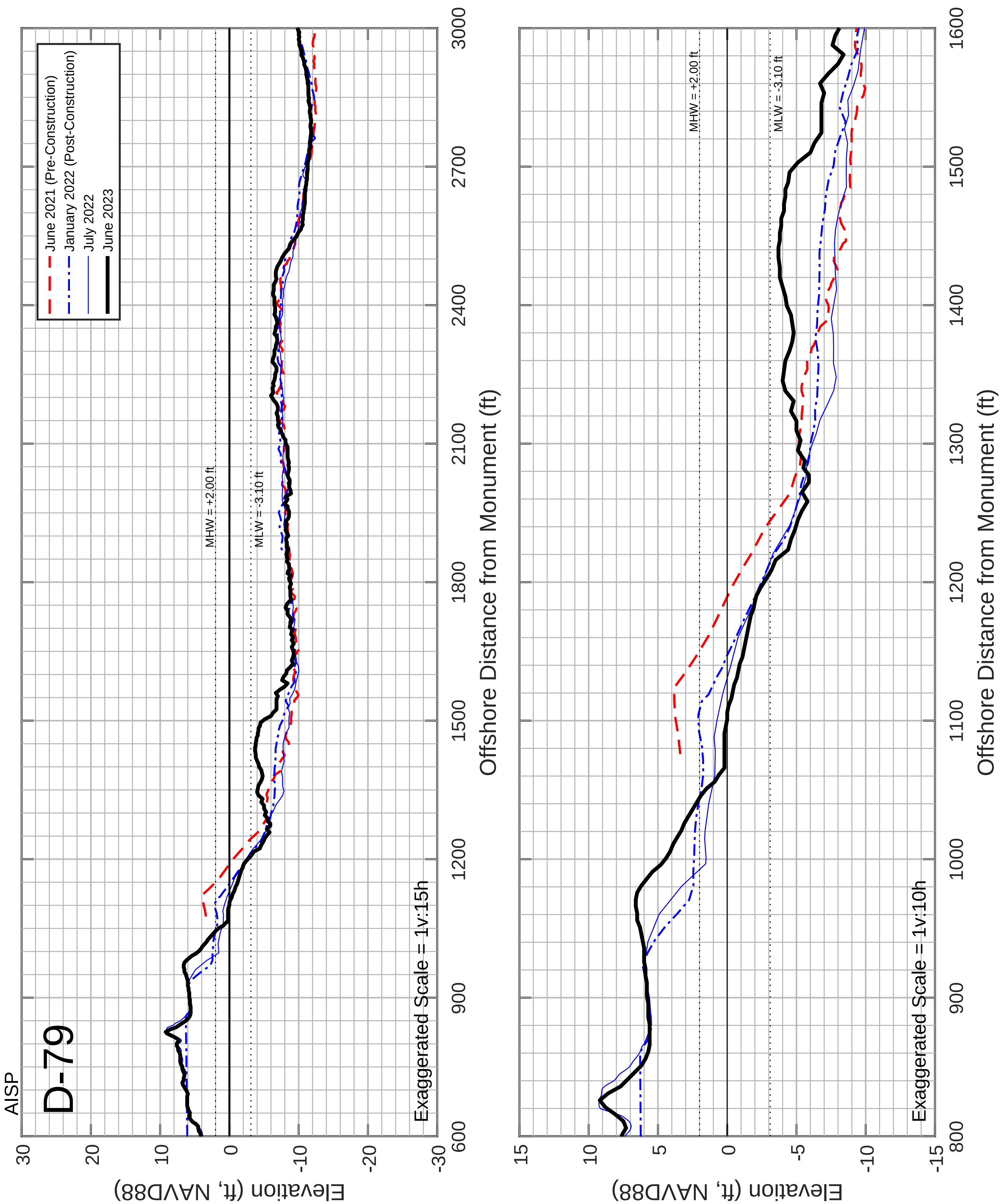


Figure B-31: Measured beach profiles at monument D-79 Amelia Island, Florida.

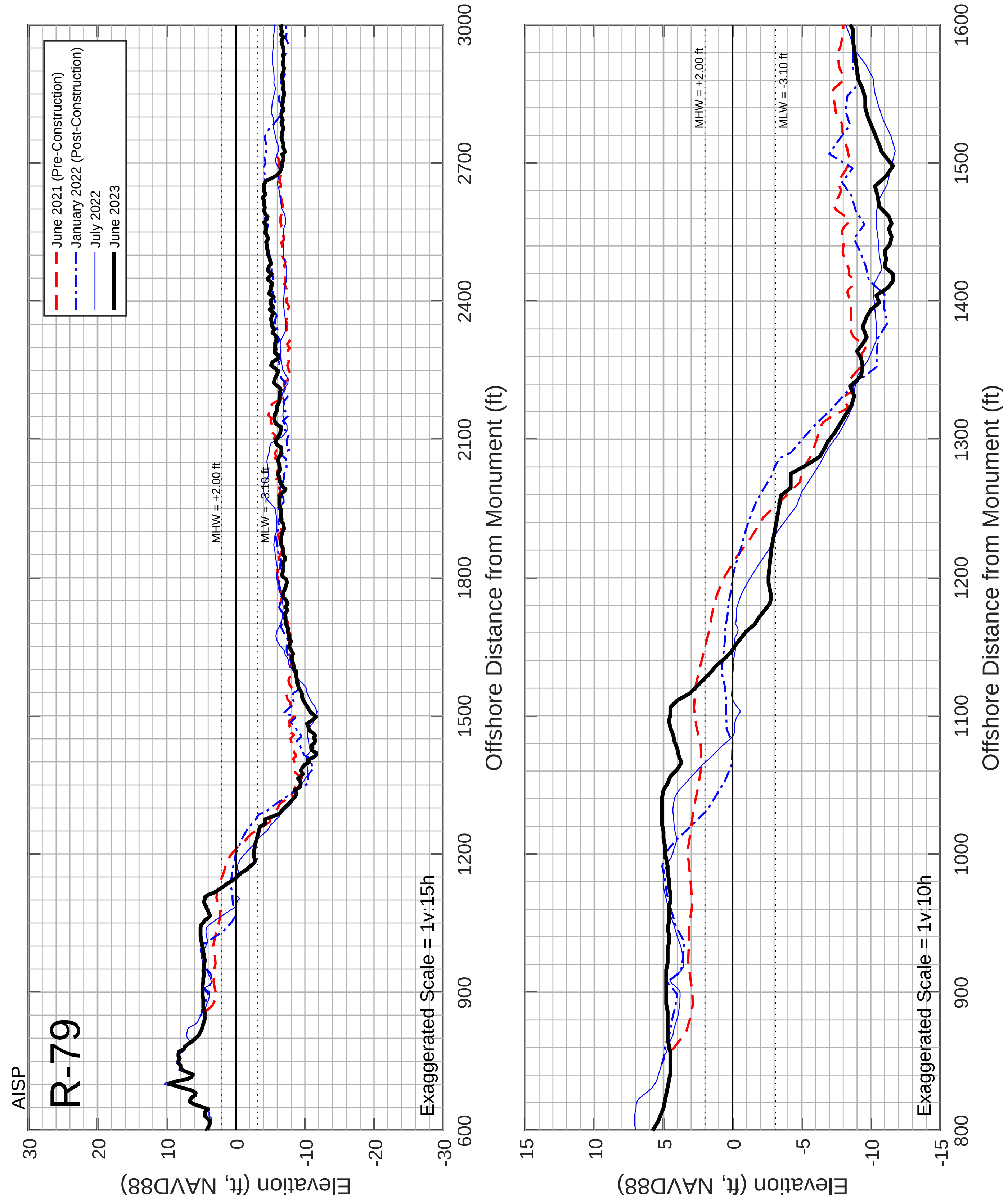


Figure B-32: Measured beach profiles at monument R-79 Amelia Island, Florida.

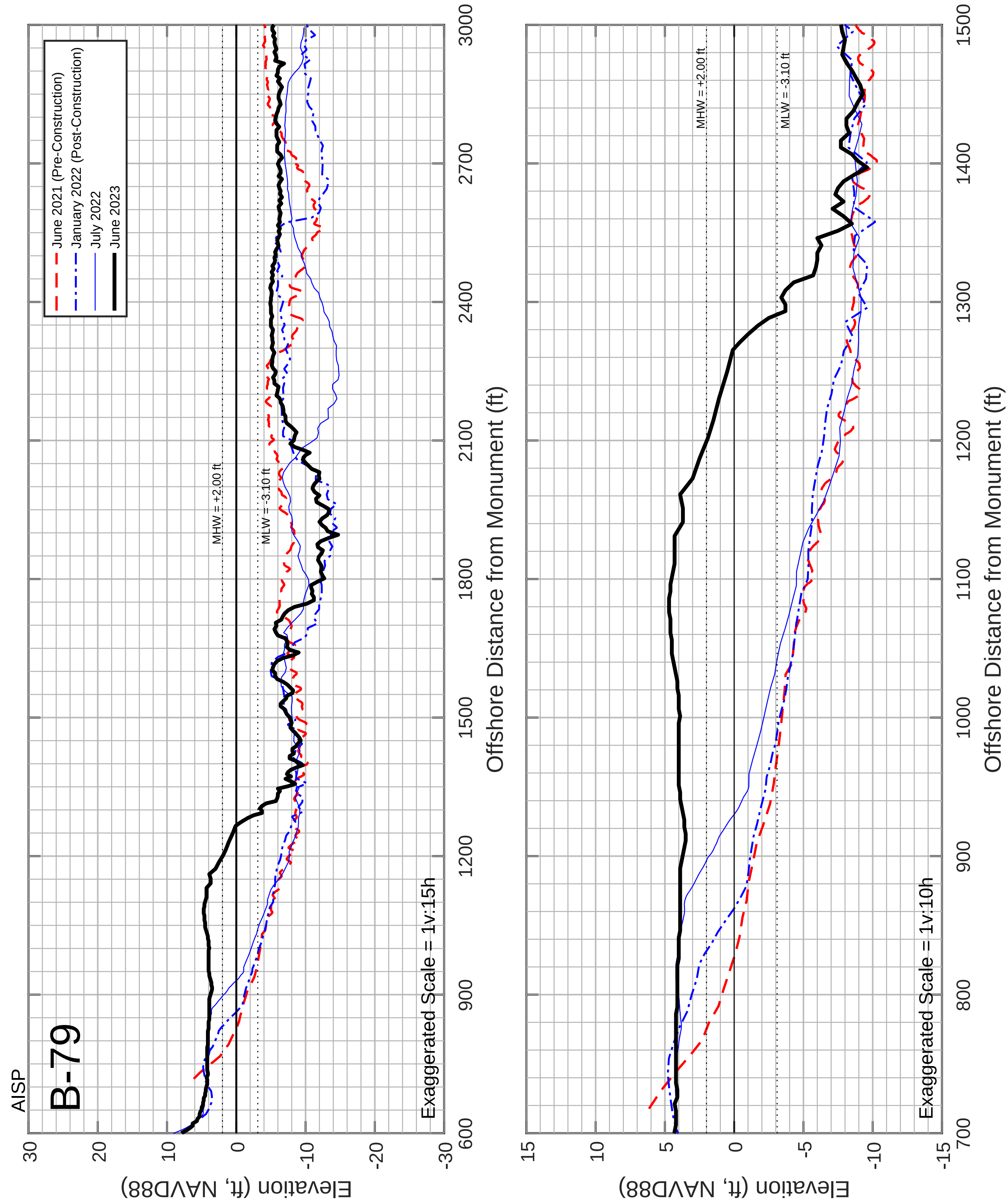


Figure B-33: Measured beach profiles at monument B-79 Amelia Island, Florida.

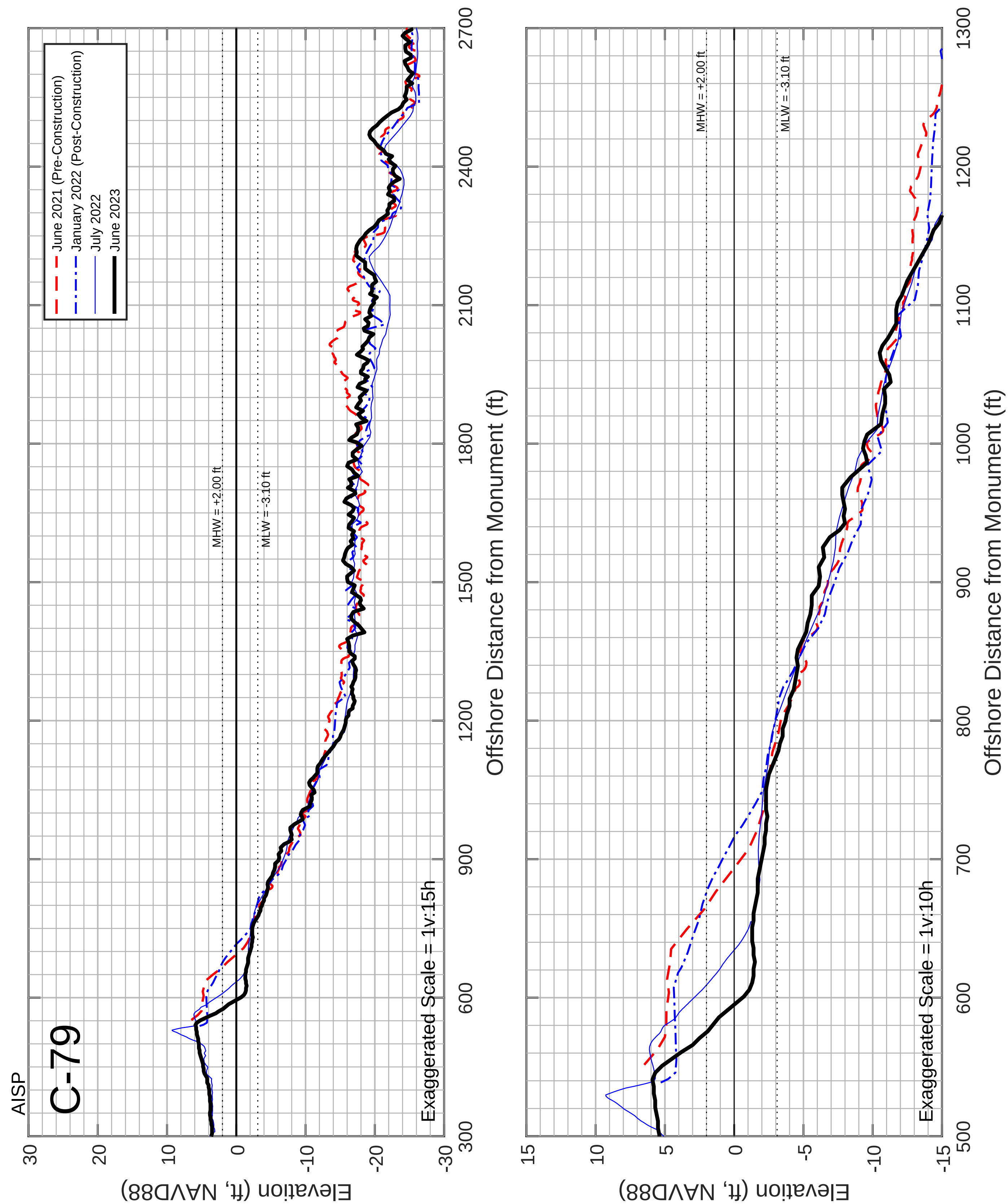


Figure B-34: Measured beach profiles at monument C-79 Amelia Island, Florida.

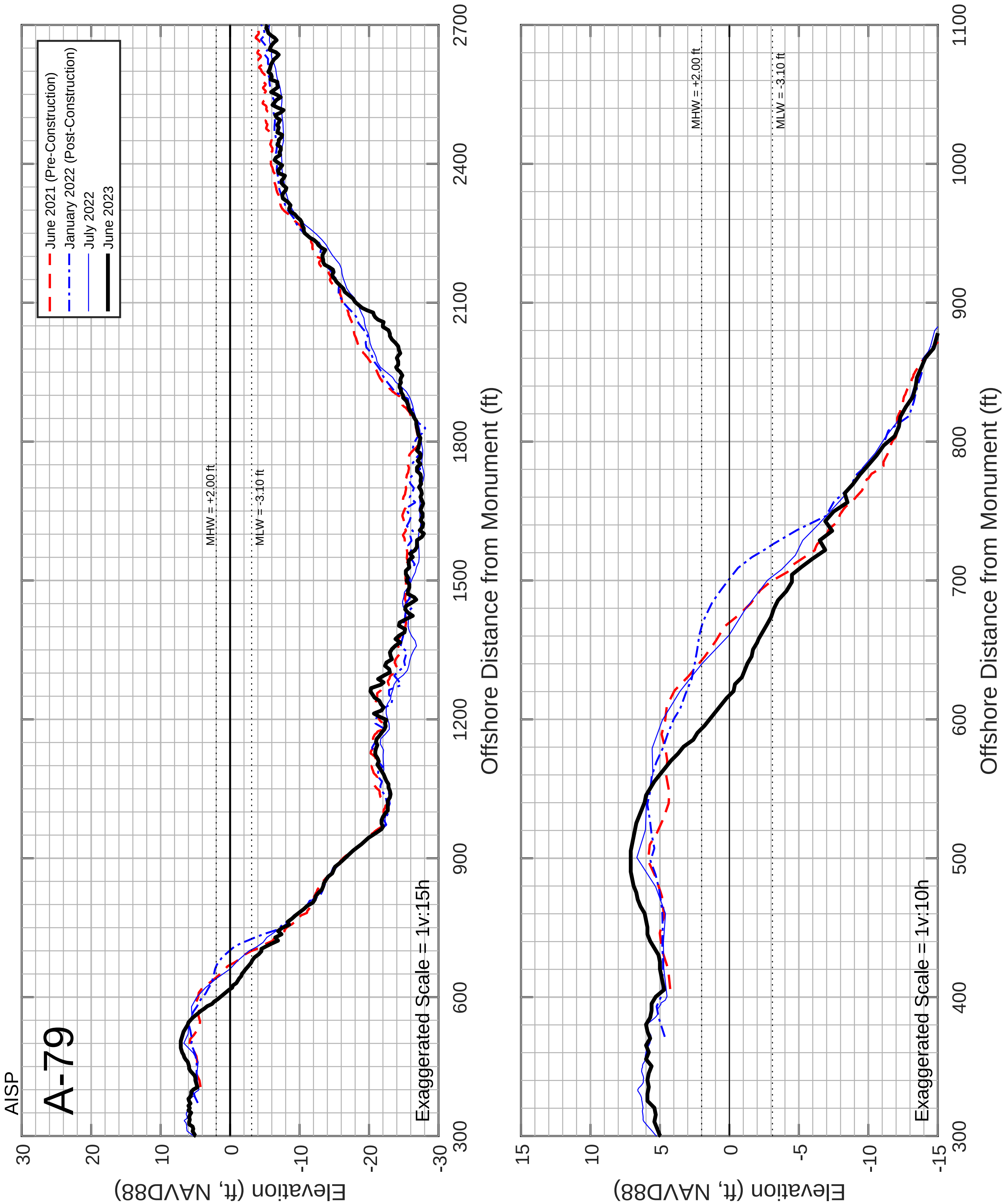


Figure B-35: Measured beach profiles at monument A-79 Amelia Island, Florida.

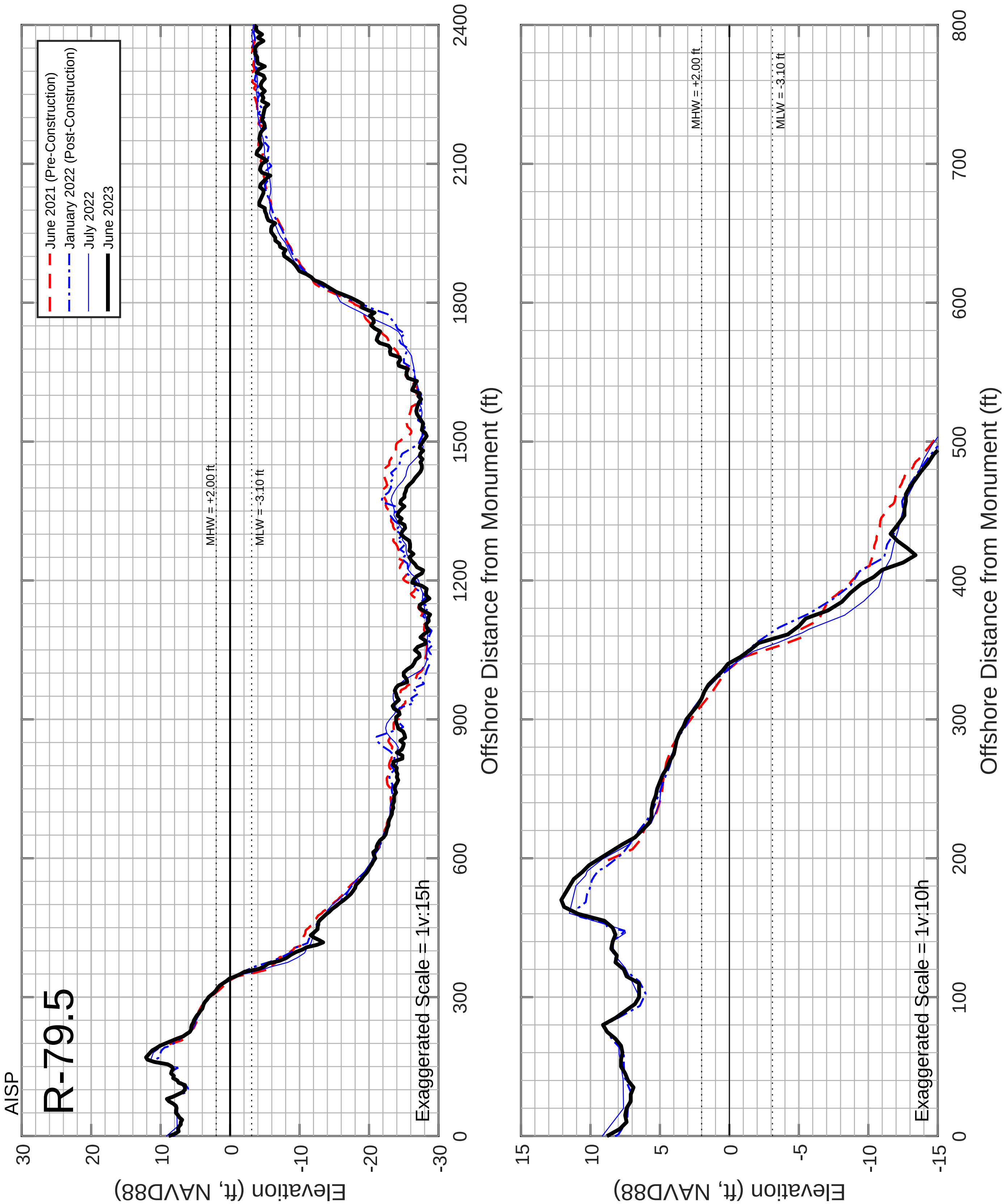


Figure B-36: Measured beach profiles at monument R-79.5 Amelia Island, Florida.

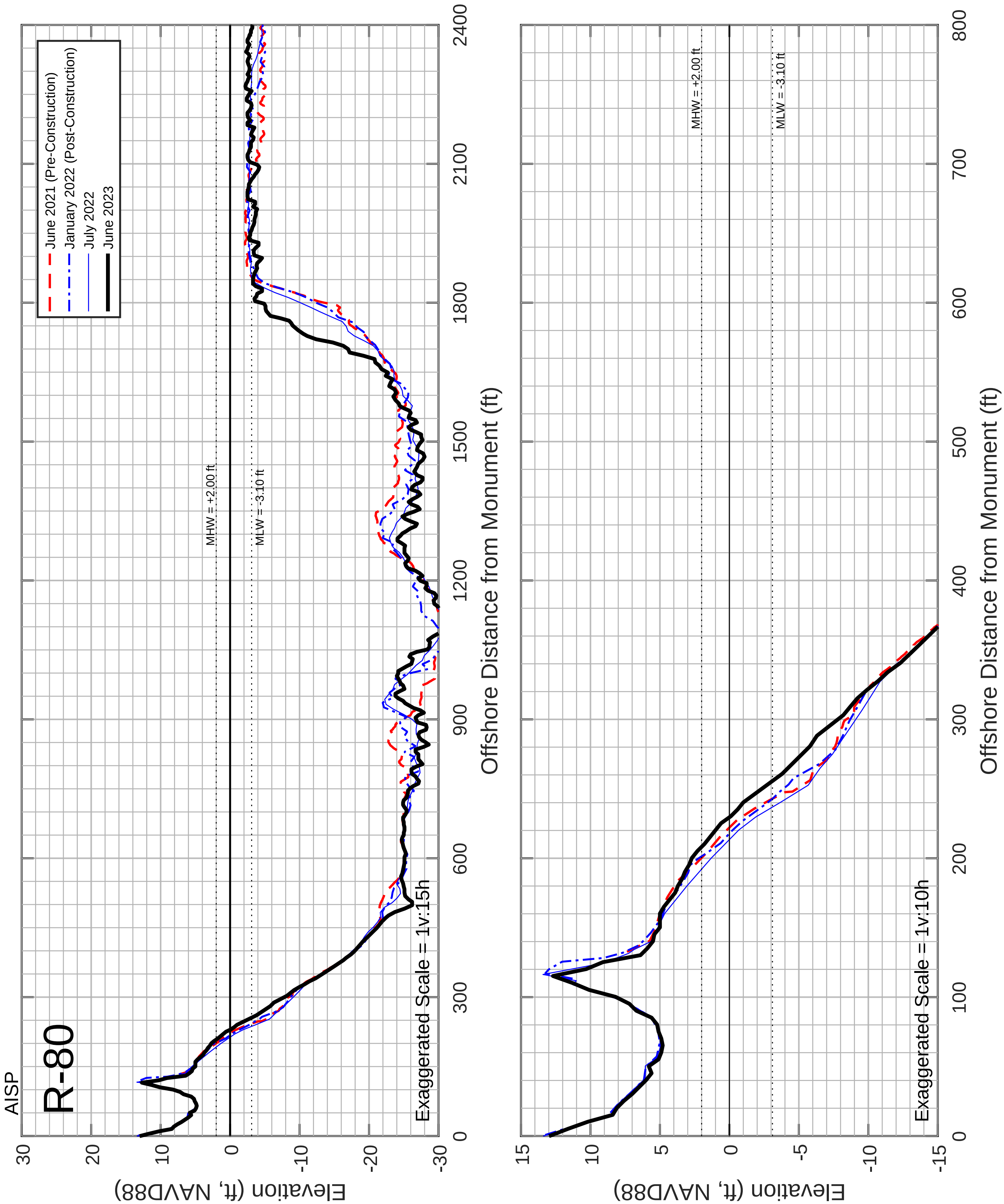


Figure B-37: Measured beach profiles at monument R-80 Amelia Island, Florida.

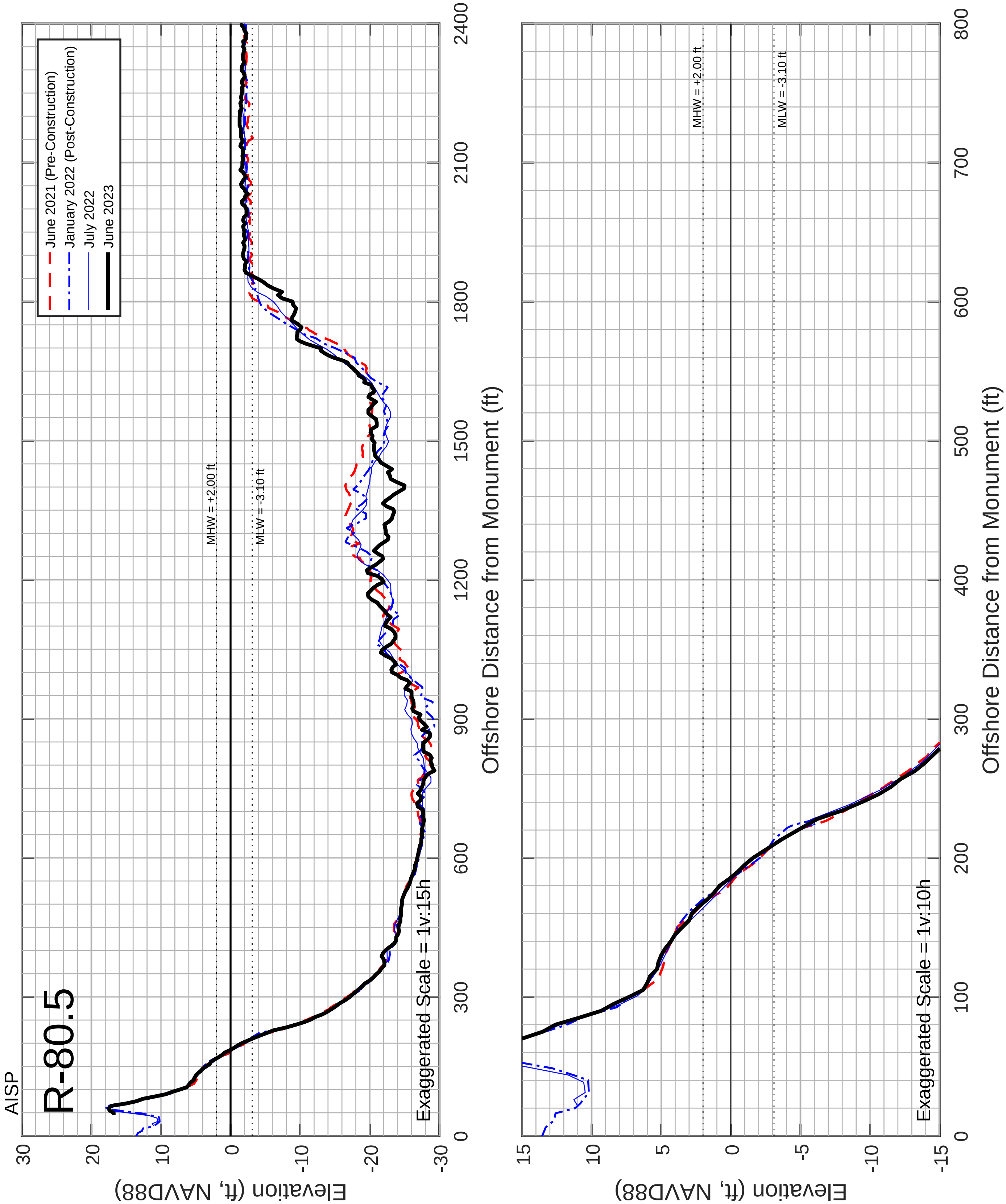


Figure B-38: Measured beach profiles at monument R-80.5 Amelia Island, Florida.

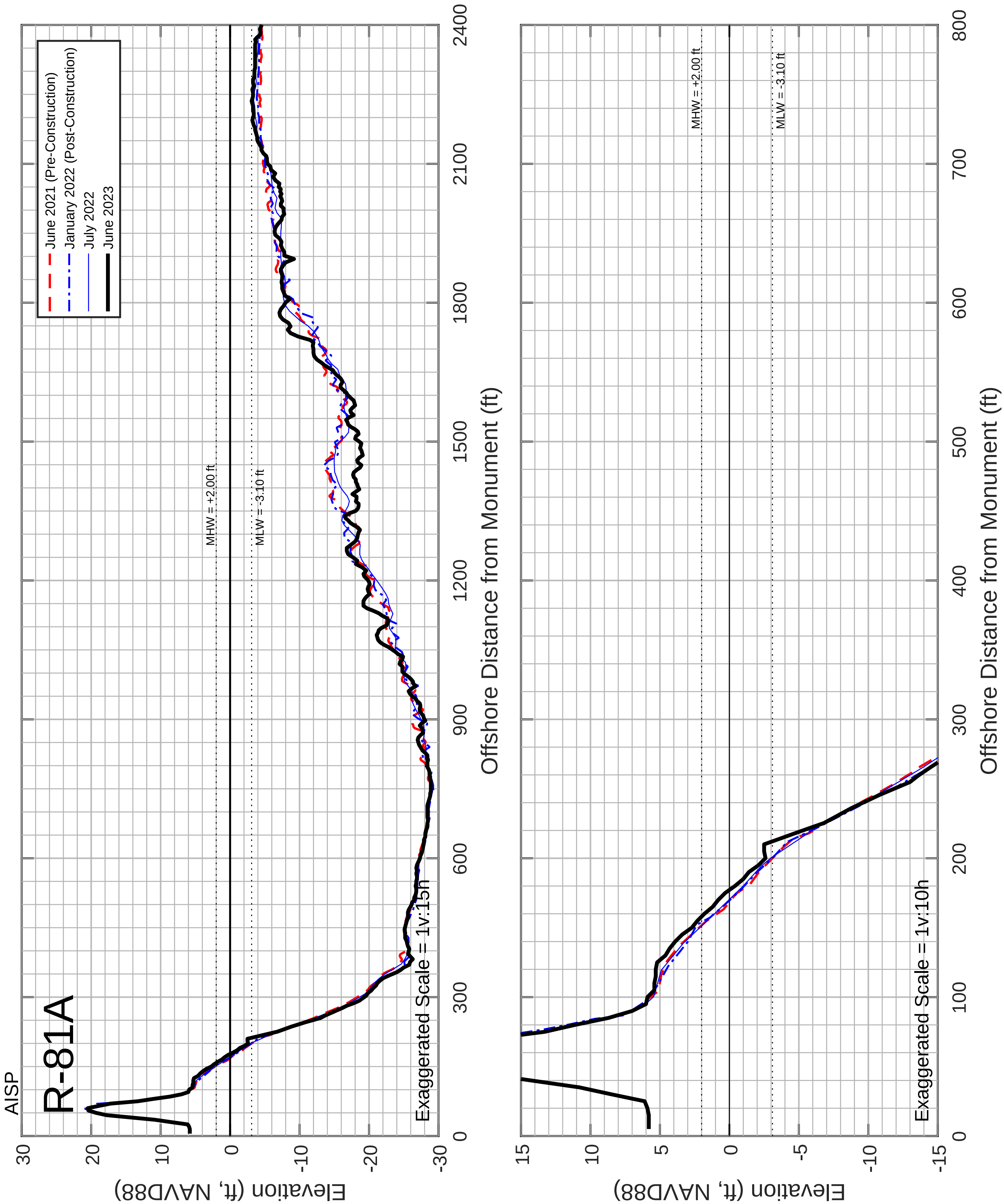


Figure B-39: Measured beach profiles at monument R-81A Amelia Island, Florida.

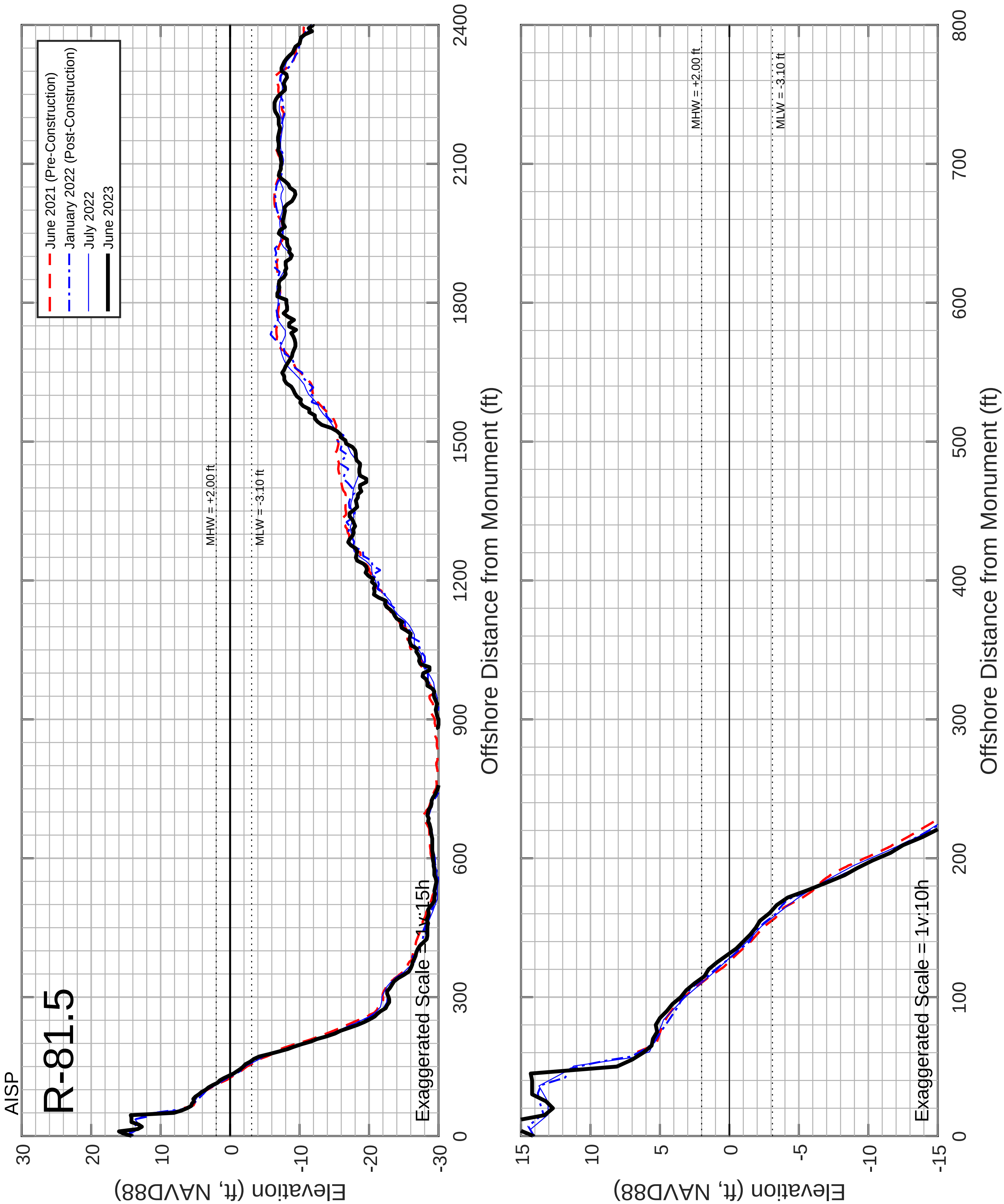


Figure B-40: Measured beach profiles at monument R-81.5 Amelia Island, Florida.

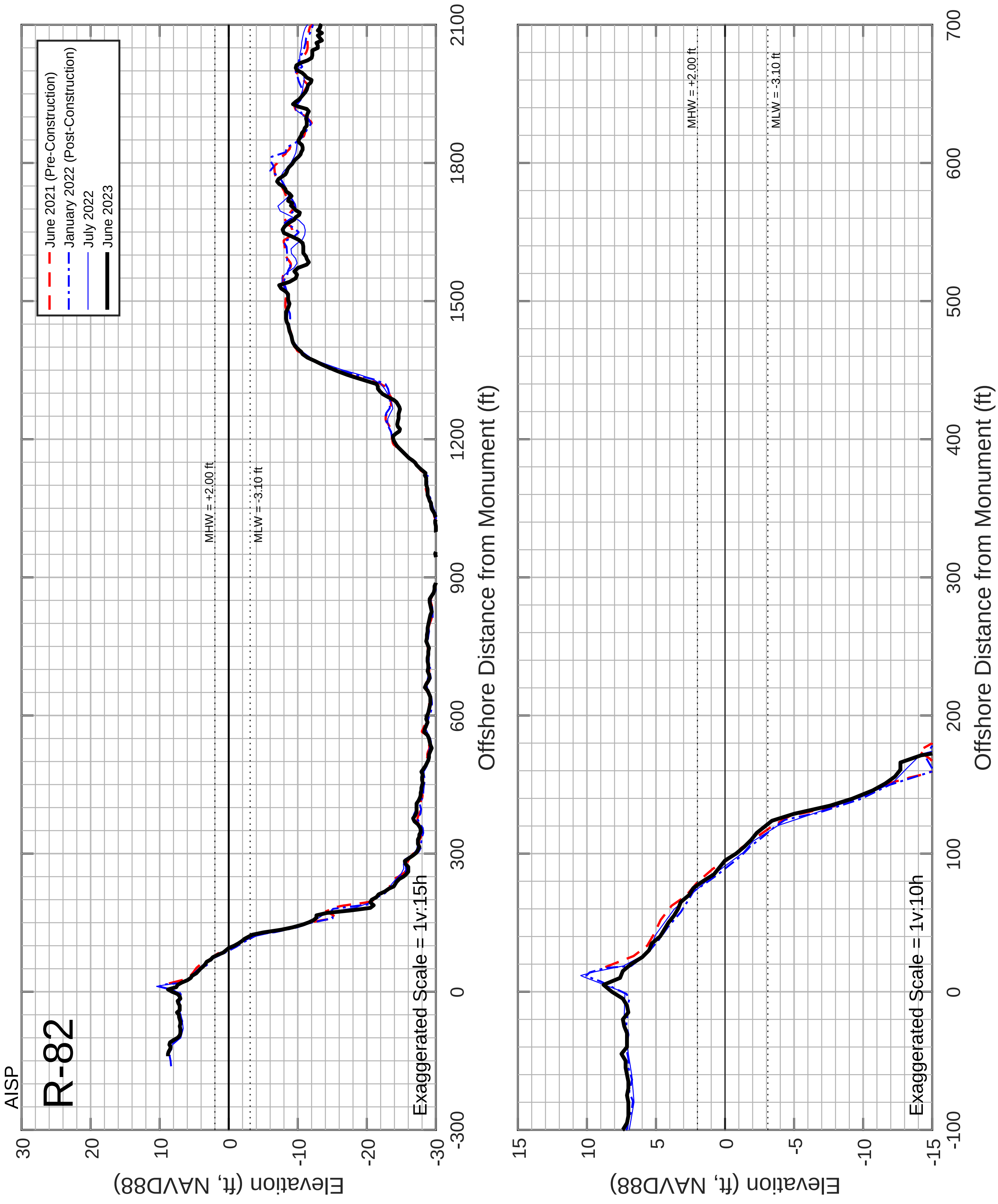


Figure B-41: Measured beach profiles at monument R-82 Amelia Island, Florida.

APPENDIX C:
Historical Beach Monitoring Profile Plots (R-55 to R-82)

This appendix contains plots of selected South Amelia Island beach profile surveys. In addition to the 2021 project pre-, post-, and year two post-construction surveys, the February 1974 (FDEP condition survey), May 1994 (pre-1994 project), June 2002 (pre-2002 project) and April 2011 (pre-2011 project) profile surveys are also plotted where available. The location of the survey monuments (R-55 to R-82) are listed in **Appendix B**.

Plots of the beach profiles are provided as **Figures C.1** through **C.41**. Note that the pre- and post- construction beach monitoring profiles were surveyed several weeks before and after fill placement at a given monument/project and some level of the expected post-fill beach equilibration is apparent in the plotted beach profiles.

