

Digital Elevation Model of Central Florida: Procedures, Data Sources, and Analysis

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Summary

In November of 2014, NOAA's National Geophysical Data Center (NGDC) developed an integrated bathymetric–topographic digital elevation model (DEM) of Central Florida for NOAA's National Weather Service (NWS) and Pacific Marine Environmental Laboratory (PMEL). The DEM will be used to support modeling tsunami generation, propagation, and inundation. The DEM covers Central Florida including the communities of Cape Canaveral, Cocoa Beach, Satellite Beach, Melbourne, Sebastian, Indian River Shores, and Fort Pierce. Extents of this DEM, procedures, data sources, and analysis are described below. The methodologies used by NGDC in developing DEM are described in the NOAA Technical Memorandum-52 for Central California and San Francisco Bay (Carignan et al., 2011).

DEM Specifications

The Central Florida DEM was built to the specifications listed in Table 1. Figure 1 shows this 1/3 arc-second Central Florida integrated topographic–bathymetric DEM boundary in red, the 2007 Daytona Beach and 2010 Palm Beach integrated topographic–bathymetric 1/3 arc-second DEMs in green.

Table 1. Specifications for the Central Florida, Florida DEM.

<i>Cell Size</i>	1/3 arc-second
<i>Coverage</i>	79.95° to 80.88° W, 27.27° to 28.88° N
<i>Coordinate System</i>	Geographic decimal degrees
<i>Horizontal Datum</i>	World Geodetic System 1984 (WGS 84)
<i>Vertical Datum</i>	NAVD 88
<i>Vertical Units</i>	Meters
<i>Grid Format</i>	ASCII raster grid

