doi: 10.25923/45d1-c972

Processing Summary Report

EX-21-04: 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts (ROV & Mapping)

New England and Corner Rise Seamounts
Newport, Rhode Island to Newport, Rhode Island
June 30 - July 29, 2021

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September 22, 2021

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Introduction

NOAA Ocean Exploration is the only federal program dedicated to exploring our deep ocean, closing prominent gaps in our basic understanding of U.S. deep waters and the seafloor and delivering the ocean information needed to strengthen the economy, health, and security of our nation.

Using the latest tools and technology, NOAA Ocean Exploration explores previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, NOAA Ocean Exploration allows scientists, resource managers, students, members of the general public, and others to actively experience ocean exploration, expanding available expertise, cultivating the next generation of ocean explorers, and engaging the public in exploration activities. From this exploration, NOAA Ocean Exploration makes the collected data needed to understand our ocean publicly available, so we can maintain the health of our ocean, sustainably manage our marine resources, accelerate our national economy, and build a better appreciation of the value and importance of the ocean in our everyday lives.

Report Purpose

The purpose of this report is to briefly describe the acoustic seafloor, water column, and subseafloor mapping data collection and processing methods used by NOAA Ocean Exploration on NOAA Ship *Okeanos Explorer* during the 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts expedition, EX-21-04, and to present a summary of mapping results and mapping-related expedition activities. A separate report detailing the ROV activities of the expedition will be available through the NOAA Central Library.[1]

A detailed description of *Okeanos Explorer's* mapping equipment and capabilities is available in the "NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report 2021," which is archived in the NOAA Central Library.[2]

For further information about general equipment calibration procedures, data acquisition, processing, reporting, and archiving, see the "NOAA Ocean Exploration Deepwater Exploration Mapping Procedures Manual V1," which is archived in the NOAA Central Library[3] and also available from the website.[4]

[1] https://doi.org/10.25923/8fmt-6630

[2] https://doi.org/10.25923/qbjz-m470

[3] https://doi.org/10.25923/jw71-ga98

[4] https://oceanexplorer.noaa.gov/data/publications/mapping-procedures.html *(last accessed: 08/31/2021)*

Expedition Objectives

The 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts expedition (EX-21-04) was a combined mapping and remotely operated vehicle (ROV) telepresence-enabled expedition that departed from Newport, Rhode Island on June 30, 2021 and returned on July 29, 2021, for a total of 30 days-at-sea. The primary objective of this expedition was to collect critical information of deepwater areas of the New England and Corner Rise Seamounts in both the U.S. Exclusive Economic Zone (EEZ) and international waters. Additional mapping objectives were to collect data to effectively plan ROV dives for both scientific objectives and safe navigation, and to map deepwater areas containing no or poor quality bathymetry data.

Atlantic U.S. deep-sea exploration contributes to NOAA's Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE), a major multi-year, multi-national, collaborative ocean exploration campaign focused on raising our collective knowledge and understanding of the North Atlantic Ocean. Building on previous work in the North Atlantic, including the 2011-2014 Atlantic Canyons Undersea Mapping Expeditions (ACUMEN), NOAA's ASPIRE campaign will provide data to inform research planning and management decisions in the region, by broadening both the geographic focus to include more of the U.S. Atlantic and Canada, and the scope of partnerships to include U.S. federal agencies, such as U.S. Geological Survey (USGS) and Bureau of Ocean Energy Management (BOEM), as well as international partners from Canada and Europe. ASPIRE will also support the National Strategy for Mapping, Exploring, and Characterizing the United States EEZ[5] and Seabed 2030.

The complete objectives for this expedition are detailed in "Project Instructions: EX-21-04, 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts (ROV & Mapping)," which is archived in the NOAA Central Library.[6]

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[5] https://oeab.noaa.gov/wp-content/uploads/2021/01/2020-national-strategy.pdf *(last accessed: 07/23/2021)*

[6] https://doi.org/10.25923/f2tr-y414

Operational Personnel

EX-21-04 included onboard personnel inclusive of the ship's force and the mission team, and shore-based personnel (who participated remotely via telepresence) (see **Tables 1** and **2**).

Table 1. EX-21-04 Onboard personnel.

Name	Role	Affiliation	Dates Aboard
Kasey Cantwell	Expedition Coordinator	NOAA Ocean Exploration	06/30 – 07/29
Shannon Hoy	Mapping Lead	NOAA Ocean Exploration (CNSP)[1]	06/30 – 07/29
Kim Galvez	Expedition Coordinator (in training)	NOAA Ocean Exploration (CNSP)[1]	06/30 – 07/29
Rhian Waller	Science Lead	University of Maine (UCAR[2])	06/30 – 07/29
Chris Ritter	GFOE Lead	GFOE[4]	06/30 – 07/29
Dan Frietas	Mapping Watch Lead	UCAR[2]	06/30 – 07/29
SST Charlie Wilkins	Senior Survey Tech	OMAO[3]	06/30 – 07/29
LT Bryan Pestone	Operations Officer	OMAO[3]	06/30 – 07/29
Josh Carlson	Engineering Team	GFOE[4]	06/30 – 07/29
Chris Wright	Engineering Team	GFOE[4]	06/30 – 07/29
Jim Meyers	Engineering Team	GFOE[4]	06/30 – 07/29
Levi Unema	Engineering Team	GFOE[4]	06/30 – 07/29
Anya Jenson	Engineering Team	GFOE[4]	06/30 – 07/29
Sean Kennison	Engineering Team	GFOE[4]	06/30 – 07/29
Lars Murphy	Engineering Team	GFOE[4]	06/30 – 07/29
Jon Mefford	Engineering Team	GFOE[4]	06/30 – 07/29
Roland Brian	Engineering Team	GFOE[4]	06/30 – 07/29
Bob Knott	Engineering Team	GFOE[4]	06/30 – 07/29
Emily Narrow	Engineering Team	GFOE[4]	06/30 – 07/29
Art Howard	Engineering Team	GFOE[4]	06/30 – 07/29

[1]Cherokee Federal

[2]University Corporation for Atmospheric Research

[3]NOAA Office of Marine and Aviation Operations

[4]The Global Foundation for Ocean Exploration

Table 2. EX-21-04 Shore-based personnel.

