Long Island Sound Seafloor Mapping Program

CT-DEEP award CDEP 2023-191

REPORT
Developing Dynamic Habitat-Based Ecological Decision Support Tools and Data to Characterize Deep-water Habitats (LIS Mapping Phase 4B-Part 1)

Reporting period
March 3, 2023 to September 30, 2025

SUBMITTED TO:

THE LONG ISLAND SOUND CABLE FUND STEERING COMMITTEE
STATE OF CONNECTICUT, DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION, OFFICE OF LONG ISLAND SOUND PROGRAMS;
STATE OF NEW YORK, DEPARTMENT OF ENVIRONMENTAL CONSERVATION, BUREAU OF MARINE RESOURCES;
NEW YORK DEPARTMENT OF STATE, OFFICE OF PLANNING, DEVELOPMENT, AND COMMUNITY INFRASTRUCTURE;
CONNECTICUT SEA GRANT;
NEW YORK SEA GRANT;
AND
U.S. ENVIRONMENTAL PROTECTION AGENCY, REGIONS 1 AND 2

BY:
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1. Introduction/Background

1.1. Project background

In June 2004, a settlement fund was created for the purpose of mapping the benthic environment of Long Island Sound (LIS) to identify areas of special resource concern, as well as areas that may be more suitable for the placement of energy and other infrastructure. This activity shall assist managers in the State of Connecticut, the State of New York, Connecticut and New York Sea Grant, and the U.S. Environmental Protection (USEPA) agency with their mandates to preserve and protect coastal and estuarine environments and water quality of Long Island Sound, while balancing competing human and energy needs with protection and restoration of essential ecological function and habitats.
This resulted in creation of the Long Island Sound Cable Fund Habitat Mapping Initiative. As part of this initiative a pilot (Phase I) project was conducted from 2012 to 2014 in the central LIS between Bridge Port and Port Jefferson by collaborative groups of the Lamont–Doherty Earth Observatory (LDEO) Collaborative, Long Island Sound Mapping and Research Collaborative (LISMaRC), and NOAA's Ocean Service Collaborative. Based on the result of the pilot and the recommendations of the Steering Committee the mapping project was first expanded to cover the Phase II area in Eastern LIS (Fig. 1.1). After the conclusion of Phase II, the Steering Committee has determined areas III and IV in the western and central Long Island Sound, respectively for the phases of the work. This report covers work in area IV.