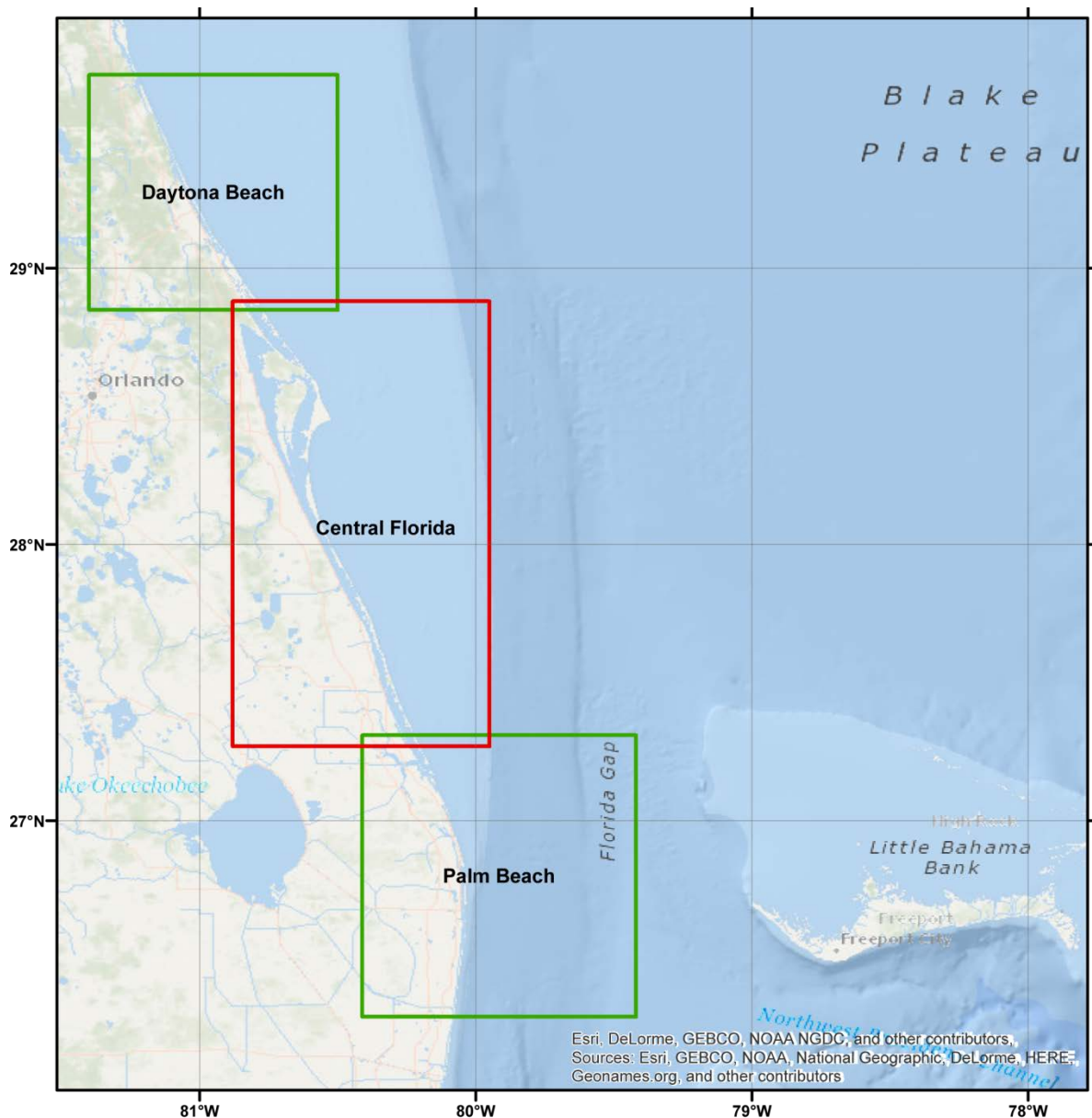


Figure 1. Map image of the boundaries for the 1/3 arc-second Central Florida DEM in red and the previously developed DEMs in green.

Data Sources and Processing

Digital coastlines were extracted from NOAA’s Office of Coast Survey (OCS) ENC Direct to GIS online extraction service (http://nauticalcharts.noaa.gov/csdl/ctp/encdirect_new.htm). These coastlines were merged and edited to match either recently acquired high resolution lidar data or imagery available via Google Earth and ESRI’s World Imagery map service (<http://www.arcgis.com/features/maps/imagery.html>). Bathymetric and topographic data were downloaded from NOAA’s Office for Coastal Management (OCM), the U.S. Army Corps of Engineers (USACE), the South Florida Water Management District (SFWMD), the St. Johns River Water Management District (SJRWMD), U.S. Geological Society (USGS), and NGDC. Figure 2 shows the source and coverage of the datasets used in developing the Central Florida DEM.