Name	Role	Affiliation
Jason Chaytor	Science Lead	U.S. Geological Survey (UCAR[1])
Kira Mizell	Science Lead	U.S. Geological Survey (UCAR[1])

[1]University Corporation for Atmospheric Research

Summary of Mapping Results

NOAA Ocean Exploration mapped 54,710 square kilometers (sq km) of seafloor during the 30 days-at-sea for EX-21-04. Of the 54,710 sq km mapped, 4,110 sq km was deeper than 200 meters (m) and within the U.S. EEZ and Territorial Sea. Multibeam bathymetry data coverage is shown in **Figure 1.** Focused mapping operations targeted previously unmapped seamounts in the North Atlantic, resulting in new bathymetric maps of approximately 20 seamounts (**Figure 2**). Fourteen ROV dives were planned and navigated using bathymetry acquired during this expedition, and typically within hours of ROV deployment. Mapping operations generally occurred overnight, utilizing the time in between ROV dives, unless ROV dives were not feasible due to prevailing conditions, in which case mapping occurred 24-hours per day.

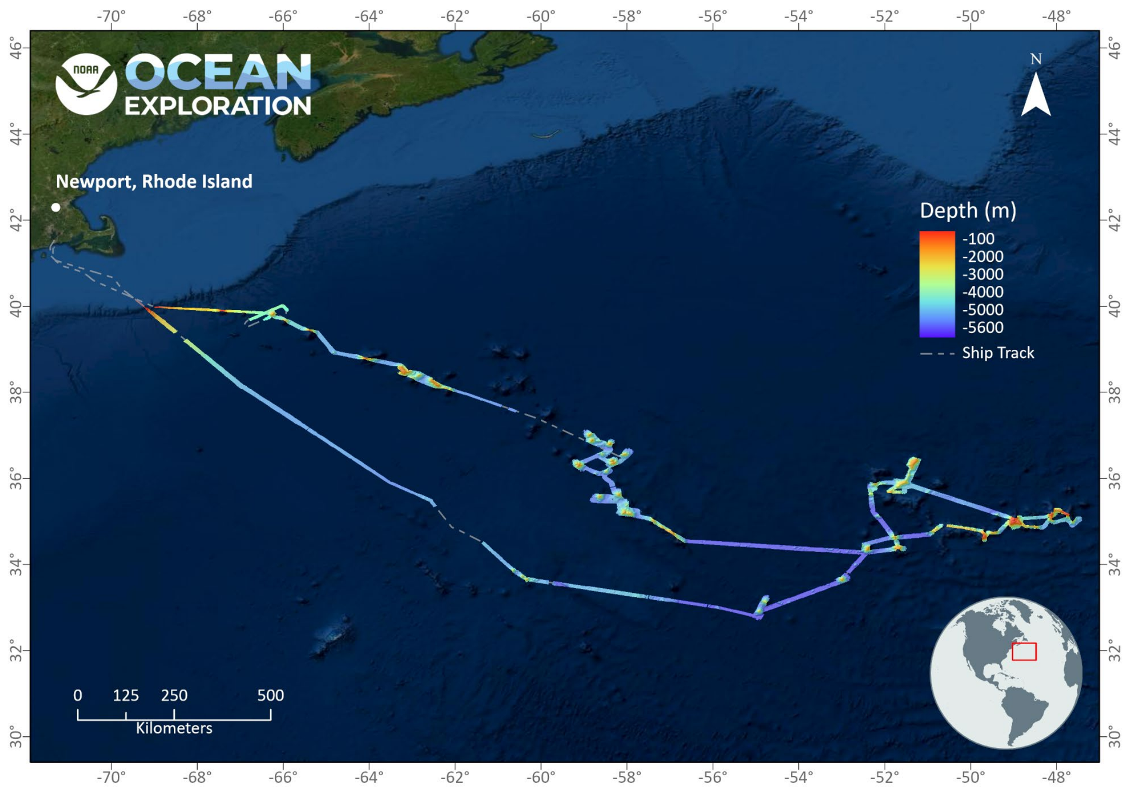

Figure 1. Overview of bathymetric mapping coverage completed during the 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts (ROV & Mapping) expedition (EX-21-04).

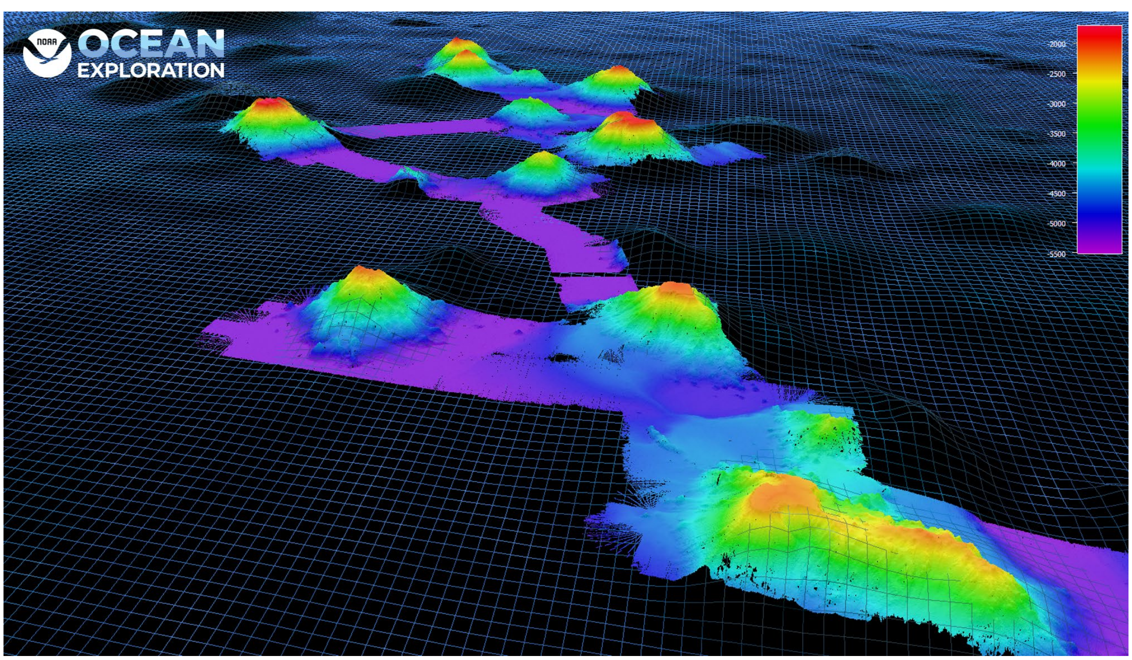

Figure 2. Bathymetry of the New England Seamounts collected during EX-21-04.