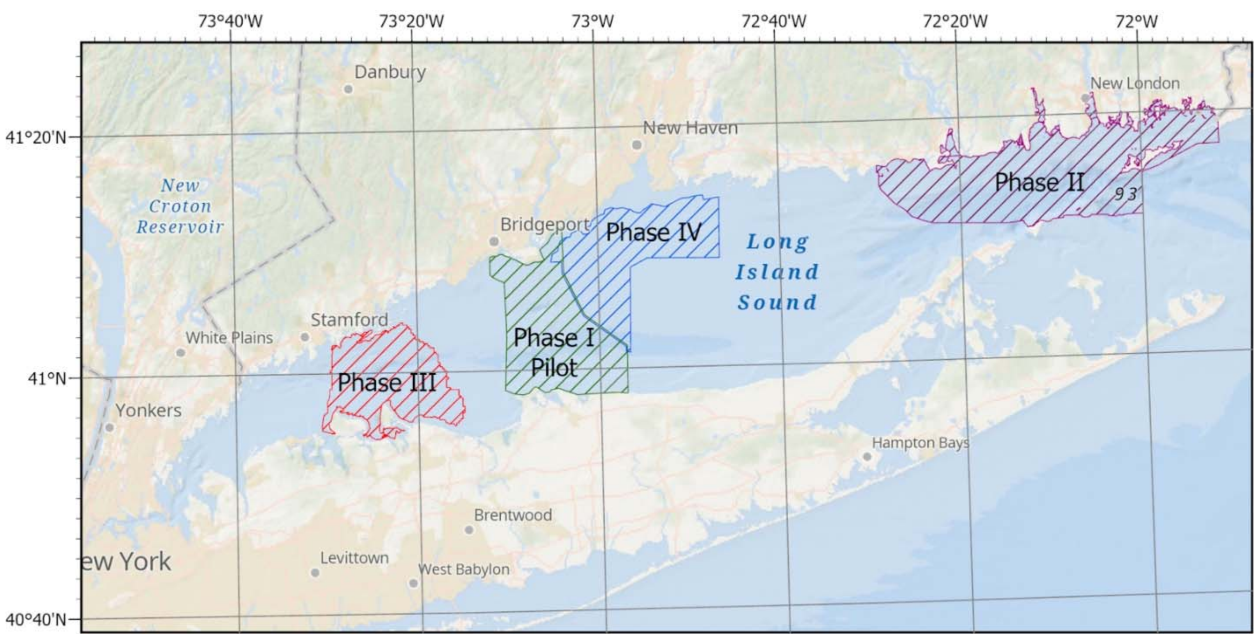

Fig. 1.1: Long Island Sound mapping project areas (phases).

The work in area IV has been broken up in several phases. In phase 4A bathymetry and backscatter acoustic data have been previously collected by Dr. Roger Flood from Stony Brook University (SBU). In phase 4B the LDEO/Queens College team is collecting subbottom data and sediment grabs (this report) while the LISMaRC team is collecting biological samples and images

as well as physical oceanographic data. This phase also includes a workshop to determine options to improve the use of the collected data.
The detailed analysis of the sediments grabs and collections and analysis of sediment cores will be done by the LDEO/Queens College team as part of a subsequent phase 4C project.

1.2 Project area and goals

The Phase IV area is shown in Figs. 1.1 and 3.2. The overarching goal of this project is to collect sediment grab samples and subbottom data across the phase IV area that will form the basis of later analysis and determination of sediment texture and environments. The details have been laid out in the statement of work (SOW) for area 4 as described in the contract (Appendix A).
This supporting work included the:

(1) collection of 150 sediment grabs samples in the phase 4 area
(2) visual description and photos of the sediment samples
(3) collection of subbottom seismic profiles
(4) archiving of the sediment descriptions and acoustic data collected as part of this phase 4B project in the MGDS database

Note that, as described in the proposed work, this phase 4B work does not include detailed interpretation or the generation of the interpreted products such as maps of sediment texture and environments. These products will be derived as part of phase 4C work, which also includes the necessary detailed analyses of the samples collected as part of this phase 4B component.

2. QAPP process

This project required a written Quality Assurance Project Plan (QAPP) to be approved by EPA. CT DEEP prepared one QAPP document that combined the Lamont/Queens part as well as the LISMARC part of the project. We worked with CT DEEP by providing details and background information for the QAPP. Work began right after the start of the project. The final QAPP was signed and submitted on June 12 2023 and approved a month later. This was a requirement before the actual work could start.

3. Subbottom Seismic data

3.1 Subbottom data acquisition

As part of the project phase LIS 4B we conducted a subbottom seismic survey of the phase 4 area. Subbottom seismic data provide insights into the subsurface sediment structure.
The data provide guidance for subsequent sediment coring by identifying locations of softer sediments that allow better recovery of samples. The subbottom data also place the results of the sediment cores into a wider spatial and temporal context and provide valuable guidance for the interpretation and characterization of sediment environments.
In 2023 we started the subbottom survey using an older Chirp subbottom profiler system consisting of an EdgeTech 424 tow fish and an EdgeTech 3200 acquisition unit with Discovery software. However, this old system had technical issues, which eventually led to frequent and

eventually total failure. We then conducted the survey using a new high-resolution subbottom chip system consisting of an EdgeTech 3400-OTS system with an updated discovery system that was purchased as part of the LIS phase 3B project (Figure 3.1).

Fig. 3.1 EdgeTech 3400-OTS subbottom system

The system was operated using an acoustic sweep signal between 2-16 kHz that results in a nominal high vertical resolution of ~0.1m. The horizontal resolution depends on the survey speed. The system transmits data at a rate of 4-5 pings/second. At survey speeds of 4-5 knots these transmission rates result in an along track spacing of traces between 0.5 and 1m. Data were recorded in EdgeTech's proprietary jsf format as well as in Standard SEGY format.
The subbottom data are geo-referenced using a differential GPS system mounted on the ship, which provides horizontal accuracy <1m. The offset between the ships DGPS antenna and the actual towed fish location was determined for later correction of the positions.
The actual subbottom survey was performed in different phases using the RV Pritchard due to the initial technical issues, vessel schedule and weather (Table 3.1). In total we collected 60 subbottom lines, with a total of ~450 km of subbottom data (Figure 3.2).

Table 3.1: Subbottom field data collection details.

