Data Documentation

Dataset Information

Dataset Title:

Bathymetry, acoustic backscatter, and LiDAR data collected in Long Island Sound for the Phase II Long Island Sound Seafloor Mapping Project (NCEI Accession 0167531 version 2)

Description:

This dataset contains multibeam bathymetry, backscatter, and LiDAR bathymetry and reflectance. These GeoTiffs represent water depth and acoustic intensity of the seafloor from Phase II of the Long Island Sound (LIS) Benthic Habitat Priority Areas of Interest (AOI) project. The original Phase II datasets were surveyed by NOAA Ship *Nancy Foster* (R-352), NOAA Ship *Thomas Jefferson*, and the Navigation Response Team (*NRT-5)* using 400 khz Reson 7125 multibeam sonars from 2003 to 2014. In 2018, the LIS Cable Fund contracted the State University of New York (SUNY) at Stony Brook School of Marine and Atmospheric Sciences (SoMAS) to fill gaps and resurvey areas where multibeam data was not acceptable with the R/V *Pritchard* using 400 khz Kongsberg dual-swath EM2040c multibeam sonars in coordination with the NOAA National Centers for Coastal Ocean Science (NCCOS) Biogeography Branch and the NOAA Integrated Ocean and Coastal Mapping (IOCM) Program. The multibeam and LiDAR were corrected, calibrated, and integrated into a seamless 32-bit raster using CARIS and ArcGIS. Backscatter data was collected and mosaicked into a raster using Fledermaus Geocoder Toolbox, ArcGIS 10.4, and PCI Geomatica 2018 software.

Purpose:

These integrated bathymetric and backscatter rasters were created to provide the LIS Mapping and Research Collaborative a baseline model for benthic habitat classification in the Phase II Area of Interest. Multibeam acoustic bathymetry, backscatter, and LiDAR bathymetry can be used to study the changing geomorphology of the seafloor, characterizing surficial seafloor features, and delineating benthic habitats.

Methods:

Multibeam bathymetry data was collected within the LIS Phase II Seafloor Mapping Area of Interest aboard the NOAA Ship *Thomas Jefferson* between 2003 and 2014, as well as subsequent mapping missions within the Phase II AOI from NOAA's Navigational Response Team in 2014 and the NOAA Ship *Nancy Foster* in 2015. All multibeam data was acquired in .hsx format with hull-mounted Reson 7125 echosounders. Line spacing for acquisition was three times the water depth, and data was retained out to 60 degrees from nadir. Heave, roll, pitch and heading correctors were collected using an Applanix POS/MV Model 320 V4 inertial measurement unit (IMU) and associated Trimble GPS (Global Positioning System) antennas. Sound velocity profiles were acquired with a Seabird Electronics SeaCat SBE19P CTD (Conductivity, Temperature, and Depth) profiler and processed using NOAA's Velocwin V8.85 software, then applied directly to the raw data. Positioning was obtained using Trimble Zephyr GPS receivers.

Raw .hsx data were imported, converted, and processed into CARIS 9.0 HDCS data. Sound velocity profiles were applied to the bathymetry to correct for refraction artifacts. Measured tidal heights from NOAA, USGS, and Coast Guard base stations were applied to correct for vertical offsets based on National Water Level Observation Network (NWLON). Total Propagated Uncertainty measurements were calibrated into each vessel configuration for each survey. All of the corrections were merged, then each swath of sonar was filtered, cleaned, and reviewed for outliers in CARIS swath editor. A three-dimensional (3D) CARIS Base surface was created for each survey using the combined uncertainty bathymetry estimator (CUBE) from the filtered soundings. The surfaces were cleaned using CARIS subset editor and exported as a 32 bit Bathymetry Attributed Grid (BAG) 2m surfaces. Each surface was projected to the NOAA Mean Lower-Low Water (MLLW) vertical datum and to NAD83 UTM Zone 18N.

