# **DESCRIPTIVE REPORT**

Type of Survey:	Habitat Mapping		
Registry Number:	W00603		
	LOCALITY		
State(s):	Florida		
General Locality:	Florida Keys National Marine Sanctuary		
Sub-locality:	Dry Tortugas		
-	2021		
CHIEF OF PARTY Timothy Battista			
	LIBRARY & ARCHIVES		
Date:			

W00603

NATIONAL	REGISTRY NUMBER:				
HYDROGRAP	W00603				
INSTRUCTIONS: The Hydrog	<b>INSTRUCTIONS:</b> The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.				
State(s):	Florida				
General Locality:	Florida Keys National Marine Sanctu	ary			
Sub-Locality:	Dry Tortugas				
Scale:	15000				
Dates of Survey:	03/18/2021 to 04/10/2021				
Instructions Dated:	02/25/2021				
Project Number:	ESD-PHB-21				
Field Unit:	NOAA Ship Nancy Foster				
Chief of Party:	Timothy Battista				
Soundings by:	Kongsberg Maritime EM 2040 (MBES)				
Imagery by:	Kongsberg Maritime EM 2040 (MBE	S Backscatter)			
Verification by:	Atlantic Hydrographic Branch				
Soundings Acquired in:	meters at Mean Lower Low Water				

Remarks:

Field Acquisition - NF-21-01

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in NAD83 UTM 17N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

# DESCRIPTIVE REPORT SUMMARY

### A. Area Surveyed

This hydrographic survey was conducted without formal project instructions. The survey was referred to as NF-21-01 FKNMS EFH during field acquisition and was assigned by AHB to ESD-AHB-21 and Registary Number W00603 after acquisition.

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
24° 45' 48" N	24° 34' 10" N
38° 6' 15" W	82° 40' 3" W



Figure 1: NF 21-01 FKNMS EFH

The project number was updated upon ingestion to ESD-PHB-21.

#### **B.** Survey Purpose

The project is being conducted in support of the National Center for Coastal Ocean Science (NCCOS) to provide bathymetric data of critical benthic habitats in the Florida Keys national Marine Sanctuary. Bathymetric and Acoustic Backscatter data from the project was collected with Kongsberg multibeam echosounders (MBES) and will be utilized by the Office of Coast Survey (OCS) to update the nautical charts in the surveyed area and the Marine Spatial Ecology Division to create benthic habitat charts.



#### C. Intended Use of Survey

The entire survey is adequate to supersede previous data.

#### D. Data Acquisition and Processing

No Data Acquisition and Processing Report (DAPR) is provided with this survey.

This survey was conducted from the NOAA Ship Nancy Foster and using the complete coverage MBES specification as defined in the Hydrographic Survey Specifications and Deliverables (HSSD). Prior to data collection at the Areas of Interest (AOI), static drafts were measured and confirmed with the SIS/HVF and a patch test was performed on both MBES systems on DN079. While conducting the survey bathymetric coverage was monitored by creating CUBE surfaces with 2m resolutions as per the HSSD. Sounding densities generally meet the 95% of all nodes population criteria. The NF21 Dry Tortugas AOI was surveyed with both Kongsberg EM2040 and Kongsberg EM710 systems simultaneously, although only the EM2040 data was post-processed and the EM710 will be used for multi-spectral analysis only if needed. Acoustic backscatter and intermittent water column data information was concurrently collected with the MBES data for additional habitat delineation.

The Nancy Foster is outfitted with an Applanix POS/MV 320 Version 5 GNSS inertial system. The POS/MV was used to measure attitude, heading, heave, and position for the MBES system. The POS/MV is comprised of an Inertial Motion Unit (IMU), two dual frequency GNSS antennas and a topside control unit. The POS/MV is augmented in real time with Fugro Marinestar SBAS Satellite service which improves the POS/MV positional accuracies to sub-DGPS standards. The POS/MV position, timing, heading and motion data were output to the Hypack and SIS acquisition systems using the POS/MV real-time ethernet option at 25 Hz. Additionally, using ethernet and USB logging controls, the POS/MV was configured to log TrueHeave<sup>TM</sup> and all of the raw observable groups needed to post process real-time navigation data. The POS/MV logged 13 megabyte files, which resulted in multiple files created per day.