Survey	Survey date	Field days	Vessel	# lines	Length/km
LIS2302	August 7 2023	1	RV Pritchard	0	0
LIS2401	August 5-12, 2024	5	RV Pritchard	40	293
LIS2501	May 12-16, 2025	4	RV Pritchard	20	152
total		**10**		**60**	**451**

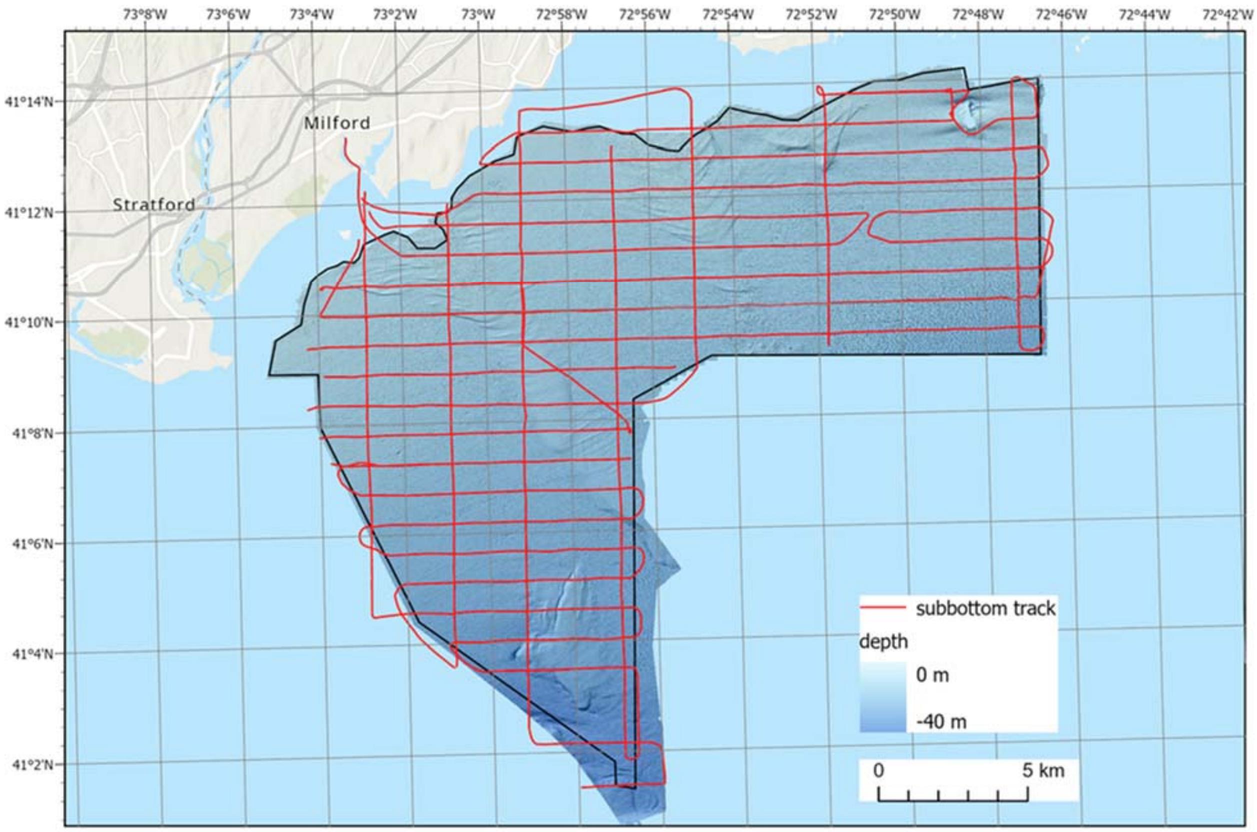

Fig. 3.2: Map of the new subbottom profiles (red) collected in area 4.

3.2 Subbottom data processing and results

Data processing of the subbottom data was performed using a combination of tools including the EdgeTech Discovery software system, Chesapeake SonarWiz, and various in-house scripts. The data were corrected for horizontal offsets of the tow fish to the GPS antenna (layback correction) and vertical offset, which is caused by tides and tow depth) by aligning the seafloor reflection in each line with the bathymetry data provided by Roger Flood from his surveys in SonarWiz. For each subbottom file we exported the corrected data in SEGY format and generated images in jpeg format and exported the corrected.

