Environmental Assessment and Evaluation Study for Designation of an Ocean Dredged Material Disposal Site for the Southern Maine, New Hampshire, and Northern Massachusetts Coastal Region

U.S. Environmental Protection Agency, Region 1

In cooperation with U.S. Army Corps of Engineers, New England District

August 2019

Environmental Assessment and Evaluation Study for Designation of an Ocean Dredged Material Disposal Site for the Southern Maine, New Hampshire, and Northern Massachusetts Coastal Region

U.S. Environmental Protection Agency
Region 1
Boston, Massachusetts

<u>Comments on this Draft Environmental Assessment should be addressed to</u>:

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<u>Comments must be received no later than</u>:

30 days after publication of the Proposed Rule for the designation of an Ocean Dredged Material Disposal Site for the Southern Maine, New Hampshire, and Northern Massachusetts Coastal Region and notice of availability for the Draft Environmental Assessment in the Federal Register.

<u>For further information, please contact</u>:

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LIST OF ACRONYMS

aRPD	Apparent redox potential discontinuity
ASMFC	Atlantic States Fisheries Management Commission
CADS	Cape Arundel Disposal Site
CY	Cubic yards
CZMA	Coastal Zone Management Act
DAMOS	Disposal Area Monitoring System
DO	Dissolved oxygen
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental impact statement
EPA	U.S. Environmental Protection Agency
ERL	Effects-range low
ERM	Effects-range median
ESA	Endangered Species Act
DAMOS	Disposal Site Monitoring System
DEIS	Draft Environmental Impact Statement
FEIS	Final Environmental Impact Statement
GOM	Gulf of Maine
ISDSH	Isles of Shoals Historic Disposal Site
IOSN	Isles of Shoals North Disposal Site
MCZM	Maine Office of Coastal Zone Management
MDMR	Maine Department of Marine Resources
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHCP	New Hampshire Coastal Program
NHDES	New Hampshire Department of Environmental Services
NHPA	National Historic Preservation Act
NERDT	Northeast Regional Dredging Team
NMFS	National Marine Fisheries Service
NOAA	U.S. National Oceanic and Atmospheric Administration
ODMDS	Ocean Dredged Material Disposal Site
PCBs	Polychlorinated Biphenyls
PAHs	Polycyclic Aromatic Hydrocarbons
ppb	Parts per billion
PV	Plan-view imaging
ROV	Remotely operated vehicle
SHPO	State Historic Preservation Officer
SMMP	Site Management and Monitoring Plan
SPI	Sediment profile imaging
TOC	Total organic carbon
USACE	U.S. Army Corps of Engineers
ww	Wet weight
ZSF	Zone of Siting Feasibility

FINDING OF NO SIGNIFICANT IMPACT

The Region 1 office of the United States Environmental Protection Agency (EPA, Region 1, or the Region) finds that its action to designate the Isles of Shoals North (IOSN) site as an Ocean Dredged Material Disposal Site (ODMDS) will not significantly impact the environment and natural resources of the Gulf of Maine. As a result, Region 1 is issuing this Finding of No Significant Impact (FONSI) pursuant to EPA's Statement of Policy for Voluntary Preparation of National Environmental Policy Act (NEPA) Documents, 63 FR 58045 (Oct. 29, 1998). See also 40 C.F.R. § 1508.13. The Region's FONSI is based on the discussion herein as well as the analysis presented in the Environmental Assessment (EA), which is appended below and incorporated herein by reference.

INTRODUCTION

The availability of an ODMDS in the vicinity of southern Maine, New Hampshire, and northern Massachusetts is necessary to maintain safe navigation of authorized federal channels and for other public and private permitted dredging projects. Projected dredging needs for the area were calculated to be approximately 1.5 million cubic yards (CY) of material over the next 20 years. While there are some alternatives to open-water disposal available, such as beneficial use, the projected dredging needs quantities significantly exceed the capacity of available practicable alternatives. The states of Maine and New Hampshire have expressed concern over this situation to the EPA. While the current situation does not constitute an imminent hazard to life and property, the EPA has agreed that a prudent management action was required in order to meet the long-term dredging needs of southern Maine, New Hampshire, and northern Massachusetts.

EPA and U.S. Army Corps of Engineers (USACE) evaluated the possibility of expanding the existing Cape Arundel Disposal Site, which was selected for short-term use by the USACE, to accommodate the region's dredging needs. However, studies revealed that suitable areas for an ODMDS are limited at this site due to capacity and diversity of habitats in and around the existing site. EPA and the USACE also evaluated the potential to reuse another site which had been used prior to the passage of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, however, the site is located in an area that contains a diversity of habitats that are not compatible with the placement of dredge material under MPRSA.

Given the lack of available existing capacity among both ocean disposal and other alternatives, and the incompatibility of some material types with those other alternatives, the EPA is seeking to designate an ODMDS that will serve the region's long-term dredging needs.

PROPOSED ACTION

EPA is proposing to designate the Isles of Shoals North (IOSN) site as an ODMDS. This will provide the region with an appropriate disposal location to meet the long-term dredging needs of the southern Maine, New Hampshire, and northern Massachusetts region.

ALTERNATIVES CONSIDERED

The attached EA considers the following alternatives for the designation of an ODMDS in the vicinity of northern Massachusetts, New Hampshire, and southern Maine, as well as the "no action" alternative (*i.e.*, the option of not designating a site):

> No Action Alternative: Within the context of ocean placement, the no action alternative would be for EPA to refrain from designating a new ODMDS for the placement of dredged material. The most plausible outcome of the no action alternative is that existing and proposed navigation projects in southern Maine, New Hampshire, and northern Massachusetts would not be maintained and/or could be terminated as the increased costs to transport dredge material long distances would make project maintenance infeasible. Terminating maintenance dredging would reduce the safety of the projects for both small and large ships and would have an adverse economic impact to the region.
>
> Cape Arundel Disposal Site Alternative: The Cape Arundel Disposal Site (CADS) is located in the Gulf of Maine and is situated near Cape Arundel in southern Maine. CADS has received dredged material periodically between 1975 and 2019 , though some records indicate the site may have been used since the 1930s. CADS is defined as a 1500-foot (457 meter) diameter circle on the seafloor centered at 43° 17.805' N, 70° 27.170' W, with its center located approximately 3.2 miles (5.1 km) south-southeast of Cape Arundel, Maine.
>
> Cape Arundel Disposal Site Expansion Alternative: An area located in federal waters to the east of, and adjacent to, the existing CADS site (described above) was considered for potential inclusion in an expanded site.
>
> Historic Isles of Shoals Disposal Site Alternative: The historic Isles of Shoals Disposal Site (IOSH) is located in the Gulf of Maine, approximately 8 nautical miles east of Portsmouth, New Hampshire and just east of the Isles of Shoals. This historic site was used prior to the passage of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 for material from Portsmouth Harbor, NH and Rye Harbor, NH.
>
> Isles of Shoals North Disposal Site Alternative: The Isles of Shoals North Disposal Site (IOSN) is located in the Gulf of Maine, approximately 10.8 nautical miles east of Portsmouth, New Hampshire. This site is currently defined as an 8,500-foot (2590-meter) diameter circle on the seafloor with its center located at 70° 26.995' W and 43° 1.142' N.

EPA's Preferred Alternative is to designate the Proposed IOSN site as an ODMDS.

ENVIRONMENTAL EFFECTS

The alternatives analysis and EA concludes that the IOSN site would have the least effects on the ecological and socio-economic environments of all the alternatives considered. Periodic insignificant and short-term effects to water quality and biological resources in areas of the ODMDS would be likely realized during disposal events. However, these effects will be infrequent and limited to periods of active dredged material disposal. Long term impacts to the resources in the IOSN footprint are anticipated to be limited to the creation of sediment mounds on the seafloor. Dredged material mounds are not expected to interfere with ecological processes, commerce, or navigation in the vicinity of the site.

Designation of an ocean dredged material disposal site by EPA does not by itself authorize the disposal at that site of dredged material from any dredging project. Designation of the IOSN would only make that ocean site available to receive dredged material from a specific project if it is permitted or authorized by the USACE. Such permit or authorization will only be provided if the applicable MPRSA regulations are satisfied, which means that no environmentally preferable, practicable alternative for managing that dredged material exists, and that analysis of the dredged material indicates that it is suitable for ocean disposal under the MPRSA.

CONCLUSIONS

Based on the environmental impact and alternatives analysis presented in the EA, EPA has determined that the proposed action, the designation of IOSN as an ODMDS, would have no significant impact on the human environment or natural resources within the Gulf of Maine.

Deborah A. Szaro Date
Acting Regional Administrator

Environmental Assessment and Evaluation Study for Designation of an Ocean Dredged Material Disposal Site for the Southern Maine, New Hampshire and Northern Massachusetts Coastal Region

1.0 PROJECT PURPOSE AND NEED

This Environmental Assessment (EA) and Ocean Dredged Material Disposal Site (ODMDS) Evaluation has been jointly prepared by the U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (EPA). The purpose of this evaluation is to provide documentation in support of final designation by EPA of one ODMDS needed for long-term use by navigation projects on the coasts of southern Maine, New Hampshire, and northern Massachusetts. This evaluation will select one of the alternative ODMDSs and determine if the selected ODMDS fully meets all criteria and factors set forth in Parts 228.5 and 228.6 of Title 40 Code of Federal Regulations (CFR). These regulations were promulgated in accordance with the criteria set out in Sections 102 and 103 of the Marine Protection, Research, and Sanctuaries Act of 1972. Further, this document is intended to provide sufficient information to determine compliance with the National Environmental Policy Act and other applicable laws and regulations (e.g., the National Historic Preservation Act, the Coastal Zone Management Act, and Endangered Species Act). se of the proposed IOSN site would be for the disposal of dredged material determined to be suitable for ocean disposal to support the operation and maintenance of several federally authorized navigation projects in southern Maine, New Hampshire, and northern Massachusetts, as well as for separate MPRSA Section 103 permit evaluations for disposal of dredged material from other non-federal dredging projects.

The availability of an ODMDS near the coastline of southern Maine, New Hampshire, and northern Massachusetts is necessary to maintain safe navigation of authorized federal channels and permitted actions. Projected dredging needs for the area were calculated to be approximately 1.5 million cubic yards (CY) of material over the next 20 years (see Section 2.2). While there are alternatives to ocean disposal available, the quantity of dredged material projected to be generated over the planning horizon significantly exceeds the capacity of available practicable alternatives. The states of Maine and New Hampshire have expressed concern over this situation to both the USACE and EPA. While the current situation does not constitute an imminent hazard to life and property, the EPA and USACE agreed that a prudent management action was required to meet the long-term dredging needs of the southern Maine, New Hampshire, and northern Massachusetts coastal region.

The USACE and EPA did study the possibility of expanding the nearby, active Cape Arundel Disposal Site (CADS), selected by the USACE under MPRSA Section 103, to accommodate the regions dredging needs. However, studies revealed that suitable areas with sufficient capacity for an ODMDS are limited at that location. Additionally, a former, historically used disposal site near the Isles of Shoals was examined for potential use, however, the former site is in an area that contains a diversity of habitats that are not compatible with the ocean disposal of dredged material.

Given the lack of available existing capacity and the incompatibility of material types associated with alternative options available (see Section 4.0), the EPA is seeking to designate an ODMDS that will serve the region's long-term dredging needs.

2.0 BACKGROUND

2.1 Statutory and Regulatory Requirements

The Marine Protection, Research, and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act, was passed in recognition of the fact that the disposal of material into ocean waters could potentially result in unacceptable adverse environmental effects. Under Title I of the MPRSA, the EPA and USACE were assigned responsibility for developing and implementing regulatory programs to ensure that ocean disposal would not "... unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities."

The EPA administers and enforces the overall program for ocean disposal. Under Section 102 of the MPRSA, EPA is responsible for establishing the environmental criteria that are to be addressed before an ocean dredged material disposal permit can be granted. EPA's ocean dumping criteria are published at 40 CFR 220-229. Under section 103 of the Marine Protection, Research and Sanctuaries Act (MPRSA), the U.S. Army Corps of Engineers (USACE) is the federal agency that decides whether to issue a permit authorizing the ocean disposal of dredged materials. In the case of federal navigation projects, USACE may implement the MPRSA directly in the USACE projects involving ocean disposal of dredged materials. While USACE does not administratively issue itself a permit, dredged material from USACE projects must meet the same requirements as those for which a permit would be issued to be dispose of dredged material into ocean waters. USACE relies on EPA's ocean dumping criteria when evaluating permit requests for (and implementing federal projects involving) the transportation of dredged material for the purpose of dumping it into ocean waters. MPRSA permits and federal projects involving ocean dumping of dredged material are subject to EPA review and concurrence. EPA may concur with or without conditions or decline to concur on the permit, i.e. non-concur. If EPA concurs with conditions, the final permit must include those conditions. If EPA declines to concur (non-concurs) on an ocean dumping permit for dredged material, the USACE cannot issue the permit.

The MPRSA criteria (40 CFR, Part 228) states that final site designation under Section 102(c) must be based on environmental studies of each site and on historical knowledge of the impact of dredged material disposal on areas similar to such sites in physical, chemical, and biological characteristics. General criteria (40 CFR 228.5) and specific factors (40 CFR 228.6) that must be considered prior to site designation are described and evaluated in this assessment. Related federal statutes applicable to the site designation process include the National Environmental Policy Act; the Coastal Zone Management Act; the National Historic Preservation Act and the Endangered Species Act. As required by Section 104(a)(3) of the MPRSA, ocean disposal of dredged material can occur only at a site that has been designated to receive dredged material. Pursuant to Section 102(c), the EPA has the responsibility for site designation. Section 103(b), while encouraging use of EPA-designated sites where feasible, does provide for alternative site selection by the USACE when a suitable EPA-designated site is not available. However, the same ocean dumping criteria (40 CFR 228.5-228.6) are used in the evaluation process that leads to alternative site selection and the EPA must concur with the selection.

An EPA-designated ocean disposal site requires a site management and monitoring plan. Use of the designated site is subject to any restrictions included in the management and monitoring plan and EPA's designation regulations. These restrictions are based on an in-depth evaluation of the site and potential disposal activity as well as public review and comment. Designation of an ODMDS in itself does not result in disposal of dredged material.

2.2 Southern Maine, New Hampshire, and Northern Massachusetts Dredging Needs

The draw area (i.e., the area from which dredged material would come from) for the ODMDS would encompass any projects closer to that site than to either the Portland or Massachusetts Bay disposal sites. The center of the Zone of Siting Feasibility (ZSF) is located about 42 miles from the Massachusetts Bay Disposal Site (MBDS) and 43 miles from the Portland Disposal Site (PDS). Harbors and navigation projects that require an ocean disposal site within this area generally do not have sandy or other course-grained sediments suitable for nourishment purposes on nearby beaches or in nearshore feeder bar systems. Also, some harbors that do generate sandy material are either too far from suitable beaches or have no non-federal sponsors willing and capable of providing the funds needed to facilitate placement as nourishment.

Table 2-1 shows the Federal Navigation Projects located within the draw area and the current total shoal volumes present in each (from latest condition surveys). Some harbors such as Wells Harbor, Maine and Hampton Harbor, New Hampshire, yield sandy dredged materials and have adjacent beaches that are typically nourished, either by direct placement or nearshore bar placement. Other Federal Navigation Projects, such as the Exeter River, Lamprey River, and Bellamy River, in New Hampshire would either be placed upland, as was done with the neighboring Cocheco River in 2005 or would be beneficially used somewhere around Great Bay.

The volume listed for Portsmouth Harbor is for the upcoming navigation improvement project that would widen the upper-most turning basin for the 35-foot channel. Periodic maintenance dredging of the Portsmouth Harbor channel is accomplished about every ten years and typically yields coarse sandy material that's placed in-river.

TABLE 2-1
FEDERAL NAVIGATION PROJECTS IN DRAW AREA OF PROPOSED ISLES OF SHOALS

Federal Navigation Projects Closer to proposed IOSN than to Either MBDS or PDS	Cubic Yards	Source of Volume Data	Frequency of Dredging in Next 20 Years
Cape Porpoise Harbor, ME	25,000	2013 Condition Survey	Once
Kennebunk River, ME	16,300	2014 After-Dredge Survey	Once
Wells Harbor, ME	31,000	2017 condition (partial)*	Every 3 Years
Josias River, ME	8,500	2014 Condition Survey	Once
Pepperell Cove, ME	152,700	2014 Condition Survey	Once
Portsmouth Harbor, NH & ME	753,800	2014 Feasibility Report	Once
Little Harbor, NH	205,800	2013 Condition Survey	Once
Rye Harbor, NH	49,100	2014 Condition Survey	Once
Hampton Harbor, NH	85,000	2017 condition survey	Every 10 Years
Newburyport Harbor, MA (9-Foot Inner Channel)	21,100	2016 Condition Survey	Once
Ipswich River, MA	30,000	2016 Condition Survey	Once
Essex River, MA	69,800	2015 Condition Survey	Once
TOTAL	**1,448,100**		

* Wells 2017 volume includes the 8’ entrance channel and the 8’ settling basins. It does not include anything upstream of the basins.

3.0 ANALYSIS OF ALTERNATIVES

The alternatives for the placement of dredged material from the southern Maine, New Hampshire, and northern Massachusetts complex of projects that were considered by the EPA and USACE for the purposes of this document include no-action, upland placement, beach placement, nearshore placement and ocean placement. The various alternatives are discussed below.

3.1 No-Action Alternative

Within the context of ocean disposal, the no-action alternative would be for EPA to refrain from designating a new ODMDS for the disposal of dredged material. The most plausible outcome of the no-action alternative is that existing and proposed navigation projects in southern Maine, New Hampshire, and northern Massachusetts would not be maintained and/or could be terminated as the increased costs to transport dredge material long distances would make project maintenance unfeasible. Terminating maintenance dredging would reduce the safety of the projects for both small and large ships and would have an adverse economic impact to the region.

One option under the no-action alternative would include continuing use of the existing CADS (a USACE-selected ocean disposal site that will expire on December 21, 2021). However, the site already has use restrictions (limited to 80,000 CY per project) that would make full maintenance of many of the projects in the region unlikely.

Another option under the no-action alternative would be for the USACE to select an alternative site for short-term use as a disposal site. Under MPRSA section 103(a), if the use of an EPA-designated site is not feasible, then the USACE has the authority to select alternate sites. While the selection of a site would be subject to meeting the appropriate criteria and would have to receive the concurrence of EPA (the substantive requirements for information and evaluation of a Section 103 action are similar to those of an EPA formal designation under Section 102), use of a Section 103 site is limited to five years, with one possible five-year extension. Therefore, 103 site selections by the USACE are temporary and offer only a stopgap solution.

None of the disposal options under the no-action alternative meet the long-term maintenance needs of the projects from southern Maine, New Hampshire, and northern Massachusetts. For these reasons, the no- action alternative is deemed unacceptable by the EPA. However, for the purposes of determining whether the designation of an ODMDS is acceptable, the no-action alternative is evaluated throughout the Environmental Assessment for comparison to the other alternatives.

3.2 Upland Placement Alternative

Upland alternatives for the placement of dredge material include placement at landfills, the use of confined disposal facilities (CDFs), or beneficially using the material for environmental and economic restoration of degraded lands. Each individual dredging project will need to evaluate any available upland placement alternatives during the planning phase for each project, as an inventory of all potential upland alternatives in the study area is beyond the scope of this document. Environmental impacts associated with upland placement vary depending on the current use of the upland site. Sites such as landfills and degraded uplands tend to have minimal environmental impacts to the specific sites, while the creation of CDFs may involve construction related impacts. The disadvantages of upland placement are additional costs for dewatering/processing the dredged material, additional material handling, increased transportation costs, and increased impacts to air quality associated with the transportation. Given the volume of dredge material noted in the dredging needs section of this EA, the capacity of available upland placement areas for all of the material from the southern Maine, New Hampshire, and northern Massachusetts projects within the study area is likely insufficient to meet long-term disposal needs. Additionally, upland placement is generally not feasible for operational, economic, and environmental reasons.

3.3 Beach Placement Alternative

Beach placement is a common form of beneficial use in which suitable sandy dredged material is placed on beaches in close proximity to the dredge area. This is one of the most common beneficial use of dredged material in New England. In the ZSF for southern Maine, New Hampshire, and northern Massachusetts (see Section 4.2), this alternative is commonly used for maintenance dredging of entrance channels and anchorages for Hampton Harbor (New Hampshire) and Wells Harbor (Maine). Beach placement usually involves using a hydraulic pipeline dredge to pump materials from the dredge area directly onto the receiving beach. For most projects, this requires a receiving beach within about one mile of the dredging site. Material that is primarily fine-grained (silts/clays) is not appropriate for placement on beaches, as the high energy nature of most New England beaches would continually re-suspend the fine-grained material in the water column and create severe environmental impacts to adjacent nearshore habitats. While beach placement is an acceptable placement alternative for sandy dredged material, the majority of material in the southern Maine, New Hampshire, and northern Massachusetts study area is fine-grained material that is incompatible with beach placement.

3.4 Nearshore Bar/Berm Placement Alternative

The practice of depositing clean sandy or silty-sand materials from hopper dredges into the nearshore littoral bar system off beaches is common in much of New England. This method of dredging and placement allows placement of the material in beach systems at a greater distance from the dredging site than can be achieved with a pipeline dredge, and it also allows natural forces to sort fine sands from the coarser sands.

Nearshore berms are submerged, high-relief mounds, generally built parallel to the shoreline. They are commonly constructed of sediment removed from a nearby dredging project. There are typically two types: feeder berms and stable berms. Feeder berms are transient features that contain predominantly clean sand placed in the nearshore zone directly adjacent to a beach. The physical benefits of feeder berms include the introduction of new sediment to the littoral system, indirect beach nourishment through onshore sediment transport, and a reduction in nearshore wave energy along with reduced shoreline erosion. Stable berms are generally longer-lasting features constructed in deeper water or low-energy environments, where sediment transport is limited. These stable berms can be constructed with finer-grained sandy material or sediments containing a mix of sands and silts since the environment is not conducive to wave- or current-induced sediment transport. The physical benefits to stable berms include reduced wave energy along the shoreline, lower shoreline erosion, and enhanced habitat for fisheries. While nearshore placement is an acceptable placement alternative for silty-sand and sandy dredged material, the majority of material in the southern Maine, New Hampshire, and northern Massachusetts study area is fine-grained material (i.e., silts and clays) that is incompatible with this alternative. he placement of predominately fine-grained material in the nearshore environment would likely significantly increase suspended sediments in the water column which could negatively impact ecological resources in the vicinity of the site. Therefore, this alternative, which will need to be evaluated on a project by project basis, was determined to be an unacceptable alternative for material that would be placed at an ODMDS.

3.5 Unconfined Ocean (Open-Water) Disposal

Unconfined disposal refers to areas where dredged material is placed directly on the seafloor through release from a bottom-release hopper or barge at the surface. Three historic/potential unconfined ocean disposal alternatives have been identified for potential use by USACE navigation projects and private projects within the southern Maine, New Hampshire and northern Massachusetts study area (Table 3-1).

Table 3-1. Potential Ocean (Open-Water) Disposal Site Alternatives within the southern Maine, New Hampshire, and northern Massachusetts study area.

Site ID	Type	Site Name	Authority	Available Capacity (CY)	Site Expiration Date
CADS	Unconfined Ocean (Open-Water)	Cape Arundel Disposal Site	USACE-selected	800,000	January 17, 2019
IOSH	Unconfined Ocean (Open-Water)	Isles of Shoals Disposal Site Historic (former disposal location)	USACE-selected	unknown	Candidate Site
IOSN	Unconfined Ocean (Open-Water)	Proposed Isles of Shoals Disposal Site North	EPA-designated	TBD	Candidate Site

3.5.1 Cape Arundel Disposal Site (CADS)

The Cape Arundel Disposal Site (CADS) is located in the Gulf of Maine near Cape Arundel in southern Maine (Figure 3-1). CADS received dredged material periodically between 1975 and 2010, though some records indicate the site may have been used since the 1930s. CADS is defined as a 1500-foot (457 m) diameter circle on the seafloor centered at 43° 17.805' N, 70° 27.170' W, with its center located approximately 3.2 mile (5.1 km) south-southeast of Cape Arundel, Maine (Figure 3-1). As an alternative dredged material disposal site selected by the USACE under the MPRSA in 1985 (and not a formally designated site by the EPA), CADS was closed in 2010 when its temporary status ended. The site was reopened by Congressional legislation in 2014 for a period of five years or until designation of an alternative dredged material disposal site for southern Maine was completed. Site use will expire on December 31, 2021.

Water depths at CADS vary from 98 feet to 138 feet with complex topography. CADS is generally deeper in the north and south and shallower in the west and southeast portions. Past surveys have found hard rock outcrops in the shallower areas and relatively soft sediment in the deeper basins in CADS (SAIC 1991). As part of this alternative, an additional area located in federal waters to the east of the existing site would be considered for potential expansion of the disposal site boundary (Figure 3-2).

Figure 3-1. Location of the Cape Arundel Disposal Site

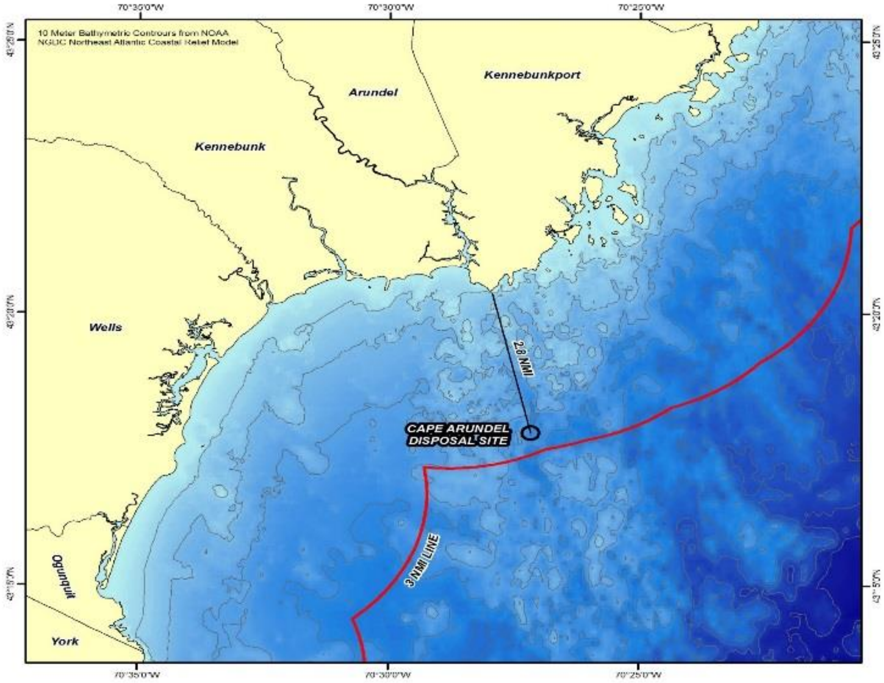
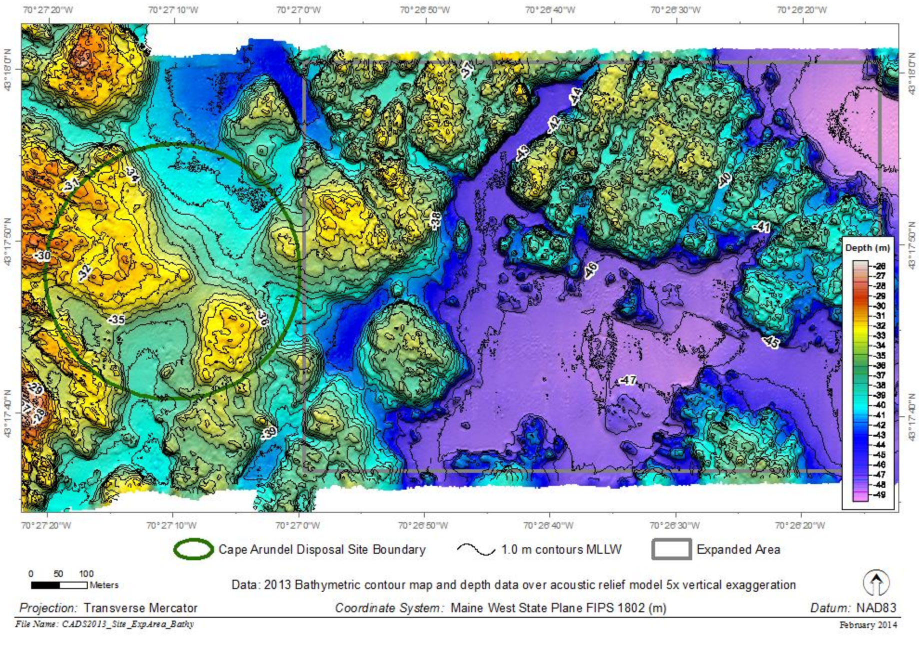


Figure 3-2. Bathymetric Map of the existing Cape Arundel Disposal Site and potential expansion area



3.5.2 Historic Isles of Shoals Disposal Site (IOSH)

The Historic Isles of Shoals Disposal Site (IOSH) is located in the Gulf of Maine, approximately eight nautical miles east of Portsmouth, New Hampshire and just east of the Isles of Shoals (Figure 3-3). This historic site was used prior to the passage of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 for material from Portsmouth Harbor, NH and Rye Harbor, NH. Table 3-2 contains data on use of the site by USACE projects.

Table 3-2. Use of the Historic Isles of Shoals Disposal Site by USACE projects.

Site	Date	Quantity (CY)	Material Type	Source of Material
ISDSH	1964	670,000	Mixed sand, gravel, and rock	Portsmouth Harbor Improvement Project
ISDSH	1964	2,470	Rock and Mixed	Rye Harbor
ISDSH	1970	61,400	Mixed sand and silty material	Portsmouth Harbor Back Channels Improvement Project

A side scan sonar survey of IOSH was completed by EPA in July 2010. The survey showed that the site contains a mosaic of soft-bottom and hard-bottom areas. The soft-bottom areas were likely predominately silt, while the hard-bottom areas contained boulder fields, rock outcrops, and ledge ridges (Figure 3-4). Given the diversity of habitat types in the IOSH, the limited areas of soft bottom area that would be compatible with the disposal of fine-grained dredged material, and the recommendations of federal and state resource agencies which noted that IOSH is a prime area for marine resources and is an important fishing ground, the EPA has removed this alternative from consideration for designation as an ODMDS.

Figure 3-3. Historic Isles of Shoals Disposal Site

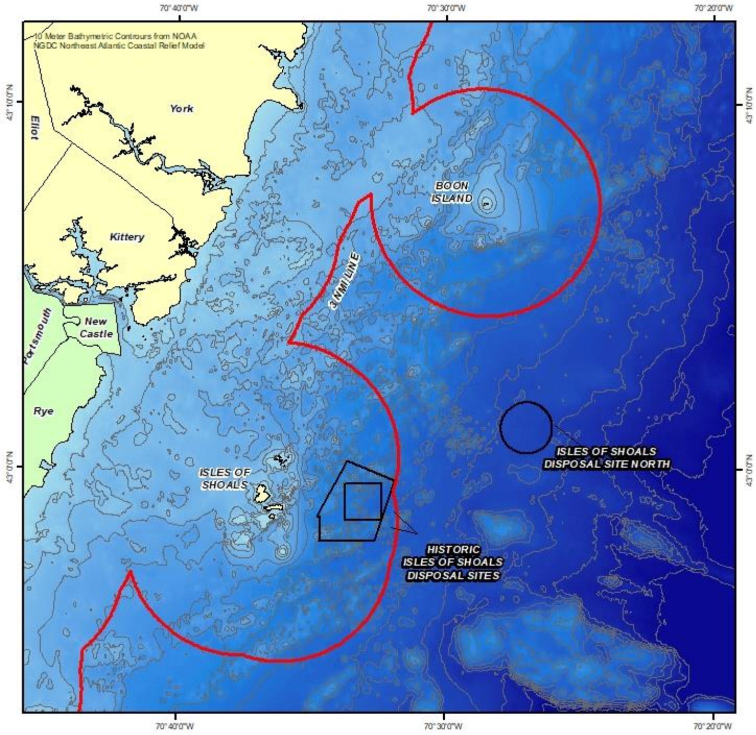
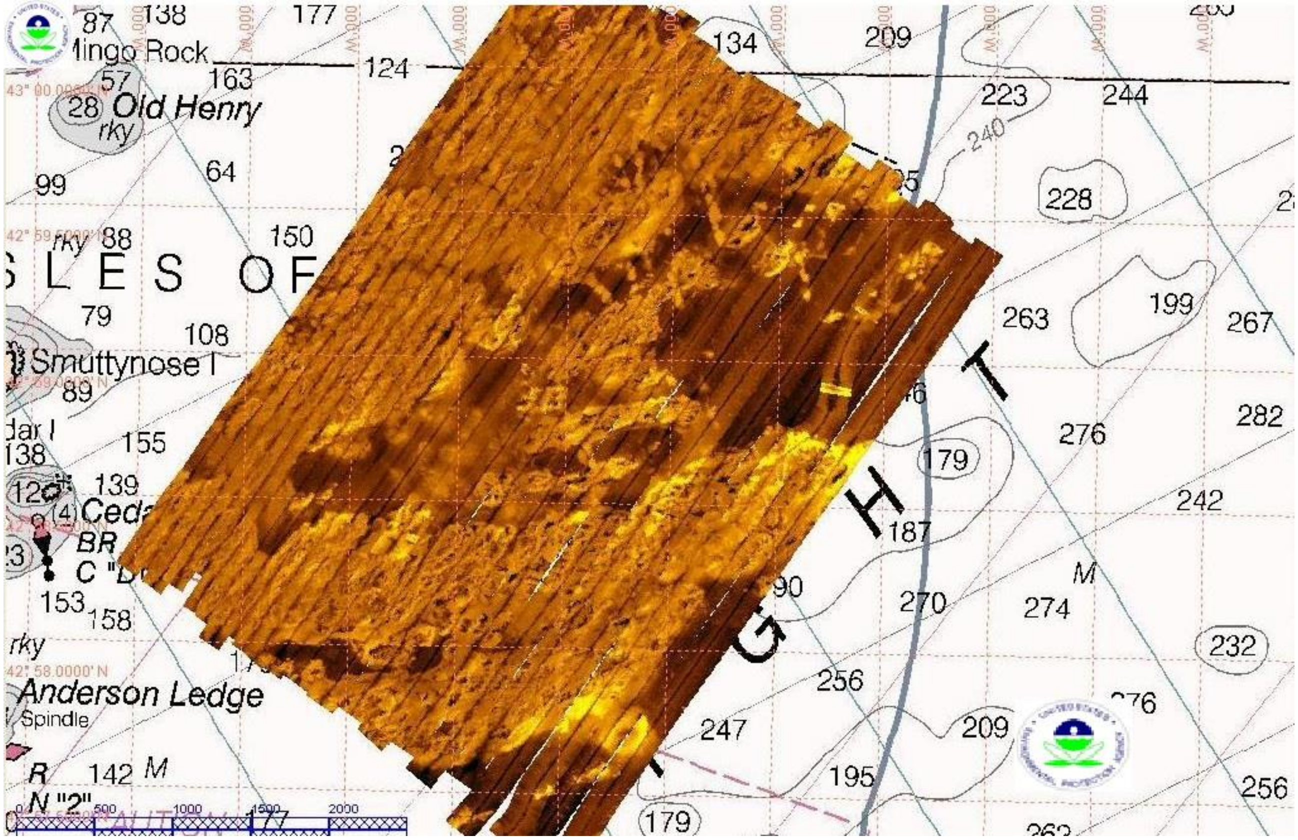


Figure 3-4. Side scan sonar (July 2010) of the Historic Isles of Shoals Disposal Site.



3.5.3 Isles of Shoals Disposal Site North (IOSN)

The proposed Isles of Shoals Disposal Site North (IOSN) is located in the Gulf of Maine, approximately 10.8 nautical miles east of Portsmouth, NH (Figure 3-5). This potential disposal site is currently defined as a 8,500-foot (2590-meter) diameter circle on the seafloor with its center located at 70° 26.995’ W and 43° 1.142’ N. Water depths at the proposed IOSN vary from 255 feet to 340 feet and gradually slope from approximately 295 feet on the western boundary to 328 feet in the southeastern portion of the site. The area is generally flat soft-bottom (Figure 3-6).

Figure 3-5. Location of the Proposed Isles of Shoals Ocean Disposal Site

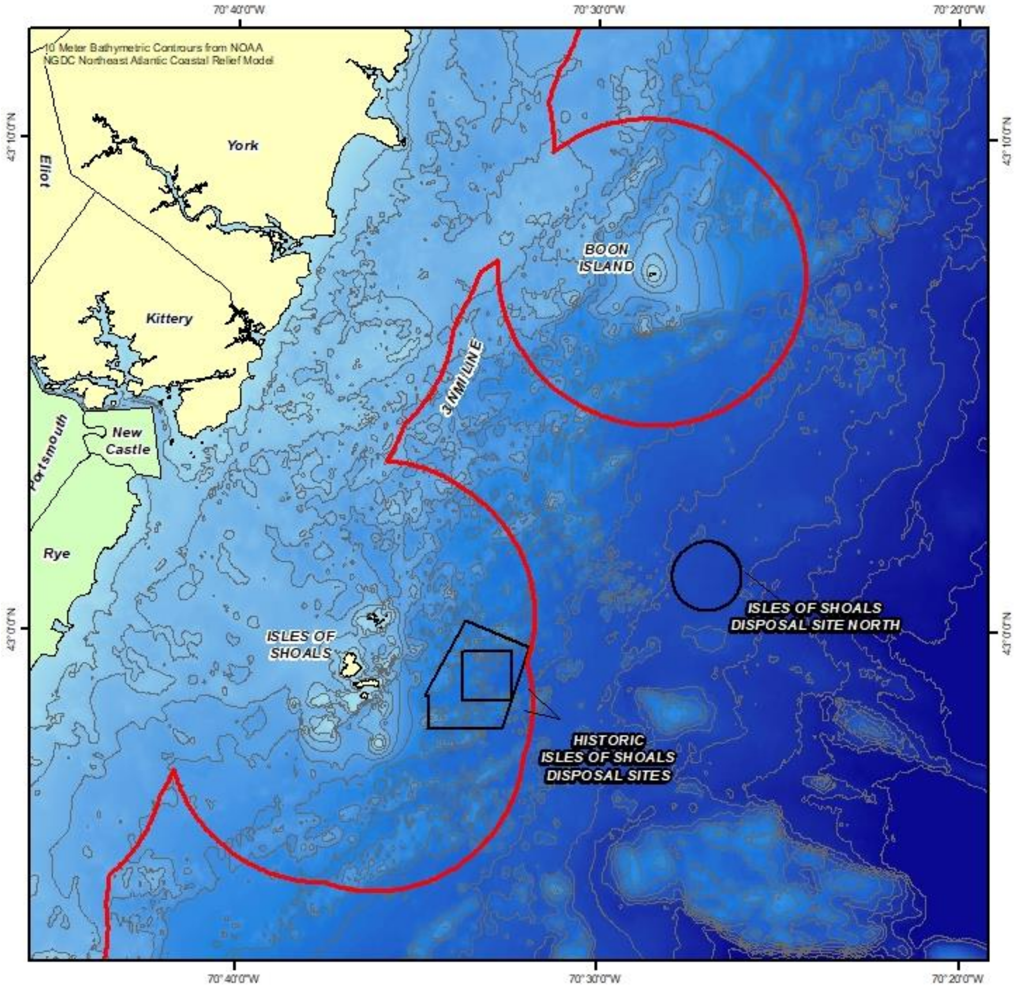
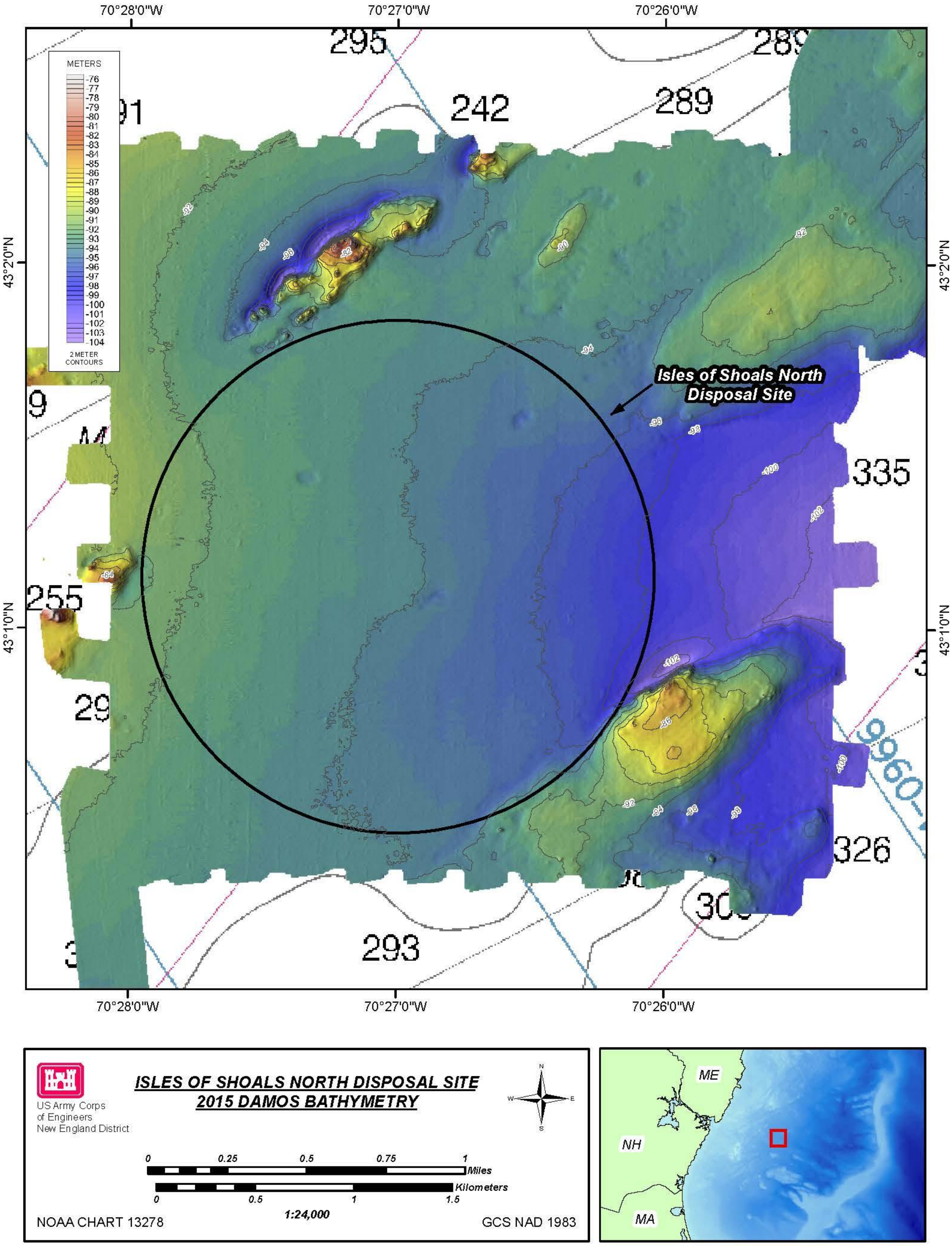


Figure 3-6. Bathymetry of the Proposed Isles of Shoals Ocean Disposal Site



3.6 Disposal off the Continental Shelf

Locating dump sites off the continental shelf is one of the five general criteria required to be addressed under Criteria for the Management of Disposal Sites for Ocean Dumping [40 CFR 228.5(e)], subject to a determination of feasibility and practicability. For projects in southern Maine, New Hampshire, and northern Massachusetts, potential disposal areas located off the continental shelf would be at least 230 nautical miles offshore. This distance is well beyond the economical haul distance for typical coastal hopper dredges or tugs and scows. The longer distance would increase fuel consumption and generate more emissions, contributing to local and regional air quality problems. The longer tug and barge transits also increase the potential for accidents that could jeopardize the safety of the crew.

Transporting dredged material off the continental shelf also presents potentially significant environmental concerns. Benthic and pelagic ecosystems near the shelf contain important fishery resources and the effects of disposal operations on them are not well understood. Fine-grained sediment and rocky habitats may be directly impacted by disposal of dredged material. These deep-water areas are stable and generally not disturbed by wave action or sediment movement. Consequently, the benthic invertebrate communities in these deep, offshore environments are adapted to very stable conditions and would be less able to survive disturbance from the immediate impact of disposal and the long-term alteration of substrate type. As previously noted, the longer transits increase the potential for accidents, which could result in the accidental dumping of dredged material in an ecologically important area either in transit to the shelf or on it. The cost for site evaluation necessary to designate a site and subsequent monitoring, along with unanswered environmental concerns about the effects of disposal in such areas, makes off-shelf disposal undesirable as well as infeasible.

3.7 Preferred Alternative

Based on an evaluation of the alternative solutions previously discussed, disposal of dredged material from the southern Maine, New Hampshire, and northern Massachusetts region into the ocean is necessary and unavoidable. USACE and EPA have concluded that the designation of the proposed Isles of Shoals North ODMDS is necessary to meet the long-term disposal needs of the study area.

4.0 OCEAN DUMPING SITE DESIGNATION PROCESS

4.1 Overview

The disposal of material, including dredged sediments, into the ocean is permitted only at sites or in areas where the impact of disposal activities on other uses of that area and the marine environment would be minimal. The Marine Protection, Research, and Sanctuaries Act (MPRSA) authorizes EPA to designate areas for ocean dumping and requires sites selected in locations that mitigate adverse impacts to the greatest extent practicable. Under MPRSA section 102, EPA is responsible for designating sites for the ocean dumping of all materials, including dredged material. EPA designates ocean disposal sites through rulemaking and sites are published at 40 CFR 228. EPA bases the designation of an ocean disposal site on environmental studies of a proposed site, environmental studies of regions adjacent to the site, and historical knowledge of the impact of disposal on areas similar to the sites in physical, chemical and biological characteristics. All studies for the evaluation and potential selection of dredged material disposal sites are conducted in accordance with the criteria published in 40 CFR 228.5 and 228.6. Only dredged material that is permitted (or, in the case of a federal navigation project, authorized) for disposal under the MPRSA may be disposed in an EPA designated ocean dredged material disposal site. For the proposed IOSN site, EPA and the USACE generally followed the site designation procedures developed by a joint task force of EPA and USACE personnel titled, *General Approach to Designation Studies for Ocean Dredged Material Disposal Sites* (EPA and USACE, 1984).

The procedures utilize a hierarchical framework that initially establishes the broadest economically and operationally feasible area of consideration for site location. A step-by-step sequence of activities is then conducted to eliminate critical and/or unsuitable sub-areas. Further evaluation of alternative sites (candidate sites) within this area entails various levels of assessment as suggested by the sensitivity and value of critical resources or uses at risk, and potential for unreasonable adverse impact presented by the disposal of dredged material. The site designation criteria at 40 CFR 228.5 and 228.6 are applied to the information assembled through this process, and a final site or sites are selected and proposed for formal designation.

The site designation process is structured into three major phases (Figure 4-1). Phase I includes the delineation of the general area being considered for locating a site and the identification and collection of the necessary information on critical resources and uses, and on the physical and environmental processes for the area. Reasonable distance of haul is the determining factor and will be affected by considerations such as available dredging equipment, energy use constraints, cost, and safety considerations. Then a preliminary analysis, based on available data, is applied to identify and map reach boundaries for critical resources, as well as areas of incompatibility. Such critical areas and resources may include clustered areas of geographically limited habitats, fisheries and shellfisheries, navigation lanes, beaches, and marine sanctuaries.

Phase II primarily involves the elimination of sensitive and incompatible areas, determining additional data needs, and identification of candidate sites within the area based on the information collected and processed in Phase I. Phase III primarily involves the evaluation of candidate sites, selection of a proposed site or sites for designation, and the development of management strategies.

4.2 Defining a Zone of Siting Feasibility

The ZSF is an appropriate area of consideration to ensure that a full range of reasonable and practicable alternatives is considered. The EPA site designation guidance manual (EPA, 1986) describes the factors that should be addressed in identifying the ZSF. Specifically, EPA recommends locating ocean disposal sites within an economically and operationally feasible radius from the point of dredging. Other considerations include navigational restrictions, political or other jurisdictional boundaries, distance to the edge of the continental shelf, the feasibility of surveillance and monitoring, and operational and transportation costs (Pequegnat *et al.*, 1981). Thus, the ZSF represents the area from within which a range of reasonable specific alternatives may be selected for evaluation. By doing so, study efforts can be focused on areas that will actually meet project needs.

4.3 Southern Maine, New Hampshire, and northern Massachusetts Zone of Siting Feasibility

The ZSF analyzed in this EA includes the region of southern Maine, New Hampshire, and northern Massachusetts between Cape Porpoise, Maine and the waters north of Cape Ann, Massachusetts. These boundaries were chosen as they are the points that are approximately halfway between the proposed IOSN and the Portland Disposal Site (PDS) to the north and the Massachusetts Bay Disposal Site (MBDS) to the south. The PDS and the MBDS are the nearest EPA-designated ocean disposal sites in the region and are located about 85.5 miles apart. Factors involved in the defining of the ZSF include dredge cycle time, weather, and distance from potential source harbors. A site roughly central to this area of the coast would give a maximum haul distance of about 21 miles for any harbor to either the PDS, MBDS or a new centrally located site. This ZSF meets the dredging needs in the region and represents a reasonable haul distance for marinas, boatyards, commercial docks, and federal harbors and anchorages in the region.

The amount of time necessary to maintain a coastal project (exclusive of weather downtime) is a function of dredging a scow or hopper full of material (loading), then transporting that material to and placing it at a disposal site. This is called “cycle time” and the cycle time can be different for each dredge. Loading time is essentially fixed based on the characteristics of the sediments being dredged, the dredge itself (size of bucket, drag arms, etc.) and the dredging site conditions. The time to discharge material also is basically fixed for a given dredge and the type of material. Transport time depends primarily on the haul distance to the disposal site. Thus, the critical variable for new construction or maintenance dredging is haul distance between the dredging site and disposal site from both a time and cost perspective. A significant haul distance will affect the ability to construct or maintain the individual project.

Weather is also a significant limiting factor for dredging and ocean disposal of material along the east coast that must be considered in the development of the ZSF. While tugs/scows and hopper dredges are generally able to work safely in North Atlantic coastal waters during all months of the year, the probability of down time due to rough seas or other adverse weather conditions during the winter months is possible. The longer the haul distance (time) to the disposal site, the more likely that adverse weather conditions will stop or limit work. More frequent work stoppage increases the probability that dredging of a particular harbor might require more than one dredging season to complete.

Thus, this EA examines the potential environmental impacts associated with the use of a potential open-water dredged material disposal site in the area of southern Maine, New Hampshire, and northern Massachusetts, and the no-action alternative. Figure 4-2 shows the current assessment area, referred to in this document as the Zone of Siting Feasibility (ZSF).

Figure 4-1. Phases of the Site Designation Process

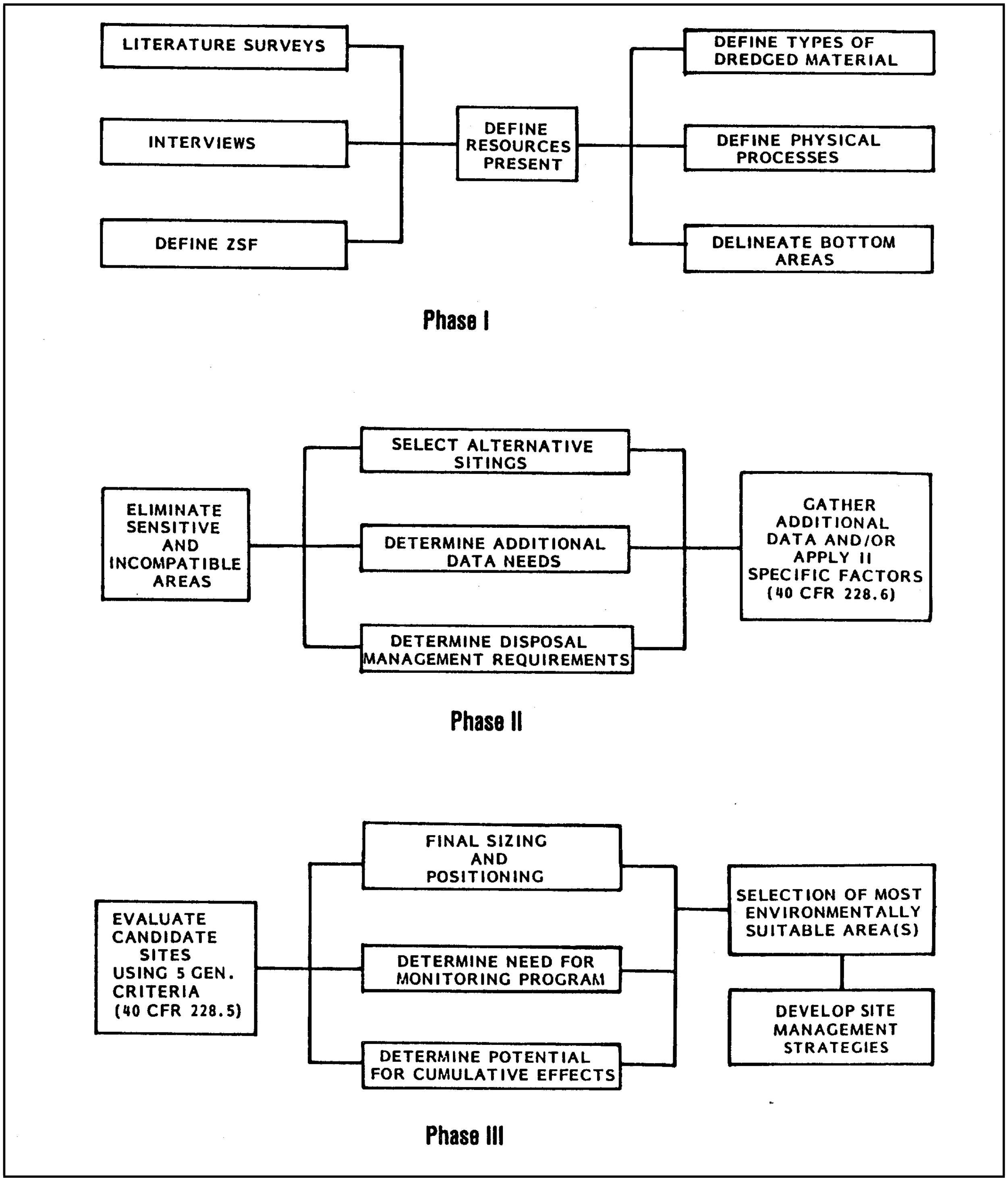
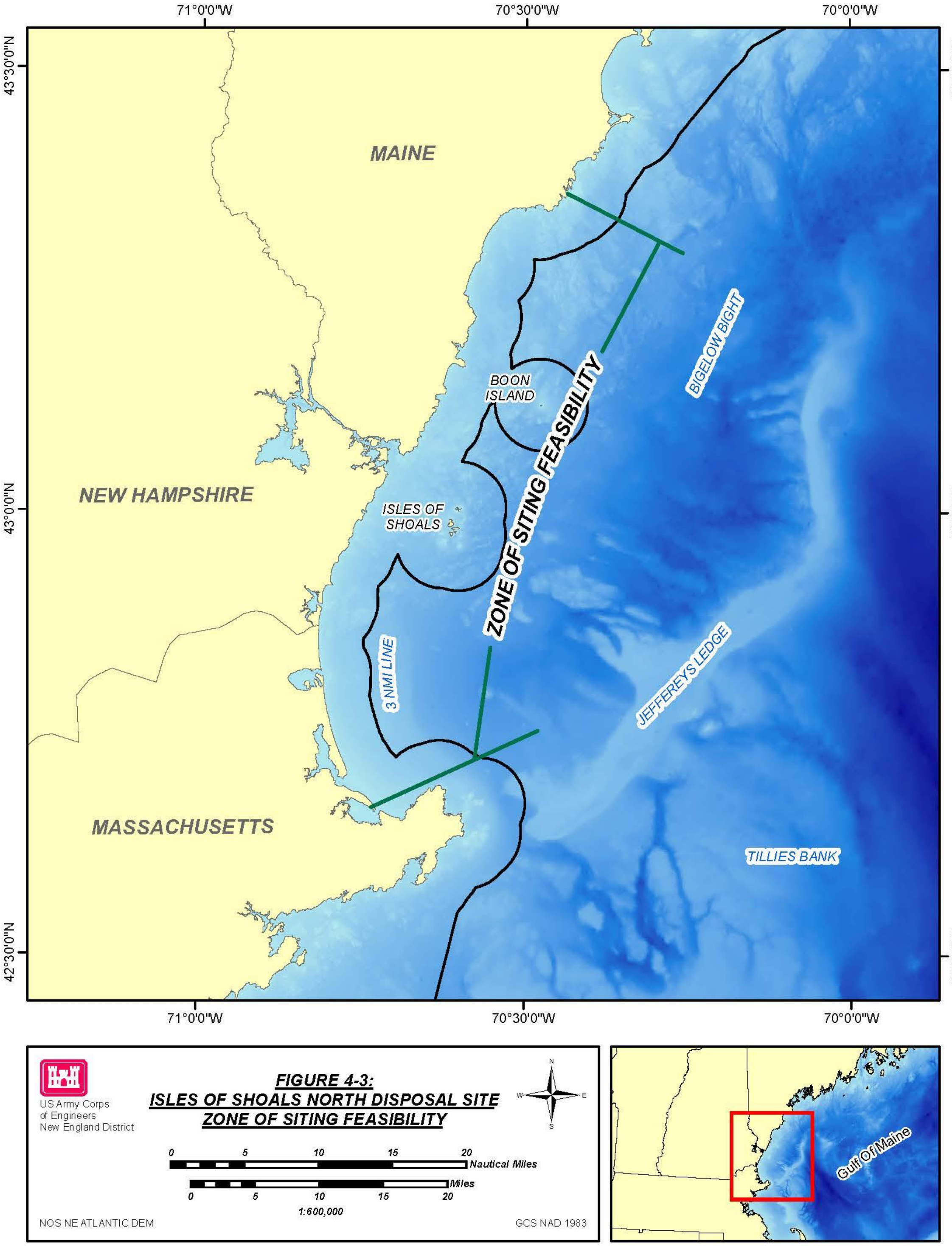


Figure 4-2. Zone of Siting Feasibility



4.4 Four General and Eleven Specific Criteria for Ocean Disposal Site Selection

EPA bases the designation an ODMDS on the evaluation of compliance with the four general and eleven specific criteria at 40 CFR 228.5 and 228.6. A discussion of each criterion for the proposed site can be found below.

4.4.1 Application of Four General Criteria (40 CFR 228.5)

Minimize Interference with Other Activities (a.). The first of the four general criteria require that a determination be made as to whether the proposed site or its use will minimize interference with other activities in the marine environment. EPA and USACE used information from a variety of sources to determine what activities may be interfered with by the disposal of dredged material at the proposed IOSN ODMDS. EPA considered recreational activities, commercial fishing areas, cultural or historically significant areas, commercial and recreational navigation, and existing scientific research activities.

The information noted above was obtained from: the states of Maine's and New Hampshire's Inshore Trawl Survey (http://www.maine.gov/dmr/science-research/projects/trawlsurvey/index.html); a report on biological resources submitted to USACE from Maine's Bureau of Marine Science (Appendix F); information on cultural resources was obtained from NOAA's Office of Coast Survey (http://www.nauticalcharts.noaa.gov/); USACE archival files for Federal Navigation Projects and disposal sites located in the ZSF; recent condition surveys of Federal Navigation Projects located in the ZSF (http://www.nae.usace.army.mil/Missions/Navigation.aspx); personal communications with the shipping industry (Portsmouth Pilots); biological community (benthos, fish, and lobster) and sediment sampling; and USACE DAMOS archives (http://www.nae.usace.army.mil/Missions/Disposal-Area-Monitoring-System-DAMOS/). This information allows EPA to determine the degree of existing use and how the indirect effect of site designation and disposal of dredged material may interfere with these uses.

In terms of interference with other activities, the known activities that spatially overlap with the proposed ODMDS include recreational activities such as boating and whale watching, recreational fishing for groundfish, and commercial fishing for lobster, Atlantic herring, and other groundfish, and recreational and commercial navigation. Even though these activities may spatially overlap, the proposed ODMDS and the disposal of dredged material in the site either do not interfere with the activities at all (whale watching, boating, navigation), or do not interfere with the activities at a level that would result in significant effects to the activity.

The information gathered about existing activities at the proposed ODMDS has not identified any potential conflicts that would eliminate the site from consideration for final ODMDS designation.

Minimizes Changes in Water Quality (b.). The second of the four general criteria requires changes to ambient seawater quality levels occurring outside the disposal site to be within water quality criteria, and that no detectable contaminants reach beaches, shoreline, sanctuaries, or geographically limited fisheries or shellfisheries. No significant contaminant or suspended solids releases are expected. Based on previous monitoring work at similar disposal sites by the USACE's Disposal Area Monitoring System (DAMOS) program, disposal of either sandy or fine-grained material would not have any long-term impact on the water quality at the proposed

IOSN site. No adverse water quality impacts to any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery near the proposed ODMDS are expected. The proposed IOSN site is located in a depositional area and material placed at the site is anticipated to remain within the site boundaries.

Interim Sites Which Do Not Meet Criteria (c.). Effective January 9, 2009, 40 CFR Part 288.5 was amended by removing and reserving paragraph (c).

Size of Sites (d.). The fourth general criterion requires that the size, configuration and location of the site be evaluated as part of the study and that the size be limited. Ocean disposal sites are sized to localize, for identification and control, any immediate adverse impact and permit the implementation of effective monitoring and surveillance programs to prevent long-term impacts over time.

The proposed IOSN has been sized to provide sufficient capacity to accommodate material dredged from the Federal Navigation Projects within the ZSF, as well as material from smaller private projects. The size of the proposed IOSN was calculated based on the requirement to provide at least 20 years of disposal capacity per site, without the site accumulating dredged material to a height that could potentially interfere with navigation and allow for both management of dredged material disposal within the site and monitoring of the disposal mounds and adjacent areas. The site covers a shallow basin area bounded by a slope to higher ground on the west and by small ridges to the north and southeast, leaving a deeper area in the central and east areas of the site. This topography, and the significant depth of the site (about 300 feet) should allow for long term containment of any material placed there.

Bathymetric surveys of the disposal area following disposal events will be conducted as part of the Site Management and Monitoring Plan (SMMP, Appendix G). The results will be used to document the fate of the dredged material and provide information for future management.

Sites off the Continental Shelf (e.). Potential disposal areas located off the continental shelf (off-shelf) would be a significant distance offshore, and impractical for dredging projects. The nearest point on the continental shelf/slope boundary to Portsmouth Harbor is more than 230 miles south, about 96 miles southeast of Nantucket. The distant to the slope due east is about 270 miles. The haul distance to an off-shelf disposal site is therefore much greater than the average operational limit of the southern Maine, New Hampshire, and northern Massachusetts projects, making an off-shelf site infeasible for all projects. Additionally, the cost for evaluation and monitoring and the uncertainty of the environmental effects of off-shelf ocean disposal makes the option undesirable.

Benthic and pelagic ecosystems near the shelf contain important fishery resources and the effects of disposal operations upon those resources are not well understood. Fine-grain sediment and rocky habitats would be directly impacted in disposal operations. These deep-water areas are stable and generally not disturbed by wave action or sediment movement. Consequently, these areas have benthic invertebrate communities that are adapted to very stable conditions and would not likely be able to survive disturbance from disposal. Little is known of the ecology of benthic communities on the continental slope, and disposal in this area could cause impacts of unknown severity and duration.

4.4.2 Application of Eleven Specific Criteria (40 CFR 228.6)

Geographical Position, Depth of Water, Bottom Topography and Distance from the Coast (1). The proposed IOSN is located in the Gulf of Maine, approximately 10.8 nmi (20 km) east of Portsmouth, New Hampshire (Figure 3-3), or about 13 statute miles east of Whaleback Light at the harbor entrance. This potential disposal site is currently defined as a 8,500-foot (2590-meter) diameter circle on the seafloor with its center located at 70° 26.995’ W and 43° 1.142’ N. Water depths at the proposed IOSN vary from 255 feet to 340 feet and gradually slope from approximately 295 feet on the western boundary to 328 feet in the southeastern portion of the site. The designated site would be used for disposal of dredged material from authorized Federal Navigation Projects and non-USACE projects permitted under the MPRSA.

Based upon consideration of the location, depth of water, bottom topography, and distance from the coast, the Isles of Shoals North Site is suitable for the disposal of dredged material when done in accordance with the Site Management and Monitoring Plan (SMMP; see Appendix G).

Location in Relation to Breeding, Spawning, Nursery, Feeding, or Passage Areas of Living Resources in Adult of Juvenile Phases (2). The proposed IOSN is located approximately 11 nautical miles offshore of New Hampshire where species characteristic of the offshore areas of the Gulf of Maine occur. A broad scale assessment of physical, chemical and biological characteristics of this area of the Gulf of Maine are described within the “State of the Gulf of Maine Report” (http://www.gulfofmaine.org/2/sogom-homepage/), a modular document made up of a series of theme or issue papers. Marine pelagic communities of zooplankton (e.g., copepods, euphausiids, pteropods, and chaetognaths), meroplankton (fish and invertebrate larvae), forage species, and pelagic predators have coast-wide distribution and generally display seasonal changes in abundance.

Spawning. The proposed site supports a variety of pelagic and demersal fish species and epibenthic invertebrates including lobster and Atlantic herring. Many of these species have a reproductive strategy that includes releasing a large quantity of eggs so that some individuals will survive the substantial mortality common to the species during the larval and juvenile stages. The alteration of the seafloor at the proposed site (in discrete locations year to year) from the disposal of dredged material may temporarily impact resource spawning, however effects would be short-term and localized. Additionally, resource spawning is not exclusive to the proposed site and occur within the entire ZSF as well as outside the ZSF.

Passage Areas. Various anadromous resources (e.g., herring, alewife, striped bass, Atlantic salmon, Atlantic sturgeon, shortnose sturgeon, etc.) that utilize the rivers and watersheds of southern Maine and New Hampshire may pass over the proposed disposal site area. Ocean disposal of dredged material at the site is not anticipated to interfere with fish passage or adversely affect habitat used by transiting resources.

Nursery Areas. The proposed IOSN is a flat expanse of fine-grained sediments in 255-340 feet of water. This type of habitat is not generally noted as preferred nursery habitat for Gulf of Maine species. Therefore, no significant effects to nursery areas are expected from the designation of proposed IOSN as an ODMDS.

Feeding. The proposed disposal site is not known to congregate organisms because of food resources. However, the substrate does provide prey items (polychaetes, amphipods, bivalves, gastropods, shrimp, etc.) that are consumed by bottom-feeding fish, lobster, crab, and other demersal organisms. Jeffery's Ledge, located to the east of the proposed IOSN, is an important feeding ground for humpback whales and right whales in the summer and fall months and serves as prime recreational whale watching areas. However, no effects to Jeffery's Ledge are anticipated, as the proposed site is a depositional area which will retain any dredged material placed there.

In summary, the proposed IOSN ODMDS encompass these resources however the site does not provide unique breeding, spawning, nursery, feeding, or passage habitat. Additionally, the habitat for the species that inhabit the proposed IOSN is not geographically limited to the ZSF and the disposal of dredged material occurs for discrete periods of time over a discrete spatial area. Thus, the temporary effects to the habitat at the site are not likely to translate into significant effects at a population or species level.

Location in Relation to Beaches and other Amenity Areas (3). The proposed IOSN is located approximately 10.8 nmi (20 km) east of Portsmouth, NH. The shoreward edge of the site is approximately nine nautical miles off the nearest beaches in Rye, NH and is in waters ranging from 255 to 340 feet deep.

Types and Quantity of Wastes Proposed to be Disposed of, and Proposed Methods of Release, including Methods of Packing the Waste, if Any (4). Dredged material subject to the MPRSA is not a waste. Sites that are designated will receive dredged material transported by either government or private contractor hopper dredges or scows. Current hopper dredges or scows available for use have hopper capacities ranging from 800 to 6,000 CY. This would be the likely volume range of dredged material deposited in any one dredging disposal cycle.

The dredged material to be removed from federal projects in the southern Maine, New Hampshire, and northern Massachusetts varies greatly from year to year depending upon need and funding. The majority of the dredged material to be placed in the ocean would come from shoals in the channels, anchorages, and turning basins in navigation projects within the study area and would consist primarily of fine-grained marine sediments that have been transported into the projects by tidal currents, riverine deposition, and upland erosion. The fine-grained material undergoes rigorous testing to confirm that the material is suitable for ocean disposal. The proposed site has been sized to accommodate the quantity of material to be placed.

Feasibility of Surveillance and Monitoring (5). The feasibility of surveillance and monitoring is maximized when disposal sites are located near shore and a port where research vessels can be launched. The closer the sites are to such facilities the lower the cost to monitor (lower fuel costs, less time). Thus, when considering feasibility, sites are chosen as close to shore as possible to meet criteria for operational capability and safety for dredges, and to match the grain size of the dredged material the site will be receiving as closely as possible. The EPA and USACE will monitor the designated site for physical, biological, and chemical attributes. The seafloor will be surveyed for bathymetry annually, and the benthic infauna and epibenthic organisms will be monitored every five years, as funding allows. The EPA and USACE New England District's Disposal Area Monitoring System (DAMOS)will conduct routine monitoring and special studies.

Dispersal, Horizontal Transport and Vertical Mixing Characteristics of the Area Including Prevailing Current Direction and Velocity, if Any (6). Section 6.3 of this document provides a detailed discussion regarding this criterion. The proposed IOSN site is in federal waters in water depth of approximately 255 to 340 feet. Water circulation in the vicinity of proposed IOSN is strongly influenced by the counterclockwise flow, or gyre, normally occurring in the Gulf of Maine. The circulation of the Gulf consists of two circular gyres, one counterclockwise within the interior of the Gulf, and the second, clockwise over Georges Bank. Maine coastal waters are included as the western portion of the counterclockwise gyre within the Gulf. Current patterns in the vicinity of the proposed IOSN are typified by coastal-parallel, non-tidal southerly drift currents generated by the overall circulation of the Gulf of Maine.

Based upon the fine-grained sediments that dominate the area that proposed IOSN encompasses, it can be concluded that the area is depositional in nature. Consequently, any material disposed of at the proposed site will likely remain within the site and not be significantly affected or transported away from the site by currents.

Existence and Effects of Current and Previous Discharges and Dumping in the Area (including Cumulative Effects) (7). USACE dredging and disposal records do not show evidence of dredged material ever being placed at the area that encompasses the proposed IOSN. The only known disposal activity in the ZSF has been at either the former Isles of Shoals disposal site (IOSH) which was used, according to USACE files, in the 1960s and early 1970s, or at the CADS. Both IOSH and CADS are considered in this document as alternative disposal sites (see Section 3.0).

The EPA and USACE DAMOS program routinely monitor active and historic disposal sites throughout the New England region. In general, results from decades of monitoring efforts indicate that the placement of sediments found suitable for ocean disposal do not significantly alter the long-term functions and values of seafloor bottom as potential habitat for biological communities or contribute to long-term changes in water quality or water circulation at the disposal sites.

Interference with Shipping, Fishing, Recreation, Mining Extraction, Desalination, Fish and Shellfish Culture, Areas of Special Scientific Importance and Other Legitimate Uses of the Ocean (8).

Shipping. The EPA does not anticipate conflicts with commercial navigation at the Isles of Shoals North site. In personal communication (teleconference) on November 21, 2016, between Mr. Mark Habel of the USACE-NAE and Mr. Chris Holt of the Portsmouth Pilots, USACE-NAE discussed the proposed IOSN disposal site location and its anticipated use with respect to navigation transit impacts. The USACE stated that for large projects, like the Portsmouth Harbor improvement project, about three disposal trips per day were anticipated during the fall to winter construction window. Mr. Holt indicated that vessels transiting to and from Portsmouth Harbor from the south and southeast follow a route inshore of the Isles of Shoals. Vessels approaching or departing to and from the east and northeast (Maine and Canada) do cross the general area of the proposed IOSN disposal site. The pilots stated that conflicts between dredge disposal operations and shipping for large and small projects can be avoided by adequate notice to mariners of disposal activities and frequent marine communication between the disposal tugs and the Portsmouth Pilots.

Commercial and Recreational Fishing. Commercial fishing in the vicinity of the proposed

IOSN includes lobster fishing, Atlantic herring trawling, and groundfish gill netting and bottom trawling. These activities are not exclusive to the site and occur within the entire ZSF as well as outside the ZSF. Fishing efforts vary annually in intensity because of shifting movement of the target species and seasonal restrictions.

The principal recreational fishing off the coast of southern Maine, New Hampshire, and northern Massachusetts is for groundfish and is done primarily from charter and private boats. Private and charter boats generally conduct fishing for striped bass and cod, which are generally associated with hard bottom substrates (e.g., ledge, boulder, and cobble habitat).

The potential exists for conflicts between the ocean disposal dredge material and commercial fishing for lobster and herring. Ocean disposal of dredge material could interfere with lobster fishing gear if it were present and a small percentage of the lobster resources present at whichever portion of the site is being used in any particular year would be buried during disposal events. However, with proper coordination efforts between the USACE and the lobster fishermen’s association, impacts to fishing gear can be eliminated and disposal events can be localized within the site on a yearly basis to minimize impacts to lobster resources present. Transit of the tugs/scows or hopper dredges to, from, and at the site during months when herring trawlers are actively fishing could interfere with the herring fishery. Additionally, depending on the month(s) in which disposal occurs, some herring resources (i.e., eggs) present at the site have the potential to be buried during disposal events. However, with proper coordination efforts between the USACE and the herring fishermen’s association, impacts to fishing gear can be eliminated and disposal events can be localized within the site on a yearly basis to minimize impacts to any herring resources present.

Recreation. The waters in the vicinity of the proposed IOSN offer a variety of marine related recreation opportunities such as recreational boating, whale watching, and fishing. Given the discrete spatial and temporal components of dredge material disposal, it is unlikely that any interference would occur with these activities.

Mineral Extraction. There are no known mineral extraction operations or proposed operations in the vicinity of the proposed disposal site. The disposal site is not expected to interfere with any future offshore mining or oil/gas exploration or extraction.

Desalination. There are no desalination plants in the area of the proposed IOSN.

Fish and Shellfish Culture. There are no commercial fish aquaculture or shellfish aquaculture operations that would be impacted by use of the proposed IOSN Site.

Areas of Special Scientific Importance. There are no known oceanographic research efforts directly within the area of the proposed ODMDS. The Maine Department of Marine Resources and the New Hampshire Fish and Game Department partner to conduct groundfish surveys in coastal waters of Maine and New Hampshire. The Maine-New Hampshire Inshore Trawl Survey is a resource assessment survey performed along the coastal waters of Maine and New Hampshire. Bi-annual surveys, spring and fall, have been conducted since the fall of 2000. This survey is a collaborative research project inventorying groundfish resources by using a commercial fishing vessel as a platform. This study would not be impacted by disposal at the proposed site.

Coastal Zone Management. The preferred action (designation of the proposed IOSN Site) has been determined by the EPA to be consistent with the states of Maine's and New Hampshire's Coastal Zone Management Programs. The states will review this consistency determination with a request to provide written notification of their findings.

The Existing Water Quality and Ecology of the Site as Determined by Available Data or by Trend Assessment or Baseline Survey (9). Water and sediment quality analyses conducted in conjunction with past disposal actions in the New England region have not identified any adverse water quality impacts from ocean disposal of dredged material. The ecology of the proposed ODMDS is typical of a northwest Atlantic fine-grained bottom community. This determination is based mainly on fisheries and benthic data. Neither the pelagic or benthic communities should sustain long-term adverse effects because of their resilience to episodic disturbance and widespread distribution off the New England coast.

Potentiality for the Development or Recruitment of Nuisance Species in the Disposal Site (10). Nuisance species are considered as any undesirable organism not previously existing at the disposal site. They are either transported or recruited to the site because the disposal of dredged materials created an environment where they could establish. Most of the dredged material from projects in southern Maine, New Hampshire, and northern Massachusetts that would be placed at the disposal site historically have been classified as uncontaminated marine silts and clays, which are similar to the sediments found at the proposed IOSN site. Disposal at a designated proposed IOSN site shall be limited to dredged material determined to be suitable for ocean disposal under the MPRSA and the ocean dumping regulations. Therefore, it is highly unlikely that any nuisance species could be established at the proposed disposal site since habitat (i.e., sediment type) or contaminant levels are unlikely to change over the long-term use of the site.

Existence at or in Close Proximity to the Site of any Significant Natural or Cultural Features of Historical Importance (11). Jeffery's Ledge, located to the east of the proposed IOSN, is an important feeding ground for humpback whales and right whales in the summer and fall months and serves as a prime recreational whale watching area.

Sidescan sonar of the proposed IOSN was conducted and no potential shipwrecks or other cultural features were noted. The cultural resource literature search conducted for the proposed IOSN area did not identify any shipwrecks in the vicinity. While undiscovered shipwrecks could occur in the area, it is unlikely based on the results of the sidescan survey of the area. Based on this information, it is unlikely that any significant cultural resources will be affected by the designation and use of the disposal site.

5.0 DETERMINATION OF COMPLIANCE AND SELECTION FOR FORMAL DESIGNATION (40 CFR 227)

Determination of Environmental Acceptability of Ocean Disposal (Subpart B). The USACE and EPA have documented for the record via this evaluation the anticipated environmental effects from designation of an ocean dredged material disposal site offshore of southern Maine, New Hampshire, and northern Massachusetts and from the potential future regulated use of that site pursuant to the SMMP (Appendix G) for disposal of dredged materials. Designation of an ocean dredged material disposal site does not mandate use; however, once designated, the use of the site is anticipated. Material that could be disposed in the ocean is anticipated to be clean marine fine-grained material (primarily silts and clays) from the Federal Navigation Projects in coastal areas of southern Maine, New Hampshire, and northern Massachusetts.

By regulation, dredged sediments suitable for ocean dumping may not contain any materials listed in Section 227.5 or contain any of the materials listed in Section 227.6 except as trace contaminants. Determination of trace contaminants is accomplished by USACE and EPA evaluation of the dredged material employing the procedures of applicable national and regional testing manuals. Compliance with the applicable prohibitions, limits, and conditions for site use will assure that formal designation of ocean dredged material disposal sites and their use will not unduly degrade or endanger the marine environment.

With respect to this subpart, it is concluded that site designation and use would present:

a) No unacceptable adverse effects on human health and no significant damage to the resources of the marine environment;
b) No unacceptable adverse effect on the marine ecosystem;
c) No unacceptable adverse persistent or permanent effects due to the dumping of dredged materials; and
d) No unacceptable adverse effect on the ocean for other uses as a result of direct environmental impact.

Determination of Need for Designation of Sites (Subpart C). The need for ocean dumping has been adequately documented by a thorough evaluation of the factors listed in Section 227.15. No practicable alternatives presently exist to manage dredged sediments from southern Maine, New Hampshire, and northern Massachusetts federal projects. Designation of an ocean dredged material disposal site to fulfill the present and anticipated future need is required. While the use of a designated site is anticipated, that use is not mandated by the designation. Notwithstanding compliance with the other ocean dumping criteria, ocean dumping of dredged material may not be authorized if there is no need for the dumping, and alternative means of disposal are available, as determined in accordance with Subpart C. These factors must be evaluated and documented for the record for each proposed dumping on an individual project basis.

Impact on Esthetics, Recreational and Economic Values (Subpart D). In itself, designation of the proposed ODMDSs has no effect on esthetics, recreational or economic values. Designation of an ODMDS does not mandate use. However, use of the site once designated is anticipated and the potential for adverse effects results from the individual and cumulative disposals at the designated site.

The location of the ODMDS is chosen to minimize resource impacts and use conflicts to acceptable levels, not to necessarily avoid all conflicts. Potential impacts to esthetics, recreation, and economics from using the proposed site offshore of southern Maine and New Hampshire were evaluated by USACE and EPA and are documented in this evaluation study. The EPA's site designation rule will define site use conditions that, in conjunction with the SMMP (Appendix G), will limit the extent and severity of any impacts to acceptable levels.

Recreational use and esthetics and the potential effects of disposal operations on these factors are described in detail in Sections 6-8 and 7-8 of this evaluation, respectively. No significant adverse effects on recreational use and esthetics are expected. The economic use (i.e., commercial and recreational fishing) and the potential effects of disposal operations on economics are described in detail in Section 6-6 and 7-6 of this evaluation. No significant adverse effects towards economic resources are anticipated.

EPA must also consider the consequences of not authorizing disposal sites and use of those sites, including without limitation, the impact on esthetic, recreation and economic values with respect to the municipalities and industries involved. Without ocean disposal, the Federal Navigation Projects in southern Maine and New Hampshire cannot be economically maintained. The benefits associated with continued ocean commerce of the southern Maine and New Hampshire region are substantial on a regional and national scale. While all economic values would not be completely lost, failure to maintain the navigation projects could result in severe economic disruption to municipalities, industries, and individuals throughout the region. Failure to maintain the navigation projects would not be expected to directly impact recreational uses or esthetic values defined by this subpart.

With respect to this subpart, it is concluded that the designation and use of the proposed ODMDS would not result in unacceptable adverse effects to esthetic, recreational, and economic values. Further, it is concluded that in the absence of an ODMDS, unacceptable adverse economic effects to municipalities and industries will occur throughout the region.

Impact on Other Uses of the Ocean (Subpart E). This evaluation study identified and assessed the nature and extent of existing and potential use of the disposal site itself and of any areas that reasonably may be affected by designation of the site and its use. Temporary and long-range effects were evaluated with particular emphasis on any irreversible or irretrievable commitment of resources that would result from use of the designated site. Based on these evaluations, it is concluded that there would be no unacceptable adverse effect on other uses of the ocean as defined by this subpart.

6.0 AFFECTED ENVIRONMENT

6.1 General Location

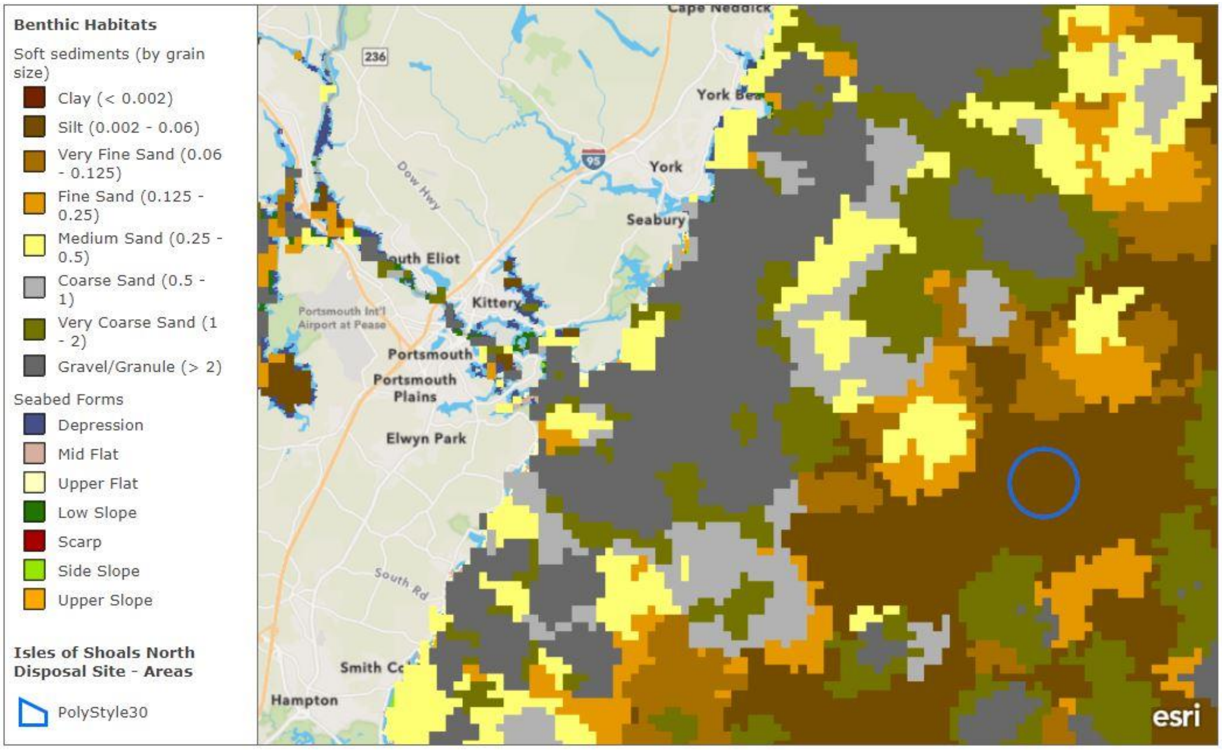
The proposed Isles of Shoals Disposal Site North (IOSN) is located in the Gulf of Maine seaward of the three-nautical mile limit of the territorial sea in federal waters, just northeast of the Isles of Shoals and approximately 20 km (10.8 nmi) east of Portsmouth, New Hampshire (Figure 3-5). The site is defined as a 8,500-foot (2590-meter) diameter circle on the seafloor with its center located at 70° 26.995’ W and 43° 1.142’ N. Water depths at the proposed IOSN vary from 255 feet to 340 feet and gradually slope from approximately 295 feet on the western boundary to 328 feet in the southeastern portion of the site (Figure 3-6).

6.2 Sediments

In general, the bathymetry of the seafloor in the vicinity of the proposed IOSN is a fairly uniform flat bottom. Surficial sediments at the site were sampled in November of 2010 by the USACE using a 0.4 m^2 grab sampler. Sample locations are noted in Figure 6-3. Sediments at all stations were dominated by silt-clay (Table 6-1). All stations, with the exception of Station B, were composed of 93% or more of silt clay (with the remaining fraction sands). The sediments at Station B were composed of 80% silts and clays and 20% sands. Grain size curves of all samples can be found in Appendix B.

A review of data from the Northeast Ocean Data Portal (https://www.northeastoceandata.org) shows that the sediments within the proposed IOSN are primarily silts. Figure 6-1 illustrates the sediments within proposed IOSN and the surrounding Gulf of Maine.

Figure 6-1. Surficial Sediment Types of the Gulf of Maine
(Northeast Ocean Data Portal, https://www.northeastoceandata.org)



Anderson, M. G., Greene, J., Morse, D., Shumway, D. and Clark, M (2010) Benthic Habitats of the Northwest Atlantic in Greene, J.K., M.G. Anderson, J. Odell, and N. Steinberg, eds. The Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats and Ecosystems. Phase One. The Nature Conservancy, Eastern U.S. Division, Boston, MA. | Esri, HERE, Garmin, METI/NASA, USGS, EPA, NPS, USDA

In September 2015, USACE’s DAMOS program performed a monitoring survey of proposed IOSN (Guarinello, et al., 2016) using the Sediment-Profile Imaging/Plan View Imaging (SPI/PV) monitoring technique that involves deploying an underwater camera system to photograph a plan view of the seafloor as well as a cross-section of the sediment-water interface. The SPI/PV monitoring survey concluded that the sediments at all stations surveyed were characterized as soft muds (e.g., silt/clay). SPI camera penetration depths throughout the site also indicated soft sediments with a mean penetration depth of 15.2 cm and a range from 9.3 to 18.7 cm. The SPI data showed no evidence of low dissolved oxygen or sedimentary methane within the sediments of the proposed disposal site.

6.3 Oceanographic Circulation and Water Quality

6.3.1 Oceanographic Circulation

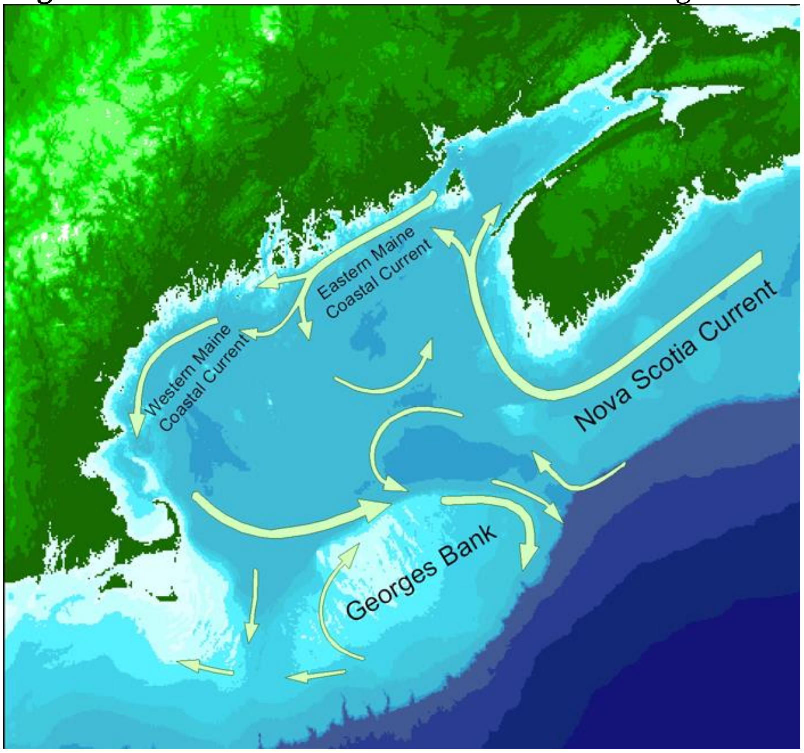
The water column at proposed IOSN behaves in a manner typical of northeastern continental shelf regions, with isothermal conditions less than 6°C during the winter, giving way to stratified conditions with maximum surface temperatures on the order of 18°C, and a strong thermocline at a depth of 20-30 meters during the summer months. The water column overturns during the fall, returning to isothermal conditions. Although this typical water column structure is persistent over the long term, there are anomalous perturbations that can cause significant variations, particularly in the winter months.

Water circulation in the vicinity of proposed IOSN is strongly influenced by the counterclockwise flow, or gyre, normally occurring in the Gulf of Maine (Figure 6-2) (http://www.gulfofmaine-census.org/about-the-gulf/oceanography/circulation/). The circulation of the Gulf consists of two circular gyres, one counterclockwise within the interior of the Gulf, and the second, clockwise over Georges Bank. Maine coastal waters are included as the western portion of the counterclockwise gyre within the Gulf. Studies using drift bottles and sea-bed drifters (Bigelow, 1927; Bumpus, 1976) indicated seasonal variability in this circulation under the combined effects of local wind stress and input of freshwater flows. In general, the circulation gyres are most strongly developed in the summer; during the winter, the interior gyre tends to move northward and become more diffuse.

Current patterns in the vicinity of the proposed IOSN are typified by coastal-parallel, non-tidal southerly drift generated by the overall circulation of the Gulf of Maine. The southerly flow is affected by tidally induced currents (averaging 15 cm/sec) that generate inshore and offshore movements, and local topography that may create local eddies. Strong northeast storms can generate southwesterly flows with speeds of 30-40 cm/sec. Bottom currents are influenced by topographic features in the region that disrupt the vertical coherence of the current structure. Near bottom currents in the region are generally less than 10 cm/sec and highly variable in direction (USACE, 1989).

Wave conditions in the vicinity of coastal southern Maine result from both local wind wave formation and propagation of long period waves (swell) generated on the adjoining continental shelf. USACE (1989) stated that the sheltering provided by the coastline limits wave generation from the westerly direction and that waves from the westerly quadrants larger than 1.8 m (6 feet) occur only 0.2% of the time on an annual basis and waves over 3.7 m (12 feet) are virtually nonexistent. Conversely, waves from the easterly quadrant that are over 1.8 m (6 feet) occur 4% of the time, or nearly twenty times more frequently, and waves over 3.7 m (12 feet) occur approximately 0.5% of the year.

Figure 6-2. Currents of the Gulf of Maine and Georges Bank



6.3.2 Water Quality

This section describes the water quality in the water column of the Gulf of Maine in the vicinity of the proposed ODMDS. Water quality is evaluated using the following parameters: turbidity, nutrients, dissolved oxygen, metals, and organic compounds. This evaluation relies primarily on information collected during previous studies of the Cape Arundel Disposal Site (USACE, 1989), data from EPA coastal nutrient trend monitoring (EPA, 2011), and data from Northeastern Regional Association of Coastal Ocean Observing System (NERACOOS) ocean observing system buoys in the Gulf of Maine (NERACOOS, 2017).

6.3.2.1 pH

The pH values in the waters in vicinity of the proposed IOSN site generally ranged from 7.78 to 8.15. These are typical ocean pH values, which generally change little because of the large buffering capacity of seawater (USACE, 1989).

6.3.2.2 Dissolved Oxygen (DO)

Average DO concentrations in the water column in the vicinity of proposed IOSN rarely fall below 6.5 mg/L (EPA, 2011; NERACOOS, 2017). This indicates that the water quality is excellent in this area. DO has the tendency to decline during the middle of the year due to stratification, respiration, and warming of the water.

6.3.2.3 Nutrients

Nitrogen and phosphorous compounds are essential nutrients that are metabolized by primary producers (e.g. plankton, algae) in photosynthetic processes. It is this primary production that forms the lowest trophic level of marine food webs. Excess nutrients can cause eutrophication and influence phytoplankton populations. Nitrogenous compounds (ammonia and nitrate) are of particular concern as nitrogen is often limiting in ocean waters. Phosphorous concentrations, although a concern in fresh water systems, are rarely limiting in the marine environment.

Water column analyses of nutrients (ammonia, nitrates, and phosphorous) were obtained during a study of the Cape Arundel Disposal Site (USACE, 1989). Data showed that nutrient concentrations varied seasonally with highest concentrations in the winter. This seasonal variation is most likely the result of biological activity and uptake.

6.3.2.4 Turbidity

Turbidity affects the depth of light penetration and therefore primary productivity in the water column. Particulate material suspended in the water column contributes to turbidity. Although not equivalent, turbidity is often measured by concentrations of suspended solids in grams/liter. Shevenell's (1974) data for the coastal waters of New Hampshire suggests that the suspended solid concentrations at nearby Cape Arundel are low (1-3 mg/1). Data from EPA’s coastal nutrient monitoring (EPA, 2011) measured turbidity at sites located inshore and further offshore than the proposed IOSN and found turbidity levels ranging between 0.5 – 0.9 NTUs, also suggesting that the turbidity in offshore waters contain low levels of suspended sediments.

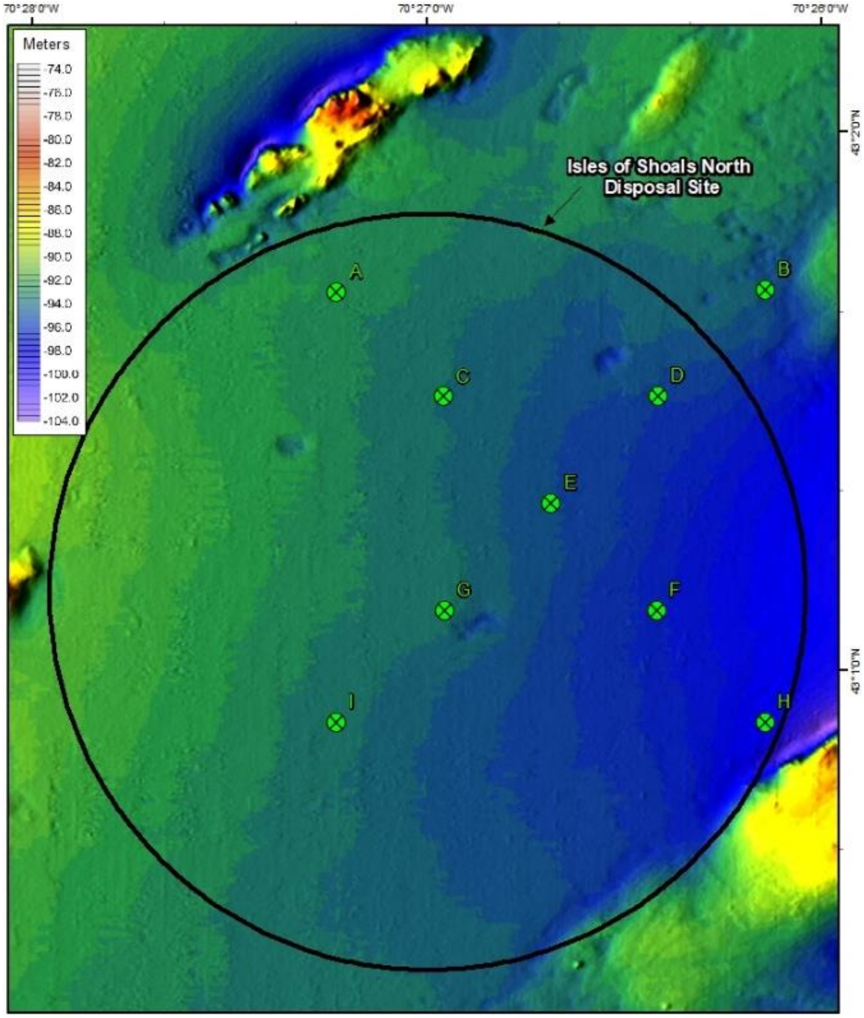
6.3.2.5 Metals and Organic Compounds

There are no existing data that characterize the sediment chemistry of the sediments at the proposed IOSN site. The Cape Arundel Disposal Site evaluation (USACE, 1989) noted that the sediments at the CADS site were similar in metal and organic compound concentrations to nearby reference areas, which were at low levels. As the proposed IOSN site is far from contaminant sources, the sediment concentrations of metals and organic compounds are anticipated to be similar to other sites in the Gulf of Maine, such as the baseline conditions at CADS and the CADS reference areas (USACE, 1989).

Table 6-1. Grain Size for Isles of Shoals North Disposal Site, November 2010

Station	Depth (ft)	% Sand	% Silt & Clay
A	319	2.1	97.9
B	314	20.2	79.8
C	315	2.4	97.6
D	318	3.4	96.6
E	316	3.7	96.3
F	321	2.4	97.6
G	317	3.9	96.1
H	328	7.3	92.7
I	313	2.1	97.9

FIGURE 6-3. USACE Sample Locations at the Isles of Shoals Disposal Site North, November 2010



6.4 Geology

Barnhardt et. al (1996) note that the surficial materials of the inner continental shelf of the northwestern Gulf of Maine are the most complex of any place along the Atlantic continental margin of the United States. Igneous, metamorphic, and sedimentary rocks spanning hundreds of millions of years of Earth's history form the regional basement. Glacial deposits, containing all class sizes from boulders to mud, partially cover these rocks. The materials, in turn, have been reworked by coastal processes during extreme fluctuations of sea level over the past few thousand years to create better sorted modern deposits. The surficial sediments at the proposed IOSN are fine-grained silts and clays (Table 6-1 and Figure 6-1).

6.5 Biological Resources

6.5.1 Plankton and Fish Larvae

Phytoplankton

Phytoplankton communities in the northeastern coastal shelf consist of a diverse assemblage of species, the most abundant of which can be divided into three main groups. These groups are the small-sized diatoms, the phytoflagellates, and the ultraplankton (2-5 um in size). The small diatoms (e.g., *Skeletonema costatum* and *Rhizosolenia delicatula*) are seasonally associated with spring and fall blooms, with highest concentrations occurring near shore and close to large estuaries. The phytoflagellates are a diverse group (dinoflagellates, coccolithophores, cryptomonads, and euglenoids) which occur in high numbers during late spring and summer. The ultraplankton are a ubiquitous group primarily composed of unidentified round or oval non-flagellated cells in the 2-5 um size range.

The species composition and annual cycles of the phytoplankton community in the Gulf of Maine were have been described by Lillick (1940), Bigelow (1940), TRIGOM (1974), Marshall and Cohn (1983), Marshall (1984), Sherman et al. (1983, 1984), and Johnson et al. (2011). Phytoplankton densities in the Gulf of Maine are lowest in the winter and peak during spring and fall blooms. Winter diatom populations are concentrated along the western coast of the Gulf of Maine. Predominant species include *Skeletonema costatum*, *Thalassiosira nordenskioldii*, *T. rutala*, *T. aestivalis*, *Leptocyndricus danicus*, and *Nitzchia pungens*. The predominant dinoflagellate species are *Ceratium fusus*, *C. lineatum*, *C. tripos* and *Prorocetrum micans*.

Bloom conditions occur in late March and early April (Johnson et al. 2011). The spring bloom is characterized by the rapid development of high populations of small, mostly chained and colonial diatoms such as *Skeletonema costatum*, *L. danicus*, *Asterionella glacialis*, and *Rhizosolenia delicatula*. The spread of these diatoms from the nearshore seaward generally corresponds to the nearshore circulation pattern in the Gulf of Maine. As the bloom progresses, the dominant diatoms are replaced in a successional sequence by larger diatom species, both single celled and colonial. The number of dinoflagelates in the southwest portion of the Gulf of Maine also increases with the addition of several species of *Gymnodium* (Sherman et al. 1983 and 1984).

Diatom numbers decrease during the summer, with small diatoms retaining population centers along the coast (Johnson et al. 2011). Dinoflagelate populations increase in the summer. Highest concentrations occur along the western margin where species such as *Ceratium fusus*, *C. lineatum*, *C. tripos*, *Prorocentrum balticum*, *P. micans*, and several species of *Protoperidinium* and *Gonyaulux* are common. The pattern of the fall bloom is similar to the spring bloom. The dominant diatoms include *A. gracialis*, *L. danicus*, and *S. costatum*. Dinoflagellates increase slightly in the nearshore.

Primary Productivity and Chlorophyll a

In general, phytoplankton productivity off the northeast continental shelf is high May through September and low from December to February with peaks of high productivity in March and October. The estimated annual productivity in the waters around proposed IOSN is on the order of

260 gC/m^2 (Sherman et al., 1988). Chlorophyll *a* standing stock reaches its highest values during the spring bloom, tapers off during the summer and has a secondary maximum in the fall. During the spring period, most of the production is attributable to diatoms. Dinoflagellates and flagellates contribute significantly to the production in the summer. Although chlorophyll *a* concentrations are low during the summer relative to spring and fall levels, primary production in coastal waters remains high. This is a result of the increased summer solar radiation and from the efficiency of small nanoplankton with high turnover rates that dominate the plankton.

Zooplankton

The zooplankton community of Gulf of Maine waters is generally dominated by the ubiquitous copepods, *Calanus finmarchicus, Centrophages typicus*, and *Pseudocalanus minutus*. *C. finmarchicus* is the dominant species from spring through early fall, when *C. typicus* becomes dominant. *P. minutus* is abundant from spring through summer but in lower concentrations than *C. calunus* (Sherman et al., 1988). *C. finmarchicus* and *P. minutus* are herbivorous, *C. typicus* is omnivorous, but prefers zooplankton prey. Other typical copepod species include *Temora longicornis*, *Acartia longiremis,* and *Oithona similis* (Sherman, 1968, 1970). Zooplankton biomass (as measured by displacement volume) in coastal Gulf of Maine waters peaks in July and October (Sherman et al., 1988). Overall, in the Gulf of Maine, peak zooplankton biomass occurs in May with a gradual decline through fall.

Microzooplankton (zooplankton capable of passing through a 333-um mesh net) are also an important component of the Gulf of Maine zooplankton community (Johnson et al. 2011). Principal components of the microzooplankton include immature copepods (eggs, naupuli, and copepodites), and members of the copepod genus *Oithona*. The microzooplankton component is most abundant in summer and autumn (Johnson et al. 2011). Zooplankton encountered in winter and early spring are primarily adults. Microzooplankton biomass in northeast shelf waters may be approximately 30% of the biomass retained by a standard 333 um net.

Fish eggs and larvae

Information concerning the ichthyoplankton of coastal Maine waters is available from several sources. For this EA, data was drawn from Bigelow (1924), Normandeau (1985), and the coastal Maine MARMAP studies (Morse et al., 1987; (Johnson, et al. 2011). Long-term studies conducted in coastal New Hampshire by Normandeau (1985) indicate that highest concentrations of planktonic eggs in the Gulf of Maine occur from June through August. Eggs of cunner, yellowtail flounder, mackerel, hake (*Urophycis* spp.), and rockling are predominant during the summer peak. Although concentrations of planktonic eggs are low from October through April, substantial numbers of demersal eggs, from species such as Atlantic herring, are presumably present at this time.

Planktonic larvae are most abundant in coastal Gulf of Maine during July and August. Atlantic mackerel and cunner are the predominant species at this time. Secondary peaks dominated by American sand lance (*Ammodytes* spp., February-April) and Atlantic herring (October-November) also occur.

6.5.2 Benthos

Benthic samples were collected at nine stations on November 1, 2010, within the proposed IOSN disposal area (Figure 6-2). At each station, samples for benthic community analysis and sediment grain size analyses were retrieved using a 0.04 m^2 modified Van Veen grab. The results of the survey showed that the site is uniform both physically (the sediments have a very high fine silt/clay content) (USACE, 2014) and biologically (Larsen, 2011).

The results of the benthic community analysis indicate that, while not extremely diverse, the macroinvertebrate fauna at the proposed IOSN shows a mix of short-lived opportunistic species and longer-living stable climax community species (Larsen, 2011). The benthic community sampled consisted of 40 species representing just four phyla (Table 6-2). The assemblage is noteworthy for its lack of oligochaetes, nearly ubiquitous elsewhere, and the absence of echinoderms and colonial species. Polychaetes were the overwhelmingly dominating taxa within the community in terms of numbers of species and individuals. Density was relatively low, while the species richness, diversity and evenness were also at low to modest levels (Larsen, 2011). One species, the polychaete *Paraonis gracilis*, was the numerical dominant at eight of the nine stations sampled.

As previously described, the DAMOS program conducted a monitoring survey of proposed IOSN in September 2015 (Guarinello, et al., 2016) using the Sediment-Profile Imaging/Plan View Imaging (SPI/PV) monitoring technique. The SPI data showed that the apparent redox potential discontinuity (aRPD) depths (an approximation of the depth between oxygen-rich and oxygen-poor sediments) at the proposed disposal site stations were relatively deep, indicative of a healthy seafloor that has been biologically modified by infaunal reworking. The average station aRPD depths ranged from 4.8 to 9.5 cm with an overall mean of 7.3 cm across all the proposed disposal site stations (Guarinello, et al., 2016). The DAMOS survey also concluded that Stage 3 infauna (i.e., a diverse, stable benthic community) were present across the proposed disposal site with the predominant stage at all stations being Stage 1 on 3 (Stage 1 communities tend to fluctuate rapidly and are characterized by short-lived, opportunistic species with a rapid reproductive rates). Evidence for the presence of Stage 3 fauna included large-bodied infauna, deep subsurface burrows, and/or deep feeding voids; opportunistic Stage 1 taxa were indicated by the presence of small tubes at the sediment water interface. Subsurface feeding voids, indicating Stage 3 fauna, were present in at least one replicate of all but two stations surveyed. The mean of maximum subsurface feeding void depth ranged from 5.7 to 15.9 cm with an overall mean of 9.9 cm (Guarinello, et al., 2016).

In summary, the study area is physically homogeneous and inhabited by a benthic invertebrate community that is predominately Stage 1 on 3. Richness, at the species and higher taxonomic levels, and density are low relative to both further inshore and further offshore habitats. Deposit-feeding polychaetes dominate the fauna qualitatively and quantitatively. The complete benthic community analysis report (Larsen, 2011) is attached as Appendix C and the DAMOS report (Guarinello, et al., 2016) is attached as Appendix D.

Table 6-2. Benthic community collected at proposed IOSN stations in 2010.

	STATIONS								
Taxon	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Annelida									
Aglaophamus neotenus	-	1	-	-	-	-	-	-	-
Ampharete arctica	6	12	2	-	4	3	-	7	4
Aricidea suecica	-	-	-	-	-	-	1	-	-
Ceratocephale loveni	1	-	1	2	2	2	-	1	-
Chaetozone setosa	-	-	-	1	-	-	-	-	-
Cossura longocirrata	2	2	7	9	19	9	4	4	5
Harmothoe extenuata	-	-	-	-	-	-	-	1	-
Lepidonotus squamatus	6	-	-	-	-	-	-	-	-
Lepidonotus squamatus	-	-	-	-	-	-	-	-	1
Lumbrineris latreilli	-	-	-	-	-	-	-	-	1
Maldane sarsi	-	1	-	-	-	-	-	-	-
Mediomastus ambiseta	-	1	-	4	-	3	-	3	3
Nephtys incisa	-	-	-	1	-	-	-	-	-
Ninoe nigripes	-	6	-	-	1	-	-	2	3
Owenia fusiformis	-	-	2	1	-	1	2	2	2
Paramphinome pulchella	-	-	-	1	-	-	-	2	-
Paraonis gracilis	8	8	20	1	22	16	8	20	47
Praxillella gracilis	-	-	-	-	1	1	-	5	2
Prionospio sp	-	-	-	2	4	-	1	4	-
Sabaco elongatus	-	2	-	4	2	-	1	15	7
Scalibregma inflatum	-	-	-	-	-	-	-	1	-
Scoletoma tenuis	1	-	-	-	-	-	-	3	-
Syllid juvenile	-	-	-	1	-	-	-	-	-

Table 6-2 (continued). Benthic community collected at proposed IOSN stations in 2010.

	STATIONS								
Taxon	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Tharyx acutus	1	-	-	-	-	-	-	1	-
Unidentified Polychaete	1	-	-	-	-	-	-	-	-
Arthropoda									
Cyclaspis varians	-	-	-	-	-	-	-	1	-
Eudorella pusilla	1	-	-	-	-	-	-	-	-
Harpinia propinqua	1	-	-	-	-	-	-	-	-
Leptocheirus plumulosus	-	-	-	1	-	-	-	-	-
Leptostylis longimana	-	-	-	-	-	-	-	1	-
Paracaprella tenuis	-	-	1	-	-	1	-	-	-
Photis sp.	-	-	-	-	-	-	-	-	1
Mollusca									
Astarte undata	-	-	-	1	-	1	-	1	-
Chaetoderma nitidulum	-	-	-	-	-	-	1	-	-
Parvicardium pinnulatum	-	-	-	-	-	-	-	1	-
Thyasira sp.	-	-	-	-	1	-	-	1	-
Unidentified bivalve (juv.)	-	-	-	-	1	-	-	-	-
Rhynchocoela									
Micrura sp.	-	-	-	-	1	-	1	-	-
Unidentified Nemertean	3	-	-	-	-	-	-	-	3

6.5.3 Fish

The proposed IOSN area supports a variety of pelagic and demersal fish species. The habitat at the proposed disposal site is not a rare or especially unique habitat for the Gulf of Maine, consisting of a primarily flat, silt/clay bottom. Species identified as common in the Gulf of Maine during the characterization of the CADS (USACE, 1989) include the fish species noted in Table 6-3.

Fish community data collected jointly by the states of Maine and New Hampshire was also used to describe the communities at proposed IOSN. The Maine-New Hampshire (MENH) Inshore Trawl Survey samples areas off of coastal New Hampshire and Maine in the Gulf of Maine in spring (typically the first week of May) and the fall (typically the last week of September) (Maine DMR, 2016 – See Appendix F). Sampling in the vicinity of the proposed IOSN has been conducted since the fall of 2000 and there have been 136 trawl tows made in proximity to the proposed disposal site from 2000 through 2015 (See Appendix F – Figure 9). A total of 65 spring tows were performed and a total of 71 tows were made in the fall. Specifics of the bottom trawl procedures and protocols can be found at https://www.maine.gov/dmr/science-research/projects/trawlsurvey/reports/documents/proceduresandprotocols.pdf. A total of 91 species were caught in all tows, with the spring tows averaging 21 species per tow (with a minimum of 9 and a maximum of 33) and the fall tows averaging 23 species per tow (with a minimum of 8 and a maximum of 34). Table 6-4 shows a listing of all fish species caught from the trawl tows in the vicinity of the proposed IOSN. The average tow catch weight was 75.20 kg per tow in the spring and 321.52 kg per tow in the fall. The dominant fish species by weight in the MENH trawls in the fall were spiny dogfish, silver hake, and Atlantic Herring. The dominant fish species by weight in the MENH trawls in the spring were American plaice and silver hake.

Table 6-3. Species identified during the 1989 characterization of the Cape Arundel Disposal Site (USACE, 1989).

Bottom-Dwelling Fish		**Pelagic or Semi-Demersal Fish**	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
American plaice	*Hippoglossoides platessoides*	Spiny dogfish	*Squalus acanthias*
Atlantic cod	*Gadus morhua*	Sandlance	*Ammodytes americanus*
Winter flounder	*Pseudopleuronectes americanus*	Atlantic mackerel	*Scomber scombrus*
Yellowtail flounder	*Limanda ferruginea*	Atlantic herring	*Clupea harengus*
Witch flounder	*Glyptocephalus cynoglossus*	Atlantic menhaden	*Brevoortia tyrannus*
Ocean pout	*Macrozoarces americanus*	Alewife	*Alosa pseudoharengus*
Red hake	*Urophycis chuss*	Blueback Herring	*Alosa aestivalis*
Silver hake	*Merluccius bilinearis*	Bluefish	*Pomatomas saltatrix*
White hake	*Urophycis tenuis*	Redfish	*Sebastes fasciatus*
Atlantic Wolffish	*Anarhichas lupus*	Bluefin Tuna	*Thunnus thynnus*
Sea raven	*Hemitripterus americanus*	Butterfish	*Peprilus triacanthus*
Haddock	*Melanogrammus aeglefinus*		
Goosefish (Monkfish)	*Lophius americanus*		
Pollock	*Pollachius virens*		
Little skate	*Raja erinacea*		
Barndoor skate	*Raja laevis*		
Thorny skate	*Raja radiata*		
Smooth skate	*Malacoraja senta*		
Cusk	*Brosme*		
Snake blenny	*Lumpenus lumpretaeformis*		
Wrymouth	*Cryptacanthodes maculatus*		
Rock gunnel	*Pholis gunnellus*		
Sea Raven	*Hemitripterus americanus*		
Longhorn sculpin	*Myoxocephalus octodecemspinosus*		
Shorthorn sculpin	*Myoxocephalus scorpius*		
Mailed sculpin	*Triglops ommatistius*		
Grubby	*Myoxocephalus aenaeus*		
Lumpfish	*Cyclopterus lumpus*		

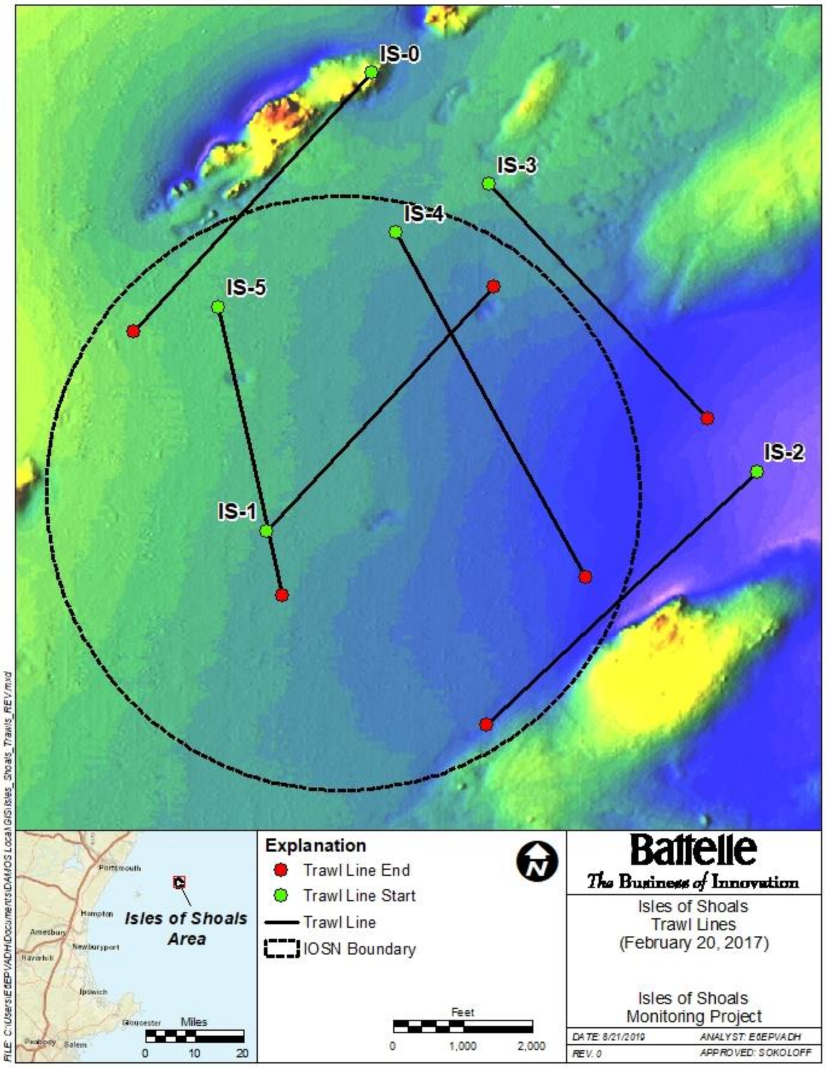
Table 6-4. Species identified from the Maine-New Hampshire (MENH) Inshore Trawl Survey in the vicinity of the proposed IOSN during the spring and fall (2000-2015).

Common Name	Scientific Name	Common Name	Scientific Name
Acadian Redfish	*Sebastes fasciatus*	Little Skate	*Raja erinacea*
Alewife	*Alosa pseudoharengus*	Longhorn Sculpin	*Myoxocephalus octodecemspinosus*
Alligatorfish	*Aspidophoroides monopterygius*	Lumpfish	*Cyclopterus lumpus*
American Plaice	*Hippoglossoides platessoides*	Moustache Sculpin	*Triglops murrayi*
American Sand Lance	*Ammodytes americanus*	Northern Pipefish	*Syngnathus fuscus*
American Shad	*Alosa sapidissima*	Northern Puffer	*Sphoeroides maculatus*
Atlantic Cod	*Gadus morhua*	Northern Sea robin	*Prionotus carolinus*
Atlantic Halibut	*Hippglossus hippoglossus*	Ocean Pout	*Macrozoarces americanus*
Atlantic Herring	*Clupea harengus*	Pearlsides	*Maurolicus muelleri*
Atlantic Mackerel	*Scomber scombrus*	Pollock	*Pollachius virens*
Atlantic Silverside	*Menidia*	Rainbow Smelt	*Osmerus mordax*
Atlantic Torpedo	*Torpedo nobiliana*	Red Hake	*Urophycis chuss*
Barndoor Skate	*Raja laevis*	Scup	*Stenotomas chrysops*
Bigeye Scad	*Selar crumenopthalmus*	Sea Raven	*Hemitripterus americanus*
Black Sea Bass	*Centropristis striata*	Silver Hake	*Merluccius bilinearis*
Blueback Herring	*Alosa aestivalis*	Silver Rag	*Ariomma bondi*
Bluefish	*Pomatomas saltatrix*	Smooth Skate	*Raja senta*
Bristled Longbeak	*Dichelopandalus leptocerus*	Snakeblenny	*Lumpenus lumpretaeformis*
Buckler Dory	*Zenopsis conchifera*	Spiny Dogfish	*Squalus acanthias*
Butterfish	*Peprilus triacanthus*	Spotted Hake	*Urophycis regia*
Cunner	*Tautogolabrus adspersus*	Spotted Tinselfish	*Xenolepidichthys dalgleishi*
Daubed Shanny	*Lumpenus maculatus*	Thorny Skate	*Raja radiata*
Fourbeard Rockling	*Enchelyopus cimbrius*	White Hake	*Urophycis tenuis*
Fourspot Flounder	*Paralichthys oblongus*	Windowpane	*Scophthalmus aquosus*
Goosefish	*Lophius americanus*	Winter Flounder	*Pseudopleuronectes americanus*
Greenland Halibut	*Reinhardtius hippoglossoides*	Winter Skate	*Raja ocellata*
Grubby	*Myoxocephalus aenaeus*	Witch Flounder	*Glyptocephalus cynoglossus*
Gulf Stream Flounder	*Citharichthys arctifrons*	Wrymouth	*Cryptacanthodes maculatus*
Haddock	*Melanogrammus aeglefinus*	Yellowtail Flounder	*Limanda ferruginea*

The USACE sampled the area within the proposed IOSN site on May 24, 2016, and February 20, 2017, (Battelle, 2017 See Appendix E). Six trawl transects were established within the proposed site (Figure 6-4) and at each location a 15-minute trawl was performed at a speed of approximately 2.6 knots. In general, species composition of the fish community was similar to that reported by USACE (1989) and from the MENH data set (Maine DMR, 2016).

In the May 2016 effort, the total number of individuals caught during the spring sampling was 12,218 across a total of 24 species. The mean species per tow was 15, with a minimum of 13 species and a maximum of 18 species. The numerically dominant species in the May effort at all stations were silver hake (*Merluccius bilinearis*) and American plaice (*Hippoglossoides platessoides*). In the February 2016 effort, the total number of individuals caught was 26,131 across a total of 28 species. The mean species per tow was 15, with a minimum of 11 species and a maximum of 18 species. The numerically dominant species in the February effort were silver hake (*Merluccius bilinearis*) and alewives/blueback herring (*Alosa pseudoharengus, Alosa aestivalis*) (Battelle, 2017).

Figure 6-4. Location of USACE trawl transects in May 2016 and February 2017.

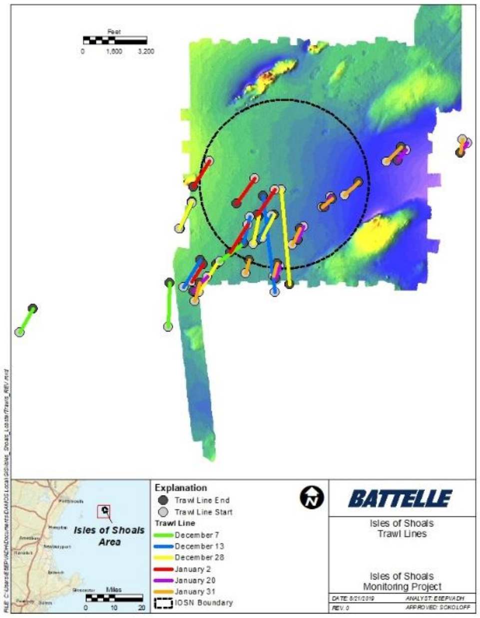


6.5.4 Shellfish and Lobster

The Maine DMR Lobster Monitoring Program has routinely collected lobster population data throughout the state since 1985, with the sampling occurring primarily from May through November and occasionally in the winter months, as conditions allow. Each lobster management zone (Figure 6-7) is sampled three times monthly from May through November with trips spread throughout the zone. Zone G is the southwestern most lobster management zone spanning from the Presumpscott River (near Portland, Maine) south to the New Hampshire border, and is the zone in which the proposed IOSN is located. Using a subset of data from Zone G that was relevant to the location of the proposed IOSN, the Maine DMR Lobster Monitoring Program calculated a mean catch of 0.39 legal lobsters per trap (± 0.09 lobsters) during the December through April timeframe, which was comparable to the overall Zone G winter catches. The mean catch in the May through November timeframe ranged from 1-2 legal lobsters per trap (Maine DMR, 2016 – See Appendix F).

