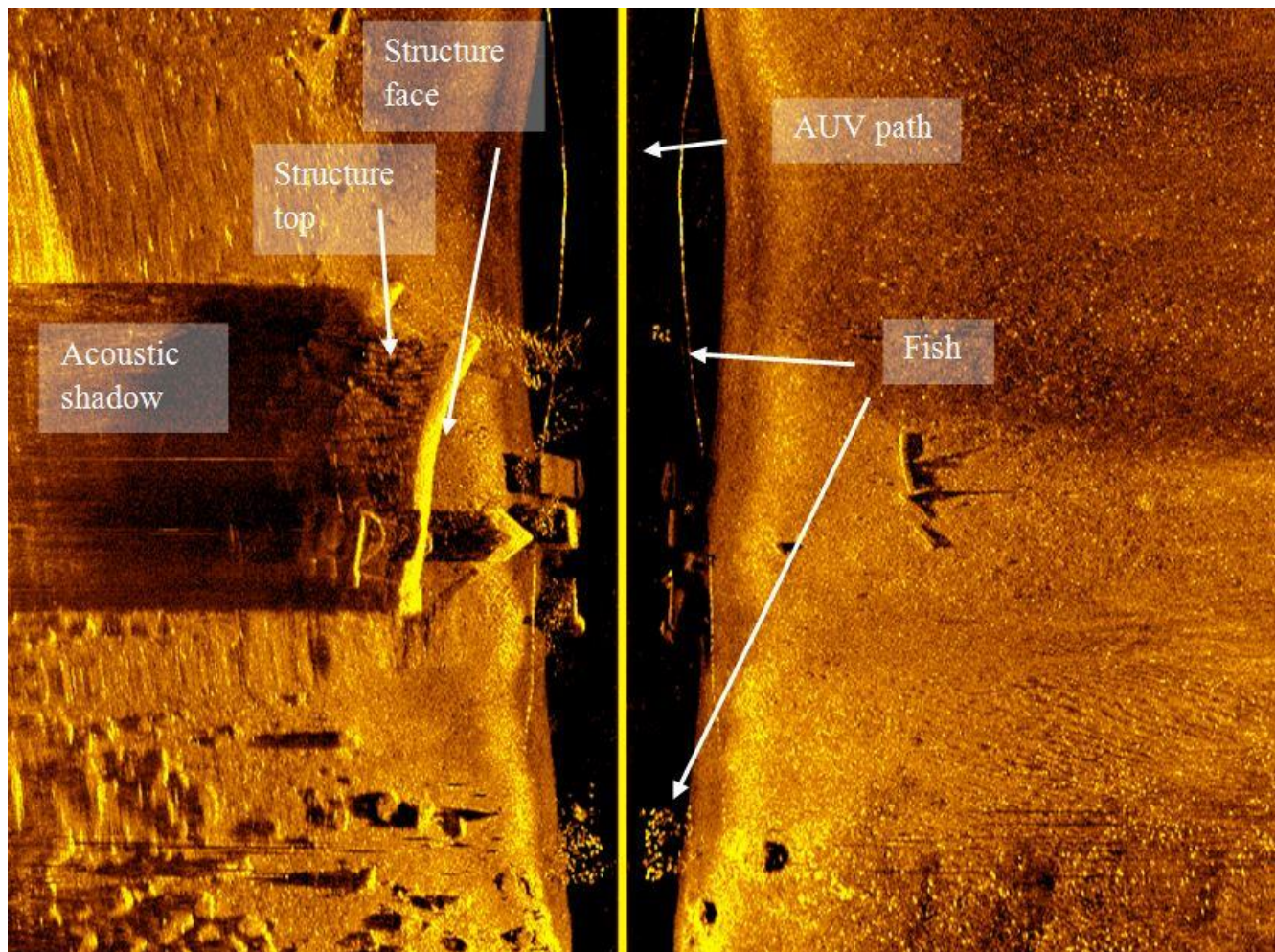




Procedures and Criteria for Evaluating Benthic Mapping Data

A Northeast Coastal and Barrier Network Methods Document

Natural Resource Report NPS/NCBN/NRR—2019/2050



ON THE COVER

Example of side scan sonar data from Gateway National Recreation Area, from *Submerged marine habitat mapping at Sandy Hook Unit, Gateway National Recreation Area: A post-Hurricane Sandy study*, Grothues, et al., 2019.

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Natural Resource Report NPS/NCBN/NRR—2019/2050

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Fort Collins, Colorado

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Abstract

The National Park Service (NPS) Northeast Coastal and Barrier Network (NCBN) initiated benthic habitat mapping projects from 2014-2018 at four coastal parks in the Northeast Region with four different research institutions through supplemental funding following Hurricane Sandy. This document describes the list of data deliverables and associated specifications that was developed for these mapping projects. The list is comprised of 32 datasets grouped into five data categories (sidescan and bathymetry data; sub-bottom seismic reflection profiles; ground-truth data; geological features and surficial sediment classification; habitat classification), as well as a sixth category for large format maps and a final report. Specifications include acceptable file formats, metadata needs, geospatial referencing preferences, and other details unique to each deliverable. This document also includes two appendices. Appendix A presents the data deliverables and associated specifications for benthic mapping projects as bulleted checklist for ease of reference. Appendix B presents a suggested file directory structure for benthic mapping projects to assist with data organization and management.

The purpose of this document is to provide guidance to NPS data and project managers and project Principle Investigators in the establishment of benthic habitat mapping projects and the final review of data products. This guidance is meant to ensure consistency and compatibility across projects, but also to be flexible and adaptable to accommodate the goals of a given project and NPS objectives.

Acknowledgments

We would like to thank the private investigators (PIs) and their teams that conducted mapping projects at four Northeast Coastal and Barrier Network parks: the University of Delaware for Assateague Island National Seashore; Rutgers University for Gateway National Recreation Area; the University of Rhode Island for Fire Island National Seashore; and the Center for Coastal Studies for Cape Cod National Seashore. In addition, these mapping teams diligently worked with our team to discuss data collection methods, data formats, and report and data deliverables for these projects. We would also like to thank Dr. Charles Roman, a now retired National Park Service (NPS) scientist, for leading these mapping projects throughout the proposal and planning phases and initial project phase. His advocacy and support of habitat mapping studies at NPS parks provided this opportunity to demonstrate how valuable such studies can be from both ecological and management perspectives. Thank you also to Dennis Skidds from the NPS Northeast Coastal and Barrier Network, who assisted in the initial development of the data deliverables checklist; and to Roland Duhaime from the University of Rhode Island, who assisted in the initial development of this report and provided guidance to ensure project data formats and deliverables are consistent with NPS protocols.

List of Acronyms

CMECS	Coastal and Marine Ecological Classification Standard
CSDGM	Content Standard for Digital Geospatial Metadata
CTD	conductivity, temperature, and depth
DEM	digital elevation model
ESRI	Environmental Systems Research Institute, Inc.
FGDC	Federal Geographic Data Committee
GIS	Geographic Information System
ITIS	Integrated Taxonomic Information System
LiDAR	light detection and ranging
MPES	multi-phase echosounder
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NCBN	Northeast Coastal and Barrier Network
NPS	National Park Service
PI	principle investigator
SAV	submerged aquatic vegetation
TSN	taxonomic serial number
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

1. Introduction and Purpose

The National Park Service (NPS) Northeast Coastal and Barrier Network (NCBN) initiated benthic habitat mapping projects at four coastal parks in the Northeast with four different research institutions (Table 1) through supplemental funding following Hurricane Sandy. The projects were conducted from 2014 to 2018. Benthic mapping projects often involve a variety of data collection methods, based on the characteristics of the project study site (e.g. size, water depth, water clarity) and project goals. A list of data deliverables and associated specifications was drafted, with the goal of assuring consistency and compatibility across all four projects. The list was then discussed in a meeting with the principal investigators (PIs) of each mapping project, NPS staff, and University of Rhode Island Environmental Data Center staff prior to the start of the projects. The list was revised until a consensus was reached by all parties on each deliverable and NPS was satisfied that the list met the agency's objectives. The list was further revised during and after the completion of the projects based on review of the deliverables (e.g. completeness, quality) and how well they met NPS needs. For example, some data deliverables were entirely removed from the initial list, while others were defined more specifically.

The purpose of this document is to provide guidance to NPS data and project managers and project PIs in the establishment of benthic mapping projects and the final review of benthic mapping data products. This document is meant to ensure consistency and compatibility across projects, but also to be flexible and adaptable to accommodate the goals of a given project and NPS needs.

This document is focused on the specifications and review of data deliverables for benthic mapping projects. The data specifications represent the minimum data standards. This document does not address the instruments and methodologies used to acquire, process, and analyze such data. Readers may want to refer to the *Priority Data on Marine and Estuarine Resources Within Northeastern National Parks: Inventory and Acquisition needs* (Hart et al., 2013), as it provides a detailed review of benthic mapping data types and potential methodologies, and laid the groundwork for NPS benthic mapping efforts, including the four projects that served as the basis for this document.

This document also includes two appendices. Appendix A presents the data deliverables and associated specifications for benthic mapping projects as bulleted checklist for ease of reference. Appendix B presents a suggested file directory structure for benthic mapping projects to assist with data organization and management.

Table 1. Benthic habitat mapping projects were conducted between 2014 and 2018 at four coastal parks in the Northeast United States, and served as the basis for this document. Also listed are the research institutions that led each project, and the citation and link for each final report.

Coastal Park	Research Institution	Citation and Link to Final Report
Cape Cod National Seashore (Massachusetts)	Center for Coastal Studies	Borrelli, M., S. E. Fox, E. J. Shumchenia, C. G. Kennedy, B. A. Oakley, J. B. Hubeny, H. Love, T. L. Smith, B. Legare, A. Mittermayr, and G. S. Giese. 2019. Submerged marine habitat mapping at Cape Cod National Seashore: A post-hurricane Sandy study. Natural Resource Report NPS/NCBN/NRR—2019/1877. National Park Service, Fort Collins, Colorado. (https://irma.nps.gov/DataStore/Reference/Profile/2259397)
Fire Island National Seashore (New York)	University of Rhode Island	LaFrance Bartley, M., J. W. King, B. A. Oakley, and B. J. Caccioppoli. 2018. Submerged marine habitat mapping at Fire Island National Seashore: A post-hurricane Sandy study. Natural Resource Report NPS/NCBN/NRR—2018/1797. National Park Service, Fort Collins, Colorado. (https://irma.nps.gov/DataStore/Reference/Profile/2257350)
Gateway National Recreation Area (New Jersey)	Rutgers University	Grothues, T. M., D. Levin, N. Psuty, A. Habeck, R. Petrecca, J. Dobarro, G. Taghon, and M. P. De Luca. 2018. Submerged marine habitat mapping at Sandy Hook Unit, Gateway National Recreation Area: A post-Hurricane Sandy study. Natural Resource Report NPS/NCBN/NRR—2019/1865. National Park Service, Fort Collins, Colorado. (https://irma.nps.gov/DataStore/Reference/Profile/2258874)
Assateague Island National Seashore (Maryland)	University of Delaware	Trembanis, A. C., D. C. Miller, E. Ebula, H. M. Rusch, and E. R. Rothermel. 2019. Submerged marine habitat mapping at Assateague Island National Seashore: A post-Hurricane Sandy study. Natural Resource Report NPS/NCBN/NRR—2019/1871. National Park Service, Fort Collins, Colorado. (https://irma.nps.gov/DataStore/Reference/Profile/2259164)

2. Required Data Deliverables

Staff from the NPS, University of Rhode Island, and the PIs of the four mapping projects developed the Data Deliverables Checklist (Appendix A), a spreadsheet of benthic mapping deliverables that identifies and describes the specifications of 32 datasets grouped into five data categories, as well as a sixth category for large format maps and a final report. The specifications include acceptable file formats, metadata needs, geospatial referencing preferences, and other specifications unique to each deliverable. Benthic mapping project PI(s) and other relevant parties should be provided with the Data Deliverables Checklist prior to the start of a project (e.g. during the cooperative agreement or contract phase). The information in the checklist should be discussed among NPS staff and project PI(s), and revised accordingly, to ensure relevancy and feasibility of all deliverables on a project-by-project basis. The agreed upon Data Deliverables Checklist should be provided to data reviewers to guide the data review process at the end of a project.

It is important that the data deliverables adhere to the prescribed specifications and directory structure to facilitate the data review process, future data access, and consistency across projects.

The following six deliverable categories are commonly required for a benthic mapping project:

1. Sidescan and Bathymetry Data
2. Sub-bottom Seismic Reflection Profiles
3. Ground-truth Data
4. Geological Features and Surficial Sediment Classification
5. Habitat Classification
6. Final Maps and Report

Most of these six categories include multiple data deliverables (see Appendix A), each addressed in Section 3, below.

3. Evaluation Procedures

The process of reviewing a benthic mapping project consists of both the review of the draft final report and spatial and tabular data deliverables. While the focus of this document is on review of the data deliverables, reviewing the report concurrently may help clarify aspects of the data sets, such as data collection dates, missing data, or special circumstances during the data collection process that may have affected data outcomes. Similarly, the datasets can serve to cross check the report content.

Complete datasets for benthic mapping projects can be very large (e.g. multiple terabytes) and should be delivered to reviewers on external hard drives following the file directory structure provided in Appendix B. Reviewers will be provided a version of the Data Deliverables Checklist (Appendix A), which identifies and describes the specifications of each deliverable, that has additional columns, such as “Reviewer Notes” and “Date Received,” that can be used to guide and track the review process. The reviewer’s notes and comments about each data deliverable will be communicated to the project PI(s) upon completion of the data review. (Note: The deliverables checklist and/or directory structure may be updated or revised to suit the needs of a given project.)

3.1 Metadata

Metadata should be a component of every deliverable (tabular and spatial data) for any benthic mapping project. This section provides a brief explanation of metadata requirements and highlights the overarching importance of metadata. The information provided in this section should be used to guide the creation of all required metadata for the deliverables listed in the Data Deliverables Checklist (Appendix A).

3.1.1 Non-spatial Metadata

For spreadsheets and other non-spatial tabular data deliverables, metadata can be included as descriptive text at the top of the spreadsheet (i.e. header information), a separate tab (sheet) in the spreadsheet file, or in a separate, clearly labeled text file. Metadata must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps.

Attribute labels in the file(s) must be understandable to any user. Metadata must contain a data dictionary or field descriptions that clearly define all attribute labels (e.g. study site names, sample station names, units of measure, data values, species names, sediment fractions/categories, classification terminology, etc.), especially if codes are used.

For tabular data that contains spatial information (e.g. geographic coordinates of sample station locations, water depth values), additional metadata regarding data projections and referencing to horizontal and vertical datums must be included (refer to starred “*” bullets in Section 3.1.2).

A README text file should be included in the relevant metadata folder, in addition to the metadata that is a part of the tabular data. The README file should describe how the metadata were created and how to access it.

3.1.2 Spatial Metadata

The following are key points regarding metadata, minimum data standards, and file format specifications for all spatial data deliverables submitted as GIS files:

- Data must be submitted as ESRI ArcGIS feature class shapefiles (.shp) and/or geodatabases (.gdb), or other established geographic information system (GIS) formats.
- *Data must use the current horizontal and vertical datums from the National Spatial Reference System (NSRS). The current NSRS datums (as of the publication of this document) are the North American Datum of 1983 (NAD83(2011), Epoch 2010.00) and the North American Vertical Datum of 1988 (NAVD88). (Note: Datums considered “current” are subject to change and should be agreed upon by NPS staff and project PI(s) at the start of a project. Both horizontal and vertical datums will be replaced in 2022 by the North American Terrestrial Reference Frame of 2022 (NATRF2022), based on GPS/GNSS and a GRAV-D-based geoid (GEOID2022) (<https://www.ngs.noaa.gov/datums/newdatums/index.shtml>).)
- *Data must be projected either in the Universal Transverse Mercator (UTM) coordinate system with the zone specified (easting/northing), or in the geographic coordinate system (latitude/longitude).
- The projection information must be defined in the GIS file, not just stated in a separate document, so that the data project accurately when imported into a GIS.
- The planar distance unit should be meters.
- Metadata should be compliant with the [Federal Geographic Data Committee \(FGDC\) Content Standard for Digital Geospatial Metadata \(CSDGM\) specifications](#) and incorporated into all GIS files. Each metadata file should have the same base name as the spatial data that it documents. Metadata must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, spatial resolution of the data, horizontal and vertical datums data are referenced to, projection information, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps.
- The preferred metadata format is extensible markup language (.xml), although text file format (.txt) will be accepted.
- Attribute labels in the file(s) must be understandable to any user. Metadata must contain a data dictionary or field descriptions that clearly define all attribute labels (e.g. study site names, sample station names, units of measure, data values, species names, sediment fractions/categories, classification terminology, etc.), especially if codes are used.
- A README.txt file should be included in each of the five metadata folders (see Appendices A and B) that explains how the metadata were created and how to access it within ArcCatalog. XML metadata files from feature classes need not be copied to the metadata folders.

The CSDGM identifies the following seven metadata components:

1. Identification Information**
2. Data Quality Information
3. Spatial Data Organization Information
4. Spatial Reference Information
5. Entity and Attribute Information
6. Distribution Information
7. Metadata Reference Information**

The FGDC lists categories one and seven (starred “**” above) as “mandatory” and the other five categories as “mandatory if applicable.” A detailed set of essential metadata elements for each of the seven metadata components can be found in the [FGDC CSDGM Essential Metadata Elements document](#). For NPS benthic mapping projects, all categories are applicable and should be considered mandatory. Many of the elements within each category are crucial for fully understanding a dataset and must be included to render the data most useful over the long-term.

Most GIS software packages allow for the creation of geospatial metadata (e.g. ArcCatalog in ESRI ArcGIS). Alternatively, there are several independent metadata tools that can be used to create and edit metadata. Examples include the EPA Metadata Editor, USGS Online Metadata Editor, and USGS Metadata Wizard. Readers should consult the [FGDC Geospatial Metadata Tools website](#) for a more thorough list and discussion of geospatial metadata tools.

When evaluating metadata, the reviewer should open a sample of geospatial files in a GIS and examine them to verify that metadata is present and complete. Metadata can be examined using ESRI ArcCatalog or ArcMap.

3.2 Sidescan and Bathymetry Data

Sidescan and bathymetry data are collected using acoustic sonars. These two data sets can be acquired independently or simultaneously, depending on the sonar system that is used. Sidescan sonar data are acquired using a sidescan sonar system or derived from multibeam echosounder sonar data (referred to as backscatter). Bathymetry data can be collected using a single beam or multibeam echosounder sonar. Bathymetry data can also be collected using a LiDAR system equipped with a blue-green laser in areas with clear and shallow waters. Sidescan and bathymetry data are commonly collected simultaneously in shallow waters using an interferometric or a multi-phase echosounder (MPES) sonar. This approach is beneficial because it ensures the collection of co-located data and can reduce survey time, instrument needs, and cost.

3.2.1 Vessel Configuration File(s)

This deliverable should be an American Standard Code for Information Interchange (ASCII) text (.txt) or spreadsheet (.csv, .xlsx) file that contains the survey vessel dimensions (length, width, draft) and survey instrument positions and offsets applied during data acquisition (Table 2). Multiple files should be provided if more than one vessel or configuration was used for data acquisition.

Metadata should be contained in the header or in a separate file and include the applicable attributes stated in Section 3.1.1.

Open file(s) to verify completeness (e.g. confirm the requested information is included, and that the values seem reasonable and match those stated in the vessel configuration schematic (Section 3.2.2)), correct format, and that metadata is complete and contained in the header or in a separate file.

Table 2. Vessel configuration file from Fire Island National Seashore benthic habitat mapping project. Note: Full metadata* not shown.