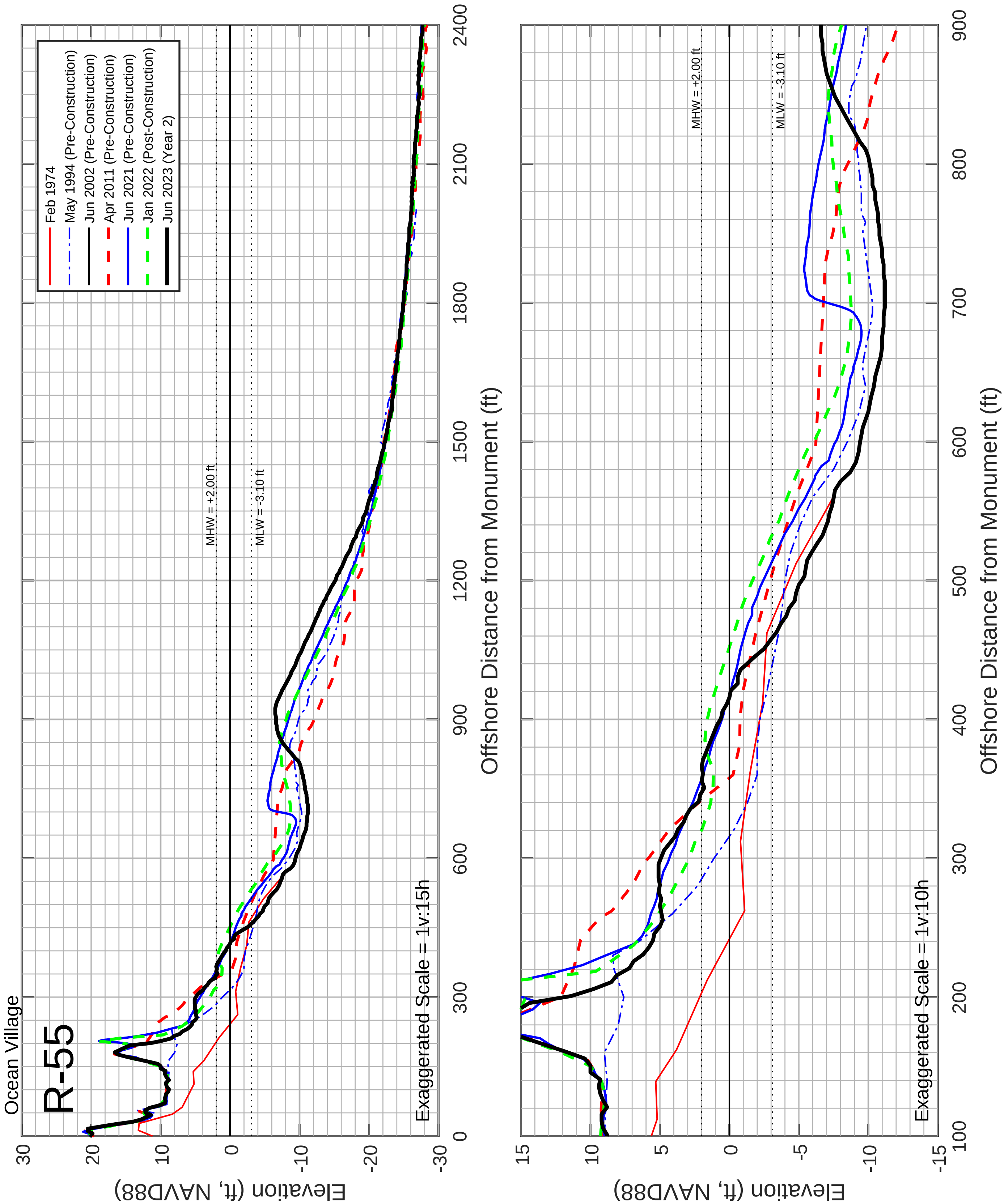


Figure C-01: Measured beach profiles at monument R-55 Amelia Island, Florida.

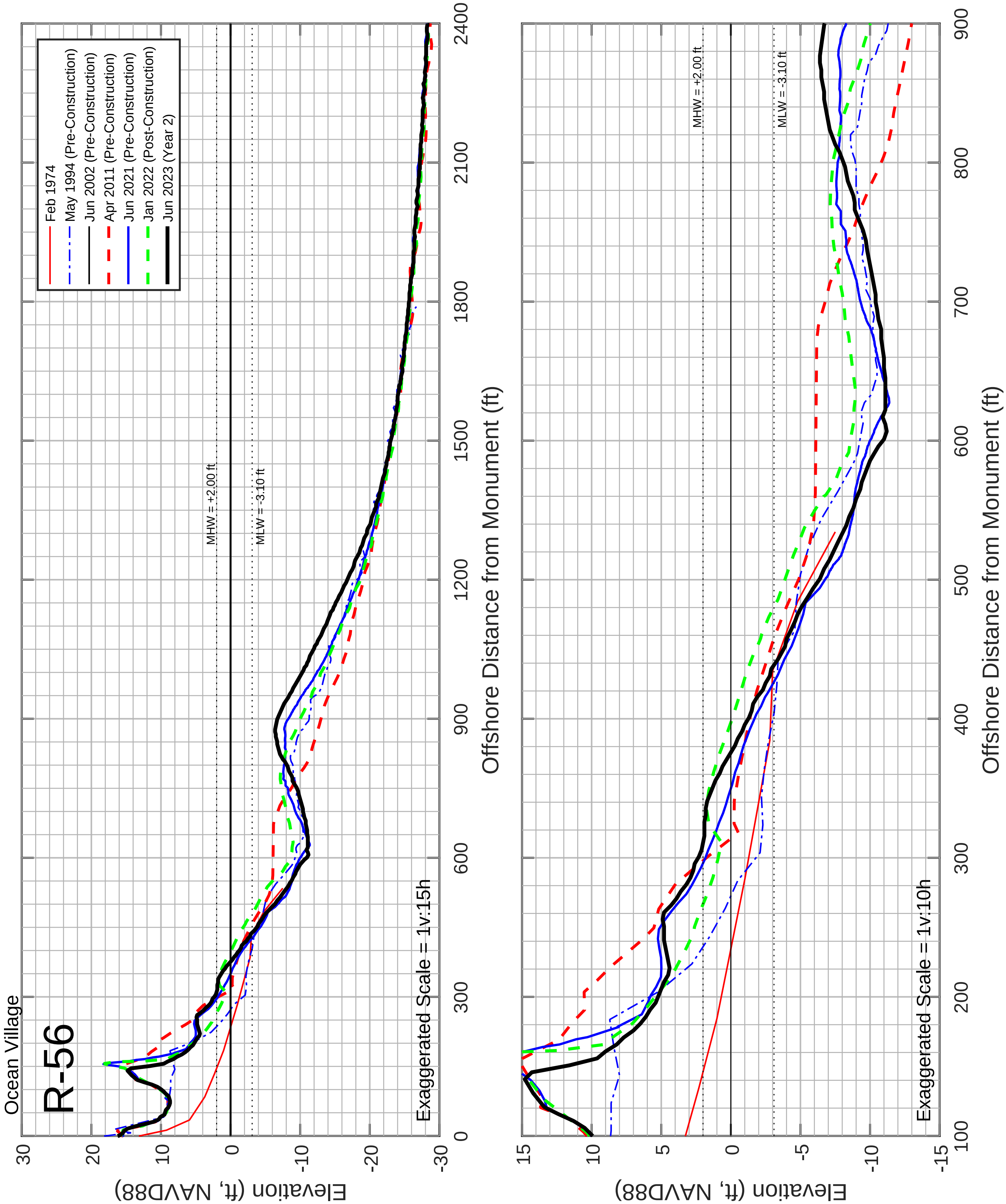


Figure C-02: Measured beach profiles at monument R-56 Amelia Island, Florida.

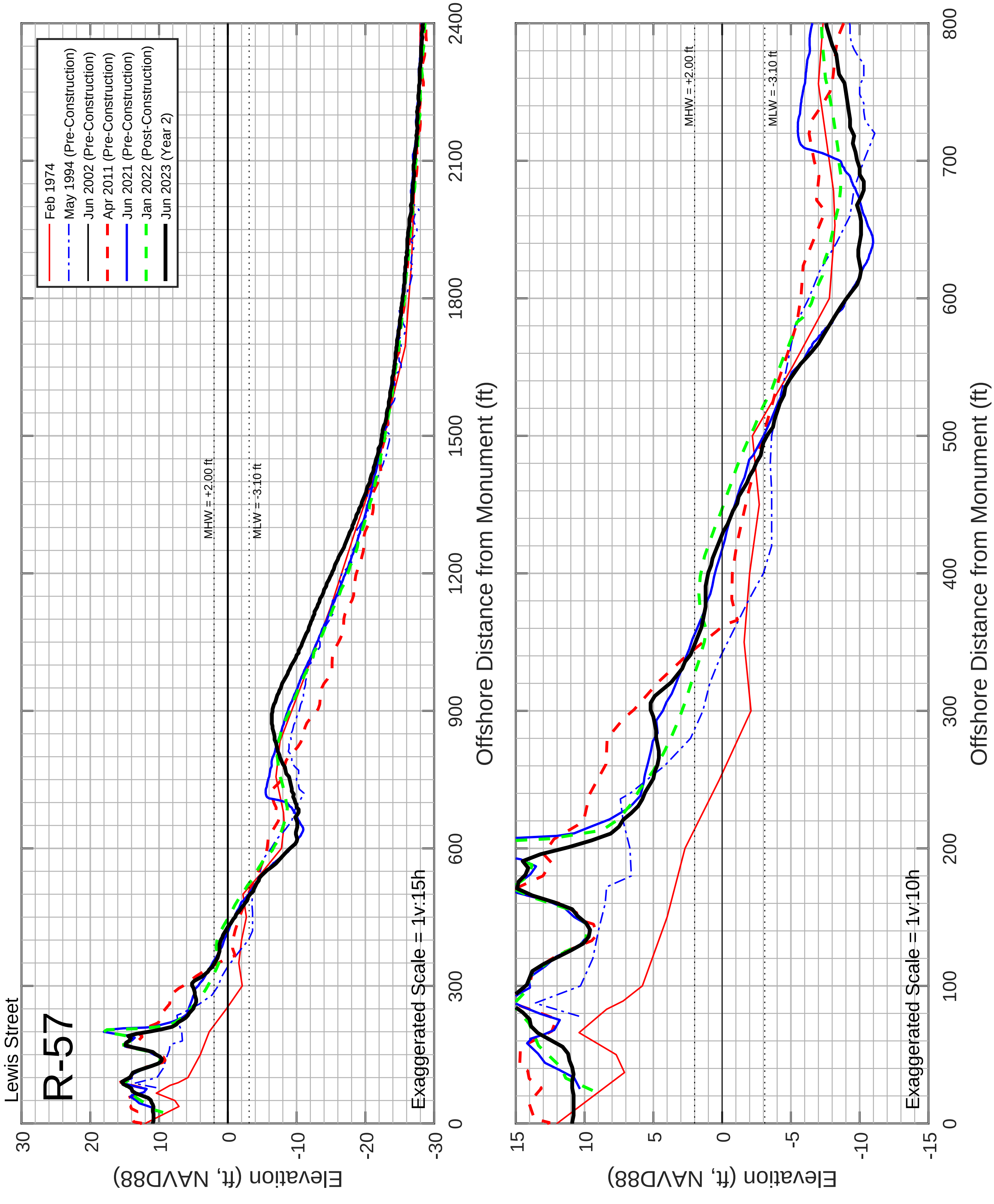


Figure C-03: Measured beach profiles at monument R-57 Amelia Island, Florida.

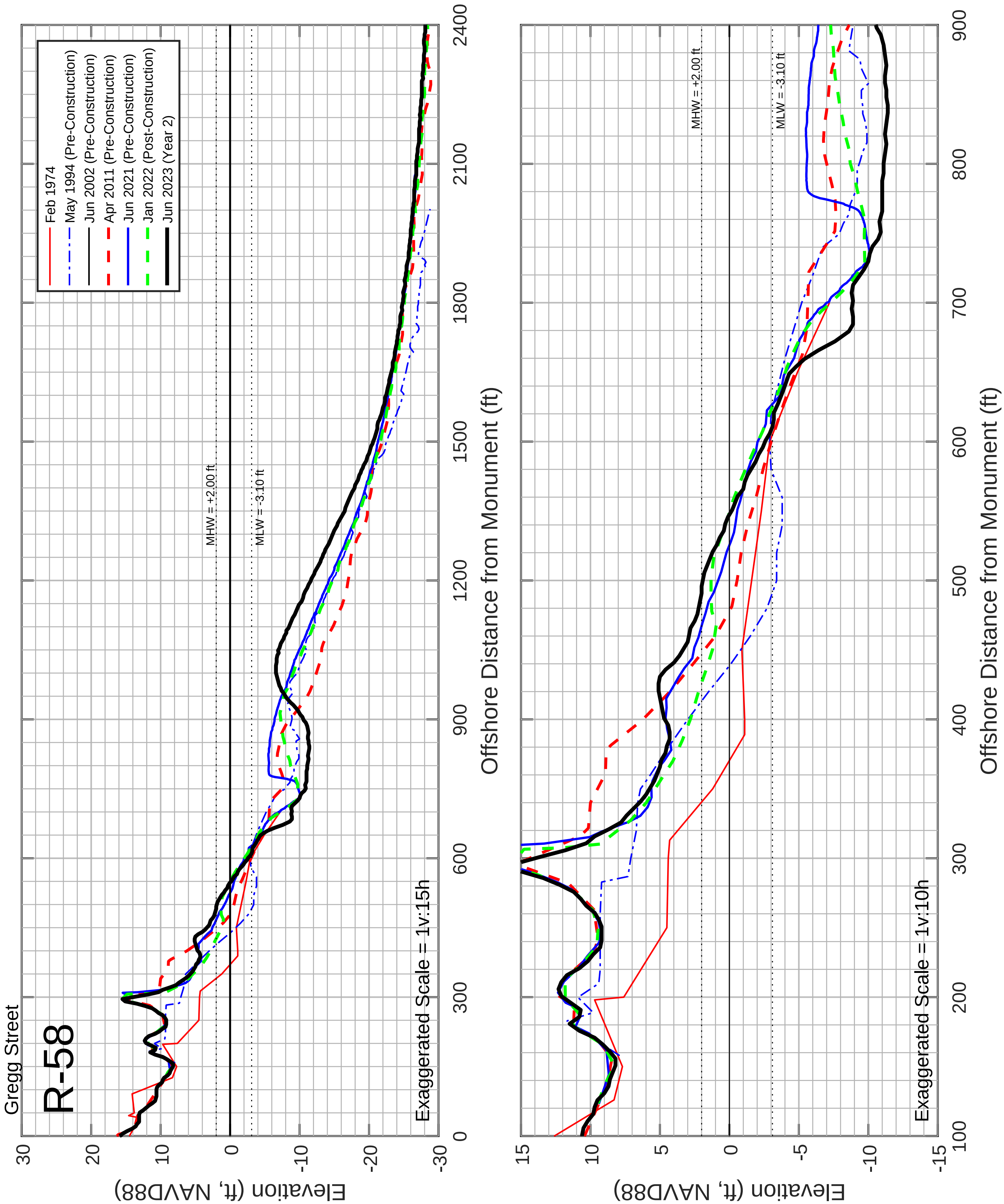


Figure C-04: Measured beach profiles at monument R-58 Amelia Island, Florida.

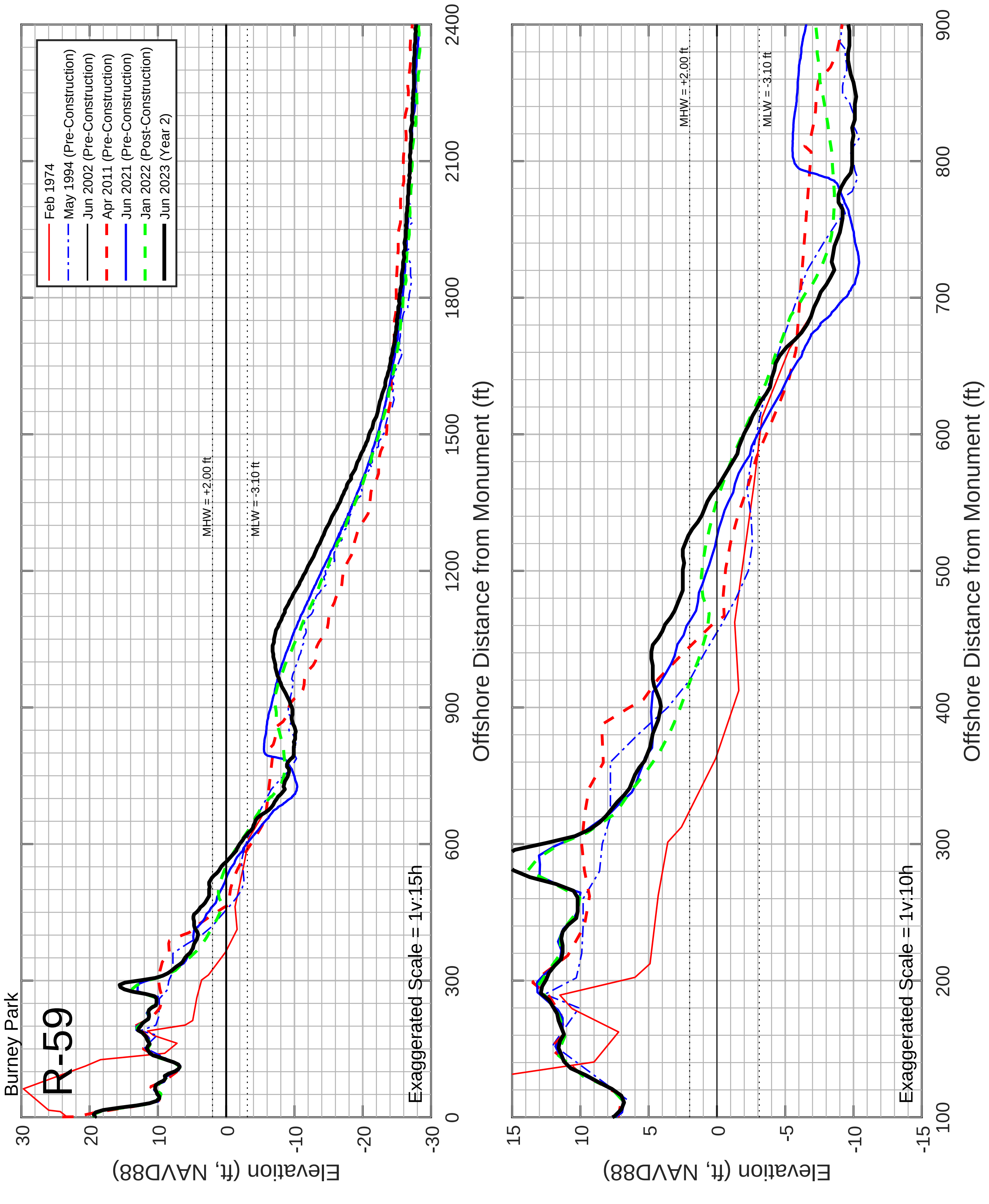


Figure C-05: Measured beach profiles at monument R-59 Amelia Island, Florida.

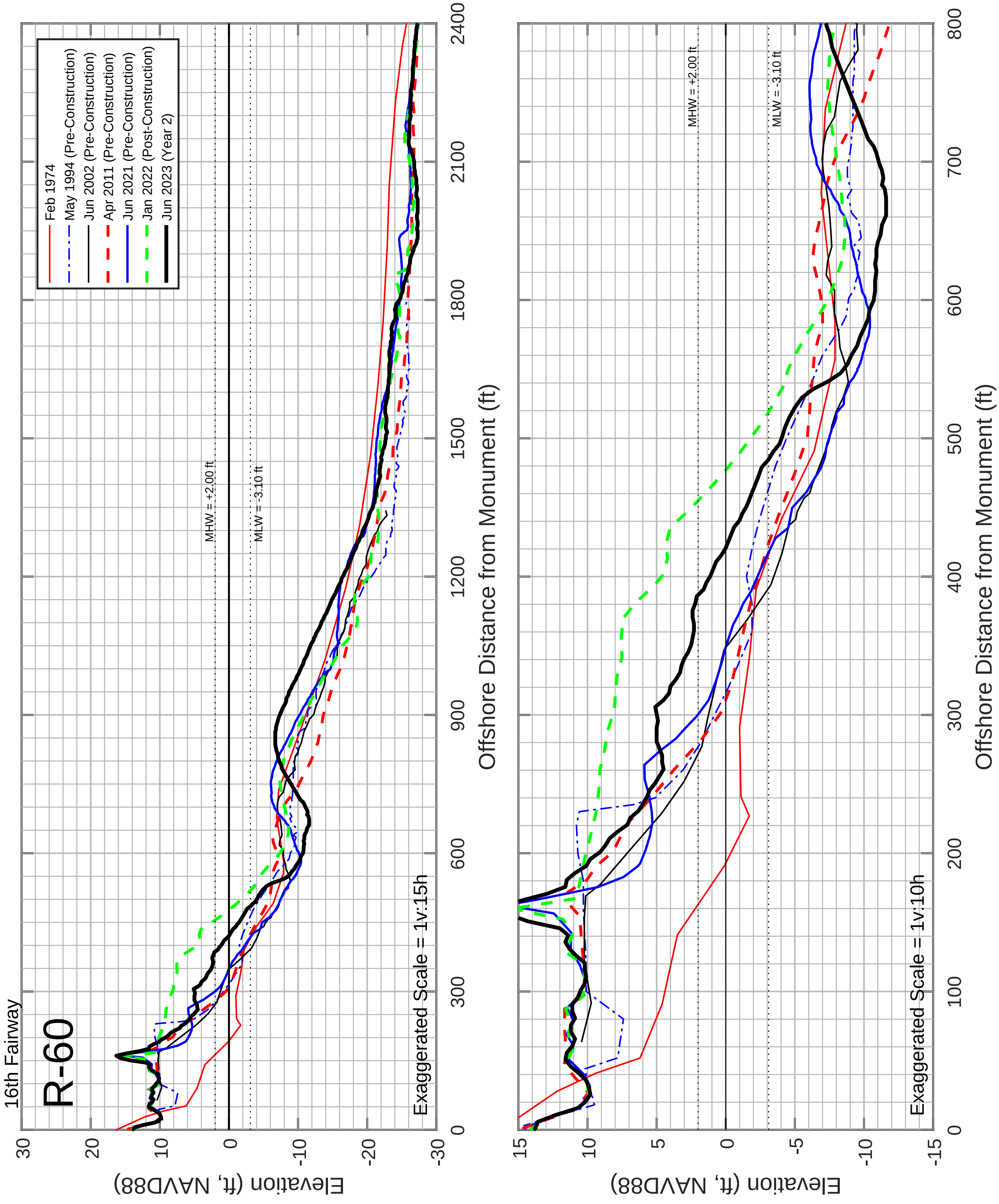


Figure C-06: Measured beach profiles at monument R-60 Amelia Island, Florida.

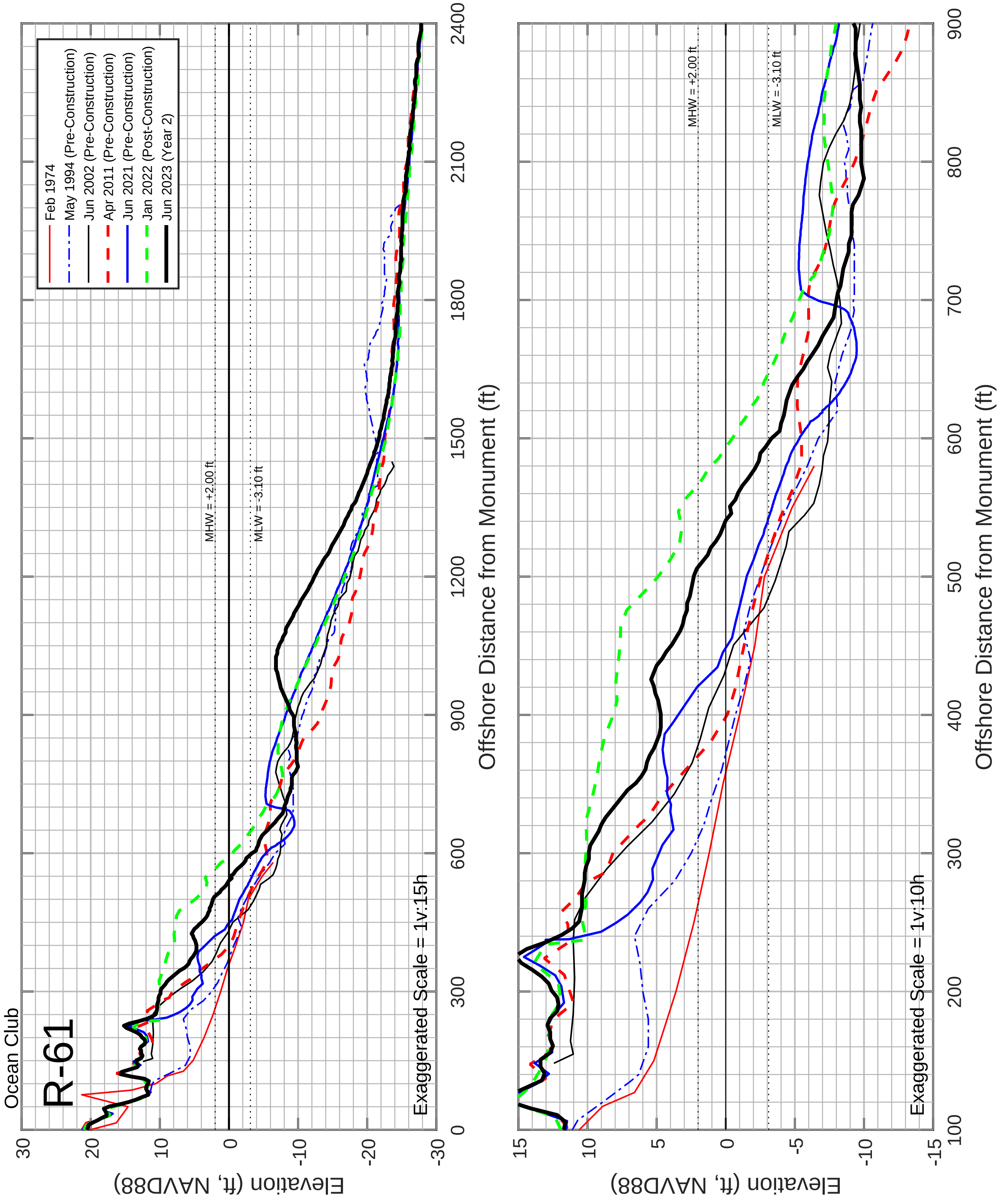


Figure C-07: Measured beach profiles at monument R-61 Amelia Island, Florida.

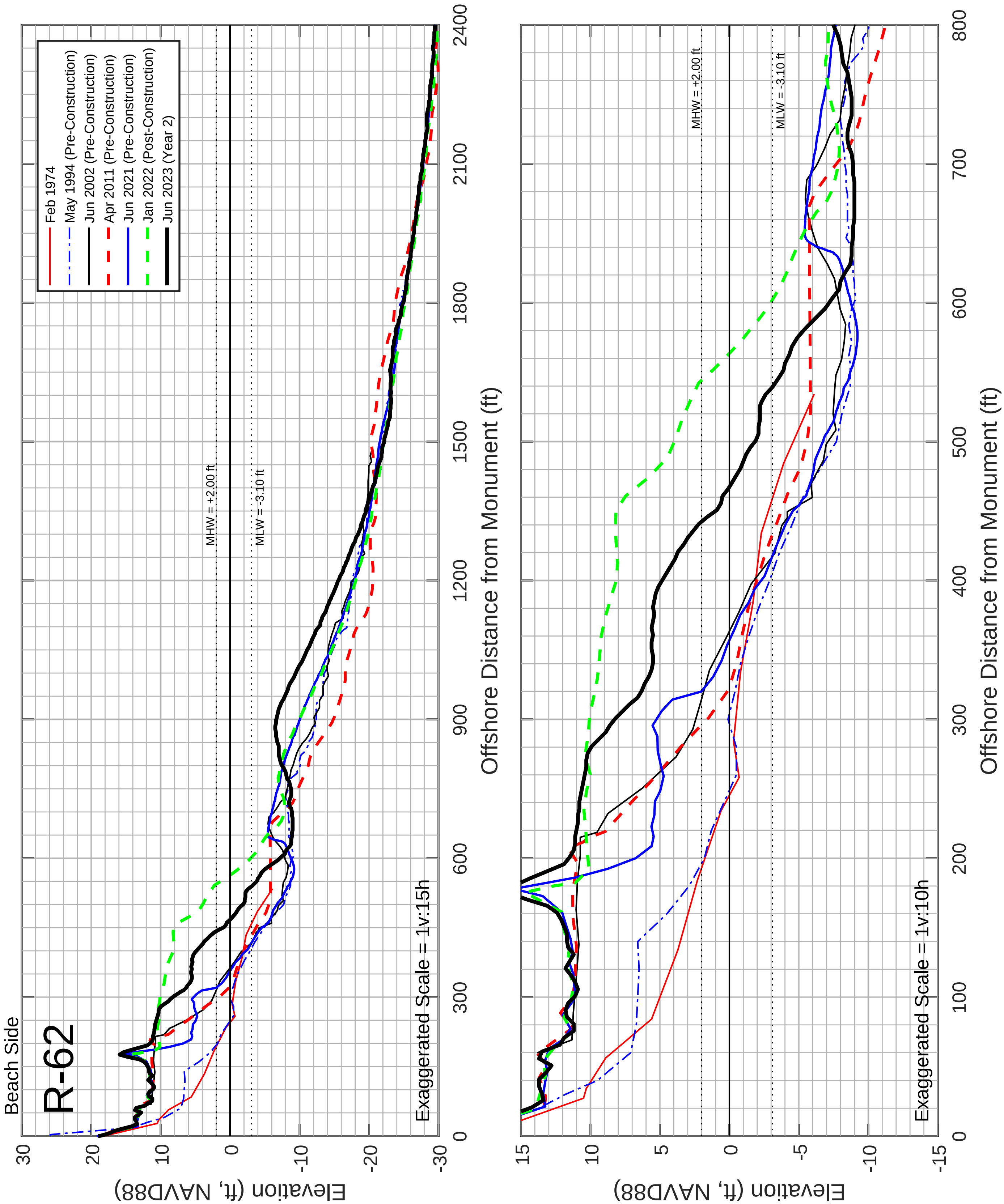


Figure C-08: Measured beach profiles at monument R-62 Amelia Island, Florida.

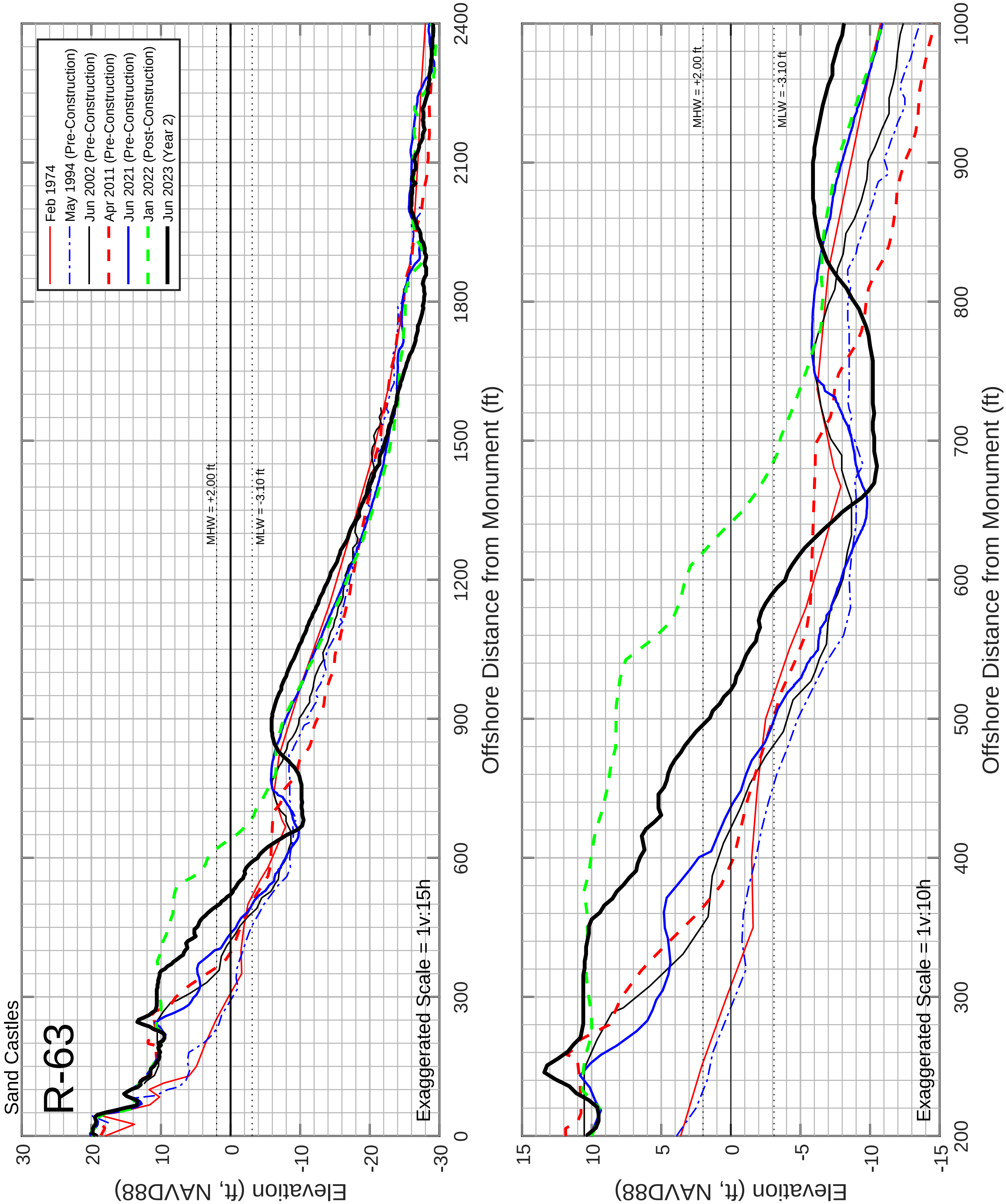


Figure C-09: Measured beach profiles at monument R-63 Amelia Island, Florida.

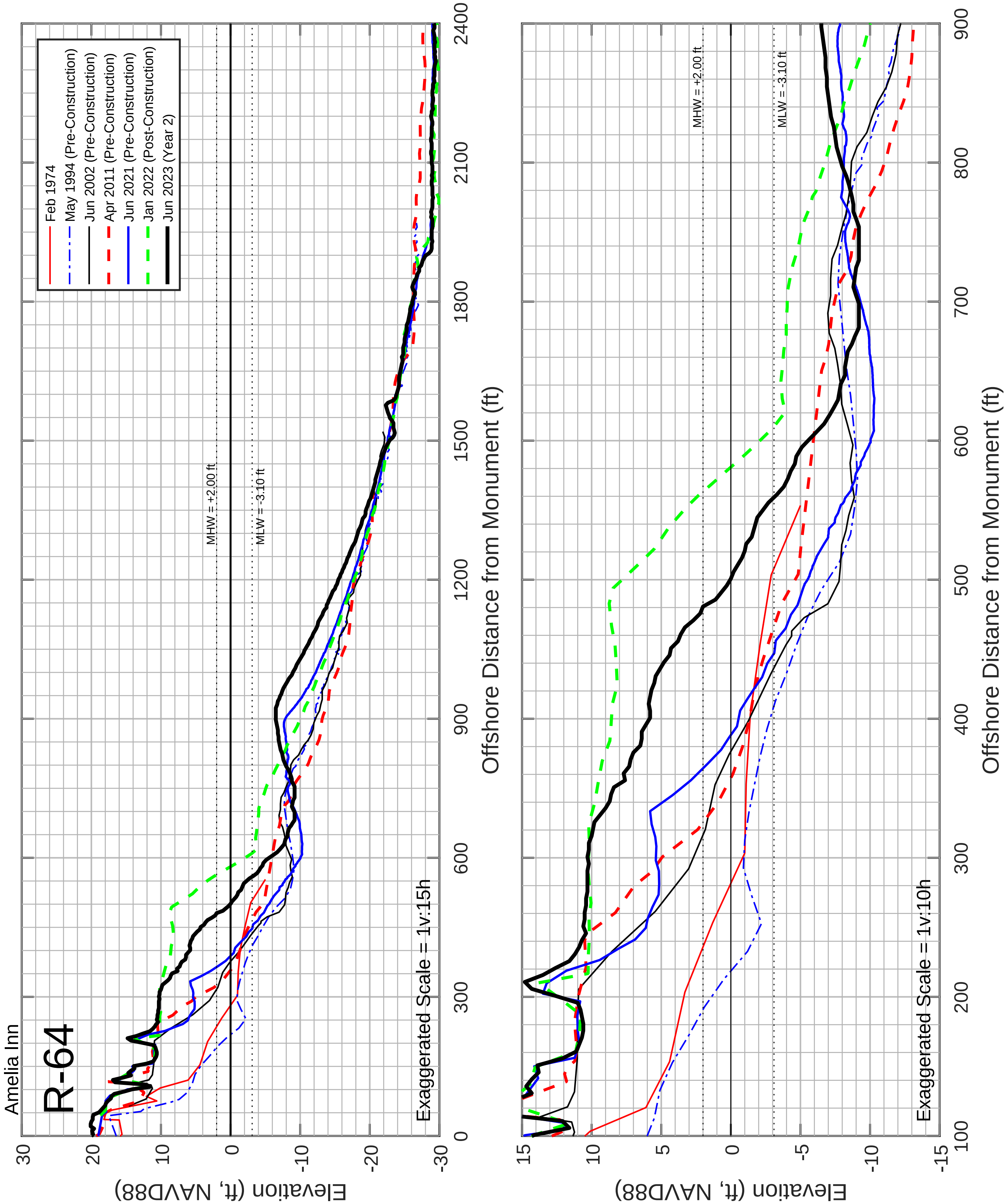


Figure C-10: Measured beach profiles at monument R-64 Amelia Island, Florida.

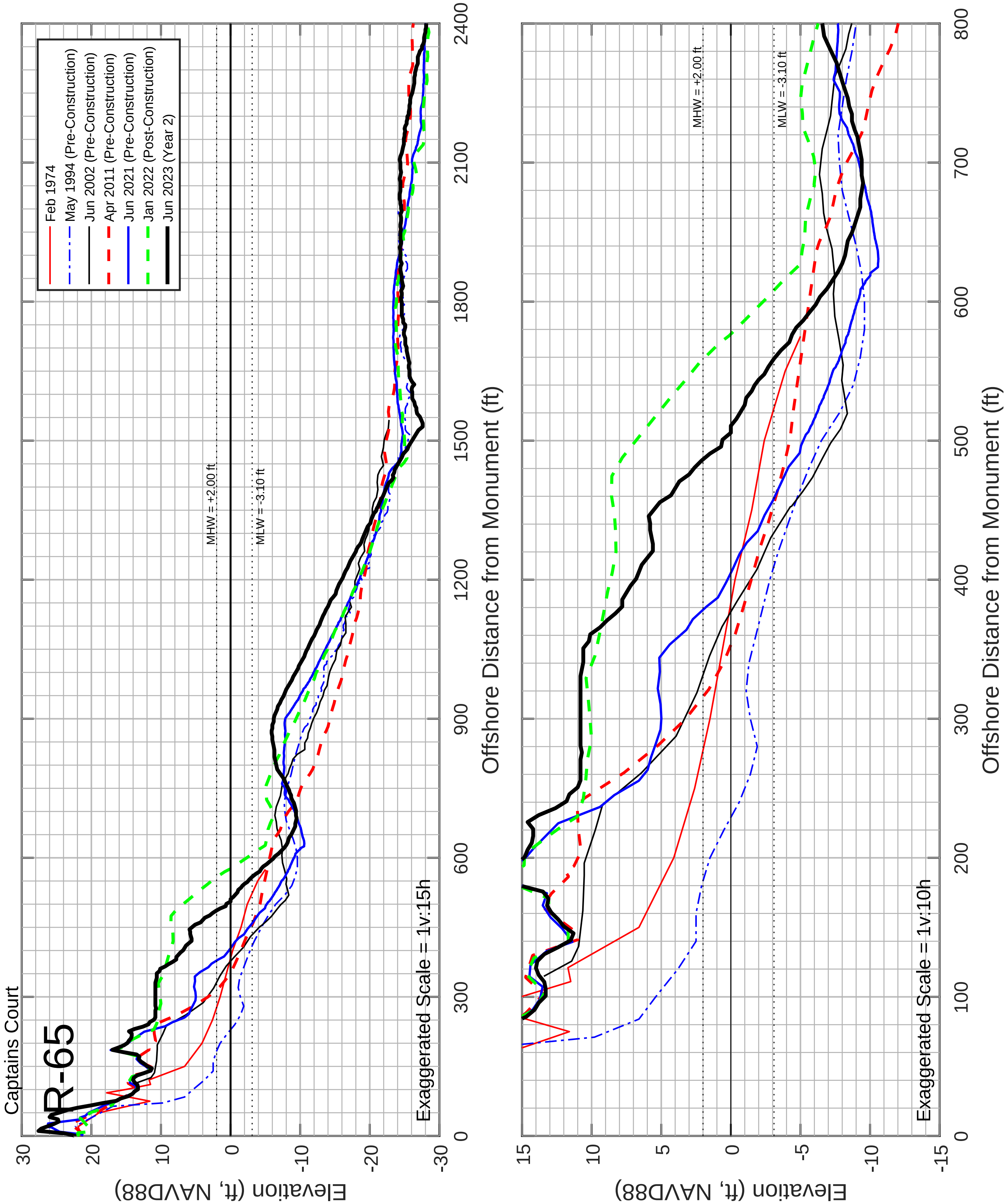


Figure C-11: Measured beach profiles at monument R-65 Amelia Island, Florida.

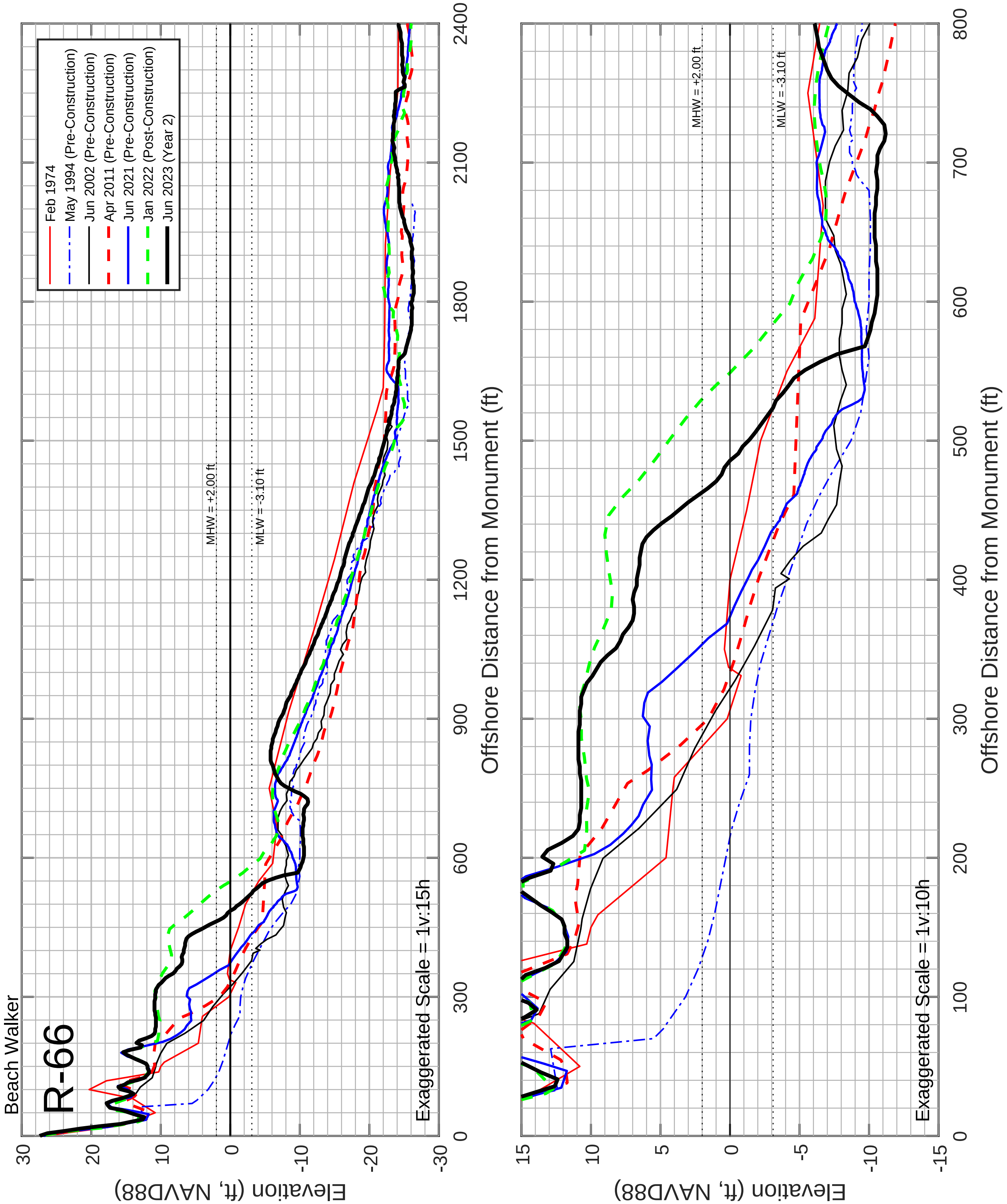


Figure C-12: Measured beach profiles at monument R-66 Amelia Island, Florida.