USACE collected lobster abundance data in and around the proposed IOSN in December 2016 and January 2017 to assess the winter lobster community in the area (Battelle, 2017 – Appendix E). A total of six deployment/retrieval events were conducted. For the first four deployment events (December 7, 13, and 28, 2016, and January 2, 2017), six trawls, each containing 20 vented traps, were deployed from a commercial lobster vessel. For the fifth deployment event (January 20, 2017), six trawls of 16 vented traps were used, and for the sixth deployment event (January 31, 2017), eight trawls of 16 vented traps were used. The placement of the lobster trawls in and around the proposed IOSN was conducted with input from the captains of both the *F/V Rolling Stone* and *F/V Jacquie and Nicole* (local lobstermen). Figure 6-5 shows the locations of each of the deployments. The mean catch ranged from 0.6 to 2.15 legal lobsters per trap and from 1.1 to 4.9 shorts (i.e., lobsters under the legal size) per trap. The mean number of lobsters per trawl generally decreased from December through January. Appendix E contains all the lobster data collected during the effort.

Figure 6-5 Location of USACE lobster pot trawl transects in 2016 - 2017.



6.5.5 Wildlife

Birds

Several species of migratory birds have the potential to use or transit over the waters in the vicinity of proposed IOSN. USFWS's "Information for Planning and Consultation" (IPaC) (https://ecos.fws.gov/ipac/) lists 32 species of migratory birds that may or have the potential to occur at the proposed IOSN. They include Arctic Tern (*Sterna paradisaea*), Atlantic Puffin (*Fratercula arctica*), Black Scoter (*Melanitta nigra*), Black-legged Kittiwake (*Rissa tridactyla*), Common Eider (*Somateria mollissima*), Common Loon (*Gavia immer*), Common Murre (*Uria aalge),* Common Tern (*Sterna hirundo*), Cory's Shearwater (*Calonectris diomedea*), Double-crested Cormorant (*Phalacrocorax auritus*), Great Black-backed Gull (*Larus marinus*), Great Cormorant (*Phalacrocorax carbo*), Great Shearwater (*Puffinus gravis*), Herring Gull (*Larus argentatus*), Hudsonian Godwit (*Limosa haemastica*), Laughing Gull (*Larus atricilla*), Least Tern (*Sterna antillarum*), Long-tailed Duck (*Clangula hyemalis*), Manx Shearwater (*Puffinus puffinus*), Northern Gannet (*Morus bassanus*), Pomarine Jaeger (S*tercorarius pomarinus*), Purple Sandpiper (*Calidris maritima*), Razorbill (*Alca torda*), Red-necked Phalarope (*Phalaropus lobatus*), Red-throated Loon (*Gavia stellate*), Sooty Shearwater (*Puffinus griseus*), Surf Scoter (*Melanitta perspicillata*), White-winged Scoter (*Melanitta fusca*), Wilson's Storm-petrel (*Oceanites oceanicus*).

Mammals

Several species of marine mammals (whales, dolphins, porpoises, and seals) have the potential to occur in the vicinity of the proposed IOSN. Whale species include humpback whales (*Megapetera novaengliae*), right whales (*Eubalaena glacialis*), fin whales (*Balaenoptera physalus*), and minke whales (*Balaenoptera acutorostrata*). Dolphin and porpoise species include harbor porpoise (*Phocoena phocoena*), common dolphin (*Delphinus delphis*), white-sided dolphin (*Lagenorhynchus acutus*), white-beaked dolphin (*L. albirostris*), Atlantic pilot whale (*Globicephala melaena*), and killer whale (*Orcinus orca*). Seal species include harbor seals (*Phoca vitulina*) and gray seals (*Halichoerus grypus*).

Reptiles

The leatherback turtle (*Dermochelys coriacea*) is the only reptile species that occurs in the vicinity of the proposed IOSN. Leatherbacks are widely distributed globally with spawning occurring in tropical latitudes and adults moving into temperate waters to feed. Leatherback turtles have been reported in New England waters in July through early November.

6.5.6 Threatened and Endangered Species

There are a number of species found in Gulf of Maine waters that are currently listed as threatened or endangered under the Endangered Species Act. They are summarized below.

Northern Right Whale (Endangered)

The north Atlantic right whale (*Eubalaena glaciala*) is one of the most endangered large whales in the world. The range of the right whale occurs from Nova Scotia and Newfoundland

(Sergeant, 1966; Mitchell, 1974; Sutcliffe and Brodie, 1977; Hay, 1985), into the lower Bay of Fundy (Arnold and Gaskin, 1972; Kraus and Prescott, 1981, 1982; Reeves et al., 1983) and throughout the Gulf of Maine south of cape Cod Bay and the Great South Channel (Watkins and Schevill, 1976, 1979, 1982) in the spring and summer. In the winter, right whales occur from cape Cod Bay (Watkins and Schevill, 1976) south to Georgia and Florida (Moore, 1953; Kraus, 1986) and into the Gulf of Mexico (Moore and Clark, 1963; Schmideley, 1981).

Fin Whale (Endangered)

Fin whales, Balaenoptera physalus, are the most abundant and widely distributed whale, both spatially and temporarily, over the shelf waters of the northwest Atlantic (Leatherwood et al., 1976) occurring as far south as Cape Lookout, North Carolina and penetrating far inside the Gulf of St. Lawrence. In the shelf waters of the Gulf of Maine the frequency of fin whale sightings increases from spring through the fall (Hain et al., 1981; CETAP, 1982; Powers and Payne, 1982; Payne et al. 1984, Chu, 1986). The areas of Jeffery's Ledge, Stellwagen Bank, and the Great South Channel have the greatest concentrations of whales during spring through fall. There is a decrease in on-shelf sightings of fin whales in winter. However, fin whales do overwinter in the Gulf of Maine.

Leatherback Sea Turtle (Endangered)

Leatherback sea turtles have been reported in New England waters in July through early November. Inshore seasonal movements may be linked to those of the jellyfish *Cyanea capillata*, which periodically occur in the project area, and, therefore, could be used by Leatherbacks for foraging. They could also pass through the area while migrating or seeking prey (NMFS, 1991). The population of Leatherbacks has been declining worldwide, but their specific status in the United States is unknown (Wallace et al 2015).

Shortnose Sturgeon (Endangered)

Shortnose sturgeon occur along the U.S. Atlantic coast. Available information on shortnose sturgeon indicates that they make coastal migrations with the Gulf of Maine (i.e. between the Merrimack and Kennebec Rivers) and make at least occasional short visits to Great Bay (New Hampshire) (NMFS, 2016). Based on patterns of detections by acoustic receivers in Great Bay, it is thought that shortnose sturgeon visit Great Bay at least during the spring and fall; although there is no known spawning in the nearby Piscataqua River. Migrating shortnose sturgeon may be present in the nearshore areas of the Gulf of Maine. However, no tagged shortnose sturgeon have been detected at a deployed buoy (NERACOOS Western Maine Shelf Buoy #B01) in the vicinity of the proposed IOSN site. The proposed IOSN site may serve as a migratory corridor for shortnose sturgeon (Zach Jylkka, NMFS_PRD, personal communication).

Atlantic Sturgeon (Threatened)

The marine range for Atlantic sturgeon includes all marine waters, plus coastal bays and estuaries from Labrador, Canada to Cape Canaveral, Florida. The Gulf of Maine distinct population segments (DPS) of Atlantic sturgeon is currently listed as federally threatened. An Atlantic sturgeon was detected as recently as June 2012 in Great Bay, New Hampshire, and acoustic receivers in the vicinity of the Isles of Shoals (GoMOOS buoy E01) have detected tagged Atlantic sturgeon. The proposed IOSN site may serve as a migratory corridor for Atlantic sturgeon (Zach Jylkka, NMFS_PRD, personal communication).

Atlantic salmon (Endangered)

Seaward migrating juvenile Gulf of Maine (GOM) DPS Atlantic salmon have been recorded by acoustic telemetry moving southward toward the vicinity of the proposed IOSN area. Atlantic salmon have been detected in the vicinity of GoMOOS Buoy E01, however they have not been detected in the buoy closest to the proposed IOSN (B01) since its deployment in 2005. It is unlikely that this species would be in the vicinity of the proposed IOSN during winter months. In addition, once out-migrating Atlantic salmon smolts have transitioned to saltwater, growth is rapid, and the post-smolts have been reported to move close to the surface in small schools and loose aggregations (Dutil and Coutu, 1988).

6.5.7 Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act strengthened the ability of the National Marine Fisheries Service (NMFS) and regional Fishery Management Councils to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "essential fish habitat" (EFH) and is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Act establishes measures to protect EFH. Federal agencies must consult with NMFS on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. The NMFS must coordinate with other federal agencies to conserve and enhance EFH, and in turn NMFS must provide recommendations to federal and state agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH resulting from actions or proposed actions authorized, funded, or undertaken by that agency.

Managed species listed for the area that includes the IOSN include: Atlantic wolffish *Anarhichas lupus* (eggs, larvae, juveniles, adults), little skate *Leucoraja erinacea* (adults), ocean pout *Macrozoarces americanus* (adult, eggs), smooth skate *Malacoraja senta* (juvenile, adult), silver hake *Merluccius bilinearis* (eggs, larvae, juveniles, adults), thorny skate *Amblyraja radiata* (juvenile, adult), Atlantic cod *Gadus morhua* (eggs, larvae, juveniles, adults), haddock *Melanogrammus aeglefinus* (juveniles, adults), pollock *Pollachius virens* (eggs, larvae, juveniles, adults), red hake *Urophycis chuss* (adults), white hake *Urophycis tenuis* (eggs, larvae, juveniles, adults), redfish *Sebastes fasciatus* (larvae, juveniles), witch flounder *Glyptocephalus cynoglossus* (eggs, larvae, juveniles, adults), yellowtail flounder *Pleuronectes ferruginea* (eggs, larvae), windowpane flounder *Scopthalmus aquosus* (larvae), American plaice *Hippoglossoides platessoides* (eggs, larvae, juveniles, adults), Atlantic halibut *Hippoglossus hippoglossus* (eggs, larvae, juveniles, adults), Atlantic sea herring *Clupea harengus* (larvae, juveniles, adults), monkfish *Lophius americanus* (eggs, larvae, juveniles, adults), blue shark *Prionace glauca* (juvenile, adult, basking shark *Cetorhinus maximus* (all) , common thresher shark *Alopias vulpinus* (all), porbeagle shark *Lamna nasus* (all), northern shortfin squid *Illex illecebrosus* (juvenile, adult), longfin inshore squid *Doryteuthis pealeii* (adult), Atlantic mackerel *Scomber scombrus* (larvae), Atlantic butterfish *Peprilus triacanthus* (juvenile adult), spiny dogfish *Squalus acanthias* (juveniles, adults), and bluefin tuna *Thunnus thynnus* (juvenile and adults).

6.6 Commercial and Recreational Fisheries

General

The seven square miles surrounding the proposed IOSN, designated as the Greater Atlantic Region Statistical Area 513 (Figure 6-6), is a relatively productive fishing area for lobster, scallop, and various ground fish. The lobster represents the largest active fishery in the area that encompasses the proposed IOSN (Maine DMR, 2016). In 1984, the US landings reported in Area 513 for all species were approximately 49,069 metric tons (Table 6-5), with a dollar value of $46,430,897 (USACE, 1989). In 2016, the US landings reported in Area 513 were approximately 22,674 metric tons (Table 6-5) with a dollar value of approximately $18,797,500 (NMFS, 2017).

Figure 6-6. Greater Atlantic Region Statistical Areas for Fisheries Landings

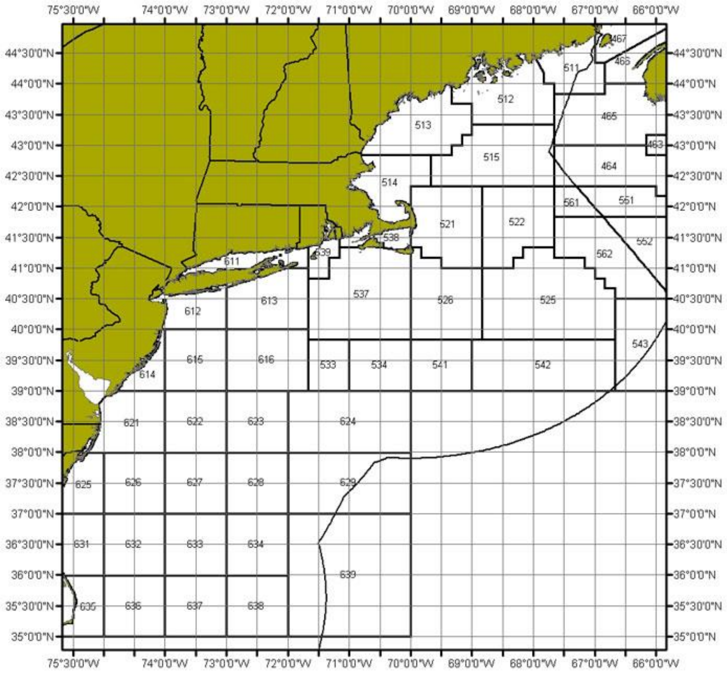


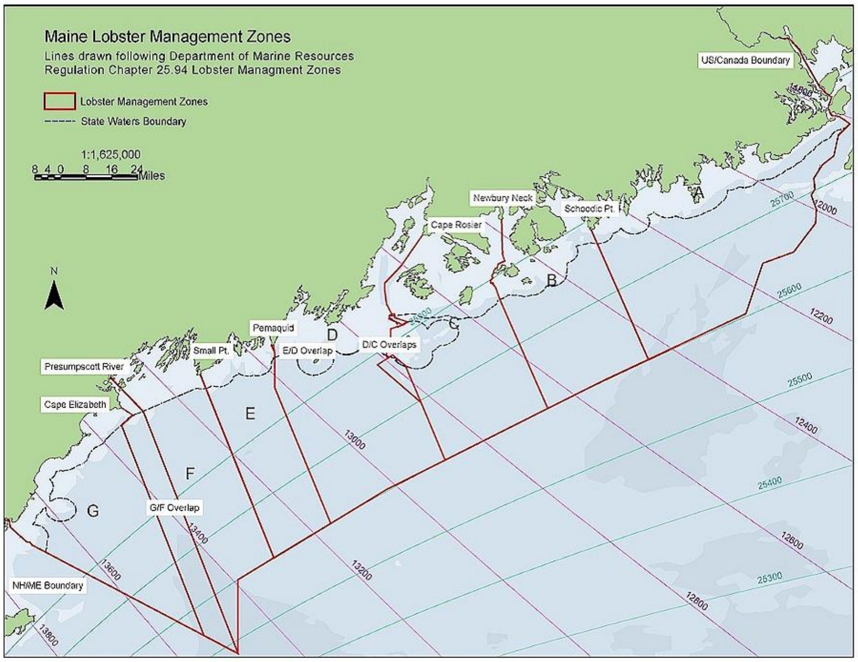
Table 6-5. Catch (in metric tons) from NMFS Area 513 from 1984 and 2016.

Species	**Area 513 – 1984 data (metric tons)**	**Area 513 – 2016 data (metric tons)**
Cod	4,490	36
Haddock	708	187
Redfish	659	52
Silver Hake	2,842	211
Red hake	203	38
Pollock	3,624	191
American Plaice	3,136	178
Witch Flounder	1,564	34
Yellowtail Flounder	235	4
Halibut	74	2
Winter Flounder	458	2
Summer Flounder	4	2
Windowpane Flounder	0	-
Cusk	329	6
Scup	-	2
White Hake	1,717	72
Wolffish	264	-
Herring	5,967	18,436
Mackerel	74	53
Bluefish	43	2
Butterfish	2	3
Menhaden	8,796	1,245
Spiny Dogfish	566	318
Skates	144	1
Short *Finned* Squid (*Illex*)	5	-
Long Finned Squid (*Loligo*)	0	1
Lobster	3,995	1,480
Shrimp	2,511	9
Crab	336	5
Surf Clams	-	-
Quahogs	-	-
Sea Scallops	392	18
Confidential Species Combined	**-**	**88**
Total	**49,069**	**22,674**

Lobster Fishery

While reporting requirements for lobster landings do not specify exact coordinates, the Gulf of Maine is divided into several lobster zone management areas (Figure 6-7) to document and interpret lobster catch data. The proposed IOSN is located within the State of Maine Lobster Management Zone G and can be used as proxy for activity in the region and give a glimpse into seasonal use of the coastal shelf waters. Maine DMR (2016) extrapolated dealer and harvester reports for lobster landings for the years 2009 to 2014 for harvesters that reported Zone G harvesting and dealers who reported a landing port located in Zone G (see Appendix F). The Zone G lobster fishery represents an average of 16,446 trips completed by 252 active harvesters annually during the period of 2009 through 2014. Maine DMR (2016) has extrapolated the data from Zone G to conclude that 36% of the total weight, 25% of trips, and 28% of active harvesters for the lobster fishery occurred in federal waters.

Figure 6-7. State of Maine Lobster Management Zones



C. Rubicam, 8/9/02, DMR Maine Whale Plan

Atlantic Herring Fishery

The proposed IOSN is in the same general vicinity as significant summer and fall Atlantic herring fishing grounds and inside the Massachusetts/New Hampshire herring spawn closure area (Maine DMR, 2016). The bulk of the herring fishing in this area occurs between June and November. As mandated by the Atlantic States Marine Fisheries Commission (ASMFC), the MA/NH herring spawn closure, which prohibits any landings of Atlantic herring, begins by default on September 21, and remains closed for fishing for approximately 30 days (ASMFC, 2016), or until the herring are finished spawning. The 2008-2015 average metric tons of Atlantic herring landings per month are shown in Figure 6-8 for the Massachusetts/New Hampshire herring spawn closure area (in which the proposed IOSN is located). Herring fishery data taken from the Northeast Ocean Data Portal (https://www.northeastoceandata.org) show the location of the proposed IOSN site in relation to herring fishing activities for 2015-2016 (Figure 6-9).

Figure 6-8. Atlantic herring landings by month for the MA/NH Spawn Closure Area for the years 2008-2015.

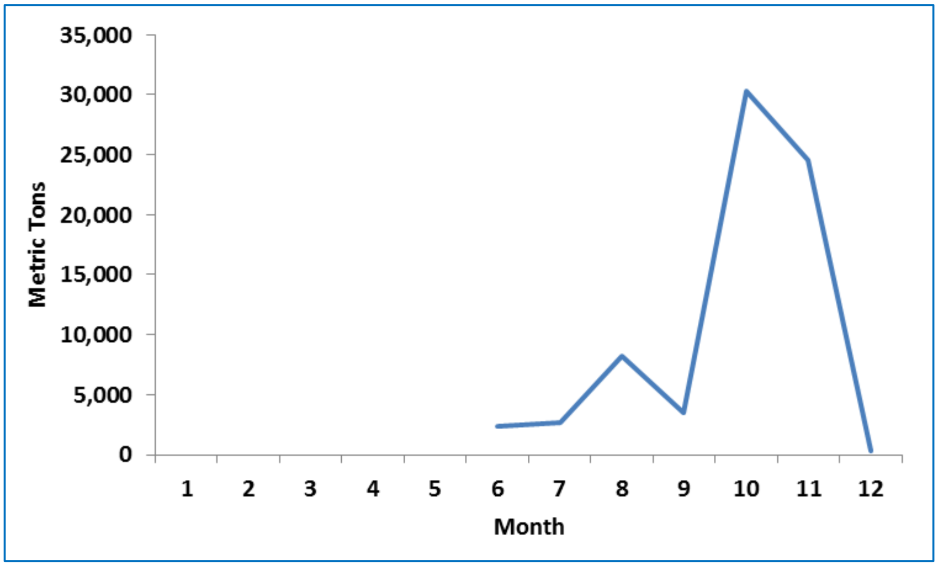
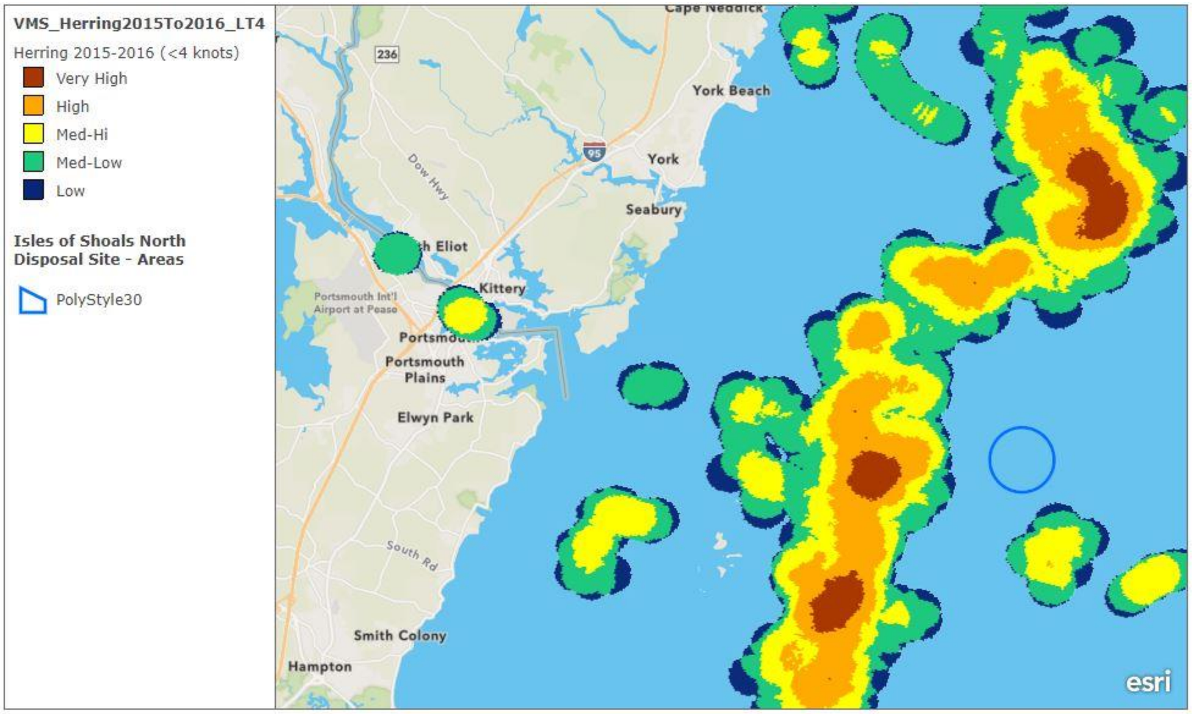


Figure 6-9. Herring fishery activity for 2015-2016
Northeast Ocean Data Portal (https://www.northeastoceandata.org)



Anderson, M. G., Greene, J., Morse, D., Shumway, D. and Clark, M (2010) Benthic Habitats of the Northwest Atlantic in Greene, J.K., M.G. Anderson, J. Odell, and N. Steinberg, eds. The Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats and Ecosystems. Phase One. The Nature Conservancy, Eastern U.S. Division, Boston, MA. | Esri, HERE, Garmin, METI/NASA, USGS, EPA, NPS, USDA | Northeast Ocean Data | NROC, NMFS

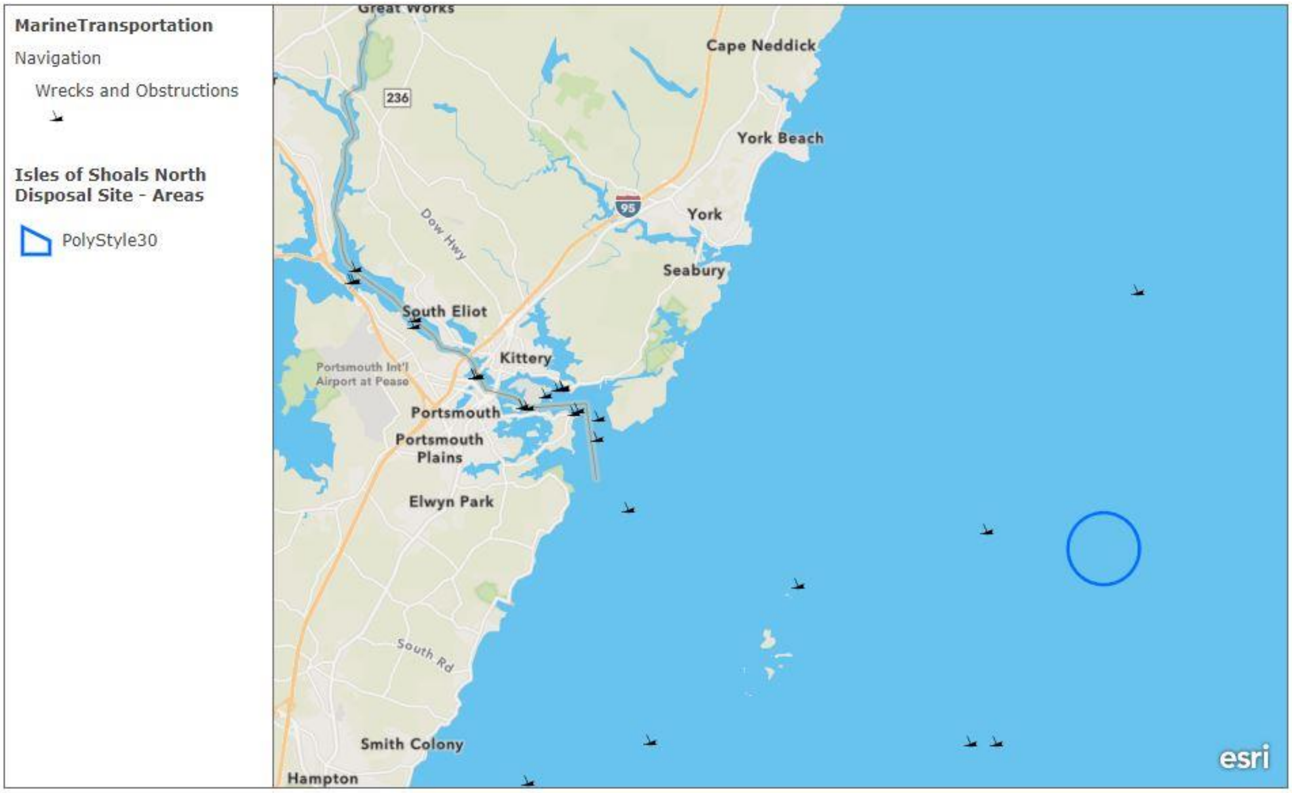
Recreational Fishery

Sport fishing is a popular activity along the southern Maine and New Hampshire coast. Fishing generally takes place at spots where ledges, holes, or other structure attracts large fish. Charter vessels and private fishing boats comprise the recreational fishing fleet.

6.7 Historic and Cultural Resources

Prehistoric cultural resources are unlikely to be found within the offshore area since this area was underwater during the ancient past and would not have provided a location for settlement or resource procurement. Shipwrecks are the most probable cultural resource expected to exist in the offshore area. Historical review uncovered no known shipwrecks in the area. As seen in Figure 6-10, no shipwrecks were noted in a review of the Northeast Ocean Portal shipwreck and obstruction data (https://www.northeastoceandata.org). A side-scan sonar survey of the proposed IOSN detected no shipwrecks or other historic remnants. Based on this information, it is unlikely that any significant cultural resources would be affected by designation of the disposal site.

Figure 6-10. Shipwrecks in the Gulf of Maine in the vicinity of proposed IOSN. Northeast Ocean Data Portal (https://www.northeastoceandata.org)



Anderson, M. G., Greene, J., Morse, D., Shumway, D. and Clark, M (2010) Benthic Habitats of the Northwest Atlantic in Greene, J.K., M.G. Anderson, J. Odell, and N. Steinberg, eds. The Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats and Ecosystems. Phase One. The Nature Conservancy, Eastern U.S. Division, Boston, MA. | Esri, HERE, Garmin, METI/NASA, USGS, EPA, NPS, USDA | Northeast Ocean Data

6.8 Recreational Uses

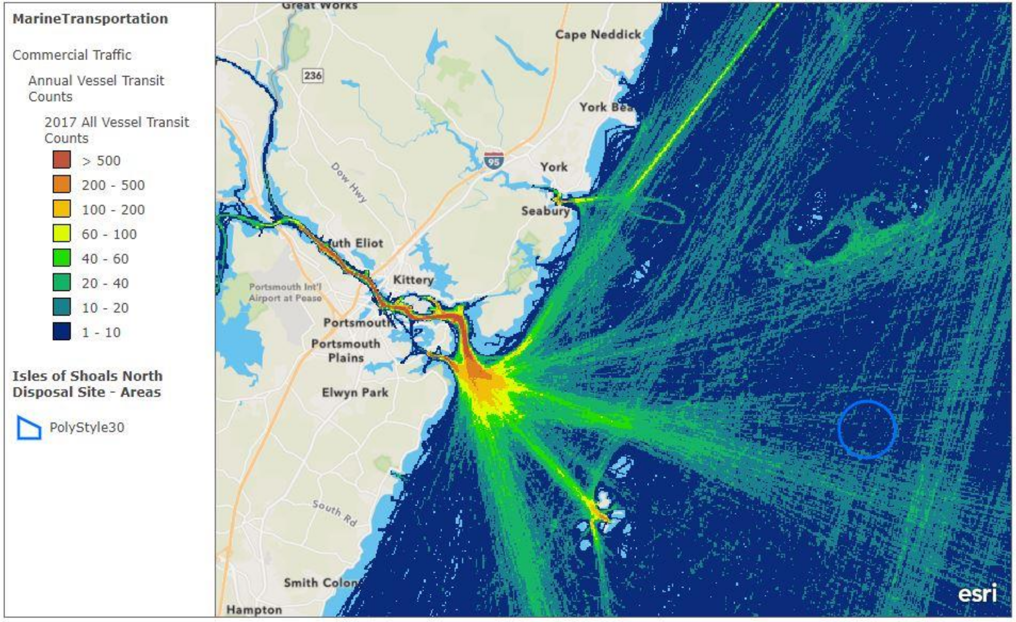
The coastal waters off southern Maine and New Hampshire offers a wide variety of recreation opportunities during all seasons of the year. Peak recreational use tends to occur between March and November when coastal waters are calm and air temperatures are warm. Coastal beaches, rivers, and embayment's receive a continual influx of recreationists throughout the year. As the proposed IOSN is located in federal waters approximately 10 nautical miles from the closest shore point, the primary recreational uses of the site likely include sightseeing (in the form of whale watching), fishing, and boating.

6.9 Shipping

Portsmouth, New Hampshire is the closest major commercial shipping port to the proposed IOSN. In 2011, Portsmouth received approximately 3,047,000 tons of waterborne commerce (USACE, 2014). Petroleum products comprise the majority of commodities shipped and received at Portsmouth Harbor, accounting for 62% of all commodities since 1991. In recent years dry bulk products (e.g., coal, gypsum, and non-metal minerals) have shown a significant increase at Portsmouth Harbor (USACE, 2014).

Vessels transiting to and from Portsmouth Harbor from the south and southeast follow a route inshore of the Isles of Shoals, while vessels approaching or departing to and from the east and northeast (Maine and Canada) do cross the general area of the proposed IOSN disposal site (personal communication with Mr. Chris Holt of the Portsmouth Pilots, November 2016). A map of commercial vessels transiting through the area in the vicinity of the proposed IOSN (Northeast Ocean Portal Marine Transportation data, https://www.northeastoceandata.org) is shown in Figure 6-11.

Figure 6-11. Marine Transportation in the Gulf of Maine in the vicinity of proposed IOSN. Northeast Ocean Data Portal (https://www.northeastoceandata.org)



Anderson, M. G., Greene, J., Morse, D., Shumway, D. and Clark, M (2010) Benthic Habitats of the Northwest Atlantic in Greene, J.K., M.G. Anderson, J. Odell, and N. Steinberg, eds. The Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats and Ecosystems. Phase One. The Nature Conservancy, Eastern U.S. Division, Boston, MA. | Esri, HERE, Garmin, METI/NASA, USGS, EPA, NPS, USDA | Northeast Ocean Data

6.10 Mineral, Oil, and Gas Exploration

There are no known efforts to mine the area that encompasses the proposed IOSN for minerals, oil, or gas.

6.11 Hazardous, Toxic and Radioactive Waste

There are no know sources of hazardous, toxic, or radioactive wastes in the area of the proposed IOSN.

6.12 Marine Sanctuaries

There are no marine sanctuaries in the vicinity of the proposed IOSN.

6.13 Air Quality

The EPA has established seven criteria pollutants that are of concern with respect to the health and welfare of the general public. Areas that do not meet the National Ambient Air Quality Standards (NAAQS) set by EPA (or state standards that are equal to current or former NAAQS) are considered to be in non-attainment. The area around the proposed IOSN is currently in attainment of all NAAQS (source: https://www3.epa.gov/airquality/urbanair/sipstatus/reports/me_areabypoll.html retrieved May 18, 2017):

Carbon Monoxide (CO)	Attainment
Lead (Pb)	Attainment
Nitrogen Dioxide (NO2)	Attainment
Ozone (O3)	Attainment
Particulate Matter <10µm (PM10)	Attainment
Particulate Matter <2.5µm (PM2.5)	Attainment
Sulfur Dioxide (SO2)	Attainment

6.14 Noise

Ambient noise levels offshore are generally low, limited to vessels passing through the region. Recreational boaters may contribute minimally to the amount of noise in the area. There are no noise-sensitive institutions, structures, or facilities in the area.

7.0 ENVIRONMENTAL EFFECTS

7.1 General Effects of Ocean Disposal of Dredged Material

During disposal at unconfined ocean disposal sites, dredged material released from a scow descends through the water column and then deposits on the seafloor over a limited area. Most of the sediment falls rapidly to the seafloor, but approximately 1-5% of the discharged sediment remains suspended in a plume and then settles to the seafloor (Ruggaber and Adams, 2000; Tavolaro, 1984; USACE, 1986). Field studies have confirmed that these plumes are transient and have short-term (i.e., hours in duration) impacts on water quality (Dragos and Lewis, 1993; Dragos and Peven, 1994; SAIC, 2004; SAIC, 2005a; SAIC, 2005b; ENSR, 2008).

Dredged material disposed of at ocean sites may result in physical changes to the seafloor, altering the grain size and/or total organic carbon (TOC) if the sediment properties of the dredged material are different from the ambient seafloor sediments. Dredged material from the southern Maine, New Hampshire, and northern Massachusetts region generally consists of both coarse-grained sands (e.g., Hampton Harbor (NH) and Wells Harbor (ME)) as well as very fine sand to silts and clays (e.g., Rye Harbor (NH) and Cape Porpoise Harbor (ME)).

Dredged material is typically disposed of at target navigation coordinates. The overlap of multiple dredged material disposal events at a designated location ultimately builds discernible, low-profile mounds within a disposal site, altering the topography of the area. Multiple disposal events may result in sediment accumulations several inches to several feet high with a radius of about 70 to 700 feet. The accumulation of dredged material thus has a physical impact by decreasing the relative water depth above the dredged material disposal site, which has the potential to modify ambient currents and sediment transport. However, disposal sites are selected in areas, and managed, to control the number and elevation of mounds created to avoid interferences with shipping and navigation, as well as to avoid sediment transport and major alterations of bottom currents and dynamics. Mound formation at disposal sites throughout New England has not been found to interfere with regional flow patterns and transport or substantially impact bottom currents or other physical dynamics (ENSR, 2007).

The most prevalent process occurring right after disposal is reconsolidation of the sediment due to the weight of the material in the mound. As a result of this settling process, a portion of the water trapped in the dredged material is expelled, reducing the mound's total volume. The amount of water released, and rate of this process depends on the properties of the sediment, including grain size and water content. Most consolidation has been found to occur within the first year or two of disposal (Silva, et al., 1994).

In addition, once deposited on the seafloor, dredged material may potentially physically impact the surrounding area through potential sediment transport from currents, storm activity, or disturbance by fishing activity. These impacts have been observed to be minimal at disposal sites studied under the DAMOS program (Fredette and French, 2004). Studies in New England over the last 35 years, including those of the DAMOS program, have documented the general stability of dredged material mounds at various designated disposal sites by recording bathymetry before and after active disposal operations, and periodically thereafter (EPA, 2004; ENSR, 2007; Carey, et al., 2015). Studies of sites in Maine coastal waters (Portland Disposal Site in 2007 and 2014, Eastern Passage Site in 2012, Machias Bay Site in 2012, and the Douglas Island Site in 2011) also have yielded similar results.

7.2 Sediments

No-Action Alternative

Under the No-Action Alternative, no changes to sediments at the proposed site would occur.

Preferred Alternative

The majority of material to be dredged from harbors in southern Maine, New Hampshire, and northern Massachusetts and placed at the proposed IOSN site will be fine-grained silts and clays (See section 2.2). The site also would likely be used for dredging projects from harbors located between Cape Ann and Cape Arundel, as these locations would be a shorter haul distance to the proposed IOSN site than to the alternatives, which are existing EPA-designated ocean disposal sites: Portland Dredged Material Disposal Site (PDS) and Massachusetts Bay Disposal Site (MBDS). Sampling of the surficial sediments at the proposed IOSN site revealed that the sediments are also fine-grained (See Section 6.2). Therefore, it can be concluded that the physical nature of the sediments at the proposed IOSN site would remain similar following the majority of disposal events in which the site is used. The possibility does exist for sediments that are coarse sand, gravel, cobble and rock to be placed at the site should suitable beneficial uses be unavailable. This would change the sediment characteristics at the location where material is placed from fine-grained to sand/gravel/rock, making the site more physically diverse.

Long-term impacts on sediment quality would not be likely at the proposed IOSN. Under the Ocean Dumping Regulations, dredged sediments suitable for disposal at the site may not contain any materials listed in Section 227.5 or contain any of the materials listed in Section 227.6 except as trace contaminants. Determination of trace contaminants is accomplished by USACE and EPA evaluation of the dredged material employing the procedures of applicable national and regional testing manuals.

7.3 Oceanographic Circulation and Water Quality

7.3.1 Oceanographic Circulation

No-Action Alternative

Under the No-Action Alternative, no changes to oceanographic circulation patterns would occur.

Preferred Alternative

Circulation of coastal waters results from an interaction of regional oceanic circulation, astronomical tides, local wind-generated surface waves and current, swell, and river flows as affected by inland meteorological events. Time scales for coastal circulation processes range from seconds for wind generated waves to months for seasonal weather patterns to years for large-scale events. The effect of storms and tidally-influenced bottom currents on the bottom sediments within the proposed IOSN site are expected to be minimal as the site is located in a deep area (approximately 300 feet deep) and has a nearly uniform layer of fine sediments throughout the site. It can be inferred from the presence of the fine-grained material at the site, that the proposed IOSN is located in a depositional area, or an area that accumulates fine-grained sediments due to the lack of high energy currents or tidal influences. Impacts to circulation at depositional areas have been observed to be minimal at disposal sites studied under the DAMOS program (Fredette and French, 2004). Therefore, with proper site management, no significant alterations to oceanographic circulation are expected.

7.3.2 Water Quality

No-Action Alternative

Under the no-action alternative, the water quality of the proposed IOSN site would remain unchanged.

Preferred Alternative

The primary impacts to the water quality following dredged material disposal are associated with the residual particles that remain suspended from minutes to a few hours after the majority of sediment has reached the seafloor. These impacts may be adverse (light reduction, interference with biological processes) or beneficial (increased productivity of specific species as the suspended sediment may serve as a food source). The impacts of suspended solids on dissolved oxygen (DO) water column concentrations are expected to be minimal. Although DO levels may temporarily decline following disposal in offshore areas, no major declines or persistent impacts have been observed for the disposal of general sediment classes found in the northeast region (Fredette and French, 2004; Johnson, et al., 2008).

Other potential effects on the water column and water quality could include the release of nutrients from discharged sediments. Nutrients in sediments are generally bound to the sediment and organic particles and can occur in the pore water (water within the sediments) depending on the physical and chemical properties of the sediment. In general, offshore coastal waters are nitrogen-limited and not as biologically sensitive to placement-related nutrients compared to inshore lakes, which are phosphorus-limited (Johnson, et al., 2008). However, as seen in Long Island Sound (LIS), based on estimates of the average sediment total nitrogen concentration in sediments in coastal waters in LIS (Jones and Lee, 1981) and current estimates of the amount of dredged material placed in open-water sites in LIS to date, the annual disposal of dredged material at the open-water sites in LIS is estimated to add less than one tenth of one percent of the overall annual nitrogen loading to Long Island Sound.

Similar to nutrients, water quality may be impacted by the release of contaminants from sediment during disposal. Sediment testing of dredged material limits the degree of sediment contamination that is allowed at designated sites and is designed to limit the potential release of contaminants during disposal. Contaminants may be sediment-bound or in pore water, and the sediment affinity and release into the water column is influenced by characteristics of the contaminant (several are hydrophobic), as well as environmental conditions (Jones-Lee and Lee, 2005; Eggleton and Thomas, 2004). However, as was the case with sediment quality, long-term impacts on water quality would not be likely at the proposed IOSN site as current sediment testing protocols under MPRSA do not allow disposal of contaminated sediments at designated ODMDS and the Federal Navigation Projects in the ZSF generally have low contamination levels within their sediments.

7.4 Geology

No-Action Alternative

Under the no-action alternative, the geology and surficial sediments of the proposed IOSN site would remain unchanged.

Preferred Alternative

Dredged material disposed of at the proposed IOSN site is not expected to move from the area. The depths at the proposed IOSN site (about 300 feet) and the fine-grained nature of the surficial material indicate that this site is not subject to significant storm generated waves and currents. Monitoring of similar deep-water disposal sites such as the Massachusetts Bay Disposal Site and the Portland Disposal Site has not shown significant movement of dredged material away from the disposal mounds. Since most of material to be dredged from harbors in southern Maine, New Hampshire, and northern Massachusetts and placed at the proposed IOSN site will be fine-grained silts and clays, the surficial sediment type should remain similar. Dredged material mounds will be created raising the elevation of the seafloor in some areas. However, the site will be managed to avoid impacts to shipping and fishing activities in the area. Therefore, no significant changes to the geology of the area are expected.

7.5 Biological Resources

7.5.1 Plankton and Fish Larvae

No-Action Alternative

The No-Action Alternative will have no effect on the plankton community of the Gulf of Maine.

Preferred Alternative

There is potential for short-term impacts to plankton from dredged material entrainment and sediment plumes in the water column during disposal events. Upon disposal in ocean waters, most of the dredged material quickly falls to the seafloor, which entrains a small volume of planktonic organisms (e.g., phytoplankton, zooplankton, and larval stages of fish and invertebrates) and displaces others with the movement of water. Increased turbidity resulting from dredged material disposal would temporarily alter water quality; this has short-term impacts on plankton which could be detrimental or beneficial, depending on the species and composition of the dredged material. The suspended solids may reduce light penetration in limited spatial areas, which may temporarily reduce photosynthesis (Kraus, 1991; Dragos and Lewis, 1993; Dragos and Peven, 1994). Most phytoplankton productivity occurs in surface waters above the most turbid portion of the sediment plumes that typically occur closer to the seafloor at open-water sites (ENSR, 2008). Significant impacts to the Gulf of Maine plankton community are not expected if the proposed IOSN site is designated as an ODMDS.

7.5.2 Benthos

No-Action Alternative

The No-Action Alternative will have no effect on the benthic community of the Gulf of Maine.

Preferred Alternative

For over 40 years, studies and monitoring efforts have been conducted in New England to understand the consequences of dredged material placement to benthic habitats and local food webs (Wolf, et al., 2012; Fredette and French; 2004; Valente, 2007). The type and extent of impacts depend on the characteristics of both the dredged material and the habitat at the placement site

(Bolam, et al., 2006). Although short-term impacts and long-term changes in habitat due to sediment type and elevation of the seafloor have occurred at studied disposal sites, there is no evidence of long-term effects on benthic processes or habitat conditions (Germano, et al., 2011; Lopez, et al., 2014).

One of the key biological impacts is the burial of benthic invertebrates where dredged material is deposited. Sediment type, sediment depth, burial duration, temperature, and adaptive features such as an organism's ability to burrow and to survive can affect the ability of organisms to migrate to normal depths of habitation. Benthic disturbance from dredged material placement at designated disposal sites has direct, immediate effects on sessile epifauna and infauna (Germano, et al., 1994, 2011). Sediment accumulations greater than 6 inches are expected to smother most benthic infauna (Lopez, et al., 2014). Large decapod crustaceans (i.e., cancer crabs, shrimp species, lobster) can penetrate deeply into the sediment, which provides them with mechanisms that enable them to survive some burial. Other strong deposit feeders can withstand burial of four inches or more (Jackson and James, 1979; Bellchambers and Richardson, 1995), while 0.4 inch of sediment can kill attached epifaunal suspension feeders (Kranz, 1974). The greatest impacts from burial occur in the central mound area, where multiple deposits result in the thickest amounts of placed sediment (Germano, et al., 1994). The burial on benthic invertebrate populations is typically a short-term impact, because infauna rapidly recolonize the freshly placed, organic-rich material (when compared to the disposal site sediments).

Additional short-term impacts of disposal may occur. Small surface-dwelling animals (e.g., some amphipod and polychaete species) may be dislodged and transported to the outer region of the deposit with water and sediment movement. The sediment plume may temporarily interfere with benthic feeding and respiration in the water column.

The physical nature of seafloor sediments defines the type of habitat that is available for benthic organisms to colonize, and thus the types of organisms and benthic community that can live and thrive on the mounds. Potential long-term impacts may include changes in benthic community composition that result from potential alterations in sediment grain size and TOC as well as alterations in seafloor elevation.

The rate of benthic recolonization and the recovery rate of dredged material placement mounds have been intensively studied in New England and other marine environments. The DAMOS program uses a tiered monitoring framework (Germano, et al., 1994) to define the standards against which the data are evaluated and to determine if additional investigation is required. Explicit Tier 1 criteria for benthic recovery are in the form of a null hypothesis: Stage 2 or 3 assemblages (deposit-feeding taxa) are present on the disposal mound one year from cessation of disposal operations. Acceptance of the null hypothesis would provide verification that the evaluation of the sediments during the permitting process was correct. Rejection of the null hypothesis would lead to the next level of investigation (Tier 2).

SPI has been used since 1982 to test the model of benthic succession in response to physical disturbance from dredged material placement (Rhoads, et al., 1978; Germano, et al., 2011) (additional information is presented in Section 4.8 and Figure 4-30). SPI depicts a vertical cross section of sediment up to eight inches deep, providing visual evidence of organism-sediment interactions and the sediment-water interface. A process-based model (Rhoads and Germano, 1982, 1986) has been used to interpret the ecological effects of dredged material in New England

(Germano, et al., 1994) and minimize the impacts of disturbance through tiered monitoring (Fredette, 1998; Fredette and French, 2004). Initially, there may be an absence of visible species, called Stage 0. According to the successional model (Rhoads and Germano, 1986), within a few days to weeks of physical disturbance or deposition of dredged material, Stage 1 organisms (small, tube-dwelling surface deposit feeders) settle on the surface sediment. Stage 2 infaunal deposit feeders gradually replace the Stage 1 organisms, and then larger Stage 3 infaunal deposit feeders (which feed in a head-down orientation, creating distinctive feeding voids) inhabit the sediment (Germano, et al., 2011). The dredged material characteristics and the benthic community composition and structure affect the rate of succession, which typically results in a deepening of the bioturbated mixed sediment layer and convergence with the surrounding benthic habitat conditions (Zajac, 2001). The successional model has not been developed for coarse sediments or cohesive clays (Germano, et al., 2011). The timing of disturbance relative to seasonal pulses of settlement and growth of larvae also strongly influence the nature and rate of recolonization (Zajac and Whitlatch, 1982; Wilber, et al., 2007). The establishment of a mature community may take months to years to complete and depends in part on whether additional physical disturbances interrupt the successional process.

DAMOS and other programs have repeatedly documented recolonization of mound surfaces with surface and infaunal assemblages typical of the sediments surrounding the placement site (Germano, et al., 2011). The outer region of the dredged material mound, known as the apron, can introduce higher organic sediment content than the ambient sediment, supplying a new food source for deposit feeders (Lopez, et al., 2014). The apron has been found to extend 300 ft to 1,600 ft beyond the acoustically detectable margin of the mound (multibeam surveys can reliably detect accumulations greater than four inches, and single-beam fathometers can detect greater than eight inches of accumulated sediment (Fredette and French, 2004; Carey, et al., 2012). Within months, high settlement densities of opportunist species (polychaetes, amphipods, bivalves, and meiofauna) occur, and rapid bioturbation that mixes the deposit with seafloor sediments usually makes the apron area indistinguishable (Germano, et al., 2011; Lopez, et al., 2014). These studies also have found that the recovery of the mound apex, which is generally the most disturbed area, tends to be slower than at the mound apron, where deposited sediments are thinner and burial impacts are fewer. Mounds that have been in place for two or more years consistently support mature benthic assemblages that are similar to reference areas outside of the open-water placement site and are stable over time.

Benthic community and productivity changes may in turn affect higher trophic levels (a feeding stratum in the food chain) by providing more or less prey at a given location or prey that is more or less suitable for a variety of species. Erosion of silts and clays and sediment changes also may provide positive attributes, such as armoring the surface against further erosion and creating microhabitats within the placement site that provide greater variability in benthic habitat, leading to continued, if not greater, utilization of the area by fish and shellfish (SAIC, 2001a).

Abrupt changes in topography or bottom type can create rich habitat for finfish and motile shellfish like lobster, and artificial structures (artificial reefs) can also provide such typically rich habitat (Ries and Sisk, 2004; Macreadie, et al., 2010; Macreadie, et al., 2012). Clark and Kasal (1994) explored the concept of stable dredged material mounds providing substantial fisheries resource benefits as a long-term management objective for dredged material placement. Anecdotal fishery reports have indicated that mounds and berms create conditions conducive to enhanced fisheries production. Few definitive scientific studies have been conducted to support this claim, although limited data from the Rockland Disposal Site off the coast of Maine suggest that the placement mound supports an active population of megafauna (SAIC, 2001b).

As the proposed IOSN area is a physically homogeneous habitat composed of fine-grained sediments (USACE, 2013) which are inhabited by a benthic invertebrate community that is predominately Stage 1 on 3 (Guarinello et al, 2016), the periodic disposal of dredged material at the site should not significantly alter the long-term benthic community profile at the site. The disposal of dredged material at the site, as noted above, will result in short-term loss of the benthic communities in discreet areas of the site through the burial of the benthos. However, colonization of the impacted portions of the proposed IOSN site through recruitment from the surrounding benthic communities is anticipated to occur and allow the benthic communities in the impacted areas to return to pre-impact conditions.

7.5.3 Fish

No-Action Alternative

The No-Action Alternative will have no effect on the fish community of the Gulf of Maine.

Preferred Alternative

Potential intermittent, short-term impacts to fish include the direct destruction and burial of bottom-dwelling species and disturbance of fish throughout the water column within the localized area. Due to their mobility, most fish would be expected to move out of a dredged material burial area. The sediment plume following disposal would also have potential short-term water quality impacts that may also have indirect impacts on fish by temporarily altering certain finfish behaviors, such as migration, spawning, foraging, schooling, and predator evasion (O'Connor, 1991). Increased turbidity has also been associated with potential gill abrasion and respiratory damage (Saila, et al., 1971; Wilber and Clark, 2001). However, fish species may avoid disposal areas during periods of high turbidity (Packer, et al., 1999).

Sediment characteristics and the life stage of species affect how sensitive species are to suspended sediment, with egg and larval stages tending to be the most sensitive (Johnson, et al., 2008; Wilber and Clark, 2001). However, these impacts are limited both in duration and spatially due to the short time needed for dredged material to reach the bottom (Kraus, 1991; Dragos and Lewis, 1993; Dragos and Peven, 1994). Saila, et al. (1971) also point out that “aquatic animals are able to tolerate high concentrations of suspended sediments for short periods.” Since the tolerance level for suspended solids is high in shallow and mid-depth coastal waters, and fish and lobster may experience major changes in turbidity during storms, Saila, et al. (1971) conclude that mortality due to elevated sediment concentrations in the water column resulting from ocean disposal of dredged material is not likely. Following these turbid periods, finfish and shellfish may be drawn back to a disposal site by irregularities in the substrate and the presence of new material containing infaunal organisms and other forage (EPA, 2004).

Given the fish communities that have been noted to occur within the area that the proposed IOSN site encompasses (see Section 6.5.3), negative long-term effects to fish resources at the site are not expected. The periodic disposal of dredged material at the site may result in the short-term displacement of mobile fish species from limited areas of the site during disposal activities and short-term decreases in the forage base (i.e., the burial of the benthic communities). However, those impacts are not expected to change the overall fish community structure at the site or present any long-term impacts to the fish communities present.

Physical changes to sediment characteristics would potentially result in habitat impairment or enhancement, depending on the type of change and the benthic response. However, as noted above, the majority of dredged material to be placed at the proposed IOSN is fine-grained silts and clays, which are compatible with existing sediments at the proposed IOSN.

7.5.4 Shellfish and Lobster

No-Action Alternative

The No-Action Alternative will have no effect on the shellfish and lobster resources of the Gulf of Maine.

Preferred Alternative

Lobster resources in the footprint of the proposed ODMDS would be affected. Direct impacts to lobster resources would come from the burial of lobsters and increases in suspended sediments during active dredged material placement events. As noted in section 6.5.4, lobster catch data in the vicinity of the proposed site were comparable to other lobster zone G catch data. Therefore, while impacts to lobster resources would be realized during disposal events, the distribution of lobster resources throughout the Gulf of Maine and the highly localized areal extent of the proposed site would not pose a significant impact to overall lobster populations in the vicinity of the site and therefore, direct impacts are expected to be minimal. As noted in Table 2-1, the projected site usage for dredged material disposal over a 20-year period is expected to be infrequent, thus allowing significant intervals of time for lobster resource recovery. In addition, each dredging project's material would be placed to create discrete mounds within the overall site (as opposed to spreading material over the entire extent of the site) and be monitored by DAMOS to ensure that direct impacts to the site are as minimal as possible. As discussed in section 7.5.3, marine organisms such as lobster have evolved tolerance levels for short-term increases in suspended sediment levels, so lobster resources outside the direct footprint of a placement should not be significantly affected by the disposal process. Therefore, only minimal short-term and highly localized effects to lobster resources are anticipated as a result of designating the site as an ODMDS.

7.5.5 Wildlife

No-Action Alternative

The No-Action Alternative will have no effect on wildlife resources of the Gulf of Maine.

Preferred Alternative

Ocean disposal of dredged material at the proposed IOSN has the potential to impact birds, marine mammals, and reptiles. Direct impacts would be from vessel strikes, harassment/displacement from noise during dredged material disposal, and harassment/displacement from the ocean disposal of dredged material (sediments). Temporary sediment plumes may also cause avoidance of the local area.

Twelve species of marine mammals, 30 species of birds and one reptile species may occur at the proposed IOSN site. The potential for vessel strikes is limited by the slow speed of tugboat and barge operations. Recent ship speed reductions imposed on all vessels 65 feet and greater in length have been found to be effective in reducing strikes to whales (Conn and Silber, 2013; NOAA, 2013). No strikes to endangered or threatened species or to dolphins and seals are known to have occurred in the history of the DAMOS program. Potential adverse impacts to wildlife resources would be limited and of short duration.

7.5.6 Threatened and Endangered Species

No-Action Alternative

The No-Action Alternative will have no effect on threatened and endangered species of the Gulf of Maine.

Preferred Alternative

Humpback whales, Northern Right whales, Fin whales, and Leatherback sea turtles have the potential to use the waters of the proposed IOSN site. Disposal activities may result in harassment, vessel strikes, exposure of endangered and threatened species to dredged material, and short-term impacts to prey. To minimize these risks, coordination with NMFS, EPA, and USACE will be conducted to develop appropriate measures to be implemented to reduce the likelihood of a project vessel using the proposed IOSN site from interacting with a whale or sea turtle. The recommendations may include reduced vessel speed, maintaining a safe distance from observed listed species, and the presence of a NMFS-trained observer on board the disposal vessel.

Additionally, the listed fish species noted in Section 6.5.6 (shortnose sturgeon, Atlantic sturgeon, and Atlantic salmon) have the potential to occur in the vicinity of the proposed IOSN site. All of these species are coastal migrants that traverse coastal waters between spawning events that occur in various river systems of New England. However, all these fish species are generally transient at the proposed site and the likelihood of their presence is small and impacts are not anticipated to occur.

The conservation recommendations noted above will be incorporated in the SMMP for the proposed IOSN site. EPA has made the preliminary determination that the proposed designation of the IOSN is not likely to adversely affect any threatened or endangered species and will be initiating a Section 7 consultation with NMFS as part of this action.

7.5.7 Essential Fish Habitat

No-Action Alternative

The No-Action Alternative will have no effect on essential fish habitat in the Gulf of Maine.

Preferred Alternative

The potential impacts of disposal on Essential Fish Habitat (EFH) at the proposed IOSN site were initially evaluated for the Portsmouth Harbor and Piscataqua River Navigation Improvement Dredging Project (USACE, 2014) and are reevaluated here for future projects that may use proposed IOSN (see Appendix H). The evaluation concluded the following: (1) there would be temporary impacts to demersal species, or species having demersal eggs or larvae, during disposal activities that could persist until the benthic habitat recovered; (2) species that have pelagic eggs and larvae may also be adversely impacted by material released from the scow as it descends through the water column; and (3) some juveniles and adults may not be able to escape the descending plume and may be buried or otherwise damaged. Based upon the additional species abundance data and habitat information documented for the proposed IOSN site (and contained within this EA), the determination has been made that the potential for impacts to most species with life history stages present at the proposed IOSN site was low and that only short-term effects to EFH would be realized. A complete EFH Assessment is included as Appendix H.

7.6 Commercial and Recreational Fisheries

No-Action Alternative

The No-Action Alternative will have no effect on commercial and recreational fishing in the Gulf of Maine.

Preferred Alternative

Commercial and recreational fishing activities occur throughout the Gulf of Maine, including areas within or near the proposed IOSN site. However, the area encompassed by the proposed site does not provide unique habitat for the most commonly targeted commercial and recreational species. Additionally, the proposed site represents a very small areal footprint in the context of similar habitats available throughout the entire Gulf of Maine.

Commercial and recreational fishing may be affected by dredged material disposal through interference with fishing methods or site availability. For example, dredged material disposal may result in a restriction on the amount of time that the site is available for commercial fishing activities because fishermen do not want to risk loss of gear during times of active disposal. These impacts would not likely occur during the summer months, as dredging is generally restricted in the ZSF to late fall and winter for the protection of critical life stages of shellfish and finfish and to avoid interference with commercial fishing activities. Therefore, it is anticipated that the designation of the proposed site as an ODMDS will have minimal effects on commercial and recreational fisheries.

As noted in Section 6.6 and Appendix F, the primary fisheries target species in the vicinity of the proposed site are Atlantic herring and lobster. These two fisheries are specifically discussed below.

Atlantic Herring Fishery

Given the distribution of Atlantic herring and the highly localized extent of the proposed site, impacts to the Atlantic herring fishery are anticipated to be minimal. As noted above, disposal of dredged material at the proposed site would generally be restricted temporally to late fall and winter months, thus reducing potential for impact to the Atlantic herring fishery which is most active in the summer and early fall (figure 6-7). Additionally, the projected site usage for the ocean disposal of dredged material (see Table 2-1) is expected to be infrequent. Therefore, no significant effects to the Atlantic herring fishery are expected as a result of designating the site as an ODMDS.

Lobster Fishery

The lobster fishery may be affected by the designation and use of the proposed site. Impacts to the lobster fishery would include the burial of some lobster resources and reduced availability of the site to be fished (to avoid gear loss) during the infrequent disposal events. As noted in section 6.5.4, lobster catch data at the proposed site are comparable to other lobster zone G catch data. Given the distribution of lobster resources throughout the Gulf of Maine and the highly localized extent of the proposed site, impacts to the lobster fishery are expected to be minimal. As noted in Table 2-1, the projected site usage for dredged material placement over a 20-year period is expected to be infrequent. In addition, each dredge project's material would be placed within discrete mounds within the overall site (as opposed to spreading material over the entire extent of the site) and be monitored by the DAMOS program to ensure that impacts to the site are as minimal as possible. Therefore, the minimal effects to the lobster fishery as a result of designating the site as an ODMDS are anticipated to be short-term and highly localized.

7.7 Historic and Cultural Resources

There are no known historic or cultural resources within the proposed IOSN site. It is unlikely that any significant cultural resources would be affected by designation of the proposed IOSN site as an ODMDS.

7.8 Recreational Uses

It is not anticipated that marine recreation in the project area will be impacted by either the Preferred Alternative or the No-Action Alternative.

7.9 Shipping

No-Action Alternative

The no-action alternative would not change the shipping use of the proposed site.

Preferred Alternative

No anticipated conflicts with commercial navigation and the designation of the proposed IOSN site are anticipated. In personal communication (teleconference) on November 21, 2016, between Mr. Mark Habel of the USACE-NAE and Mr. Chris Holt of the Portsmouth Pilots, USACE-NAE discussed the proposed IOSN site location and its anticipated use with respect to navigation transit impacts. The USACE stated that for large projects such as the Portsmouth Harbor improvement project, about three disposal trips per day were anticipated during the fall to winter construction window. Mr. Holt indicated that vessels transiting to and from Portsmouth Harbor from the south and southeast follow a route inshore of the Isles of Shoals. Vessels approaching or departing to and from the east and northeast (Maine and Canada) do cross the general area of the proposed IOSN disposal site. However, the pilots stated that conflicts between dredge disposal operations and shipping for large and small projects can be avoided by adequate notice to mariners of disposal activities and frequent marine communication between the disposal tugs and the Portsmouth Pilots.

7.10 Mineral, Oil, and Gas Exploration

There are no known efforts to mine the proposed IOSN site for minerals, oil, or gas. The use of the site as a dredged material disposal area would likely preclude future use of the site for mineral extraction. Oil and gas extraction activities are not common in the Gulf of Maine.

7.11 Hazardous, Toxic and Radioactive Waste

There are no know sources of hazardous, toxic, or radioactive wastes in the area of the proposed IOSN. Neither the No-Action Alternative nor the Preferred Alternative would have impacts associated with hazardous, toxic, or radioactive waste.

7.12 Marine Sanctuaries

There are no marine sanctuaries in the vicinity of the proposed IOSN site. Neither the No-Action Alternative nor the Preferred Alternative would have impacts to marine sanctuaries.

7.13 Air Quality

The designation of the proposed IOSN site in the GOM is not expected to have significant impacts on air quality. Impacts to air quality at the site would occur only during dredged material disposal events and would come from air emissions or dust generation associated with the operation of the marine vessels (e.g., tugs or hopper dredges) transiting to the site. All equipment would be properly outfitted with air pollution controls, as required by the air quality control regulations (Section 176(c)(1) of the Clean Air Act) and proper controls for minimizing the generation of dust would be implemented. Some volatile organic compounds may be released from exposed disposal sediments on barges. The effects on air quality in the ZSF and at the proposed site are described below.

7.13.1 Effects of Dredging Operations in the ZSF

While the area of the proposed IOSN is currently in attainment for all of the National Ambient Air quality Standards (NAAQS), future authorizations of specific dredging and dredged material disposal projects by the USACE would be evaluated under the General Conformity Requirements of Section 176(c)(1) of the Clean Air Act in order to determine if the proposed action would cause or contribute to an exceedance of the NAAQS and to determine if the project conforms to the State Implementation Plan (SIP). The primary pollutants of concern with dredging related actions are nitrogen oxides (NOx) and carbon monoxide (CO). It should be noted, however, that some projects might satisfy the conformity requirements pursuant to one of the specific exemptions outlined in EPA Regulations at 40 CFR 51.853(c)(ix).

7.13.2 Effects of Disposal at the Proposed ODMDS

During transport of the dredged material from dredging sites to the proposed IOSN site, tugs and other equipment used in the process would generate minor amounts of air pollutants. As the material would be disposed under water, dust and volatilization would not occur and there would be no long-term effects on air quality from disposal operations. The availability of the proposed IOSN site for ocean disposal of dredged materials from harbors located between Cape Ann and Cape Arundel would save significant haul miles compared to the alternative of transporting that material to the more distant Portland Dredged Material Disposal Site or Massachusetts Bay Disposal Site and would reduce air emissions regionally.

7.14 Noise

No-Action Alternative

The no-action alternative would not change to the noise environment at the proposed site.

Preferred Alternative

As ambient noise levels offshore are generally low, impacts to the noise environment at the proposed IOSN site would be limited to noise from tugs/scows and/or hopper dredges transiting to the site for material disposal. The use of the proposed IOSN site for dredged material disposal is not anticipated to occur every year, and in the years that it is used, disposal events would only occur in low numbers of times per day (2-3 at most). Therefore, all noise impacts are expected to be short in duration (i.e., minutes) and highly localized to whichever small portion of the overall proposed IOSN site is being used in a given year. Additionally, the noise generated from transiting vessels would be no greater than that experienced by other vessels transiting the area. Therefore, no significant effects are anticipated.

8.0 CUMULATIVE IMPACTS

The Council on Environmental Quality regulations implementing the procedural provisions of NEPA require federal agencies to consider the cumulative impacts of a proposal (40 CFR 1508.25(c)). A cumulative impact to the environment is the impact that results from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7). This type of an assessment is important because significant cumulative impacts can result from several smaller actions that by themselves do not have significant impacts.

In general, with respect to the disposal of dredged material at designated sites, cumulative impacts could occur as a result of multiple disposal events at the same designated site and as a result of other, unrelated activities such as shipping, recreation, and fishing that occur on or near the Gulf of Maine.

8.1 Cumulative Impacts from the No-Action Alternative

The no-action alternative involves not selecting a site as an ODMDS and therefore has no cumulative effect to the Gulf of Maine. However, the elimination of the maintenance of Federal Navigation Projects and private dredging projects (e.g., marinas, commercial berthing areas, and ferry terminals) in the ZSF would adversely affect regional commerce by reducing maritime trade and fishing activity.

8.2 Cumulative Impacts from the Preferred Alternative

This EA evaluates the potential impact of the proposed designation of the IOSN as an ODMDS. Although cumulative impacts could occur, as discussed below, and throughout the EA, the designation of a disposal site off the coast of southern Maine and New Hampshire is not expected to result in any significant adverse cumulative impacts. Short-term, temporary impacts such as topographic change, burial of organisms in the disposal area, changes in the benthic community, and potential changes to the local food web may occur. However, any short-term temporary impacts can be minimized or mitigated through proper site management methods.

Temporary changes from the ocean disposal of dredged material have been ongoing at sites in the Gulf of Maine for decades. The evaluation conducted in this EA and a review of DAMOS monitoring data from sites in the GOM did not find evidence that any of these short-term changes have resulted in significant unacceptable adverse impacts to the GOM. However, potential long-term impacts of disposal of dredged material at the proposed alternative site is described and analyzed in Section 7 of this document and below.

The impact of the availability of an ODMDS may increase shipping, recreational boating, and recreational and commercial fishing activities that occur on or near the Gulf of Maine. The use of an ODMDS could potentially allow more areas to be dredged, thus increasing the availability of vessel related activities in the Gulf of Maine.

Topographic Change

The overlap of multiple dredged material disposal events eventually builds discernible mounds within a disposal site, altering the topography of the area. While changes associated with single events are likely to be negligible, the cumulative impact can be more substantial. As multiple disposal events occur, accumulations that range from several inches to several feet in height are built above the seafloor. These accumulations are not anticipated to cause adverse impacts to resources or current or future navigational uses of the site as mound height will be restricted to allow the current activities that occur at the proposed site (fishing and navigation) to continue.

Alteration of Local Bottom Currents

One physical impact due to changes in topography is the potential alteration of local bottom water currents within a site. However, no alterations to regional flow patterns are expected. Therefore, no changes to the current or future uses of the site are expected.

Burial of Organisms

One of the key biological impacts due to changes in topography is the burial of organisms in the disposal area. Those species that are not able to avoid the descending dredged material or burrow through the deposited material may be eliminated from the site following multiple disposal events. Burial becomes problematic if the buried organisms constitute a significant shellfishery, are spatially limited, or are considered a unique community or population within the water body. Because sediment type greatly influences the ability of buried organisms to migrate through the sediment to their normal depths of habitation, the type of material deposited can influence the level of survival, the rate of recovery of the site, and the diversity of the community that recolonizes the area. Recolonization and the management of mound placement are expected to minimize these impacts. Therefore, the current and future uses of the site by the commercial fishing and shipping industries are not anticipated to change.

Changes in Benthic Community and Local Food Web

Biological impacts also include those to the benthic community and local food web caused by changes in the physical properties of the substrate when deposited dredged material alters the habitat type. Dredged material disposal over time may result in physical changes to the sediment properties of the site. Such changes define the type of habitat that is available for benthic organisms to colonize and thus the types of organisms and benthic community that can live and thrive on the mounds. This in turn may influence the use of the disposal site by higher trophic levels (a feeding stratum in the food chain) and potentially affect the interaction of various species with the mounds, including those of recreational or commercial importance. The rate at which the benthic community recovers depends on many factors. The first consideration is the texture of the deposited material. Any substantial change in texture of the seafloor reduces the ability for similar organisms to recolonize the impacted area. Physical disturbance to the sea floor by storms would also affect the timing, and perhaps the nature of recovery. It is a well-documented fact that dredged sediments placed at disposal sites are quickly recolonized with biological communities that are healthy and able to support species typically found in the ambient surroundings. Studies of the effects of disturbance (including dredged material disposal) indicate that it is highly probable that the benthic habitats at a site will eventually be recolonized by a functioning infaunal community, although it may not be exactly the same as the one present before disposal. Therefore, the current and future uses of the site by the commercial fishing and shipping industries are not anticipated to change.

Bioaccumulation

Bioaccumulation is defined as the uptake and retention of contaminants into tissues of organisms from external sources. While bioaccumulation of a contaminant by an organism may or may not result in detrimental impacts to that organism, it can be an indicator that the population, similar organisms, and higher tropic-level organisms that prey on the contaminated organisms may be potentially at risk of adverse impacts. The cumulative sources of contaminants that may bioaccumulate include historical disposal of dredged material, new disposal activities, and other contaminant sources to a region. The disposal of dredged material at an ocean disposal site can alter the conditions controlling bioaccumulation, resulting in a localized change in the rate of uptake and possible risks of associated adverse health effects. However, evaluation and management of dredged material is designed to minimize this effect.

8.3 Conclusion of Cumulative Impacts Analysis

At the proposed IOSN site, disposal of dredged material could result in the release of suspended sediments into the water column and short-term, temporary impacts to fish and shellfish and their associated water column and bottom habitats. Other activities in the GOM that could result in the resuspension of sediments and bottom disturbances include nonpoint source discharges, the use of the area by ships and recreational watercraft through prop scouring and anchoring activities, and impacts from fishing gear (e.g., bottom trawls and lobster pots). Thus, the impacts of the disposal of dredged material in the GOM at the proposed IOSN site, together with those resulting from other unrelated activities, could result in small incremental impacts. However, the designation of an ODMDS, in conjunction with past, current, and future uses of the site, is not anticipated to have significant negative long-term cumulative impacts.

9.0 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

9.1 Federal Action

The proposed federal action consists of designating an ODMDS to serve the southern Maine, New Hampshire, and northern Massachusetts region. Site designation does not create or confer rights on any person to use a designated site upon the effective date of site designation. Persons or entities who seek to use a site must first obtain all applicable environmental permits and approvals and a federal permit under the MPRSA, or in the case of the USACE, meet the substantive permit requirements, in order to actually use a designated ocean dredged material disposal site. This process would include meeting the requirements of applicable statutes and regulations. The EPA recognizes, however, that site designation is intended to have a practical result. When a site is designated, it is expected that such sites will be used by persons or entities meeting the statutory and regulatory criteria for ocean disposal of dredged material. Therefore, actual disposal is an indirect effect of site designation and is included in the evaluation of effects under the below listed statutes.

9.2 Compliance

National Environmental Policy Act

This Draft EA was prepared for public review pursuant to NEPA with EPA in the role of the lead agency and the USACE as the cooperating agency. The Draft EA will be circulated to the appropriate local, state and federal agencies, as well as other interested stakeholders and citizens. Comments received will be addressed in the Final EA. Upon completion of the Final EA, the project would be in full compliance with NEPA.

Endangered Species Act

This Draft EA concludes that the proposed action is not likely to adversely impact listed species. Concurrence is being requested with this determination and this project will be fully coordinated with NMFS.

Fish and Wildlife Coordination Act

This Draft EA concludes that the proposed action would likely have no adverse impact fish or wildlife. Concurrence is being requested with this determination and this project will be fully coordinated with NMFS and FWS.

Clean Water Act

As the proposed ODMDS location is located outside the jurisdictional limits of this Act, a Section 404(b)(1) evaluation is not applicable to this project and was not prepared.

Clean Air Act

In general, the short-term impacts from transportation and construction equipment associated with the disposal of dredged material in the proposed ODMDS does not significantly impact air quality. As all of Maine is designated as an attainment area for federal air quality standards under the Clean Air Act, a conformity determination is not required.

Coastal Zone Management Act

Although the project area is outside the defined coastal zone for Maine and New Hampshire, transportation of dredged material to the site will be through the coastal zone. All projects utilizing this site will be fully coordinated with the Maine and New Hampshire office's responsible for Coastal Zone Management and would be in compliance with the Act.

Farmland Protection Policy

No prime or unique farmland would be impacted by designating proposed IOSN as an ODMDS. This Act is not applicable.

Wild and Scenic Rivers Act of 1968

No designated wild and scenic river reached would be affected by project related activities. This Act is not applicable.

Marine Mammal Protection Act

This Draft EA concludes that the proposed action is not likely to adversely impact marine mammals. Concurrence is being requested with this determination and this project will be fully coordinated with NMFS and FWS. This project would be in full compliance with this Act.

Estuary Protection Act

No designated estuary would be impacted by project activities. This Act is not applicable.

Submerged Lands Act

This project would not occur on submerged lands of the state of Maine or New Hampshire. This project would be in compliance with the Act.

Coastal Barrier Resources Act and Coastal Barrier Improvement Act

There are no designated coastal barrier resources in the project area that would be impacted by this project. These Acts are not applicable.

Rivers and Harbors Act

The proposed action would not obstruct or pollute navigable waters of the United States because the site is over ten miles outside the boundary of the territorial seas. This project would be in compliance with the Act.

Anadromous Fish Conservation Act

This Draft EA concludes that the proposed action will unlikely adversely impact anadromous fish. Concurrence is being requested with this determination and this project will be fully coordinated with NMFS. This project would be in compliance with the Act.

Marine Protection, Research, and Sanctuaries Act

The MPRSA regulates the transportation and subsequent disposal of materials, including dredged materials, into ocean waters. The proposed designation of IOSN site as an ODMDS is being undertaken pursuant to Section 102 of the MPRSA. The four general (40 CFR 228.5) and eleven specific (40 CFR 228.6) criteria for the selection of sites have been discussed and included in Section 4.0 of this document. The EPA is responsible for MPRSA compliance of all ocean disposal activities and this designation would be in full compliance with the Act.

Magnuson-Stevens Fishery Conservation and Management Act

The project area is located within the jurisdiction of the MSFCMA, and an EFH assessment has been prepared that evaluates potential impacts on NMFS-managed fish species and their essential fish habitats. This Draft EA concludes that any adverse impact to EFH will be minor and temporary. This designation will be fully coordinated with NMFS and would be in compliance with the Act.

Executive Order 11593, Protection & Enhancement of the Cultural Environment

Consultations with appropriate State Historic Preservation Officers (SHPOs) pertaining to the protection of the cultural environment will be conducted by EPA and the USACE to ensure compliance with this order.

Executive Order 12898, Environmental Justice

The proposed activity would not result in adverse human health or environmental effects or exclude persons from participating in, deny persons the benefits of, or subject persons to discrimination because of their race, color, or natural origin. Further, the proposed activity would not impact "subsistence consumption of fish and wildlife." This project would be in compliance with this Executive Order.

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks

The proposed action would not result in adverse environmental health risks or safety risks to children. The proposed action would be in compliance with this Executive Order.

Executive Order 13089, Coral Reef Protection

There are no coral reefs in or near the project area, therefore, this Executive Order does not apply.

Executive Order 13112, Invasive Species

There are no components in the dredged material or consequences of its disposal that would be expected to attract or result in recruitment of nuisance species to the area. The proposed action would be in compliance with this Executive Order.

Executive Order 13158, Marine Protected Areas

EPA considered the location of any marine protected areas during the evaluation of the project alternatives. The proposed action will avoid harm to natural and cultural resources protected by any designated marine protected areas. The proposed action would be in compliance with this Executive

Order.

Executive Order 13186, Responsibilities of Federal Agencies to the Migratory Bird Treaty Act

Migratory birds are not expected to be adversely impacted by the proposed action. The proposed action would be in compliance with this Executive Order.

10.0 COORDINATION AND OUTREACH

Coordination and outreach of this project with the organizations listed in Table 10-1 has been on-going. An inter-agency kick-off meeting for the project was held on May 5, 2016. A second inter-agency meeting occurred on December 10, 2018, to present the proposed IOSN preferred alternative. EPA and USACE presented the project and preferred alternative at the New Hampshire State Dredging Team meeting on February 6, 2019 and the Maine State Dredging Team meeting on March 11, 2019. In addition, periodic project updates have been provided at all New England Regional Dredging Team meetings as well as at the New Hampshire and Maine State Dredging Team meetings from 2016- present. Letters of interest in engaging in consultation were sent to all Federally Recognized Tribes in Maine on July 5, 2019. Houlton Band of Maliseet Indians requested Government to Government consultation which occurred on August 13, 2019. EPA also presented the project on a monthly EPA Regional Tribal Operations Committee call, which includes New England Tribal environmental directors, on August 14, 2019. The project was presented to various regional stakeholders at the Piscataqua Region Estuaries Partnership, the local National Estuary Program, Management Committee meeting on December 18, 2019 and the Gulf of Maine Council for the Marine Environment meeting on July 10, 2019. EPA and USACE have begun and will continue outreach to the lobster fishing industry though organizations such as the Maine Lobster Zone G Council. The draft EA will have a Public Notice and public review period. Continued coordination with states, tribes, stakeholders, and the public is being planned throughout the public review period.

Table 10-1 List of Organizations

Federal Agencies	Tribes	State Agencies	Local Agencies	Other Stakeholders
National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service	Aroostook Band of Micmacs	ME Dept. of Environmental Protection	NH Port Authority	New Hampshire Dredging Task Force
U.S. Fish and Wildlife Service	Houlton Band of Maliseet Indians	ME Coastal Program	Portsmouth Pilots Inc.	Maine State Dredging Team
U.S. Coast Guard	Penobscot Indian Nation	ME Dept Marine Resources		New England Regional Dredge Team

U.S. Navy	Passamaquoddy Tribe of Indians Indian Township Reservation	ME State Historic Preservation Officer		Piscataqua Region Estuaries Partnership Management Committee
	Passamaquoddy Tribe of Indians Pleasant Point Reservation	ME Geological Service		Gulf of Maine Council on the Marine Environment
		NH Dept. of Environmental Services		Lobster Zone G Council
		NH Fish and Game Dept		
		NH State Historic Preservation Officer		
		NH Coastal Program		
		MA Coastal Zone Management		

11.0 SELECTION OF OCEAN DISPOSAL SITES FOR FORMAL DESIGNATION

The EPA has determined that the decision to designate the proposed IOSN site as an ODMDS is supported by the information contained within this Environmental Assessment, including the evaluation of the criteria described in 40 CFR Parts 220 through 228. Disposal and site management will be performed in accordance with the SMMP (Appendix G) that was developed pursuant to 40 CFR 228.9 and with any use restrictions that may be specified in the final rule for the designation. The IOSN site is proposed for designation by EPA through formal rulemaking, and this ODMDS EA and the appendices provide the technical support for this action.

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Environmental Assessment and Evaluation Study for a Designation of an Ocean Dredged Material Disposal Site in Southern Maine, New Hampshire, and Northern Massachusetts

Appendix A

Sediment Grain Size Data from IOSN

SEDIMENT SEIVE ANALYSIS RESULTS
ISLES OF SHOALS NORTH
ALTERANTIVE OCEAN PLACEMENT SITE

GeoTesting
EXPRESS

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

Transmittal

TO:

Richard Heidebrecht
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742

DATE: 12/21/2010	GTX NO: 10463
RE: Isles of Shoals Site N	

COPIES	DATE	DESCRIPTION
	12/21/2010	**December 2010 Laboratory Test Report**

REMARKS:

SIGNED:
Joe Tomei, Laboratory Manager

CC:

APPROVED BY:
Nancy Hubbard, Project Manager

GeoTesting
EXPRESS

Boston
Atlanta
New York

www.geocomp.com/geotesting

December 21, 2010

Richard Heidebrecht
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742

RE: Isles of Shoals Site N, (GTX-10463)

Dear Richard:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received nine samples from you on 12/15/2010. These samples were labeled as follows:

Boring Number	Sample Number	Depth
Site N	A	319 ft
Site N	B	314 ft
Site N	C	315 ft
Site N	D	318 ft
Site N	E	316 ft
Site N	F	321 ft
Site N	G	317 ft
Site N	H	328 ft
Site N	I	313 ft

GTX performed the following test on each of these samples:

ASTM D 422 – Grain Size Analysis with Hydrometer

A copy of your test request is attached.

The results presented in this report apply only to the items tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of these samples will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

Respectfully yours,

Joe

Joe Tomei
Laboratory Manager

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

Geotechnical Test Report 12/21/2010

GTX-10463
Isles of Shoals Site N Project

Client Project No.: Call #13

Prepared for:

U.S. Army Corps of Engineers

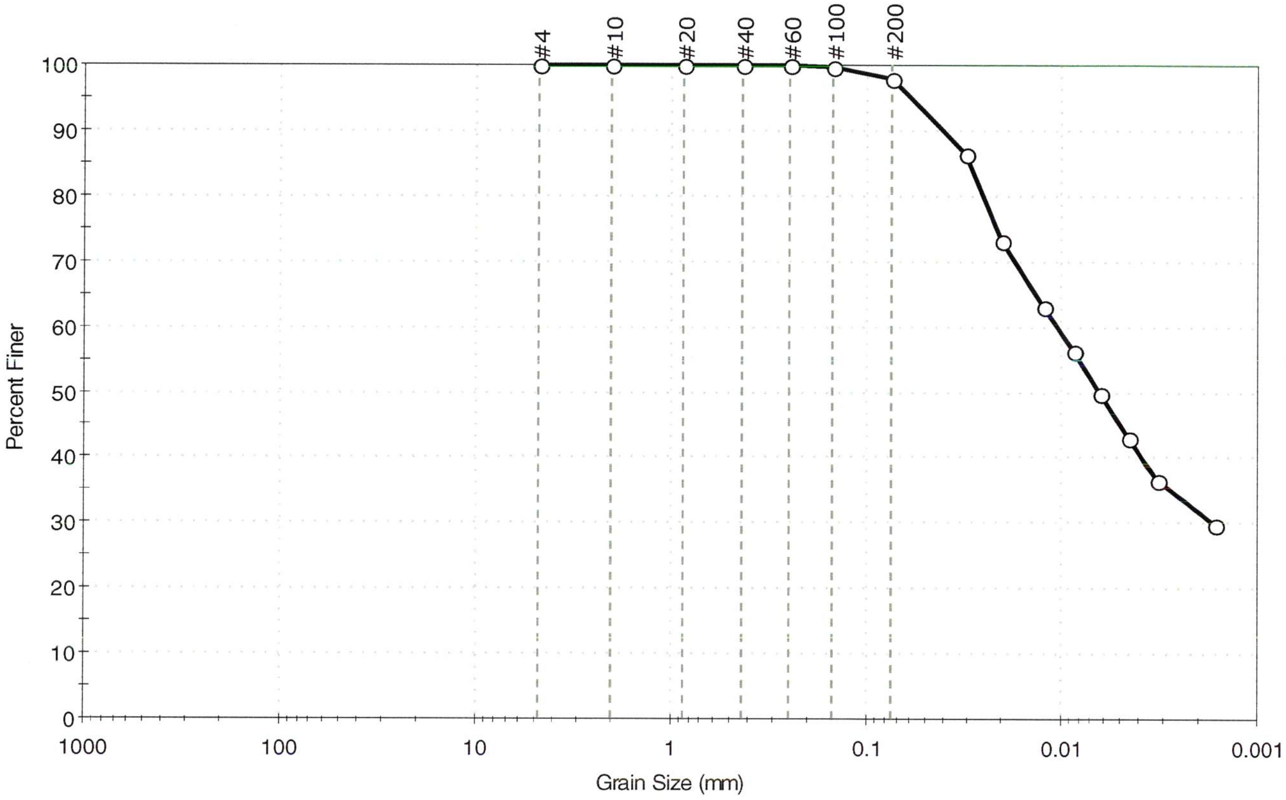
GeoTesting EXPRESS

Client: U.S. Army Corps of Engineers
Project: Isles of Shoals Site N
Location: ---
Project No: GTX-10463

Boring ID: Site N
Sample Type: bag
Tested By: jbr
Sample ID:A
Test Date: 12/17/10
Checked By: jdt
Depth : 319 ft
Test Id: 201085

Test Comment: ---
Sample Description: Moist, brown silty clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	2.1	97.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	98		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0308	86		
---	0.0202	73		
---	0.0122	63		
---	0.0086	56		
---	0.0062	50		
---	0.0045	43		
---	0.0032	37		
---	0.0016	30		

Coefficients

D_{85} =0.0295 mm
D_{30} =0.0017 mm
D_{60} =0.0103 mm
D_{15} =N/A
D_{50} =0.0063 mm
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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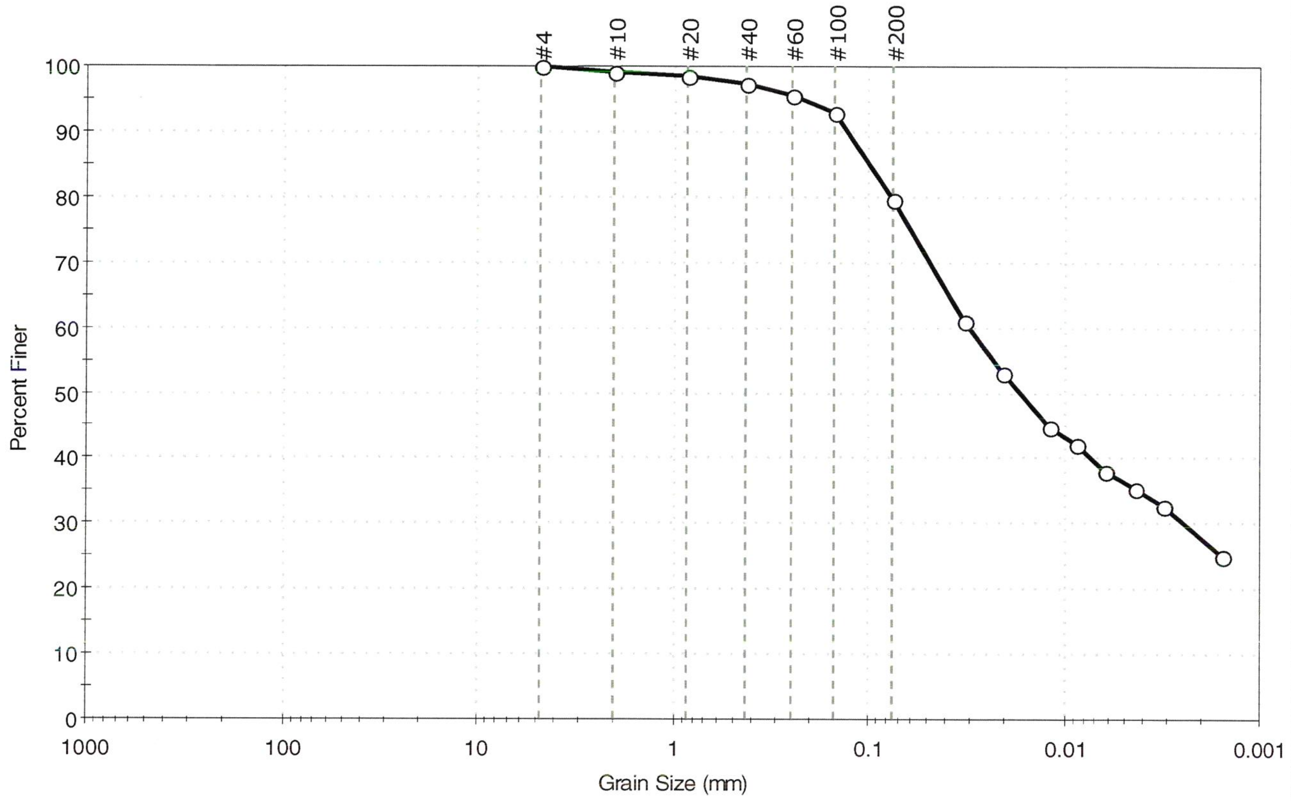
Client: U.S. Army Corps of Engineers
Project: Isles of Shoals Site N
Location: --- Project No: GTX-10463
Boring ID: Site N Sample Type: bag Tested By: jbr
Sample ID:B Test Date: 12/17/10 Checked By: jdt
Depth : 314 ft Test Id: 201086
Test Comment: ---
Sample Description: Moist, brown silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	20.2	79.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	97		
#60	0.25	96		
#100	0.15	93		
#200	0.075	80		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0328	61		
---	0.0209	53		
---	0.0121	45		
---	0.0087	42		
---	0.0062	38		
---	0.0044	35		
---	0.0032	33		
---	0.0016	25		

Coefficients

D_{85} =0.0988 mm D_{30} =0.0025 mm
D_{60} =0.0307 mm D_{15} =N/A
D_{50} =0.0170 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

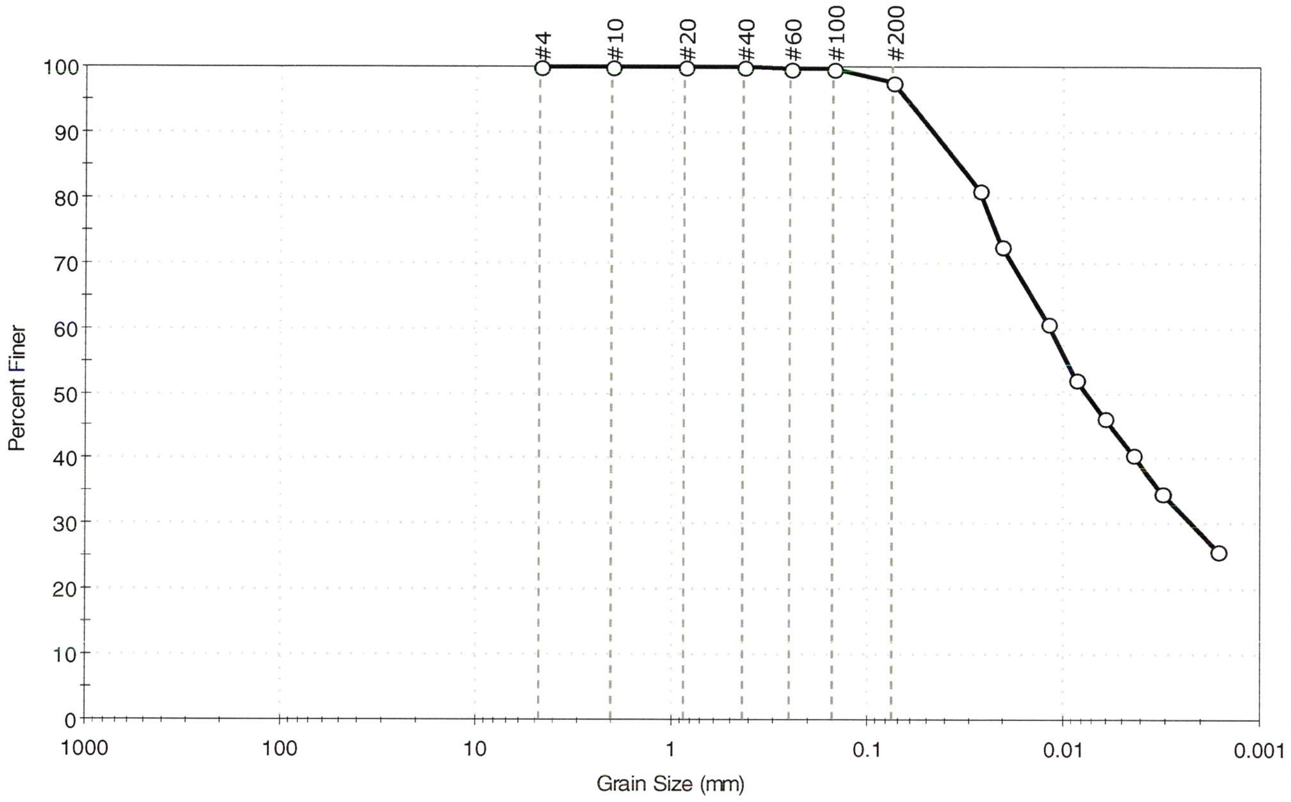
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client: U.S. Army Corps of Engineers
Project: Isles of Shoals Site N
Location: --- Project No: GTX-10463
Boring ID: Site N Sample Type: bag Tested By: jbr
Sample ID:C Test Date: 12/17/10 Checked By: jdt
Depth : 315 ft Test Id: 201087
Test Comment: ---
Sample Description: Moist, brown silty clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	2.4	97.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	98		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0269	81		
---	0.0205	72		
---	0.0120	61		
---	0.0086	52		
---	0.0062	46		
---	0.0044	41		
---	0.0032	35		
---	0.0016	26		

Coefficients

D_{85} =0.0341 mm
D_{60} =0.0116 mm
D_{50} =0.0076 mm
C_u =N/A
D_{30} =0.0022 mm
D_{15} =N/A
D_{10} =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

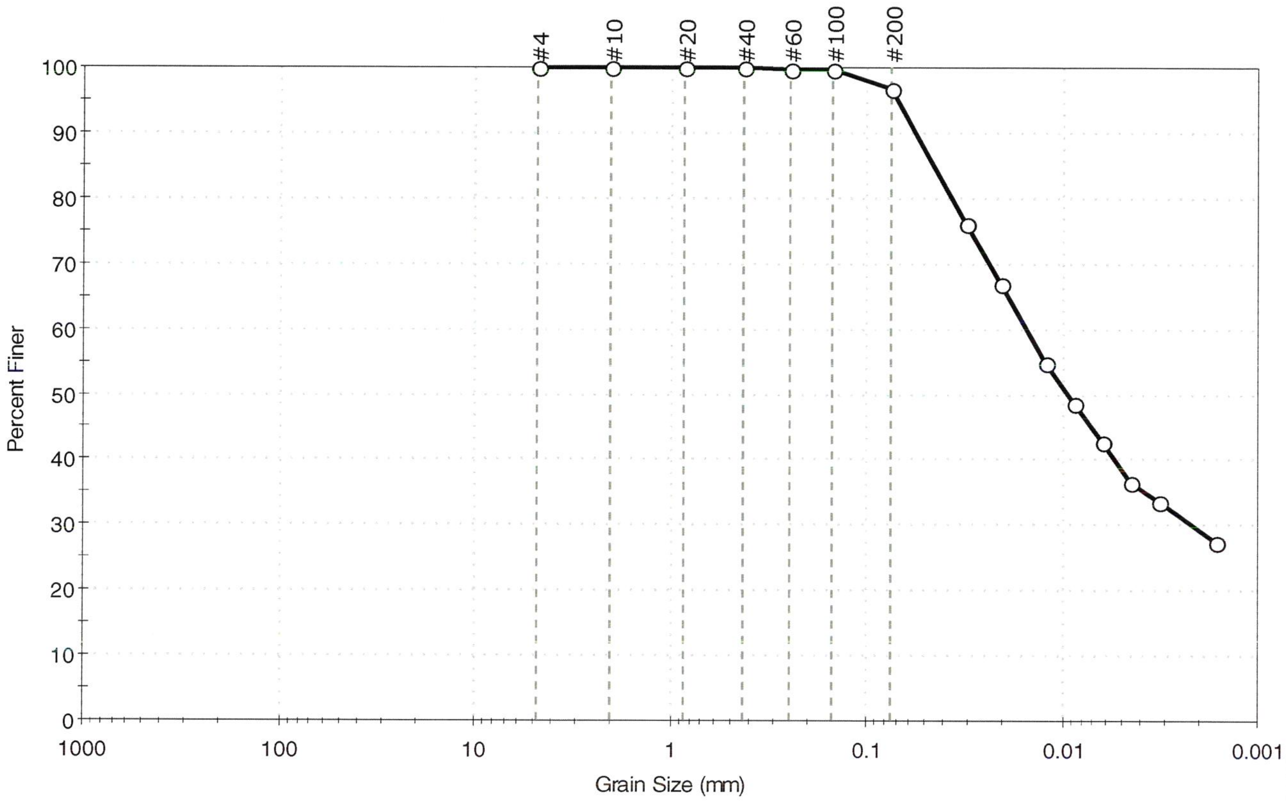
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	U.S. Army Corps of Engineers				
Project:	Isles of Shoals Site N				
Location:	---			Project No:	GTX-10463
Boring ID:	Site N	Sample Type:	bag	Tested By:	jbr
Sample ID:	D	Test Date:	12/17/10	Checked By:	jdt
Depth :	318 ft	Test Id:	201088		

Test Comment: ---
Sample Description: Moist, brown silty clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	3.4	96.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	97		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0314	76		
---	0.0207	67		
---	0.0121	55		
---	0.0088	49		
---	0.0062	43		
---	0.0045	37		
---	0.0032	34		
---	0.0016	27		

Coefficients

D_{85} =0.0456 mm	D_{30} =0.0022 mm
D_{60} =0.0152 mm	D_{15} =N/A
D_{50} =0.0093 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

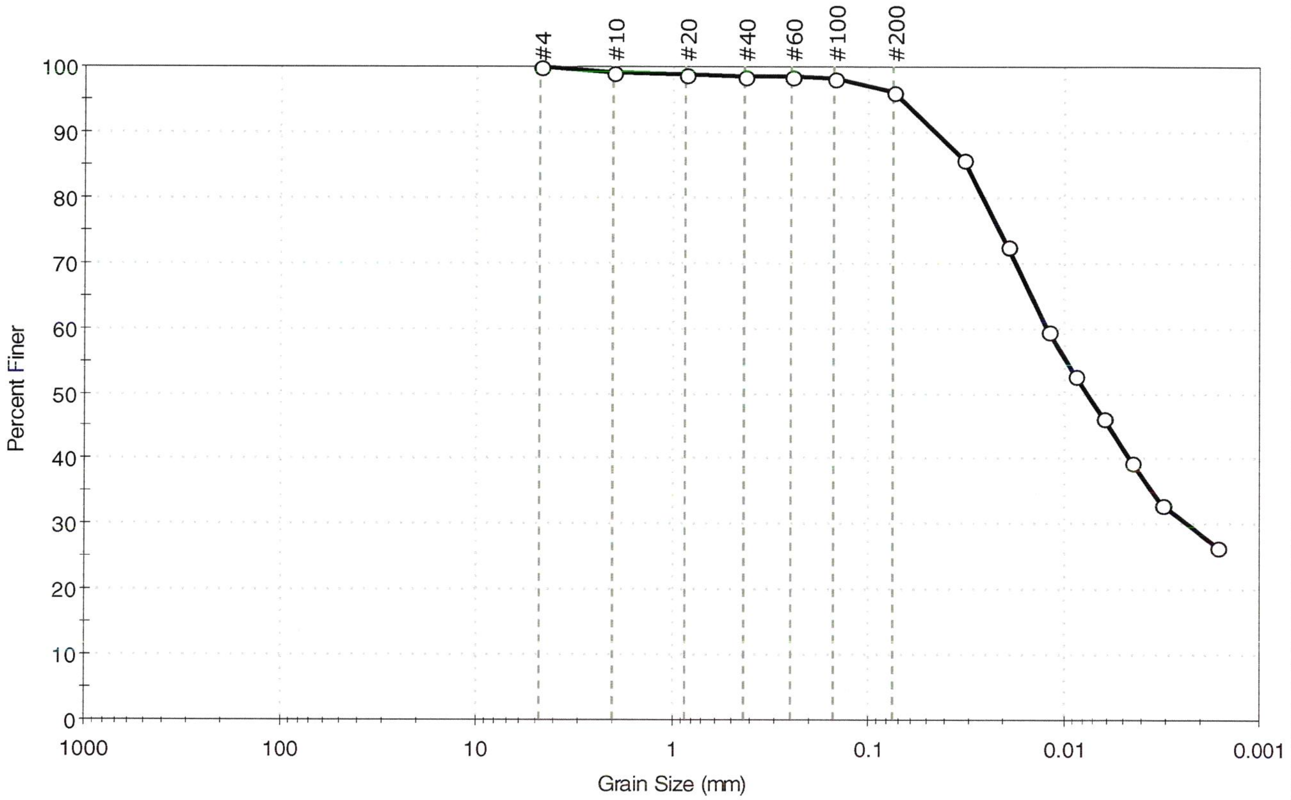
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting
EXPRESS

Client: U.S. Army Corps of Engineers
Project: Isles of Shoals Site N
Location: --- Project No: GTX-10463
Boring ID: Site N Sample Type: bag Tested By: jbr
Sample ID:E Test Date: 12/17/10 Checked By: jdt
Depth : 316 ft Test Id: 201089
Test Comment: ---
Sample Description: Moist, brown silty clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	3.7	96.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	99		
#60	0.25	99		
#100	0.15	98		
#200	0.075	96		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0328	86		
---	0.0191	73		
---	0.0120	59		
---	0.0087	53		
---	0.0062	46		
---	0.0045	40		
---	0.0032	33		
---	0.0017	26		

Coefficients

D_{85} =0.0316 mm
D_{30} =0.0024 mm
D_{60} =0.0122 mm
D_{15} =N/A
D_{50} =0.0075 mm
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

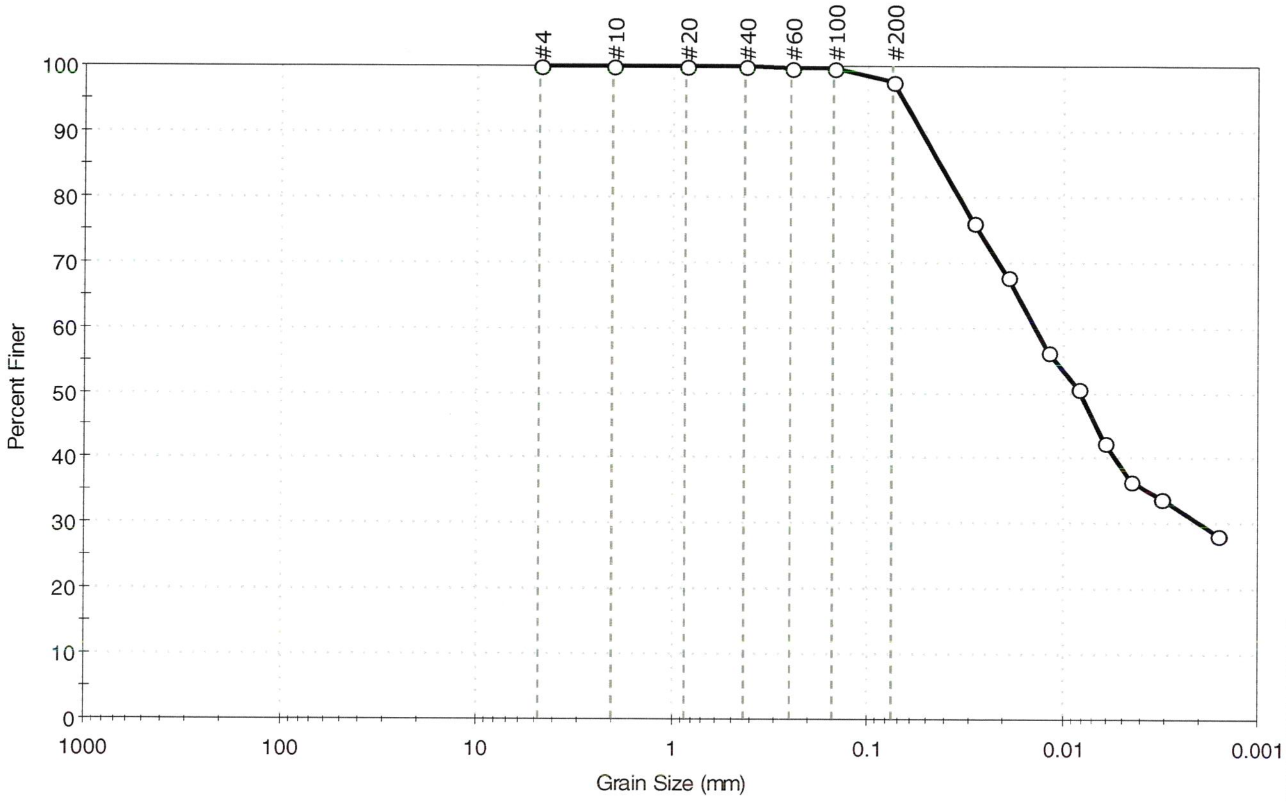
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	U.S. Army Corps of Engineers				
Project:	Isles of Shoals Site N				
Location:	---			Project No:	GTX-10463
Boring ID: Site N		Sample Type:	bag	Tested By:	jbr
Sample ID:F		Test Date:	12/17/10	Checked By:	jdt
Depth :	321 ft	Test Id:	201090		
Test Comment:	---				
Sample Description:	Moist, brown silty clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	2.4	97.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	98		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0286	76		
---	0.0191	68		
---	0.0119	56		
---	0.0084	51		
---	0.0062	42		
---	0.0045	37		
---	0.0032	34		
---	0.0016	28		

Coefficients

D_{85} =0.0425 mm	D_{30} =0.0020 mm
D_{60} =0.0138 mm	D_{15} =N/A
D_{50} =0.0082 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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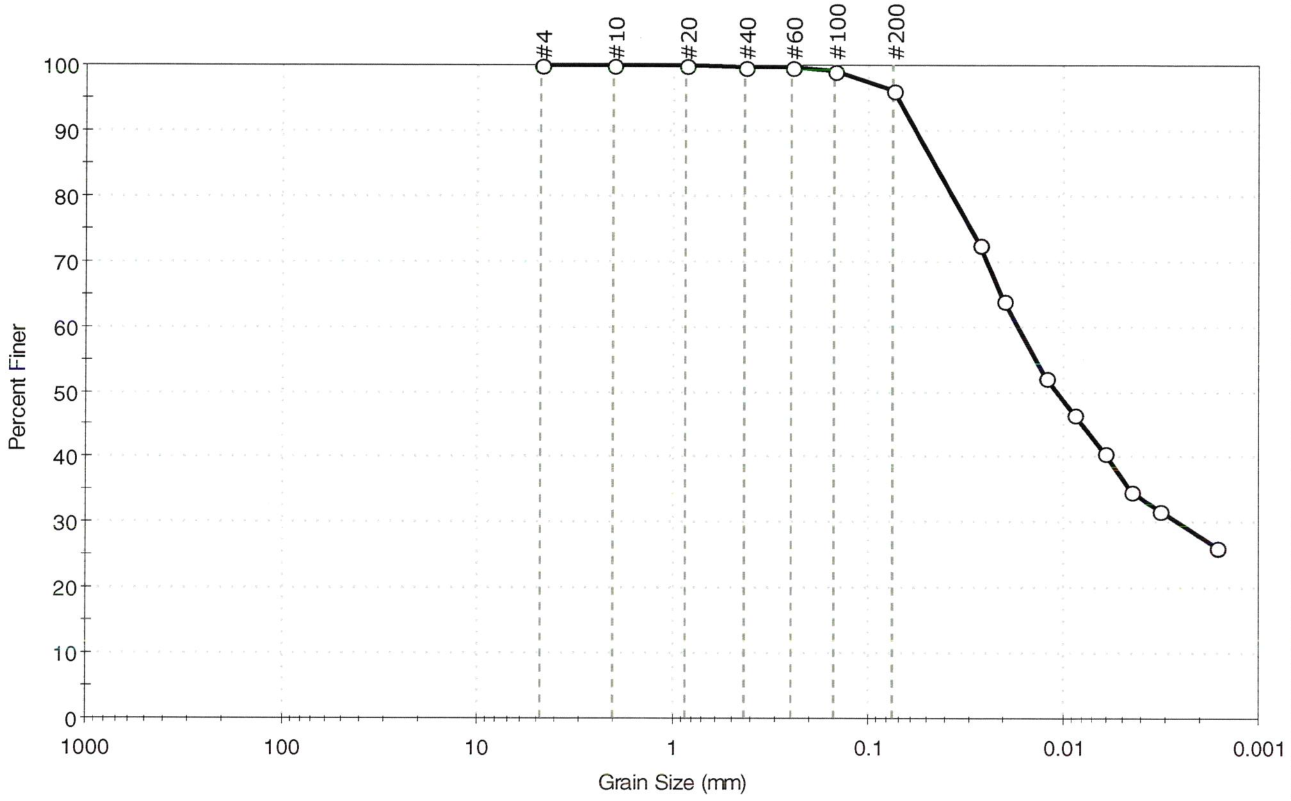
GeoTesting EXPRESS

Client: U.S. Army Corps of Engineers
Project: Isles of Shoals Site N
Location: ---
Project No: GTX-10463

Boring ID: Site N
Sample ID:G
Depth : 317 ft
Sample Type: bag
Test Date: 12/17/10
Test Id: 201091
Tested By: jbr
Checked By: jdt

Test Comment: ---
Sample Description: Moist, brown silty clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	3.9	96.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	99		
#200	0.075	96		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0268	73		
---	0.0203	64		
---	0.0122	52		
---	0.0088	46		
---	0.0062	41		
---	0.0045	35		
---	0.0032	32		
---	0.0016	26		

Coefficients

D_{85} =0.0461 mm
D_{30} =0.0026 mm
D_{60} =0.0171 mm
D_{15} =N/A
D_{50} =0.0107 mm
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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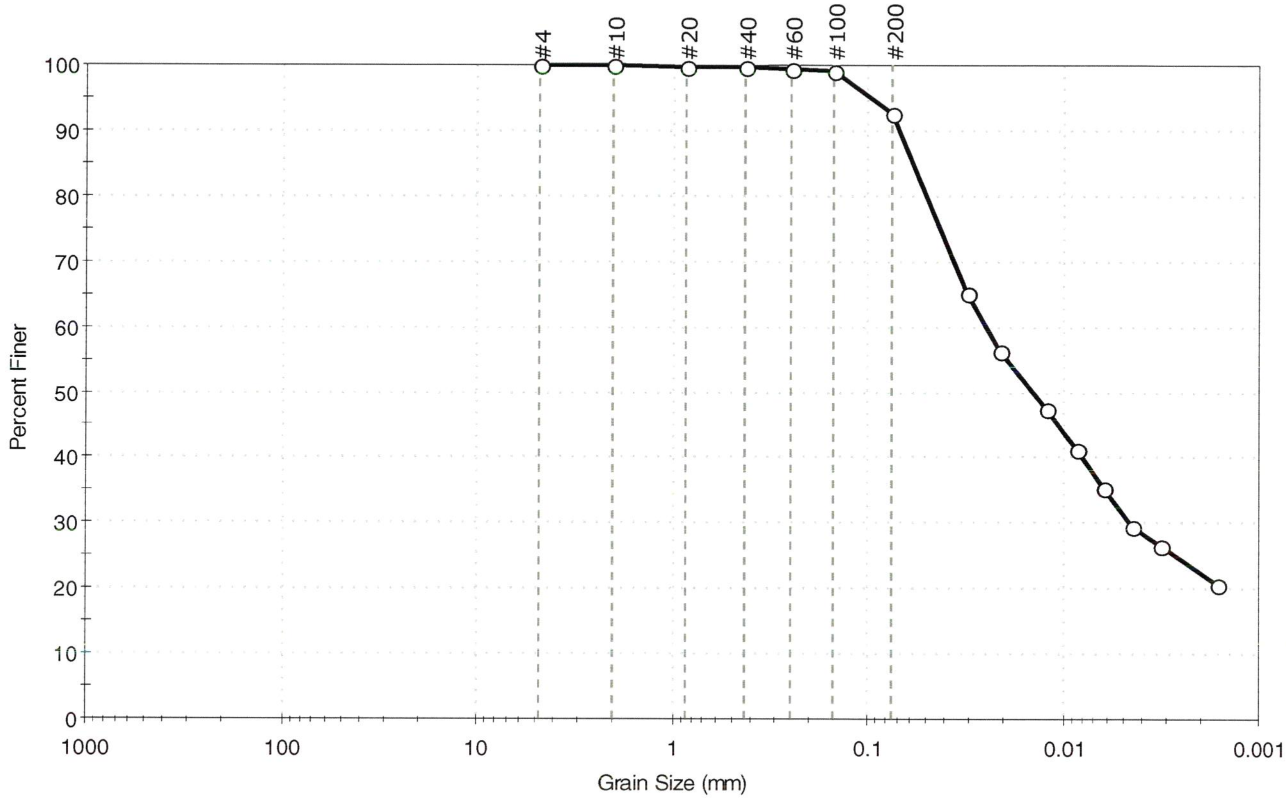
GeoTesting EXPRESS

Client: U.S. Army Corps of Engineers
Project: Isles of Shoals Site N
Location: --- Project No: GTX-10463
Boring ID: Site N Sample Type: bag Tested By: jbr
Sample ID:H Test Date: 12/17/10 Checked By: jdt
Depth : 328 ft Test Id: 201092
Test Comment: ---
Sample Description: Moist, brown silt
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	7.3	92.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	99		
#200	0.075	93		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0311	65		
---	0.0213	56		
---	0.0124	47		
---	0.0085	41		
---	0.0063	36		
---	0.0045	30		
---	0.0032	27		
---	0.0017	21		

Coefficients

D_{85} =0.0586 mm
D_{30} =0.0046 mm
D_{60} =0.0250 mm
D_{15} =N/A
D_{50} =0.0146 mm
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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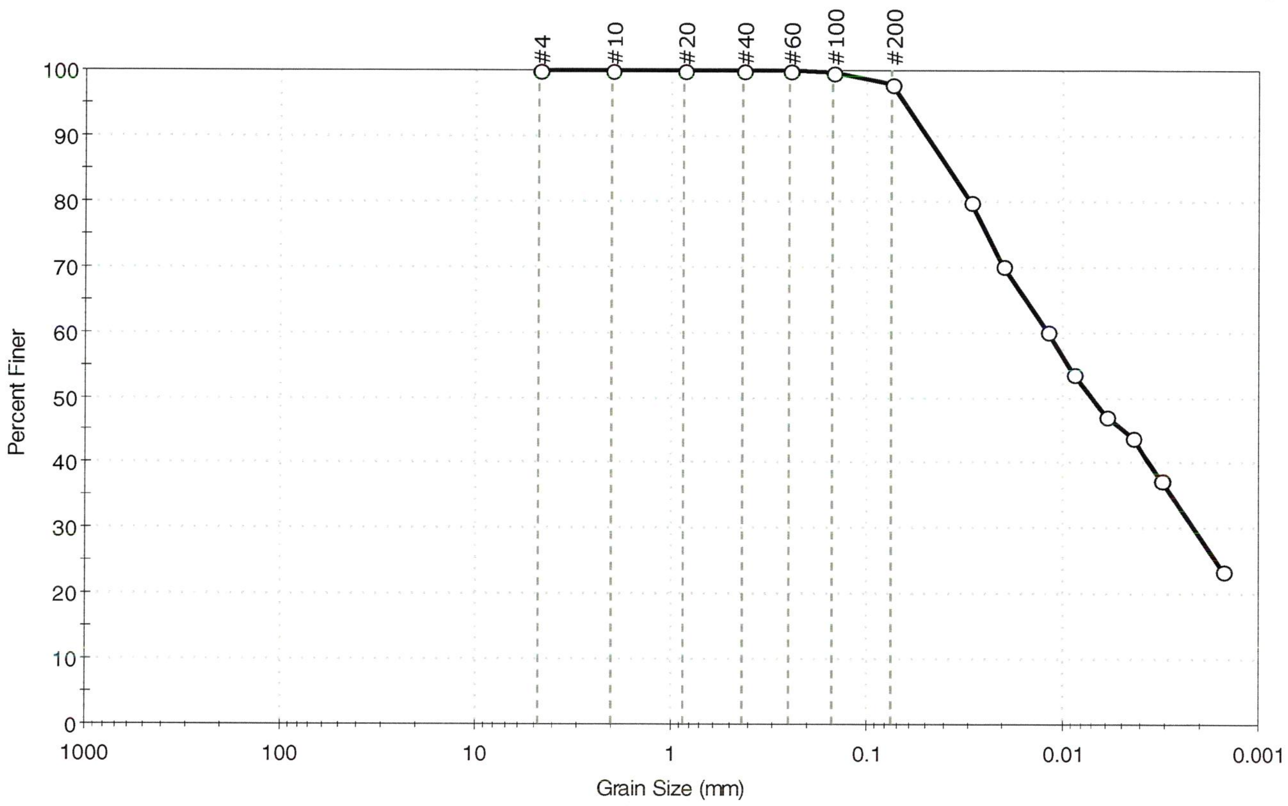
Client:	U.S. Army Corps of Engineers				
Project:	Isles of Shoals Site N				
Location:	---			Project No:	GTX-10463
Boring ID:	Site N	Sample Type:	bag	Tested By:	jbr
Sample ID:	I	Test Date:	12/17/10	Checked By:	jdt
Depth :	313 ft	Test Id:	201093		
Test Comment:	---				
Sample Description:	Moist, brown silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	2.1	97.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	98		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0293	80		
---	0.0204	70		
---	0.0121	60		
---	0.0087	54		
---	0.0060	47		
---	0.0044	44		
---	0.0031	37		
---	0.0015	24		

Coefficients

D_{85} = 0.0383 mm	D_{30} = 0.0021 mm
D_{60} = 0.0119 mm	D_{15} = N/A
D_{50} = 0.0070 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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U.S. ARMY CORPS OF ENGINEERS

Richard Heidebrecht 978-318-8513 **CHAIN OF CUSTODY RECORD**

PROJ. NO.

PROJECT NAME: Isles of Shoals Site N

SAMPLERS: *(Signature)* Todd Randall

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CON-TAINERS	Wet Sieve & Hydrometer						REMARKS
A	11/1			✓	Site N	1	✓						319' Depth
B	11/1			✓		1	✓						314' Depth
C	11/1	940		✓		1	✓						315' Depth
D	11/1			✓		1	✓						318' Depth
E	11/1	1200		✓		1	✓						316' Depth
F	11/1	1040		✓		1	✓						321' Depth
G	11/1	1015		✓		1	✓						317' Depth
H	11/1	1115		✓		1	✓						328' Depth
I	11/1	1140		✓		1	✓						313' Depth

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
	12/15/10 9:50				
Relinquished by: *(Signature)*	**Date / Time**	**Received by:** *(Signature)*	**Relinquished by:** *(Signature)*	**Date / Time**	**Received by:** *(Signature)*

Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Remarks
				Call #13

Distribution: Original Accompanies Shipment; Copy 1 to Sample Custodian; Copy 2 to Coordinator Field Files

GeoTesting
EXPRESS

WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$
B	pore pressure parameter for $\Delta\sigma_3$
CIU	isotropically consolidated undrained triaxial shear test
CR	compression ratio for one dimensional consolidation
C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \text{ x } D_{60})$
C_u	coefficient of uniformity, D_{60}/D_{10}
C_c	compression index for one dimensional consolidation
C_α	coefficient of secondary compression
c_v	coefficient of consolidation
c	cohesion intercept for total stresses
c'	cohesion intercept for effective stresses
D	diameter of specimen
D_{10}	diameter at which 10% of soil is finer
D_{15}	diameter at which 15% of soil is finer
D_{30}	diameter at which 30% of soil is finer
D_{50}	diameter at which 50% of soil is finer
D_{60}	diameter at which 60% of soil is finer
D_{85}	diameter at which 85% of soil is finer
d_{50}	displacement for 50% consolidation
d_{90}	displacement for 90% consolidation
d_{100}	displacement for 100% consolidation
E	Young's modulus
e	void ratio
e_c	void ratio after consolidation
e_o	initial void ratio
G	shear modulus
G_s	specific gravity of soil particles
H	height of specimen
PI	plasticity index
i	gradient
K_o	lateral stress ratio for one dimensional strain
k	permeability
LI	Liquidity Index
m_v	coefficient of volume change
n	porosity
PI	plasticity index
P_c	preconsolidation pressure
p	$(\sigma_1 + \sigma_3) / 2$, $(\sigma_v + \sigma_h) / 2$
p'	$(\sigma'_1 + \sigma'_3) / 2$, $(\sigma'_v + \sigma'_h) / 2$
p'_c	p' at consolidation
Q	quantity of flow
q	$(\sigma_1 - \sigma_3) / 2$
q_f	q at failure
q_o, q_i	initial q
q_c	q at consolidation
S	degree of saturation
SL	shrinkage limit
s_u	undrained shear strength
T	time factor for consolidation

T	temperature
t	time
U, UC	unconfined compression test
UU, Q	unconsolidated undrained triaxial test
u_a	pore gas pressure
u_e	excess pore water pressure
u, u_w	pore water pressure
V	total volume
V_g	volume of gas
V_s	volume of solids
V_v	volume of voids
V_w	volume of water
V_o	initial volume
v	velocity
W	total weight
W_s	weight of solids
W_w	weight of water
w	water content
w_c	water content at consolidation
w_f	final water content
w_l	liquid limit
w_n	natural water content
w_p	plastic limit
w_s	shrinkage limit
w_o, w_i	initial water content
α	slope of q_f versus p_f
α'	slope of q_f versus p_f'
γ_t	total unit weight
γ_d	dry unit weight
γ_s	unit weight of solids
γ_w	unit weight of water
ε	strain
ε_{vol}	volume strain
ε_h, ε_v	horizontal strain, vertical strain
μ	Poisson's ratio, also viscosity
σ	normal stress
σ'	effective normal stress
σ_c, σ'_c	consolidation stress in isotropic stress system
σ_h, σ'_h	horizontal normal stress
σ_v, σ'_v	vertical normal stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
τ	shear stress
φ	friction angle based on total stresses
φ'	friction angle based on effective stresses
φ'_r	residual friction angle
φ_{ult}	φ for ultimate strength

Environmental Assessment and Evaluation Study for a Designation of an Ocean Dredged Material Disposal Site in Southern Maine, New Hampshire, and Northern Massachusetts

Appendix B

Benthic Community Analysis Report

IDENTIFICATION AND ENUMERATION OF MUDDY BOTTOM BENTHIC MACROFAUNA FROM THE ISLES OF SHOALS-NORTH AREA, NORTHEAST GULF OF MAINE

Contract No. W912WJ-11-M-0020

SUBMITTED BY:

PETER FOSTER LARSEN, Ph.D.

COASTAL SCIENCES

91 KNICKERBOCKER ROAD

BOOTHBAY, MAINE 04537

This report represents analytical results of benthic samples received by Coastal Sciences on November 10, 2010 from the US Army Corps of Engineers.