Vessel Size	GPS (Applanix POS MV) Location	Sonar (Teledyne Benthos C3D) Location
W: 2.46 m	X (Bow (+) / Aft (-)): 1.37 m	X (Bow (+) / Aft (-)): 3.88 m
L: 7.53 m	Y (Port (+) / Starboard (-)): 0.00 m	Y (Port (+) / Starboard (-)): 0.00 m
H: 0.76 m	Z (Up (+) / Down (-)): 1.74 m	Z (Up (+) / Down (-)): -0.48 m

* **Metadata:** Vessel Configuration File for Fire Island National Seashore benthic habitat mapping project. The sidescan and bathymetry surveys were conducted within in Otis Pike Wilderness Area between July 10th and September 24th, 2014 on a 28ft pontoon boat. Ocean Imaging Consultants (OIC) software was used for data acquisition (GeoDas) and processing (CleanSweep). Surveys were conducted by the University of Rhode Island Graduate School of Oceanography.

3.2.2 Vessel Configuration Schematic(s)

This deliverable should be a standard image file (.jpg, .tiff, .bmp) containing a diagram of the survey vessel dimensions (length, width, draft) and survey instrument positions and offsets applied during data acquisition (Figure 1). Multiple files should be provided if more than one vessel or configuration was used for data acquisition.

Metadata should be contained in the header or in a separate file and include the applicable attributes stated in Section 3.1.1.

Open file(s) to verify completeness (e.g. confirm the requested information is included, and that the values seem reasonable and match those stated in the vessel configuration text file (Section 3.2.1)), correct format, and that metadata is complete and contained in the header or in a separate file.

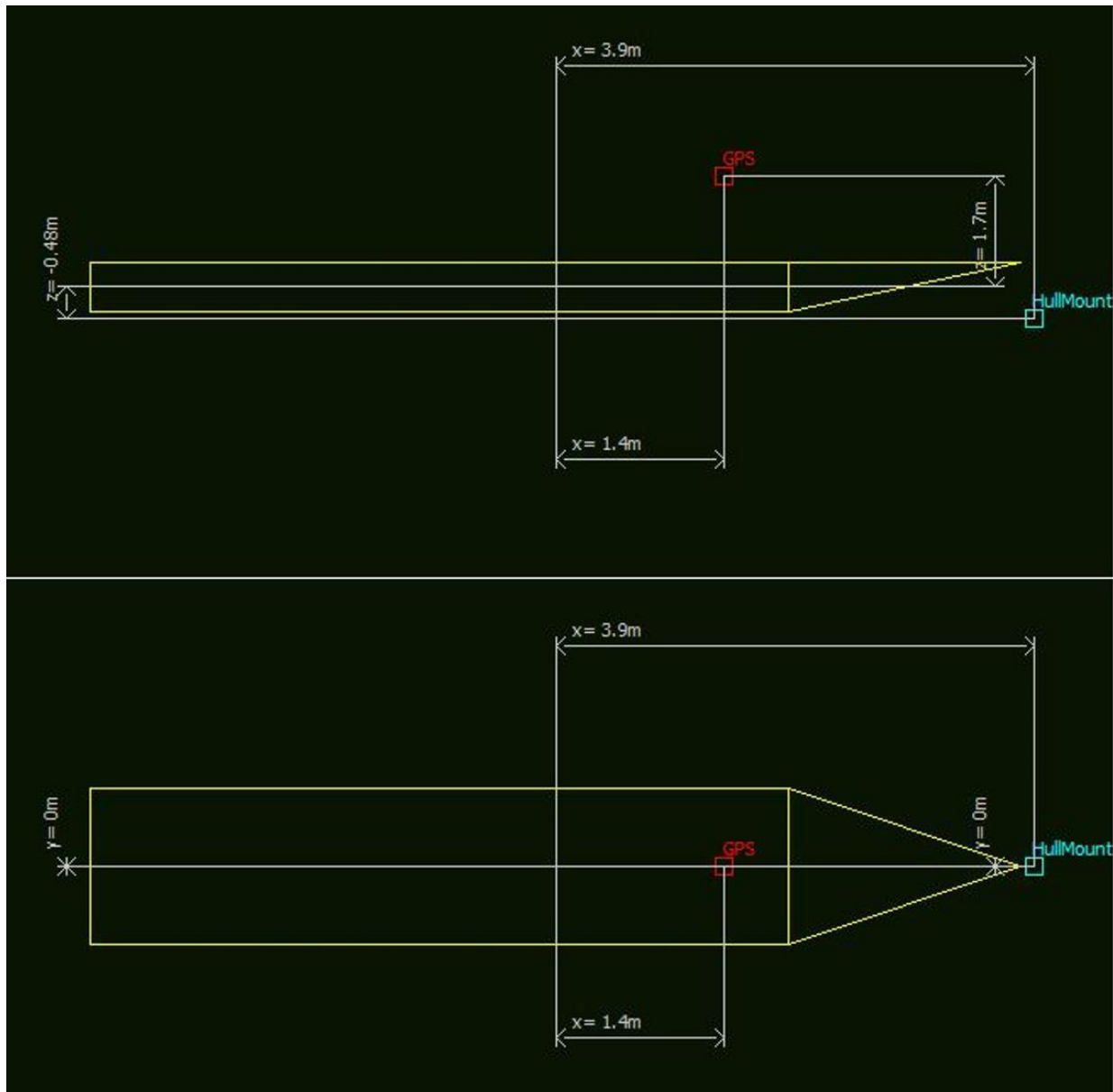


Figure 1. An example of a vessel configuration schematic from the Fire Island National Seashore benthic habitat mapping project. Note: Metadata not included.

3.2.3 Sidescan and Bathymetry Coverage File(s)

This deliverable should be a geospatial dataset (.shp, .gdb) of polygon features that depict the location(s) of the study site(s) at which sidescan and bathymetry surveys were executed (Figure 2). One file (or set of files) can be provided if the sidescan and bathymetry survey extent is identical within the study site(s).

Data should be referenced to the most current NSRS horizontal datum and projection information must be defined in the feature class. Metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the file(s) in a GIS and check for completeness (e.g. the dataset covers all of the site(s) within which survey data was acquired), locational accuracy, correct projection, and correct format. Verify metadata is present and complete.

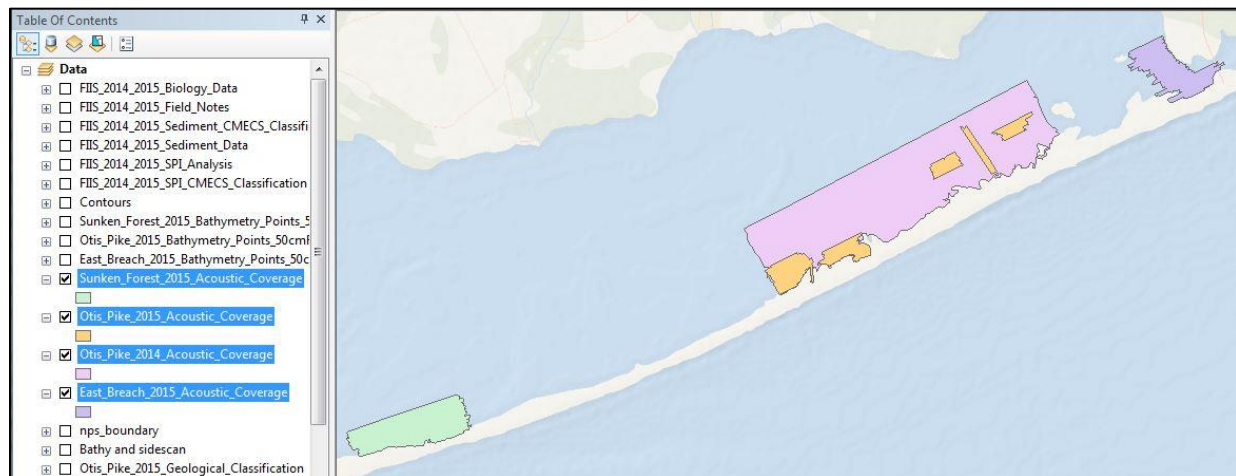


Figure 2. An example of sidescan and bathymetric survey coverage files from the Fire Island National Seashore benthic habitat mapping project. The bathymetry and sidescan data were collected simultaneously, resulting in one set of coverage files for both surveys.

3.2.4 Sidescan and Bathymetry Cruise Track Lines

This deliverable should consist of a geospatial dataset (.shp, .gdb) of line features showing the navigational track lines of the survey vessel recorded during the sidescan and bathymetry data collection mission(s) (Figure 3). One file (or set of files) can be provided if the sidescan and bathymetry track lines are identical (i.e. data were collected simultaneously). Separate track line files should be provided if sidescan and bathymetry surveys followed different paths. Each study site should have a separate file that is named accordingly. Line files should be merged to produce a single track line file if multiple line files were recorded for a given study site (e.g. based on date of survey, a sub-section of the larger study site, or individual track lines).

Data should be referenced to the most current NSRS horizontal datum and projection information must be defined in the feature class. Metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the file(s) in a GIS and check for completeness (e.g. the dataset covers the entirety of the survey site(s)), locational accuracy, correct projection, and correct format. Verify the metadata is present and complete.

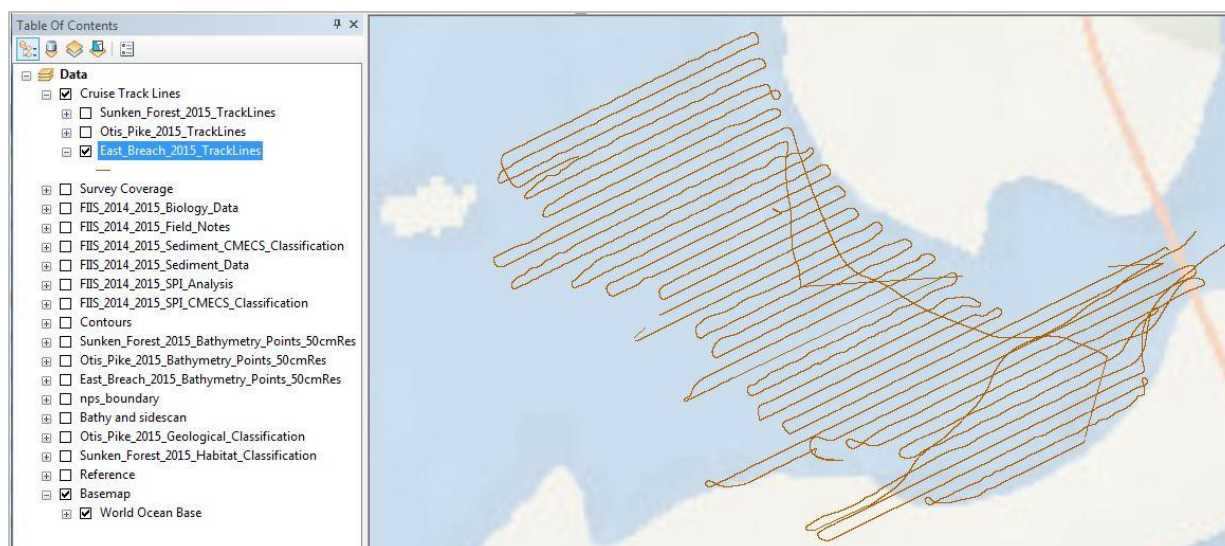


Figure 3. An example of sidescan and bathymetry data acquisition cruise track lines from the “East Breach” study site surveyed for the Fire Island National Seashore benthic habitat mapping project. The bathymetry and sidescan data were collected simultaneously, resulting in one track line file (or set of files) for both surveys.

3.2.5 Raw Sidescan and Bathymetry Sonar Data

Raw sonar files refer to the unprocessed sidescan and bathymetry data that have been collected for the project. These files can be quite large, with a dataset for a typical project easily exceeding one terabyte. Raw sonar file formats vary based on the sonar and software used to collect the data. Specialized and proprietary software is usually needed to access and examine raw sonar data. If possible, data should be collected in common file formats, such as XTF and JSF, because they can be read by a larger range of software packages. The specific file formats for this deliverable should be agreed upon by NPS staff and project PI(s) in the cooperative agreement or contract before the start of the project.

The sidescan and bathymetric data will be contained within one file if an interferometric or MPES sonar system was used to collect the raw sonar data. If independent systems were used, there will be separate files for the raw sidescan and bathymetry data.

Metadata must be included in a separate text file. In addition to the specifications stated in Section 3.1.1, metadata must provide details of the sonar(s) used for data acquisition and the horizontal and vertical datums the raw data is referenced to.

Open the raw data folder to verify completeness (e.g. it contains an appropriate number of data files), correct format (Figure 4), and that metadata is complete and contained in a separate text file. Examine a subset of the raw data files in an appropriate software to check that the data can be opened and processed, are of suitable quality, and are georeferenced and project properly. If data are organized in multiple directories and/or from different dates, examine samples of files from multiple folders or dates. Note: it is possible that data reviewers will not have the required software to open

and examine the raw sonar files. If this is the case, reviewers should ask the peer review coordinator if there are colleagues with the appropriate software.

Name	Date modified	Type	Size
 20150619161440_Binned.jsf	9/11/2017 12:46 PM	JSF File	186,474 KB
 20150619162756_Binned.jsf	9/11/2017 12:47 PM	JSF File	493,813 KB
 20150619164222_Binned.jsf	9/11/2017 12:47 PM	JSF File	88,944 KB
 20150619164616_Binned.jsf	9/11/2017 12:47 PM	JSF File	295,571 KB
 20150619165719_Binned.jsf	9/11/2017 12:47 PM	JSF File	123,585 KB
 20150619170422_Binned.jsf	9/11/2017 12:47 PM	JSF File	155,461 KB

Figure 4. An example of a raw sonar data file listing from the Fire Island National Seashore benthic habitat mapping project. In this case, each file is named according to the date (e.g. June 19, 2015) and time (e.g. 16:14:40) at the start of data logging; this is a common naming convention. This data was collected using a multi-phase echosounder (MPES) sonar system, and, as such, the sidescan and bathymetry data are contained in one file (JSF format).

3.2.6 Sidescan and Bathymetry Mosaics

Sidescan and bathymetry mosaics are created by “stitching” together adjacent individual track lines of sidescan and bathymetry data to create a continuous and more comprehensive “map view” of the data. Mosaic(s) may have coverage gaps depending on the design of the data acquisition survey. For benthic mapping projects conducted in shallow waters, full-coverage sidescan sonar data and partial-coverage bathymetry data is commonly acquired throughout the study sites(s). The difference in coverage is due to the swath range of the bathymetry data being dependent on the water depth more so than for sidescan data. Common practice to plan the survey line spacing according to what is required to acquire full-coverage sidescan data and then accept the bathymetry coverage that such line spacing provides. However, the line spacing and coverage extent to be achieved for both sidescan and bathymetry data should be discussed on a project-by-project basis, as the decision depends on the goals of the project, the water depth of the study site(s), and available resources. The line spacing and coverage specifications should be agreed upon by NPS staff and project PI(s) in the cooperative agreement or contract before the start of the project.

The sidescan imagery mosaic(s) (Figure 5) should be delivered in a standard georeferenced image format, preferably GeoTIFF (.tif. or .tiff) or JPEG2000 (.jpx or .jp2), which store the georeferencing information in the header of the image file. Other file formats that store the georeferencing information in an accompanying world file are also acceptable; e.g. .tif (with its accompanying .tfw world file), .bil (with .blw or .bilw), and .jpg (with .jgw or .jpgw). The preferred format for the bathymetry mosaic(s) (Figure 6) is a digital elevation model (DEM), but other georeferenced raster formats are also acceptable. For large study sites, the sidescan and bathymetry mosaics can be tiled (e.g. broken up into several mosaics) to reduce file sizes and improve the visual layout of maps.

All sidescan and bathymetry mosaics should present processed data with a horizontal spatial resolution of 1m or less. Sidescan mosaics should represent data that have been processed to remove the central nadir region and color balanced to enhance feature identification. The cell values in the bathymetry mosaic(s) should represent processed water depth values as a single raster band with units specified. Mosaics presented in red, green and blue (RGB) color ramp values that result in three bands and do not represent actual depth values are not acceptable.

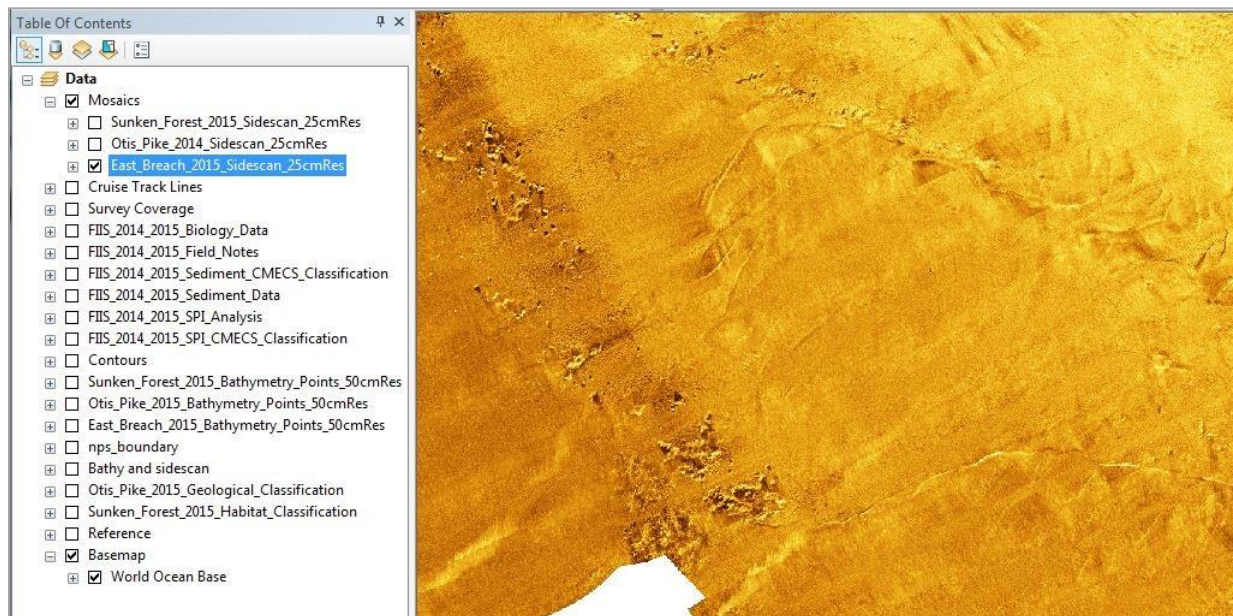


Figure 5. An example of a portion of a processed sidescan mosaic from the Fire Island National Seashore benthic habitat mapping project.

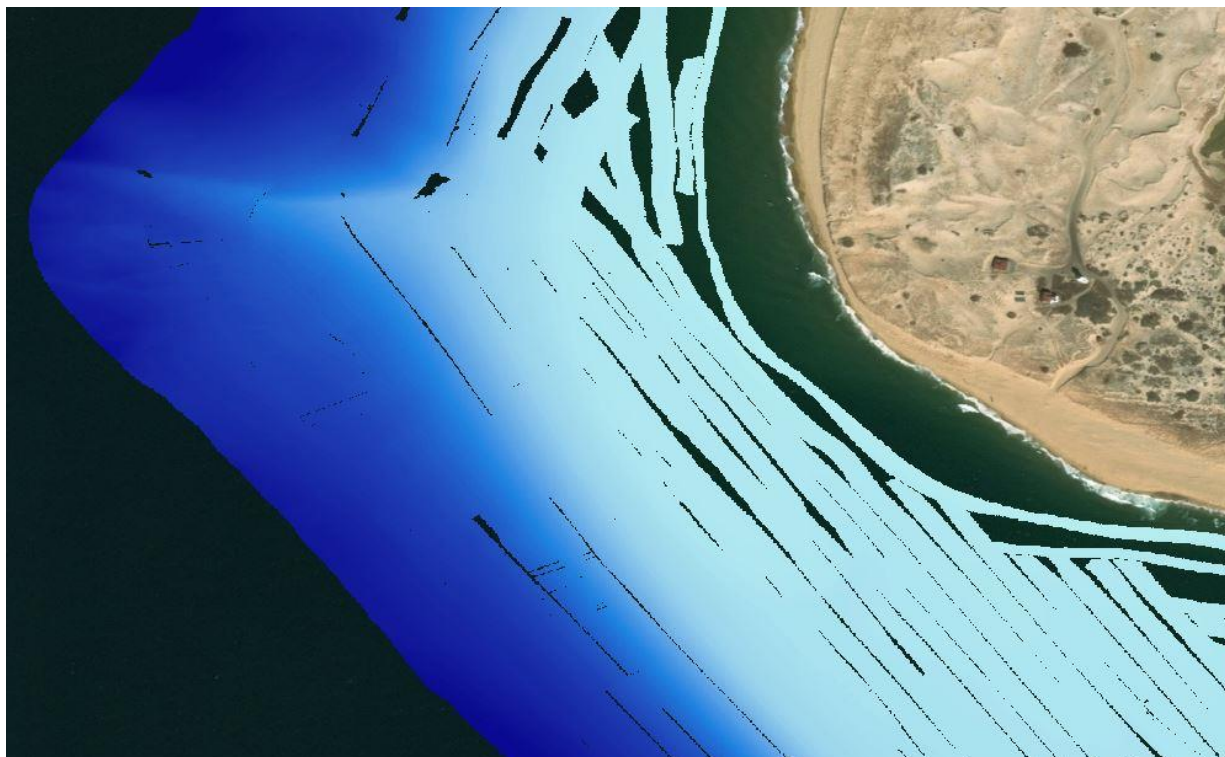


Figure 6. An example of a portion of a bathymetric mosaic from the Cape Cod National Seashore benthic habitat mapping project. Darker blues indicate greater depths. Satellite imagery is displayed in the background.

