

Digital Elevation Models of Cold Bay and King Cove, Alaska: Procedures, Data Sources, and Analysis

Prepared for the National Tsunami Hazard Mitigation Program (NTHMP) and the University of Alaska at Fairbanks (UAF) by the NOAA National Geophysical Data Center (NGDC)

December 24, 2013

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Summary

In December of 2013, NOAA’s National Geophysical Data Center (NGDC) developed integrated bathymetric–topographic digital elevation models (DEMs) of Cold Bay and King Cove, Alaska for the National Tsunami Hazard Mitigation Program (NTHMP) and for the Geophysical Institute at the University of Alaska, Fairbanks (UAF). The nested DEMs will be used to support modeling tsunami generation, propagation, and inundation. The DEMs cover the western portion of the Alaska Peninsula in the Aleutians East Borough. The communities are less than 30 km apart and have a combined population of around 1000. Extents of these DEMs, procedures, data sources, and analysis are described below. The methodologies used by NGDC in developing nested DEMs are described in the NOAA Technical Memorandum-40 for Prince William Sound, Alaska (Caldwell et al., 2011).

DEM Specifications

The Cold Bay and King Cove DEMs were built to the specifications listed in Table 1. Figure 1 shows the Cold Bay DEM boundaries in red and King Cove DEM boundaries in green.

Table 1. Specifications for the nested Cold Bay and King Cove, Alaska DEMs.

	Cold Bay, Alaska	King Cove, Alaska
Cell Size	Coverage Area	
<i>8/15 arc-second</i>	162.58° to 162.78° W, 55.14° to 55.26° N	162.24° to 162.38° W, 55.00° to 55.10° N
<i>8/3 arc-second</i>	162.10° to 163.10° W, 54.70° to 55.70° N	161.84° to 162.80° W, 54.58° to 55.34° N
<i>8 arc-second</i>	161.50° to 164.50° W, 53.00° to 56.00° N	161.80° to 163.80° W, 54.24° to 55.50° N
Coordinate System	Geographic decimal degrees	
Horizontal Datum	World Geodetic System 1984 (WGS 84)	
Vertical Datum	Mean Higher High Water (MHHW)	
Vertical Units	Meters	
Grid Format	ASCII raster grid	