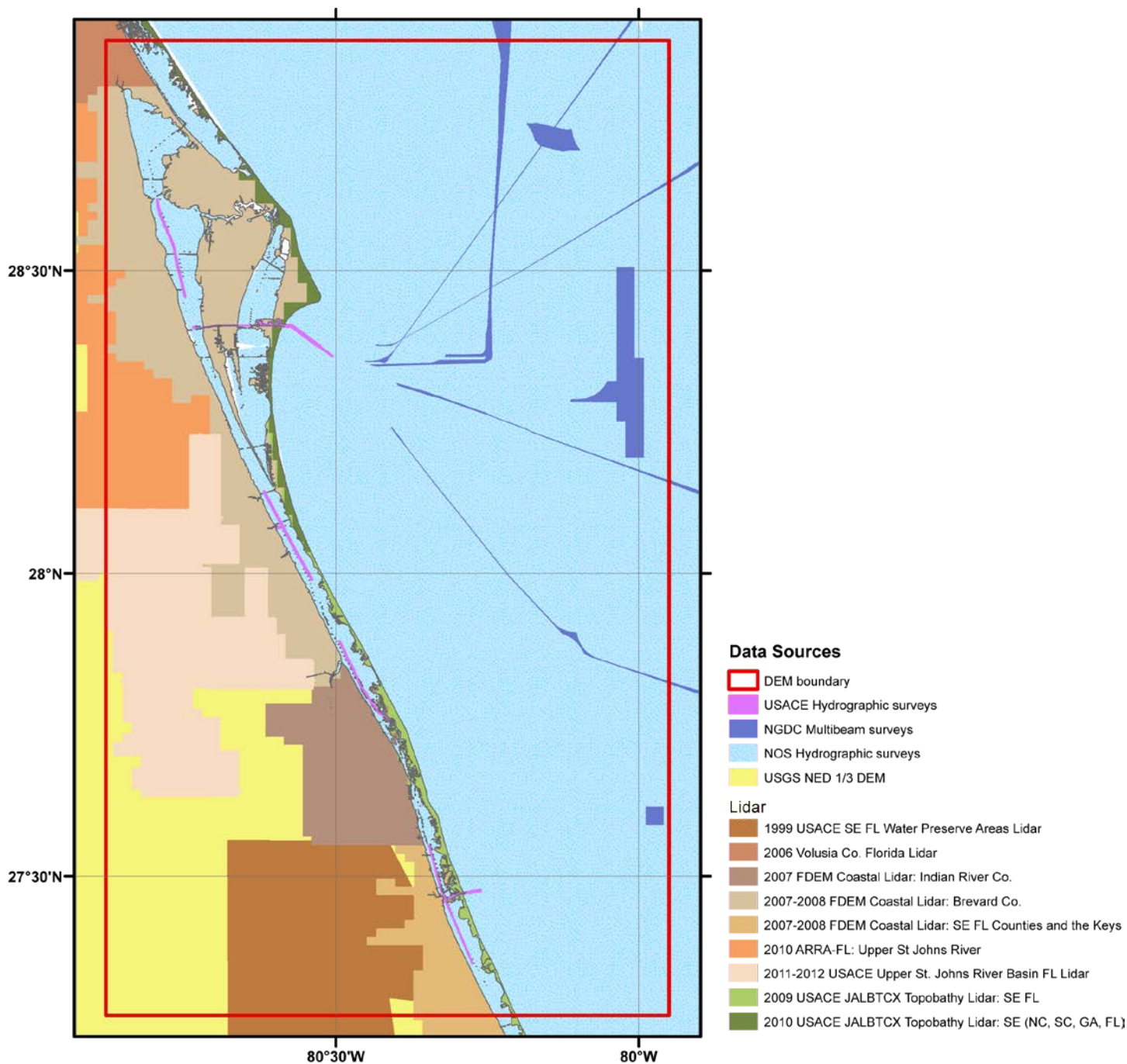


Figure 2. Source and coverage of the datasets used in compiling the Central Florida DEM.

Table 2 lists the bathymetry data used in the compilation of the Central Florida DEM including NOS hydrographic surveys (Appendix A) and multibeam surveys (Appendix B), and USACE harbor surveys.

Table 2: Bathymetric data sources used in compiling the Central Florida DEM.

<i>Source</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
NOAA NOS	1874 to 2007	Hydrographic survey soundings	< 1 meter to several kilometers	Unknown, NAD 27 geographic, NAD 83 geographic, or NAD 83 UTM Zone 17 North	Local Low Water (LLW), Mean Low Water (MLW), or Mean Lower Low Water (MLLW)
USACE	2000 to 2014	Hydrographic condition survey	< 5 meter point spacing and ~ 30 meter line spacing	NAD 83 Florida State Planes, East Zone, US Foot or NAD 27 Florida State Planes, East Zone(901), US Foot	MLW or MLLW
NGDC	1997 to 2010	Multibeam bathymetry	10 meter grid	NAD 83 geographic	Assumed Mean Sea Level (MSL)

Bathymetric data were transformed to WGS 84 geographic and NAVD 88 using GDAL and NOAA's VDatum transformation tool. Table 3 illustrates the range of vertical datums within Central Florida. Where recent, higher resolution data exists, older data were superseded.

Table 3: Central Florida vertical datum information. Difference in vertical datums to MLLW in meters.