3.3 Subbottom Results

The resulting images of all lines together with the SEGY files can be downloaded from the database (http://www.marine-geo.org/portals/lis/). The data show a variety of subbottom features as can be seen in the examples of Figure 3.3.

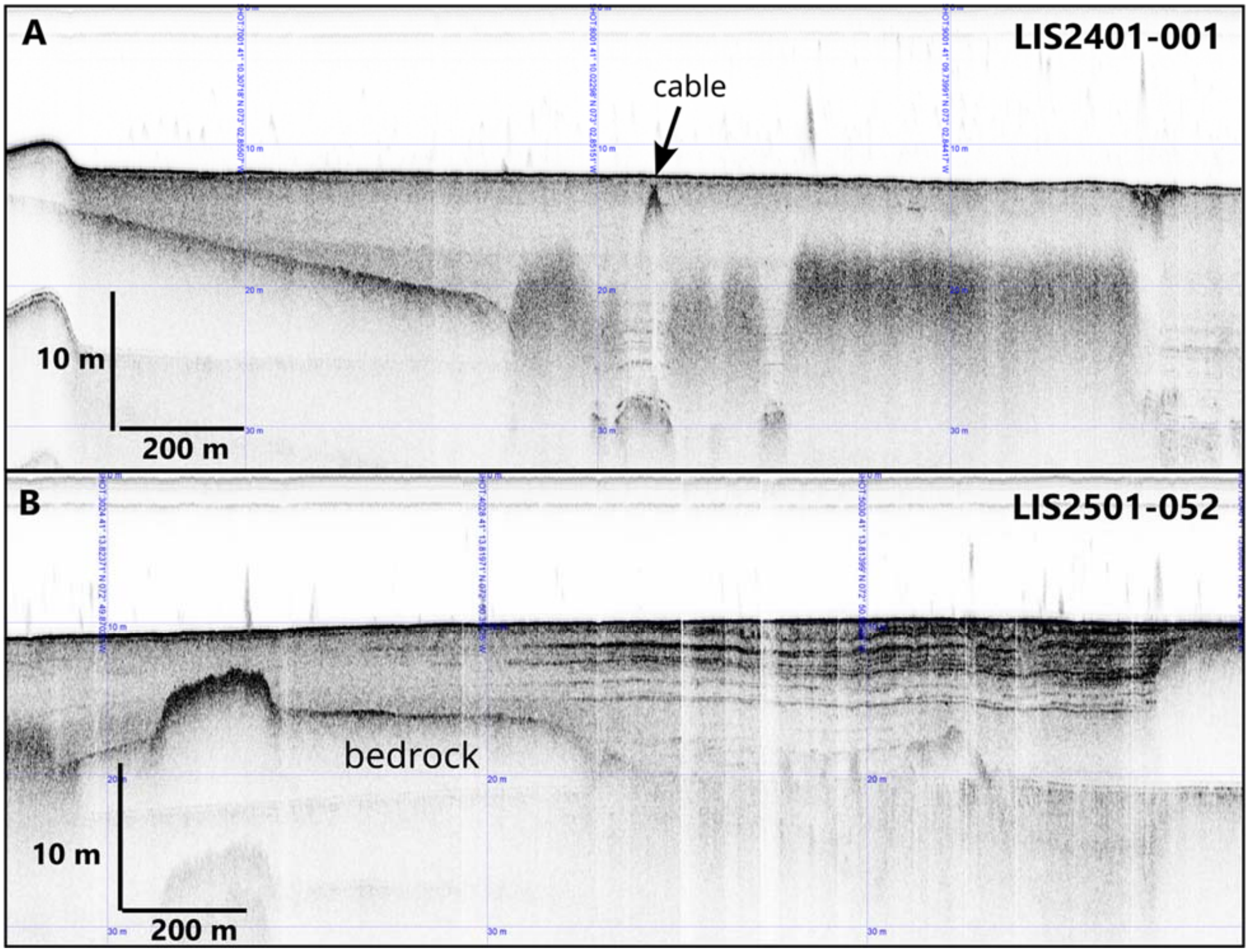

Fig 3.3: Examples of subbottom data in area 4.

4. Sediment grab samples

4.1 Sediment grab sample collection

Sediment texture (which includes grain size distribution, composition, sorting, etc.) is an essential element of any habitat classification. Gravel, sand, mud and various mixtures of these major grain size classes provide very different habitats. Sampling sites were chosen based on preliminary interpretation of backscatter data from the area. The goal of the site selection was to achieve a dense and well-distributed coverage of the study area that was representative of the range of observed backscatter signatures and depositional regimes.