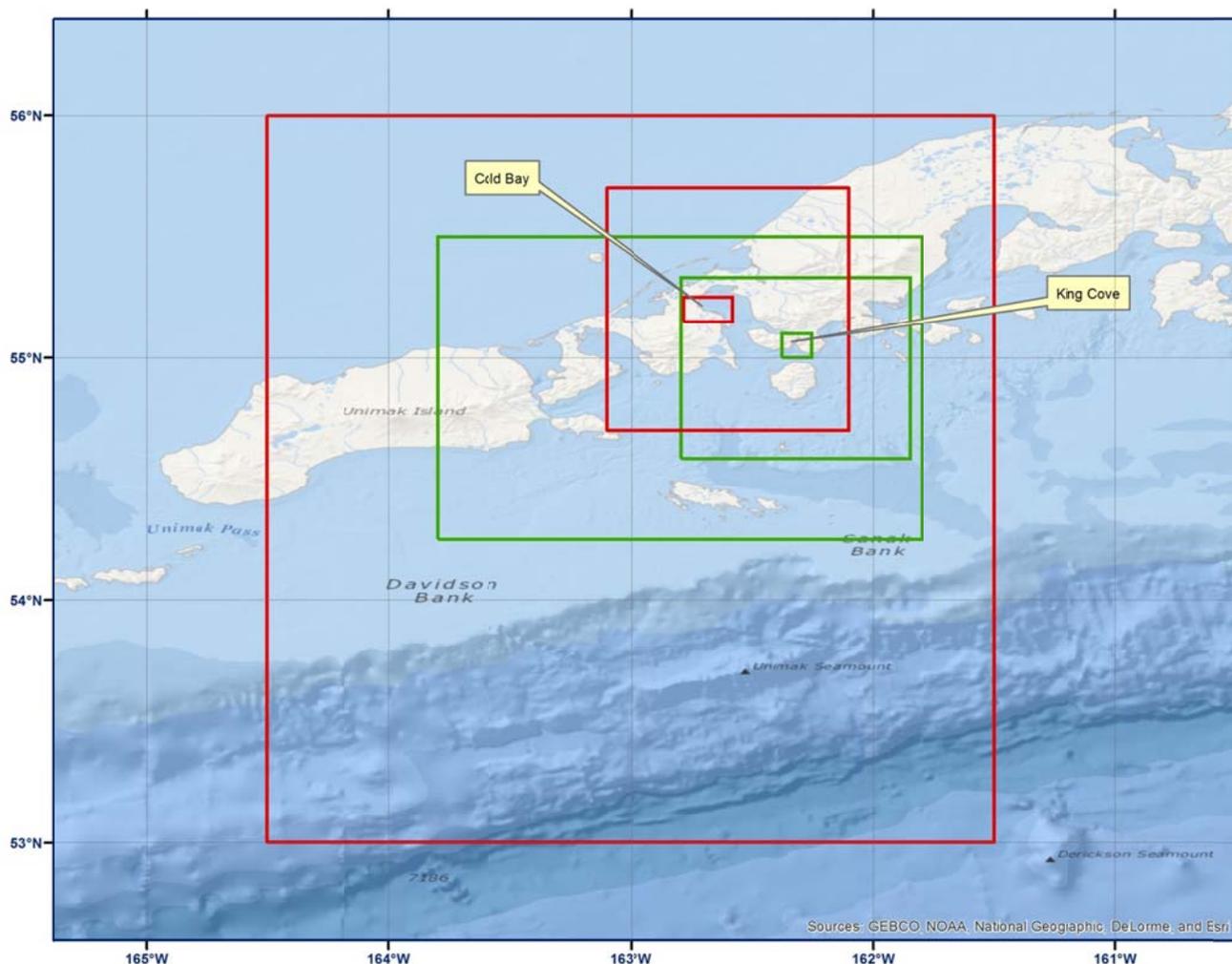


Figure 1. Map image of the boundaries for the 8/15, 8/3, and 8 arc-second Cold Bay nested DEMs in red and King Cove DEMs in green.

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). The coastlines were merged and edited to match ESRI’s World Imagery map service (<http://www.arcgis.com/features/maps/imagery.html>), and topographic data.

Table 2 lists the bathymetry data used in the compilation of the Cold Bay and King Cove DEM including NOS hydrographic surveys (Appendix A), NOAA Electronic Navigational Chart (ENC) soundings, USACE harbor surveys, NGDC trackline bathymetry, and NGDC multibeam survey data (Appendix B). ENC sounding data 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). The USACE Alaska District provided NGDC with hydrographic condition survey data for King Cove Harbor and Babe Newman Harbor. NOS hydrographic survey data were downloaded from NGDC. Multibeam surveys were downloaded from NGDC as 3 arc-second

gridded data and converted to point data. The multibeam data was edited in *QT Modeler* removing overlapping data and eliminating errors in data collection.

Table 2: Bathymetric data sources used in compiling the Cold Bay and King Cove 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	1901 to 2009	Hydrographic survey soundings	1 meter to several kilometers	Unknown, Early Alaska Datums, NAD 1927, NAD 83 UTM Zone 3, or NAD 83 UTM Zone 4	Mean Lower Low Water (MLLW)
NOAA OCS	1966 to 2012	Extracted chart soundings	20 meters to hundreds of meters	WGS 84 geographic	MLLW
USACE	2010	Hydrographic condition survey	1 meter to 10 meters	NAD 83 AK (CORS96) State Plane Zone 5 (feet)	MLLW
NGDC multibeam	1984 to 2012	Multibeam swath sonar	Gridded to 3 arc-second	NAD 83 geographic	Assumed Mean Sea Level (MSL)
NGDC Trackline	1957 to 2004	Trackline bathymetry	~100 meters to 1000 meters	NAD 83 geographic	Assumed Mean Sea Level (MSL)

Bathymetric data were transformed to WGS 84 and MHHW as needed and where recent, higher resolution data exists, older data were deleted. A digital version of NOS hydrographic survey H04492 was not available so this survey was manually digitized. Vertical datum transformations were based on the NOAA tide station located in King Cove Harbor (Table 3).

Table 3: Relationship between MHHW and other vertical datums at the King Cove tide gauge # 9459881.

<i>Vertical Datum</i>	<i>Difference to MHHW (meters)</i>
MHHW	0
MHW	0.207
MTL	0.942
MSL	0.957
MLW	1.678
MLLW	2.082

The bathymetric data were converted to xyz format before combining with the coastline data to generate bathymetric pre-surfaces at 1/3 arc-second, 1 arc-second, and 3 arc-second. These bathymetric surface grids were converted to xyz format before incorporating in the final DEM. The 1/3 arc-second surface was used in the 8/15 arc-second DEM, the 1 arc-second surface was used in the 8/3 arc-second DEM, and the 3 arc-second surface was used in the 8 second DEM.