Sidescan mosaics should be referenced to the most current NSRS horizontal datum and projection information must be defined in the image file (e.g. GeoTIFF) or in an associated file (e.g. .tif with accompanying .twf file). Bathymetry mosaics should be referenced to the most current NSRS horizontal and vertical datums and projection information must be defined within the raster file (e.g. DEM). Metadata for sidescan and bathymetry mosaics should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the file(s) in a GIS and check for completeness (e.g. the dataset covers the entirety of the survey site(s)), locational accuracy, correct projection, and correct format. In addition, check that the agreed upon data coverage was achieved, there are no discrepancies (such as anomalous depth values in the bathymetry mosaic(s)), and the sidescan mosaic(s) represent processed data, with the nadir region removed and color balanced to allow for visualization of bottom features. Verify metadata is present and complete.

3.2.7 Sidescan Individual Track Line Images

This deliverable refers to the images of individual survey track lines of sidescan data used to create the mosaic (Figure 7). The image files in this deliverable should represent sidescan data that have been processed to remove the central nadir region and color balanced to enhance feature identification (Figure 8).



Figure 7. An example of an individual track line image displaying processed sidescan data (i.e. central nadir region removed and color balanced). The sidescan data shown are from the Fire Island National Seashore benthic habitat mapping project.

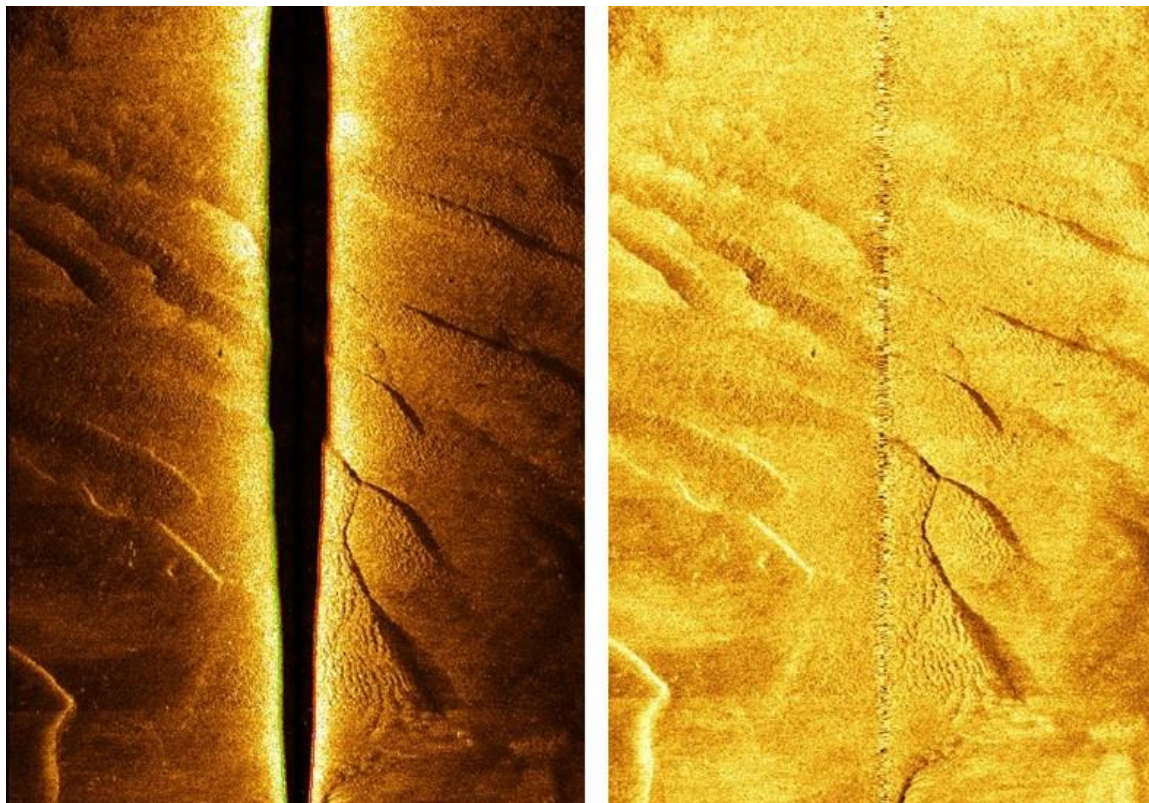


Figure 8. An example of unprocessed (left) and processed (right) sidescan data for comparison purposes. Processing involves removing the central nadir region and balancing the image color to enhance feature identification. The sidescan data shown are from the Fire Island National Seashore benthic habitat mapping project.

Imagery files should be delivered in a standard georeferenced image format, preferably GeoTIFF (.tif. or .tiff) or JPEG2000 (.jpx or .jp2), which store the georeferencing information in the header of the image file. Other file formats store the georeferencing information in an accompanying world file are also acceptable; e.g.tif (with its accompanying .tfw world file), .bil (with .blw or .bilw), and jpg (with .jgw or .jpgw).

Data should be referenced to the most current NSRS horizontal datum and projection information must be defined in the image file (e.g. GeoTIFF) or in an associated file (e.g. .tif with accompanying .twf file). Metadata should be provided for each image file, either in the header, as an accompanying .xml, .xlsx, .csv, or .txt file for each image with the same base name (i.e. multiple individual files), or as an accompanying .xml, .xlsx, .csv, or .txt file that lists all images for the project (i.e. one combined file). Metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the track line images folder to verify completeness (e.g. it contains an appropriate number of data files) and correct format. Verify metadata is present and complete. Examine a subset of images in a GIS to check for locational accuracy, correct projection, and that the files represent processed data, with the nadir region removed and color balanced to allow for the visualization of bottom features. If images are organized in multiple directories and/or from different dates, examine samples of images from multiple folders or dates.

3.2.8 Bathymetry Depth Contours

Depth contours depict variations in seafloor relief and are derived from bathymetry data. The creation of depth contours might not be appropriate for every benthic mapping project. The necessity and utility of depth contours depends on the goals of the project, geographic location, water depth of the study site(s), and available resources. Therefore, this deliverable and associated specifications should be agreed upon by NPS staff and project PI(s) in the cooperative agreement or contract before the start of the project. Specifications should include contour intervals and conditions under which contour lines should be interpolated.

This deliverable should be a geospatial dataset (.shp, .gdb) of line features that depict depth contours throughout the study site(s) where the bathymetry data were collected (Figure 9).

Data should be referenced to the most current NSRS horizontal and vertical datums and projection information must be defined in the feature class. Metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the depth contour file(s) in a GIS and check for completeness (e.g. the dataset covers the entirety of the survey site(s)), locational accuracy, correct projection, and correct format. Verify that the agreed upon specifications (e.g. contour interval, interpolation) were followed. Verify metadata is present and complete.

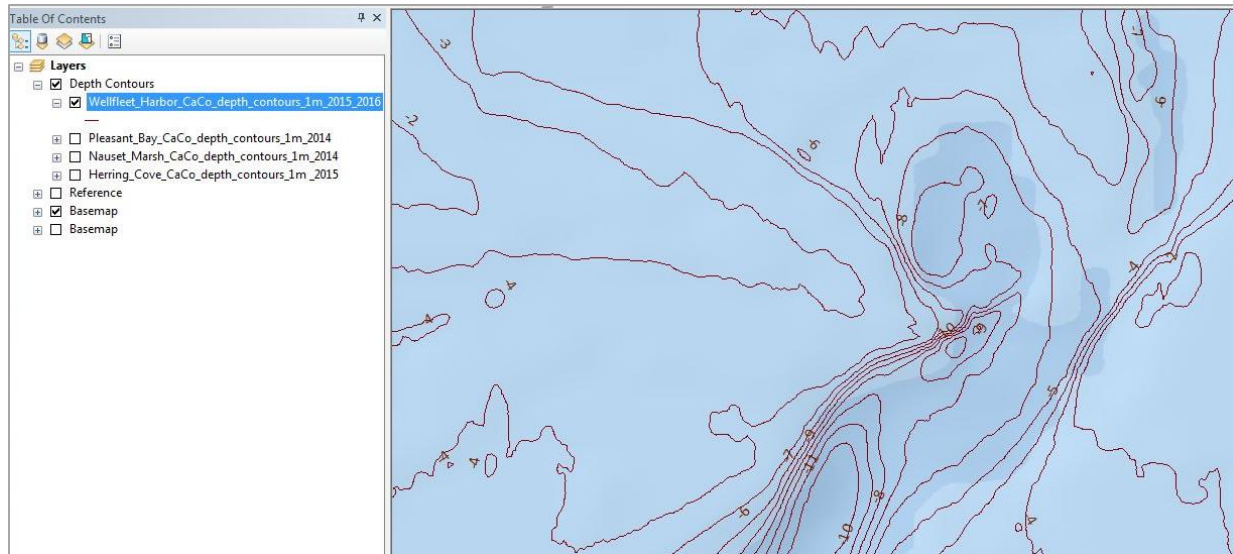


Figure 9. An example of depth contours (1m interval, not interpolated) from the Cape Cod National Seashore benthic habitat mapping project.

3.2.9 Bathymetry Point Generic Text File(s)

This deliverable should consist of an ASCII text file(s) (.txt) containing records with x (longitude), y (latitude), and z (water depth) values. The horizontal spatial resolution of the data points should be 1m or less.

Data should reflect processed water depth and coordinate values (not raw bathymetric data) and be referenced to the most current NSRS horizontal and vertical datums. Metadata should be contained in the header or in a separate file and include the applicable attributes stated in Section 3.1.1.

Open the text file(s) to verify completeness (e.g. the dataset covers the entirety of the survey site(s)), correct format, and that metadata is complete and contained in the header or in a separate file.

Import the text file(s) into a GIS so the spatial distribution and projection of data points can be visually examined. Check for locational accuracy, correct projection, data gaps, outliers (indicating bad data values) or obvious anomalies.

3.2.10 Tide File(s)

Tidal height files are typically used to correct the water depth values of the raw bathymetry data. Tidal data are not needed if height corrections are applied to the bathymetry in real-time, e.g. data is acquired in conjunction with a real-time kinematic Global Positioning System (RTK GPS). The necessity and utility of tidal data depends on the data collection methodology and the non-bathymetry-related goals of the project. Therefore, this deliverable and associated specifications should be agreed upon by NPS staff and project PI(s) in the cooperative agreement or contract before the start of the project.

Tide file(s) should be in spreadsheet (.csv, .xlsx), ASCII text (.txt), or PDF (.pdf) format and contain water level readings (e.g. tidal heights) with corresponding time and date over the duration of the

acoustic survey mission(s) (Figure 10). Additional data may be included, such as temperature, salinity, and barometric pressure.

Data should be referenced to the most current NSRS horizontal and vertical datums. Metadata should be contained in the header or in a separate file and include the applicable attributes stated in Section 3.1.1, as well as the tide station name(s) and location(s) (geographic coordinates), time reference (e.g. Coordinated Universal Time (UTC), Greenwich Mean Time (GMT), Eastern Standard Time (EST), etc.), source of the tide data (e.g. NOAA tide station, USGS tide station, self-deployed system, etc.), and link to website where data can be accessed (if applicable). Metadata can be delivered in spreadsheet (.csv, .xlsx), ASCII text (.txt), or PDF (.pdf) file format.

Open the file(s) to verify completeness (e.g. the dataset covers the range of survey site(s) and date(s)), correct format, and that metadata is complete and contained in the header or in a separate file.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Tide file for 2015 used to correct bathymetry data collected in Otis Pike Wilderness Area, Sunken Forest, and the area to the east of the new breachway. Tide data referenced to NAVD88. Time is reported in GMT. Tide data collected as part of The Great South Bay Project led by Charles Flagg and others at Stony Brook University. Data available for download at http://po.msrb.sunysb.edu/GSB/ . Tide Station located in Bellport Marina on Long Island, NY (Lat = 40.7523; Lon = -72.9331).											
2	Date			Time (GMT)			NAVD88	Detided	Temp	Sal	Fluor	Turb
3	year	month	day	hour	minute	second	Height (m)	Height (m)	Deg C	psu	volts	volts
4	2015	6	1	0	0	0	-0.04	-0.08	21.97	28.634	0.64	0.52
5	2015	6	1	0	30	0	-0.01	-0.09	21.9	28.725	0.53	0.53
6	2015	6	1	1	0	0	0.02	-0.1	21.85	28.834	0.43	0.47
7	2015	6	1	1	30	0	0.04	-0.11	21.86	28.794	0.49	0.46
8	2015	6	1	2	0	0	0.03	-0.14	21.78	28.63	0.52	0.57
9	2015	6	1	2	30	0	0	-0.18	21.66	28.56	0.54	0.83
10	2015	6	1	3	0	0	-0.04	-0.21	21.61	28.557	0.54	1.14
11	2015	6	1	3	30	0	-0.09	-0.24	21.52	28.52	0.54	1.37
12	2015	6	1	4	0	0	-0.12	-0.24	21.41	28.45	0.54	1.4
13	2015	6	1	4	30	0	-0.15	-0.24	21.28	28.324	0.51	1.33
14	2015	6	1	5	0	0	-0.18	-0.23	21.13	28.207	0.48	1.39
15	2015	6	1	5	30	0	-0.21	-0.21	20.97	28.131	0.48	1.41
16	2015	6	1	6	0	0	-0.23	-0.2	20.83	28.091	0.48	1.33
17	2015	6	1	6	30	0	-0.26	-0.2	20.67	28.037	0.48	1.24
18	2015	6	1	7	0	0	-0.3	-0.21	20.48	27.929	0.47	1.16
19	2015	6	1	7	30	0	-0.34	-0.21	20.34	27.813	0.45	1.07

Figure 10. An example of a tide file from the Fire Island National Seashore benthic habitat mapping project.

3.2.11 Sidescan and Bathymetry Metadata

Refer to Section 3.1.

3.3 Sub-bottom Seismic Reflection Profiles

Sub-bottom seismic reflection profile data is collected using a sub-bottom profiling sonar system. These acoustic instruments operate over a range of frequencies, depending on the type of

environment to be surveyed. Sub-bottom data might not be appropriate for all benthic mapping projects. The necessity and utility of sub-bottom data depends on project goals and geographic location of the study site(s). Therefore, this deliverable and associated specifications should be agreed upon by NPS staff and project PI(s) in the cooperative agreement or contract before the start of the project.

3.3.1 Vessel Configuration File(s)

An ASCII text (.txt) file that contains the vessel configuration information should be provided if sub-bottom data was collected using a different configuration than for the sidescan and bathymetry surveys. Refer to Section 3.2.1 for details.

3.3.2 Vessel Configuration Schematic(s)

A standard image file (.jpg, .tiff, .bmp) that contains the vessel configuration diagram should be provided if sub-bottom data was collected using a different configuration than for the sidescan and bathymetry surveys. Refer to Section 3.2.2 for details.

3.3.3 Sub-bottom Coverage File(s)

A geospatial dataset (.shp, .gdb) of polygon features that depict the location(s) of the study site(s) should be provided if sub-bottom data was collected outside of the spatial boundary(ies) of the sidescan and bathymetry coverage file(s). Refer to Section 3.2.3 for details.

3.3.4 Sub-bottom Cruise Track Lines

This deliverable should consist of a geospatial dataset (.shp, .gdb) of line features showing the navigational tracks of the survey vessel recorded during the sub-bottom data collection mission(s) (Figure 11). If sub-bottom data were collected on the same mission(s) as the sidescan and/or bathymetry survey(s), a README.txt file explaining that the cruise track lines are identical to the other survey(s) should be put in this folder. Each study site should have a separate line file that is named accordingly. Line files should be merged to produce a single track line file if multiple line files were recorded for a given study site (e.g. based on date of survey, a sub-section of the larger study site, or individual track lines).

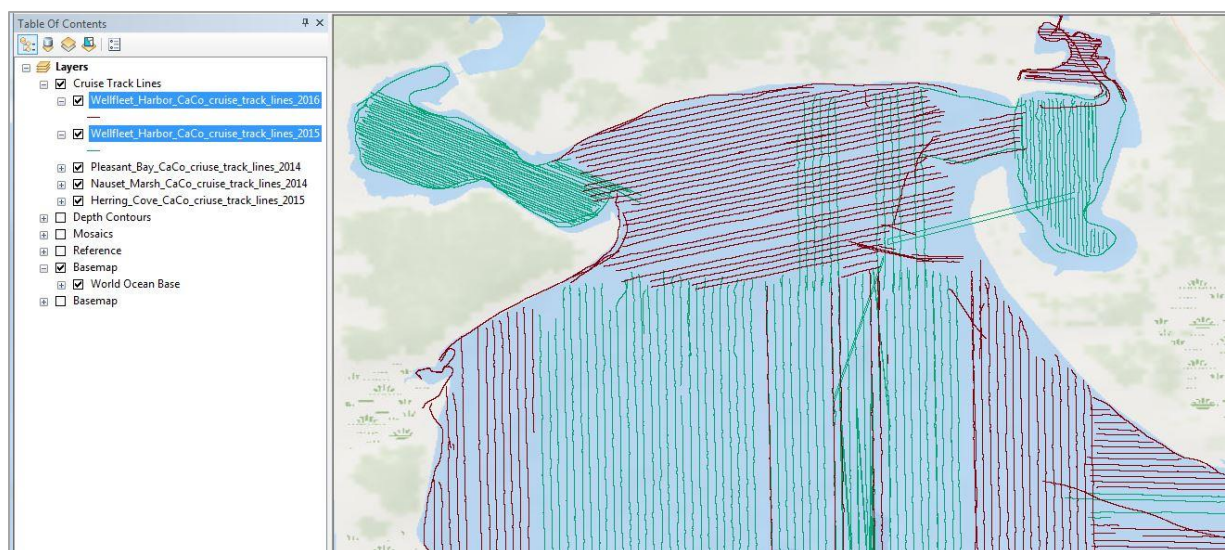


Figure 11. An example of sub-bottom data acquisition cruise track lines from 2015 (green) and 2016 (red) from the Cape Cod National Seashore benthic habitat mapping project.

Data should be referenced to the most current NSRS horizontal datum and projection information must be defined in the feature class. Metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the file(s) in a GIS and check for completeness (e.g. the dataset covers the agreed upon specifications, such as location and coverage extent), locational accuracy, correct projection, and correct format. Verify metadata is present and complete.

3.3.5 Raw Sub-bottom Data

Raw sub-bottom files refer to the unprocessed sub-bottom profile data that have been collected for the project. Raw file formats can vary based on the instrument and software used to collect the data. Specialized and proprietary software is sometimes needed to access and examine raw sub-bottom data. If possible, data should be collected in common file formats, such as SGY and/or JSF, because they can be read by a larger range of software packages. The specific file formats for this deliverable should be agreed upon by NPS staff and project PI(s) in the cooperative agreement or contract before the start of the project.