Green LiDAR data and near-infrared (NIR) LiDAR data (used for water surface model creation that is incorporated during refraction of the green bathymetric data) was acquired for the CT Topobathy LiDAR project using a Riegl VQ-820G Topobathy LiDAR systems. Two-dimensional (2D) breaklines representing land/water interfaces were created using E-Cognition. These 2D breaklines were manually reviewed and adjusted where necessary to ensure all well-defined hydrographic features (at 1:1200-scale) were represented with breaklines. Refraction angles were calculated between the air, surface of the water, and the water column to produce the depth values. The final processed LiDAR was exported as LAS files to the NAD83 UTM Zone 19N. The processed LAS files were imported into Global Mapper V.16 Lidar Module and were converted to a classified grid. Land, water surface, and water column data was removed, leaving only the data of the bathymetry data. The extracted bathymetry was then exported from Global Mapper as a 32bit 2m Geotiff. The LiDAR Bathymetry vertical datum had to be transformed from WGS 84 into NOAA MLLW tidal datum and the UTM Zone 19N projection was changed to 18N using NOAA's Vdatum V.32 software. The BAG surfaces of each individual survey imported into ArcGIS 10.7 and converted to 32bit geotiffs. The geotiffs were then merged with the bathymetric LiDAR geotiff using the Raster Calculator to adjust for vertical offsets and the Mosaic to New Raster tools in Spatial Analyst, creating the final merged 2m grid in UTM Zone 18n NAD 83.

Subsequent multibeam bathymetry and backscatter surveys were conducted by the State University of New York (SUNY) at Stony Brook School of Marine and Atmospheric Sciences (SoMAS) to fill in data gaps and resurvey areas where the NOAA data quality was not optimal. Surveys were conducted by the R/V *Pritchard* from 2017-12-17 to 2018-07-11 using Kongsberg Em 3002 and dual swath Em 2040c. Bathymetry was acquired in .ALL format.

Bathymetry was corrected for refraction using sound velocity profiles, vessel motion using the smoothed best estimate of trajectory (SBET), and was cleaned for data noise and errant soundings using CARIS Hips and Sips v. 11. The bathymetry blocks were exported as 32-bit rasters and converted from NAVD88 to the MLLW tidal datum using the Vdatum tool from the NOAA Center for Operational Oceanographic Products and Services (CO-OPS). The SoMAS bathymetry was seamlessly merged with the preliminary Long Island Sound Phase II mosaic using ArcGIS "Mosaic to New Raster Tool" in Arc 10.7. The final unified surface was separated into standard International Hydrographic Order (IHO) depth thresholds.

The multibeam backscatter and side scan .gsf data were corrected for geometric and radiometric distortions using FMGT. In particular, the following corrections were applied where appropriate and when artifacts were evident: AVG Trend, TX Power and RX Gain, Slant-Range

correction Area Correction, Spreading, Slant-Range and Extracted Beam Pattern. As no theoretical beam pattern for the Reson 7125 system exists, it was extracted for each vessel from a mapped area that was flat and had a relatively uniform (sandy) substrate. Individual lines were also truncated based on ping number and/or angle of incidence where appropriate. The final mosaics were exported as geotiffs in NAD 1983 zone 18N on a relative 0-255 linear color scale. The intensity results varied between each vessel as there were no ground validation samples that could be applied to acurately assess and calibrate the beam patterns. The geotiffs were imported into PCI Geomatica where manual color balancing, edge dodge and burn, and feathering techniques were applied to seamlessly merge the overlapping datasets. The 2015 *Nancy Foster* data was used as the baseline for merging the other data sets together, which varied in quality and color scheme. Once the mosaics were finally merged together, a final mosaic was exported as a 2m, NAD83 UTM Zone 18n, 8bit Geotiff.