Peter F. Larsen, Ph.D.
Coastal Sciences

TABLE OF CONTENTS

INTRODUCTION

The Gulf of Maine is one of the world's most productive fishing grounds and best-studied continental seas. Since the last glaciation, the Gulf has undergone a rapid and dynamic geological and oceanographic evolution that has produced the rich and intricate ecological system that we witness today (Bousfield and Thomas 1975, Shaw, *et al.*, 2002). Interest the benthic macrofauna of the Gulf began early and several investigations qualitatively documented the high invertebrate species richness of the region (Mighels, 1843; Stimpson, 1853; Verrill, 1872, 1874; and Webster and Benedict, 1887; Kinsley, 1901; others). In more recent times, the rich macrobenthos of the offshore Gulf has been documented quantitatively by Rowe, *et al.*, (1975), Theroux and Wigley (1998) and others. Likewise, the coastal embayments and estuarine bottoms of New England have also been sampled widely (Larsen, 1979; Larsen and Gilfillan, 2004); Hale, 2010; and many others). All these studies confirm the rich and complex zoogeography described by Bousfield and Thomas (1975).

In spite of the high level of investigative activity, there remain other areas and systems in the Gulf of Maine that are not adequately described. One of these is the muddy bottoms of the coastal region (Lewis Incze, Gulf of Maine Area Program, Census of Marine Life, personal communication). Such areas generally fall between the deeper waters sampled from large oceanographic vessels and nearshore environments sampled from smaller workboats. Nevertheless, increased knowledge of these mid-depth soft sediment patches is required by environmental managers as the proposed uses for the coastal margin are accelerating. In particular, several demonstration projects for the development of offshore wind power are now being planned. These projects could potentially disturb these stable depositional areas by the impact of cable footings to secure the floating turbine platforms and the passage of transmission lines to the coast. In this communication we describe the benthic community inhabiting a muddy bottom in 100m water off the coast of southern Maine.

METHODS

Sampling occurred at nine stations on November 1, 2010 within a 780m radius circle approximately 14 km east northeast of the Isles of Shoals in the northwestern Gulf of Maine (Fig. 1). This is the proposed Isles of Shoals-North disposal area. The sampling site is in an area known as the Bigelow Bight and lies between the shallow Jeffreys Ledge and the Maine coast. At each station, samples for fauna and sediment analyses were retrieved using a 0.04 m^2 modified Van Veen grab. The faunal samples were sieved on a 0.5 mm screen and fixed in 10% formalin solution with the vital stain Rose Bengal.

The nine faunal samples were transferred from the U.S. Army Corps of Engineers to Coastal Sciences on November 10, 2010. In the laboratory, the formalin was removed from the samples by gentle washing on a 0.5 mm sieve and the samples were preserved in 70% ethanol. The benthic macrofauna in each sample was separated from the limited inorganic debris and sorted to major taxonomic categories. This process was accomplished by trained personnel using binocular dissecting microscopes. A subsample of the residue of each sample was reexamined to insure complete removal of the fauna. No problems were detected. Each taxonomic group was examined by an experienced marine taxonomist who identified each individual to the lowest practical taxonomic level, usually the species level, and enumerated the number of individuals in each taxon. Synonymies were made current using the World Register of Marine Species (www.marinespecies.org/).

Zoogeographic affinities and feeding types were determined using standard references such as Pettibone (1963), Gosner (1971), Bousfield (1973), Fauchald and Jumars (1979) and Watling (1979) as well as several websites including using the World Register of Marine Species (www.marinespecies.org/).

The numerical data were analyzed using the statistical package PRIMER v6 (Clarke and Gorley, 2006). Univariate community structure analyses performed include density (N), species richness (S), Shannon diversity (H^1, base *e*) and Pielou's Evenness (J^1). The faunal relationships were also investigated using numerical classification and ordination. Species data were square root transformed to moderate the influence of abundant species. A hierarchical agglomerative classification scheme was employed using the Bray-Curtis similarity index. The group-average linking method was used to produce a dendrogram of sample relatedness and a 2-dimensional ordination of stations was accomplished using the non-metric multidimensional scaling (MDS) technique found in PRIMER. Multivariate analyses were limited to species that occurred at two or more stations.

Species accumulation curves were utilized to assess the adequacy of the sampling and to estimate the unknown biodiversity of the northwestern Gulf of Maine community. The Chao 2 formula was chosen. This is a presence-absence measure that relies on the number of species that occur in one sample and the number that occur in two samples to calculate an estimate of the maximum number of species expected (Colwell and Coddington, 1994).

RESULTS

Abiotic Factors

Descriptive details of station location, depth and sediment type are presented in Table 1. The stations were in close proximity to one another; the maximum distance between any two stations being about 1.5 km. Depth was rather uniform as all stations occurred at depths between 95 and 100 m. The sediments can be characterized as fine. Seven of the nine stations exhibited silt/clay content in excess of 96%. Two stations, B and H, were somewhat coarser with silt/clay contents of 79.8 and 92.7%, respectively. The non-silt/clay fractions of all the samples consisted of sand. Moist, brown silty clay is the visual description of all of the samples. The Folk classification of these sediments is silt (Folk, 1968).

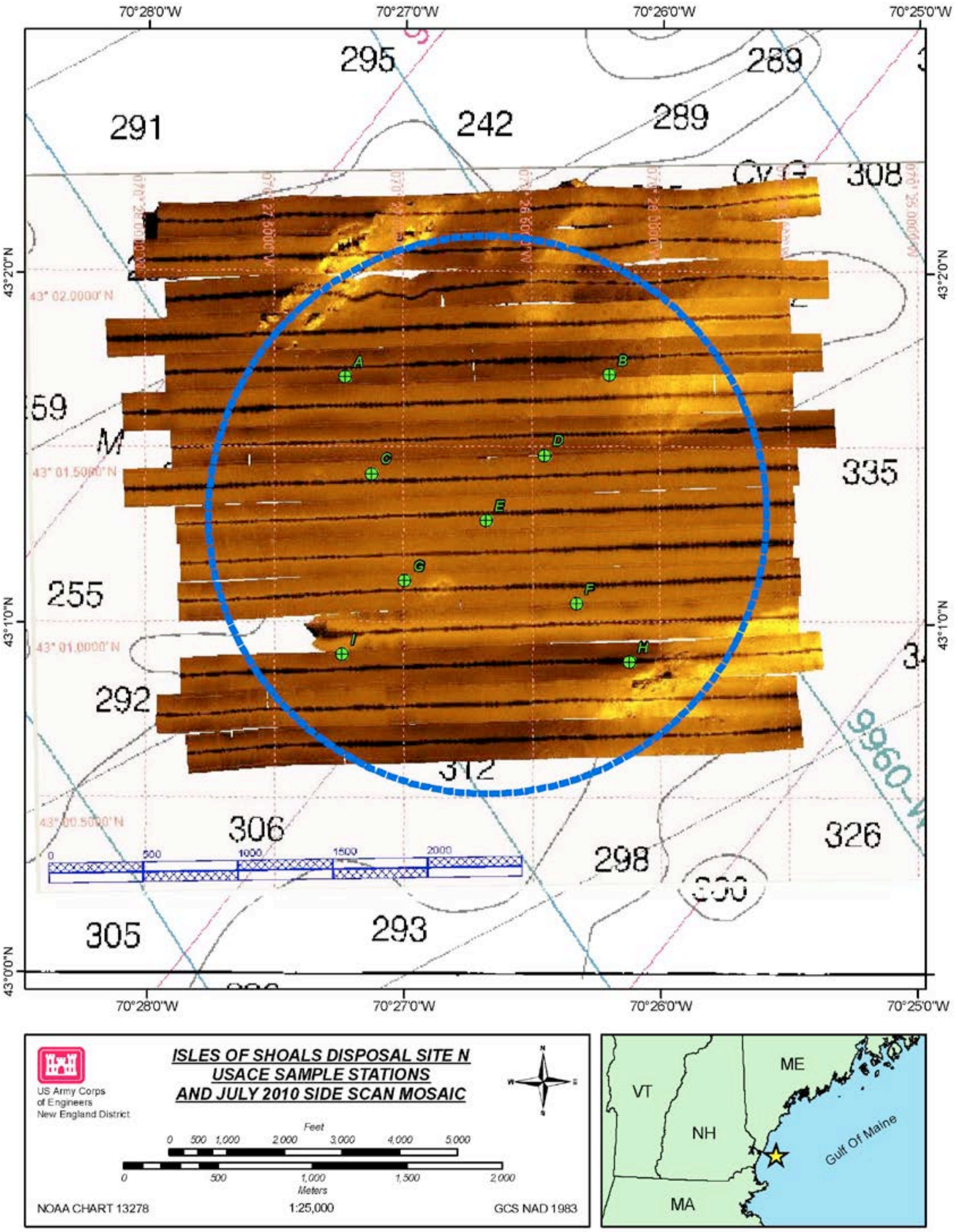

Figure 1. Isles of Shoals-North Station Locations with Side Scan Sonar Mosaic Superimposed. Depths are in Feet.

Faunal Composition, Abundance and Dominance

A total of 40 taxa from four phyla were identified from the nine samples (Table 2). Thirty-two taxa were identified to the species level. No colonial species were encountered. The number of taxa at the stations ranged from seven to 19 with a mean of 10.7 (Table 3). The fauna was dominated by polychaetes that accounted for 25 of the 40 taxa or 62.5% of the fauna. Percentage representation of other taxa was 17.5% Arthropoda, 15% Mollusca and 5% Rhynchocoela.

TABLE 1. Location and Environmental Characteristics of the Nine Benthic Stations from the Northwestern Gulf of Maine.

Station	Latitude	Longitude	Depth (m)	% Sand	% Silt & Clay
A	43.028412	-70.45389	97.2	2.1	97.9
B	43.028527	-70.43678	95.7	20.2	79.8
C	43.023773	-70.45215	96.0	2.4	97.6
D	43.024674	-70.44097	96.9	3.4	96.6
E	43.021569	-70.44474	96.3	3.7	96.3
F	43.017613	-70.43885	97.8	2.4	97.6
G	43.018689	-70.45004	96.6	3.9	96.1
H	43.014840	-70.43541	100.0	7.3	92.7
I	73.015181	-70.45402	95.4	2.1	97.9

Density at the stations ranged from 400 to 1,950 individuals/m^2 with a mean density of 1,055/m^2 (Table 3). The numerical dominance of polychaetes was very pronounced. Polychaetes represented 93.2% of all individuals. Percentage of total individuals of Mollusca, Arthropoda and Rhynchocoela were 2.6, 2.1 and 2.1 percent, respectively.

Numerical dominance of the most abundant species ranged from moderate to high (Table 3). The percentage of the fauna represented by the dominant species ranged from 14 to 51%. At eight of the nine stations the dominant species was the deposit feeding polychaete *Paraonis gracilis* that accounted for over 40% of the individuals at four of the nine stations. The only other species obtaining dominant status was another deposit feeder, the polychaete *Cossura longocirrata*.

Most of the Shannon informational diversity values (base log *e*) were constrained within a rather narrow range with the low species richness (Table 3). Station C was something of an outlier. Mean diversity was 1.811 and the range was 1.184 -2.367. Evenness also did not vary widely. Evenness values ranged from 0.6362 to 0.9182 with a mean of 0.8035.

Zoogeographic Affinities and Feeding Guilds

It was possible to assign zoogeographic affinities to 32 of the 40 identified taxa (Table 4).

Fifteen of the taxa, 47%, could be classified as Boreal in their distribution. Another 34% of the taxa were considered to have a Boreal-Virginian geographic range. Taxa characterized as being Arctic or Virginian in their zoogeographic affinities each represented nine per cent of the identified species.

TABLE 2. List of Taxa Collected During the Isles of Shoals-North Benthic Survey

Phylum	Species	Phylum	Species
Rhynchocoela		**Arthropoda**	
	Micrura sp. (Ehrenberg, 1971)		*Cyclaspis varians* Calman, 1912
	Nemertean		*Eudorella pusilla* Sars, 1871
Mollusca			*Harpinia propinqua* Sars, 1891
	Astarte undata (Gould, 1841)		*Leptocheirus plumulosus* Shoemaker, 1932
	Bivavle juv.		*Leptostylis longimana* (Sars, 1865)
	Parvicardium pinnulatum (Conrad, 1831)		*Paracaprella tenuis* Mayer, 1903
	Chaetoderma nitidulum (Loven, 1844)		*Photis* sp. Kroyer, 1842
	Thyasira gouldi (Philippi, 1845)		
	Thyasira sp. (Lamarck, 1818)		
Annelida			
	Aglaophamus neotenus (Noyes, 1980)		
	*Ampharete arctica (*Malmgrem, 1866)		
	Aricidea suecica (Eliason, 1920)		
	Ceratocephale loveni (Malmgren, 1867)		
	Chaetozone setosa (Malmgren, 1867)		
	Cossura longocirrata (Webster & Benedict, 1887)		
	Harmothoe extenuata (Grube, 1840)		
	Lepidonotus squamatus (Linnaeus, 1758)		
	Lumbrineris latreilli Audouin & Milne Edwards, 1834		
	Scoletoma tenuis Verrill, 1873		
	Maldane sarsi Malmgren, 1865		
	Mediomastus ambiseta (Hartman, 1947)		
	Nephtys incisa Malmgren, 1865		
	Ninoe nigripes Verrill, 1973		
	Owenia fusiformis Delle Chiaje, 1844		

	Paramphinome pulchella Sars, 1869		
	Paraonis gracilis (Tauber, 1879)		
	Praxillella gracilis (M. Sars, 1861)		
	Praxillella praetermissa (Malmgren, 1865)		
	Prionospio sp Malmgren, 1867.		
	Sabaco elongatus (Verrill, 1873)		
	Scalibregma inflatum Rathke, 1843		
	Syllid juvenile		
	Tharyx acutus Webster & Benedict, 1887		
	Unknown		

TABLE 3. Community Parameters and Numerical Dominance

Station	**Species Richness**	**Density (m^2)**	**Evenness (J^1)**	**Diversity (H^1)**	**Numerical Dominance**
A	11	775	0.8561	2.053	*Paraonis gracilis* 26%
B	7	400	0.9182	1.787	*Paraonis gracilis* 14%
C	6	825	0.6609	1.184	*Paraonis gracilis* 61%
D	14	825	0.875	2.309	*Cossura longocirrata* 31%
E	10	1,425	0.7059	1.625	*Paraonis gracilis* 37%
F	10	950	0.7556	1.740	*Paraonis gracilis* 42%
G	8	475	0.8195	1.704	*Paraonis gracilis* 42%
H	19	1,875	0.8039	2.367	*Paraonis gracilis* 26%
I	11	1,950	0.6362	1.526	*Paraonis gracilis* 60%

On the basis of abundance, the distribution among the zoogeographic provinces was much more skewed. A full 71% of the individuals encountered could be defined as Boreal in character. The remaining individuals were divided rather evenly between Arctic, Boreal-Virginian and Virginian affinities.

The taxa encountered were assigned to one of four feeding guilds for the purposes of analysis. Surface deposit feeders, subsurface deposit feeders and omnivores were grouped together as deposit feeders in this analysis. Deposit feeders were the most prevalent of the feeding guilds. Twenty-three of the 40 species, 59%, were classified as deposit feeders.

Carnivores accounted for 23% of the taxa while only 18% were considered suspension feeders. A different pattern emerged when the analysis was done on the basis of individuals. Here 88% of the community consisted of deposit feeders, nine per cent were carnivores and suspension feeders represented only three per cent of the fauna.

Multivariate Analyses

The dendrogram based on group-average sorting classification using the Bray-Curtis similarity measure on square-root transformed data did not present a clear-cut spatial pattern (Fig. 2). Only four stations were linked in pair-groupings. Stations C and F and stations H and I formed the two pair-groupings at a very high level of similarity. Station E was then linked to the C/F grouping and the five stations were joined at nearly 60% similarity. The remaining stations then were chain-linked to the five-station cluster, i.e. individual stations were sequentially added to the dendrogram singly. They were no higher level dichotomies indicating basic dissimilarities in the station array. The SIMPROF routine of PRIMER was run to test the null hypothesis that the set of samples do not differ from each other in the dendrogram structure. Groupings that do not reject the null hypothesis are connected with red lines in the test output. As indicated in Fig. 2, all samples are connected by red lines and, hence, it can be concluded that all of the samples came from the same community.

The biological relationships among the nine samples were further investigated using a two dimensional non-metric multi-dimensional scaling (MDS) ordination also with the Bray-Curtis similarity measure calculated on square root transformed abundance data. Similar to the cluster analysis, the MDS did not reveal any segregation of groups of stations (Fig. 3). Stations C, E, F, H and I were grouped towards the center while Stations A, B, D and G were spaced around the periphery. The stress level of 0.07 indicates that the MDS is “a good ordination with no real prospect of misleading interpretation; 3- or higher dimensional solutions will not add any additional information” (Clarke and Warwick, 2001).

TABLE 4. Zoogeographic Affinities and Feeding Guilds of Taxa Collected in a Mud Habitat, Northwestern Gulf of Maine.

Phylum and Species		**Zoogeographic Affinity**	**Feeding Guild**
Phylum Rhynchocoela			
	Micrura sp. Ehrenberg, 1971	BV	Carnivorous
	Nemertean		Carnivorous
Phylum Mollusca			
	Astarte undata Gould, 1841	B	Suspension
	Bivavle juv.		Suspension
	Parvicardium pinnulatum (Conrad, 1831)	BV	Suspension
	Chaetoderma nitidulum (Loven, 1844)	B	Omnivorous
	Thyasira gouldi (Philippi, 1845)	B+	Suspension
	Thyasira sp. Lamarck, 1818		Suspension
Phylum Annelida			
	Aglaophamus neotenus Noyes, 1980	B	Deposit
	Ampharete arctica Malmgrem, 1866	A+	Deposit
	Aricidea suecica (Eliason, 1920)	A+	Deposit
	Ceratocephale loveni Malmgren, 1867	B	Deposit
	Chaetozone setosa Malmgren, 1867	B	Surface deposit
	Cossura longocirrata Webster & Benedict, 1887	B	Surface deposit
	Harmothoe extenuata (Grube, 1840	B	Carnivorous
	Lepidonotus squamatus (Linnaeus, 1758)	B	Carnivorous
	Lumbrineris latreilli Audouin & Milne Edwards, 1834	BV	Carnivorous
	Scoletoma tenuis Verrill, 1873	BV	Carnivorous
	Maldane sarsi Malmgren, 1865	B	Subsurface deposit
	Mediomastus ambiseta (Hartman, 1947)		Deposit
	Nephtys incisa Malmgren, 1865	B	Deposit
	Ninoe nigripes Verrill, 1973	BV	Carnivorous
	Owenia fusiformis Delle Chiaje, 1844	BV	Surface deposit
	Paramphinome pulchella Sars, 1869	BV	Carnivorous
	Paraonis gracilis (Tauber, 1879)	B	Deposit
	Praxillella gracilis (M. Sars, 1861)		Subsurface deposit
	Praxillella praetermissa (Malmgren, 1865)	B	Subsurface deposit
	Prionospio sp Malmgren, 1867.		Surface deposit
	Sabaco elongatus (Verrill, 1873)	V	Subsurface deposit
	Scalibregma inflatum Rathke, 1843	BV	Subsurface deposit
	Syllid juvenile		Carnivorous
	Tharyx acutus Webster & Benedict, 1887	B+	Surface deposit
	Unknown		

Phylum Arthropoda			
	Cyclaspis varians Calman, 1912	V	Deposit
	Eudorella pusilla Sars, 1871	BV	Deposit
	Harpinia propinqua Sars, 1891	B	Surface deposit
	Leptocheirus plumulosus Shoemaker, 1932	V	Suspension
	Leptostylis longimana (Sars, 1865)	A+	Deposit
	Paracaprella tenuis Mayer, 1903	BV	Suspension/carnivorous
	Photis sp. Kroyer, 1842	BV	Deposit

Species Accumulation Analysis

The observed species accumulation curve (Sobs) and the calculated Chao 2 values are plotted in Figure 4. Tabulated values are presented in Table 5. The values are the product of 999 permutations at each step as the sample size is increased by adding samples randomly. The figure and table indicate that, while the Sobs curve continued to incline smoothly, the Chao 2 curve reached an asymptote when approximately six samples were accumulated. The Chao 2 estimator predicted that the number of species in this community is expected to be about 75 with a standard deviation of 20 under conditions of infinite sampling. The survey recovered slightly more than 50% of the theoretical total species number.

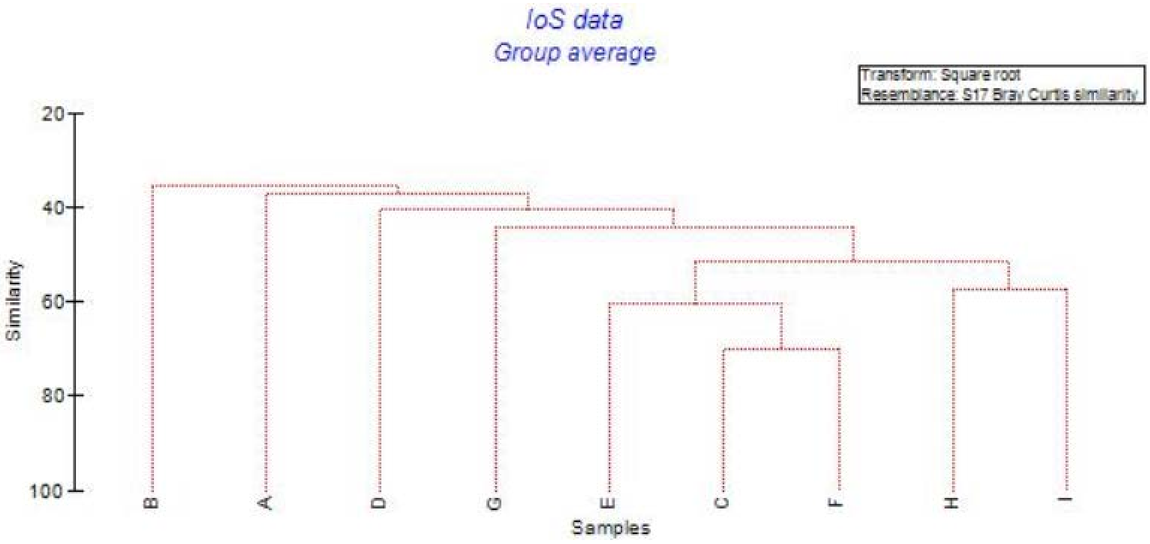

Figure 2. Dendrogram Based on a Group-Average Sorting Classification using the Bray-Curtis Similarity Measure on Square Root Transformed Data.

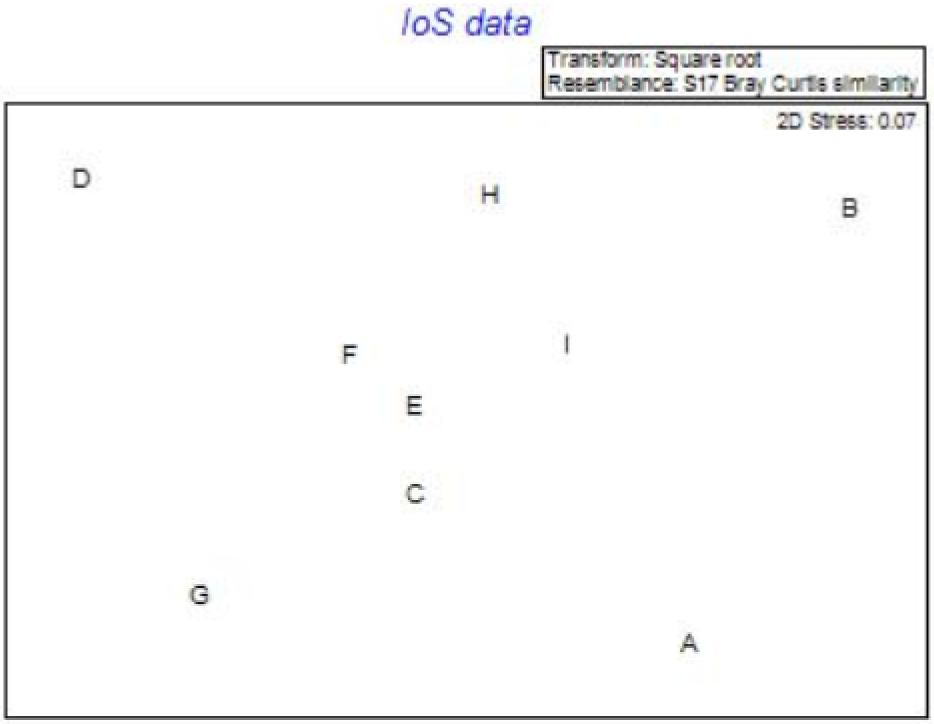

Figure 3. MDS Ordination of the Nine Samples Based on Square Root Transformed Species Abundances and Bray-Curtis Similarities (stress = 0.07).

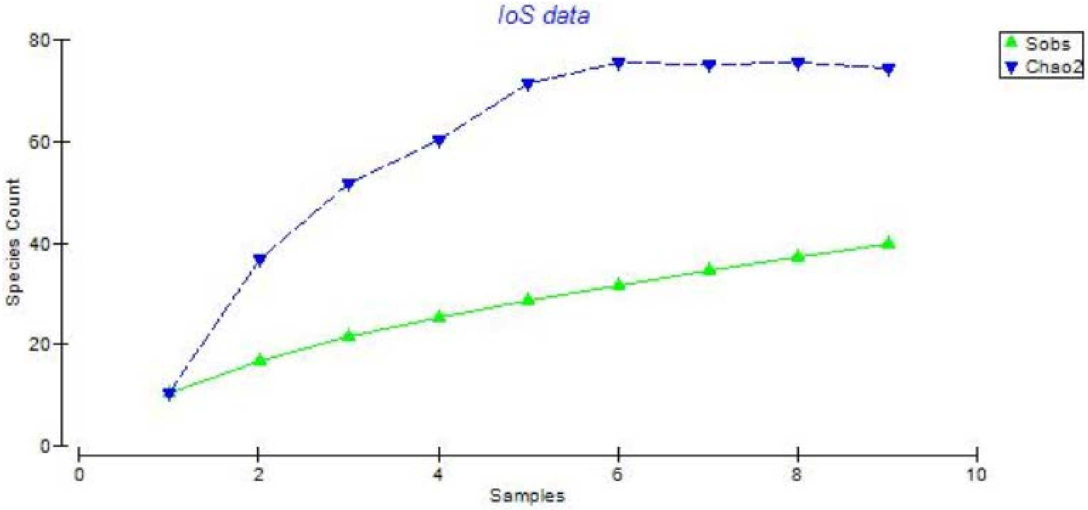

Figure 4. Plot of Observed Species Accumulation Curve (Sobs) and the Curve Predicted by the Chao 2 Extrapolator.

TABLE 5. Number of Observed Species (Sobs) and True Total Number of Species Predicted to be Found (Chao 2) with Infinite Sampling Following the Same Sampling Protocol

Station	Sobs	Sobs(SD)	Chao2	Chao2(SD)
1	10.62	3.66	10.62	12.69
2	16.65	3.91	36.05	15.56
3	21.42	3.91	50.39	24.20
4	25.43	3.54	60.79	28.43
5	28.89	3.28	70.93	33.98
6	32.07	2.85	76.53	33.15
7	34.85	2.31	75.54	27.57
8	37.54	1.56	76.50	24.95
9	40.00	0.00	74.57	20.56

DISCUSSION

The salient result of this benthic survey in the northwest Gulf of Maine is the uniformity of the environment both physically and biologically. The stations occur over a very narrow depth range and the sediments have a very high silt/clay content that can be described as silt (Table 1). In the limited area covered by the survey, there is no reason to suspect that temperatures and currents are not equally uniform.

The macroinvertebrate fauna at the site is limited. The benthic community consists of only 40 species representing just four phyla (Table 2). The assemblage is noteworthy for its lack of oligochaetes, nearly ubiquitous elsewhere, and the absence of echinoderms and colonial species. Polychaetes are the characteristic taxa overwhelmingly dominating the community in terms of numbers of species and individuals. Density is relatively low while the univariate statistics, species richness, diversity and evenness, are also at low to modest levels. One species, the polychaete *Paraonis gracilis*, is the numerical dominant at eight of the nine stations.

The zoogeographic affinities of the species that could be characterized range from Arctic to Virginian (Table 4). The largest group has a Boreal affinity followed by the Boreal-Virginian group accounting for about a third of the taxa. Fewer than one in ten of the taxa are considered to be either Arctic or Virginian. Numerically, however, individuals of the Boreal species make up nearly three-quarters of the community.

The functional group in this fine-grained habitat is overwhelmingly deposit feeders as would be expected. Species in this generalized feeding guild partition the environment by practicing several variations of obtaining nutrition from the sediments. Some, such as the four maldanid polychaete species, feed relatively deeply within the subsurface sediments. Other subsurface feeders, *Scalibregma inflatum*, feed higher in the sediment column while several other species, *Cossura longocirrata* and *Tharyx acutus*, feed on the very sediment surface.

Hence, a large number of deposit-feeders can be supported.

The biological homogeneity is confirmed by multivariate analyses of the community data. Cluster analysis does not dissect the stations into any discernible pattern. SIMPROF indicates that there are no statistically significant differences among the branches of the dendrogram (Figure 2). MDS analysis, likewise, shows no separation of samples that would indicate any coherent underlying biological divisions (Figure 3). It can be concluded that the samples were drawn from the same faunal community.

The species accumulation analyses are revealing. While the observed species curve climbs smoothly, the Chao 2 curve reaches an asymptote rather quickly (Figure 4, Table 5). This suggests that the true species complement would be reached with a finite amount of additional sampling. The Chao 2 estimate of the true species number is less than twice the number of species actually observed (Table 5) indicating that further sampling would add rare species to the species list while not affecting the numerical dominance observed (Appendix).

In summary, the study area is physically homogeneous and inhabited by a limited benthic invertebrate community. Richness, at the species and higher taxonomic levels, and density are low relative to both more inshore and more offshore habitats. Deposit-feeding polychaetes dominate the fauna qualitatively and quantitatively. The community can be considered Boreal in its zoogeographic affinity. Further sampling would undoubtedly add to the species total but would probably not modify the characterization of the community significantly. This communication helps to fill an identified gap in our knowledge of the Gulf of Maine ecosystem.

ACKNOWLEDGEMENTS

We are grateful to Hannah Proctor of Normandeau Associates for the confirmation of several polychaete identifications.

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APPENDIX

COMMUNITY STRUCTURE TABLES

TABLE 1A. Isles of Shoals-North Benthic Sample A

Species	Total	Cum. Tot.	%	Cum. %	Higher Taxon
Paraonis gracilis	8	8	25.8	25.8	Annelida
Lepidonotus squamatus	6	14	19.4	45.2	Annelida
Ampharete arctica	6	20	19.4	64.5	Annelida
Nemertean	3	23	9.7	74.2	Rhynchocoela
Cossura longocirrata	2	25	6.5	80.6	Annelida
Scoletoma tenuis	1	26	3.2	83.9	Annelida
Ceratocephale loveni	1	27	3.2	87.1	Annelida
Tharyx acutus	1	28	3.2	90.3	Annelida
Unknown	1	29	3.2	93.5	Annelida
Harpinia propinqua	1	30	3.2	96.8	Arthropoda
Eudorella pusilla	1	31	3.2	100.0	Arthropoda
Number of Species:	11				
Density (m^{-2}):	775				
Diversity (H'):	2.053				

TABLE 2A. Isles of Shoals-North Benthic Sample B

Species	Total	Cum. Tot.	%	Cum. %	Higher Taxon
Paraonis gracilis	4	4	13.8	13.8	Annelida
Ampharete arctica	4	8	13.8	27.6	Annelida
Ninoe nigripes	3	11	10.3	37.9	Annelida
Cossura longocirrata	2	13	6.9	44.8	Annelida
Sabaco elongatus	2	15	6.9	51.7	Annelida
Mediomastus ambiseta	1	16	3.4	55.2	Annelida
Maldane sarsi	1	17	3.4	58.6	Annelida
Aglaophamus neotenus	1	18	3.4	62.1	Annelida
Paraonis gracilis	4	22	13.8	75.9	Annelida
Ampharete arctica	4	26	13.8	89.7	Annelida
Ninoe nigripes	3	29	10.3	100.0	Annelida
Number of Species:	11				
Density (m^{-2}):	725				
Diversity (H'):	1.787				

TABLE 3A. Isles of Shoals-North Benthic Sample C

Species	Total	Cum. Tot.	%	Cum. %	Higher Taxon
Paraonis gracilis	20	20	60.6	60.6	Annelida
Cossura longocirrata	7	27	21.2	81.8	Annelida
Ampharete arctica	2	29	6.1	87.9	Annelida
Owenia fusiformis	2	31	6.1	93.9	Annelida
Ceratocephale loveni	1	32	3.0	97.0	Annelida
Paracaprella tenuis	1	33	3.0	100.0	Annelida
Number of Species:	6				
Density (m^{-2}):	825				
Diversity (H'):	1.184				

TABLE 4A. Isles of Shoals-North Benthic Sample D

Species	Total	Cum. Tot.	%	Cum. %	Higher Taxon
Cossura longocirrata	9	9	31.0	31.0	Annelida
Sabaco elongatus	4	13	44.8	44.8	Annelida
Mediomastus ambiseta	4	17	58.6	58.6	Annelida
Prionospio sp.	2	19	65.5	65.5	Annelida
Ceratocephale loveni	2	21	72.4	72.4	Annelida
Paramphinome pulchella	1	22	75.9	75.9	Annelida
Syllid juvenile	1	23	79.3	79.3	Annelida
Paraonis gracilis	1	24	82.8	82.8	Annelida
Owenia fusiformis	1	25	86.2	86.2	Annelida
Nephtys incisa	1	26	89.7	89.7	Annelida
Chaetozone setosa	1	27	93.1	93.1	Annelida
Leptocheirus plumulosus	1	28	96.6	96.6	Arthropoda
Astarte undata	1	29	100.0	100.0	Mollusca
Number of Species:	13				
Density (m^{-2}):	725				
Diversity (H'):	2.309				

TABLE 5A. Isles of Shoals-North Benthic Sample E

Species	Total	Cum. Tot.	%	Cum. %	Higher Taxon
Paraonis gracilis	22	22	38.6	38.6	Annelida
Cossura longocirrata	19	41	33.3	71.9	Annelida
Ampharete arctica	4	45	7.0	78.9	Annelida
Prionospio sp.	4	49	7.0	86.0	Annelida
Ceratocephale loveni	2	51	3.5	89.5	Annelida
Sabaco elongatus	2	53	3.5	93.0	Annelida
Ninoe nigripes	1	54	1.8	94.7	Annelida
Praxillella gracilis	1	55	1.8	96.5	Annelida
Thyasira sp.	1	56	1.8	98.2	Mollusca
Bivavle juv.	1	57	1.8	100.0	Mollusca
Number of Species:	10				
Density (m^{-2}):	1425				
Diversity (H'):	1.625				

TABLE 6A. Isles of Shoals-North Benthic Sample F

Species	Total	Cum. Tot.	%	Cum. %	Higher Taxon
Paraonis gracilis	16	16	42.1	42.1	Annelida
Cossura longocirrata	9	25	23.7	65.8	Annelida
Ampharete arctica	3	28	7.9	73.7	Annelida
Mediomastus ambiseta	3	31	7.9	81.6	Annelida
Ceratocephale loveni	2	33	5.3	86.8	Annelida
Praxillella gracilis	1	34	2.6	89.5	Annelida
Owenia fusiformis	1	35	2.6	92.1	Annelida
Micrura sp.	1	36	2.6	94.7	Rhynchocoela
Paracaprella tenuis	1	37	2.6	97.4	Arthropoda
Astarte undata	1	38	2.6	100.0	Mollusca
Number of Species:	10				
Density (m^{-2}):	950				
Diversity (H'):	1.740				

TABLE 7A. Isles of Shoals-North Benthic Sample G

Species	Total	Cum. Tot.	%	Cum. %	Higher Taxon
Paraonis gracilis	8	8	42.1	42.1	Annelida
Cossura longocirrata	4	12	21.1	63.2	Annelida
Owenia fusiformis	2	14	10.5	73.7	Annelida
Sabaco elongatus	1	15	5.3	78.9	Annelida
Aricidea suecica	1	16	5.3	84.2	Annelida
Prionospio sp.	1	17	5.3	89.5	Annelida
Chaetoderma nitidulum	1	18	5.3	94.7	Mollusca
Micrura sp.	1	19	5.3	100.0	Rhynchocoela
Number of Species:	8				
Density (m^{-2}):	475				
Diversity (H'):	1.704				

TABLE 8A. Isles of Shoals-North Benthic Sample H

Species	Total	Cum. Tot.	%	Cum. %	Higher Taxon
Paraonis gracilis	20	20	26.3	26.3	Annelida
Sabaco elongatus	15	35	19.7	46.1	Annelida
Ampharete arctica	7	42	9.2	55.3	Annelida
Praxillella gracilis	5	47	6.6	61.8	Annelida
Cossura longocirrata	4	51	5.3	67.1	Annelida
Prionospio sp.	4	55	5.3	72.4	Annelida
Scoletoma tenuis	3	58	3.9	76.3	Annelida
Mediomastus ambiseta	3	61	3.9	80.3	Annelida
Owenia fusiformis	2	63	2.6	82.9	Annelida
Ninoe nigripes	2	65	2.6	85.5	Annelida
Scalibregma inflatum	1	66	1.3	86.8	Annelida
Paramphinome pulchella	2	68	2.6	89.5	Annelida
Ceratocephale loveni	1	69	1.3	90.8	Annelida
Tharyx acutus	1	70	1.3	92.1	Annelida
Harmothoe extenuata	1	71	1.3	93.4	Annelida
Astarte undata	1	72	1.3	94.7	Mollusca
Thyasira gouldi	1	73	1.3	96.1	Mollusca
Parvicardium pinnulatum	1	74	1.3	97.4	Mollusca
Cyclaspis varians	1	75	1.3	98.7	Arthropoda
Leptostylis longimana	1	76	1.3	100.0	Arthropoda
Number of Species:	20				
Density (m^{-2}):	1900				
Diversity (H'):	2.367				

TABLE 9A. Isles of Shoals-North Benthic Sample I

Species	**Total**	**Cum. Tot.**	**%**	**Cum. %**	**Higher Taxon**
Paraonis gracilis	47	47	59.5	59.5	Annelida
Sabaco elongatus	7	54	8.9	68.4	Annelida
Cossura longocirrata	5	59	6.3	74.7	Annelida
Ampharete arctica	4	63	5.1	79.7	Annelida
Ninoe nigripes	3	66	3.8	83.5	Annelida
Mediomastus ambiseta	3	69	3.8	87.3	Annelida
Nemertean	3	72	3.8	91.1	Rhynchocoela
Praxillella praetermissa	2	74	2.5	93.7	Annelida
Owenia fusiformis	2	76	2.5	96.2	Annelida
Lumbrineris latreilli	1	77	1.3	97.5	Annelida
Lepidonotus squamatus	1	78	1.3	98.7	Annelida
Photis sp.	1	79	1.3	100.0	Arthropoda
Number of Species:	12				
Density (m^{-2}):	1975				
Diversity (H'):	1.526				

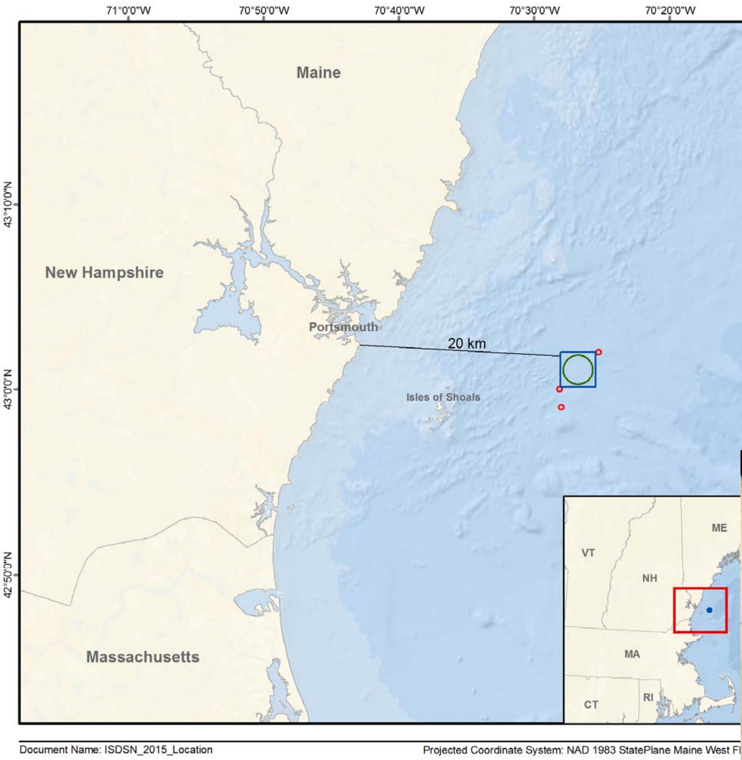
Environmental Assessment and Evaluation Study for a Designation of an Ocean Dredged Material Disposal Site in Southern Maine, New Hampshire, and Northern Massachusetts

Appendix C

DAMOS Summary Report for Monitoring Survey at IOSN

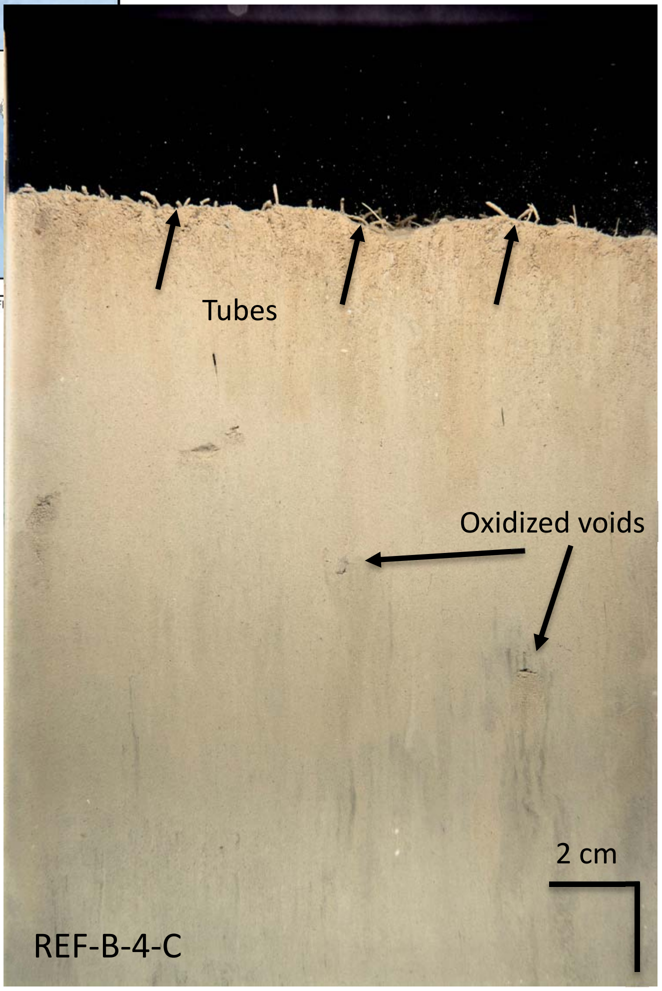
Data Summary Report for the Monitoring Survey at the Isles of Shoals Disposal Site North - September 2015

Disposal Area Monitoring System DAMOS



Document Name: ISDSN_2015_Location

Projected Coordinate System: NAD 1983 StatePlane Maine West Fl



D A M O S

DISPOSAL AREA MONITORING SYSTEM

Data Summary Report

2016-D-01

June 2016

US Army Corps of Engineers®

New England District

This report should be cited as:

Guarinello, M. L.; Carey, D. A.; Wright, C. 2016. Data Summary Report for the Monitoring Survey at the Isles of Shoals Disposal Site North, September 2015. U.S. Army Corps of Engineers, New England District, Concord, MA, 63 pp.

Note on units of this report: As a scientific data summary, information and data are presented in the metric system. However, given the prevalence of English units in the dredging industry of the United States, conversions to English units are provided for general information in Section 1. A table of common conversions can be found in Appendix A.

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LIST OF ACRONYMS

aRPD	Apparent redox potential discontinuity
ASCII	American Standard Code for Information Interchange
CCOM	Center for Coastal and Ocean Mapping
CI	Confidence interval
CTD	Conductivity-temperature-depth
DAMOS	Disposal Area Monitoring System
DGPS	Differential global positioning system
GIS	Graphic information system
GPS	Global positioning system
ISDSN	Isles of Shoals Disposal Site North
JHC	Joint Hydrographic Center
JPEG	Joint Photographic Experts Group
MBES	Multibeam echosounder
MLLW	Mean lower low water
MPRSA	Marine Protection Research and Sanctuaries Act
NAE	New England District
NEF	Nikon Electronic Format
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NTRIP	Network transport of RTCM data over IP
PV	Plan-view
RGB	Red green blue (file format)
RTCM	Radio Technical Commission for Maritime Services
RTK	Real time kinematic GPS
SHP	Shapefile or geospatial data file
SOP	Standard Operating Procedures
SPI	Sediment-profile imaging
TVG	time-varied gain
TIF	Tagged image file
USACE	U.S. Army Corps of Engineers

1.0 INTRODUCTION

A monitoring survey was conducted at a potential new open water dredged material disposal site, the Isles of Shoals Disposal Site North (ISDSN), in September 2015 as part of the U.S. Army Corps of Engineers (USACE) New England District (NAE) Disposal Area Monitoring System (DAMOS) Program. DAMOS is a comprehensive monitoring and management program designed and conducted to address environmental concerns surrounding the placement of dredged material at aquatic disposal sites throughout the New England region. An overview of the DAMOS Program and ISDSN is provided below.

1.1 Overview of the DAMOS Program

The DAMOS Program features a tiered management protocol designed to ensure that any potential adverse environmental impacts associated with dredged material disposal are promptly identified and addressed (Germano et al. 1994). For over 35 years, the DAMOS Program has collected and evaluated disposal site data throughout New England. Based on these data, patterns of physical, chemical, and biological responses of seafloor environments to dredged material disposal activity have been documented (Fredette and French 2004).

DAMOS monitoring surveys fall into two general categories: confirmatory studies and focused studies. The data collected and evaluated during these studies provide answers to strategic management questions in determining the next step in the disposal site management process to guide the management of disposal activities at existing sites, plan for use of future sites, and evaluate the long-term status of historic sites.

Confirmatory studies are designed to test hypotheses related to expected physical and ecological response patterns following placement of dredged material on the seafloor at established, active disposal sites. Two primary goals of DAMOS confirmatory monitoring surveys are to document the physical location and stability of dredged material placed into the aquatic environment and to evaluate the biological recovery of the benthic community following placement of dredged material. Several survey techniques are employed in order to characterize these responses to dredged material placement. Sequential acoustic monitoring surveys (including bathymetric, acoustic backscatter, and side-scan sonar data collection) are performed to characterize the height and spread of discrete dredged material deposits or mounds created at open water sites as well as the accumulation/consolidation of dredged material into confined aquatic disposal cells.

Sediment-profile (SPI) and plan-view (PV) imaging surveys are often performed in both confirmatory and focused studies to provide further physical characterization of the material and to support evaluation of seafloor (benthic) habitat conditions and recovery over time. Each type of data collection activity is conducted periodically at disposal sites and the conditions found after a defined period of disposal activity are compared with the long-term data set at specific sites to determine the next step in the disposal site management process (Germano et al. 1994).

Focused studies are periodically undertaken within the DAMOS Program to evaluate inactive or historical disposal sites and contribute to the development of dredged material placement and management techniques. Focused DAMOS monitoring surveys may also feature additional types of data collection activities as deemed appropriate to achieve specific survey objectives, such as subbottom profiling, towed video, sediment coring, or grab sampling. The 2015 ISDSN investigation was considered a confirmatory/reconnaissance study for possible designation of the site as a formal disposal site by the U.S. Environmental Protection Agency (USEPA) under Section 103 of the Marine Protection Research and Sanctuaries Act (MPRSA). This survey included a baseline acoustic survey and a SPI/PV imaging survey.

1.2 Introduction to the Isles of Shoals Disposal Site North

ISDSN is located in the Gulf of Maine, approximately 20 km (10.8 nmi) east of Portsmouth, New Hampshire (Figure 1-1). ISDSN is being considered by NAE for selection as a dredged material disposal site and for possible designation by USEPA under Section 103 of MPRSA. This potential disposal site is currently defined as a 3000-m (9840-ft) diameter circle on the seafloor with its center located at 70° 26.680' W and 43° 1.309' N. Three potential reference areas (REF-A, REF-B, and REF-C) were defined as 250-m radius circles located at 70° 25.165' W, 42° 59.282' N; 70° 28.039' W, 43° 0.257' N; and 70° 27.895' W, 43° 2.280' N, respectively (Figure 1-2). Reference areas were selected based on a review of existing data prior to the survey to represent areas of the seafloor with similar bathymetric characteristics. Previous work at the site has included side-scan sonar performed by USEPA from their ocean survey vessel *BOLD* and grab sampling for grain size and benthic biology analysis performed by NAE (all unpublished data).

Water depths at ISDSN vary from 78 m (255 ft) to 104 m (340 ft) and gradually slope from approximately 90 m (295 ft) on the western boundary to 100 m (328 ft) in the southeastern portion of the site (Figure 1-2). Topographic highs are present in the northwest, southeast, and northeast corners of the site (Figure 1-2). In 2015 the Center for Coastal and Ocean Mapping Joint Hydrographic Center at the University of New Hampshire (UNH/NOAA CCOM) published composite bathymetric and backscatter data for the Western Gulf of Maine, an area that includes ISDSN (UNH/NOAA CCOM 2015). These data were used for comparison purposes.

1.3 2015 Survey Objectives

An acoustic survey was conducted at ISDSN to characterize the seafloor topography and surface features. Additionally, a sediment-profile/plan-view (SPI/PV) imaging survey was conducted to further define the physical characteristics of surface sediment and to assess the benthic status over the proposed site and potential reference areas (Figure 1-2).

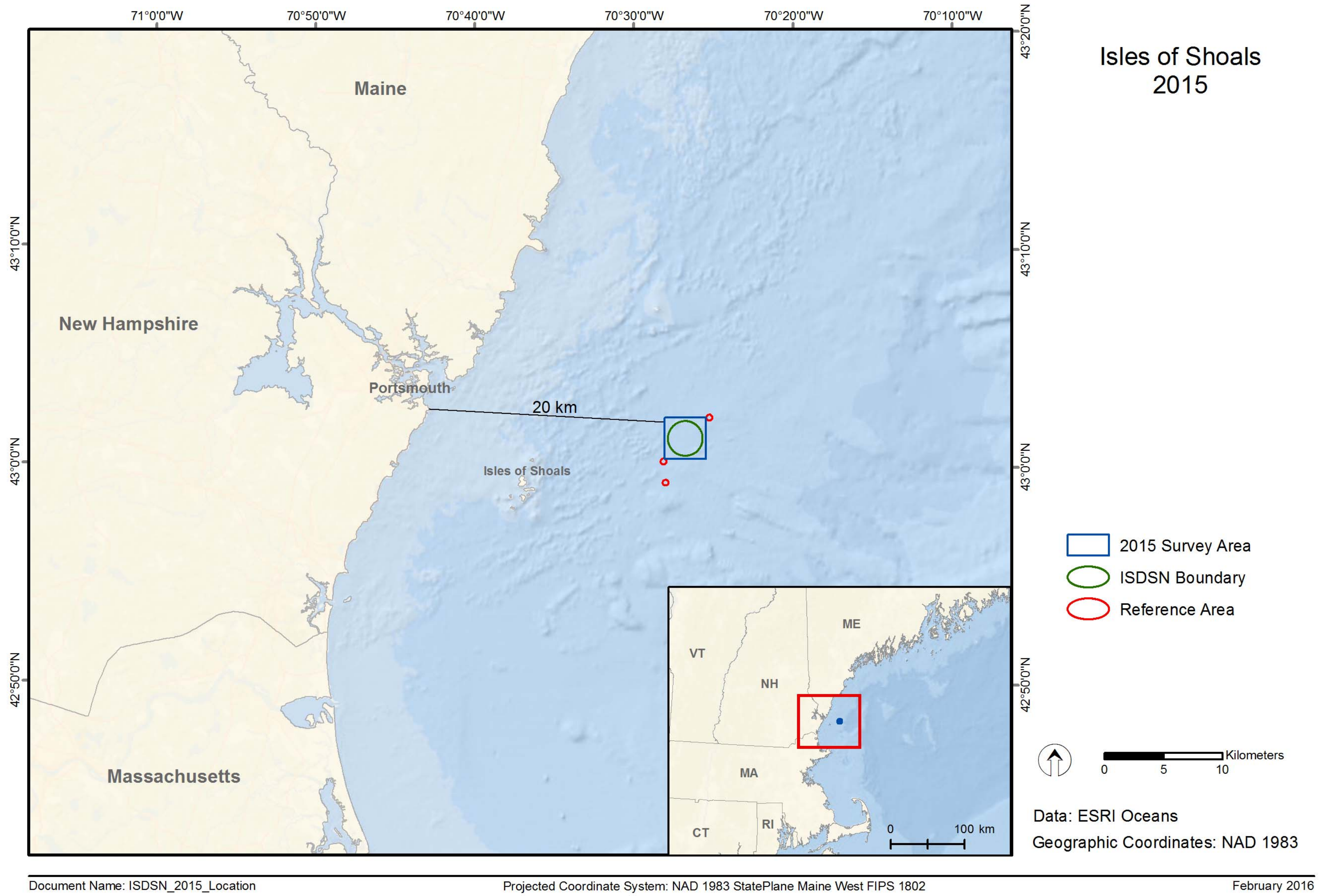


Figure 1-1. Location of Isles of Shoals Disposal Site North (ISDSN)

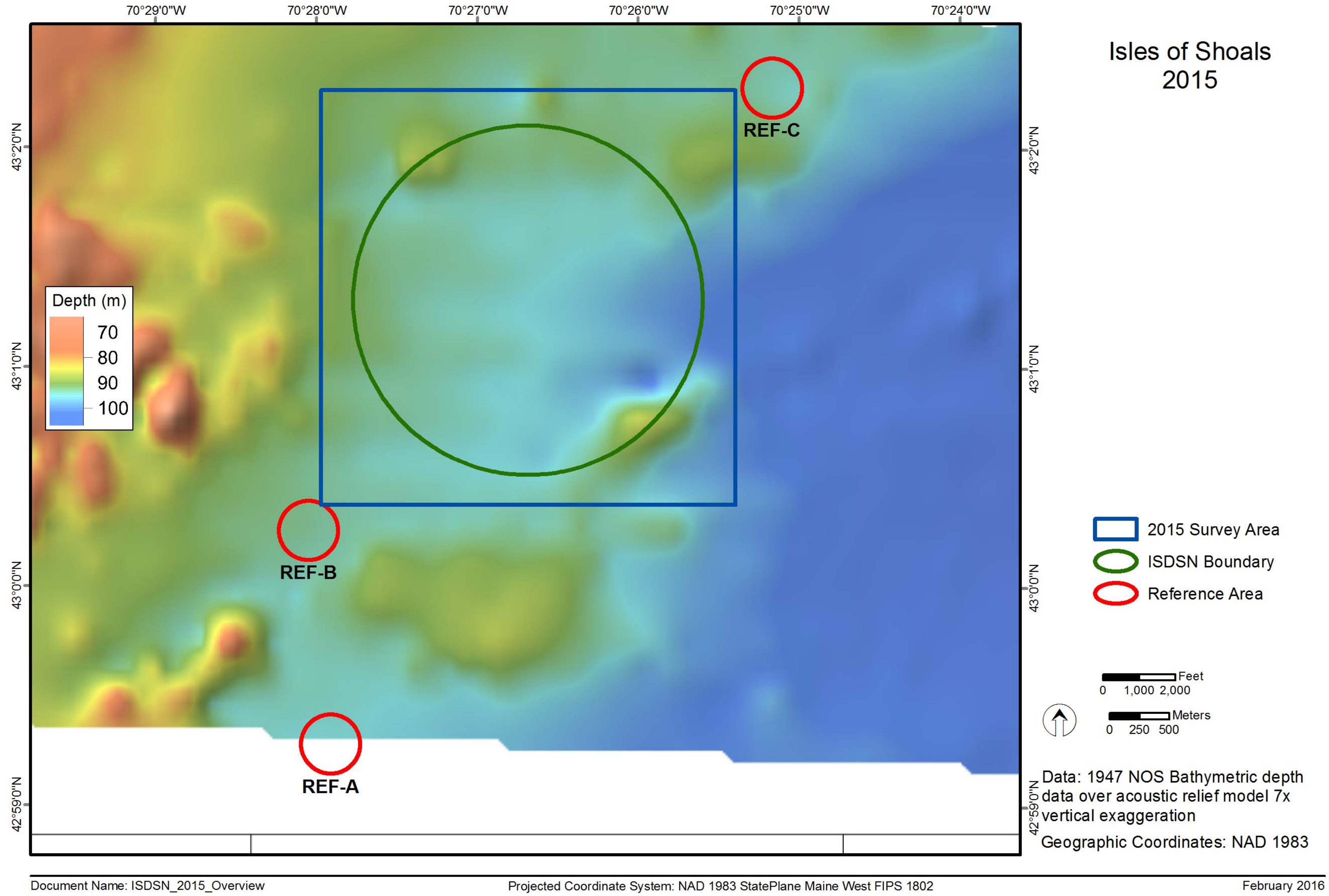


Figure 1-2. ISDSN site boundary and reference areas on existing bathymetry from an NOS 1947 data set

2.0 METHODS

The September 2015 survey at ISDSN was conducted by a team of investigators from DAMOSVision (CoastalVision, CR Environmental, and Germano & Associates) aboard the 55-foot R/V *Jamie Hanna*. The acoustic survey was conducted 15-16 September 2015 and the SPI/PV survey was conducted 25-27 September 2015. An overview of the methods used to collect, process, and analyze the survey data is provided below. Detailed Standard Operating Procedures (SOPs) for data collection and processing are available in Carey et al. (2013).

2.1 Navigation and On-Board Data Acquisition

Navigation for the acoustic survey was accomplished using a Hemisphere VS-330 Real-time kinematic Global Positioning System (RTK GPS) which received base station correction through the Keynet NTRIP broadcast. Horizontal position accuracy in fixed RTK mode was approximately 2 cm. A dual-antennae Hemisphere VS110 differential GPS (DGPS) was available if necessary as a backup. The GPS system was interfaced to a desktop computer running HYPACK MAX® hydrographic survey software. HYPACK MAX® continually recorded vessel position and GPS satellite quality and provided a steering display for the vessel captain to accurately maintain the position of the vessel along pre-established survey transects and targets. Vessel heading measurements were provided by an IxBlue Octans III fiber optic gyrocompass.

Navigation for the SPI survey was accomplished using a Hemisphere R110 sub-meter DGPS.

2.2 Acoustic Survey

The acoustic survey included bathymetric, backscatter, and side-scan sonar data collection. The bathymetric data provided measurements of water depth that, when processed, were used to map the seafloor topography. Backscatter and side-scan sonar data provided images that supported the characterization of surface sediment texture and roughness. Each of these acoustic data types is useful for assessing dredged material placement and surface sediment features.

2.2.1 Acoustic Survey Planning

The acoustic survey featured a high spatial resolution survey of ISDSN. DAMOSVision hydrographers coordinated with USACE NAE scientists and reviewed alternative survey designs. For ISDSN, a 3500 × 3500 m area was selected. Hydrographers obtained site coordinates, imported them to graphic information system (GIS) software, and created maps to aid planning. Base bathymetric data were obtained from the National Ocean Service Hydrographic Data Base to estimate the transect separation required to obtain full bottom coverage using an assumed beam angle limit of 90-degrees (45 degrees to port, 45 degrees to starboard). Transects spaced 150 m apart and cross-lines spaced 500 m apart were created to meet conservative beam angle constraints (Figure 2-1). The proposed survey area and design were then reviewed and approved by NAE scientists. Additional transects were added to the southwest and northeast of the primary survey area to characterize potential reference areas.

2.2.2 Acoustic Data Collection

The 2015 multibeam bathymetric survey of ISDSN was conducted 15-16 September 2015. Data layers generated by the survey included bathymetric, acoustic backscatter, and side-scan sonar and were collected using an R2Sonic 2022 broadband multibeam echosounder (MBES). This 200-400 kHz system forms up to 256 1-2° beams (frequency dependent) distributed equiangularly or equidistantly across a 10-160° swath. The MBES transducer was mounted amidships to the port rail of the survey vessel using a high strength adjustable boom. The primary GPS antenna was mounted on the transducer boom. The transducer depth below the water surface (draft) and antenna height were checked and recorded at the beginning and end of data acquisition, and the draft was confirmed using the "bar check" method.

An IxBlue Octans III motion reference unit (MRU) was interfaced to the MBES topside processor and to the acquisition computer. Precise linear offsets between the MRU and MBES were recorded and applied during acquisition. Depth and backscatter data were synchronized using pulse-per-second timing and transmitted to the HYPACK MAX® acquisition computer via Ethernet communications. Several patch tests were conducted during the survey to allow computation of angular offsets between the MBES system components.

The system was calibrated for local water mass speed of sound by performing sound velocity profile (SVP) casts at frequent intervals throughout the survey day using a Seabird, Inc. SBE-19 CTD.

2.2.3 Bathymetric Data Processing

Bathymetric data were processed using HYPACK HYSWEEP® software. Processing components are described below and included:

- Adjustment of data for tidal elevation fluctuations
- Correction of ray bending (refraction) due to density variation in the water column
- Removal of spurious points associated with water column interference or system errors
- Development of a grid surface representing depth solutions
- Statistical estimation of sounding solution uncertainty
- Generation of data visualization products

Tidal adjustments were accomplished using RTK GPS. Water surface elevations derived using RTK were adjusted to Mean Lower Low Water (MLLW) elevations using NOAA's VDATUM Model. Processed RTK tide data were successfully ground-truthed against a data series acquired at NOAA's Fort Point Tide Station (#8423898). While tidal amplitudes from RTK data and NOAA data were similar, the comparison documented a high tide time offset of approximately -15 minutes between the NOAA Station and the survey area.

Correction of sounding depth and position (range and azimuth) for refraction due to water column stratification was conducted using a series of fourteen sound-velocity profiles acquired by the survey team. Data artifacts associated with refraction remain in the bathymetric surface model at a relatively fine scale (generally less than 5 to 10 cm) relative to the survey depth.

Data acquired in the disposal site portion of the survey area were filtered to accept only beams falling within an angular limit of 45° to minimize refraction artifacts. Spurious sounding solutions were rejected based on the careful examination of data on a sweep-specific basis.

The R2Sonics 2022 MBES system was operated at 200 kHz. At this frequency the system has a published beam width of 2.0°. Assuming an average depth of 94 m and a maximum beam angle of 45°, the average diameter of the beam footprint was calculated at approximately 3.8 × 3.6 m (13.7 m^2). Data were reduced to a cell (grid) size of 5.0 × 5.0 m, acknowledging the system's fine range resolution while accommodating beam position uncertainty. This data reduction was accomplished by calculating and exporting the average elevation for each cell in accordance with USACE recommendations (USACE 2013).

Statistical analysis of data as summarized on Table 2-1 showed negligible tide bias and vertical uncertainty substantially lower than values recommended by USACE (2013) or NOAA (2015). Note that the most stringent National Ocean Service (NOS) standard for this project depth (Special Order 1A) would call for a 95th percentile confidence interval (95% CI) of 0.82 m at the maximum site depth (103.8 m) and 0.75 m at the average site depth (94.1 m).

Reduced data were exported in ASCII text format with fields for Easting, Northing, and MLLW Elevation (meters). All data were projected to the Maine State Plane (West), NAD83 (metric). A variety of data visualizations were generated using a combination of ESRI ArcMap (V.10.1) and Golden Software Surfer (V.13). Visualizations and data products included:

- ASCII data files of all processed soundings including MLLW depths and elevations
- Contours of seabed elevation (50-cm and 1.0-m intervals) in a geospatial data file (SHP) format suitable for plotting using GIS and computer-aided design software
- 3-dimensional surface maps of the seabed created using 5× vertical exaggeration and artificial illumination to highlight fine-scale features not visible on contour layers delivered in grid and tagged image file (TIF) formats, and
- An acoustic relief map of the survey area created using 2× vertical exaggeration, delivered in georeferenced TIF format.

2.2.4 Backscatter Data Processing

Backscatter data were extracted from cleaned MBES TruePix formatted files then used to provide an estimation of surface sediment texture based on seabed surface roughness. Mosaics of backscatter data were created using HYPACK®'s implementation of GeoCoder software developed by scientists at the University of New Hampshire's NOAA Center for Coastal and Ocean Mapping (UNH/NOAA CCOM). A seamless mosaic of unfiltered backscatter data was developed and exported in grayscale TIF format. Backscatter data were also exported in ASCII format with fields for Easting, Northing, and backscatter (dB). A Gaussian filter was applied to backscatter data to minimize nadir artifacts and the filtered data were used to develop backscatter values on a 2-m grid. The grid was exported as an ESRI binary GRD format to facilitate comparison with other data layers.

2.2.5 Side-Scan Sonar Data Processing

Side-scan sonar data were processed using both Chesapeake Technology, Inc. Sonar Wiz software and HYPACK®'s implementation of GeoCoder software to generate a database of images that maximized both textural information and structural detail.

A seamless mosaic of side-scan sonar data was developed using GeoCoder and exported in grayscale TIF format using a resolution of 0.35 m per pixel. This mosaic optimized textural information but is less well suited for analysis of fine seabed structures due to blending of overlapping data. Three additional mosaics of side-scan data were created using SonarWiz to facilitate detailed inspection of sonar imagery. Mosaic versions included raw swath data, data with a customized time-varied gain (TVG) curve developed to normalize across-track signal attenuation, and a version that utilized an automatic gain adjustment algorithm.

2.2.6 Acoustic Data Analysis

The processed bathymetric grids were converted to rasters, and bathymetric contour lines and acoustic relief models were generated and displayed using GIS. The backscatter mosaics and filtered backscatter grid were combined with acoustic relief models in GIS to facilitate visualization of relationships between acoustic datasets. This is done by rendering images and color-coded grids with sufficient transparency to allow three-dimensional acoustic relief model to be visible underneath.

2.3 Sediment-Profile and Plan-View Imaging Survey

SPI/PV imaging are monitoring techniques used to provide data on the physical characteristics of the seafloor and the status of the benthic biological community (Germano et al. 2011).

2.3.1 SPI and PV Survey Planning

For the ISDSN survey, a total of 45 SPI/PV stations were planned with 30 stations located in the proposed disposal site, and 5 stations in each of the three proposed reference areas (REF-A, REF-B, and REF-C). A random location generator was used to select the locations of all the SPI/PV stations (Figure 2-2). SPI/PV station locations are provided in Table 2-1 and actual SPI/PV station replicate locations are provided in Appendix B.

2.3.2 Sediment-Profile Imaging

The SPI technique involves deploying an underwater camera system to photograph a cross-section of the sediment-water interface. In the 2015 survey at ISDSN, high-resolution SPI images were acquired using a Nikon® D7100 digital single-lens reflex camera mounted inside an Ocean Imaging® Model 3731 pressure housing. The pressure housing sat atop a wedge-shaped steel prism with a glass front faceplate and a back mirror. The mirror was mounted at a 45° angle to reflect the profile of the sediment-water interface. As the prism penetrated the seafloor, a trigger activated a time-delay circuit that fired an internal strobe to obtain a cross-sectional image of the upper 15–20 cm of the sediment column (Figure 2-3).

The camera remained on the seafloor for approximately 20 seconds to ensure that a successful image had been obtained. Details of the camera settings for each digital image are available in the associated parameters file embedded in each electronic image file. For this survey, the ISO-equivalent was set at 640, shutter speed was 1/250, f-stop was f9, and storage was in compressed raw Nikon Electronic Format (NEF) files (approximately 30 MB each).

Test exposures of the X-Rite Color Checker Classic Color Calibration Target were made on deck at the beginning of the survey to verify that all internal electronic systems were working to design specifications and to provide a color standard against which final images could be checked for proper color balance. After deployment of the camera at each station, the frame counter was checked to ensure that the requisite number of replicates had been obtained. In addition, a prism penetration depth indicator on the camera frame was checked to verify that the optical prism had actually penetrated the bottom to a sufficient depth. If images were missed or the penetration depth was insufficient, the camera frame stop collars were adjusted and/or weights were added or removed, and additional replicate images were taken. Changes in prism weight amounts, the presence or absence of mud doors, and frame stop collar positions were recorded for each replicate image.

Each image was assigned a unique time stamp in the digital file attributes by the camera's data logger and cross-checked with the time stamp in the navigational system's computer data file. In addition, the field crew kept redundant written sample logs. Images were downloaded periodically to verify successful sample acquisition and/or to assess what type of sediment/depositional layer was present at a particular station. Digital image files were renamed with the appropriate station names immediately after downloading as a further quality assurance step.

2.3.3 Plan-View Imaging

An Ocean Imaging® Model DSC24000 plan-view underwater camera (PV) system with two Ocean Imaging® Model 400-37 Deep Sea Scaling lasers was attached to the sediment-profile camera frame and used to collect plan-view photographs of the seafloor surface; both SPI and PV images were collected during each "drop" of the system. The PV system consisted of a Nikon D-7100 encased in an aluminum housing, a 24 VDC autonomous power pack, a 500 W strobe, and a bounce trigger. A weight was attached to the bounce trigger with a stainless steel cable so that the weight hung below the camera frame; the scaling lasers projected two red dots that are separated by a constant distance (26 cm) regardless of the field-of-view of the PV system. The field-of-view can be varied by increasing or decreasing the length of the trigger wire and thereby the camera height above the bottom when the picture is taken. As the camera apparatus was lowered to the seafloor, the weight attached to the bounce trigger contacted the seafloor prior to the camera frame hitting the bottom and triggered the PV camera (Figure 2-3). Details of the camera settings for each digital image are available in the associated parameters file embedded in each electronic image file; for this survey, the ISO-equivalent was set at 640. The additional camera settings used were as follows: shutter speed 1/250, f14, white balance set to flash, color mode set to Adobe RGB, sharpening set to none, noise reduction off, and storage in compressed raw NEF files (approximately 30 MB each).

Prior to field operations, the internal clock in the digital PV system was synchronized with the GPS navigation system and the SPI camera. Each PV image acquired was assigned a time stamp in the digital file and redundant notations in the field and navigation logs. Throughout the survey, PV images were downloaded at the same time as the SPI images after collection and evaluated for successful image acquisition and image clarity.

The ability of the PV system to collect usable images was dependent on the clarity of the water column. Water conditions at ISDSN allowed use of a 0.9-m trigger wire, resulting in an area of bottom visualization approximately 1.0 m × 0.5 m in size.

2.3.4 SPI and PV Data Collection

The SPI/PV survey was conducted at ISDSN from 25-27 September 2015 aboard the R/V *Jamie Hanna*. At each station, the vessel was positioned at the target coordinates and the camera was deployed within a defined station tolerance of 10 m. Four replicate SPI and PV images were collected at each of the stations (Appendix B). The three replicates with the best quality images from each station were chosen for analysis (Appendix C).

The DGPS described above was interfaced to HYPACK® software via laptop serial ports to provide a method to locate and record sampling locations. Throughout the survey, the HYPACK® data acquisition system received DGPS data. The incoming data stream was digitally integrated and stored on the PC's hard drive. The system provided a steering display to enable the vessel captain to navigate to the pre-established survey target locations. The navigator electronically recorded the vessel's position when the equipment contacted the seafloor and the winch wire went slack. Each replicate SPI/PV position was recorded and time stamped. Actual SPI/PV sampling locations were recorded using this system.

2.3.5 Image Conversion and Calibration

Following completion of the field operations, the raw image files were color calibrated in Adobe Camera Raw® by synchronizing the raw color profiles to an X-Rite Color Checker Classic Color Calibration Target that was photographed on-site with the SPI camera. The raw images were then converted to high-resolution Photoshop Document (PSD) format files, using a lossless conversion file process, maintaining an Adobe RGB (1998) color profile. The PSD images were then calibrated and analyzed in Adobe Photoshop®. Image calibration was achieved by measuring the pixel length of a 5 cm scale bar printed on the X-Rite Color Checker Target, providing a pixel per centimeter calibration. This calibration information was applied to all SPI images analyzed. Linear and area measurements were recorded as the number of pixels and converted to scientific units using the calibration information.

Measured parameters were recorded on a Microsoft Excel© spreadsheet. Germano and Associates' senior scientist Dr. Joseph D. Germano subsequently checked these data as an independent quality assurance/quality control review of the measurements before final interpretation was performed. Spatial distributions of SPI parameters from stations within the study area were mapped using ArcGIS.

2.3.6 SPI and PV Data Analysis

Computer-aided analysis of the resulting images provided a set of standard measurements to allow comparisons between different locations and different surveys. The DAMOS Program has successfully used this technique for over 30 years to map the distribution of disposed dredged material and to monitor benthic recolonization at disposal sites.

2.3.6.1 SPI Data Analysis

Analysis of each SPI image was performed to provide measurement of the following standard set of parameters:

Sediment Type– The sediment grain size major mode and range were estimated visually from the images using a grain size comparator at a similar scale. Results were reported using the phi scale. Conversion to other grain size scales is provided in Appendix D. The presence and thickness of disposed dredged material were also assessed by inspection of the images.

Penetration Depth– The depth to which the camera penetrated into the seafloor was measured to provide an indication of the sediment density or bearing capacity. The penetration depth can range from a minimum of 0 cm (i.e., no penetration on hard substrata) to a maximum of 20 cm (full penetration on very soft substrata).

Surface Boundary Roughness– Surface boundary roughness is a measure of the vertical relief of features at the sediment-water interface in the sediment-profile image. Surface boundary roughness was determined by measuring the vertical distance between the highest and lowest points of the sediment-water interface. The surface boundary roughness measured over the width of sediment-profile images typically ranges from 0 to 4 cm and may be related to physical structures (e.g., ripples, rip-up structures, mud clasts) or biogenic features (e.g., burrow openings, fecal mounds, foraging depressions).

Apparent Redox Potential Discontinuity (aRPD) Depth– The aRPD depth provides a measure of the integrated time history of the balance between near-surface oxygen conditions and biological reworking of sediments. Sediment particles exposed to oxygenated waters oxidize and lighten in color to brown or light gray. As the particles are buried or moved down by biological activity, they are exposed to reduced oxygen concentrations in subsurface pore waters and their oxic coating slowly reduces, changing color to dark gray or black. When biological activity is high, the aRPD depth increases; when it is low or absent, the aRPD depth decreases. The aRPD depth was measured by visually assessing color and reflectance boundaries within the images, and for each image a mean aRPD was calculated.

Infaunal Successional Stage– Infaunal successional stage is a measure of the biological community inhabiting the seafloor. Current theory holds that organism-sediment interactions in fine-grained sediments follow a predictable sequence of development after a major disturbance (such as dredged material disposal) and this sequence has been divided subjectively into four stages (Rhoads and Germano 1982, 1986). Successional stage was assigned by assessing which types of species or organism-related activities were apparent in the images (Figure 2-4).

Additional components of the SPI analysis included calculation of means and ranges for the parameters listed above and mapping of means of replicate values from each station. Station means were calculated from three replicates from each station and used in statistical analysis.

2.3.6.2 PV Data Analysis

The PV images provided a much larger field-of-view than the SPI images and provided valuable information about the landscape ecology and sediment topography in the area where the pinpoint "optical core" of the sediment profile was taken. Unusual surface sediment layers, textures, or structures detected in any of the sediment-profile images can be interpreted in light of the larger context of surface sediment features; i.e., is a surface layer or topographic feature a regularly occurring feature and typical of the seafloor in this general vicinity or just an isolated anomaly? The scale information provided by the underwater lasers allows for accurate density counts (number per square meter) of attached epifaunal colonies, sediment burrow openings, or larger macrofauna or fish which may have been missed in the sediment-profile cross section. Information on sediment transport dynamics and bedform wavelength were also available from PV image analysis. Analysts calculated the image size and field-of-view and noted sediment type; recorded the presence of bedforms, burrows, tubes, tracks, trails, epifauna, mud clasts, and debris; and included descriptive comments (Appendix C).

2.3.7 Statistical Methods

In order to meet the objective of this survey to assess the baseline status of benthic community at the proposed disposal site relative to reference area conditions, statistical analyses were conducted to compare key SPI variables between the proposed disposal site and reference areas (REF-A, REF-B, REF-C). The aRPD depth and successional stage measured in each image are the best indicators of infaunal activity measured by SPI and were, therefore, used in this comparative analysis. Standard boxplots were generated for visual assessment of the central tendency and variation in each of these variables within the proposed disposal site and each reference area. Tests rejecting the inequivalence between the reference areas and disposal site were conducted, as described in detail below.

The objective to look for differences is conventionally addressed using a point null hypothesis of the form, "There is no significant difference in benthic conditions between the reference area and the disposal site." However, there is always some difference (perhaps only to a very small decimal place) between groups, but the statistical significance of this difference may or may not be ecologically meaningful. On the other hand, differences may not be detected due to insufficient statistical power. Without a power analysis and specification of what constitutes an ecologically meaningful difference, the results of conventional point null hypothesis testing often provide inadequate information for ecological assessments (Germano 1999). An approach using an inequivalence null hypothesis will identify when groups are statistically similar, within a specified interval, which is more suited to the objectives of the DAMOS monitoring program.

For an inequivalence test, the null hypothesis presumes the difference is great; this is recognized as a "proof of safety" approach because rejection of the inequivalence null hypothesis requires sufficient proof that the difference was actually small (e.g., McBride 1999). The null and alternative hypotheses for the inequivalence hypothesis test are:

H_0: $d < -\delta$ or $d > \delta$ (presumes the difference is great)

H_A: $-\delta < d < \delta$ (requires proof that the difference is small)

where d is the difference between a reference mean and a site mean. If the inequivalence null hypothesis is rejected, then it is concluded that the two means are equivalent to one another within ±δ units. The size of δ should be determined from historical data, and/or best professional judgment, to identify a maximum difference that is within background variability and is therefore not ecologically meaningful. Primarily differences greater than δ are of ecological interest. Previously established δ values of 1 cm for aRPD depth, and 0.5 for successional stage rank (on the 0–3 scale) were used.

The test of this inequivalence (interval) hypothesis can be broken down into two one-sided tests, TOST (McBride 1999, Schuirmann 1987). Assuming a symmetric distribution, the inequivalence hypothesis is rejected at α of 0.05 if the 90% confidence interval for the measured difference (or, equivalently, the 95% upper limit *and* the 95% lower limit for the difference) is wholly contained within the equivalence interval [-δ, +δ]. The statistics used to test the interval hypotheses shown here are based on the Central Limit Theorem (CLT) and basic statistical properties of random variables. A simplification of the CLT states that the mean of any random variable is normally distributed. Linear combinations of normal random variables are also normal so a linear function of means is also normally distributed. When a linear function of means is divided by its standard error the ratio follows a t-distribution with degrees of freedom associated with the variance estimate. Hence, the t-distribution can be used to construct a confidence interval around any linear function of means.

In this survey, four distinct locations were sampled, three were categorized as reference areas (REF-A, REF-B, REF-C) and one was the proposed disposal location. The difference equation of interest was the linear contrast of the average of the three reference means minus the disposal site mean, or

$$\hat{d} = [1/3 \text{ x } (\text{Mean}_{\text{REF-A}} + \text{Mean}_{\text{REF-B}} + \text{Mean}_{\text{REF-C}}) - (\text{Mean}_{\text{Disposal}})] \qquad [\text{Eq. 1}]$$

where $\text{Mean}_{\text{Disposal}}$ was the mean for all samples within the proposed disposal site. The three reference areas collectively represented ambient conditions, but if the means were different among these three areas, then pooling them into a single reference group would inflate the variance estimate because it would include the variability between areas, rather than only the variability between stations within each single homogeneous area. The effect of keeping the three reference areas separate has no effect on the grand reference mean when sample size is equal among these areas, but it ensures that the variance is truly the residual variance within a single population with a constant mean.

The difference equation, $\hat{d}$, for the comparison of interest was specified in Eq. 1 and the standard error of this difference equation uses the fact that the variance of a sum is the sum of the variances for independent variables, or:

$$SE(\hat{d}) = \sqrt{\sum_j \left(S_j^2 c_j^2 / n_j\right)} \qquad \text{[Eq. 2]}$$

where:

c_j = coefficients for the *j* means in the difference equation, $\hat{d}$ [Eq. 1] (i.e., for equation 1 shown above, the coefficients were 1/3 for each of the 3 reference areas, and -1 for the proposed disposal site).

S_j^2 = variance for the *j*th area. If equal variances are assumed, the pooled residual variance estimate equal to the mean square error from an ANOVA based on all groups involved, can be used for each S_j^2.

n_j = number of stations for the *j*th area.

The inequivalence null hypothesis is rejected (and equivalence concluded) if the confidence interval on the difference of means, $\hat{d}$, is fully contained within the interval [–δ , + δ]. Thus the decision rule was to reject H_0 (the two groups are inequivalent) if:

$$D_L = \hat{d} - t_{\alpha,\upsilon} SE(\hat{d}) > -\delta \quad \text{and} \quad D_U = \hat{d} + t_{\alpha,\upsilon} SE(\hat{d}) < \delta \qquad \text{[Eq. 3]}$$

where:

$\hat{d}$ = observed difference in means between the reference areas and disposal site.

$t_{\alpha,\upsilon}$ = upper (1-α)*100th percentile of a Student's t-distribution with υ degrees of freedom (α = 0.05)

$SE(\hat{d})$ = standard error of the difference ([Eq. 2])

υ = degrees of freedom for the standard error. If a pooled residual variance estimate was used, this was the residual degrees of freedom from an ANOVA on all groups (total number of stations minus the number of groups); if separate variance estimates were used, degrees of freedom were calculated based on the Welch-Sattherthwaite estimation (Satterthwaite 1946, Welch 1947, with the results nicely summarized on the Wikipedia page for 'Welch-Satterthwaite equation'; a two sample example is found in Zar 1996).

Validity of normality and equal variance assumptions was tested using Shapiro-Wilk's test for normality on the area residuals ($\alpha = 0.05$) and Levene's test for equality of variances among the 4 areas ($\alpha = 0.05$). If normality was not rejected but equality of variances was, then normal parametric confidence bounds were calculated, using separate variance estimates for each group. If normality was rejected, then non-parametric bootstrapped estimates of the confidence bounds were calculated.

Table 2-1.

Accuracy and Uncertainty Analysis of Bathymetric Data

		Results (m)		
Survey Date(s)	**Quality Control Metric**	**Mean**	**95% Uncertainty**	**Range**
9/15-16/2015	Cross-Line Swath Comparisons	0.01	0.22	
	Within Cell Uncertainty	0.05	0.11	0.00 - 2.76
	Beam Angle Uncertainty (0 - 45d)	0.01	0.24	0.18 - 0.34

Notes:

1. The mean of cross-line nadir and full swath comparisons are indicators of tide bias.
2. 95% uncertainty values were calculated using the sums of mean differences and standard deviations expressed at the 2-sigma level.
3. Within cell uncertainty values include biases and random errors.
4. Beam angle uncertainty was assessed by comparing cross-line data (45-degree swath limit) with a reference surface created using mainstay transect data.
5. Swath and cell based comparisons were conducted using 5 m x 5 m cell averages. These analyses do not exclude sounding variability associated with terrain slopes. Uncertainties associated with slope are depicted on maps within the report.

Table 2-2.

ISDSN 2015 Survey Target SPI/PV Station Locations

Station Name	Easting	Northing	Latitude (N)	Longitude (W)
1	875912.3	22183.2	43° 1.958'	70° 27.734'
2	876412.2	22524.9	43° 2.144'	70° 27.367'
3	877234.2	22130.5	43° 1.933'	70° 26.761'
4	877545.5	22478.6	43° 2.121'	70° 26.533'
5	877941.7	22565.0	43° 2.168'	70° 26.241'
6	878791.4	22387.7	43° 2.074'	70° 25.615'
7	875969.1	21497.3	43° 1.588'	70° 27.691'
8	876584.5	21520.4	43° 1.602'	70° 27.238'
9	877339.6	21411.6	43° 1.544'	70° 26.681'
10	877728.6	21485.9	43° 1.585'	70° 26.396'
11	877985.3	21553.2	43° 1.622'	70° 26.207'
12	879052.3	21994.4	43° 1.862'	70° 25.422'
13	875832.2	20694.7	43° 1.154'	70° 27.790'
14	876554.8	21230.5	43° 1.445'	70° 27.259'
15	877289.0	20785.4	43° 1.206'	70° 26.717'
16	877801.4	21117.6	43° 1.387'	70° 26.341'
17	878404.0	21208.7	43° 1.437'	70° 25.898'
18	878830.8	20720.2	43° 1.174'	70° 25.582'
19	875797.3	20486.5	43° 1.042'	70° 27.815'
20	876498.9	20371.9	43° 0.982'	70° 27.298'
21	876919.1	20552.2	43° 1.079'	70° 26.989'
22	877888.8	20380.9	43° 0.989'	70° 26.275'
23	878195.8	20359.4	43° 0.977'	70° 26.049'
24	878642.4	20506.2	43° 1.058'	70° 25.721'
25	876075.3	19586.3	43° 0.556'	70° 27.608'
26	876515.2	19306.1	43° 0.406'	70° 27.283'
27	877318.7	19706.0	43° 0.623'	70° 26.693'
28	877533.2	19591.3	43° 0.562'	70° 26.535'
29	878431.0	19305.2	43° 0.409'	70° 25.873'
30	878971.3	19320.4	43° 0.418'	70° 25.476'
REF-A-01	875836.9	17199.6	43° -0.733'	70° 27.777'
REF-A-02	875624.1	17210.3	43° -0.728'	70° 27.934'
REF-A-03	875561.9	17012.4	43° -0.835'	70° 27.979'
REF-A-04	875537.4	17332.6	43° -0.662'	70° 27.998'
REF-A-05	875605.9	17165.6	43° -0.752'	70° 27.947'
REF-B-01	875644.3	18929.2	43° 0.200'	70° 27.923'

Station Name	Easting	Northing	Latitude (N)	Longitude (W)
REF-B-02	875339.8	19183.8	43° 0.337'	70° 28.148'
REF-B-03	875391.3	18874.4	43° 0.170'	70° 28.109'
REF-B-04	875358.0	19172.3	43° 0.331'	70° 28.135'
REF-B-05	875543.7	19033.2	43° 0.257'	70° 27.997'
REF-C-01	879365.9	22613.4	43° 2.197'	70° 25.193'
REF-C-02	879444.2	22982.5	43° 2.396'	70° 25.136'
REF-C-03	879499.2	22702.5	43° 2.245'	70° 25.095'
REF-C-04	879216.8	22819.3	43° 2.308'	70° 25.303'
REF-C-05	879286.3	22806.2	43° 2.301'	70° 25.252'

Notes
1. Grid coordinates are State Plane Maine West FIPS 1802 (NAD83), metric
2. Geographic coordinates are NAD83 degrees decimal minute

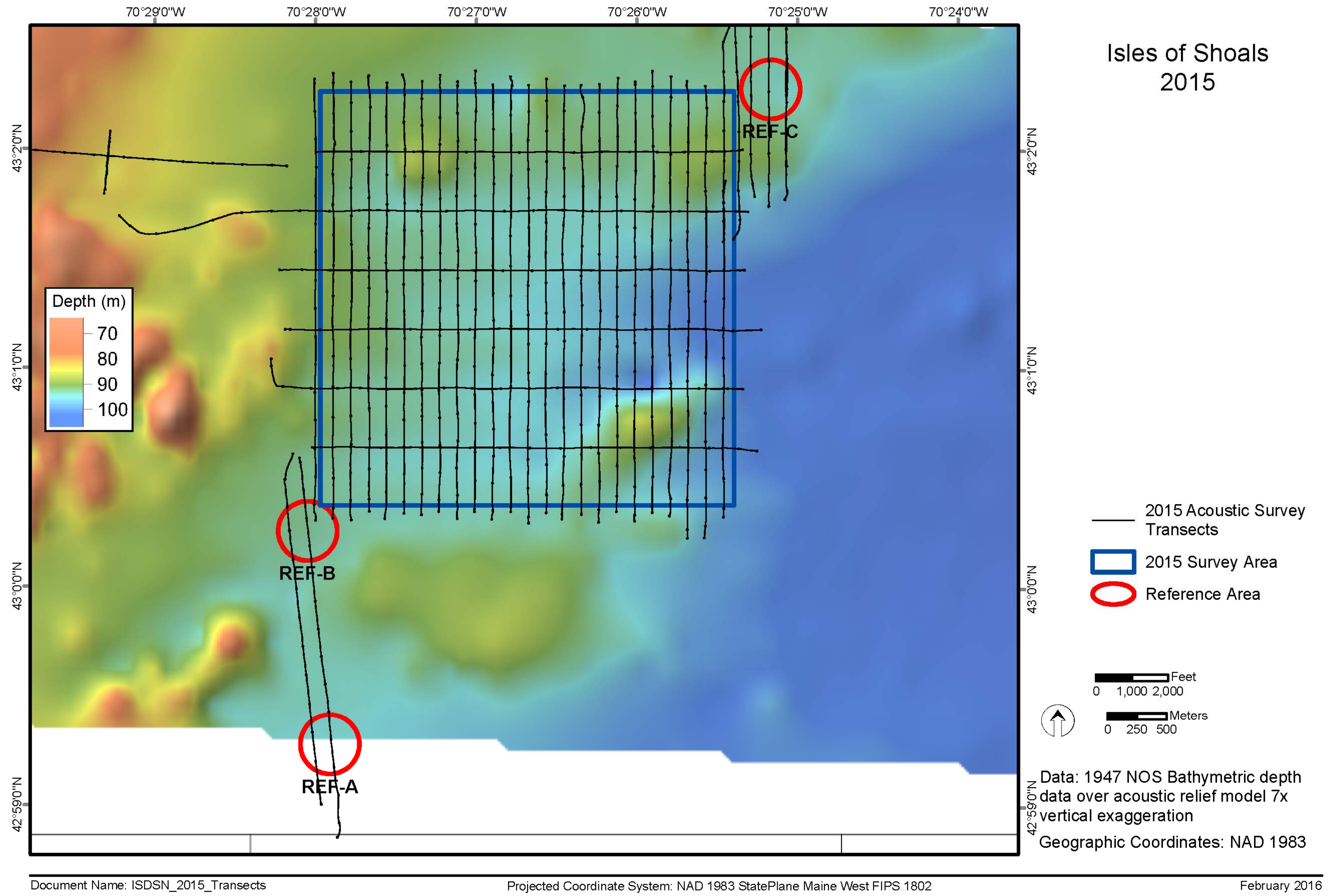


Figure 2-1. ISDSN acoustic survey area and tracklines

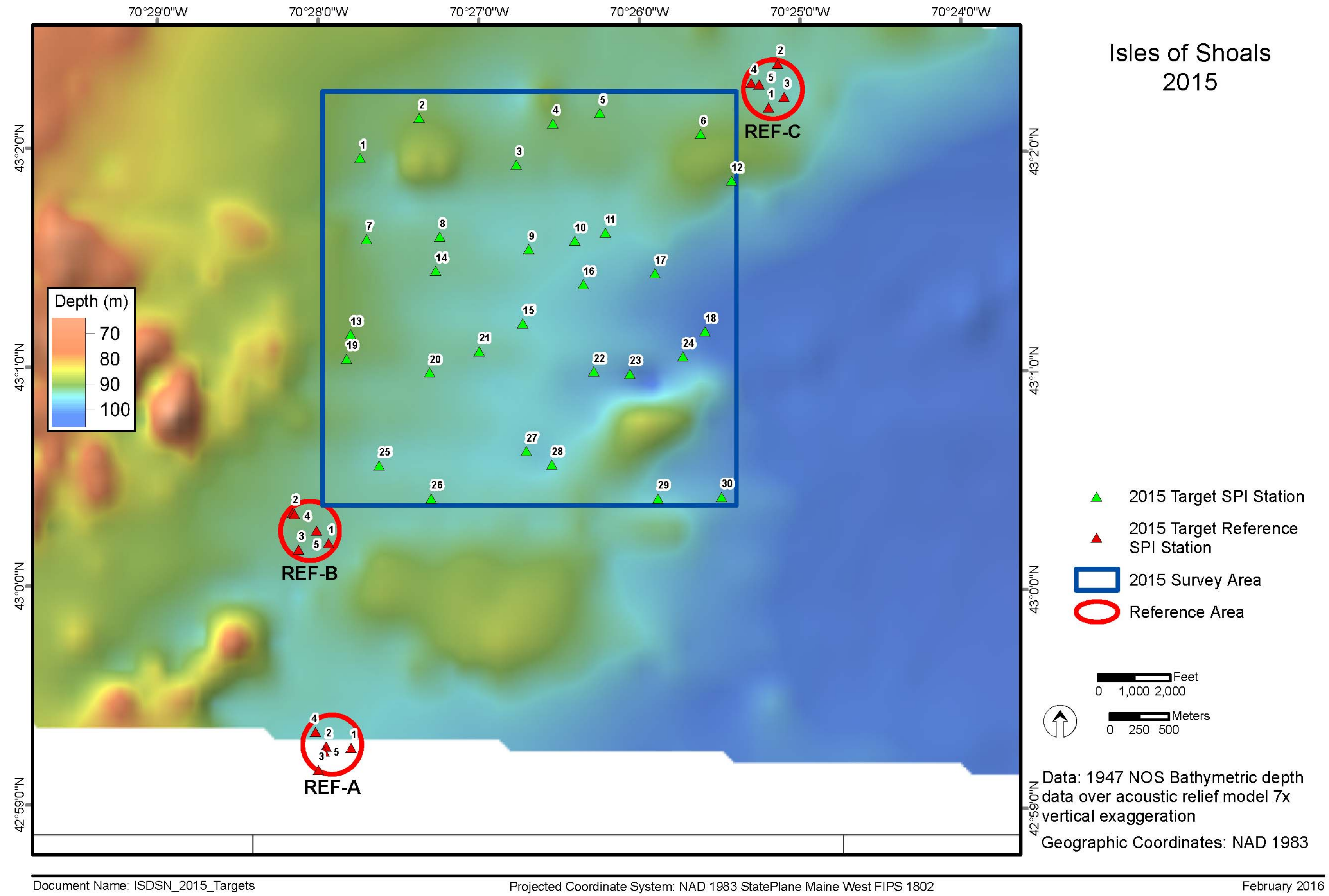


Figure 2-2. ISDSN proposed disposal site and reference areas with target SPI/PV stations

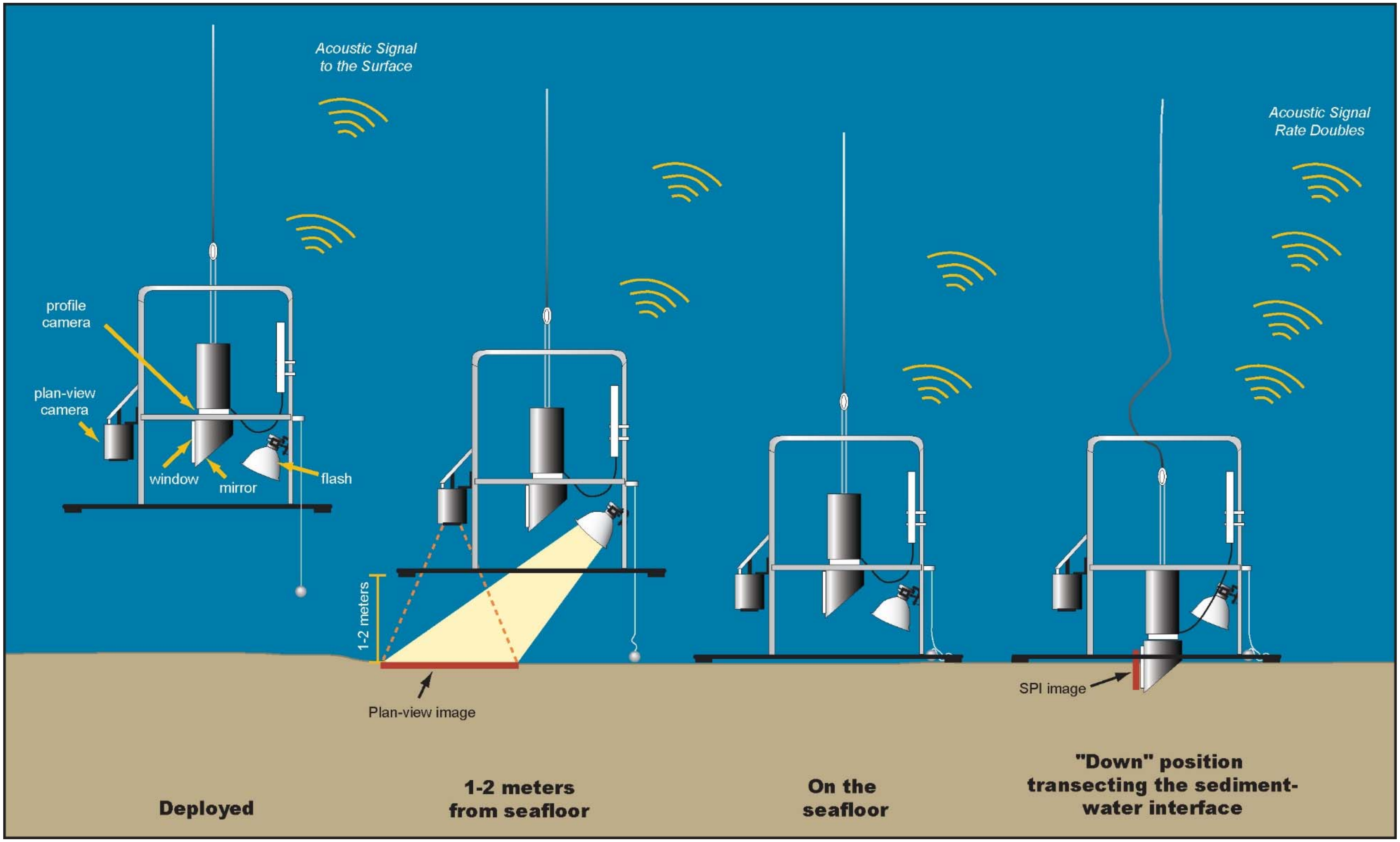


Figure 2-3. Schematic diagram of the SPI/PV camera deployment

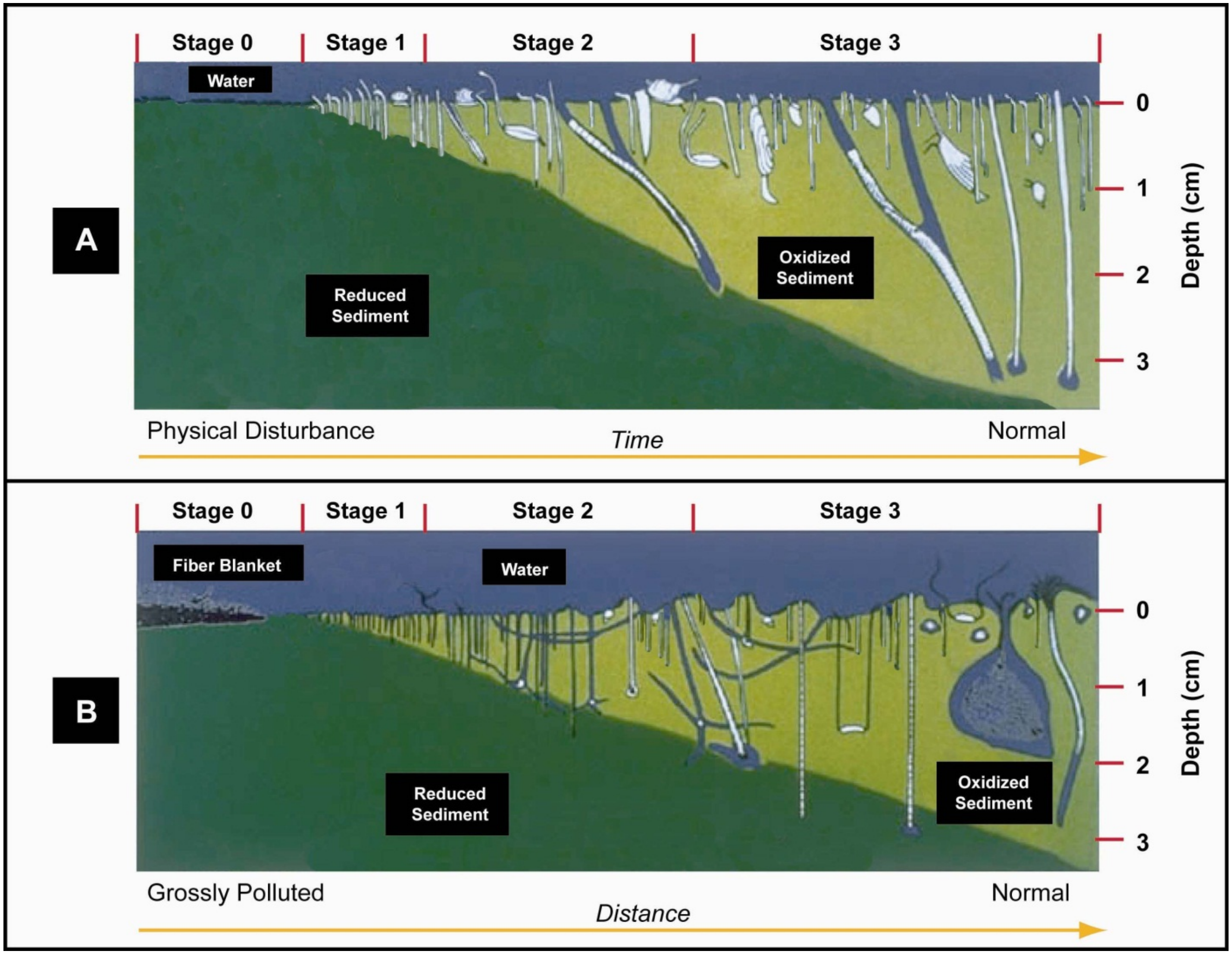


Figure 2-4. The stages of infaunal succession as a response of soft-bottom benthic communities to (A) physical disturbance or (B) organic enrichment; from Rhoads and Germano (1982)

3.0 RESULTS

3.1 Acoustic Survey

An acoustic survey was conducted in September 2015 to characterize seafloor topography and surface features over the entire ISDSN site and reference areas.

3.1.1 Bathymetry

Water depths at ISDSN varied from 77.7 m to 103.8 m and gradually sloped from approximately 90 m on the western boundary to 100 m in the southeastern portion of the site (Figure 3-1). Depths ranged from 90 to 95 m in the northeast portion of the site. The shallowest depths were on two distinct topographic highs in the southeast corner and northwest corners of ISDSN, rising from 10 to 20 m off the surrounding seafloor. The northeast quadrant of the site also had a noticeable topographic high, rising from 3 to 10 m from the surrounding seafloor (Figure 3-1).

Multibeam bathymetric data rendered as a color scale by depth over an acoustic relief model (grayscale with hill-shading) provided a more detailed representation of these topographic highs and of the entire site (Figure 3-2). These data also revealed several depressions near the center of the site, as well as a group of circular features in the northeast quadrant of the site (Figure 3-2). The small craters in the northeast quadrant are consistent with dredged material disposal features seen at other disposal sites and may indicate the presence of historical dredged material placement (Carey et al. 2013). Stations in this region and to the northeast in REF-C also had evidence of possible dredged material in SPI images (discussed below in section 3.2).

3.1.2 Acoustic Backscatter and Side-Scan Sonar

Acoustic backscatter data provided an estimate of surface sediment texture (hard, soft, rough, and smooth). Side-scan sonar data are higher resolution and more responsive to minor surface textural features and slope than backscatter results and can reveal additional information about topographic and textural properties of the seafloor.

A mosaic of unfiltered backscatter data for ISDSN (Figure 3-3) generally revealed the shallower areas as harder surfaces having a stronger acoustic return (lighter gray in Figure 3-3) and deeper areas as soft sediment having a weaker acoustic return (darker gray). Filtered backscatter results were processed into a grid file and presented in a quantitative form where backscatter intensity values were assigned a color (Figure 3-4). In this filtered and gridded display, the finer-scale details were less visible, but the relative intensity of backscatter returns were easier to discern.

Areas with stronger returns (-37 to -28 db) were the topographic highs in the northwest, southeast, and northeast corners of the site (Figure 3-3). Those in the northwest and southeast may be glacial outcrops based on their sharp topographic profiles, hard backscatter returns, and the textural differences evident in the side-scan sonar data (Figure 3-5).

Filtered backscatter data showed the larger depressions toward the center of the site clearly (Figure 3-4). These depressions had weaker return signals than surrounding sediments indicating softer sediments and the potential to serve as depositional areas for fine-grained sediments. The circular features in the northeast quadrant were also clearly visible in both the unfiltered backscatter (Figure 3-3) and side-scan sonar data (Figure 3-5). These results indicated that the small craters that make up the circular features were both softer than surrounding sediments (based on backscatter) and had different surface topographical/textural properties compared to surrounding sediments (based on side-scan sonar).

3.1.3 Comparison with Previous Bathymetry

The bathymetry data of ISDSN as surveyed in 2015 were consistent with existing bathymetric data, which were collected and aggregated at a regional scale (UNH/NOAA CCOM 2015). These data reveal the same topographic highs and lows as the 2015 survey data, as well as the area of circular features in the northeastern quadrant of the site.

3.2 Sediment-Profile and Plan-View Imaging

The primary purposes of the SPI/PV survey at ISDSN were to characterize the physical features of the surface sediment throughout the study area and to assess the status of benthic communities within the proposed disposal site. A station summary of some measured parameters can be found in Tables 3-1 and 3-2 with a complete set of results in Appendix C.

3.2.1 Reference Areas

There are three areas proposed as reference areas, REF-A located 2 km south of the southwest corner of the 2015 survey area, REF-B located at the southwest corner of the 2015 survey area, and REF-C located just outside the 2015 survey area at the northeast corner (Figure 3-6).

Physical Sediment Characteristics

Depth of reference area stations ranged from 92.7 m to 97.5 m with a mean of 95.2 m. All stations were characterized by soft muds (e.g., silt/clay) with a major grain size mode of >4 phi (Table 3-1, Figure 3-7). Camera penetration depths also indicated soft sediments with a mean penetration depth of 14.3 cm and a range from 8.9 to 16.9 cm (Table 3-1, Figure 3-8). The shallowest camera penetration depths were in REF-C, just to the northeast of the topographic rise found in the northeast corner of the survey area (Figure 2-2). Camera penetrations at REF-C were all shallower than 12.2 cm; in contrast, the minimum penetration depth at the other reference areas was 15.2 cm (Table 3-1, Figure 3-9).

Possible dredged material was visible at all stations in REF-C (Figure 3-9). Neither of the other references areas showed signs of dredged material. There was no evidence of low dissolved oxygen or sedimentary methane in the reference areas.

Boundary roughness ranged from 0.9 to 1.5 cm, with a mean of 1.2 cm (Figure 3-10). All of this small-scale topography can be attributed to the surface and subsurface activity of benthic organisms evidenced as small burrowing openings, pits, mounds, etc. (e.g., Figure 3-11).

Biological Conditions

The average station aRPD depths ranged from 4.6 to 8.2 cm with an overall mean of 7.0 cm (SD±1.1) across all reference stations (Table 3-1, Figure 3-12 and Appendix C). Mean aRPD depths at REF-C were all shallower than 6.7 cm; in contrast the minimum aRPD depth at the other reference areas was 7.2 cm (Figure 3-13). This is consistent with the shallower penetration depths observed at REF-C (Table 3-1). Overall the aRPD depths at the reference area stations were relatively deep, indicative of a healthy seafloor and were biologically modified by infaunal reworking.

Stage 3 infauna were present across all three reference areas with the predominant stage at all three reference areas being Stage 1 on 3 (Table 3-1, Figure 3-14). Evidence for the presence of Stage 3 fauna included large-bodied infauna, deep subsurface burrows, and/or deep feeding voids (Figure 3-15); opportunistic Stage 1 taxa were indicated by the presence of small tubes at the sediment water interface (Figure 3-15). Subsurface feeding voids, indicating Stage 3 fauna, were present in at least 1 replicate of all but 1 station surveyed (Table 3-1). The mean of maximum subsurface feeding void depth ranged from 2.5 to 12.0 cm with an overall mean of 8.7 cm (SD±2.7) (Table 3-1; Figures 3-16).

Plan-View Imaging

The plan-view area of seafloor imaged ranged from 0.44 to 0.67 m^2. Oxidized silt/clay surface sediments with varying degrees of biological activity were seen in all PV images taken at the reference areas. Many images included small tubes and small to medium burrows, indicating the presence of deposit-feeding infauna (Figure 3-17). Tubes were generally sparse in their frequency, as were medium to large burrows, whereas small burrows were more frequent.

Small shrimp were seen at the seafloor surface in approximately half of the images. Anemones were seen at two locations in Reference Area C (C1-A, C2-D). All stations had tracks indicative of mobile epifauna (e.g., crab, shrimp, gastropods). These tracks often covered much of the visible seafloor in the images, indicating an active mobile epifaunal community at the reference areas (Figure 3-18). At the reference areas, plan-view images confirmed the physical and biological observations from the acoustic and SPI surveys.

3.2.2 Proposed Disposal Site

Physical Sediment Characteristics

Depth of the proposed disposal site stations ranged from 93.9 m to 103.6 m with a mean of 96.9 m (Figure 3-19). All stations were characterized by soft muds (e.g., silt/clay) with a major grain size mode of >4 phi (Table 3-2; Figure 3-20). Camera penetration depths throughout the site also indicated soft sediments with a mean penetration depth of 15.2 cm and a range from 9.3 to 18.7 cm (Table 3-2; Figure 3-21). The shallowest camera penetration depths were seen in stations along the north boundary and in the northeast and southeast corners of the proposed disposal site, in the vicinity of topographic rises in this portion of the proposed disposal site (Figure 3-21).

Possible dredged material was visible at Stations 5, 6, 12, 28, 29, 30, stations in the northeast and southeast corners of the survey area (Figure 3-22). There was no evidence of low dissolved oxygen or sedimentary methane within the proposed disposal site.

Boundary roughness ranged from 0.6 to 2.4 cm, with a mean of 1.1 cm (Figure 3-23). All of this small-scale topography can be attributed to the surface and subsurface activity of benthic organisms evidenced as small burrowing openings, pits, mounds, etc. (e.g., Figure 3-11).

Biological Conditions

The average station aRPD depths ranged from 4.8 to 9.5 cm with an overall mean of 7.3 cm (SD±1.1) across all the proposed disposal site stations (Table 3-2; Figure 3-24 and Appendix C). Only Station 6, in the northeast corner of the site was less than 5.0 cm (Figure 3-24). Overall the aRPD depths at the proposed disposal site stations were relatively deep, indicative of a healthy seafloor and were biologically modified by infaunal reworking (Figure 3-25).

Stage 3 infauna were present across the proposed disposal site with the predominant stage at all stations being Stage 1 on 3 (Table 3-2, Figure 3-26). Evidence for the presence of Stage 3 fauna included large-bodied infauna, deep subsurface burrows, and/or deep feeding voids (Figure 3-25); opportunistic Stage 1 taxa were indicated by the presence of small tubes at the sediment water interface (Figure 3-25). Subsurface feeding voids, indicating Stage 3 fauna, were present in at least 1 replicate of all but 2 stations surveyed (Table 3-2). The mean of maximum subsurface feeding void depth ranged from 5.7 to 15.9 cm with an overall mean of 9.9 cm (SD±2.6) (Table 3-2; Figure 3-27).

Plan-View Imaging

The plan-view area of seafloor imaged ranged from 0.42 to 0.72 m^2. Oxidized silt/clay surface sediments with varying degrees of biological activity were seen in all PV images taken at the proposed disposal site. Many images included small tubes and small to medium burrows, indicating the presence of deposit-feeding infauna (Figure 3-17). Tubes were generally sparse in their frequency, as were medium to large burrows. Small burrows were more frequent across much of the site.

Small shrimp were seen at the seafloor surface at 19 of the stations. Other epifauna were rarely seen (crab at 17-A, gastropod at 7-A, and anemone at 30-A), however, all but one station (1) had tracks indicative of these and other mobile epifauna. These tracks often covered much of the visible seafloor in the images, indicating an active mobile epifaunal community at ISDSN (Figure 3-18). A small fish was seen at Station 15. Within ISDSN, plan-view images confirmed both the physical and biological observations from the acoustic and SPI surveys.

3.2.3 Comparison to Reference Areas

3.2.3.1 Mean aRPD Variable

The mean aRPD depth for the proposed disposal site was 7.29 cm, comparable to the grand mean of the reference areas (7.01 cm). Area mean aRPD depths in the reference area ranged from 5.72 to 7.82 cm and were the shallowest at reference area C (Table 3-3; Figure 3-28). The standard deviation among stations for aRPD depths across all sampling areas ranged from 0.28 to 1.07 cm (Table 3-3).

A statistical inequivalence test was performed to determine whether or not the difference observed in mean aRPD values between the three reference areas and the proposed disposal site was statistically significant. The station mean aRPD data from all four locations were combined to assess normality and estimate pooled variance. Results for the normality test indicated that the area residuals (i.e., each observation minus the area mean) were not significantly different from a normal distribution (Shapiro-Wilk's test p-value = 0.53, with alpha = 0.05). Levene's test for equality for variances could not be rejected (p-value = 0.08, with alpha = 0.05). These results indicate that normally distributed data with equal variances can be assumed. Therefore, normal equations and a pooled variance estimate were used to construct the confidence interval for the difference equation.

The confidence region for the difference between the reference areas versus the proposed disposal site mean was contained within the interval [-1, +1] (Table 3-4). The conclusion was that the three reference areas and proposed disposal site did have significantly equivalent aRPD values in the 2015 survey, with a difference in means of approximately -0.28 cm, with reference areas having shallower aRPD values than proposed disposal locations (Table 3-4).

3.2.3.2 Successional Stage Rank Variable

Across the reference and disposal areas, Stage 3 fauna were consistently found, often along with Stage 1 fauna (Table 3-1, 3-2). To evaluate these successional stages numerically, a successional stage rank variable was applied to each image. A value of 3 was assigned to Stage 3, 2 on 3, or 1 on 3 designations, a value of 2 was applied to Stage 2 or 1 on 2, a value of 1 was applied to Stage 1, and images from which the stage could not be determined were excluded from calculations. The maximum successional stage rank among replicates was used to represent the station value.

The successional stage rank variable was uniformly 3 across all three reference areas and the proposed disposal site (Table 3-3). Therefore, no statistics were required to conclude that these areas were statistically equivalent.

Table 3-1.

Summary of ISDSN Reference Stations Sediment-Profile Imaging Results (station means), September 2015

Station	Water Depth (m)	Grain Size Major Mode (phi) [a]	Mean Prism Penetration Depth (cm)	Mean Boundary Roughness (cm)	Predominant Type of Boundary Roughness	Mean aRPD (cm)	Dredged Material Present	Mean # of Subsurface Feeding Voids	Mean of Maximum Subsurface Feeding Void Depth (cm)	Predominant Successional Stage [b]
REF-A-01	95.7	>4	16.2	1.0	Biological	8.2	No	1.3	10.2	1 on 3
REF-A-02	96.0	>4	16.9	1.0	Biological	7.9	No	1.3	8.3	1 on 3
REF-A-03	94.5	>4	15.9	1.4	Biological	7.6	No	3.7	12.0	1 on 3
REF-A-04	94.8	>4	15.5	1.5	Biological	7.9	No	2.3	12.0	1 on 3
REF-A-05	95.1	>4	16.9	1.3	Biological	7.5	No	2.0	11.9	1 on 3
REF-B-01	92.7	>4	15.7	1.2	Biological	8.1	No	0.3	2.5	1 on 3
REF-B-02	93.3	>4	15.2	1.1	Biological	7.6	No	1.7	10.3	1 on 3
REF-B-03	93.0	>4	16.6	0.9	Biological	7.4	No	1.7	9.4	1 on 3
REF-B-04	94.5	>4	15.5	1.1	Biological	7.2	No	2.0	8.8	1 on 3
REF-B-05	93.3	>4	16.0	1.4	Biological	7.2	No	2.0	9.0	1 on 3
REF-C-01	96.9	>4	10.5	1.2	Biological	6.1	Possible	1.7	7.5	1 on 3
REF-C-02	96.9	>4	8.9	1.0	Biological	4.6	Possible	0.0	--	1 on 3
REF-C-03	97.5	>4	10.8	1.0	Biological	5.8	Possible	2.3	8.8	1 on 3
REF-C-04	96.9	>4	12.0	1.2	Biological	5.4	Possible	0.3	5.8	1 on 3
REF-C-05	96.9	>4	12.2	1.2	Biological	6.7	Possible	0.3	5.2	1 on 3
Max	97.5		16.9	1.5		8.2		3.7	12.0	
Min	92.7		8.9	0.9		4.6		0.0	2.5	
Mean	95.2		14.3	1.2		7.0		1.5	8.7	

Ind = Indeterminate
a Grain Size: “/” indicates layer of one phi size range over another (see Appendix D)
b Successional Stage: “on” indicates one Stage is found on top of another Stage (i.e., 1 on 3);“→” indicates one Stage is progressing to another Stage (i.e., 2→3)

Table 3-2.

Summary of ISDSN Site Stations Sediment-Profile Imaging Results (station means), September 2015

Station	Water Depth (m)	Grain Size Major Mode (phi) [a]	Mean Prism Penetration Depth (cm)	Mean Boundary Roughness (cm)	Predominant Type of Boundary Roughness	Mean aRPD (cm)	Dredged Material Present	Mean # of Subsurface Feeding Voids	Mean of Maximum Subsurface Feeding Void Depth (cm)	Predominant Successional Stage [b]
01	94.5	>4	17.3	0.8	Biological	7.1	No	2.0	8.9	1 on 3
02	93.9	>4	14.0	1.8	Biological	6.2	No	0.7	7.1	1 on 3
03	97.2	>4	15.9	0.6	Biological	7.4	No	1.0	9.1	1 on 3
04	96.3	>4	14.2	0.7	Biological	5.7	No	1.3	6.8	1 on 3
05	96.0	>4	12.9	1.3	Biological	6.3	Possible	0.3	12.4	1 on 3
06	96.6	>4	11.9	2.4	Biological	4.8	Possible	4.0	8.7	1 on 3
07	94.5	>4	15.9	0.9	Biological	6.4	No	1.7	9.7	1 on 3
08	95.1	>4	17.6	1.0	Biological	7.9	No	2.3	15.9	1 on 3
09	98.1	>4	16.8	0.7	Biological	6.8	No	2.0	11.4	1 on 3
10	98.1	>4	14.9	0.9	Biological	6.6	No	0.0	--	1 on 3
11	98.1	>4	16.3	1.3	Biological	6.1	No	0.7	9.1	1 on 3
12	95.1	>4	9.4	0.9	Biological	7.1	Possible	0.7	9.2	1 on 3
13	93.9	>4	15.3	1.5	Biological	7.4	No	2.3	6.3	1 on 3
14	95.1	>4	15.3	1.4	Biological	7.3	No	1.3	9.5	1 on 3
15	97.5	>4	16.5	1.2	Biological	8.0	No	1.3	12.3	1 on 3
16	99.1	>4	15.9	1.3	Biological	9.5	No	0.7	7.6	1 on 3
17	101.2	>4	17.1	1.1	Biological	8.8	No	2.0	14.0	1 on 3
18	103.6	>4	17.9	0.8	Biological	8.0	No	2.3	11.6	1 on 3
19	94.5	>4	18.7	0.7	Biological	9.0	No	2.3	13.5	1 on 3
20	96.0	>4	16.1	1.3	Biological	8.1	No	1.3	11.8	1 on 3

Ind = Indeterminate
a Grain Size: "/" indicates layer of one phi size range over another (see Appendix D)
b Successional Stage: "on" indicates one Stage is found on top of another Stage (i.e., 1 on 3);"→" indicates one Stage is progressing to another Stage (i.e., 2→3)

Table 3-2. (continued)

Summary of ISDSN Site Stations Sediment-Profile Imaging Results (station means), September 2015

Station	Water Depth (m)	Grain Size Major Mode (phi) [a]	Mean Prism Penetration Depth (cm)	Mean Boundary Roughness (cm)	Predominant Type of Boundary Roughness	Mean aRPD (cm)	Dredged Material Present	Mean # of Subsurface Feeding Voids	Mean of Maximum Subsurface Feeding Void Depth (cm)	Predominant Successional Stage [b]
21	96.6	>4	16.4	1.4	Biological	7.8	No	0.7	7.4	1 on 3
22	99.1	>4	17.2	0.8	Biological	8.2	No	2.3	7.5	1 on 3
23	100.9	>4	16.4	1.3	Biological	7.8	No	0.7	13.0	1 on 3
24	99.4	>4	15.5	0.8	Biological	7.3	No	2.7	11.1	1 on 3
25	93.9	>4	15.4	0.7	Biological	7.2	No	3.3	11.1	1 on 3
26	94.8	>4	15.9	0.8	Biological	9.0	No	1.7	10.2	1 on 3
27	96.0	>4	16.1	0.6	Biological	7.4	No	0.0	--	1 on 3
28	95.7	>4	11.1	1.1	Biological	6.3	Possible	1.3	6.7	1 on 3
29	98.1	>4	12.6	1.1	Biological	7.3	Possible	2.3	8.3	1 on 3
30	98.1	>4	9.3	1.5	Biological	6.0	Possible	0.3	5.7	1 on 3
Max	103.6		18.7	2.4		9.5		4.0	15.9	
Min	93.9		9.3	0.6		4.8		0.0	5.7	
Mean	96.9		15.2	1.1		7.3		1.5	9.8	

Ind = Indeterminate
a Grain Size: “/” indicates layer of one phi size range over another (see Appendix D)
b Successional Stage: “on” indicates one Stage is found on top of another Stage (i.e., 1 on 3);“→” indicates one Stage is progressing to another Stage (i.e., 2→3)

Table 3-3.

Summary of Station Means for aRPD and Successional Stage by Sampling Location

	Mean aRPD (cm)		**Successional Stage Rank**	
Location	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Disposal	7.29	1.07	3.0	0.00
REF-A	7.82	0.28	3.0	0.00
REF-B	7.50	0.37	3.0	0.00
REF-C	5.72	0.79	3.0	0.00

Table 3-4.

Summary Statistics and Results of Inequivalence Hypothesis Testing for aRPD Values

Difference Equation	**Observed Difference (d)**	$SE(\hat{d})$	***df* for SE**	**Confidence Bounds (D_L to D_U)[1]**	**Results[2]**
$\text{Mean}_{REF} - \text{Mean}_{ISDSN}$	-0.28	0.30	41	-0.78 to +0.22	s

[1] D_L and D_U as defined in [Eq. 3]

[2] s = Reject the null hypothesis of inequivalence: the two group means are significantly equivalent, within ± 1 cm.
d = Fail to reject the null hypothesis of inequivalence between the two group means, the two group means are different.