Mapping Statistics

Table 3 provides summary statistics of ocean mapping work during EX-21-04 June 29 - July 30, 2021 (UTC).

Table 3. Summary statistics of ocean mapping work during EX-21-04.

Statistic	Value
Ship's draft*: Start of expedition (06/30/2021) End of expedition (07/29/2021)	 Fore: 16' 1.5''; Aft STBD: 15' 10"; Aft Port: 15' 10" Fore: 15' 3.5"; Aft STBD: 16' 6"; Aft Port: 16' 0"
Linear kilometers of survey with EM 304	7026
Square kilometers mapped with EM 304	54,710
Square kilometers mapped with EM 304 within U.S. waters deeper than 200 m	4,110
Number/data volume of EM 304 raw multibeam files (.kmall)	667 files / 52.5 GB
Number/data volume of EM 304 water column multibeam files (.kmwcd)	665 files / 117 GB
Number/data volume of EK60/EK80 water column split-beam files (.raw)	3,747 / 173 GB
Number/data volume of sub-bottom sonar files (.segy, .kea, .keb)	1,132 / 4.89 GB
Number of expendable bathythermograph (XBT) casts	133
Number of conductivity, temperature, depth profiler (CTD) casts (including test casts)	0

*Prior to EX-21-01, and as a result of the full marine survey completed during the 2020/2021 drydock, it was determined that the draft markers on the bow are referenced to the bottom of the original hull, and not the base of the sonar blister on the fairing which is 16.5" lower, requiring that a +16.5" offset be applied to the draft measurements. The measurements listed in Table 3 reflect the +16.5" offset.

Mapping Sonar Setup

Kongsberg EM 304 Multibeam Sonar

NOAA Ship *Okeanos Explorer* is equipped with a 26 kilohertz (kHz) Kongsberg EM 304 MKII multibeam sonar, capable of detecting the seafloor in up to 10,000 m of water and conducting productive mapping operations in up to 8,000 m of water. The nominal transmit (TX) alongtrack beamwidth is 0.5°, and the nominal receive (RX) acrosstrack beamwidth is 1.0°. The system generates a 140° beam fan (70° port/70° starboard maximum angles), containing 512 beams with up to 800 soundings per ping cycle when in high-density mode. In waters shallower than approximately 3,300 m the system is able to operate in dual-swath mode, where one nominal ping cycle includes two swaths, resulting in up to 1,600 soundings. The multibeam sonar is used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter.

Simrad EK60/EK80 Split-Beam Sonars

The ship is equipped with a suite of Simrad EK60/EK80 split-beam fisheries sonars: 18 kHz (EK60), 38 kHz (EK80), 70 kHz (EK80), 120 kHz (EK60), and 200 kHz (EK60). These systems are quantitative scientific echosounders calibrated to identify the target strength of water column acoustic reflectors, typically biological scattering layers, fish, or gas bubbles, providing additional information about water column characteristics and anomalies. In 2019, the 38 and 70 kHz transceivers were replaced with broadband units (WBTs). WBTs use frequency modulation to acquire higher resolution water column data allowing for the detection of finer features, improved depth capability without loss of range resolution, and support of broadband frequency response of targets.

These sonars were calibrated during EX-21-01, and calibration values from that expedition were applied to the EK sonars for EX-21-04 and will continue to be applied until the next calibration scheduled for early in 2022. The “2021 EK60/EK80 Calibration Report” is available in the NOAA Central Library.[7]

Knudsen 3260 Sub-Bottom Profiler

The ship is equipped with a Knudsen 3260 sub-bottom profiler (SBP) that produces a frequency-modulated chirp signal with a central frequency of 3.5 kHz. This sonar is used to provide echogram images of shallow geological layers underneath the seafloor to a maximum depth of

[7] https://doi.org/10.25923/v5kz-ge28

approximately 80 m below the seafloor. The sub-bottom profiler is operated to provide information about sub-seafloor stratigraphy and features.

Teledyne Acoustic Doppler Current Profilers

Two acoustic Doppler current profilers (ADCPs), a Teledyne Workhorse Mariner (300 kHz) and a Teledyne Ocean Surveyor (38 kHz), are installed on the ship. Depending on environmental conditions, the 300 kHz system provides ocean current data to approximately 70 m deep, and the 38 kHz system provides data to approximately 1,200 m deep. The 38 kHz system is capable of collecting data in narrowband and broadband frequency ranges. The ADCPs gather data prior to remotely operated vehicle (ROV) and conductivity, temperature, depth profiler (CTD) deployments in order to assess currents in support of safe operations. The ADCPs are typically not run concurrently with the other sonars during mapping operations due to issues of interference.

During EX-21-01 the 38 kHz transducer experienced temperature spikes, and at the beginning of EX-21-03, the 38 kHz ADCP permanently failed and was not operational for the duration of the expedition. The 38 kHz will not be operational until the transducer is replaced, and thus was not operational for EX-21-04.

Data Acquisition Summary

Following departure, and once the ship reached suitable depths, data acquisition began with the EM 304 multibeam sonar, EK60/EK80 (18, 38, 70, 120, and 200 kHz) split-beam sonars, and the Knudsen 3260 sub-bottom profiler, with these sonars running concurrently using a Kongsberg Synchronization Unit (K-Sync). During ROV operations, the EM 304 multibeam sonar and Knudsen sub-bottom profiler were secured while the 300 kHz ADCP and the entire suite of EK split-beam sonars (in continuous wave mode) acquired data.

Multibeam survey lines were planned to maximize edge-matching of existing bathymetric data, data gap filling in areas with existing bathymetric coverage, or to meet scientific objectives. In regions with no existing data, lines were optimized for potential discoveries and to complete relatively large contiguous areas to support interpretation of features from bathymetry and backscatter.

Throughout the expedition, multibeam data quality was monitored in real time by acquisition watchstanders. Ship speed was adjusted to maintain data quality and sounding density as necessary, and line spacing was planned to ensure one-quarter to one-third swath-width overlap between lines, depending on the environmental conditions and impact on the quality of the outer swath regions. Angles were generally left open (70°/70°) during transits to maximize data collection and were adjusted on both the port and starboard sides to ensure the best data quality and coverage. If outer beams were returning obviously spurious soundings (e.g., due to attenuation or low grazing angle), beam angles were gradually reduced and monitored closely until a high-quality swath was obtained. Throughout the majority of the expedition the EM 304 depth mode was manually set to “Very Deep” as sector tearing when in “Deeper” mode was persistent while mapping seamounts.