Metadata must be included in a separate text file. In addition to the specifications stated in Section 3.1.1, metadata must provide details of the instrument(s) used for data acquisition and the horizontal and vertical datums the raw data is referenced to.

Open the raw data folder to verify completeness (e.g. it contains an appropriate number of data files), correct format, and that metadata is complete and contained in a separate text file. Examine a subset of the raw data files in an appropriate software to check that the data can be opened and processed, are of suitable quality, and are georeferenced and project properly. If data are organized in multiple directories and/or from different dates, examine samples of files from multiple folders or dates. Note: it is possible that data reviewers will not have the required software to open and examine the raw

sonar files. If this is the case, reviewers should ask the peer review coordinator if there are colleagues with the appropriate software.

3.3.6 Processed Sub-bottom Images

The images for this deliverable should show the processed sub-bottom images with reflectors and/or facies visible in the data. Facies describe the characteristics of sediment that is present and reflectors indicate the boundaries between facies (e.g. due to change in physical properties, such as density) (Figure 12). Two sets of processed images should be provided: the georeferenced data that reflects the real-world spatial orientation and the non-georeferenced data that can be viewed at a higher spatial resolution. All images should be provided in a standard image file format, preferably GeoTIFF.

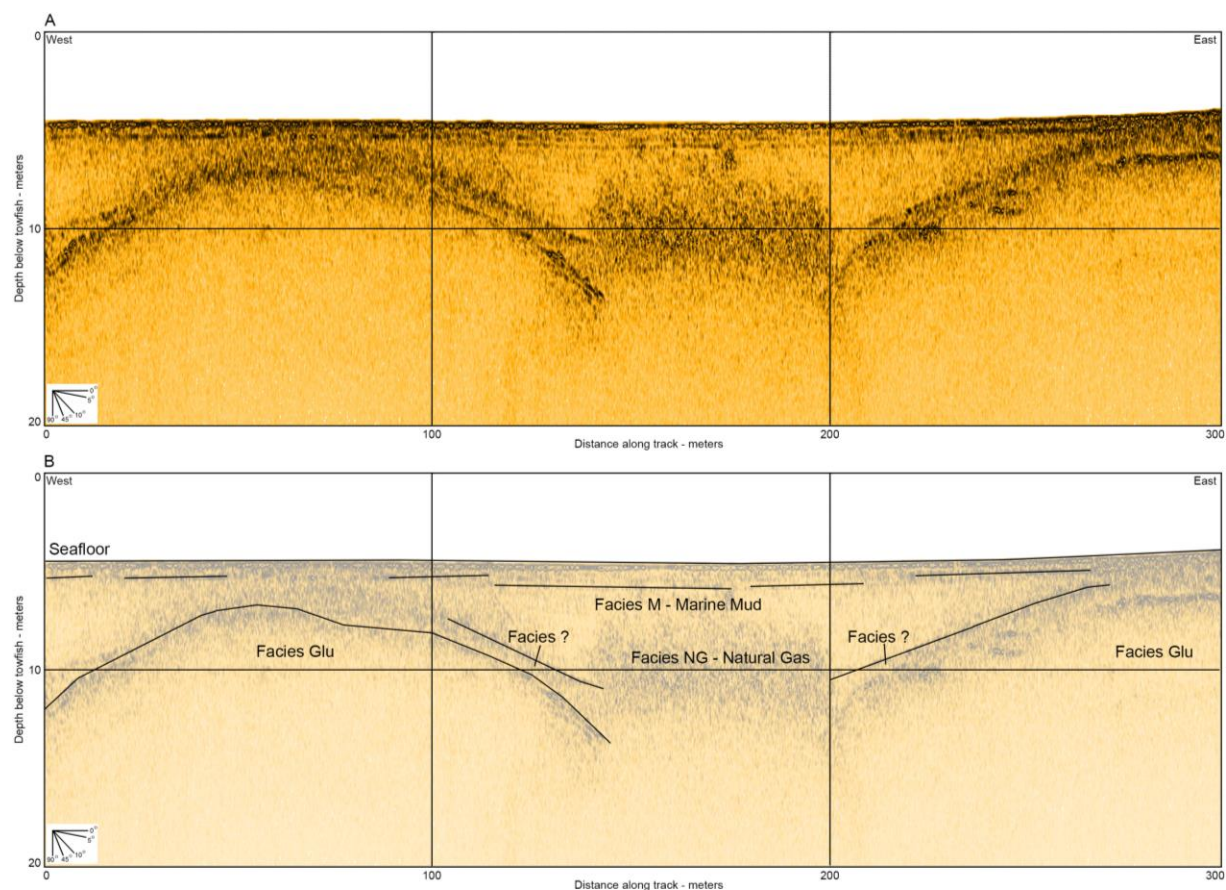


Figure 12. An example of raw (top) and processed (bottom) sub-bottom image from the Cape Cod National Seashore benthic mapping project. In the processed image, reflectors are shown as black lines and facies are labeled.

Data should be referenced to the most current NSRS horizontal and vertical datums. Metadata should be provided for each image file, either in the header, as an accompanying .xml, .xlsx, .csv, or .txt file for each image with the same base name (i.e. multiple individual files), or as an accompanying .xml, .xlsx, .csv, or .txt file that lists all images for the project (i.e. one combined file). Metadata should contain the applicable attributes stated in Section 3.1.1, as well as raw line/file names (if different from processed) and starting and ending coordinates of track lines.

Open the processed images folder to verify completeness (e.g. it contains an appropriate number of data files) and correct format. Verify metadata is present and complete. Examine a subset of images in a GIS to check for locational accuracy, correct projection, and that the files represent processed data, with reflectors and/or facies visible. If image are organized in multiple directories and/or from different dates, examine samples of images from multiple folders or dates.

3.3.7 Sub-bottom Metadata

Refer to Section 3.1.

3.4 Ground-truth Data

3.4.1 Ground-truth Coverage File(s)

A geospatial dataset (.shp, .gdb) of polygon features that depict the location(s) of the study site(s) should be provided if ground-truth data was collected outside of the spatial boundary(ies) of the sidescan and bathymetry coverage file(s). Refer to Section 3.2.3 for details.

3.4.2 Ground-truth Locations and Descriptions

This deliverable should be a geospatial dataset (.shp, .gdb) of point features showing the location of each ground-truth data collection station (Figure 13). Sample station location ID must be included for each record as an attribute field (Station_ID). This Station_ID field be identical to the Station_ID field (in name and format) in the *Biological_Data* and *Sediment_Data* deliverables. Identical Station_ID fields in these datasets will allow attribute joining of the sampling station locations to the sediment data and biological data.

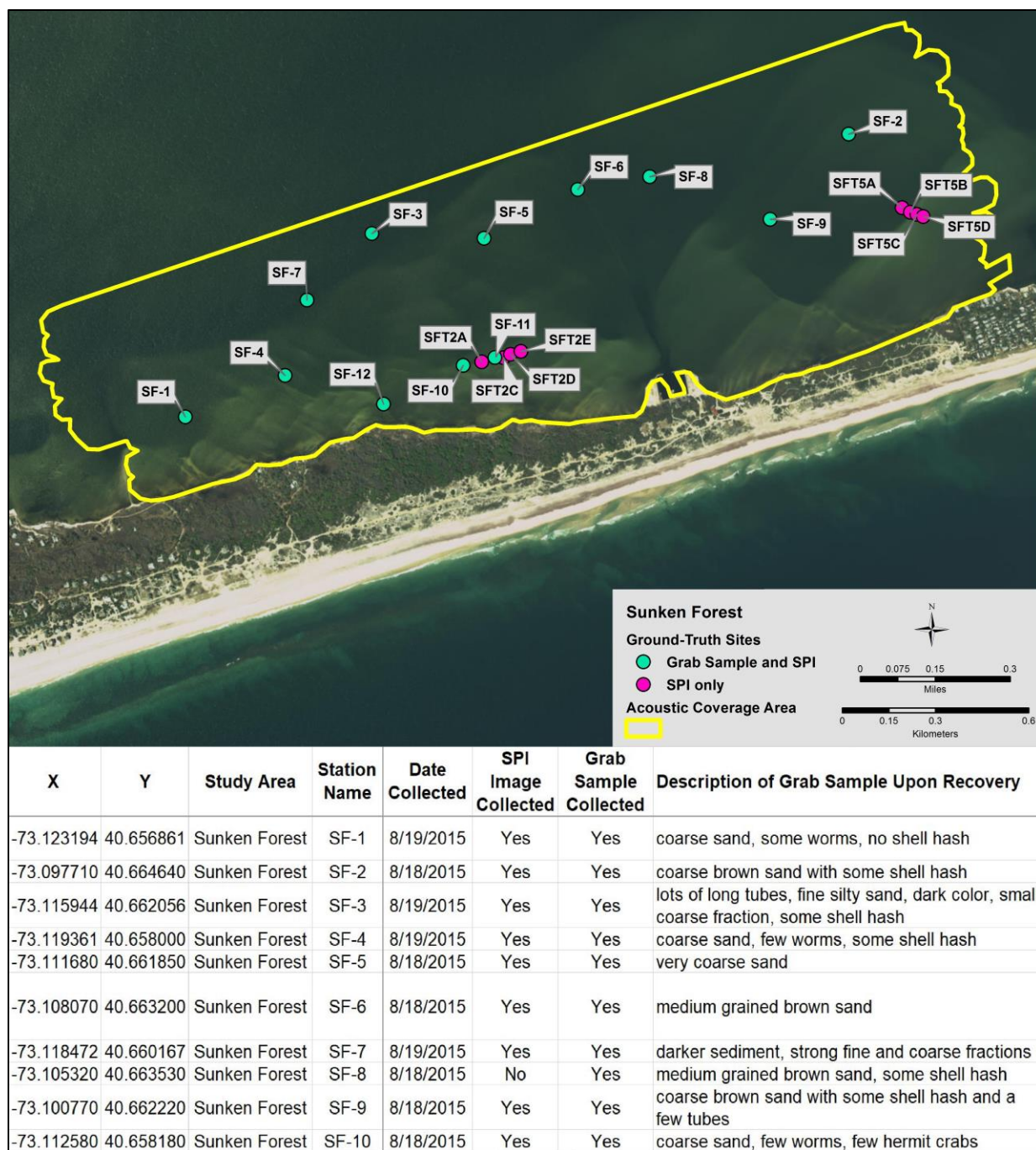


Figure 13. An example of a geodatabase feature class showing ground-truth locations (top) and a sample of the associated attribute table (bottom) for the Sunken Forest study site from the Fire Island National Seashore benthic habitat mapping project.

Additional attribute fields should include geographic coordinates (latitude/longitude) of station locations, date(s) and method(s) of data collection (e.g. grab samples, still photographs, video), relevant field or lab notes (e.g. general description of grab sample upon recovery, water depth), and any other information deemed relevant by NPS staff and project PIs.

Data should be referenced to the most current NSRS horizontal and vertical datums and projection information must be defined in the feature class. Metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open file(s) in a GIS and check for completeness (e.g. the dataset includes all sample stations, all attributes stated above are included), locational accuracy, correct projection, and correct format. Verify metadata is present and complete, and that definitions and descriptions are provided for any coded attribute labels.

3.4.3 Biological Data

This deliverable should include a complete list of the taxa and associated abundances identified within the biological sample(s) collected at each sample station (Figure 14). Sample station location ID must be included for each record as an attribute field (Station_ID). This Station_ID field must be identical to the Station_ID field (in name and format) in the *Ground_Truth_Locations_And_Descriptions* and *Sediment_Data* deliverables. Identical Station_ID fields in these datasets will allow attribute joining of the biological data to the sampling station locations and sediment data.

Additional attribute fields should include date(s) of data collection, method(s) of data collection (e.g. grab samples, imagery), species level (or lowest possible taxa) identification and abundance organized by sample station, hierarchical scientific name structure of each species (phylum to species) (Figure 14), functional grouping for each species, the accepted Integrated Taxonomic Information System (ITIS) Taxonomic Serial Number (TSN) identification, the name of the lab(s) and person(s) who conducted the species identification, and any other information deemed relevant by NPS staff and project PI(s). Other attributes that are relevant, but not required, may also be included in the data files (e.g. dominant species, species diversity measures, water depth, geographic coordinates of sample locations).

This deliverable can either be a geospatial dataset (.shp, .gdb) and/or a stand-alone spreadsheet (.xlsx, .csv) or database (.accdb, .dbf). If a geospatial dataset, sample location geographic coordinates and species information should be included in the attribute table. If a stand-alone spreadsheet or database, data must be in a format that can be easily converted to a GIS layer (e.g. .csv or .xlsx file with no spaces in column headings). Commonly, both types of files will be provided. The geospatial dataset will have an attribute table with the Station_ID, location coordinates, and some of the attributes listed above (e.g. date(s) of data collection, method(s) of data collection). The spreadsheet or database will contain the Station_ID, a list of species and associated abundances recovered at each sample station, and the remaining attributes stated above (e.g. species level identification and abundance, hierarchical scientific name structure of each species, functional grouping for each species, ITIS TSN identification, name of the lab(s) and person(s) who conducted the species identification).

	A	B	C	D	E	F	G	H	I	J	K	L
	Biological data for study areas within Fire Island National Seashore. Data collected in 2014 and 2015. Grab samples were acquired using a Van Veen grab sampler. Samples collected in triplicate at each sample site. Samples collected, sieved and preserved by URI research team. Organisms counted and identified by Keith Brewer of Ecological Consulting Organization (Long Island, NY).											
1	Longitude	Latitude	Study Area	Station_ID	Date Collected	<i>Ampelisca verrilli</i>	<i>Corophium sp</i>	<i>Lysianopsis alba</i>	<i>Microdeutopus gryllotalpa</i>	<i>Leptochelia savignyi</i>	<i>Gemma gemma</i>	<i>Mulinia lateralis</i>
2												
3	-72.99325	40.69854	Otis Pike	SG104_rep1	10/14/2014	20	0	0	0	0	7	8
4	-72.99325	40.69854	Otis Pike	SG104_rep2	10/14/2014	4	0	0	0	0	2	5
5	-72.99325	40.69854	Otis Pike	SG104_rep3	10/14/2014	13	0	1	0	0	0	4
6	-72.98235	40.7033	Otis Pike	SG105_rep1	10/15/2014	32	0	0	0	0	5	16
7	-72.98235	40.7033	Otis Pike	SG105_rep2	10/15/2014	30	0	0	0	0	3	3
8	-72.98235	40.7033	Otis Pike	SG105_rep3	10/15/2014	17	0	0	0	0	4	2
9	-72.97485	40.69719	Otis Pike	SG106_rep1	10/15/2014	0	0	3	0	0	63	1
10	-72.97485	40.69719	Otis Pike	SG106_rep2	10/15/2014	1	0	0	0	0	33	0
11	-72.97485	40.69719	Otis Pike	SG106_rep3	10/15/2014	1	0	0	0	0	42	3
12	-72.96136	40.70429	Otis Pike	SG107_rep1	10/17/2014	2	0	0	0	1	13	0
13	-72.96136	40.70429	Otis Pike	SG107_rep2	10/17/2014	2	0	0	0	5	23	0
14	-72.96136	40.70429	Otis Pike	SG107_rep3	10/17/2014	2	0	0	0	3	19	2
15	-73.0048	40.70565	Otis Pike	SG108_rep1	10/15/2014	76	0	0	0	0	0	737
16	-73.0048	40.70565	Otis Pike	SG108_rep2	10/15/2014	112	0	0	0	0	0	688
17	-73.0048	40.70565	Otis Pike	SG108_rep3	10/15/2014	66	0	0	0	0	1	544
18	-72.98862	40.70946	Otis Pike	SG110_rep1	10/15/2014	96	0	0	0	0	0	32

	A	B	C	D	E	F	G	H	I	J	K	L	M
	Kingdom	Phylum	Class	Order	Family	Genus	Species	Functional Description	ITIS TSN Identification	Total Number of Individuals	Number of samples with species	% of individuals to total	% of Samples found in
1													
2	Animalia	Annelida	Polychaeta	Eunicida	Oenonidae	Arabella	Arabella iricolor	Burrowing polychaete	66441	10	5	0.016	3.012
3	Animalia	Annelida	Polychaeta	Terebellida	Ampharetidae	Asabellides	Asabellides oculata	Tube building species	67786	4	3	0.006	1.807
4	Animalia	Annelida	Polychaeta	N/A	Maldanidae	Asychis	Asychis elongata	Tube-dwelling	67519	2	2	0.003	1.205
5	Animalia	Annelida	Polychaeta	Phyllodocida	Syllidae	Brania	Brania clavata		65761	873	22	1.381	13.253
6	Animalia	Annelida	Polychaeta	Phyllodocida	Syllidae	Brania	Brania wellfleetensis	Colonization by burrowing and bedload transport	65762	53	33	0.084	19.880
7	Animalia	Annelida	Polychaeta	N/A	Capitellidae	Capitella	Capitella sp.	Burrowing polychaete	67414	503	86	0.796	51.807
8	Animalia	Annelida	Polychaeta	N/A	Maldanidae	Clymenella	Clymenella torquata	Head down tube-dweller	67528	29	16	0.046	9.639
9	Animalia	Annelida	Polychaeta	N/A	Maldanidae	Clymenella	Clymenella zonalis	Tube-dwelling	67531	22	8	0.035	4.819
10	Animalia	Annelida	Polychaeta	Eunicida	Onuphidae	Diopatra	Diopatra cuprea	average, tube-dwelling comprised of shell fragments	66180	16	16	0.025	9.639
11	Animalia	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Eteone	Eteone heteropoda	Deposit feeder	65266	39	21	0.062	12.651
12	Animalia	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Eteone	Eteone lactea	Deposit feeder	65267	97	22	0.153	13.253
13	Animalia	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Eumida	Eumida sanguinea	Predatory species	65343	120	33	0.190	19.880
14	Animalia	Annelida	Polychaeta	Phyllodocida	Syllidae	Exogone	Exogone dispar	Tube-dwelling	65722	409	56	0.647	33.735
15	Animalia	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	Glycera americana	Found in shallow marine	66106	117	58	0.185	34.940
16	Animalia	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	Glycera dibranchiata	Found in shallow marine	66107	25	14	0.040	8.434
17	Animalia	Annelida	Polychaeta	Phyllodocida	Goniadidae	Goniadella	Goniadella gracilis		66148	1	1	0.002	0.602
18	Animalia	Annelida	Polychaeta	Phyllodocida	Hesionidae	Gyptis	Gyptis vittata	Prefers hard substrate	65470	11	8	0.017	4.819
19	Animalia	Annelida	Polychaeta	Phyllodocida	Polynoidae	Harmothoe	Harmothoe imbricata	Predatory species	64513	10	2	0.016	1.205
20	Animalia	Annelida	Polychaeta	N/A	Capitellidae	Heteromastus	Heteromastus filiformis	Long, thin, red worm	67420	1533	86	2.425	51.807

Figure 14. A sample of species identification and abundance dataset (top), and a sample of species scientific name structure and functional description (bottom). Data are from the Fire Island National Seashore benthic habitat mapping project.

Geographic coordinates for all file types should be referenced to the most current NSRS horizontal datum. Metadata should be contained in the header or in a separate file and include the applicable attributes stated in Section 3.1.1. For geospatial datasets, projection information must be defined in the feature class(es), and metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the file(s) to verify completeness (e.g. the dataset presents species-level taxonomic identification and abundance information for each biological sample, all attributes stated above are included) and correct format(s). If geospatial data are provided, open the file(s) to check for locational accuracy and correct projection. Check that metadata is present and complete, and that definitions and descriptions are provided for any coded attribute labels.