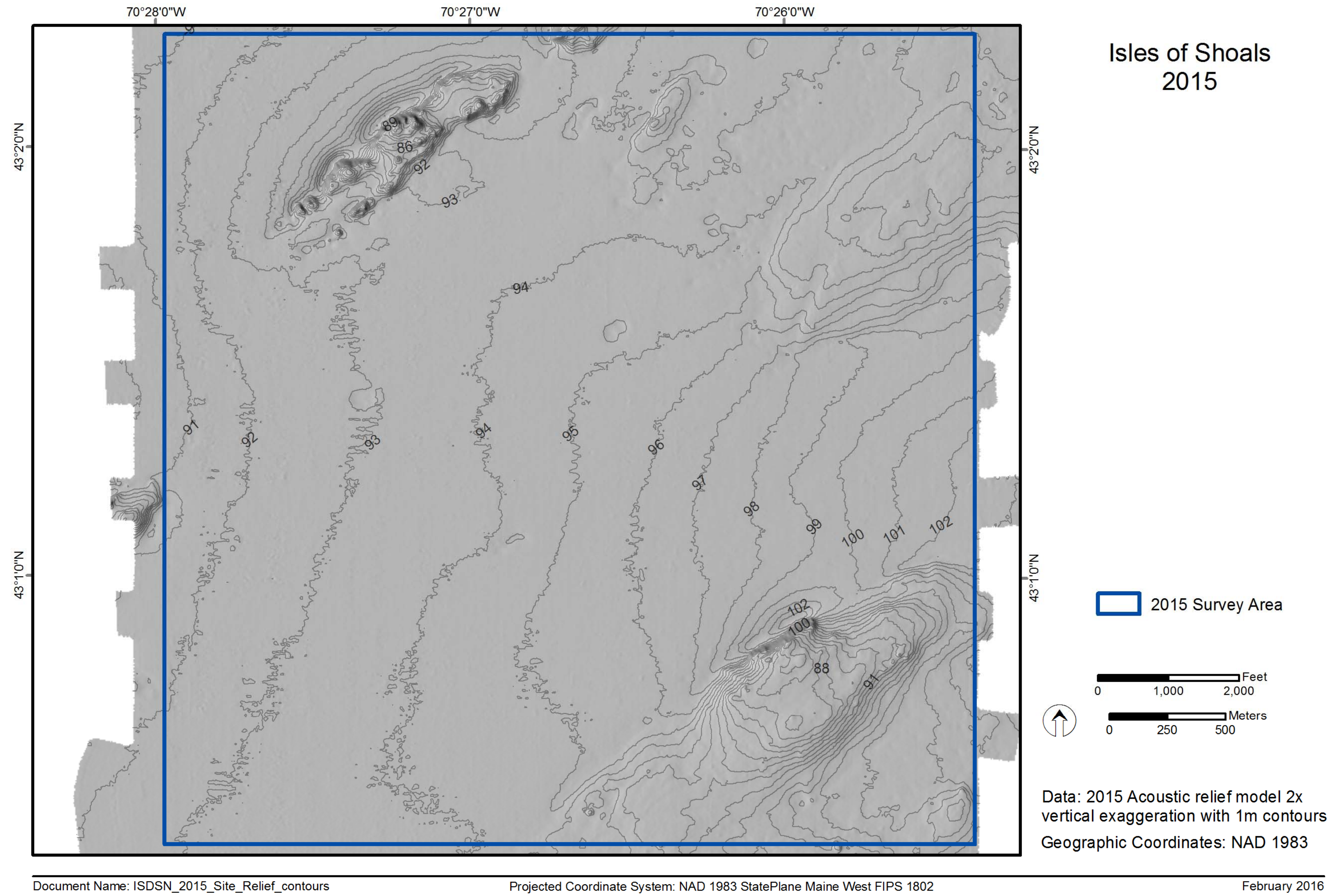
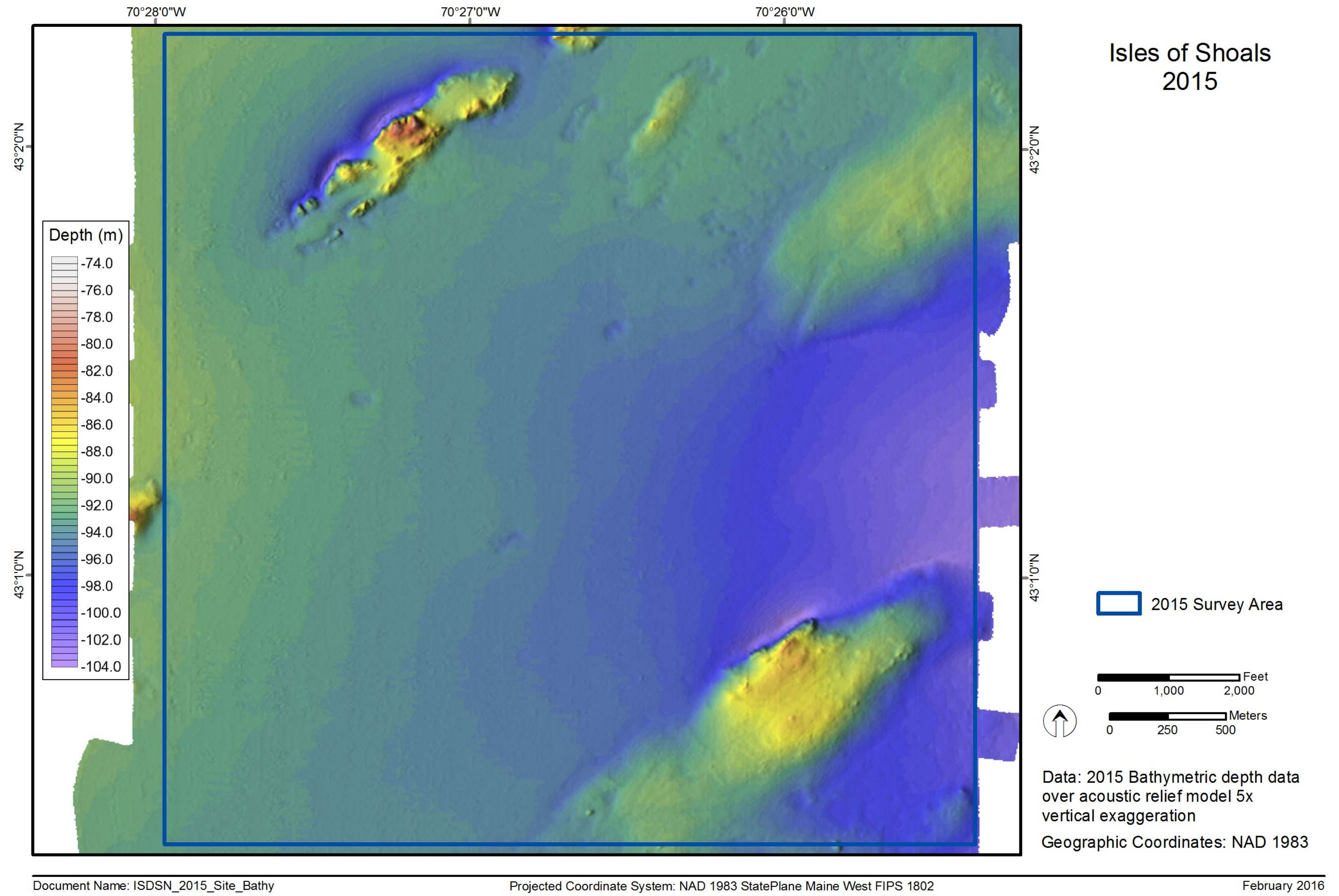


Figure 3-1. Bathymetric contour map of ISDSN – September 2015



Data: 2015 Bathymetric depth data over acoustic relief model 5x vertical exaggeration

Geographic Coordinates: NAD 1983

Document Name: ISDSN_2015_Site_Bathy

Projected Coordinate System: NAD 1983 StatePlane Maine West FIPS 1802

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Figure 3-2. Bathymetric depth data over acoustic relief model of ISDSN – September 2015

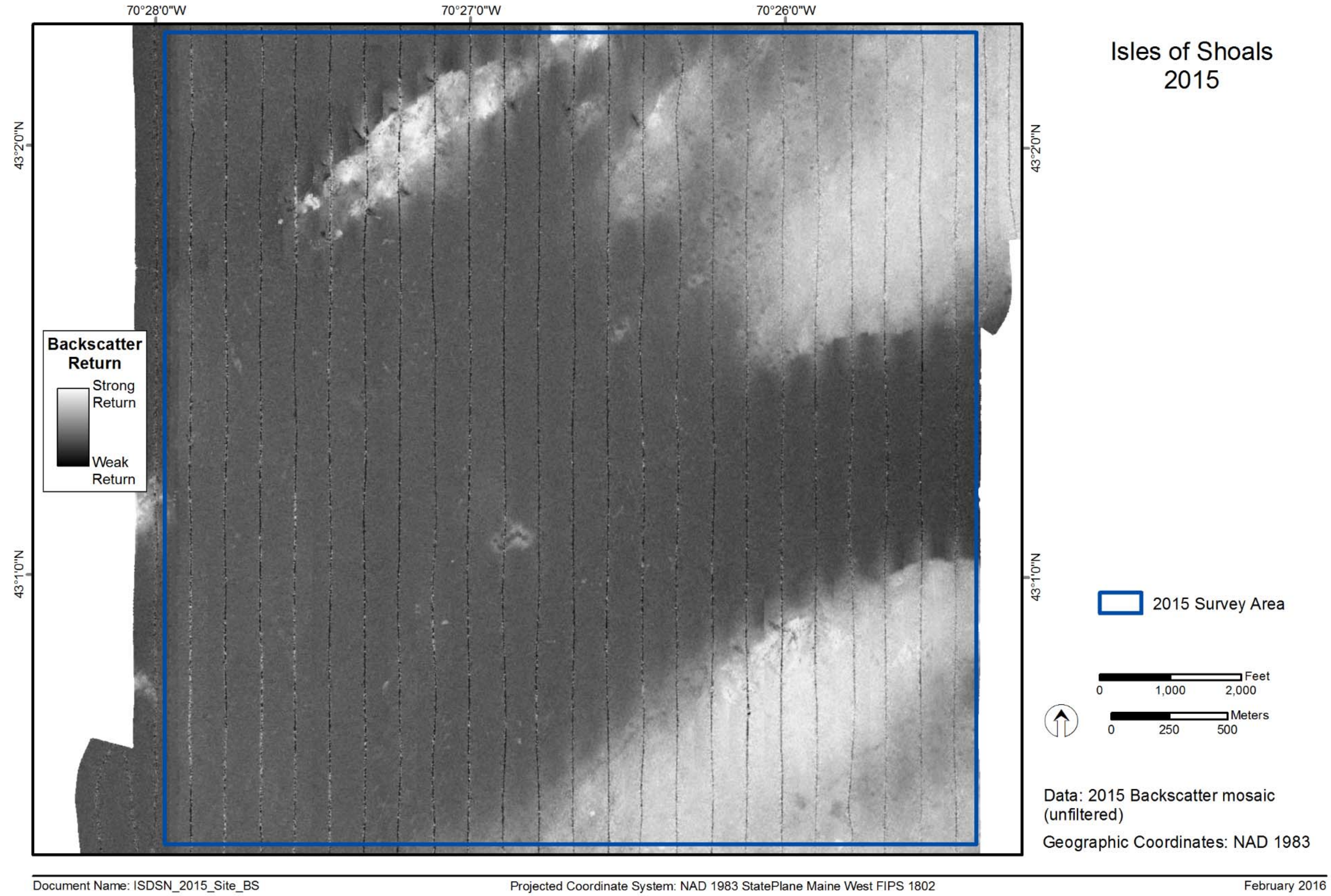


Figure 3-3. Mosaic of unfiltered backscatter data of ISDSN – September 2015

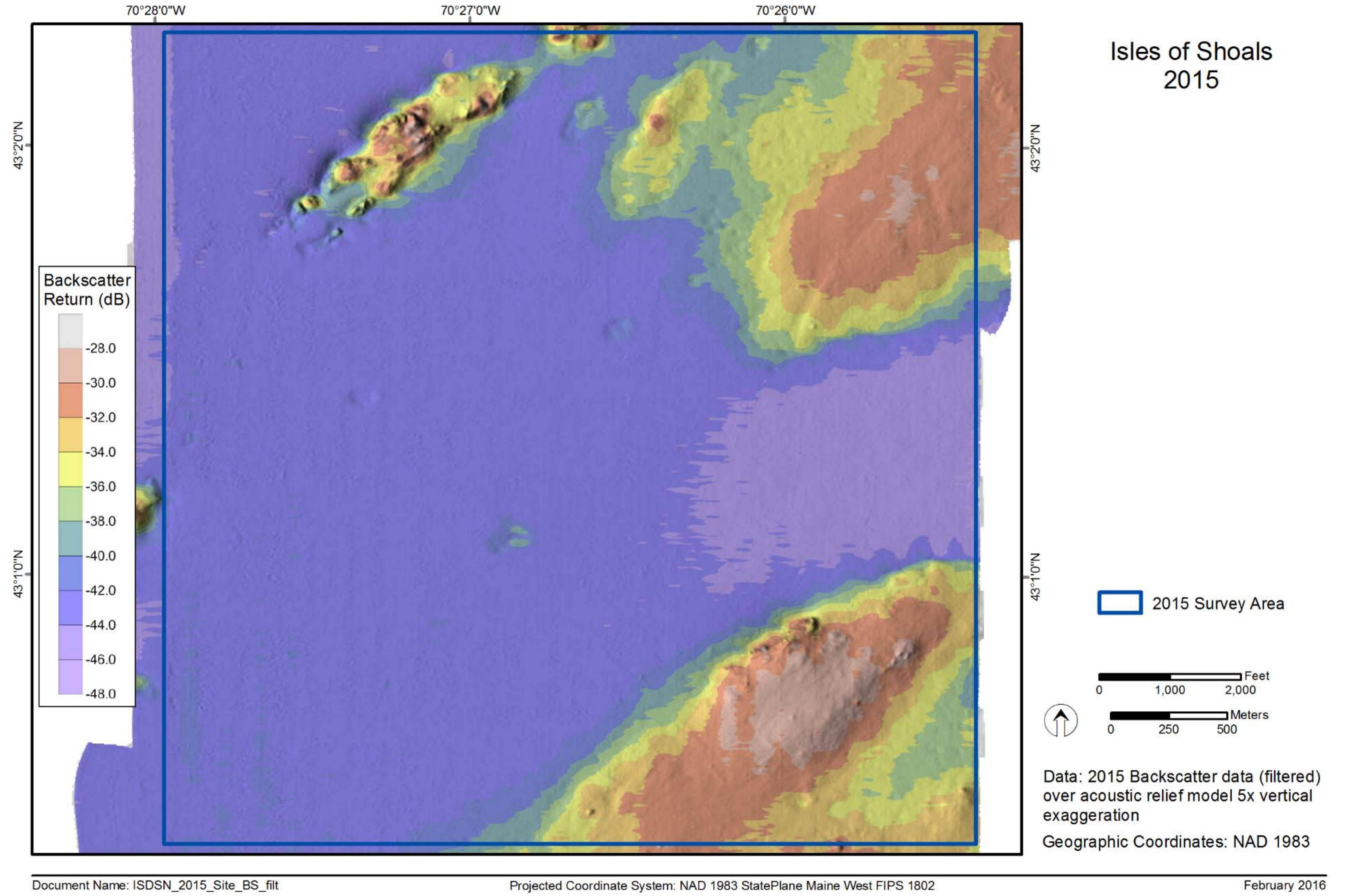


Figure 3-4. Filtered backscatter over acoustic relief model of ISDSN – September 2015

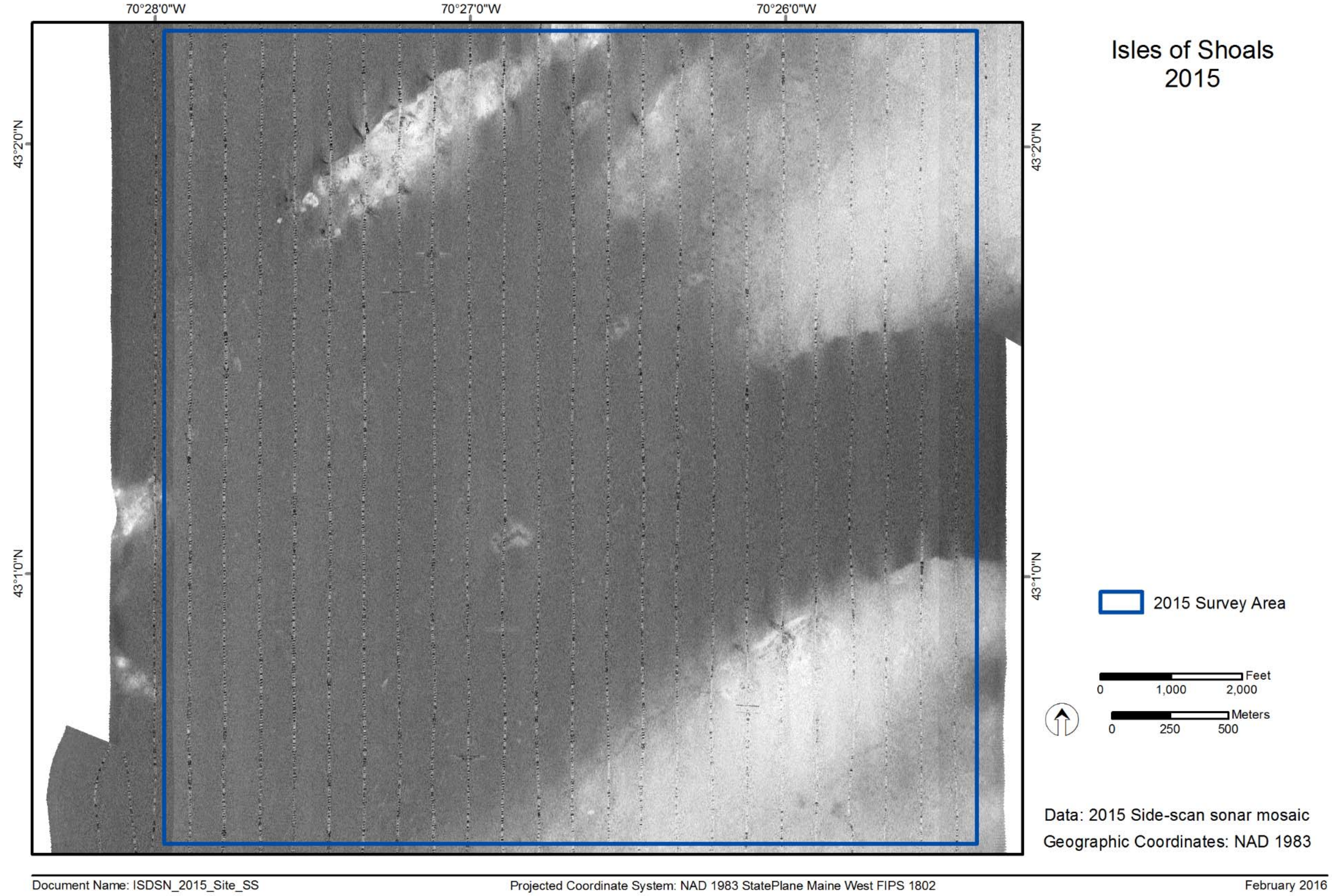


Figure 3-5. Side-scan mosaic of ISDSN – September 2015

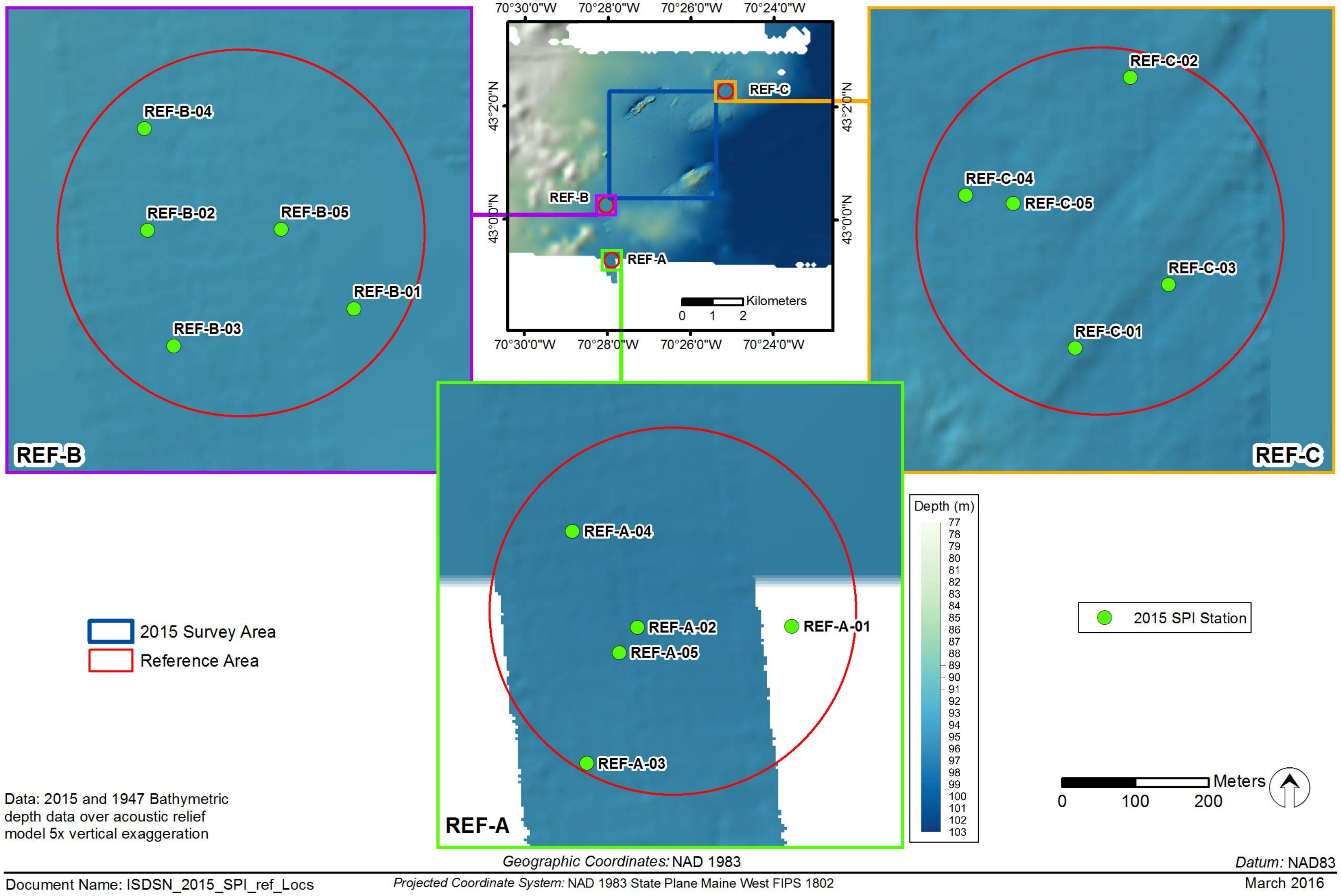


Figure 3-6. Bathymetric depth data at ISDSN proposed reference areas with SPI/PV stations indicated

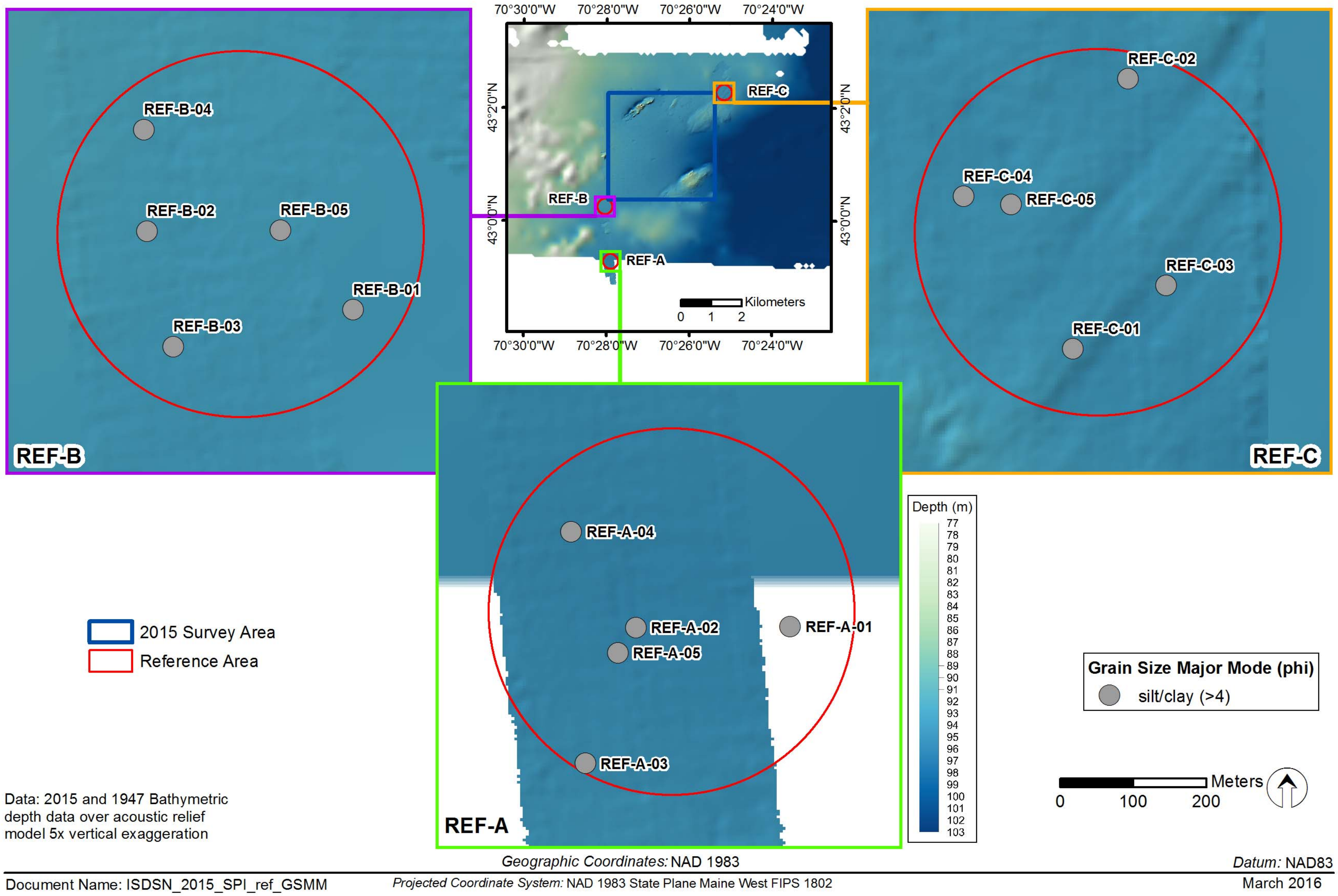


Figure 3-7. Sediment grain size major mode (phi units) at the ISDSN reference areas

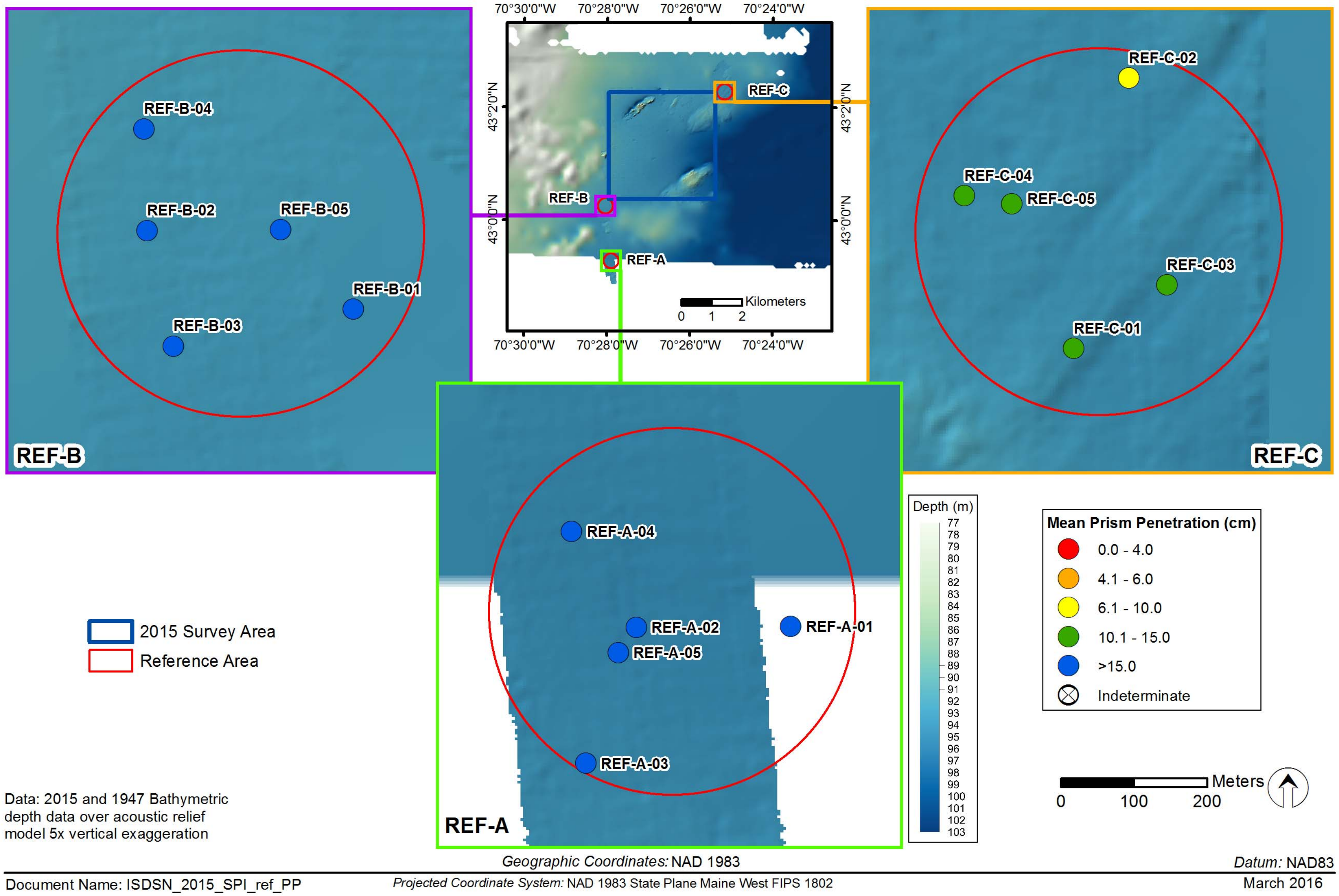


Figure 3-8. Mean station camera prism penetration depths (cm) at the ISDSN reference areas

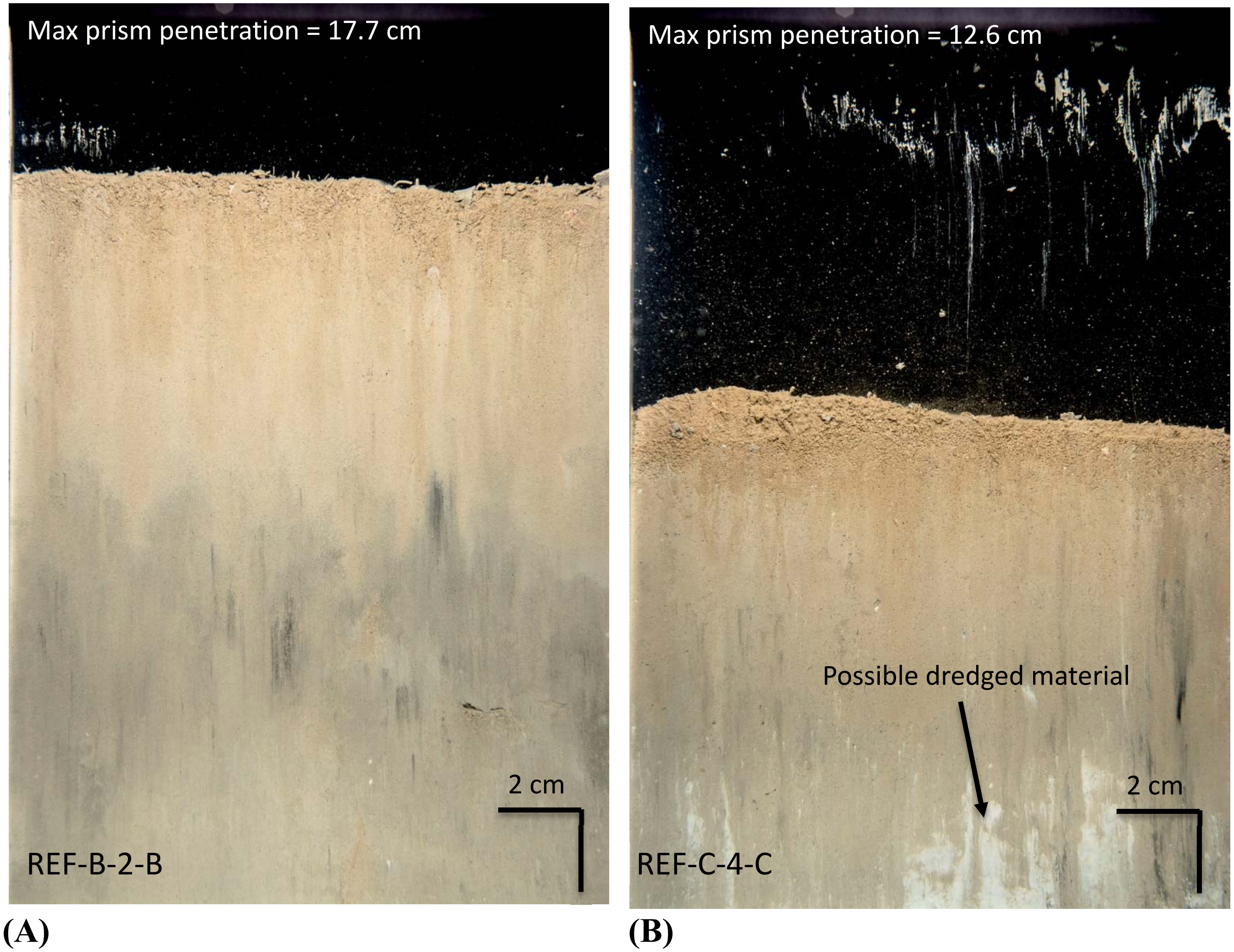


Figure 3-9. Sediment-profile images from (A) Station REF-B-2 and (B) Station REF-C-4 where camera penetration depths were shallower and where there was evidence of possible dredged material at depth

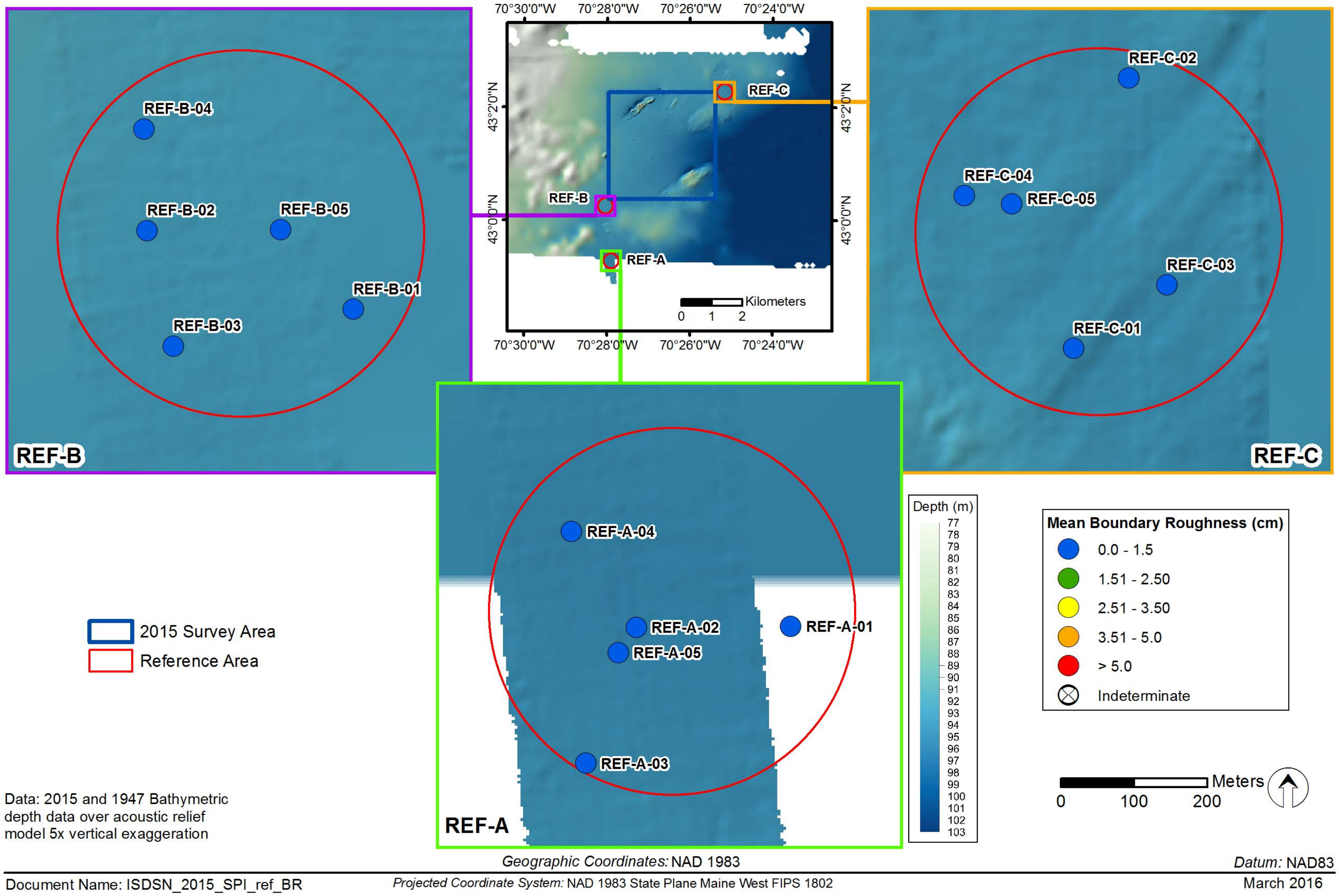
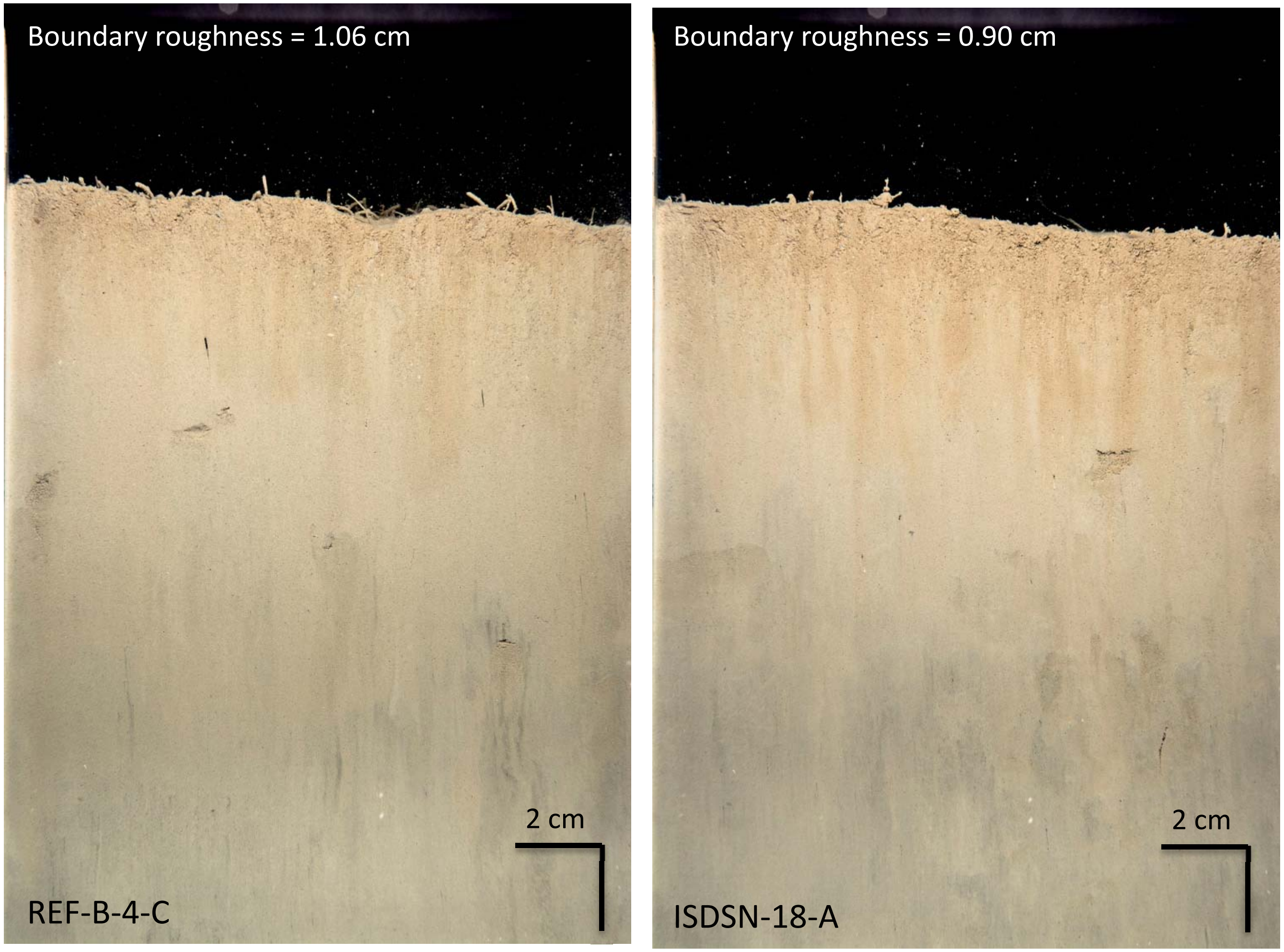


Figure 3-10. Mean station small-scale boundary roughness values (cm) at the ISDSN reference areas



(A) **(B)**

Figure 3-11. Sediment-profile images depicting small-scale boundary roughness created by biological activity of surface and subsurface dwelling infauna at (A) Station REF-B-4 and (B) Station ISDSN-18

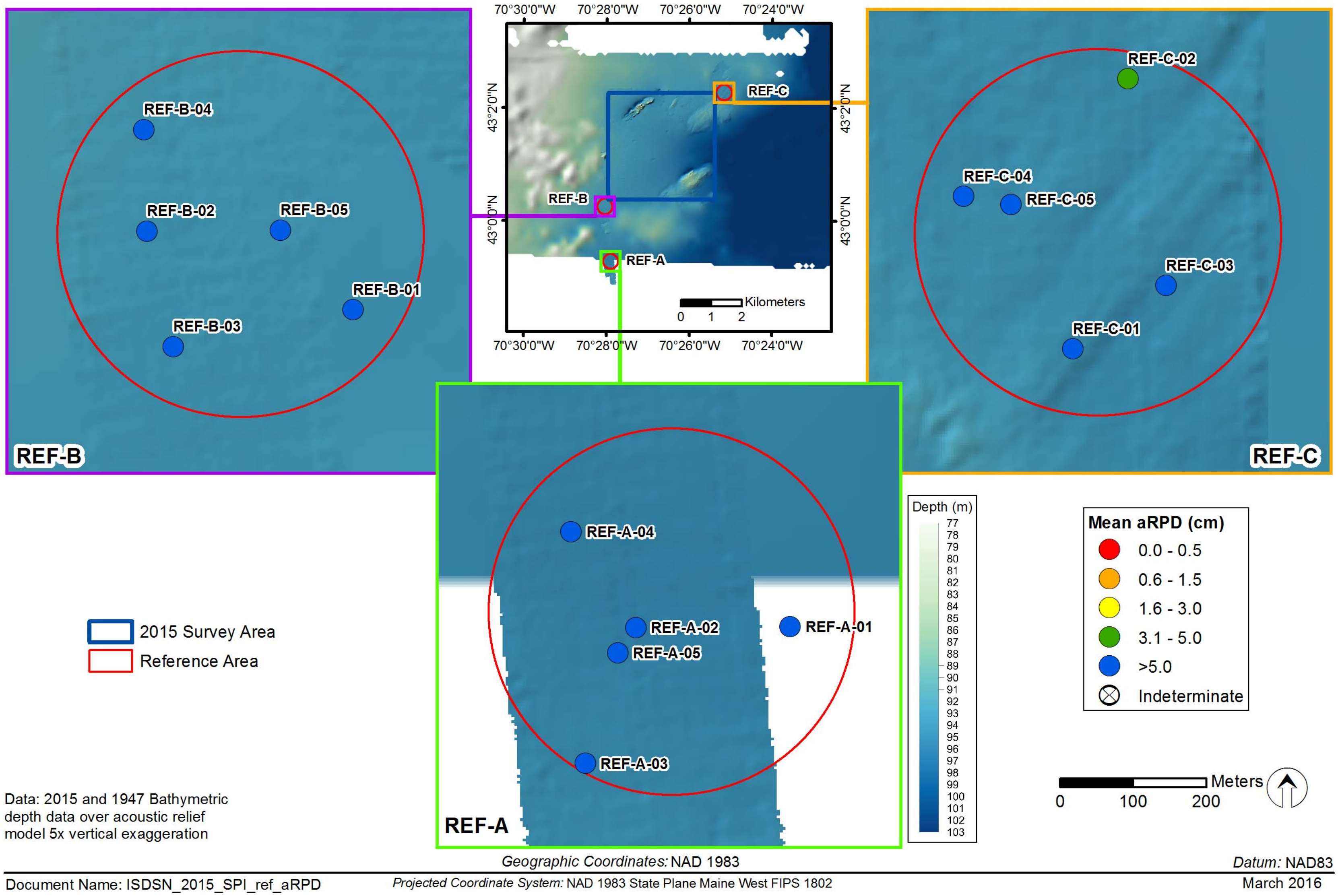
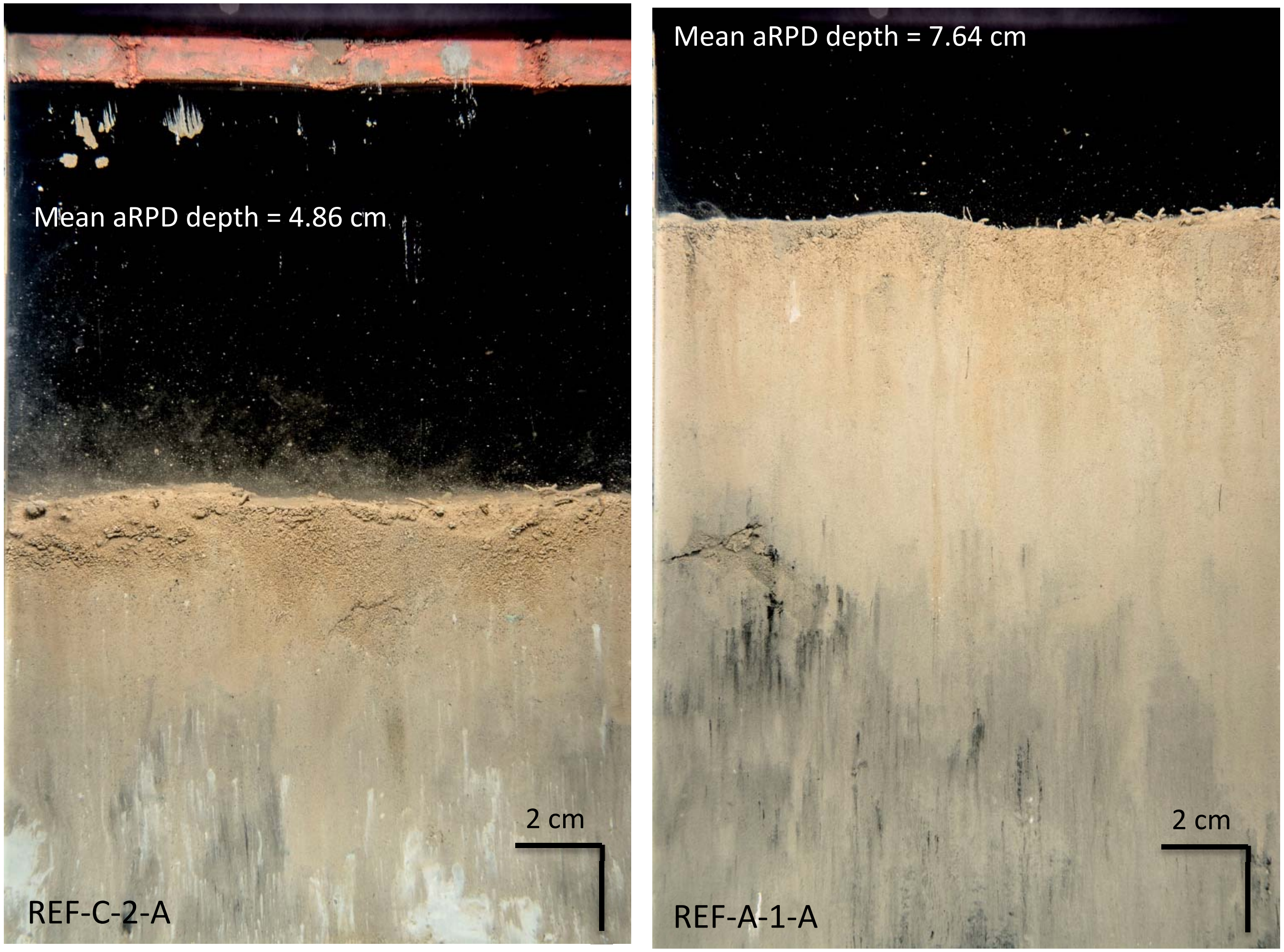


Figure 3-12. Mean station aRPD depths (cm) at the ISDSN reference areas



(A) **(B)**

Figure 3-13. Mean aRPD depths (cm) were shallower at (A) Station REF-C-2, compared to the other reference areas, e.g., (B) Station REF-A-1. Note: The sloughing of sediment particles near the surface of (A) is an occasional artifact of the camera action.

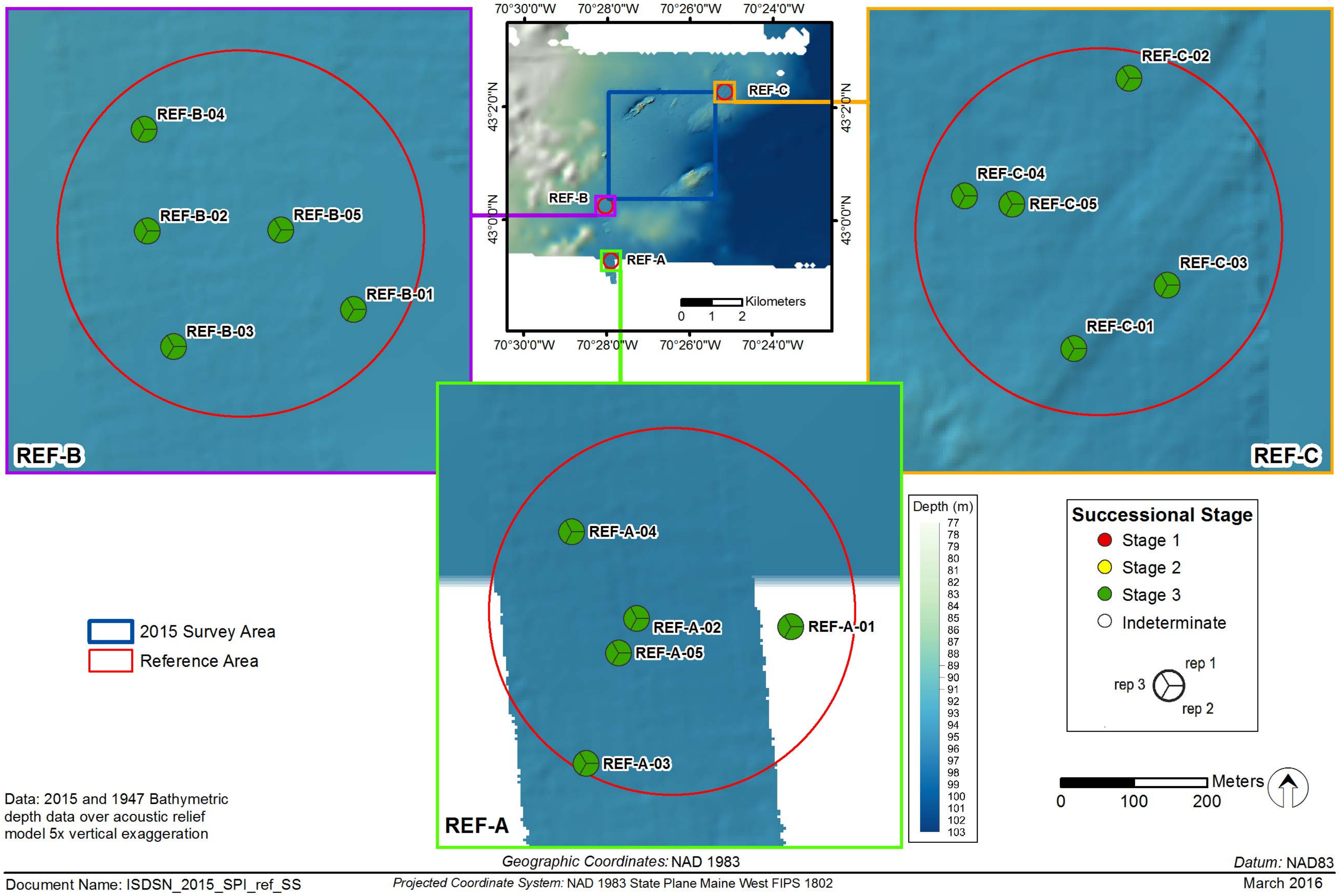
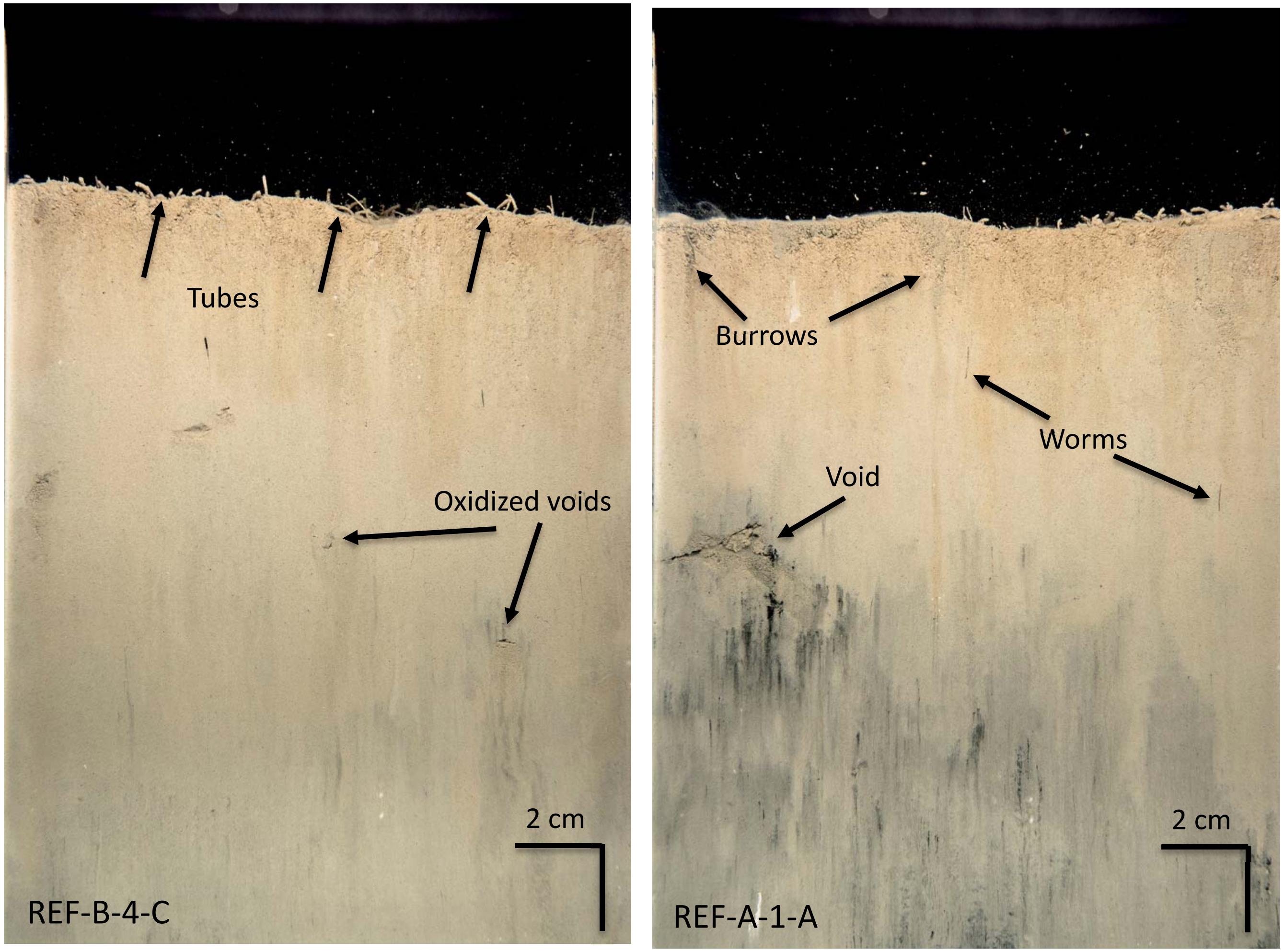


Figure 3-14. Infaunal successional stages found at stations at the ISDSN reference areas



(A) (B)

Figure 3-15. Infaunal successional stages found at the ISDSN reference areas: Stage 1 on 3 at (A) Station REF-B-4 with small tubes at surface and oxidized voids at depth; (B) Station REF-A-1 with fecal pellets, small tubes at surface, clear subsurface burrows, polychaetes (worm), and a large void

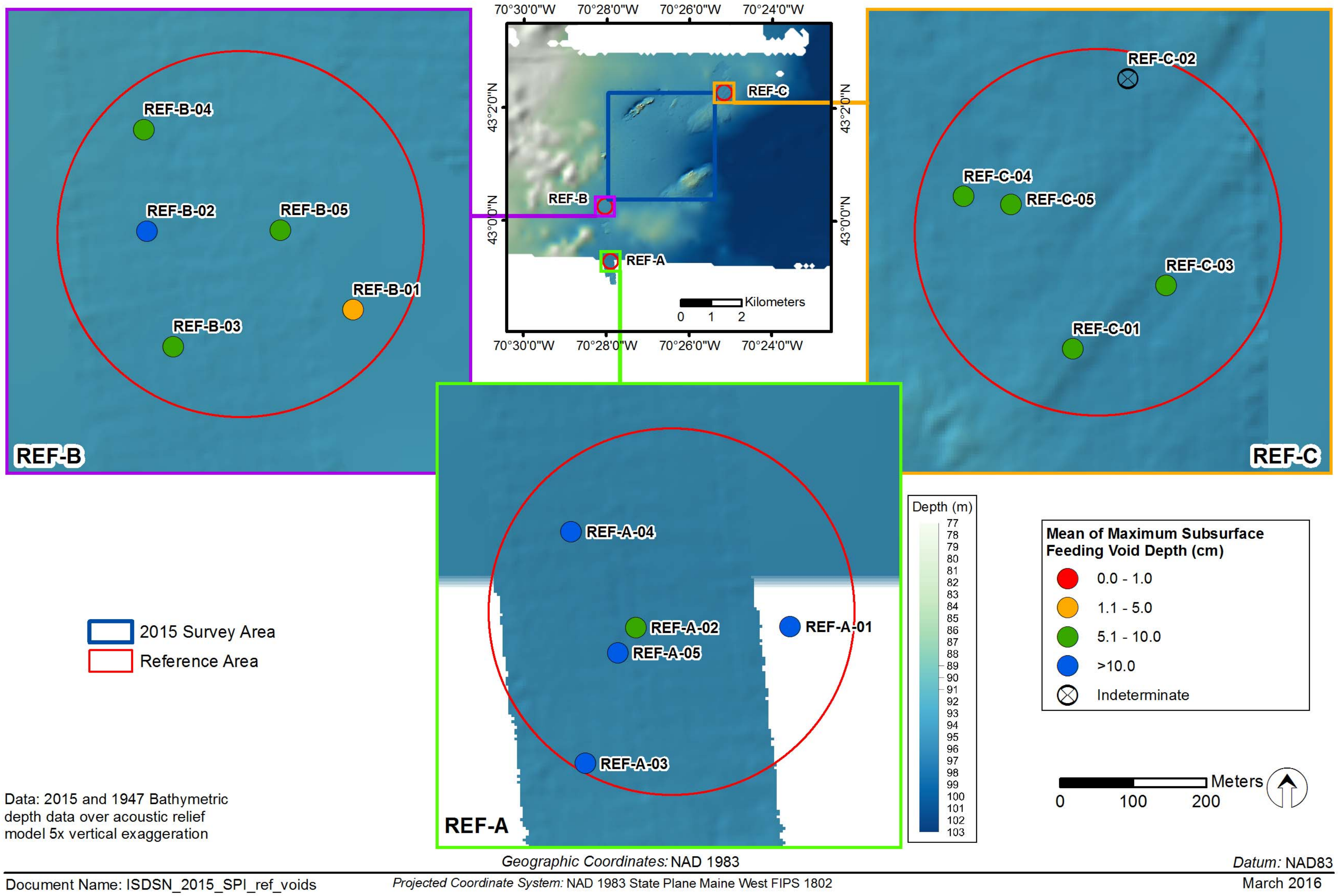


Figure 3-16. Maximum subsurface feeding void depth at ISDSN reference areas

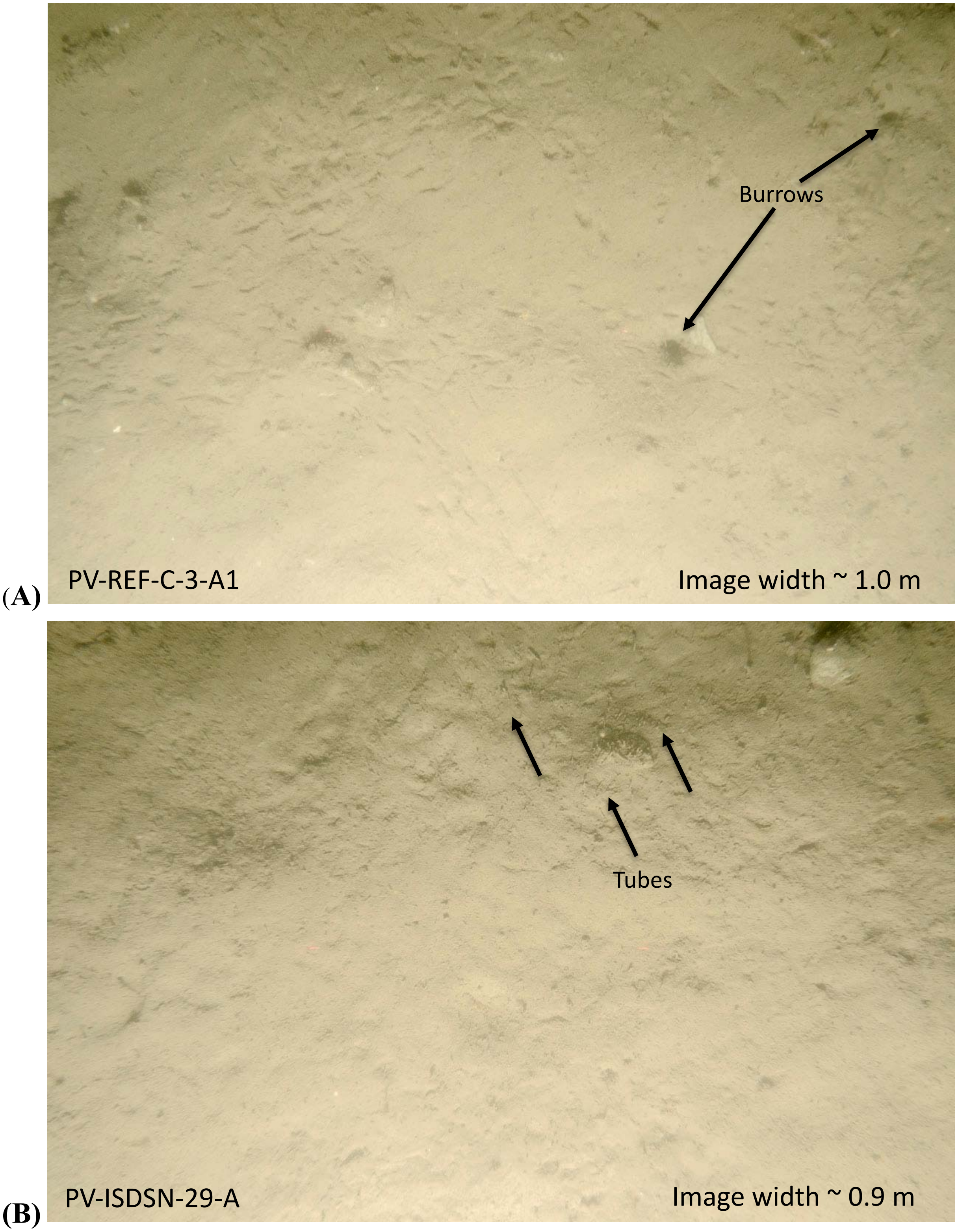
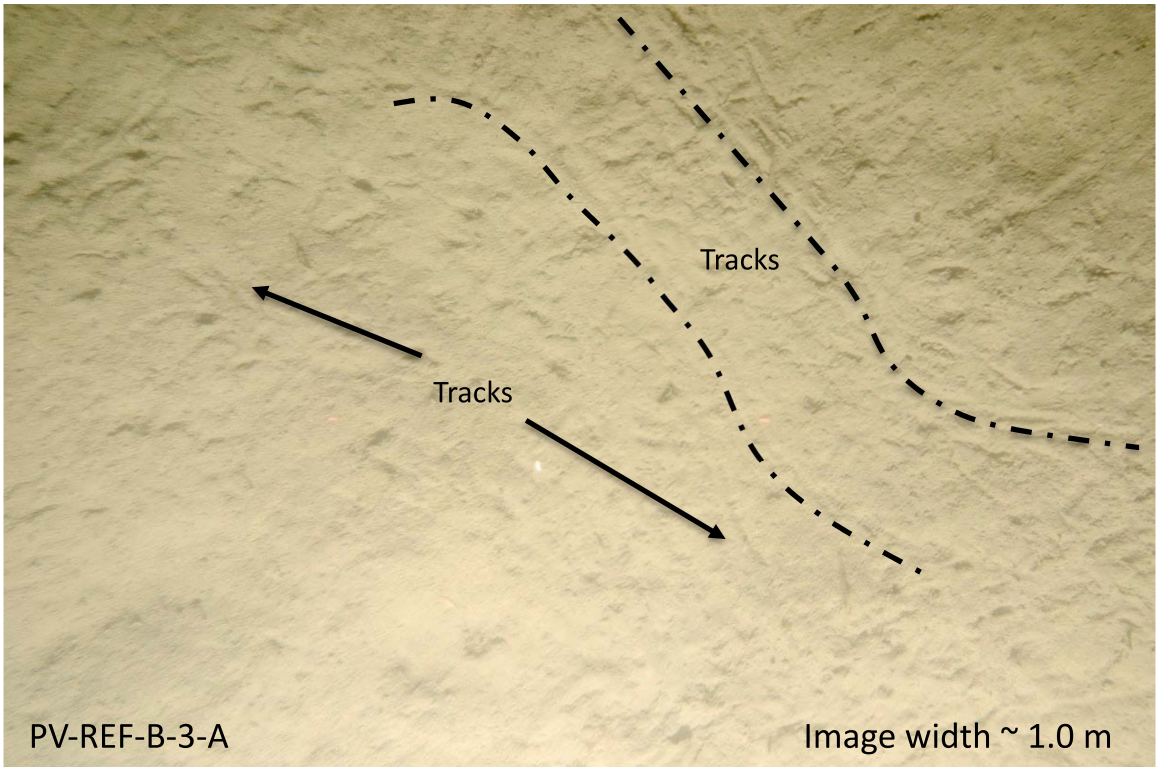
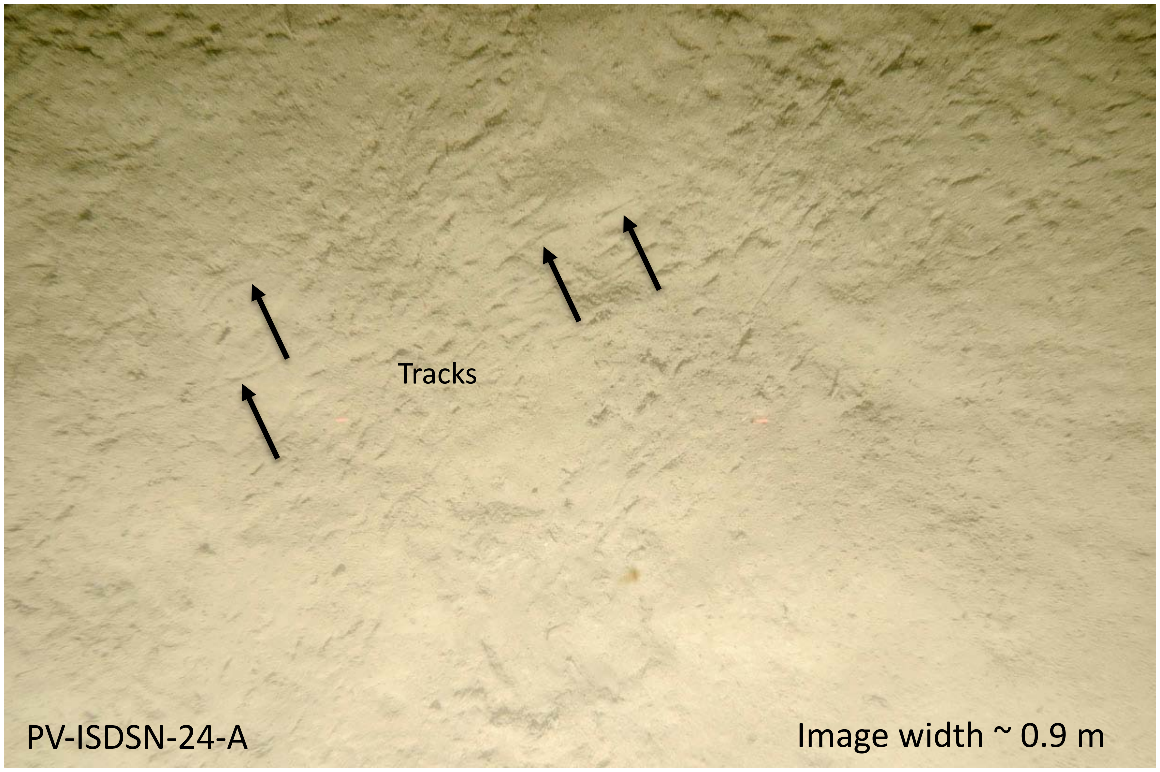


Figure 3-17. Plan-view images depicting small to medium burrows and small tubes at (A) Station REF-C-3 and (B) ISDSN-29



(**A**)



(B)

Figure 3-18. Plan-view images depicting tracks indicative of a mobile epifauna community at (A) Station REF-B-3-A and (B) ISDSN-24-A

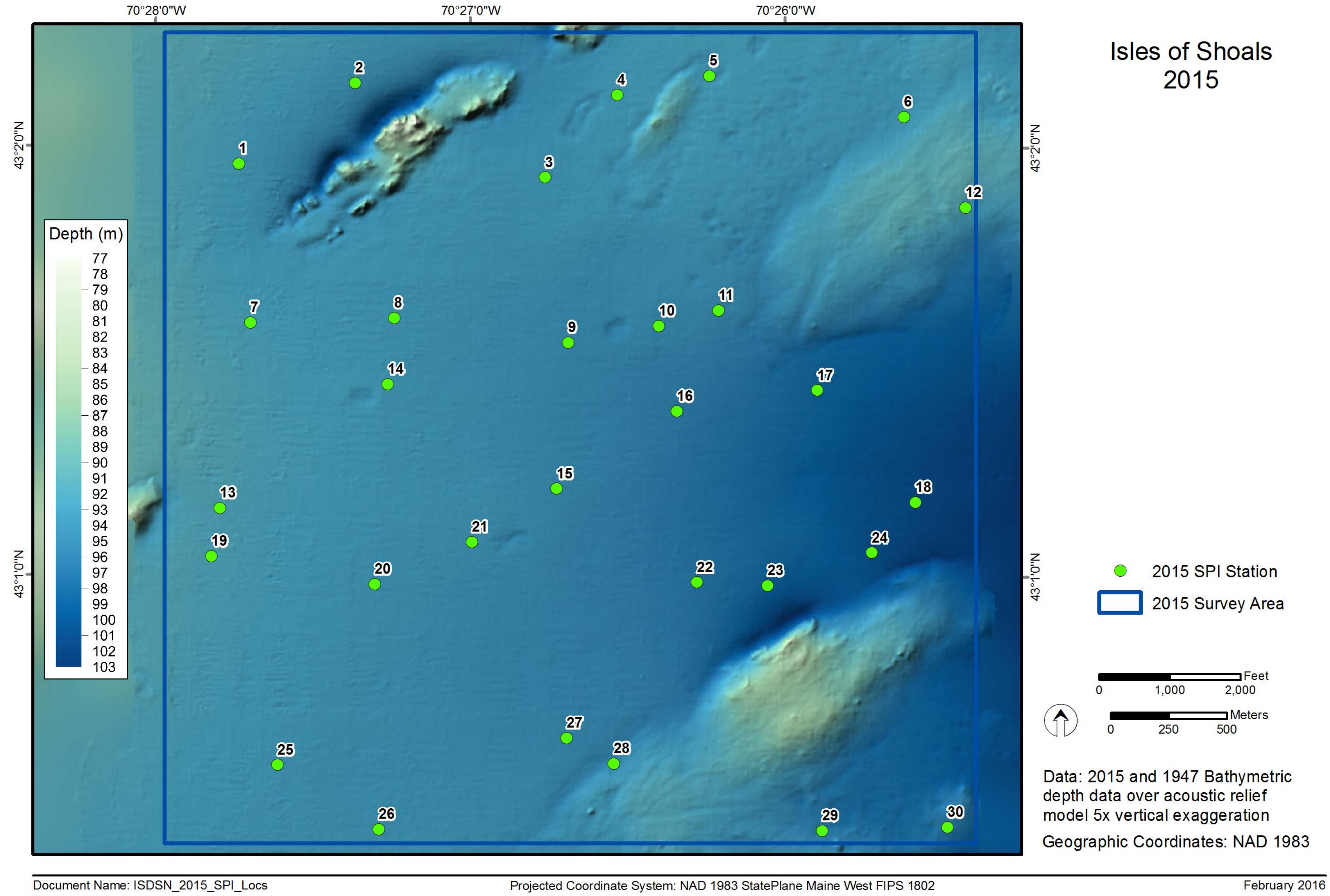


Figure 3-19. ISDSN with SPI/PV stations indicated

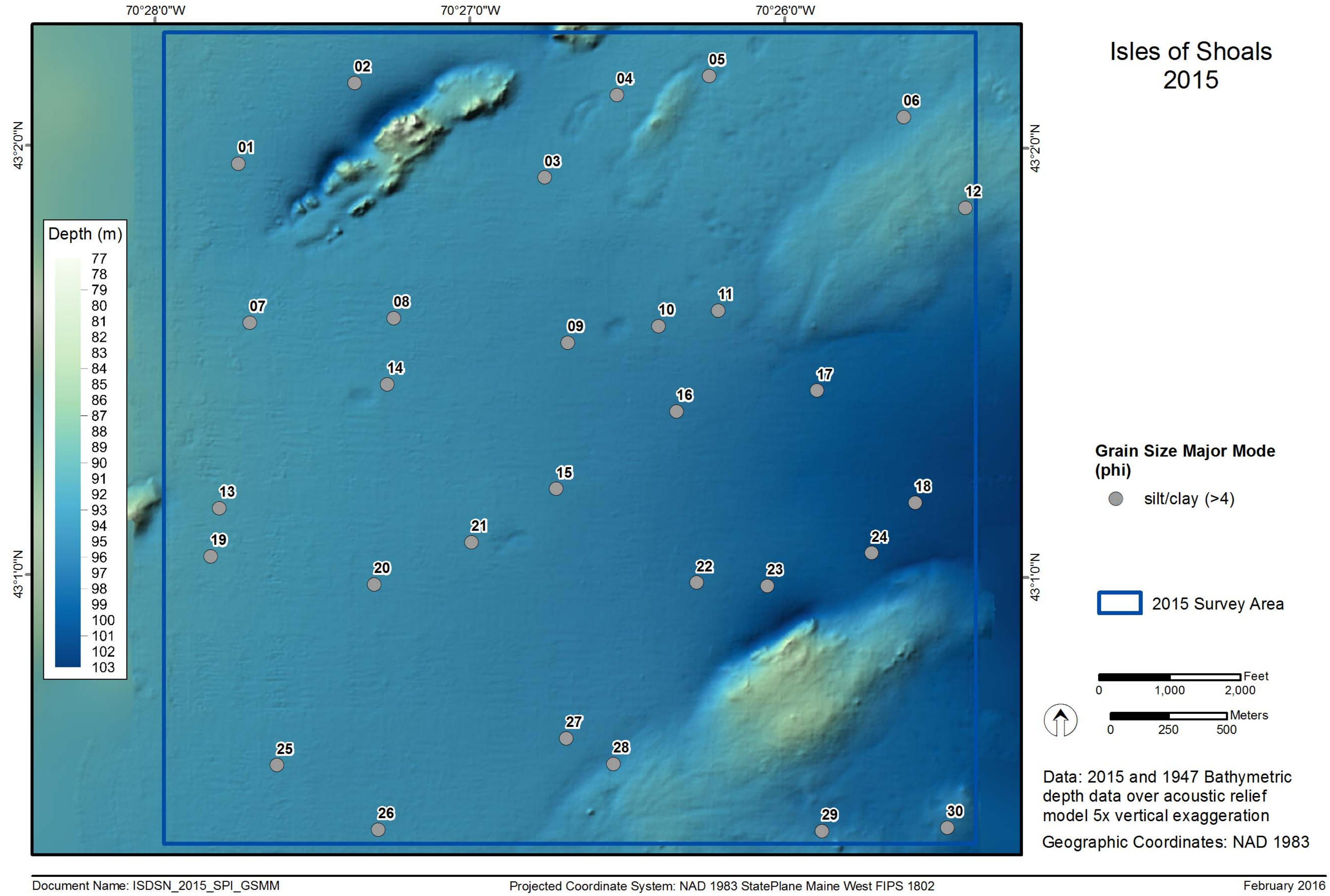


Figure 3-20. Sediment grain size major mode (phi) at ISDSN

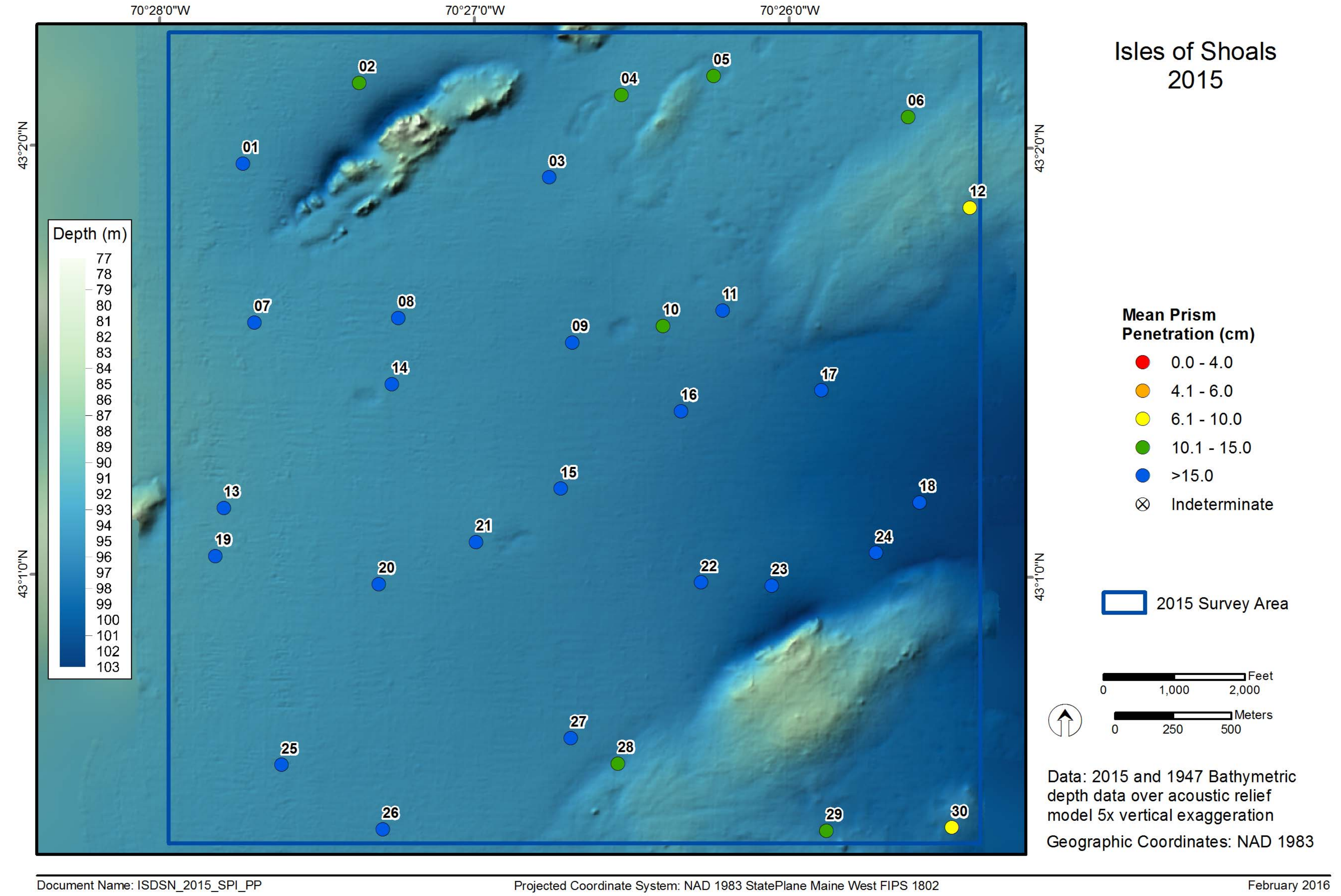
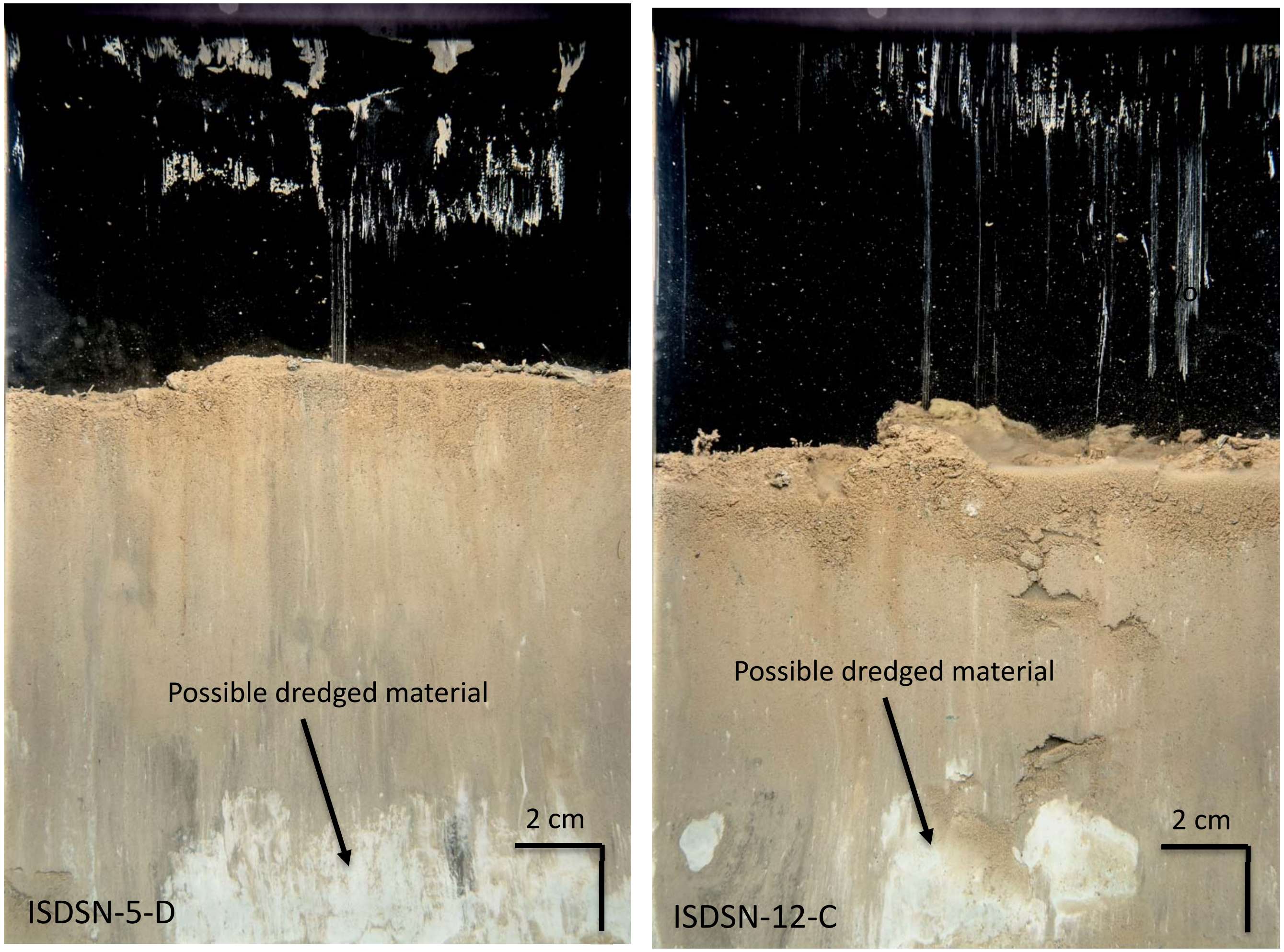


Figure 3-21. Mean station camera prism penetration depth (cm) at ISDSN



(A) **(B)**

Figure 3-22. Sediment-profile images with evidence of possible dredged material at (A) Station ISDSN-5 and (B) Station ISDSN-12

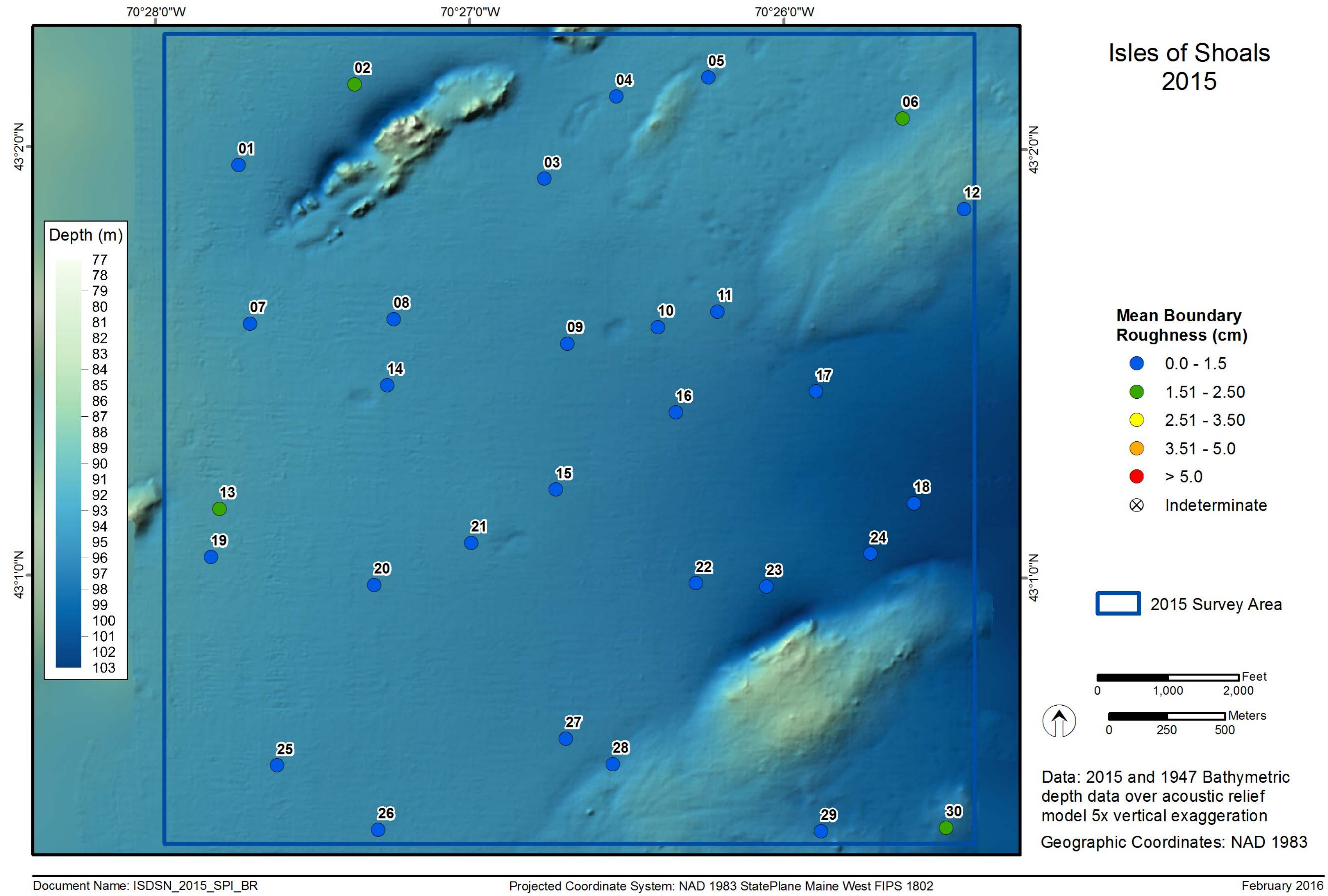
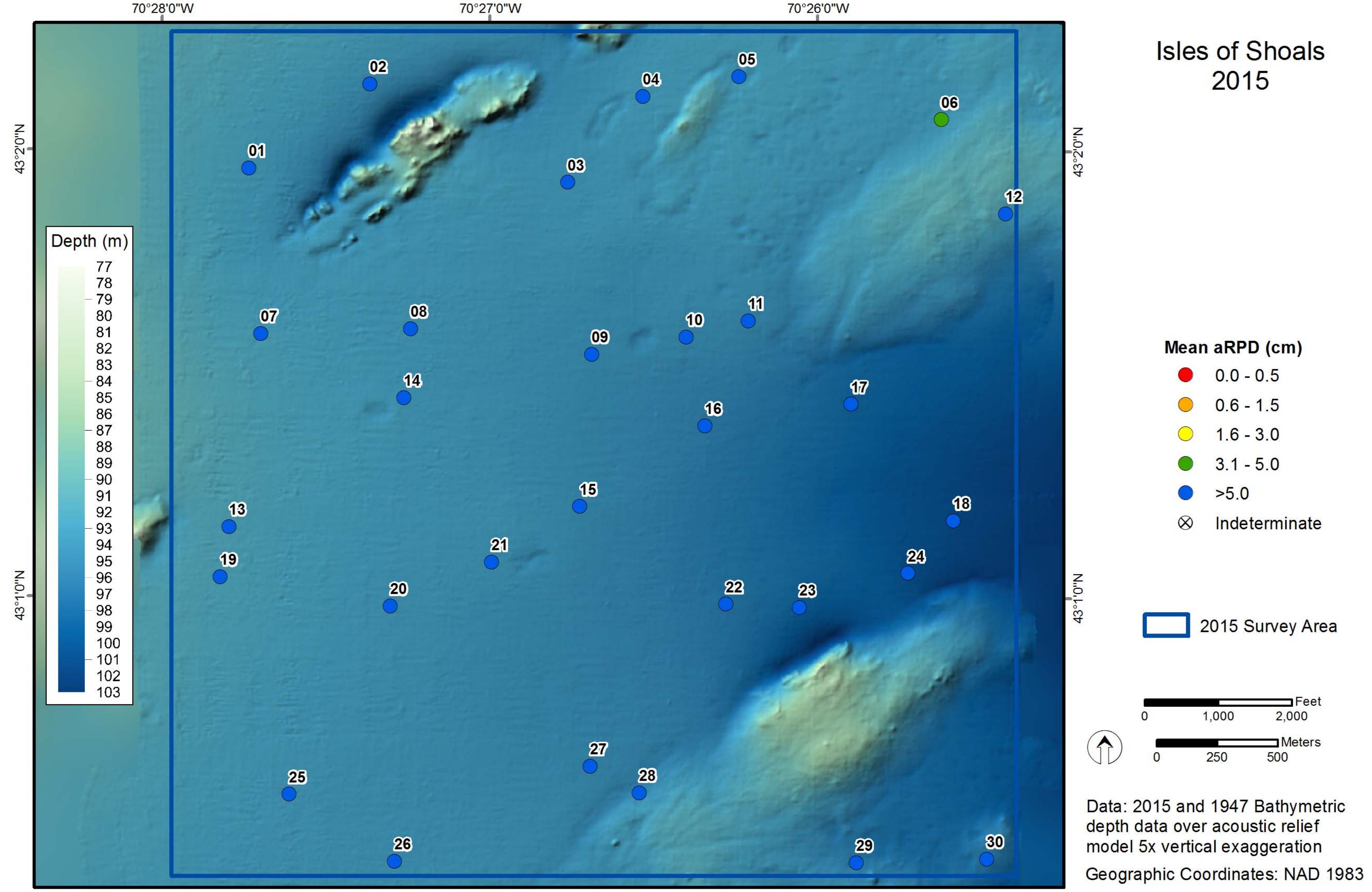


Figure 3-23. Mean station small-scale boundary roughness values (cm) at ISDSN



Document Name: ISDSN_2015_SPI_aRPD

Projected Coordinate System: NAD 1983 StatePlane Maine West FIPS 1802

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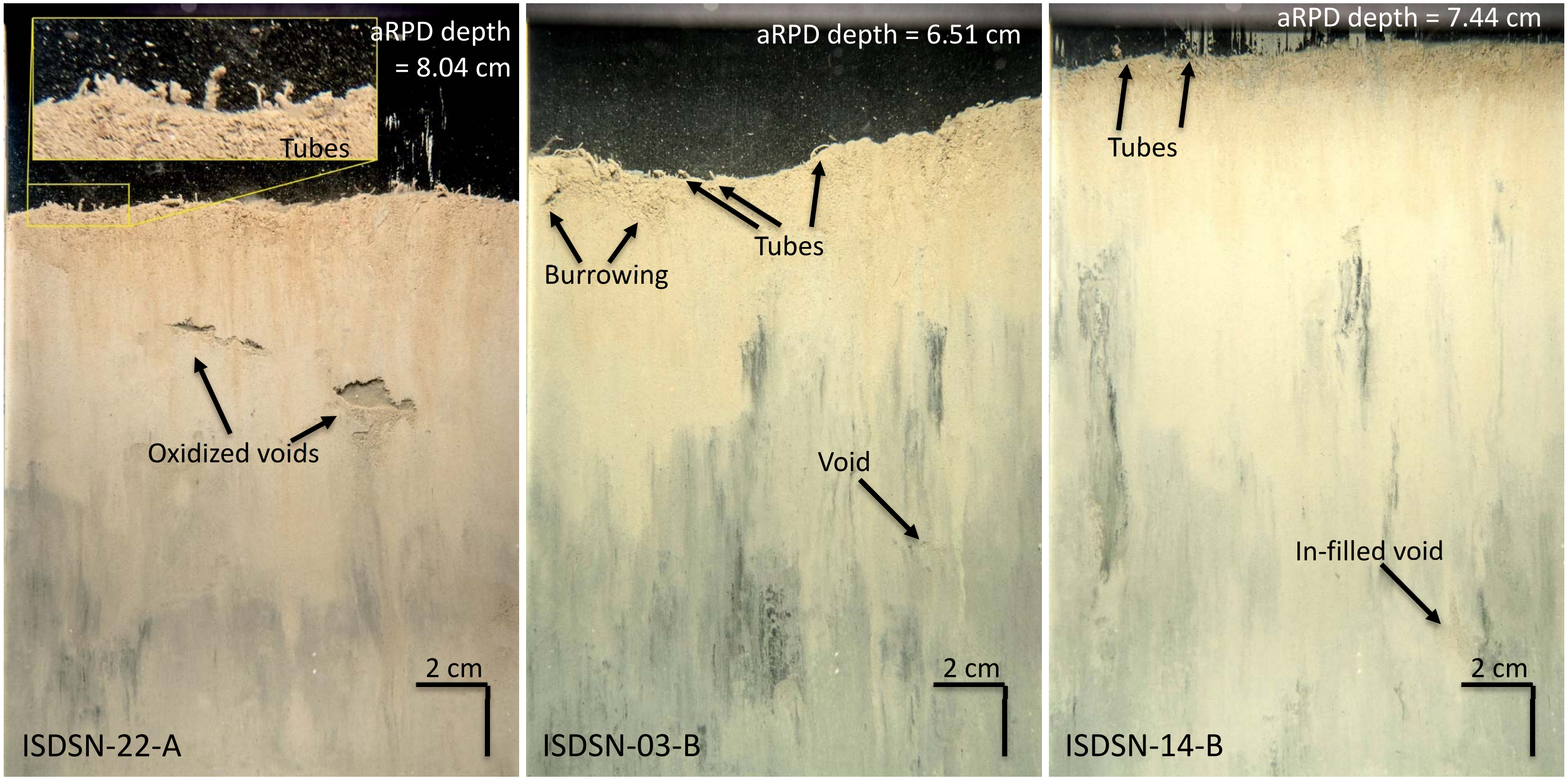
Figure 3-24. Mean station aRPD depth (cm) at ISDSN



(A) **(B)** **(C)**

Figure 3-25. Mean aRPD depths (cm) and infaunal successional stages found at ISDSN: Stage 1 on 3 at (A) Station ISDSN-22 with small tubes at surface, shallow burrowing, and oxidized voids at depth; (B) Station ISDSN-3 with small tubes at surface, shallow burrowing, and subsurface void; and (C) Station ISDSN-14 with small to medium tubes at surface, shallow burrowing, in-filled voids at depth

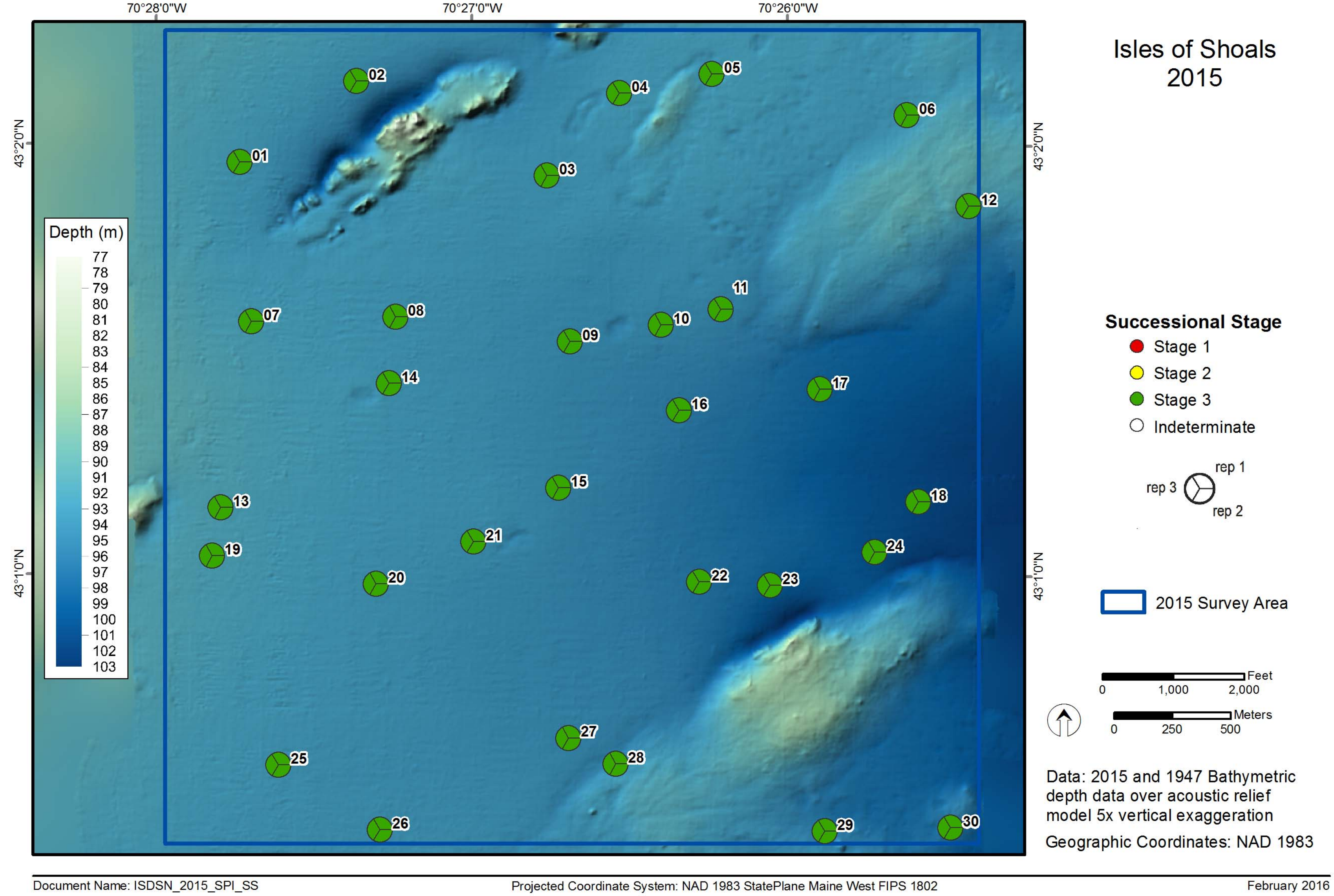


Figure 3-26. Infaunal successional stages found at ISDSN

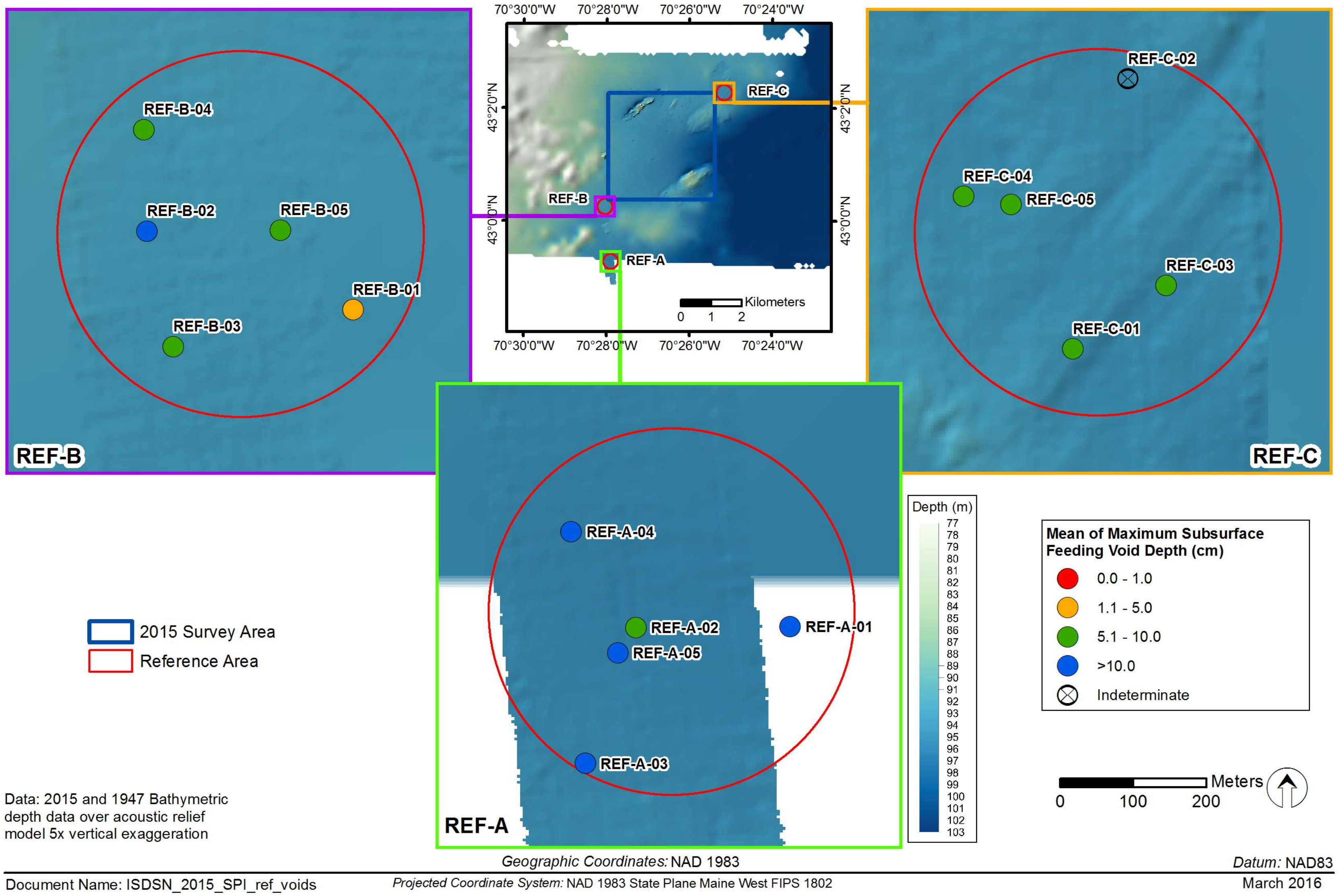


Figure 3-27. Maximum subsurface feeding void depth at ISDSN reference areas

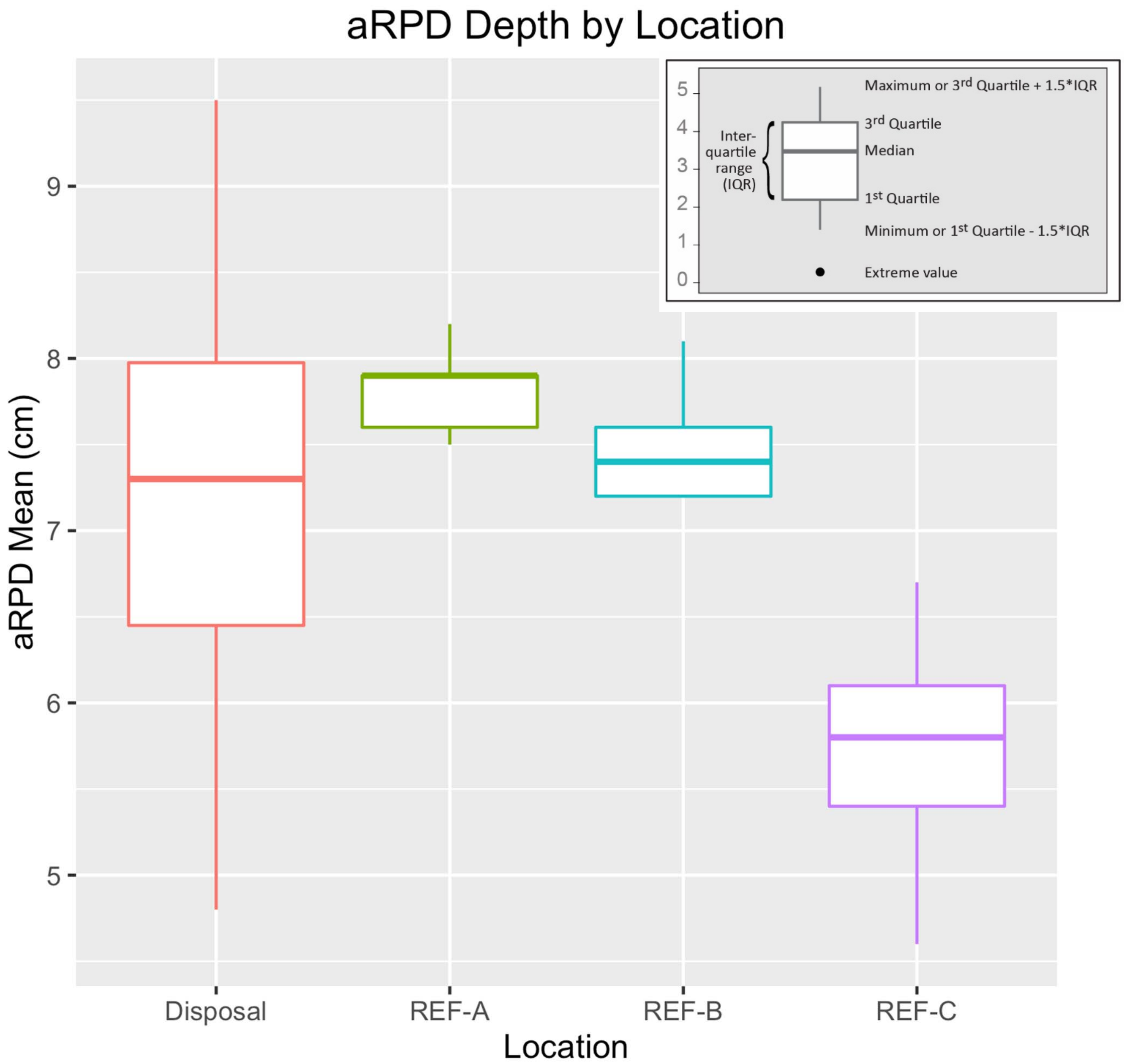


Figure 3-28. Boxplot showing distribution of station mean aRPD depths (cm) for 2015 ISDSN and each of the reference areas

4.0 SUMMARY

The objectives of the 2015 survey at ISDSN were to:

Objective 1: Characterize the seafloor topography and surface features of the potential site and reference areas by completing a multibeam bathymetric survey.

Objective 2: Use SPI and PV to further define the physical characteristics of surface sediment and to assess the benthic status over the proposed site and potential reference areas.

The 2015 survey revealed that ISDSN and the proposed reference areas can generally be characterized as low energy depositional environments dominated by fine-grained soft sediments and robust, mature benthic communities. Acoustic data, camera penetration depth, and grain size determinations indicated the physical nature of the sediments was predominantly soft and fine-grained. The consistently deep aRPD values and Stage 1 on 3 successional stages found in SPI images across the reference areas and the proposed disposal site are characteristic of a healthy, soft-bottom benthic ecosystem. Statistical tests revealed the reference areas and proposed disposal site were statistically equivalent in terms of aRPD depths, a SPI variable that is a reliable indicator of infaunal activity. Further, the ubiquitous presence of epifaunal tracks in PV images signified an active mobile epifaunal community across both the reference areas and at the ISDSN.

Topographic highs in the northwest, northeast, and southeast corners of the survey area, including REF-C, were shallower and harder than sediments in other part of the survey area. However, all SPI stations sampled in these regions had grain size and camera prism penetration depths consistent with soft-bottom habitats. It is important to note that no SPI/PV stations were located on the topographic highs in the northwest and southeast, which appear to be glacial outcrops based on their sharp topographic relief, hard backscatter returns, and textural properties evident in side-scan sonar data.

The results of the 2015 survey point to the possibility that dredged material was previously placed in the vicinity of ISDSN. There was evidence of potential dredged material in SPI images from the northeast and southeast sections of ISDSN and from REF-C. These results should be viewed cautiously as it is possible for the camera to carry cohesive clays, often indicative of dredged materials, from one station to another and create smearing artifacts in images at stations subsequent to where the clay was initially encountered. Acoustic data also revealed an area of small craters in the northeast portion of the survey area, a pattern that is often associated with dredged material placement. The possible presence of dredged material at ISDSN and REF-C should be considered when evaluating the potential designation of ISDSN as a formal disposal site and when finalizing reference areas to be used for future surveys.

The 2015 survey established baseline conditions of seafloor topography as well as physical and biological characteristics of the surface sediment at ISDSN. The results from this survey can be used as a temporal reference point should ISDSN be designated as a formal disposal site and require monitoring as part of the DAMOS Program.

5.0 REFERENCES

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6.0 DATA TRANSMITTAL

Data transmittal to support this data report will be provided as a separate deliverable for inclusion in a Technical Support Notebook. The data submittal will include:

- Scope of Work
- Raw and processed acoustic survey data
- Report figures and associated files, including an ArcGIS geo-database
- Survey field logs
- Raw and adjusted SPI/PV images (raw NEF images have been converted to JPEG files for ease of use in report and general use by client; image size approximately 1200 x 1800 pixels).
- Report figures and associated files, including an ArcGIS geo-database
- Popup: interactive SPI data map
- Electronic copies of all final report products

APPENDIX A

TABLE OF COMMON CONVERSIONS

Metric Unit Conversion to English Unit		**English Unit Conversion to Metric Unit**	
1 meter 1 m	3.2808 ft	1 foot 1 ft	0.3048 m
1 square meter 1 m^2	10.7639 ft^2	1 square foot 1 ft^2	0.0929 m^2
1 kilometer 1 km	0.6214 mi	1 mile 1 mi	1.6093 km
1 cubic meter 1 m^3	1.3080 yd^3	1 cubic yard 1 yd^3	0.7646 m^3
1 centimeter 1 cm	0.3937 in	1 inch 1 in	2.54 cm

APPENDIX B

ISDSN ACTUAL SPI/PV REPLICATE LOCATIONS

September 2015

ISDSN September 2015 SPI/PV Replicate Locations

Replicate	Latitude (N)	Longitude (W)	Replicate	Latitude (N)	Longitude (W)
ISDSN-01-A	43° 1.959'	70° 27.735'	ISDSN-08-A	43° 1.600'	70° 27.239'
ISDSN-01-B	43° 1.959'	70° 27.735'	ISDSN-08-B	43° 1.600'	70° 27.238'
ISDSN-01-C	43° 1.958'	70° 27.734'	ISDSN-08-C	43° 1.600'	70° 27.237'
ISDSN-01-D	43° 1.957'	70° 27.732'	ISDSN-08-D	43° 1.600'	70° 27.237'
ISDSN-02-A	43° 2.147'	70° 27.366'	ISDSN-09-A	43° 1.544'	70° 26.686'
ISDSN-02-B	43° 2.144'	70° 27.364'	ISDSN-09-B	43° 1.544'	70° 26.685'
ISDSN-02-C	43° 2.146'	70° 27.366'	ISDSN-09-C	43° 1.543'	70° 26.686'
ISDSN-02-D	43° 2.148'	70° 27.365'	ISDSN-09-D	43° 1.542'	70° 26.682'
ISDSN-03-A	43° 1.929'	70° 26.760'	ISDSN-10-A	43° 1.583'	70° 26.398'
ISDSN-03-B	43° 1.932'	70° 26.764'	ISDSN-10-B	43° 1.584'	70° 26.399'
ISDSN-03-C	43° 1.931'	70° 26.765'	ISDSN-10-C	43° 1.583'	70° 26.400'
ISDSN-03-D	43° 1.932'	70° 26.762'	ISDSN-10-D	43° 1.585'	70° 26.403'
ISDSN-04-A	43° 2.121'	70° 26.533'	ISDSN-11-A	43° 1.619'	70° 26.209'
ISDSN-04-B	43° 2.120'	70° 26.532'	ISDSN-11-B	43° 1.618'	70° 26.205'
ISDSN-04-C	43° 2.122'	70° 26.534'	ISDSN-11-C	43° 1.617'	70° 26.212'
ISDSN-04-D	43° 2.120'	70° 26.535'	ISDSN-11-D	43° 1.623'	70° 26.212'
ISDSN-05-A	43° 2.166'	70° 26.240'	ISDSN-12-A	43° 1.862'	70° 25.424'
ISDSN-05-B	43° 2.167'	70° 26.243'	ISDSN-12-B	43° 1.859'	70° 25.424'
ISDSN-05-C	43° 2.167'	70° 26.241'	ISDSN-12-C	43° 1.863'	70° 25.424'
ISDSN-05-D	43° 2.167'	70° 26.241'	ISDSN-12-D	43° 1.861'	70° 25.425'
ISDSN-06-A	43° 2.072'	70° 25.621'	ISDSN-13-A	43° 1.155'	70° 27.790'
ISDSN-06-B	43° 2.076'	70° 25.617'	ISDSN-13-B	43° 1.155'	70° 27.790'
ISDSN-06-C	43° 2.075'	70° 25.618'	ISDSN-13-C	43° 1.154'	70° 27.791'
ISDSN-06-D	43° 2.072'	70° 25.620'	ISDSN-13-D	43° 1.153'	70° 27.791'
ISDSN-07-A	43° 1.588'	70° 27.695'	ISDSN-14-A	43° 1.445'	70° 27.259'
ISDSN-07-B	43° 1.590'	70° 27.697'	ISDSN-14-B	43° 1.444'	70° 27.258'
ISDSN-07-C	43° 1.589'	70° 27.694'	ISDSN-14-C	43° 1.444'	70° 27.258'
ISDSN-07-D	43° 1.590'	70° 27.692'	ISDSN-14-D	43° 1.442'	70° 27.258'

Notes:
1) Coordinate system NAD83
2) This table reflects all attempts to collect SPI/PV replicates at each target station. The three replicates with the best quality images were used for analysis.

ISDSN September 2015 SPI/PV Replicate Locations

Replicate	Latitude (N)	Longitude (W)	Replicate	Latitude (N)	Longitude (W)
ISDSN-15-A	43° 1.203'	70° 26.720'	ISDSN-22-A	43° 0.986'	70° 26.274'
ISDSN-15-B	43° 1.206'	70° 26.719'	ISDSN-22-B	43° 0.986'	70° 26.278'
ISDSN-15-C	43° 1.205'	70° 26.718'	ISDSN-22-C	43° 0.987'	70° 26.279'
ISDSN-15-D	43° 1.203'	70° 26.716'	ISDSN-22-D	43° 0.987'	70° 26.277'
ISDSN-16-A	43° 1.385'	70° 26.340'	ISDSN-23-A	43° 0.979'	70° 26.050'
ISDSN-16-B	43° 1.384'	70° 26.339'	ISDSN-23-B	43° 0.973'	70° 26.048'
ISDSN-16-C	43° 1.384'	70° 26.340'	ISDSN-23-C	43° 0.977'	70° 26.052'
ISDSN-16-D	43° 1.384'	70° 26.340'	ISDSN-23-D	43° 0.980'	70° 26.048'
ISDSN-17-A	43° 1.434'	70° 25.894'	ISDSN-24-A	43° 1.056'	70° 25.718'
ISDSN-17-B	43° 1.437'	70° 25.898'	ISDSN-24-B	43° 1.057'	70° 25.719'
ISDSN-17-C	43° 1.434'	70° 25.899'	ISDSN-24-C	43° 1.056'	70° 25.718'
ISDSN-17-D	43° 1.432'	70° 25.898'	ISDSN-24-D	43° 1.054'	70° 25.718'
ISDSN-18-A	43° 1.174'	70° 25.580'	ISDSN-25-A	43° 0.557'	70° 27.605'
ISDSN-18-B	43° 1.173'	70° 25.579'	ISDSN-25-B	43° 0.559'	70° 27.608'
ISDSN-18-C	43° 1.175'	70° 25.580'	ISDSN-25-C	43° 0.560'	70° 27.609'
ISDSN-18-D	43° 1.172'	70° 25.579'	ISDSN-25-D	43° 0.560'	70° 27.607'
ISDSN-19-A	43° 1.043'	70° 27.816'	ISDSN-26-A	43° 0.408'	70° 27.283'
ISDSN-19-B	43° 1.044'	70° 27.817'	ISDSN-26-B	43° 0.408'	70° 27.281'
ISDSN-19-C	43° 1.043'	70° 27.817'	ISDSN-26-C	43° 0.406'	70° 27.282'
ISDSN-19-D	43° 1.042'	70° 27.816'	ISDSN-26-D	43° 0.408'	70° 27.280'
ISDSN-20-A	43° 0.980'	70° 27.297'	ISDSN-27-A	43° 0.623'	70° 26.686'
ISDSN-20-B	43° 0.980'	70° 27.297'	ISDSN-27-B	43° 0.625'	70° 26.696'
ISDSN-20-C	43° 0.981'	70° 27.295'	ISDSN-27-C	43° 0.625'	70° 26.690'
ISDSN-20-D	43° 0.980'	70° 27.295'	ISDSN-27-D	43° 0.625'	70° 26.693'
ISDSN-21-A	43° 1.079'	70° 26.989'	ISDSN-28-A	43° 0.563'	70° 26.536'
ISDSN-21-B	43° 1.077'	70° 26.987'	ISDSN-28-B	43° 0.562'	70° 26.535'
ISDSN-21-C	43° 1.079'	70° 26.988'	ISDSN-28-C	43° 0.564'	70° 26.538'
ISDSN-21-D	43° 1.077'	70° 26.986'	ISDSN-28-D	43° 0.565'	70° 26.536'

Notes:
1) Coordinate system NAD83
2) This table reflects all attempts to collect SPI/PV replicates at each target station. The three replicates with the best quality images were used for analysis.

ISDSN September 2015 SPI/PV Replicate Locations

Replicate	Latitude (N)	Longitude (W)	Replicate	Latitude (N)	Longitude (W)
ISDSN-29-A	43° 0.408'	70° 25.874'	REF-B-01-A	43° 0.201'	70° 27.926'
ISDSN-29-B	43° 0.408'	70° 25.871'	REF-B-01-B	43° 0.204'	70° 27.925'
ISDSN-29-C	43° 0.409'	70° 25.872'	REF-B-01-C	43° 0.203'	70° 27.924'
ISDSN-29-D	43° 0.410'	70° 25.875'	REF-B-01-D	43° 0.205'	70° 27.925'
ISDSN-30-A	43° 0.417'	70° 25.475'	REF-B-02-A	43° 0.259'	70° 28.133'
ISDSN-30-B	43° 0.417'	70° 25.476'	REF-B-02-B	43° 0.261'	70° 28.133'
ISDSN-30-C	43° 0.417'	70° 25.473'	REF-B-02-C	43° 0.260'	70° 28.131'
ISDSN-30-D	43° 0.417'	70° 25.475'	REF-B-02-D	43° 0.259'	70° 28.134'
REF-A-01-A	43° -0.729'	70° 27.776'	REF-B-03-A	43° 0.174'	70° 28.106'
REF-A-01-B	43° -0.731'	70° 27.780'	REF-B-03-B	43° 0.172'	70° 28.108'
REF-A-01-C	43° -0.731'	70° 27.776'	REF-B-03-C	43° 0.173'	70° 28.109'
REF-A-01-D	43° -0.730'	70° 27.776'	REF-B-03-D	43° 0.172'	70° 28.107'
REF-A-02-A	43° -0.730'	70° 27.931'	REF-B-04-A	43° 0.334'	70° 28.135'
REF-A-02-B	43° -0.725'	70° 27.931'	REF-B-04-B	43° 0.334'	70° 28.136'
REF-A-02-C	43° -0.727'	70° 27.931'	REF-B-04-C	43° 0.333'	70° 28.139'
REF-A-02-D	43° -0.730'	70° 27.931'	REF-B-04-D	43° 0.333'	70° 28.135'
REF-A-03-A	43° -0.831'	70° 27.981'	REF-B-05-A	43° 0.260'	70° 27.999'
REF-A-03-B	43° -0.834'	70° 27.975'	REF-B-05-B	43° 0.257'	70° 27.994'
REF-A-03-C	43° -0.832'	70° 27.977'	REF-B-05-C	43° 0.256'	70° 27.995'
REF-A-03-D	43° -0.831'	70° 27.979'	REF-B-05-D	43° 0.256'	70° 27.993'
REF-A-04-A	43° -0.660'	70° 27.996'	REF-C-01-A	43° 2.194'	70° 25.190'
REF-A-04-B	43° -0.662'	70° 27.996'	REF-C-01-B	43° 2.197'	70° 25.196'
REF-A-04-C	43° -0.659'	70° 27.996'	REF-C-01-C	43° 2.195'	70° 25.194'
REF-A-04-D	43° -0.660'	70° 27.995'	REF-C-01-D	43° 2.195'	70° 25.193'
REF-A-05-A	43° -0.749'	70° 27.949'	REF-C-02-A	43° 2.393'	70° 25.136'
REF-A-05-B	43° -0.752'	70° 27.942'	REF-C-02-B	43° 2.395'	70° 25.136'
REF-A-05-C	43° -0.752'	70° 27.948'	REF-C-02-C	43° 2.394'	70° 25.138'
REF-A-05-D	43° -0.748'	70° 27.945'	REF-C-02-D	43° 2.396'	70° 25.141'

Notes:
1) Coordinate system NAD83
2) This table reflects all attempts to collect SPI/PV replicates at each target station. The three replicates with the best quality images were used for analysis.