Data Sources and Cited Publications:

- NOAA OCS. 2007. H11250: NOS Hydrographic Survey, Long Island Sound, The Race, 2003-10-06 to 2003-11-01. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H10001-H12000/H11250.html
- NOAA OCS. 2008. H11361: NOS Hydrographic Survey, Long Island Sound, Sixmile Reef, 2004-10-11 to 2004-11-15. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H10001-H12000/H11361.html
- NOAA OCS. 2008. H11442: NOS Hydrographic Survey, Long Island Sound, Approaches to Niantic River, 2005-04-18 to 2005-05-06. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H10001-H12000/H11442.html
- NOAA OCS. 2008. H11441: NOS Hydrographic Survey, Long Island Sound, New London Harbor and Approaches, 2005-04-27 to 2005-05-22. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H10001-H12000/H11441.html
- NOAA OCS. 2009. H11997: NOS Hydrographic Survey, Long Island Sound, 3 Nautical Miles North of Mulford Point, 2008-09-15 to 2008-10-29. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H10001-H12000/H11997.html
- NOAA OCS. 2009. H11445: NOS Hydrographic Survey, Long Island Sound, North Shore of Plum Island, 2008-09-16 to 2008-10-01. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H10001-H12000/H11445.html
- NOAA OCS. 2010. H12012: NOS Hydrographic Survey, Long Island Sound, 3 Nautical Miles South of the Entrance to the Connecticut River, 2009-04-18 to 2009-04-30. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H12001-H14000/H12012.html
- NOAA OCS. 2010. H12013: NOS Hydrographic Survey, Long Island Sound, The Entrance to the Connecticut River, 2009-04-19 to 2009-05-17. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H12001-H14000/H12013.html
- NOAA OCS. 2013. H12298: NOS Hydrographic Survey, Long Island Sound, 3 Nautical Miles Southeast of Fisher Island, 2011-08-31 to 2011-11-16. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H12001-H14000/H12298.html
- NOAA OCS. 2015. H12508: NOS Hydrographic Survey, Long Island Sound, Saybrook Outer Bar to Salt Works Bay, 2013-07-30 to 2014-05-29. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H12001-H14000/H12508.html
- NOAA OCS. 2016. H12676: NOS Hydrographic Survey, Long Island Sound, Fishers Island Sound, 2014-05-27 to 2014-10-24. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H12001-H14000/H12676.html

- NOAA OCS. 2018. H12509: NOS Hydrographic Survey, Long Island Sound, Long Rock to Duck Island, 2014-07-30 to 2014-11-09. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/H12001-H14000/H12509.html
- NOAA OCS. 2019. W00405: NOS Hydrographic Survey, Long Island Sound, 5NM South of New London Harbor, 2015-09-17 to 2015-10-19. NOAA National Centers for Environmental Information, https://www.ngdc.noaa.gov/nos/W00001-W02000/W00405.html
- IHO. 2008. IHO Standards for Hydrographic Surveys (S-44), 5th Edition. Special Publication No. 44. International Hydrographic Bureau, Monaco, 28 pp., https://www.iho.int/iho_pubs/standard/S-44_5E.pdf.
- NOAA NOS. 2018. NOS Hydrographic Surveys Specifications and Deliverables. 159 pp., https://nauticalcharts.noaa.gov/publications/docs/standards-and-requirements/specs/hssd-2018.pdf

People & Projects

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Partners:

- US DOC; NOAA; NOS; Office of Coast Survey (OCS)
- State University of New York (SUNY) at Stony Brook, School of Marine and Atmospheric Sciences (SoMAS)
- Columbia University, Lamont Doherty Earth Observatory (LDEO)
- Connecticut Department of Energy & Environmental Protection (DEEP)
- University of Connecticut (UConn)

Funding:

- US DOC; NOAA; NOS; National Centers for Coastal Ocean Science (NCCOS)
- Connecticut Department of Energy and Environmental Protection (CTDEP)
- Long Island Sound Resource Center (LISRC)

Associated Online Resources:

- NCCOS Project #140, Mapping the Long Island Sound Seafloor, https://coastalscience.noaa.gov/project/mapping-long-island-sound-seafloor/
- University of Connecticut, Long Island Sound Habitat Mapping, https://lismap.uconn.edu/