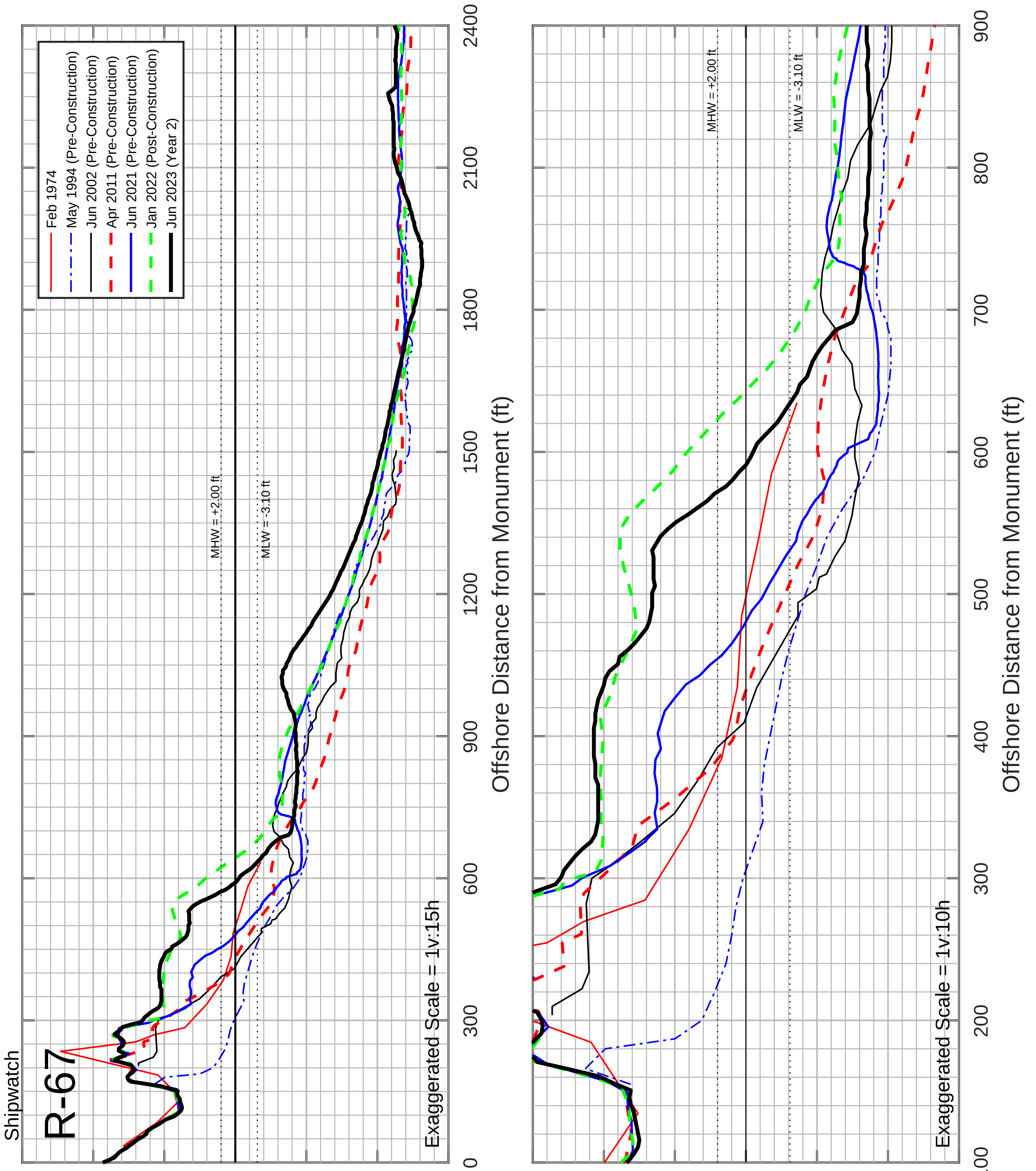


Figure C-13: Measured beach profiles at monument R-67 Amelia Island, Florida.

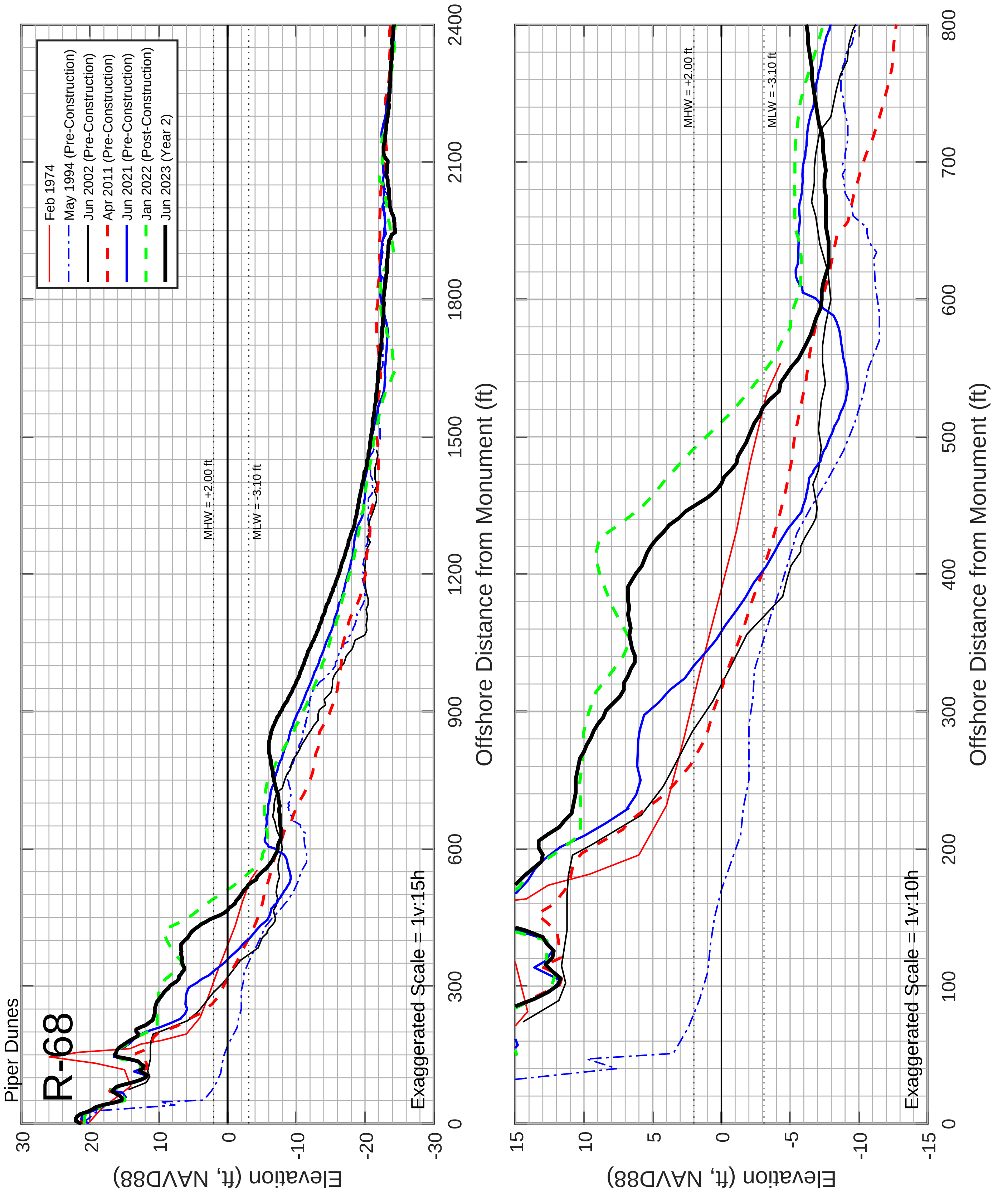


Figure C-14: Measured beach profiles at monument R-68 Amelia Island, Florida.

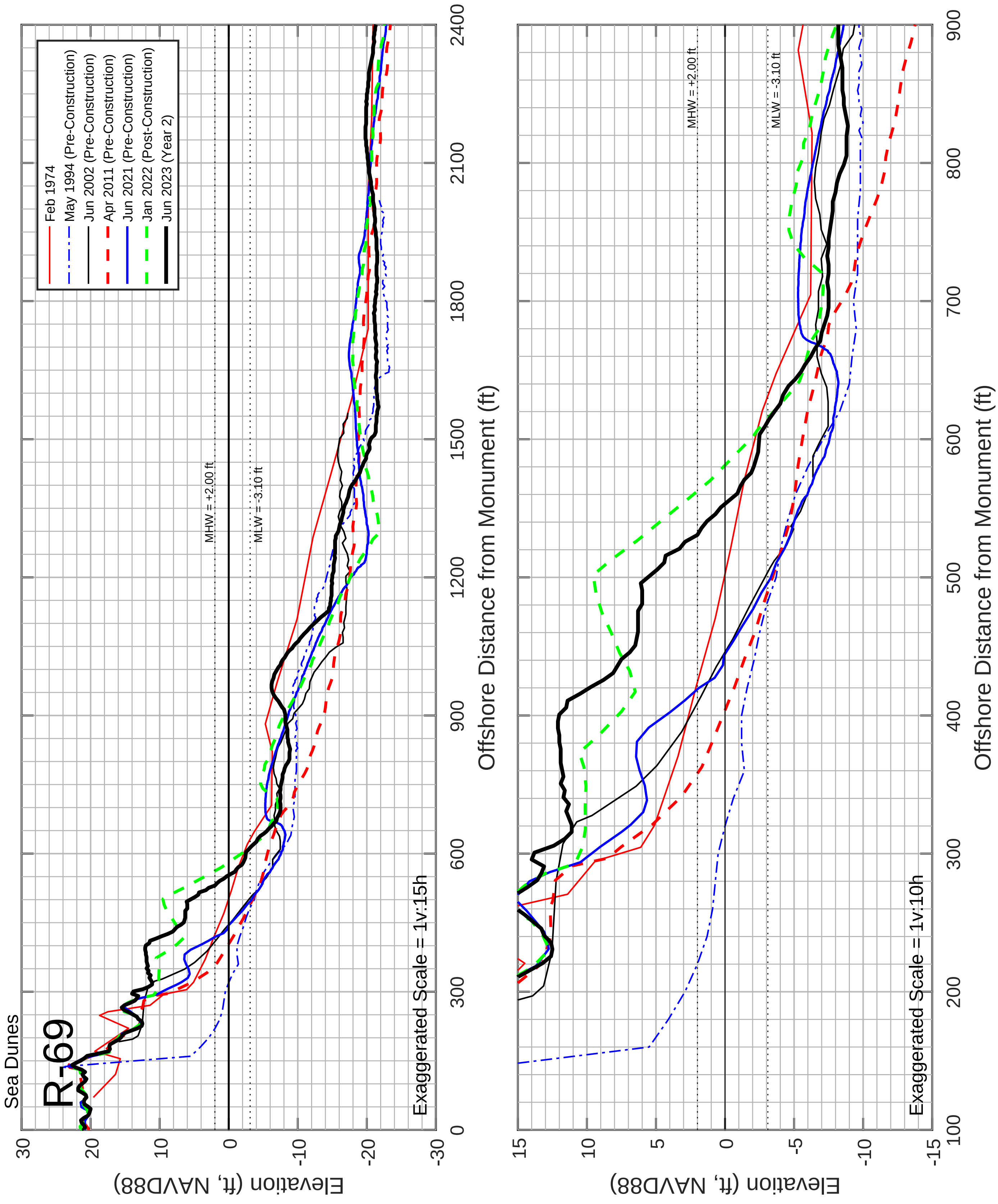


Figure C-15: Measured beach profiles at monument R-69 Amelia Island, Florida.

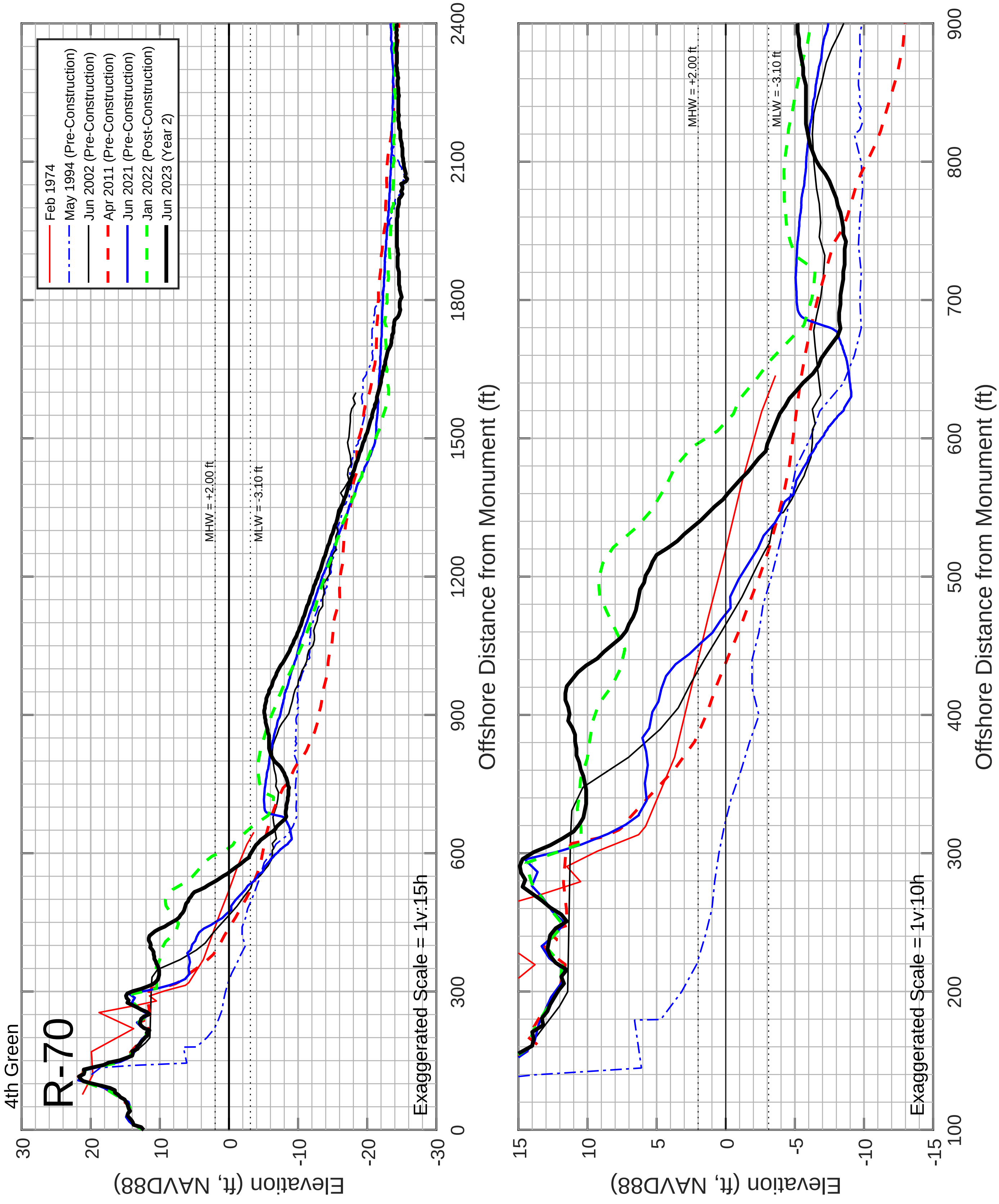


Figure C-16: Measured beach profiles at monument R-70 Amelia Island, Florida.

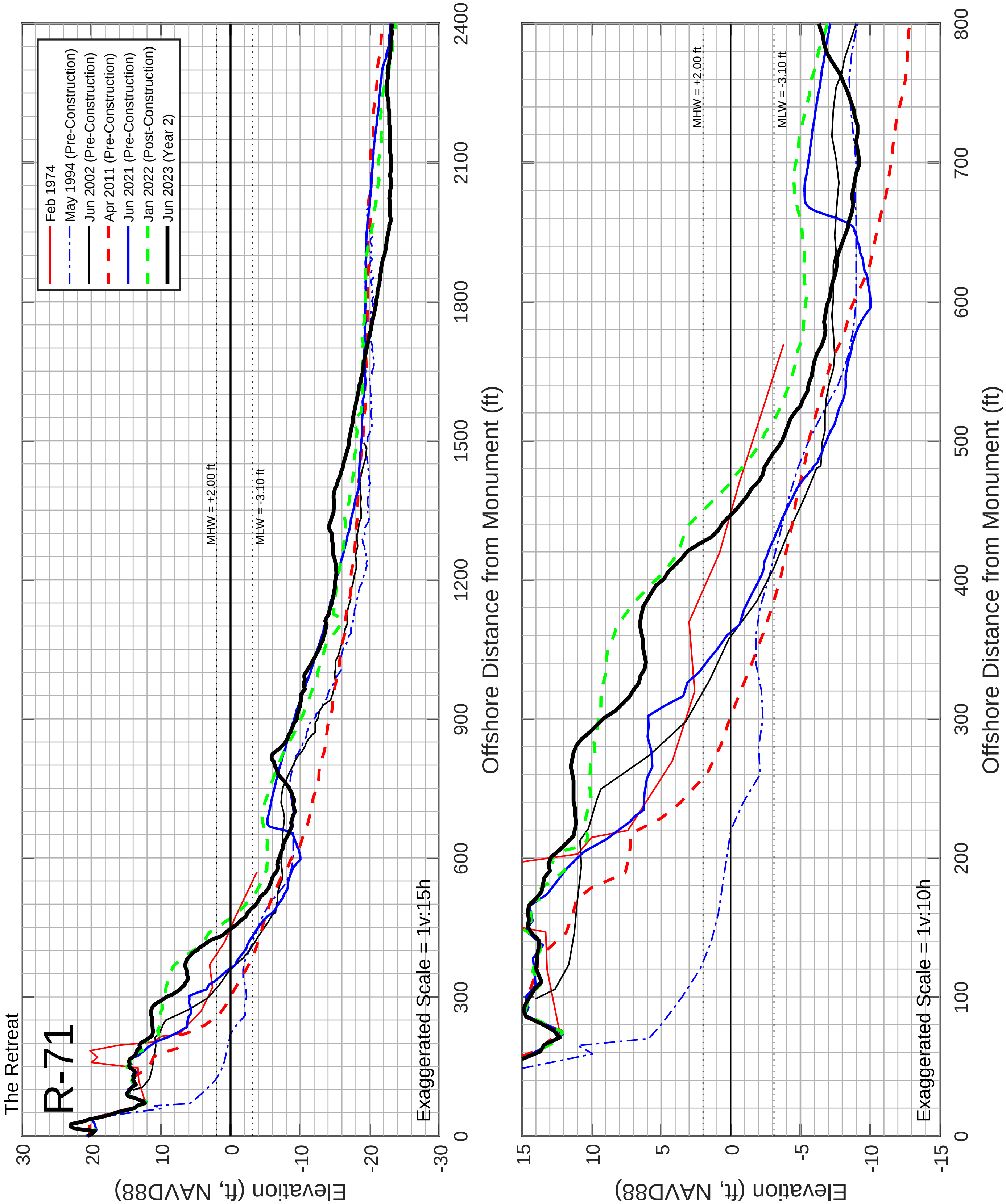


Figure C-17: Measured beach profiles at monument R-71 Amelia Island, Florida.

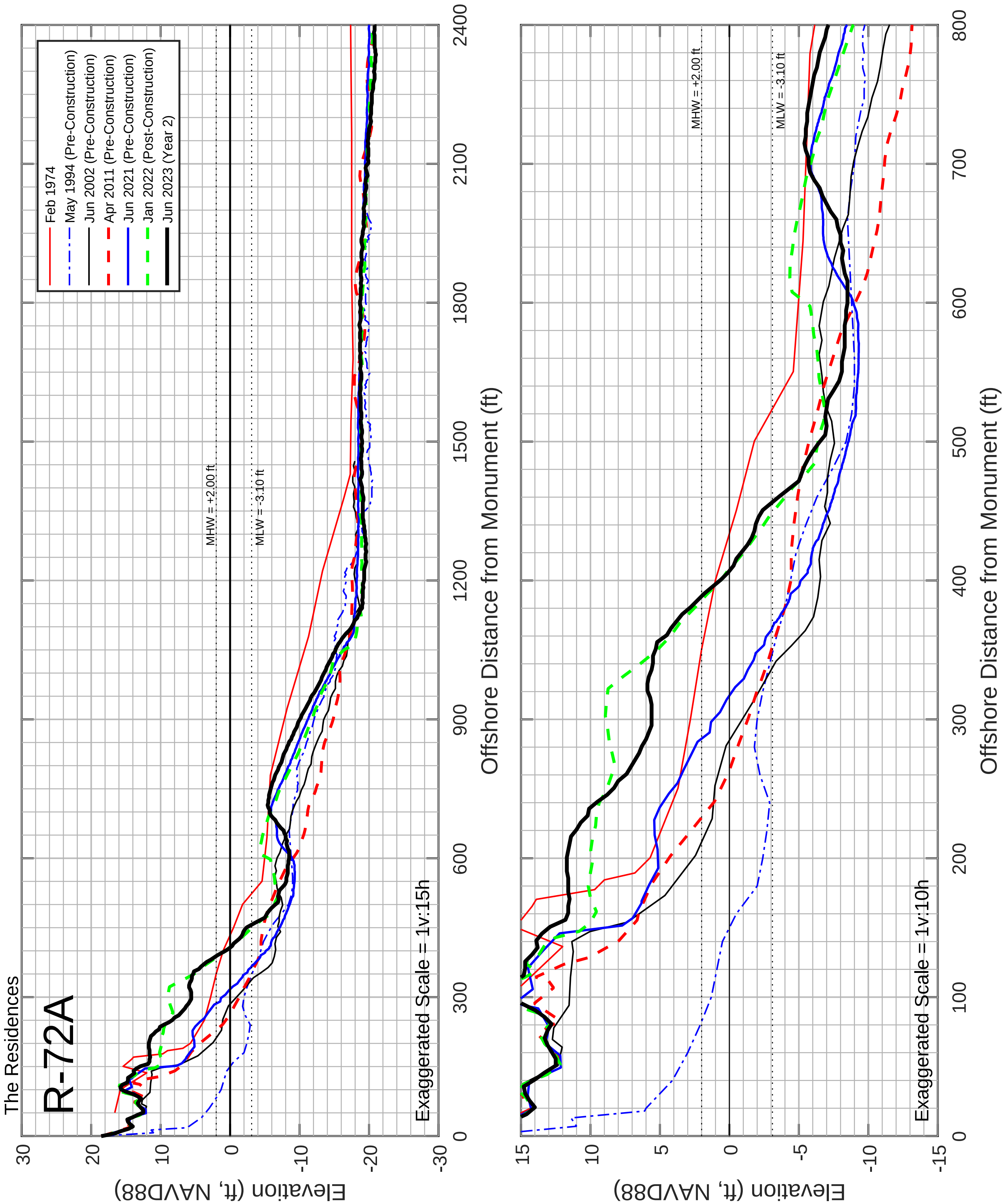


Figure C-18: Measured beach profiles at monument R-72A Amelia Island, Florida.

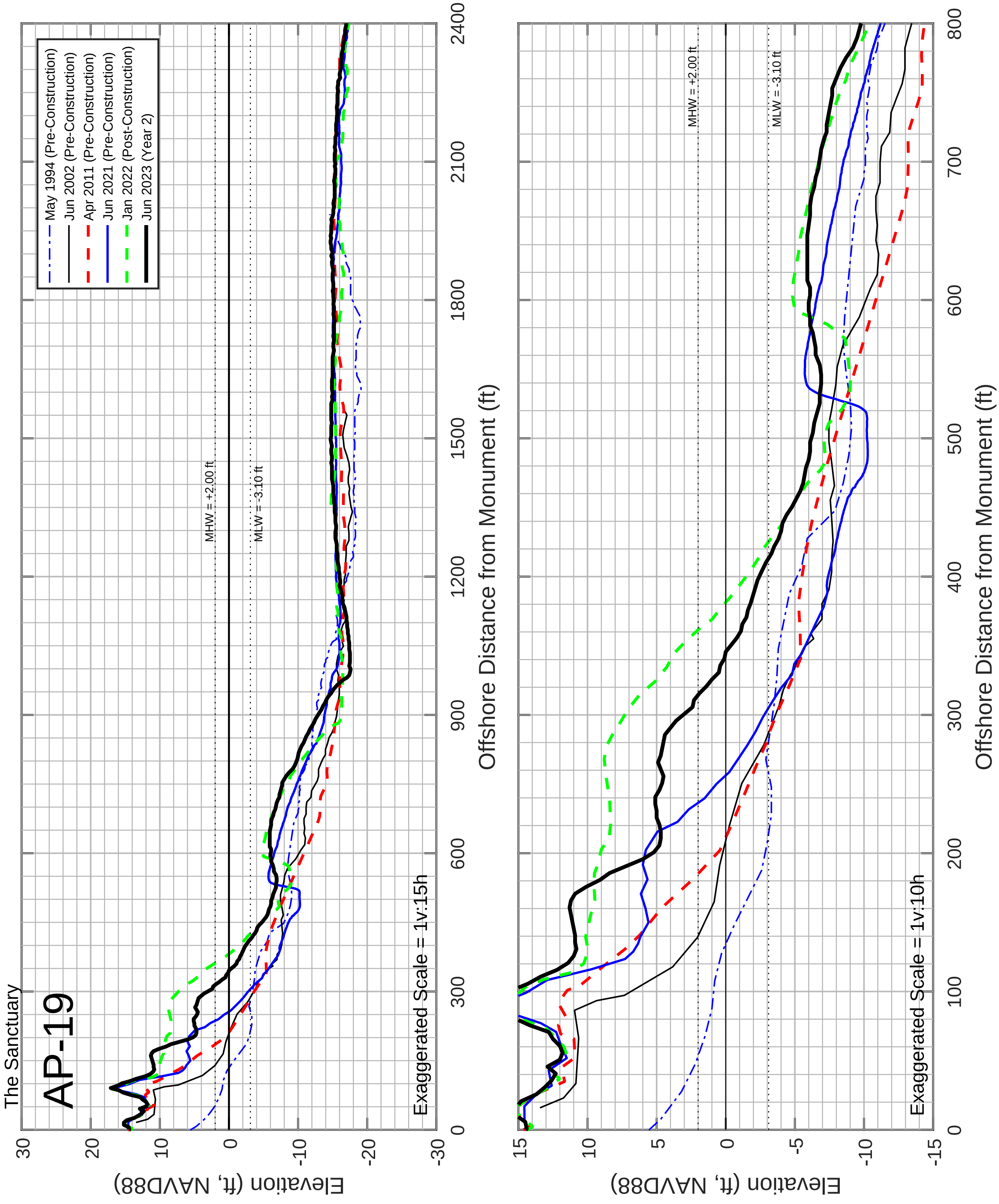


Figure C-19: Measured beach profiles at monument AP-19 Amelia Island, Florida.

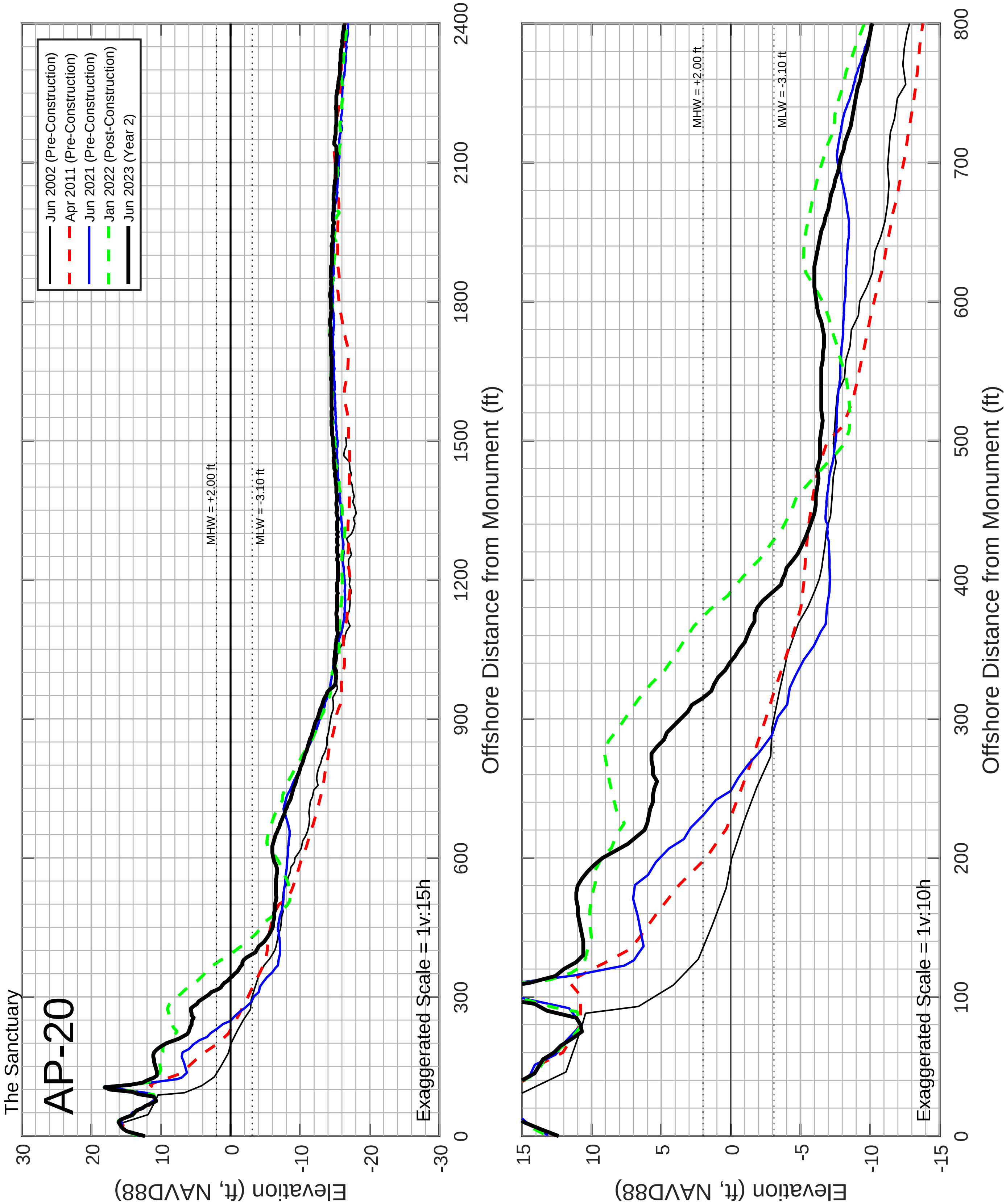


Figure C-20: Measured beach profiles at monument AP-20 Amelia Island, Florida.

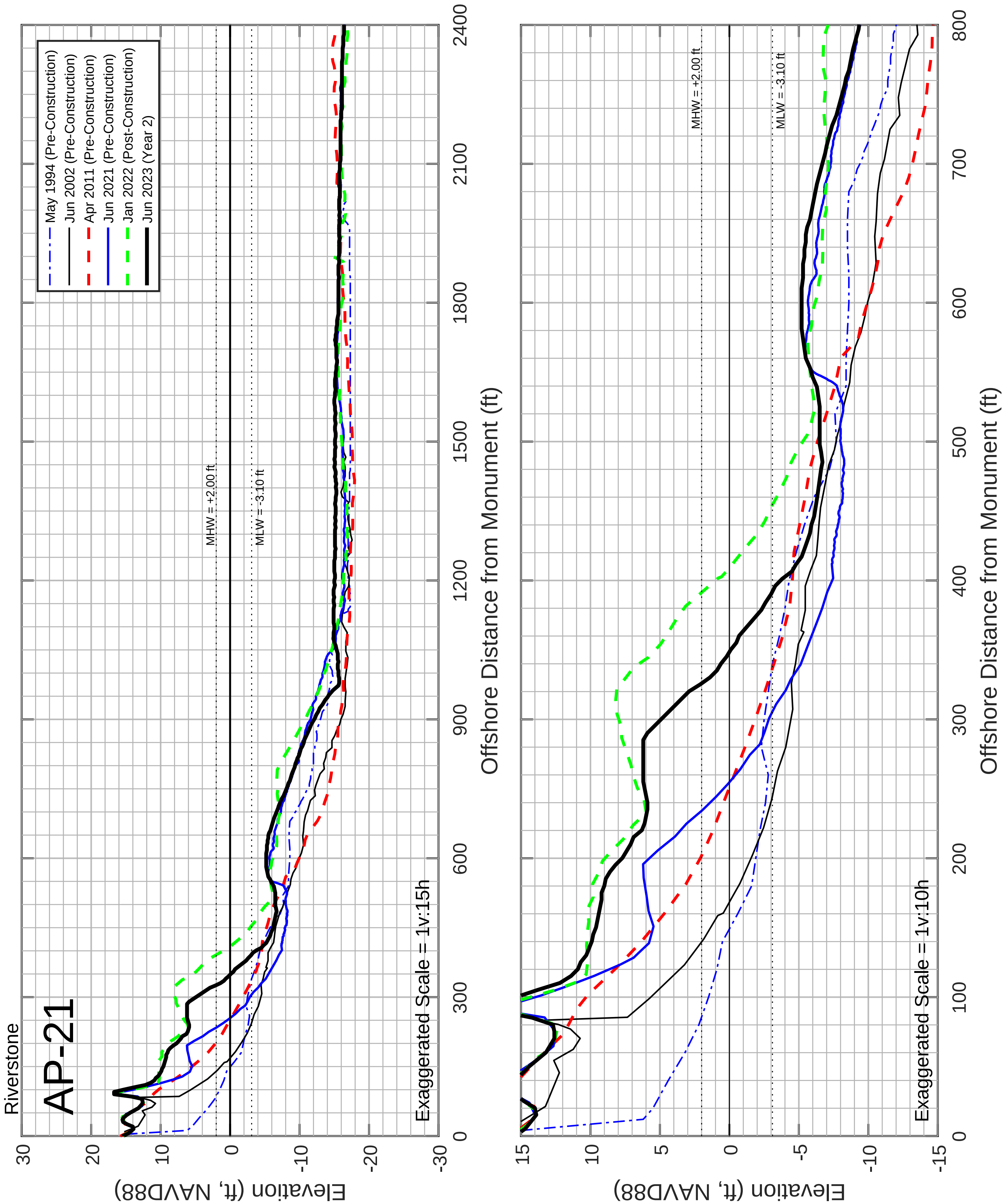


Figure C-21: Measured beach profiles at monument AP-21 Amelia Island, Florida.

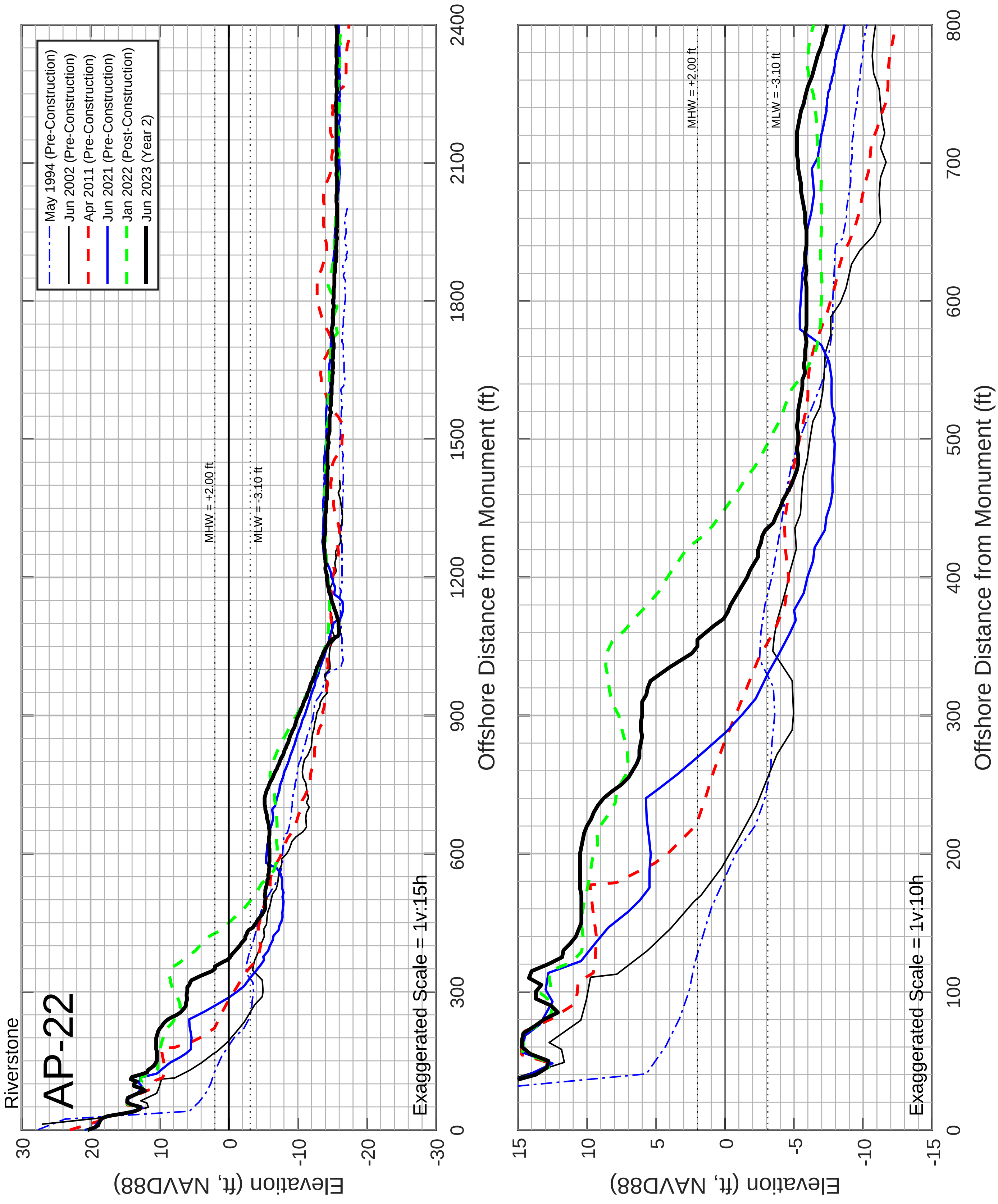


Figure C-22: Measured beach profiles at monument AP-22 Amelia Island, Florida.

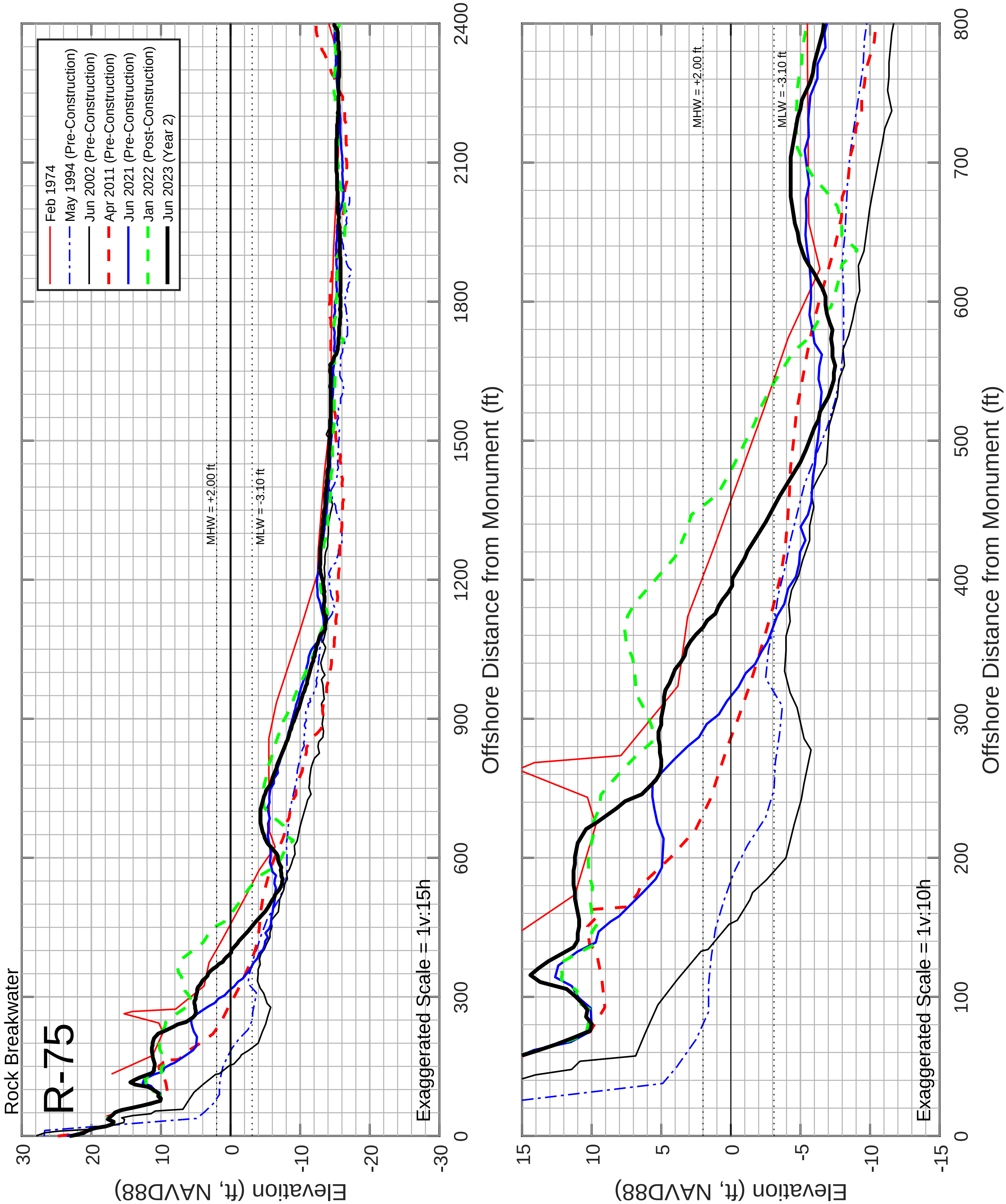


Figure C-23: Measured beach profiles at monument R-75 Amelia Island, Florida.

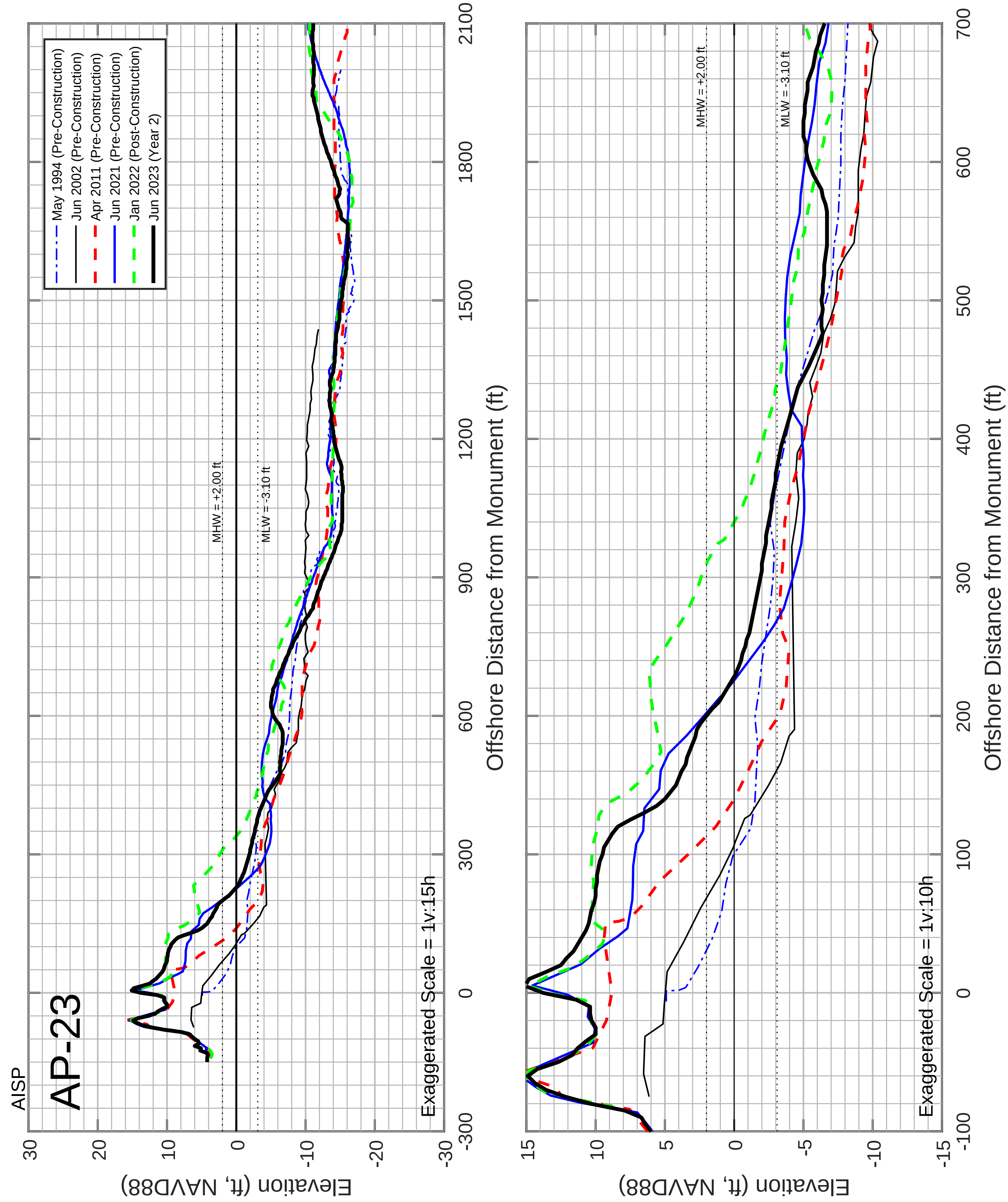


Figure C-24: Measured beach profiles at monument AP-23 Amelia Island, Florida.