3.4.4 Sediment Data

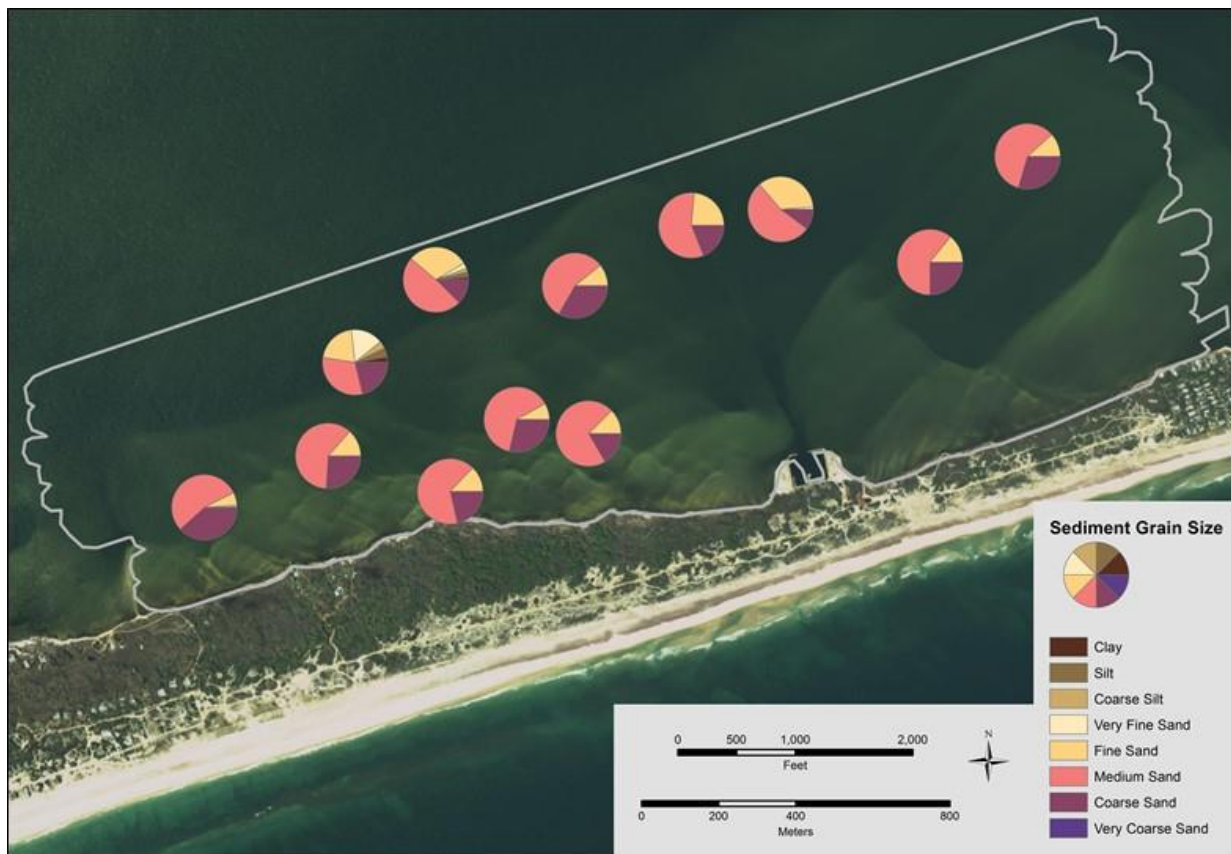
This deliverable should include the grain size analysis results of the sediment sample(s) collected at each sample station. Grain size fractions should be reported using the Wentworth classification system (Wentworth, 1922). Sample station location ID must be included for each record as an attribute field (Station_ID). This Station_ID field must be identical to the Station_ID field (in name and format) in the *Ground_Truth_Locations_And_Descriptions* and *Biological_Data* deliverables. Identical Station_ID fields in these datasets will allow attribute joining of the sediment data to the sampling station locations and biological data.

Additional attribute fields should include date(s) of data collection, method(s) of data collection (e.g. grab samples, imagery), general description of sediment types collected (e.g. from field or lab observations), and any other information deemed relevant by NPS staff and project PIs. Other attributes that are relevant, but not required, may also be included in the data files (e.g. sediment groupings, water depth, geographic coordinates of sample locations).

This deliverable can either be a geospatial dataset (.shp, .gdb) and/or a stand-alone spreadsheet (.xlsx, .csv) or database (.accdb, .dbf). If a geospatial dataset, sample location geographic coordinates and sediment information should be included in the attribute table (Figure 15). If a stand-alone spreadsheet or database, data must be in a format that can be easily converted to a GIS layer (e.g. .csv or .xlsx file with no spaces in column headings). Commonly, both types of files will be provided. The geospatial dataset will have an attribute table with the Station_ID, location coordinates, and some of the attributes listed above (e.g. date(s) of data collection, method(s) of data collection). The spreadsheet or database will contain the Station_ID, the sediment grain size fractions according to the Wentworth classification system (Wentworth, 1922) for each sample station, and the remaining attributes stated above (e.g. general description).

Geographic coordinates for all file types should be referenced to the most current NSRS horizontal datum. Metadata should be contained in the header or in a separate file and include the applicable attributes stated in Section 3.1.1. For geospatial datasets, projection information must be defined in the feature class(es), and metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the file(s) to verify completeness (e.g. the dataset presents the Wentworth classification system (Wentworth, 1922) grain size fractions for each sediment sample, all attributes stated above are included) and correct format(s). If geospatial data are provided, open the file(s) to check for locational accuracy and correct projection. Check that metadata is present and complete, and that definitions and descriptions are provided for any coded attribute labels.



Table



FIS_2014_2015_Sediment_CMECS_Classification

	OBJECTID*	X	Y	Study_Area	Station_ID	Date_Collected	Code_Co	Origin	Class	Subclass	Group	Subgroup
	49	-73.123194	40.656861	Sunken Forest	SF1	8/19/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	50	-73.09771	40.66464	Sunken Forest	SF2	8/18/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	51	-73.115944	40.662056	Sunken Forest	SF3	8/19/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	52	-73.119361	40.658	Sunken Forest	SF4	8/19/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	53	-73.11168	40.66185	Sunken Forest	SF5	8/18/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	54	-73.10807	40.6632	Sunken Forest	SF6	8/18/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	55	-73.118472	40.660167	Sunken Forest	SF7	8/19/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	56	-73.10532	40.66353	Sunken Forest	SF8	8/18/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	57	-73.10077	40.66222	Sunken Forest	SF9	8/18/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	58	-73.11258	40.65818	Sunken Forest	SF10	8/18/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	59	-73.111361	40.658389	Sunken Forest	SF11	8/19/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)
	60	-73.11564	40.65711	Sunken Forest	SF12	8/19/2015	S 1.2.2.2.3	Geologic substrate (1)	Unconsolidated Mineral Substrate (2)	Fine Unconsolidated Substrate (2)	Sand (2)	Medium Sand (3)

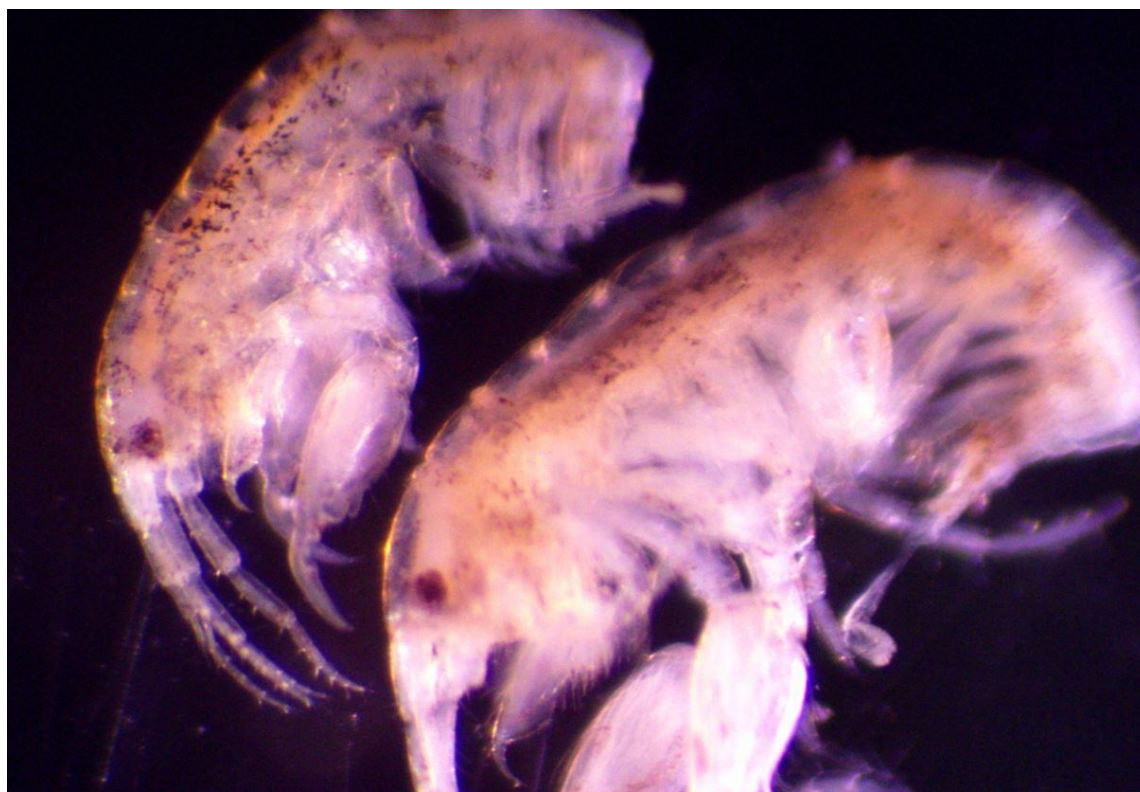
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Sunken Forest: Sediment Grain Size for each Ground-Truth Sample Location According to the Wentworth Scale																			
2	X	Y	Study Area	Station_ID	Date collected	% clay	% silt	% coarse silt	% very fine sand	% fine sand	% medium sand	% coarse sand	% very coarse sand	Standard Deviation	Inclusive Standard Deviation	Inclusive Kurtosis	Inclusive Skewness	Inclusive Mean	Total fine grain fraction (clay-very fine sand)	Total sand fraction (fine, med, coarse sand)
3	-73.12319	40.65686	Sunken Forest	SF1	8/19/2015	0.00	0.21	1.11	0.33	6.22	54.01	36.97	1.15	190.24	0.57	0.97	-0.02	1.18	1.65	97.20
4	-73.09771	40.66464	Sunken Forest	SF2	8/18/2015	0.00	0.00	0.00	0.00	11.74	58.49	29.52	0.25	168.44	0.57	0.94	0.00	1.31	0.00	99.75
5	-73.11594	40.66206	Sunken Forest	SF3	8/19/2015	1.37	2.53	1.77	2.63	30.54	48.78	12.38	0.00	159.61	0.93	1.54	-0.24	1.82	8.30	91.70
6	-73.11936	40.65800	Sunken Forest	SF4	8/19/2015	0.00	0.00	0.00	0.00	13.45	60.55	25.91	0.08	158.98	0.56	0.94	0.00	1.37	0.00	99.91
7	-73.11168	40.66185	Sunken Forest	SF5	8/18/2015	0.00	0.00	0.00	0.00	10.57	55.59	32.86	0.98	185.20	0.59	0.94	0.00	1.26	0.00	99.02
8	-73.10807	40.66320	Sunken Forest	SF6	8/18/2015	0.00	0.00	0.00	0.17	23.43	57.47	18.87	0.06	156.38	0.60	0.95	0.01	1.55	0.17	99.77
9	-73.11847	40.66017	Sunken Forest	SF7	8/19/2015	2.65	4.50	3.74	15.75	20.47	30.84	21.21	0.83	239.83	1.60	1.23	-0.36	2.09	26.64	72.52
10	-73.10532	40.66353	Sunken Forest	SF8	8/18/2015	0.00	0.00	0.00	1.13	35.07	53.67	10.13	0.00	132.66	0.60	0.95	0.02	1.78	1.13	98.87
11	-73.10077	40.66222	Sunken Forest	SF9	8/18/2015	0.00	0.00	0.00	0.00	14.25	60.65	25.05	0.06	157.72	0.56	0.94	0.00	1.39	0.00	99.95
12	-73.11258	40.65818	Sunken Forest	SF10	8/18/2015	0.00	0.00	0.00	0.00	8.09	63.16	28.69	0.06	150.88	0.50	0.95	0.00	1.29	0.00	99.94
13	-73.11136	40.65839	Sunken Forest	SF11	8/19/2015	0.00	0.00	0.00	0.00	12.51	70.93	16.56	0.00	123.43	0.46	0.96	0.00	1.46	0.00	100.00
14	-73.11564	40.65711	Sunken Forest	SF12	8/19/2015	0.00	0.00	0.00	0.00	12.78	65.77	21.45	0.00	139.01	0.51	0.95	0.00	1.41	0.00	100.00

Figure 15. An example of a geodatabase feature class showing sediment grain size fractions (top), sample of associated attribute table (center), and sample of associated Excel spreadsheet (bottom). Data are from the Sunken Forest study site from the Fire Island National Seashore benthic habitat mapping project.

3.4.5 Still Imagery

This deliverable refers to any still imagery collected within the study site(s), including photographs of species recovered in the biological samples (Figure 16), of sediment samples upon recovery in the field, and of the sediment-water interface using a Sediment Profile Imagery (SPI) camera (Figure 17). The images for this deliverable should be provided in a standard image file format (.tiff, .bmp, .jpg). Each image file name should reflect the sample station location ID (Station_ID) and date the image was captured. The Station_ID for each record should be consistent with that of the *Ground_Truth_Locations_And_Descriptions* deliverable, and of other deliverables (e.g. *Sediment_Data*, *Biological_Data*) when multiple data types were collected at the same location. Identical Station_ID fields in these datasets will allow attribute joining of the still imagery to the sampling station locations and other various deliverables.

Watermarks embedded within the images are preferred, but not required, and may include attributes such as file name, Station_ID, date/time and/or sample location coordinates.



CACO_Submerged_Mapping_Ground_truthing_Image_Database.xlsx [Read-Only]

	A	B	C	D	E	F	G	H	I
1	UniqueID	Park	Project	Year	Site	Station	Replicate	Filename	Description
81	2014_PB28-3	CACO	BenHAB	2014	PB	28	3	Amphi_Microprotopus_maculatus_9_CACC	Gnathopod
82	2014_NM11-3	CACO	BenHAB	2014	NM	11	3	Amphi_Microprotopus_raneyi_1_CACO	Gnathopod
83	2014_NM11-3	CACO	BenHAB	2014	NM	11	3	Amphi_Microprotopus_raneyi_2_CACO	Whole
84	2014_PB15-1	CACO	BenHAB	2014	PB	15	1	Amphi_Microprotopus_raneyi_3_CACO	Female Whole

Figure 16. An example of still imagery: Amphipods recovered in macrofauna grab (top) and sample of associated spreadsheet linking image with additional attribute information (bottom). Data are from the Cape Cod National Seashore benthic habitat mapping project.

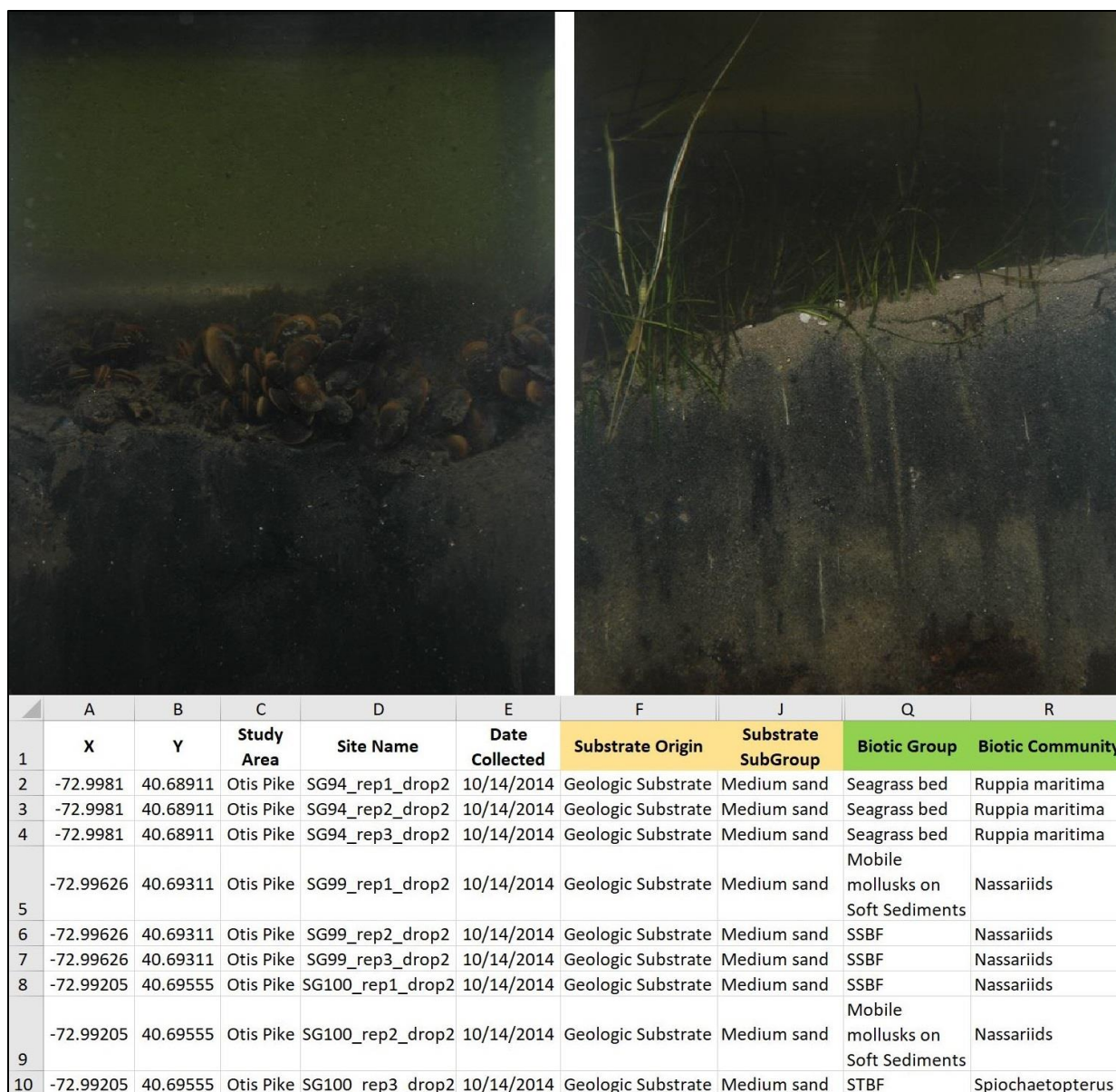


Figure 17. An example of still imagery: Sediment Profile Images (SPI) of a blue mussel (*Mytilus edulis*) bed (top left) and widgeongrass (*Ruppia maritima*) (top right) and a sample of associated spreadsheet linking images with additional attribute information (bottom). Data are from the Otis Pike study site from the Fire Island National Seashore benthic habitat mapping project.

Geographic coordinates should be referenced to the most current NSRS horizontal datum. Metadata should be an accompanying spreadsheet (.xlsx, .csv) or database (.accdb, .dbf) that contains the applicable attributes stated in Section 3.1.1. In addition, the metadata spreadsheet should associate image file names with sample station location (Station_ID), collection date, and brief description for each record. Other attributes that are relevant, but not required, may also be included in the data files (e.g. water depth, geographic coordinates of sample locations). The spreadsheet must be in a format

that can be easily converted to a GIS layer (e.g. no spaces in column headings, coordinates provided in decimal degrees).

Open the files to verify completeness (e.g. the dataset present imagery for all sample stations, each image follows the correct naming convention using Station_ID and date) and correct format. Verify metadata is present and complete, including that file names are associated with the additional attribute stated above, and that definitions and descriptions are provided for any coded attribute labels. In situations where it is impractical to open every image, examine a subset of files. If images are organized in multiple directories and/or from different dates, examine samples of images from multiple folders or dates.

3.4.6 Video Imagery

This deliverable refers to any video imagery collected within the study site(s), including video collected at sample stations (e.g. by attaching a camera to the grab sampler) and across transition zones between habitat types (e.g. by towing camera with a sled). The video for this deliverable should be provided in a standard file format (.avi, .mp4, .wmv, or .mov).