- Battista, T., W. Sautter, and G. Kagesten. 2017. Bathymetry and acoustic backscatter collected in Long Island Sound for the Phase I Long Island Sound Seafloor Mapping Project 2014 (NCEI Accession 0167946). NOAA National Centers for Environmental Information. Dataset. https://accession.nodc.noaa.gov/167946
- Battista, T., W. Sautter, and R. Husted. 2017. Bathymetry and acoustic backscatter data collected in Long Island Sound for the Phase III Long Island Sound Seafloor Mapping Project 2015 (NCEI Accession 0167532). NOAA National Centers for Environmental Information. Dataset. https://accession.nodc.noaa.gov/167532

Extents

Start Date: 2003-10-20
End Date: 2018-07-11

Northern Boundary: 41.367559067953096
Southern Boundary: 41.1727956299922
Western Boundary: -72.4933275538804
Eastern Boundary: -71.84386899419657

Keywords

Sea Areas, Water Bodies, Marine Protected Areas:

- Northeast Atlantic Ocean
- Long Island Sound
- Connecticut
- Fishers Island
- New London
- New York
- Continental Shelf
- Fishers Island Sound

NOAA Ships, Other Ships, Platforms:

- NRT-5
- NOAA SHIP NANCY FOSTER
- NOAA SHIP THOMAS JEFFERSON
- R/V PRITCHARD

NCCOS Keywords:

- NCCOS Research Priority > Marine Spatial Ecology
- NCCOS Research Topic > Habitat Mapping
- NCCOS Research Location > Region > East Coast
- NCCOS Research Location > U.S. States and Territories > New York
- NCCOS Research Location > U.S. States and Territories > Connecticut
- NCCOS Research Data Type > Geospatial
- NCCOS Research Data Type > Field Observation
- NCCOS Research Data Type > Derived Data Product

File Information

Total File Size: 5.8 GB total, 40 files in 7 folders (unzipped), 1.5 GB (zipped)

Data Files:

- LISphaseII_Unified_IHO_0to20m_Bathymetry_1m.TIF 5 files, 4.26 GB (777 MB zipped)
- LISphaseII_Unified_IHO_18to40m_Bathymetry_2m.TIF 5 files, 160 GB (142 MB zipped)
- LISphaseII_Unified_IHO_36to80m_Bathymetry_4m.TIF 5 files, 47.7 MB (45.9 MB zipped)
- LISphaseII_Unified_IHO_72to160m_Bathymetry_8m.TIF 5 files, 98.5 MB (1.58 MB zipped)
- LISphaseII_LiDARintensity_1m.TIF 5 files, 242 MB (7.72 MB zipped)
- LISphaseII_Unified_Backscatter_2m.TIF 5 files, 509 MB (70.9 MB zipped)
- LISphaseII_Unified_Bathymetry_2m.TIF 5 files, 513 MB (492 MB zipped)

Data File Formats: GeoTiff .TIF (and ancillary files .TFW, .AUX.XML, .OVR, .XML)
Data File Compression: no compression
GIS Projection: NAD 1983 UTM Zone 5N
GIS Resolution:

- 1x1 meters (0 to 20m depth range IHO)
- 2x2 meters (18 to 40m depth range IHO)
- 4x4 meters (36 to 80m depth range IHO)
- 8x8 meters (72 to 160m depth range IHO)
- 2x2 meters (Unified Bathymetry and Backscatter)

Documentation Files:

- NCCOS-LIS-PhaseII-Mapping_BrowseGraphic.JPG
- NCCOS-LIS-PhaseII-Mapping_PreviewGraphic_PriorityAreas_v1.PNG
- NCCOS-LIS-PhaseII-Mapping_PreviewGraphic_PriorityAreas_v2.JPG
- NCCOS-LIS-PhaseII-Mapping_DataDocumentation_v1.PDF
- NCCOS-LIS-PhaseII-Mapping_DataDocumentation_v2.PDF

Parameter Information

Major parameters:

- Acoustic Bathymetry
- Acoustic Backscatter
- LiDAR Intensity

Parameter Descriptions:

Parameter: Acoustic Bathymetry
Property Type: measured
Units: meters
Observation Category: in situ
Sampling Instrument: Reson 7125 and Kongsberg EM2040c Multibeam Echo Sounder
Sampling and Analyzing Method:

Measurement of depth of the seafloor. Acoustic bathymetry was collected aboard NOAA Ships *Thomas Jefferson*, *Nancy Foster*, and the *NRT-5* using Reson 7125 multibeam echosounders (MBES). A subsequent multibeam survey for gap filling and resurvey areas with poor data quality were collected by the SoMAS R/V *Pritchard* using a Kongsberg EM2040c MBES. All bathymetry data was processed by NCCOS using CARIS HIPS and SIPS software. The raw soundings were cleaned and had sound velocity profiles and GPS navigation applied to create a Combined Uncertainty Bathymetric

Estimation (CUBE) surface of the survey area. The *Thomas Jefferson* and the *Nancy Foster* data were merged seamlessly using ArcMap "Mosaic to New Raster" tool.

Data Quality Method:

Bathymetry was vertically and horizontally corrected by the POS MV system to the ellipsoid and then converted to the NOAA Mean-Low Low Water (MLLW) datum for NOAA hydrographic survey specs and deliverables. Acoustic noise and vessel motion artifacts were filtered by setting a threshold of the standard deviations of the nodes form the CUBE surface. QAQC tools from NOAA Pydro software were used for crossline analysis, finding data gaps, and outlying data (flyers).

Parameter: Acoustic Backscatter
Property Type: measured
Units: decibels
Observation Category: in situ
Sampling Instrument: Reson 7125 and Kongsberg EM2040c Multibeam Echo Sounder
Sampling and Analyzing Method:

Measurement of relative intensity of the sea floor. Acoustic imagery data (backscatter) was collected aboard NOAA Ships *Thomas Jefferson*, *Nancy Foster*, and the *NRT-5* using Reson 7125 multibeam echosounders (MBES). A subsequent multibeam survey for gap filling and resurvey areas with poor data quality were collected by the SoMAS R/V *Pritchard* using a Kongsberg EM2040c MBES. All backscatter data was processed by NCCOS using FMGT software. The raw sounding and beam form were combined to create a mosaic of the survey area. Datasets were manually edited for constantly of intensity over multiple years and sampling systems. The intensity mosaics were merged seamlessly using PCI Geomatica 2018.

Data Quality Method:

NCCOS reviewed and processed the acoustic imagery (backscatter) aspect data using Fledermaus geocoder toolbox (FMGT). FMGT combined the raw intensity from the MBES with the edited/cleaned bathymetry data from CARIS HDCS to get a mosaic cleared of noise and data artifacts.

Parameter: LiDAR Intensity
Property Type: measured
Units: decibels
Observation Category: in situ
Sampling Instrument: Riegl VQ-820G LiDAR
Sampling and Analyzing Method:

Data for the CT Topobathy LiDAR project was acquired by NOAA using a Riegl VQ-820G Topobathy LiDAR systems. Both green LiDAR data and NIR LiDAR data (used for water surface model creation that is incorporated during refraction of the green bathymetric data) was acquired. NOAA Contractors used E-Cognition to create 2D breaklines representing land/water interfaces. The final processed LiDAR was exported as LAS files to the NAD83 UTM Zone 19N. The processed LAS files were imported into Global Mapper V.16 Lidar Module and intensity was extracted. The extracted intensity was then exported from Global Mapper as an 8bit 1m Geotiff.

Data Quality Method:

These 2D breaklines were manually reviewed and adjusted where necessary to ensure all well-defined hydrographic features (at 1:1200-scale) were represented with

breaklines. Refraction angles were calculated between the air, surface of the water, and the water column to produce the depth values. LiDAR reflectivity dynamic range did not compare to the multibeam backscatter, so it was decided that the intensity should be served as a separate product.

Document Information

Date:	2020-02-13
Resource Provider:	NCCOS Data Manager, nccos.data@noaa.gov, US DOC; NOAA; NOS; National Centers for Coastal Ocean Science (NCCOS)
Comment:	This data documentation describes data files archived as a NOAA NCEI data accession, and is intended to provide dataset-level metadata for the purposes of discovery, use, and understanding.
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