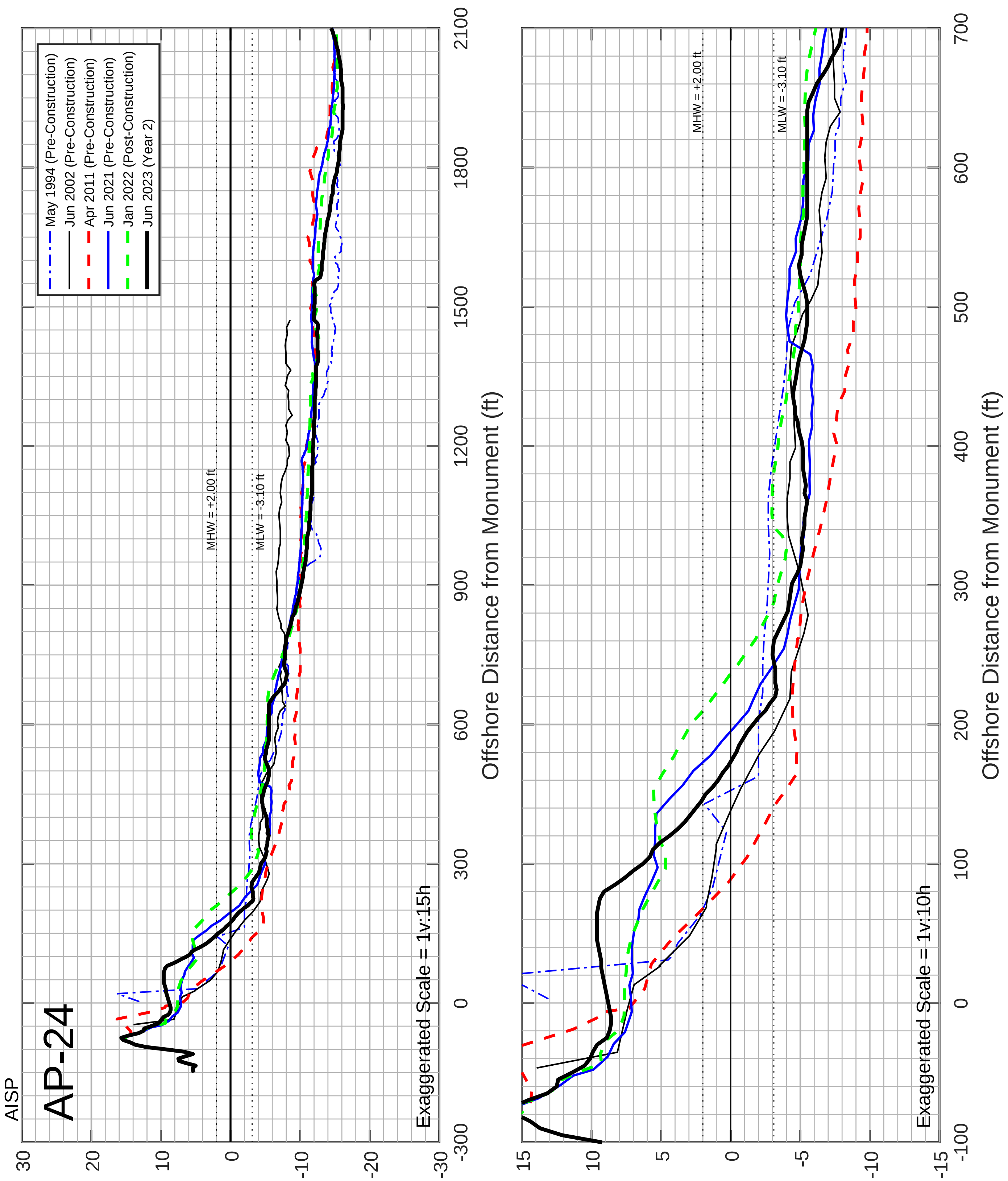


Figure C-25: Measured beach profiles at monument AP-24 Amelia Island, Florida.

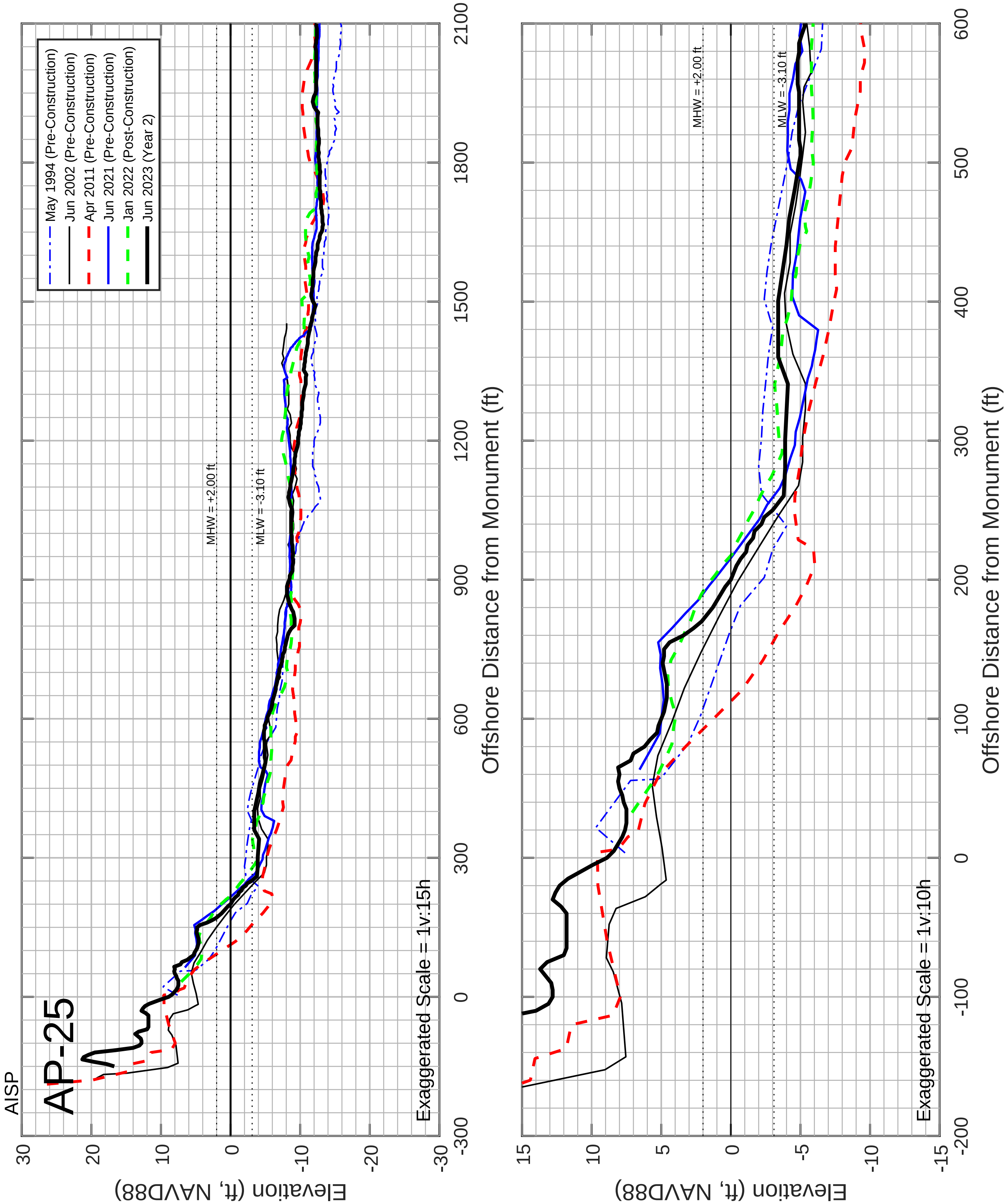


Figure C-26: Measured beach profiles at monument AP-25 Amelia Island, Florida.

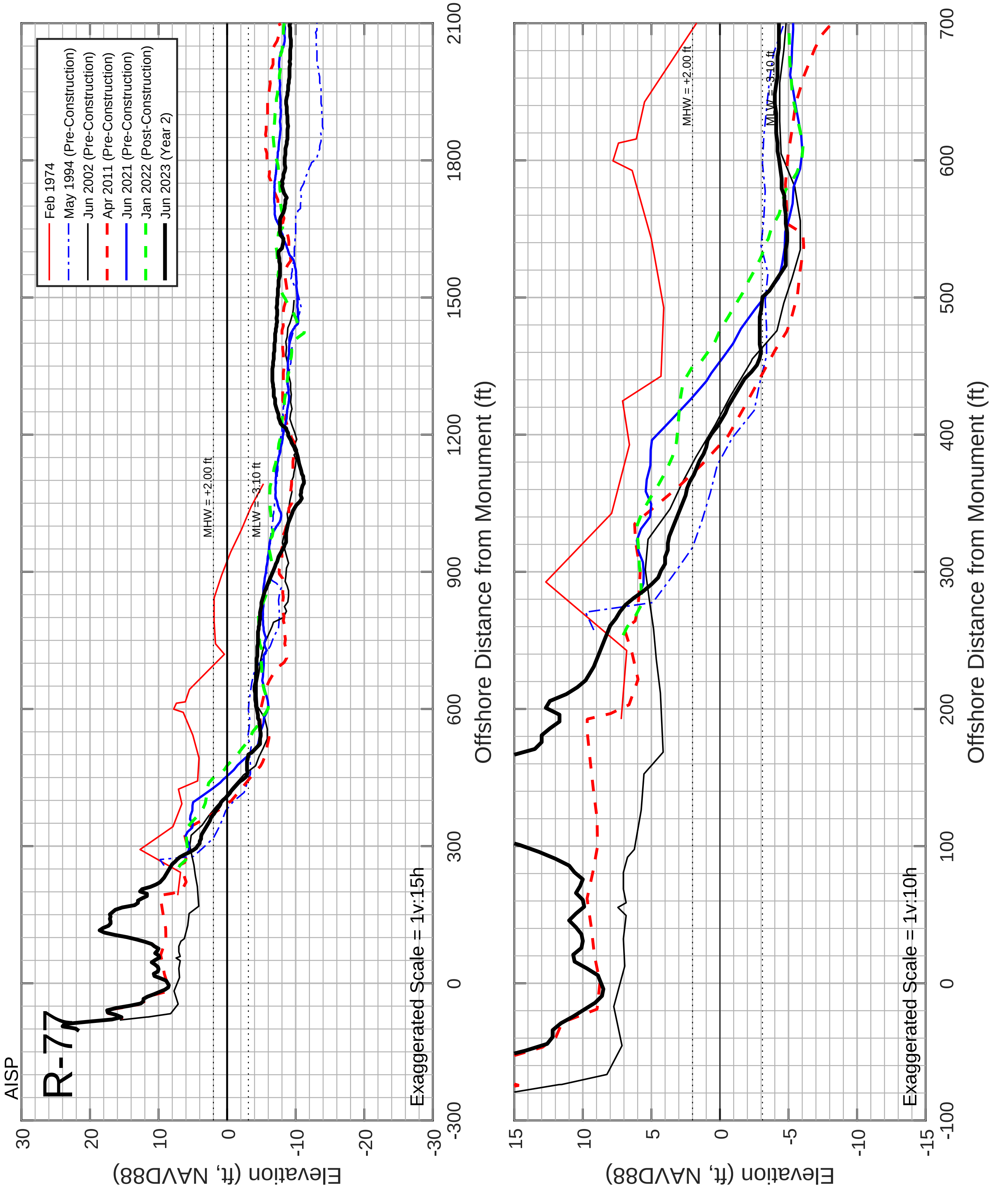


Figure C-27: Measured beach profiles at monument R-77 Amelia Island, Florida.

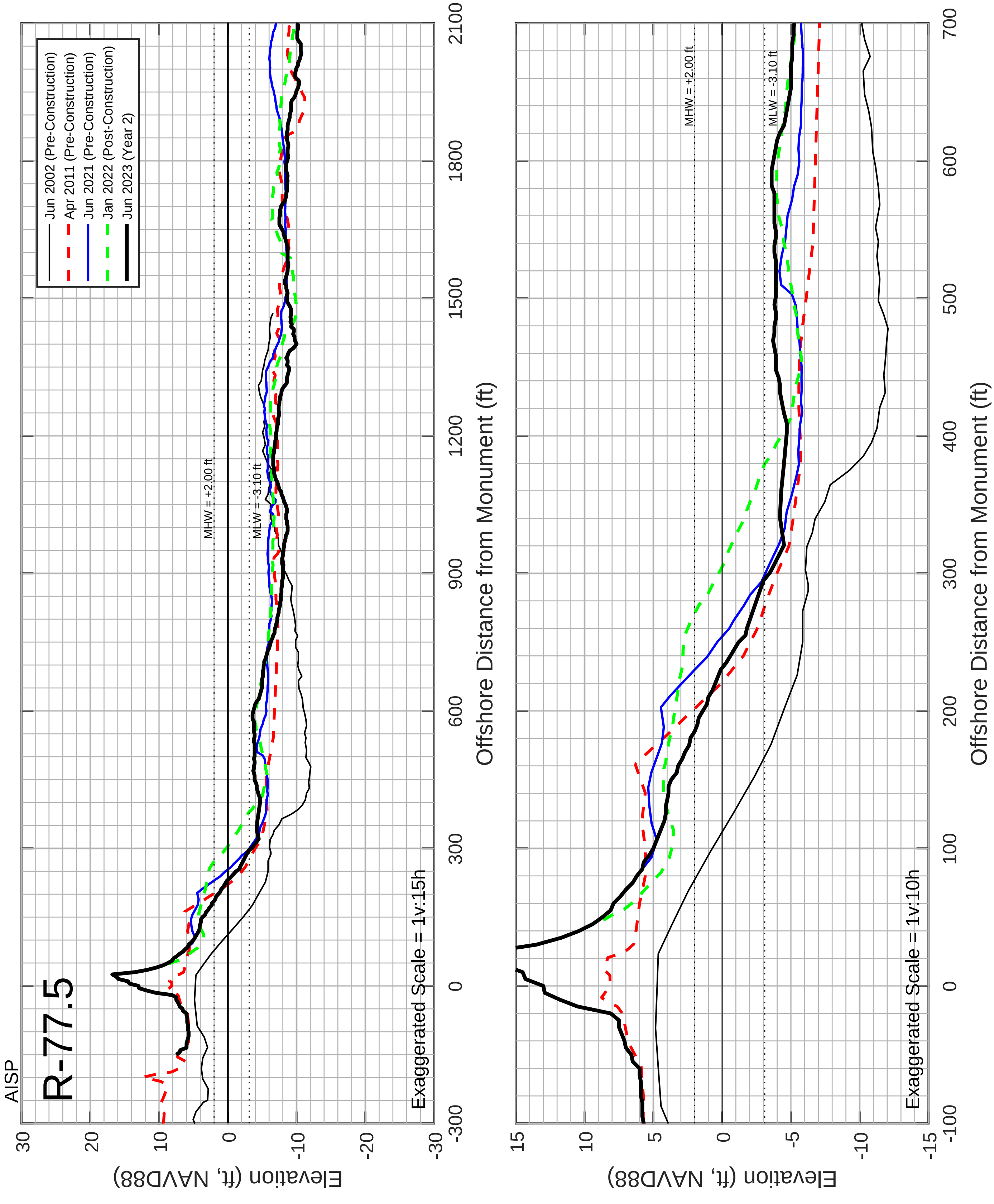


Figure C-28: Measured beach profiles at monument R-77.5 Amelia Island, Florida.

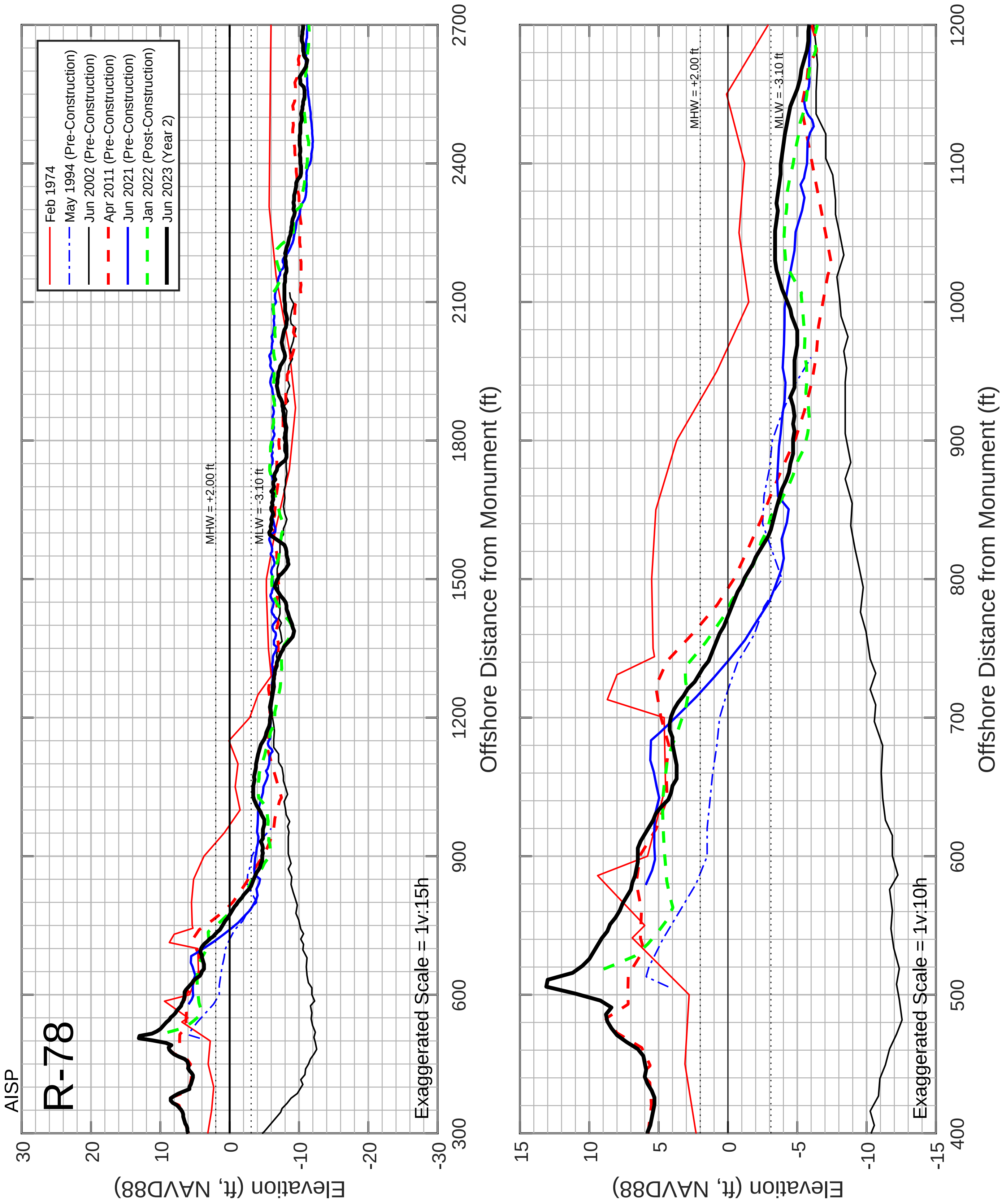


Figure C-29: Measured beach profiles at monument R-78 Amelia Island, Florida.

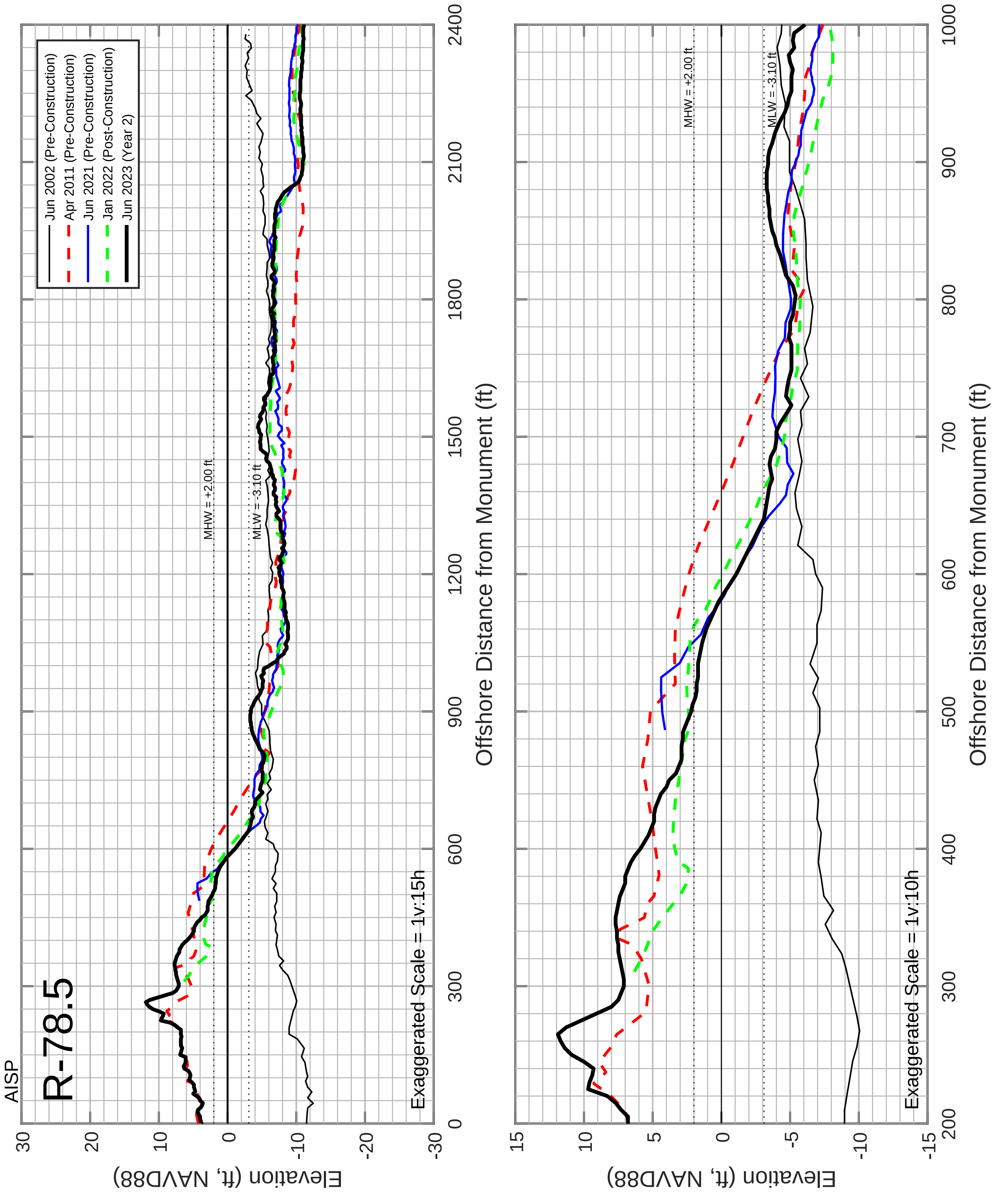


Figure C-30: Measured beach profiles at monument R-78.5 Amelia Island, Florida.

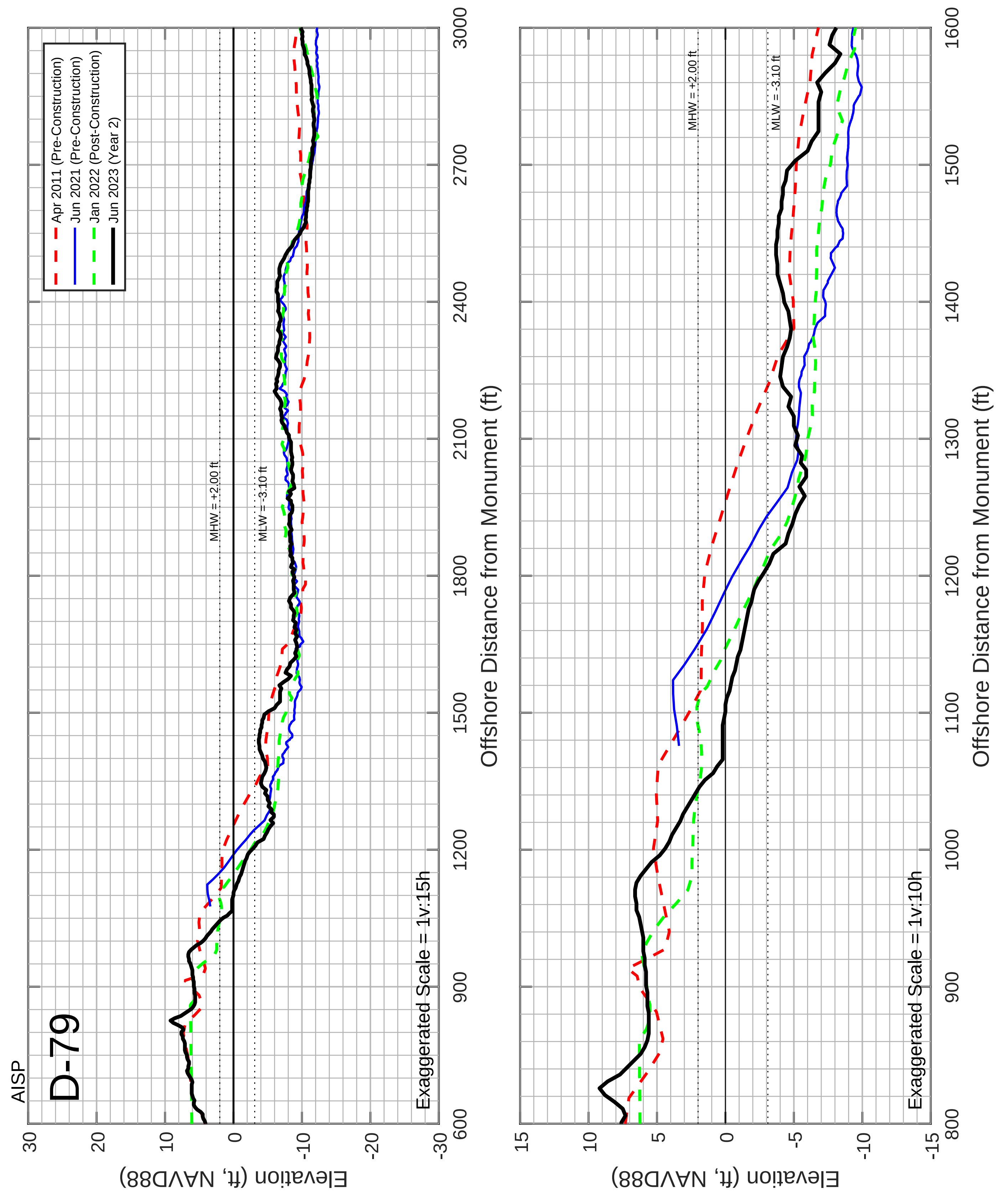


Figure C-31: Measured beach profiles at monument D-79 Amelia Island, Florida.

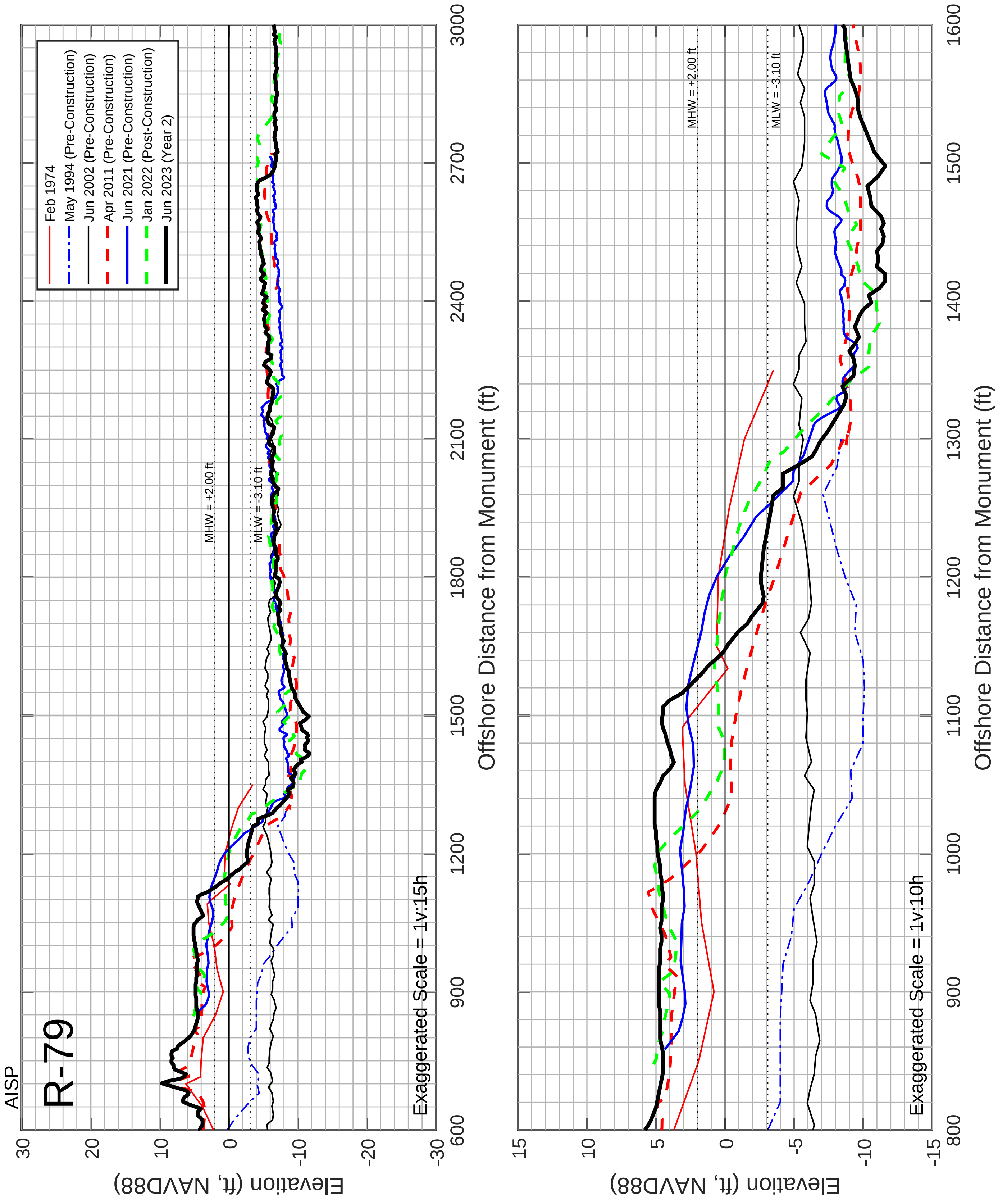


Figure C-32: Measured beach profiles at monument R-79 Amelia Island, Florida.

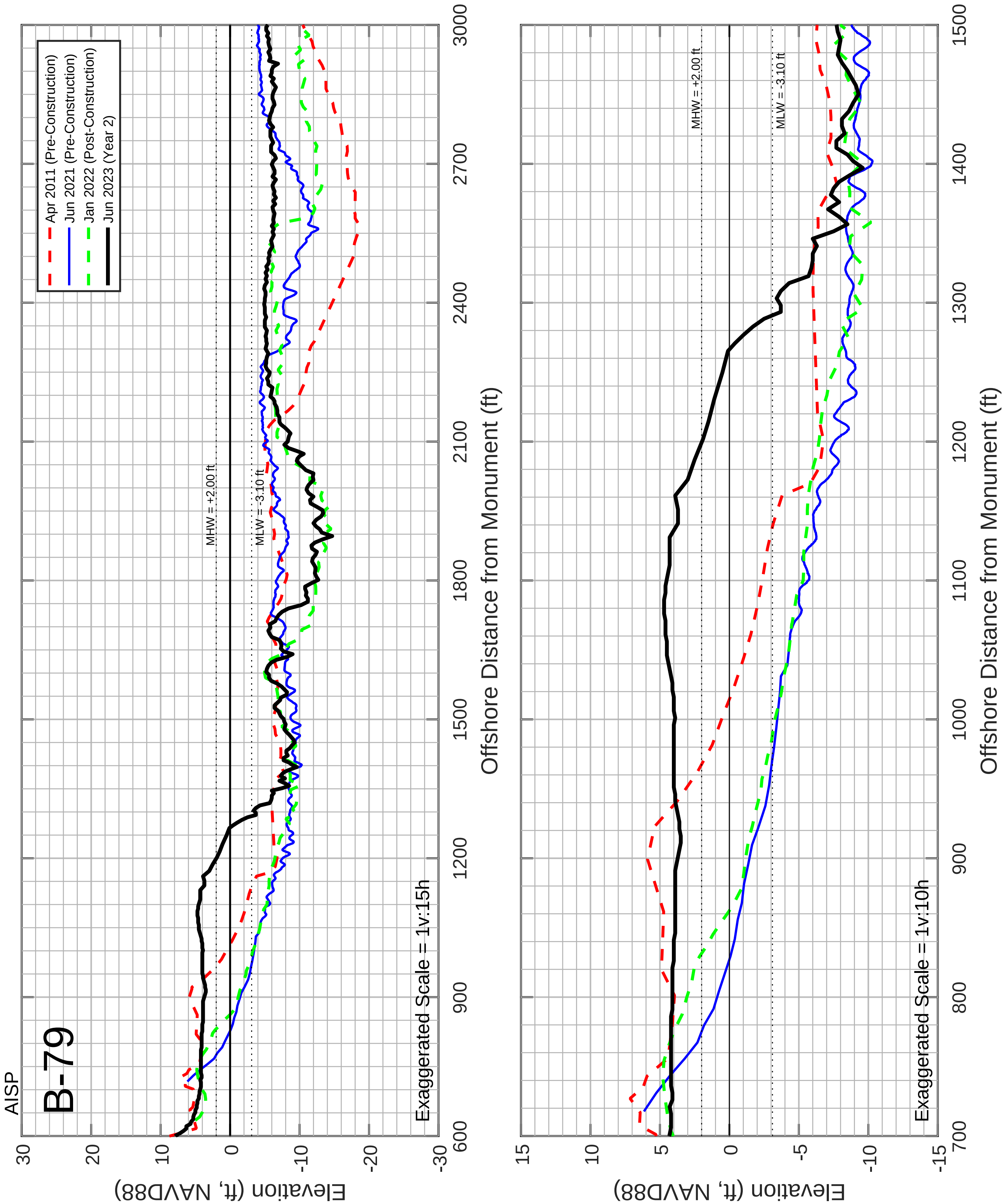


Figure C-33: Measured beach profiles at monument B-79 Amelia Island, Florida.

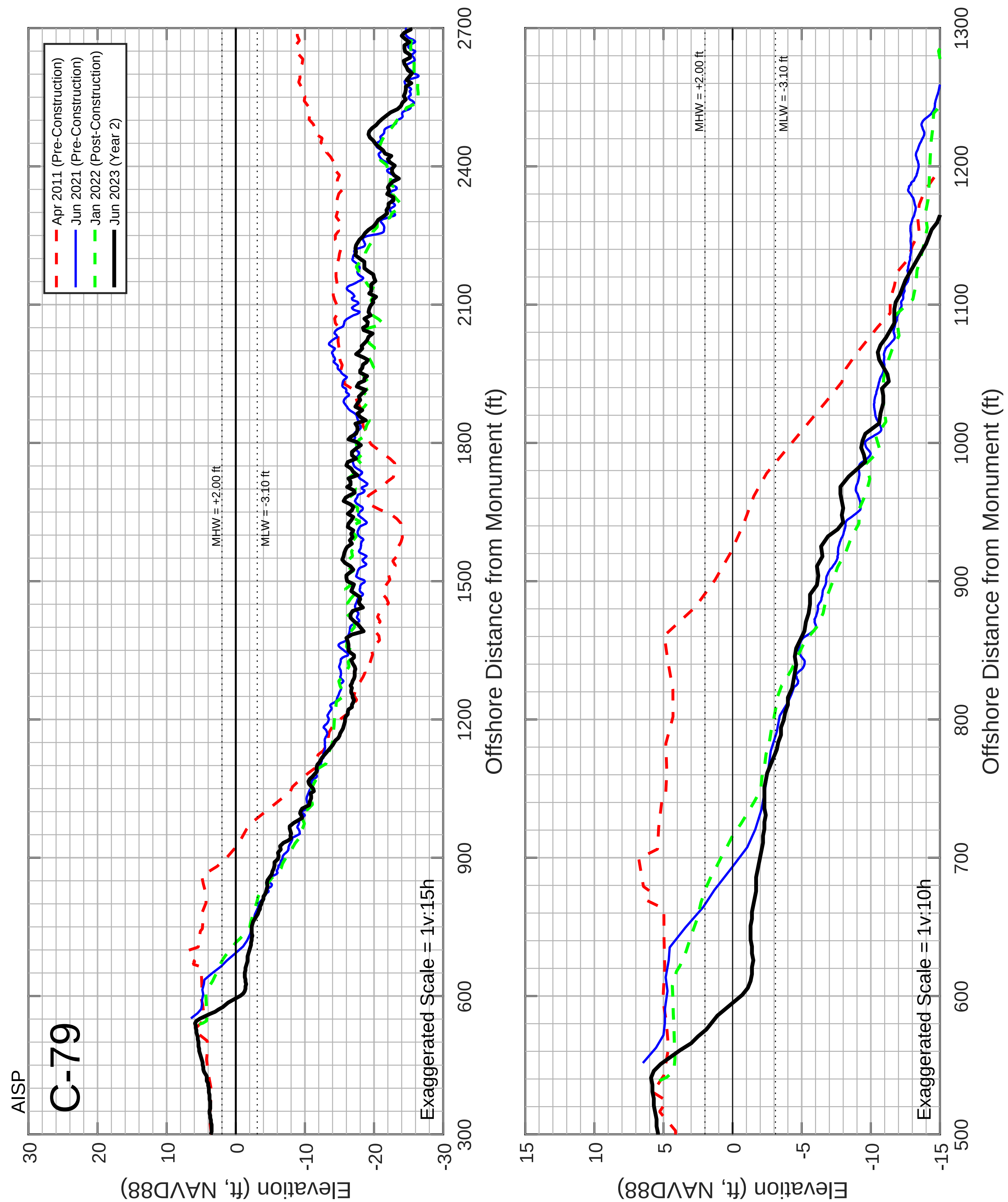


Figure C-34: Measured beach profiles at monument C-79 Amelia Island, Florida.

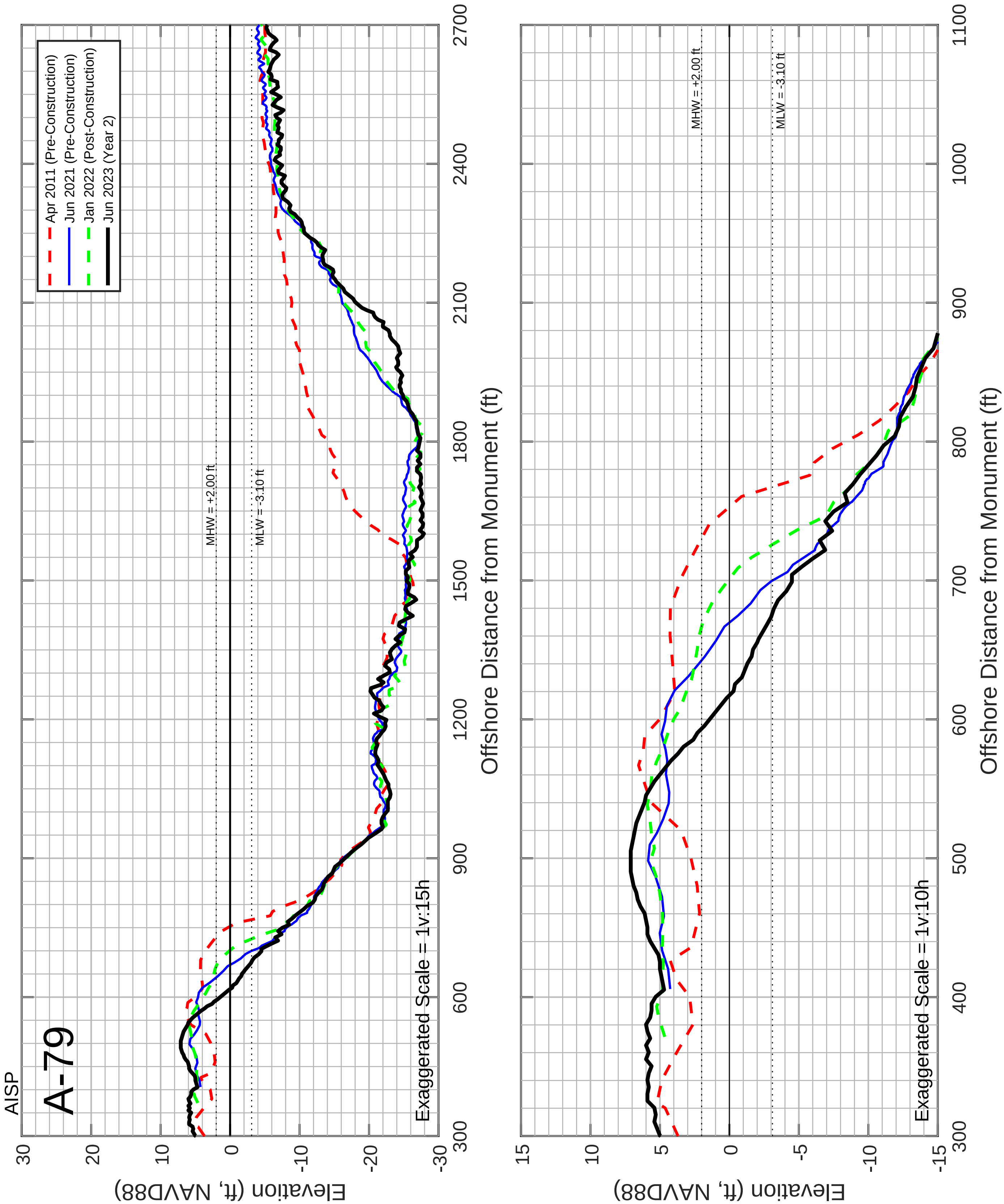


Figure C-35: Measured beach profiles at monument A-79 Amelia Island, Florida.