The POS/MV onboard the foster incurred intermittent dropouts that made several \*.all files to have no ellipsoidal heights embedded within the navigation data. The days/lines that were effected were DN082/0134-139 and DN098/644 and DN100/0744. Attempts were made using POSpac SBETs and reapplication of GPS Heights with the \*.000 files to salvage theses lines. The results were unsuccessful and it was determined that the TCARI and ZDF solutions created more vertical error than just applying a zero tide file. The effected lines are included in the final BAGS to create complete MBES coverage for backscatter processing and to resolve holidays. It is recommended that if another cruise occurs in the area that these line be re-acquired.

Corrected Heights were obtained by utilizing an ellipsoid referenced separation model with separations derived from the NAD83/GRS80 ellipsoid to MLLW utilizing VDATUM and Geoid12b. This separation model was applied to the realtime POS/MV Fugro Marinestar SBAS navigation and delivers published accuracies in the 10cm range. Due to the remote location of the FKNMS AOI, CORS station corrections were not available to produce PPK SBETs for post processed navigation. Zoned Tides were also not sufficient for processing due to the large distances from the nearest two tide stations in Key West and Naples, Florida. Additionally, TrueHeave files were applied to the Nancy Foster MBES data to improve vessel attitude correctors.

All acquisition and processing workstations are located in the Dry Lab of the Nancy Foster, are networked as a workgroup, and are interfaced with the ship's backup system. Xylem Hypack 2020 was used for vessel navigation. Kongsberg Seafloor Information System (SIS) software was used to acquire the EM2040 and EM710 bathymetric data in the .all format. Bathymetric survey data was converted and processed in Caris HIPS with modifications to the default Combined Uncertainty Bathymetric Estimator (CUBE) Parameters XML file. The default CUBE Parameters XML was replaced with the XML file issued to

all NOAA hydrographic field units included with the Field Procedures Manual. This updated XML file uses the resolution dependent maximum propagation distance values required in the HSSD. Processing methodology followed the standard Caris HIPS CUBE workflow. These steps include data conversion using HSTB supplied HVF files for each MBES system , filtering, TrueHeave application, GPS tide correction (VDATUM Separation Model), Total Propagated Uncertainty (TPU) calculation, merging, and swath/subset editing. NOAA's QC Tools was used to generate a .HOB file of potential fliers. All potential fliers were then validated or flagged as rejected. Due to the steeper terrain of the reef shelf break, some soundings identified as fliers are in fact soundings trying to resolve vertical surfaces.

Acoustic backscatter was collected with both Kongsberg systems for benthic habitat delineation and chart creation. The Marine Spatial Ecology Division is processing the backscatter with FMGT and data will be included with the final deliverables.

All sound speed profiles were concatenated and organized into one complete file for the survey area (ESD-AHB-21\_concatenated.svp). Sound velocity casts were applied in real time to the MBES data with SIS software. Velocity casts were taken at approximately four-hour frequency intervals with the RapidCAST underway SV Profiler throughout the survey areas. Ray-tracing uncertainty analyses were performed periodically to ensure the four-hour sampling rate was sufficient to keep up with water column variability.



Figure 3: NOAA Ship Nancy Foster

Туре	Manufacturer	Model
Multibeam Echosounder	Kongsberg	EM2040
Multibeam Echosounder	Kongsberg	EM710
Primary Sound Speed Profiler	Teledyne Oceanscience	rapidCAST
Secondary Sound Speed Profiler	Sea-Bird	SBE-19
Positioning & Attitude	Applanix	POS/MV 320 v5
Positioning & Attitude	Trimble	BD982

Figure 4: Major Survey Components



Figure 5: Spatial Distribution of Sound Speed Casts FKNMS

Surface W00603\_MB\_2m\_MLLW\_3of7 was from the lines that were impacted SBET dropouts. This surface was compared to the surrounding data and the surface was shifted by 1.4 meters per HSD policy to agree with surrounding data. The uncertainty of this surface was recalculated to account for the manual shift and is covered in the uncertainty section of this survey.

#### E. Uncertainty

Results from the crossline analysis, final CUBE surface uncertainties, and TVU QA results indicate internal consistency of the MBES data within IHO Order 1 specifications for survey W00603. The survey site met uncertainty standards for IHO 1.

A total of 70.54 nautical miles of crosslines, or 7.54% of all survey lines were ran for analysis of W00603 survey accuracy. Crosslines were run in a direction of less than 45 degrees to main scheme lines across most of the surveyed area, providing a good representation for analysis for IHO compliance. For water depths less than 100m, IHO Order 1 was used. Crossline analysis was performed using the Caris HIPS QC Line Report tool. This tool compares crossline data to a gridded surface and reports results by beam number and IHO compliance by the percentage of soundings that fall within the selected criteria. The W00603 crosslines were compared to a 2m CUBE surface encompassing mainscheme data for IHO Order 1.