Real-time corrections to the data upon acquisition included: continuous application of surface sound speed obtained with a hull-mounted Reson SV-70 probe, application of water column sound speed profiles obtained with Sippican Deep Blue Expendable Bathythermographs (XBTs), and application of roll, pitch, and heave motion corrections obtained with POS MV 320 version 5 inertial motion unit. No tidal corrections were applied to the raw or processed data. Sound speed profiles were conducted every four hours or more frequently as dictated by local oceanographic conditions (typically every two hours when operating near currents). Reson sound speed values were continuously compared against secondarily derived sound speed values from the ship’s onboard thermosalinograph flow-through system as a quality assurance measure.

Simrad EK60/EK80 split-beam water column sonar data were collected throughout the majority of the expedition, including during ROV dives. Any deviations from standard acquisition settings are noted in the associated Watch Log. Data were monitored in real time for quality but were not post-processed. **Figure 3** shows the EK60/EK80 data collected during EX-21-04.

Knudsen 3260 sub-bottom profiler data were also collected during the majority of the expedition. Any deviations from standard acquisition settings are noted in the associated Watch Log. **Figure 4** shows where sub-bottom data were collected during EX-21-04.

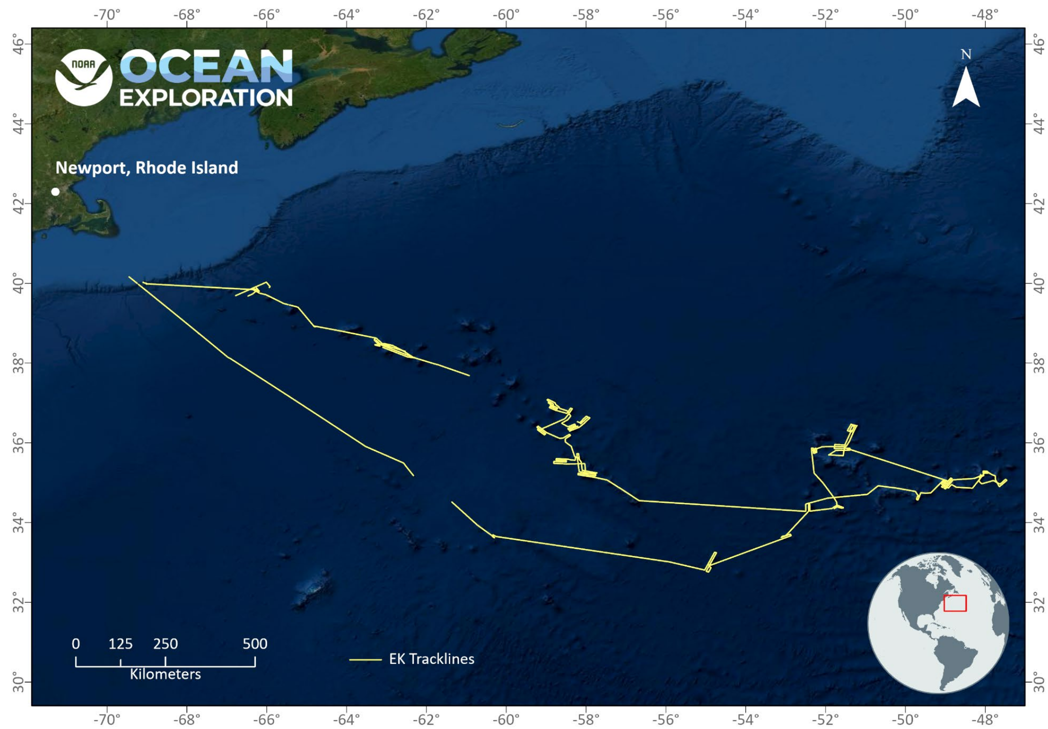

Figure 3. Simrad EK60/EK80 split-beam sonar data collection tracklines (in yellow) collected during EX-21-04.

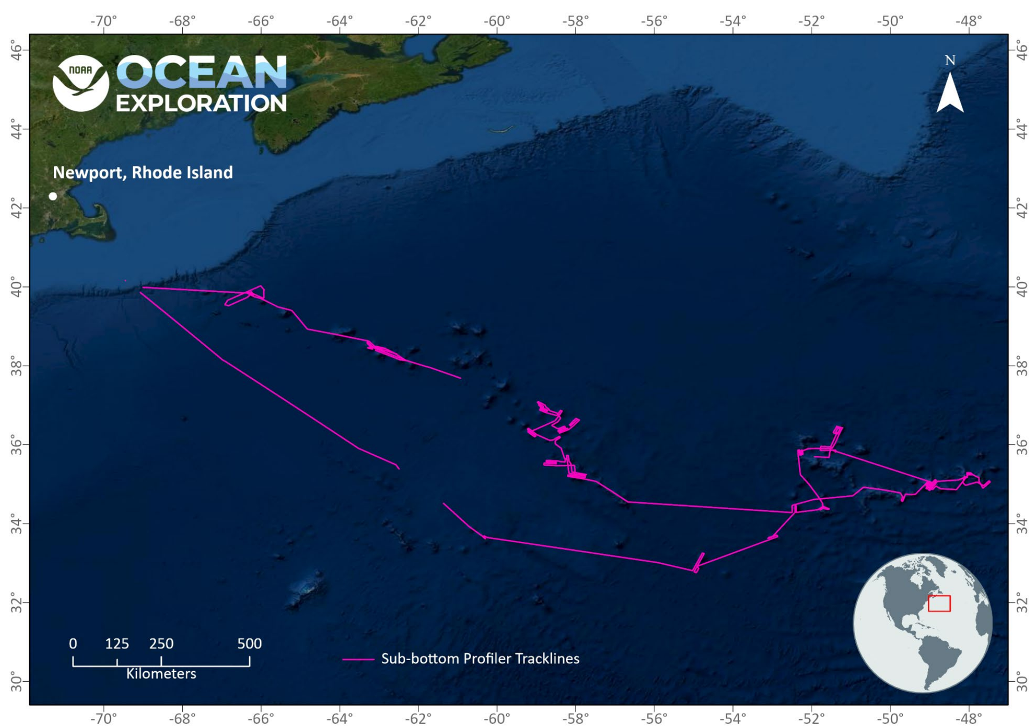

Figure 4. Sub-bottom profiler data collection tracklines (in pink) collected during EX-21-04.