Each video file name should reflect the sample station location ID (Station_ID) and date the video was captured. The Station_ID for each record should be consistent with that of the *Ground_Truth_Locations_And_Descriptions* deliverable, and of other deliverables (e.g. *Sediment_Data*, *Biological_Data*) when multiple data types were collected at the same location. Identical Station_ID fields in these datasets will allow attribute joining of the video imagery to the sampling station locations and other various deliverables.

Watermarks embedded within the video are preferred, but not required, and may include attributes such as file name, Station_ID, date/time and/or sample location coordinates.

Geographic coordinates should be referenced to the most current NSRS horizontal datum. Metadata should be an accompanying spreadsheet (.xlsx, .csv) or database (.accdb, .dbf) that contains the applicable attributes stated in Section 3.1.1. In addition, the metadata spreadsheet should associate video file names with sample station location (Station_ID), collection date, and brief description for each record. Other attributes that are relevant, but not required, may also be included in the data files (e.g. water depth, geographic coordinates of sample locations). The spreadsheet must be in a format that can be easily converted to a GIS layer (e.g. no spaces in column headings, coordinates provided in decimal degrees).

Open the files to verify completeness (e.g. the dataset present video for all sample stations, each image follows the correct naming convention using Station_ID and date) and correct format. Verify metadata is present and complete, including that file names are associated with the additional attribute stated above, and that definitions and descriptions are provided for any coded attribute labels. In situations where it is impractical to open every video, examine a subset of files. If videos are organized in multiple directories and/or from different dates, examine samples of videos from multiple folders or dates.

3.4.7 CTD Profile(s)

This deliverable should be an ASCII (.txt) or spreadsheet (.xlsx, .csv) file(s) containing CTD (conductivity, temperature, and water depth) readings at known sample locations (Figure 18). CTD cast recordings also commonly include measurements of sound velocity, density, and salinity.

	A	B	C	D							
1	Cast taken within East Breach on June 16, 2015 at 14:20. Location: Lat = 40' 44' 28.62; Long = -72' 53' 24.34										
2	Survey conditions: Calm, light winds, partially sunny										
3	Report User Name:	South Lab									
4	Report Computer Name:	NAV4-SOUTHLAB									
5	Application:	WinSitu.exe									
6	Application Version:	5.6.25.0									
7											
8	Log File Properties										
9	File Name	cast 10_2015-06-16_14-27-16-528.wsl									
10	Create Date	6/16/2015 14:27									
11											
12	Device Properties										
13	Device	Aqua TROLL 200									
14	Site	Breach East									
15	Device Name										
16	Serial Number	128388									
17	Firmware Version	1.27									
18	Hardware Version	1									
19	Device Address	1									
20	Device Comm Cfg	19200		8 Even							
21	Used Memory	10									
22	Used Battery	58									
	cast 10_2015-06-16_14-27-16-528		Formatted_Cast_Data								
	A	B	C	D	E	F	G	H	I	J	K
1			Sensor: PCTD(G) 35ft	Sensor: PCTD(G) 35ft	Sensor: PCTD(G) 35ft	Sensor: PCTD(G) 35ft	Sensor: PCTD(G) 35ft	Sensor: PCTD(G) 35ft	Sensor: PCTD(G) 35ft	Sensor: PCTD(G) 35ft	Sensor: PCTD(G) 35ft
2		Elapsed Time	SN#: 128388	SN#: 128388	SN#: 128388	SN#: 128388	SN#: 128388	SN#: 128388	SN#: 128388	SN#: 128388	SN#: 128388
3	Date and Time	Seconds	Pressure (PSI)	Temperature (C)	Depth (ft)	Actual Conductivity	Specific Conductivity	Salinity (PSU)	Total Dissolved Solids	Resistivity (ohm-cm)	Water Density (g/cm3)
4	6/16/2015 14:21	0	0.451	19.596	1.015	41268	46017	30.134	29.911	24.232	1.021
5	6/16/2015 14:22	60	0.75	18.736	1.69	41186	46784	30.654	30.41	24.28	1.022
6	6/16/2015 14:23	120	1.18	18.392	2.657	41136	47078	30.851	30.601	24.31	1.022
7	6/16/2015 14:24	180	2.113	18.277	4.76	33739	38710	24.821	25.162	29.639	1.017

Figure 18. A sample of a conductivity, temperature, and depth (CTD) file from the Fire Island National Seashore benthic habitat mapping project.

Data should be referenced to the most current NSRS horizontal and vertical datums. Metadata should be contained in the header or in a separate file and include the applicable attributes stated in Section 3.1.1. In addition, the geographic coordinates and time of each CTD cast should be included. Survey conditions should also be noted in the metadata to provide contextual information about the data (e.g. windy - indicating water column is likely well mixed; calm and sunny - indicating stratification may be present) and if conditions are typical of the area or not.

Open the file(s) to verify completeness (e.g. the dataset covers the range of survey site(s) and date(s)), correct format, and that metadata is complete and contained in the header or in a separate file.

3.4.8 Ground-truth Metadata

See Section 3.1.

3.5 Geological Features and Surficial Sediment Classification

3.5.1 Final Geological Features and Surficial Sediment Classification

This geospatial dataset (.shp, .gdb) should consist of polygon features that describe the geological features and surficial sediment characteristics of the study site(s) (Figure 19). The classification scheme should follow the [Coastal and Marine Ecological Classification Standard](#) (CMECS), particularly the Geoform and Substrate Components. CMECS provides a list of defined terms for the user to select from for each component. For instances where none of the listed terms are suitable, the user is permitted to include “preliminary terms,” which should be noted as such and include a definition. The report [Submerged Marine Habitat Mapping at Fire Island National Seashore: A Post-hurricane Sandy Study](#) (LaFrance Bartley et al., 2018) provides an overview of CMECS and is a comprehensive example of how to apply the framework to benthic habitat mapping datasets.

Additional attributes should include the area of each polygon, distilled classification description of each polygon (if necessary), and any other information deemed relevant by NPS staff and project PIs. Topology of the final classification must be clean so that boundaries of adjacent classes are coincident and there are no gaps or overlap among polygon boundaries or duplicate features.

Data should be referenced to the most current NSRS horizontal datum and projection information must be defined in the feature class. Metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the file(s) in a GIS and check for completeness (e.g. the dataset covers the entirety of the study site(s)), locational accuracy, correct projection, and correct format. Open and examine the attribute table to verify the presence and appropriateness of CMECS classes and any descriptions. Also verify that an “area” attribute exists and that the geometry has been calculated accurately. Perform a topology check to insure there are no gaps, slivers of overlap, duplicate features, etc. Check that metadata is present and complete, and that definitions and descriptions are provided for any coded attribute labels.

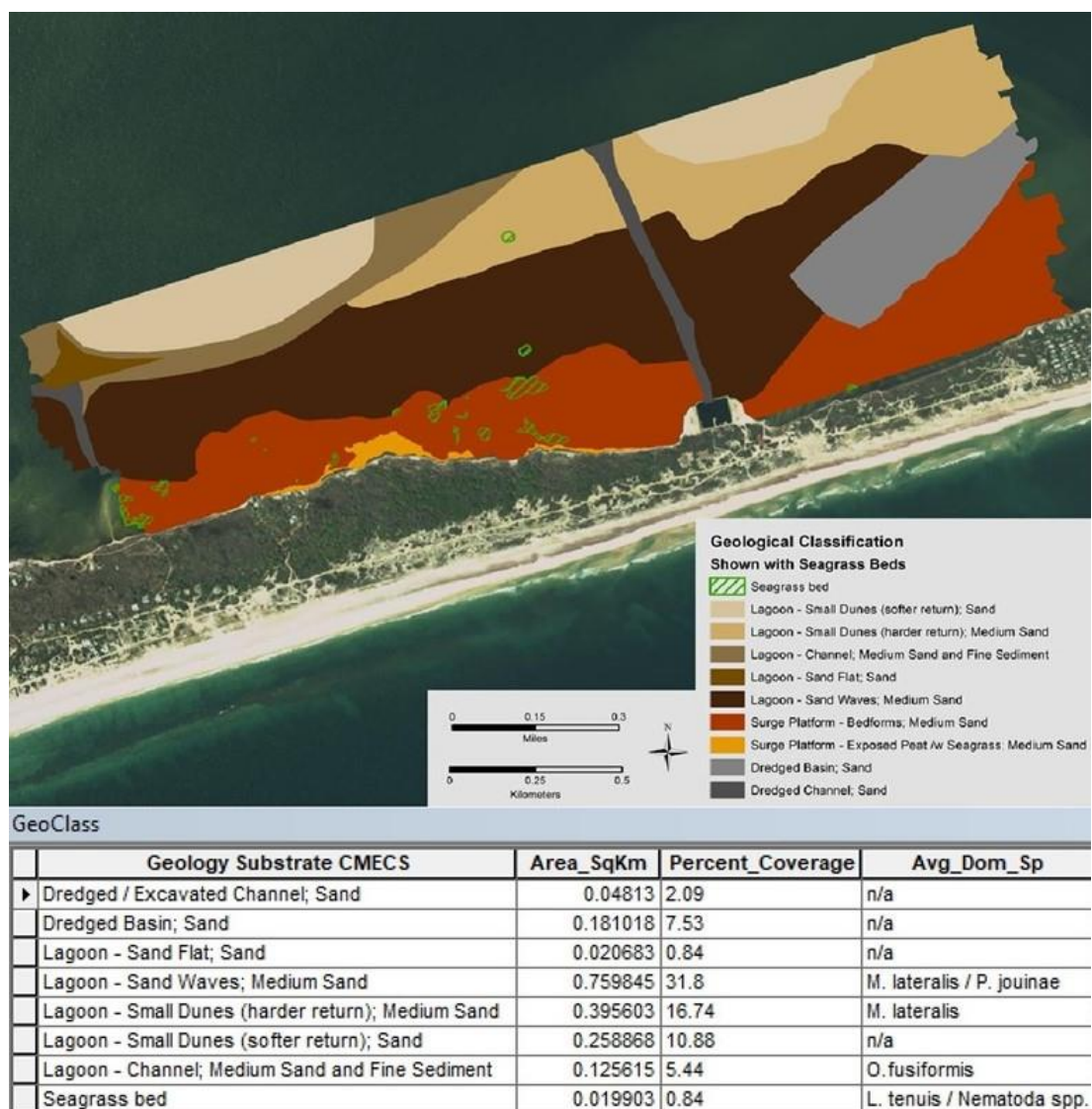


Figure 19. An example of a geological features and surficial sediment classification map (top) and a sample of the associated attribute table (bottom) for the Sunken Forest study site from the Fire Island National Seashore benthic habitat mapping project. The classification nomenclature follows the Geoform and Substrate Components of the Coastal and Marine Ecological Classification Standard (CMECS) framework.

3.5.2 Geological Features and Surficial Sediment Classification Metadata

See Section 3.1.

3.6 Habitat (Biotope) Classification

3.6.1 Final Habitat (Biotope) Classification

This geospatial dataset (.shp, .gdb) should consist of polygon features that describe the benthic habitat characteristics of the study site(s) (Figure 20). The classification scheme should follow the [Coastal and Marine Ecological Classification Standard](#) (CMECS). In CMECS, habitats are referred to as “biotopes” and integrate biological characteristics (i.e. the Biotic Component) and

environmental characteristics (i.e. as described by the Geologic, Substrate, and/or Water Column components). CMECS provides a list of defined terms for the user to select from for each component. For instances where none of the terms are suitable, the user is permitted to include “preliminary terms,” which should be noted as such and include a definition. The final report of the Fire Island National Seashore benthic habitat mapping study (LaFrance Bartley et al., 2018) provides an overview of CMECS and is a comprehensive example of how to apply the framework to benthic habitat mapping datasets (<https://irma.nps.gov/DataStore/Reference/Profile/2257350>).

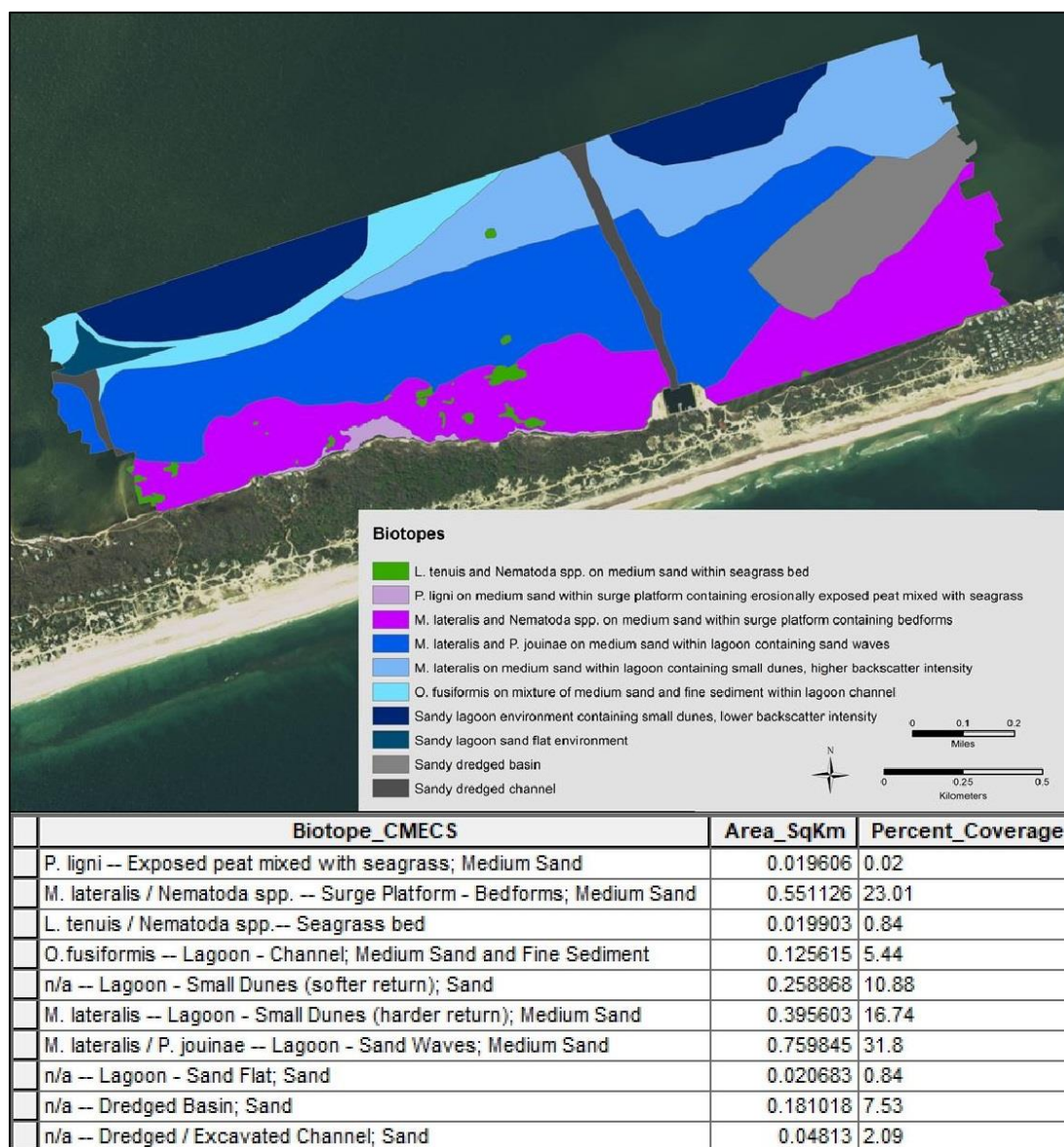


Figure 20. An example of a habitat (i.e. Biotope) classification map (top) and a sample of the associated attribute table (bottom) for the Sunken Forest study site from the Fire Island National Seashore benthic habitat mapping project. The classification nomenclature follows the Biotic, Geoform and Substrate Components of the Coastal and Marine Ecological Classification Standard (CMECS) framework.

Additional attributes should include the area of each polygon, distilled classification description of each polygon (if necessary), and any other information deemed relevant by NPS staff and project PIs. Topology of the final classification must be clean so that boundaries of adjacent classes are coincident and there are no gaps or overlap among polygon boundaries or duplicate features.

Data should be referenced to the most current NSRS horizontal datum and projection information must be defined in the feature class. Metadata should be compliant with FGDC specifications and adhere to the requirements stated in Section 3.1.2.

Open the file(s) in a GIS and check for completeness (e.g. the dataset covers the entirety of the study site(s)), locational accuracy, correct projection, and correct format. Open and examine the attribute table to verify the presence and appropriateness of CMECS classes and any descriptions. Also verify that an “area” attribute exists and that the geometry has been calculated accurately. Perform a topology check to insure there are no gaps, slivers of overlap, duplicate features, etc. Check that metadata is present and complete, and that definitions and descriptions are provided for any coded attribute labels.

3.6.2 Habitat (Biotope) Classification Metadata

See Section 3.1.

3.7 Final Maps and Report

3.7.1 Large-format Maps

Large-format maps should be provided for the following deliverables:

- Sidescan mosaic(s)
- Bathymetry mosaic(s)
- Coverage extent and/or cruise track lines
- Ground-truth data
- Geological features and surficial sediment classification, following the CMECS framework
- Habitat (i.e. Biotope) classification, following the CMECS framework
- Associated spatial metrics, if calculated, e.g., slope, rugosity, bubble plots of abundance and species diversity metrics
- Note: Maps may also include relevant statistical analyses outputs, e.g., PCA plots, (n)MDS plots, graphs, data tables

The maps should include the following basic cartographic elements:

- Title
- Legend
- Scale
- North arrow

- Inset locator map
- Map credits (cartographer, data sources, data date(s), map creation date, projection info)
- Graticule (optional)

Maps should be delivered as ESRI ArcGIS generated Map Packages (from either ArcMap Desktop (.mpk) or ArcGIS Pro (.mpkx)). A Map Package contains a map document (.mxd) and the data referenced by the layers it contains, packaged into a single, portable file, which preserves the characteristics of the original digital map, including content, scale, and symbology. If ESRI software is not to be used, an equivalent deliverable must be included, which should be agreed upon by NPS staff and project PI(s) in the cooperative agreement or contract before the start of the project.

In addition, large-format maps should be exported as print-ready PDF files that are suitable for public viewing. The scale of the map (i.e. 1:5,000, 1:2,000, 1:10,000, etc.) should be discussed by NPS staff and project PI(s) prior to final delivery to assure that an appropriate scale and level of detail are provided. As a general guideline, international paper size A1 (594 x 841 mm) is appropriate for a large-format map; in some cases, size A2 (420 x 594 mm) would be appropriate. Anything smaller than size A2 is not acceptable as a large-format map.

Open the ESRI map packages (or equivalent) and the PDF documents to examine the maps for completeness, including that the datasets cover the entirety of the study site(s), the datasets follow the specifications outlined in this document, all cartographic elements stated above are clearly presented, and dimensions stated above are adhered to.

3.7.2 Final Report

The final report will be reviewed separately, both by technical and editorial reviewers. However, it is recommended that data reviewers also read the report. The report may to help clarify questions reviewers may have regarding the data deliverables, such as missing data, data collection date(s), collection or analytical techniques, or any special circumstances during the project (e.g. data collection, analysis) that may have affected the outcome of the final data deliverables. The report should follow the general scientific reporting format, with distinct sections for the introduction, methods, results, discussion, and conclusion. The discussion section should describe how the project and its findings are applicable to the NPS, e.g., in relation to guiding management decisions.