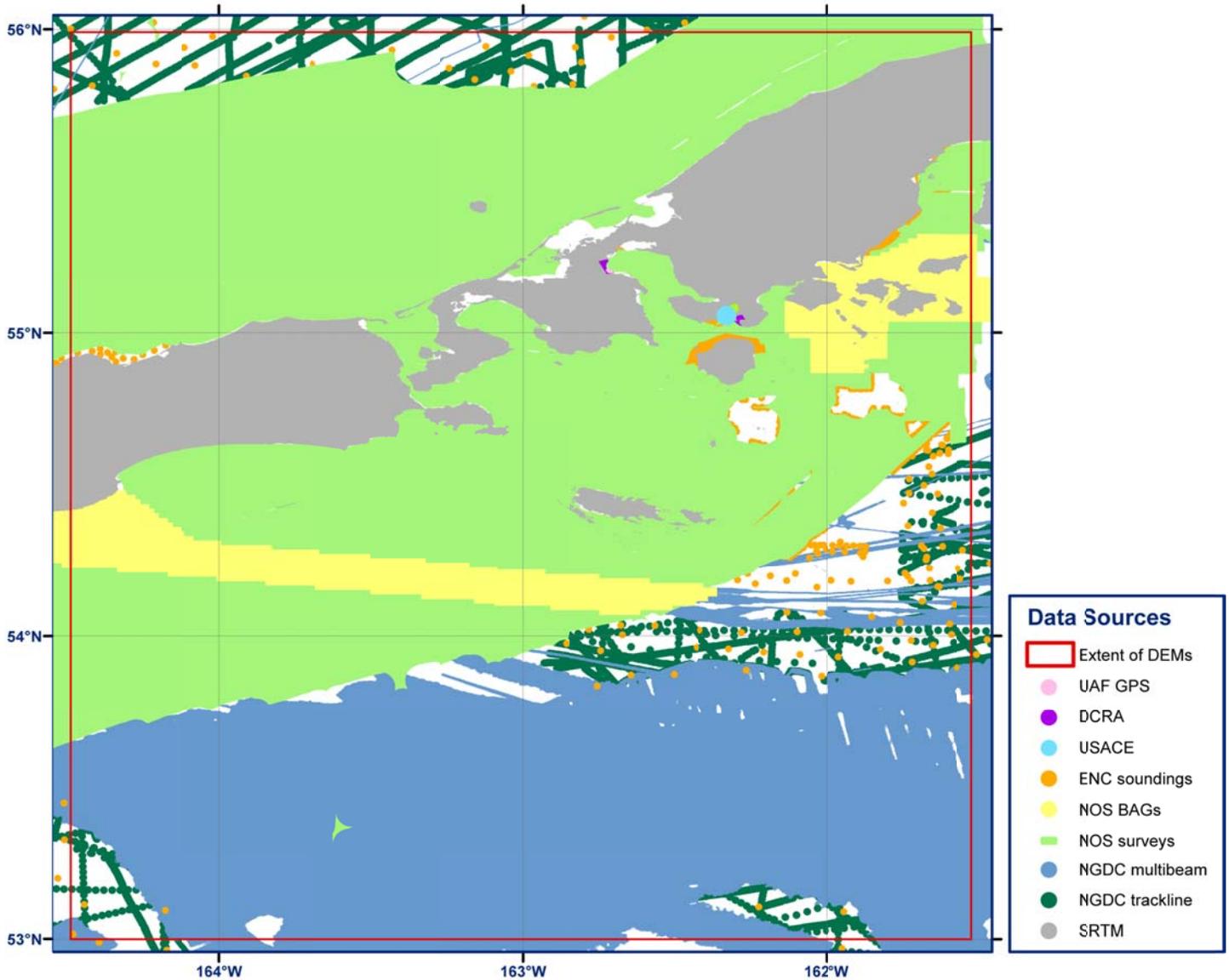


Figure 2. Source and coverage of the datasets used in compiling the Cold Bay and King Cove DEMs.

Topographic data used in developing the Cold Bay and King Cove DEM is listed in Table 4. Alaska’s Division of Community and Regional Affairs (DCRA) provided topographic data of both communities. The CAD files were transformed to GIS format using ArcGIS. The USACE harbor survey also provided detailed topographic coverage of the harbor areas. The SRTM DEM provided full topographic coverage at 1 arc-second. The void filled version was used to eliminate the need for additional low resolution data patches. Vertical datum transformations were based on the NOAA tide station located in King Cove Harbor (Table 3). All topographic data were converted to xyz format for the final gridding process.