Multibeam Sonar Data Quality Assessment and Data Processing

The bathymetry data were generated using a Kongsberg EM 304 MKII multibeam system, and recorded using Kongsberg's Seafloor Information System (SIS) software as *.kmall files. Collocated to the bathymetric data, bottom backscatter data were collected and stored within the *.kmall files, both as beam averaged backscatter values, and as full time series values (snippets) within each beam. Water column backscatter data were recorded separately within *.kmwcd files.

The full-resolution multibeam .kmall files (Level-00 data) were imported into QPS Qimera, and then processed and cleaned of noise and artifacts. Outlier soundings were removed using multiple methods including automatic filtering and/or manual cleaning with the swath and subset editing tools. The default sound speed scheduling method used was “Nearest-in-Time” using a crossfade of 60 seconds. If another method was implemented, it will be noted in the associated log. Gridded digital terrain models were created using the weighted moving average algorithm and were exported in multiple formats using QPS Fledermaus software. Daily bathymetric surfaces were created and sent to shore. **Figure 5** shows the onboard multibeam data processing workflow.

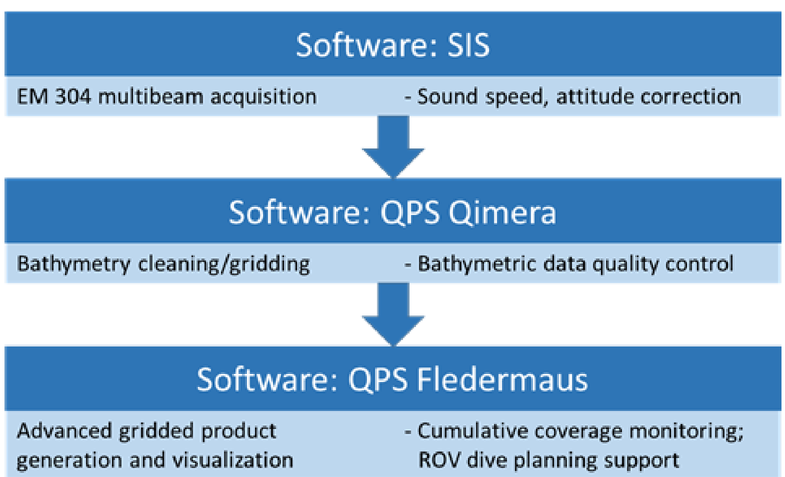

Figure 5. Shipboard multibeam data processing workflow.

The mapping team performed a final quality check of the data using QPS Qimera and Fledermaus software. This involved additional fine cleaning of soundings and minimization of residual artifacts from sound speed biases and field-cleaning errors. Depth values were compared from orthogonal lines (crosslines) to evaluate the consistency of the multibeam sonar data collected during the expedition.

A crossline analysis was completed using the Crosscheck Tool in QPS Qimera software to evaluate the data against the Order 1 S-44 standards set by the International Hydrographic Organization (IHO, 2008).

Each line of cleaned full resolution data was exported to a *.gsf file (Level-01 data). The processed and cleaned files were used to create a static surface in QPS Qimera. This final surface was re-projected into the field geographic WGS84 reference frame in QPS Fledermaus software and saved as a *.sd file for archiving. Using QPS Fledermaus, this *.sd bathymetric grid file was then exported into ASCII XYZ text file (*.xyz), color image (*.tif), floating point geotiff (*.tif), and Google Earth (*.kmz) file formats. The *.gsf files were used to create daily backscatter mosaics using QPS FMGT. All products maintain horizontal referencing to WGS84 (G1762) and vertical referencing to the assumed mean waterline. There is a complete accounting of each individually archived multibeam data file and of each bathymetric surface product in the multibeam data acquisition and processing logs archived with the dataset.

Crossline Analysis

A crossline was run on July 14, 2021, as shown in **Figure 6**, and the results are presented in **Table 4**.

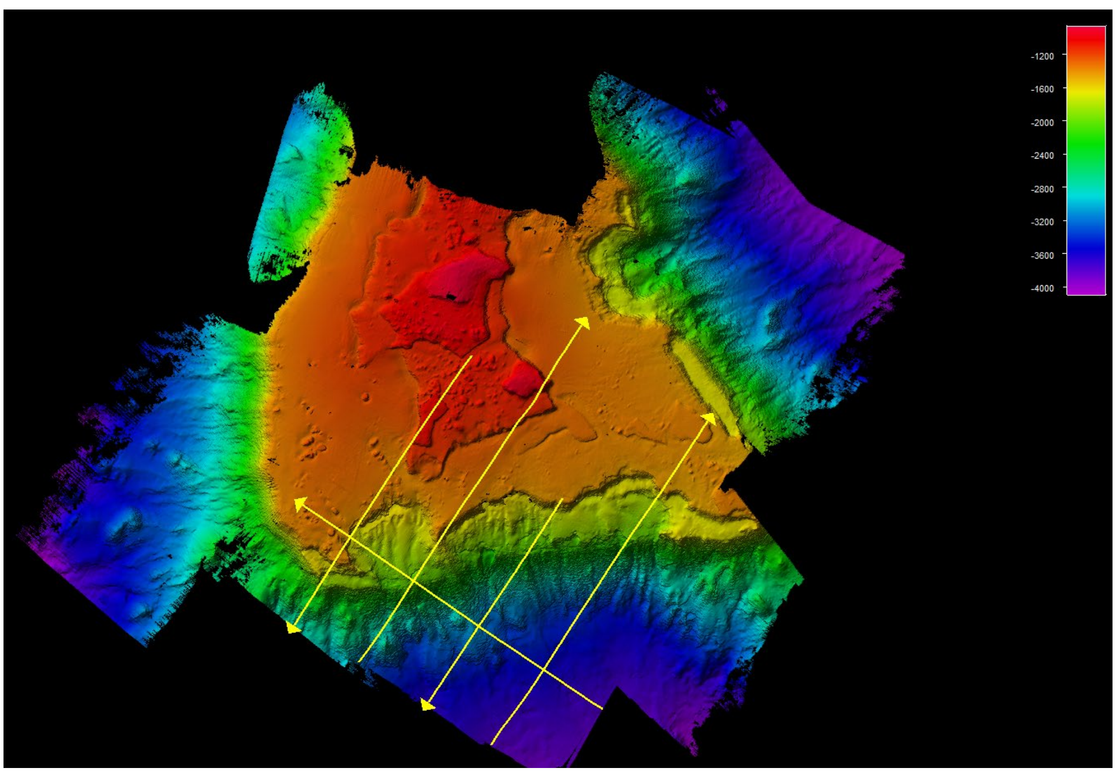

Figure 6. EX-21-04 crossline (shown in yellow) used for comparison against the bathymetric grid generated via orthogonal multibeam survey lines.