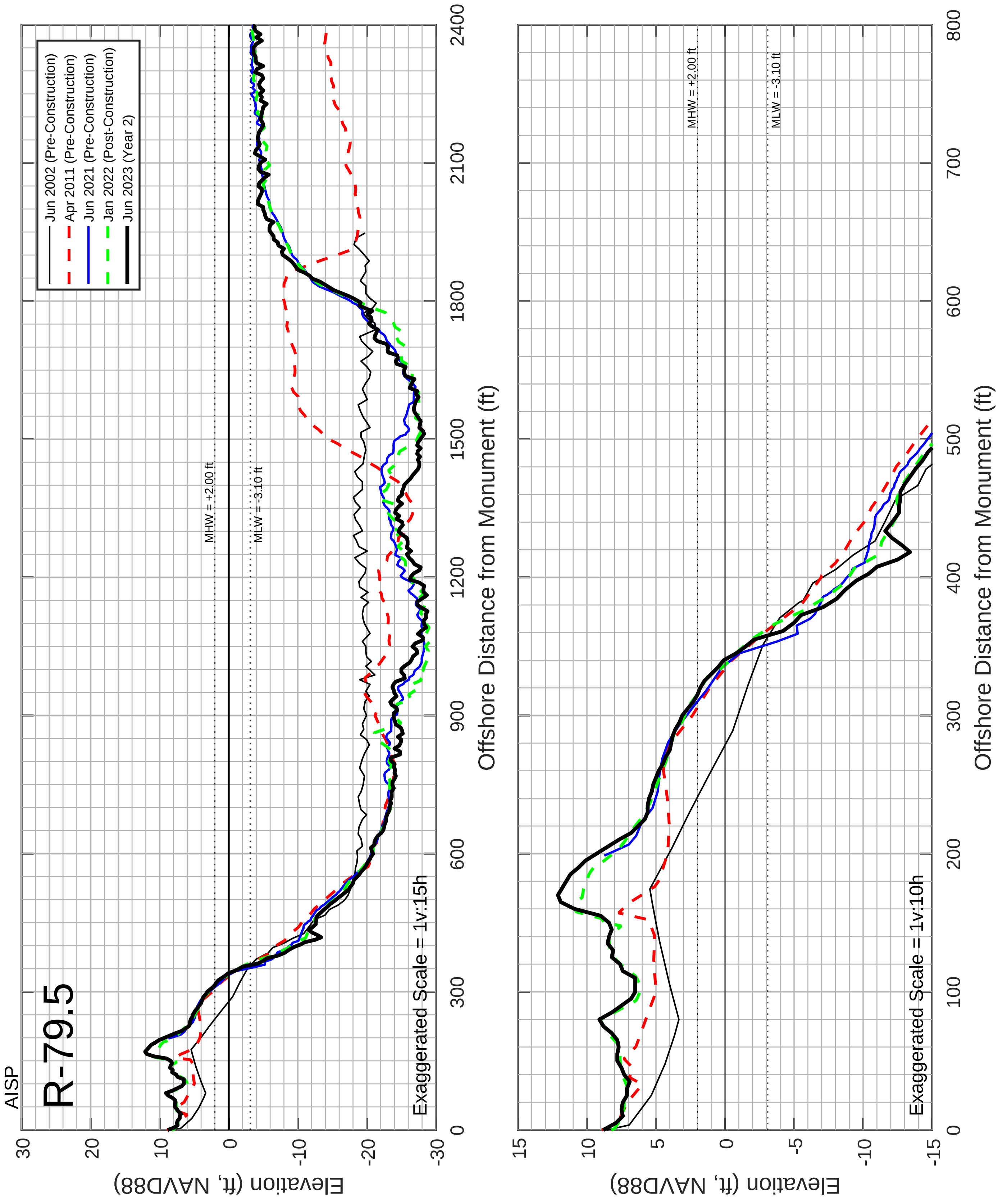


Figure C-36: Measured beach profiles at monument R-79.5 Amelia Island, Florida.

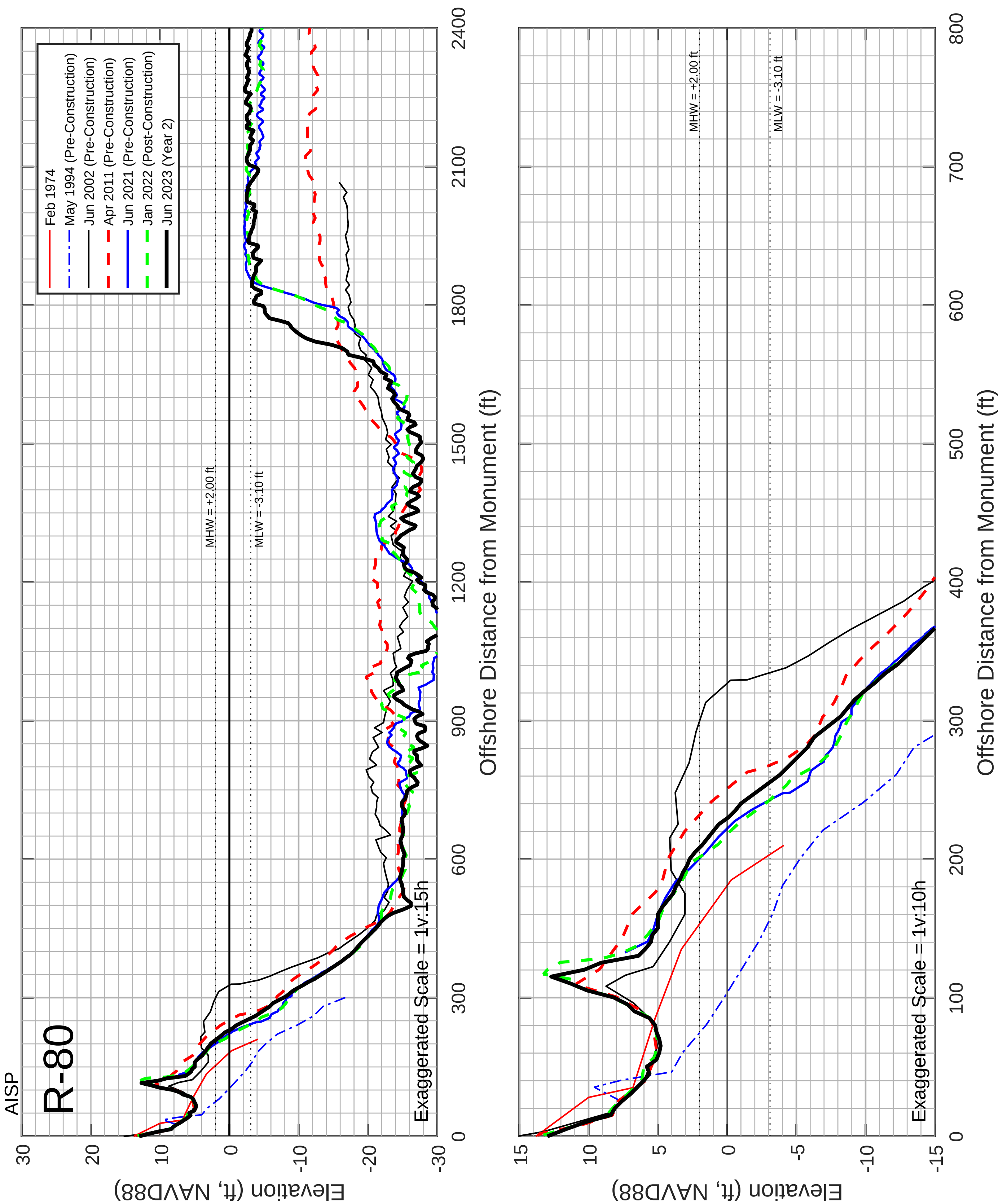


Figure C-37: Measured beach profiles at monument R-80 Amelia Island, Florida.

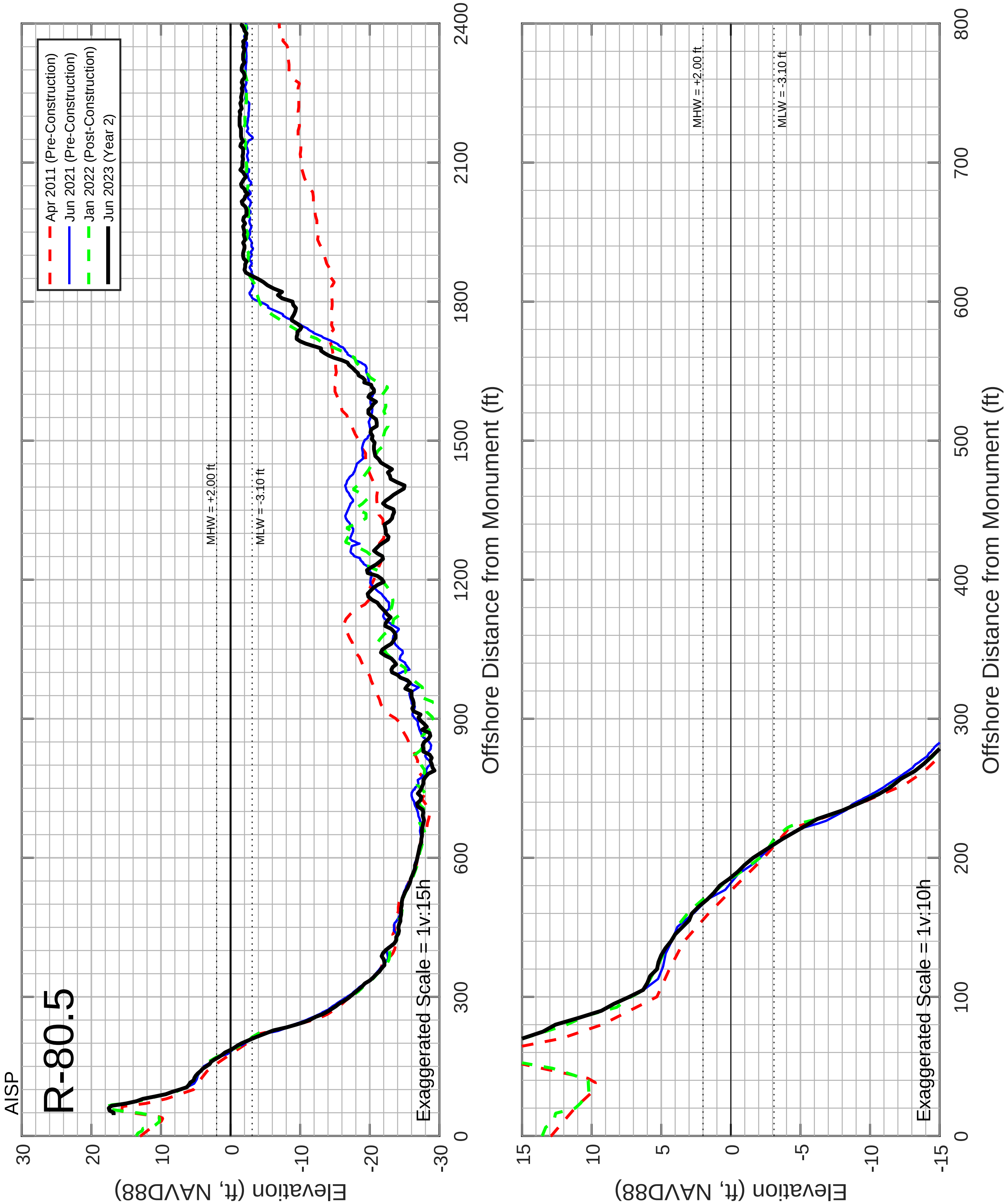


Figure C-38: Measured beach profiles at monument R-80.5 Amelia Island, Florida.

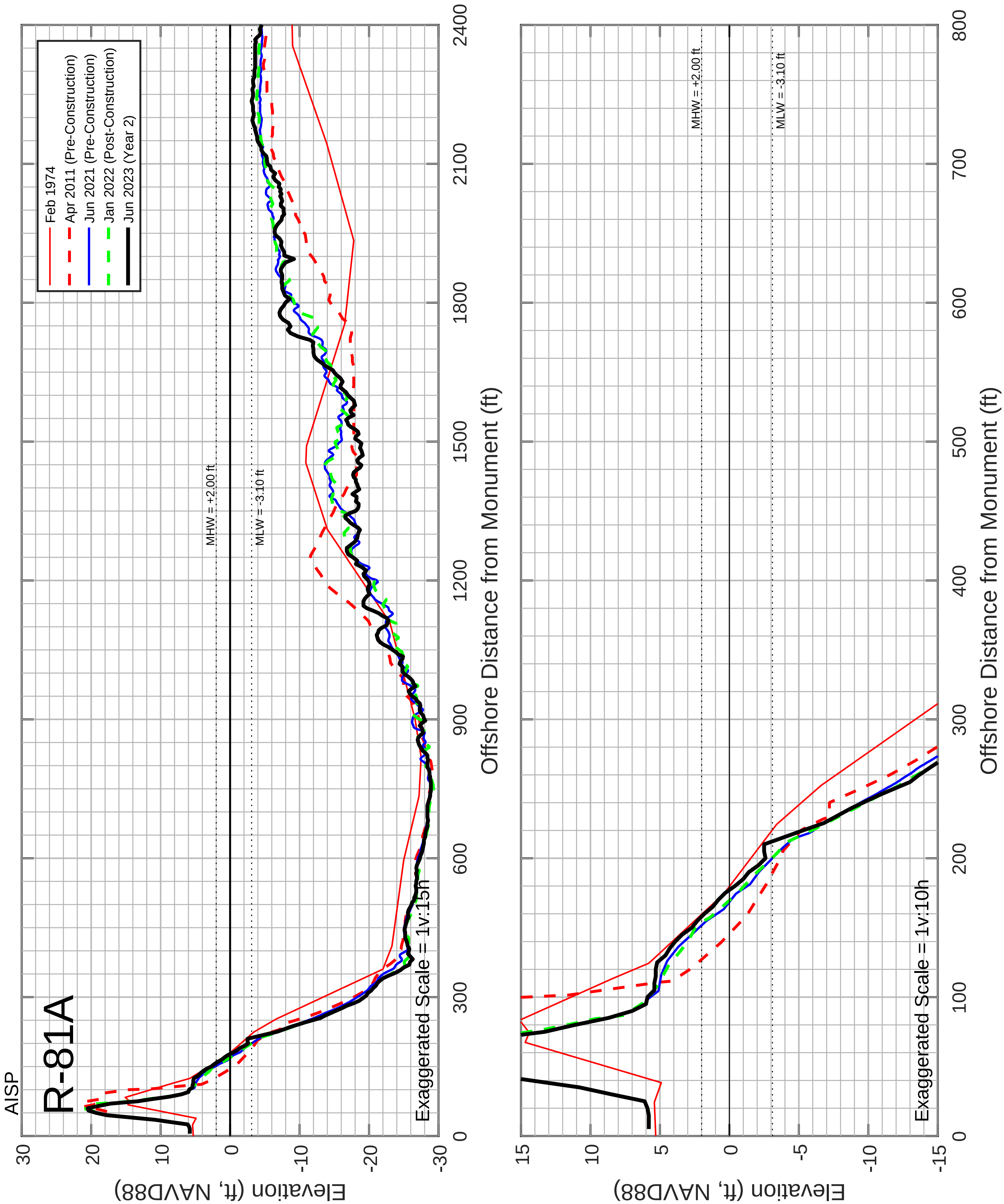


Figure C-39: Measured beach profiles at monument R-81A Amelia Island, Florida.

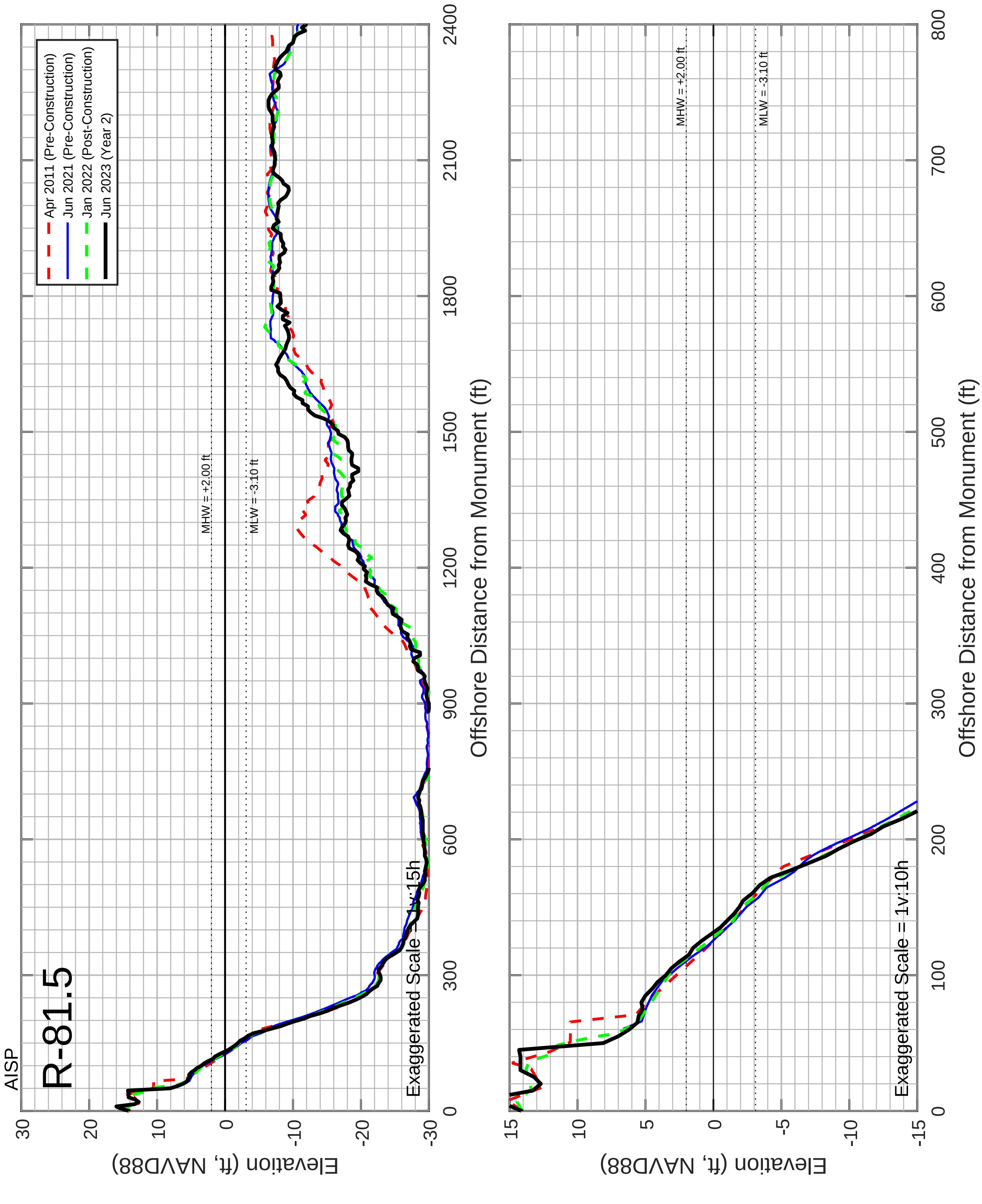


Figure C-40: Measured beach profiles at monument R-81.5 Amelia Island, Florida.

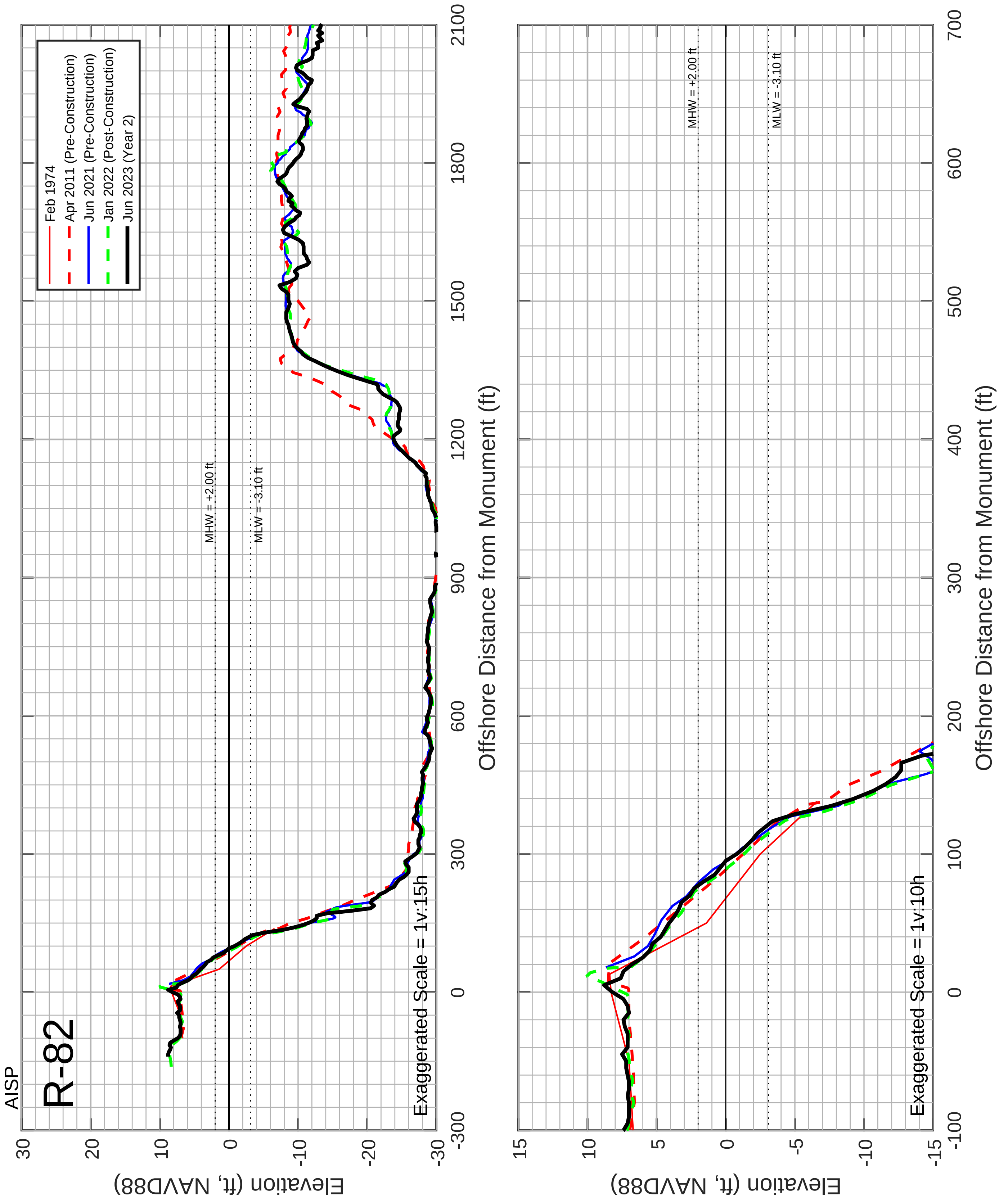


Figure C-41: Measured beach profiles at monument R-82 Amelia Island, Florida.

APPENDIX D:
Oblique Drone Photography
South Amelia Island and Nassau Sound

This appendix contains prints of the oblique aerial/drone photography of South Amelia Island and Nassau Sound taken during the Year 2 monitoring period (June 2023 through August 2023). The photo dates included in this appendix are as follows:

- August 27, 2022 (Olsen Associates, Inc.)
- October 1, 2022 (Olsen Associates, Inc.)
- November 11, 2022 (Olsen Associates, Inc.)
- March 30, 2023 (Olsen Associates, Inc.)
- April 12, 2023 – Pre-Tilling (Olsen Associates, Inc.)
- April 14, 2023 – Post-Tilling (Olsen Associates, Inc.)
- May 31, 2023 (Olsen Associates, Inc.)
- August 27, 2023 (Olsen Associates, Inc.)

Photosets from June 4, 2022 and August 8, 2022 were provided in the Year 1 monitoring report (Olsen 2022). For each photoset, prints of selected photos are provided in this Appendix. Digital copies of all the photos and videos are provided on the accompanying USB drive.

Amelia Island Oblique Drone Photography

August 27, 2022

Flown by: Olsen Associates, Inc.


27-August-2022


27-August-2022


27-August-2022


27-August-2022

Amelia Island Oblique Drone Photography

October 1, 2022
Post Hurricane Ian

Flown by: Olsen Associates, Inc.

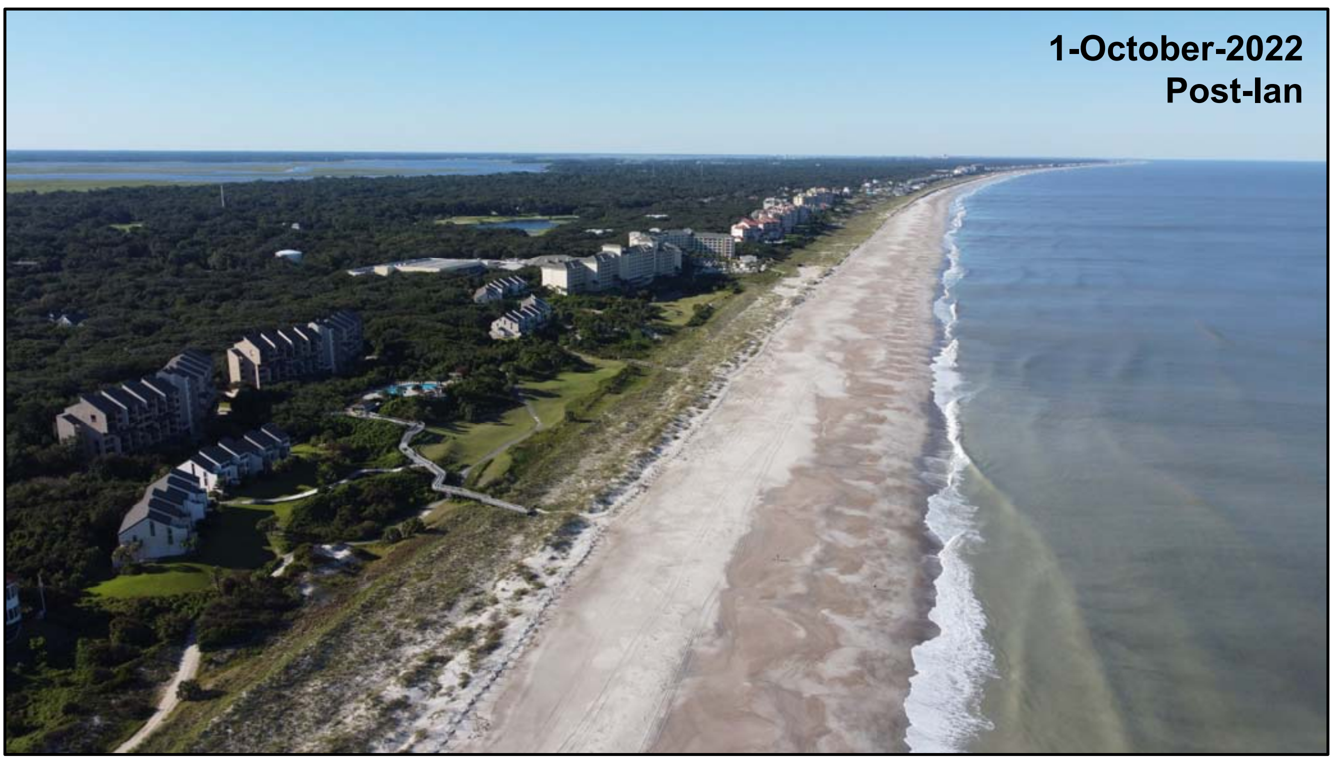

1-October-2022
Post-Ian


1-October-2022
Post-Ian


1-October-2022
Post-Ian


1-October-2022
Post-Ian


1-October-2022
Post-Ian


1-October-2022
Post-Ian


1-October-2022
Post-Ian


1-October-2022
Post-Ian

Amelia Island Oblique Drone Photography

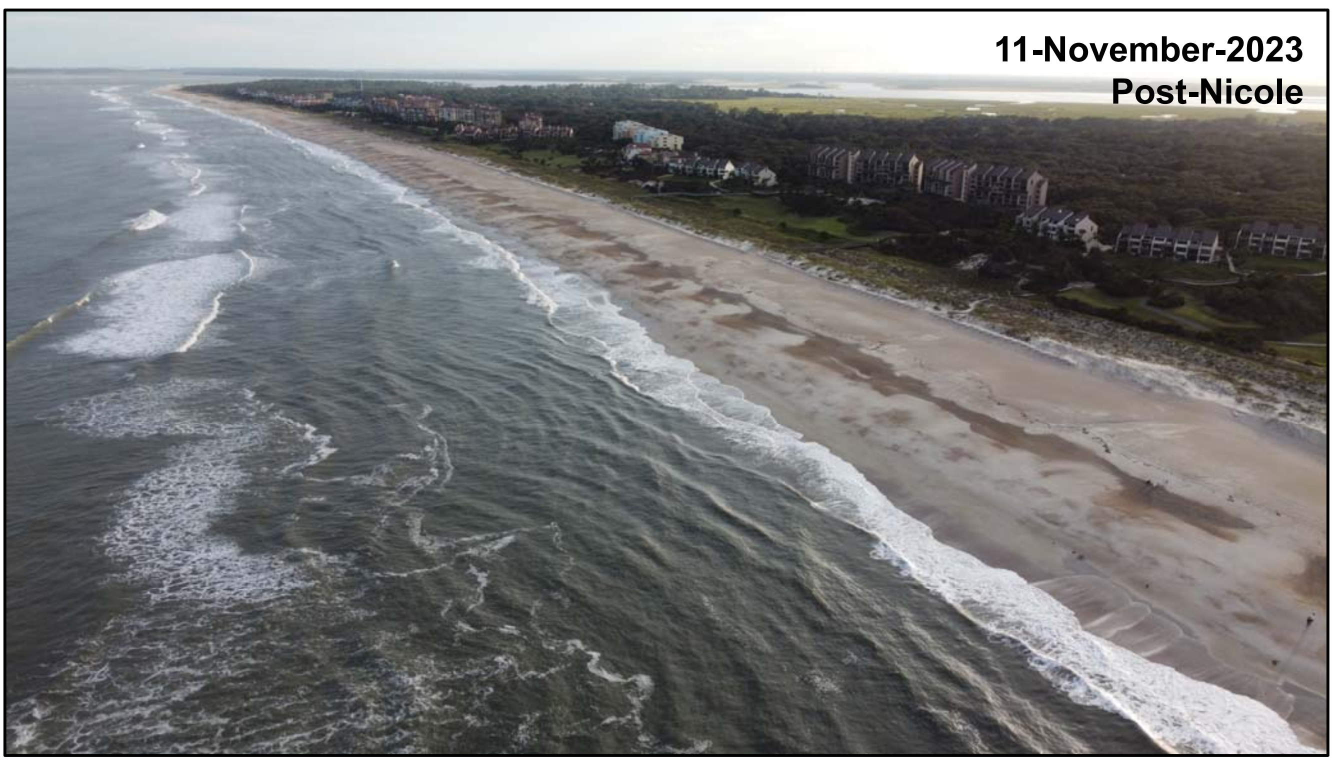
November 11, 2022
Post Hurricane Nicole

Flown by: Olsen Associates, Inc.

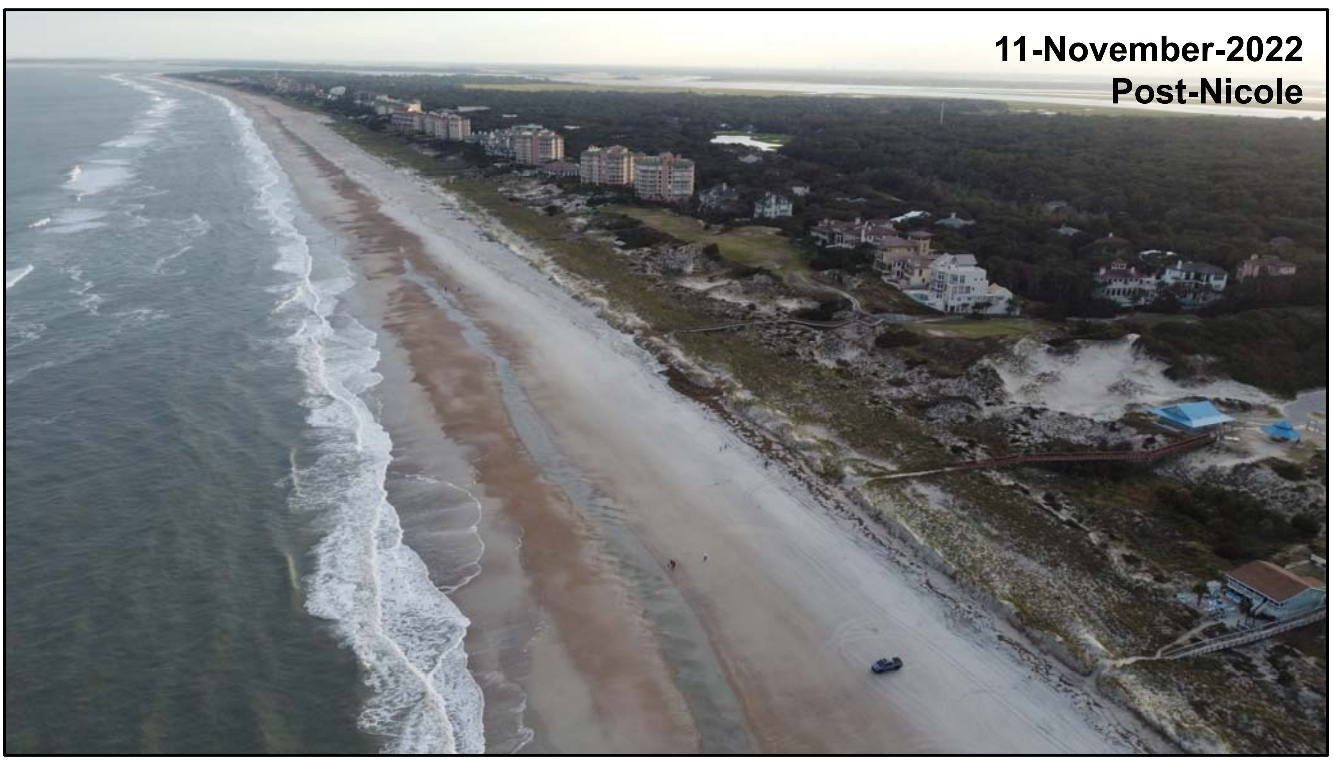

11-November-2022
Post-Nicole

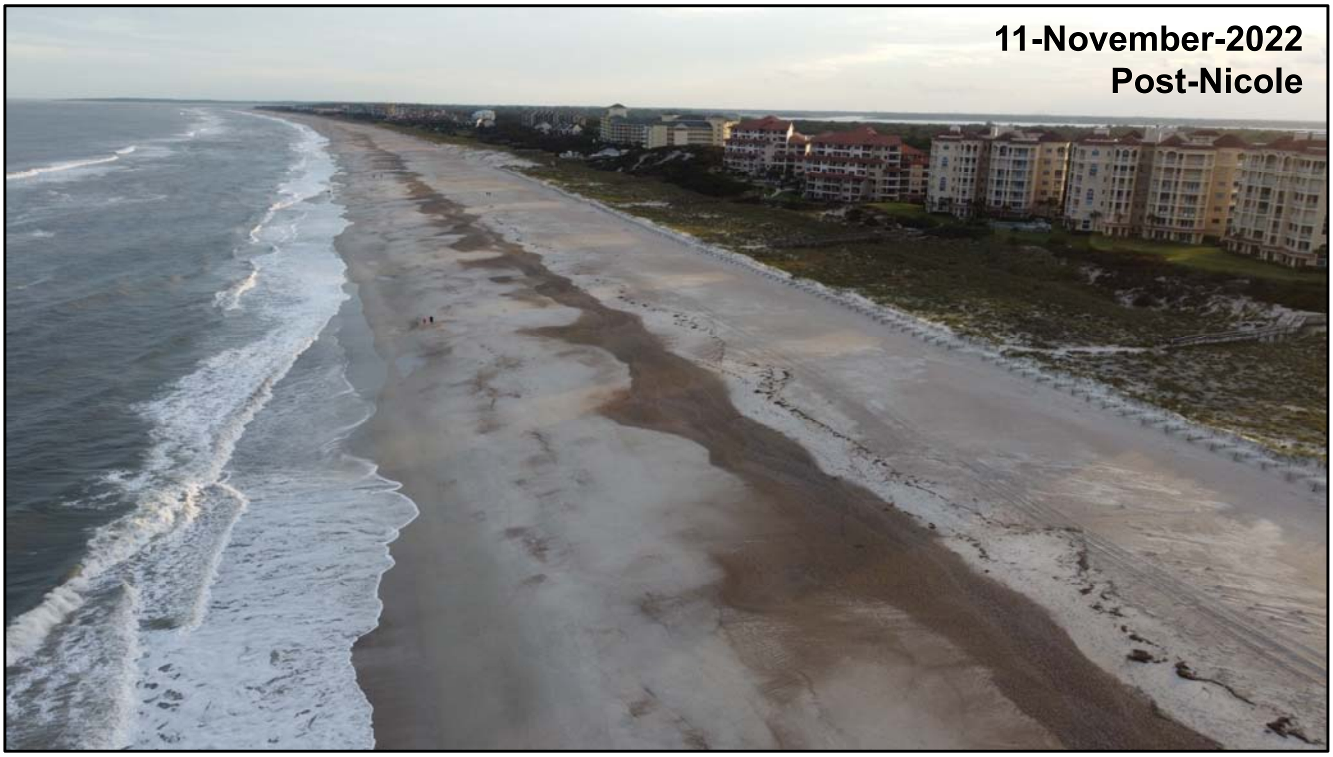

11-November-2022
Post-Nicole

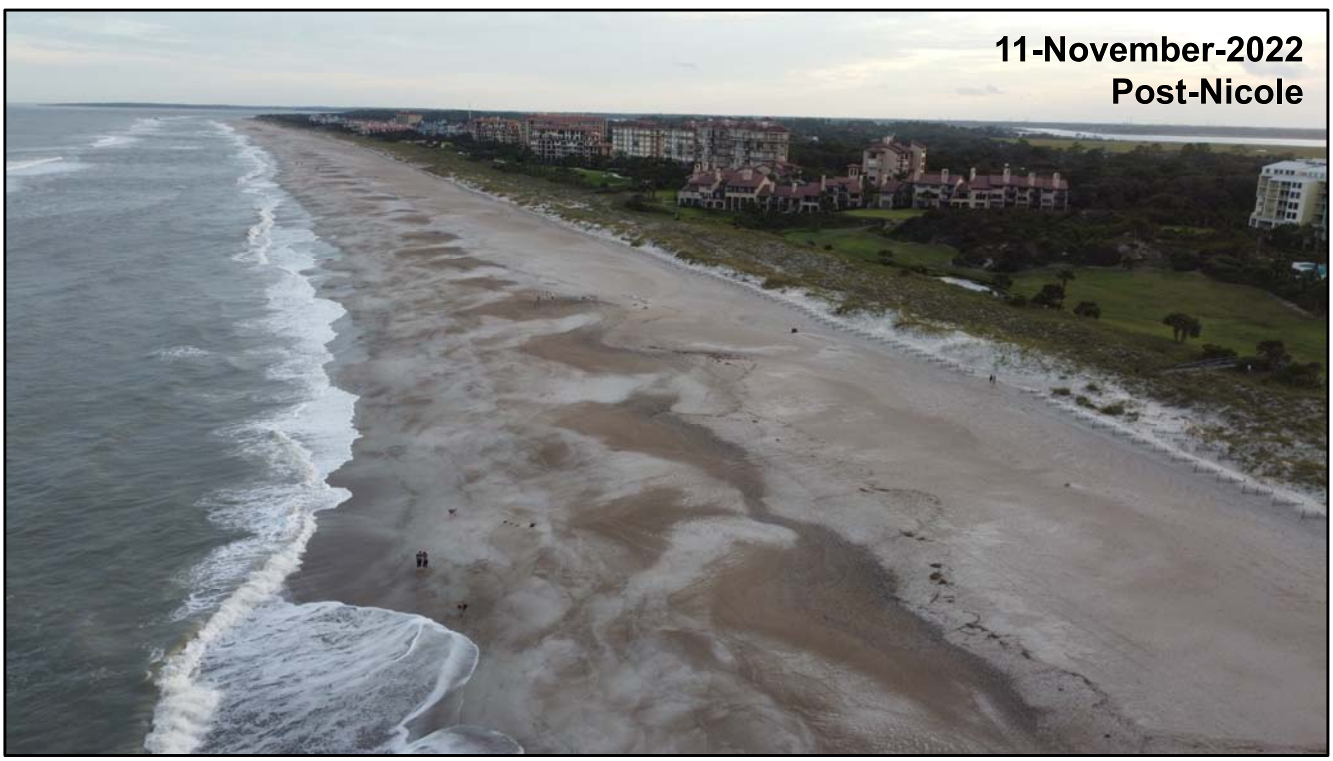

11-November-2023
Post-Nicole


11-November-2023
Post-Nicole


11-November-2022
Post-Nicole


11-November-2022
Post-Nicole


11-November-2022
Post-Nicole


11-November-2022
Post-Nicole

Amelia Island Oblique Drone Photography

March 30, 2023

Flown by: Olsen Associates, Inc.


30-March-2023


30-March-2023


30-March-2023


30-March-2023


30-March-2023


30-March-2023


30-March-2023


30-March-2023


30-March-2023


30-March-2023

Amelia Island Oblique Drone Photography

April 12, 2023
(Pre-Tilling)

Flown by: Olsen Associates, Inc.


12-April-2023
Pre-Tilling


12-April-2023
Pre-Tilling


12-April-2023
Pre-Tilling


12-April-2023
Pre-Tilling


12-April-2023
Pre-Tilling


12-April-2023
Pre-Tilling

Amelia Island Oblique Drone Photography

April 14, 2023
(Pre-Tilling)

Flown by: Olsen Associates, Inc.


14-April-2023
Post-Tilling


14-April-2023
Post-Tilling


14-April-2023
Post-Tilling


14-April-2023
Post-Tilling

14-April-2023
Post-Tilling

14-April-2023
Post-Tilling

Amelia Island Oblique Drone Photography

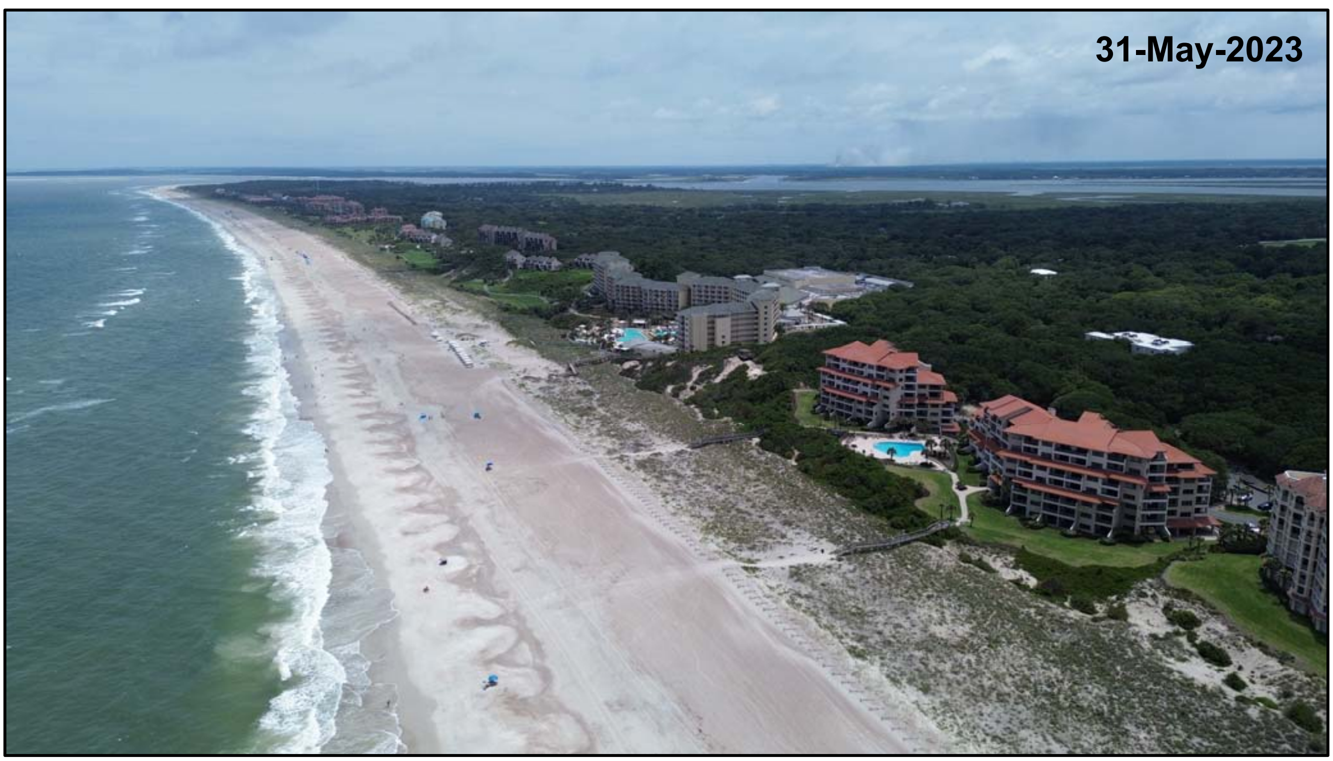
May 31, 2023

Flown by: Olsen Associates, Inc.