References

- Borrelli, M., and Others. 2019. Submerged marine habitat mapping at Cape Cod National Seashore: A post-hurricane Sandy study. Natural Resource Report. NPS/NCBN/NRR—2019/1877. National Park Service. Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2259397> (accessed 18 September 2019).
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- Hart, T. E., H. A. Neckles, B. S. Kopp. 2013. Priority data on marine and estuarine resources within northeastern National Parks: Inventory and acquisition needs. Natural Resources Report. NPS/NCBN/NRR—2013/612. National Park Service. Fort Collins, Colorado. Available at: <https://pubs.er.usgs.gov/publication/70042978> (accessed 18 September 2019).
- LaFrance Bartley, M., and Others. 2018. Submerged marine habitat mapping at Fire Island National Seashore: A post-hurricane Sandy study. Natural Resource Report. NPS/NCBN/NRR—2018/1797. National Park Service. Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2257350> (accessed 18 September 2019).
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- Wentworth, C. K. 1922. A scale of grade and class terms for clastic sediments. *Journal of Geology* 3:377-392.

Appendix A. Benthic Mapping Data Deliverables Checklist

Checklist of Deliverables for NPS Benthic Habitat Mapping Studies

General Notes:

Data Specifications

The specifications in this spreadsheet are presented as recommendations for a typical benthic mapping project. They are subject to review and modification on a project-by-project basis. The specifications could be modified based on project goals and characteristics of a particular study site, such as size, water depth, nearshore wave or current regime, or other parameters, as agreed upon by NPS staff and project PI(s) in the cooperative agreement or contract before the start of the project.

Feature Classes

In ArcGIS, a feature class is a collection of geographic features with the same geometry type (such as point, line, or polygon), the same attributes, and the same spatial reference. A shapefile is a common type of feature class introduced by ESRI in the 1990s as an open standard for geospatial vector data. Feature classes are also a component of a geodatabase, a newer ESRI data model. Therefore, feature class is a general term that can be used to refer to either a shapefile or a feature class within a geodatabase.

KMZ files

NPS does not require KML or KMZ files, though projects are welcome to supply these products.

Horizontal and Vertical Datum Reference Information

All spatial data (including georeferenced images) must be referenced to the most current horizontal and vertical datums from the National Spatial Reference System (NSRS). Geographic data must use the most recent adjustment and epoch of the North American Datum of 1983 (currently NAD83(2011), Epoch 2010.00) in either Universal Transverse Mercator (UTM; eastings/northings) with the zone specified or as geographic coordinates (latitude/longitude), and adequately documented. Elevation and bathymetry values should be referenced to the most recent North American Vertical Datum and epoch (currently NAVD88). If a GPS is used to derive orthometric (e.g. NAVD88) heights, include the reference ellipsoid (and epoch) and geoid that were used to obtain the heights to ensure that the dataset can stand independently of the final report.

*Note 1: Datums considered “current” are subject to change and should be agreed upon by NPS staff and project PI(s) at the start of a project.

*Note 2: Both horizontal and vertical datums will be replaced in 2022 by the North American Terrestrial Reference Frame of 2022 (NATRF2022), based on GPS/GNSS and a GRAV-D-based geoid (GEOID2022) (<https://www.ngs.noaa.gov/datums/newdatums/index.shtml>).

Geographic Projection Information

Feature class projection information must be defined within the GIS file, so that the data project accurately when imported into a GIS. Projection information stated only in a separate document is not acceptable.

Attribute Labels

Column headings in spreadsheets and feature class attribute tables need to be understandable to any user. If an attribute label is coded or is too long (and gets truncated during the creation of a shapefile due to ArcMap's 10-character limit), an alias should be used to provide a longer, clearly understandable attribute label. A data dictionary or field descriptions must be present in the metadata that clearly define all attribute labels and column headings (e.g. study site names, sample station names, units of measure, data values, species names, sediment fractions/categories, classification terminology, etc.).

Metadata

For non-spatial data, such as spreadsheets (e.g. .xlsx, .csv) and other tabular data (e.g. .txt), metadata may be presented as descriptive text in the header, a separate tab in a spreadsheet, or in a separate clearly labeled file. For spatial data, FGDC compliant metadata (<https://www.fgdc.gov/metadata>) must accompany all data sets. Metadata should either be an integrated part of each feature class (e.g. geodatabase, shapefile) or as a stand-alone xml file (e.g. for shapefiles, an associated .xml file with the same base name as the shapefile needs to be included). Metadata can be created within GIS software packages (e.g. ArcCatalog in ESRI ArcGIS) or using independent metadata tools (e.g. EPA Metadata Editor, USGS Online Metadata Editor, USGS Metadata Wizard). For both non-spatial and spatial data, must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name, date(s) of data collection, spatial resolution of the data, horizontal and vertical datums data are referenced to, projection information, unit(s) of measure, methods and software used to acquire and process the data, data processing steps, and any other information deemed relevant by NPS staff and/or project PI(s). Metadata must also include a data dictionary or field descriptions defining all attribute labels. In addition, a README.txt file should be included in each of the relevant Metadata folders (within the prescribed directory structure) that explains how the metadata were created and how to access it. Note: XML metadata files from feature classes need not be copied to the Metadata folders.

Data Category and Deliverable

The data type and product (below in Table A.1) correspond to folders and sub-folders in the directory structure prescribed for data delivery (presented in Appendix B in this document). For example, the raw sidescan and bathymetry sonar data should be organized in the \1_Sidescan_and_bathymetry_data\Raw_sonar_data folder.

Table A.1. List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
1	1_Sidescan_and_bathymetry_data	Vessel_configuration_file	ASCII text (.txt) or spreadsheet (.csv, .xlsx)	- Detail of survey vessel dimensions (length, width, draft) and offsets of survey instruments. - Multiple files should be provided if more than one vessel or configuration was used. - Metadata required.
2	1_Sidescan_and_bathymetry_data	Vessel_configuration_schematic	Standard image file (.jpg, .bmp, .tiff)	- Image version of vessel configuration file (diagram). - Detail of survey vessel measurements (length, width, draft) and offsets of survey instruments. - Multiple files should be provided if more than one vessel or configuration was used. - Metadata required.
3	1_Sidescan_and_bathymetry_data	Coverage_files	Feature class (.shp, .gdb)	- Polygon feature class of location of study site(s) surveyed. - Provide one feature class / set of feature classes if sidescan and bathymetry surveys have identical coverage; provide two separate feature classes / set of feature classes if sidescan and bathymetry surveys have different coverage. - File(s) must be georeferenced to the most current horizontal datum from the National Spatial Reference System (NSRS¹). - Projection information must be defined in the feature class so that the data project accurately when imported into a geographic information system. - Metadata required.

¹NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
4	1_Sidescan_and_bathymetry_data	Cruise_track_lines	Feature class (.shp, .gdb)	- Line feature class showing the navigational track lines of the survey vessel recorded during sidescan and bathymetry data collection mission(s). - Provide one feature class / set of feature classes if sidescan and bathymetry surveys have identical coverage; provide two separate feature classes / set of feature classes if sidescan and bathymetry surveys have different coverage. - Provide separate feature class per study site. - Merge line files to produce a single feature class if multiple line files were recorded for a given study site (e.g. based on date of survey, a sub-section of the larger study site, or individual track lines). - File(s) must be georeferenced to the current horizontal datum from the National Spatial Reference System (NSRS¹). - The projection information must be defined in the feature so that the data project accurately when imported into a geographic information system. - Metadata required.
5	1_Sidescan_and_bathymetry_data	Raw_sonar_data	Multiple file formats; common formats (.XTF, .JSF) preferred	- Raw data files acquired by sonar system(s). - File formats will be instrument and software dependent, and often proprietary. When possible, common file formats (e.g. XTF, JSF) should be used that allow access by a wider range of software packages and users. The specific file formats for this deliverable should be agreed upon by NPS staff and project private investigator(s) in the cooperative agreement or contract. - There will be one file / set of files that contain both raw sidescan and raw bathymetric data if an interferometric or MPES sonar system was used to collect the data; there will be two separate files / set of files if sidescan and bathymetric data were collected using different systems. - Metadata required. - Additional metadata should include: - Description of the sonar system(s) used for data acquisition - Horizontal and vertical datums the raw data is referenced to

¹ NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
6	1_Sidescan_and_bathymetry_data	Mosaics	• <u>Sidescan</u>: GeoTIFF or JPEG2000 preferred; tif, bil, jpg, and other standard image file formats acceptable • <u>Bathymetry</u>: DEM preferred; other raster acceptable	• Sonar data presented as a continuous and comprehensive "map view" by "stitching" together adjacent individual track lines of processed data. • Line spacing and coverage requirements for this deliverable should be agreed upon by NPS staff and project private investigators(s) in the cooperative agreement or contract. The decision should take into consideration project goals, water depth of the study site(s), and available resources. • Mosaics should be tiled, if necessary (e.g. for large study sites) to reduce file size and improve visual layout of maps. • Horizontal spatial resolution should be ≤ 1 m for all mosaics. • Sidescan mosaic(s) should represent data that have been processed to remove the central nadir region and color balanced to enhance feature identification. • Cell values in bathymetry raster datasets must represent processed water depth values as a single raster band with units specified. Mosaic(s) presented in RGB color ramp values that result in three bands and do not represent actual water depth values are not acceptable. • Mosaics must be georeferenced to the current horizontal datum (sidescan and bathymetry) and vertical datum (bathymetry) from the National Spatial Reference System (NSRS¹). • The projection information must be defined in the image (e.g. .GeoTIFF) or in an associated file (e.g. .tif with accompanying .twf file) so that the data project accurately when imported into a geographic information system. • Metadata required.
7	1_Sidescan_and_bathymetry_data	Sidescan_individual_track_line_images	GeoTIFF or JPEG2000 preferred; tif, bil, jpg, and other standard image file formats acceptable	• Processed image of each sidescan track line with central nadir region removed and color balancing performed to enhance feature identification. • Images must be georeferenced to the current horizontal datum from the National Spatial Reference System (NSRS¹). • The projection information must be defined in the image (e.g. .GeoTIFF) or in an associated file (e.g. .tif with accompanying .twf file) so that the data project accurately when imported into a geographic information system. • Metadata required.

¹NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
8	1_Sidescan_and_bathymetry_data	Depth_contours	Feature class (.shp, .gdb)	- Line feature class depicting variations in seafloor relief derived from bathymetry data. - Depth contours may not be an appropriate deliverable for every benthic mapping project. The necessity and utility of depth contours depends on factors such as project goals, geographic location, water depth of the study site(s), available resources. - Depth contours and associated specifications should be agreed upon by NPS staff and project private investigator(s) in the cooperative agreement or contract. Specifications should include contour intervals and conditions under which contour lines should be interpolated. - File(s) must be georeferenced to the current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). - The projection information must be defined in the feature so that the data project accurately when imported into a geographic information system. - Metadata required.
9	1_Sidescan_and_bathymetry_data	Bathymetry_point_generic_text_file	ASCII text file (.txt), .xyz, or other standard text file	- File(s) containing x (longitude), y (latitude), and z (water depth) values. - Horizontal spatial resolution should be ≤ 1 m. - Data should reflect processed depth and coordinate values (not raw bathymetric data). - Data must be georeferenced to the current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). - Metadata required.

¹ NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
10	1_Sidescan_and_bathymetry_data	Tide_files	Spreadsheet (.csv, .xlsx), ASCII text file (.txt) or other standard text file, or PDF (.pdf)	- File(s) containing tidal height data and associated information. - Tide file(s) may not be an appropriate deliverable for every benthic mapping project. The necessity and utility of tidal data depends on project goals and data collection methodology (e.g. is such data needed to correct raw bathymetric data, or is raw data corrected in real-time through the incorporation of an RTK GPS system?). This deliverable should be agreed upon by NPS staff and project PI(s) in the cooperative agreement or contract. - File(s) should include water level readings (e.g. tidal heights) with corresponding date(s) and times for the duration of the acoustic survey mission(s). - Additional data may be included, such as temperature, salinity, and barometric pressure. - Data must be georeferenced to the current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). - Metadata required. - Additional metadata should include: - Tide station name(s) and location(s) - Time reference (e.g. UTC, GMT, EST) - Source of tide data (e.g. NOAA, USGS, self-deployed system) - Link to website where data can be accessed (if applicable)

¹ NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
11 (continued)	1_Sidescan_and_bathymetry_data	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- Should be a component of every deliverable (non-spatial tabular and spatial feature class data). - Must contain a data dictionary or field descriptions that clearly define all attribute labels (e.g. study site names, sample station names, units of measure, data values, species names, sediment fractions/categories, classification terminology, etc.), especially if codes are used, so that labels are understandable to any user. - For non-spatial data, metadata: - Can be included as descriptive text at the top of the spreadsheet (i.e. header information), a separate tab (sheet) in the spreadsheet file, or in a separate, clearly labeled file. - Must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps. - If file contains spatial information (e.g. geographic coordinates, water depth values), additional metadata regarding data projections and referencing to horizontal and vertical datums must be included (see below). - A README.txt file should be included in this Metadata folder that explains how the metadata were created and how to access it. - Spatial data format and reference specifications: - Must be submitted as ESRI ArcGIS feature class shapefiles (.shp) and/or geodatabases (.gdb), or other established geographic information system formats. - Data must be georeferenced to the current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). The current NSRS datums (as of the publication of this document) are the North American Datum of 1983 (NAD83(2011), Epoch 2010.00) and the North American Vertical Datum of 1988 (NAVD88). (Note: Datums considered "current" are subject to change and should be agreed upon by NPS staff and project private investigator(s) at the start of a project. Both the NSRS horizontal and vertical datums will be replaced in 2022 by the North American Terrestrial Reference Frame of 2022 (NATRF2022), based on GPS/GNSS and a GRAV-D-based geoid (GEOID2022)¹).

¹ NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

² FGDC= Federal Geographic Data Committee (<https://www.fgdc.gov/metadata>; <https://www.fgdc.gov/metadata/csdgm-standard>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
11 (continued)	1_Sidescan_and_bathymetry_data	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- Spatial data format and reference specifications (continued): - Must be projected either in the Universal Transverse Mercator (UTM) coordinate system with the zone specified (easting/northing), or in the geographic coordinate system (latitude/longitude). - The projection information must be defined in the feature so that the data project accurately when imported into a geographic information system. - Planar distance unit should be meters. - For spatial data, metadata: - Must be FGDC² compliant. - Must be an integrated part of each feature class (e.g. for shapefile, needs to be an associated .xml file with same base name as shapefile). The preferred metadata format is extensible markup language (.xml), although text file format (.txt) will be accepted. - Must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, spatial resolution of the data, horizontal and vertical datums data are referenced to, projection information, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps. - A README.txt file should be included in each of this Metadata folder that explains how the metadata were created and how to access it within ArcCatalog. - XML metadata
12	2_Subbottom_seismic_reflection_profiles	Vessel_configuration_file	ASCII text (.txt) or spreadsheet (.csv, .xlsx)	- If data was acquired using a different configuration than for sidescan and bathymetry surveys. - Detail of survey vessel dimensions (length, width, draft) and offsets of survey instruments. - Multiple files should be provided if more than one vessel or configuration was used. - Metadata required.

² FGDC= Federal Geographic Data Committee (<https://www.fgdc.gov/metadata>; <https://www.fgdc.gov/metadata/csdgm-standard>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
13	2_Subbottom_seismic_reflection_profiles	Vessel_configuration_schematic	Standard image file (.jpg, .bmp, .tiff)	• If data was acquired using a different configuration than for sidescan and bathymetry surveys. • Image version of vessel configuration file (diagram). • Detail of survey vessel measurements (length, width, draft) and offsets of survey instruments. • Multiple files should be provided if more than one vessel or configuration was used. • Metadata required.
14	2_Subbottom_seismic_reflection_profiles	Coverage_files	Feature class (.shp, .gdb)	• If data was acquired outside the spatial boundary(ies) of the sidescan and bathymetry surveys. • Polygon feature class of location of study site(s) surveyed. • Provide one feature class / set of feature classes if sidescan and bathymetry surveys have identical coverage; provide two separate feature classes / set of feature classes if sidescan and bathymetry surveys have different coverage. • File(s) must be georeferenced to the most current horizontal datum from the National Spatial Reference System (NSRS¹). • Projection information must be defined in the feature class so that the data project accurately when imported into a geographic information system. • Metadata required.
15	2_Subbottom_seismic_reflection_profiles	Cruise_track_lines	Feature class (.shp, .gdb)	• Line feature class showing the navigational track lines of the survey vessel recorded during sub-bottom data collection mission(s). • If data were collected on the same mission(s) as the sidescan and/or bathymetry survey(s), a README.txt file explaining that the cruise track lines are identical to the other survey(s) should be included in this folder. • Provide separate feature class per study site. • Merge line files to produce a single feature class if multiple line files were recorded for a given study site (e.g. based on date of survey, a sub-section of the larger study site, or individual track lines). • File(s) must be georeferenced to the current horizontal datum from the National Spatial Reference System (NSRS¹). • The projection information must be defined in the feature so that the data project accurately when imported into a geographic information system. • Metadata required.

¹ NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
16	2_Subbottom_seismic_reflection_profiles	Raw_subbottom_data	Multiple file formats; common formats (.SGY, .JSF) preferred	- Raw data files acquired by sonar system(s). - File formats will be instrument and software dependent, and often proprietary. When possible, common file formats (e.g. SGY, JSF) should be used that allow access by a wider range of software packages and users. The specific file formats for this deliverable should be agreed upon by NPS staff and project private investigator(s) in the cooperative agreement or contract. - Metadata required. - Additional metadata should include: - Description of the sonar system(s) used for data acquisition - Horizontal and vertical datums the raw data is referenced to
17	2_Subbottom_seismic_reflection_profiles	Processed_images	GeoTIFF or JPEG2000 preferred; other standard image file formats acceptable	- Processed image of each survey line with reflectors and/or facies shown. - Two sets of processed images should be provided: - The georeferenced data that reflects the real-world spatial orientation - The non-georeferenced data that can be viewed at a higher spatial resolution - Images must be georeferenced to the current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). - The projection information must be defined in the image (e.g. .GeoTIFF) or in an associated file (e.g. .tif with accompanying .twf file) so that the data project accurately when imported into a geographic information system. - Meta data required. - Additional metadata should include: - Date raw line/file name (if different from processed) - Starting and ending coordinates of the survey line(s).

¹NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
18	2_Subbottom_seismic_reflection_profiles	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- Should be a component of every deliverable (non-spatial tabular and spatial feature class data). - Must contain a data dictionary or field descriptions that clearly define all attribute labels (e.g. study site names, sample station names, units of measure, data values, species names, sediment fractions/categories, classification terminology, etc.), especially if codes are used, so that labels are understandable to any user. - For non-spatial data, metadata: - Can be included as descriptive text at the top of the spreadsheet (i.e. header information), a separate tab (sheet) in the spreadsheet file, or in a separate, clearly labeled file. - Must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps. - If file contains spatial information (e.g. geographic coordinates, water depth values), additional metadata regarding data projections and referencing to horizontal and vertical datums must be included (see below). - A README.txt file should be included in this Metadata folder that explains how the metadata were created and how to access it. - Spatial data format and reference specifications: - Must be submitted as ESRI ArcGIS feature class shapefiles (.shp) and/or geodatabases (.gdb), or other established geographic information system (GIS) formats. - Data must be georeferenced to the current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). The current NSRS datums (as of the publication of this document) are the North American Datum of 1983 (NAD83(2011), Epoch 2010.00) and the North American Vertical Datum of 1988 (NAVD88). (Note: Datums considered "current" are subject to change and should be agreed upon by NPS staff and project private investigator(s) at the start of a project. Both horizontal and vertical datums will be replaced in 2022 by the North American Terrestrial Reference Frame of 2022 (NATRF2022), based on GPS/GNSS and a GRAV-D-based geoid (GEOID2022)².) - Must be projected either in the Universal Transverse Mercator (UTM) coordinate system with the zone specified (easting/northing), or in the geographic coordinate system (latitude/longitude).