Crossline file:

0308_20210714_040927_EX2104_MB.kmall

Mainscheme line files:

0234_20210711_214218_EX2104_MB.kmall
0238_20210711_225001_EX2104_MB.kmall
0244_20210712_014049_EX2104_MB.kmall
0248_20210712_023829_EX2104_MB.kmall

Table 4. Crosscheck results.

Statistic	Value
Number of points of comparison	2,784,806
Grid cell size (m)	25
Difference mean (m)	0.9235
Difference median (m)	0.4244
Difference standard deviation (m)	7.0995
Difference range (m)	[-259.66, 181.06]
Mean + 2* standard deviation (m)	15.1226
Median + 2* standard deviation (m)	14.6234
Data mean (m)	-2064.878
Reference mean (m)	-2065.802
Data z-range (m)	[-3921.44, -903.05]
Reference z-range (m)	[-3919.87, -908.90]
Order 1 error limit (m)	26.86
Order 1 # rejected	26050
Order 1 p-statistic	0.009354
Order 1 survey	ACCEPTED

These results confirm that the data collected meet International Hydrographic Organization Order 1 specifications for data quality.

Acquisition and Processing Software

Table 5 provides a list of the acquisition and processing software versions that were used during EX-21-04.

Table 5. Versions of acquisition and processing software used during EX-21-04.

Software	Purpose	Version
SIS	EM 304	5.7.0
EK80	EK suite	2.0.1
EchoControl	Knudsen	4.09
UHDAS	ADCPs	14.04
AMVERSEAS	Autolaunch XBT	9.3
WinMK21	XBT	3.0.2
K-Sync	Synchronization	1.9.0
Qimera	Bathymetry	2.4.0
FMGT	Backscatter	7.9.7
FMMidwater	Water Column	7.9.3
Sound Speed Manager	Sound Velocity Profiles	2021.2.0
NRCan (SegJp2)	Sub-bottom	1.0
Fledermaus 7	Visualization/Data Analysis	7.8.11

Data Archiving Procedures

All mapping data collected by NOAA Ocean Exploration on *Okeanos Explorer* are archived and publicly available within 90 days of the end of each expedition via the National Centers for Environmental Information (NCEI) online archives. The complete data management plan (which describes the raw and processed data formats produced for this expedition) is available as an appendix in the “Project Instructions: EX-21-04, 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts (ROV & Mapping),” which is archived in the NOAA Central Library. For each data type, raw data (Level 00), processed data (Level 01), derived products (Level 02), and ancillary files may be available, depending on the dataset and the level of staffing for the expedition. **Tables 6 - 10** describe the data archived for each dataset. For further information about proprietary software and freeware that can handle the varying data types, refer to the “NOAA OER Deepwater Exploration Mapping Procedures Manual.”

Table 6. EM 304 bathymetry and seabed backscatter dataset.

Level	Description	File Type
Level 00	Raw multibeam files (in native sonar format) that include both raw bathymetry and backscatter (horizontal referencing = WGS84)	.kmall
Level 01	Processed multibeam files in generic sensor format that include bathymetry and backscatter (horizontal referencing = WGS84)	.gsf
Level 02	Gridded multibeam data and backscatter mosaics (horizontal referencing = WGS84)	.xyz, .tif, .tif (floating point GeoTIFF, .kmz, .sd, .scene
Ancillary files	Mapping watchstander log, weather log, sound speed profile log, multibeam acquisition and processing log, backscatter correction file, built-in self test logs, processing unit parameters, telnet session records	.xlsm, .xlsx, .txt

Table 7. EM 304 water column backscatter dataset.

Level	Description	File Type
Level 00	Raw multibeam files (in native sonar format) that include water column backscatter (horizontal referencing = WGS84)	.kmwcd
Level 01	n/a	n/a
Level 02	QPS Fledermaus objects such as beam fan, beam line, volume and/or track line; produced if time and staffing allows (horizontal referencing = WGS84)	.sd, .scene
Ancillary files	Mapping watchstander log, weather log, sound speed profile log, multibeam acquisition and processing log, water column data log, built-in self test logs, processing unit parameters, recorded telnet sessions	.xlsm, .xlsx, .txt

Table 8. EK60/EK80 split-beam echosounder dataset.

Level	Description	File Type
Level 00	Raw water column files provided in native sensor format (horizontal referencing = WGS84)	.raw, .idx
Level 01	n/a	n/a
Level 02	n/a	n/a
Ancillary files	Mapping watchstander log, weather log, EK data log, EK calibration report, calibration files and the raw files used for calibration	.xlsm, .xlsx, .txt, .pdf, .xml, .raw, .idx

Table 9. Knudsen 3260 sub-bottom profiler dataset.

Level	Description	File Type
Level 00	Raw sub-bottom files provided in native sonar format (horizontal referencing = WGS84)	.sgy, .kea, .keb
Level 01	Raw sub-bottom files converted to images and shapefiles of the tracklines; produced as time and staffing levels allow	.jpg, .shp
Level 02	n/a	n/a
Ancillary files	Mapping watchstander log, weather log, sub-bottom profiler data log	.xlsm, .xlsx

Table 10. Sound speed profiles dataset.

Level	Description	File Type
Level 00	Raw profile data for any XBT or CTD cast	.txt, .hex, .cnv
Level 01	Processed sound speed profiles created for multibeam data acquisition	.asvp
Level 02	n/a	n/a
Ancillary Files	Mapping watchstander log, sound speed profile log, profile locations as a shapefile and in Google Earth format, any associated calibration files	.xlsm, .xlsx, .shp, .kml, .cal, .xml, .pdf

All sonar data is permanently discoverable within the NCEI archives[8] and searchable through the Ocean Exploration Digital Atlas,[9] which provides access to all of the data collected during an expedition. The locations for specific data types (at the time of writing this report) are detailed in **Table 11**. For any challenges accessing data, send an inquiry to NCEI,[10] or contact the Ocean Exploration Mapping Team.[11]

Table 11. Locations of data collected during EX-21-04 (at the time of writing this report).