	<i>#8721604, Trident Pier, Port Canaveral</i>	<i>#8721649, Cocoa Beach</i>	<i>#8722004, Sebastian Inlet</i>	<i>#8722029, Sebastian, Indian River</i>	<i>#8722105, Vero Beach</i>
NAVD88	0.873	0.856	0.741	0.342	0.921
MHHW	1.193	1.211	0.741	0.136	1.19
MHW	1.086	1.103	0.683	0.114	1.089
MTL	0.569	0.575	0.362	0.068	0.573
MSL	0.573	0.575	0.374	0.068	0.573
MLW	0.053	0.048	0.041	0.021	0.057
MLLW	0	0	0	0	0

The bathymetric data were converted to xyz format before combining with the coastline data to generate a bathymetric pre-surface at 1/3 arc-second. This bathymetric surface grid was converted to xyz format before incorporating in the final DEM.

Topographic-bathymetric data (Table 4) were transformed to WGS 84 geographic using GDAL and converted to xyz format. These data were not clipped to the coastline but where 2010 data existed, the older 2009 data were removed. Topographic data used in developing the Central Florida DEM are listed in Table 5. Transformations to WGS 84 geographic were done using GDAL. As all topographic data were available in NAVD 88, no vertical datum changes were necessary. All topographic data were converted to xyz format for the final gridding process. The converted xyz data files were clipped to the coastline to remove NoData values and returns over water. Jetties and breakwaters that were not completely resolved in the topographic data were supplemented by digitizing the features and creating additional data points with elevation values matching surrounding data. Several small ponds that had NoData values were given a constant value based on surrounding data.

Table 4: Topographic-Bathymetric data source used in compiling the Central Florida DEM.

<i>Source</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
2010 U.S. Army Corps of Engineers (USACE) JALBTCX Topobathy Lidar: Southeast (NC, SC, GA, FL)	2010	Topographic-Bathymetric Lidar DEM	2 meter	NAD 83 geographic	NAVD 88
2009 U.S. Army Corps of Engineers (USACE) JALBTCX Topobathy Lidar: Southeast Florida	2009	Topographic-Bathymetric Lidar DEM	2 meter	NAD 83 geographic	NAVD 88

Table 5: Topographic data sources used in compiling the Central Florida DEM.

<i>Source - Title</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
SFWMD - 1999 U.S. Army Corps of Engineers (USACE) Southeast Florida Water Preserve Areas Lidar	1999 to 2000	Raster DEM	25 foot	NAD 83 HARN State Plane FL East FIPS 0901 (feet)	NAVD 88
OCM - 2006 Volusia County Florida Lidar	2006	Lidar GeoTIFF	2 meters	NAD 83 geographic	NAVD 88
OCM - 2007 Florida Division of Emergency Management (FDEM) Coastal Lidar: Indian River County	2007	Lidar GeoTIFF	2 meters	NAD 83 geographic	NAVD 88
OCM - 2007 Florida Division of Emergency Management (FDEM) Lidar Project: Brevard County	2007 to 2008	Lidar GeoTIFF	2 meters	NAD 83 geographic	NAVD 88
OCM - 2007-2008 Florida Division of Emergency Management (FDEM) Coastal Lidar: Southeast Florida Counties and the Keys	2007 to 2008	Lidar GeoTIFF	2 meters	NAD 83 geographic	NAVD 88

<i>Source - Title</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
SJRWMD - USGS 2010 ARRA-FL: Upper St Johns River North	2010	Raster DEM	3 meters	NAD 83 to UTM zone 17N HARN (meters)	NAVD 88
2011-2012 USACE Upper St. Johns River Basin FL Lidar	2012	DTM	5 feet	NAD 83 NSRS2007 State Plane FL East FIPS 0901 (US feet)	NAVD 88
USGS NED	2013	Topographic DEM	1/3 arc second	NAD 83 geographic	NAVD 88

DEM Development

Development of the Central Florida DEM followed procedures documented in NOAA Technical Memorandum NGDC-52 for Central California and San Francisco Bay (Carignan et al., 2011). Exceptions being the bathymetric pre-surface was generated at 1/3 arc-second. Gridding weight was modified to Table 6.

Table 6: Data hierarchy used to assign gridding weight in MB-System.