ISDSN September 2015 SPI/PV Replicate Locations

Replicate	Latitude (N)	Longitude (W)	Replicate	Latitude (N)	Longitude (W)
REF-C-03-A	43° 2.241'	70° 25.097'			
REF-C-03-B	43° 2.246'	70° 25.096'			
REF-C-03-C	43° 2.243'	70° 25.099'			
REF-C-03-D	43° 2.244'	70° 25.099'			
REF-C-04-A	43° 2.306'	70° 25.300'			
REF-C-04-B	43° 2.306'	70° 25.301'			
REF-C-04-C	43° 2.307'	70° 25.303'			
REF-C-04-D	43° 2.305'	70° 25.303'			
REF-C-05-A	43° 2.301'	70° 25.253'			
REF-C-05-B	43° 2.299'	70° 25.255'			
REF-C-05-C	43° 2.301'	70° 25.255'			
REF-C-05-D	43° 2.300'	70° 25.257'			

Notes:
1) Coordinate system NAD83
2) This table reflects all attempts to collect SPI/PV replicates at each target station. The three replicates with the best quality images were used for analysis.

APPENDIX C

SEDIMENT-PROFILE AND PLAN-VIEW IMAGE ANALYSIS RESULTS FOR ISDSN SURVEY, SEPTEMBER 2015

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
Site	1	A	09/27/15	7:28:10	310	12.5	1	>4	>4	2	>4 to 2	250.4	17.3	17.0	17.9	0.9	Biological	FALSE	80.6	5.6
Site	1	B	09/27/15	7:28:59	310	12.5	1	>4	>4	2	>4 to 2	242.2	16.7	16.3	17.0	0.7	Biological	FALSE	92.1	6.4
Site	1	C	09/27/15	7:29:53	310	12.5	1	>4	>4	2	>4 to 2	261.4	18.0	17.5	18.3	0.8	Biological	FALSE	135.9	9.4
Site	2	A	09/27/15	17:08:59	308	12.5	1	>4	>4	2	>4 to 2	209.2	14.4	12.6	15.0	2.4	Biological	FALSE	104.3	7.2
Site	2	B	09/27/15	17:09:44	308	12.5	1	>4	>4	2	>4 to 2	229.0	15.8	15.3	16.0	0.7	Biological	FALSE	92.1	6.4
Site	2	D	09/27/15	17:11:09	308	12.5	1	>4	>4	2	>4 to 2	173.2	11.9	10.7	13.1	2.4	Physical	FALSE	75.0	5.2
Site	3	A	09/27/15	10:31:27	319	12.5	1	>4	>4	2	>4 to 2	246.9	17.0	16.7	17.3	0.6	Biological	FALSE	114.7	7.9
Site	3	B	09/27/15	10:32:39	319	12.5	1	>4	>4	2	>4 to 2	228.3	15.7	15.5	15.9	0.5	Biological	FALSE	94.4	6.5
Site	3	D	09/27/15	10:34:11	319	12.5	1	>4	>4	2	>4 to 2	215.5	14.9	14.5	15.0	0.6	Biological	FALSE	112.2	7.7
Site	4	A	09/27/15	10:44:18	316	12.5	1	>4	>4	2	>4 to 2	223.8	15.4	15.3	15.6	0.2	Biological	FALSE	74.2	5.1
Site	4	C	09/27/15	10:45:52	316	12.5	1	>4	>4	2	>4 to 2	189.9	13.1	12.6	13.6	0.9	Biological	FALSE	86.9	6.0
Site	4	D	09/27/15	10:46:35	316	12.5	1	>4	>4	2	>4 to 2	204.4	14.1	13.6	14.7	1.0	Biological	FALSE	87.8	6.1

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
Site	5	A	09/27/15	10:55:54	315	12.5	1	>4	>4	2	>4 to 2	171.6	11.8	10.6	12.3	1.7	Biological	FALSE	88.6	6.1
Site	5	B	09/27/15	10:56:43	315	12.5	1	>4	>4	2	>4 to 2	201.2	13.9	13.4	14.4	1.0	Biological	FALSE	95.5	6.6
Site	5	D	09/27/15	10:58:26	315	12.5	1	>4	>4	2	>4 to 2	190.6	13.1	12.5	13.6	1.1	Biological	FALSE	88.4	6.1
Site	6	A	09/27/15	11:09:44	317	12.5	1	>4	>4	2	>4 to 2	191.9	13.2	11.5	14.7	3.2	Biological	FALSE	82.3	5.7
Site	6	B	09/27/15	11:10:30	317	12.5	1	>4	>4	2	>4 to 2	169.1	11.7	10.0	12.6	2.7	Biological	FALSE	77.2	5.3
Site	6	D	09/27/15	11:12:04	317	12.5	1	>4	>4	2	>4 to 2	155.2	10.7	10.2	11.5	1.4	Biological	FALSE	47.7	3.3
Site	7	A	09/27/15	7:52:41	310	12.5	1	>4	>4	2	>4 to 2	249.8	17.2	16.7	17.7	1.0	Biological	FALSE	98.7	6.8
Site	7	B	09/27/15	7:53:26	310	12.5	1	>4	>4	2	>4 to 2	234.4	16.2	15.5	16.6	1.1	Biological	FALSE	78.7	5.4
Site	7	C	09/27/15	7:54:08	310	12.5	1	>4	>4	2	>4 to 2	208.3	14.4	14.0	14.8	0.8	Biological	FALSE	101.3	7.0
Site	8	A	09/27/15	8:04:46	312	12.5	1	>4	>4	2	>4 to 2	272.5	18.8	18.5	19.1	0.6	Biological	FALSE	107.5	7.4
Site	8	B	09/27/15	8:05:28	312	12.5	1	>4	>4	2	>4 to 2	233.3	16.1	15.7	16.9	1.3	Biological	FALSE	108.7	7.5
Site	8	C	09/27/15	8:06:17	312	12.5	1	>4	>4	2	>4 to 2	259.3	17.9	17.1	18.2	1.1	Biological	FALSE	129.7	8.9

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
Site	9	A	09/27/15	9:37:28	322	12.5	1	>4	>4	2	>4 to 2	249.5	17.2	16.7	17.5	0.8	Biological	FALSE	105.2	7.2
Site	9	C	09/27/15	9:38:57	322	12.5	1	>4	>4	2	>4 to 2	239.2	16.5	16.2	16.7	0.5	Biological	FALSE	94.9	6.5
Site	9	D	09/27/15	9:39:51	322	12.5	1	>4	>4	2	>4 to 2	242.0	16.7	16.3	16.9	0.6	Biological	FALSE	96.4	6.6
Site	10	A	09/27/15	10:08:47	322	12.5	1	>4	>4	2	>4 to 2	218.6	15.1	14.5	15.8	1.3	Biological	FALSE	99.5	6.9
Site	10	B	09/27/15	10:09:30	322	12.5	1	>4	>4	2	>4 to 2	239.7	16.5	16.1	17.0	0.8	Biological	FALSE	92.2	6.4
Site	10	C	09/27/15	10:10:18	322	12.5	1	>4	>4	2	>4 to 2	189.2	13.0	12.8	13.2	0.4	Biological	FALSE	93.5	6.4
Site	11	A	09/27/15	10:15:29	322	12.5	1	>4	>4	2	>4 to 2	234.5	16.2	14.5	16.9	2.3	Biological	FALSE	76.2	5.3
Site	11	B	09/27/15	10:16:20	322	12.5	1	>4	>4	2	>4 to 2	217.0	15.0	14.5	15.5	1.0	Biological	FALSE	73.2	5.0
Site	11	D	09/27/15	10:18:13	322	12.5	1	>4	>4	2	>4 to 2	259.6	17.9	17.6	18.2	0.7	Biological	FALSE	116.8	8.1
Site	12	A	09/27/15	12:42:29	312	12.5	1	>4	>4	2	>4 to 2	102.0	7.0	6.6	7.5	0.9	Biological	TRUE	102.0	7.0
Site	12	B	09/27/15	12:43:15	312	12.5	1	>4	>4	2	>4 to 2	143.9	9.9	9.6	10.4	0.8	Biological	FALSE	117.0	8.1
Site	12	C	09/27/15	12:44:14	312	12.5	1	>4	>4	2	>4 to 2	163.4	11.3	10.9	11.9	1.0	Biological	FALSE	91.0	6.3
Site	13	A	09/27/15	8:29:09	308	12.5	1	>4	>4	2	>4 to 2	211.1	14.6	12.9	16.2	3.4	Physical	FALSE	103.0	7.1

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
Site	13	B	09/27/15	8:29:52	308	12.5	1	>4	>4	2	>4 to 2	229.7	15.8	15.4	16.2	0.8	Biological	FALSE	95.1	6.6
Site	13	C	09/27/15	8:30:39	308	12.5	1	>4	>4	2	>4 to 2	226.7	15.6	15.5	15.9	0.4	Biological	FALSE	124.1	8.6
Site	14	A	09/27/15	8:16:05	312	12.5	1	>4	>4	2	>4 to 2	192.0	13.2	11.6	14.5	2.9	Biological	FALSE	105.1	7.2
Site	14	B	09/27/15	8:16:46	312	12.5	1	>4	>4	2	>4 to 2	209.8	14.5	13.8	14.8	0.9	Biological	FALSE	107.9	7.4
Site	14	C	09/27/15	8:17:27	312	12.5	1	>4	>4	2	>4 to 2	265.2	18.3	18.1	18.5	0.4	Biological	FALSE	105.4	7.3
Site	15	A	09/27/15	9:12:09	320	12.5	1	>4	>4	2	>4 to 2	245.9	17.0	16.5	17.3	0.8	Biological	FALSE	130.3	9.0
Site	15	B	09/27/15	9:12:53	320	12.5	1	>4	>4	2	>4 to 2	219.5	15.1	13.9	16.0	2.1	Biological	FALSE	114.5	7.9
Site	15	C	09/27/15	9:13:38	320	12.5	1	>4	>4	2	>4 to 2	254.0	17.5	17.1	17.8	0.7	Biological	FALSE	103.9	7.2
Site	16	A	09/27/15	9:25:14	325	12.5	1	>4	>4	2	>4 to 2	248.9	17.2	16.5	17.5	1.0	Biological	FALSE	171.9	11.9
Site	16	C	09/27/15	9:26:52	325	12.5	1	>4	>4	2	>4 to 2	215.1	14.8	14.0	16.2	2.2	Biological	FALSE	130.3	9.0
Site	16	D	09/27/15	9:27:41	325	12.5	1	>4	>4	2	>4 to 2	228.6	15.8	15.4	16.0	0.6	Biological	FALSE	110.8	7.6
Site	17	A	09/27/15	12:57:07	332	12.5	1	>4	>4	2	>4 to 2	228.4	15.7	14.8	16.5	1.7	Biological	FALSE	115.5	8.0
Site	17	B	09/27/15	12:58:13	332	12.5	1	>4	>4	2	>4 to 2	247.7	17.1	16.9	17.2	0.3	Biological	FALSE	124.5	8.6
Site	17	C	09/27/15	12:59:02	332	12.5	1	>4	>4	2	>4 to 2	267.1	18.4	17.7	19.0	1.3	Biological	FALSE	143.4	9.9
Site	18	A	09/27/15	13:11:18	340	12.5	1	>4	>4	2	>4 to 2	245.1	16.9	16.4	17.3	0.9	Biological	FALSE	119.0	8.2

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
Site	18	B	09/27/15	13:12:11	340	12.5	1	>4	>4	2	>4 to 2	277.6	19.1	18.6	19.5	0.9	Biological	FALSE	115.2	7.9
Site	18	D	09/27/15	13:13:56	340	12.5	1	>4	>4	2	>4 to 2	258.0	17.8	17.6	18.3	0.8	Biological	FALSE	114.8	7.9
Site	19	A	09/27/15	8:35:26	310	12.5	1	>4	>4	2	>4 to 2	256.6	17.7	17.3	18.1	0.7	Biological	FALSE	154.9	10.7
Site	19	B	09/27/15	8:36:16	310	12.5	1	>4	>4	2	>4 to 2	278.7	19.2	19.0	19.6	0.6	Biological	FALSE	130.7	9.0
Site	19	D	09/27/15	8:37:47	310	12.5	1	>4	>4	2	>4 to 2	276.9	19.1	18.8	19.7	0.9	Biological	FALSE	107.9	7.4
Site	20	A	09/27/15	8:47:38	315	12.5	1	>4	>4	2	>4 to 2	224.3	15.5	14.8	16.2	1.3	Biological	FALSE	117.6	8.1
Site	20	B	09/27/15	8:48:29	315	12.5	1	>4	>4	2	>4 to 2	227.8	15.7	14.7	16.5	1.8	Biological	FALSE	117.3	8.1
Site	20	C	09/27/15	8:49:16	315	12.5	1	>4	>4	2	>4 to 2	248.5	17.1	16.6	17.4	0.8	Biological	FALSE	117.7	8.1
Site	21	A	09/27/15	9:00:33	317	12.5	1	>4	>4	2	>4 to 2	224.2	15.5	14.8	15.9	1.1	Biological	FALSE	106.7	7.4
Site	21	B	09/27/15	9:01:13	317	12.5	1	>4	>4	2	>4 to 2	248.4	17.1	15.8	18.0	2.2	Biological	FALSE	125.9	8.7
Site	21	D	09/27/15	9:02:43	317	12.5	1	>4	>4	2	>4 to 2	242.6	16.7	16.2	17.0	0.8	Biological	FALSE	108.7	7.5
Site	22	A	09/27/15	13:44:28	325	12.5	1	>4	>4	2	>4 to 2	233.1	16.1	15.7	16.5	0.8	Biological	FALSE	116.6	8.0
Site	22	B	09/27/15	13:45:17	325	12.5	1	>4	>4	2	>4 to 2	260.1	17.9	17.5	18.3	0.7	Biological	FALSE	121.9	8.4
Site	22	C	09/27/15	13:46:20	325	12.5	1	>4	>4	2	>4 to 2	255.4	17.6	17.3	18.1	0.7	Biological	FALSE	117.3	8.1

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
Site	23	A	09/27/15	13:36:47	331	12.5	1	>4	>4	2	>4 to 2	228.5	15.7	14.8	16.4	1.6	Biological	FALSE	108.6	7.5
Site	23	C	09/27/15	13:38:34	331	12.5	1	>4	>4	2	>4 to 2	256.5	17.7	17.0	18.2	1.2	Biological	FALSE	133.1	9.2
Site	23	D	09/27/15	13:39:35	331	12.5	1	>4	>4	2	>4 to 2	227.9	15.7	15.2	16.1	1.0	Biological	FALSE	96.8	6.7
Site	24	A	09/27/15	13:23:19	326	12.5	1	>4	>4	2	>4 to 2	218.4	15.1	14.5	15.8	1.3	Biological	FALSE	114.5	7.9
Site	24	B	09/27/15	13:24:32	326	12.5	1	>4	>4	2	>4 to 2	213.8	14.7	14.5	14.9	0.5	Biological	FALSE	86.6	6.0
Site	24	C	09/27/15	13:25:19	326	12.5	1	>4	>4	2	>4 to 2	241.4	16.6	16.3	17.0	0.7	Biological	FALSE	116.4	8.0
Site	25	A	09/27/15	15:01:18	308	12.5	1	>4	>4	2	>4 to 2	181.6	12.5	12.2	12.8	0.6	Biological	FALSE	109.8	7.6
Site	25	B	09/27/15	15:02:15	308	12.5	1	>4	>4	2	>4 to 2	230.5	15.9	15.5	16.3	0.8	Biological	FALSE	100.7	6.9
Site	25	C	09/27/15	15:03:03	308	12.5	1	>4	>4	2	>4 to 2	259.0	17.9	17.4	18.1	0.7	Biological	FALSE	102.5	7.1
Site	26	A	09/27/15	14:52:28	311	12.5	1	>4	>4	2	>4 to 2	239.3	16.5	16.2	16.9	0.7	Biological	FALSE	125.2	8.6
Site	26	C	09/27/15	14:54:18	311	12.5	1	>4	>4	2	>4 to 2	230.4	15.9	15.4	16.1	0.7	Biological	FALSE	138.0	9.5
Site	26	D	09/27/15	14:55:05	311	12.5	1	>4	>4	2	>4 to 2	222.3	15.3	14.8	15.9	1.1	Biological	FALSE	127.2	8.8
Site	27	A	09/27/15	14:37:46	315	12.5	1	>4	>4	2	>4 to 2	241.3	16.6	16.1	16.8	0.7	Biological	FALSE	119.2	8.2
Site	27	B	09/27/15	14:38:51	315	12.5	1	>4	>4	2	>4 to 2	227.7	15.7	15.2	16.0	0.8	Biological	FALSE	92.8	6.4
Site	27	C	09/27/15	14:39:35	315	12.5	1	>4	>4	2	>4 to 2	233.1	16.1	15.8	16.3	0.5	Biological	FALSE	110.2	7.6

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
Site	28	A	09/27/15	14:31:22	314	12.5	1	>4	>4	2	>4 to 2	157.5	10.9	9.8	11.8	2.0	Biological	FALSE	86.3	5.9
Site	28	B	09/27/15	14:32:08	314	12.5	1	>4	>4	2	>4 to 2	185.6	12.8	12.3	13.2	0.9	Biological	FALSE	100.0	6.9
Site	28	C	09/27/15	14:32:57	314	12.5	1	>4	>4	2	>4 to 2	138.6	9.6	9.3	9.7	0.4	Biological	FALSE	88.1	6.1
Site	29	A	09/27/15	14:16:32	322	12.5	1	>4	>4	2	>4 to 2	201.8	13.9	13.2	14.4	1.2	Biological	FALSE	133.0	9.2
Site	29	B	09/27/15	14:17:19	322	12.5	1	>4	>4	2	>4 to 2	168.1	11.6	11.3	11.9	0.6	Biological	FALSE	101.0	7.0
Site	29	C	09/27/15	14:18:18	322	12.5	1	>4	>4	2	>4 to 2	179.0	12.3	11.7	13.1	1.4	Biological	FALSE	81.7	5.6
Site	30	B	09/27/15	14:04:15	322	12.5	1	>4	>4	2	>4 to 2	148.6	10.2	9.5	10.7	1.2	Biological	FALSE	100.0	6.9
Site	30	C	09/27/15	14:05:12	322	12.5	1	>4	>4	2	>4 to 2	143.6	9.9	9.3	10.3	1.0	Biological	FALSE	84.8	5.8
Site	30	D	09/27/15	14:06:07	322	12.5	1	>4	>4	2	>4 to 2	112.3	7.7	6.4	8.8	2.4	Physical	FALSE	76.7	5.3
REF-A	1	A	09/27/15	16:23:17	314	12.5	1	>4	>4	2	>4 to 2	243.8	16.8	16.6	17.0	0.4	Biological	FALSE	110.8	7.6
REF-A	1	B	09/27/15	16:24:09	314	12.5	1	>4	>4	2	>4 to 2	231.8	16.0	15.2	16.9	1.7	Biological	FALSE	96.8	6.7
REF-A	1	C	09/27/15	16:25:09	314	12.5	1	>4	>4	2	>4 to 2	230.0	15.9	15.4	16.2	0.8	Biological	FALSE	149.4	10.3
REF-A	2	A	09/27/15	16:11:34	315	12.5	1	>4	>4	2	>4 to 2	267.5	18.4	17.9	18.7	0.9	Biological	FALSE	100.6	6.9

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
REF-A	2	B	09/27/15	16:12:27	315	12.5	1	>4	>4	2	>4 to 2	254.3	17.5	16.9	18.3	1.4	Biological	FALSE	137.4	9.5
REF-A	2	C	09/27/15	16:13:17	315	12.5	1	>4	>4	2	>4 to 2	212.9	14.7	14.4	15.0	0.7	Biological	FALSE	104.8	7.2
REF-A	3	A	09/27/15	16:31:31	310	12.5	1	>4	>4	2	>4 to 2	251.1	17.3	17.0	17.6	0.7	Biological	FALSE	122.6	8.4
REF-A	3	B	09/27/15	16:32:48	310	12.5	1	>4	>4	2	>4 to 2	215.0	14.8	14.2	16.0	1.7	Biological	FALSE	103.0	7.1
REF-A	3	C	09/27/15	16:33:38	310	12.5	1	>4	>4	2	>4 to 2	224.5	15.5	14.3	16.2	1.9	Biological	FALSE	105.6	7.3
REF-A	4	A	09/27/15	16:02:40	311	12.5	1	>4	>4	2	>4 to 2	244.1	16.8	16.3	17.1	0.8	Biological	FALSE	137.9	9.5
REF-A	4	C	09/27/15	16:04:16	311	12.5	1	>4	>4	2	>4 to 2	217.4	15.0	15.4	18.0	2.6	Biological	FALSE	107.1	7.4
REF-A	4	D	09/27/15	16:05:06	311	12.5	1	>4	>4	2	>4 to 2	213.5	14.7	14.4	15.3	0.9	Biological	FALSE	100.1	6.9
REF-A	5	A	09/27/15	16:16:41	312	12.5	1	>4	>4	2	>4 to 2	252.3	17.4	16.6	17.9	1.2	Biological	FALSE	140.2	9.7
REF-A	5	B	09/27/15	16:17:34	312	12.5	1	>4	>4	2	>4 to 2	248.3	17.1	16.6	17.9	1.3	Biological	FALSE	88.1	6.1
REF-A	5	D	09/27/15	16:19:26	312	12.5	1	>4	>4	2	>4 to 2	235.0	16.2	15.8	17.2	1.4	Biological	FALSE	98.1	6.8
REF-B	1	A	09/27/15	15:36:35	304	12.5	1	>4	>4	2	>4 to 2	218.1	15.0	13.8	15.8	2.0	Biological	FALSE	113.5	7.8
REF-B	1	B	09/27/15	15:37:23	304	12.5	1	>4	>4	2	>4 to 2	233.1	16.1	15.8	16.4	0.6	Biological	FALSE	118.9	8.2
REF-B	1	C	09/27/15	15:38:10	304	12.5	1	>4	>4	2	>4 to 2	232.1	16.0	15.4	16.4	1.0	Biological	FALSE	120.3	8.3

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
REF-B	2	A	09/27/15	15:21:55	306	12.5	1	>4	>4	2	>4 to 2	221.5	15.3	15.0	15.6	0.6	Biological	FALSE	119.1	8.2
REF-B	2	B	09/27/15	15:23:12	306	12.5	1	>4	>4	2	>4 to 2	253.4	17.5	17.1	17.7	0.7	Biological	FALSE	108.4	7.5
REF-B	2	C	09/27/15	15:24:14	306	12.5	1	>4	>4	2	>4 to 2	185.5	12.8	11.9	13.8	1.9	Biological	FALSE	103.9	7.2
REF-B	3	A	09/27/15	15:44:16	305	12.5	1	>4	>4	2	>4 to 2	243.2	16.8	16.1	17.2	1.1	Biological	FALSE	103.7	7.1
REF-B	3	B	09/27/15	15:45:10	305	12.5	1	>4	>4	2	>4 to 2	216.0	14.9	14.4	15.3	0.9	Biological	FALSE	103.7	7.1
REF-B	3	C	09/27/15	15:46:00	305	12.5	1	>4	>4	2	>4 to 2	264.6	18.2	17.8	18.6	0.8	Biological	FALSE	112.8	7.8
REF-B	4	B	09/27/15	15:16:27	310	12.5	1	>4	>4	2	>4 to 2	201.1	13.9	13.7	14.1	0.3	Biological	FALSE	97.3	6.7
REF-B	4	C	09/27/15	15:17:19	310	12.5	1	>4	>4	2	>4 to 2	248.3	17.1	16.6	17.6	1.1	Biological	FALSE	119.8	8.3
REF-B	4	D	09/27/15	15:18:05	310	12.5	1	>4	>4	2	>4 to 2	223.6	15.4	14.6	16.4	1.8	Biological	FALSE	97.4	6.7
REF-B	5	A	09/27/15	15:29:06	306	12.5	1	>4	>4	2	>4 to 2	262.6	18.1	16.8	18.9	2.1	Biological	FALSE	111.7	7.7
REF-B	5	B	09/27/15	15:30:13	306	12.5	1	>4	>4	2	>4 to 2	237.6	16.4	16.2	16.7	0.5	Biological	FALSE	101.2	7.0
REF-B	5	C	09/27/15	15:31:07	306	12.5	1	>4	>4	2	>4 to 2	196.7	13.6	12.6	14.3	1.6	Biological	FALSE	101.1	7.0
REF-C	1	A	09/27/15	11:23:16	318	12.5	1	>4	>4	2	>4 to 2	172.6	11.9	11.5	12.3	0.7	Biological	FALSE	96.2	6.6
REF-C	1	B	09/27/15	11:24:00	318	12.5	1	>4	>4	2	>4 to 2	151.4	10.4	9.6	11.3	1.7	Physical	FALSE	82.3	5.7

Location	Station	Replicate	Date	Time	Depth (ft)	Stop Collar Setting (in)	# of Weights (per side)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	aRPD > Pen	aRPD Area (sq cm)	Mean aRPD (cm)
REF-C	1	C	09/27/15	11:24:49	318	12.5	1	>4	>4	2	>4 to 2	132.1	9.1	8.3	9.5	1.2	Biological	FALSE	85.1	5.9
REF-C	2	A	09/27/15	11:39:53	318	12.5	1	>4	>4	2	>4 to 2	85.1	5.9	9.8	10.4	0.6	Biological	FALSE	70.6	4.9
REF-C	2	B	09/27/15	11:40:46	318	12.5	1	>4	>4	2	>4 to 2	148.1	10.2	10.0	10.4	0.5	Biological	FALSE	63.5	4.4
REF-C	2	C	09/27/15	11:41:38	318	12.5	1	>4	>4	2	>4 to 2	156.1	10.8	9.6	11.5	1.9	Biological	FALSE	64.7	4.5
REF-C	3	A	09/27/15	11:30:04	320	12.5	1	>4	>4	2	>4 to 2	155.3	10.7	9.6	11.3	1.7	Biological	FALSE	91.6	6.3
REF-C	3	B	09/27/15	11:31:12	320	12.5	1	>4	>4	2	>4 to 2	166.5	11.5	11.3	11.7	0.4	Biological	FALSE	91.8	6.3
REF-C	3	D	09/27/15	11:33:09	320	12.5	1	>4	>4	2	>4 to 2	147.2	10.1	9.8	10.5	0.7	Biological	FALSE	67.2	4.6
REF-C	4	A	09/27/15	11:56:13	318	12.5	1	>4	>4	2	>4 to 2	178.2	12.3	11.3	12.9	1.7	Biological	FALSE	76.1	5.2
REF-C	4	B	09/27/15	11:57:17	318	12.5	1	>4	>4	2	>4 to 2	170.0	11.7	11.3	12.0	0.7	Biological	FALSE	65.4	4.5
REF-C	4	C	09/27/15	11:58:12	318	12.5	1	>4	>4	2	>4 to 2	173.6	12.0	11.3	12.6	1.3	Biological	FALSE	93.8	6.5
REF-C	5	A	09/27/15	11:49:01	318	12.5	1	>4	>4	2	>4 to 2	175.9	12.1	11.7	12.8	1.1	Biological	FALSE	94.5	6.5
REF-C	5	B	09/27/15	11:49:52	318	12.5	1	>4	>4	2	>4 to 2	185.3	12.8	12.3	13.0	0.7	Biological	FALSE	101.8	7.0
REF-C	5	C	09/27/15	11:50:47	318	12.5	1	>4	>4	2	>4 to 2	171.7	11.8	10.7	12.6	1.9	Biological	FALSE	97.1	6.7

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
Site	1	A	No		0	-	No	No	Low	No	-	2	2.7	9.0	5.9	1 on 3
Site	1	B	No		0	-	No	No	Low	No	-	1	4.1	6.3	5.2	1 on 3
Site	1	C	No		0	-	No	No	Low	No	-	3	3.2	11.3	7.2	1 on 3
Site	2	A	No		0	-	No	No	Low	No	-	1	5.2	6.2	5.7	1 on 3
Site	2	B	No		0	-	No	No	Low	No	-	1	6.3	8.0	7.1	1 on 3
Site	2	D	No		10	Ox	No	No	Low	No	-	0				1 on 3
Site	3	A	No		5	Mix	No	No	Low	No	-	1	10.9	12.3	11.6	1 on 3
Site	3	B	No		0	-	No	No	Low	No	-	1	6.2	7.5	6.9	1 on 3
Site	3	D	No		0	-	No	No	Low	No	-	1	6.4	7.4	6.9	1 on 3
Site	4	A	No		0	-	No	No	Low	No	-	3	4.8	8.7	6.8	1 on 3
Site	4	C	No		10	Mix	No	No	Low	No	-	0				1 on 3
Site	4	D	No		0	-	No	No	Low	No	-	1	3.7	4.8	4.3	1 on 3

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
Site	5	A	Possible	Dark gray sediment streaked with white clay.	0	-	No	No	Low	No	-	0				1 on 3
Site	5	B	Possible	Dark gray sediment streaked with white clay.	1	Reduced	No	No	Low	No	-	0				1 on 3
Site	5	D	Possible	White fines at depth.	0	-	No	No	Low	No	-	1	10.9	12.4	11.6	1 on 3
Site	6	A	Possible	Mottled gray and white clay beneath ambient sediment.	0	-	No	No	Low	No	-	2	2.8	6.8	4.8	1 on 3
Site	6	B	Possible	Mottled gray and white clay beneath ambient sediment.	1	Red	No	No	Low	No	-	3	4.2	8.7	6.5	1 on 3
Site	6	D	Possible	Mottled gray and white clay beneath ambient sediment.	6	Mix	No	No	Low	No	-	7	1.6	10.4	6.0	1 on 3
Site	7	A	No		0	-	No	No	Low	No	-	1	6.0	7.1	6.5	1 on 3
Site	7	B	No		0	-	No	No	Low	No	-	3	3.6	14.6	9.1	1 on 3
Site	7	C	No		0	-	No	No	Low	No	-	1	6.5	7.3	6.9	1 on 3
Site	8	A	No		0	-	No	No	Low	No	-	6	4.5	16.4	10.5	1 on 3
Site	8	B	No		0	-	No	No	Low	No	-	1	14.3	15.4	14.8	1 on 3
Site	8	C	No		0	-	No	No	Low	No	-	0				1 on 3

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
Site	9	A	No		0	-	No	No	Low	No	-	1	7.5	8.4	8.0	1 on 3
Site	9	C	No		0	-	No	No	Low	No	-	1	9.1	11.8	10.4	1 on 3
Site	9	D	No		0	-	No	No	Low	No	-	4	8.4	14.1	11.2	1 on 3
Site	10	A	No		0	-	No	No	Low	No	-	0				1 on 3
Site	10	B	No		0	-	No	No	Low	No	-	0				1 on 3
Site	10	C	No		0	-	No	No	Low	No	-	0				1 on 3
Site	11	A	No		0	-	No	No	Low	No	-	1	12.5	12.8	12.6	1 on 3
Site	11	B	No		0	-	No	No	Low	No	-	0				1 on 3
Site	11	D	No		0	-	No	No	Low	No	-	1	5.0	5.5	5.3	1 on 3
Site	12	A	Possible	Small white and green clay deposits in SWI.	0	-	No	No	Low	No	-	0				1 on 3
Site	12	B	Possible	Small white and green clay deposits in SWI.	2	Mix	No	No	Low	No	-	0				1 on 3
Site	12	C	Possible	Clay inclusions at depth.	5	Mix	No	No	Low	No	-	2	2.4	9.2	5.8	1 on 3
Site	13	A	No		0	-	No	No	Low	No	-	1	6.8	7.1	7.0	1 on 3

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
Site	13	B	No		2	Red	No	No	Low	No	-	5	4.3	8.8	6.5	1 on 3
Site	13	C	No		0	-	No	No	Low	No	-	1	2.3	2.9	2.6	1 on 3
Site	14	A	No		0	-	No	No	Low	No	-	3	4.4	13.6	9.0	1 on 3
Site	14	B	No		0	-	No	No	Low	No	-	1	4.2	5.4	4.8	1 on 3
Site	14	C	No		0	-	No	No	Low	No	-	0				1 on 3
Site	15	A	No		0	-	No	No	Low	No	-	0				1 on 3
Site	15	B	No		2	Red	No	No	Low	No	-	2	3.7	7.4	5.5	1 on 3
Site	15	C	No		0	-	No	No	Low	No	-	2	10.3	17.2	13.7	1 on 3
Site	16	A	No		0	-	No	No	Low	No	-	1	3.7	4.7	4.2	1 on 3
Site	16	C	No		0	-	No	No	Low	No	-	0				1 on 3
Site	16	D	No		0	-	No	No	Low	No	-	1	9.9	10.5	10.2	1 on 3
Site	17	A	No		2	Red	No	No	Low	No	-	2	5.1	9.9	7.5	1 on 3
Site	17	B	No		0	-	No	No	Low	No	-	2	15.9	17.2	16.6	1 on 3
Site	17	C	No		1	Red	No	No	Low	No	-	2	6.3	14.9	10.6	1 on 3
Site	18	A	No		0	-	No	No	Low	No	-	1	4.9	5.6	5.3	1 on 3

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
Site	18	B	No		0	-	No	No	Low	No	-	0				1 on 3
Site	18	D	No		0	-	No	No	Low	No	-	6	8.5	17.6	13.0	1 on 3
Site	19	A	No		0	-	No	No	Low	No	-	1	4.4	6.6	5.5	1 on 3
Site	19	B	No		0	-	No	No	Low	No	-	4	2.3	15.5	8.9	1 on 3
Site	19	D	No		0	-	No	No	Low	No	-	2	6.4	18.5	12.4	1 on 3
Site	20	A	No		0	-	No	No	Low	No	-	0				1 on 3
Site	20	B	No		0	-	No	No	Low	No	-	1	9.9	10.3	10.1	1 on 3
Site	20	C	No		4	Mix	No	No	Low	No	-	3	3.4	13.3	8.4	1 on 3
Site	21	A	No		0	-	No	No	Low	No	-	1	2.4	3.4	2.9	1 on 3
Site	21	B	No		0	-	No	No	Low	No	-	1	8.8	11.5	10.1	1 on 3
Site	21	D	No		0	-	No	No	Low	No	-	0				1 on 3
Site	22	A	No		0	-	No	No	Low	No	-	3	3.2	7.9	5.5	1 on 3
Site	22	B	No		0	-	No	No	Low	No	-	3	1.9	8.0	4.9	1 on 3
Site	22	C	No		0	-	No	No	Low	No	-	1	4.5	6.7	5.6	3

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
Site	23	A	No		0	-	No	No	Low	No	-	0				1 on 3
Site	23	C	No		0	-	No	No	Low	No	-	1	3.0	11.2	7.1	1 on 3
Site	23	D	No		0	-	No	No	Low	No	-	1	12.6	14.7	13.6	1 on 3
Site	24	A	No		0	-	No	No	Low	No	-	1	4.4	8.6	6.5	1 on 3
Site	24	B	No		0	-	No	No	Low	No	-	1	8.7	9.1	8.9	1 on 3
Site	24	C	No		0	-	No	No	Low	No	-	6	4.0	15.4	9.7	1 on 3
Site	25	A	No		0	-	No	No	Low	No	-	3	2.7	10.5	6.6	1 on 3
Site	25	B	No		0	-	No	No	Low	No	-	3	5.1	10.3	7.7	1 on 3
Site	25	C	No		0	-	No	No	Low	No	-	4	3.0	12.5	7.7	1 on 3
Site	26	A	No		0	-	No	No	Low	No	-	1	6.3	7.2	6.8	1 on 3
Site	26	C	No		0	-	No	No	Low	No	-	2	9.1	10.4	9.8	1 on 3
Site	26	D	No		0	-	No	No	Low	No	-	2	5.4	13.0	9.2	1 on 3
Site	27	A	No		0	-	No	No	Low	No	-	0				1 on 3
Site	27	B	No		0	-	No	No	Low	No	-	0				1 on 3
Site	27	C	No		0	-	No	No	Low	No	-	0				1 on 3

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
Site	28	A	Possible	Dark mottled sediment under aRPD.	0	-	No	No	Low	No	-	2	5.0	6.2	5.6	1 on 3
Site	28	B	Possible	Dark mottled sediment under aRPD.	0	-	No	No	Low	No	-	0				1 on 3
Site	28	C	Possible	Dark mottled sediment under aRPD.	3	Mix	No	No	Low	No	-	2	4.8	7.2	6.0	1 on 3
Site	29	A	Possible	Dark mottled sediment under aRPD.	0	-	No	No	Low	No	-	4	4.5	11.6	8.1	1 on 3
Site	29	B	Possible	White sediment is irregularly distributed in lower layers of sediment.	0	-	No	No	Low	No	-	2	4.5	8.2	6.3	1 on 3
Site	29	C	Possible	White sediment is irregularly distributed in lower layers of sediment.	0	-	No	No	Low	No	-	1	4.3	5.2	4.7	1 on 3
Site	30	B	Possible	Dark gray and white mottled sediment to pen maximum.	4	Red	No	No	Low	No	-	1	5.7	5.7	5.7	1 on 3
Site	30	C	Possible	Dark gray and white mottled sediment to pen maximum.	3	Red	No	No	Low	No	-	0				1 on 3
Site	30	D	Possible	Dark gray and white mottled sediment to pen maximum.	10	Mix	No	No	Low	No	-	0				1 on 3
REF-A	1	A	No		0	-	No	No	Low	No	-	1	6.9	8.6	7.8	1 on 3
REF-A	1	B	No		0	-	No	No	Low	No	-	2	10.3	15.3	12.8	1 on 3
REF-A	1	C	No		0	-	No	No	Low	No	-	1	5.7	6.7	6.2	1 on 3
REF-A	2	A	No		0	-	No	No	Low	No	-	0				1 on 3

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
REF-A	2	B	No		0	-	No	No	Low	No	-	3	4.6	7.1	5.9	1 on 3
REF-A	2	C	No		0	-	No	No	Low	No	-	1	9.3	9.4	9.4	1 on 3
REF-A	3	A	No		0	-	No	No	Low	No	-	4	5.0	17.1	11.1	1 on 3
REF-A	3	B	No		0	-	No	No	Low	No	-	2	3.3	8.4	5.9	1 on 3
REF-A	3	C	No		0	-	No	No	Low	No	-	5	4.2	10.3	7.2	1 on 3
REF-A	4	A	No		0	-	No	No	Low	No	-	2	1.8	8.1	4.9	1 on 3
REF-A	4	C	No		0	-	No	No	Low	No	-	3	3.2	13.0	8.1	1 on 3
REF-A	4	D	No		0	-	No	No	Low	No	-	2	1.9	14.9	8.4	1 on 3
REF-A	5	A	No		0	-	No	No	Low	No	-	0				1 on 3
REF-A	5	B	No		0	-	No	No	Low	No	-	3	6.7	11.9	9.3	1 on 3
REF-A	5	D	No		0	-	No	No	Low	No	-	3	2.4	11.9	7.1	1 on 3
REF-B	1	A	No		0	-	No	No	Low	No	-	0				1 on 3
REF-B	1	B	No		0	-	No	No	Low	No	-	1	2.1	2.5	2.3	1 on 3
REF-B	1	C	No		0	-	No	No	Low	No	-	0				1 on 3

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
REF-B	2	A	No		0	-	No	No	Low	No	-	2	5.1	6.8	6.0	1 on 3
REF-B	2	B	No		0	-	No	No	Low	No	-	1	12.3	12.6	12.5	1 on 3
REF-B	2	C	No		0	-	No	No	Low	No	-	2	5.7	11.3	8.5	1 on 3
REF-B	3	A	No		0	-	No	No	Low	No	-	3	3.7	6.0	4.8	1 on 3
REF-B	3	B	No		0	-	No	No	Low	No	-	2	5.9	12.8	9.3	1 on 3
REF-B	3	C	No		0	-	No	No	Low	No	-	0				1 on 3
REF-B	4	B	No		0	-	No	No	Low	No	-	1	11.1	11.7	11.4	1 on 3
REF-B	4	C	No		0	-	No	No	Low	No	-	4	4.8	10.4	7.6	1 on 3
REF-B	4	D	No		0	-	No	No	Low	No	-	1	3.1	4.2	3.6	1 on 3
REF-B	5	A	No		0	-	No	No	Low	No	-	1	3.0	3.7	3.4	1 on 3
REF-B	5	B	No		0	-	No	No	Low	No	-	5	2.3	14.3	8.3	1 on 3
REF-B	5	C	No		0	-	No	No	Low	No	-	0				1 on 3
REF-C	1	A	Possible	Large inclusions of white clay near penetration maximum.	0	-	No	No	Low	No	-	4	5.5	11.2	8.3	1 on 3
REF-C	1	B	Possible	White clay near penetration maximum.	0	-	No	No	Low	No	-	0				1 on 3

Location	Station	Replicate	Dredged Material	Dredged Material Comments	Mud Clast Number	Mud Clast State	Methane?	Low DO?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent SPI	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage
REF-C	1	C	Possible	White clay near penetration maximum.	0	-	No	No	Low	No	-	1	3.3	3.9	3.6	1 on 3
REF-C	2	A	Possible	Mottled white clay near penetration maximum.	0	-	No	No	Low	No	-	0				1 on 3
REF-C	2	B	Possible	Mottled white clay near penetration maximum.	0	-	No	No	Low	No	-	0				1 on 3
REF-C	2	C	Possible	Mottled white clay near penetration maximum.	0	-	No	No	Low	No	-	0				1 on 3
REF-C	3	A	Possible	Mottled white clay near penetration maximum.	0	-	No	No	Low	No	-	3	3.4	7.3	5.4	1 on 3
REF-C	3	B	Possible	Mottled white clay near penetration maximum.	1	Ox	No	No	Low	No	-	4	3.5	10.2	6.8	1 on 3
REF-C	3	D	Possible	Mottled white clay near penetration maximum.	0	-	No	No	Low	No	-	0				1 on 3
REF-C	4	A	Possible	Very dark black and gray clay.	0	-	No	No	Low	No	-	1	3.3	5.8	4.5	1 on 3
REF-C	4	B	Possible	Very dark black and gray clay.	0	-	No	No	Low	No	-	0				1 on 3
REF-C	4	C	Possible	Mottled white clay near penetration maximum.	0	-	No	No	Low	No	-	0				1 on 3
REF-C	5	A	Possible	Mottled white clay near penetration maximum.	0	-	No	No	Low	No	-	0				1 on 3
REF-C	5	B	Possible	Mottled white clay near penetration maximum.	0	-	No	No	Low	No	-	0				1 on 3
REF-C	5	C	Possible	Very dark black and gray and white clay.	0	-	No	No	Low	No	-	1	4.2	5.2	4.7	1 on 3

Location	**Station**	**Replicate**	**Comment**
Site	1	A	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer, becoming streaked with gray and black material deeper below SWI. Few tubes visible at SWI. Large void at ~6 cm below SWI. Long burrow opening transected to far right. Small brittle star dragged into sediment. Thin burrow halos abundant in upper 10 cm of sediment column. *Corymorpha* in background
Site	1	B	Fine sediment with fluffy pelleted surface and cohesive reduced material deposited by prism. Pullback from prism causing material to fall between prism sediment interface. Sediment is reddish tan, streaked with pale tan in upper portion of sediment column, transitions to darker streaked material deep in column. Large void at 5 cm below SWI. Burrowing organism transected with crushed shell dragged from position.
Site	1	C	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer, becoming gray and black material deep in sediment column. Few tubes visible at SWI. Three large voids in sediment column. Very thick aRPD. Infauna visible.
Site	2	A	Fine sediment with fluffy pelleted surface with large transected burrow opening to far right. Pullback from prism causing material to fall between prism sediment interface. Sediment is reddish tan, streaked with pale tan in upper portion of sediment column, transitions to slightly darker material deep in column. Large void at 5 cm below SWI. Small tubes at SWI and dragged into sediment column.
Site	2	B	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer, becoming slightly less luminous past aRPD. Thin streaks of gray begin at 7 cm below SI. Single small void. Two burrowing textures in upper 6 cm of sediment. Small stage 1 tubes at SWI.
Site	2	D	Fine sediment at SWI with many clasts and rough boundary. SWI was physically disturbed by camera (previous reps). Distinct transition at aRPD from bright tan to pale gray-tan. Abundant burrowing textures in sediment. Small shell crushed at lower right corner. Large tubes at SWI.
Site	3	A	Fine sediment at SWI is heavily pelleted and loose. Small clasts of mixed state and small tubes present. Long red burrows visible extending from SWI. Large void at 12 cm below SWI. Sediment in upper portion of sediment column is bright tan and red hued transitions to pale gray with patches of near black at depth. Infauna abundant.
Site	3	B	Fine sediment at SWI is heavily pelleted and loose. Stage 1 tubes present. Large void in sediment column contains oxidized material Infauna near small black patch near bottom edge of image.
Site	3	D	Fine sediment at SWI is heavily pelleted and loose. Sediment column is mostly pale tan with dark streaks deep in sediment column. Long oxidized halos stemming from SWI. Small streak of white clay near penetration maximum. Stage 1 tubes present. Large infilled void in sediment column.
Site	4	A	Fine sediment at SWI is heavily pelleted and loose. Sediment column is mostly pale tan becoming darker and streaked deep in sediment column. Long oxidized halos stemming from SWI. Stage 1 tubes present. Few large voids in sediment column.
Site	4	C	Fine sediment at SWI is heavily pelleted and loose. Sediment column is mostly pale tan becoming slightly darker and streaked deep in sediment column. Long oxidized halos stemming from SWI. Stage 1 tubes present, large tubes also visible. Small patch of white fines near pen maximum. Burrow opening transected at SWI. Small burrows transected in sediment column.
Site	4	D	Fine sediment at SWI is heavily pelleted and loose. Sediment column is mostly pale tan becoming slightly darker and streaked deep in sediment column. Long oxidized halos stemming from SWI. Stage 1 tubes present. Large oxidized void in sediment column.

Location	Station	Replicate	Comment
Site	5	A	Fine sediment at SWI is heavily pelleted and loose, burrow opening transected at SWI. Sediment column is mostly pale tan transitioning to what appears to be historical DM, slightly darker and streaked deep in sediment column. Long oxidized halos stemming from SWI. Stage 1 tubes present. White fines are streaked throughout sediment column.
Site	5	B	Fine sediment at SWI is heavily pelleted and loose. Sediment column is mostly pale tan transitioning to what appears to be historical DM, slightly darker and streaked deep in sediment column. Long oxidized halos stemming from SWI. Stage 1 tubes present, transected burrows at depth
Site	5	D	Fine sediment at SWI is heavily pelleted and loose. Sediment column is mostly pale tan transitioning to what appears to be historical DM, slightly darker and streaked deep in sediment column with large mass of white fines near penetration maximum. Long oxidized halos stemming from SWI. Stage 1 tubes present. Small network of voids in lower left.
Site	6	A	Fine sediment at SWI is heavily pelleted and loose. Upper layer of sediment column is pale and rusty orange with small inclusions of white fines. Underlying layer is streaked and mottled white and gray with what appears to be historical DM. SWI is slightly disturbed by prism pullback. Tubes visible at SWI. Few large voids in sediment.
Site	6	B	Fine sediment at SWI is heavily pelleted and loose. Upper layer of sediment column is pale and rusty orange with small inclusions of white fines. Underlying layer is streaked and mottled white and gray with what appears to be historical DM. SWI is disturbed by large burrow opening to far left and smaller opening to far right. Few large voids visible in sediment column.
Site	6	D	Fine sediment at SWI is heavily pelleted and loose. Upper layer of sediment column is pale and rusty orange with small inclusions of white fines. Underlying layer is streaked and mottled white and gray with what appears to be historical DM. Large object in far field is encrusted with organisms. Many small clasts near prism. Abundant voids in sediment column.
Site	7	A	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer, becoming slightly less luminous past aRPD. Single infilled void in upper 7 cm of sediment column. Burrowing evident as oxidized halos stemming from SWI.
Site	7	B	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer, becoming slightly less luminous past aRPD. Several small voids are infilled. Polychaete visible in sediment. Camera artifacts deposited at SWI. Burrowing evident as oxidized halos stemming from SWI.
Site	7	C	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer, becoming slightly less luminous past aRPD. Single small void. Burrowing evident as oxidized halos stemming from SWI.
Site	8	A	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer, becoming slightly less luminous past aRPD. Burrowing evident as oxidized halos stemming from SWI. Cluster of small voids in sediment column. Burrowing evident as oxidized halos stemming from SWI.
Site	8	B	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer, becoming slightly less luminous past aRPD. Burrowing evident as oxidized halos stemming from SWI. Small void deep in sediment column. Small tubes at SWI, dragged into sediment column. Large red polychaete visible.
Site	8	C	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to a streaked and mottled pale tan sediment. Burrowing evident as oxidized halos stemming from SWI. Evidence of subsurface burrowing. Small tubes at SWI, dragged into sediment column.

Location	Station	Replicate	Comment
Site	9	A	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to a streaked and mottled pale tan sediment. Burrowing evident as oxidized halos stemming from SWI. Void to far right. Polychaete visible in sediment. Sediment is especially mottled and dark surrounding void.
Site	9	C	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to slightly duller gray-tan sediment. Burrowing evident as oxidized halos stemming from SWI. Large, deep void in sediment column. Additional burrowing textures near penetration maximum. Material deposited on SWI by prism. Few tubes dragged into sediment column.
Site	9	D	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to slightly duller gray-tan sediment. Burrowing evident as oxidized halos stemming from SWI. Several large infilled voids in sediment. Infaunal appendages visible throughout sediment column.
Site	10	A	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to slightly duller gray-tan sediment. Burrowing evident as oxidized halos stemming from SWI. Burrowing textures visible deep in sediment column. Small patch of darker sediment near center of image, ~5 cm below SWI. Tubes visible at SWI.
Site	10	B	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to slightly duller gray-tan sediment. Burrowing evident as oxidized halos stemming from SWI. Burrowing textures visible deep in sediment column. Small tubes at SWI. Reduced sediment at SWI deposited by prism faceplate.
Site	10	C	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to slightly duller gray-tan sediment. Burrowing evident as oxidized halos stemming from SWI. Very small red sea star dragged into sediment.. Small tubes at SWI. Reduced sediment at SWI deposited by prism faceplate.
Site	11	A	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to slightly duller, streaky, gray-tan sediment. Burrowing evident as oxidized halos stemming from SWI. Abundant tubes at SWI.
Site	11	B	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to slightly duller, streaky, gray-tan sediment. Burrowing evident as oxidized halos stemming from SWI. Abundant burrowing textures in sediment column. SWI dips to far left where burrow was transected.
Site	11	D	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to slightly duller, streaky, gray-tan sediment. Burrowing evident as oxidized halos stemming from SWI. Abundant burrowing textures in sediment column. Single small void at 5 cm below SWI. Reduced material at SWI deposited by prism.
Site	12	A	Reddish tan fine sediment with large burrow in center of SWI. Many tubes at SWI. Traces of white and green clay in sediment column suggest historical DM. Shallow penetration. aRPD > Pen.
Site	12	B	Reddish tan fine sediment with large burrow in center of SWI. Many tubes at SWI. Traces of white and green clay in sediment column suggest historical DM. Shallow penetration. Large clast at SWI. Large red worm at depth to far right.
Site	12	C	Reddish tan fine sediment with large burrow in center of SWI. Many tubes at SWI. Traces of white and green clay in sediment column and mass of white clay in lower half of image suggest historical DM. Shallow penetration.
Site	13	A	Fine sediment with fluffy pelleted layer at SWI. Reddish tan in upper layer transitions to slightly duller, gray tan sediment. Burrow structures evident in textural changes throughout sediment column. SPI camera appears to have contact on slight slope.

Location	Station	Replicate	Comment
Site	13	B	Fine sediment with loose layer at SWI. Reddish tan in upper layer transitions to slightly duller, gray tan sediment. Burrow structures evident in textural changes throughout sediment column. Small tubes at surface. Cluster of small voids in sediment column.
Site	13	C	Fine sediment with loose layer at SWI. Reddish tan in upper layer transitions to slightly duller, gray tan sediment. Burrow structures evident in textural changes throughout sediment column. Few tubes visible at SWI. Large void 2 cm below SWI, transected burrows at depth.
Site	14	A	Fine sediment with loose layer at SWI. Reddish tan in upper layer transitions to slightly duller, gray tan sediment. Burrow structures evident in textural changes throughout sediment column. Small tubes at SWI. SWI depresses to left, ridge is visible in far field.
Site	14	B	Fine sediment with loose layer at SWI. Reddish tan in upper layer transitions to slightly duller, gray tan sediment. Burrow structures evident in textural changes throughout sediment column. Small tubes at SWI. Infilled voids and burrows visible throughout sediment column.
Site	14	C	Fine sediment with loose layer at SWI. Reddish tan in upper layer transitions to slightly duller, gray tan sediment. Burrow structures evident in textural changes throughout sediment column. Small tubes at SWI. Infilled voids and burrows visible throughout sediment column.
Site	15	A	Fine sediment with loose layer at SWI. Reddish tan in upper layer transitions to slightly duller, gray tan sediment. Burrow structures evident in textural changes throughout sediment column. Small tubes at SWI.
Site	15	B	Fine sediment with loose layer at SWI. Reddish tan in upper layer transitions to slightly duller, gray tan sediment. Burrow structures evident in textural changes throughout sediment column. Large tubes at SWI Large burrow to right side of SWI terminating in two voids.
Site	15	C	Fine sediment with loose layer at SWI. Reddish tan in upper layer transitions to slightly duller, gray tan sediment. Burrow structures evident in textural changes throughout sediment column. Small tubes at SWI. Large burrow in lower left corner of image. Infilled burrow in right side of sediment column.
Site	16	A	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes recolonizing SWI. Sediment column has been extensively reworked, very thick aRPD. Infilled void just under SWI. Prism pullback has caused slight slumping under SWI.
Site	16	C	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes recolonizing SWI. Sediment column has been extensively reworked, very thick aRPD. Mud clasts artifacts from wiper blade on SWI; transected burrows at depth
Site	16	D	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes dragged into sediment.. Sediment column has been extensively reworked, very thick aRPD. Small void along left edge. Burrow visible at right edge.
Site	17	A	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes at SWI. Sediment column has been extensively reworked. Two partially infilled voids along left edge of image. Large polychaete near penetration maximum.
Site	17	B	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes at SWI. Sediment column has been extensively reworked. Large void cut off by bottom of image. Mud clast artifact on SWI deposited by prism.
Site	17	C	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes at SWI. Sediment column is mottled and streaked at depth. Dark gray material present in lower few cm of column. Camera deposited mud clast artifacts at SWI.
Site	18	A	Silt-clay to penetration. Orange-tan in upper layer with slightly gray material at depth. aRPD is very thick, extensive reworking is apparent. Stage 1 tubes have recolonized and pelletized SWI. Infilled voids, partially infilled void, and infaunal bodies visible in sediment column.

Location	Station	Replicate	Comment
Site	18	B	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed with white and black streaks to penetration maximum. Small tubes at SWI. Sediment column is mottled and streaked at depth. Long burrow visible in center of image with infilled reduced void. Camera deposited mud clast artifacts at SWI. Prism pullback causing slumping of upper few cm.
Site	18	D	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes at SWI. Sediment column is mottled and streaked at depth. Many open and infilled relic voids in sediment column. Prism pullback creating slumping in upper few centimeters.
Site	19	A	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes at SWI. Sediment column is mottled and streaked at depth. Infilled void to center right. Material is much darker and streaked in lower portion of image.
Site	19	B	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes at SWI. Sediment column is mottled and streaked at depth, black patch near penetration maximum. Several small void networks have been transected.
Site	19	D	Silt-clay to penetration. Orange-tan in upper layer with mottled gray sed to penetration maximum. Small tubes at SWI. Sediment column is light colored to penetration maximum, with streaks of gray under aRPD. Two large voids.
Site	20	A	Silt-clay to penetration. Orange-tan in upper layer with slightly gray material at depth. aRPD is very thick, extensive reworking is apparent. Stage 1 tubes have recolonized and pelletized SWI. Few infilled voids and burrow structures visible in sediment column.
Site	20	B	Silt-clay to penetration. Orange-tan in upper layer with gray material at depth. Small tubes at SWI. Sediment column is extensively reworked. Polychaetes and small voids visible in sediment column.
Site	20	C	Silt-clay to penetration. Orange-tan in upper layer with gray material at depth. Small tubes at SWI. Sediment column is extensively reworked. Many small infilled void structures. Three open voids. Cluster of clasts of mixed redox state at SWI.
Site	21	A	Silt-clay to penetration. Orange-tan in upper layer with mottled dark gray sed to penetration maximum. Small tubes at SWI. Sediment column is extensively reworked. Pelleted depression at SWI is vertical transport from void and burrow below.
Site	21	B	Silt-clay to penetration. Sediment is mottled from SWI to pen maximum. Large void to right edge of image. SWI is mounded in center. Camera artifacts at SWI. Few small tubes.
Site	21	D	Silt-clay to penetration. Orange-tan in upper layer with mottled dark gray sed to near penetration maximum. Many tubes recolonizing SWI, few quite large. Mud clast artifacts from prism at SWI. Slight pullback slumping at SWI.
Site	22	A	Silt-clay to penetration. Orange-tan in upper layer with mottled gray material at depth. Small tubes at SWI. Sediment column is extensively reworked. Two large voids, single infilled void. Small red brittle star dragged into sediment.
Site	22	B	Silt-clay to penetration. Orange-tan in upper layer with slightly gray material at depth. aRPD is very thick, extensive reworking is apparent. Stage 1 tubes have recolonized and pelletized SWI. Reduced mud clasts artifacts have fallen from prism. Very large void just under SWI.
Site	22	C	Silt-clay to penetration. Orange-tan in upper layer with slightly gray material at depth. aRPD is very thick, extensive reworking is apparent. Polychaetes visible in sediment column. Very large infilled void near SWI. Several reduced mud clast artifacts have fallen from wiper blade.

Location	Station	Replicate	Comment
Site	23	A	Silt-clay to penetration. Orange-tan in upper layer with slightly mottled sed to penetration maximum. Small tubes at SWI. Sediment column is extensively reworked. Polychaete visible along left edge. Gastropod at SWI.
Site	23	C	Silt-clay to penetration. Orange-tan in upper layer. aRPD is very thick, extensive reworking is apparent. Stage 1 tubes have recolonized and pelletized SWI. Large burrow opening transected at SWI, ejecting reduced material. Large void network below opening. Black material to far left edge.
Site	23	D	Silt-clay to penetration. Orange-tan in upper layer. aRPD is very thick, extensive reworking is apparent. Stage 1 tubes have recolonized and pelletized SWI. Burrow opening transected at SWI. Void near penetration max, directly below opening.
Site	24	A	Silt-clay to penetration. Orange-tan in upper layer with slightly gray material at depth. aRPD is very thick, extensive reworking is apparent. Abundant tubes at heavily pelleted SWI.. Large void is mostly infilled.
Site	24	B	Silt-clay to penetration. Very mottled tan, orange, and gray sediment, streaking downward. Few tubes at SWI. Large mud clast artifacts deposited by prism. Small polychaete visible. Small void to far right.
Site	24	C	Silt-clay to penetration. Very mottled tan, orange, and gray sediment, streaking downward. Few tubes at SWI. Large mud clast artifacts deposited by prism. Many small voids in sediment column. Burrow opening at SWI. Prism pullback slumping in first few cm of sediment column.
Site	25	A	Silt-clay to penetration. Orange-tan in upper layer with slightly gray material to penetration maximum. Several voids in sediment column. Reworking of sediment is obvious. SWI is colonized by small tubes and heavily pelleted.
Site	25	B	Silt-clay to penetration. Orange-tan in upper layer with slightly gray material to penetration maximum. Several small voids in sediment column. Light mottling in center of image. Few small tubes at SWI.
Site	25	C	Silt-clay to penetration. Orange-tan in upper layer with slightly gray material to penetration maximum. Several small voids in sediment column. Small tubes at SWI. Prism pullback causing slumping in upper few cm of sediment column.
Site	26	A	Silt-clay to penetration. Orange-tan in upper layer with slightly gray material at depth. aRPD is very thick, extensive reworking is apparent. Abundant tubes at heavily pelleted SWI. Small void to left edge. Burrowing textures abundant.
Site	26	C	Silt-clay to penetration. Orange-tan in upper layer with some reduced organics at depth. Mud clast artifacts from prism at SWI. Black deposit deep in sediment column. Abundant burrow textures.
Site	26	D	Silt-clay to penetration. Orange-tan in upper layer with some reduced organics at depth. Mud clast artifacts from prism at SWI. Black deposit deep in sediment column. Burrow and mound transected at surface, terminating in large void in center of image.
Site	27	A	Silt-clay to penetration. Orange-tan in upper layer with slightly gray sed to penetration maximum. SWI is heavily pelleted. Small tubes present. Small polychaete visible in sediment column. Deep burrow halo transected extends from SWI to pen maximum. Black sediment near penetration maximum.
Site	27	B	Silt-clay to penetration. Orange-tan in upper layer with slightly gray sed to penetration maximum. SWI is heavily pelleted. Small tubes present. Small polychaete visible in sediment column. Deep aRPD.
Site	27	C	Silt-clay to penetration. Orange-tan in upper layer with slightly gray sed to penetration maximum. SWI is heavily pelleted. Small tubes present. Few polychaetes visible in sediment column.

Location	Station	Replicate	Comment
Site	28	A	Silt-clay to penetration. Orange-tan in upper layer with what appears to be dark gray and white historical DM to penetration maximum. SWI is heavily pelleted. Small tubes present. Small voids in sediment column, polychaetes visible.
Site	28	B	Silt-clay to penetration. Orange-tan in upper layer with what appears to be dark gray and white historical DM to penetration maximum. SWI is heavily pelleted. Small tubes present. Large areas of burrowing textures at aRPD. Small organisms visible in sediment column. Reduced mud clast artifacts from camera deposited at SWI. Transected burrows at depth
Site	28	C	Silt-clay to penetration. Orange-tan in upper layer with what appears to be dark gray and white historical DM to penetration maximum. SWI is heavily pelleted. Small tubes present. Few small voids and burrow textures in sediment. Sediment column is heavily streaked. Few small clasts at SWI.
Site	29	A	Silt-clay to penetration. Orange-tan in upper layer with what appears to be dark gray and white historical DM to penetration maximum. SWI is heavily pelleted. Small tubes present. Few small voids and burrow textures in sediment. Pullback slumping at SWI. Long oxic halo transected.
Site	29	B	Silt-clay to penetration. Orange-tan sediment becomes slightly less saturated at aRPD. White clay inclusions abundant in lower portion of sediment column. SWI is heavily pelleted. Small tubes present. Large burrow opening transected, terminating in pair of large voids. Reduced mud clast artifacts deposited by prism at SWI.
Site	29	C	Silt-clay to penetration. Orange-tan sediment becomes slightly less saturated at aRPD. White clay inclusions abundant in lower portion of sediment column. SWI is heavily pelleted. Small tubes present. Single void near transected burrow at SWI. Mud clast artifacts at SWI deposited by prism.
Site	30	B	Silt-clay to penetration. Orange-tan in upper layer with what appears to be slightly gray and white mottled historical DM to penetration maximum. SWI is heavily pelleted. Small tubes present. Void to far left edge of image. Polychaetes visible.
Site	30	C	Silt-clay to penetration. Orange-tan in upper layer with what appears to be slightly gray and white mottled historical DM to penetration maximum. SWI is heavily pelleted. Small tubes present. Clasts at SWI from camera wiper blade.
Site	30	D	Silt clay to penetration. SWI is disturbed. Clasts of different redox states at SWI. Abundant tubes. What appears to be historical DM to penetration. Shallow penetration.
REF-A	1	A	Silt-clay to penetration. Orange-tan in upper layer with slightly gray sed to penetration maximum. SWI is heavily pelleted. Small tubes present. Few polychaetes visible in sediment column. Long burrow halo to penetration max.
REF-A	1	B	Silt-clay to penetration. Orange-tan in upper layer with slightly gray sed to penetration maximum. SWI is heavily pelleted. Small tubes present. Very small voids near pen maximum.
REF-A	1	C	Silt-clay to penetration. Orange-tan in upper layer with slightly gray sed to penetration maximum. SWI is heavily pelleted. Small tubes present. Small void under transected burrowing opening.
REF-A	2	A	Silt-clay to penetration. Orange-tan in upper layer with slightly mottled gray and white sed to penetration maximum. SWI is heavily pelleted. Small tubes present. Burrow halos and infilled voids suggest reworking.

Location	Station	Replicate	Comment
REF-A	2	B	Silt-clay to penetration. Orange-tan in upper layer with slightly gray sediment underneath. SWI is heavily pelleted. Small tubes present. Small voids below SWI.
REF-A	2	C	Silt-clay to penetration. Orange-tan in upper layer with mottled black and tan sed to pen maximum. SWI is heavily pelleted. Few small tubes at SWI and dragged into sediment. Very small void to left side of image.
REF-A	3	A	Silt-clay to penetration. Orange-tan in upper layer with mottled dark gray and tan sed to pen maximum. SWI is heavily pelleted. Few small tubes at SWI. Large network of voids in sediment column.
REF-A	3	B	Silt-clay to penetration. Orange-tan in upper layer with mottled dark gray and tan sed to pen maximum. SWI is heavily pelleted. Small tubes at SWI. Large void 3 cm below SWI. Abundant burrow textures throughout sediment column.
REF-A	3	C	Silt-clay to penetration. Orange-tan in upper layer with mottled light gray to pen maximum. SWI is heavily pelleted. Small tubes at SWI. Network of large voids in sediment column,
REF-A	4	A	Silt-clay to penetration. Orange-tan in upper layer with mottled light gray to pen maximum. SWI is heavily pelleted. Small tubes at SWI. Large void and polychaete in sediment column.
REF-A	4	C	Silt-clay to penetration. Orange-tan in upper layer with mottled light gray to pen maximum. SWI is heavily pelleted. Small tubes at SWI. Several voids in sediment column. Reduced mud clast artifacts deposited by prism at SWI.
REF-A	4	D	Silt-clay to penetration. Orange-tan in upper layer with mottled light gray to pen maximum. SWI is heavily pelleted. Small tubes at SWI. Large transected burrow in lower left corner .
REF-A	5	A	Silt-clay to penetration. Orange-tan in upper layer with mottled light gray to pen maximum. SWI is heavily pelleted. Small tubes at SWI. Large infilled burrows transected near penetration depth.
REF-A	5	B	Silt-clay to penetration. Orange-tan in upper layer with mottled light gray to pen maximum. SWI is heavily pelleted. Small tubes at SWI. Three partially infilled burrows in sediment column. Large gray mud clast artifacts deposited by prism at SWI.
REF-A	5	D	Silt-clay to penetration. Orange-tan in upper layer with patches of reduced sediment at depth. SWI is heavily pelleted. Small tubes at SWI. Three partially infilled burrows in sediment column. Small gray mud clast artifacts deposited by prism at SWI.
REF-B	1	A	Silt-clay to penetration. Orange-tan transitions to pale gray at depth. SWI is heavily pelleted. Small tubes at SWI. Burrowing evident in textures throughout sediment column.
REF-B	1	B	Silt-clay to penetration. Orange-tan transitions to pale gray at depth. SWI is heavily pelleted. Few small tubes at SWI. Large mud clast artifacts deposited by prism. Reworking is evident by deep aRPD and small voids.
REF-B	1	C	Silt-clay to penetration. Orange-tan transitions to mottled gray at depth. SWI is heavily pelleted. Large mud clast artifacts deposited by prism. Reworking is evident by deep aRPD and burrowing textures.

Location	Station	Replicate	Comment
REF-B	2	A	Silt-clay to penetration. Orange-tan transitions to mottled gray and black sed at depth. SWI is heavily pelleted. Small tubes at SWI. :Large void in sediment column. Infauna visible near penetration maximum.
REF-B	2	B	Silt-clay to penetration. Orange-tan transitions to mottled gray with few black streaks at depth. SWI is heavily pelleted. Small tubes at SWI. Small void. Long burrow halo extends in patches to penetration maximum.
REF-B	2	C	Silt-clay to penetration. Orange-tan transitions to mottled gray compact clay sed to penetration. SWI is heavily pelleted. Small tubes at SWI. Long burrow terminating in two voids.
REF-B	3	A	Silt-clay to penetration. Orange-tan transitions to mottled gray with few black streaks at depth. SWI is heavily pelleted. Small tubes at SWI. Few small voids in upper portion of sediment column.
REF-B	3	B	Silt-clay to penetration. Orange-tan transitions to mottled gray and black sed at depth. SWI is heavily pelleted. Small tubes at SWI. Mostly infilled oxidized voids visible in sediment column. Infaunal body in sediment. Streaking and oxidized halos suggest extensive reworking.
REF-B	3	C	Silt-clay to penetration. Orange-tan transitions to mottled gray and black sed at depth. SWI is heavily pelleted. Small tubes at SWI. Mostly infilled oxidized voids visible in sediment column. Infaunal body in sediment. Long burrow halos in sediment. Mud clasts artifacts deposited at SWI by prism.
REF-B	4	B	Silt-clay to penetration. Orange-tan transitions to pale gray at depth. SWI is heavily pelleted. Few very small tubes at SWI. Void near penetration maximum.
REF-B	4	C	Silt-clay to penetration. Orange-tan transitions to pale gray at depth. SWI is heavily pelleted. Dense assemblage of small tubes at SWI. Several small oxidized voids in sediment column. Very slight color change under aRPD.
REF-B	4	D	Silt-clay to penetration. Orange-tan transitions to mottled gray with few black streaks at depth. SWI is heavily pelleted. Small tubes at SWI. Small mud clast artifacts deposited by prism at SWI. Oxidized void in upper 3 cm of sediment. Large oxidized burrow texture near penetration maximum.
REF-B	5	A	Silt-clay to penetration. Orange-tan transitions to mottled gray sed with few black streaks at depth. SWI is heavily pelleted. Small tubes at SWI. Small near SWI.
REF-B	5	B	Silt-clay to penetration. Orange-tan transitions to pale gray at depth with slight mottling. SWI is heavily pelleted. Small tubes at SWI. Sediment column has been extensively reworked. Abundant a small voids and burrows visible.
REF-B	5	C	Silt-clay to penetration. Orange-tan transitions to pale gray at depth with slight mottling. SWI is heavily pelleted. Abundant small tubes at SWI. Small black inclusions in sediment column. Long oxidized halos extending from SWI.
REF-C	1	A	Silt-clay to penetration. Orange-tan transitions to what appears to be white clay DM near penetration maximum. Transition at aRPD is very slight. Infilled burrows and voids throughout sediment. Large anemone visible at SWI. SWI is heavily pelletized with few small tubes.
REF-C	1	B	Silt-clay to penetration. Orange-tan transitions to what appears to be mottled white clay DM near penetration maximum. Transition at aRPD is very slight. Infilled burrows and voids throughout sediment. Firm object in midfield may be contributing to boundary roughness. Tubes at SWI.

Location	Station	Replicate	Comment
REF-C	1	C	Silt-clay to penetration. Dark orange-tan transitions to what appears to be mottled white clay DM near penetration maximum. Transition at aRPD is very slight. Mall void at right edge of image. Few tubes at SWI. Mud clast artifacts deposited at SWI by prism.
REF-C	2	A	Silt-clay to penetration. Dark orange-tan transitions to what appears to be very mottled white clay DM near penetration maximum. Few tube sat SWI/ Small reduced mud clast artifacts at Swig, deposited by prism. Infilled burrow opening three cm below SWI.
REF-C	2	B	Silt-clay to penetration. Dark orange-tan transitions to what appears to be very mottled white clay DM near penetration maximum. Few tube sat SWI/ Small reduced mud clast artifacts at SWI, deposited by prism. Infilled burrow Along far left edge of image as well as below white clay to mid right. Small infauna visible to far right.
REF-C	2	C	Silt-clay to penetration. Dark orange-tan transitions to what appears to be very mottled white clay DM near penetration maximum. Few tube sat SWI/ Small reduced mud clast artifacts at SWI, deposited by prism. Large burrow opening transected at SWI.
REF-C	3	A	Silt-clay to penetration. Dark orange-tan transitions to what appears to be very mottled white clay DM near penetration maximum. Tubes at SWI. SWI is heavily pelleted. Several large voids in sediment column. Burrow transected to far left. Shell dragdown near center of image causing circular feature in sediment.
REF-C	3	B	Silt-clay to penetration. Orange-tan transitions to what appears to be very mottled white and dark gray DM near penetration maximum. Tubes at SWI. SWI is heavily pelleted. Small voids and transected burrows in sediment column. Reduced sediment at depth. Polychaete near pen maximum.
REF-C	3	D	Silt-clay to penetration. Orange-tan transitions to what appears to be very mottled white and dark gray DM near penetration maximum. Tubes at SWI. SWI is heavily pelleted. Transected burrows at depth; PV image at this station shows large burrow openings. Mud clast artifacts deposited at SWI by prism.
REF-C	4	A	Silt-clay to penetration. Orange-tan transitions to what appears to be very mottled black and dark gray DM near penetration maximum. Tubes at SWI. SWI is heavily pelleted. Large void to far right of image. Polychaete visible near image center.
REF-C	4	B	Silt-clay to penetration. Orange-tan transitions to what appears to be very mottled black and dark gray DM near penetration maximum. Tubes at SWI. SWI is heavily pelleted. Long oxidized halos extending from SWI. Possible burrow transected near penetration maximum.
REF-C	4	C	Silt-clay to penetration. Orange-tan transitions to what appears to be very mottled white historical DM near penetration maximum. Tubes at SWI. SWI is heavily pelleted. Long oxidized halos extending from SWI, transected burrows at depth.
REF-C	5	A	Silt-clay to penetration. Orange-tan transitions to what appears to be very mottled white historical DM near penetration maximum. Tubes at SWI. SWI is heavily pelleted. Large polychaete visible in sediment column. Pullback fro prism causing slumping between sediment and prism interface.
REF-C	5	B	Silt-clay to penetration. Orange-tan transitions to what appears to be very mottled white historical DM near penetration maximum. Small organism transected. Large animal in far field (crab).
REF-C	5	C	Silt-clay to penetration. Orange-tan transitions to what appears to be very mottled white and gray historical DM near penetration maximum. Small void with surrounding burrow halo extending to penetration maximum.

Location	Station	Replicate	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m²)	Sediment Type	Surface Ox	Debris	Bedforms	Tubes	Burrows	Tracks	Epifauna	Flora	Number of Fish
Site	1	A	09/27/15	7:27:57	88.9	59.3	0.5	Silt/Clay	Ox	None	None	Present	Sparse	None	None	None	0
Site	1	C	09/27/15	7:29:39	79.1	52.8	0.4	Silt/Clay	Ox	None	None	Present	Sparse	None	None	None	0
Site	1	D	09/27/15	7:30:29	85.3	56.9	0.5	Silt/Clay	Ox	None	None	Present	Present	None	Shrimp	None	0
Site	2	A	09/27/15	17:08:46	89.2	59.5	0.5	Silt/Clay	Ox	None	None	Present	Present	Abundant	Shrimp	None	0
Site	3	A	09/27/15	10:31:15	85.9	57.3	0.5	Silt/Clay	Ox	None	None	Present	Present	Sparse	Shrimp	None	0
Site	3	C	09/27/15	10:33:08	88.2	58.8	0.5	Silt/Clay	Ox	None	None	Present	Present	Present	IND	None	IND
Site	4	A	09/27/15	10:44:05	96.4	64.2	0.6	Silt/Clay	Ox	None	None	Sparse	Present	Present	Shrimp	None	0
Site	5	A	09/27/15	10:55:42	91.0	60.6	0.6	Silt/Clay	Ox	None	None	Present	Present	Present	None	None	0
Site	6	A	09/27/15	11:09:29	95.5	63.6	0.6	Silt/Clay	Ox	Shell fragments and small clasts	None	Present	Present	Sparse	Shrimp	None	0
Site	7	A	09/27/15	7:52:29	89.1	59.4	0.5	Silt/Clay	Ox	None	None	Present	Present	Present	None	None	0
Site	7	D	09/27/15	7:54:42	89.0	59.4	0.5	Silt/Clay	Ox	None	None	Abundant	Present	Present	Gastropod; Shrimp	None	0
Site	8	A	09/27/15	8:04:34	91.6	61.1	0.6	Silt/Clay	Ox	None	None	Present	Abundant	Present	Shrimp	None	0
Site	8	C	09/27/15	8:06:04	83.4	55.6	0.5	Silt/Clay	Ox	None	None	Present	Abundant	Abundant	None	None	0

Location	**Station**	**Replicate**	**Date**	**Time**	**Image Width (cm)**	**Image Height (cm)**	**Field of View imaged (m²)**	**Sediment Type**	**Surface Ox**	**Debris**	**Bedforms**	**Tubes**	**Burrows**	**Tracks**	**Epifauna**	**Flora**	**Number of Fish**
Site	9	A	09/27/15	9:37:16	84.4	56.3	0.5	Silt/Clay	Ox	None	None	Present	Abundant	Abundant	None	None	0
Site	10	A	09/27/15	10:08:34	91.5	61.0	0.6	Silt/Clay	Ox	None	None	Present	Abundant	Present	Shrimp	None	0
Site	10	B	09/27/15	10:09:18	IND	IND	IND	Silt/Clay	Ox	None	None	Present	Sparse	Sparse	Shrimp	None	0
Site	11	A	09/27/15	10:15:16	103.4	68.9	0.7	Silt/Clay	Ox	None	None	Present	Present	Sparse	None	None	0
Site	11	B	09/27/15	10:16:05	95.5	63.6	0.6	Silt/Clay	Ox	None	None	Sparse	Present	Sparse	None	None	0
Site	11	D	09/27/15	10:18:00	98.5	65.7	0.6	Silt/Clay	Ox	None	None	Sparse	Present	Sparse	Shrimp	None	0
Site	12	A	09/27/15	12:42:18	91.0	60.6	0.6	Silt/Clay	Ox	Small shell fragments	None	Present	Sparse	Sparse	Shrimp	None	0
Site	12	B	09/27/15	12:43:02	IND	IND	IND	Silt/Clay	Ox	IND	IND	IND	IND	IND	IND	IND	0
Site	12	D	09/27/15	12:44:49	IND	IND	IND	Silt/Clay	Ox	Shell fragments	None	IND	Sparse	IND	IND	IND	0
Site	13	A	09/27/15	8:28:56	86.7	57.8	0.5	Silt/Clay	Ox	None	None	Present	Present	Dense	None	None	0
Site	13	C	09/27/15	8:30:27	95.4	63.6	0.6	Silt/Clay	Ox	Small mud clasts	None	Sparse	Present	Abundant	Shrimp	None	0
Site	13	D	09/27/15	8:31:16	93.7	62.5	0.6	Silt/Clay	Ox	Small to large mud clasts	None	Sparse	Sparse	None	None	None	0
Site	14	A	09/27/15	8:15:51	94.8	63.2	0.6	Silt/Clay	Ox	None	None	Sparse	Present	Present	Shrimp	None	0

Location	Station	Replicate	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m²)	Sediment Type	Surface Ox	Debris	Bedforms	Tubes	Burrows	Tracks	Epifauna	Flora	Number of Fish
Site	15	A	09/27/15	9:11:57	84.8	56.5	0.5	Silt/Clay	Ox	None	None	Present	Sparse	Present	Shrimp	None	1
Site	15	D	09/27/15	9:14:09	87.8	58.6	0.5	Silt/Clay	Ox	None	None	Present	Present	Abundant	Shrimp	None	0
Site	16	A	09/27/15	9:25:02	87.2	58.1	0.5	Silt/Clay	Ox	None	None	Present	Present	Abundant	None	None	0
Site	17	A	09/27/15	12:56:54	90.6	60.4	0.5	Silt/Clay	Ox	None	None	Present	Present	Abundant	Crab	None	0
Site	17	B	09/27/15	12:57:57	85.9	57.3	0.5	Silt/Clay	Ox	None	None	Sparse	Present	Abundant	None	None	0
Site	18	A	09/27/15	13:11:06	83.6	55.8	0.5	Silt/Clay	Ox	None	None	Present	Present	Abundant	Shrimp	None	0
Site	18	B	09/27/15	13:11:57	81.5	54.3	0.4	Silt/Clay	Ox	None	None	Present	Sparse	Abundant	None	None	0
Site	19	A	09/27/15	8:35:14	92.5	61.6	0.6	Silt/Clay	Ox	None	None	Sparse	Sparse	Abundant	None	None	0
Site	19	B	09/27/15	8:36:04	94.6	63.1	0.6	Silt/Clay	Ox	None	None	Present	Present	Abundant	None	None	0
Site	19	D	09/27/15	8:37:34	92.9	61.9	0.6	Silt/Clay	Ox	None	None	Present	Present	Present	None	None	0
Site	20	A	09/27/15	8:47:25	88.9	59.3	0.5	Silt/Clay	Ox	None	None	Present	Present	Present	Shrimp	None	0
Site	21	A	09/27/15	9:00:18	98.2	65.5	0.6	Silt/Clay	Ox	None	None	Present	Present	Abundant	Shrimp	None	0
Site	22	A	09/27/15	13:44:15	97.3	64.8	0.6	Silt/Clay	Ox	None	None	Present	Present	Abundant	None	None	0
Site	22	C	09/27/15	13:46:08	86.1	57.4	0.5	Silt/Clay	Ox	None	None	Present	Present	Abundant	None	None	0
Site	23	A	09/27/15	13:36:34	89.6	59.7	0.5	Silt/Clay	Ox	None	None	Present	Present	Abundant	Shrimp	None	0

Location	Station	Replicate	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m^2)	Sediment Type	Surface Ox	Debris	Bedforms	Tubes	Burrows	Tracks	Epifauna	Flora	Number of Fish
Site	23	B	09/27/15	13:37:24	90.0	60.0	0.5	Silt/Clay	Ox	None	None	Present	Present	Present	Shrimp	None	0
Site	23	C	09/27/15	13:38:21	97.7	65.1	0.6	Silt/Clay	Ox	None	None	Present	Present	Present	Shrimp	None	0
Site	24	A	09/27/15	13:23:07	86.7	57.8	0.5	Silt/Clay	Ox	None	None	Sparse	Present	Present	Shrimp	None	0
Site	24	B	09/27/15	13:24:17	86.4	57.6	0.5	Silt/Clay	Ox	None	None	Present	Sparse	None	Shrimp	None	0
Site	24	C	09/27/15	13:25:05	86.9	57.9	0.5	Silt/Clay	Ox	None	None	Sparse	Sparse	Present	None	None	0
Site	25	A	09/27/15	15:01:05	90.2	60.1	0.5	Silt/Clay	Ox	None	None	Present	Present	Abundant	None	None	0
Site	26	A	09/27/15	14:52:14	89.1	59.4	0.5	Silt/Clay	Ox	None	None	Sparse	Present	Present	Shrimp	Algae	0
Site	26	B	09/27/15	14:53:17	98.4	65.6	0.6	Silt/Clay	Ox	None	None	Abundant	Present	Present	None	None	0
Site	26	C	09/27/15	14:54:05	96.6	64.4	0.6	Silt/Clay	Ox	None	None	Sparse	Sparse	Sparse	None	None	0
Site	27	A	09/27/15	14:37:33	103.9	69.2	0.7	Silt/Clay	Ox	None	None	Present	Present	Present	Shrimp	None	0
Site	27	B	09/27/15	14:38:39	92.5	61.7	0.6	Silt/Clay	Ox	None	None	Present	Sparse	Present	Shrimp	Algae	0
Site	27	C	09/27/15	14:39:23	93.8	62.5	0.6	Silt/Clay	Ox	None	None	Present	Present	Present	Shrimp	None	0
Site	28	A	09/27/15	14:31:10	98.0	65.3	0.6	Silt/Clay	Ox	None	None	Present	Present	Abundant	None	None	0
Site	29	A	09/27/15	14:16:20	87.2	58.1	0.5	Silt/Clay	Ox	Large mud clast	None	Present	Present	Present	None	None	0

Location	Station	Replicate	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m²)	Sediment Type	Surface Ox	Debris	Bedforms	Tubes	Burrows	Tracks	Epifauna	Flora	Number of Fish
Site	30	A	09/27/15	14:03:05	85.4	57.0	0.5	Silt/Clay	Ox	None	None	Sparse	Sparse	Present	Anemone	None	0
REF-A	1	A	09/27/15	16:23:05	96.3	64.2	0.6	Silt/Clay	Ox	None	None	Present	Sparse	Abundant	None	None	0
REF-A	1	B	09/27/15	16:23:57	93.0	62.0	0.6	Silt/Clay	Ox	None	None	Present	Sparse	Abundant	Shrimp	None	0
REF-A	1	C	09/27/15	16:24:57	90.2	60.2	0.5	Silt/Clay	Ox	None	None	Abundant	Sparse	Sparse	Shrimp	None	0
REF-A	2	A	09/27/15	16:11:20	92.9	61.9	0.6	Silt/Clay	Ox	None	None	Present	Present	Present	Shrimp	None	0
REF-A	2	B	09/27/15	16:12:15	90.2	60.2	0.5	Silt/Clay	Ox	None	None	Present	Present	Present	Shrimp	None	0
REF-A	3	A	09/27/15	16:31:18	96.7	64.4	0.6	Silt/Clay	Ox	None	None	Present	Present	Present	Shrimp	None	0
REF-A	3	B	09/27/15	16:32:36	85.4	56.9	0.5	Silt/Clay	Ox	None	None	Present	Abundant	Present	None	None	0
REF-A	3	C	09/27/15	16:33:26	87.4	58.3	0.5	Silt/Clay	Ox	None	None	Present	Present	Present	None	None	0
REF-A	4	A	09/27/15	16:02:28	91.7	61.1	0.6	Silt/Clay	Ox	None	None	Present	Sparse	Present	None	None	0
REF-A	5	A	09/27/15	16:16:27	94.2	62.8	0.6	Silt/Clay	Ox	None	None	Present	Present	Sparse	None	None	0
REF-B	1	A	09/27/15	15:36:22	100.1	66.7	0.7	Silt/Clay	Ox	None	None	Present	Present	Abundant	Shrimp	None	0
REF-B	1	B	09/27/15	15:37:09	94.1	62.7	0.6	Silt/Clay	Ox	None	None	Present	Sparse	Abundant	None	None	0

Location	**Station**	**Replicate**	**Date**	**Time**	**Image Width (cm)**	**Image Height (cm)**	**Field of View imaged (m²)**	**Sediment Type**	**Surface Ox**	**Debris**	**Bedforms**	**Tubes**	**Burrows**	**Tracks**	**Epifauna**	**Flora**	**Number of Fish**
REF-B	1	C	09/27/15	15:37:58	92.1	61.4	0.6	Silt/Clay	Ox	None	None	Present	Present	Abundant	None	None	0
REF-B	2	A	09/27/15	15:21:42	83.9	55.9	0.5	Silt/Clay	Ox	None	None	Abundant	Present	Abundant	Shrimp	None	0
REF-B	2	B	09/27/15	15:23:00	91.8	61.2	0.6	Silt/Clay	Ox	None	None	Abundant	Present	Abundant	Shrimp	None	0
REF-B	2	D	09/27/15	15:24:47	88.2	58.8	0.5	Silt/Clay	Ox	None	None	Present	Sparse	Present	Shrimp	None	0
REF-B	3	A	09/27/15	15:44:04	84.6	56.4	0.5	Silt/Clay	Ox	None	None	Sparse	Abundant	Abundant	Shrimp	None	0
REF-B	3	B	09/27/15	15:44:57	80.8	53.9	0.4	Silt/Clay	Ox	None	None	Present	Present	Abundant	Shrimp	None	0
REF-B	3	C	09/27/15	15:45:48	92.4	61.6	0.6	Silt/Clay	Ox	None	None	Present	Present	Present	Shrimp	None	0
REF-B	4	A	09/27/15	15:15:30	88.3	58.9	0.5	Silt/Clay	Ox	None	None	Present	Present	Abundant	None	None	0
REF-B	4	C	09/27/15	15:17:08	92.3	61.5	0.6	Silt/Clay	Ox	None	None	Present	Present	Abundant	None	None	0
REF-B	5	A	09/27/15	15:28:55	98.0	65.3	0.6	Silt/Clay	Ox	None	None	Present	Present	Abundant	Shrimp	None	0
REF-B	5	B	09/27/15	15:30:00	100.5	67.0	0.7	Silt/Clay	Ox	None	None	Abundant	Sparse	Abundant	Shrimp	None	0
REF-B	5	C	09/27/15	15:30:55	90.3	60.2	0.5	Silt/Clay	Ox	None	None	Abundant	Present	Abundant	Shrimp	None	0
REF-C	1	A	09/27/15	11:23:02	95.1	63.4	0.6	Silt/Clay	Ox	None	None	Sparse	Present	Present	Anemone	None	0

Location	Station	Replicate	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m^2)	Sediment Type	Surface Ox	Debris	Bedforms	Tubes	Burrows	Tracks	Epifauna	Flora	Number of Fish
REF-C	1	B	09/27/15	11:23:47	90.6	60.4	0.5	Silt/Clay	Ox	Small mud clasts	None	Sparse	Sparse	Sparse	None	None	0
REF-C	2	A	09/27/15	11:39:41	85.7	57.1	0.5	Silt/Clay	Ox	Small mud clasts	None	Sparse	Present	Sparse	Shrimp	None	0
REF-C	2	D	09/27/15	11:42:38	IND	IND	IND	Silt/Clay	Ox	IND	IND	IND	IND	IND	Anemone	IND	IND
REF-C	3	A	09/27/15	11:29:48	96.4	64.2	0.6	Silt/Clay	Ox	Small mud clasts	None	Sparse	Present	Abundant	None	None	0
REF-C	4	A	09/27/15	11:55:59	96.1	64.1	0.6	Silt/Clay	Ox	Small mud clasts	None	Present	Sparse	Abundant	None	None	0
REF-C	4	B	09/27/15	11:57:05	86.3	57.6	0.5	Silt/Clay	Ox	Rope	None	Present	Present	Abundant	None	None	0
REF-C	5	A	09/27/15	11:48:46	93.5	62.3	0.6	Silt/Clay	Ox	Anthropogenic Debris	None	Present	Sparse	Present	Shrimp	None	0
REF-C	5	B	09/27/15	11:49:39	91.6	61.1	0.6	Silt/Clay	Ox	None	None	IND	IND	IND	IND	None	0

Location	Station	Replicate	Other Salient Features/Comment
Site	1	A	Loosely packed fine sediment is oxidized, light tan in color. SWI is pocked with small irregularities and low accumulations of sediment. Small tubes are barely visible on surface.
Site	1	C	Loosely packed fine sediment is oxidized, light tan in color. Some medium length tubes lying on surface. Large masses of sediment have fallen from prism onto SWI.
Site	1	D	Loosely packed fine sediment is oxidized, light tan in color. SWI is pocked with small irregularities and low accumulations of sediment. Large tubes visible against sediment surface. Large burrow near lasers.
Site	2	A	Loosely packed fine sediment is oxidized, light tan in color. SWI marked with shallow burrow depressions and long track marks.
Site	3	A	Loosely packed fine sediment is oxidized, light tan in color. Burrow openings apparent in SWI. Large shrimp between lasers.
Site	3	C	Loosely packed fine sediment is oxidized, light tan in color. Burrow openings apparent in SWI. Fauna just above lasers- small fish or shrimp. Tracks and small irregularities in sediment. Weak resuspension of material.
Site	4	A	Loosely packed fine sediment is oxidized, light tan in color. Burrow openings apparent in SWI, few are large. Shrimp at SWI. Many side by side paired tracks in sediment. Large tubes are visible, smaller tubes may not be visible at distance.
Site	5	A	Loosely packed fine sediment is oxidized, light tan in color. Burrow openings apparent in SWI, few are large. Side by side paired tracks in sediment. Large tubes are visible, smaller tubes may not be visible at distance.
Site	6	A	Loosely packed fine sediment is oxidized, light tan in color. Large burrow opening visible. Several shrimp at SWI. Large shell fragments are scant on SWI. Many small clasts, white and gray in color, scattered across SWI.
Site	7	A	Loosely packed fine sediment is oxidized, light tan in color. Burrow openings visible in SWI, one is moderately large. Many tracks visible. Shallow depression near center of image. Small tubes cover sediment surface.
Site	7	D	Loosely packed fine sediment is oxidized, light tan in color. Burrow openings visible in SWI, one is moderately large. Small gastropod above left laser. Shrimp at SWI. Small tubes cover sediment surface.
Site	8	A	Loosely packed fine sediment is oxidized, light tan in color. Many small burrow openings visible. Small tubes are visible throughout image in low density. Few small shrimp.
Site	8	C	Loosely packed fine sediment is oxidized, light tan in color. Many small burrow openings visible. Small tubes are visible throughout image in low density. SWI is heavily marked by small sets of tracks.

Location	Station	Replicate	Other Salient Features/Comment
Site	9	A	Loosely packed fine sediment is oxidized, light tan in color. Many small burrow openings visible. Small tubes are visible throughout image in low density. SWI is heavily marked by small sets of tracks.
Site	10	A	Loosely packed fine sediment is oxidized, light tan in color. Many small burrow openings visible. Small tubes are visible throughout image in low density. SWI is heavily marked by small sets of tracks. Small shrimp at SWI. Organisms blurry in water column.
Site	10	B	Loosely packed fine sediment is oxidized, light tan in color. Small tubes visible. Water column is cloudy with resuspended sediment. Single shrimp visible.
Site	11	A	Loosely packed fine sediment is oxidized, light tan in color. Small tubes visible. Large burrow in upper right. Water column is cloudy with resuspended sediment.
Site	11	B	Loosely packed fine sediment is oxidized, light tan in color. Small tubes visible. Water column is cloudy with resuspended sediment. Burrows visible in SWI.
Site	11	D	Loosely packed fine sediment is oxidized, light tan in color. Small tubes visible. Water column is cloudy with resuspended sediment. Few burrows visible in SWI. Shrimp.
Site	12	A	Loosely packed fine sediment is oxidized, light tan in color. Clusters of growth in patches. Small shrimp. Small shell fragments and rocks scattered across SWI.
Site	12	B	Very turbid water column. Lasers/benthic features are not visible.
Site	12	D	Very turbid water column. Lasers are not visible. Shell fragments and small tubes visible in upper right.
Site	13	A	Loosely packed fine sediment is oxidized, light tan in color. Dense tracks across SWI. Several medium burrows. Large burrow in upper right. Few tubes.
Site	13	C	Loosely packed fine sediment is oxidized, light tan in color. Small tracks across SWI. Small burrows visible. Single shrimp. Few tubes.
Site	13	D	Loosely packed fine sediment is oxidized, light tan in color. Large mud clasts in upper 1/3 of image from camera base sled. Small mud clasts across SWI. Many tubes in upper portion of image, fewer in lower half.
Site	14	A	Loosely packed fine sediment is oxidized, light tan in color. Small tracks across SWI. Small burrows visible. Small shrimp in lower left corner. Few tubes.

Location	Station	Replicate	Other Salient Features/Comment
Site	15	A	Loosely packed fine sediment is oxidized, light tan in color. Many tracks across SWI. Small burrows visible. Fish swimming in water column. Very small tubes visible on SWI. Shrimp in lower right.
Site	15	D	Loosely packed fine sediment is oxidized, light tan in color. Many tracks across SWI. Small burrows visible. Several shrimp visible in image. Very small tubes visible on SWI.
Site	16	A	Loosely packed fine sediment is oxidized, light tan in color. Abundant tracks cover SWI. Small tubes visible against SWI.
Site	17	A	Loosely packed fine sediment is oxidized, light tan in color. Abundant tracks cover SWI. Small tubes visible against SWI. Few reduced burrow mounds visible. Crab in lower right corner.
Site	17	B	Loosely packed fine sediment is oxidized, light tan in color. Abundant tracks cover SWI. Small tubes visible against SWI.
Site	18	A	Loosely packed fine sediment is oxidized, light tan in color. Abundant tracks cover SWI. Small tubes visible against SWI. Shrimp.
Site	18	B	Loosely packed fine sediment is oxidized, light tan in color. Abundant tracks cover SWI. Small tubes visible against SWI.
Site	19	A	Loosely packed fine sediment is oxidized, light tan in color. Abundant tracks cover SWI. Image is not in focus. Few small tubes visible
Site	19	B	Loosely packed fine sediment is oxidized, light tan in color. Abundant tracks cover SWI. Image is not in focus. Small tubes visible
Site	19	D	Loosely packed fine sediment is oxidized, light tan in color. Many tracks cover SWI. Image is not in focus. Small tubes visible. Several large burrow openings in SWI.
Site	20	A	Loosely packed fine sediment is oxidized, light tan in color. Many tracks cover SWI. Large burrow in center of image. Shrimp to far right.
Site	21	A	Loosely packed fine sediment is oxidized, light tan in color. Many tracks cover SWI. Small tubes and burrows visible.. Single small shell fragment at SWI.
Site	22	A	Loosely packed fine sediment is oxidized, light tan in color. Many thin tracks cover SWI. Small tubes and burrows visible. Large burrow in lower right.
Site	22	C	Loosely packed fine sediment is oxidized, light tan in color. Many tracks cover SWI. Small tubes and burrows visible.
Site	23	A	Loosely packed fine sediment is oxidized, light tan in color. Many tracks cover SWI. Small tubes and burrows visible. Small shrimp.

Location	Station	Replicate	Other Salient Features/Comment
Site	23	B	Loosely packed fine sediment is oxidized, light tan in color. Many tracks cover SWI. Small tubes and burrows visible. Small shrimp.
Site	23	C	Loosely packed fine sediment is oxidized, light tan in color. Many tracks cover SWI. Small tubes and burrows visible. Many shrimp at SWI.
Site	24	A	Loosely packed fine sediment is oxidized, light tan in color. Few burrow openings visible. SWI appears slightly slumped. Small clasts cover SWI. Shrimp.
Site	24	B	Loosely packed fine sediment is oxidized, light tan in color. Clusters of small mud clasts on surface. One large burrow on left. Small tubes, cluster lying on surface near right laser. Shrimp.
Site	24	C	Loosely packed fine sediment is oxidized, light tan in color. Visible portion of SWI is covered with a dense network of tracks. Tubes at SWI. Few burrows visible.
Site	25	A	Loosely packed fine sediment is oxidized, light tan in color. SWI is covered with a dense network of tracks. Tubes at SWI. Few burrows visible.
Site	26	A	Loosely packed fine sediment is oxidized, light tan in color. SWI is covered with a dense network of tracks. Tubes at SWI. Few burrows visible. Small bit of yellow algae visible, partially buried on surface. Few small shrimp at SWI.
Site	26	B	Loosely packed fine sediment is oxidized, light tan in color. Tracks and tubes at SWI. Few medium burrows visible at upper right.
Site	26	C	Loosely packed fine sediment is oxidized, light tan in color. Few tubes, tracks, and burrows visible. Turbid water column.
Site	27	A	Loosely packed fine sediment is oxidized, light tan in color. Tubes at SWI. Large burrow in lower portion of image. Shrimp at SWI.
Site	27	B	Loosely packed fine sediment is oxidized, light tan in color. Tubes at SWI. Shrimp at SWI. Yellow algae in lower right.
Site	27	C	Loosely packed fine sediment is oxidized, light tan in color. Set of tracks diagonally across image. Tubes at SWI. Shrimp at SWI.
Site	28	A	Loosely packed fine sediment is oxidized, light tan in color. Many tracks across SWI. Small shell fragment. Few medium burrows
Site	29	A	Loosely packed fine sediment is oxidized, light tan in color. Large clast in top right corner of image.

Location	Station	Replicate	Other Salient Features/Comment
Site	30	A	Loosely packed fine sediment is oxidized, light tan in color. Tracks at SWI. Large clast in top left corner of image. Large anemone at SWI.
REF-A	1	A	Loosely packed fine sediment is oxidized, light tan in color. Abundant tracks at SWI. Large burrow opening in upper right with tubes surrounding rim of burrow. Tubes visible at SWI.
REF-A	1	B	Loosely packed fine sediment is oxidized, light tan in color. Abundant tracks at SWI. Tubes visible at SWI. Several large burrows visible. Shrimp.
REF-A	1	C	Loosely packed fine sediment is oxidized, light tan in color. Tracks at SWI. Tubes visible at SWI. Several large burrows visible. Shrimp in upper right.
REF-A	2	A	Loosely packed fine sediment is oxidized, light tan in color. Tracks at SWI. Tubes visible at SWI. Three large burrows.
REF-A	2	B	Loosely packed fine sediment is oxidized, light tan in color. Tracks at SWI. Tubes visible at SWI. Shrimp in center of lasers.
REF-A	3	A	Loosely packed fine sediment is oxidized, light tan in color. Tracks at SWI. Tubes visible at SWI. Couple shrimp at SWI.
REF-A	3	B	Loosely packed fine sediment is oxidized, light tan in color. Many small burrow openings at SWI. Tubes visible at SWI. Tracks at SWI.
REF-A	3	C	Loosely packed fine sediment is oxidized, light tan in color. Few small burrow openings at SWI. Tubes visible at SWI. Series of tracks running diagonally from lower left to upper right of image.
REF-A	4	A	Loosely packed fine sediment is oxidized, light tan in color. Few small burrow openings at SWI. Tubes visible at SWI.
REF-A	5	A	Loosely packed fine sediment is oxidized, light tan in color. Few small burrow openings at SWI. Tubes visible at SWI. Few tracks.
REF-B	1	A	Loosely packed fine sediment is oxidized, light tan in color. Large burrow opening in top left corner of image. Small tubes visible against SWI. Small fecal coils. SWI is studded with many tracks.
REF-B	1	B	Loosely packed fine sediment is oxidized, light tan in color. Small tubes visible against SWI. Small tracks cross SWI.

Location	**Station**	**Replicate**	**Other Salient Features/Comment**
REF-B	1	C	Loosely packed fine sediment is oxidized, light tan in color. Burrows visible.. Small tubes visible against SWI. Small tracks cross SWI.
REF-B	2	A	Loosely packed fine sediment is oxidized, light tan in color. Burrows visible. Abundant small tubes. Few shrimp visible.
REF-B	2	B	Loosely packed fine sediment is oxidized, light tan in color. Many small burrows. Abundant small tubes. Few shrimp visible.
REF-B	2	D	Loosely packed fine sediment is oxidized, light tan in color. Few small burrows. Water column is clouded with resuspended sediment. Few shrimp visible.
REF-B	3	A	Loosely packed fine sediment is oxidized, light tan in color. Few tubes visible from distance. Many small burrows. Dense network of tracks. Few shrimp visible.
REF-B	3	B	Loosely packed fine sediment is oxidized, light tan in color. Small burrows in upper right, large burrow in lower right corner of image. Dense network of tracks. Few shrimp visible.
REF-B	3	C	Loosely packed fine sediment is oxidized, light tan in color. Few tracks. Single shrimp visible.
REF-B	4	A	Loosely packed fine sediment is oxidized, light tan in color. Rough uneven SWI with many small tracks. Large burrow opening to far left.
REF-B	4	C	Loosely packed fine sediment is oxidized, light tan in color. Rough uneven SWI with many small tracks. Large burrows to right half of image.
REF-B	5	A	Loosely packed fine sediment is oxidized, light tan in color. Rough uneven SWI with many small tracks. Small shrimp at SWI,
REF-B	5	B	Loosely packed fine sediment is oxidized, light tan in color. Rough uneven SWI with many small tracks. Small shrimp at SWI, large burrow on lower left corner.
REF-B	5	C	Loosely packed fine sediment is oxidized, light tan in color. Rough uneven SWI with many small tracks. Small shrimp at SWI.
REF-C	1	A	Loosely packed fine sediment is oxidized, light tan in color. SWI is very smooth, interrupted by tracks, small burrows. Large anemone visible in image.

Location	Station	Replicate	Other Salient Features/Comment
REF-C	1	B	Loosely packed fine sediment is oxidized, light tan in color. Small clasts deposited at SWI. Hydroid growth.
REF-C	2	A	Loosely packed fine sediment is oxidized, light tan in color. Small clasts deposited at SWI. Shrimp in center of image.
REF-C	2	D	Image is very cloudy. SWI is oxidized but no features visible. Large anemone visible.
REF-C	3	A	Loosely packed fine sediment is oxidized, light tan in color. Small clasts deposited at SWI. Abundant tracks cross SWI. Few large burrow openings visible.
REF-C	4	A	Loosely packed fine sediment is oxidized, light tan in color. Small clasts deposited at SWI. Abundant tracks cross SWI. Few large burrow openings visible.
REF-C	4	B	Loosely packed fine sediment is oxidized, light tan in color. Small clasts deposited at SWI. Abundant tracks cross SWI. Large rope crosses upper left corner of image.
REF-C	5	A	Loosely packed fine sediment is oxidized, light tan in color. Shrimp in image. Large square objected covered with mud drape in center of image.
REF-C	5	B	Image is very cloudy. SWI is oxidized but no features visible.

APPENDIX D

GRAIN SIZE SCALE FOR SEDIMENTS

Phi (Φ) Size	**Size Range (mm)**	**Size Class (Wentworth Class)**
<-1	>2	Gravel
0 to –1	1 to 2	Very coarse sand
1 to 0	0.5 to 1	Coarse sand
2 to 1	0.25 to 0.5	Medium sand
3 to 2	0.125 to 0.25	Fine sand
4 to 3	0.0625 to 0.125	Very fine sand
>4	<0.0625	Silt/clay

Environmental Assessment and Evaluation Study
for a Designation of an
Ocean Dredged Material Disposal Site in
Southern Maine, New Hampshire, and Northern Massachusetts

Appendix D
Fish Trawl and Lobster Pot Trawl Survey report of IOSN

Contract Number: W912WJ-12-D-0004
Delivery Order Number: 33

Final Report for Isles of Shoals North Site Fisheries and Lobster Monitoring Portsmouth, New Hampshire

Submitted to:
U.S. Army Corps of Engineers
North Atlantic Division
New England District

Prepared by:
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March 2017

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1. INTRODUCTION

1.1 Project Description and Technical Approach

The United States Army Corps of Engineers, North Atlantic Division, New England District needs to assess the potential impacts to fisheries resources at a potential disposal site off the coast of Maine and New Hampshire to be used for the Portsmouth River navigation improvement project. The Corps requires baseline information on the fish community in the project area. The work described in this report was assembled to support the New England District in gathering fish and lobster abundance data.

1.2 Scope of Work

The project scope of work consisted of fish and lobster abundance measurements at the Isles of Shoals North Site (IOSN) in the spring of 2016 and the winter of 2016/2017.

1.3 Organization of this Report

This report was prepared in accordance with the requirements outlined in the New England District (NAE) Statement of Work (SOW) for Boston Harbor and Portsmouth Harbor Fisheries Monitoring dated February 29, 2016. Following this introduction, the materials and methods used in support of this study are presented in Section 2.0. Section 3.0 presents the results of the data gathered. Attachments A and B contain the fish abundance data for the spring and winter sampling events. Attachment C contain the fish field log sheets and photos are included in Attachment D. Attachment E contains the lobster field log sheets.

2. MATERIALS AND METHODS

2.1 Spring Collection of Fish Abundance Data

For the spring sampling effort, Battelle and its subcontractor CR Environmental collected fish abundance data at the IOSN. The sampling occurred May 24, 2016, and was performed using the F/V *Nicole Leigh*.

Sampling activities were performed according to the Field Sampling Plan (FSP) (Battelle, 2016). At the Isles of Shoals site, 6 otter trawls were conducted using a commercial otter trawl with a liner sewn into the net and cod end to reduce the mesh size to 0.25 inch to enable the capture of juvenile fish along with larger individuals. The net employed had a sweep of 55 feet with a total distance of 85 feet between the doors. Each trawl was conducted for 15 minutes at speed of approximately 2.6 knots. Figure 2-1 shows the locations of the trawls at the Isles of Shoals, and Table 2-1 provides the start and end coordinates, time, and water depth for each trawl.

Table 2-1. Start and End Coordinates, Time and Depth for IOSN Spring Fish Trawls

Station ID	DATE	Start				End			
		LAT	LONG	TIME	Depth (ft)	LAT	LONG	TIME	Depth (m)
IS-0	5/24/2016	43.02712788	-70.45885956	15:27	52.5	43.0326187	-70.4465	15:42	52.5
IS-1	5/24/2016	43.01431638	-70.4594692	13:23:	52.5	43.0204651	-70.4467	13:39	53.1
IS-2	5/24/2016	43.02080519	-70.42572132	14:17	56.9	43.015199	-70.4401	14:34	54.1
IS-3	5/24/2016	43.01995392	-70.42847991	10:16:	55.6	43.0285307	-70.4391	10:32	52.5
IS-4	5/24/2016	43.03061571	-70.44935621	11:25:	52.5	43.0236862	-70.4442	11:38	53.1
IS-5	5/24/2016	43.01535966	-70.44630492	12:29:	53.1	43.0237056	-70.4553	12:44	52.5

[1] Coordinates in North American Datum 83

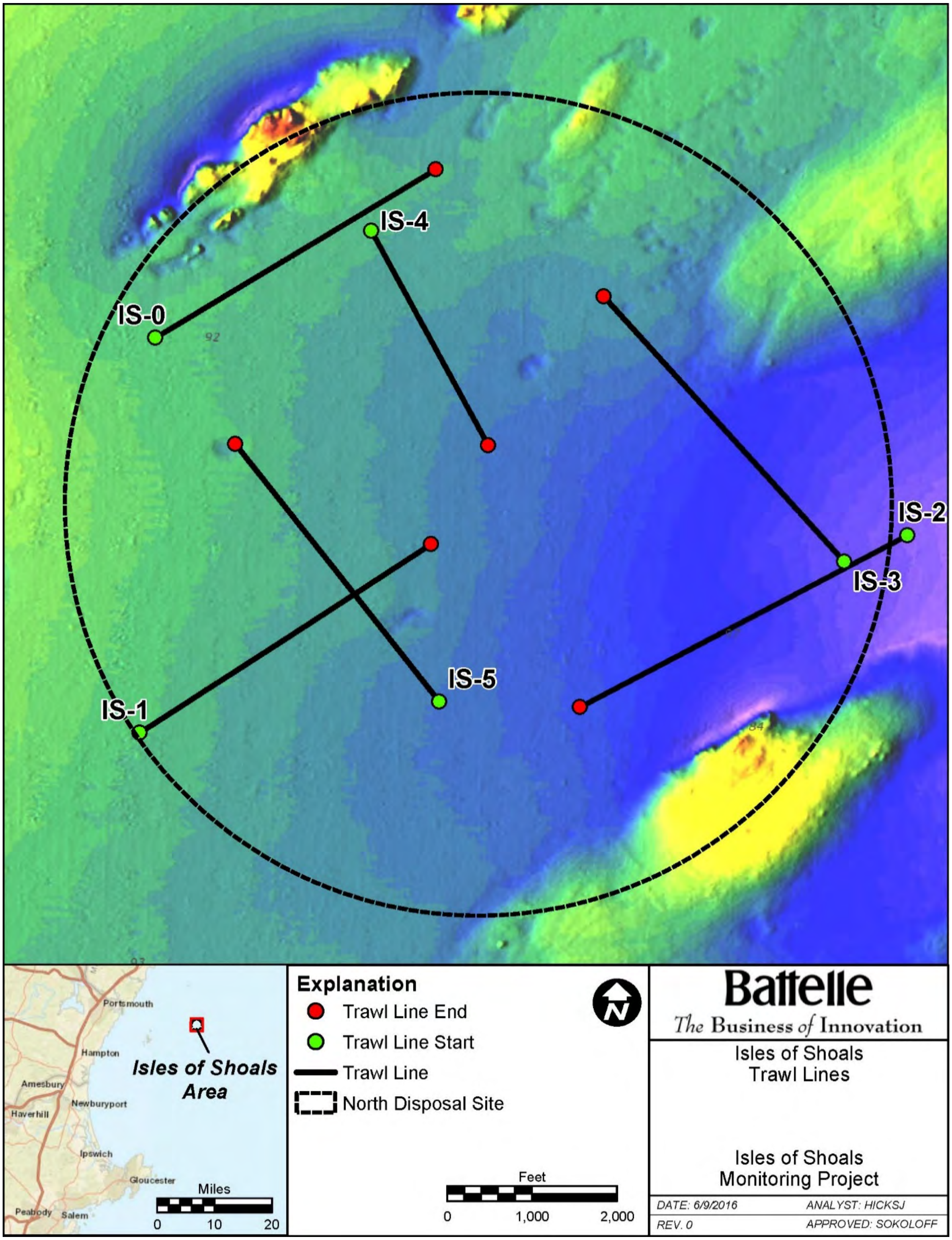

Figure 2-1. Map Showing the IOSN Spring Trawl Lines

2.2 Winter Collection of Fish Abundance Data

For the winter sampling effort, Battelle and its subcontractor CR Environmental collected fish abundance data at the Isles of Shoals Harbor. The sampling occurred on February 20, 2017, and was performed using the F/V *Nicole Leigh*.

Isles of Shoals sampling activities were performed per the Field Sampling Plan (FSP) (Battelle, 2016). At the Isles of Shoals site, 6 otter trawls were conducted using a commercial otter trawl with a liner sewn into the net and cod end to reduce the mesh size to 0.25 inch to enable the capture of juvenile fish along with larger individuals. The net employed had a sweep of 55 feet with a total distance of 85 feet between the doors. Each trawl was conducted for approximately 20 minutes at speed of approximately 2.4 – 2.8 knots. Figure 2-2 shows the locations of the trawls at the Isles of Shoals, and Table 2-2 provides the start and end coordinates, time and water depth for each trawl.

Table 2-2. Start and End Coordinates, Time and Depth for IOSN Winter Fish Trawls

Station ID	DATE	Start				End			
		LAT	LONG	TIME	Depth (ft)	LAT	LONG	TIME	Depth (m)
IS-0	02/20/2017	43.03559744	70.44844499	10:20	48.0	43.02539072	70.46121523	10:41	51.0
IS-1	02/20/2017	43.01754018	70.45400075	17:22	52.5	43.02717493	70.44183696	17:43	53.8
IS-2	02/20/2017	43.01994712	70.42767681	16:33	56.3	43.00992203	70.44212129	16:54	53.8
IS-3	02/20/2017	43.03122547	70.44208684	15:17	51.9	43.02202677	70.43031723	15:36	55.3
IS-4	02/20/2017	43.02931055	70.44712052	13:40	52.8	43.01573919	70.43685407	14:03	53.8
IS-5	02/20/2017	43.02635373	70.45662874	12:02	51.3	43.01500299	70.45312078	12:23	51.9

[1] Coordinates in North American Datum 83

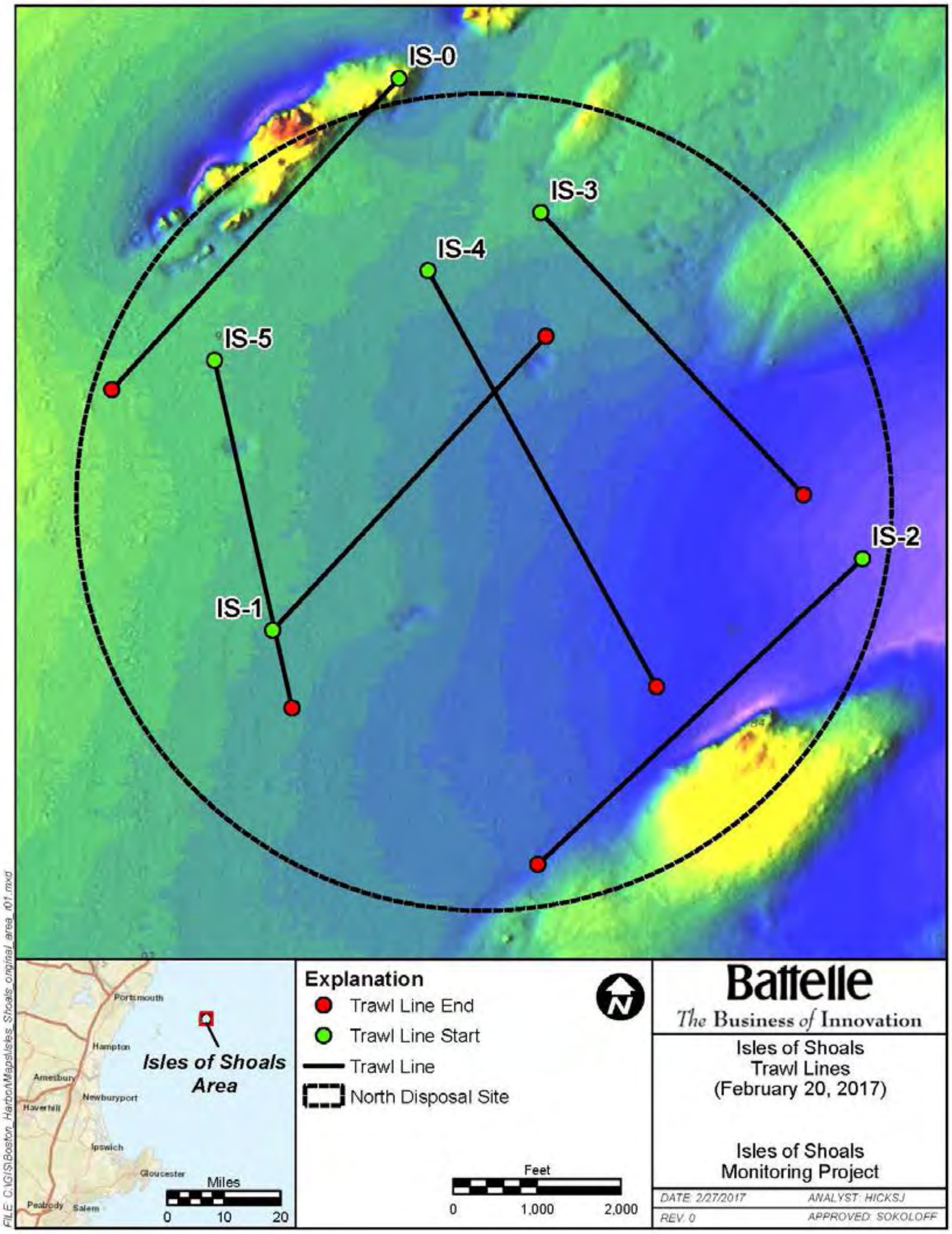

Figure 2-2. Map Showing the IOSN Winter Trawl Lines

2.3 Winter Collection of Lobster Abundance Data

Battelle collected lobster abundance data in and around the Isles of Sholes Site North (IOSN) in December 2016 and January 2017 to assess the winter lobster community in the area. Catch sampling of lobsters was conducted over a total of 6 deployment events. For the first deployment event (Dec. 4-7, 2016) three trawls, each containing 20 vented traps were deployed from a commercial lobster vessel. The next three deployment events (Dec.7-13; Dec. 20-28; Dec. 28- Jan. 2, 2017) six trawls were deployed, each containing 20 vented traps. For the fifth deployment event (Jan. 7-20, 2017) six trawls of 16 vented traps were used, and for the sixth deployment event (Jan. 20-31, 2017) eight trawls of 16 vented traps were used. The placement of the lobster trawls in and around IOSN was conducted with input from the captains of both the F/V *Rolling Stone* and F/V *Jacquie and Nicole* (local lobstermen). Figure 2-3 shows the locations of the lobster trawl lines at the IOSN site.

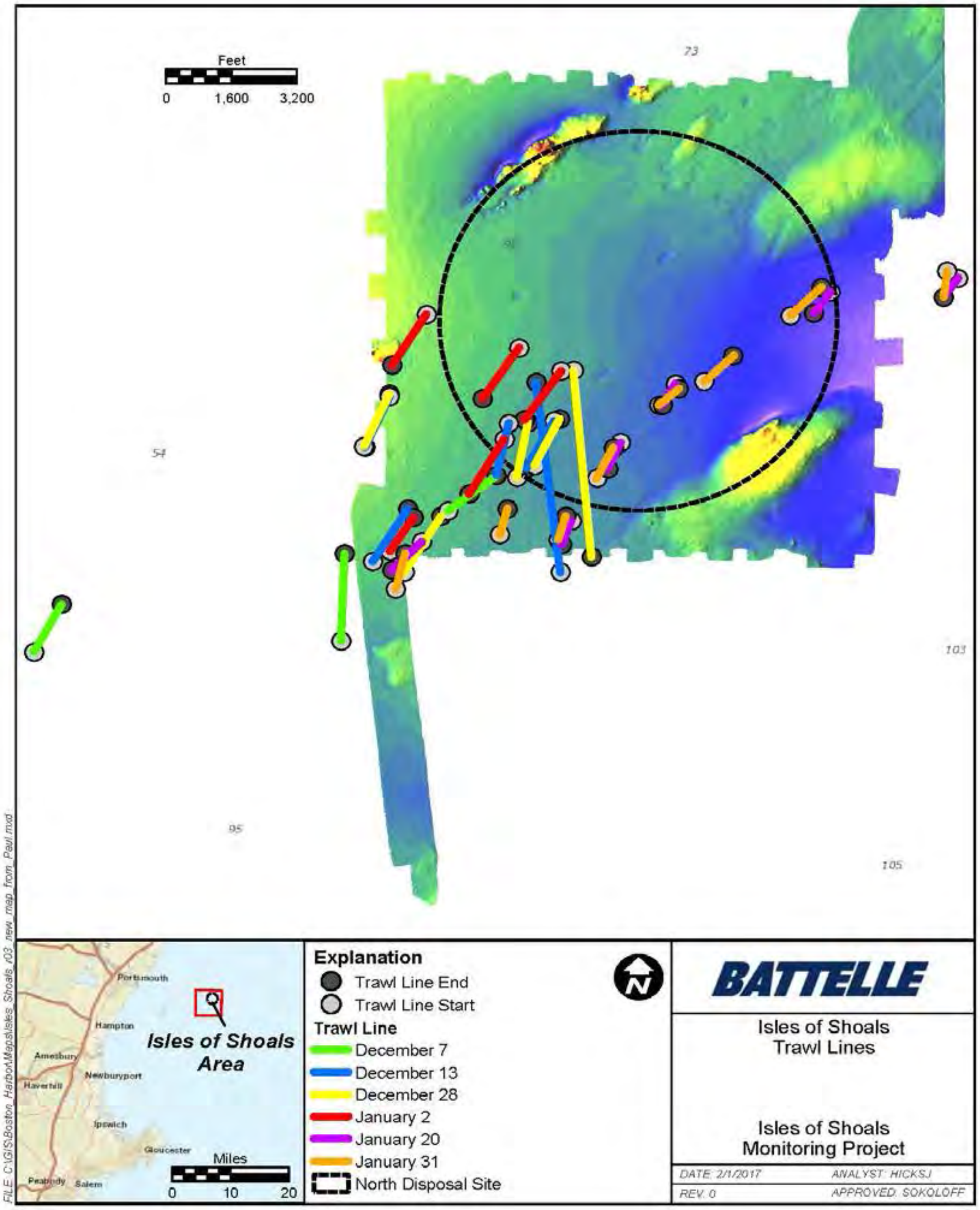

Figure 2-3. Isles of Shoals North Site Lobster Trawl Lines (the northwestern most trawl from 28-Dec overlaps with the northwestern most trawl from 13-Dec.)