Survey specific uncertainty parameters were used for computing TPU within HIPS. During surface finalization in HIPS, the "greater of the two" option was selected, where the calculated uncertainty from TPU is compared to the standard deviation of the soundings influencing the node, and where the greater value is assigned as the final uncertainty of the node. The uncertainty of the finalized surface increased for nodes where the standard deviation of the node was greater than the TPU.

Uncertainty evaluation was reviewed using NOAA's Pydro's Grid QA tool to evaluate compliance against the HSSD resolution and density requirements for Complete Coverage. The Grid QA was completed on representative finalized BAG surfaces from the W00603 survey. Results of this process includes statistics and graphs for uncertainty standards, depth distribution and data density. Selected graphs are presented below from performed evaluations. Grid QA Uncertainty Standards results on the 2 meter finalized surface pass at 100% of grid nodes meet the maximum allowable TVU, Data Density results of 99.5% of grid nodes are populated with at least 5 soundings. Line QC crossline analysis shows the the 2m surface compared to the crossline exceed the RMS 95% requirement for IHO 1 compliance and is shown in the below graph.

All of the results for both the Grid QA and Line QC reports can be found in the Digital Data folder included with this report.

Compute TPU

•	<b>≵</b> ↓∣ 🖨 🕰				
🗆 Input					
	Source	Selection			
Ξ	Tide				
	Measure	0 (m)			
	Zoning	0 (m)			
Ξ	Sound Speed				
	Measured	2 (m/s)			
	Surface	0.5 (m/s)			
Ξ	Uncertainty Source				
	Source	Custom			
	Position	Realtime			
	Sonar	Realtime			
	Heading	Realtime			
	Pitch	Realtime			
	Roll	Realtime			
	Vertical	Delayed Heave			
	Tide	Static			
Ξ	Sweep parameters				
	Peak to peak heave	0 (m)			
	Maximum Roll	0.0			
	Maximum Pitch	0.0			

Figure 6: Compute HIPS TPU Options



Figure 7: EM2040 STT IHO 1 Compliance



Figure 8: Uncertainty Standards 2m 2040 Finalized Surface

New surfaces were created during survey review to align with best practices within the Office of Coast survey. When the surface was finalized "Uncertainty" was chosen as the uncertainty layer to align with the 2022 HSSD. Surfaces W00603\_MB\_1m\_MLLW\_1of7, W00603\_MB\_2m\_MLLW\_2of7, W00603\_MB\_4m\_MLLW\_4of7, and W00603\_MB\_4m\_MLLW\_5of7 utilize this way of calculating uncertainty. Surface W00603\_MB\_2m\_MLLW\_3of7 has uncertainty calculated using the following formula: 1m + 2% \* Depth. This is to account for the manual shift performed during office review. Surfaces W00603\_MB\_4m\_MLLW\_6of7 and W00603\_MB\_16m\_MLLW\_7of7 have uncertainty calculated using the following formula to account for the uncertainty associated with not having tides applied to the data: 2m + 5% \* Depth.

#### F. Results and Recommendations

The following are the largest scale ENCs, which cover the survey area:

ENC	Scale	Edition	Update Application Date	Issue Date
US3FL90M	1:180000	31	10/28/2021	10/28/2021
US5FL91M	1:30000	17	03/30/2020	03/30/2020

The following surfaces and/or BAGs were submitted to the Processing Branch:

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
W00603_MB_1m_MLLW_1of7	BAG	1 m	12.76 m - 20.0 m	NOAA_1m	Complete MBES
W00603_MB_2m_MLLW_20f7	BAG	2 m	18.0 m - 40.0 m	NOAA_2m	Complete MBES
W00603_MB_2m_MLLW_3of7	BAG	2 m	27.33 m - 41.84 m	NOAA_2m	Complete MBES
W00603_MB_4m_MLLW_4of7	BAG	4 m	36.0 m - 57.15 m	NOAA_4m	Complete MBES
W00603_MB_4m_MLLW_5of7	BAG		25.03 m - 33.59 m	NOAA_4m	MBES Trackline
W00603_MB_4m_MLLW_6of7	BAG	4 m	13.62 m - 40.0 m	NOAA_4m	MBES Trackline
W00603_MB_16m_MLLW_7of7	BAG	16 m	36.0 m - 91.23 m	NOAA_16m	MBES Trackline

The chart comparison for W00603 was performed by comparing a shoal biased sounding layer generated in CARIS to each chart that covers the area. A 500 meter shoal sounding surface of the entire survey area was generated from the finalized 2m CUBE depth surface for W00603. The chart comparison was conducted by visually reviewing the shoal biased sounding selections comparing to the charted soundings.