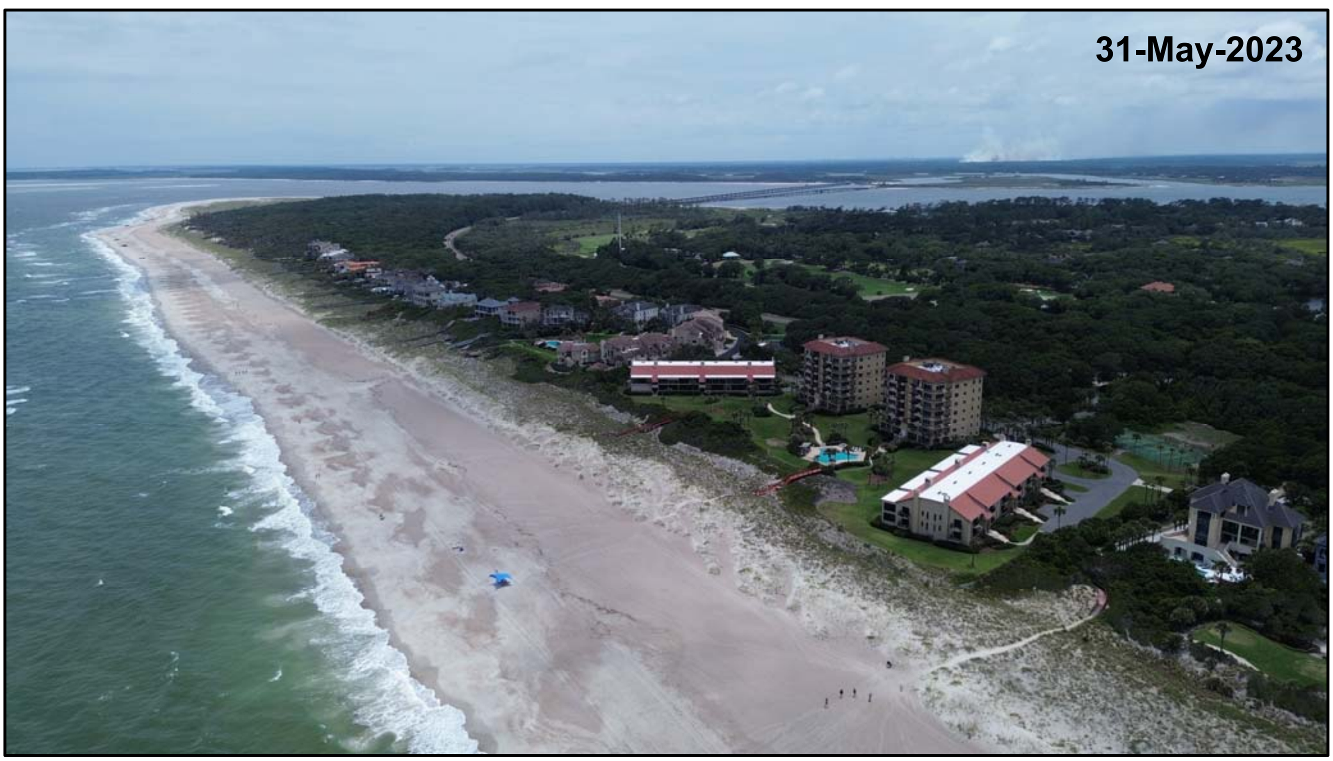

31-May-2023


31-May-2023


31-May-2023


31-May-2023


31-May-2023


31-May-2023


31-May-2023

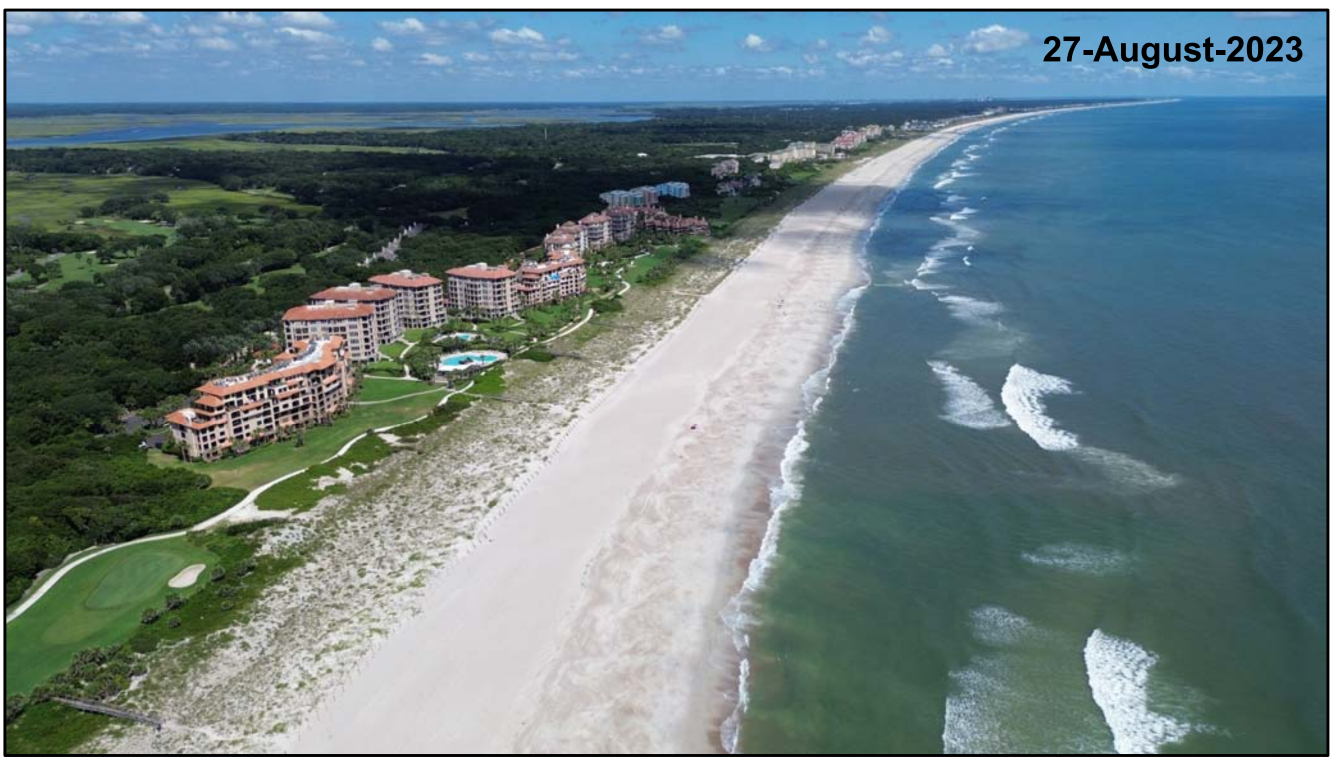

31-May-2023

Amelia Island Oblique Drone Photography

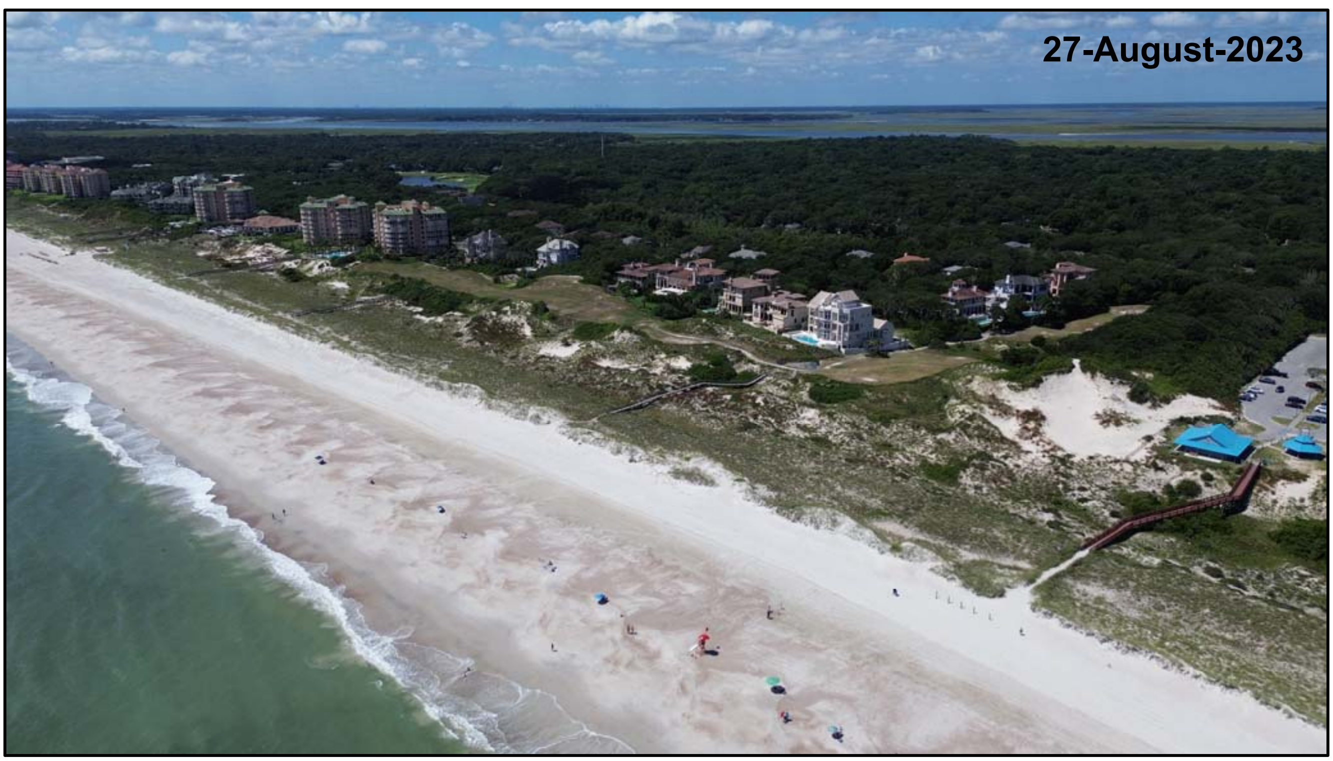
August 27, 2022

Flown by: Olsen Associates, Inc.

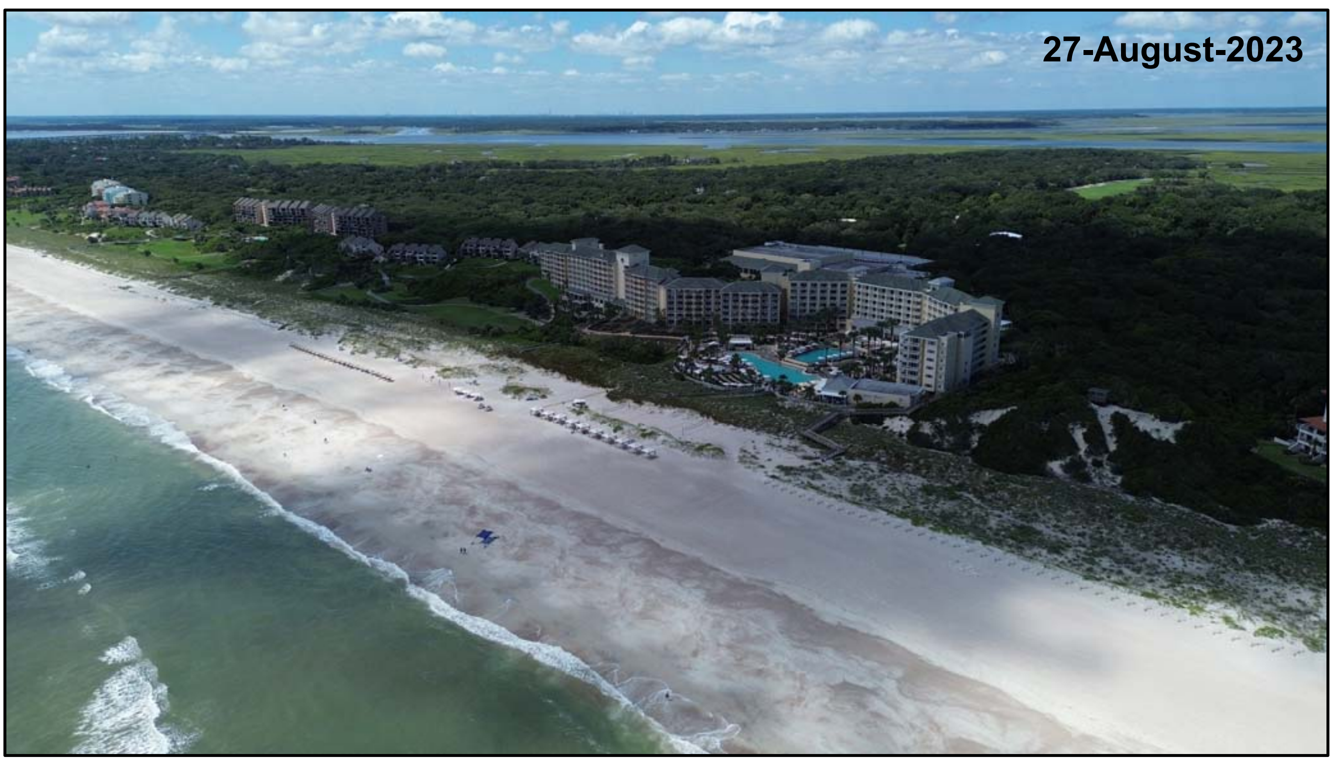

27-August-2023

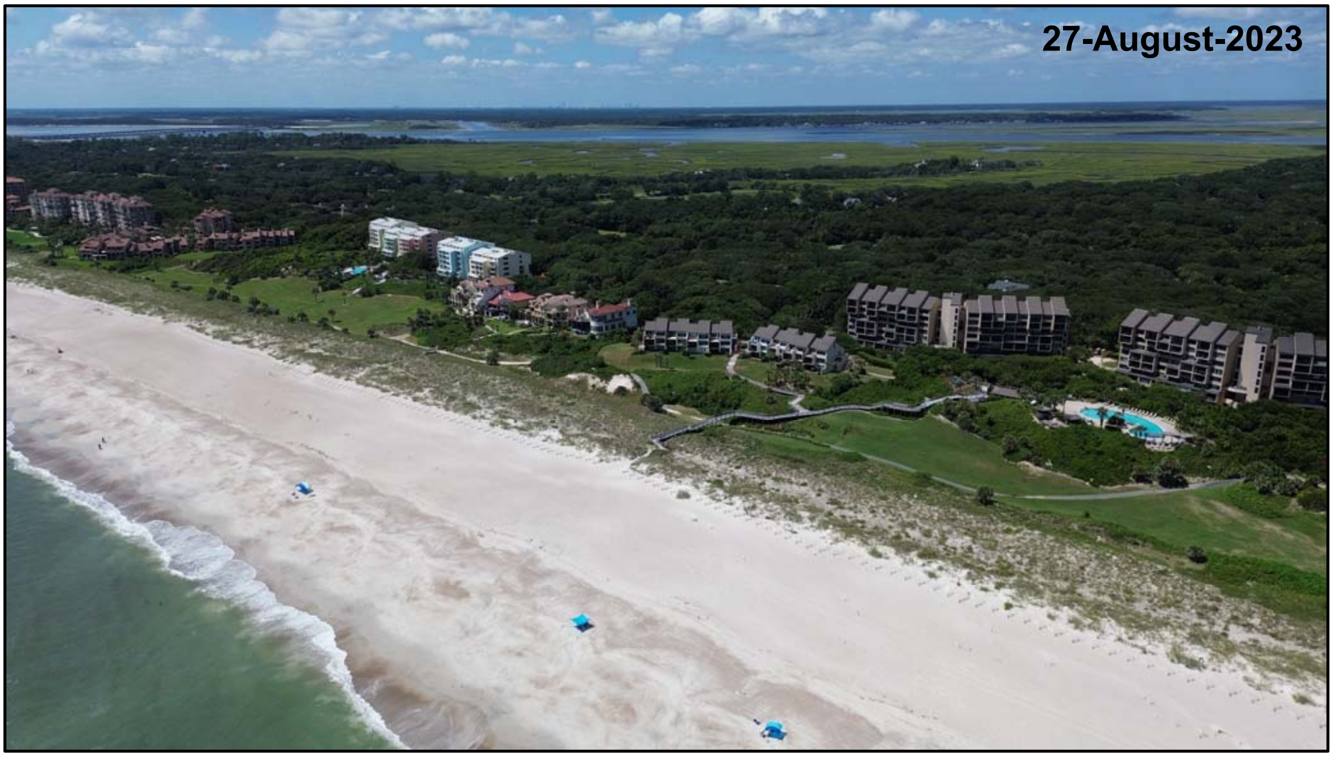

27-August-2023


27-August-2023


27-August-2023


27-August-2023


27-August-2023


27-August-2023


27-August-2023


27-August-2023


27-August-2023

APPENDIX E:
2023 South Amelia Island Year 2 Post-Construction Orthorectified Aerial Photography

This appendix contains aerial photography of South Amelia Island and Nassau Sound flown June 25, 2023 by Kucera International, Inc.[1] An index sheet is provided as **Figure E-1** and the aerial photography is presented as **Figures E-2** through **E-12**. Also depicted in the figures are the monitoring stations and profile azimuths (summarized in **Appendix B**, **Table B.2)**. Copies of the flight report and metadata file are included at the end of the appendix.

[1] Kucera International, Inc.; 38133 Western Parkway; Willoughby, OH 44094.

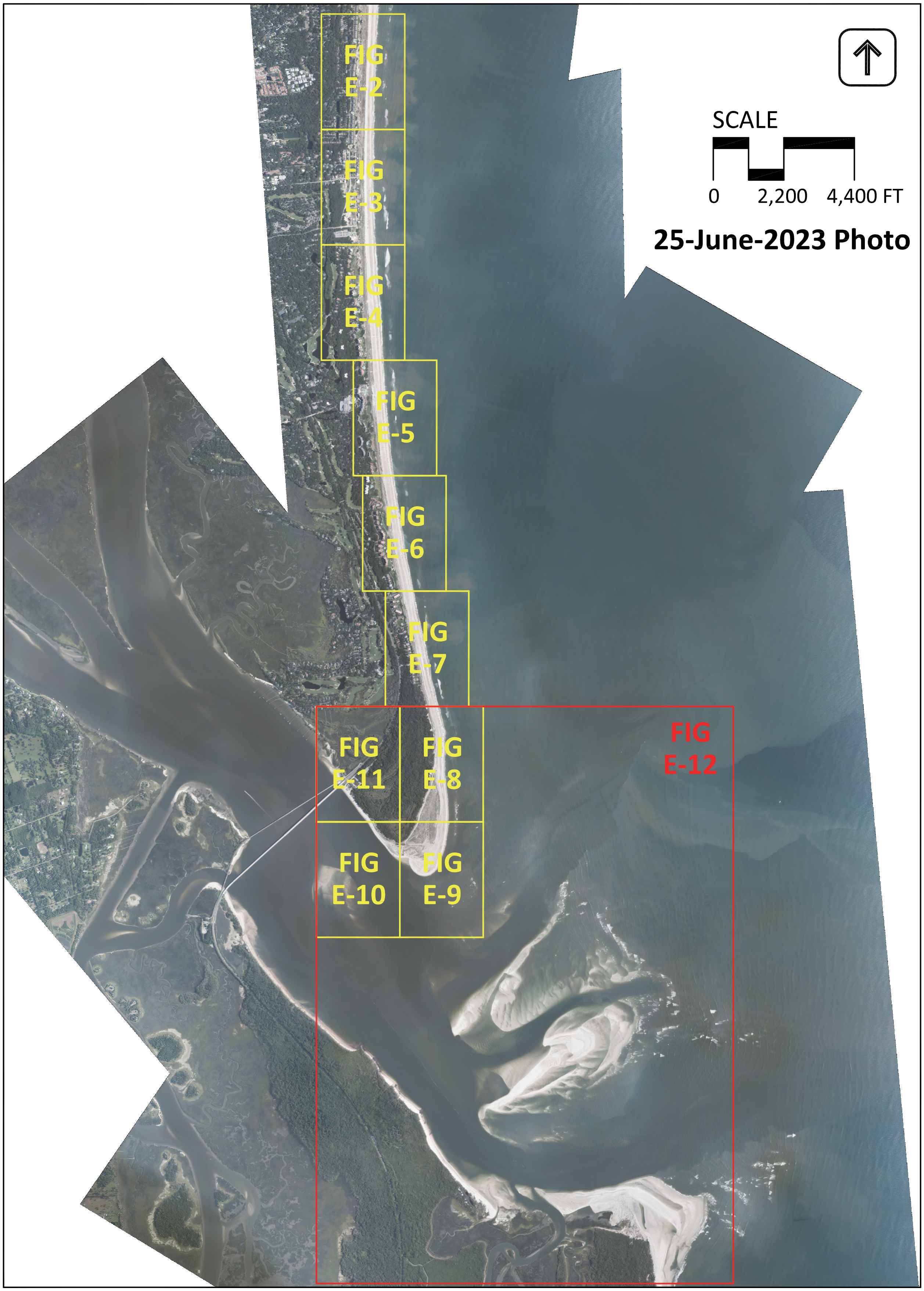


Figure E.1: South Amelia Island June 2023 aerial photography index sheet.

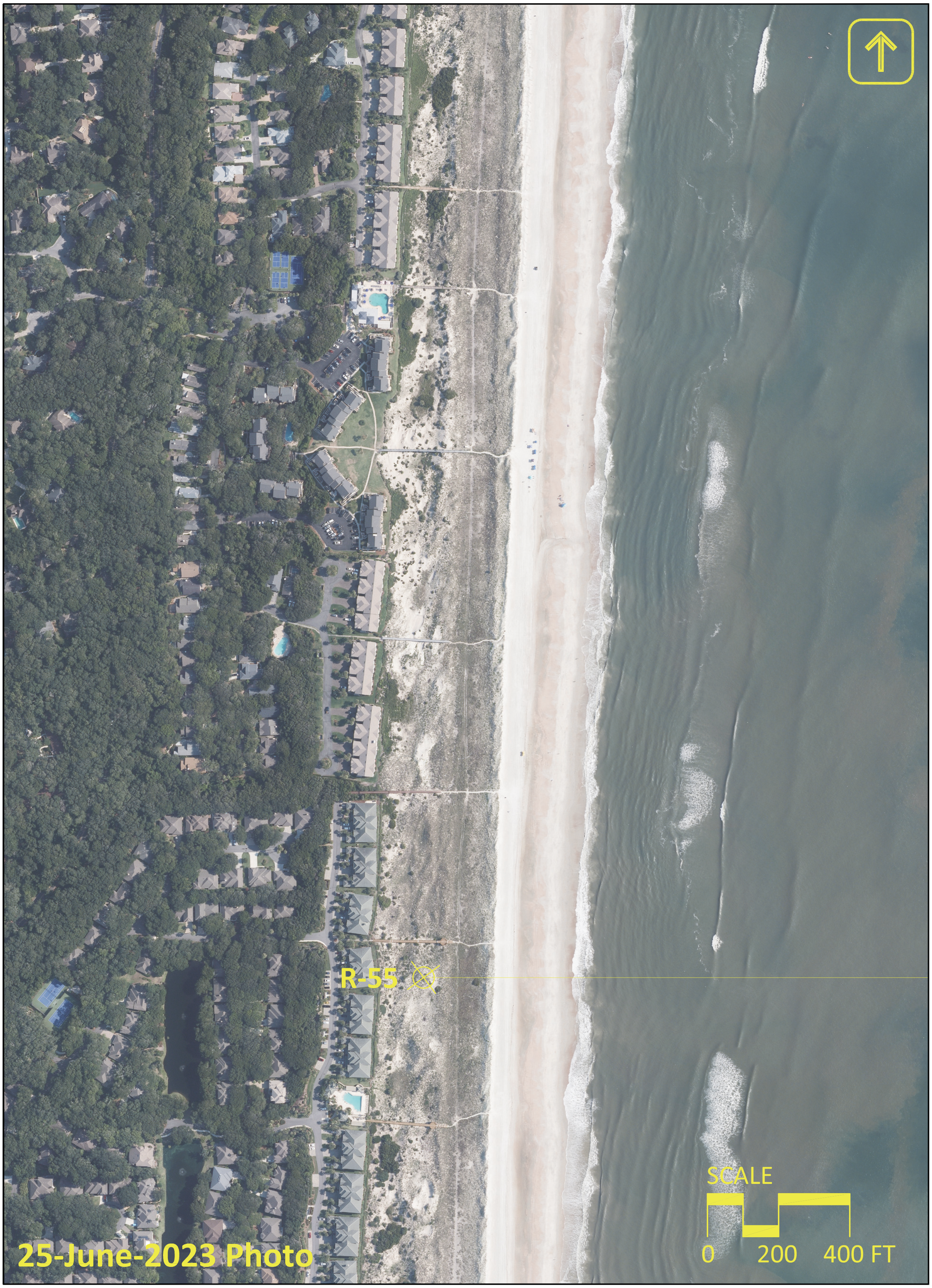


Figure E.2: South Amelia Island June 2023 aerial photography (Sheet 1 of 11).

Figure E.3: South Amelia Island June 2023 aerial photography (Sheet 2 of 11).

Figure E.4: South Amelia Island June 2023 aerial photography (Sheet 3 of 11).

Figure E.5: South Amelia Island June 2023 aerial photography (Sheet 4 of 11).

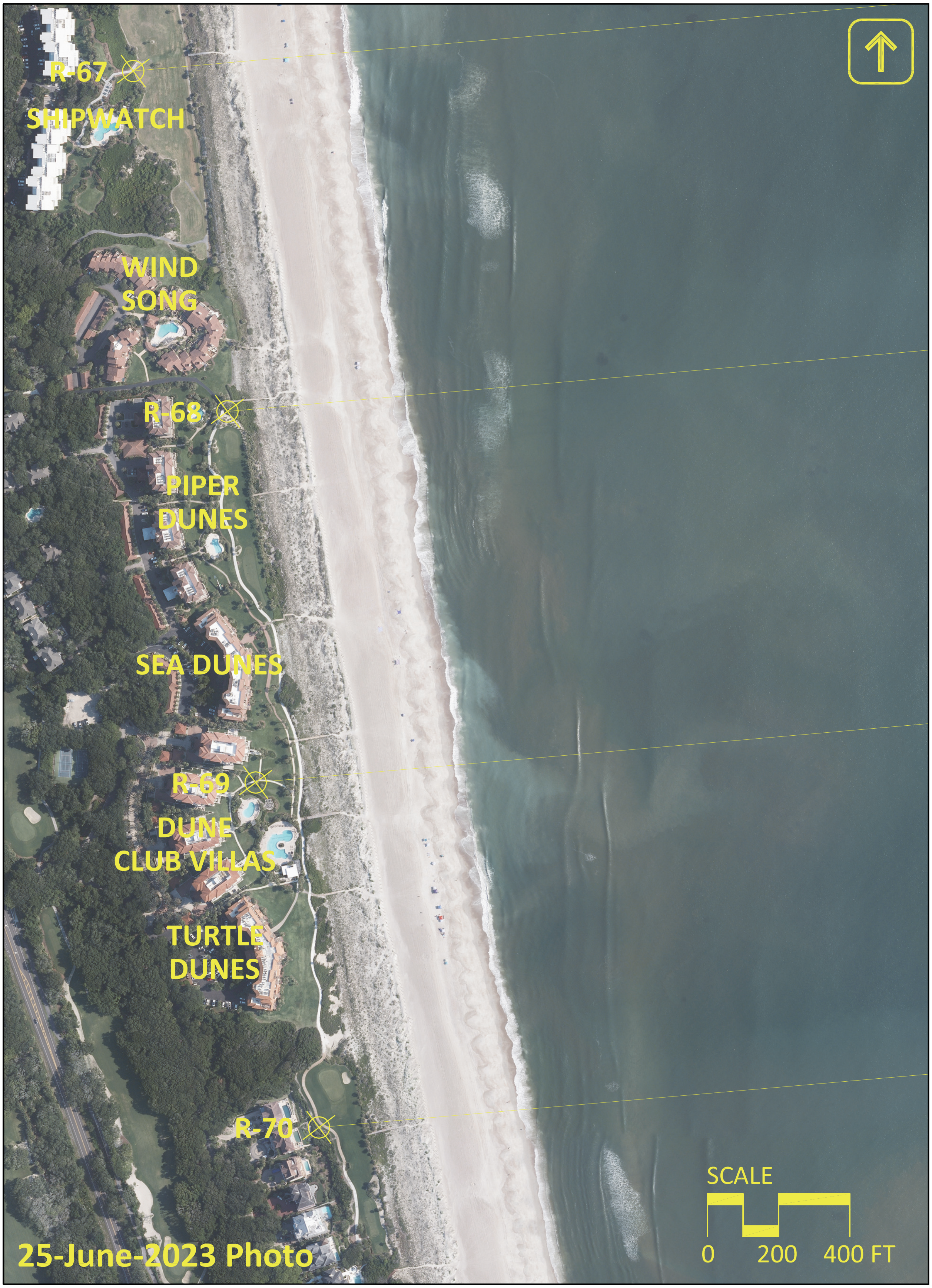


Figure E.6: South Amelia Island June 2023 aerial photography (Sheet 5 of 11).

Figure E.7: South Amelia Island June 2023 aerial photography (Sheet 6 of 11).

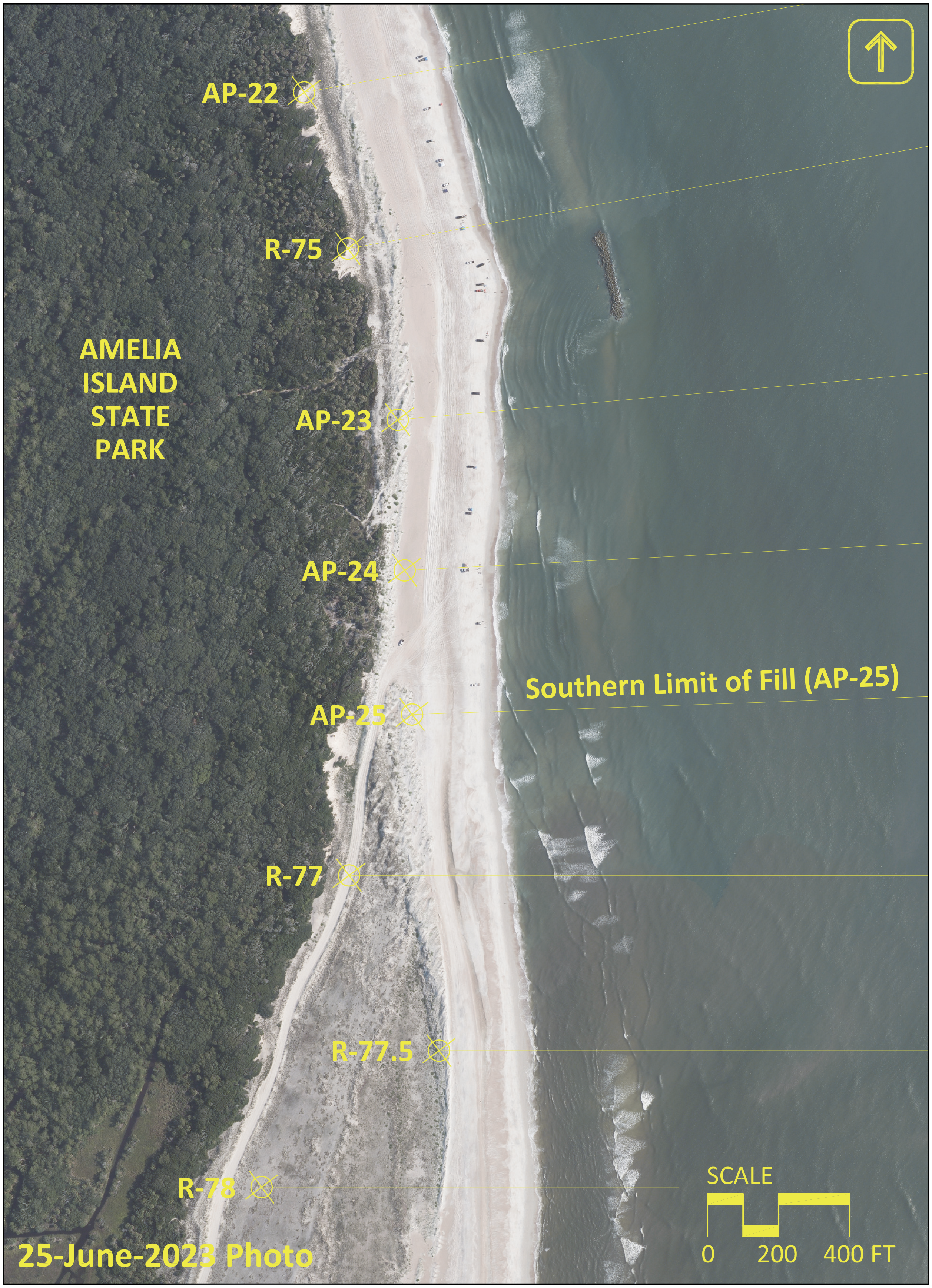


Figure E.8: South Amelia Island June 2023 aerial photography (Sheet 7 of 11).

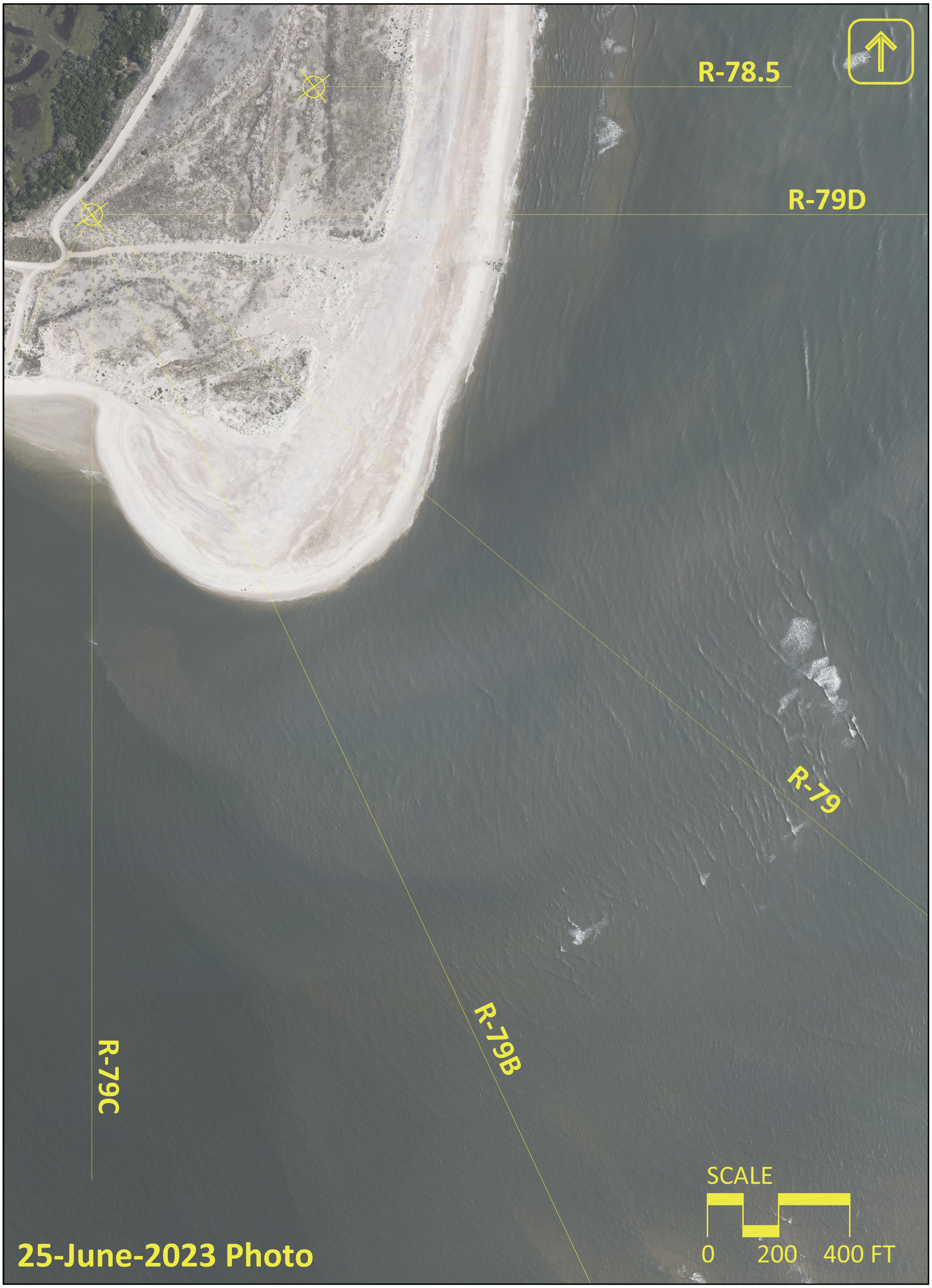


Figure E.9: South Amelia Island June 2023 aerial photography (Sheet 8 of 11).

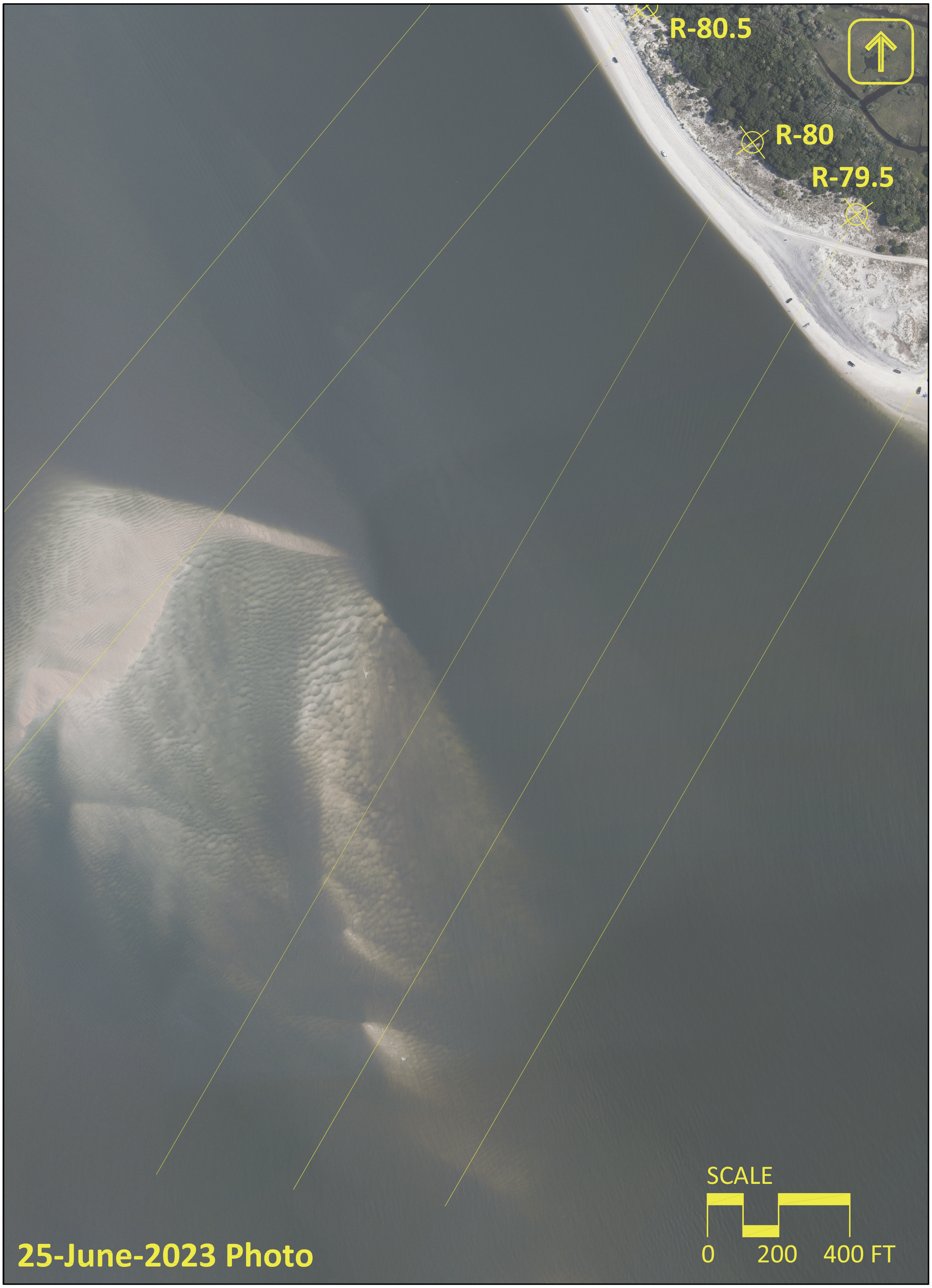


Figure E.10: South Amelia Island June 2023 aerial photography (Sheet 9 of 11).

Figure E.12: South Amelia Island June 2023 aerial photography (Sheet 10 of 11).

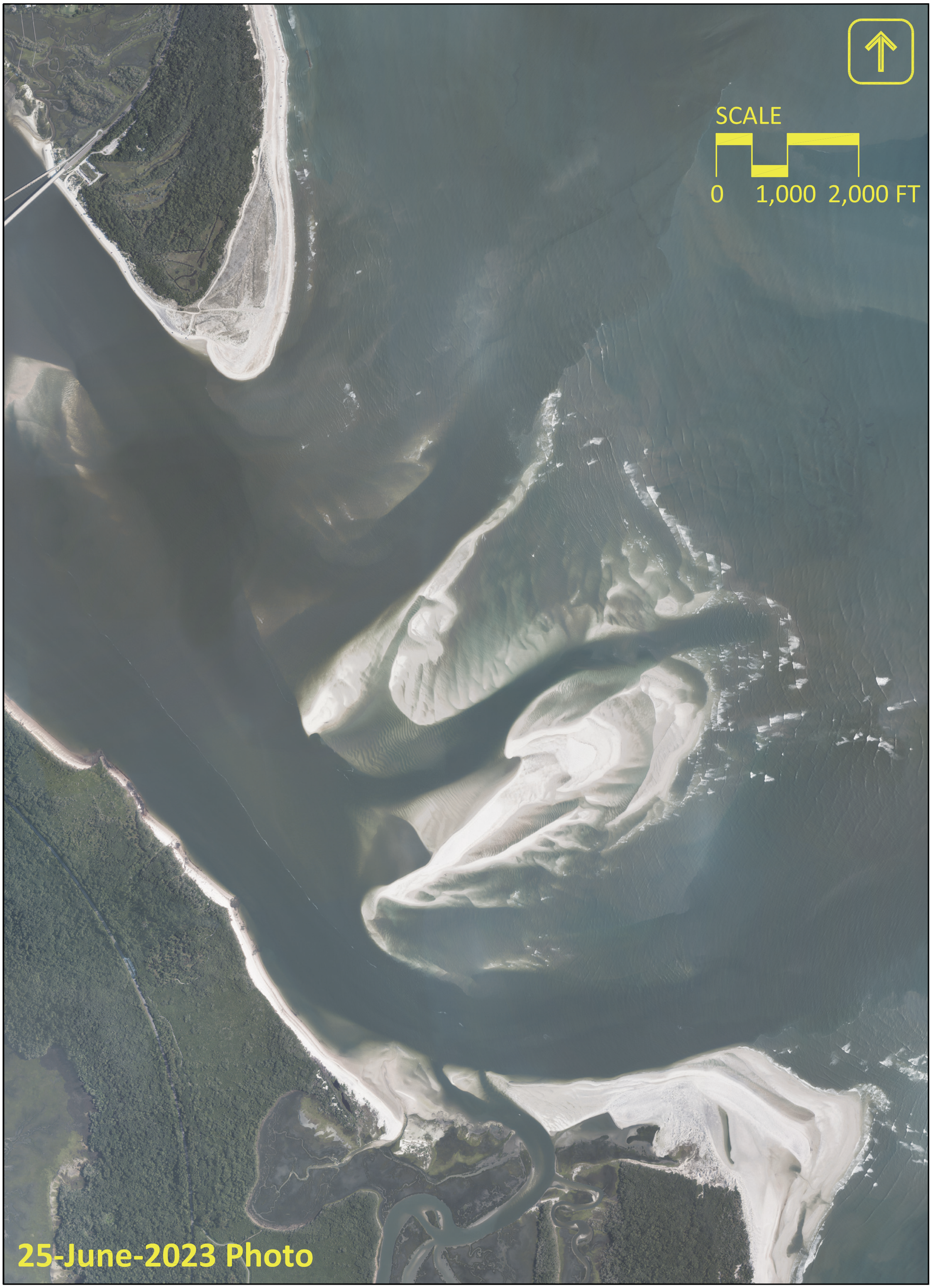


Figure E.12: South Amelia Island June 2023 aerial photography (Sheet 11 of 11).