Data Type	Description	Location
EM 304 bathymetry and backscatter data	EM 304 bathymetric and backscatter data, supporting informational logs, and ancillary files are available through the NCEI Bathymetry Data Viewer	https://maps.ngdc.noaa.gov/viewers/bathymetry/
Water column data (EM 304 and EK60/EK80)	EM 304 and EK60/EK80 water column data, supporting data, and informational logs are available through the NCEI Water Column Sonar Data Viewer	https://www.ngdc.noaa.gov/maps/water_column_sonar/index.html
Knudsen 3260 sub-bottom profiler data	Sub-bottom data, supporting data, and informational logs are available in the NCEI data archives	May be requested directly from NCEI: https://www.ncei.noaa.gov/ National Centers for Environmental Information (NCEI) E/NE42 325 Broadway Boulder, Colorado USA 80305 ncei.info@noaa.gov (828) 271-4800

8 https://www.ngdc.noaa.gov/
9 https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm
10 ncei.info@noaa.gov
11 oar.oer.exmappingteam@noaa.gov

Data Type	Description	Location
Sound speed profiles	Ancillary sound speed profiles are available along with all mapping data per expedition in the NCEI data archives, or within the oceanographic archive for the expedition.	https://maps.ngdc.noaa.gov/viewers/bathymetry/ or through the oceanographic archives at: https://www.ncei.noaa.gov/
Reports	Reports are archived in the NOAA Central Library's Ocean Exploration Program (OEP) institutional repository	NOAA Central Library home: https://library.noaa.gov/ OEP institutional repository: https://repository.library.noaa.gov/cbrowse?pid=noaa%3A4&parentId=noaa%3A4

Expedition Schedule

Table 12. EX-21-04 schedule.

Date (UTC)	Activity
06/30	Depart Newport, RI. Transit mapping.
07/01	Transit mapping.
07/02	Transit mapping.
07/03	Transit and dive site mapping. Dive 01: "North Bermuda Tritop" Seamount.
07/04	Transit mapping.
07/05	Transit and dive site mapping. Dive 02: Congress "south" Seamount.
07/06	Transit and dive site mapping. Dive 03: "Hopscotch" Seamount.
07/07	Transit and dive site mapping. Dive 04: "Dumbbell" Guyot.
07/08	Transit and dive site mapping. Dive 05: Rockaway Seamount.
07/09	Transit and dive site mapping. Dive 06: Castle Rock Seamount.
07/10	Transit and dive site mapping. Dive 07: "Corner Rise 1" Seamount.
07/11	Transit and dive site mapping. Dive 08: MacGregor Seamount.
07/12	Transit and dive site mapping. Dive 09: Yakutat "shallow" Seamount.
07/13	Transit and dive site mapping. Dive 10: Yakutat "deep" Seamount.

Date (UTC)	Activity
07/14	Transit and dive site mapping. Dive 11: Caloosahatchee Ridge
07/15	Transit mapping.
07/16	Transit mapping.
07/17	Dive site mapping. Dive 12: "Y" Seamount.
07/18	Transit and dive site mapping. Dive 13: "Next to Hodgsen" Seamount.
07/19	Transit and dive site mapping. Dive 14: "Seven" Seamount.
07/20	Transit and dive site mapping. Dive 15: Allegheny Seamount.
07/21	Transit mapping. Poor weather conditions.
07/22	Transit mapping. Poor weather conditions.
07/23	Transit mapping and site conditions reconnaissance. Dive 16: Gosnold Seamount.
07/24	Focused mapping of Atlantis II seamount and site conditions reconnaissance. Dive 17: Gosnold "shallow" Seamount.
07/25	Transit mapping and site conditions reconnaissance. Dive 18: "Asterina" Seamount.
07/26	Transit site conditions reconnaissance. Dive cancelled due to poor weather conditions, focused sub-bottom data collection occurred.
07/27	Sub-bottom data collection. Dive 19: Retriever Seamount.
07/28	Transit mapping. Dive 20: Water column exploration of Hydrographer Canyon.
07/29	Arrive Newport, RI.

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Appendix A: Daily Log Entries

The following entries were excerpted from each of the daily expedition situation reports provided by the onboard team to the onshore support team, and therefore are somewhat informal in language. These are included to provide situational awareness for future users of the data collected during this expedition. All times are in local ship time (-4 hours from UTC).

June 30

While in port, the following mapping software were updated to the most current versions: SIS (5.7), Sound Speed Manager (2021.2.0), Qimera (2.4.0), and ArcPRO (2.8.1).

All sonars started up normally and all built-in-systems-tests (BISTs) passed for the EM 304. Transit mapping commenced once in operational depths.

July 01

Mapping continued while transiting to the first dive location. Seas increased throughout the day and data quality is moderate.

Overnight, SIS's graphical user interface (GUI) crashed prompting a warning "Geographical window has failed. SIS will continue pinging and logging. Do you wish to restart SIS GUI." The watchstander clicked "yes" to this message. Once SIS started back up, it would automatically start pinging but displaying the following error: "Echo sounder EM304_60: Ping status is faulty. The echosounder is pinging. Try to turn pinging on and off to correct the problem." There seemed to be no way to stop pinging the EM 304 with SIS and a hard restart of the processing unit (PU) was necessary. This behavior is new with the 5.7 update. If this message returns, the team will say "no" to the GUI restart warning, manually stop pinging and recording, and restart SIS to hopefully avoid the pinging loop.

The mapping lead reached out to Kongsberg who advised using the K-controller application to stop pinging if SIS is not communicating with the sonar. Having the files sent to shore during the ROV expedition is allowing Kongsberg to troubleshoot on the fly and will hopefully lead to quick bugfix turnaround.

July 02

Transit mapping continued. Overnight, SIS displayed the same "GUI restart" message. Instead of clicking "yes", the watchstander clicked "no", manually shut down pinging and recording, and restarted SIS. Everything started up normally and the issue with the pinging loop was avoided.

POS MV occasionally stops Ethernet logging, seemingly with no cause. Watchstanders are diligently monitoring to ensure that no data is lost.

The mapping lead is communicating with NCEI with regard to daily bathymetry products not displaying correctly in the Live Operations Map.

July 03

The area of interest for Dive 01 was mapped around 0530. What appeared to be one seamount in the satellite altimetry data, was actually two peaks and approximately 700 m shallower than predicted. The mapping team immediately turned around a processed surface for dive planning, and then produced the navigational products. Displaying the real-time locations of the vehicles with the bathymetry was fully operational throughout the dive.

When switching over from ROV to mapping operations, Sound Speed Manager (SSM) lost connection with SIS. The cause has yet to be determined.