Table 4: Topographic data sources used in compiling the Cold Bay and King Cove DEM.

<i>Source</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
DCRA	2002	CAD	< 1 meter	NAD 83 Alaska State Plane Zone 7 North (ft.)	NAVD 88
SRTM void filled	2001	Topographic DEM	1 arc second	WGS 84 geographic	EGM96 (Earth Gravitational Model 1996)
USACE	2010	Topographic points	~ 10 meter point spacing	NAD 83 Alaska State Plane Zone 7 North (ft.)	MLLW
UAF	2011?	GPS points			MHHW

DEM Development

Development of the Cold Bay and King Cove DEM followed procedures documented in NOAA Technical Memorandum NGDC-40 for Prince William Sound, Alaska (Caldwell et al., 2011). Exceptions being the bathymetric pre-surfaces were generated at 1/3, 1, and 3 arc-seconds. The following data were used in the bathy surface but not the final grids, pre-1943 NOS survey data, coastal scale ENC soundings data, and trackline. Gridding weight was modified to Table 5.

Table 5: Data hierarchy used to assign gridding weight in MB-System.

<i>Dataset</i>	<i>Relative Gridding Weight</i>
UAF GPS points	1000
USACE topographic points	1000
NOS BAGs	100
DCRA extracted topographic points	100
NOS surveys (no pre-1943)	10
USACE hydrographic survey	10
SRTM DEM	1
Bathymetric pre-surface	1
Extracted ENC approach and harbor soundings	1
Coastline	1
NGDC multibeam swath sonar	.1

DEM Analysis

The completed Cold Bay and King Cove DEMs were compared to nautical charts, topographic maps, and high resolution imagery. Inconsistencies were evaluated and resolved based on most reliable data available.

Acknowledgement

The authors thank Anne Dollard (USACE, Alaska District) and George Plumley (State of Alaska, Division of Community and Regional Affairs, DCRA) for providing data used in developing the Cold Bay and King Cove, Alaska DEMs.

Reference

Caldwell, R.J., B.W. Eakins, E. Lim (2011). Digital Elevation Model of Prince William Sound, Alaska: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-40, NOAA, pp. 41.

Appendix A: NOS Surveys

<i>Survey ID</i>	<i>Date</i>	<i>Scale</i>	<i>Original Horizontal Datum</i>	<i>Original Vertical Datum</i>
H02557	1901		UNKNOWN	Mean Lower Low Water
H03194	1910		UNKNOWN	Mean Lower Low Water
H03305	1911	40000	UNKNOWN	Mean Lower Low Water
H03305A	1911	20000	UNKNOWN	Mean Lower Low Water
H03579	1913	180000	UNKNOWN	Mean Lower Low Water
H03654	1913	100000	UNKNOWN	Mean Lower Low Water
H04301	1923	60000	UNKNOWN	Mean Lower Low Water
H04314	1923	20000	UNKNOWN	Mean Lower Low Water
H04315	1923	20000	UNKNOWN	Mean Lower Low Water
H04374	1924	20000	UNKNOWN	Mean Lower Low Water
H04375	1923	20000	UNKNOWN	Mean Lower Low Water
H04378	1924	20000	UNKNOWN	Mean Lower Low Water
H04380	1924	20000	UNKNOWN	Mean Lower Low Water
H04391	1924	10000	UNKNOWN	Mean Lower Low Water
H04394	1924	20000	UNKNOWN	Mean Lower Low Water
H04490	1925	20000	UNKNOWN	Mean Lower Low Water
H04491	1925	40000	UNKNOWN	Mean Lower Low Water
H04492	1925	10000	UNKNOWN	Mean Lower Low Water
H04393	1924	20000	UNKNOWN	Mean Lower Low Water
H04496	1925	20000	UNKNOWN	Mean Lower Low Water
H04498	1925	20000	UNKNOWN	Mean Lower Low Water
H04499	1925	20000	UNKNOWN	Mean Lower Low Water
H04500	1925	20000	UNKNOWN	Mean Lower Low Water
H06139	1936	80000	Early Alaska Datums	Mean Lower Low Water
H06143	1936	40000	Early Alaska Datums	Mean Lower Low Water
H06146	1936	20000	Early Alaska Datums	Mean Lower Low Water
H06150	1936	10000	Early Alaska Datums	Mean Lower Low Water
H06270	1937	240000	UNKNOWN	Mean Lower Low Water
H06278	1937	80000	Early Alaska Datums	Mean Lower Low Water
H06279	1937	80000	Early Alaska Datums	Mean Lower Low Water
H06280	1937	10000	Early Alaska Datums	Mean Lower Low Water
H06281	1937	20000	Early Alaska Datums	Mean Lower Low Water
H06384	1938	10000	Early Alaska Datums	Mean Lower Low Water
H06385	1938	20000	Early Alaska Datums	Mean Lower Low Water
H06386	1938	20000	Early Alaska Datums	Mean Lower Low Water
H06387	1938	40000	Early Alaska Datums	Mean Lower Low Water
H06464	1939	80000	UNKNOWN	Mean Lower Low Water
H06465	1939	40000	UNKNOWN	Mean Lower Low Water
H06482	1939	10000	UNKNOWN	Mean Lower Low Water
H06483	1939	40000	Early Alaska Datums	Mean Lower Low Water
H06484	1938	40000	Early Alaska Datums	Mean Lower Low Water
H06485	1940	40000	Early Alaska Datums	Mean Lower Low Water
H06486	1939	80000	Early Alaska Datums	Mean Lower Low Water
H06487	1940	20000	Early Alaska Datums	Mean Lower Low Water
H06488	1939	20000	Early Alaska Datums	Mean Lower Low Water