All sediment grab samples were collected using a modified van Veen grab. On August 14-17 2023 (LIS2302), we collected 68 samples within the study area onboard the RV Pritchard (Fig. 4.1). Later, in November 15-18 2023 (LIS2303), we collected 95 samples within the study area onboard the R/V Seawolf (Fig 4.2).

Figure 4.1: modified van Veen grab system with GoPro camera (left) and sample procedure (right).

During these surveys bottom videos were obtained using a GoPro (Hero 6) camera system with an external light source. In general, locations where material was not recovered the nature of the sites was revealed by the seafloor video images collected from these sites.

4.2 Field descriptions and surface images

Upon recovery of the grab samples, a surface photo was taken and a brief description of the sediment texture and composition was noted in a table. Each sample was characterized by: whether the surface was oxidized or not, by its stiffness (very soft, soft, stiff, or very stiff) and color (gray-green, gray). The grain size (mud, sand, gravel, and pebbles), wood, shell, oyster, mussel, living vegetation and anthropogenic contents were classified as: absent, rare, common and abundant. We also noted if there was hydrogen sulfide odor or not. In the general comments section, we noted particular characteristics of each sample.

After the visual description, the surface sediments (0-2cm) were sampled directly into pre-weighed and pre-cleaned polystyrene jars, which were then sealed and placed in a cooler on ice until they were placed in cold storage at the Lamont-Doherty Core Repository. Sampling tools were cleaned and dried between samples.

In addition to the samples collected directly by our group, we received sediment samples from the ecology surveys conducted by the LISMARC group, which they conducted in 2023 and in 2024. These samples were included in the sample preparation process for future chemical analysis.