3. RESULTS

3.1 Spring Collection of Fish Abundance Data

A summary of the fish abundance data collected in May 2016 is provided in Table 3-1 of this section. In the spring the number of individuals at a station ranged from 1226 individuals at IS-4, to 3,846 at individuals at IS-2. The total number of individuals caught during the spring sampling was 12,218 across a total of 24 species. The mean species per station was 15, with 13 different species being caught at IS-0, IS4, and IS-5, and maximum species diversity of 18 at IS-2. The dominant species collected were silver hake, dab, alewife, and haddock.

3.2 Winter Collection of Fish Abundance Data

A summary of the fish abundance data collected in February of 2017 is provided in Table 3-2. In the winter the number of individuals at a station ranged from 3,546 individuals at IS-5, to 5,027 at individuals at IS-1. The total number of individuals caught during the winter sampling was 26,131 across a total of 28 species. The mean species per station was 15, with 11 different species being caught at IS-0, and maximum species diversity of 18 at IS-1. The dominant species collected were the alewife/blueback herring complex, silver hake, lobster and winter flounder.

3.3 Winter Collection of Lobster Abundance Data

A summary of lobster abundance data collected in December 2016 to January 2017 is summarized in Table 3-3. A total of 2,161 lobsters were collected during the study: 1,475 (68%) lobsters were shorts (i.e., lobsters under the legal size) and 686 (32%) lobsters were of legal size. For each deployed trap, an average of 3.7 lobsters were caught: 2.5 shorts and 1.2 legal sized. The mean catch ranged from 2.2 to 5.9 lobsters per trap, with a mean of 0.7 to 2.2 legal lobsters per trap and 1.1 to 4.9 shorts per trap.

Table 3-1. Summary of Fish Abundance Data from IOSN Spring Fish Trawls

STATION	Sampling Event	# of Individuals	# of Species
IS0	Spring 2016	1741	13
IS1	Spring 2016	1722	17
IS2	Spring 2016	3846	18
IS3	Spring 2016	2267	15
IS4	Spring 2016	1226	13
IS5	Spring2016	1416	13
Minimum	**Spring 2016**	**1226 (IS4)**	**13 (IS0, IS4, &IS5)**
Maximum	**Spring 2016**	**3846 (IS2)**	**18 (IS2)**
Mean	**Spring 2016**	**2036**	**15**
Total	**Spring 2016**	**12218**	**24**

Table 3-2. Summary of Fish Abundance Data from IOSN Winter Fish Trawls

STATION	Sampling Event	# of Individuals	# of Species
IS0	Winter 2017	3785	11
IS1	Winter 2017	5027	18
IS2	Winter 2017	4815	14
IS3	Winter 2017	4906	14
IS4	Winter 2017	4052	17
IS5	Winter 2017	3546	15
Minimum	**Winter 2017**	**3546 (IS5)**	**11 (IS0)**
Maximum	**Winter 2017**	**5027 (IS1)**	**18 (IS1)**
Mean	**Winter 2017**	**4355**	**15**
Total	**Winter 2017**	**26131**	**28**

Table 3-3. Summary of Lobster Abundance Data Collected From IOSN.

Deployment Date	Retrieval Date	# of Traps (Vented)	# of Shorts Caught	# of Legal Lobsters Caught	Total Lobsters Caught
4-Dec-16	7-Dec-16	20	63	30	93
4-Dec-16	7-Dec-16	20	58	29	87
4-Dec-16	7-Dec-16	20	74	38	112
7-Dec-16	13-Dec-16	20	98	20	118
7-Dec-16	13-Dec-16	20	39	43	82
7-Dec-16	13-Dec-16	20	36	30	66
7-Dec-16	13-Dec-16	20	57	39	96
7-Dec-16	13-Dec-16	20	41	29	70
20-Dec-16	28-Dec-17	20	75	15	90
20-Dec-16	28-Dec-16	20	45	17	62
20-Dec-16	28-Dec-16	20	29	14	43
20-Dec-16	28-Dec-16	20	58	17	75
20-Dec-16	28-Dec-16	20	36	15	51
28-Dec-16	2-Jan-17	20	40	18	58
28-Dec-16	2-Jan-17	20	56	20	76
28-Dec-16	2-Jan-17	20	52	21	73
28-Dec-16	2-Jan-17	20	68	13	81
28-Dec-16	2-Jan-17	20	52	13	65
7-Jan-16	20-Jan-17	16	27	17	44
8-Jan-16	20-Jan-17	16	27	18	45
7-Jan-16	20-Jan-17	16	39	21	60
7-Jan-16	20-Jan-17	16	35	18	53
7-Jan-16	20-Jan-17	16	36	25	61
7-Jan-16	20-Jan-17	16	44	25	69
20-Jan-17	31-Jan-17	16	18	21	39
20-Jan-17	31-Jan-17	16	28	17	45
20-Jan-17	31-Jan-17	16	48	20	68
20-Jan-17	31-Jan-17	16	39	21	60
20-Jan-17	31-Jan-17	16	41	15	56
20-Jan-17	31-Jan-17	16	34	18	52
20-Jan-17	31-Jan-17	16	46	16	62
20-Jan-17	31-Jan-17	16	36	13	49

4. REFERENCES

Battelle. 2016. Field Sampling Plan for Boston Harbor and Portsmouth Harbor Fisheries Monitoring Boston, MA and Portsmouth, NH. Submitted to U.S. Army Corps of Engineers North Atlantic Division New England District under Contract W912WJ-12-D-0004.

Battelle. 2016. Final Field Sampling Plan for Boston Harbor and Portsmouth Harbor Fisheries Monitoring Boston, MA and Portsmouth, NH Addendum #1. Submitted to U.S. Army Corps of Engineers North Atlantic Division New England District under Contract W912WJ-12-D-0004.

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Attachment A: Spring Fish Abundance Data Collected May 24, 2016.

Trawl Name	Scientific Name	Common Name	# of Individuals
IS-0	*Merluccius bilinearis*	Silver Hake	1512
IS-0	*Hippoglossoides platessoides*	Dab	93
IS-0	*Alosa pseudoharengus*	Alewife	61
IS-0	*Melanogrammus aeglefinus*	Haddock	23
IS-0	*Homarus americanus*	Lobster	22
IS-0	*Sebastes norvegicus*	Redfish	12
IS-0	*Limanda ferruginea*	Yellowtail Flounder	6
IS-0	*Pollachius virens*	Pollock	4
IS-0	*Urophycis chuss*	Red Hake	3
IS-0	*Pleuronectes putnami*	Gray Sole	2
IS-0	*Clupea harengus*	Atlantic Herring	1
IS-0	*Leucoraja erinacea*	Little Skate	1
IS-0	*Lophius americanus*	Monkfish	1
IS-1	Merluccius bilinearis	Silver Hake	1342
IS-1	Alosa pseudoharengus	Alewife	126
IS-1	Hippoglossoides platessoides	Dab	108
IS-1	Melanogrammus aeglefinus	Haddock	73
IS-1	Homarus americanus	Lobster	33
IS-1	Urophycis chuss	Red Hake	12
IS-1	Limanda ferruginea	Yellowtail Flounder	11
IS-1	Pleuronectes putnami	Gray Sole	4
IS-1	Alosa mediocris	Spotted Shad	3
IS-1	Clupea harengus	Atlantic Herring	2
IS-1	Paralichthys oblongus	Four Spot Flounder	2
IS-1	Pseudopleuronectes americanus	Blackback Flounder	1
IS-1	Enchelyopus cimbrius	Fourbeard Rockling	1
IS-1	Lophius americanus	Monkfish	1
IS-1	Pollachius virens	Pollock	1
IS-1	Sebastes norvegicus	Redfish	1
IS-1	Illex illecebrosus, Doryteuthis pealeil	Short Fin Squid, Long Fin Squid	1
IS-2	*Merluccius bilinearis*	Silver Hake	3487
IS-2	*Hippoglossoides platessoides*	Dab	88
IS-2	*Sebastes norvegicus*	Redfish	75
IS-2	*Melanogrammus aeglefinus*	Haddock	73
IS-2	*Alosa pseudoharengus*	Alewife	42
IS-2	*Homarus americanus*	Lobster	37
IS-2	*Urophycis chuss*	Red Hake	15
IS-2	*Limanda ferruginea*	Yellowtail Flounder	8
IS-2	*Pleuronectes putnami*	Gray Sole	6
IS-2	*Alosa mediocris*	Hickory Shad	3
IS-2	*Clupea harengus*	Atlantic Herring	2
IS-2	*Enchelyopus cimbrius*	Fourbeard Rockling	2

IS-2	*Leucoraja erinacea*	Little Skate	2
IS-2	*Pollachius virens*	Pollock	2
IS-2	*Alosa aestivalis*	Blueback Herring	1
IS-2	*Lophius americanus*	Monkfish	1
IS-2	*Squalus acanthias*	Spiny Dogfish	1
IS-2	*Cryptacanthodes maculatus*	Wrymouth Blenny	1
IS-3	*Merluccius bilinearis*	Silver Hake	2100
IS-3	*Hippoglossoides platessoides*	Dab	47
IS-3	*Alosa pseudoharengus*	Alewife	46
IS-3	*Homarus americanus*	Lobster	25
IS-3	*Melanogrammus aeglefinus*	Haddock	16
IS-3	*Sebastes norvegicus*	Redfish	9
IS-3	*Urophycis chuss*	Red Hake	8
IS-3	*Pleuronectes putnami*	Gray Sole	3
IS-3	*Lophius americanus*	Monkfish	3
IS-3	*Limanda ferruginea*	Yellowtail Flounder	3
IS-3	*Pollachius virens*	Pollock	2
IS-3	*Illex illecebrosus, Doryteuthis pealeil*	Short Fin Squid, Long Fin Squid	2
IS-3	*Aspidophoroides monopterygius*	Alligator Fish	1
IS-3	*Pseudopleuronectes americanus*	Blackback Flounder	1
IS-3	*Enchelyopus cimbrius*	Fourbeard Rockling	1
IS-4	*Merluccius bilinearis*	Silver Hake	948
IS-4	*Alosa pseudoharengus*	Alewife	99
IS-4	*Hippoglossoides platessoides*	Dab	86
IS-4	*Melanogrammus aeglefinus*	Haddock	41
IS-4	*Homarus americanus*	Lobster	28
IS-4	*Pleuronectes putnami*	Gray Sole	9
IS-4	*Limanda ferruginea*	Yellowtail Flounder	5
IS-4	*Urophycis chuss*	Red Hake	4
IS-4	*Sebastes norvegicus*	Redfish	2
IS-4	*Myoxocephalus scorpius*	Longhorn Scuplin	1
IS-4	*Lophius americanus*	Monkfish	1
IS-4	*Clupea harengus*	Sea Herring	1
IS-4	*Cryptacanthodes maculatus*	Wrymouth Blenny	1
IS-5	*Merluccius bilinearis*	Silver Hake	1065
IS-5	*Alosa pseudoharengus*	Alewife	177
IS-5	*Melanogrammus aeglefinus*	Haddock	42
IS-5	*Homarus americanus*	Lobster	30
IS-5	*Sebastes norvegicus*	Redfish	7
IS-5	*Pleuronectes putnami*	Gray Sole	6
IS-5	*Limanda ferruginea*	Yellowtail Flounder	4
IS-5	*Urophycis chuss*	Red Hake	3
IS-5	*Gadus morhua*	Cod	2
IS-5	*Alosa mediocris*	Spotted Shad	2
IS-5	*Paralichthys oblongus*	Four Spot Flounder	1
IS-5	*Clupea harengus*	Sea Herring	1

Attachment B: Winter Fish Abundance Data Collected February 20, 2017.

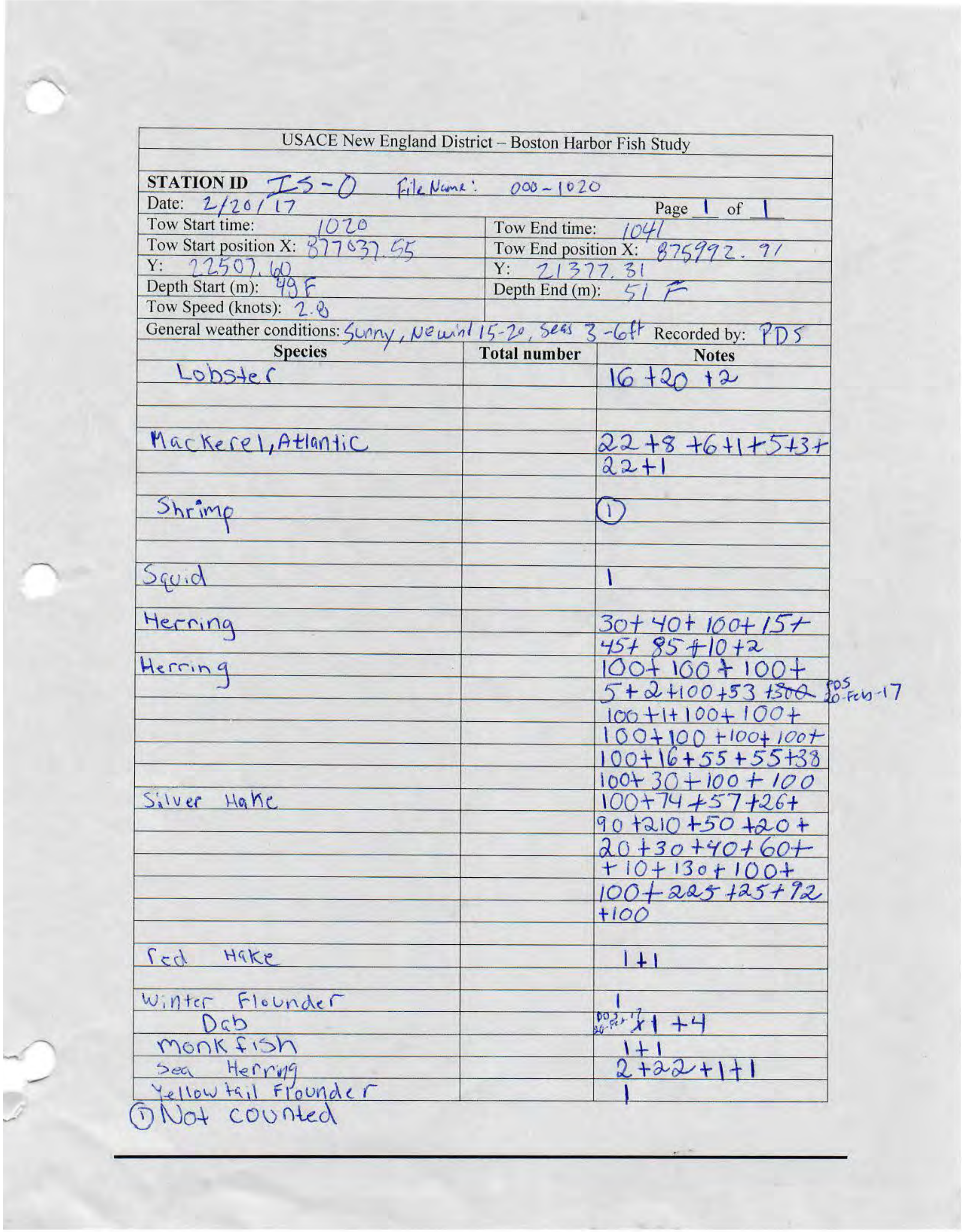
Trawl Name	Scientific Name	Common Name	# of Individuals
IS-0	*Alosa pseudoharengus, Alosa aestivalis*	Alewife, Blueback Herring	2082
IS-0	Scomber colias	Atlantic Mackerel	68
IS-0	*Homarus americanus*	Lobster	38
IS-0	*Clupea harengus*	Atlantic Herring	26
IS-0	*Hippoglossoides platessoides*	Dab	5
IS-0	*Urophycis chuss*	Red Hake	2
IS-0	*Lophius americanus*	Monkfish	2
IS-0	*Illex illecebrosus, Doryteuthis pealeil*	Short Fin Squid, Long Fin Squid	1
IS-0	*Pseudopleuronectes americanus*	Winter Flounder	1
IS-0	*Limanda ferruginea*	Yellowtail Flounder	1
IS-1	*Merluccius bilinearis*	Silver Hake	4315
IS-1	*Alosa pseudoharengus, Alosa aestivalis*	Alewife, Blueback Herring	557
IS-1	*Homarus americanus*	Lobster	44
IS-1	Scomber colias	Atlantic Mackerel	37
IS-1	*Clupea harengus*	Atlantic Herring	27
IS-1	*Hippoglossoides platessoides*	Dab	14
IS-1	*Urophycis chuss*	Red Hake	10
IS-1	*Lophius americanus*	Monkfish	6
IS-1	*Scophthalmus aquosus*	Windowpane Flounder	3
IS-1	*Myoxocephalus scorpius*	Longhorn Scuplin	3
IS-1	*Pleuronectes putnami*	Gray Sole	3
IS-1	*Illex illecebrosus, Doryteuthis pealeil*	Short Fin Squid, Long Fin Squid	2
IS-1	*Pollachius virens*	Pollock	1
IS-1	*Pseudopleuronectes americanus*	Winter Flounder	1
IS-1	*Tautogolabrus adspersus*	Cunner	1
IS-1	*Prionotus alatus*	Spiny Searobin	1
IS-1	*Paralichthys oblongus*	Four Spot Flounder	1
IS-1	*Limanda ferruginea*	Yellowtail Flounder	1
IS-2	*Merluccius bilinearis*	Silver Hake	3194
IS-2	*Alosa pseudoharengus, Alosa aestivalis*	Alewife, Blueback Herring	1342
IS-2	*Clupea harengus*	Atlantic Herring	163
IS-2	Scomber colias	Atlantic Mackerel	46
IS-2	*Homarus americanus*	Lobster	46
IS-2	*Melanogrammus aeglefinus*	Haddock	5
IS-2	*Hippoglossoides platessoides*	Dab	5
IS-2	*Lophius americanus*	Monkfish	3
IS-2	*Pleuronectes putnami*	Gray Sole	3
IS-2	*Urophycis chuss*	Red Hake	3
IS-2	*Myoxocephalus scorpius*	Longhorn Scuplin	2
IS-2	*Sebastes norvegicus*	Redfish	1

IS-2	*Scophthalmus aquosus*	Windowpane Flounder	1
IS-2	*Prionotus carolinus*	Northern Searobin	1
IS-3	*Alosa pseudoharengus, Alosa aestivalis*	Alewife, Blueback Herring	3660
IS-3	*Merluccius bilinearis*	Silver Hake	1112
IS-3	*Homarus americanus*	Lobster	61
IS-3	*Clupea harengus*	Atlantic Herring	46
IS-3	*Hippoglossoides platessoides*	Dab	8
IS-3	Scomber colias	Atlantic Mackerel	7
IS-3	*Pseudopleuronectes americanus*	Winter Flounder	3
IS-3	*Cryptacanthodes maculatus*	Wrymouth Blenny	2
IS-3	*Alosa mediocris*	Hickory Shad	2
IS-3	*Myoxocephalus scorpius*	Longhorn Scuplin	1
IS-3	*Melanogrammus aeglefinus*	Haddock	1
IS-3	*Placopecten magellanicus*	Sea Scallop	1
IS-3	*Pleuronectes putnami*	Gray Sole	1
IS-3	*Limanda ferruginea*	Yellowtail Flounder	1
IS-4	*Merluccius bilinearis*	Silver Hake	2062
IS-4	*Alosa pseudoharengus, Alosa aestivalis*	Alewife, Blueback Herring	1552
IS-4	*Clupea harengus*	Atlantic Herring	369
IS-4	*Homarus americanus*	Lobster	36
IS-4	*Hippoglossoides platessoides*	Dab	12
IS-4	Scomber colias	Atlantic Mackerel	5
IS-4	*Illex illecebrosus, Doryteuthis pealeil*	Short Fin Squid, Long Fin Squid	3
IS-4	*Urophycis chuss*	Red Hake	3
IS-4	*Alosa mediocris*	Hickory Shad	2
IS-4	*Pleuronectes putnami*	Gray Sole	1
IS-4	*Paralichthys oblongus*	Four Spot Flounder	1
IS-4	*Cryptacanthodes maculatus*	Wrymouth Blenny	1
IS-4	*Lophius americanus*	Monkfish	1
IS-4	*Pseudopleuronectes americanus*	Winter Flounder	1
IS-4	*Melanogrammus aeglefinus*	Haddock	1
IS-4	*Centropristis striata*	Black Sea Bass	1
IS-4	*Prionotus alatus*	Spiny Searobin	1
IS-5	*Alosa pseudoharengus, Alosa aestivalis*	Alewife, Blueback Herring	2055
IS-5	*Homarus americanus*	Lobster	38
IS-5	*Hippoglossoides platessoides*	Dab	10
IS-5	Scomber colias	Atlantic Mackerel	5
IS-5	*Pseudopleuronectes americanus*	Winter Flounder	4
IS-5	*Alosa mediocris*	Hickory Shad	2
IS-5	*Cryptacanthodes maculatus*	Wrymouth Blenny	1
IS-5	*Myxine glutinosa*	Atlantic Hagfish	1
IS-5	*Illex illecebrosus, Doryteuthis pealeil*	Short Fin Squid, Long Fin Squid	1
IS-5	*Limanda ferruginea*	Yellowtail Flounder	1

*Alewife (*Alosa pseudoharengus)* and Blueback Herring (*Alosa aestivalis*) were combined in the enumeration process and are presented within this document as the “Alosa complex.”

**Some values are estimations of abundance calculated by enumerating one fish tote worth of a single species and multiplying by the total number of fish totes filled for that species. Estimations were used to minimize mortality to the catch.

Attachment C: Fish Abundance Field Log Sheets



USACE New England District – Boston Harbor Fish Study

STATION ID IS-0 File Name: 000-1020

Date: 2/20/17 Page 1 of 1

Tow Start time: 1020

Tow End time: 1041

Tow Start position X: 877037.55

Tow End position X: 875992.91

Y: 22507.60

Y: 21377.31

Depth Start (m): 49 F

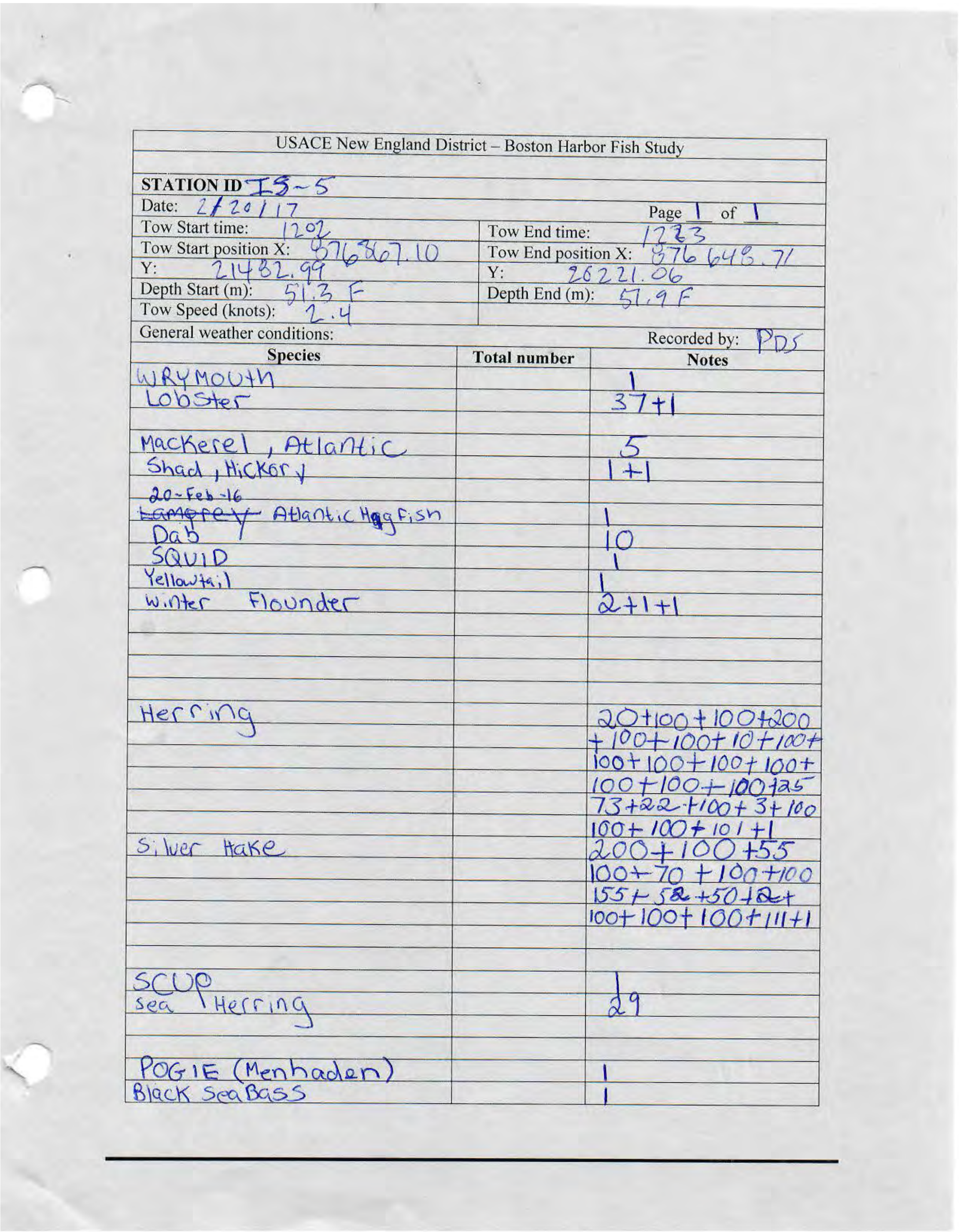
Depth End (m): 51 F

Tow Speed (knots): 2.8

General weather conditions: Sunny, NE wind 15-20, seas 3-6ft Recorded by: PDS

Species	Total number	Notes
Lobster		16 +20 +2
Mackerel, Atlantic		22 +8 +6 +1 +5 +3 +
		22 +1
Shrimp		①
Squid		1
Herring		30+ 40+ 100+ 15+
		45+ 85 +10 +2
Herring		100+ 100 + 100+
		5 + 2 +100 +53 ~~+500~~ PDS 20-Feb-17
		100 +1+ 100+ 100+
		100+ 100 +100+ 100+
		100+ 16 + 55 + 55 +38
		100+ 30 + 100 + 100
Silver Hake		100+ 74 +57 +26+
		90 +210 +50 +20 +
		20 +30 +40 + 60+
		+ 10+ 130+ 100+
		100+ 225 +25 +92
		+100
red Hake		1+1
winter Flounder		1
Dab		PDS 20-Feb-17 x1 +4
monkfish		1+1
Sea Herring		2 +22 +1 +1
Yellowtail Flounder		1

① Not counted



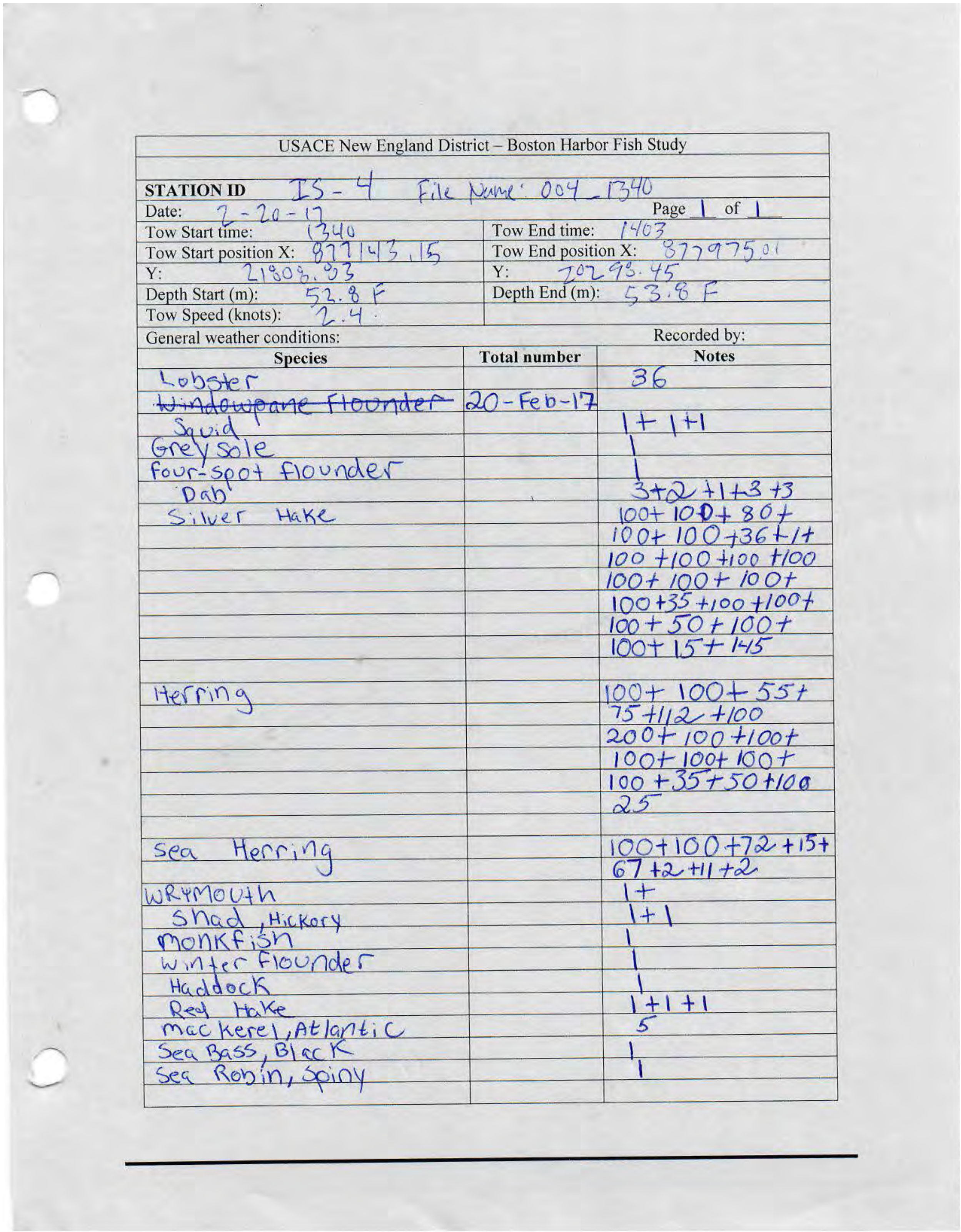
USACE New England District – Boston Harbor Fish Study

STATION ID IS-5
Date: 2/20/17 Page 1 of 1

Tow Start time: 1202	Tow End time: 1223
Tow Start position X: 876867.10	Tow End position X: 876 648.71
Y: 21482.99	Y: 26221.06
Depth Start (m): 51.3 F	Depth End (m): 51.9 F
Tow Speed (knots): 2.4	

General weather conditions:
Recorded by: PDS

Species	Total number	Notes
WRYMOUTH		1
Lobster		37+1
Mackerel, Atlantic		5
Shad, Hickory		1+1
20-Feb-16		
~~Lamprey~~ Atlantic Hagfish		1
Dab		10
SQUID		1
Yellowtail		1
winter Flounder		2+1+1
Herring		20+100+100+200
		+100+100+10+100+
		100+100+100+100+
		100+100+100+25
		73+22+100+3+100
		100+100+101+1
Silver Hake		200+100+55
		100+70+100+100
		155+52+50+2+
		100+100+100+111+1
SCUP		1
sea Herring		29
POGIE (Menhaden)		1
Black SeaBass		1



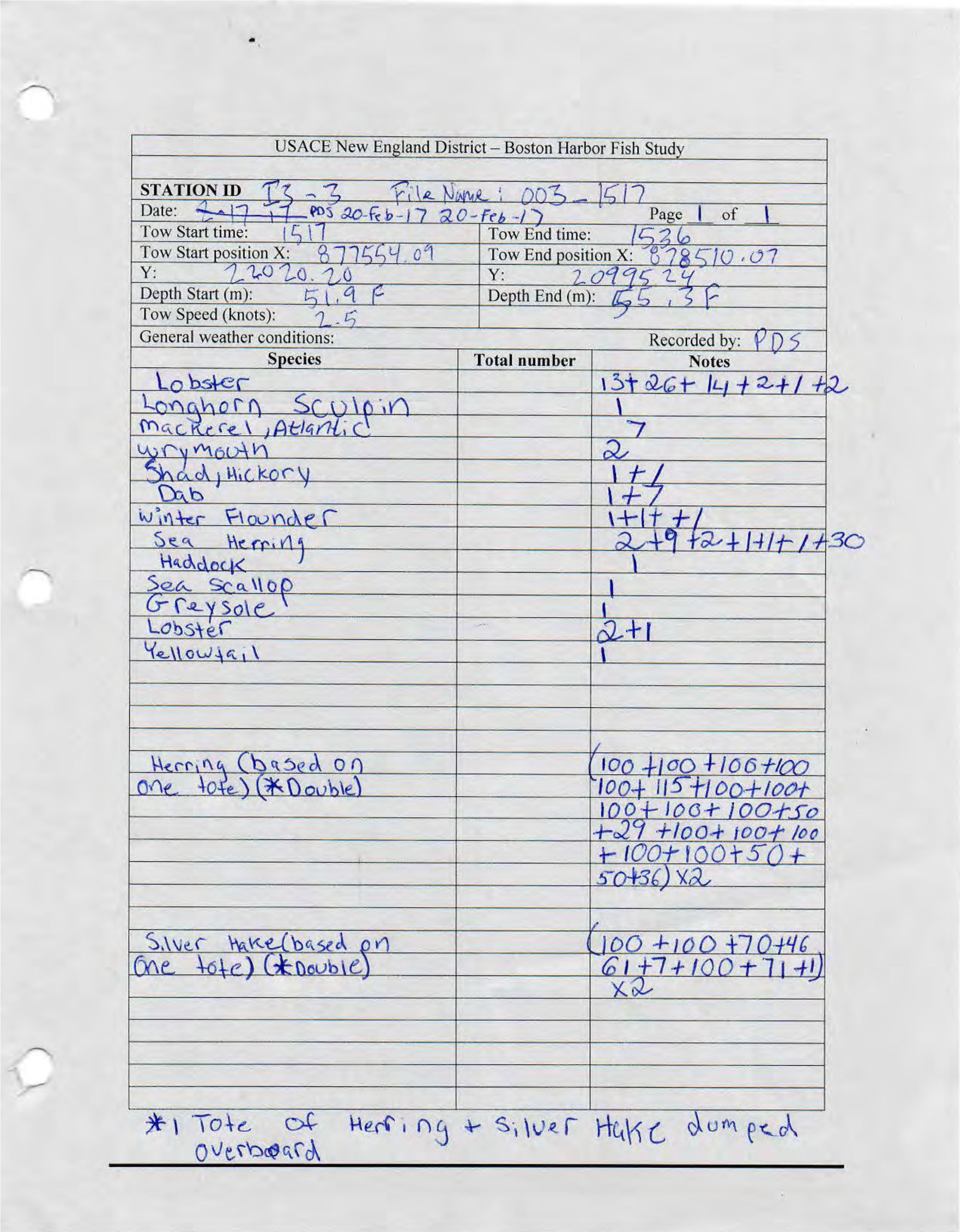
USACE New England District – Boston Harbor Fish Study

STATION ID IS - 4 File Name: 004_1340
Date: 2 - 20 - 17 Page 1 of 1

Tow Start time: 1340	Tow End time: 1403
Tow Start position X: 877143.15	Tow End position X: 877975.01
Y: 21808.83	Y: 20293.45
Depth Start (m): 52.8 F	Depth End (m): 53.8 F
Tow Speed (knots): 2.4	

General weather conditions:
Recorded by:

Species	Total number	Notes
Lobster		36
~~Windowpane Flounder~~	20-Feb-17	
Squid		1+1+1
Grey sole		1
four-spot flounder		1
Dab		3+2+1+3+3
Silver Hake		100+100+80+
		100+100+36+1+
		100+100+100+100
		100+100+100+
		100+35+100+100+
		100+50+100+
		100+15+145
Herring		100+100+55+
		75+112+100
		200+100+100+
		100+100+100+
		100+35+50+100
		25
Sea Herring		100+100+72+15+
		67+2+11+2
WRYMOUTH		1+
Shad, Hickory		1+1
monkfish		1
winter Flounder		1
Haddock		1
Red Hake		1+1+1
mackerel, Atlantic		5
Sea Bass, Black		1
Sea Robin, Spiny		1

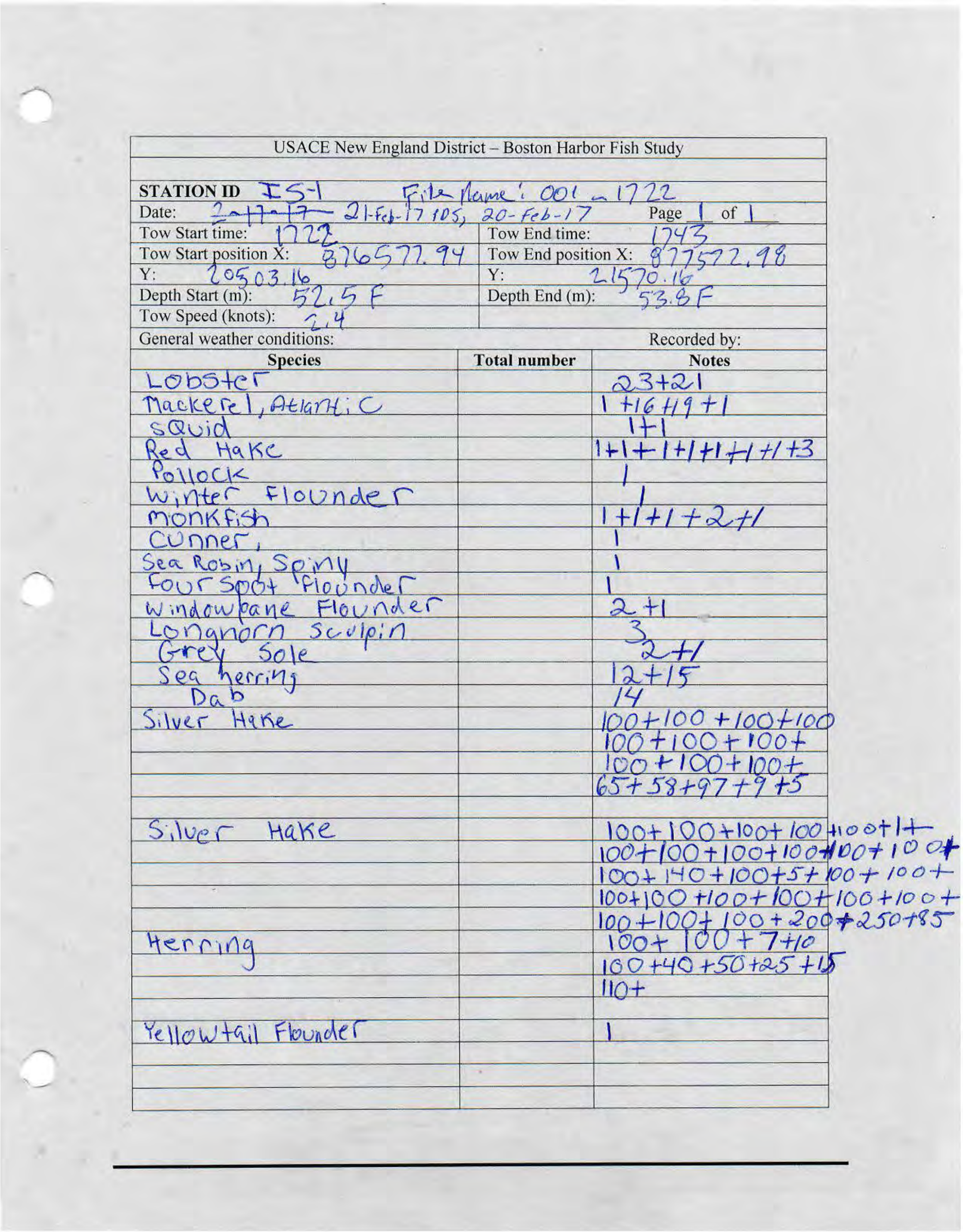


USACE New England District – Boston Harbor Fish Study

STATION ID I3 - 3 File Name : 003 - 1517
Date: ~~2-17-17~~ PDS 20-Feb-17 20-Feb-17 Page 1 of 1
Tow Start time: 1517
Tow End time: 1536
Tow Start position X: 877554.09
Y: 2202 0.20
Tow End position X: 878510.07
Y: 2099524
Depth Start (m): 51.9 F
Depth End (m): 55.3 F
Tow Speed (knots): 2.5
General weather conditions:
Recorded by: PDS

Species	Total number	Notes
Lobster		13+26+14+2+1+2
Longhorn Sculpin		1
mackerel, Atlantic		7
wrymouth		2
Shad, Hickory		1+1
Dab		1+7
winter Flounder		1+1+ +1
Sea Herring		2+9+2+1+1+1+30
Haddock		1
Sea Scallop		1
Greysole		1
Lobster		2+1
Yellowtail		1
Herring (based on one tote) (*Double)		(100+100+100+100 100+115+100+100+ 100+100+100+50 +29+100+100+100 +100+100+50+ 50+36) X2
Silver Hake (based on One tote) (*Double)		(100+100+70+46 61+7+100+71+1) X2

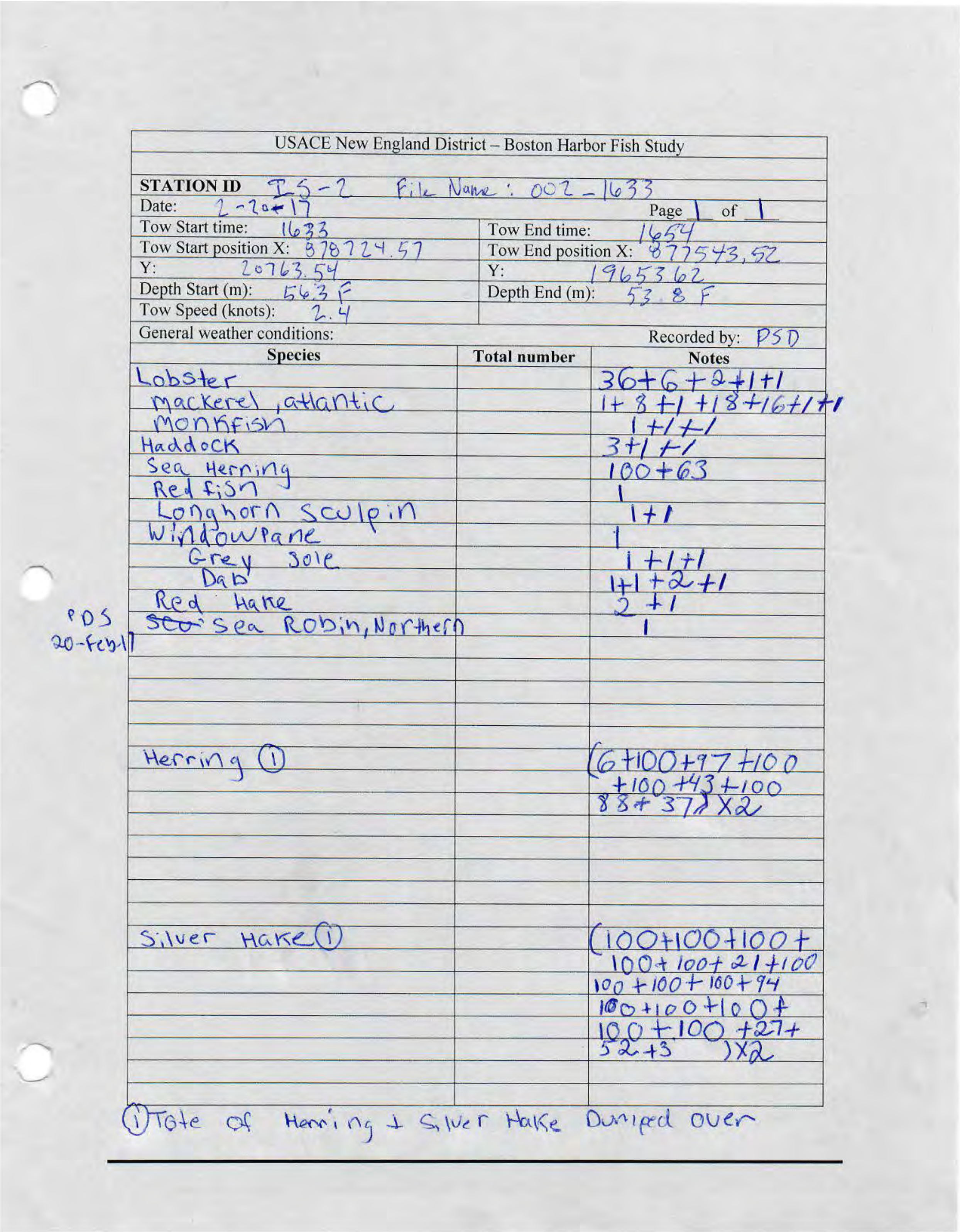
*1 Tote of Herring + Silver Hake dumped overboard



USACE New England District – Boston Harbor Fish Study

STATION ID IS-1 File Name: 001 _ 1722
Date: ~~2-17-17~~ 21-Feb-17 105, 20-Feb-17 Page 1 of 1
Tow Start time: 1722 Tow End time: 1743
Tow Start position X: 876577.94 Tow End position X: 877572.98
Y: 20503.16 Y: 21570.16
Depth Start (m): 52.5 F Depth End (m): 53.8 F
Tow Speed (knots): 2.4
General weather conditions: Recorded by:

Species	Total number	Notes
Lobster		23+21
Mackerel, Atlantic		1+16+19+1
squid		1+1
Red Hake		1+1+1+1+1+1+1+3
Pollock		1
winter Flounder		1
monkfish		1+1+1+2+1
cunner,		1
Sea Robin, Spiny		1
Four Spot Flounder		1
windowpane Flounder		2+1
Longhorn sculpin		3
Grey Sole		2+1
Sea herring		12+15
Dab		14
Silver Hake		100+100+100+100
		100+100+100+
		100+100+100+
		65+58+97+9+5
Silver Hake		100+100+100+100+100+1+
		100+100+100+100+100+100+
		100+140+100+5+100+100+
		100+100+100+100+100+100+
		100+100+100+200+250+85
Herring		100+100+7+10
		100+40+50+25+15
		110+
Yellowtail Flounder		1



USACE New England District – Boston Harbor Fish Study

STATION ID IS-2 File Name: 002_1633

Date: 2-20+17 Page 1 of 1

Tow Start time: 1633	Tow End time: 1654
Tow Start position X: 878724.57	Tow End position X: 877543,52
Y: 20763.54	Y: 1965362
Depth Start (m): 56.3 F	Depth End (m): 53.8 F
Tow Speed (knots): 2.4	

General weather conditions: Recorded by: PSD

Species	Total number	Notes
Lobster		36+6+2+1+1
mackerel, atlantic		1+8+1+18+16+1+1
monkfish		1+1+1
Haddock		3+1+1
Sea Herning		100+63
Red fish		1
Longhorn Sculpin		1+1
Windowpane		1
Grey Sole		1+1+1
Dab		1+1+2+1
Red Hake		2+1
~~sea~~ Sea Robin, Northern		1
Herring ①		(6+100+97+100 +100+43+100 88+37) X2
Silver Hake ①		(100+100+100+ 100+100+21+100 100+100+100+94 100+100+100+ 100+100+27+ 52+3)X2

PDS
20-Feb-17

① Tote of Herring + Silver Hake Dumped over

Attachment D: Fish Abundance Field Photos

Spring Photos

Sample Trawl at IS5 including American Plaice, Lobster, Cod, Silver Hake

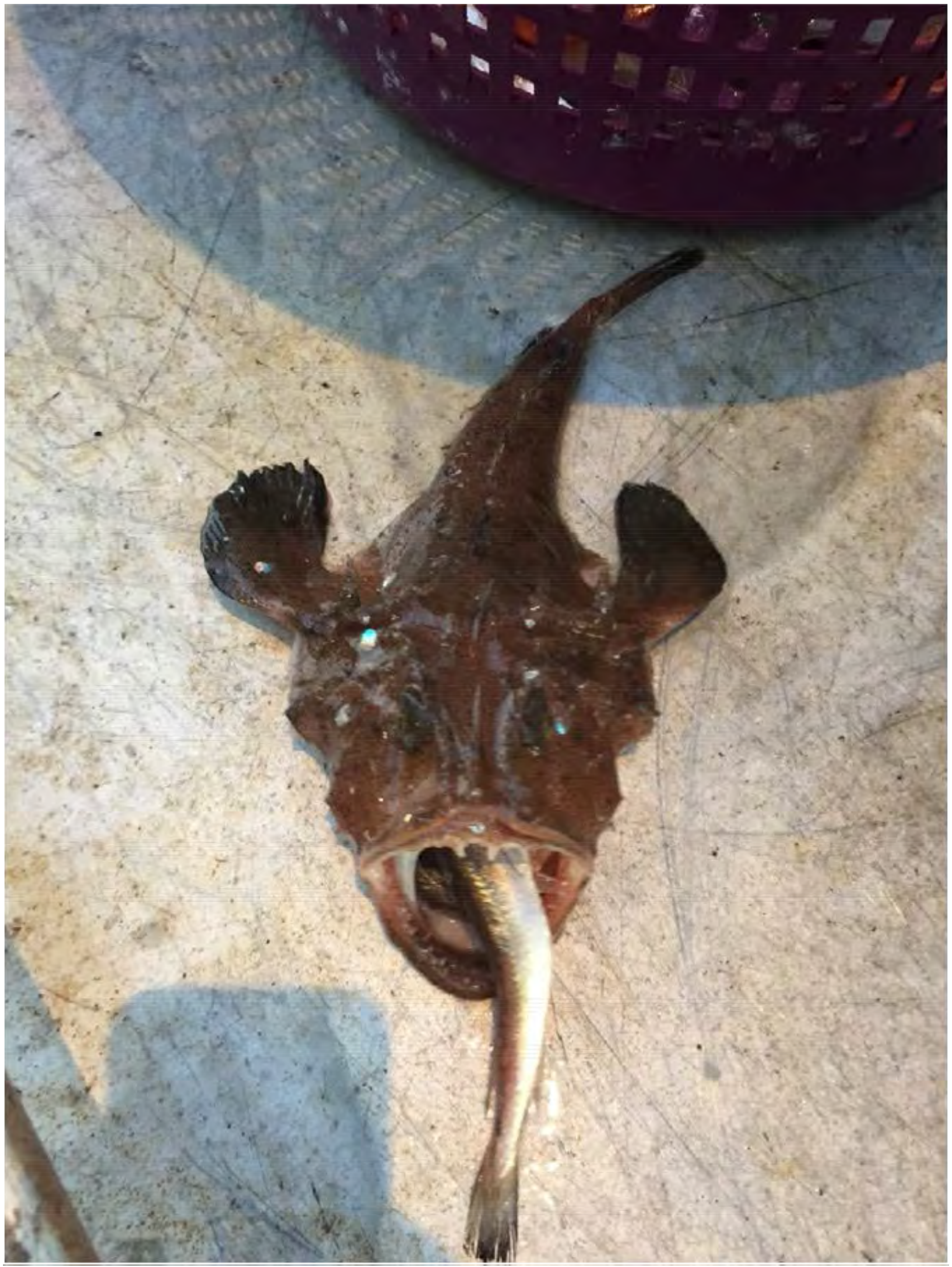
Cod IS-5

Winter photos

Sample Trawl at IS-0 including Yellowtail Flounder, Atlantic Herring, Blueback Herring, Alewife, Shrimp, Atlantic Mackerel

Haddock IS-4

Winter Flounder at IS-4



Monkfish with Silver Hake in its mouth IS-4

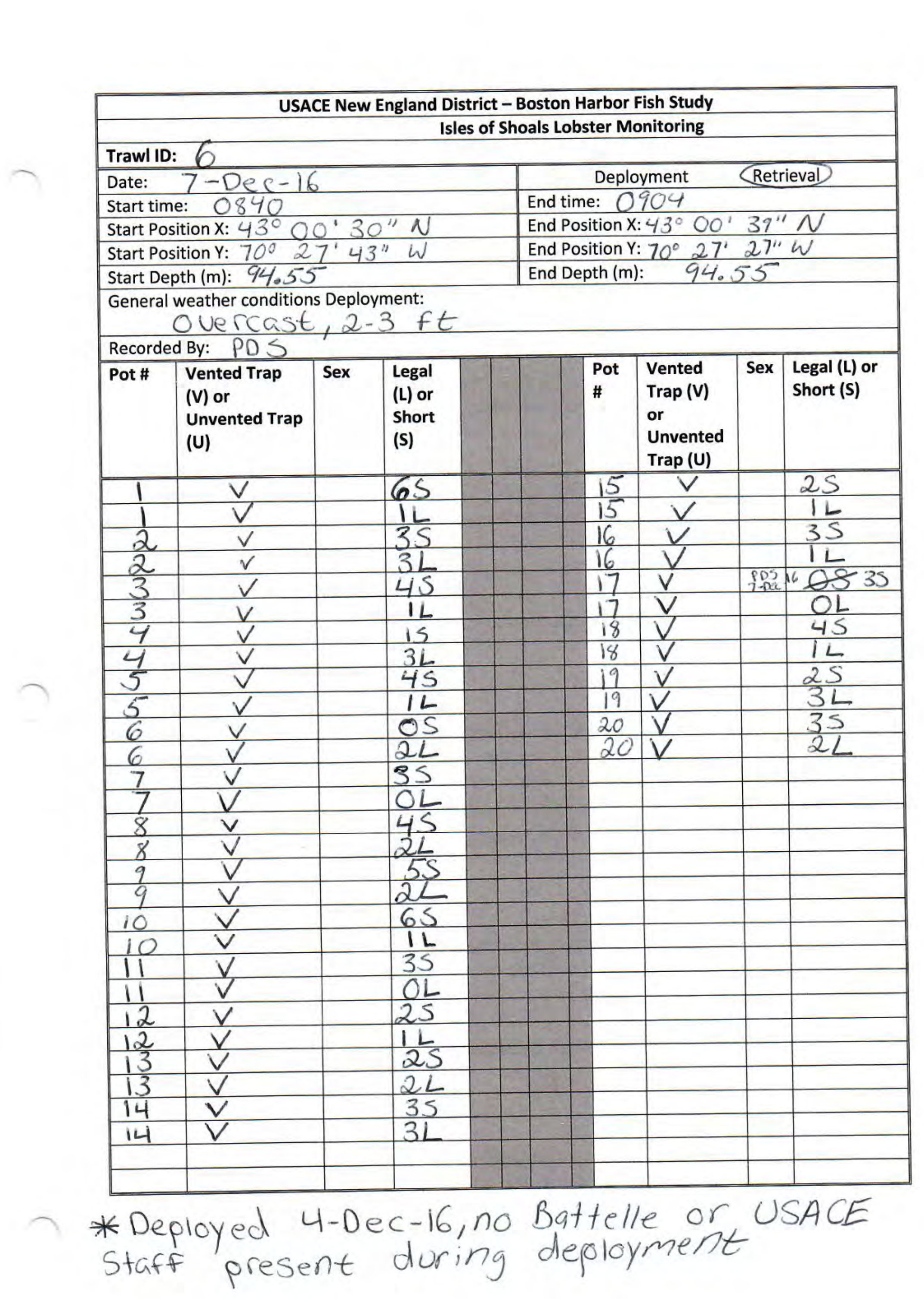
Hagfish at IS-5

Wrymouth and Black Sea Bass IS-5

Atlantic Mackerel and Atlantic Herring IS-5

Squid IS-5

Attachment E: Lobster Abundance Field Log Sheets



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID: 6

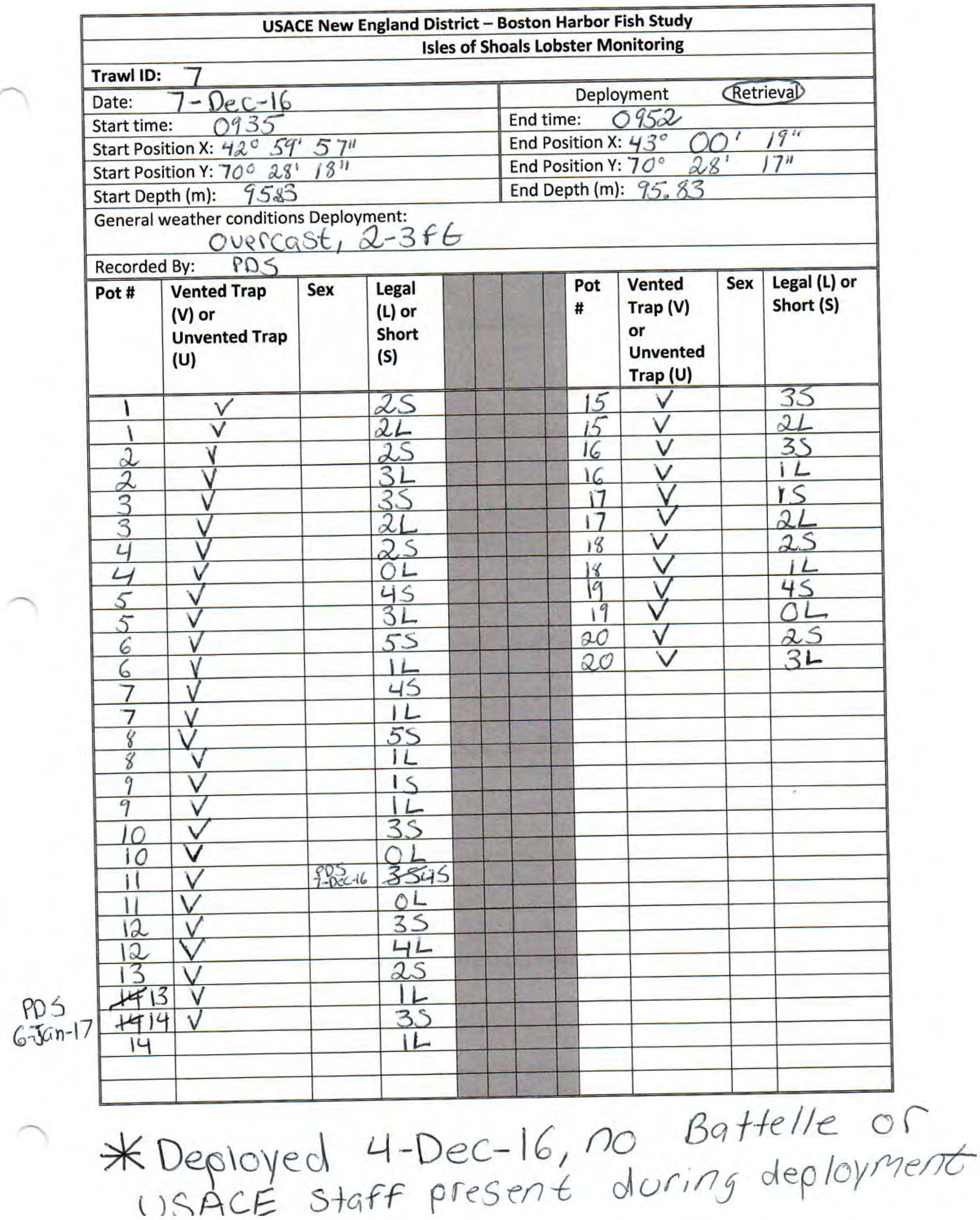
Date: 7-Dec-16	Deployment [✓ Retrieval]
Start time: 0840	End time: 0904
Start Position X: 43° 00' 30" N	End Position X: 43° 00' 37" N
Start Position Y: 70° 27' 43" W	End Position Y: 70° 27' 27" W
Start Depth (m): 94.55	End Depth (m): 94.55

General weather conditions Deployment: Overcast, 2-3 ft

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)	Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		6S	15	V		2S
1	V		1L	15	V		1L
2	V		3S	16	V		3S
2	V		3L	16	V		1L
3	V		4S	17	V	PDS 7-Dec-16	~~0S~~ 3S
3	V		1L	17	V		0L
4	V		1S	18	V		4S
4	V		3L	18	V		1L
5	V		4S	19	V		2S
5	V		1L	19	V		3L
6	V		0S	20	V		3S
6	V		2L	20	V		2L
7	V		3S				
7	V		0L				
8	V		4S				
8	V		2L				
9	V		5S				
9	V		2L				
10	V		6S				
10	V		1L				
11	V		3S				
11	V		0L				
12	V		2S				
12	V		1L				
13	V		2S				
13	V		2L				
14	V		3S				
14	V		3L				

*Deployed 4-Dec-16, no Battelle or USACE Staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID: 7

Date: 7-Dec-16

Deployment [✓ Retrieval]

Start time: 0935

End time: 0952

Start Position X: 42° 59' 57"

End Position X: 43° 00' 19"

Start Position Y: 70° 28' 18"

End Position Y: 70° 28' 17"

Start Depth (m): 9583

End Depth (m): 95.83

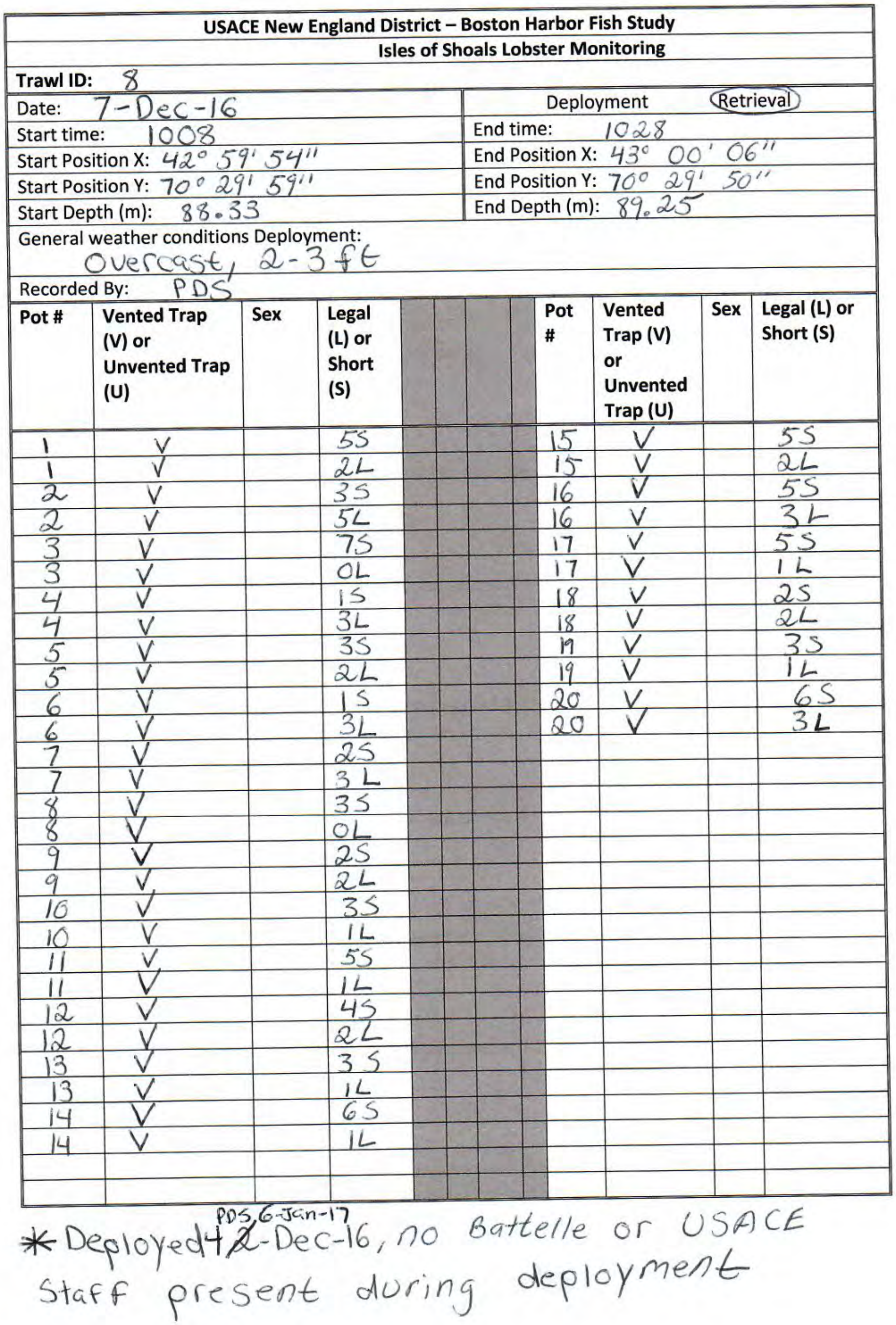
General weather conditions Deployment: overcast, 2-3fG

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		2S					15	V		3S
1	V		2L					15	V		2L
2	V		2S					16	V		3S
2	V		3L					16	V		1L
3	V		3S					17	V		1S
3	V		2L					17	V		2L
4	V		2S					18	V		2S
4	V		0L					18	V		1L
5	V		4S					19	V		4S
5	V		3L					19	V		0L
6	V		5S					20	V		2S
6	V		1L					20	V		3L
7	V		4S								
7	V		1L								
8	V		5S								
8	V		1L								
9	V		1S								
9	V		1L								
10	V		3S								
10	V		0L								
11	V	PDS 7-Dec-16	~~3S~~4S								
11	V		0L								
12	V		3S								
12	V		4L								
13	V		2S								
~~14~~13	V		1L								
~~14~~14	V		3S								
14			1L								

PDS
6-Jan-17

*Deployed 4-Dec-16, no Battelle or USACE staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID: 8

Date: 7-Dec-16	Deployment [✓ Retrieval]
Start time: 1008	End time: 1028
Start Position X: 42° 59' 54"	End Position X: 43° 00' 06"
Start Position Y: 70° 29' 59"	End Position Y: 70° 29' 50"
Start Depth (m): 88.33	End Depth (m): 89.25

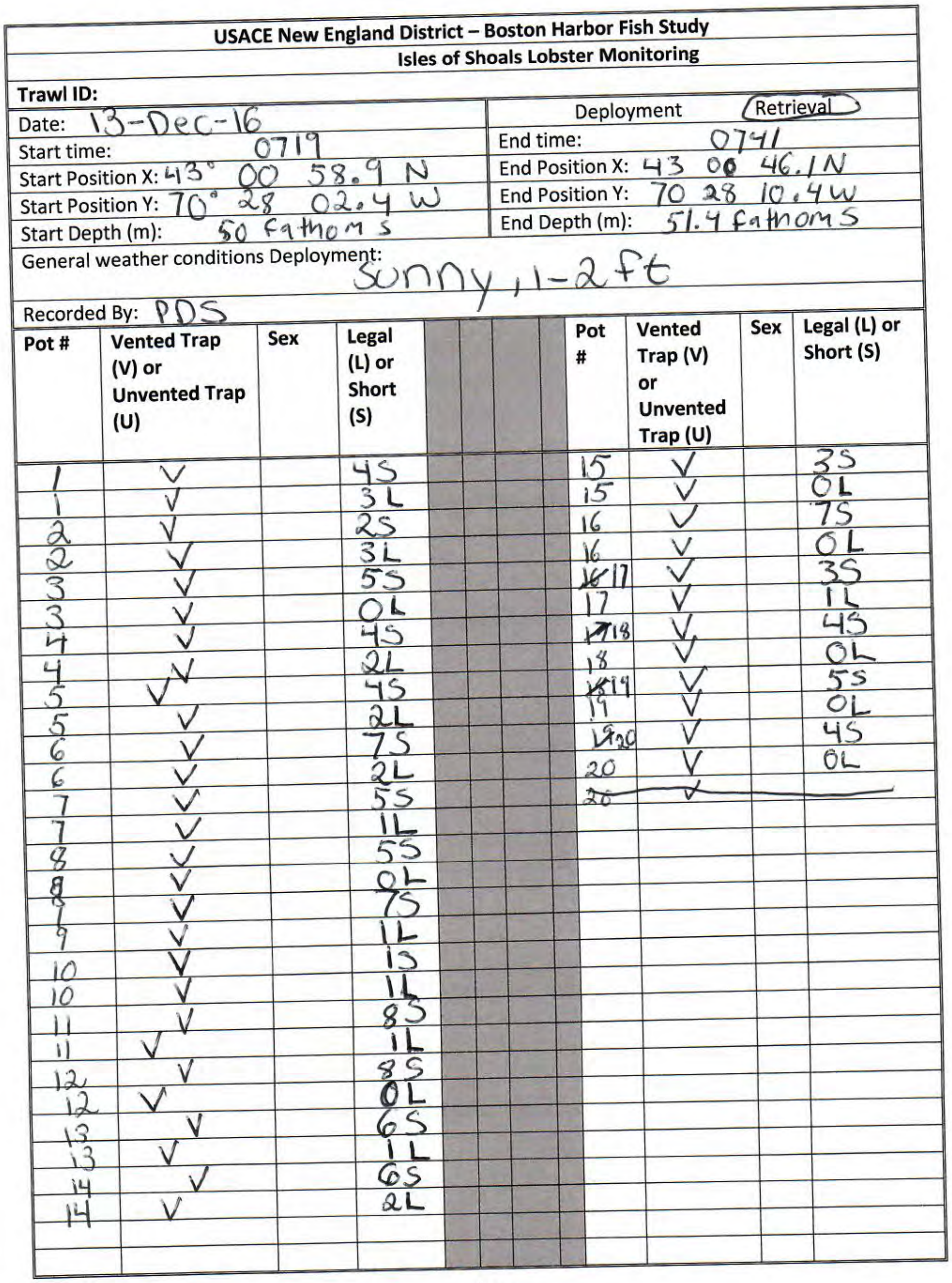
General weather conditions Deployment:
Overcast, 2-3 ft

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)	Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		5S	15	V		5S
1	V		2L	15	V		2L
2	V		3S	16	V		5S
2	V		5L	16	V		3L
3	V		7S	17	V		5S
3	V		0L	17	V		1L
4	V		1S	18	V		2S
4	V		3L	18	V		2L
5	V		3S	19	V		3S
5	V		2L	19	V		1L
6	V		1S	20	V		6S
6	V		3L	20	V		3L
7	V		2S				
7	V		3L				
8	V		3S				
8	V		0L				
9	V		2S				
9	V		2L				
10	V		3S				
10	V		1L				
11	V		5S				
11	V		1L				
12	V		4S				
12	V		2L				
13	V		3S				
13	V		1L				
14	V		6S				
14	V		1L				

PDS, 6-Jan-17

*Deployed 4~~2~~-Dec-16, no Battelle or USACE Staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 13-Dec-16

Start time: 0719

Start Position X: 43° 00 58.9 N

Start Position Y: 70° 28 02.4 W

Start Depth (m): 50 fathoms

Deployment [✓ Retrieval]

End time: 0741

End Position X: 43 00 46.1N

End Position Y: 70 28 10.4W

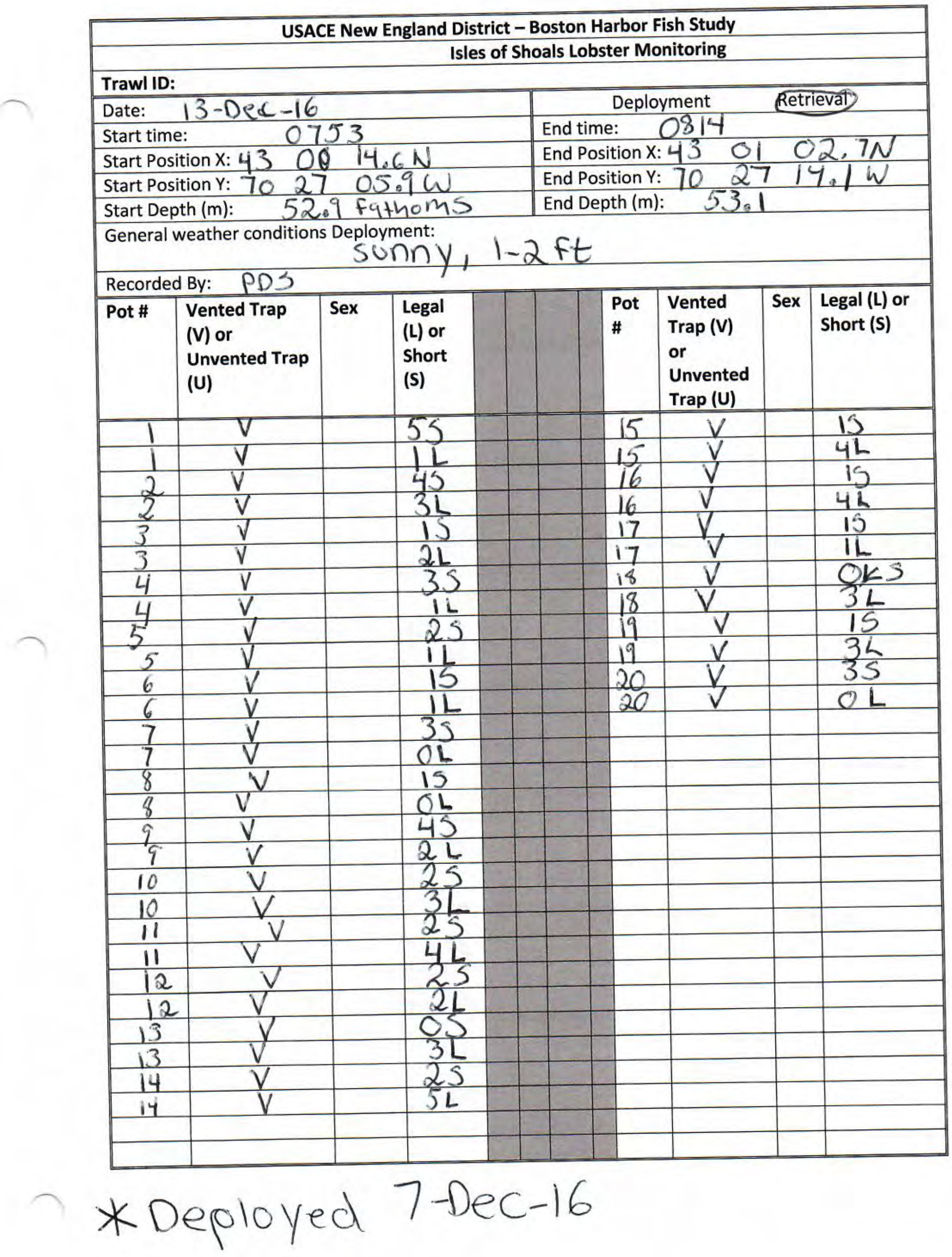
End Depth (m): 51.4 fathoms

General weather conditions Deployment: Sunny, 1-2ft

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**	**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		4S	15	V		3S
1	V		3L	15	V		0L
2	V		2S	16	V		7S
2	V		3L	16	V		0L
3	V		5S	~~16~~ 17	V		3S
3	V		0L	17	V		1L
4	V		4S	~~17~~ 18	V		4S
4	V		2L	18	V		0L
5	V		4S	~~18~~ 19	V		5S
5	V		2L	19	V		0L
6	V		7S	~~19~~ 20	V		4S
6	V		2L	20	V		0L
7	V		5S	~~20~~	~~V~~		
7	V		1L				
8	V		5S				
8	V		0L				
9	V		7S				
9	V		1L				
10	V		1S				
10	V		1L				
11	V		8S				
11	V		1L				
12	V		8S				
12	V		0L				
13	V		6S				
13	V		1L				
14	V		6S				
14	V		2L				

* Deployed 7-Dec-16



USACE New England District – Boston Harbor Fish Study
Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 13-Dec-16
Start time: 0753
Start Position X: 43 00 14.6N
Start Position Y: 70 27 05.9W
Start Depth (m): 52.9 fathoms

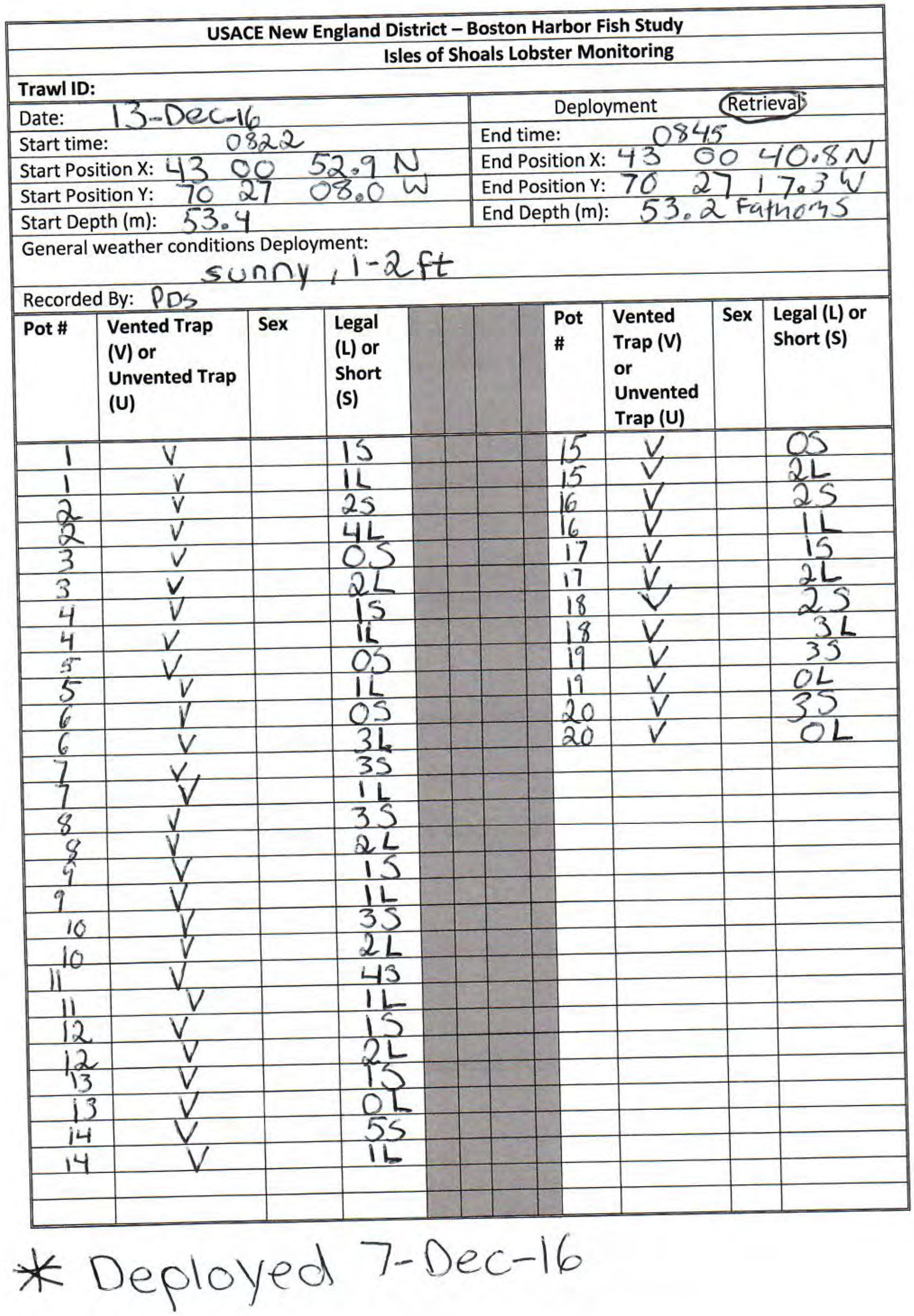
Deployment [✓ Retrieval]
End time: 0814
End Position X: 43 01 02.7N
End Position Y: 70 27 14.1 W
End Depth (m): 53.1

General weather conditions Deployment: sunny, 1-2 ft

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)	Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		5S	15	V		1S
1	V		1L	15	V		4L
2	V		4S	16	V		1S
2	V		3L	16	V		4L
3	V		1S	17	V		1S
3	V		2L	17	V		1L
4	V		3S	18	V		OKS
4	V		1L	18	V		3L
5	V		2S	19	V		1S
5	V		1L	19	V		3L
6	V		1S	20	V		3S
6	V		1L	20	V		0L
7	V		3S				
7	V		0L				
8	V		1S				
8	V		0L				
9	V		4S				
9	V		2L				
10	V		2S				
10	V		3L				
11	V		2S				
11	V		4L				
12	V		2S				
12	V		2L				
13	V		0S				
13	V		3L				
14	V		2S				
14	V		5L				

*Deployed 7-Dec-16



USACE New England District – Boston Harbor Fish Study
Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 13-Dec-16

Deployment [✓ Retrieval]

Start time: 0822

End time: 0845

Start Position X: 43 00 52.9 N

End Position X: 43 00 40.8 N

Start Position Y: 70 27 08.0 W

End Position Y: 70 27 17.3 W

Start Depth (m): 53.4

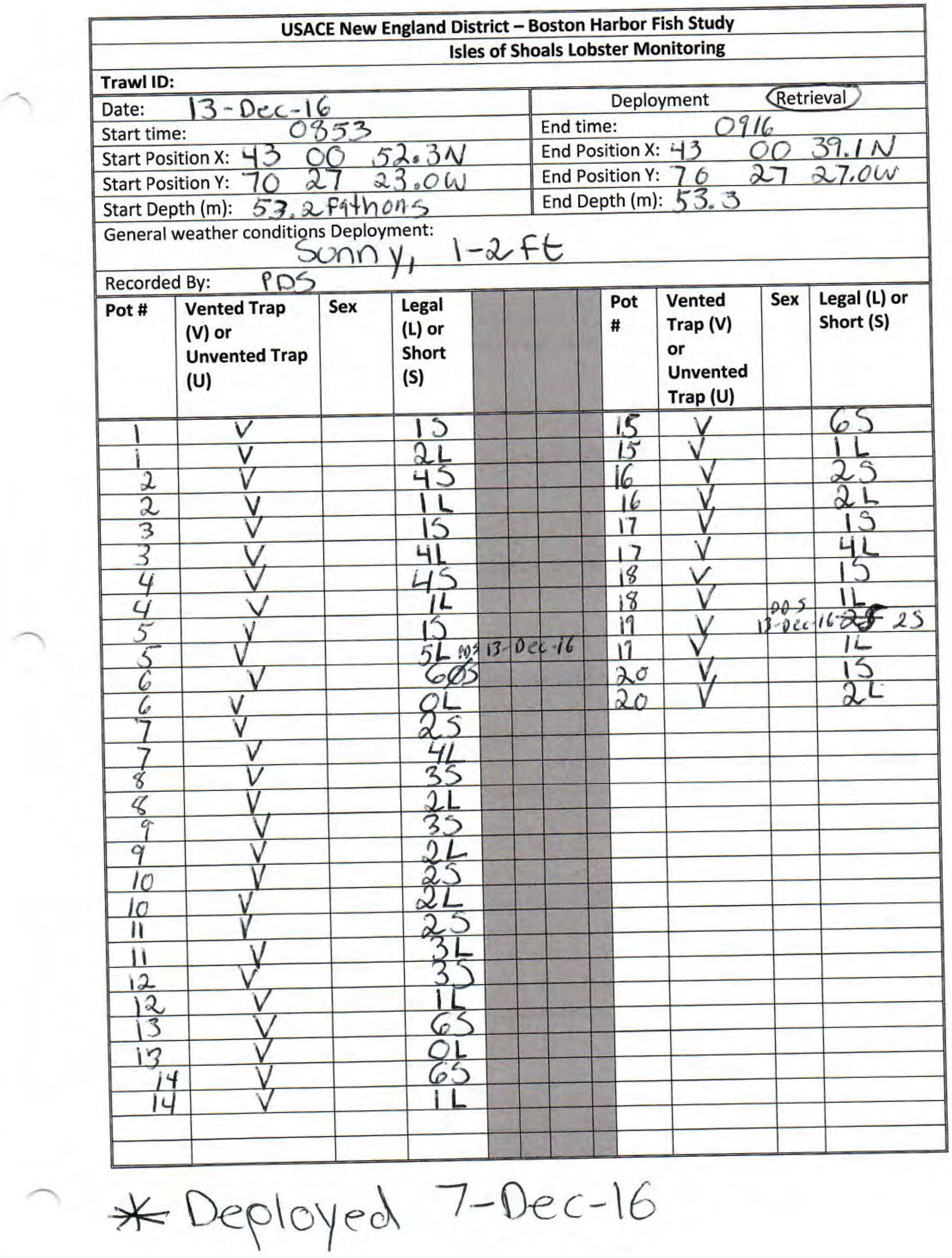
End Depth (m): 53.2 Fathoms

General weather conditions Deployment: sunny, 1-2 ft

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**	**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		1S	15	V		0S
1	V		1L	15	V		2L
2	V		2S	16	V		2S
2	V		4L	16	V		1L
3	V		0S	17	V		1S
3	V		2L	17	V		2L
4	V		1S	18	V		2S
4	V		1L	18	V		3L
5	V		0S	19	V		3S
5	V		1L	19	V		0L
6	V		0S	20	V		3S
6	V		3L	20	V		0L
7	V		3S				
7	V		1L				
8	V		3S				
8	V		2L				
9	V		1S				
9	V		1L				
10	V		3S				
10	V		2L				
11	V		4S				
11	V		1L				
12	V		1S				
12	V		2L				
13	V		1S				
13	V		0L				
14	V		5S				
14	V		1L				

* Deployed 7-Dec-16



USACE New England District – Boston Harbor Fish Study
Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 13-Dec-16
Start time: 0853
Start Position X: 43 00 52.3N
Start Position Y: 70 27 23.0W
Start Depth (m): 53.2 Fathons

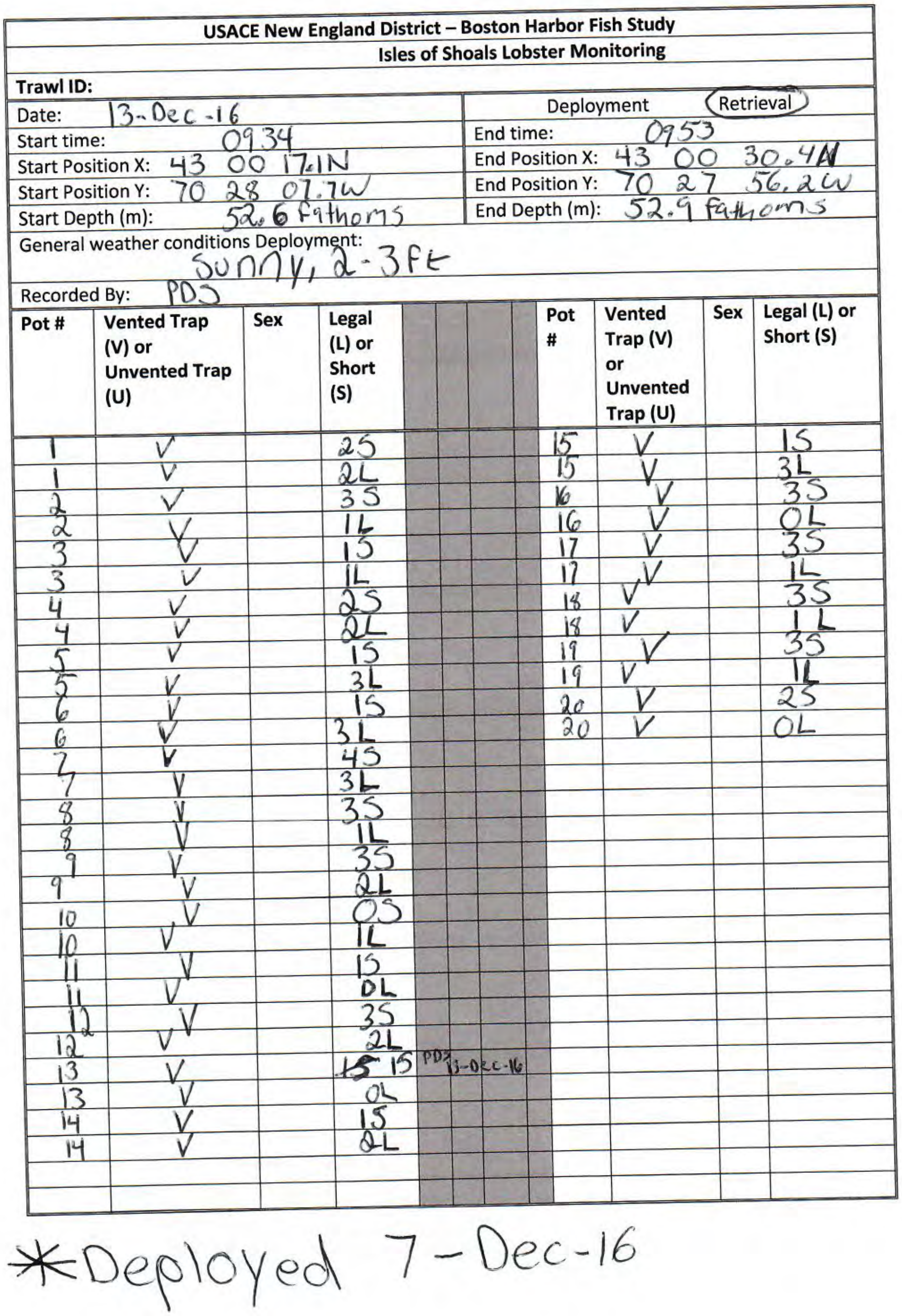
Deployment [✓ Retrieval]
End time: 0916
End Position X: 43 00 39.1N
End Position Y: 76 27 27.0W
End Depth (m): 53.3

General weather conditions Deployment: Sonny, 1-2 ft

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)	Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		1S	15	V		6S
1	V		2L	15	V		1L
2	V		4S	16	V		2S
2	V		1L	16	V		2L
3	V		1S	17	V		1S
3	V		4L	17	V		4L
4	V		4S	18	V		1S
4	V		1L	18	V		1L
5	V		1S	19	V	PDS 13-Dec-16	~~2S~~ 2S
5	V		5L PDS 13-Dec-16	17	V		1L
6	V		60S	20	V		1S
6	V		0L	20	V		2L
7	V		2S				
7	V		4L				
8	V		3S				
8	V		2L				
9	V		3S				
9	V		2L				
10	V		2S				
10	V		2L				
11	V		2S				
11	V		3L				
12	V		3S				
12	V		1L				
13	V		6S				
13	V		0L				
14	V		6S				
14	V		1L				

* Deployed 7-Dec-16



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

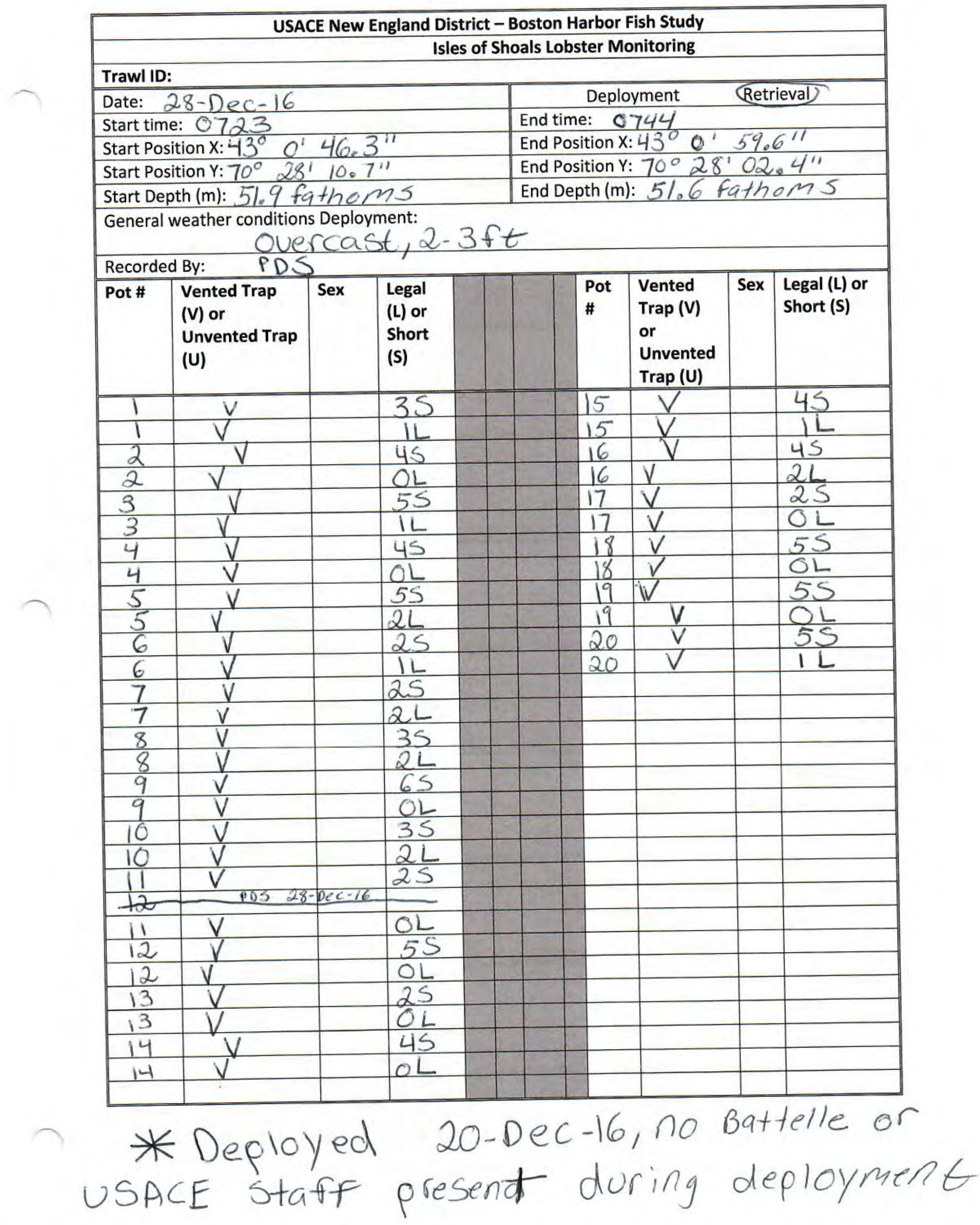
Date: 13-Dec-16	Deployment [✓ Retrieval]
Start time: 0934	End time: 0953
Start Position X: 43 00 17.1N	End Position X: 43 00 30.4N
Start Position Y: 70 28 07.7W	End Position Y: 70 27 56.2W
Start Depth (m): 52.6 fathoms	End Depth (m): 52.9 fathoms

General weather conditions Deployment: Sunny, 2-3ft

Recorded By: PDJ

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**	**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		2S	15	V		1S
1	V		2L	15	V		3L
2	V		3S	16	V		3S
2	V		1L	16	V		0L
3	V		1S	17	V		3S
3	V		1L	17	V		1L
4	V		2S	18	V		3S
4	V		2L	18	V		1L
5	V		1S	19	V		3S
5	V		3L	19	V		1L
6	V		1S	20	V		2S
6	V		3L	20	V		0L
7	V		4S				
7	V		3L				
8	V		3S				
8	V		1L				
9	V		3S				
9	V		2L				
10	V		0S				
10	V		1L				
11	V		1S				
11	V		0L				
12	V		3S				
12	V		2L				
13	V		~~1S~~ 1S PDJ 13-Dec-16				
13	V		0L				
14	V		1S				
14	V		2L				

*Deployed 7-Dec-16



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 28-Dec-16

Deployment [✓ Retrieval]

Start time: 0723

End time: 0744

Start Position X: 43° 0' 46.3"

End Position X: 43° 0' 59.6"

Start Position Y: 70° 28' 10.7"

End Position Y: 70° 28' 02.4"

Start Depth (m): 51.9 fathoms

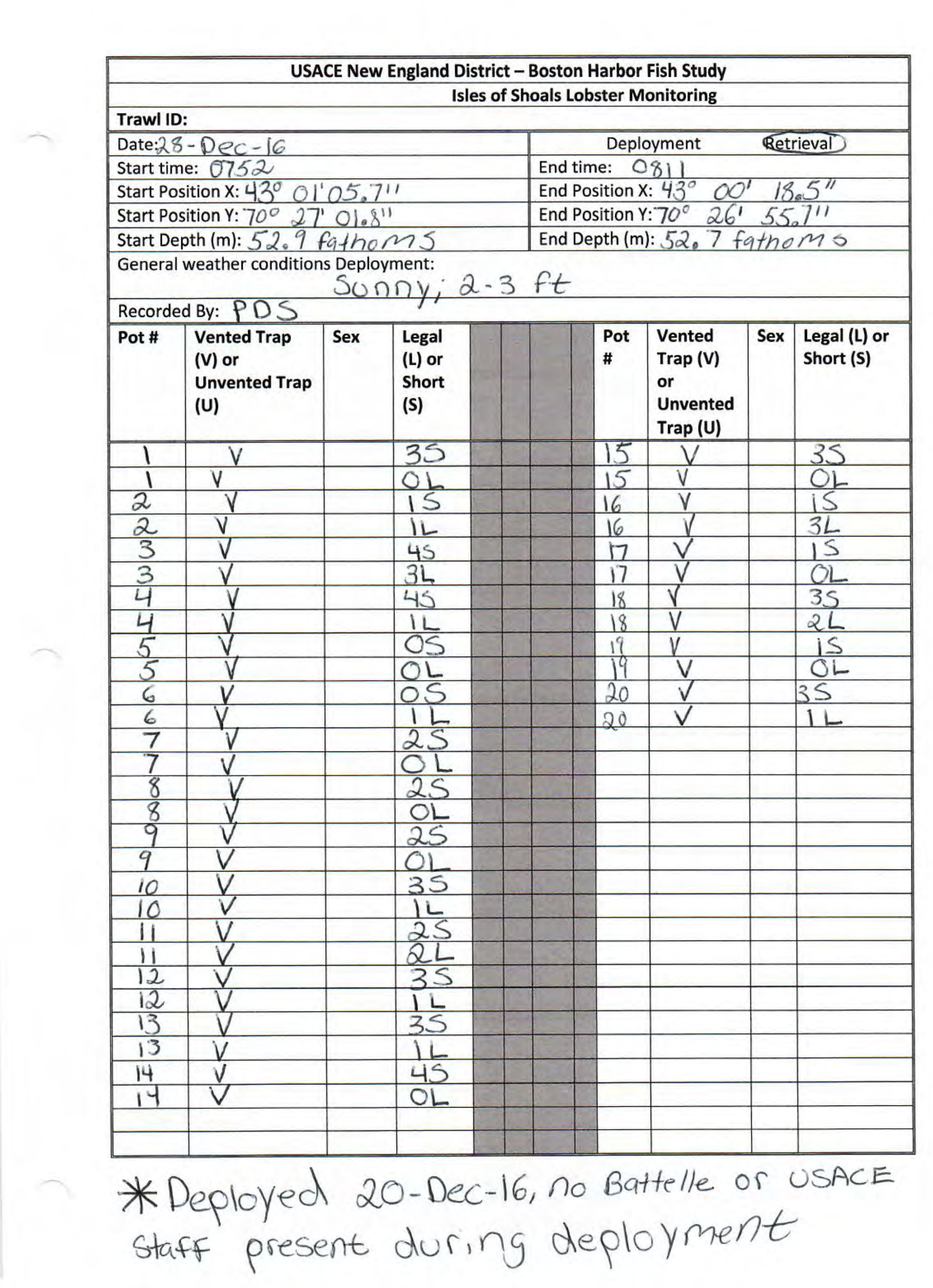
End Depth (m): 51.6 fathoms

General weather conditions Deployment: Overcast, 2-3ft

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		3S					15	V		4S
1	V		1L					15	V		1L
2	V		4S					16	V		4S
2	V		0L					16	V		2L
3	V		5S					17	V		2S
3	V		1L					17	V		0L
4	V		4S					18	V		5S
4	V		0L					18	V		0L
5	V		5S					19	V		5S
5	V		2L					19	V		0L
6	V		2S					20	V		5S
6	V		1L					20	V		1L
7	V		2S								
7	V		2L								
8	V		3S								
8	V		2L								
9	V		6S								
9	V		0L								
10	V		3S								
10	V		2L								
11	V		2S								
~~12~~	PDS 28-Dec-16										
11	V		0L								
12	V		5S								
12	V		0L								
13	V		2S								
13	V		0L								
14	V		4S								
14	V		0L								

* Deployed 20-Dec-16, no Battelle or USACE staff present during deployment



USACE New England District – Boston Harbor Fish Study

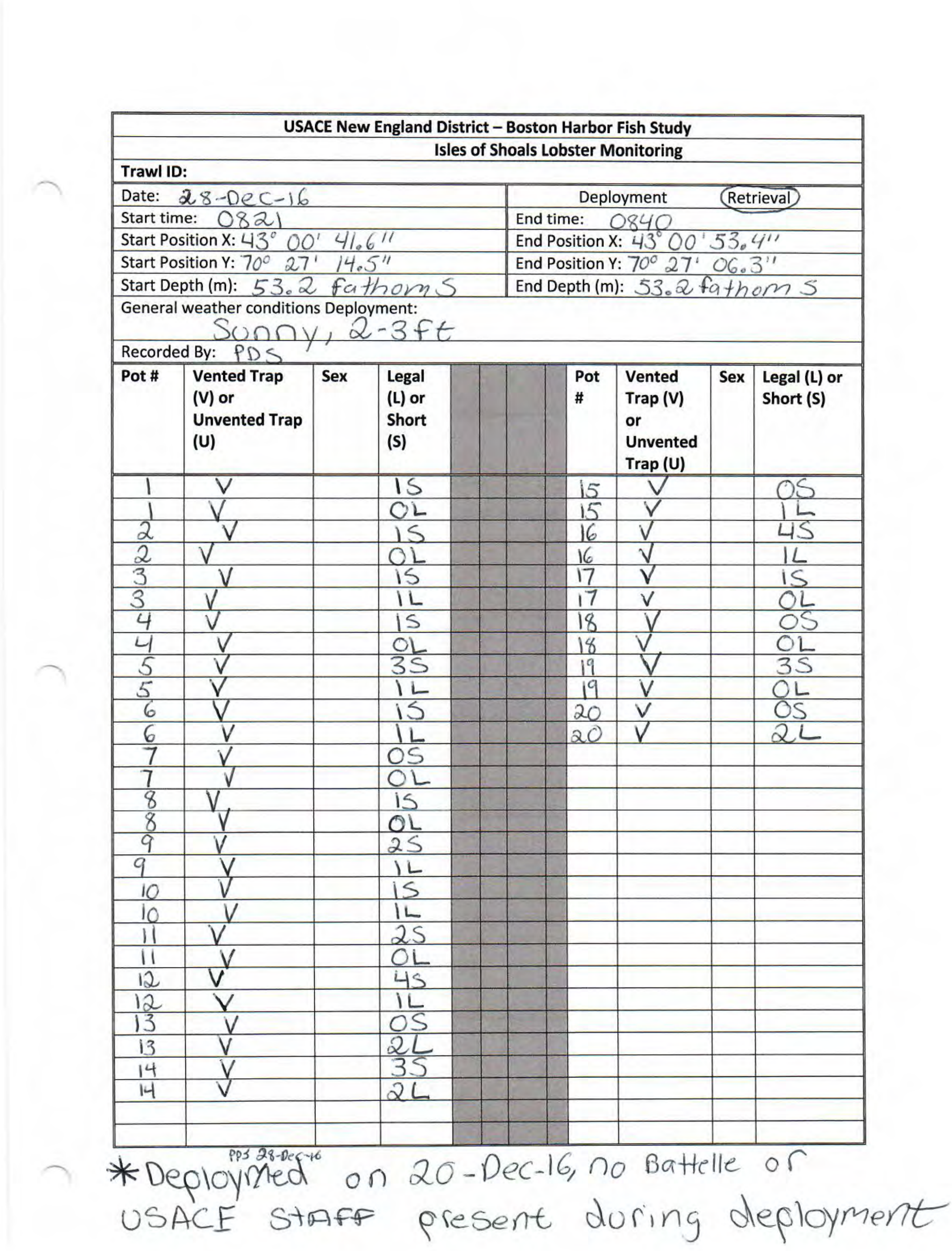
Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 28-Dec-16
Deployment [✓ Retrieval]
Start time: 0752
End time: 0811
Start Position X: 43° 01'05.7''
End Position X: 43° 00' 18.5"
Start Position Y: 70° 27' 01.8''
End Position Y: 70° 26' 55.7''
Start Depth (m): 52.9 fathoms
End Depth (m): 52.7 fathoms
General weather conditions Deployment: Sonny; 2-3 ft
Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		3S					15	V		3S
1	V		0L					15	V		0L
2	V		1S					16	V		1S
2	V		1L					16	V		3L
3	V		4S					17	V		1S
3	V		3L					17	V		0L
4	V		4S					18	V		3S
4	V		1L					18	V		2L
5	V		0S					19	V		1S
5	V		0L					19	V		0L
6	V		0S					20	V		3S
6	V		1L					20	V		1L
7	V		2S								
7	V		0L								
8	V		2S								
8	V		0L								
9	V		2S								
9	V		0L								
10	V		3S								
10	V		1L								
11	V		2S								
11	V		2L								
12	V		3S								
12	V		1L								
13	V		3S								
13	V		1L								
14	V		4S								
14	V		0L								

* Deployed 20-Dec-16, no Battelle or USACE staff present during deployment



USACE New England District – Boston Harbor Fish Study

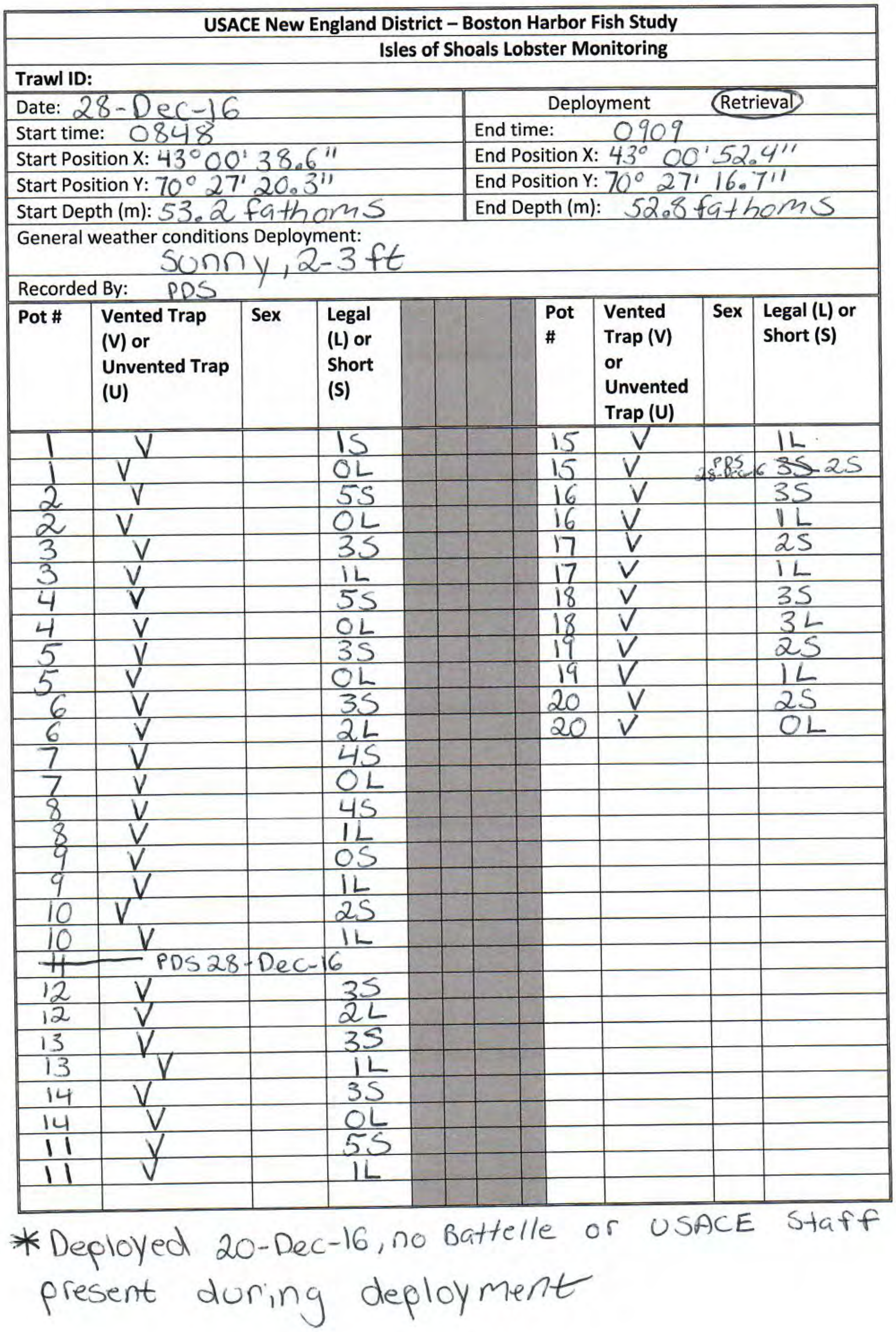
Isles of Shoals Lobster Monitoring

Trawl ID:	
Date: 28-Dec-16	Deployment [✓ Retrieval]
Start time: 0821	End time: 0840
Start Position X: 43° 00' 41.6''	End Position X: 43° 00' 53.4''
Start Position Y: 70° 27' 14.5''	End Position Y: 70° 27' 06.3''
Start Depth (m): 53.2 fathoms	End Depth (m): 53.2 fathoms
General weather conditions Deployment: Sunny, 2-3ft	
Recorded By: PDS	

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)				Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		1S				15	V		0S
1	V		0L				15	V		1L
2	V		1S				16	V		4S
2	V		0L				16	V		1L
3	V		1S				17	V		1S
3	V		1L				17	V		0L
4	V		1S				18	V		0S
4	V		0L				18	V		0L
5	V		3S				19	V		3S
5	V		1L				19	V		0L
6	V		1S				20	V		0S
6	V		1L				20	V		2L
7	V		0S							
7	V		0L							
8	V		1S							
8	V		0L							
9	V		2S							
9	V		1L							
10	V		1S							
10	V		1L							
11	V		2S							
11	V		0L							
12	V		4S							
12	V		1L							
13	V		0S							
13	V		2L							
14	V		3S							
14	V		2L							

PPS 28-Dec-16

*Deployed on 20-Dec-16, no Battelle or USACE staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 28-Dec-16

Deployment [✓ Retrieval]

Start time: 0848

End time: 0909

Start Position X: 43°00' 38.6"

End Position X: 43° 00' 52.4"

Start Position Y: 70° 27' 20.3"

End Position Y: 70° 27' 16.7"

Start Depth (m): 53.2 fathoms

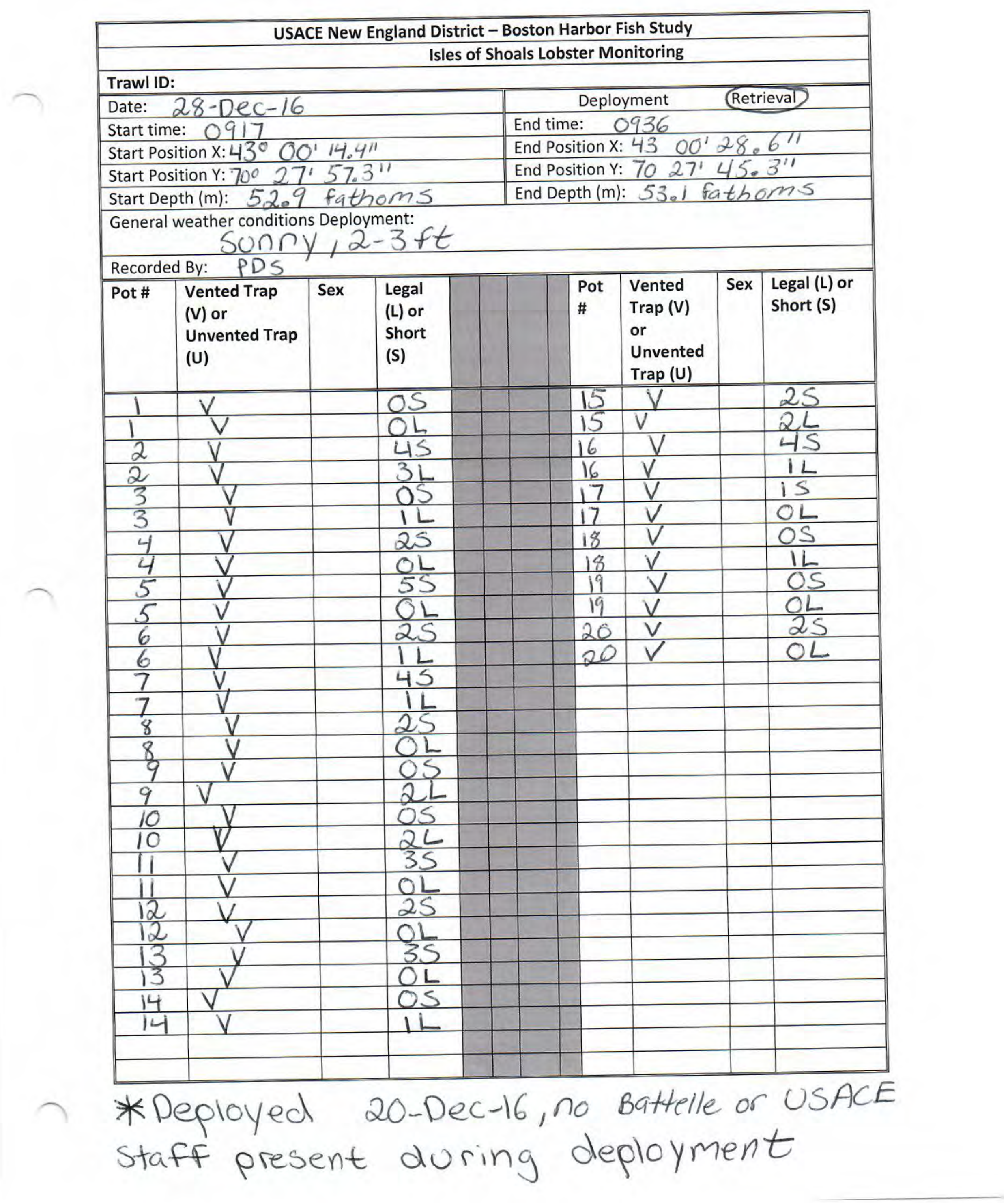
End Depth (m): 52.8 fathoms

General weather conditions Deployment: Sunny, 2-3 ft

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		1S					15	V		1L
1	V		0L					15	V	PDS 28-Dec-16	~~3S~~ 2S
2	V		5S					16	V		3S
2	V		0L					16	V		1L
3	V		3S					17	V		2S
3	V		1L					17	V		1L
4	V		5S					18	V		3S
4	V		0L					18	V		3L
5	V		3S					19	V		2S
5	V		0L					19	V		1L
6	V		3S					20	V		2S
6	V		2L					20	V		0L
7	V		4S								
7	V		0L								
8	V		4S								
8	V		1L								
9	V		0S								
9	V		1L								
10	V		2S								
10	V		1L								
~~11~~	PDS 28-Dec-16										
12	V		3S								
12	V		2L								
13	V		3S								
13	V		1L								
14	V		3S								
14	V		0L								
11	V		5S								
11	V		1L								

*Deployed 20-Dec-16, no Battelle or USACE Staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 28-Dec-16

Start time: 0917

Start Position X: 43° 00' 14.4"

Start Position Y: 70° 27' 57.3"

Start Depth (m): 52.9 fathoms

Deployment [✓ Retrieval]

End time: 0936

End Position X: 43 00' 28.6"

End Position Y: 70 27' 45.3"

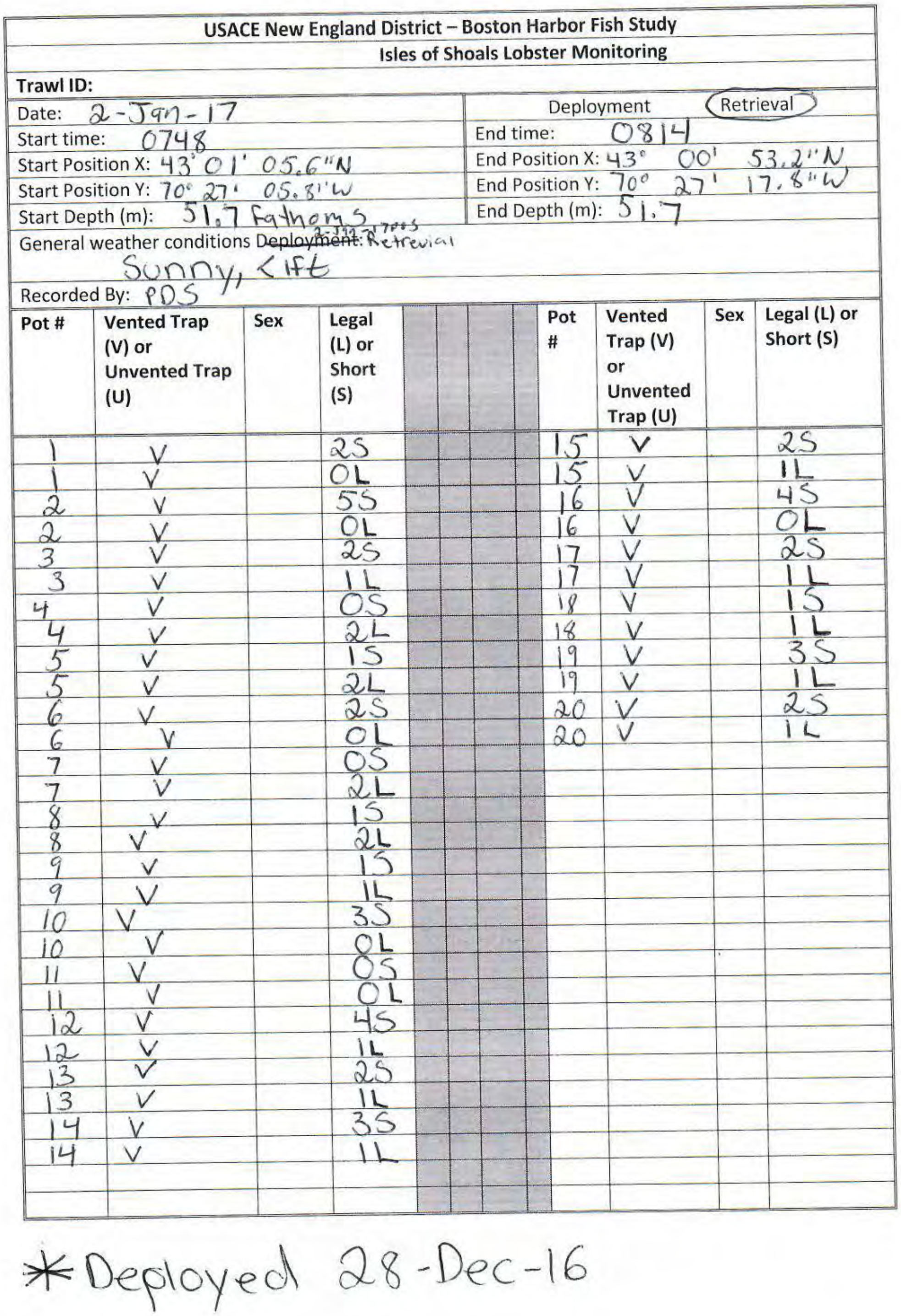
End Depth (m): 53.1 fathoms

General weather conditions Deployment: Sonny, 2-3ft

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**	▨	▨	▨	▨	**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		0S					15	V		2S
1	V		0L					15	V		2L
2	V		4S					16	V		4S
2	V		3L					16	V		1L
3	V		0S					17	V		1S
3	V		1L					17	V		0L
4	V		2S					18	V		0S
4	V		0L					18	V		1L
5	V		5S					19	V		0S
5	V		0L					19	V		0L
6	V		2S					20	V		2S
6	V		1L					20	V		0L
7	V		4S								
7	V		1L								
8	V		2S								
8	V		0L								
9	V		0S								
9	V		2L								
10	V		0S								
10	V		2L								
11	V		3S								
11	V		0L								
12	V		2S								
12	V		0L								
13	V		3S								
13	V		0L								
14	V		0S								
14	V		1L								

*Deployed 20-Dec-16, no Battelle or USACE Staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 2-Jan-17

Start time: 0748

Start Position X: 43° 01' 05.6"N

Start Position Y: 70° 27' 05.8"W

Start Depth (m): 51.7 Fathoms

Deployment [✓ Retrieval]