Surveyed soundings generally compare well with the ENC charts, although there are some discrepancies in locations, they don't indicate system bias. Examples of the comparison results captured in the following images.

Finalized surfaces were exported from Caris in the BAG format. The Caris CUBE surface are also included in the digital data deliverable. The CUBE surface and BAGs use the same naming nomenclature, survey number, sonar model, sounding type, vertical datum and resolution in meters . The resolutions selected

were in accordance with the HSSD for Complete Coverage specifications for single resolution surfaces. Depth thresholding was not utilized for this surveys deliverable due the varieties of resolutions at all depths required for benthic habitat analysis and delineation.



Figure 9: W00603 vs US3FL90M



Figure 10: W00604 vs US5FL91M

The surfaces listed above differ from those originally submitted by the field unit and reflect the data that was archived at NCEI. Surfaces were updated to reflect the best practices at HSD and include the trackline data that was not orignally included in the surface submissions by the field unit.

### G. Vertical and Horizontal Control

The vertical datum for this project is Mean Lower Low Water. The vertical control method used was VDatum.

The vertical datum for this project is MLLW 83-01 NTDE. Tidal data was applied with a MLLW Separation Model (File: NF\_Coverage\_AreaNEWOBJ(A)\_100m\_NAD83-MLLW\_geoid12b.csar) supplied by CO-OPS.

Not all data was reduced to MLLW via the SEP. Data associated with surface W00603\_MB\_1m\_MLLW\_10f7, W00603\_MB\_2m\_MLLW\_20f7, W00603\_MB\_4m\_MLLW\_40f7, and W00603\_MB\_4m\_MLLW\_50f7 were all reduced to MLLW using the SEP model above. Surface W00603\_MB\_2m\_MLLW\_30f7 was reduced to MLLW using a constant separation values as described in Section D of this report. Data associated with surface W00603\_MB\_4m\_MLLW\_60f7 and W00603\_MB\_4m\_MLLW\_70f7 are trackline surfaces with no tides applied, which is allowed by the 2022 HSSD.

The horizontal datum for this project is North American Datum of 1983 (NAD 83). The projection used for this project is Universal Transverse Mercator (UTM) Zone 17.

The projection used for this survey is Projected UTM Zone 17 North. There were no HorCon or VertCon operations performed for this survey.

#### H. Additional Results

#### Zero Tide Applied

As mentioned previously, the POS/MV onboard the foster incurred intermittent dropouts that made several \*.all files have no ellipsoidal heights embedded within the navigation data. The days/lines that were effected were DN082/0134-139, DN098/644 and DN100/0744. Attempts were made using POSpac SBETs and re-application of GPS Heights with the \*.000 files to salvage theses lines. The results were unsuccessful and it was determined that the TCARI and ZDF solutions created more vertical error than just applying a zero tide file. The effected lines are included in the final BAGS to create complete MBES coverage for backscatter processing and to resolve holidays. It is recommended that if another cruise occurs in the area that these line be re-acquired.



Figure 11: DN082 Line 0134 Zero Tides - Approx 1.5m vertical error

As stated in Section D of this report, surfaces with vertical offsets were addressed using a vertical shift. Transit Lines

Survey Transit lines were not included with the final BAG/CSAR surfaces, but are included with the HDCS deliverables



Figure 12: Transit lines

*Transit lines were incorporated into surfaces W00603\_MB\_4m\_MLLW\_5of7, W00603\_MB\_4m\_MLLW\_6of7, and W00603\_MB\_16m\_MLLW\_7of7.* 

## I. Approval

As Chief of Party, field operations for this hydrographic survey were conducted under my direct supervision, with frequent personal checks of progress and adequacy. I have reviewed the attached survey data and reports.

All field sheets, this Survey Summary Report, and all accompanying records and data are approved. All records are forwarded for final review and processing to the Processing Branch.

The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys Specifications and Deliverables, Field Procedures Manual, Standing and Letter Instructions, and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Survey Summary Report.

Approver Name	Title	Date	Signature	
Mike Stecher	Sheet Manager	12/09/2021	Michael Stochar	Digitally signed by Michael Stec DN: cn=Michael Stecher, o=Soln Hydro Inc, ou, email=mike@solmarhydro.com,
			Stecher	Date: 2021.12.10 13:17:37 -08'00