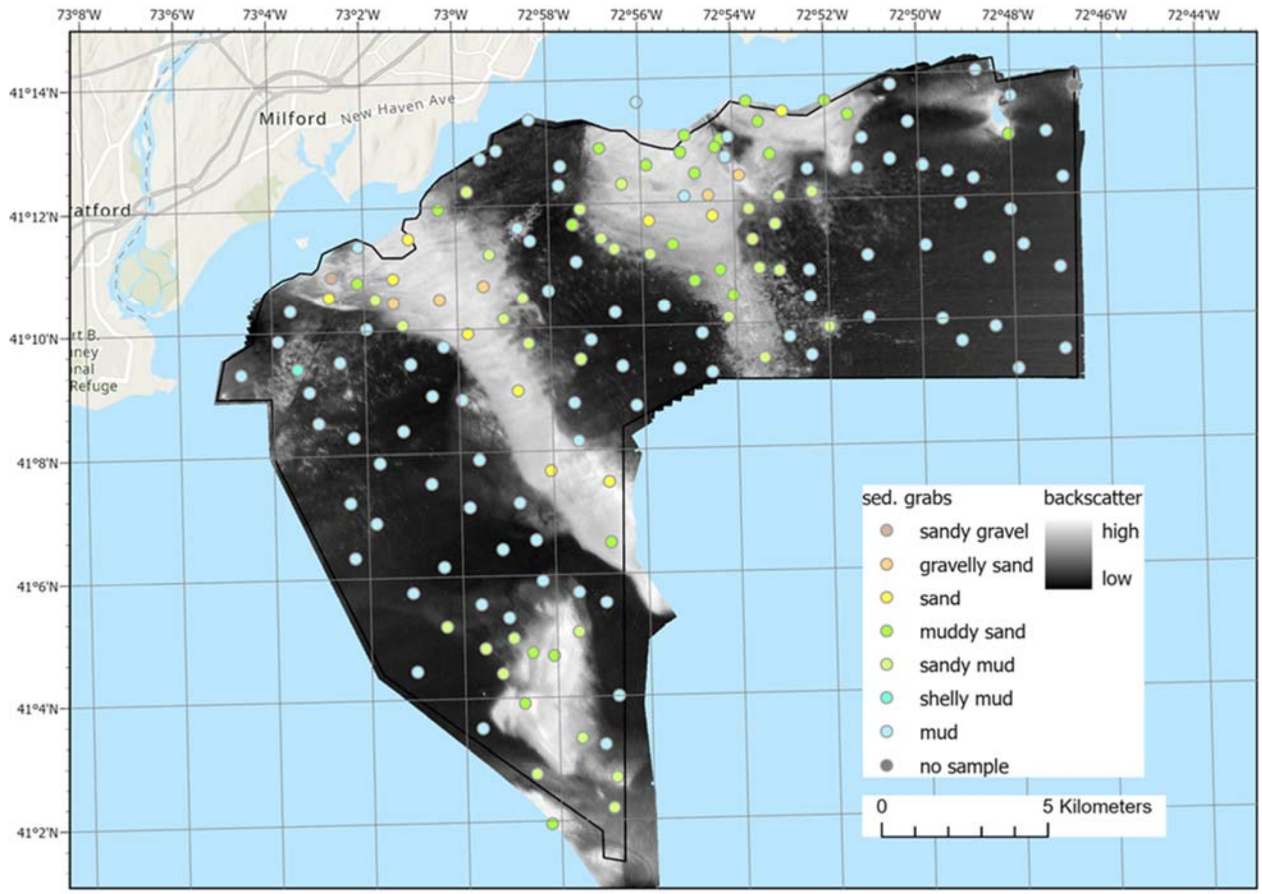

Fig. 4.2: Map with sediment grab locations colored by field description lithology. Background image are backscatter data.

4.3 Analysis of bottom images

The video footage of the grab samples was processed using the open source Shotcut Open Source software (https://www.shotcut.org/) to crop videos to parts where the bottom is visible, convert them to mp4 format, and to extract still images of the bottom. The still images were inspected manually and it was determined if they show large grain size types including gravel, pebbles, or boulders. Figure 4.3 shows some examples. The images were georeferenced using the location information of the sample sites.

The sediment of the study area is often muddy and as result the water near the bottom is very turbid and the images are not always clear.

Fig. 4.3: examples of sediment grab bottom images taken by the GoPro system (top) and the corresponding surface grab photos.

4.3 Sample processing

Upon return to the laboratory, the grab sample jars were stored at 4°C, and one of the 0-2cm sediment sample jars was weighed and then frozen. Water content was determined by comparing the net sample weight before and after freeze drying. Following this, the dried samples were arranged on a sheet of paper and photographed for reference. The quartering method or 'pie slice' method was used to obtain representative subsamples. For each grab sample, 2 aliquots were taken for grain size analysis in the event duplicate analysis was necessary; a third aliquot was taken for bulk chemical composition organic content and matrix density. Any remaining sample was archived in its original polystyrene jar. The grain size aliquots remained un-ground while the aliquot collected for bulk chemistry was homogenized using a mortar and pestle to pass through a 500-micron sieve. Following this step, representative sub-samples of the bulk homogenized material were taken for XRF (3-5g) and C and N (0.5g). The remaining bulk homogenized material was stored in a clean 20mL borosilicate glass scintillation vial pending matrix density analysis.

Peroxide treatment

Prior to determining the grain size distribution, organic matter was removed by treating sediments with 30% hydrogen peroxide. Grain size aliquots were weighed into beakers with watch glasses (glass/Queens College; Teflon; LDEO) and enough distilled water was added to cover the samples. At this point, 30% H_2O_2 was added in increments of 5mL until no visible reaction occurred up to a total of 25mL, each time allowing the reaction to proceed to

completion while covered with a watch glass to prevent loss. After the reaction was complete following the addition of the final 5mL volume of 30% hydrogen peroxide, the watch glass was removed and the sample was allowed to dry on a hot plate at 120°C (LDEO) or on the deck of the hood at room temperature (Queens College). Once the sample was dried, it was re-weighed and the organic content was computed as a difference in sample mass before-and-after the peroxide treatment.
Future analysis conducted as part of LIS 4C will include a detailed grain size analysis, XRF element analysis and Carbon and nitrogen (CN) analysis.

5. Stakeholder workshop collaboration

Another goal of the phase 4B project was to determine how the different products are used by different stakeholders and make suggestions on how they can be best distributed. This effort was led by the LISMaRC team. We participated in the effort by contributing and advising on the original workshop planning and two team members, Frank Nitsche and Tim Kenna, participated in the actual workshop, which was held on April 4, 2024 on the University of Connecticut Avery Point campus. We also reviewed and commented on the workshop report.
One of our team members, Vicky Ferrini, participated in the follow-up workshop on July 10, 2025.