End time: 0814

End Position X: 43° 00' 53.2"N

End Position Y: 70° 27' 17.8"W

End Depth (m): 51.7

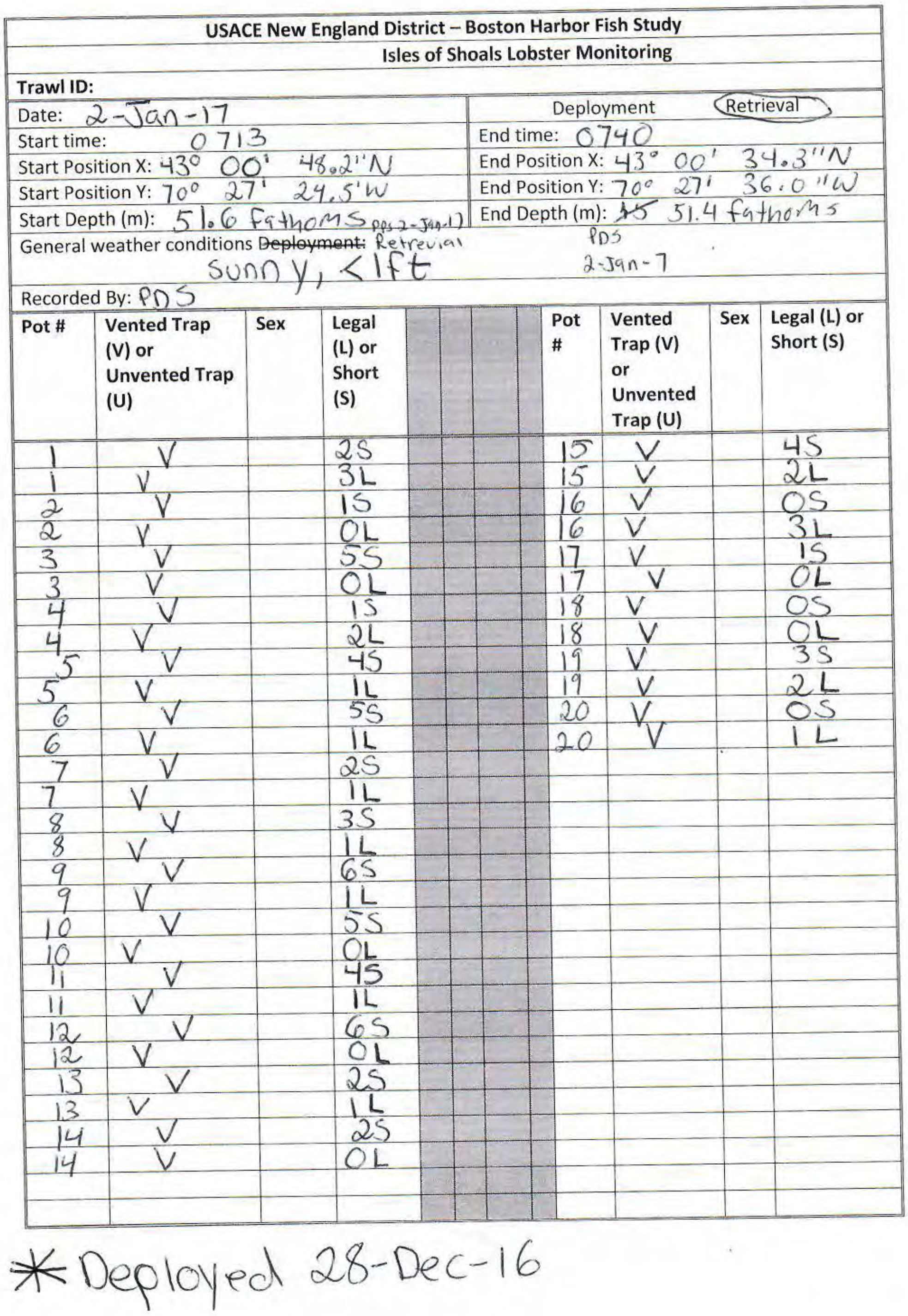
General weather conditions ~~Deployment~~: Retrieval 2-Jan-17 PDS

Sunny, <1ft

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)					Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		2S					15	V		2S
1	V		0L					15	V		1L
2	V		5S					16	V		4S
2	V		0L					16	V		0L
3	V		2S					17	V		2S
3	V		1L					17	V		1L
4	V		0S					18	V		1S
4	V		2L					18	V		1L
5	V		1S					19	V		3S
5	V		2L					19	V		1L
6	V		2S					20	V		2S
6	V		0L					20	V		1L
7	V		0S								
7	V		2L								
8	V		1S								
8	V		2L								
9	V		1S								
9	V		1L								
10	V		3S								
10	V		0L								
11	V		0S								
11	V		0L								
12	V		4S								
12	V		1L								
13	V		2S								
13	V		1L								
14	V		3S								
14	V		1L								

*Deployed 28-Dec-16



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 2-Jan-17

Deployment [✓ Retrieval]

Start time: 0713

End time: 0740

Start Position X: 43° 00' 48.2''N

End Position X: 43° 00' 34.3''N

Start Position Y: 70° 27' 24.5'W

End Position Y: 70° 27' 36.0''W

Start Depth (m): 51.6 fathoms PDS 2-Jan-17

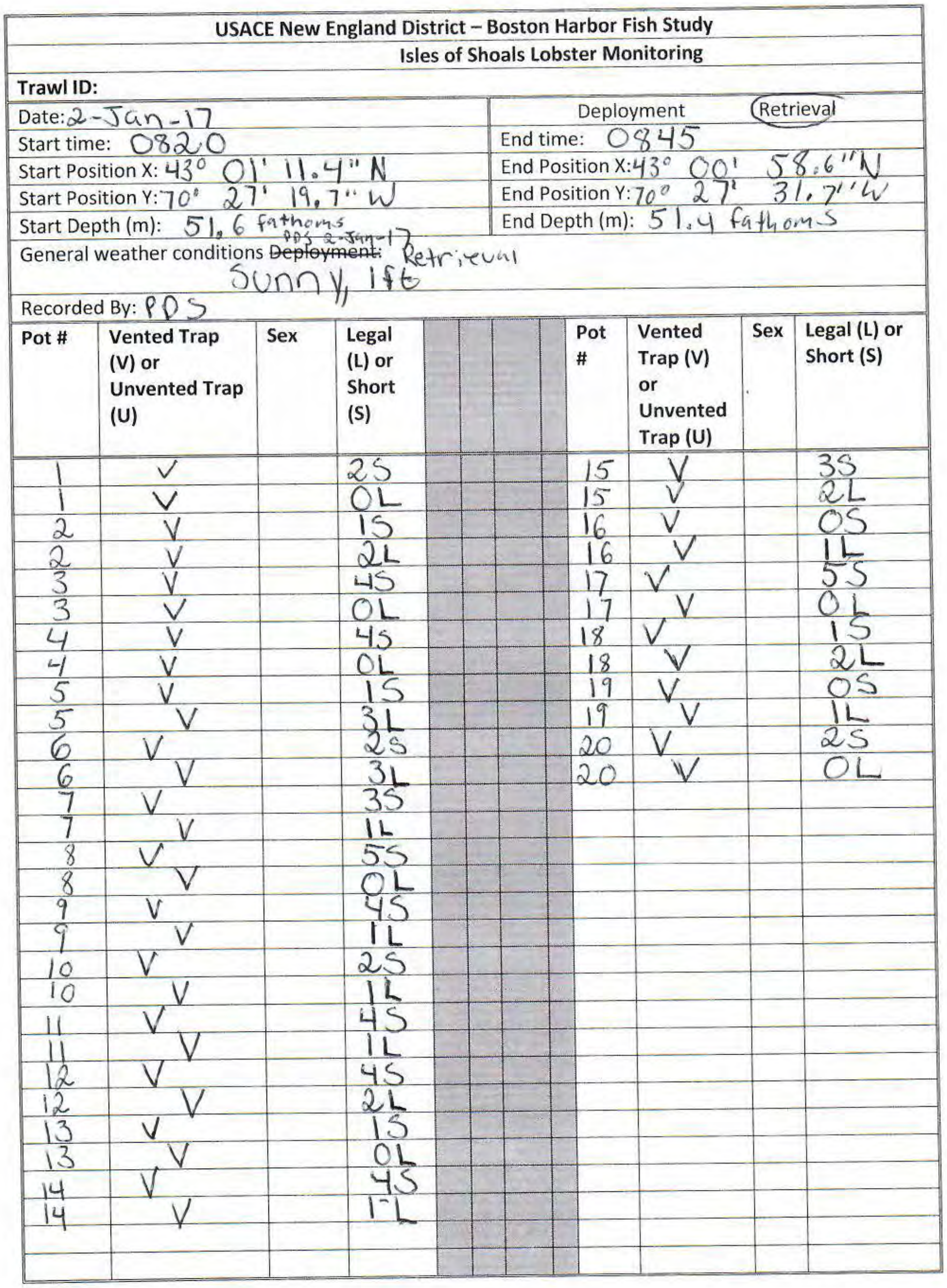
End Depth (m): ~~15~~ 51.4 fathoms PDS 2-Jan-7

General weather conditions ~~Deployment:~~ Retrieval sunny, <1ft

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		2S					15	V		4S
1	V		3L					15	V		2L
2	V		1S					16	V		0S
2	V		0L					16	V		3L
3	V		5S					17	V		1S
3	V		0L					17	V		0L
4	V		1S					18	V		0S
4	V		2L					18	V		0L
5	V		4S					19	V		3S
5	V		1L					19	V		2L
6	V		5S					20	V		0S
6	V		1L					20	V		1L
7	V		2S								
7	V		1L								
8	V		3S								
8	V		1L								
9	V		6S								
9	V		1L								
10	V		5S								
10	V		0L								
11	V		4S								
11	V		1L								
12	V		6S								
12	V		0L								
13	V		2S								
13	V		1L								
14	V		2S								
14	V		0L								

*Deployed 28-Dec-16



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

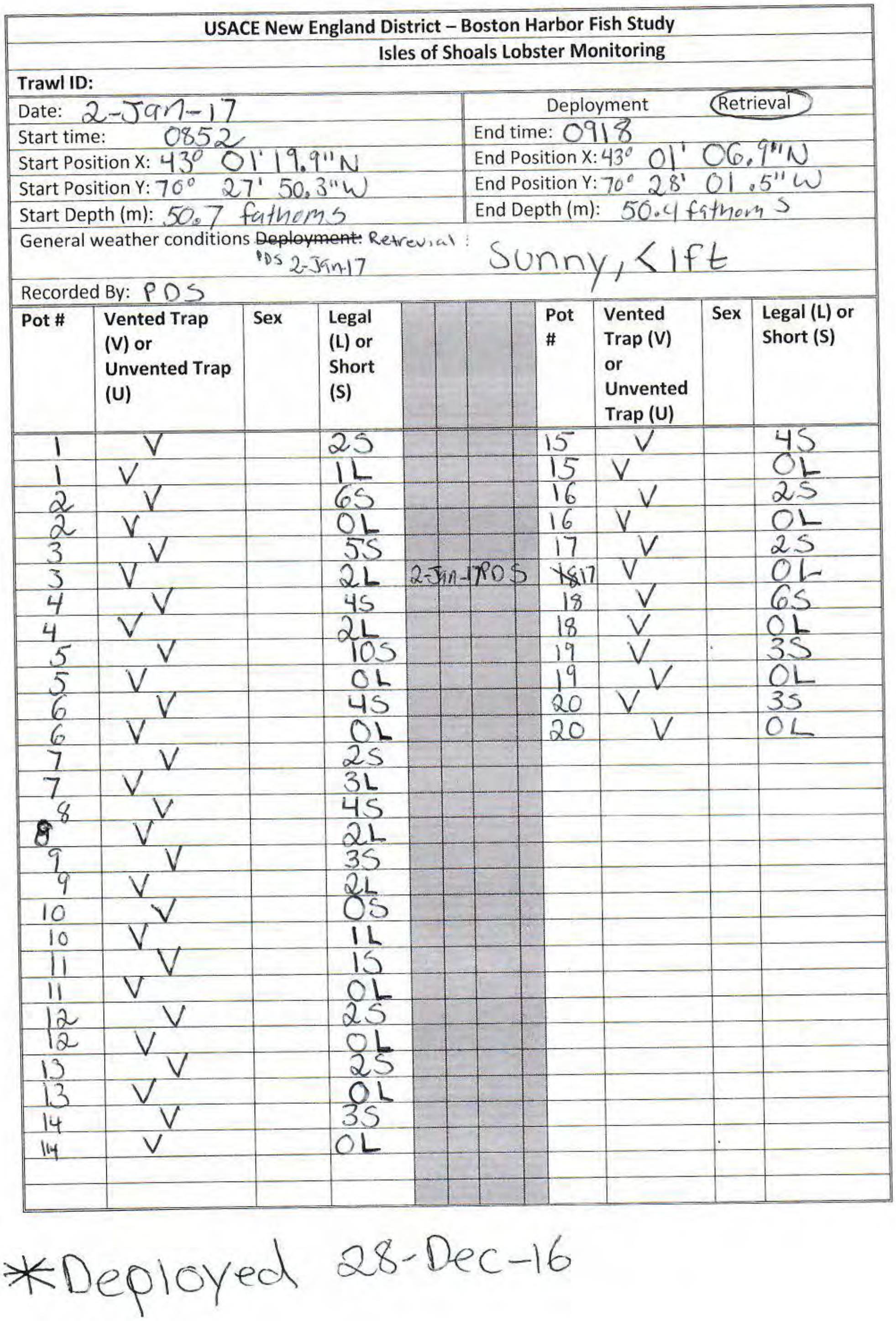
Date: 2-Jan-17	Deployment [✓ Retrieval]
Start time: 0820	End time: 0845
Start Position X: 43° 01' 11.4" N	End Position X: 43° 00' 58.6" N
Start Position Y: 70° 27' 19.7" W	End Position Y: 70° 27' 31.7" W
Start Depth (m): 51.6 fathoms	End Depth (m): 51.4 fathoms

General weather conditions ~~Deployment:~~ PDS 2-Jan-17 Retrieval
Sunny, 1ft

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**	**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		2S	15	V		3S
1	V		0L	15	V		2L
2	V		1S	16	V		0S
2	V		2L	16	V		1L
3	V		4S	17	V		5S
3	V		0L	17	V		0L
4	V		4S	18	V		1S
4	V		0L	18	V		2L
5	V		1S	19	V		0S
5	V		3L	19	V		1L
6	V		2S	20	V		2S
6	V		3L	20	V		0L
7	V		3S				
7	V		1L				
8	V		5S				
8	V		0L				
9	V		4S				
9	V		1L				
10	V		2S				
10	V		1L				
11	V		4S				
11	V		1L				
12	V		4S				
12	V		2L				
13	V		1S				
13	V		0L				
14	V		4S				
14	V		1L				

*Deployed 28-Dec-16



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 2-Jan-17

Start time: 0852

Start Position X: 43° 01' 19.9"N

Start Position Y: 70° 27' 50.3"W

Start Depth (m): 50.7 fathoms

Deployment [✓ Retrieval]

End time: 0918

End Position X: 43° 01' 06.9"N

End Position Y: 70° 28' 01.5" W

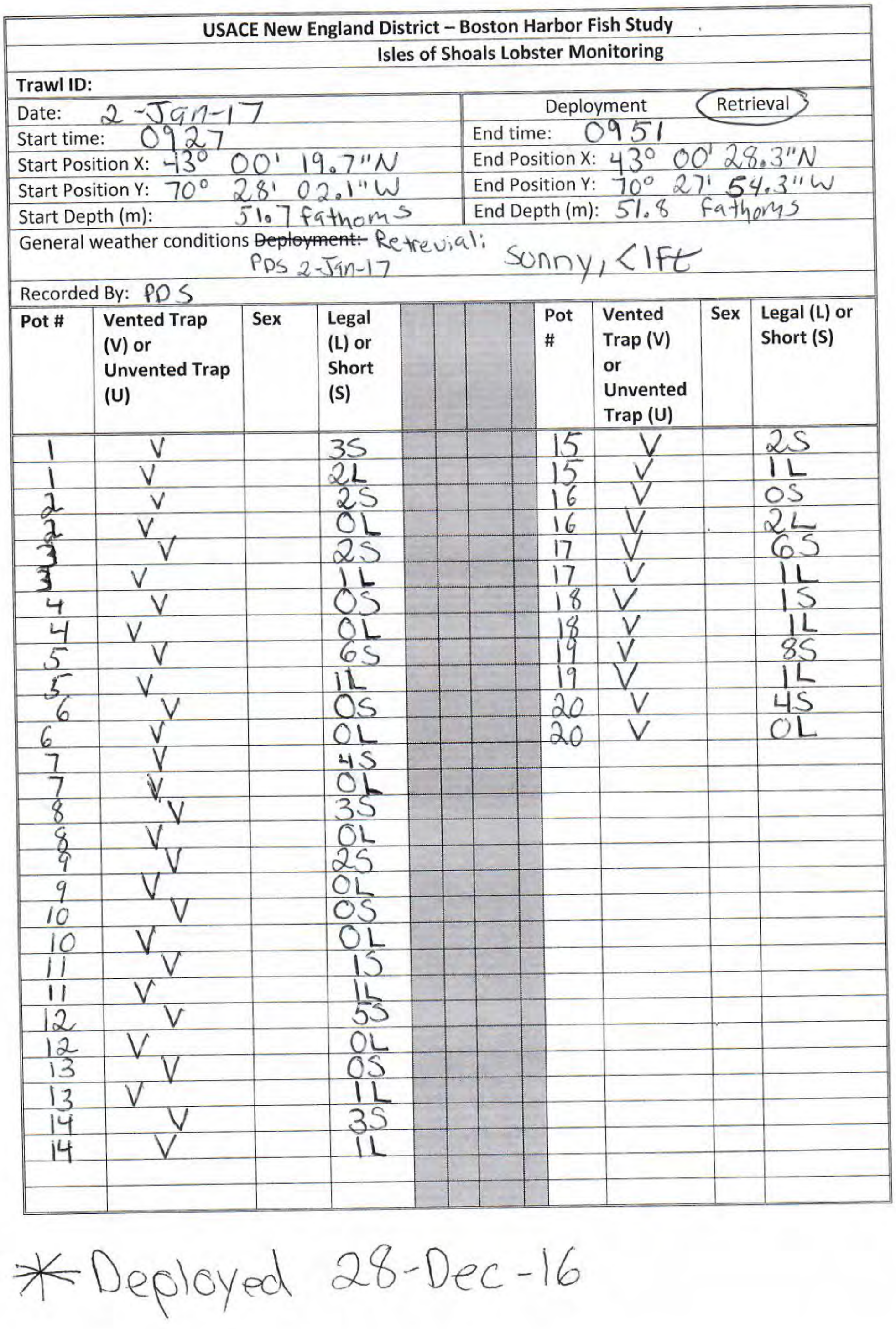
End Depth (m): 50.4 fathoms

General weather conditions ~~Deployment:~~ Retrieval : PDS 2-Jan-17 Sunny, <1ft

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		2S					15	V		4S
1	V		1L					15	V		0L
2	V		6S					16	V		2S
2	V		0L					16	V		0L
3	V		5S					17	V		2S
3	V		2L	2-Jan-17 PDS				~~18~~17	V		0L
4	V		4S					18	V		6S
4	V		2L					18	V		0L
5	V		10S					19	V		3S
5	V		0L					19	V		0L
6	V		4S					20	V		3S
6	V		0L					20	V		0L
7	V		2S								
7	V		3L								
8	V		4S								
8	V		2L								
9	V		3S								
9	V		2L								
10	V		0S								
10	V		1L								
11	V		1S								
11	V		0L								
12	V		2S								
12	V		0L								
13	V		2S								
13	V		0L								
14	V		3S								
14	V		0L								

*Deployed 28-Dec-16



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

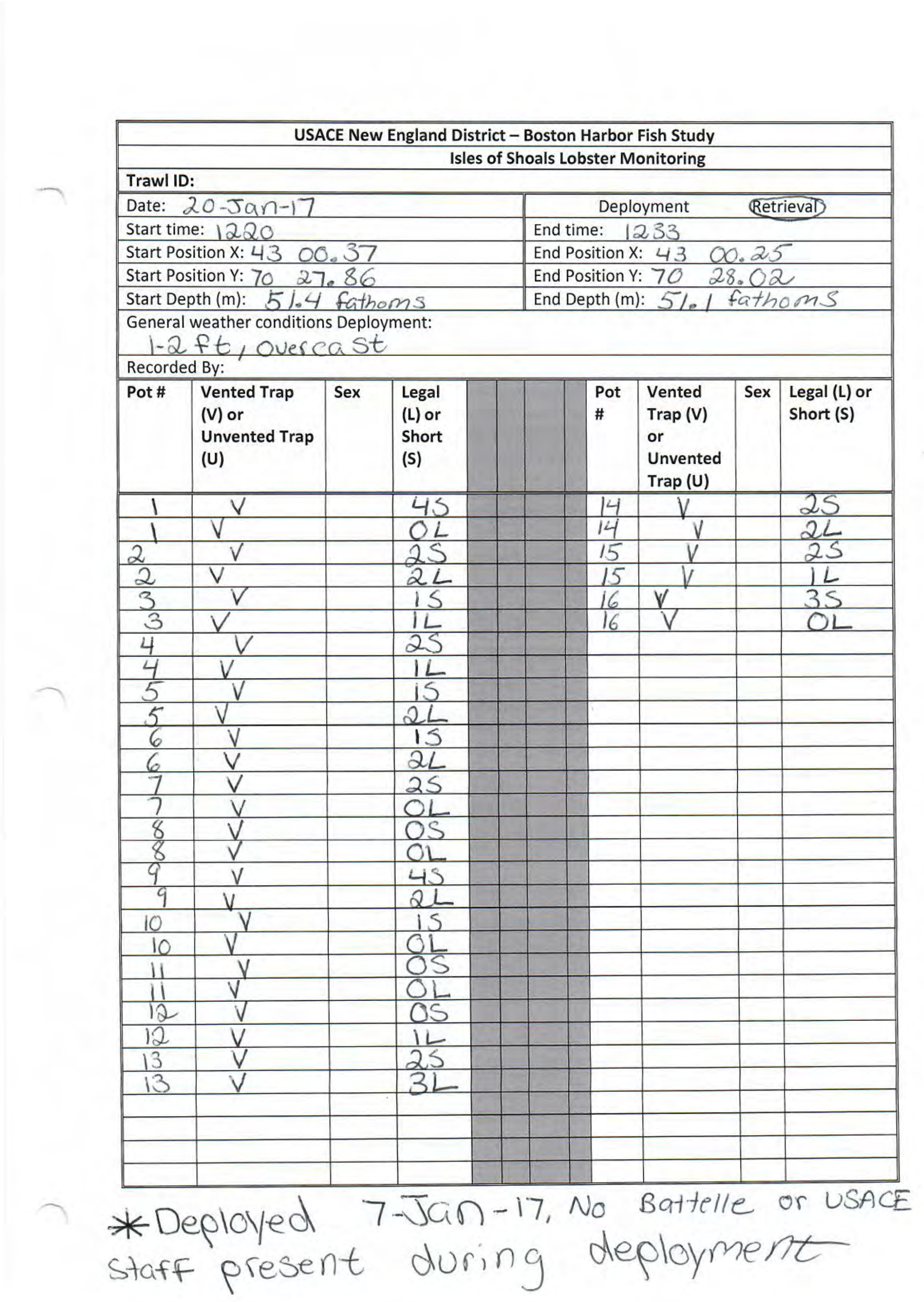
Date: 2-Jan-17	Deployment [✓ Retrieval]
Start time: 0927	End time: 0951
Start Position X: 43° 00' 19.7"N	End Position X: 43° 00' 28.3"N
Start Position Y: 70° 28' 02.1"W	End Position Y: 70° 27' 54.3"W
Start Depth (m): 51.7 fathoms	End Depth (m): 51.8 fathoms

General weather conditions ~~Deployment:~~ Retrevial: Sunny, <1ft
PDS 2-Jan-17

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		3S					15	V		2S
1	V		2L					15	V		1L
2	V		2S					16	V		0S
2	V		0L					16	V		2L
3	V		2S					17	V		6S
3	V		1L					17	V		1L
4	V		0S					18	V		1S
4	V		0L					18	V		1L
5	V		6S					19	V		8S
5	V		1L					19	V		1L
6	V		0S					20	V		4S
6	V		0L					20	V		0L
7	V		4S								
7	V		0L								
8	V		3S								
8	V		0L								
9	V		2S								
9	V		0L								
10	V		0S								
10	V		0L								
11	V		1S								
11	V		1L								
12	V		5S								
12	V		0L								
13	V		0S								
13	V		1L								
14	V		3S								
14	V		1L								

*Deployed 28-Dec-16



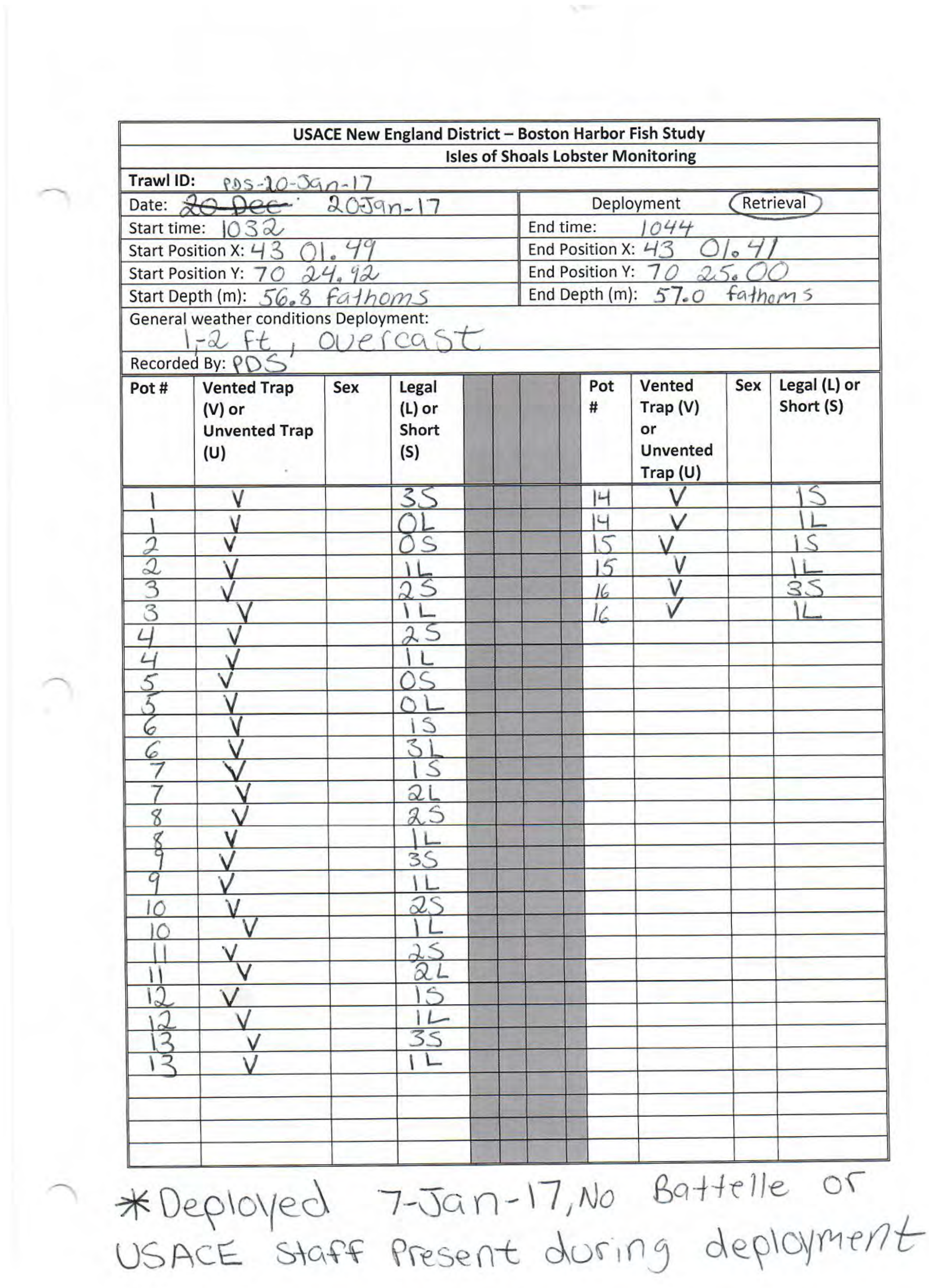
USACE New England District – Boston Harbor Fish Study
Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 20-Jan-17
Deployment [✓ Retrieval]
Start time: 1220
End time: 1233
Start Position X: 43 00.37
End Position X: 43 00.25
Start Position Y: 70 27.86
End Position Y: 70 28.02
Start Depth (m): 51.4 fathoms
End Depth (m): 51.1 fathoms
General weather conditions Deployment: 1-2 ft, overcast
Recorded By:

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**	**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		4S	14	V		2S
1	V		0L	14	V		2L
2	V		2S	15	V		2S
2	V		2L	15	V		1L
3	V		1S	16	V		3S
3	V		1L	16	V		0L
4	V		2S				
4	V		1L				
5	V		1S				
5	V		2L				
6	V		1S				
6	V		2L				
7	V		2S				
7	V		0L				
8	V		0S				
8	V		0L				
9	V		4S				
9	V		2L				
10	V		1S				
10	V		0L				
11	V		0S				
11	V		0L				
12	V		0S				
12	V		1L				
13	V		2S				
13	V		3L				

*Deployed 7-Jan-17, No Battelle or USACE staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID: PDS-20-Jan-17

Date: ~~20 Dec~~ 20Jan-17

Deployment [✓ Retrieval]

Start time: 1032

End time: 1044

Start Position X: 43 01.49

End Position X: 43 01.41

Start Position Y: 70 24.92

End Position Y: 70 25.00

Start Depth (m): 56.8 fathoms

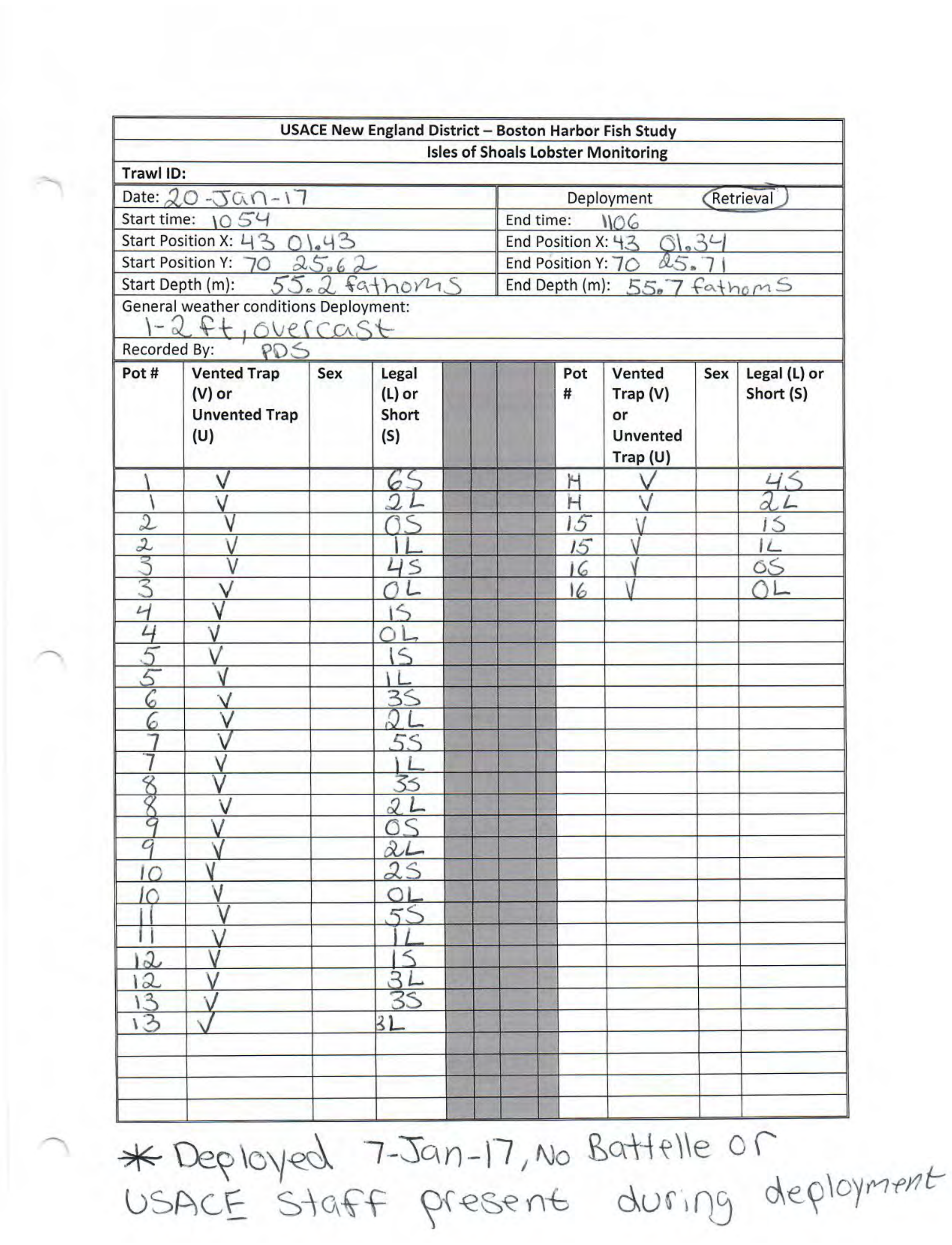
End Depth (m): 57.0 fathoms

General weather conditions Deployment: 1-2 ft, overcast

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)	Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		3S	14	V		1S
1	V		0L	14	V		1L
2	V		0S	15	V		1S
2	V		1L	15	V		1L
3	V		2S	16	V		3S
3	V		1L	16	V		1L
4	V		2S				
4	V		1L				
5	V		0S				
5	V		0L				
6	V		1S				
6	V		3L				
7	V		1S				
7	V		2L				
8	V		2S				
8	V		1L				
9	V		3S				
9	V		1L				
10	V		2S				
10	V		1L				
11	V		2S				
11	V		2L				
12	V		1S				
12	V		1L				
13	V		3S				
13	V		1L				

*Deployed 7-Jan-17, No Battelle or USACE staff present during deployment



USACE New England District – Boston Harbor Fish Study

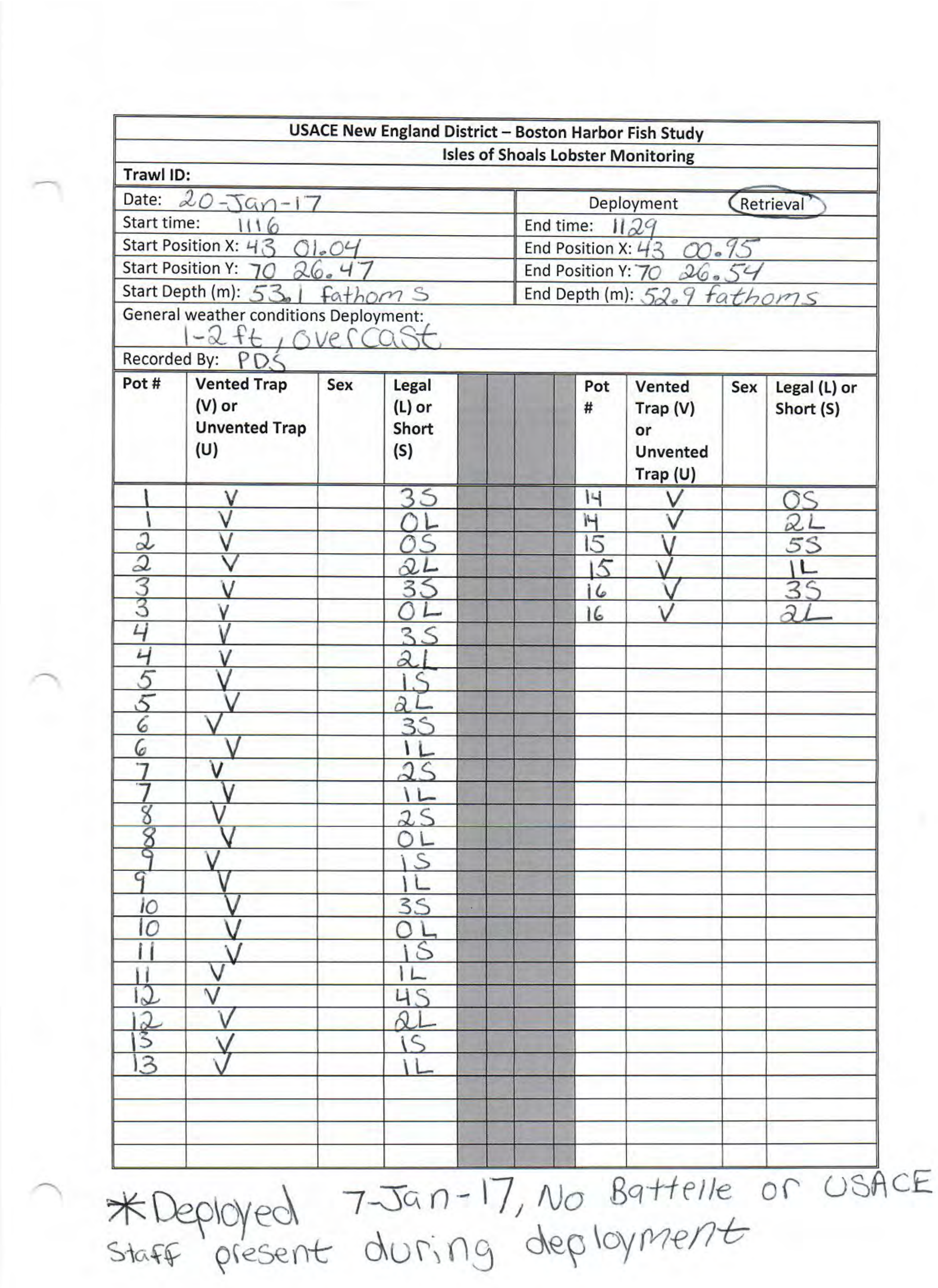
Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 20-Jan-17
Deployment [✓ Retrieval]
Start time: 1054
End time: 1106
Start Position X: 43 01.43
End Position X: 43 01.34
Start Position Y: 70 25.62
End Position Y: 70 25.71
Start Depth (m): 55.2 fathoms
End Depth (m): 55.7 fathoms
General weather conditions Deployment: 1-2 ft, overcast
Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		6S					H	V		4S
1	V		2L					H	V		2L
2	V		0S					15	V		1S
2	V		1L					15	V		1L
3	V		4S					16	V		0S
3	V		0L					16	V		0L
4	V		1S								
4	V		0L								
5	V		1S								
5	V		1L								
6	V		3S								
6	V		2L								
7	V		5S								
7	V		1L								
8	V		3S								
8	V		2L								
9	V		0S								
9	V		2L								
10	V		2S								
10	V		0L								
11	V		5S								
11	V		1L								
12	V		1S								
12	V		3L								
13	V		3S								
13	V		3L								

* Deployed 7-Jan-17, No Battelle or USACE staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 20-Jan-17

Deployment [✓ Retrieval]

Start time: 1116

End time: 1129

Start Position X: 43 01.04

End Position X: 43 00.95

Start Position Y: 70 26.47

End Position Y: 70 26.54

Start Depth (m): 53.1 fathoms

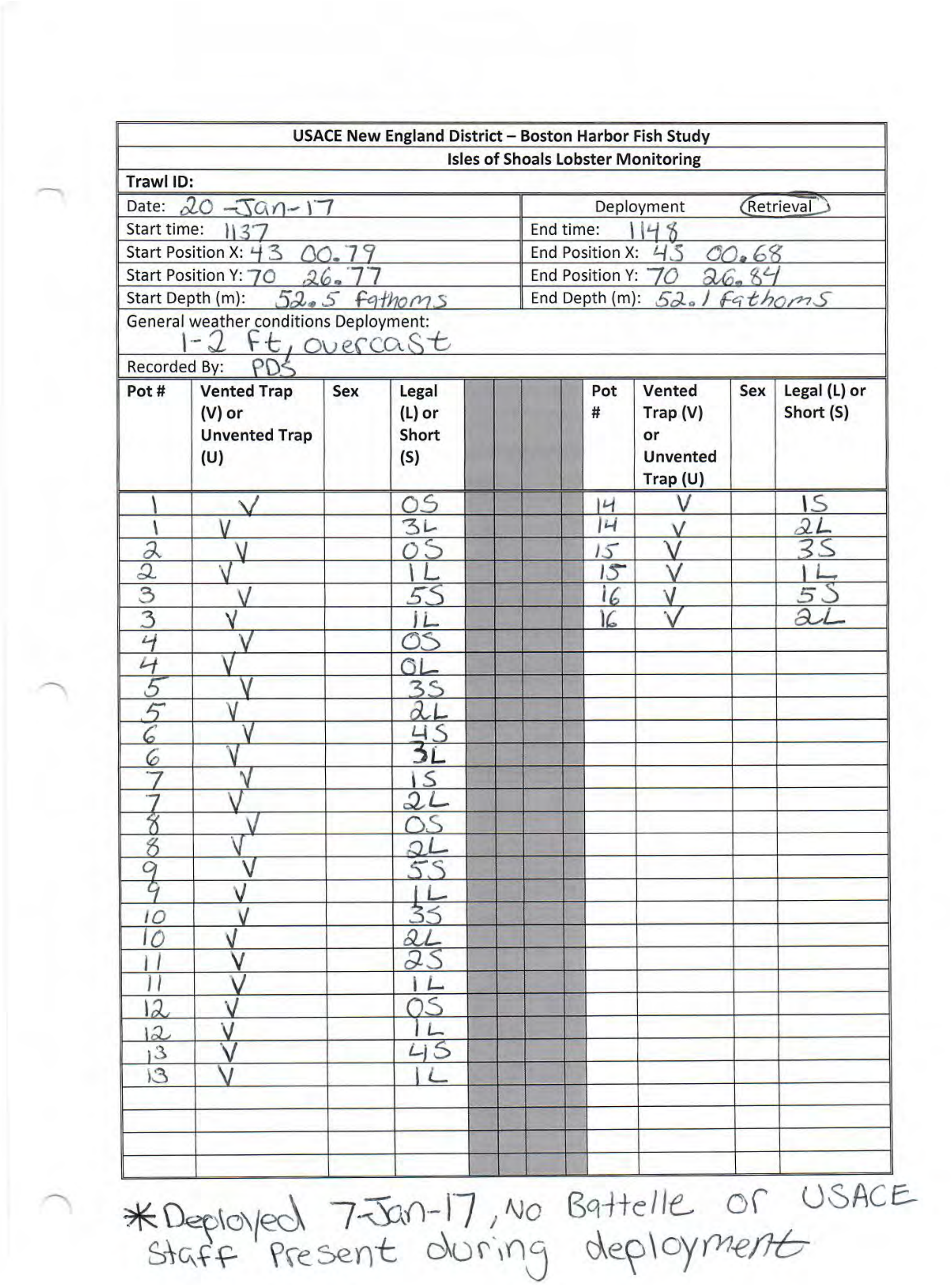
End Depth (m): 52.9 fathoms

General weather conditions Deployment: 1-2 ft, overcast

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)	Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		3S	14	V		0S
1	V		0L	14	V		2L
2	V		0S	15	V		5S
2	V		2L	15	V		1L
3	V		3S	16	V		3S
3	V		0L	16	V		2L
4	V		3S				
4	V		2L				
5	V		1S				
5	V		2L				
6	V		3S				
6	V		1L				
7	V		2S				
7	V		1L				
8	V		2S				
8	V		0L				
9	V		1S				
9	V		1L				
10	V		3S				
10	V		0L				
11	V		1S				
11	V		1L				
12	V		4S				
12	V		2L				
13	V		1S				
13	V		1L				

*Deployed 7-Jan-17, No Battelle or USACE staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

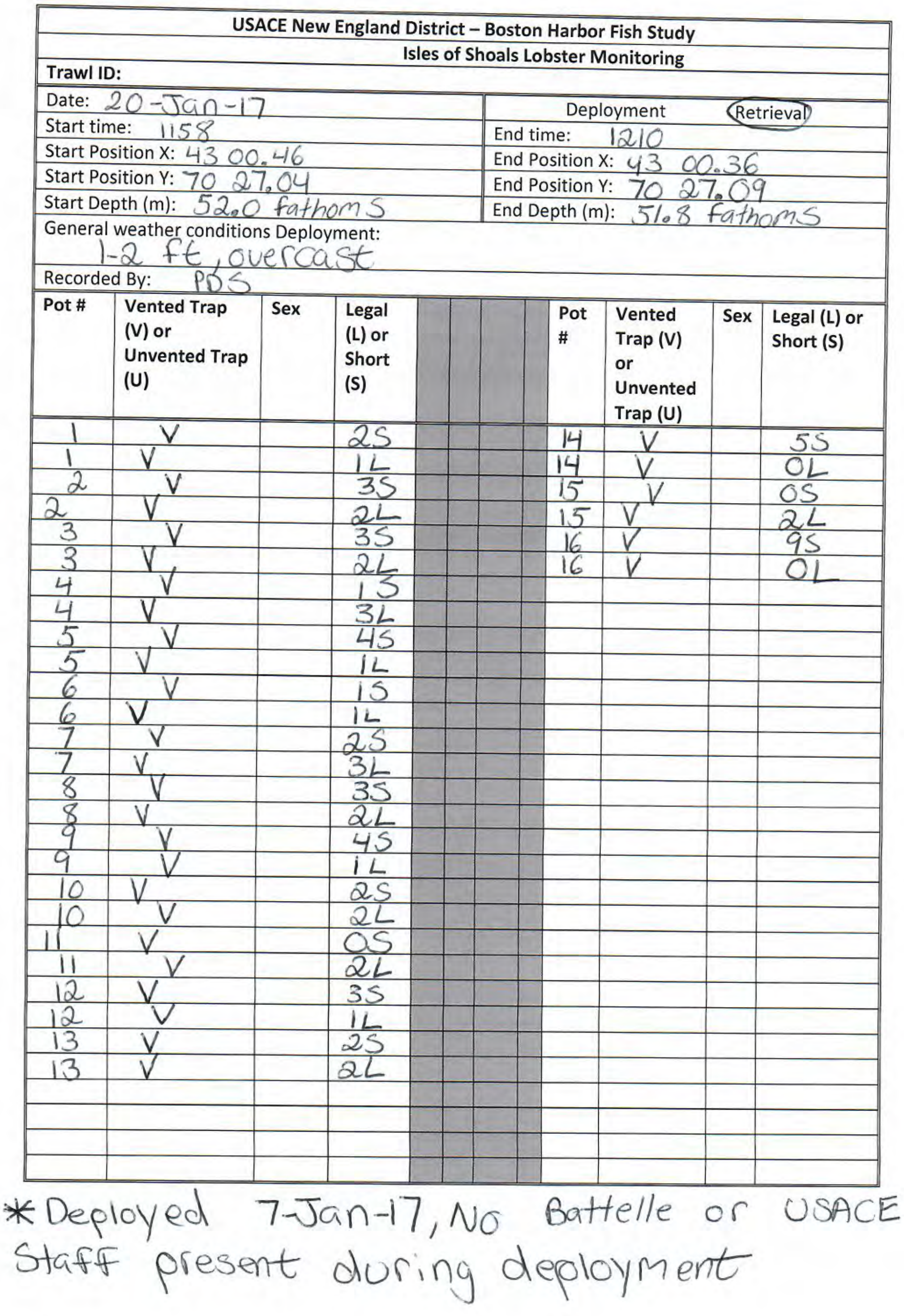
Date: 20-Jan-17	Deployment [✓ Retrieval]
Start time: 1137	End time: 1148
Start Position X: 43 00.79	End Position X: 43 00.68
Start Position Y: 70 26.77	End Position Y: 70 26.84
Start Depth (m): 52.5 fathoms	End Depth (m): 52.1 fathoms

General weather conditions Deployment: 1-2 ft, overcast

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)	Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		0S	14	V		1S
1	V		3L	14	V		2L
2	V		0S	15	V		3S
2	V		1L	15	V		1L
3	V		5S	16	V		5S
3	V		1L	16	V		2L
4	V		0S				
4	V		0L				
5	V		3S				
5	V		2L				
6	V		4S				
6	V		3L				
7	V		1S				
7	V		2L				
8	V		0S				
8	V		2L				
9	V		5S				
9	V		1L				
10	V		3S				
10	V		2L				
11	V		2S				
11	V		1L				
12	V		0S				
12	V		1L				
13	V		4S				
13	V		1L				

*Deployed 7-Jan-17, No Battelle or USACE Staff Present during deployment



USACE New England District – Boston Harbor Fish Study
Isles of Shoals Lobster Monitoring

Trawl ID:

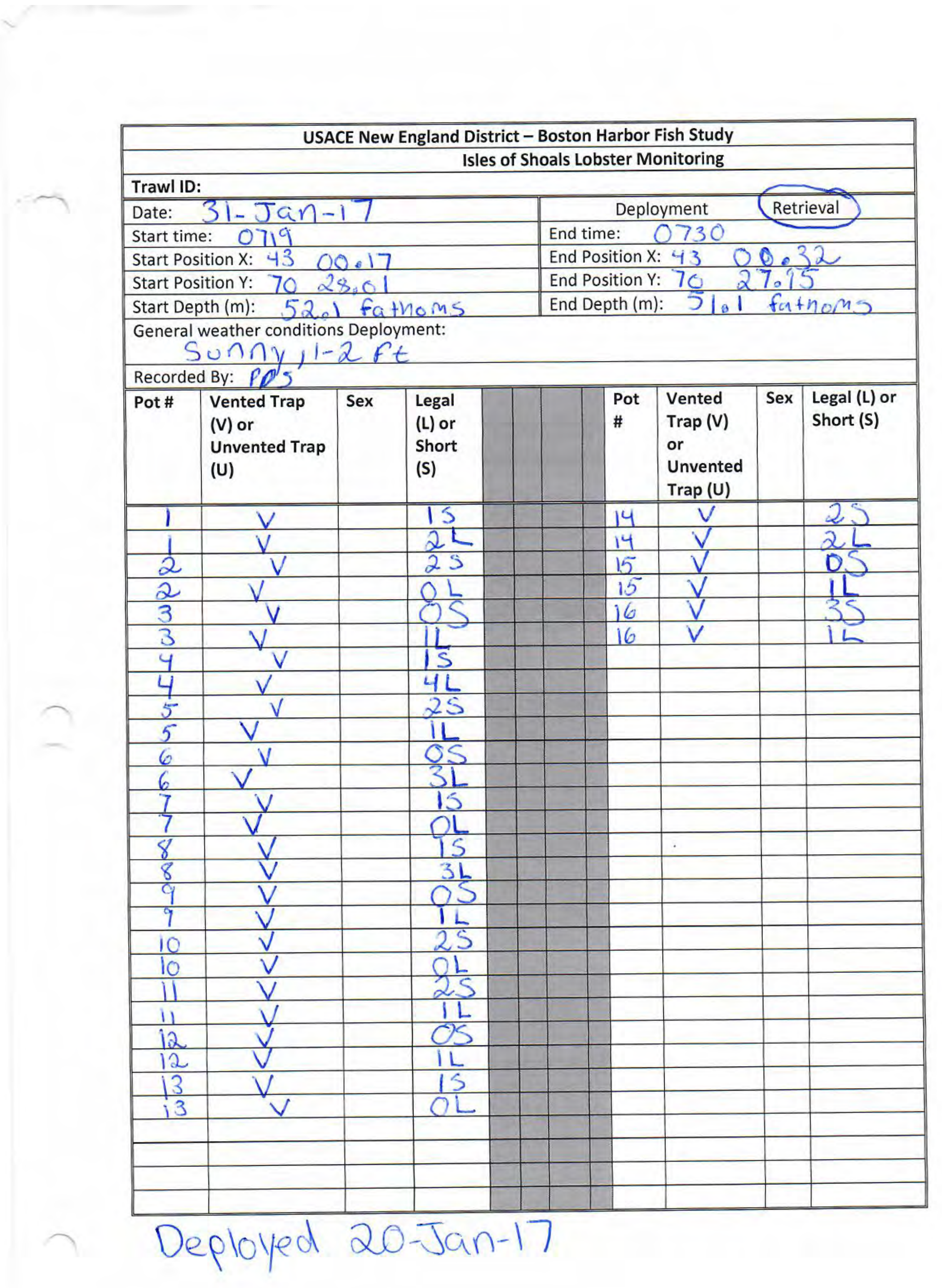
Date: 20-Jan-17	Deployment [✓ Retrieval]
Start time: 1158	End time: 1210
Start Position X: 43 00.46	End Position X: 43 00.36
Start Position Y: 70 27.04	End Position Y: 70 27.09
Start Depth (m): 52.0 fathoms	End Depth (m): 51.8 fathoms

General weather conditions Deployment:
1-2 ft, overcast

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		2S					14	V		5S
1	V		1L					14	V		0L
2	V		3S					15	V		0S
2	V		2L					15	V		2L
3	V		3S					16	V		9S
3	V		2L					16	V		0L
4	V		1S								
4	V		3L								
5	V		4S								
5	V		1L								
6	V		1S								
6	V		1L								
7	V		2S								
7	V		3L								
8	V		3S								
8	V		2L								
9	V		4S								
9	V		1L								
10	V		2S								
10	V		2L								
11	V		0S								
11	V		2L								
12	V		3S								
12	V		1L								
13	V		2S								
13	V		2L								

*Deployed 7-Jan-17, No Battelle or USACE Staff present during deployment



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

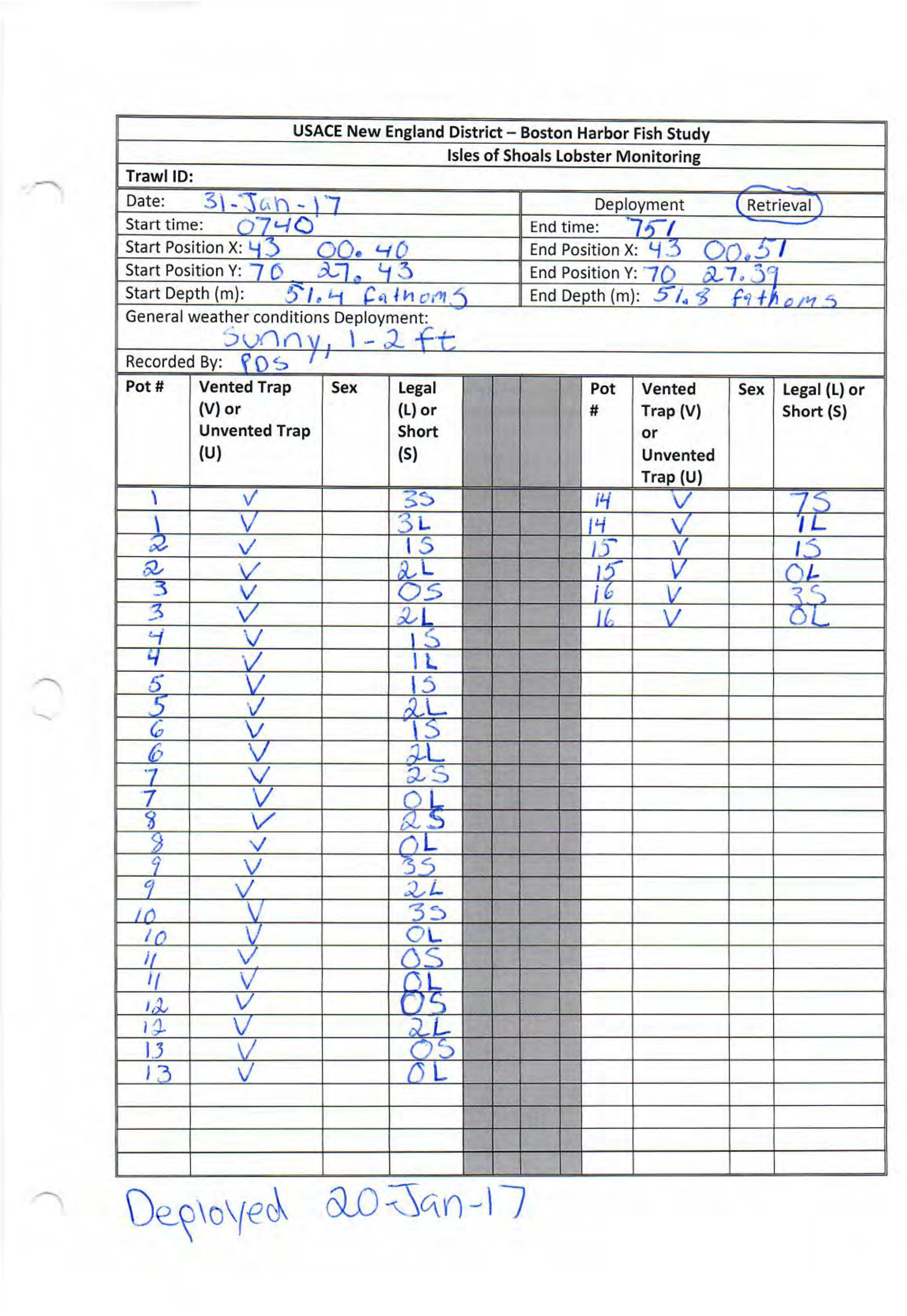
Date: 31-Jan-17	Deployment [✓ Retrieval]
Start time: 0719	End time: 0730
Start Position X: 43 00.17	End Position X: 43 00.32
Start Position Y: 70 28.01	End Position Y: 70 27.15
Start Depth (m): 52.1 fathoms	End Depth (m): 51.1 fathoms

General weather conditions Deployment: Sunny, 1-2 ft

Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		1S					14	V		2S
1	V		2L					14	V		2L
2	V		2S					15	V		0S
2	V		0L					15	V		1L
3	V		0S					16	V		3S
3	V		1L					16	V		1L
4	V		1S								
4	V		4L								
5	V		2S								
5	V		1L								
6	V		0S								
6	V		3L								
7	V		1S								
7	V		0L								
8	V		1S								
8	V		3L								
9	V		0S								
9	V		1L								
10	V		2S								
10	V		0L								
11	V		2S								
11	V		1L								
12	V		0S								
12	V		1L								
13	V		1S								
13	V		0L								

Deployed 20-Jan-17



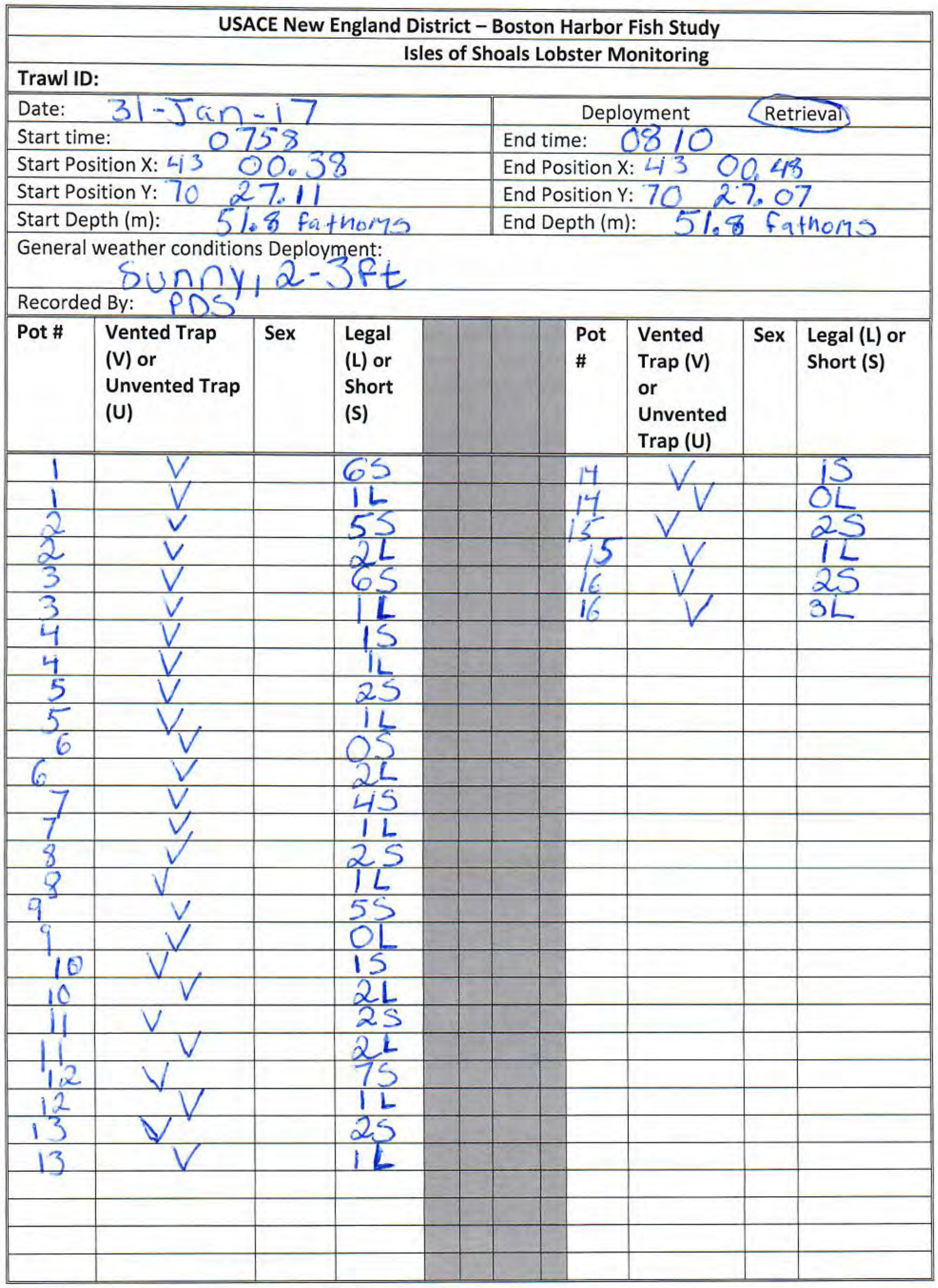
USACE New England District – Boston Harbor Fish Study
Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 31-Jan-17
Deployment [✓ Retrieval]
Start time: 0740
End time: 751
Start Position X: 43 00.40
End Position X: 43 00.51
Start Position Y: 70 27.43
End Position Y: 70 27.39
Start Depth (m): 51.4 fathoms
End Depth (m): 51.8 fathoms
General weather conditions Deployment: Sunny, 1-2 ft
Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		3S					14	V		7S
1	V		3L					14	V		1L
2	V		1S					15	V		1S
2	V		2L					15	V		0L
3	V		0S					16	V		3S
3	V		2L					16	V		0L
4	V		1S								
4	V		1L								
5	V		1S								
5	V		2L								
6	V		1S								
6	V		2L								
7	V		2S								
7	V		0L								
8	V		2S								
8	V		0L								
9	V		3S								
9	V		2L								
10	V		3S								
10	V		0L								
11	V		0S								
11	V		0L								
12	V		0S								
12	V		2L								
13	V		0S								
13	V		0L								

Deployed 20-Jan-17



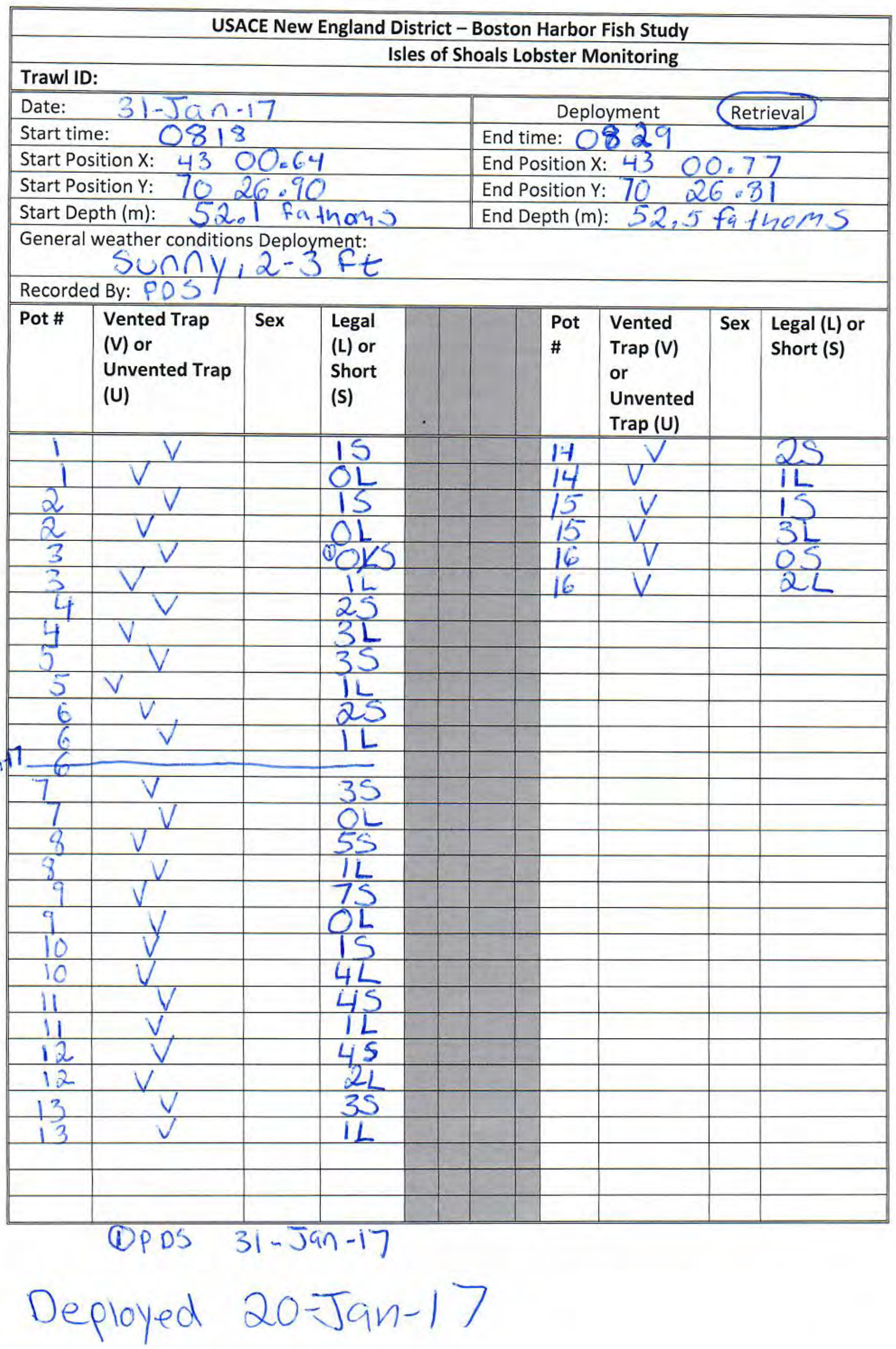
USACE New England District – Boston Harbor Fish Study
Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 31-Jan-17
Deployment [✓ Retrieval]
Start time: 0758
End time: 0810
Start Position X: 43 00.38
End Position X: 43 00.48
Start Position Y: 70 27.11
End Position Y: 70 27.07
Start Depth (m): 51.8 fathoms
End Depth (m): 51.8 fathoms
General weather conditions Deployment: Sunny, 2-3ft
Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**					**Pot #**	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		6S					14	V		1S
1	V		1L					14	V		0L
2	V		5S					15	V		2S
2	V		2L					15	V		1L
3	V		6S					16	V		2S
3	V		1L					16	V		3L
4	V		1S								
4	V		1L								
5	V		2S								
5	V		1L								
6	V		0S								
6	V		2L								
7	V		4S								
7	V		1L								
8	V		2S								
8	V		1L								
9	V		5S								
9	V		0L								
10	V		1S								
10	V		2L								
11	V		2S								
11	V		2L								
12	V		7S								
12	V		1L								
13	V		2S								
13	V		1L								

Deployed 20-Jan-17



USACE New England District – Boston Harbor Fish Study
Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 31-Jan-17	Deployment [✓ Retrieval]
Start time: 0818	End time: 0829
Start Position X: 43 00.64	End Position X: 43 00.77
Start Position Y: 70 26.90	End Position Y: 70 26.81
Start Depth (m): 52.1 fathoms	End Depth (m): 52.5 fathoms

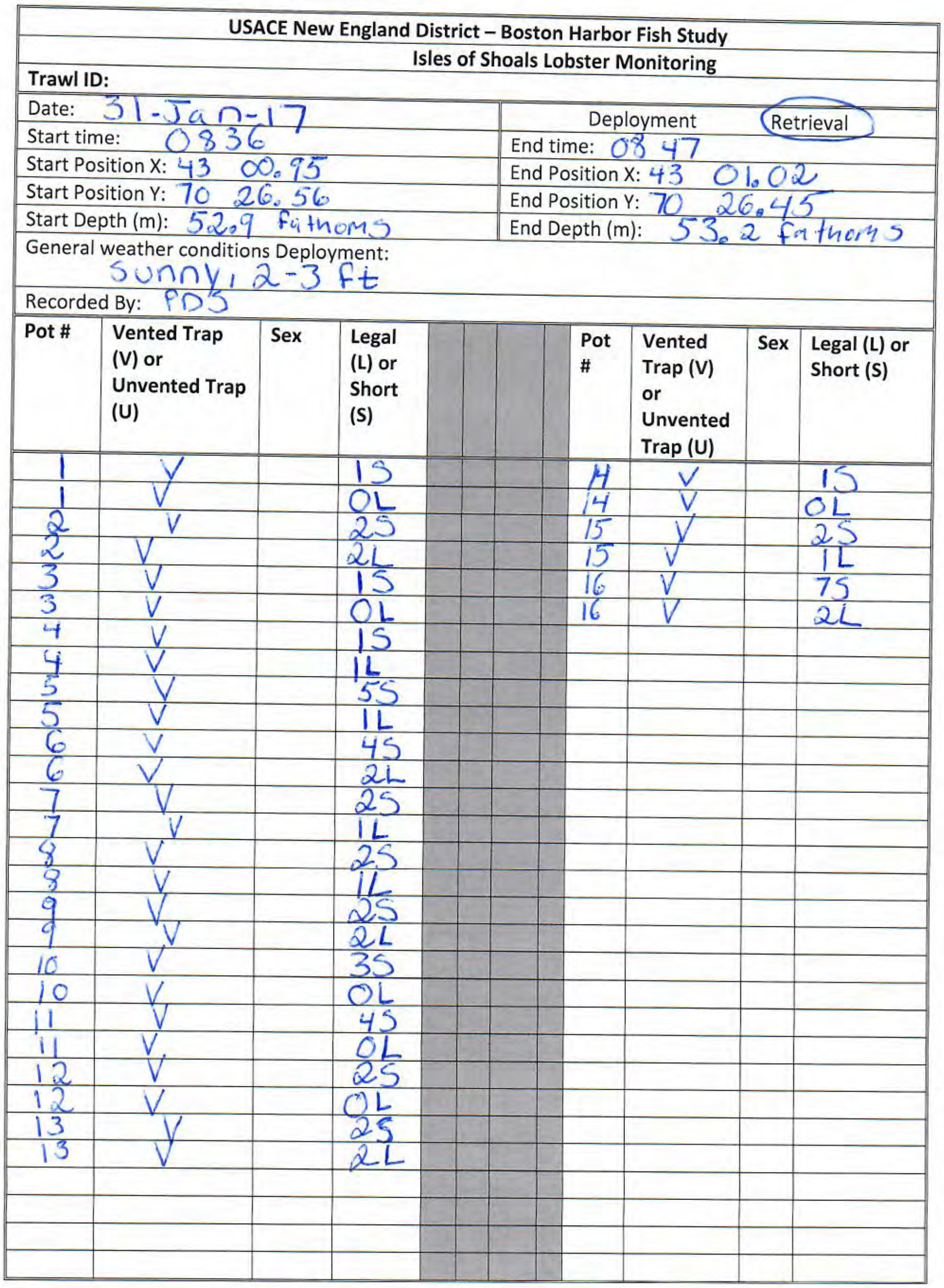
General weather conditions Deployment: Sunny, 2-3 ft

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)				Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		1S				14	V		2S
1	V		0L				14	V		1L
2	V		1S				15	V		1S
2	V		0L				15	V		3L
3	V		①0~~L~~S				16	V		0S
3	V		1L				16	V		2L
4	V		2S							
4	V		3L							
5	V		3S							
5	V		1L							
6	V		2S							
6	V		1L							
~~6~~ PDS 31-Jan-17										
7	V		3S							
7	V		0L							
8	V		5S							
8	V		1L							
9	V		7S							
9	V		0L							
10	V		1S							
10	V		4L							
11	V		4S							
11	V		1L							
12	V		4S							
12	V		2L							
13	V		3S							
13	V		1L							

① PDS 31-Jan-17

Deployed 20-Jan-17



USACE New England District – Boston Harbor Fish Study
Isles of Shoals Lobster Monitoring

Trawl ID:

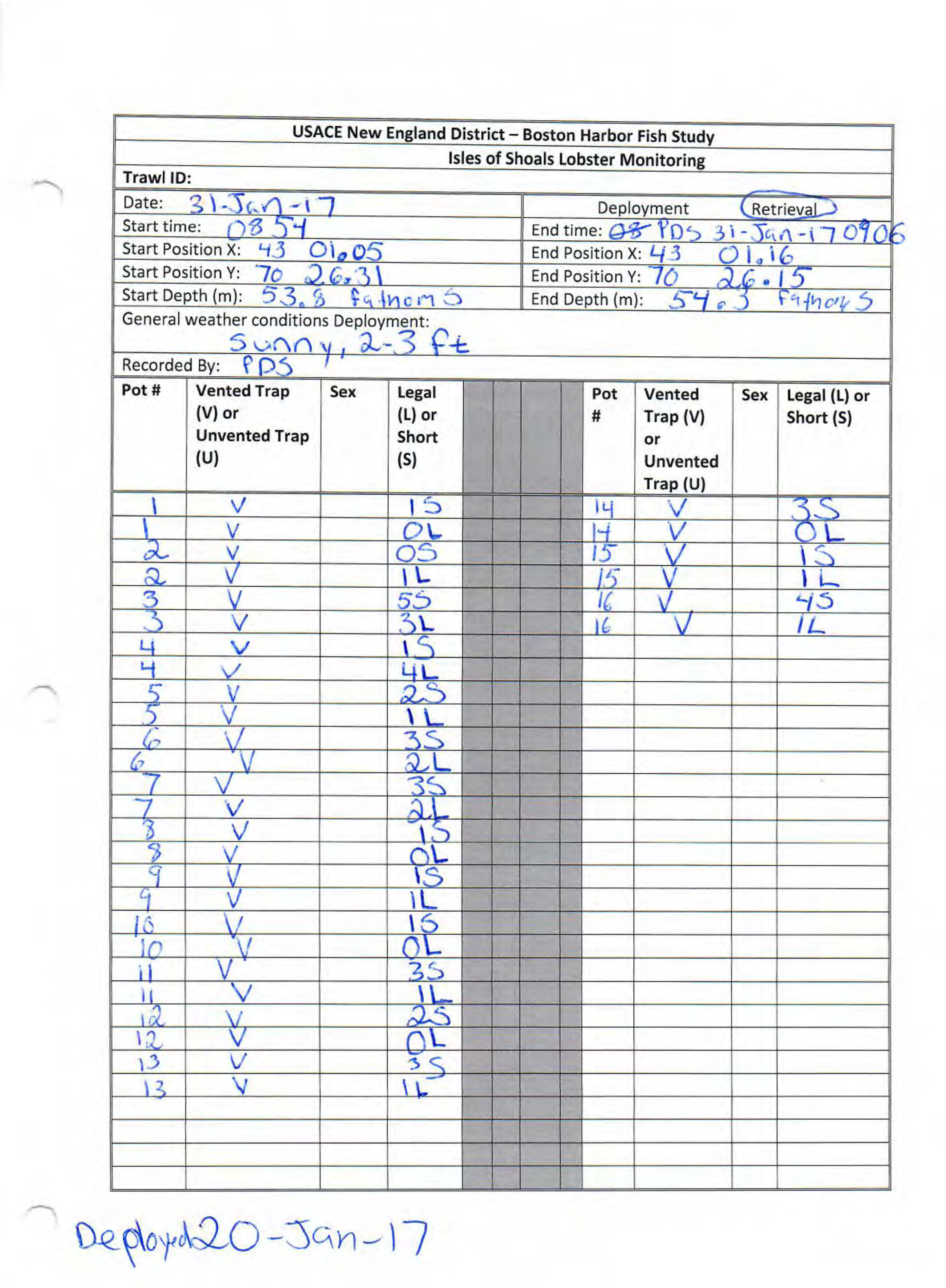
Date: 31-Jan-17
Start time: 0836
Start Position X: 43 00.95
Start Position Y: 70 26.56
Start Depth (m): 52.9 fathoms

Deployment [✓ Retrieval]
End time: 08 47
End Position X: 43 01.02
End Position Y: 70 26.45
End Depth (m): 53.2 fathoms

General weather conditions Deployment: Sunny, 2-3 ft
Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)					Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		1S					H	V		1S
1	V		0L					14	V		0L
2	V		2S					15	V		2S
2	V		2L					15	V		1L
3	V		1S					16	V		7S
3	V		0L					16	V		2L
4	V		1S								
4	V		1L								
5	V		5S								
5	V		1L								
6	V		4S								
6	V		2L								
7	V		2S								
7	V		1L								
8	V		2S								
8	V		1L								
9	V		2S								
9	V		2L								
10	V		3S								
10	V		0L								
11	V		4S								
11	V		0L								
12	V		2S								
12	V		0L								
13	V		2S								
13	V		2L								

Deployed 20-Jan-17



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 31-Jan-17

Deployment [✓ Retrieval]

Start time: 0854

End time: ~~08~~ PDS 31-Jan-17 0906

Start Position X: 43 01.05

End Position X: 43 01.16

Start Position Y: 70 26.31

End Position Y: 70 26.15

Start Depth (m): 53.8 fathoms

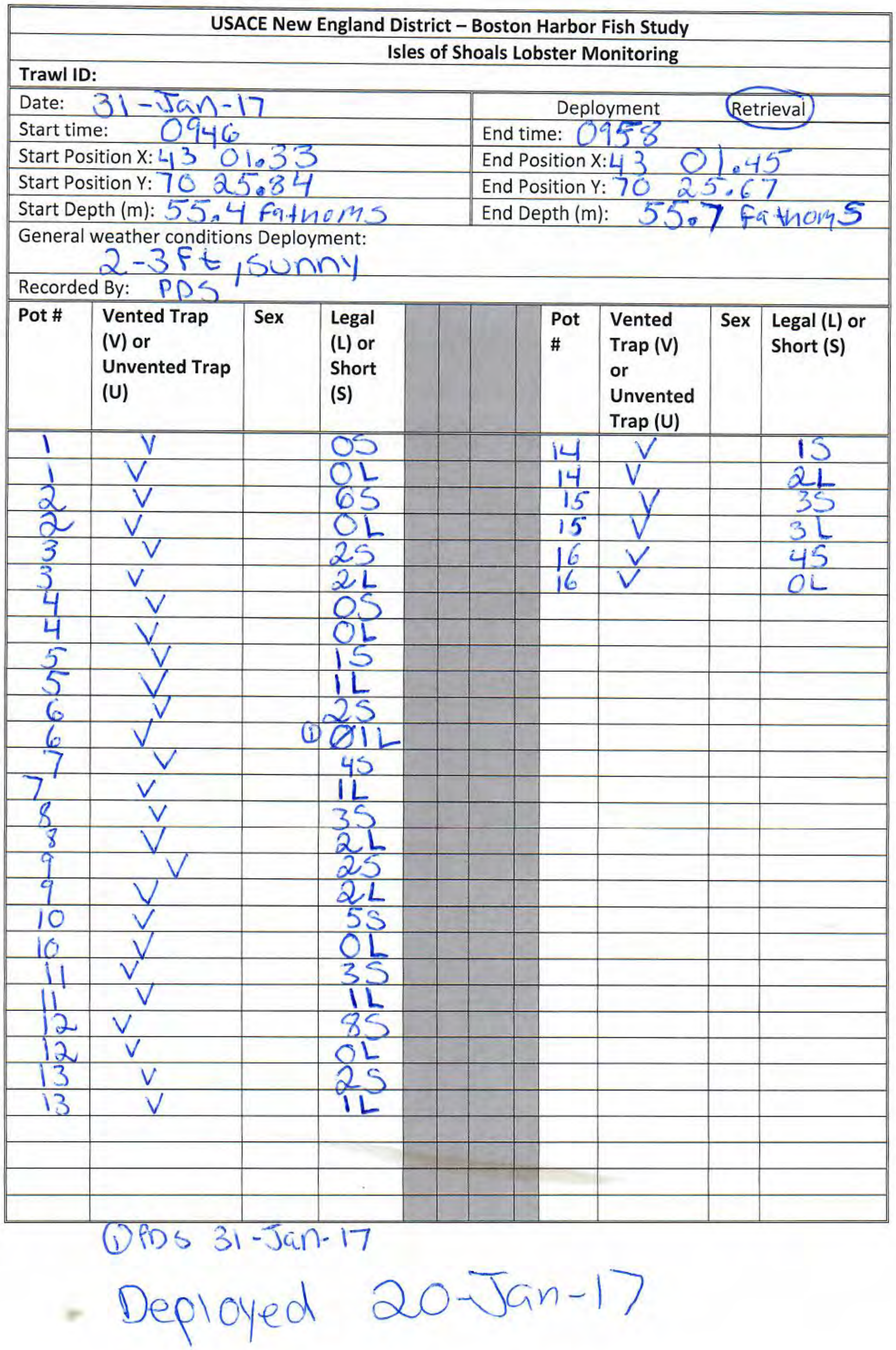
End Depth (m): 54.3 fathoms

General weather conditions Deployment: Sunny, 2-3 ft

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)					Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		1S					14	V		3S
1	V		0L					14	V		0L
2	V		0S					15	V		1S
2	V		1L					15	V		1L
3	V		5S					16	V		4S
3	V		3L					16	V		1L
4	V		1S								
4	V		4L								
5	V		2S								
5	V		1L								
6	V		3S								
6	V		2L								
7	V		3S								
7	V		2L								
8	V		1S								
8	V		0L								
9	V		1S								
9	V		1L								
10	V		1S								
10	V		0L								
11	V		3S								
11	V		1L								
12	V		2S								
12	V		0L								
13	V		3S								
13	V		1L								

Deployed 20-Jan-17



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 31-Jan-17

Start time: 0946

Start Position X: 43 01.33

Start Position Y: 70 25.84

Start Depth (m): 55.4 Fathoms

Deployment [✓ Retrieval]

End time: 0958

End Position X: 43 01.45

End Position Y: 70 25.67

End Depth (m): 55.7 Fathoms

General weather conditions Deployment: 2-3Ft, Sunny

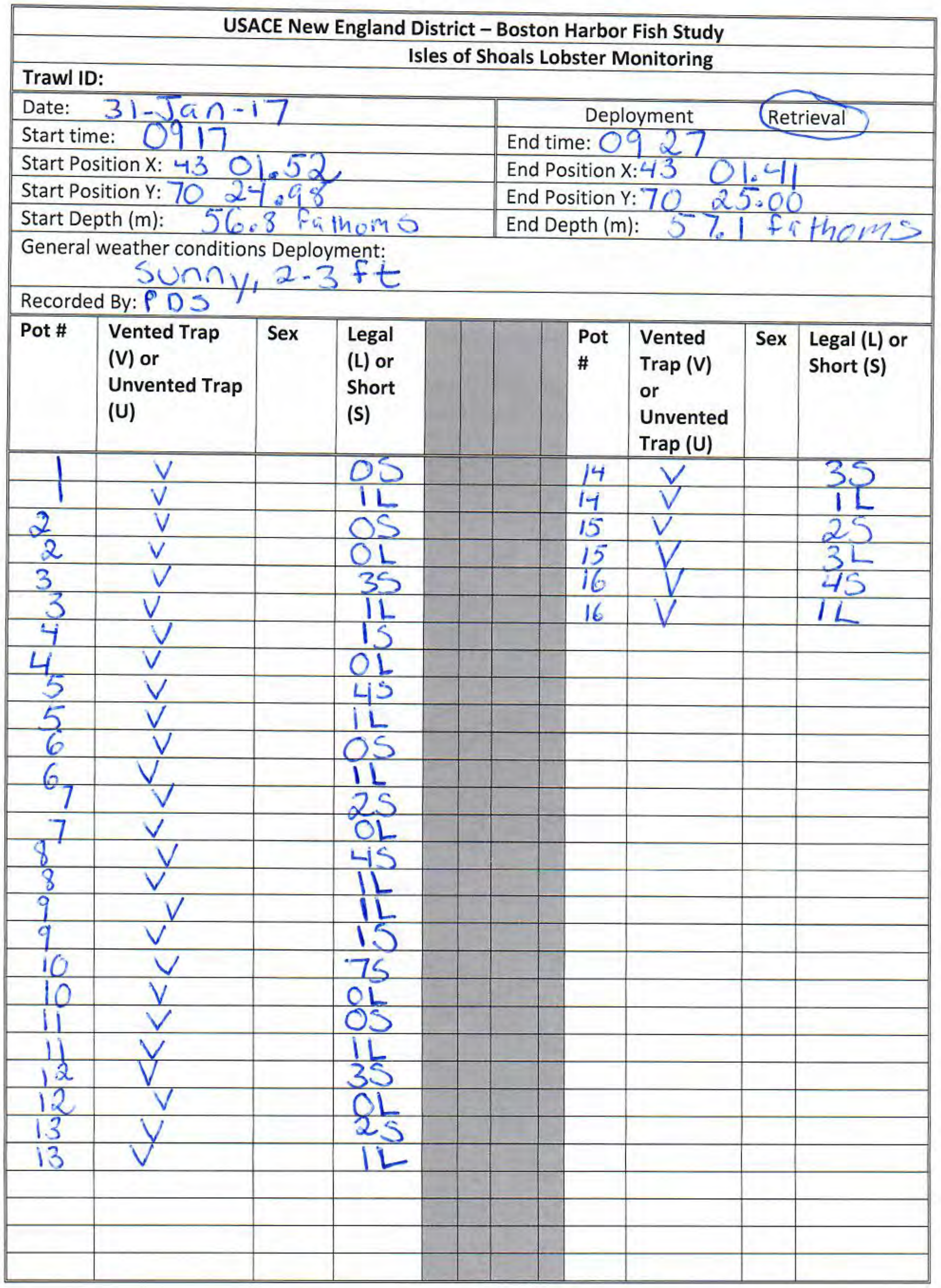
Recorded By: PDS

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
1	V		0S
1	V		0L
2	V		6S
2	V		0L
3	V		2S
3	V		2L
4	V		0S
4	V		0L
5	V		1S
5	V		1L
6	V		2S
6	V		① ~~0~~ 1L
7	V		4S
7	V		1L
8	V		3S
8	V		2L
9	V		2S
9	V		2L
10	V		5S
10	V		0L
11	V		3S
11	V		1L
12	V		8S
12	V		0L
13	V		2S
13	V		1L

Pot #	**Vented Trap (V) or Unvented Trap (U)**	**Sex**	**Legal (L) or Short (S)**
14	V		1S
14	V		2L
15	V		3S
15	V		3L
16	V		4S
16	V		0L

① PDS 31-Jan-17

Deployed 20-Jan-17



USACE New England District – Boston Harbor Fish Study

Isles of Shoals Lobster Monitoring

Trawl ID:

Date: 31-Jan-17

Start time: 0917

Start Position X: 43 01.52

Start Position Y: 70 24.98

Start Depth (m): 56.8 fathoms

Deployment [✓ Retrieval]

End time: 09 27

End Position X: 43 01.41

End Position Y: 70 25.00

End Depth (m): 57.1 fathoms

General weather conditions Deployment: Sunny, 2-3 ft

Recorded By: PDS

Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)					Pot #	Vented Trap (V) or Unvented Trap (U)	Sex	Legal (L) or Short (S)
1	V		0S					14	V		3S
1	V		1L					14	V		1L
2	V		0S					15	V		2S
2	V		0L					15	V		3L
3	V		3S					16	V		4S
3	V		1L					16	V		1L
4	V		1S								
4	V		0L								
5	V		4S								
5	V		1L								
6	V		0S								
6	V		1L								
7	V		2S								
7	V		0L								
8	V		4S								
8	V		1L								
9	V		1L								
9	V		1S								
10	V		7S								
10	V		0L								
11	V		0S								
11	V		1L								
12	V		3S								
12	V		0L								
13	V		2S								
13	V		1L								

Deployed 20-Jan-17

Environmental Assessment and Evaluation Study
for a Designation of an
Ocean Dredged Material Disposal Site in
Southern Maine, New Hampshire, and Northern Massachusetts

Appendix E
Bureau of Marine Science Comments on the Proposed IOSN

Bureau of Marine Science Comments On The Proposed Isle of Shoals Disposal Site

Submitted:

January 21, 2016

Compiled by :

Carl Wilson, Director Bureau of Marine Science

Maine Department of Marine Resources

Contributions from:

Robert Watts (Lobster Fishery Landings)

Kathleen Reardon, Katherine Thomson and Erin Summers (Lobster Biology, Spatial Distribution, Large Whale)

James Becker, Matt Cieri (Atlantic herring)

Sally Sherman (Inshore Trawl Survey, Groundfish Characterization)

SUMMARY

Bureau of Marine Science staff were queried for input on the proposed disposal area immediately north of Isle of Shoals, Maine, in Federal Waters. Comments are focused on the location of the disposal site, the timing of likely disposal activity, and likely impacts of transit to and from the disposal area. Key issues that were brought forward include; the activity and significance of lobster fishing in Federal waters during likely disposal time period; the timing of herring spawning and importance of the early Fall herring fishery; the presence of a hotspot of historic sightings for Humpback and Right whales associated with Jeffreys Ledge southeast of the proposed disposal site; and the direct observations that several commercially important groundfish species are seen in the proposed area. Observations made while conducting these surveys indicate that the area is utilized by commercial lobster, groundfish trawlers and gillnetters as well as by herring trawlers.

AMERICAN LOBSTER

Landings

Lobster represents the largest active fishery in the area. We are unable to evaluate direct impact as reporting requirements do not specify exact coordinates. However, Lobster Management Zone G, relative to State and Federal waters gives a proxy for activity in the region and a glimpse into seasonal use.

Dealer and harvester reports for lobster landings were exptrapolated for years 2008 to 2014 for harvesters that reported zone G and dealers who reported a landing port located in zone G. Data were queried from both Federal and State dealers from ACCSP's SAFIS database and ME DMR's MARVIN database. Harvester data were queried from ME DMR's MARVIN database and NMFS NERO database. Only those harvesters that were selected as part of ME DMR's 10% lobster harvester reporting requirement were queried from the harvester data. Data were grouped by year (and then into quarters) and distance from shore. If an individual grouping would not meet our confidentiality provision they were removed from the data set.

The Zone G lobster fishery represents an average of 16,446 trips completed by 252 active harvesters annually during the period of 2009 through 2014 (Table 1). The proposed disposal area is in entirely federal waters, we extrapolate over this period that 36% of the total pounds, 25% of trips and 28% of active harvesters occurred in Federal waters (Figure 1).

Disposal in the proposed area, will likely be during late fall, winter and early spring. Within Zone G, during the winter nearly 75% of landings occur from Federal waters. Federal waters represent 48% of lobsters landed in the fall, and 39% in the Spring (Figure 2).

Table 1, 2009 – 2014 number of lobster trips and active harvesters.

Year	LOB_ZONE	Total Trips	Active Harvesters
2009	G	15,814	275
2010	G	16,318	261
2011	G	15,825	255
2012	G	16,843	253
2013	G	17,111	238
2014	G	16,762	227

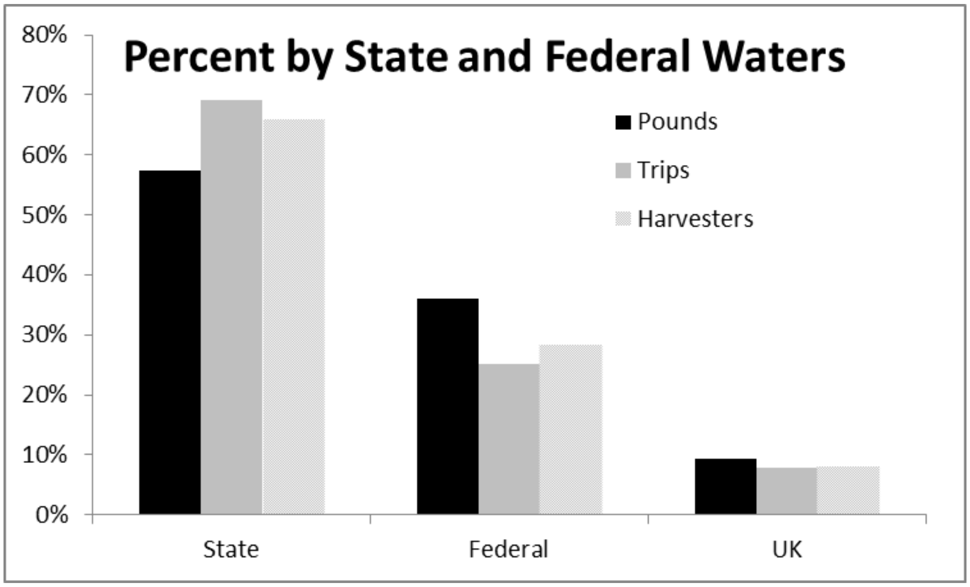


Figure 1. Percentage of pounds landed, trips, and active harvesters in State, Federal and unknown (UK) waters during 2009-2014 in Zone G.

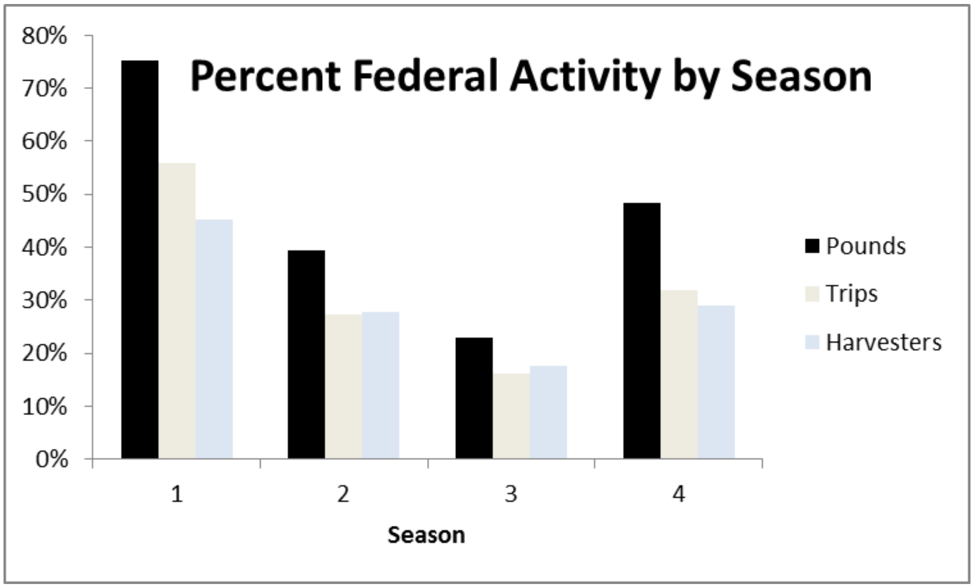


Figure 2. The percentage of Pounds, Trips and Harvesters by season in Federal Waters in Zone G, 2009-2014.

DMR Lobster Monitoring Program Comments

The DMR has limited direct observations on commercial lobster vessels in the vicinity of the proposed dredge disposal site. The DMR has conducted at-sea lobster sampling primarily during the months of May through November since 1985, which was expanded to include all lobster zones in 2000. Each zone is sampled three times monthly from May through November with trips spread throughout the zone. Zone G is the southwesternmost lobster management zone spanning from the Presumpscott River (near Portland, Maine) south to the New Hampshire border. Winter trips are opportunistic and are completed on a regional basis in the southern, midcoast, and downeast portions of the Maine Coast. The southern winter sampling covers ports from Kittery to Friendship, Maine.

For this analysis, lobster landings and associated values were compiled for a subset of Lobster Management Area Zone G spanning from 42.95° N to 43.125° N and west of -70.35° W to the shore. This subset is the area most representative and likely to be impacted by the proposed dredging, transit and disposal activity. Lobster sea sampling data from 2008 until 2014 were considered.

The DMR conducted 3 trips in the subarea during December through April in the period 2008-2014 and 25 trips in Zone G for these months (Table 2). The mean size of lobsters was slightly higher in the subarea as compared with mean size in the greater zone, however, the difference does not appear significant since standard errors overlap (Table 2). The percent of the catch that that consists of females is also slightly higher in the subarea (Table 2).

Table 2. Summary statistics and standard errors for mean trip values for subarea and for Zone G for all months and Dec-April (2008-2014). CL = carapace length.

	All months	**Dec - April**
Subarea		
Mean CL (mm)	84.45 ± 0.84	87.02 ± 2.68
% Females	64.95% ± 1.71%	67.55% ± 6.50%
Mean Depth (fm)	18.56 ± 2.36	26.45 ± 9.05
# Trips	29	3
Zone G		
Mean CL (mm)	85.1 ± 0.57	85.38 ± 1.37
% Females	61.04% ± 0.76%	64.68% ± 1.93%
Mean Depth (fm)	22.54 ± 1.10	7.94 ± 3.81
# Trips	172	25

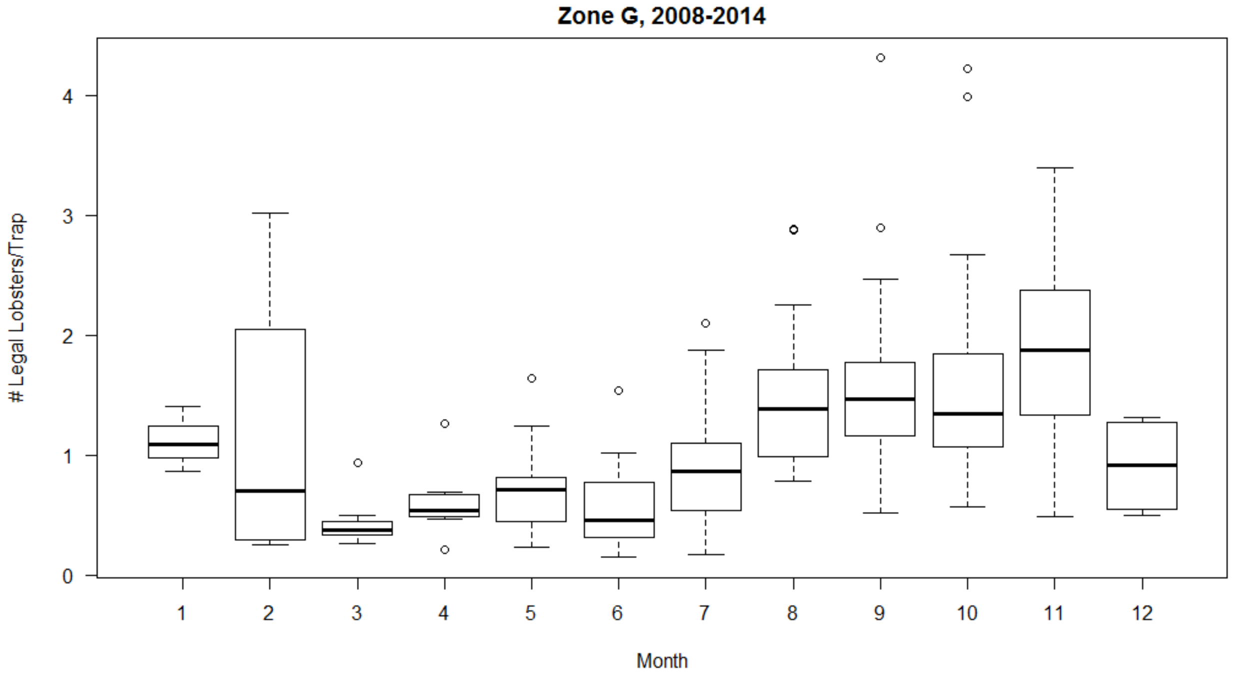


Figure 3. Median catch per trap (# legal lobsters) by trip for lobster management Zone G (2008-2014).

Disposal Site

The subarea adjacent to the proposed disposal site was observed to be fished by commercial and recreational harvesters from 2008 through 2014. Mean lobster catch per trap was highest in November near the proposed dumping site as well as in Zone G (Figure 3), which implies that there is high fishing activity at the beginning of the potential active dredge time period. Furthermore, lobster catch was relatively high in February for these years (Figure 3) and therefore winter catches could be impacted by disposal activity . The DMR is unable to disclose monthly lobster catches for the subarea during the winter months for confidentiality reasons, since only three trips were conducted in that area from December through April for that time period. However, the mean catch was 0.39 legal lobsters per trap (± 0.09 lobsters) for those four trips, which is comparable to Zone G winter catches.

Transit Routes

Although limited data are available from the monitoring programs for lobster fishing effort and catch data in the immediate area of the proposed dumping site, fishing effort is relatively high along the transit routes between the proposed dumping site and the ports of Portland, Maine and Portsmouth, New Hampshire (Figure 4). There was lobster activity along the likely transit route to Portsmouth, NH in both the summer and the winter in 2000 – 2014 (Figure 4). Steps should be actively taken to communicate with the fishing community to minimize impacts.

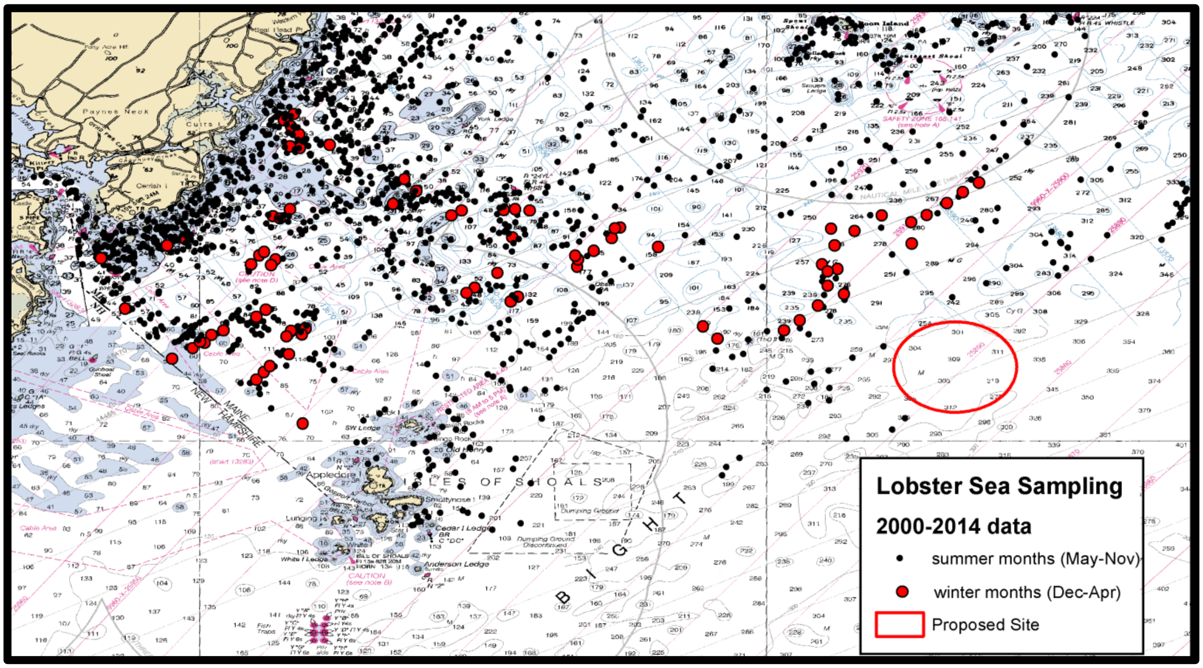


Figure 4. Lobster Sea Sampling locations for 2000-2014 in summer (black points) and winter (red points) months in relation to the proposed dredge disposal site (red circle).

Lobster gear characterization

The DMR completed a lobster gear characterization survey in 2010 as a retrospective evaluation of gear that was fished in 2009. A paper survey was mailed to all license holders with a 10% return. Inside the Atlantic Large Whale Take Reduction Plan Exemption Line in Zone G (Figure 5, thick black line), which is mostly within state waters, excluding the areas around Boon Island and Isles of Shoals, the fishery used mostly single, paired, and triple lobster trap configurations with peak fishing occurring from July – September. In non-exempt state waters fishermen deployed ten trap trawls in addition to singles, pairs, and triples. Peak fishing occurred in non-exempt state waters from July – October. Outside state waters and inside the 12nm line, the fishery used trawls of two, three, six, ten, twelve, and twenty traps in 2009. Peak fishing occurred in this outer area from November – March. Since June 2015, the whale regulations have prohibited singles in non-exempt state waters and established a minimum trawl length of three traps between the 3nm state waters line and the new 6 mile whale regulation line. These new rules have changed the configuration of gear outside the exemption and 3nm state line.

Though gear configuration does not have a direct relationship with dredge disposal, the transit route could potentially have more impact in areas with more end lines from fishing activity.

Atlantic Large Whales

There is a hotspot of historic sightings for Humpback and Right whales associated with Jeffreys Ledge southeast of the proposed disposal site (Figure 5). This is a highly important feeding ground for Right and Humpback Whales in the summer and fall and to a lesser extent in the spring (Figure 5). The importance of these feeding grounds is reflected in the creation of a management area in the latest iteration of the Atlantic Large Whale Take Reduction Plan to increase gear marking by fishermen utilizing this area. The proposed disposal site is directly west of the management area (Figure 5). However, we do not foresee that these activities will have a negative impact on Atlantic large whales, especially if conducted in the winter when whale activity in this area is low.

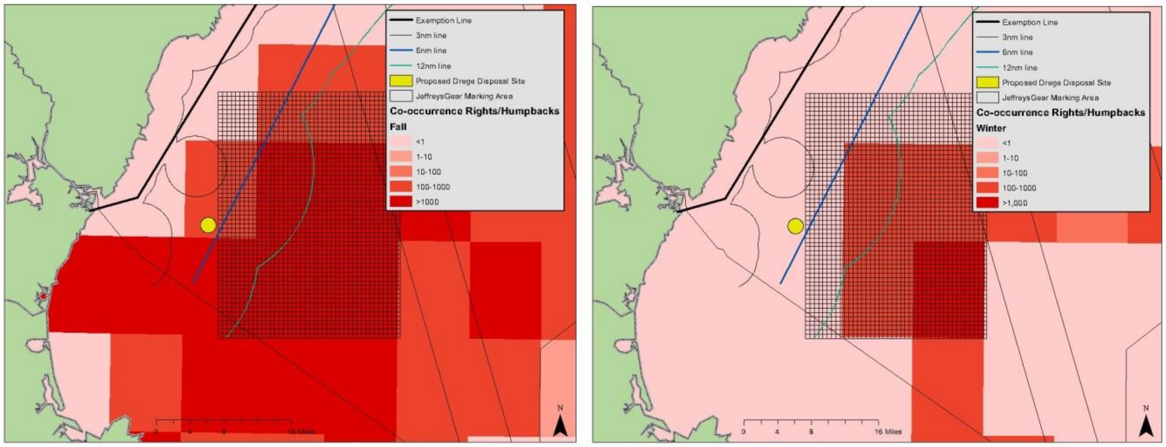


Figure 5. Atlantic Large Whale Co-occurrence model for Right and Humpback Whales in the Fall and Winter in relation to the proposed disposal site (yellow point).

ATLANTIC HERRING

The location of the proposed dredging disposal site lies in proximity to significant summer and fall Atlantic herring landings and fishing grounds, and inside the MA/NH herring spawn closure (Figures 6A and 6B.) The bulk of the herring fishing in this area occurs between June and November (Figure 7.). As mandated by the ASMFC, the MA/NH herring spawn closure, which prohibits any landings of Atlantic herring, begins by default on September 21st, and remains closed for fishing for 30 days (ASMFC, 2016). If herring samples collected by the ME DMR reveal the spawn condition of the commercially caught herring are not ready to spawn the closure dates can be postponed, or the opposite holds true if the herring appear ready prior to the default date. This closure helps protect herring in the area that are close to releasing their eggs and the eggs that are already on the benthos, and is implemented to secure successful spawning and incubation of the eggs.

Particulate dispersed into the water column by the dredging disposal could interfere with the schooling behavior of Atlantic herring and therefore interfere with fishing success whether by purse seine, mid-water trawl, or small mesh bottom trawl (Connor, et al., 2006).

The site is located in prime spawning grounds of Atlantic herring and depending on the rate and amount of dredged material that is dumped into the water it could in theory impact the necessary adhesion of eggs to the appropriate substrates, smother the eggs on the benthos, inhibit fertilization, and interfere with the incubation and developmental processes (Suedel, Kim, Clarke, and Linkov, 2008). However, lighter density particles would probably be carried south southwest with the Western Maine Coastal Current (Figure 8).

Given the highly localized area of the proposed site and the status of the herring stock, impacts on the inshore component should be minimal. But there could be a local effect on fishing for a limited time. Of course all of this is if the dumping coincides with the summer/fall fishery and the spawning season of the US Atlantic Herring, therefore timing of the disposal is paramount.

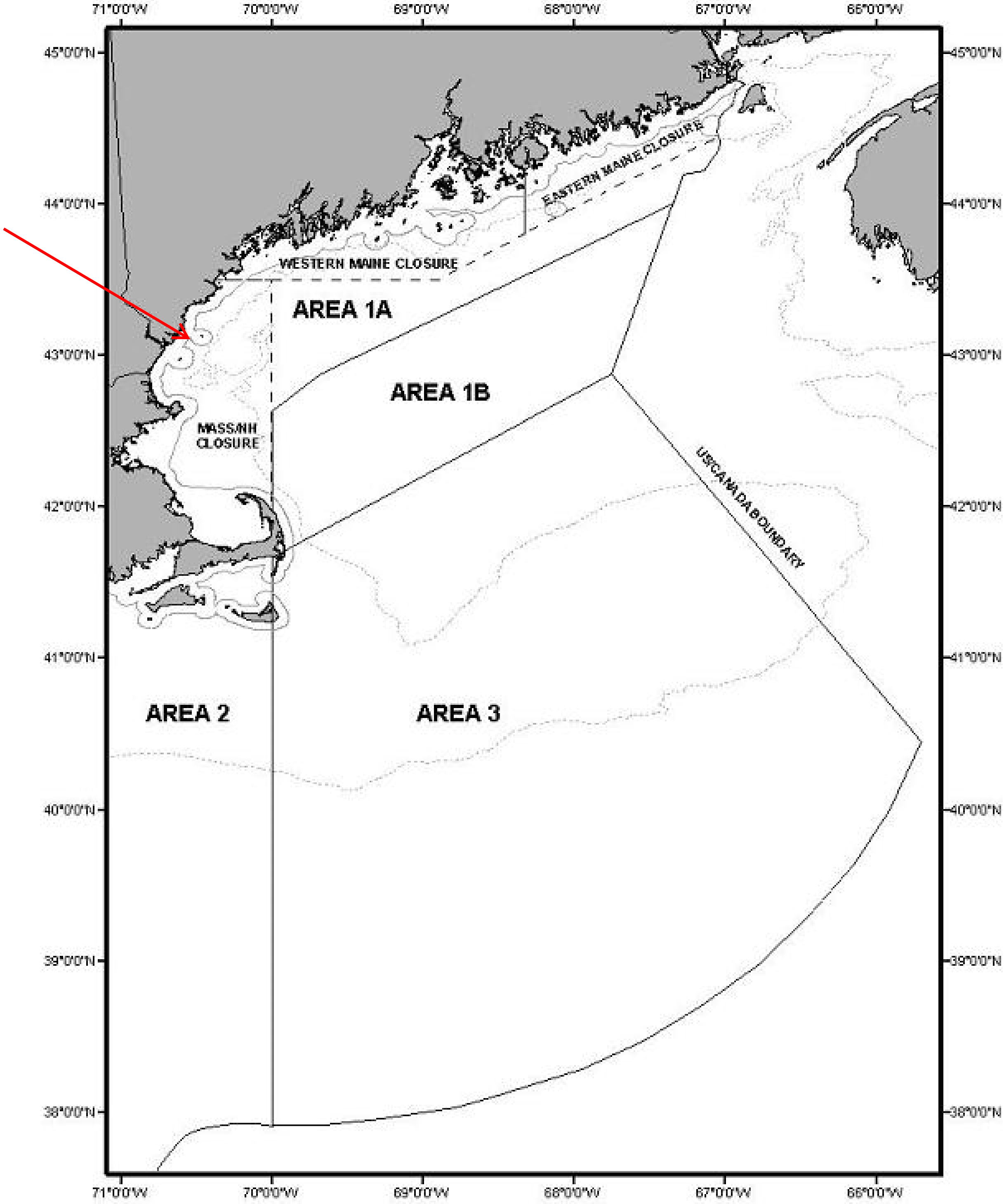


Figure 6A. Spawning Closure Areas of the US Atlantic Herring fishery

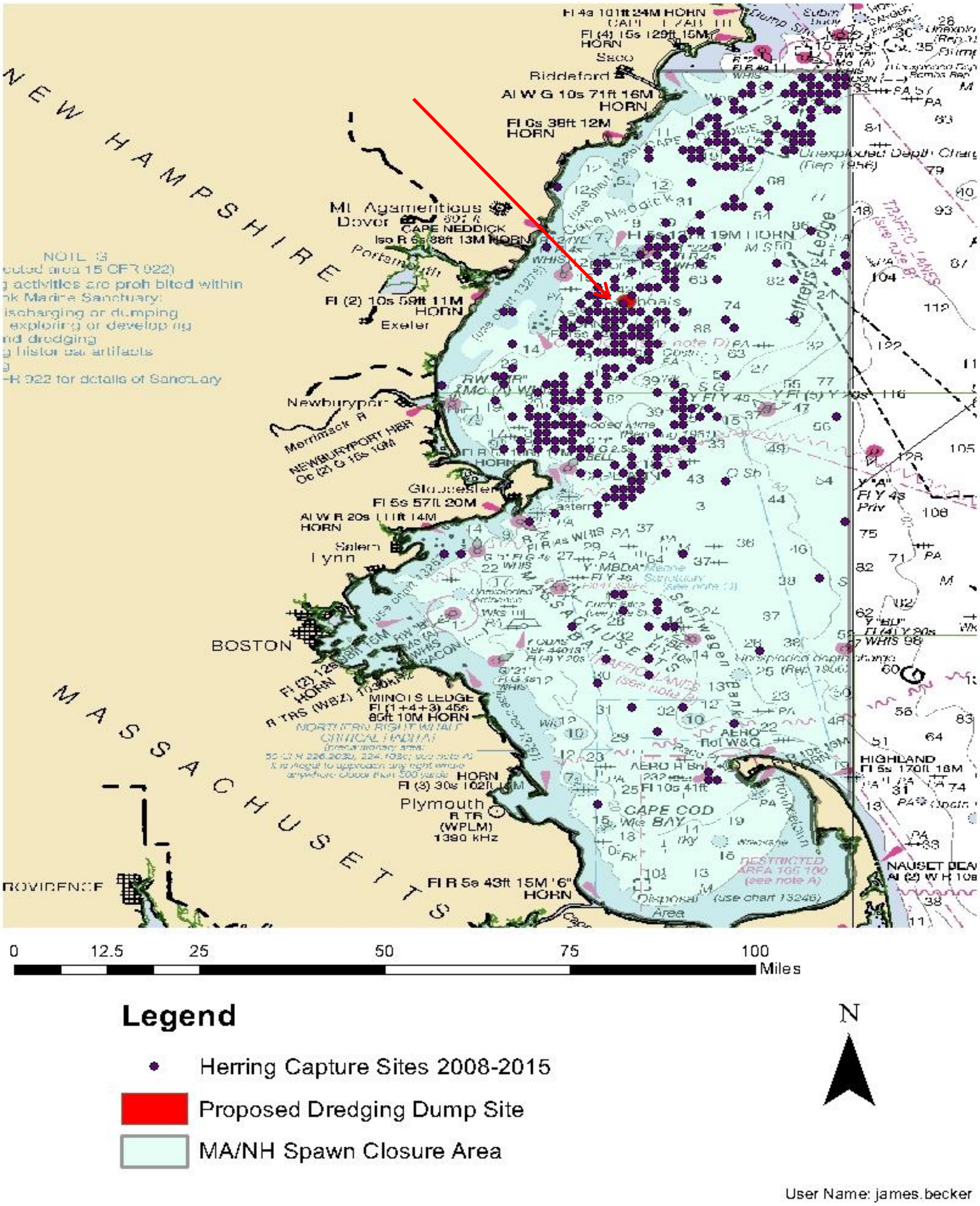


Figure 6B. Atlantic herring capture sites in the MA/NH spawn closure and proposed dredge disposal site.

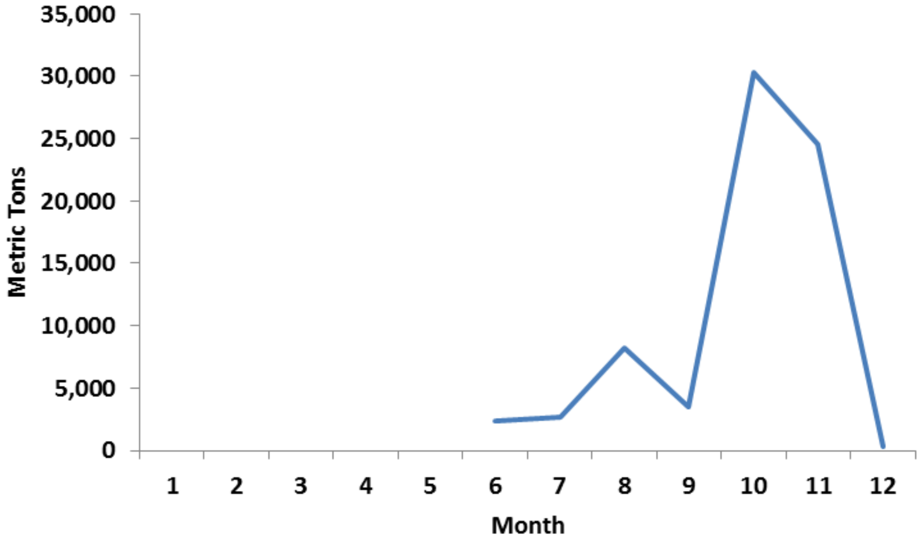


Figure 7. Atlantic herring landings by month for the MA/NH Spawn Closure Area for the years 2008-2015

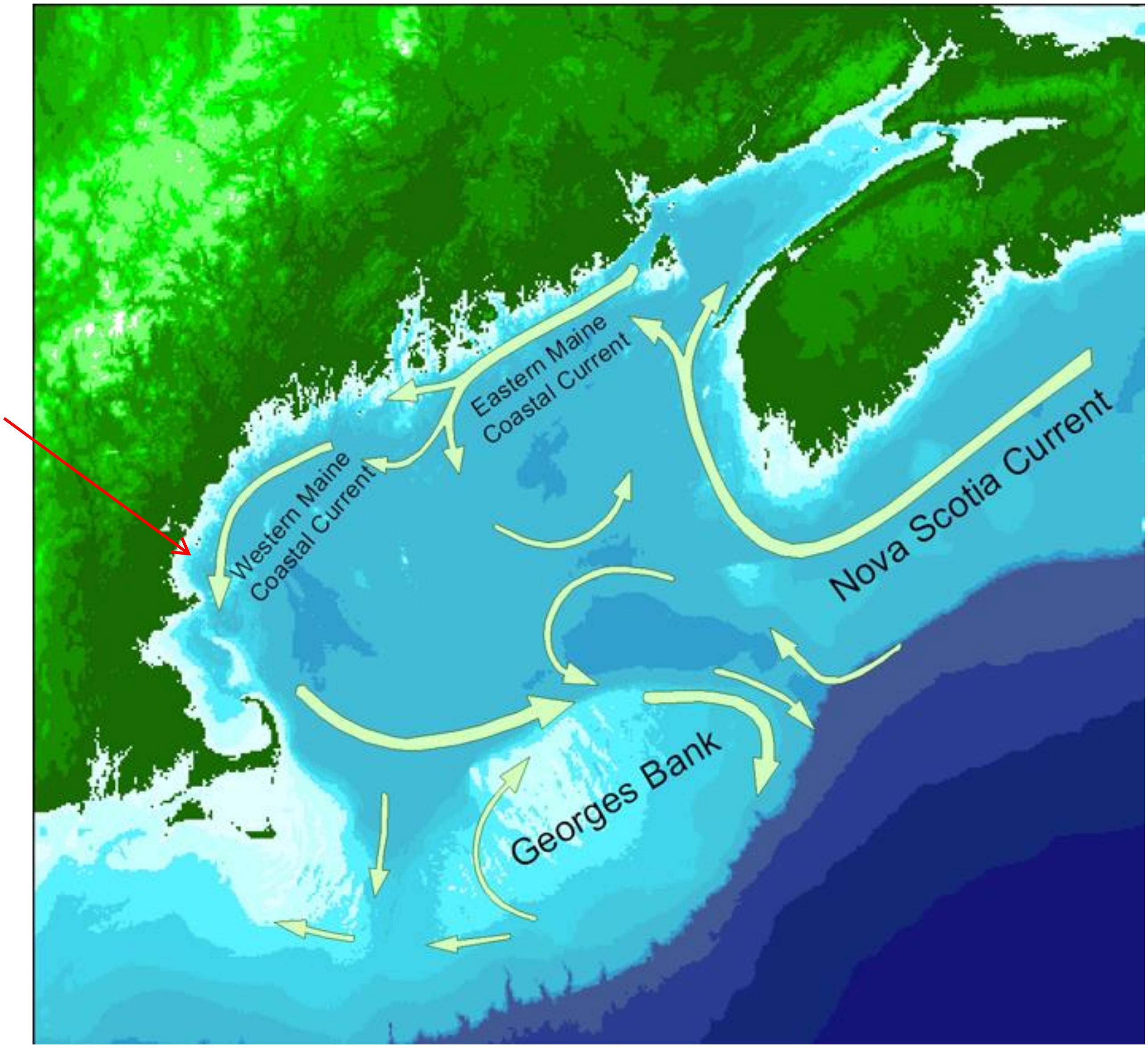


Figure 8. Currents of the Gulf of Maine and Georges Bank.

References

Atlantic States Marine Fisheries Council (ASMFC), 2016: http://www.greateratlantic.fisheries.noaa.gov/regs/fr.html

Clarke, D., Hay, D., Rice, S., Schoellhamer, D., Smith, P. 2006. Potential Impacts of Dredging on Pacific Herring in San Francisco Bay. U.S. Army Corps of Engineers South Pacific Division, White Paper: (1-86)

Suedel, B.C., Kim, J., Clarke, D.G. , and Linkov, I. 2008 A Risk-Informed Decision Making Framework for Setting Environmental Windows for Dredging Projects. Science of the Total Environment, 403, (1-3): 1-11

INSHORE TRAWL SURVEY – GROUNDFISH

The Maine-New Hampshire (MENH) Inshore Trawl Survey samples this area in spring, typically the first week of May, and fall, the last week of September. The survey has been sampling this area since the fall of 2000. There were 136 tows made in proximity to the disposal site from 2000 through 2015 (Figure 9). Spring tows totaled 65 and fall 71. The total number of species caught in these tows is 91. For the spring tows an average of 21 species per tow were caught with a minimum of 9 and a maximum of 33 in any one tow. For the fall, 23 species were caught with a range of 8 to 34 species in any one tow. The catch weight for a tow ranged from 1.82 to 1493.31 kg (Figure 9), the spring average tow catch weight was 75.20 kg and the fall was 321.52 kg.