<i>Survey ID</i>	<i>Date</i>	<i>Scale</i>	<i>Original Horizontal Datum</i>	<i>Original Vertical Datum</i>
H06586	1940	40000	Early Alaska Datums	Mean Lower Low Water
H06587	1940	20000	Early Alaska Datums	Mean Lower Low Water
H06588	1940	20000	Early Alaska Datums	Mean Lower Low Water
H06589	1940	20000	Early Alaska Datums	Mean Lower Low Water
H06590	1940	20000	Early Alaska Datums	Mean Lower Low Water
H06591	1940	20000	Early Alaska Datums	Mean Lower Low Water
H06592	1940	10000	Early Alaska Datums	Mean Lower Low Water
H06593	1940	20000	Early Alaska Datums	Mean Lower Low Water
H06624	1941	20000	Early Alaska Datums	Mean Lower Low Water
H06699	1941	40000	Early Alaska Datums	Mean Lower Low Water
H06702	1941	20000	Early Alaska Datums	Mean Lower Low Water
H06703	1941	20000	Early Alaska Datums	Mean Lower Low Water
H06704	1941	5000	Early Alaska Datums	Mean Lower Low Water
H06716	1941	10000	Early Alaska Datums	Mean Lower Low Water
H06736	1940	120000	Early Alaska Datums	Mean Lower Low Water
H06767	1942	20000	Early Alaska Datums	Mean Lower Low Water
H06768	1942	20000	Early Alaska Datums	Mean Lower Low Water
H06769	1942	20000	Early Alaska Datums	Mean Lower Low Water
H06772	1942	20000	Early Alaska Datums	Mean Lower Low Water
H06773	1942	20000	UNKNOWN	Mean Lower Low Water
H06790	1941	40000	Early Alaska Datums	Mean Lower Low Water
H06791	1941	80000	Early Alaska Datums	Mean Lower Low Water
H06972	1943	20000	Early Alaska Datums	Mean Lower Low Water
H06973	1943	100000	Early Alaska Datums	Mean Lower Low Water
H07030	1943	100000	Early Alaska Datums	Mean Lower Low Water
H07031	1945	5000	Early Alaska Datums	Mean Lower Low Water
H07972	1952	200000	UNKNOWN	Mean Lower Low Water
H08297	1956	20000	Early Alaska Datums	Mean Lower Low Water
H08298	1956	20000	Early Alaska Datums	Mean Lower Low Water
H08299	1956	20000	Early Alaska Datums	Mean Lower Low Water
H08300	1956	20000	Early Alaska Datums	Mean Lower Low Water
H08301	1956	20000	Early Alaska Datums	Mean Lower Low Water
H08302	1956	40000	Early Alaska Datums	Mean Lower Low Water
H08303	1956	40000	Early Alaska Datums	Mean Lower Low Water
H08304	1956	100000	Early Alaska Datums	Mean Lower Low Water
H08373	1957	20000	Early Alaska Datums	Mean Lower Low Water
H08374	1957	20000	Early Alaska Datums	Mean Lower Low Water
H08375	1957	20000	Early Alaska Datums	Mean Lower Low Water
H08432	1958	20000	North American Datum 1927	Mean Lower Low Water
H08433	1958	20000	North American Datum 1927	Mean Lower Low Water
H08434	1958	60000	North American Datum 1927	Mean Lower Low Water
H08485	1959	20000	North American Datum 1927	Mean Lower Low Water
H08486	1959	20000	North American Datum 1927	Mean Lower Low Water
H08488	1959	60000	North American Datum 1927	Mean Lower Low Water
H11436	2005	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11437	2005	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11438	2005	10000	NAD83 UTM zone 4 north	Mean Lower Low Water