July 04

Transit continued to Congress Seamount. The majority of the transit occurred in depths greater than 5000 m. When in “Auto Mode,” the desired pulse mode was “Very Deep,” although the transition to “Extra Deep” should occur around 5000 m. Depending on the conditions, the sonar could perform well when in depths greater than 5000 m and with speeds over 10 knots when in “Very Deep” mode, allowing coverage of two times water depth. However, if sea state increased, the pulse mode needed to be forced into “Extra Deep” to improve the quality, and, consequently, reduce coverage.

SIS stopped gridding and attempts to grid with standard troubleshooting steps (restart HDDS, restart SIS, and restart PU) were unsuccessful. The assumption is that since departure, the ship has been transiting for the past five days and crossed three UTM zones, and a memory cap was reached. A new SIS survey was created and everything functioned normally.

July 05

Overnight Congress North and Congress South Seamounts (or peaks) were mapped. The mapping team immediately processed the bathymetry to decide the location of Dive 02, as this was another ‘map and dive.’ The pulse mode while surveying was forced into “Very Deep” as sector tearing occurred when in “Deeper” when in “Auto Mode” on the first seamount.

The GUI message continues to appear about twice a watch.

July 06

Overnight mapping included transiting to 'Hopscotch' seamount (operational reference name only) and collecting new data on the seamount itself, which was processed for the imminent dive.

Other than the GUI restart messages and logging randomly stopping of POSpac data, all mapping systems are functioning normally.

July 07

Overnight mapping included transiting and a small survey over Justus Seamount and "Dumbbell" Guyot for the upcoming dive. The pulse mode was forced in "Very Deep" to mitigate sector tearing.

July 08

Overnight mapping included transiting and a small survey on the southern end of Rockaway Seamount for the upcoming dive. The pulse mode was forced in "Very Deep" to mitigate sector tearing.

July 09

Overnight mapping included a focused survey of Castle Rock Seamount using a different line planning technique to first establish the flanks of the seamount and fill in from the outside in, which proved successful.

July 10

Overnight strategic transit was planned to map the potential connection between Castle Rock and Corner Rise Seamounts. Mapping operations provided coverage on a previously unmapped seamount, including an interesting slumped feature where Dive 07 ended up occurring.

July 11

Overnight mapping consisted of a straight transit to MacGregor Seamount, including collecting new data over the dive site. The new mapping data revealed significant differences from the 2005 data and the dive track was amended to accommodate.

July 12

Following the dive, a focused survey was performed over the southeastern region of Macgregor Seamount. The ship then transited to Yakutat seamount and the next dive site area was remapped.

Fledermaus and Qimera frequently freeze. The mapping team has tried restarting the computers, however the issue still persists. No updates are currently available for these software.

July 13

Overnight mapping operations added coverage and filled gaps on and around Yakutat Seamount.

July 14

Overnight coverage was added to MacGregor Seamount and the dive location on Caloosahatchee Seamount was remapped.

July 15

The ship transited to the New England Seamounts, opportunistically building coverage when feasible.

The mapping team is investigating one line of data that is only showing half of the collected data in Qimera. The mapping lead has reached out to Kongsberg for more information.

July 16

The ship arrived in the general area for Dive 12 around 1400, at which time a focus survey began for Dive 12 and Dive 13.

July 17

A focused survey was completed of the unofficially named “Y” seamount (operational reference name only) to plan today’s dive. SIS seems to be glitching more than normal. It is likely that a new survey will need to be started soon.

There has been an increase in the number of failed AXBT launches. The SST performed standard maintenance on the autolauncher in an attempt to reduce failures.

July 18

Overnight a focused survey was performed to complete the coverage of Hodgsen Seamount.

Prior to the dive, the ADCP server needed to be restarted to fix communication to speed log webpage.

July 19

Overnight a focused survey of unofficially named "Seven" seamount (operational reference name only) was performed, as well as an advantageous survey of an unmapped seamount.

July 20

Strategic mapping occurred overnight to ensure nearby sites were mapped in the event the current was too strong at Allegheny Seamount. The mapping team also captured currents at each backup site for decision making in the morning.

July 21

Overnight the mapping team edged-matched while transiting to Michael Seamount and performed a focused survey upon arrival. After the decision to cancel the dive was made, mapping of an unnamed seamount commenced. Due to weather conditions, data quality was much higher when collected at a specific heading, and thus reciprocal lines were run when necessary.

In addition to the poor sea-state, another POS MV thrashing event occurred, degrading data quality even further. This POS MV event was experienced across the fleet.

Following mapping of the unnamed seamount, the transit to Atlantis II Seamount began. Data quality was extremely poor as a result of the sea conditions and the heading necessary to transit to the next dive site. Data was not recorded, and this decision will be assessed as data quality is monitored throughout transecting the storm.

July 22

The transit through the storm continued throughout the day. A POS MV thrashing event again occurred at 1300 UTC.

July 23

Overnight mapping operations included opportunistic transits and reconnaissance of current conditions at potential locations for Dive 16.

A POS MV thrashing event occurred again at 1300 UTC while the ROV was descending through the water column. This event followed the normal behavior with a dropout every 150 seconds for approximately 1.5 hours. The mapping lead worked with the Chief ET to describe the nature of these events and provide historical knowledge as this was the first time this occurred while the ship was in Dynamic Positioning. Follow up communication occurred with Applanix and OMAO.

July 24

Overnight mapping operations included focus survey lines on Atlantis II Seamount and reconnaissance of current conditions at potential locations for Dive 17.

July 25

Overnight mapping operations consisted of a transit to the dive location.

July 26

Overnight operations included a transit to and a focused survey of Retriever seamount (originally mapped in 2014). Following cancellation of the dive, lines designed to acquire sub-bottom data of the adjacent sediment plains were performed.

July 27

Overnight mapping operations consisted of a transit to Retriever Seamount and a focused survey upon arrival. Once the dive was cancelled due to weather, operations focused on sub-bottom lines of the adjacent sediment plain. Conditions were poor and significantly affected data quality. Towards the end of the lines, the ship had to divert to find a safe heading to mitigate the storm.

July 28

Overnight operations consisted of a direct transit to Hydrographer Canyon for Dive 20. The mapping lead supported midwater transect planning with the shoreside scientists.

A POS thrashing event occurred around 1300 UTC. The data has been provided to Applanix.

July 29

Arrival in Newport, Rhode Island. Demobilization efforts commenced.