<i>Dataset</i>	<i>Relative Gridding Weight</i>
2010 U.S. Army Corps of Engineers (USACE) JALBTCX Topobathy Lidar	1000
NGDC digitized points	1000
2009 U.S. Army Corps of Engineers (USACE) JALBTCX Topobathy Lidar	100
OCM - 2007 Florida Division of Emergency Management (FDEM) Lidar Project: Brevard County	100
OCM - 2006 Volusia County Florida Lidar	100
OCM - 2007-2008 Florida Division of Emergency Management (FDEM) Coastal Lidar: Southeast Florida Counties and the Keys	100
OCM - 2007 Florida Division of Emergency Management (FDEM) Coastal Lidar: Indian River County	100
2011-2012 USACE Upper St. Johns River Basin FL Lidar	100
SJRWMD - USGS 2010 ARRA-FL: Upper St Johns River North	100
SFWMD - 1999 U.S. Army Corps of Engineers (USACE) Southeast Florida Water Preserve Areas Lidar	100
USACE hydrographic surveys	100
NOS hydrographic surveys	100
NGDC multibeam data products	10
Coastline	1
Bathymetric pre-surface	1

<i>Dataset</i>	<i>Relative Gridding Weight</i>
NGDC multibeam surveys	1
USGS NED	0.1

MHW DEM Development

The MHW Central Florida DEM was developed by generating a conversion grid based on VDatum software. The completed conversion grid was then applied to the NAVD 88 DEM.

DEM Analysis

The completed Central Florida DEMs were compared to ENC sounding data, topographic benchmarks, and high resolution imagery. Inconsistencies were evaluated and resolved based on most current or reliable data available.

Acknowledgement

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Reference

Carignan, K.S., L.A. Taylor, B.W. Eakins, R.J. Caldwell, D.Z. Friday, P.R. Grothe, E. Lim (2011). Digital Elevation Models of Central California and San Francisco Bay: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-52, NOAA, pp. 49.

Yang, Z., E. Myers, I. Jeong, S. White (2012). VDatum for Coastal Waters from the Florida Shelf to the South Atlantic Bight: Tidal Datums, Marine Grids, and Sea Surface Topography. NOAA Technical Memorandum NOS CS 27.

VDatum Version 3.3, Florida/Georgia – Coastal Waterways, Fort Lauderdale, FL to Sapelo Island, GA. v.1 (2011). <http://vdatum.noaa.gov/welcome.html> [October 2014].

Appendix A: NOS Surveys

<i>Survey ID</i>	<i>Date</i>	<i>Scale</i>	<i>Original Horizontal Datum</i>	<i>Original Vertical Datum</i>
H01290	1874	10000	UNKNOWN	Mean Low Water
H01291	1875	20000	UNKNOWN	Mean Low Water
H01416	1878	20000	UNKNOWN	Mean Low Water
H01491A	1881	20000	UNKNOWN	Mean Low Water
H01491B	1881	20000	UNKNOWN	Mean Low Water
H01513A	1882	20000	UNKNOWN	Mean Low Water
H01513B	1882	20000	UNKNOWN	Mean Low Water
H01570	1883	20000	UNKNOWN	Mean Low Water
H01571	1883	20000	UNKNOWN	Mean Low Water
H05025	1920	5000	North American Datum 1927	Mean Low Water
H05026	1930	20000	North American Datum 1927	Mean Low Water
H05027	1930	20000	North American Datum 1927	Mean Low Water
H05028	1930	20000	North American Datum 1927	Mean Low Water
H05029	1930	80000	North American Datum 1927	Mean Low Water
H05031	1930	20000	North American Datum 1927	Mean Low Water
H05032	1930	40000	North American Datum 1927	Mean Low Water
H05034	1930	40000	North American Datum 1927	Mean Low Water
H05039	1930	40000	North American Datum 1927	Mean Low Water
H05040	1930	20000	North American Datum 1927	Mean Low Water
H05047	1930	40000	North American Datum 1927	Mean Low Water
H05057	1930	40000	North American Datum 1927	Mean Low Water
H05116	1931	40000	North American Datum 1927	Mean Low Water
H05120	1931	40000	North American Datum 1927	Mean Low Water
H05138	1931	120000	North American Datum 1927	Mean Low Water
H06727	1941	10000	North American Datum 1927	Mean Low Water
H06664	1941	10000	North American Datum 1927	Mean Lower Low Water
H06676	1941	10000	North American Datum 1927	Mean Lower Low Water
H08340	1956	10000	North American Datum 1927	Mean Low Water
H08341	1956	20000	North American Datum 1927	Mean Low Water
H08342	1956	20000	North American Datum 1927	Mean Low Water
H08343	1956	20000	North American Datum 1927	Mean Low Water
H08344	1956	20000	North American Datum 1927	Mean Low Water
H08345	1956	40000	North American Datum 1927	Mean Low Water
H08713	1962	100000	North American Datum 1927	Mean Low Water
H08714	1962	100000	North American Datum 1927	Mean Low Water
H08783	1964	100000	North American Datum 1927	Mean Low Water
H08839	1965	80000	North American Datum 1927	Mean Low Water