6. Data management

6.1 MGDS Data System Design and Infrastructure

The LIS Data Portal (https://www.marine-geo.org/collections/#!/collection/LIS) deployed at LDEO leverages the technical infrastructure of the Marine Geoscience Data System (MGDS; http://www.marine-geo.org). which is supported primarily by NSF. MGDS is a trusted data repository that provides free public access to a curated collection of marine geophysical data products and complementary data that support the needs of a diverse community of marine scientists, policy makers, educators and the general public. The MGDS team curates a metadata catalog and digital data repository that serves over 126 TB of data files, and provides links to data at over 30 external data systems and institutions. Investigator-focused data stewardship offered by MGDS supports the entire data life cycle – from planning through acquisition to long-term data archiving, dissemination and publication. The LIS Data Portal at MGDS (https://www.marine-geo.org/collections/#!/collection/LIS) hosted within the MGDS provides a solution for long-term archiving of metadata and data, as well as full access to the suite of MGDS services.

6.2 Technical Overview

MGDS is supported by enterprise-level IT infrastructure ensuring that data are replicated and that systems are monitored to ensure the integrity and security of data holdings. All data files curated by MGDS are stored locally on our servers, with the data system backed up in triplicate, and long-term (100-year) preservation of data handled through agreements with the National Data Centers operated by NOAA for appropriate data types and formats. Data files are also backed up off-site in the cloud for further security, and Data DOIs are assigned through the DataCite system to ensure long-term access, discoverability, and citation of data products. MGDS data cataloging, archiving, and discovery services are driven by a geospatially-enabled cloud-deployed PostgreSQL relational database backend, which is a rich metadata catalog that describes and provides access to data files and complementary descriptive metadata and related documents. Data can be discovered and accessed through user interfaces and through web services. In addition to PostgreSQL, the data system makes use of PostGIS, MapServer, Google Maps API, GDAL, MB-System, GMT, and OpenLayers, as well as a suite of line command tools and disciplinary data curation workflows developed in-house.

6.3 Work Accomplished

In spring 2025 the MGDS team updated the older Long Island Sound portal (https://www.marine-geo.org/portals/lis/) to the new collection portal (https://www.marine-geo.org/collections/#!/collection/LIS)

As of September 2025, we have received the datasets from the LDEO team and ingested these data in the MGDS database.

Web pages that present data sets contributed for this phase of the LIS project are:

	Description	URL
LDEO	LIS 4B Benthic Geology main page	https://www.marine-geo.org/tools/search/entry.php?id=LIS4B:BenthicGeology
LDEO	LIS 4B: Subbottom SEGY files	https://www.marine-geo.org/tools/files/32461
LDEO	LIS 4B: Subbottom profile images	https://www.marine-geo.org/tools/files/32462
LDEO	LIS 4B: Subbottom track (shapefile)	https://www.marine-geo.org/tools/files/32463
LDEO	LIS 4B: Sediment grab samples (Excel)	https://www.marine-geo.org/tools/files/32464
LDEO	LIS 4B: Sediment grab samples (shp)	https://www.marine-geo.org/tools/files/32465
LDEO	LIS 4B: Sediment grab bottom photos	https://www.marine-geo.org/tools/files/32466
LDEO	LIS 4B: Sediment grab surface photos	https://www.marine-geo.org/tools/files/32467

Note: LISMARC and SBU datasets that have not been received yet will be ingested under the LIS mapping phase 4C award.

7. Deliverables

The following deliverables of this project have been prepared together with their metadata records and have been ingested into the Marine Geoscience Data System (MGDS). See table above for download links.

For subbottom data:

- SEGY data files of all processed subbottom lines
- Images of subbottom profiles in SEGY format
- An ESRI shapefile with track lines of the subbottom profiles
- A pdf map of the subbottom track lines

For sediment grabs:

- An Excel spreadsheet with location and acquisition information of collected sediment samples(.xlsx)
- An ESRI shapefile showing the location and acquisition information of collected sediment samples referenced to NAD83(2011) and identifying the tabulated results from the preliminary sediment texture descriptions
- Scanned log sheets with photographs of the shipboard descriptions in portable document format (PDF).
- Jpeg image files of the sediment bottom images
- Jpeg image files of the sediment samples taken on the surface

All datasets are accompanied by appropriate metadata prepared in accordance with the requirements described in the contract (Appendix A).