<i>Survey ID</i>	<i>Date</i>	<i>Scale</i>	<i>Original Horizontal Datum</i>	<i>Original Vertical Datum</i>
H11439	2005	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11487	2005	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11488	2005	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11900	2008	10000	NAD83 UTM zone 3 north	Mean Lower Low Water
H11901	2008	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11902	2008	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11903	2008	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11904	2008	10000	NAD83 UTM zone 3 north	Mean Lower Low Water
H11905	2008	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11931	2008	10000	NAD83 UTM zone 4 north	Mean Lower Low Water
H11932	2008	20000	NAD83 UTM zone 4 north	Mean Lower Low Water
H12065	2009	40000	NAD83 UTM zone 3 north	Mean Lower Low Water
H12066	2009	40000	NAD83 UTM zone 3 north	Mean Lower Low Water
H12067	2009	40000	NAD83 UTM zone 3 north	Mean Lower Low Water
H12076	2009	40000	NAD83 UTM zone 4 north	Mean Lower Low Water
H12077	2009	40000	NAD83 UTM zone 4 north	Mean Lower Low Water
H12079	2009	40000	NAD83 UTM zone 4 north	Mean Lower Low Water
H12080	2009	40000	NAD83 UTM zone 4 north	Mean Lower Low Water
H12081	2009	40000	NAD83 UTM zone 4 north	Mean Lower Low Water

Appendix B: NGDC Multibeam Surveys

<i>Survey ID</i>	<i>Date</i>	<i>Ship</i>	<i>Source</i>
EW9408	1994	Maurice Ewing	Marine Geoscience Data System (MGDS)
FOCI93	1993	Surveyor	National Oceanic and Atmospheric Administration (NOAA)
HLY0201	2002	Healy	UNOLS R2R
HLY0401	2004	Healy	UNOLS R2R
HLY05TC	2005	Healy	UNOLS R2R
HLY06TD	2006	Healy	UNOLS R2R
HLY06TE	2006	Healy	UNOLS R2R
HLY06TG	2006	Healy	UNOLS R2R
HLY06TH	2006	Healy	UNOLS R2R
HLY07TD	2007	Healy	UNOLS R2R
HLY07TG	2007	Healy	UNOLS R2R
HLY07TH	2007	Healy	UNOLS R2R
HLY0803	2008	Healy	UNOLS R2R
HLY08TC	2008	Healy	UNOLS R2R
HLY08TD	2008	Healy	UNOLS R2R
HLY08TG	2008	Healy	UNOLS R2R
HLY08TI	2008	Healy	UNOLS R2R
HLY0901	2009	Healy	UNOLS R2R
HLY09TC	2009	Healy	UNOLS R2R
HLY09TD	2009	Healy	UNOLS R2R
HLY09TE	2009	Healy	UNOLS R2R
HLY1001	2010	Healy	UNOLS R2R
HLY10TD	2010	Healy	UNOLS R2R
HLY10TE	2010	Healy	UNOLS R2R
HLY1101	2011	Healy	UNOLS R2R
HLY1104	2011	Healy	UNOLS R2R
HLY11TD	2011	Healy	UNOLS R2R
HLY11TE	2011	Healy	UNOLS R2R
HLY12TB	2012	Healy	UNOLS R2R
KN195-09	2009	Knorr	UNOLS R2R
KRUS02RR	2004	Roger Revelle	University of California, Scripps Institution of Oceanography (UC/SIO)
KRUS03RR	2004	Roger Revelle	UC/SIO
MGL1110	2011	Marcus G. Langseth	UNOLS R2R
MGLN44MV	2008	Marcus G. Langseth	UNOLS R2R
MGLN45MV	2008	Marcus G. Langseth	UNOLS R2R
MRTN03WT	1984	Thomas Washington	UC/SIO
RNDB05WT	1988	Thomas Washington	UC/SIO
TN250	2010	Thomas G. Thompson	UNOLS R2R