<i>Survey ID</i>	<i>Date</i>	<i>Scale</i>	<i>Original Horizontal Datum</i>	<i>Original Vertical Datum</i>
H08840	1965	80000	North American Datum 1927	Mean Low Water
H08879	1966	80000	North American Datum 1927	Mean Low Water
H08956	1967	20000	North American Datum 1927	Mean Low Water
H08957	1967	20000	North American Datum 1927	Mean Low Water
H08958	1967	20000	North American Datum 1927	Mean Low Water
H08959	1967	5000	North American Datum 1927	Mean Low Water
H09344	1973	40000	North American Datum 1927	Mean Low Water
H09633	1976	10000	North American Datum 1927	Mean Low Water
H09665	1976	10000	North American Datum 1927	Mean Low Water
H09606	1976	10000	North American Datum 1927	Local Low Water
H09746	1978	10000	North American Datum 1927	Mean Low Water
H09860	1979	10000	North American Datum 1927	Local Low Water
H09866	1980	10000	North American Datum 1927	Mean Low Water
H09988	1981	10000	North American Datum 1927	Mean Low Water
H10067	1982	10000	North American Datum 1927	Local Low Water
H09994	1982	10000	North American Datum 1927	Mean Low Water
D00082	1983	25000	North American Datum 1927	Local Low Water
H10071	1983	10000	North American Datum 1927	Local Low Water
F00458	2000	10000	North American Datum 1983	Mean Lower Low Water
H11531	2006	10000	NAD 83 UTM 17	Mean Lower Low Water
H11532	2006	10000	NAD 83 UTM 17	Mean Lower Low Water
H11534	2006	10000	NAD 83 UTM 17	Mean Lower Low Water
H11590	2006	10000	NAD 83 UTM 17	Mean Lower Low Water
F00520	2006	5000	NAD 83 UTM 17	Mean Lower Low Water
H11533	2007	10000	NAD 83 UTM 17	Mean Lower Low Water
F00544	2007	5000	NAD 83 UTM 17	Mean Lower Low Water

Appendix B: NGDC Multibeam surveys

<i>Survey ID</i>	<i>Date</i>	<i>Ship</i>	<i>Institution</i>	<i>Original Horizontal Datum</i>	<i>Original Vertical Datum</i>
EW9702	1997	Maurice Ewing	Lamont-Doherty Earth Observatory (L-DEO)	NAD 83 geographic	assumed MSL
EW9703	1997	Maurice Ewing	L-DEO	NAD 83 geographic	assumed MSL
NF1015ARF	2010	Nancy Foster	NOAA	NAD 83 geographic	assumed MSL
PAT0503	2003	Pathfinder	U.S. Navy	NAD 83 geographic	assumed MSL
SAB2005*	2005	Cape Fear	University of North Carolina at Wilmington	NAD 83 UTM Zone 17 North	assumed MSL

* Derived multibeam products were used instead of raw mb files.