¹ NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
18 (continued)	2_Subbottom_seismic_reflection_profiles	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- Spatial data format and reference specifications (continued): - The projection information must be defined in the feature so that the data project accurately when imported into a geographic information system. - Planar distance unit should be meters. - For spatial data, metadata: - Must be FGDC² compliant. - Must be an integrated part of each feature class (e.g. for shapefile, needs to be an associated .xml file with same base name as shapefile). The preferred metadata format is extensible markup language (.xml), although text file format (.txt) will be accepted. - Must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, spatial resolution of the data, horizontal and vertical datums data are referenced to, projection information, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps. - A README.txt file should be included in each of this Metadata folder that explains how the metadata were created and how to access it within ArcCatalog. - XML metadata files from feature classes need not be copied to this Metadata folder.
19	3_Ground-truth_data	Coverage_files	Feature class (.shp, .gdb)	- If data was acquired outside the spatial boundary(ies) of the sidescan and bathymetry surveys. - Polygon feature class of location of study site(s) surveyed. - Provide one feature class / set of feature classes if sidescan and bathymetry surveys have identical coverage; provide two separate feature classes / set of feature classes if sidescan and bathymetry surveys have different coverage. - File(s) must be georeferenced to the most current horizontal datum from the National Spatial Reference System (NSRS¹). - Projection information must be defined in the feature class so that the data project accurately when imported into a geographic information system. - Metadata required.

¹ NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

² FGDC= Federal Geographic Data Committee (<https://www.fgdc.gov/metadata>; <https://www.fgdc.gov/metadata/csdgm-standard>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
20	3_Ground-truth_data	Ground_truth_locations_and_descriptions	Feature class (.shp, gdb)	- Point feature class showing the location of each ground-truth data collection station. - Sample station location ID must be included for each record as an attribute field (Station_ID). - This Station_ID must be identical to the Station_ID in the other ground-truth data deliverables so they can be related to this feature class, and easily converted into a GIS layer(s). - Additional attribute fields must include: - Geographic (latitude/longitude) coordinates of station locations - Date(s) of data collection - Method(s) of data collection (e.g. grab samples, still photographs, video) - Relevant field or lab notes (e.g. general description of grab sample upon recovery, water depth) - Any other fields deemed relevant by NPS staff and project private investigator(s) - File(s) must be georeferenced to the most current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). - Projection information must be defined in the feature class so that the data project accurately when imported into a GIS. - Metadata required.

¹NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
21	3_Ground-truth_data	Biological_data	Feature class (.shp, .gdb), spreadsheet (.csv, .xlsx), or database (.accdb, .dbf)	- A list of taxa and associated abundances identified within the biological sample(s) collected at each sample station. - Sample station location ID must be included for each record as an attribute field (Station_ID). - This Station_ID must be identical to the Station_ID in the other ground-truth data deliverables so they can be related to the "ground_truth_locations_and_descriptions" feature class, and easily converted into a geographic information system layer(s). - Additional attribute fields must include: - Date(s) of data collection - Method(s) of data collection (e.g. grab samples, still photographs, video) - Species level (or lowest possible taxa) identification and abundance organized by sample station - Hierarchical scientific name structure of each species (phylum to species) - Functional grouping for each species - Accepted ITIS TSN³ identification - Name of the lab(s) and person(s) who conducted species identification - Any other fields deemed relevant by NPS staff and project private investigator(s) - Optional attributes include: - Dominant species - Species diversity measures - Water depth - Geographic coordinates of samples stations - For spreadsheet(s) or database(s), spaces should be omitted in field names (column headings) to facilitate conversion to feature class(es). - If provided, geographic coordinates must be georeferenced to the most current horizontal datum from the National Spatial Reference System (NSRS¹). - For feature class file(s), projection information must be defined in the feature class so that the data project accurately when imported into a geographic information system. - Metadata required.

¹ NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

³ ITIS TSN = Integrated Taxonomic Information System Taxonomic Serial Number (<https://www.itis.gov>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
22	3_Ground-truth_data	Sediment_data	Feature class (.shp, .gdb), spreadsheet (.csv, .xlsx), or database (.accdb, .dbf)	• Reporting of the grain size analysis results of the sediment sample(s) collected at each sample station. • Grain size fractions should be reported using the Wentworth classification system (Wentworth, 1922). • Sample station location ID must be included for each record as an attribute field (Station_ID). • This Station_ID must be identical to the Station_ID in the other ground-truth data deliverables so they can be related to the "ground_truth_locations_and_descriptions" feature class, and easily converted into a geographic information system layer(s). • Additional attribute fields must include: ○ Date(s) of data collection ○ Method(s) of data collection (e.g. grab samples, still photographs, video) ○ General description of sediment types collected (e.g. from field or lab observations) ○ Any other fields deemed relevant by NPS staff and project private investigator(s) • Optional attributes include: ○ Sediment groupings ○ Water depth ○ Geographic coordinates of sample stations • For spreadsheet(s) or database(s), spaces should be omitted in field names (column headings) to facilitate conversion to feature class(es). • If provided, geographic coordinates must be georeferenced to the most current horizontal datum from the National Spatial Reference System (NSRS¹). • For feature class file(s), projection information must be defined in the feature class so that the data project accurately when imported into a geographic information system. • Metadata required.

¹ NSRS = National Spatial Reference System (<https://oceanservice.noaa.gov/facts/nsrs.html>; <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
23	3_Ground-truth_data	Still_imagery	Standard image file (.jpg, .bmp, .tiff) and spreadsheet (.csv, .xlsx), or database (.accdb, .dbf)	- Refers to any still imagery collected within the study site(s). - File name should reflect sample station location ID (Station_ID) and date image was captured. - This Station_ID must be identical to the Station_ID in the other ground-truth data deliverables so they can be related to the "ground_truth_locations_and_descriptions" feature class, and easily converted into a GIS layer(s). - Watermark with file name, Station_ID, date, time, and/or sample location coordinates is preferred, but not required. - An accompanying spreadsheet or database must be provided that associates each image file name with relevant attributes, including: - Sample station location (Station_ID) - Image collection date - Brief description of each image - Any other fields deemed relevant by NPS staff and project private investigator(s) - Optional attributes include: - Water depth - Geographic coordinates of sample stations - Spreadsheet or database should omit spaces should in field names (column headings) and provide geographic coordinates in decimal degrees to facilitate conversion to feature class. - If provided, geographic coordinates must be georeferenced to the most current horizontal datum from the National Spatial Reference System (NSRS¹). - Metadata required

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Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
24	3_Ground-truth_data	Video_Imagery	Standard video file (.avi, .mov, .wmv) and spreadsheet (.csv, .xlsx), or database (.accdb, .dbf)	- Refers to any video imagery collected within the study site(s). - File name should reflect sample station location ID (Station_ID) and date video was captured. - This Station_ID must be identical to the Station_ID in the other ground-truth data deliverables so they can be related to the "ground_truth_locations_and_descriptions" feature class, and easily converted into a geographic information system layer(s). - Watermark with file name, Station_ID, date, time, and/or sample location coordinates is preferred, but not required. - An accompanying spreadsheet or database must be provided that associates each video file name with relevant attributes, including: - Sample station location (Station_ID) - Video collection date - Brief description of each video - Any other fields deemed relevant by NPS staff and project private investigator(s) - Optional attributes include: - Water depth - Geographic coordinates of sample stations - Spreadsheet or database should omit spaces should in field names (column headings) and provide geographic coordinates in decimal degrees to facilitate conversion to feature class. - If provided, geographic coordinates must be georeferenced to the most current horizontal datum from the National Spatial Reference System (NSRS¹). - Metadata required.

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Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
25	3_Ground-truth_data	CTD_profiles	ASCII text (.txt) or spreadsheet (.csv, .xlsx)	- File(s) containing conductivity, temperature, and water depth readings at known sample locations. - Additional data may also be included (e.g. sound velocity, density, salinity). - File(s) must be georeferenced to the most current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). - Metadata required. - Additional metadata should include: - Geographic coordinates of sample location(s) - Time of data collection - Notes on survey conditions and if they are typical of the area to provide contextual information about the data (e.g. windy, indicating water column is likely well mixed; calm and sunny, indicating stratification may be present)
26	3_Ground-truth_data	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- Should be a component of every deliverable (non-spatial tabular and spatial feature class data). - Must contain a data dictionary or field descriptions that clearly define all attribute labels (e.g. study site names, sample station names, units of measure, data values, species names, sediment fractions/categories, classification terminology, etc.), especially if codes are used, so that labels are understandable to any user. - For non-spatial data, metadata: - Can be included as descriptive text at the top of the spreadsheet (i.e. header information), a separate tab (sheet) in the spreadsheet file, or in a separate, clearly labeled file. - Must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps. - If file contains spatial information (e.g. geographic coordinates, water depth values), additional metadata regarding data projections and referencing to horizontal and vertical datums must be included (see below). - A README.txt file should be included in this Metadata folder that explains how the metadata were created and how to access it. - Spatial data format and reference specifications: - Must be submitted as ESRI ArcGIS feature class shapefiles (.shp) and/or geodatabases (.gdb), or other established geographic information system (GIS) formats.

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Deliverable #	Data Category	Deliverable	Format	Specifications
26 (continued)	3_Ground-truth_data	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- Spatial data format and reference specifications (continued): - Data must be georeferenced to the current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). The current NSRS datums (as of the publication of this document) are the North American Datum of 1983 (NAD83(2011), Epoch 2010.00) and the North American Vertical Datum of 1988 (NAVD88). (Note: Datums considered "current" are subject to change and should be agreed upon by NPS staff and project private investigator(s) at the start of a project. Both horizontal and vertical datums will be replaced in 2022 by the North American Terrestrial Reference Frame of 2022 (NATRF2022), based on GPS/GNSS and a GRAV-D-based geoid (GEOID2022)¹.) - Must be projected either in the Universal Transverse Mercator (UTM) coordinate system with the zone specified (easting/northing), or in the geographic coordinate system (latitude/longitude). - The projection information must be defined in the feature so that the data project accurately when imported into a geographic information system. - Planar distance unit should be meters. - For spatial data, metadata: - Must be FGDC² compliant. - Must be an integrated part of each feature class (e.g. for shapefile, needs to be an associated .xml file with same base name as shapefile). The preferred metadata format is extensible markup language (.xml), although text file format (.txt) will be accepted. - Must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, spatial resolution of the data, horizontal and vertical datums data are referenced to, projection information, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps.

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Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
26 (continued)	3_Ground-truth_data	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- For spatial data, metadata (continued): - A README.txt file should be included in each of this metadata folder that explains how the metadata were created and how to access it within ArcCatalog. - XML metadata files from feature classes need not be copied to this metadata folder.
27	4_Geological_features_and_surficial_sediment_classification	Final_classification	Feature class (.shp, .gdb)	- Polygon feature class describing the geological features and surficial sediment characteristics of the study site(s). - Classification must follow the established CMECS⁴ framework, particularly the Geoform and Substrate Components. - Attribute fields must include: - CMECS⁴ classification - Distilled classification description (if necessary) - Area of each polygon - Any other fields deemed relevant by NPS staff and project private investigator(s) - Topology of final classification must be clean so that boundaries of adjacent classes are coincident and there are no gaps or overlap among polygon boundaries or duplicate features. - File(s) must be georeferenced to the most current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). - Projection information must be defined in the feature class so that the data project accurately when imported into a geographic information system. - Metadata required.

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⁴ CMECS = Coastal and Marine Ecological Classification Standard (<https://www.cmeccatalog.org/cmeccs>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
28	4_Geological_features_and_surficial_sediment_classification	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- Must contain a data dictionary or field descriptions that clearly define all attribute labels (e.g. study site names, sample station names, units of measure, data values, species names, sediment fractions/categories, classification terminology, etc.), especially if codes are used, so that labels are understandable to any user. - Spatial data format and reference specifications: - Must be submitted as ESRI ArcGIS feature class shapefiles (.shp) and/or geodatabases (.gdb), or other established geographic information system (GIS) formats. - Data must be georeferenced to the current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). The current NSRS datums (as of the publication of this document) are the North American Datum of 1983 (NAD83(2011), Epoch 2010.00) and the North American Vertical Datum of 1988 (NAVD88). (Note: Datums considered "current" are subject to change and should be agreed upon by NPS staff and project private investigator(s) at the start of a project. Both horizontal and vertical datums will be replaced in 2022 by the North American Terrestrial Reference Frame of 2022 (NATRF2022), based on GPS/GNSS and a GRAV-D-based geoid (GEOID2022)¹.) - Must be projected either in the Universal Transverse Mercator (UTM) coordinate system with the zone specified (easting/northing), or in the geographic coordinate system (latitude/longitude). - The projection information must be defined in the feature so that the data project accurately when imported into a geographic information system. - Planar distance unit should be meters. - For spatial data, metadata: - Must be FGDC² compliant. - Must be an integrated part of each feature class (e.g. for shapefile, needs to be an associated .xml file with same base name as shapefile). The preferred metadata format is extensible markup language (.xml), although text file format (.txt) will be accepted.

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Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
28 (continued)	4_Geological_features_and_surficial_sediment_classification	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- For spatial data, metadata (continued): - Must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, spatial resolution of the data, horizontal and vertical datums data are referenced to, projection information, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps. - A README.txt file should be included in each of this Metadata folder that explains how the metadata were created and how to access it within ArcCatalog. - XML metadata files from feature classes need not be copied to this Metadata folder.
29	5_Habitat_Biotope_classification	Final_classification	Feature class (.shp or .gdb)	- Polygon feature class describing the benthic habitat (i.e. Biotope) characteristics of the study site(s). - Habitat (Biotope) classification must follow the established CMECS⁴ framework, particularly the Biotic, Geoform and Substrate Components. - Attribute fields must include: - CMECS⁴ classification - Distilled classification description (if necessary) - Area of each polygon - Any other fields deemed relevant by NPS staff and project private investigator(s) - Topology of final classification must be clean so that boundaries of adjacent classes are coincident and there are no gaps or overlap among polygon boundaries or duplicate features. - File(s) must be georeferenced to the most current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). * Projection information must be defined in the feature class so that the data project accurately when imported into a geographic information system.

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Deliverable #	Data Category	Deliverable	Format	Specifications
30	5_Habitat_ Biotope_classification	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- Must contain a data dictionary or field descriptions that clearly define all attribute labels (e.g. study site names, sample station names, units of measure, data values, species names, sediment fractions/categories, classification terminology, etc.), especially if codes are used, so that labels are understandable to any user. - Spatial data format and reference specifications: - Must be submitted as ESRI ArcGIS feature class shapefiles (.shp) and/or geodatabases (.gdb), or other established geographic information system (GIS) formats. - Data must be georeferenced to the current horizontal and vertical datums from the National Spatial Reference System (NSRS¹). The current NSRS datums (as of the publication of this document) are the North American Datum of 1983 (NAD83(2011), Epoch 2010.00) and the North American Vertical Datum of 1988 (NAVD88). (Note: Datums considered "current" are subject to change and should be agreed upon by NPS staff and project private investigator(s) at the start of a project. Both horizontal and vertical datums will be replaced in 2022 by the North American Terrestrial Reference Frame of 2022 (NATRF2022), based on GPS/GNSS and a GRAV-D-based geoid (GEOID2022)¹.) - Must be projected either in the Universal Transverse Mercator (UTM) coordinate system with the zone specified (easting/northing), or in the geographic coordinate system (latitude/longitude). - The projection information must be defined in the feature so that the data project accurately when imported into a geographic information system. - Planar distance unit should be meters. - For spatial data, metadata: - Must be FGDC² compliant. - Must be an integrated part of each feature class (e.g. for shapefile, needs to be an associated .xml file with same base name as shapefile). The preferred metadata format is extensible markup language (.xml), although text file format (.txt) will be accepted.

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² FGDC= Federal Geographic Data Committee (<https://www.fgdc.gov/metadata>; <https://www.fgdc.gov/metadata/csdgdm-standard>)

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Deliverable #	Data Category	Deliverable	Format	Specifications
30 (continued)	5_Habitat_ Biotope_classification	Metadata	Extensible Markup Language (.xml), spreadsheet (.csv, .xlsx), or ASCII text file (.txt)	- For spatial data, metadata (continued): - Must provide contact information for the person/party responsible for the data and a brief description of the data, including study site name(s), date(s) of data collection, spatial resolution of the data, horizontal and vertical datums data are referenced to, projection information, unit(s) of measure, methods and software used to acquire and process the data, and any relevant data processing steps. - A README.txt file should be included in each of this Metadata folder that explains how the metadata were created and how to access it within ArcCatalog. - XML metadata files from feature classes need not be copied to this Metadata folder.
31	6_Final_maps_and_ report	Large_format_maps	ArcGIS Map Package (.mpk, .mpkx) and PDF (.pdf)	- Large format maps should be provided for the following deliverables: - Sidescan mosaic(s) - Bathymetry mosaic(s) - Coverage extent and/or cruise track lines - Ground-truth data - Geological features and surficial sediment classification, following the CMECS⁴ framework - Habitat (i.e. Biotope) classification, following the CMECS⁴ framework - Associated spatial metrics, if calculated, e.g. slope, rugosity, bubble plots of abundance and species diversity metrics - Note: Maps may also include relevant statistical analyses outputs, e.g. PCA plots, (n)MDS plots, graphs, data tables - The maps should include the following basic cartographic elements: - Title - Legend - Scale - North arrow - Inset locator map - Map credits (cartographer, data sources, data date(s), map creation date, projection info) - Graticule (optional)

⁴ CMECS = Coastal and Marine Ecological Classification Standard (<https://www.cmeccatalog.org/cmeccs>)

Table A.1 (continued). List of recommended data deliverables for NPS benthic habitat mapping studies. The list outlines 32 deliverables within six data categories, including file format and associated specifications. Refer to "General Notes" above for additional information.

Deliverable #	Data Category	Deliverable	Format	Specifications
31 (continued)	6_Final_maps_and_report	Large_format_maps	ArcGIS Map Package (.mpk, .mpkx) and PDF (.pdf)	- ESRI ArcGIS generated Map Packages from either ArcMap Desktop (.mpk) or ArcGIS Pro (.mpkx) should be provided for each map and should include a print-ready map layout and the associated datasets. If ESRI software is not to be used, an equivalent deliverable must be included, which should be agreed upon between NPS staff and project private investigator(s) at the start of a project. - Print-ready map(s) suitable for public viewing should be exported in PDF (.pdf) format. - The scale of the maps (i.e. 1:5,000, 1:2,000, 1:10,000, etc.) should be discussed by NPS staff and project private investigator(s) prior to final delivery to assure that an appropriate scale and level of detail are provided. - As a general guideline, international paper size A1 (594 x 841 mm) is appropriate for large-format maps.
32	6_Final_maps_and_report	Final Report	PDF (.pdf) and Microsoft Word Document (.doc, .docx)	- The final draft report will be reviewed separately, both by technical and editorial reviewers. - However, it is recommended that data reviewers read the report. - The report may help clarify questions regarding the data deliverables, such as missing data, data collection date(s), collection or analytical techniques, or any special circumstances during the project that may have affected the outcome of the final data deliverables.

Appendix B. Suggested File Directory Structure for Benthic Habitat Mapping Projects

A directory structure for organizing benthic mapping data deliverables is suggested below. Adhering to this data structure will help project PI(s) and NPS staff organize data, facilitate the data review process and future data access, and will provide consistency across projects. Any change to this suggested structure must be mutually agreed upon by NPS staff and project PI(s) during the planning phase of the benthic mapping project.

```
\Benthic_habitat_mapping
  \1_Sidescan_and_bathymetry_data
    \Vessel_configuration_files
    \Vessel_configuration_schematics
    \Coverage_files
    \Cruise_track_lines
    \Raw_sonar_data
    \Mosaics
    \Sidescan_individual_track_line_images
    \Bathymetry_depth_contours
    \Bathymetry_point_generic_text_files
    \Tide_files
    \Metadata
  \2_Subbottom_seismic_reflection_profiles
    \Vessel_configuration_files
    \Vessel_configuration_schematics
    \Coverage_files
    \Cruise_track_lines
    \Raw_subbottom_data
    \Processed_images
    \Metadata
  \3_Ground-truth_data
    \Coverage_files
    \Ground_truth_locations_and_descriptions
    \Biological_data
    \Sediment_data
    \Still_imagery
    \Video_imagery
    \CTD_profiles
    \Metadata
  \4_Geological_features_and_surfacial_sediment_classification
    \Final_classification
    \Metadata
```

- \5_Habitat_biotope_classification
 - \Final_classification
 - \Metadata
- \6_Final_maps_and_report
 - \Large_format_maps
 - \Final_Report

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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