Flight Report

KUCERA INTERNATIONAL INC.
EAGLE FLIGHT REPORT

Crew	Angel / Luke	**Aircraft**	N4102J		
Date	6/25/2023	**SPAN GPS**	Aft		
		TECI GPS	Novatel		
Sensor	00114634 - Eagle 2				
		Start up	KGNV	1123	
Sensor Location	Aft	**Shut Down**			
SPAN File Name	062523_N4102J_EagleT2k			**Weather**	

UltraCam Start up Checklist	**Initials**
Lens Cleaned	LV
Cables & Mount Switches OK	LV
SPAN/SD Card Has Space	LV
SPAN Status Lights	LV
Events Checked and Recording	LV
Camera & Storage Functional	LV

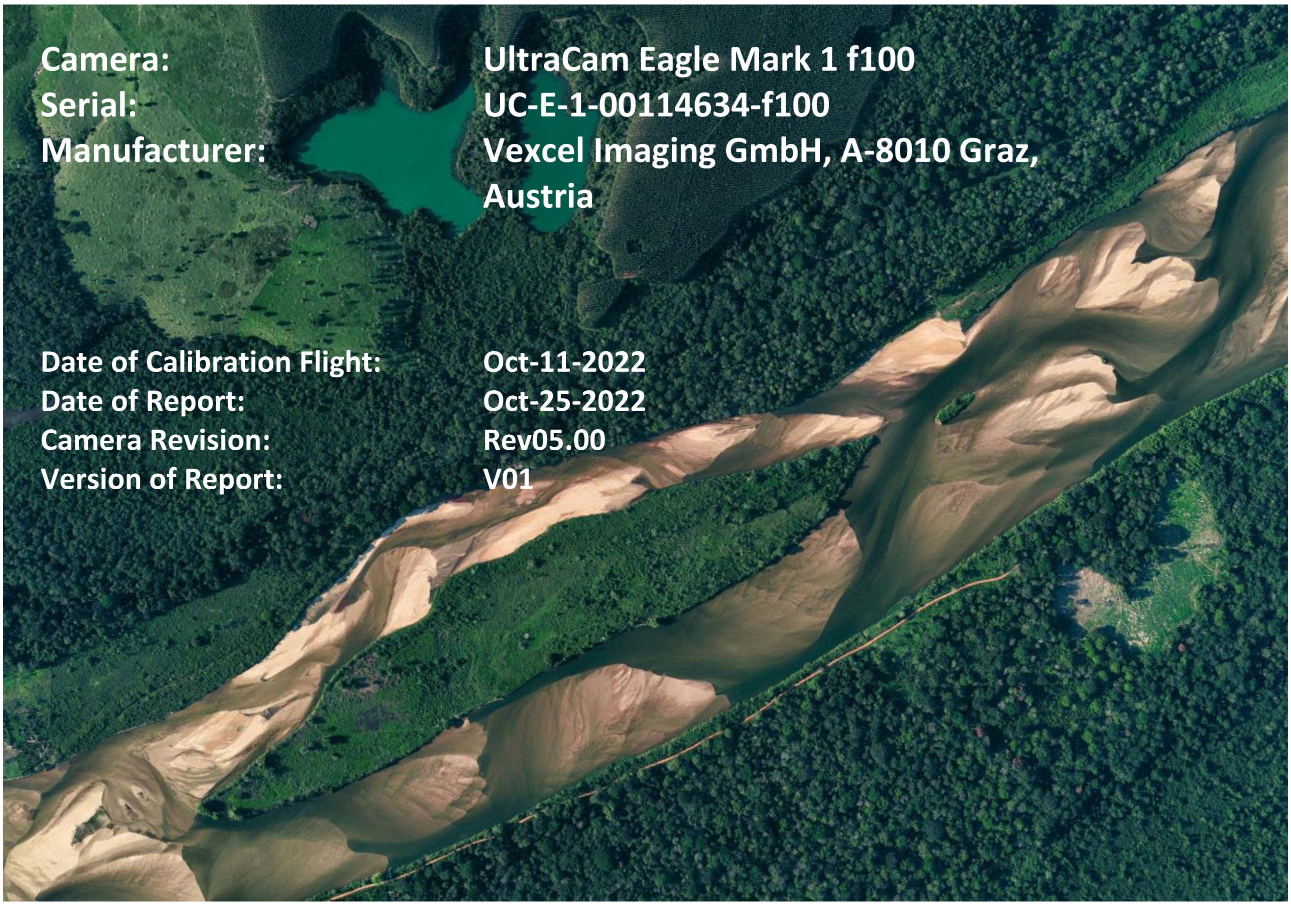
Data Unit	**Eagle Mount Used**
Data Unit #	
	Snapshot Laptop
Exposures Remaining	
Loaner FDU #	

Revised 4/20/23

Job #	Location/ Site	Line #	Flight Direction	Exposure		Flight Time		F-Stop/ Shutter	Altitude	Crab Angle	SPAN Status	Remarks
				First	Last	Start	Stop					
36599	Amelia Island	9	NE	1	15	1208	1210	F5.6 1/500	7600	-1	ok	S-Turn; Low exposure warnings over water throughout job
		2	W	16	29	1214	1216			0		
		1	E	30	43	1219	1221			-4		
		4	S	44	73	1226	1230			-5	ok	
		3	N	74	103	1234	1238			1		
		12	SE	104	120	1244	1246			-4		
		11	NW	121	138	1250	1253			-1		
		10	SE	139	156	1256	1258			-4		
		7	N	157	180	1303	1305			0	ok	
		8	S	181	204	1310	1312			-5		
		6	N	205	243	1316	1321			0		
		5	S	244	282	1329	1333			-5		

ULTRACAM

Field Calibration Report



Camera:	**UltraCam Eagle Mark 1 f100**
Serial:	**UC-E-1-00114634-f100**
Manufacturer:	**Vexcel Imaging GmbH, A-8010 Graz, Austria**

Date of Calibration Flight:	**Oct-11-2022**
Date of Report:	**Oct-25-2022**
Camera Revision:	**Rev05.00**
Version of Report:	**V01**

Bahia, Brasil 2013

Photo on page 1 courtesy of Hiparc Geotecnologia, Brasil

www.hiparc.com

UltraCam Lp, GSD25 cm, RGB

Calibration Procedure

The purpose of the Field Calibration is a verification of the camera status and calibration and consists of three major steps:

1. Test flight performed by customer
2. Processing of images and aerotriangulation (AT) by Vexcel Imaging GmbH
3. Analysis of AT results by Vexcel Imaging GmbH

Available Data

Test flight at customer's test site:

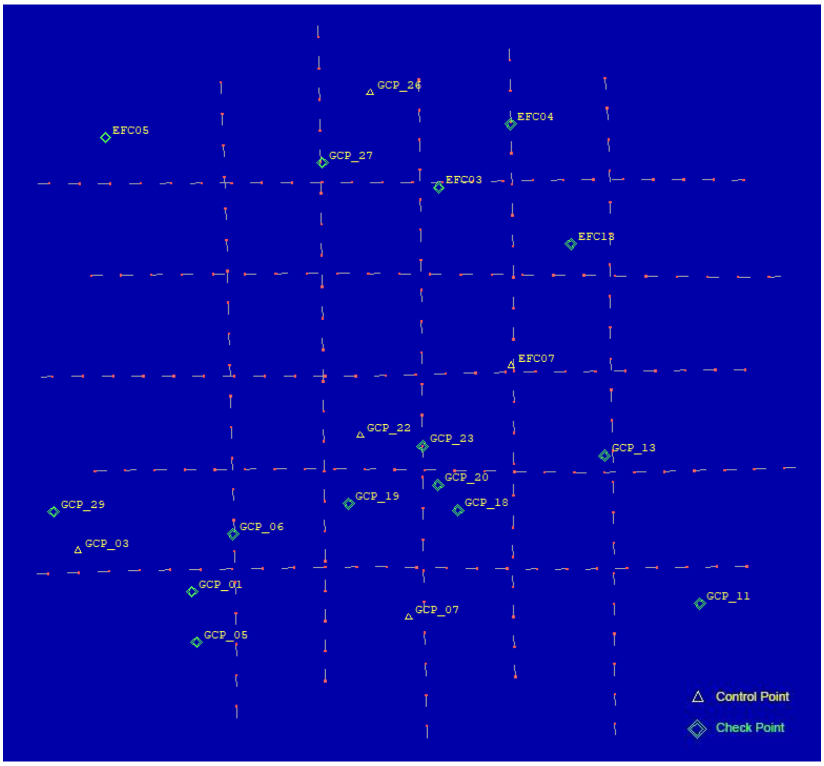
- Date of flight: 11/10/2022
- Number of images: 302 (total)
- Flying heights: 4700 sFT (GSD 0.2 sFT)
  8800 sFT (GSD 0.42 sFT)
- Number of images: 227 (GSD GSD 0.2 sFT)
  75 (GSD 0.42 sFT)
- Ground Control Points: 20 (15 were used as check points)
- Postprocessed GPS/IMU: available

Flight lines look very well done and show good overlap and image quality.

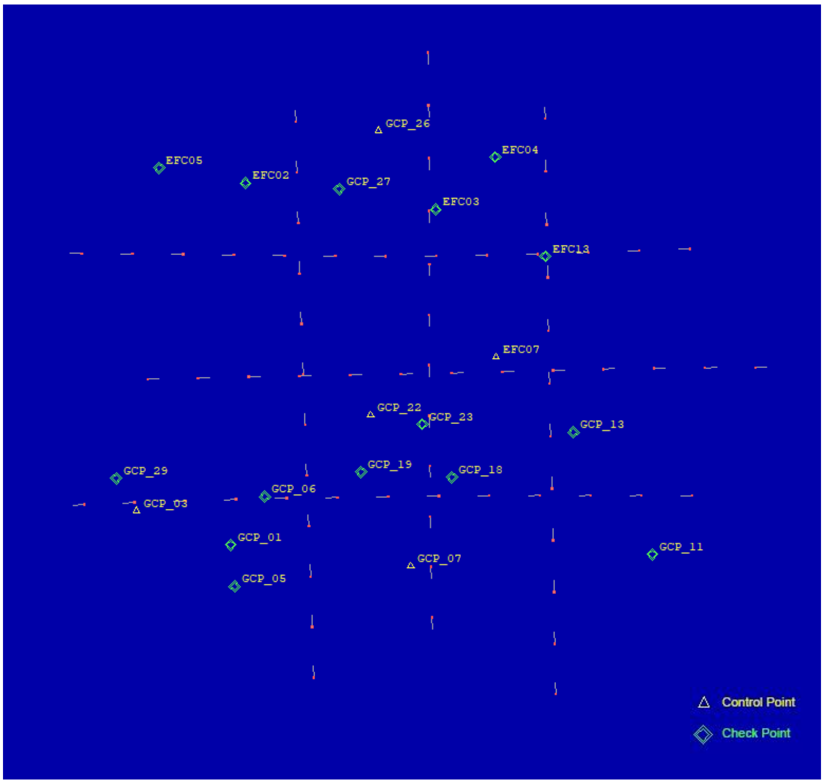
A-priori standard deviations settings

- Image measurements (x,y): 2.6 µm
- Ground Control Points (x,y/z): 0.16/0.23 sFT
- GNSS Position (x, y, z): 0.16 sFT
- IMU Pose (p,o/ k): 4 mgon / 8 mgon

- **Flight at 4700 sFT (GSD 0.2 sFT):**



- **Flight at 8800 sFT (GSD 0.42 sFT):**



Results

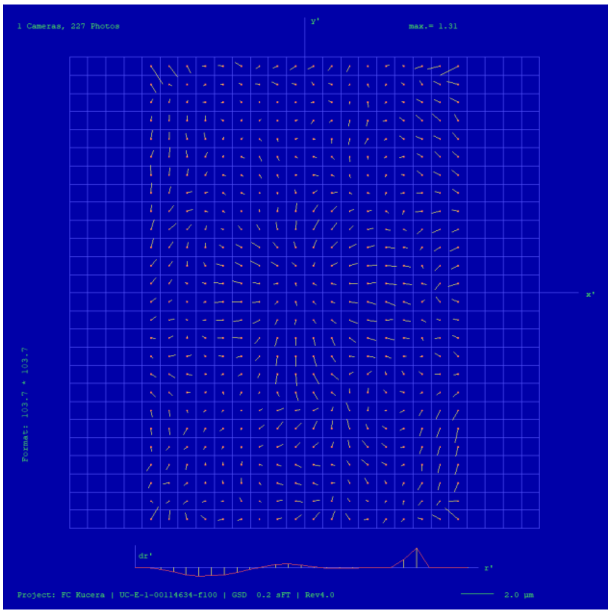
of the Aerial Triangulation with calibration Rev04.00 (laboratory calibration), as currently used by the customer.

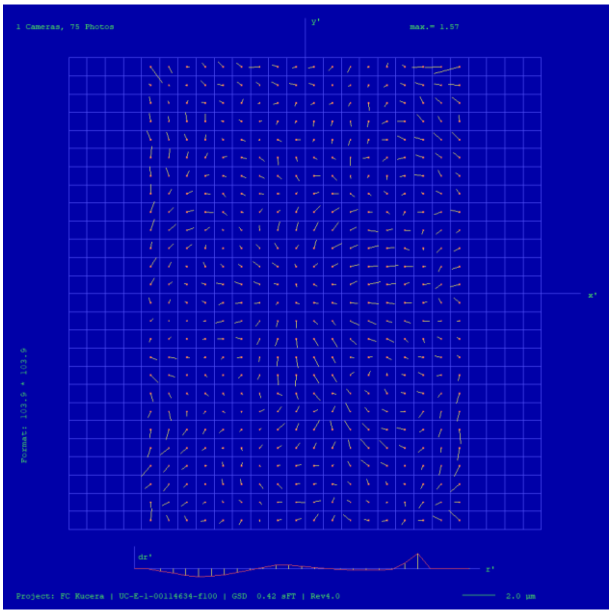
The data was processed in UltraMap v5.6.2 by Vexcel Imaging GmbH (Process to Lvl02, Automated Tie Point Collection, Bundle Adjustment and Analysis).

The results of the Bundle Adjustment are shown in the table below.

	Flight 4700 sFT (GSD 0.2sFT)	Flight 8800 sFT (GSD 0.42sFT)
Sigma 0	1.02	1.17
Mean photo scale	1:10511	1:18703
RMSE of 15 check points X/Y/Z (sFT)	0.122/0.135/0.110	0.293/0.150/0.107
RMSE of 5 control points X/Y/Z (sFT)	0.072/0.074/0.038	0.107/0.082/0.025
Number of used Tiepoints	29169	10434
Refraction Correction	used	used
Earth curvature correction	used	used
Residuals of photo measurements (x', y') in photo space(unit µm):	RMS 0.9/0.8 MAX 5.2/5.2	RMS 1.1, 0.9 MAX 5.2, 5.2

The remaining residuals in the image of the camera are shown in the plots below.





ULTRACAM

Geometric Specifications

Camera:	**UltraCam Eagle M1**
Serial:	**UC-E-1-00114634-f100**

Panchromatic Camera:	**ck = 100.500 mm**
Multispectral Camera:	**ck = 100.500 mm**
PPA Information:	**X: 0.000 mm**
	Y: 0.000 mm

Panchromatic Camera

Large Format Panchromatic Output Image

Image Format	long track cross track	68.016mm 104.052mm	13080pixel 20010pixel
Image Extent		(-34.01, -52.02)mm	(34.01, 52.02)mm
Pixel Size		5.200µm*5.200µm	
Focal Length	ck	100.500mm	± 0.002mm
Principal Point (Level 2)	X_ppa	0.000mm	± 0.002mm
	Y_ppa	0.000mm	± 0.002mm
Lens Distortion	Remaining Distortion less than 0.002mm		

Multispectral Camera

Medium Format Multispectral Output Image
(Upscaled to panchromatic image format)

Image Format	long track cross track	68.016mm 104.052mm	4360pixel 6670pixel
Image Extent		(-34.01, -52.02)mm	(34.01, 52.02)mm
Pixel Size		15.600µm*15.600µm	
Focal Length	ck	100.500mm	± 0.002mm
Principal Point (Level 2)	X_ppa	0.000mm	± 0.002mm
	Y_ppa	0.000mm	± 0.002mm
Lens Distortion	Remaining Distortion less than 0.002mm		

Conclusion

The tables and plots above show acceptable results for the processing with the camera calibration (Rev04.00). The calibration was verified with two datasets of the same test area acquired at different altitudes. The remaining distortions in the image are within an acceptable range.

The calibration is verified and within specification and updated to Rev05.00 without additional correction. This equipment operates within specifications as defined by Vexcel Imaging GmbH.

Dr. Michael Gruber
Chief Scientist, Photogrammetry
Vexcel Imaging GmbH

Philipp Zettl BSc.
Application Specialist
Vexcel Imaging GmbH

Metadata

Amelia Island, FL Color Orthoimagery, 2023

Metadata also available as - [XML]

Metadata:

Identification_Information:
  Citation:
    Citation_Information:
      Originator: Olsen Associates, Inc.
      Publication_Date: 2023
      Title: Amelia Island, FL Color Orthoimagery, 2023
      Edition: 1.0
      Geospatial_Data_Presentation_Form: Remote-sensing image
      Publication_Information:
        Publication_Place: Jacksonville, FL
        Publisher: Olsen Associates, Inc.
  Description:
    Abstract:
      This metadata record describes the 0.4' resolution orthoimagery covering the designated area of Amelia Island, FL. The orthoimagery vendor was Kucera International, Inc.
    Purpose:
      Acquire high resolution natural color aerial orthoimagery during low tide and low turbidity conditions of Amelia Island, and Nassau Sound FL. Orthoimagery has a ground resolution of 0.4'. The 3-band (RGB) natural color orthoimagery serves a variety of needs. These include but are not limited to updating base maps, mapping surface morphology and temporal change, mapping local datasets, emergency planning and response, property appraisal updates and appeals, city design, planning, asset management, public safety, defining landuse, roads, structures, pond outlines, tract lines, flood zone, transmission lines, and oil and gas pipelines and pads.
    Supplemental_Information:
      The four UCEagle bands record data in the following manner: Band 1 (blue); Band 2 (green); Band 3 (red); Band 4 (NIR). While the NIR band was collected as part of the image acquisition flights, it is not included as a deliverable under the terms of the contract.
  Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 20230625
    Currentness_Reference: Ground condition
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: Unknown
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -81.4984478411
      East_Bounding_Coordinate: -81.3762784319
      North_Bounding_Coordinate: 30.7472620016

South_Bounding_Coordinate: 30.3921332973

Keywords:
Theme:
Theme_Keyword_Thesaurus: KI Thesaurus
Theme_Keyword: Aerial imagery
Theme_Keyword: UltraCam Eagle
Theme_Keyword: Basemap
Theme_Keyword: Digital orthoimage
Theme_Keyword: orthoimage
Theme_Keyword: RGB
Theme_Keyword: RGB color
Theme_Keyword: Aerial
Theme_Keyword: Imagery
Theme_Keyword: Natural color
Theme_Keyword: Orthoimagery

Place:
Place_Keyword_Thesaurus: Olsen
Place_Keyword: Florida
Place_Keyword: Amelia Island
Place_Keyword: Atlantic Ocean
Place_Keyword: Nassau Sound
Place_Keyword: Amelia River
Place_Keyword: Little Talbot
Place_Keyword: Mayport jetty

Access_Constraints: None
Use_Constraints: None
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Albert E. Browder, Ph.D., P.E.
Contact_Organization: Olsen Associates, Inc.

Contact_Position: Senior Coastal Engineer
Contact_Address:
Address_Type: Mailing and physical address
Address: 2618 Herschel Street
City: Jacksonville
State_or_Province: FL
Postal_Code: 32204
Country: U.S.A.

Contact_Voice_Telephone: 904-387-6114 x315
Contact_Facsimile_Telephone: 904-384-7368
Contact_Electronic_Mail_Address: abrowder@olsen-associates.com
Hours_of_Service: 0900-1630

Data_Quality_Information:
Logical_Consistency_Report:
Compliance with the accuracy standard was ensured by the selection of image identifiable ground control check points and visual comparison to previously produced orthophotography. The following checks were performed: 1. The ground control check points and airborne GPS/INS data stream were validated through an aerotriangulation bundle adjustment using Trimble Inpho Systems Match-AT software. 2. Digital orthoimagery was validated through a visual inspection of control points, edge matching and general image quality. The dataset was independently evaluated by Olsen Associates, Inc.

Completeness_Report:
The following methods were used to ensure image quality: 2. Use of GPS/INS during image acquisition. 3. Checking of image identifiable controls against orthoimage product. 4. Post orthorectification accuracy approval checks for overall image quality (tone, color balance, etc.). 5. Comparison to previous orthophotos for horizontal matching.

Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
Horizontal accuracy requirement is defined by Olsen Associates, Inc. as 3 to 4 ft for the 0.4' resolution imagery. No surveyed ground control was provided. Easting and northing coordinates were recorded from the orthophotos and the point elevation was extracted from the DEM.

Quantitative_Horizontal_Positional_Accuracy_Assessment:
Horizontal_Positional_Accuracy_Value: 3-4 feet
Horizontal_Positional_Accuracy_Explanation:
With no surveyed control provided, the horizontal accuracy of the airborne GPS/INS directly georeferenced imagery was assessed by edge matching of the new orthoimagery to the previous orthophotography.

Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report:
Orthoimagery are a two dimensional representation of the Earth's surface and thus a vertical accuracy analysis is not required.

Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator:
Kucera International Inc. Willoughby, OH

Publication_Date: Unpublished material
Title: Digital Aerial Imagery
Edition: 1.0
Geospatial_Data_Presentation_Form: Remote-sensing image
Publication_Information:
Publication_Place: None
Publisher: None

Source_Scale_Denominator: 1200
Type_of_Source_Media: disc
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 20230625

Source_Currentness_Reference: Ground condition

Source_Citation_Abbreviation: IMG
Source_Contribution:
The aerial imagery was captured with a Microsoft UltraCam Eagle (UCEagle) large format digital aerial camera. The UCEagle uses an image frame based method of data collection with multiple, precisely registered CCDs collecting nadir oriented images along planned flight lines. Each CCD array collects data in one of the pan, red, green, blue or NIR spectral bands. This results in one image per frame CCD.

Source_Information:
Source_Citation:
Citation_Information:
Originator: Kucera International, Inc.
Publication_Date: 2023
Title: Ground control
Edition: 1.0
Geospatial_Data_Presentation_Form: tabular digital data
Publication_Information:
Publication_Place: None
Publisher: None

Type_of_Source_Media: disc
Source_Time_Period_of_Content:

Time_Period_Information:
Single_Date/Time:
Calendar_Date: 2023

Source_Currentness_Reference: Ground condition

Source_Citation_Abbreviation: CONT
Source_Contribution: No surveyed ground control was provided.

Source_Information:
Source_Citation:
Citation_Information:
Originator: Olsen Associates, Inc.
Publication_Date: Unknown
Title: Digital elevation model
Edition: 1.0
Geospatial_Data_Presentation_Form: Point digital data
Publication_Information:
Publication_Place: None
Publisher: None

Type_of_Source_Media: disc
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 2023

Source_Currentness_Reference: Ground condition

Source_Citation_Abbreviation: DEM
Source_Contribution:
The DEM used in the orthorectification process was provided by Olsen Associates, Inc.

Source_Information:
Source_Citation:
Citation_Information:
Originator: Kucera International, Inc.
Publication_Date: 2023
Title: Tile definition
Edition: 1.0
Geospatial_Data_Presentation_Form: Vector digital data

Type_of_Source_Media: disc
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 2023

Source_Currentness_Reference: Ground condition

Source_Citation_Abbreviation: TLDEF
Source_Contribution:
The tile definition is used to cut orthorectified imagery into manageable, usable images. Each tile is 5000' by 5000'.

Source_Information:

Source_Citation:
Citation_Information:
Originator: Kucera International, Inc.
Publication_Date: Unpublished material
Title: Orthorectified imagery
Edition: 1.0
Geospatial_Data_Presentation_Form: Remote-sensing image
Publication_Information:
Publication_Place: None
Publisher: None

Source_Scale_Denominator: 1200
Type_of_Source_Media: disc
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 2023

Source_Currentness_Reference: Ground condition

Source_Citation_Abbreviation: OIMG1
Source_Contribution:
This first level of orthorectified imagery is the product of using the aerotriangulation solution and the DEM in Inpho Orthomaster software software. These orthorectified images overlap with adjacent imagery but have yet to be mosaiced into seamless tiled orthos.

Source_Information:
Source_Citation:
Citation_Information:
Originator: Kucera International, Inc.
Publication_Date: Unpublished material
Title: Tiled orthoimage
Edition: 1.0
Geospatial_Data_Presentation_Form: Remote-sensing image
Publication_Information:
Publication_Place: None
Publisher: None

Source_Scale_Denominator: 1200
Type_of_Source_Media: disc, DVD or online
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 2023

Source_Currentness_Reference: Ground condition

Source_Citation_Abbreviation: OIMG2
Source_Contribution:
The tiled orthoimage is the result of mosaicing orthorectified imagery using Inpho Systems, Inc Geovista software. Inputs to Geovista are the orthorectified digital images (OIMG1) and the tile definition (TLDEF). The Geovista software mosaics the input imagery into seamless orthoimage tiles of a manageable file size and dimension.

Process_Step:
Process_Description:
At selected locations throughout the site, accurate GPS coordinates are surveyed or monuments found and the points are marked with targets which will be visible in the aerial imagery.

Source_Used_Citation_Abbreviation: None
Process_Date: 2023
Source_Produced_Citation_Abbreviation: CONT

Process_Step:
Process_Description:

New digital, color aerial imagery of the site is acquired using the UCEagle digital aerial camera. Airborne GPS/IMU data is recorded along with the imagery.

Source_Used_Citation_Abbreviation: None
Process_Date: 2023
Source_Produced_Citation_Abbreviation: IMG

Process_Step:
Process_Description:
Imagery and GPS/IMU data are downloaded from disc on the plane to disc on the ground. GPS/IMU mission data is processed together with simultaneously collected ground-based GPS base station data in forward and reverse directions. This precisely determines the aerial sensor's position and orientation in the terrain (project) coordinate system and allows for correct orientation of the imagery.

Source_Used_Citation_Abbreviation: IMG
Process_Date: 2023
Source_Produced_Citation_Abbreviation: IMG

Process_Step:
Process_Description:
Using the processed GPS/IMU data and correctly oriented imagery, an aerotriangulation bundle adjustment is computed (AT) using Inpho Match-AT software.

Source_Used_Citation_Abbreviation: IMG, CONT
Process_Date: 2023
Source_Produced_Citation_Abbreviation: AT

Process_Step:
Process_Description:
Orthorectified imagery is produced using Inpho Orthomaster software. The inputs are the digital aerial images, DEM and the aerotriangulation solution. The output images are overlapping orthorectified images that have yet to be mosaiced into seamless tiled orthos.

Source_Used_Citation_Abbreviation: IMG, DEM, AT
Process_Date: 2023
Source_Produced_Citation_Abbreviation: OIMG1

Process_Step:
Process_Description:
Orthorectified imagery is mosaiced, locally color-balanced and cut to the tile definition boundaries using Inpho Systems OrthoVista software. The tiled orthos are checked for accuracy against the surveyed ground control before further image editing.

Source_Used_Citation_Abbreviation: OIMG1, CONT, TLDEF
Process_Date: 2023
Source_Produced_Citation_Abbreviation: OIMG2

Process_Step:
Process_Description:
Tiled orthoimages then go through a rigorous manual QC process to evaluate for remaining hotspots (sun reflectance over water), tone quality, color balance and the feathering area between flight lines. Any imperfections at this point are manually edited. If necessary, the tiled images are then converted to required format. All images are either recorded on DVD, transferred to HD or posted on FTP for client access.

Source_Used_Citation_Abbreviation: OIMG2
Process_Date: 2023
Source_Produced_Citation_Abbreviation: OIMG2

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Raster
Raster_Object_Information:
Raster_Object_Type: Pixel

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:

Grid_Coordinate_System:
Grid_Coordinate_System_Name: State Plane Coordinate System 1983
State_Plane_Coordinate_System:
SPCS_Zone_Identifier: 0901
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.999975
Longitude_of_Central_Meridian: -81.000000
Latitude_of_Projection_Origin: 24.333333
False_Easting: 656166.666667
False_Northing: 0.000000

Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: Coordinate pair
Coordinate_Representation:
Abscissa_Resolution: 0.4
Ordinate_Resolution: 0.4

Planar_Distance_Units: U.S. Foot

Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.25722210088

Vertical_Coordinate_System_Definition:
Altitude_System_Definition:
Altitude_Datum_Name: North American Vertical Datum of 1988(GEOID09)
Altitude_Resolution: 0.1
Altitude_Distance_Units: U.S. Foot
Altitude_Encoding_Method: Implicit coordinate

Entity_and_Attribute_Information:
Overview_Description:
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Color orthoimages are comprised of pixels. Each pixel is assigned a value of 0 to 255. That number will refer to a color look-up table which contains red, green and blue (RGB) values, each from 0 to 255, for that pixel within the image. The four UCEagle color bands record data in the following manner: Band 1 (blue); Band 2 (green); Band 3 (red); Band 4 (NIR). While the NIR band was collected as part of the image acquisition flights, it is not included as a deliverable under the terms of the contract.

Entity_and_Attribute_Detail_Citation: None

Distribution_Information:
Distributor:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Albert E. Browder, Ph.D., P.E.
Contact_Organization: Olsen Associates, Inc.

Contact_Position: Senior Coastal Engineer
Contact_Address:
Address_Type: Mailing and physical address
Address: 2618 Herschel Street
City: Jacksonville
State_or_Province: FL
Postal_Code: 32204
Country: U.S.A.

Contact_Voice_Telephone: 904-387-6114 x315
Contact_Facsimile_Telephone: 904-384-7368
Contact_Electronic_Mail_Address: abrowder@olsen-associates.com
Hours_of_Service: 0900-1630

Resource_Description: Amelia Island, FL Color Orthoimagery, 2023
Distribution_Liability:
Olsen Associates, Inc. provides this geographic data "as is". This organization makes no guarantee or warranty concerning the accuracy of information contained in the geographic data. Also, this organization makes no warranty, either expressed or implied, regarding the condition of the product or its fitness for any particular purpose. The burden for determining fitness for use lies entirely with the user. Although these files have been processed successfully on computers at this organization, no warranty is made by this organization regarding the use of these data on any other system, nor does the fact of distribution constitute or imply such a warranty.

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Ordering_Instructions: Olsen Associates, Inc.

Available_Time_Period:
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Metadata_Reference_Information:
Metadata_Date: 2023
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Albert E. Browder, Ph.D., P.E.
Contact_Organization: Olsen Associates, Inc.

Contact_Position: Senior Coastal Engineer
Contact_Address:
Address_Type: Mailing and physical address
Address: 2618 Herschel Street
City: Jacksonville
State_or_Province: FL
Postal_Code: 32204
Country: U.S.A.

Contact_Voice_Telephone: 904-387-6114 x315
Contact_Facsimile_Telephone: 904-384-7368
Contact_Electronic_Mail_Address: abrowder@olsen-associates.com
Hours_of_Service: 0900-1630

Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata (CSDGM)
Metadata_Standard_Version: FGDC-STD-001-1998

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APPENDIX F:
Nassau Sound Surveys & Orthorectified Aerial Photography

Figure F.1 of this appendix presents the most recent aerial photography of Nassau Sound flown June 25, 2023 by Kucera International, Inc.[1] Copies of the flight report, calibration report and metadata file are available in **Appendix E** of this report.

Additionally, **Figure F.1** presents the most recent large-scale bathymetric survey of the Nassau Sound ebb-shoal complex conducted in June 6, 2023 by Arc Surveying & Mapping of Jacksonville, FL. **Table F.1** summarizes additional surveys of Nassau Sound conducted to date. Plots of these bathymetric surveys are provided as **Figure F.2** to **F.15** of this appendix.

Table F.1: Nassau Sound large-scale bathymetric surveys.

Survey Date	Comment	Figure Number
1991	3 Years Pre-1994 Project	Figure F.2
March 2003	Pre-Construction	Figure F.3
March 2004	Post-Construction	Figure F.4
March 2005	1st Year Post-2004 Construction	Figure F.5
July 2006	2nd Year Post-2004 Construction	Figure F.6
July 2008	4th Year Post-2004 Construction	Figure F.7
July 2010	6th Year Post-2004 Construction	Figure F.8
June 2013	9th Year Post-2004 Construction	Figure F.9
June 2016	12th Year Post-2004 Construction	Figure F.10
June 2018	14th Year Post-2004 Construction	Figure F.11
June 2020	16th Year Post-2004 Construction	Figure F.12
May 2021	17th Year Post-2004 Construction	Figure F.13
August 2022	1st Year Post-2021 Construction	Figure F.14
June 2023	2nd Year Post-2021 Construction	Figure F.15

[1] Kucera International, Inc.; 38133 Western Parkway; Willoughby, OH 44094.

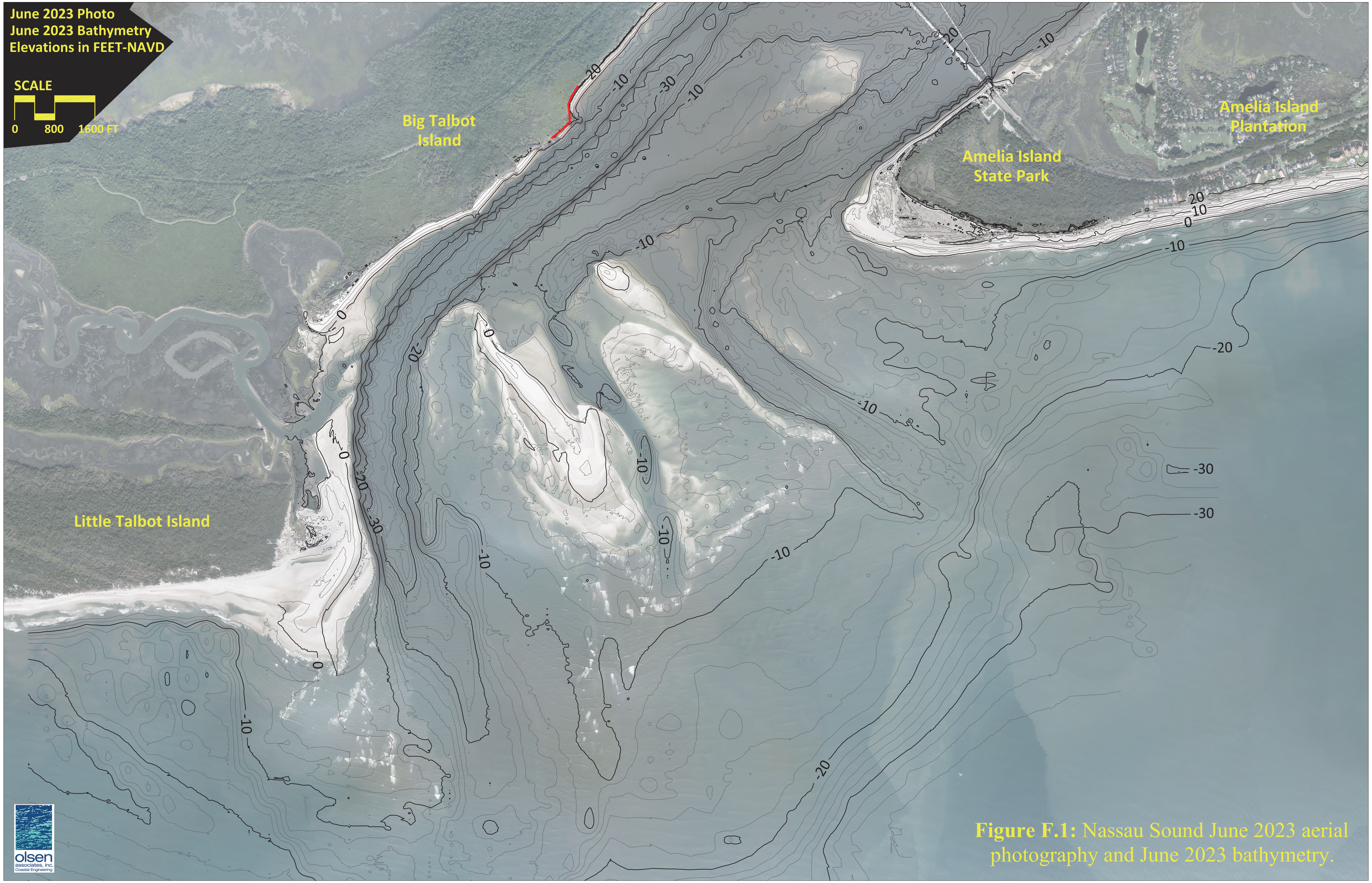

Figure F.1: Nassau Sound June 2023 aerial photography and June 2023 bathymetry.

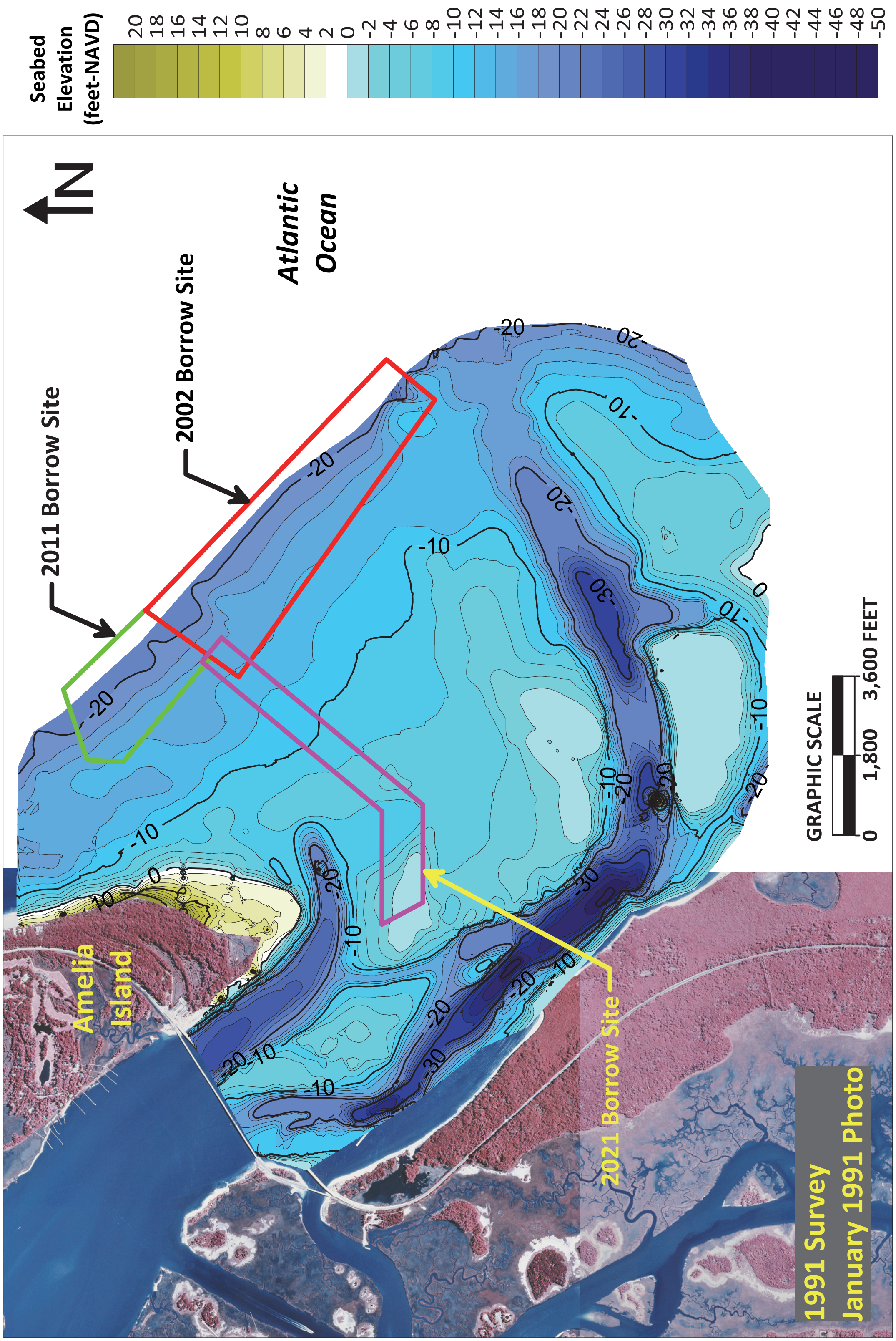

Figure F.2: Nassau Sound bathymetry (1991).

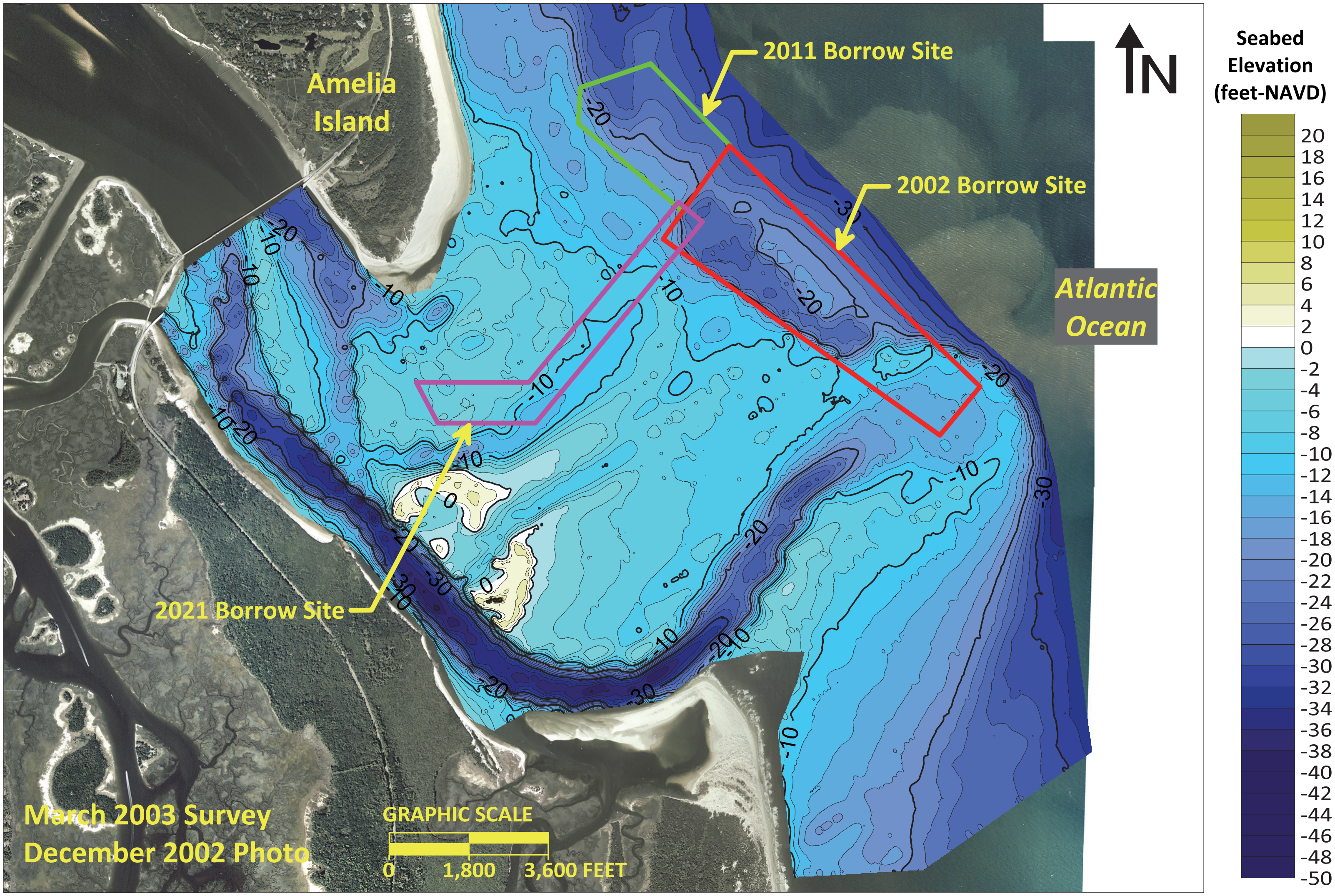

Figure F.3: Nassau Sound bathymetry (March 2003).

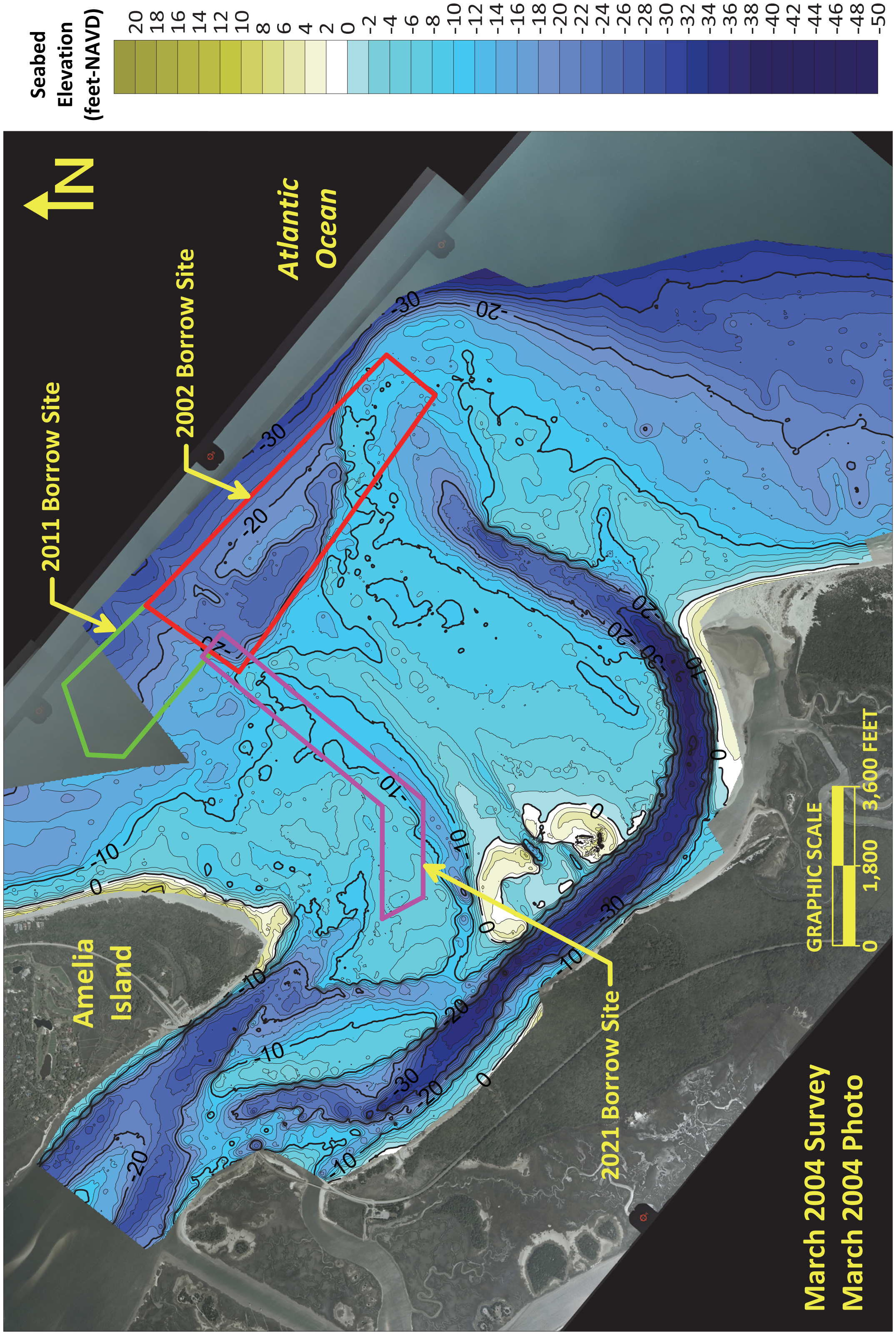

Figure F.4: Nassau Sound bathymetry (March 2004).

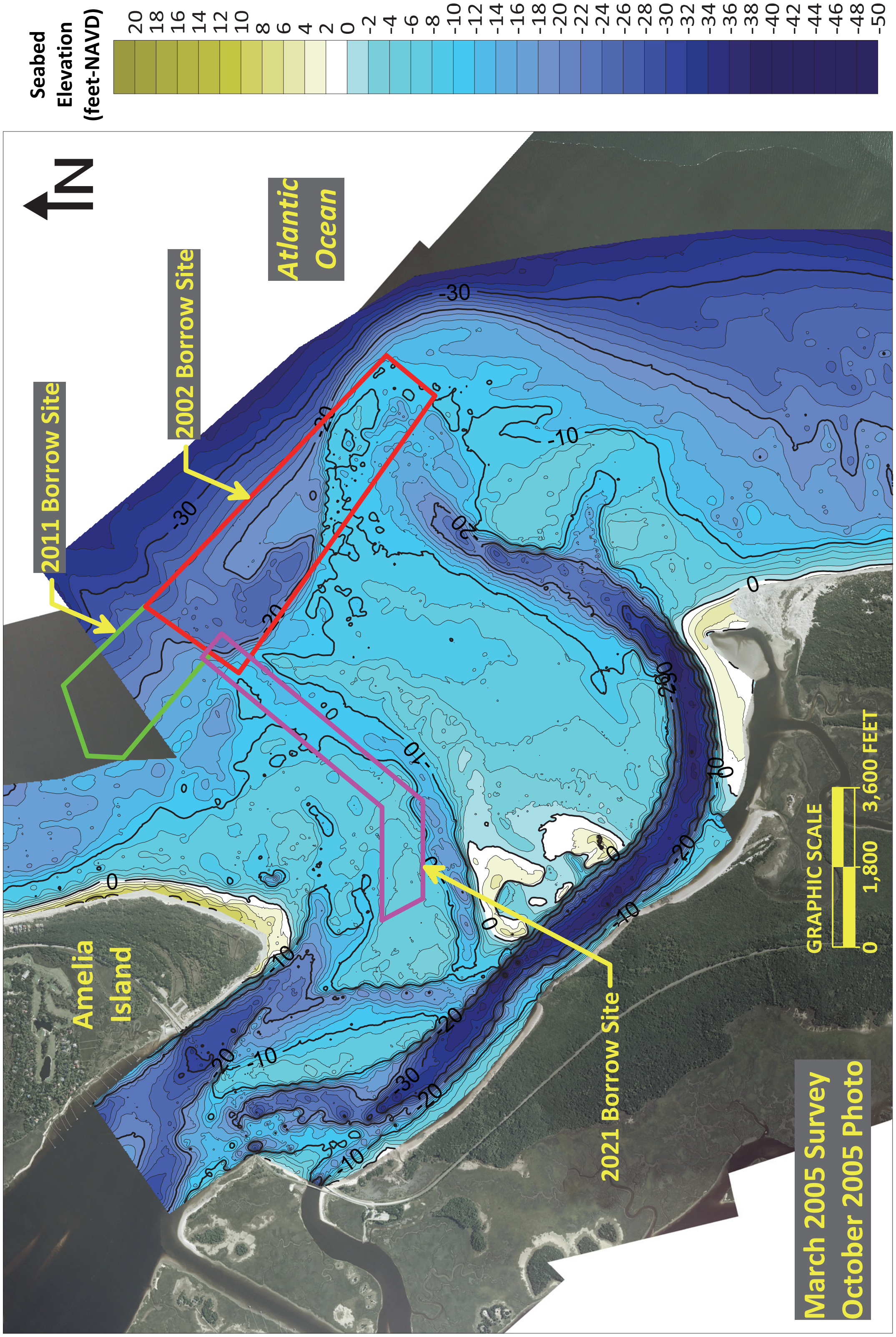

Figure F.5: Nassau Sound bathymetry (March 2005).

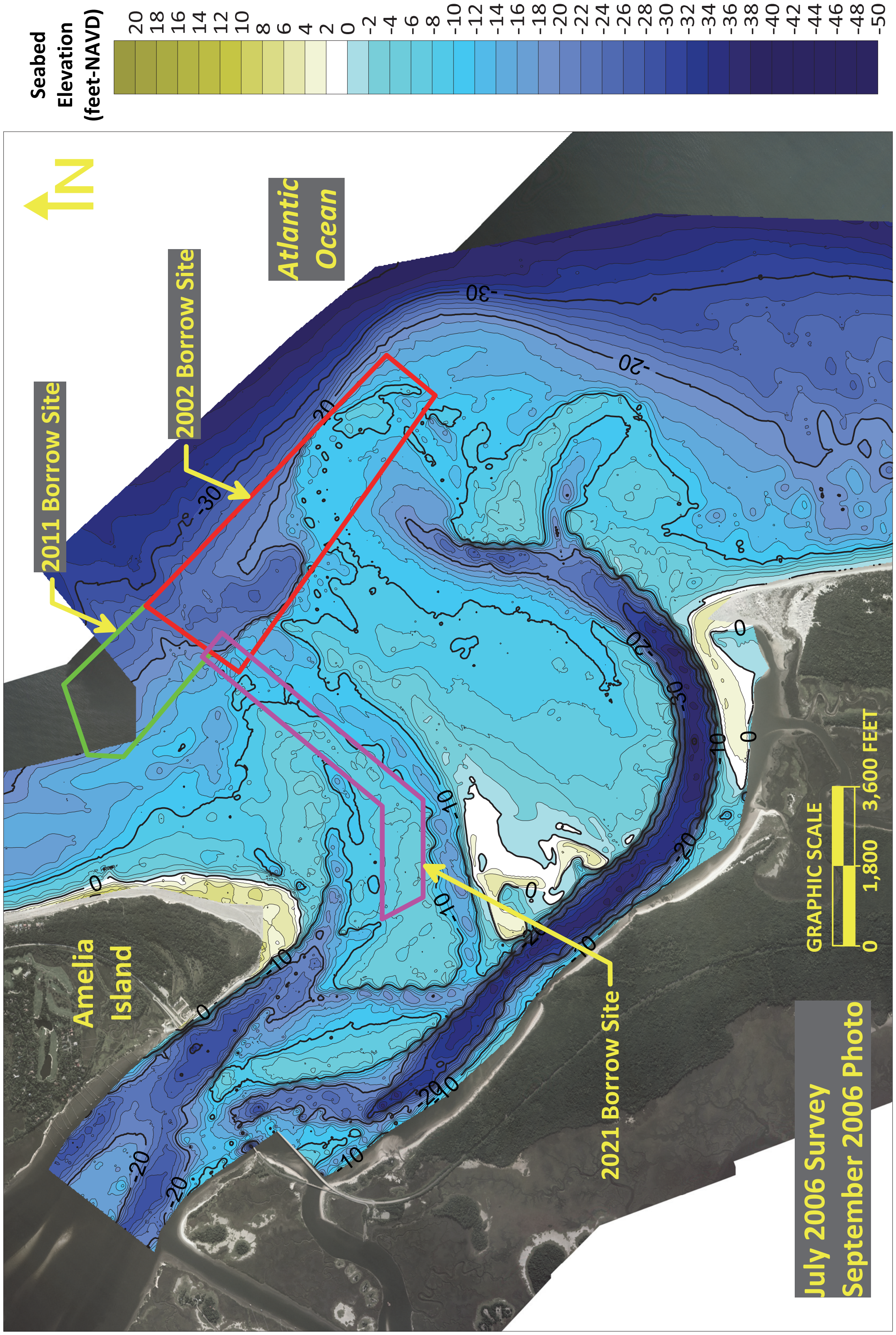

Figure F.6: Nassau Sound bathymetry (July 2006).

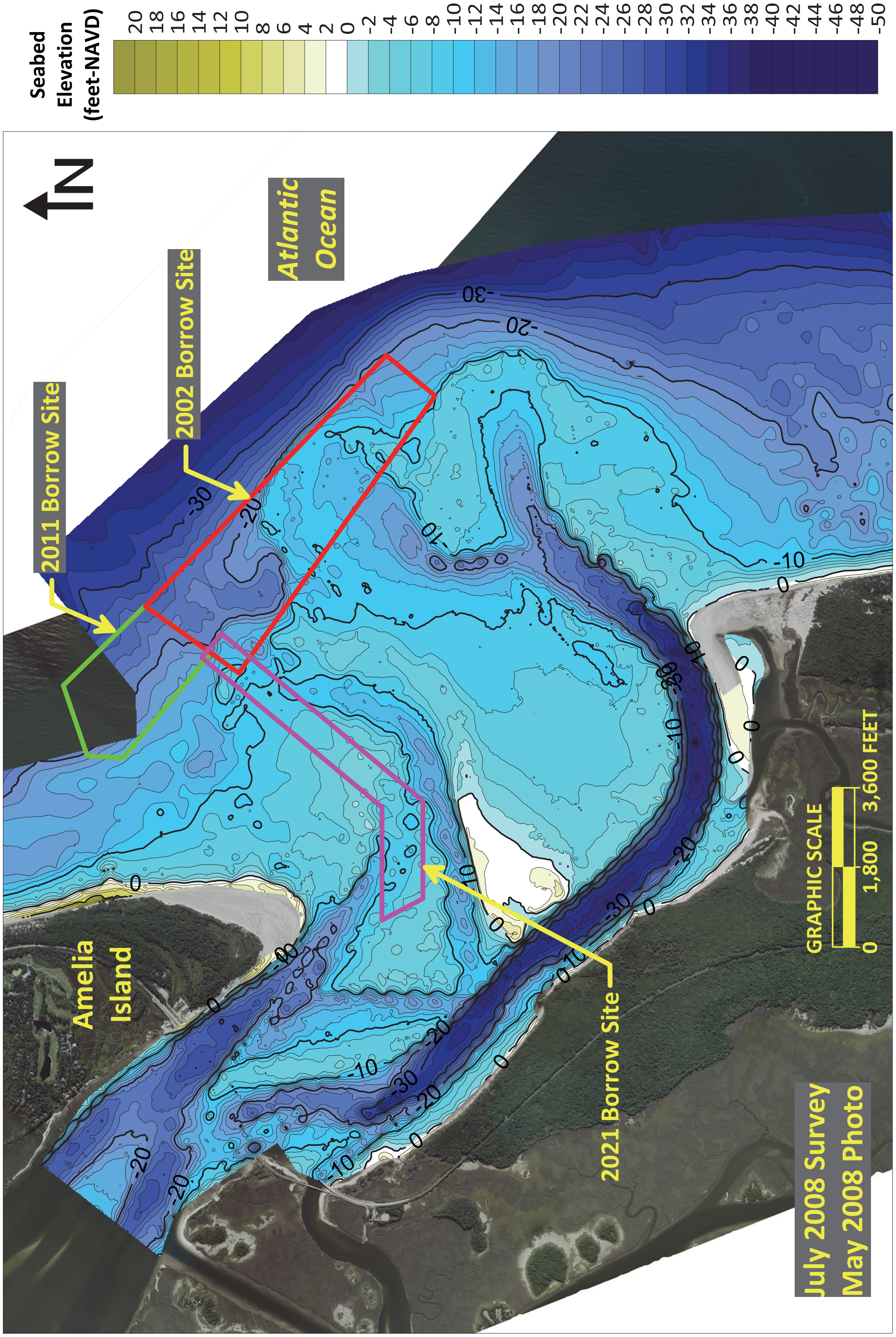

Figure F.7: Nassau Sound bathymetry (July 2008).

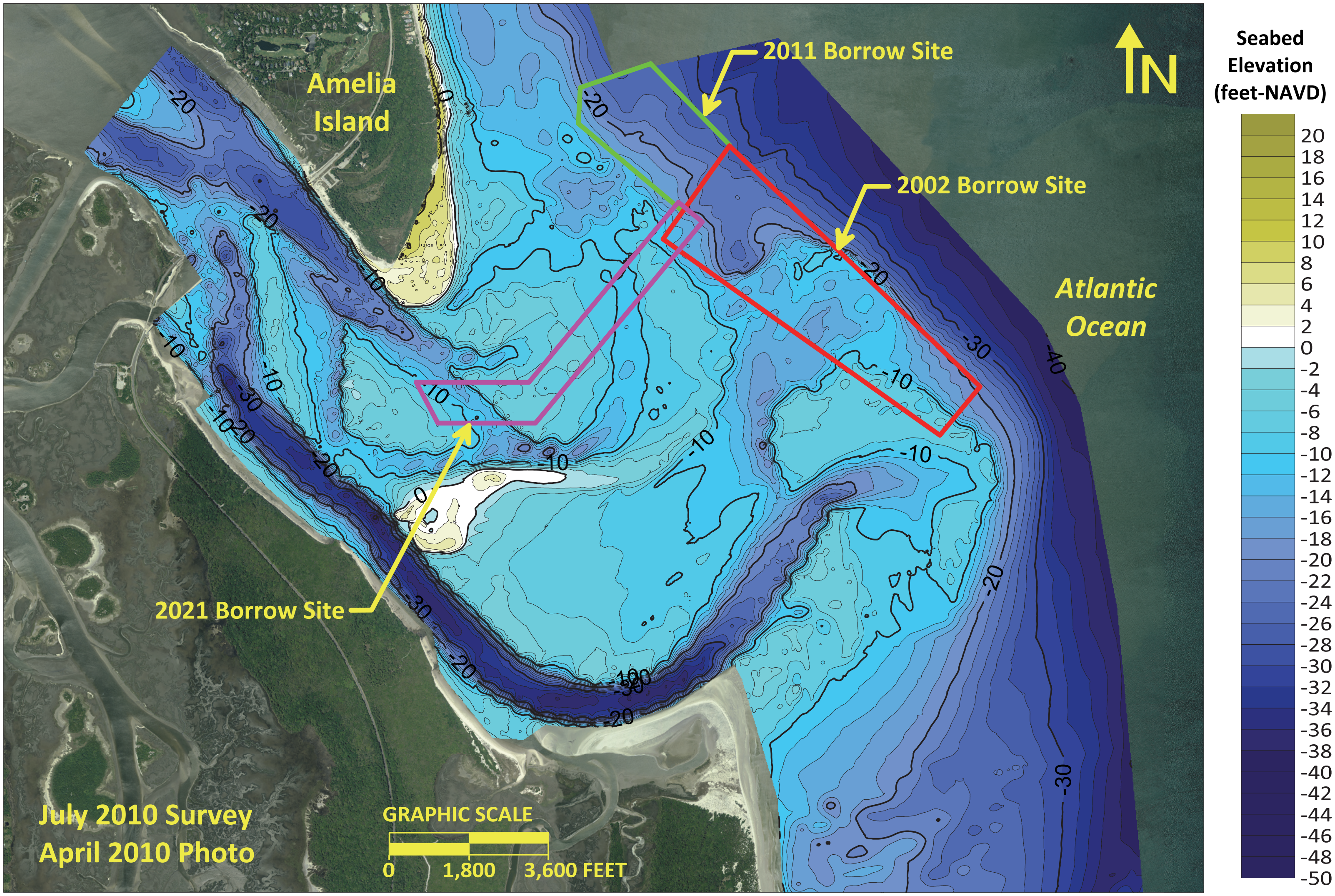

Figure F.8: Nassau Sound bathymetry (July 2010).

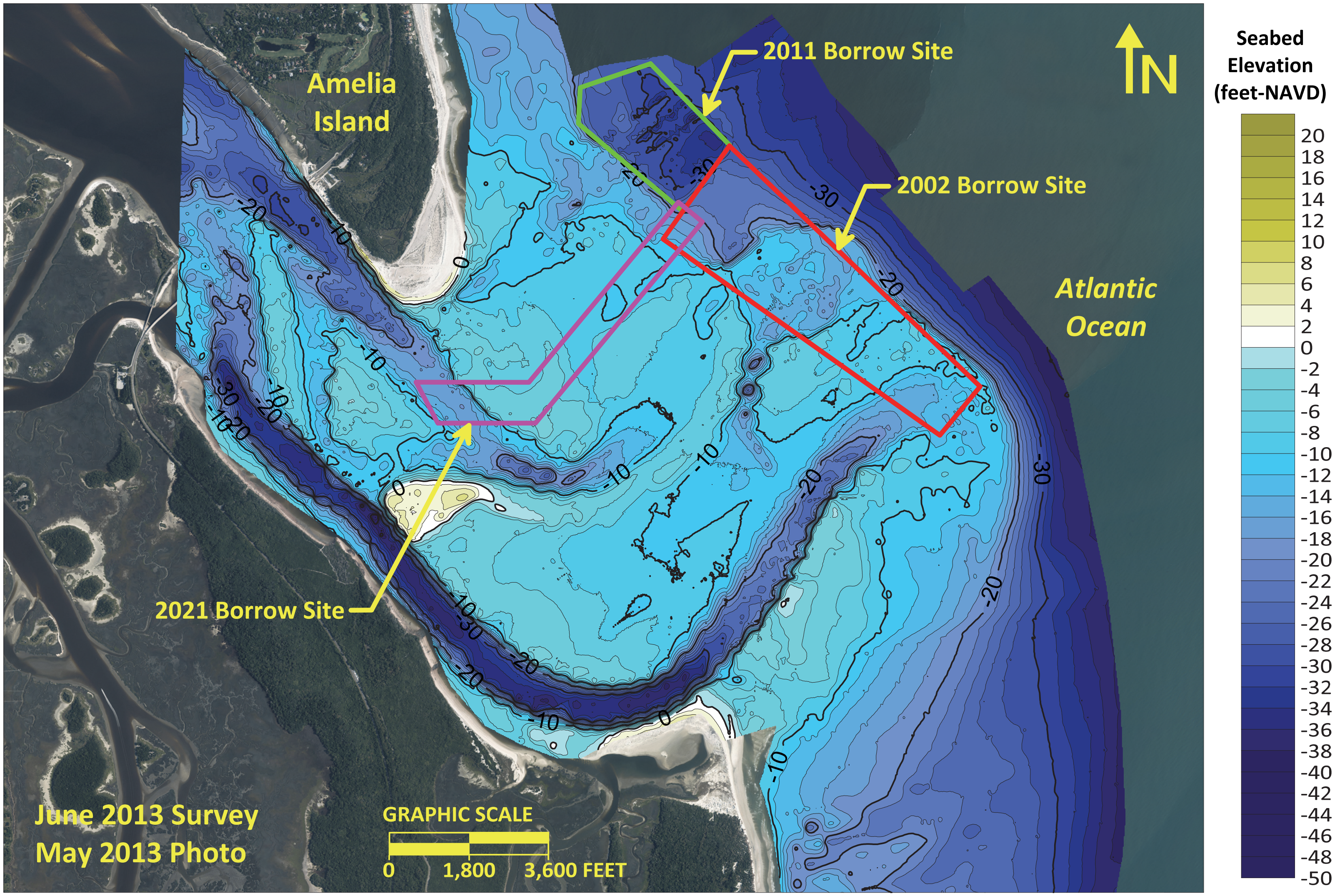

Figure F.9: Nassau Sound bathymetry (June 2013).

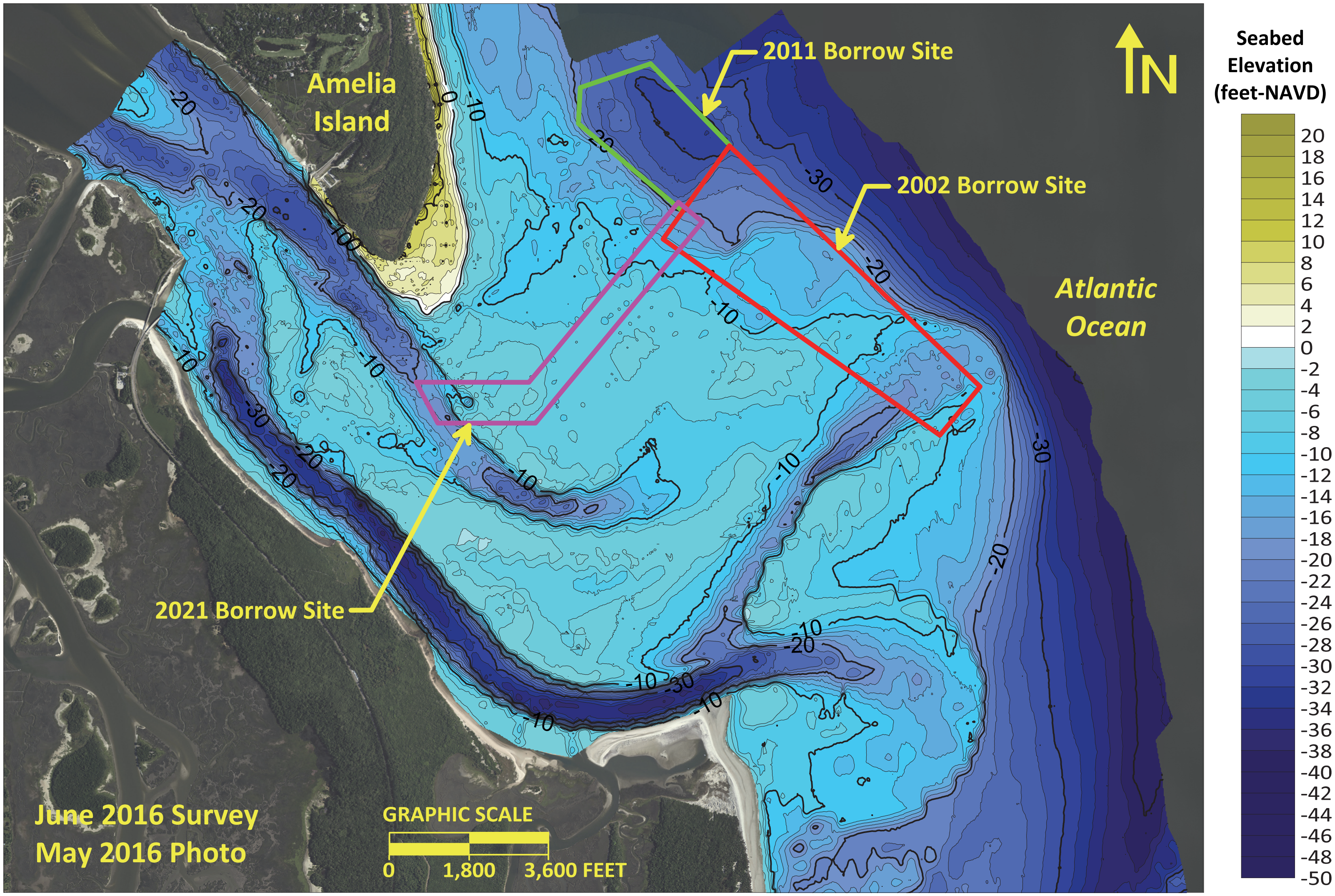

Figure F.10: Nassau Sound bathymetry (June 2016).

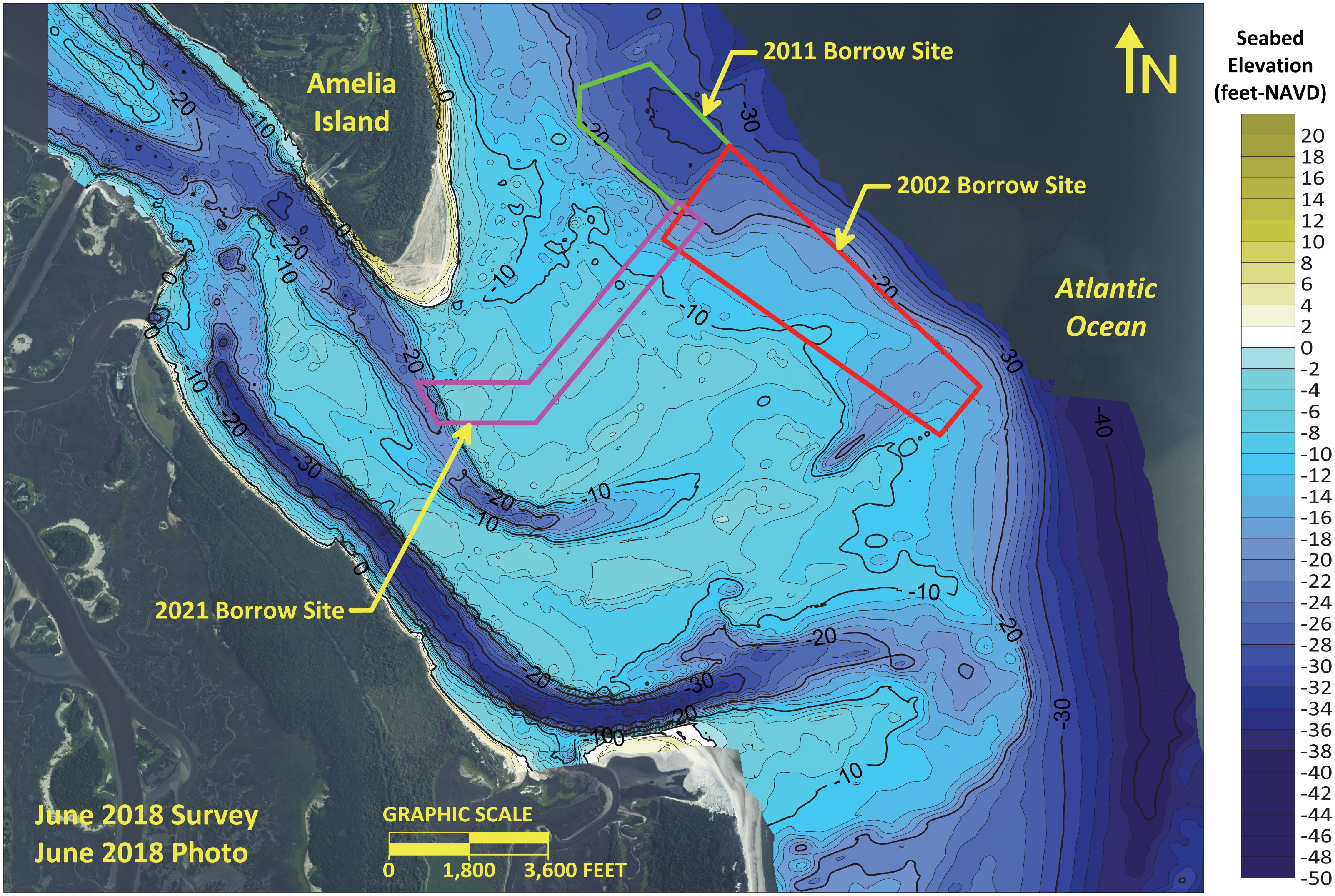

Figure F.11: Nassau Sound bathymetry (June 2018).

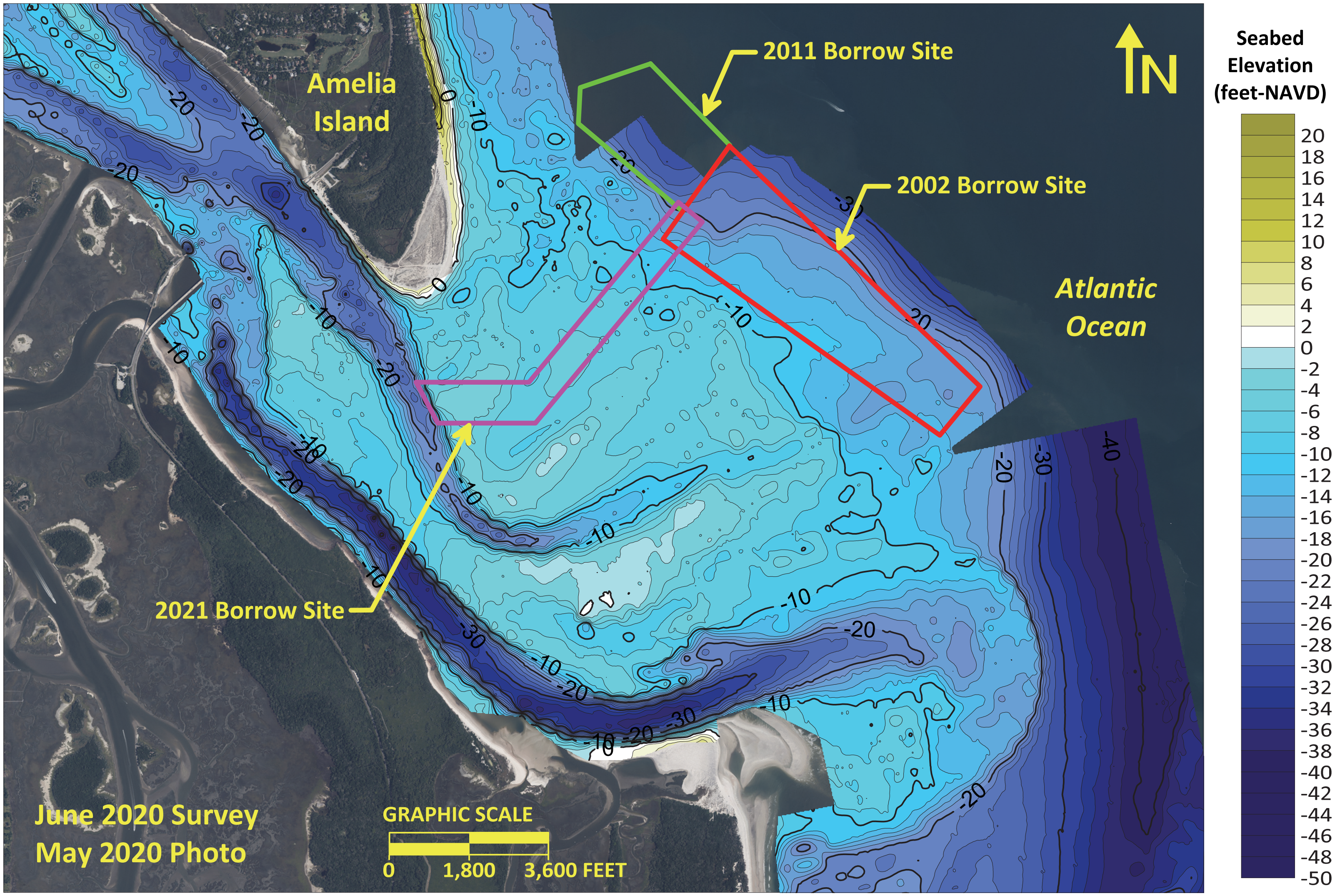

Figure F.12: Nassau Sound bathymetry (June 2020).

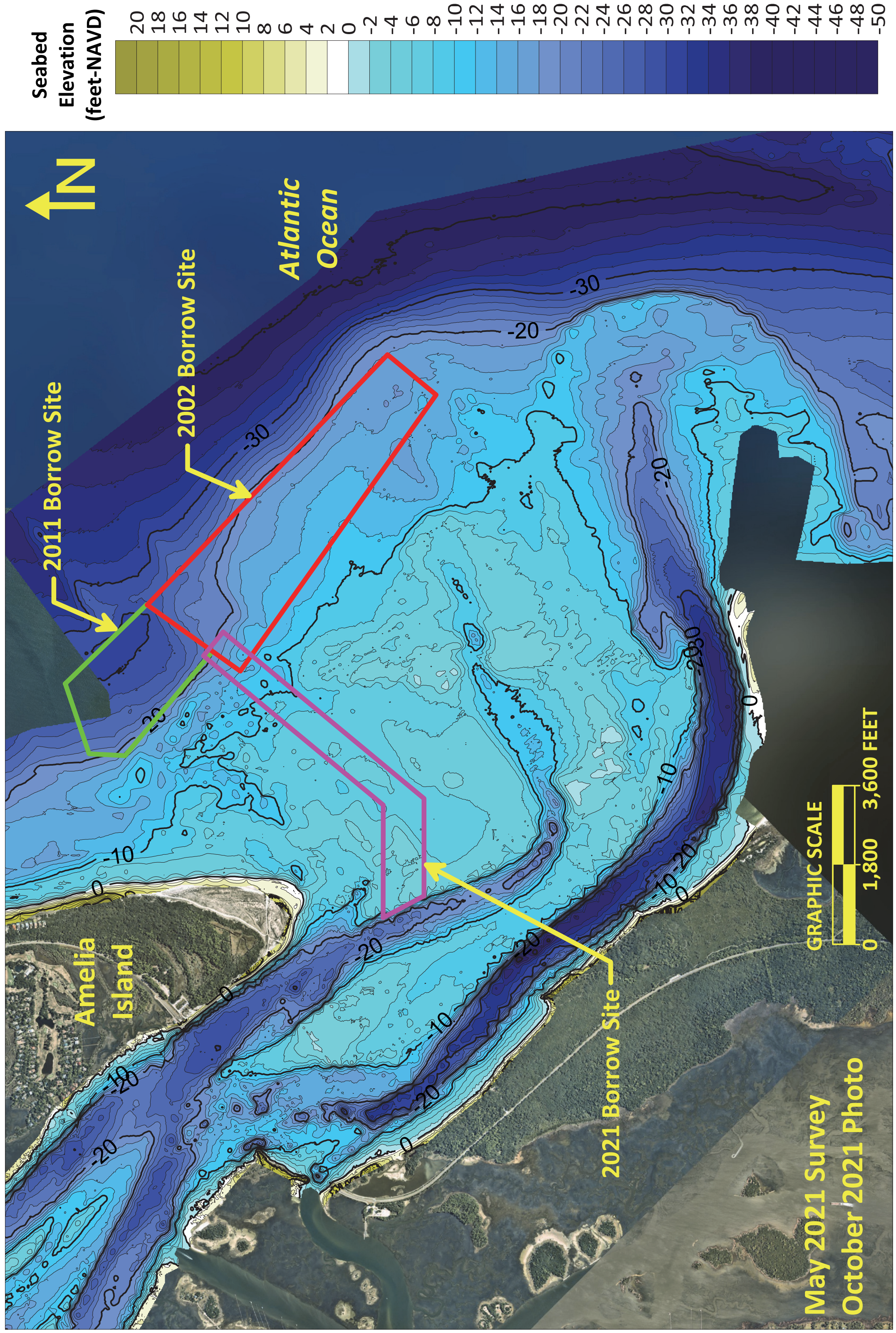

Figure F.12: Nassau Sound bathymetry (May 2021).

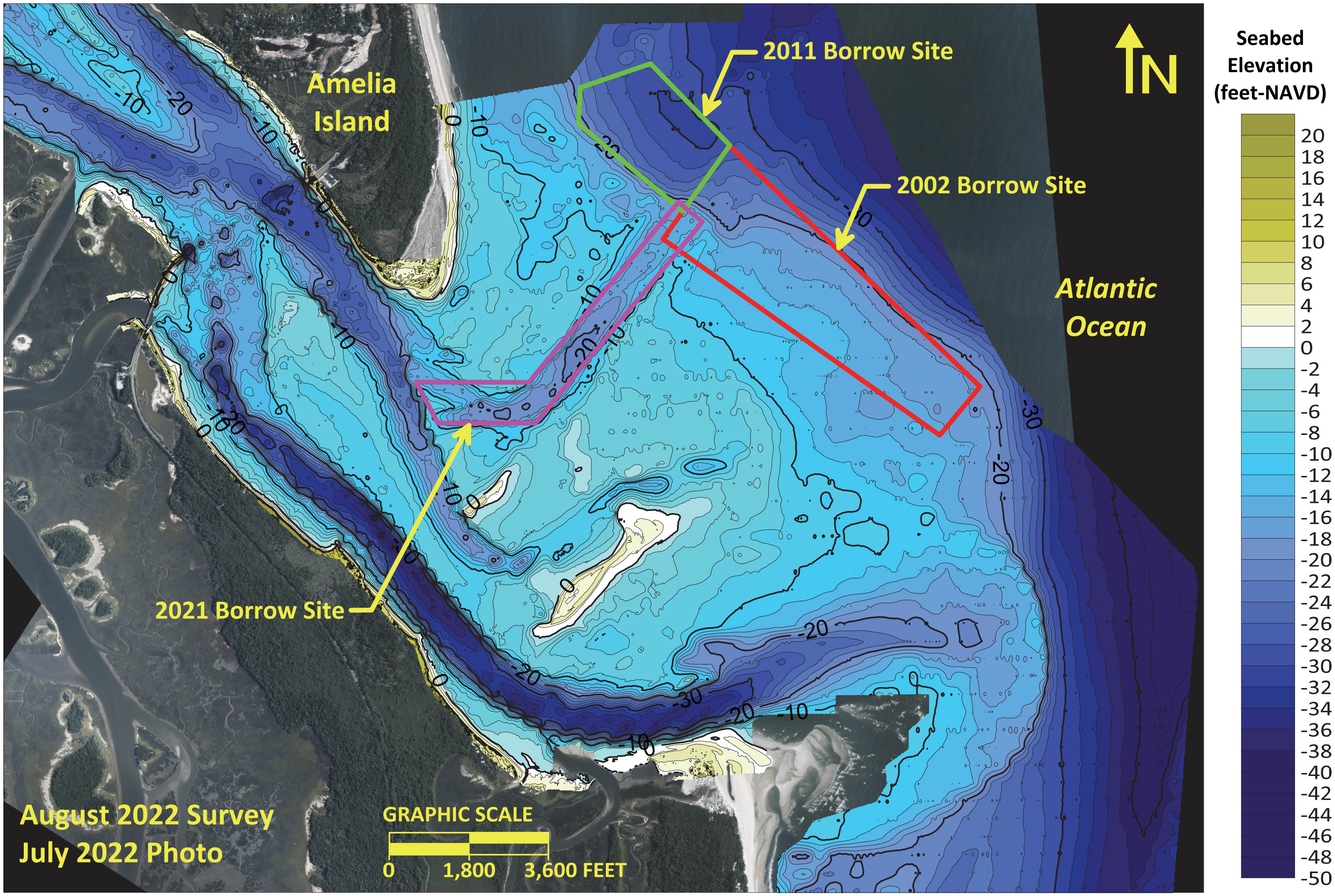

Figure F.14: Nassau Sound bathymetry (August 2022).

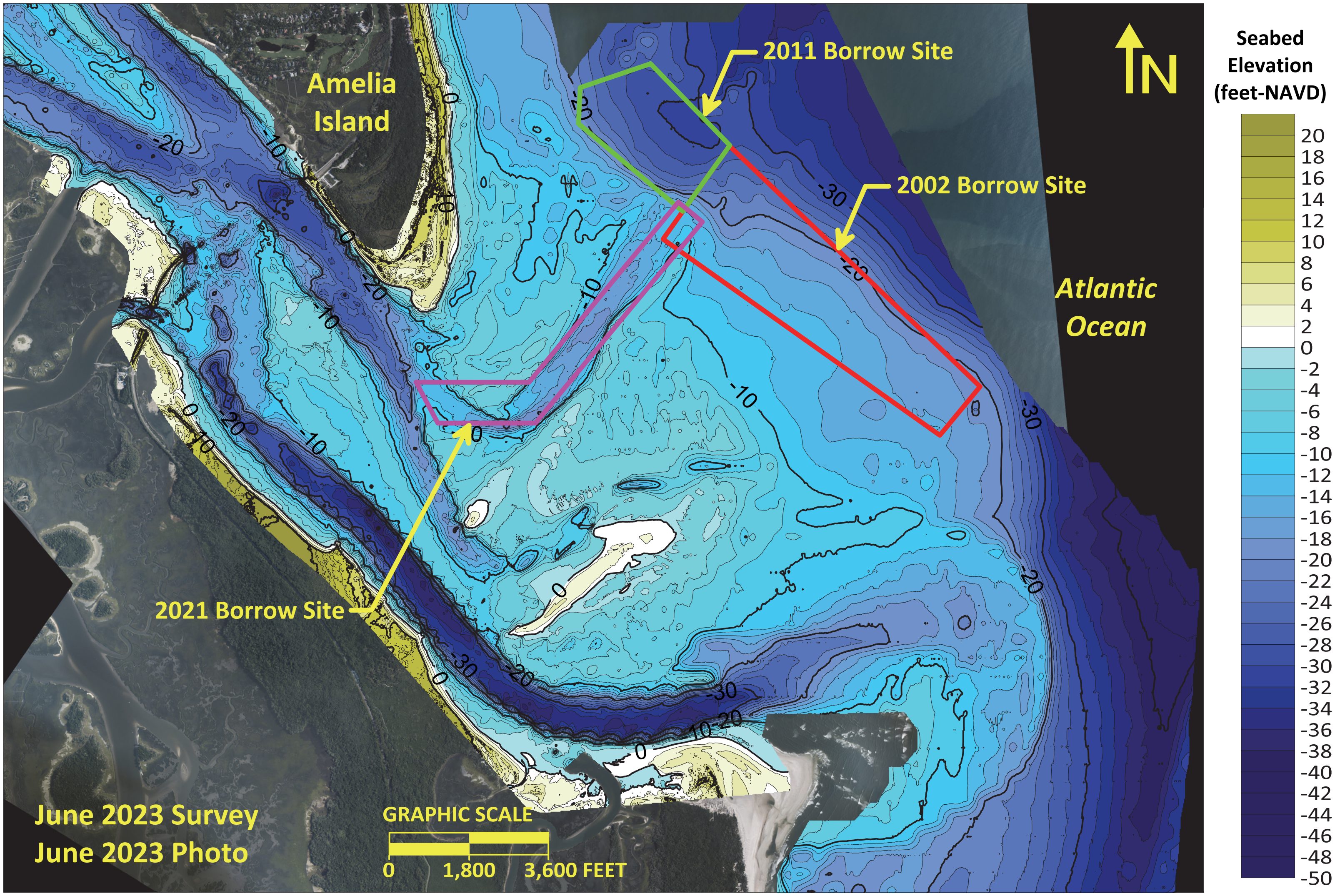

Figure F.15: Nassau Sound bathymetry (June 2023).