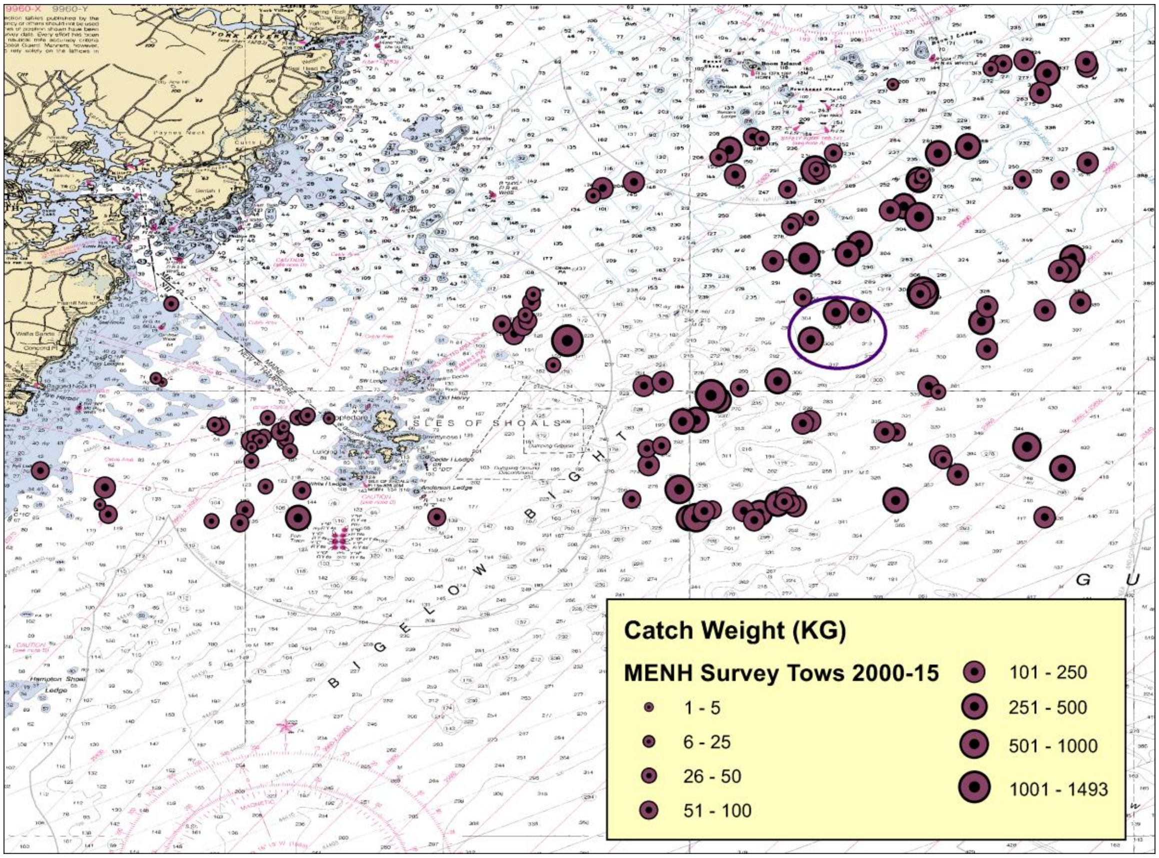
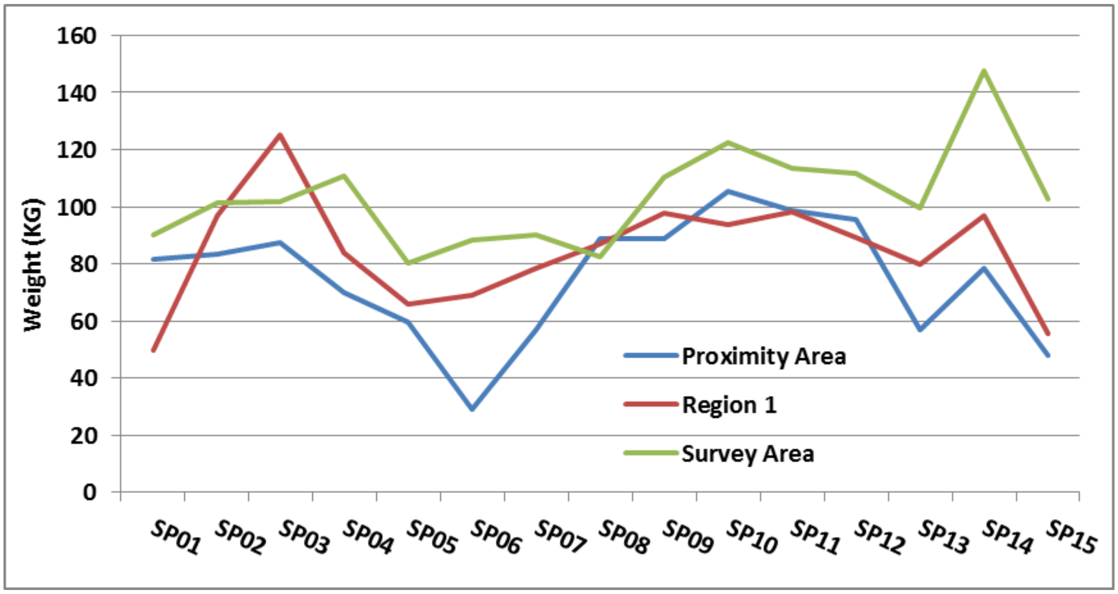


Figure 9. Bubble plot of survey tows conducted near the ACOE Isle of Shoals North disposal site both spring and fall from 2000-2015. The bubble size represents the tow catch weight in kilograms.

This area is appears more productive than the larger survey area in the fall, at least in the earlier years. Figure 10 shows the average catch weight per tow for the study area, region1 of the MENH survey which encompasses New Hampshire and southern Maine, and also for the entire survey area. The spring average catch is fairly similar to the region 1 catches and slightly less than the entire survey area.



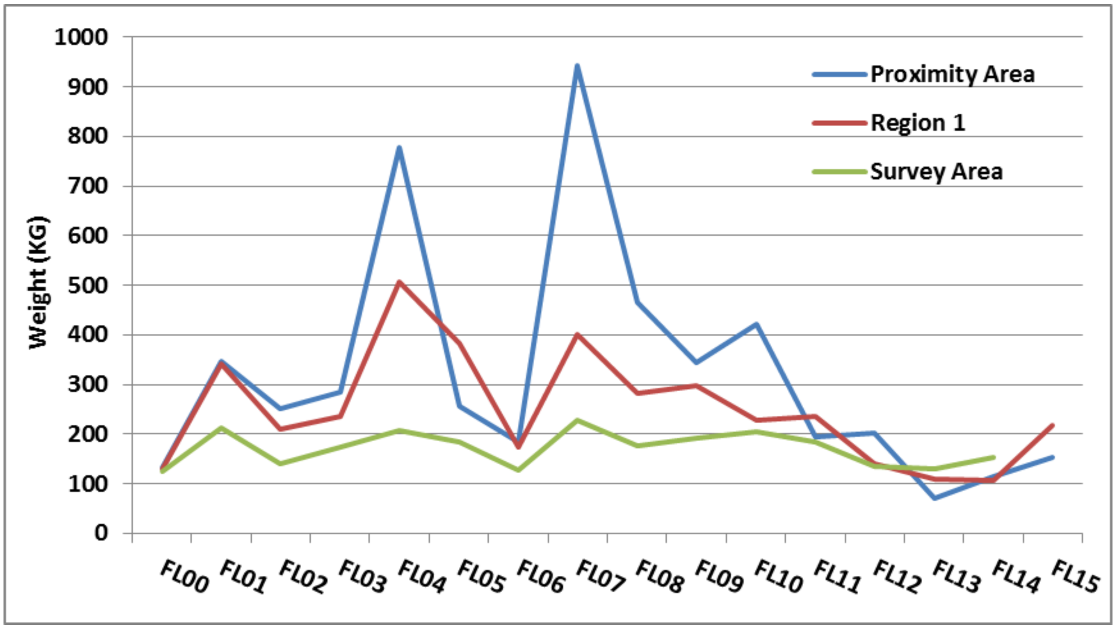


Figure 10. Seasonal average catch weights (per tow) for 3 areas. The blue line represents the area in proximity to the proposed disposal site, the red line represents MENH survey region 1 (New Hampshire and So. Maine), and the green line the entire survey area (coasts of Maine and New Hampshire.

Figure 11 indicates the top 30 species by average catch weight of finfish and invertebrates that were caught in the area over the time series shown in figure 1.

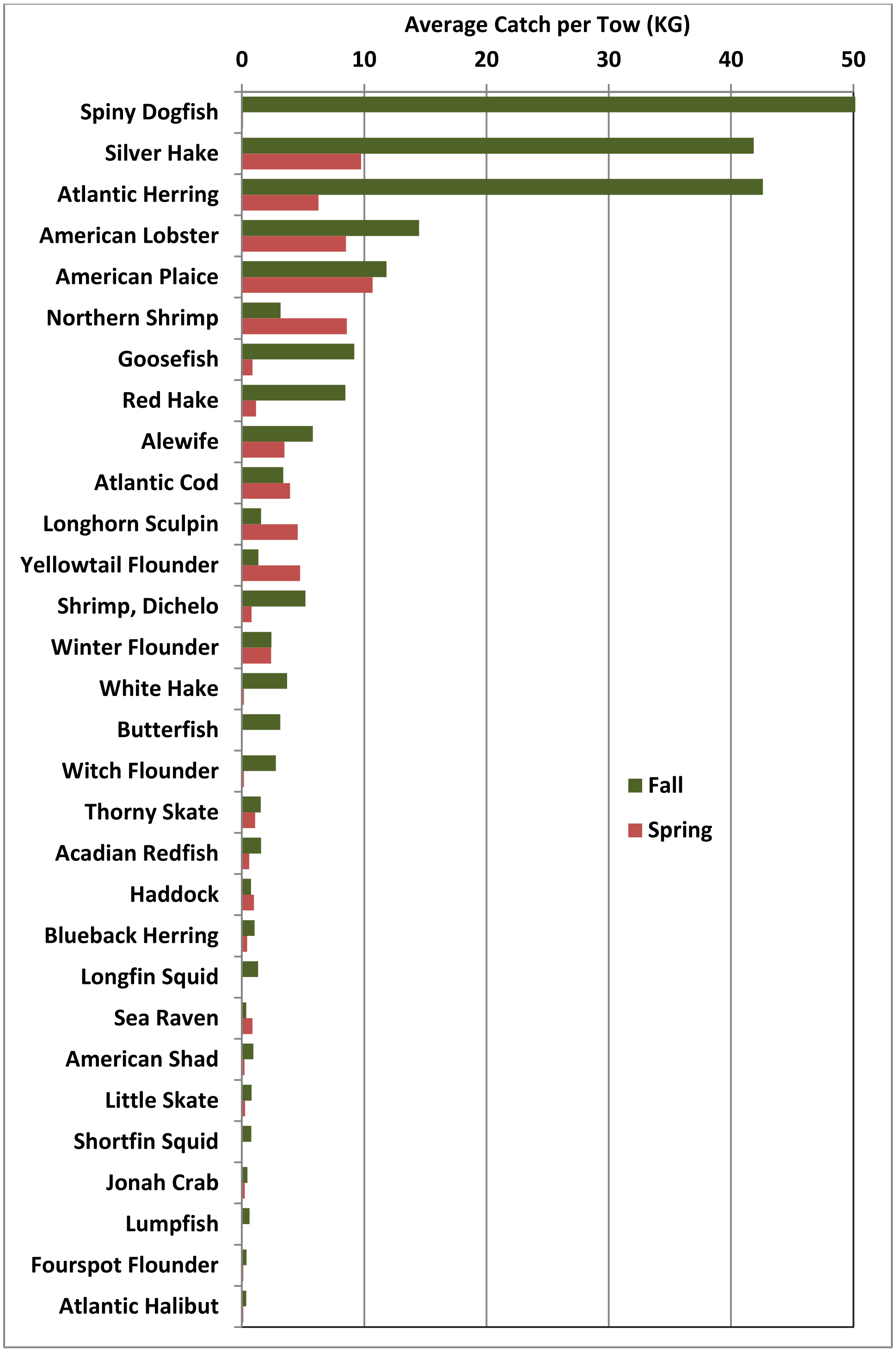


Figure 11. Average catch weight per tow for the top 30 species by season. The average weight for spiny dogfish was 135.15 kg.

Several commercially important groundfish species are seen in this area. Observations made while conducting the survey indicate that the area is utilized by commercial groundfish boats, trawlers and gillnetters as well as by herring trawlers and commercial lobsterman.

American plaice are frequently caught in tows conducted in this area, being caught in 119 of the 136 tows, for an 88% occurrence. The mean number per tow is 192 with a range per tow of 76 to 2068 Mean length for plaice in the spring tows was 18.7 cm and in the fall it was 18.1 cm. Sizes of plaice caught ranged from 5 cm to 59 cm. A sub-sample of plaice is examined for sex and maturity stage from these tows in the spring survey, approximately 35% of fish sampled were found to be near or in spawning condition. Spawning period for plaice is March to May (Burnett et al, 1989).

Goosefish (monkfish) are commonly caught in the survey tows; they are more abundant in the fall (Fig. 1). Goosefish were caught in 94 of the 136 tows conducted in the designated area. The overall average number per tow is 8 with a minimum of 1 and a maximum of 220 in any 1 tow. The mean lengths for goosefish were 23.5 cm in spring and 31.8 cm in the fall. Sizes of fish caught ranged from 7 to 88 cm, so the area is utilized by all life stages of goosefish. Of the goosefish examined for maturity in that area none were found to be near spawning condition but the spawning season is June to September (Burnett et al, 1989) so they survey timing is off somewhat.

The Gulf of Maine Atlantic cod stock is currently at an all-time low and is considered to be over fished (NEFSC REF DOC 13-1). Cod were caught in 88 of the 136 tows conducted in the designated area, 65% occurrence. The overall average number per tow is 6 with a minimum of 1 and a maximum of 179 in any 1 tow. The mean lengths for cod were 34.3 cm in spring and 39.4 cm in the fall. Sizes of fish caught ranged from 3 to 99 cm, so the area is also utilized by all life stages of cod. The majority of cod caught were examined for sex and maturity stage, approximately 10% were at or near spawning condition from this area in the spring survey. The spawning season for Atlantic cod is December to April (Burnett et al, 1989).

The GOM winter flounder stock status is considered to be currently low (NEFSC REF DOC 11-11). Winter flounder are seen in 108 out of 136 tows in the area, the catch numbers may be low with an average of 18 per tow but at 80% occurrence they are common to the area. Mean lengths are 20.2 cm for spring and 21.3 cm for fall. Sizes range from 7 cm to 49 cm. Again, the area is utilized by all life stages. Another species that maturity staging is conducted on, approximately 10% of fished examined from the area were at or near spawning condition in the spring. Spawning time typical for GOM winter flounder is March to May (Burnett et al, 1989).

Yellowtail flounder are seen in 100 out of 136 tows in the area and are more plentiful in the spring (Fig. 1). The catch numbers are at an average of 12 per tow but at 74% occurrence they are typical to the area. Mean lengths are 30.5 cm for spring and 30.1 cm for fall. Sizes range from 9 cm to 49 cm. Again, the area is utilized by all life stages. This species is also staged for maturity, approximately 38% of fished examined from the area were at or near spawning condition in the spring. Spawning period for yellowtail flounder is known to be May through August (Burnett et al, 1989).

In summary, the survey data indicates there is usage of the area by a large number of marine species. There is slight indication that the area may be used as spawning habitat. Based on survey data, American plaice, Atlantic cod, and winter flounder could potentially be using the area in the designated time frame of November to April. Winter flounder eggs are benthic and could be harmed by disposal of dredged material (NOAA Technical Memorandum NMFS-NE-138).

Table 3. List of the species caught in the MENH survey tows in the designated area and time period.

Common Name	**Scientific Name**
Acadian Redfish	*Sebastes fasciatus*
Aesop Shrimp	*Pandalus montagui*
Alewife	*Alosa pseudoharengus*
Alligatorfish	*Aspidophoroides monopterygius*
American Lobster	*Homarus americanus*
American Plaice	*Hippoglossoides platessoides*
American Sand Lance	*Ammodytes americanus*
American Shad	*Alosa sapidissima*
Anemone	*Anemonia sp.*
Atlantic Cod	*Gadus morhua*
Atlantic Halibut	*Hippglossus hippoglossus*
Atlantic Herring	*Clupea harengus*
Atlantic Mackerel	*Scomber scombrus*
Atlantic Silverside	*Menidia menidia*
Atlantic Torpedo	*Torpedo nobiliana*
Barndoor Skate	*Raja laevis*
Bigeye Scad	*Selar crumenopthalmus*
Black Sea Bass	*Centropristis striata*
Blue Mussel	*Mytilus edulis*
Blueback Herring	*Alosa aestivalis*
Bluefish	*Pomatomas saltatrix*
Bobtail Squid (unclass.)	*Sepiolidae*
Boreal Asterias	*Asterias vulgaris*
Bristled Longbeak	*Dichelopandalus leptocerus*
Buckler Dory	*Zenopsis conchifera*

Butterfish	*Peprilus triacanthus*
Cunner	*Tautogolabrus adspersus*
Daubed Shanny	*Lumpenus maculatus*
Fourbeard Rockling	*Enchelyopus cimbrius*
Fourspot Flounder	*Paralichthys oblongus*
Goosefish	*Lophius americanus*
Greenland Halibut	*Reinhardtius hippoglossoides*
Grubby	*Myoxocephalus aenaeus*
Gulf Stream Flounder	*Citharichthys arctifrons*
Haddock	*Melanogrammus aeglefinus*
Jellies, Sea pens, Salps, etc.	
Jonah Crab	*Cancer borealis*
Krill	*Euphausuid spp.*
Little Skate	*Raja erinacea*
Lobster shrimp	*Axius serratus*
Longfin Squid	*Loligo pealei*
Longhorn Sculpin	*Myoxocephalus octodecemspinosus*
Lumpfish	*Cyclopterus lumpus*
Mantis Shrimp	*Stomatopod sp.*
Moon Snail	*Lunatia heros*
Moustache Sculpin	*Triglops murrayi*
Northern Pipefish	*Syngnathus fuscus*
Northern Puffer	*Sphoeroides maculatus*
Northern Searobin	*Prionotus carolinus*
Northern Shrimp	*Pandalus borealis*
Northern Stone Crab	*Lithodes sp.*
Ocean Pout	*Macrozoarces americanus*
Octopus unclass.	*Cephalopoda spp.*
Pearlsides	*Maurolicus muelleri*
Polar Lebbeid	*Lebbeus polaris*
Pollock	*Pollachius virens*
Quahog	*Mercenaria mercenaria*
Rainbow Smelt	*Osmerus mordax*
Rat-tail Cucumber	*Caudina arenata*
Red Hake	*Urophycis chuss*
Rock Crab	*Cancer irroratus*
Sand Dollar	*Echinoidae sp.*
Scup	*Stenotomas chrysops*
Sea Raven	*Hemitripterus americanus*
Sea Scallop	*Placopecten magelanicus*
Sea sponges	*Demospongiae sp.*
Sea Urchin	*Stronglyocentrotus droebachiensis*
Sevenspine Bay Shrimp	*Crangon septemspinosa*

Shortfin Squid	*Illex illecebrosus*
Shrimp (unclass)	*Pandalus spp.*
Silver Hake	*Merluccius bilinearis*
Silver Rag	*Ariomma bondi*
Smooth Skate	*Raja senta*
Snakeblenny	*Lumpenus lumpretaeformis*
Snow Crab	*Chionectes opilio*
Spiny Dogfish	*Squalus acanthias*
Spiny Lebbeid	*Lebbeus groenlandicus*
Spotted Hake	*Urophycis regia*
Spotted Tinselfish	*Xenolepidichthys dalgleishi*
Starfish unclass.	*Stelleroideae sp.*
Ten-Ridged Whelk	*Neptunea decemcostata*
Thorny Skate	*Raja radiata*
Toad Crab	*Hyas araneus*
Waved Astarte	*Astarte undata*
White Hake	*Urophycis tenuis*
Windowpane	*Scophthalmus aquosus*
Winter Flounder	*Pseudopleuronectes americanus*
Winter Skate	*Raja ocellata*
Witch Flounder	*Glyptocephalus cynoglossus*
Wrymouth	*Cryptacanthodes maculatus*
Yellowtail Flounder	*Limanda ferruginea*

References

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Environmental Assessment and Evaluation Study for a Designation of an Ocean Dredged Material Disposal Site in Southern Maine, New Hampshire, and Northern Massachusetts

Appendix F

Essential Fish Habitat Assessment for IOSN

ESSENTIAL FISH HABITAT ASSESSMENT

Environmental Assessment and Evaluation Study
for Designation of an
Ocean Dredged Material Disposal Site in
Southern Maine, New Hampshire, and Northern Massachusetts

AUGUST 2019

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1.0 INTRODUCTION

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act require that an Essential Fish Habitat (EFH) consultation be conducted for activities that may adversely affect important habitats of federally managed marine and anadromous fish species. EFH includes "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." An assessment of EFH for the designation of an Ocean Dredged Material Disposal Site (ODMDS) in Southern Maine, New Hampshire, and Northern Massachusetts is included here for the proposed Isles of Shoals-North (IOSN) site.

2.0 PROPOSED ACTION

The availability of an ODMDS in the vicinity of southern Maine, New Hampshire, and northern Massachusetts is necessary to maintain safe navigation of authorized federal channels and permitted actions. Projected dredging needs for the area were calculated to be approximately 1.5 million cubic yards (CY) of material over the next 20 years. While there are alternatives to open water disposal available, the projected dredging needs quantities significantly exceed the capacity of available practicable alternatives. The States of Maine and New Hampshire have expressed concern over this situation to both the USACE and EPA. While the current situation does not constitute an imminent hazard to life and property, the EPA and USACE agreed that a prudent management action, the designation of an approved ODMDS, was required in order to meet the long-term dredging needs of southern Maine, New Hampshire, and northern Massachusetts.

Efforts were undertaken by the Federal government to study the possibility of expanding a currently used Section 103 site (the Cape Arundel Disposal Site) to accommodate the regions dredging needs. However, studies revealed that suitable areas for an ODMDS are limited at the current Section 103 site. Additionally, a historically used disposal site was examined for potential reuse, however, the site is located in an area that contains a diversity of habitats that are not compatible with the placement of dredge material. Given the lack of available existing capacity and the incompatibility of material types associated with alternative options available, the EPA and USACE are seeking to designate an ODMDS that will serve the region's long-term dredging needs. As such, the Isles of Shoals – North site (See Figure 3-6 of the Environmental Assessment) is being proposed to be designated as an ODMDS.

The designation of an ODMDS at the IOSN site would allow dredged material that has been found suitable for open water disposal by regulatory agencies to be placed at the site. The sources of the dredged material would be Federal Navigation Projects (FNP) and private projects within the draw area (See Section 2 of this Environmental Assessment). The estimated amount of dredged material needed to be removed within the draw area from FNPs is approximately 1.5 million cubic yards over the next 20 years. Placement events (on a year to year basis) would be infrequent as the projects within the draw area are each anticipated to be dredged only once during the projected 20-year period.

3.0 MANAGED SPECIES WITH EFH WITHIN AFFECTED AREA

Managed species listed for the area that includes the proposed IOSN site include: Atlantic wolffish *Anarhichas lupus* (eggs, larvae, juveniles, adults), little skate *Leucoraja erinacea* (adults), ocean pout *Macrozoarces americanus* (adult, eggs), smooth skate *Malacoraja senta* (juvenile, adult), silver hake *Merluccius bilinearis* (eggs, larvae, juveniles, adults), thorny skate *Amblyraja radiata* (juvenile, adult), Atlantic cod *Gadus morhua* (eggs, larvae, juveniles, adults), haddock *Melanogrammus aeglefinus* (juveniles, adults), pollock *Pollachius virens* (eggs, larvae, juveniles, adults), red hake *Urophycis chuss* (adults), white hake *Urophycis tenuis* (eggs, larvae, juveniles, adults), redfish *Sebastes fasciatus* (larvae, juveniles), witch flounder *Glyptocephalus cynoglossus* (eggs, larvae, juveniles, adults), yellowtail flounder *Pleuronectes ferruginea* (eggs, larvae), windowpane flounder *Scopthalmus aquosus* (larvae), American plaice *Hippoglossoides platessoides* (eggs, larvae, juveniles, adults), Atlantic halibut *Hippoglossus* (eggs, larvae, juveniles, adults), Atlantic sea herring *Clupea harengus* (larvae, juveniles, adults), monkfish *Lophius americanus* (eggs, larvae, juveniles, adults), blue shark *Prionace glauca* (juvenile, adult, basking shark *Cetorhinus maximus* (all) , common thresher shark *Alopias vulpinus* (all), porbeagle shark *Lamna nasus* (all), northern shortfin squid *Illex illecebrosus* (juvenile, adult), longfin inshore squid *Doryteuthis pealeii* (adult), Atlantic mackerel *Scomber scombrus* (larvae), Atlantic butterfish *Peprilus triacanthus* (juvenile adult), spiny dogfish *Squalus acanthias* (juveniles, adults), and bluefin tuna *Thunnus thynnus* (juvenile and adults).

4.0 ANALYSIS OF IMPACTS

Potential impacts to EFH from the disposal of dredged material include changes in the chemical and physical properties of the water column, changes in sediment types, and changes in water depth. Only dredged material suitable for ocean disposal would be placed at an ODMDS. Changes in the abundance and/or distribution of benthic prey species may also result from placement activities. These impacts may range from short-term, as in high total suspended solids (TSS) in the water column during placement, to longer term impacts such as the changing of bathymetry that results from the placement of dredged material.

4.1 Physical Environment

Water Quality - The impacts of the IOSN designation and subsequent material placement on water quality are not expected to be long-term. Water temperature, salinity, and dissolved oxygen (DO) may be altered during the actual disposal activities, however, these changes to the water column are temporary and will return to “pre-disposal” conditions upon completion of the disposal activities. Short-term water quality impacts will be due mostly to increased total suspended sediment (TSS) loads in the water column, and changes in DO that result from increased TSS. No appreciable changes in the salinity regime, current flows, or tide height are expected as a result of this designation.

Bathymetry/Water Depth -- The proposed IOSN designation, and subsequent disposal of dredged material at the site, would produce long-term changes to the bathymetry of disposal site due to the deposition of sediment at the site. Water depths at the disposal site will become shallower. However, the change in bathymetry is not anticipated to impact the various fish species that use the IOSN site as the long-term elevation changes will be minor (i.e., tens of feet).

Sediment Type - The sediment type at the IOSN site is not expected to change significantly. The sediment type at the proposed disposal is composed of fine-grained sediment (see section 6.2 of the Environmental Assessment). Disposal of fine-grained dredged material, which is the predominate type of material anticipated to be placed at the IOSN site, will not change the sediment composition of the disposal site to any appreciable extent.

4.2 Biological Environment

Prey Species - The abundance and/or distribution of prey species for fish for which EFH has been designated may be impacted from disposal activities if the IOSN site is used for material placement following designation. Many of the fish with EFH in the area of IOSN feed on organisms that live in or on the sediment. During disposal operations, prey species which live in the sediment in the direct footprint of the material placement are likely to be buried. As the sediments to be disposed of at IOSN are expected to be similar in nature to materials at IOSN, benthic prey species are expected to recolonize the areas within the site used for placement, thus only impacting fish during disposal events until the benthic community recolonizes the site.

Prey species that live in the water column are also likely to be impacted during disposal activities. The TSS resulting from disposal activities will likely destroy planktonic species in the vicinity of the TSS plume resulting from disposal. However, this area will be limited to the water column above each disposal event. Following completion of disposal, this habitat will be recolonized by adjacent plankton populations.

4.3 Impact to Essential Fish Habitat for Managed Species

Disposal activities that will follow the designation of the proposed IOSN site as an ODMDS are also likely to have some temporary impacts on the EFH species present at the proposed disposal site during disposal and until the benthic habitat at the disposal site recovers. Demersal species such as flounders will experience greater impacts than pelagic species, and eggs and larvae will experience greater impacts than juveniles and adults. The species with the most potential to be adversely affected by disposal would be those that have demersal eggs and larvae. Demersal eggs and larvae are likely to be buried as dredged material is dumped at the disposal site. Species that have planktonic eggs and larvae in the water column may also be seriously damaged or killed as they encounter the mass of material released from the scow.

Juveniles and adults of demersal species may be buried if they do not quickly move from the area when disposal begins. Smaller juveniles are more likely to be buried than larger juveniles or adults. Pelagic juveniles and adults will likely experience minimal impacts as they are able to quickly move from the area as disposal begins. Small pelagic juveniles, however, may be damaged or killed if they are not able to escape the rapidly descending sediment particles during the disposal activities.

4.3.1 Demersal Species

Demersal species are those fish living on or near the bottom. Demersal species found in the project area include flounders and groundfish.

Atlantic wolffish *Anarhichas lupus* (eggs, larvae, juveniles, adults)

The proposed IOSN site contains habitat designated as EFH for all life stages of Atlantic wolffish (*Anarhichas lupus*). EFH for Atlantic wolffish is generally described as bottom habitat of 40 to 240 meters deep in areas of open water. Wolffish eggs are laid on bottom substrates while larvae are both demersal and pelagic for short periods of time. Juvenile and adult wolffish are present in deep waters and do not appear to have a substrate preference.

Effects: Wolffish have been documented in the MENH nearshore trawl surveys in the vicinity of the proposed IOSN site (see Section 6.5.3 of the Environmental Assessment). The disposal of material at the proposed IOSN has the potential to impact all life stages of wolffish through burial. As impacts to the water column habitat and benthic habitat in the proposed IOSN footprint are expected to be short term and highly localized, no significant effects to wolfish EFH are anticipated.

Little Skate *Leucoraja erinacea* (adults)

The project area is designated as EFH for adult little skates (*Leucoraja erinacea*). The little skate has a coastal distribution and is found in habitats with sandy, gravelly, or mud substrates of the shallow water in the western Atlantic from Nova Scotia, Canada to North Carolina, USA. This species can tolerate a wide range of temperatures and salinity ranges from 27- 33.8 ppt. They are found from the surface waters to depths of 295 feet (90 m). The little skate does not appear to have large-scale migrations, but they do move to shallower water during the summer and move to deeper water in fall or early winter.

Effects: Little skate have been documented in the MENH nearshore trawl surveys in the vicinity of the proposed IOSN site. The disposal of material at the proposed IOSN has the potential to impact adult little skate through burial. As impacts to the benthic habitat in the proposed IOSN footprint are expected to be short term and highly localized, no significant effects to little skate EFH are anticipated.

Smooth skate *Malacoraja senta* (juvenile, adult)

The proposed IOSN site has habitat designated as EFH for juvenile and adult smooth skate (*Malacoraja senta*). Juvenile and adult smooth skate utilize benthic habitats between 100 and 400 meters in the Gulf of Maine, on the continental slope to a depth of 900 meters, and in depths less than 100 meters in the high salinity zones of a number of bays and estuaries along the Maine coast. EFH for juvenile smooth skates occurs mostly on soft mud in deeper areas, but also on sand, broken shells, gravel, and pebbles on offshore banks in the Gulf of Maine.

Effects: Smooth skate have been documented in the MENH nearshore trawl surveys in the vicinity of the proposed IOSN site. The disposal of material at the proposed IOSN has the potential to impact juvenile and adult smooth skate through burial. As impacts to the benthic habitat in the proposed IOSN footprint are expected to be short term and highly localized, no significant effects to smooth skate EFH are anticipated.

Silver hake *Merluccius bilinearis* (eggs, larvae, juveniles, adults)

EFH is designated for all life stages of silver hake (*Merluccius* bilinearis) in the proposed IOSN site. Juvenile silver hake are found on bottom habitats of all substrate types, water temperatures below 21º C, generally at depths between 66 and 886 feet (20 - 270 m) and salinities greater than 20%. The adults are also found on bottom habitats of all substrate types, at water temperatures below 22° C and generally at depths between 94 and 1,066 feet (30 - 325 m). Eggs and larvae are found in pelagic habitats from the Gulf of Maine to Cape May, New Jersey, including Cape Cod and Massachusetts Bays.

Effects: Silver hake have been documented in the MENH nearshore trawl surveys in the vicinity of the proposed IOSN site. The disposal of material at the proposed IOSN has the potential to impact all life stages of silver hake burial during disposal. As impacts to the water column habitats and benthic habitats in the proposed IOSN footprint are expected to be short term and highly localized, no significant effects to silver hake EFH are anticipated.

Witch flounder *Glyptocephalus cynoglossus* (eggs, larvae, juveniles, adults)

The witch flounder *Glyptocephalus cynoglossus* is a demersal species that is distributed throughout the Gulf of Maine and deeper waters along Georges Bank, and along the edge of the continental shelf south to Cape Hatteras, North Carolina. Witch flounder are sedentary and are more common in water depths greater than 90 meters; most are caught between 110 and 275 meters (361 and 902 feet). Witch flounder are found on substrates of mud, clay, mud/clay mixed with sand, and smooth ground between rocky patches. They spawn in late spring and summer, peaking in May and June. The eggs are pelagic and drift in the plankton. Larvae are also pelagic and are commonly found over depths of 28 to 250 meters (92 to 820 feet).

Effects. Impacts to witch flounder eggs and larvae during disposal of dredged material at the proposed IOSN site will occur if eggs and larvae are in the water column over the disposal site during disposal. Juvenile and adult witch flounder are likely to occur at IOSN as they have been documented in the MENH inshore trawl surveys. Since impacts to IOSN water column habitat and benthic habitat are expected to be short term and localized, no significant effects to witch flounder EFH are expected.

Yellowtail flounder *Limanda ferruginea* (eggs, larvae)

Yellowtail flounder *Limanda ferruginea* is a demersal species that is distributed along the northwestern Atlantic from Labrador to the Chesapeake Bay. Yellowtail flounder are a "right-eyed" species and are relatively sedentary, preferring bottoms of sand or sand and mud in waters from 30 to 90 meters (98 to 295 feet) in depth. Discrete stocks have been identified off Southern New England, Georges Bank, Cape Cod, and in the Middle Atlantic. Yellowtail flounder spawn in spring and summer with peaks observed in May. The eggs are pelagic and float near the surface in water depths ranging from 10 to 90 meters (33 to 295 feet). Larvae are also pelagic and drift in the plankton for approximately a month or two before settling to the bottom.

Effects. Impacts to yellowtail flounder eggs and larvae during disposal of dredged material at the proposed IOSN site will occur if eggs and larvae are in the water column over the disposal site during disposal. Juvenile and adult yellowtail flounder are likely to occur at IOSN as they have been documented in the MENH inshore trawl surveys. Since impacts to IOSN water column habitat and benthic habitat is expected to be short term and localized, no significant effects to yellowtail flounder EFH are expected.

Windowpane flounder *Scopthalmus aquosus* (larvae)

Windowpane flounder *Scophthalmus aquosus* is a demersal species that is distributed in the northwest Atlantic along the continental shelf from the Gulf of St. Lawrence to Florida and is particularly common in large estuaries in waters less than 56 meters (184 feet). The windowpane flounder is a "left-eyed" flounder that is found over sand, mixtures of sandy silt or mud. No seasonal migration is evident in New England waters. Spawning occurs from April through December with peaks from May through October in waters below 21ºC and salinities between 5.5 and 36 ppt. Eggs and larvae are pelagic and float near the surface, drifting with currents. Juveniles are most often observed in the sublittoral zones generally in water depths of 6 to 14 meters (20 to 46 feet).

Effects. Windowpane flounder larvae have the potential to occur at the proposed IOSN site as this species was collected in the MENH inshore trawl surveys noted above. Since impacts to IOSN water column habitat and benthic habitat are expected to be short term and localized, no significant effects to windowpane flounder EFH are expected.

American plaice *Hippoglossoides platessoides* (eggs, larvae, juveniles, adults),

The American plaice *Hippoglossoides platessoides* is a demersal species that is distributed in the Northwest Atlantic along the continental shelf from southern Labrador to Rhode Island. The American plaice is a "right-eyed" flounder that prefers substrates of mud, sand, or mud-sand mixtures. The species is generally found from the tide line down to 700 meters (2,297 feet) in depth. Spawning occurs on bottom habitats of all substrate types in waters less than 90 meters (295 feet) in depth and temperatures less than 14ºC from March through June. Eggs and larvae are pelagic floating/drifting in the surface water. Larvae sink to greater depths as they grow and at metamorphosis will take up residence on the bottom.

Effects. Impacts to American plaice eggs and larvae during disposal of dredged material at the proposed IOSN site will occur if eggs and larvae are in the water column over the disposal site during disposal. Juvenile and adult plaice are likely to occur at IOSN as they have been documented in the MENH inshore trawl surveys. Since impacts to IOSN water column habitat and benthic habitat are expected to be short term and localized, no significant effects to American plaice EFH are expected.

Atlantic halibut *Hippoglossus hippoglossus* (eggs, larvae, juveniles, adults),

EFH is designated within the project area for all life stages of the Atlantic Halibut (*Hippoglossus hippoglossus).* The eggs of the Atlantic halibut are typically found at depths of less than 700 meters in bottom waters at salinities <35ppt). Spawning, and therefore the presence of eggs, occurs from November to March with the peak in November and December. EFH for juveniles is 20-70m water depths with salinities between 30 and 35ppt in a substrate of sand, gravel or clay. For adults, the habitat includes water depths <700m with similar substrates.

Effects. Impacts to halibut eggs and larvae during disposal of dredged material at the proposed IOSN site will occur if eggs and larvae are in the water column over the disposal site during disposal. Juvenile and adult halibut are likely to occur at IOSN as they have been documented in the MENH inshore trawl surveys. Since impacts to IOSN water column habitat and benthic habitat are expected to be short term and localized, no significant effects to Atlantic halibut EFH are expected.

Ocean pout *Macrozoarces americanus* (adult, eggs)

Ocean pout *Macrozoarces americanus* are demersal eel-like fish that are distributed in the northwest Atlantic from Labrador to Delaware. This species does not make extensive migrations but does move to different habitats when seasons change. During winter and spring, ocean pout are common feeding in areas over bottom substrates of sand and sand-gravel. Feeding ceases in summer and ocean pout move to rocky areas where they spawn. Spawning occurs in September and October. Demersal eggs are guarded by adult fish until eggs hatch.

Effects. Ocean pout have been documented in the vicinity of IOSN by the MENH inshore trawl surveys noted in Section 6 of the Environmental Assessment. Ocean pout adults and eggs may experience some impact from burial during disposal operations at the proposed IOSN. However, as the ocean pout prefers sand and sandy gravel habitat, no significant effect to ocean pout EFH is expected as the sediments at the proposed disposal site are silt.

Atlantic cod *Gadus morhua* (eggs, larvae, juveniles, adults)

The Atlantic cod *Gadus morhua* is a demersal species distributed in the northwest Atlantic from Greenland to North Carolina. Cod form large loose schools several km long and wide. They tend to avoid temperatures greater than 10ºC and are most commonly found in depths of 40 to 130 meters (131 to 427 feet) within the limits of the continental shelf along rocky slopes or ledges over bottom substrates of rocky, pebbly, or gravelly areas, and sometimes over sand, clay, or mud bottoms. They can also be found in harbors, lagoons, brackish river mouths, and freshwater rivers. The Mid-Atlantic Bight population of cod tends to concentrate north of Block Island in the summer and along the New Jersey coast in winter. Spawning occurs primarily during November through May in any number of places including inlets, bays, harbors, both coastal and offshore banks, over bottoms of rock, clay, sand, mud, and aquatic vegetation. Eggs are found in bays and in the open ocean floating at or near surface. Larvae are also found at the surface, drifting with the currents. As larvae grow, they move deeper into the water column. They are commonly found over deep waters, around rocks in bays, in shallow sounds, coves with light bottoms, beaches, and in shallow water over muddy bottoms among weeds. As juveniles, cod generally move toward shore and begin a demersal existence.

Effects. Impacts to Atlantic cod eggs and larvae during disposal of dredge material may occur if eggs and larvae are in the water column over the disposal site during disposal. Those eggs and larvae at the surface are likely to be less impacted than eggs and larvae deeper in the water column. For juvenile and adult cod, the likelihood of impact is low as juvenile and adult cod prefer substrates of rocks, pebble and gravel, and the substrate at IOSN is silt. Therefore, only minimal impacts to cod and cod EFH are anticipated.

Haddock *Melanogrammus aeglefinus* (juveniles, adults)

Haddock *Melanogrammus aeglefinus* are a demersal species distributed in the western Atlantic from Greenland to Cape Hatteras, North Carolina. Adult haddock are generally more common in water depths from 45 to 135 meters (148 to 443 feet) and temperatures ranging from 2 to 10ºC. They are found in bottom habitats with substrates of sand, rock, pebbles, gravel or broken shell. Spawning occurs between January and June, peaking during March and April. Eggs are pelagic and are generally concentrated within the upper 10 meters (33 feet) of the water column. Larvae are also pelagic and are typically oceanic although they may be found in estuaries. Juveniles are found initially in the water column but will descend to the bottom as they get older. Juvenile haddock tend to remain in more shallow water on banks and shoals, moving to deeper areas as adults.

Effects: Haddock have been documented in the vicinity of the proposed IOSN site by the MENH inshore trawl surveys noted in Section 6 of the Environmental Assessment. Haddock adults may experience some impact from burial during disposal operations at the proposed IOSN. However, as haddock prefer sand and sandy gravel habitat, no significant effect to haddock EFH is expected as the sediments at the proposed disposal site are silt.

Pollock *Pollachius virens* (eggs, larvae, juveniles, adults),

EFH for all life stages of pollock (*Pollachius virens*) is designated in the vicinity of the proposed IOSN site. Pollock are typically found over bottom habitats with aquatic vegetation, sand, mud, or rocks in waters ranging from depths of <1 to 150 meters (3 to 492 feet). Salinity preference for ranges from 29 to 32 ppt.

Effects. Pollock have been documented in the vicinity of IOSN by the MENH inshore trawl surveys noted in Section 6 of the Environmental Assessment. All life stages of pollock may experience some impact from burial during disposal operations at the proposed IOSN. However, as the impacts to water column habitat and benthic habitats in the proposed IOSN location are anticipated to be short term and highly localized, no significant impacts to pollock EFH are expected.

Red hake *Urophycis chuss* (adults)

The red hake *Urophycis chuss* is distributed in the northwest Atlantic from the Gulf of St. Lawrence to North Carolina. This species undergoes extensive seasonal migrations, moving into shallow waters in the spring and summer to spawn and moving offshore to overwinter in deeper waters of the outer continental shelf and slope, particularly the area south and southwest of Georges Bank. Spawning occurs from May through November, with Southern New England a primary spawning area. Red hake spawn in coastal waters over the continental shelf in water 46.8 to 108 meters (154 to 354 feet) in depth and temperatures between 5 and 10ºC. Red hake eggs are pelagic, and float in plankton. Larvae also drift at the surface in the plankton often under eelgrass and rockweed. Young juvenile red hake are found initially at the surface, but as they grow (approximately 27 – 49 mm length) they descend to the bottom and are often found in the mantle cavity of shellfish (*i.e.*, scallops) under sponges, or in other benthic litter. Juveniles will remain in the vicinity of shellfish beds for 2 years if temperatures remain above 4ºC. If temperatures fall below 4ºC, juveniles will migrate to warmer, deeper water. Adult red hake stay close to objects on the bottom (*i.e.*, shellfish beds) and can be found over soft mud or silt substrates and less frequently over sand and shell, and never rocky bottoms. Two stocks have been identified – a Gulf of Maine-Northern Georges Bank stock and Southern Georges Bank-Middle Atlantic stock.

Effects. Red hake have been documented by the MENH inshore trawl surveys noted in Section 6 of the Environmental Assessment. Adult red hake are likely to experience some impact from burial during disposal operations at the proposed IOSN. However, larger more mobile adults and will likely move to avoid the disposal plume. As the material to be placed at the proposed IOSN is similar to the existing sediments and the benthic community at the disposal site should recover following the cessation of disposal events, no significant impact to red hake EFH is expected.

White hake *Urophycis tenuis* (eggs, larvae, juveniles, adults),

EFH is designated for all life stages of white hake *(Urophycis tenuis)* in the project area. The juvenile and adult hake can be found in waters ranging from 5 to 300 meters over mainly mud and sand substrates.

Effects. White hake have been documented by the MENH inshore trawl surveys noted in Section 6 of the Environmental Assessment. Adult white hake are likely to experience some impact from burial during disposal operations at the proposed IOSN. However, larger more mobile adults and will likely move to avoid the disposal plume. As the material to be placed at the proposed IOSN is similar to the existing sediments and the benthic community at the disposal site should recover following the cessation of disposal events, no significant impact to white hake EFH is expected.

Redfish *Sebastes fasciatus* (larvae, juveniles)

EFH for redfish larvae include pelagic habitats in the Gulf of Maine, on the southern portion of Georges Bank, and on the continental slope north of 37°38'N latitude. EFH for juvenile redfish includes sub-tidal coastal and offshore benthic habitats in the Gulf of Maine between 50 and 200 meters, and on the continental slope to a maximum depth of 600 meters north of 37°38'N latitude. Juveniles prefer bottom habitats of complex rocky reef substrates with associated structure-forming epifauna (e.g., sponges, corals) and soft sediments with cerianthid anemones. Adult EFH is offshore benthic habitats in the Gulf of Maine, primarily in depths between 140 and 300 meters, and on the continental slope to a maximum depth of 600 meters north of 37°38'N latitude. EFH for adult redfish occurs on finer grained bottom sediments and variable deposits of clays, silts, gravel, and boulders with associated structure forming epifauna (e.g. corals, sponges, cerianthid anemones, sea pens).

Effects: Redfish have been documented by the MENH inshore trawl surveys noted in Section 6 of the Environmental Assessment. All life stages are likely to experience some impact from burial during disposal operations at the proposed IOSN. Larger mobile adults will likely move to avoid the disposal plume. However, larvae and juveniles in the water column may experience impacts during material disposal at the site. As the material to be placed at the proposed IOSN is similar to the existing sediments and the benthic community at the disposal site should recover following the cessation of disposal events, no significant impact to redfish EFH is expected. Additionally, since the water column effects from disposal are short term and localized, no significant effects to larvae and/or juvenile redfish EFH are expected.

Monkfish *Lophius americanus* (eggs, larvae, juveniles, adults),

Monkfish, or goosefish *Lophius americanus* are distributed in the northwest Atlantic from the Gulf of St. Lawrence to Cape Hatteras North Carolina. Adult monkfish are found in bottom habitats with various substrates including hard sand, sand-shell mix, mud, gravel, and algae covered rocks along the continental shelf in waters from 70 to 100 meters (230 to 328 feet) in depth but may also be found at depths of 800 meters (2625 feet). Spawning occurs in these habitats at water depths of 25 to 200 meters (82 to 656 feet), water temperatures below 13ºC, and salinities ranging from 29.9 to 36.7 ppt. Eggs are shed in a continuous ribbon-like sheet of gelatinous mucus which can be as large as 12 meters (39 feet) long and 1.5 meters (5 feet) wide. These egg "veils" float in the water column, generally close to the surface. Larvae and juveniles spend several months in a pelagic phase before juveniles settle to the bottom.

Effects. Monkfish hake have been documented by the MENH inshore trawl surveys noted in Section 6 of the Environmental Assessment. All life stages are likely to experience some impact from burial during disposal operations at the proposed IOSN. Larger mobile adults will likely move to avoid the disposal plume. However, eggs, larvae and juveniles in the water column may experience impacts during material disposal at the site. As the material to be placed at the proposed IOSN is similar to the existing sediments and the benthic community at the disposal site should recover following the cessation of disposal events, no significant impact to adult monkfish EFH is expected. Additionally, since the water column effects from disposal are short term and localized, no significant effects to egg, larvae, and/or juvenile monkfish EFH are expected.

4.3.2 Pelagic Species

Pelagic species are those species that live at the surface layers or mid depth layers within the water column. Pelagic species found within the project area include bony fish, sharks, and invertebrates.

Atlantic sea herring *Clupea harengus* (larvae, juveniles, adults)

The Atlantic sea herring *Clupea harengus* is distributed in the northwest Atlantic in continental shelf waters from Labrador to Cape Hatteras, North Carolina. This species is an open water planktivorous fish that is found in large schools. Adult Atlantic sea herring are generally found offshore, but some populations may migrate inshore during spawning season. Spawning generally occurs in bottom habitats with substrates of gravel, sand, cobble, shell fragments, or aquatic macrophytes. Spawning generally occurs from July through November in well-mixed waters below 15ºC with tidal currents between 1.5 and 3.0 knots. Water depths at spawning locations range from 20 to 80 meters (66 to 262 feet) and salinities range from 32 to 33 ppt. Atlantic sea herring eggs are demersal and adhesive and are most often observed in large sheets directly on stone, gravel, or shell beds. Larvae are first found in the vicinity of spawning areas and within hours of hatching, they will form small schools and begin vertical movements upward at night until they become dispersed by currents. Juveniles drift with currents and may remain in bays/estuaries or may be found offshore at sea. As adults (in large schools), the Atlantic sea herring's movements are typically local and short range and they undertake vertical migrations - rising at night and sinking by day.

Effects. Given the distribution of Atlantic herring and the highly localized extent of the proposed site, impacts to the Atlantic herring EFH are anticipated to be minimal. As noted in the Environmental Assessment, placement of material at the proposed site would generally be restricted temporally to late fall and winter months, thus reducing potential for impact to the Atlantic herring EFH. Additionally, the projected site usage for dredged material placement (see Table 2-1 of the Environmental Assessment) is expected to be infrequent. Therefore, no significant effects to the Atlantic herring EFH are expected as a result of designating the site as an ODMDS.

Atlantic butterfish *Peprilus triacanthus* (juvenile and adult)

The Atlantic butterfish *Peprilus triacanthus* is distributed in the northwestern Atlantic from Newfoundland to Florida but is most common between the Gulf of Maine and Cape Hatteras North Carolina. This species tends to loosely school near the surface in waters overlying sand bottoms several hundred feet from shore. Butterfish are common in coastal waters during the summer months, moving north and inshore to feed. During winter, butterfish move south and offshore to deeper warmer water to overwinter. Spawning occurs in the coastal waters offshore during the summer months (June through August). Eggs and larvae are pelagic and drift in the plankton

Effects. Atlantic butterfish juveniles and adults were observed in the MENH inshore trawl surveys noted in Section 6 of the Environmental Assessment. Juvenile and adult butterfish are likely to move from the water column areas while dredged material is being disposed, resulting in only minimal impacts to individuals. As noted above, impacts to the water column are expected to be short term and localized, therefore no significant effects to Atlantic Butterfish EFH are expected.

Blue shark *Prionace glauca* (juvenile, adult)/ Basking shark *Cetorhinus maximus* (all)
Common thresher shark *Alopias vulpinus* (all)/ Porbeagle shark *Lamna nasus* (all)
Spiny dogfish *Squalus acanthias* (juveniles, adults)

EFH designation/Effects: The shark species noted above have the potential to occur in the pelagic habitat over the proposed IOSN site. As impacts to the water column habitat over the proposed IOSN site are expected to be short term and localized, no significant effects to the EFH of the various species of sharks noted above are expected.

Northern shortfin squid *Illex illecebrosus* (juvenile, adult)/ Longfin inshore squid *Doryteuthis pealeii* (adult)

EFH designation/Effects: The squid species noted above have the potential to occur in the pelagic habitat over the proposed IOSN site. As impacts to the water column habitat over the proposed IOSN site are expected to be short term and localized, no significant effects to the EFH of the various species of squid noted above are expected.

Atlantic mackerel *Scomber scombrus* (larvae)

The Atlantic mackerel *Scomber scombrus* is distributed in the northwest Atlantic between Labrador and North Carolina. The mackerel is a fast swimming pelagic fish found in very large schools. Atlantic mackerel are generally found offshore and are not dependent on the coastline or bottom substrate for any period of their lives. Smaller fish, however, may move inshore into estuaries and harbors in search of food. Spawning occurs in spring and early summer (typically June) at any location, resulting in pelagic egg and larval stages that are dispersed by currents.

Effects. Impacts to Atlantic mackerel larvae at the proposed IOSN site are expected to be minimal. Impacts to the water column habitat from dredged material disposal are expected to be short term and localized, therefore no significant effects to Atlantic mackerel EFH are expected.

Bluefin tuna *Thunnus thynnus* (juvenile and adults).

The bluefin tuna *Thunnus thynnus* is distributed in many regions including the warmer parts of the Atlantic, Pacific, and Indian oceans, as well as the Mediterranean Sea. In the western Atlantic, the bluefin tuna ranges from Labrador south along the U.S. coast into the Gulf of Mexico and the Caribbean and from Venezuela to Brazil. Bluefin tuna are a strong swift swimming migratory pelagic species. They school by size and are common in the Gulf Stream. In July through October, bluefin tuna will congregate on the continental shelf off New England. Spawning is believed to occur in May and June in the Straits of Florida and does not appear to occur north of this along the U.S. coast. Bluefin tuna eggs and larvae are pelagic and drift in the currents. Small juveniles arrive to feed in the northeastern Atlantic (Virginia to Cape Cod) in mid-June to July and will spend the winter above the 36ºN in offshore waters warmer than 16 to 17ºC.

Effects. Impacts to bluefin tuna at the proposed IOSN site are expected to be minimal. Impacts to the water column habitat from dredged material disposal are expected to be short term and localized, therefore no significant effects to Bluefin tuna EFH are expected.

5.0 CONCLUSIONS

Although the designation of IOSN as an ODMDS does not result in the disposal of dredged material at the site, the designation will allow dredged material that has been found suitable for open water placement to be placed at the site. As such, the impacts of designating the site and the subsequent placement of dredged material at the site have been considered in this EFH assessment. As noted in the Environmental Assessment and throughout this EFH Assessment, impacts to the physical and biological conditions at the IOSN site are not anticipated to be significantly affected by site designation and dredged material disposal. The majority of the impacts that would negatively affect EFH for managed species will be short term and localized and are not expected to significantly alter essential fish habitat permanently. The long-term effects of increased bathymetry in the footprint of the site is not expected to negatively affect EFH for managed species.

Environmental Assessment and Evaluation Study for a Designation of an Ocean Dredged Material Disposal Site in Southern Maine, New Hampshire, and Northern Massachusetts

Appendix G

Site Management and Monitoring Plan (SMMP)

Isles of Shoals Dredged Material Disposal Site North

Site Management and Monitoring Plan

August 2019

U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

U.S. Environmental Protection Agency
Region 1
5 Post Office Square, Suite 100
Boston, MA 02109

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ACRONYMS AND KEYWORDS

aRPD	Apparent Redox Potential Discontinuity
CFR	Code of Federal Regulations
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DAMOS	Disposal Area Monitoring System
EA	Environmental Assessment
DMR	Department of Marine Resources
DPS	Distinct Population Segment
DQM	Dredging Quality Management
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
GoMOOS	Gulf of Maine Ocean Observation System
IOSN	Proposed Isles of Shoals North
ITM	Inland Testing Manual
MPRSA	Marine Protection, Research, and Sanctuaries Act of 1972
NEPA	National Environmental Policy Act
NERACOOS	Northeast Regional Association of Coastal Ocean Observation Systems
NERDT	New England Regional Dredging Team
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
ODMDS	Ocean Dredged Material Disposal Site
QA	Quality Assurance
RIM	Regional Implementation Manual
SMMP	Site Management and Monitoring Plan
SPI	Sediment Profile Imaging
TOC	Total Organic Carbon
USACE-NAE	U.S. Army Corps of Engineers, New England District
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
QA	Quality Assurance
QAPP	Quality Assurance Project Plan

1.0 INTRODUCTION

The primary statutes governing the aquatic disposal of dredged material in the United States are the Marine Protection, Research, and Sanctuaries Act (MPRSA), 33 U.S.C. §§ 1401, et seq., and the Clean Water Act (CWA), 33 U.S.C. §§ 1251, et seq. The MPRSA applies to the disposal of dredged material in the waters of the Gulf of Maine *seaward* of the baseline from which the territorial sea of the United States is measured. This applies to both the authorization of specific disposal sites and the assessment of the suitability of specific dredged material for disposal.

Section 102(c) of the MPRSA, 33 U.S.C. § 1412(c), authorizes the U.S. Environmental Protection Agency (EPA) to designate sites where ocean disposal of dredged material may be permitted. *See also* 33 U.S.C. § 1413(b) and 40 CFR § 228.4(e). Ocean dredged material disposal sites (ODMDS) designated by EPA under the MPRSA are subject to detailed management and monitoring protocols to track site conditions and prevent the occurrence of unacceptable adverse effects to the marine environment. *See* 33 U.S.C. § 1412(c)(3). Those management and monitoring protocols are described in a Site Management and Monitoring Plan (SMMP) developed jointly by EPA and the U.S. Army Corps of Engineers (USACE). *See id.*

The Region 1 office of EPA (EPA Region 1) is proposing to designate the Isles of Shoals Dredged Material Disposal Site North (IOSN) in 2019 under Section 102(c) of the MPRSA (EPA Region 1, 2019). EPA is proposing to designate the site to help meet the long-term needs for dredged material disposal in southern Maine, New Hampshire, and northern Massachusetts (*see* Figure 1). In conjunction with the site designation, EPA Region 1 and the U.S. Army Corps of Engineers, New England District (USACE-NAE) are developing this SMMP for the proposed IOSN. Section 102(c)(3) requires that "the Administrator and the Secretary shall provide opportunity for public comment" in developing SMMPs for each EPA-designated dredged material disposal site. EPA Region 1is providing an opportunity for public comment for the SMMP at the same time as the draft Environmental Assessment and Proposed Rule for the site designation.

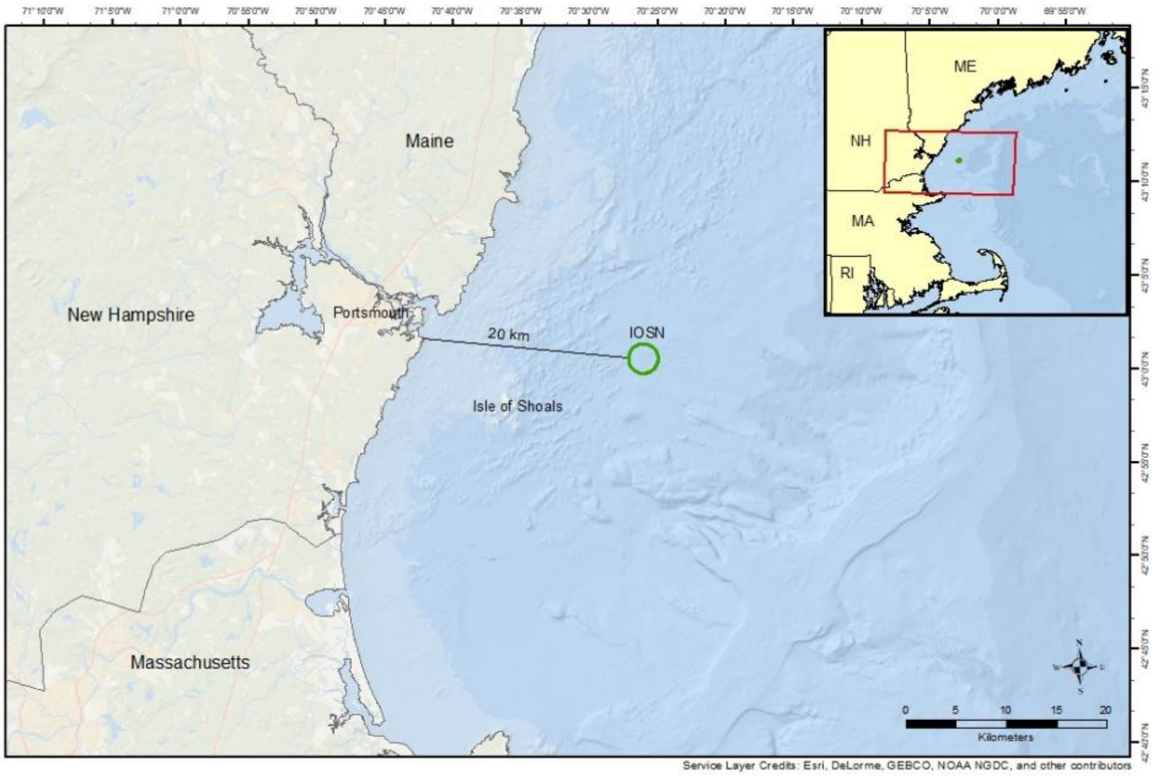

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Figure 1 - Location of the proposed Isles of Shoals Dredged Material Disposal Site North

The MPRSA further requires that SMMPs include a schedule for review and revision of the plan within 10 years after its adoption and then every 10 years thereafter. After this initial SMMP for the proposed IOSN is finalized in 2020, EPA Region 1 and the USACE-NAE will review the plan annually and will develop an update of the plan by 2029.

EPA Region 1 and the USACE-NAE will evaluate the data collected through the SMMP monitoring program annually. These data will also be periodically evaluated by other federal agencies, such as the National Marine Fisheries Service (NMFS), and by state agencies, to determine whether additional monitoring or modifications in site usage, management, or testing protocols are warranted.

2.0 REGULATORY FRAMEWORK AND AUTHORITIES

This SMMP is intended to describe a management framework and monitoring program that minimizes any potential for adverse impacts to the marine environment from dredged material disposal at the proposed IOSN. To this end, the SMMP identifies actions, provisions, and practices necessary to manage the operational aspects of dredged material disposal at the site and monitor the site. This is consistent with the SMMP requirements of Section 102(c)(3) of the MPRSA and the requirements of the Ocean Dumping Regulations. *See also* 40 CFR § 228.10(a) (the impact of disposal at designated sites should be evaluated periodically).

Management

Management of the disposal site involves: regulating the quantity and physical/chemical characteristics of dredged material that may be disposed at the site; establishing disposal controls and conditions; and monitoring the site environment to verify that permit terms are being met and that potentially unacceptable conditions that could result in significant adverse impacts are not occurring from past or continued use of the disposal site.

In addition, this SMMP also incorporates the following six requirements for ocean disposal site management plans that are described in MPRSA § 102(c)(3)(A) – (F):

1. Consideration of the quantity of the material to be disposed of at the site, and the presence, nature and bioavailability of the contaminants in the material [Section II C, *infra*];
2. A baseline assessment of conditions at the site [Section III, *infra*];
3. A program for monitoring the site [Section IV, *infra*];
4. Special management conditions or practices to be implemented at each site that are necessary for protection of the environment [Section V.A, *infra*];
5. Consideration of the anticipated use of the site over the long term, including the anticipated closure date for the site, if applicable, and any need for management of the site after closure [Section VI, *infra*]; and
6. A schedule for review and revision of the plan calling for review and revision not less frequently than 10 years after initial adoption of the plan and every 10 years thereafter [MPRSA § 102(c)(3); Section VII, *infra*].

This SMMP is consistent with EPA regulations at 40 CFR § 228.10(c) calling for EPA to periodically assess disposal sites based on the available body of pertinent data. Recognizing and correcting any potential adverse condition *before* it causes an unacceptable adverse impact to the marine environment or presents a navigational hazard to any type of vessel traffic is a central objective of this SMMP.

The practices that will be applied to address these management goals at the proposed IOSN include the following: coordination among federal and state agencies; testing of material to ensure acceptability for disposal at the site; review of general and specific permit conditions; review of allowable disposal technologies and methods; implementation of inspection, surveillance and enforcement procedures; periodic environmental monitoring at the site and at relevant reference sites for comparative evaluation; and information management and record keeping.

Monitoring

Under 40 CFR § 228.10(b), the following types of potential effects should be considered when evaluating impact at a disposal site:

- Movement of materials into sanctuaries or onto beaches or shorelines [228.10(b)(1)];
- Movement of materials toward productive fishery or shellfishery areas [228.10(b)(2)];
- Absence from the disposal site of pollutant-sensitive biota characteristic of the general area [228.10(b)(3)];
- Progressive, non-seasonal, changes in water quality or sediment composition at the disposal site when these changes are attributable to dredged materials placed at the site [228.10(b)(4)];
- Progressive, non-seasonal, changes in composition or numbers of pelagic, demersal, or benthic biota at or near the disposal site when these changes can be attributed to the effects of dredged materials placed at the site [228.10(b)(5)];
- Accumulation of material constituents (including without limitation, human pathogens) in marine biota at or near the site (*i.e.*, bioaccumulation [228.10(b)(6)]); and
- Any non-compliance with MPRSA permit conditions (information about any non-compliance should be referred to enforcement authorities, as appropriate).

The monitoring approach defined in this SMMP focuses on those factors that provide an early indication of potential unacceptable effects. The plan also incorporates ongoing regional monitoring programs in the Gulf of Maine that can provide additional information. The identification of unacceptable impacts, if any, from dredged material disposal at the proposed IOSN will be accomplished in part through comparisons of the monitoring results to historical (*i.e.*, baseline) conditions, and in part through comparison to nearby reference locations.

If site monitoring demonstrates that the disposal activities are causing unacceptable impacts to the marine environment as defined under 40 CFR § 228.10(b), the site managers will place appropriate limitations on site usage to reduce the impacts to acceptable levels. Such responses may range from limitations on the amounts and types of dredged material permitted to be disposed or limitations on disposal methods, locations, or schedules to withdrawal of the site's designation (*i.e.*, de-designation).

3.0 MANAGEMENT PLAN

All dredged material projects using the proposed IOSN must be authorized under MPRSA Section 103. The proposed IOSN will be managed in a manner that ensures the following site management goals are met:

- Only suitable material meeting the requirements of the Ocean Dumping Regulations will be allowed at the proposed IOSN disposal site.
- Ensure compliance with permit conditions;
- Avoid or minimize loss of sediment from the disposal site;
- Avoid or minimize conflicts with other uses of the area;
- Maximize the retention of site capacity;
- Avoid or minimize any adverse environmental impact from sediments placed at the site; and
- Recognize and correct conditions that could lead to unacceptable impacts.

EPA Region 1 and the USACE-NAE will jointly manage the proposed IOSN and will coordinate with other agencies as appropriate. The effectiveness of the management approach depends on having efficient planning processes, consistent compliance and enforcement, a robust yet flexible monitoring plan, and an effective communication structure that includes timely receipt and review of information relevant to the site management goals. To support this approach, EPA

Region 1 and the USACE-NAE utilize the New England Regional Dredging Team (NERDT) to share information and provide input on site management and monitoring issues. The NERDT is a federal-state interagency workgroup that meets 3-4 times per year to share information and coordinate activities on a wide range of issues related to dredging and dredged material management, including the management and monitoring of dredged material disposal sites like the proposed IOSN. In addition, EPA Region 1 and USACE-NAE have quarterly meetings at which they review monitoring data, establish monitoring objectives, and plan future monitoring surveys for disposal sites throughout New England coastal waters.

Management of the proposed IOSN will include the following practices:

- Evaluation of the suitability of material for disposal in accordance with the MPRSA;
- Specification of disposal conditions, location, and timing in permits, as appropriate;
- Requiring compliance with all permit conditions;
- Requiring disposal to occur at specified target coordinates within the site (to be determined on an annual basis);
- Utilization of tracking instrumentation on all scows placing material at the proposed IOSN in accordance with the USACE-NAE Dredging Quality Management (DQM) system to ensure compliance by allowing the determination of actual placement locations;
- Annual review of disposal coordinates and target setting with the intent of minimizing environmental impacts and maximizing long-term site capacity;
- Limiting the buildup of material in height above the bottom so that disposal mounds do not become either a hazard to navigation or likely to be mobilized by storm events;
- Conducting disposal site monitoring in a consistent, systematic manner; and
- Specification of site de-designation (*i.e.*, closure) conditions and dates when it becomes appropriate.

Specific Management Practices

In addition, special management practices may be required for individual projects using the proposed IOSN based on existing site monitoring data and long-term management goals:

- Specification of the volume of dredged material that can be placed at specific locations within the site and the total volume of dredged material that can be placed at the site;
- Modifications to the approved disposal methods, locations, or times; and
- Requirement for additional monitoring focused on a specific aspect of a project.

EPA regulations, *see* 40 CFR § 228.10(c), suggest that disposal sites be periodically assessed based on the available body of pertinent data. A central goal of this SMMP is that any potential unacceptable conditions will be recognized and corrected before the cause an adverse impact to the marine environment or presents a navigational hazard. Both EPA Region 1 and USACE-NAE will cooperate to ensure effective enforcement of all disposal requirements.

The USACE-NAE will provide EPA Region 1 with summary information on each project at two stages of the dredging and disposal process. A Summary Information Sheet will be provided when dredging operations begin, and a Summary Report will be submitted when dredging operations have been completed.

The following list describes special conditions to be applied to projects using the proposed IOSN:

- At least ten working days before the start date, the USCG First District, Aids to Navigation Office, shall be notified of the location and estimated duration of the dredging and placement operations.
- At least ten working days before the start date, the USCG Captain Sector Northern New England, shall be notified of the location and estimated duration of the dredging and placement operations.
- USCG Captain Sector Northern New England shall be notified at least two hours prior to each departure from the dredging site.
- The DQM system must be operational on each disposal scow and record each placement event. This information is automatically uploaded to a USACE-NAE database.
- Prior to the initiation of placement activity, and any time placement operations resume after having ceased for one month or more, the permittee or the permittee's representative must notify the USACE-NAE .

- The permittee must notify the USACE-NAE upon completion of dredging for the season by completing and submitting the form that the USACE-NAE will supply for this purpose.
- Except when directed otherwise by the USACE-NAE, all disposal of dredged material shall adhere to the following: The permittee shall release the dredged material within the site at a set of coordinates specified by the USACE-NAE. All disposal is to occur at the specified coordinates with the scow moving at less than three knots. This requirement must be followed except when doing so would create unsafe conditions because of weather or sea state, in which case placement within a specified distance (generally less than 350 ft [107 m]) of the specified coordinates with the scow moving only fast enough to maintain safe control is permitted. Disposal is not permitted if these requirements cannot be met due to weather or sea conditions and special attention needs to be given to predicted conditions prior to departing for the dumpsite.
- EPA Region 1 and the USACE-NAE (and/or their designated representatives) reserve all rights under applicable law to free and unlimited access to and/or inspection of: 1) the dredging project site, including the dredge plant, the towing vessel and scow, at any time during the project; 2) all records, including logs, reports, memoranda, notes, etc., pertaining to a specific dredging project (federal or non-federal); and 3) towing, survey monitoring, and navigation equipment.
- If dredged material regulated by a specific permit or federal authorization issued by the USACE-NAE is released in locations or in a manner not in accordance with the terms or conditions of the permit or authorization, the master/operator of the towing vessel shall immediately notify the USACE-NAE of the incident, as required by the permit or authorization, and provide the USACE-NAE with the relevant DQM data export. The USACE-NAE shall copy EPA Region 1 of such notification as soon as possible but no later than the next business day. In addition, the towing contractor shall make a full report of the incident to the USACE-NAE and EPA Region 1 within ten (10) days.
- From February 1 through May 31 of any year, disposal vessels including tugs, barges, and scows transiting between the dredge site and the proposed IOSN shall operate at speeds not to exceed five knots after sunset, before sunrise, or in daylight conditions where visibility is less than 1 nm (1.8 km). Disposal shall not be permitted if these requirements cannot be met due to weather or sea conditions. In that regard, the

permittee and contractor should be aware of predicted conditions before departing for the disposal site. The intent of this condition is to reduce the potential for vessel collisions with endangered species, including right whales.

- From February 1 through May 31 of any year, a marine mammal observer must be present aboard disposal vessels transiting between the dredge site and the proposed IOSN during daylight hours. The disposal vessel captain, or a crewmember assigned by the captain, may be the observer for that trip. The name of the observer must be recorded in the logbook.

  The captain, assigned crewmember, or NMFS-approved observer shall:

  a. Monitor the Right Whale Sightings Advisory System as well as other communication media (i.e., NOAA weather radio, USCG NAVTEX broadcasts, Notices to Mariners, and U.S. Coast Pilots) for general information regarding North Atlantic right whale sighting locations;
  b. Report any interactions with listed species as soon as possible (within 24-hours) to NMFS at (866) 755-NOAA or USCG via CH-16, and immediately report any injured or dead marine mammals or sea turtles to NMFS at (866) 755-NOAA; and
  c. Ensure that a separate NMFS Marine Mammal Observation Report is completed for every whale sighting and that this report is submitted to NMFS and to the USACE-NAE Marine Analysis Section within one week of the trip date (it is encouraged to provide this report within two days of returning to port).

  The vessel captain shall:

  a. Lookout for turtles and whales at all times;
  b. Employ the tug's searchlight in darkness or otherwise limited visibility for the benefit of the observer when traveling to, at, or returning from the disposal site;
  c. Avoid harassment of or direct impact to whales and turtles except when precluded by safety considerations;
  d. Ensure that the disposal vessels do not approach whales and turtles closer than 100 ft (30 m) (see additional condition below for approaching right whales);

e. Ensure that the disposal vessels adhere to NMFS regulations (50 CFR 222.32) for approaching right whales which restrict approaches within 1,500 ft (457 m) of a right whale; and
f. Ensure that dredged material is not released if whales are within 1,500 feet or turtles are within 600 ft (183 m) of the specified disposal point.

These conditions may be modified on a project-by-project basis based on factual changes or when deemed necessary as part of the individual permit review process.

Modifications to the Management Plan

Based on the findings of the monitoring program, modifications to site use could be required. In such a case, corrective measures such as, but not limited to, those listed below, will be developed by EPA Region 1 and the USACE-NAE.

- Stricter definition and enforcement of disposal permit conditions;
- Implementation of even more conservative evaluation procedures for determining whether sediments proposed for dredging are suitable for open-water disposal;
- Implementation of special management practices to prevent loss of sediment to the surrounding area;
- De-designation of the site as an available dredged material disposal site (*i.e.*, to prevent any additional disposal at the site).
- Modifications to the use of marine mammal observers during disposal operations;
- Implementation of dredging windows; and
- Any additional measures deemed necessary to further ensure compliance with the Endangered Species Act (ESA) and the Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act.
- Additional, more detailed monitoring

In addition to identifying management practices for the disposal site the MMP also must include a monitoring plan, which is provided in Section 6.0. Through the monitoring efforts results will be available through coordination and outreach. to state and federal agencies, scientific experts, and the public. To ensure communications are appropriate and timely, site management activities and monitoring findings will be disseminated through a combination of scientific reports and peer-reviewed publications, participation in the NERDT, and public meetings and fact sheets.

4.0 BASELINE ASSESSMENT

MPRSA 102(c) (3)(A) requires that the SMMP include a summary of baseline conditions at the site. Baseline conditions are reported in the Environmental Assessment (EA) for the site designation (EPA Region 1, 2019). This section provides a brief site description and overview of sensitive resources at the proposed IOSN. More detailed information is found in the EA and a recent contribution from the USACE-NAE DAMOS program (Guarinello et al, 2016). DAMOS also monitored three reference areas outside the disposal site, and they (REF-A, REF-B, and REF-C) are incorporated into this SMMP. As this is the initial SMMP for a newly designated ODMDS, there is no documented disposal history at proposed IOSN presented in this document.

Site Characteristics

The proposed IOSN is located in the Gulf of Maine, approximately 20 km (10.8 nmi) east of Portsmouth, New Hampshire (Figure 1). The site is defined as a 2,600 m (8,530 ft) diameter circle on the seafloor with its center located at 70° 26.995' W and 43° 1.142' N. Three reference areas (REF-A, REF-B, and REF-C) are defined as 250 m radius circles located at 70° 25.165' W, 42° 59.282' N; 70° 28.039' W, 43° 0.257' N; and 70° 27.895' W, 43° 2.280' N, respectively. Reference areas were selected based on a review of existing data and confirmed through a baseline survey to represent areas of the seafloor with similar bathymetric characteristics as proposed IOSN (Guarinello et al, 2016).

Water depths at proposed IOSN gradually slope from approximately 90 m (295 ft) on the western boundary to 100 m (328 ft) in the southeastern portion of the site (Figure 2). The site is generally a flat soft-bottom with topographic highs present outside the northwest, southeast, and northeast boundaries of the site (Figure 2).

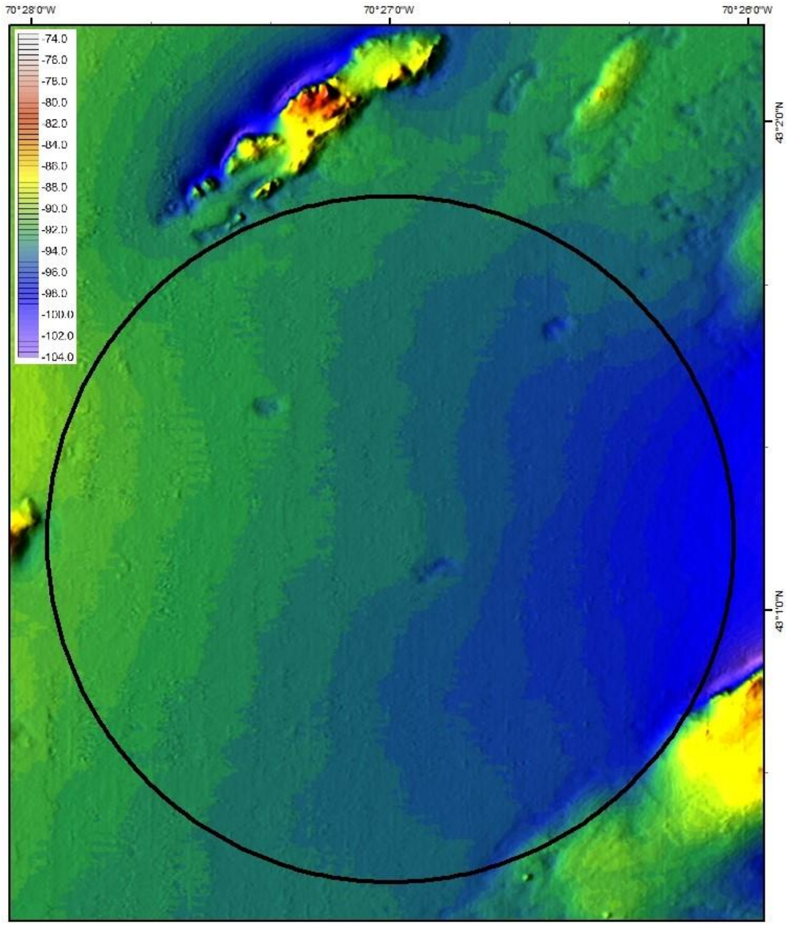


Figure 2 – Bathymetry of the proposed IOSNPROPOSED IOSN (USACE-NAE DAMOS 2015, Meters MLLW)

Site Capacity

Proposed improvement dredging of the Portsmouth Harbor and Piscataqua River Federal Navigation Project would be the primary source of dredged material for the proposed IOSN in the next decade. This project is expected to produce a volume of approximately 754,000 cubic yards of dredged material. Planned maintenance dredging of Federal Navigation Projects in Cape Porpoise, ME; Pepperell Cove, ME; Rye Harbor, NH and other harbors may also utilize the site over the next ten years.

Because of its depth (over 90 m [300 feet]) and size (5.3 km² [1.5 nmi²]), the capacity of the proposed IOSN is far in excess of the potential site use over the next 20 years so a potential closure date for the proposed IOSN has not been considered. Remaining site capacity will be updated periodically as additional bathymetric surveys are performed at the site. The need for collecting bathymetric data is based, in part, on the record of dredged material placement location and scow volume. The accuracy of this record has increased significantly with the implementation of the National Dredging Quality Management (DQM) Program, which was developed by the USACE to provide detailed tracking of dredging and scow operations nationwide. Information on this system can be found at: http://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/

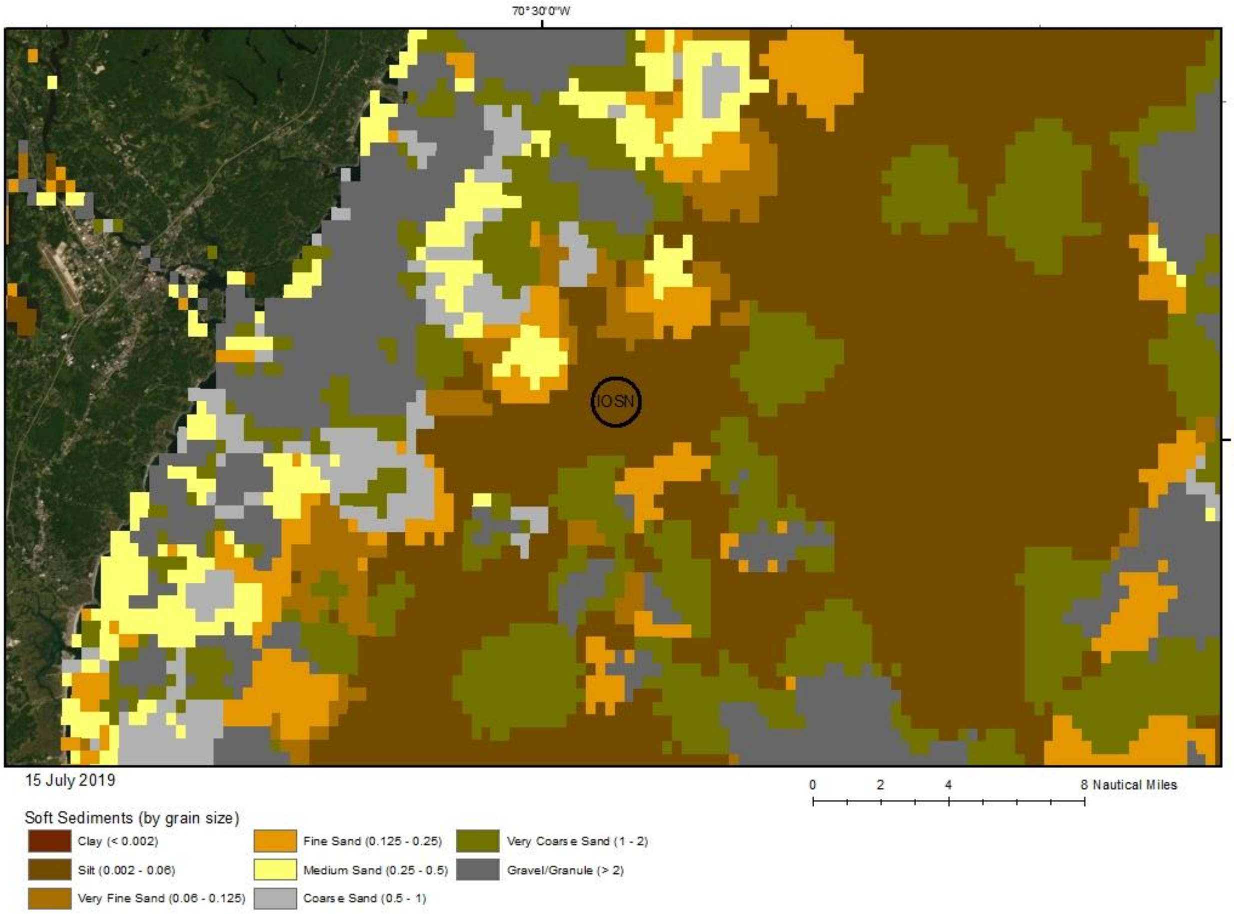
Sediment and Water Quality

All dredged material projects proposed for disposal at the proposed IOSN will be evaluated on a project-specific basis under the chemical and biological testing framework outlined in the EPA's Ocean Dumping Regulations (*see* 40 CFR Part 227) and guidance developed by EPA and the USACE (EPA/USACE, 1991,A screening level modeling is performed to further evaluate the potential for water column effects as part of the dredged material suitability determination.

In general, the seafloor in the vicinity of the proposed IOSN is a fairly uniform flat bottom made up of fine-grained sediments. Surficial sediments at the site were sampled in November of 2010 by the USACE-NAE using a 0.4 m^2 grab sampler. All sampling locations, with the exception of a single station, were composed of 93% or more of silts and clays (with the remaining fraction sand). The sediments at the remaining station were composed of 80% silts and clays and 20% sands. Grain size curves of all samples can be found in Appendix A of the EA (EPA Region 1, 2019).

A review of data from the Northeast Ocean Data Portal (https://www.northeastoceandata.org) confirms that the sediments within the proposed IOSN are primarily silts. Figure 3 illustrates the sediments within proposed IOSN and the surrounding Gulf of Maine.

Figure 3 – Surficial Sediment Types of the Gulf of Maine Including the Proposed IOSN



(Northeast Ocean Data Portal, https://www.northeastoceandata.org)

In September of 2015, the USACE-NAE DAMOS Program performed a baseline survey of the proposed IOSN (Guarinello et al, 2016) which employed hydroacoustic data collection and a Sediment-Profile Imaging/Plan View Imaging (SPI/PV) monitoring technique that involves deploying an underwater camera system to photograph a plan view of the seafloor as well as a cross-section of the sediment-water interface. The DAMOS monitoring survey concluded that the proposed IOSN and the proposed reference areas are low energy depositional environments dominated by fine-grained soft sediments and robust, mature benthic communities. Acoustic backscatter data, coupled with SPI results, confirmed the predominantly soft and fine-grained nature of the sediments. The SPI data also revealed a healthy soft-bottom benthic ecosystem with no evidence of low dissolved oxygen or sedimentary methane within the sediments of the proposed IOSN (Guarinello et al, 2016).

There are no existing data that characterize the sediment chemistry of the sediments at the proposed IOSN site. An evaluation for the Cape Arundel Disposal Site (CADS) noted that the sediments at the CADS site were similar in metal and organic compound concentrations to nearby reference areas, which were at low levels (USACE, 1989). As the proposed IOSN site is approximately 27 km (15 nmi) from CADS, and far from contaminant sources, the sediment concentrations of metals and organic compounds are anticipated to be similar to other sites in the Gulf of Maine, such as the baseline conditions at the CADS and the CADS reference areas (USACE, 1989).

The water column at proposed IOSN behaves in a manner typical of northeastern continental shelf regions, with isothermal conditions less than 6°C during the winter, giving way to stratified conditions with maximum surface temperatures on the order of 18°C, and a strong thermocline between 20 and 30 m (65 and 100 ft) during the summer months. The water column overturns during the fall, returning to isothermal conditions. Although this typical water column structure is persistent over the long term, there are anomalous perturbations that can cause significant variations, particularly in the winter months (EPA Region 1, 2019).

Current patterns in the vicinity of the proposed IOSN are typified by coastal-parallel, non-tidal southerly drift generated by the overall circulation of the Gulf of Maine. The southerly flow is affected by tidally induced currents (averaging 15 cm/sec [0.5 ft/sec]) which generate inshore and offshore movements and local topography which may create local eddies. Strong northeast storms can generate southwesterly flows with speeds of 30-40 cm/sec [1-1.3 ft/sec]. Bottom currents are influenced by topographic features in the region which disrupt the vertical coherence of the current structure. Near bottom currents in the region are generally less than 10 cm/sec (0.3 ft/sec) and highly variable in direction (USACE, 1989).

Gulf of Maine water quality in the vicinity of the proposed IOSN is discussed in the Environmental Assessment for the ODMDS designation (EPA Region 1, 2019). The data was compiled from previous studies of the CADS (USACE, 1989), data from EPA coastal nutrient trend monitoring (EPA Region 1, 2011), and data from Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) ocean observing system buoys in the Gulf of Maine (NERACOOS, 2017). In general pH, turbidity, and dissolved oxygen levels in the region are typical of open ocean environments with excellent water quality. Nutrients (ammonia, nitrates, and phosphorous) concentrations varied seasonally and reached a peak in winter months (USACE, 1989).

Living Resources

Fish and Shellfish Resources

The proposed IOSN area supports a variety of pelagic and demersal fish species. The habitat at the disposal site is not a rare or especially unique habitat for the Gulf of Maine, consisting of a primarily flat, silt/clay bottom.

Fish community data collected jointly by the states of Maine and New Hampshire were used to describe the communities at proposed IOSN. The Maine-New Hampshire (MENH) Inshore Trawl Survey samples areas off of coastal New Hampshire and Maine in the spring (typically the first week of May) and the fall (typically the last week of September) (Maine DMR, 2016 – See Appendix E in the EA). Sampling in the vicinity of the proposed IOSN has been conducted since the fall of 2000, and there have been 136 trawl tows made in proximity to the disposal site from 2000 through 2015. A total of 65 spring tows were performed, and a total of 71 tows were made in the fall. A total of 91 species were caught in all tows, with the spring tows averaging 21 species per tow and the fall tows averaging 23 species per tow. Table 1 lists all fish species caught from the trawl tows in the vicinity of the proposed IOSN. The dominant fish species by weight in the MENH fall trawls were spiny dogfish, silver hake, and Atlantic Herring. The dominant fish species by weight in the MENH spring trawls were American plaice and silver hake (EPA Region 1, 2019).

The USACE-NAE also sampled the area within the proposed IOSN site on May 24, 2016 and February 20, 2017 (See Appendix D in the EA). Six trawl transects were established within the site and at each location a 15 minutes trawl was performed at speed of approximately 2.6 knots. In general, species composition of the fish community was similar to that reported by USACE (1989) and from the MENH data set (Maine DMR, 2016).

Table 1 – Fish species identified from the Maine-New Hampshire (MENH) Inshore Trawl Survey in the vicinity of the proposed IOSN during the spring and fall (2000-2015)

Common Name	Scientific Name	Common Name	Scientific Name
Acadian Redfish	*Sebastes fasciatus*	Little Skate	*Raja erinacea*
Alewife	*Alosa pseudoharengus*	Longhorn Sculpin	*Myoxocephalus octodecemspinosus*
Alligatorfish	*Aspidophoroides monopterygius*	Lumpfish	*Cyclopterus lumpus*
American Plaice	*Hippoglossoides platessoides*	Moustache Sculpin	*Triglops murrayi*
American Sand Lance	*Ammodytes americanus*	Northern Pipefish	*Syngnathus fuscus*
American Shad	*Alosa sapidissima*	Northern Puffer	*Sphoeroides maculatus*
Atlantic Cod	*Gadus morhua*	Northern Sea robin	*Prionotus carolinus*
Atlantic Halibut	*Hippglossus hippoglossus*	Ocean Pout	*Macrozoarces americanus*
Atlantic Herring	*Clupea harengus*	Pearlsides	*Maurolicus muelleri*
Atlantic Mackerel	*Scomber scombrus*	Pollock	*Pollachius virens*
Atlantic Silverside	*Menidia*	Rainbow Smelt	*Osmerus mordax*
Atlantic Torpedo	*Torpedo nobiliana*	Red Hake	*Urophycis chuss*
Barndoor Skate	*Raja laevis*	Scup	*Stenotomas chrysops*
Bigeye Scad	*Selar crumenopthalmus*	Sea Raven	*Hemitripterus americanus*
Black Sea Bass	*Centropristis striata*	Silver Hake	*Merluccius bilinearis*
Blueback Herring	*Alosa aestivalis*	Silver Rag	*Ariomma bondi*
Bluefish	*Pomatomas saltatrix*	Smooth Skate	*Raja senta*
Bristled Longbeak	*Dichelopandalus leptocerus*	Snakeblenny	*Lumpenus lumpretaeformis*
Buckler Dory	*Zenopsis conchifera*	Spiny Dogfish	*Squalus acanthias*
Butterfish	*Peprilus triacanthus*	Spotted Hake	*Urophycis regia*
Cunner	*Tautogolabrus adspersus*	Spotted Tinselfish	*Xenolepidichthys dalgleishi*
Daubed Shanny	*Lumpenus maculatus*	Thorny Skate	*Raja radiata*
Fourbeard Rockling	*Enchelyopus cimbrius*	White Hake	*Urophycis tenuis*
Fourspot Flounder	*Paralichthys oblongus*	Windowpane	*Scophthalmus aquosus*
Goosefish	*Lophius americanus*	Winter Flounder	*Pseudopleuronectes americanus*
Greenland Halibut	*Reinhardtius hippoglossoides*	Winter Skate	*Raja ocellata*

Grubby	*Myoxocephalus aenaeus*	Witch Flounder	*Glyptocephalus cynoglossus*
Gulf Stream Flounder	*Citharichthys arctifrons*	Wrymouth	*Cryptacanthodes maculatus*
Haddock	*Melanogrammus aeglefinus*	Yellowtail Flounder	*Limanda ferruginea*

The Maine DMR Lobster Monitoring Program has routinely collected lobster population data throughout the state since 1985, with the sampling occurring primarily from May through November and occasionally in the winter months as allowed. Each lobster management zone is sampled three times monthly from May through November with trips spread throughout the zone. Zone G is the southwestern most lobster management zone spanning from the Presumpscot River (near Portland, Maine) south to the New Hampshire border and is the zone in which the proposed IOSN is located. Using a subset of data from Zone G that was relevant to the location of the proposed IOSN, the Maine DMR Lobster Monitoring Program calculated a mean catch of 0.39 legal lobsters per trap (± 0.09 lobsters) during the December through April timeframe, which was comparable to the overall zone G winter catches (EPA Region 1, 2019). The mean catch in the May through November timeframe ranged between 1 and 2 legal lobsters per trap (Maine DMR, 2016 – See Appendix E in the EA).

USACE-NAE also collected lobster abundance data in and around the proposed IOSN in December 2016 and January 2017 to assess the winter lobster community in the area. A total of 6 deployment/retrieval events were conducted. The mean catch ranged from 0.6 to 2.15 legal lobsters per trap and from 1.1 to 4.9 shorts (i.e., lobsters under the legal size) per trap (EPA Region 1, 2019). The mean number of lobsters per trawl generally decreased from December through January. Appendix D in the EA contains all the lobster data collected during the effort.

Endangered and Threatened Species

There are a number of species found in Gulf of Maine waters that are currently listed as threatened or endangered under the Endangered Species Act. They are summarized below.

Northern Right Whale *(Endangered)*

The north Atlantic right whale (*Eubalaena glaciala*) is one of the most endangered large whales in the world. The range of the right whale occurs from Nova Scotia and

Newfoundland (Sergeant, 1966; Mitchell, 1974; Sutcliffe and Brodie, 1977; Hay 1985), into the lower Bay of Fundy (Arnold and Gaskin, 1972; Kraus and Prescott, 1981, 1982, Reeves et al., 1982) and throughout the Gulf of Maine (Watkins and Schevill, 1976, 1979, 1982) in the spring and summer. In the winter, right whales occur from Cape Cod Bay (Watkins and

Schevill, 1976) south to Georgia and Florida (Moore, 1953) and into the Gulf of Mexico (Moore and Clark, 1963; Schmideley, 1981).

Fin Whale *(Endangered)*

Fin whales (*Balaenoptera physalus*) are the most cosmopolitan and abundant of the large baleen whales (Reeves and Brownell, 1982). They also are the most widely distributed whale, both spatially and temporarily, over the shelf waters of the northwest Atlantic (Leatherwood et al., 1976) occurring as far south as Cape Lookout, North Carolina and penetrating far inside the Gulf of St. Lawrence. In the shelf waters of the Gulf of Maine the frequency of fin whale sightings generally increase from spring through the fall (Hain et al., 1981; CETAP, 1982; Powers et al, 1982; Chu, 1986). The areas of Jeffery's Ledge, Stellwagen Bank, and the Great South Channel have the greatest concentrations of whales during spring through fall. There is a decrease in on-shelf sightings of fin whales in winter, however, fin whales do overwinter in the Gulf of Maine.

Leatherback Sea Turtle *(Endangered)*

Leatherback sea turtles (*Dermochelys coriacea*) have been reported in New England waters in July through early November. Inshore seasonal movements may be linked to those of the jellyfish *Cyanea capillata*, which periodically occur in the proposed IOSN area, and, therefore, could be used by Leatherbacks for foraging. They could also pass through the area while migrating or seeking prey. The population of Leatherbacks has been declining worldwide, but specific status in the United States is currently unknown.

Shortnose Sturgeon *(Endangered)*

Shortnose sturgeon (*Acipenser brevirostrum*) occur along the U.S. Atlantic coast. Available information on shortnose sturgeon indicates that they make coastal migrations within the Gulf of Maine (i.e. between the Merrimack and Kennebec Rivers) and make at least occasional short visits to Great Bay in New Hampshire (NMFS 2016). Based on patterns of detections by acoustic receivers in Great Bay, it is thought that shortnose sturgeon visit Great Bay at least during the spring and fall; although there is no known spawning in the nearby Piscataqua River. Migrating shortnose sturgeon may be present in the nearshore areas of the Gulf of Maine, however, no tagged shortnose sturgeon have been detected at a buoy (GoMOOS buoy B01) deployed in the vicinity of the proposed IOSN site. The proposed IOSN site may serve as a migratory corridor for shortnose sturgeon.

Atlantic Sturgeon *(Threatened)*

The marine range for Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* includes all marine waters, coastal bays, and estuaries from Labrador, Canada to Cape Canaveral, Florida. The Gulf of Maine distinct population segments (DPS) of Atlantic sturgeon is currently listed as federally threatened. An Atlantic sturgeon was detected as recently as June 2012 in Great Bay New Hampshire and acoustic receivers in the vicinity of the Isles of Shoals (GoMOOS buoy E01) have detected tagged Atlantic sturgeon. The proposed IOSN site may serve as a migratory corridor for Atlantic sturgeon.

Atlantic salmon *(Endangered)*

Seaward migrating juvenile Gulf of Maine DPS Atlantic salmon (*Salmo salar)* have been recorded by acoustic telemetry moving southward toward the vicinity of the proposed IOSN. Atlantic salmon have been detected in the vicinity of GoMOOS Buoy E01, however, they have not been detected in the buoy closest to the proposed IOSN (B01) since its deployment in 2005. It is unlikely that this species would be in the vicinity of the proposed IOSN during winter months.

5.0 DISPOSAL HISTORY

The proposed IOSN is a newly proposed ODMDS. There is no known record of disposal in the immediate vicinity of the proposed IOSN, but the recent USACE-NAE DAMOS baseline survey suggests that there may have been historic disposal of dredged material at the site. Hydroacoustic data from the baseline survey revealed an area of small craters in the northeast portion of the site, and SPI images from the northeast and southeast areas of the site showed evidence of potential dredged material deposits (Guarinello et al, 2016). If historic disposals did occur in the vicinity of the proposed IOSN, it was limited in extent and did not results in the formation of defined dredged material disposal features.

6.0 MONITORING

The EPA Region 1 and USACE-NAE and share responsibility for monitoring ODMDS in New England which includes the proposed IOSN. Historically, this monitoring has been performed through an interagency agreement between the EPA and USACE-NAE Disposal Area Monitoring System (DAMOS) Program. The regional monitoring uses a tiered monitoring framework (Germano *et al.,* 1994) that is consistent with the guidance for SMMPs (EPA and USACE, 1996). In addition to dedicated site surveys, data collected by other agencies and organizations will also be used as part of assessment of proposed IOSN (e.g., MENH Inshore Trawl Survey, Maine DMR Lobster Monitoring Program, and NERACOOS). Collectively, the data will be used to address the following overall site monitoring objectives:

- Assess whether disposal activities are occurring in compliance with permit and site restrictions;
- Support evaluation of the short-term and long-term fate of materials based on MPRSA site impact evaluation criteria;
- Support assessment of potential significant adverse environmental impact from dredged material disposal at the site.

This SMMP provides a general framework for the monitoring program and guides future sampling efforts at the disposal site. Specific details about those efforts (*e.g.,* sampling design, statistical comparisons) will be developed in project-specific survey plans considered during the annual agency meeting. Similarly, the schedule for the monitoring surveys will be governed by the frequency of disposal at the site, results of previous monitoring surveys, and funding resources. The data gathered under this monitoring plan will be evaluated on an ongoing basis to determine whether modifications to the site usage or designation are warranted.

EPA Region 1 and USACE-NAE jointly assess compliance with permit conditions and authorizations for specific projects. EPA Region 1 is responsible for determining if an unacceptable impact has occurred from dredged material disposal at the proposed IOSN.

However, any such determinations will be made in consultation with other agencies and will be based on available monitoring data and any other pertinent information. EPA Region 1 is also responsible for determining any modifications to site use or de-designation.

6.1 Organization of the Monitoring Program

The monitoring program is comprised of two components, compliance monitoring and environmental monitoring. Although the specific objectives of the components differ, much of the actual monitoring overlaps. Compliance monitoring includes collection of data relevant to the specific conditions in permits and authorizations (*e.g.*, where, when, and how much material can be disposed). Environmental monitoring for the disposal site is developed around four fundamental premises that establish the overall monitoring approach from a data acquisition perspective as well as the temporal and spatial scales of the measurement program:

- Testing information from projects previously authorized to use the site for dredged material disposal can provide key information about the expected quality of material that has been placed in the site;
- Lack of benthic infaunal community recovery on recently created mounds provides an early indication of potential significant adverse impact;
- Some aspects of the impact evaluation required under MPRSA Section 102(c)(3) can be accomplished using data from regional monitoring programs (*e.g.*, fisheries impact);
- Measurement of certain conditions at the site can be performed at a lower frequency (*e.g.*, long-term mound stability) or only in response to major environmental disturbances such as the passage of major storms.

The first premise requires that historic and ongoing dredged material testing results be available. The remaining premises require various types and scales of monitoring to ensure dredged material disposal at the site is not unduly impacting the marine environment. Thus, the environmental monitoring is further organized around five management focus areas that are derived from the types of potential effects required for evaluation under MPRSA [40 CFR § 228.10(b)] as described in Section 2:

- **Management Focus 1: Movement of dredged material.** This focus combines the requirements under 40 CFR 228.10(b)(1) (Movement of materials into sanctuaries, or onto beaches or shorelines) and 40 CFR 228.10(b)(2) (Movement of materials towards productive fishery or shellfishery areas) into one focus;

- **Management Focus 2: Absence of pollutant-sensitive biota.** Addresses 40 CFR 228.10(b)(3) (Absence from the disposal site of pollutant-sensitive biota characteristic of the general area);
- **Management Focus 3: Changes in water quality.** Addresses 40 CFR 228.10(b)(4) (progressive, non-seasonal, changes in water quality or sediment composition at the disposal site when these changes are attributable to materials disposed of at the site);
- **Management Focus 4: Changes in composition or numbers of biota.** Addresses 40 CFR 228.10(b)(5) (Progressive, non-seasonal, changes in composition or numbers of pelagic, demersal, or benthic biota at or near the disposal site when these changes can be attributed to the effects of materials disposed at the site);
- **Management Focus 5: Accumulation of material constituents in biota.** Addresses 40 CFR 228.10(b)(6) (Accumulation of material constituents [including without limitation, human pathogens] in marine biota at or near the site [*i.e.,* bioaccumulation]).

A tiered approach, based on a series of null hypotheses, is used to monitor compliance and address concerns under each Management Focus. Tier 1 evaluates a series of hypotheses addressing "leading indicators" that provide early evidence of unacceptable environmental responses or conditions. Examples include documentation of whether recolonization is proceeding as expected or whether mounds are deposited as planned and that no post-deposition movement is occurring. Should the hypotheses under Tier 1 be satisfied, the findings would be evaluated and decisions to conduct Tier 2 activities made. The specific condition that will initiate Tier 2 or Tier 3 monitoring will be decided between EPA and the Corps. Based on the type of event/action that has occurred, EPA and the Corps, with advice from other state and federal agencies, will work to implement the appropriate management practice with the monitoring program.

The measurement program under Tier 1 focuses on both individual dredged material mounds and the overall site conditions. New mound construction will be evaluated within one to two years of completion, and the entire site will be evaluated as needed. While specific monitoring activities are defined under each tier, the actual monitoring conducted in a given year must be consistent with budgetary constraints. Thus, prioritization of monitoring by organizational focus and findings of the monitoring program must be done annually during the Agency planning meeting.

Tiers 2 and 3 provide for progressively more detailed and focused studies to confirm or explain unexpected or potentially significant adverse conditions identified under Tier 1. For example, if Tier 1 monitoring under Management Focus 2, indicates that the benthic community was not recovering on recently deposited sediments, successive tiers would enable examination of potential causes by incorporating additional investigation of sediment characteristics and quality. However, if the results from the Tier 1 data do not suggest impact, Tier 2 activities would not be invoked.

The following sections describe the monitoring approach that will be applied to each management focus. Each subsection provides the following:

- Intent of the data gathered under the focus area;
- Statement of relevant questions and hypotheses to be addressed within each tier;
- Summary of the measurement approach and tools to be used under each successive tier.

6.2 Monitoring Elements

Compliance Monitoring

Compliance monitoring includes evaluation of information and data relevant to the conditions in specific permits and authorizations and may be gathered separately from the environmental data. The hypothesis that will be addressed is:

> *H_0 0-1: Disposal operations are not consistent with requirements of issued permits/authorizations.*

This hypothesis will be evaluated by review of the record of towed scow track and disposal location provided by the USACE Dredging Quality Management system. This information is supplemented by multibeam acoustic surveys which can provide information on the location of recently disposed dredged material. Any variances identified will be discussed by the EPA and the Corps on a project-specific basis to determine the potential magnitude of effect and the appropriate action.

Management Focus 1: Movement of the Dredged Material

This management focus addresses two concerns relative to the disposal of dredged material at the proposed IOSN site. The first is site management and compliance. The second is movement of the material after disposal. The questions that will be addressed include:

- Is the material deposited at the correct location?
- Are mounds constructed consistent with the site designation?
- Are mounds stable and dredged material retained within the disposal site?

The latter question directly addresses management concerns about material moving into sanctuaries, or onto beaches or shorelines and towards productive fishery or shellfishery areas.

Tier 1

The site designation specifies that the proposed IOSN is a non-dispersive site; therefore, significant movement of materials out of the site is not expected. Loss of mound material could mean that the material is being lost inappropriately and may potentially impact areas outside of the site, if transported beyond the site's boundary. For the purpose of Tier 1, this question is addressed through two hypotheses.

H_0 1-1: Changes in elevation for any mound are not greater than 1.0 feet (0.3 meter) over an area greater than 50 by 50 meters:

This hypothesis will be tested by determining the dimensions of disposal mounds created in a given dredging season and performing periodic monitoring of the mound using precision bathymetry techniques. The bathymetric baseline data for new or modified mounds will be collected after one year of consolidation. Bathymetric surveys of mounds (historic and recently completed) and the entire site will also be performed periodically. Information on mound size and height will be compared with previous data to determine if loss of material has occurred. Further study of the characteristic of the mound and surrounding area will be conducted under Tier 2, if large scale (50 by 50 meter) mound changes of more than 1.0 feet (0.3 meters) within any five-year interval.

H_0 1-2: Major storms (greater than 10-year return frequency) do not result in erosion and loss of material from disposal mounds at the proposed IOSN.

This hypothesis tests whether major storms have eroded mounds. Although the depth of the proposed IOSN site is such that significant erosion of mounded dredged material is not expected, this hypothesis will be tested by determining the dimensions of disposal mounds within six months following the passage of storms with a ten-year return frequency or greater. Dimensions will be determined using precision bathymetry techniques. The decision to conduct post-storm surveys will be made jointly by the site managers. If a mound changes in height by more than 1.0 feet (0.3 meters) from the previous survey, the site and surrounding area will be examined as defined under Tier 2.

Tier 2

Significant loss of material from the deposited mound may result in changes to the benthic community structure either within or beyond the site boundaries (primarily due to burial). Change in bathymetry and benthic community structure immediately outside of the site would be indicative of potential unacceptable transport. Tier 2 investigates whether significant erosion of mound height determined under Tier 1 results in the relocation of material outside of the site boundaries.

H_0 1-3: Material lost from disposal mounds at the proposed IOSN site does not increase the (a) bathymetry more than 0.5 feet (15 cm) over an area larger than 50 by 50 meters and (b) the biological indices measured with sediment profile imaging are not significantly lower than the reference site in bathymetrically changed areas.

This hypothesis will be tested by determining changes in bathymetry and sediment characteristics within 1 kilometer (0.6 miles) beyond the site boundary. The survey design will take into account the expected direction of transport based on the predominant current direction and velocity (*e.g.,* it may not be necessary to survey the entire area within 1 kilometer [0.6 miles] of the site).

Precision bathymetry will be used to define substantive changes in bathymetry and topography (greater than 0.5 foot [15 centimeters]). Sediment profile imagery will be used to evaluate changes in sediment characteristics and the benthic community. Comparison of sediment profile imagery data from areas of concern to reference areas will be used to determine whether the transported material has a potential significant adverse biological effect.

Changes in bathymetry across the mound apex or apron of more than 1.0 feet (0.3 meters) or development of large areas of predominately muddy sediments not previously documented may be an indication of substantial transport of material from the site. If such changes are documented, Tier 3 characterization of sediment quality or further characterization of benthic communities may be required.

Tier 3

The premise of this Tier is that significant transport of material beyond the site boundary could affect the benthic productivity of the area. Therefore, characterization of sediment quality may be required.

H_0 1-4: Material transported beyond the proposed IOSN boundaries does not result in significant decreases in sediment quality.

Sediment chemistry, toxicity, and benthic community structure will be measured at representative locations (determined through interagency coordination) from the area where the benthic community is depressed and at the proposed IOSN reference sites to test this hypothesis.

Chemical and toxicity testing and analysis will be conducted using methods required by the RIM (EPA and Corps, 2004) or subsequent approved documents. Benthic community sampling and analysis methods will be the same as those conducted during site designation studies. Statistical comparisons and numbers of samples will be determined during project-specific survey planning.

Data from the area of concern will be compared statistically to data collected concurrently from the proposed IOSN reference sites to determine if the quality of transported material is unacceptable. The decision of unacceptable conditions will be based on all three measures (*i.e.,* sediment quality, benthic community analysis, and toxicity).

Management Focus 2: Absence from the Disposal Site of Pollutant-Sensitive Biota Characteristic of the General Area

The premise underlying this management focus is that the infaunal community on disposal mounds recovers rapidly after disposal ceases. Therefore, the absence of or slower-than- expected recovery of the benthic infaunal community indicates a potential biological impact at the mound and by implication the ability of the site to support higher trophic levels. The long history of disposal site monitoring in New England has resulted in an excellent understanding of the rate at which benthic infauna recover from disturbances such as those caused by dredged material disposal as well as the types of communities that are expected to recolonize the mounds (SAIC 2002; Murray and Saffert, 1999; Morris, 1998; Charles and Tufts, 1997; Wiley *et al.,* 1996; Williams, 1995; Wiley, 1995; Wiley and Charles, 1995; SAIC, 1995; Wiley, 1994; Germano *et al.,* 1994; Germano *et al.,* 1993; SAIC, 1990; SAIC, 1988; SAIC, 1987; SAIC, 1985; Morton *et al.,* 1984; Scott *et al.,* 1984; Scott *et al.,* 1983; Morton and Paquett, 1983; Arimoto and Feng, 1984; Morton *et al.,* 1982; Morton and Stewart, 1982; SAIC, 1982; Morton, 1980; SAIC 1980). Thus, the questions that the monitoring program addresses are directed at determining if benthic recovery is proceeding as expected and if pollutant sensitive organisms are growing on the mounds. For Tier 1, these questions include:

- Do opportunistic species return to the mound within a growing season?
- Are the infaunal assemblages consistent with similar nearby sediments or expected recovery stage?
- Are benthic communities and populations similar to surrounding sediments?

If these questions are answered in the affirmative, the biological community on the mounds is recovering as expected, and significant adverse impact from the disposal operations is not demonstrated. If the questions are answered in the negative, investigation into potential causes is conducted under Tier 2.

Tier 1

This tier focuses on the biological recovery of the mound surface by sampling for specific, opportunistic, benthic infaunal species and the recolonization stage relative to nearby sediments.

H_0 2-1: Stage 2 or 3 assemblages (deposit-feeding taxa) are not present on the disposal mound one year after cessation of disposal operations.

This hypothesis will be tested with sediment profile imaging on the disposal mounds created in a given dredging season and by periodic imaging of older mounds. This evaluation includes estimates of grain size classes, which is a key variable affecting the types of organisms observed in the images. The initial sediment profile imaging survey should be conducted within 12 to 16 months after mound completion. Evaluation of selected historic (inactive) mounds and imaging of the proposed IOSN reference stations will be incorporated into each survey of active mounds. Sampling of historic mounds can be sequenced across years depending on budgets and the conclusions of the previous data review at the annual agency coordination meeting.

Significant adverse impact will be determined from comparison of the sediment profile imagery data on the active and historic mounds to that of the reference stations. If the comparison of the mound data to the reference areas is consistent with the expected successional sequence, the biological community on the mounds would be considered to be recovering as expected and significant adverse impact from the disposal operations not demonstrated. If there is significant departure from the successional expectation in the sediment profile imagery data between the mounds and reference site, and the grain size information from the images or reference condition cannot explain the difference, further investigation into the potential causes of the difference is conducted under Tier 2.

Tier 2

This Tier is executed if differences in the benthic recolonization data on a dredged material mound cannot be explained by differences or changes in grain size. The hypotheses are designed to determine if the observations made under Tier 1 are localized (mound specific) or regional and to determine the effect of different sediment grain size distributions on the biological observations.

H_0 2-2: The absence of opportunistic species and Stage 2 or 3 assemblages is not confined to the disposal mounds.
H_0 2-3: The range in sediment grain-sizes on the disposal mound is not different from the ambient seafloor.

These hypotheses examine whether or not the differences observed in Tier 1 extend beyond the disposal mounds and whether the grain size distribution within and outside the site can explain the biological observations. If diminished recolonization (successional) stage data is widespread and substantial movement of material is not observed under Tier 1 or 2 of Management Focus 1 or if poor water quality conditions (*e.g.*, sustained low dissolved oxygen levels) are known to have occurred in the region (Management Focus 3), assignment of the dredged material disposal as the cause is questionable. However, if the differences are widespread and cannot be attributed to other factors, an investigation of cause would be initiated under Tier 3 of this Management focus.

These hypotheses will be tested with sediment profile imaging. The full suite of information developed from the sediment profile images will be used to evaluate the similarity or differences of the areas sampled. This evaluation includes estimates of grain size classes, which is a key variable affecting the types of organisms observed in the images. The data will be used to address the above hypotheses. If the results find the effect is widespread and that grain size distributions cannot explain the biological observations, additional cause effect studies defined under Tier 3 may be conducted.

Tier 3

Tier 3 is conducted if the benthic recolonization data developed under Tier 2 indicate that potential impacts are widespread (*i.e.*, encompass areas within and beyond the site boundaries). This Tier attempts to determine if the Tier 2 findings are the result of contaminants in the sediments or sediment toxicity. Tier 3 studies will only be conducted after a review and concurrence by the agencies managing the site.

H_0 2-4: The toxicity of sediment from the disposal site is not significantly greater than the reference sites.
H_0 2-5: The benthic community composition and abundance is not equal to that at reference sites.

Sampling and analysis of the sediments for benthic infaunal enumerations and community analysis will be conducted to evaluate the status of the infaunal community and compare the community to measures of sediment quality. Sediment chemistry and toxicity will be measured at representative locations from within the deposited material and at the proposed IOSN references sites.

Chemical and toxicity measures will be conducted as defined in the RIM (EPA and Corps, 2004) or subsequent approved documents. Data from the area of concern will be compared statistically to data collected concurrently from the proposed IOSN reference sites to determine if the quality of transported material is unacceptable. The number of stations to include in the testing may be determined at the annual meeting. The decision of unacceptable conditions will be based on all three measures.

Management Focus 3: Changes in Water Quality

The premise underlying this management focus is that water quality in Bigelow Bight within the Gulf of Maine is affected by many different sources, and that dredged material placed at the site exerts minimal oxygen demand on the water column and minimal potential for other water column impacts. Moreover, dredged material plume studies indicate the cloud of particles resulting from dredged material disposal has a very short duration in the water column and turbidity levels reach ambient levels within minutes to hours. This fact, coupled with required testing that ensures residual material meets water quality criteria within an initial mixing period (within four hours within the site and always outside the site) before the material can be accepted at the site, minimizes any long-term, cumulative impact to the water column. Therefore, it is expected that significant short-term adverse effects are unlikely to result from the disposal operations.

Tier 1

Tier 1 monitoring will consist of tracking available existing coastal water quality monitoring programs to identify any longer-term trends within Bigelow Bight that might be relevant to the proposed IOSN site. Additionally, although not a concern for most projects, some projects may be required to prove that they are not exceeding Limiting Permissible Concentration (LPC) criteria at the site boundary during dredged material disposal. Thus, a measurement program to document whether short-term changes in water quality during disposal operations (H_o3-0) occurs is not proposed under Tier 1 but may be required as part of a disposal permit.

H_0 3-0: The LPC is not exceeded at the site boundary for four hours after a dredged material disposal event.

Specifics of this monitoring, as well as what follow up Tier 2 and Tier 3 monitoring would encompass would be developed through interagency coordination at such time the tier is deemed necessary.

Management Focus 4: Changes in Composition or Numbers of Pelagic, Demersal, or Benthic Biota at or Near the Disposal Site

Similar to the water column, significant impacts to pelagic or demersal species is not expected given the limited time dredged material is expected in the water column and the relatively small footprint of benthic habitat that is affected on an annual basis. Also similar to the water column, tracking of existing coastal studies of pelagic and demersal species will be performed to trends that may be relevant to the proposed IOSN site.

As noted in the Environmental Assessment for site designation, benthic biota within the immediate footprint of disposal are directly impacted, but studies have demonstrated a rapid recovery of the benthic community. Hence, site monitoring will follow the tiered structure described above as part of Management Focus 2 tracking the benthic recovery of the site.

Management Focus 5: Accumulation of Material Constituents in Marine Biota at or Near the Site

The intent of this management focus is to evaluate whether significant potential for bioaccumulation results from disposal of dredged material at the proposed IOSN site. The basic premise of this management focus is that testing of sediments for open water disposal eliminates material that poses an unacceptable risk to the marine environment from disposal. Moreover, because bioaccumulation of contaminants is a phenomenon, it may not result in the impairment or death of organisms in and of itself. However, because bioaccumulation may result in transfer and possible biomagnification of certain chemicals throughout the food chain, which may pose potential unacceptable risks to marine organisms and humans that are not addressed through the evaluation of benthic community recovery, measurements for potential bioaccumulation are precautionary and prudent.

Such bioaccumulation data can serve several purposes. The first is to help understand whether transfer of chemicals from sediments to organisms could be contributing to a significant adverse biological response (*e.g.*, failure of a benthic infaunal community to thrive). The second is to estimate potential risks posed from bioaccumulation of contaminants at the site. Taken together, this information provides assurance as to the adequacy of the dredged material testing program in preventing unsuitable material from being disposed at the site.

Tier 1

The premise of this Tier is that bioaccumulation potential at the proposed IOSN, and thus risk, does not increase after the sediments are deposited.

H_0 5-1: Bioaccumulation potential of sediments collected from the proposed IOSN is not significantly greater than the range of bulk chemical values measured in permitted projects.

This hypothesis will be tested by periodically collecting sediments from within the proposed IOSN and its reference areas and measuring the level of contaminants in the sediments. If statistically significant increases in sediment chemistry above permitted dredged material project data are found, theoretical bioaccumulation calculations will be performed. These may be performed in association with any sampling for sediment chemical analysis. If the bioaccumulation modeling indicates a significant increase in potential bioaccumulation relative to baseline conditions or reference areas more specific studies that directly measure bioaccumulation may be conducted under Tier 2.

Tier 2

Direct evidence of bioaccumulation from sediments placed at the proposed IOSN site may be obtained by comparing bioaccumulation in organisms collected from within and near (reference stations) the disposal site. The study may include collection of representative infaunal organisms from these locations and comparing the level of chemicals in their tissues or testing sediments under controlled laboratory conditions (*i.e.*, bioaccumulation bioassays) or both. The specific study questions and sampling design will be developed and approved by the agencies managing the proposed IOSN site before any study is conducted. If significant increases in bioaccumulation are determined to exist in the sediments from the site, ecological and human health risk models may be run to examine the significance of the increase. If risks increase significantly, studies described under Tier 3 would be implemented.

Tier 3

This Tier tests for transfer of bioaccumulated compounds at the site into higher trophic levels.

H_0 *5-2: Bioaccumulation of material constituents in higher tropic levels that reside at or near the site does not result from disposal of dredged material at the proposed IOSN site.*

Proving the source of contaminants measured in higher trophic level species is a difficult and complex task. Therefore, careful experimental design is required to make a cause effect link to the sediments deposited at the proposed IOSN site. The specific study design will be developed and approved by the agencies managing the proposed IOSN site before any study is conducted.

6.3 Monitoring Methods

This section describes equipment and approaches typically used to evaluate dredged material disposal sites in the northeast United States. Use of consistent techniques increases comparability with future and historic data; however, monitoring methods used at the proposed IOSN site are not limited to these technologies. New technology and approaches may be used as appropriate to the issues and questions that must be addressed. The applications of equipment and survey approach must be tailored to each individual monitoring situation, as warranted.

Mound Erosion

Loss of deposited dredged material (erosion) at the site will be investigated using precision multibeam bathymetry. Today's survey techniques and equipment have matured to the place that surveys provide full bottom coverage, and comparative surveys can detect changes in the bathymetry of mounds of approximately 6 inches (15 cm). Co-collected side scan sonar and acoustic backscatter provide additional insight into the physical characteristics of surficial sediment and processes affecting them. Sediment profile imaging systems (Rhoads and Germano, 1982; Germano *et al.*, 1994) may also be used and are useful for defining broad areas where grain size may have changed or identify thin layers of dredged material, respectively (Rhoads, 1994). Specific survey requirements and application of these measurement tools will be defined for each tier and situation investigated. Evidence of mound erosion will need to be evaluated carefully to distinguish between actual erosion and mound consolidation.

Biological Monitoring

Benthic recovery at disposal mounds will be measured by combined sediment profile and plan view imagery (Germano and Rhoads, 1982; 1994). In addition, stations at each of the reference sites will be obtained. At each station a minimum of three photos will be taken with the sediment profile imaging camera. Stations are typically randomly located within a specified area of interest to increase the statistical power of comparison of affected site with reference areas. Image analyses will provide the following information:

- Sediment grain size;
- Sediment surface boundary roughness;
- Sea floor disturbance;
- Apparent Redox Potential Discontinuity (RPD);

- Depth of camera penetration (inferring sediment strength);
- Sediment methane;
- Infaunal successional stage.

Water Quality

Should site specific monitoring be required for water quality monitoring, methodologies will be developed through interagency coordination.

Sediment Quality

Grab samples of the sediments will be collected and analyzed for grain size, total organic carbon, and selected contaminants such as trace metals (*e.g.*, mercury, lead, zinc, arsenic, iron, cadmium, copper), total PCBs, total PAH, and pesticides (EPA/Corps, 2004). The number of stations and locations will be defined during survey planning and will be sufficient to enable characterization of within and among station variability.

Bioaccumulation Measurements

Measurement of bioaccumulation will include collection of representative benthic infaunal species within the site and at reference locations. At least two types of organisms (filter feeders and sediment feeders) will be obtained and genus level species aggregated into field replicates. Sufficient biomass to enable quantifications of bio-accumulatable compounds will be obtained from grab samples (or other appropriate sample collections device). Tissue will be prepared and analyzed using methods consistent with EPA/Corps (2004). The number of stations and locations will be defined during survey planning and will be sufficient to enable characterization of within and among station variability. Between three and five replicate samples should be obtained from each station sampled including each of the reference stations. Laboratory based bioaccumulation testing will follow the requirements outlined in EPA/Corps (2004).

6.4 Quality Assurance

An important part of any monitoring program is a quality assurance (QA) regime to ensure that the monitoring data are reliable. Laboratories are required to submit Quality Assurance (QA) sheets with all analyses on a project-specific basis. Monitoring activities will be accomplished through a combination of EPA Region 1 and USACE-NAE resources (*e.g.*, employees, vessels, laboratories) and contractors. Documentation of QA/QC is required by both agencies for all monitoring activities (*i.e.*, physical, chemical, and biological sampling and testing). QA is documented in the form of Quality Assurance Project Plans (QAPP) and/or Monitoring Work Plans. QAPPs are required for all EPA Region 1 and USACE-NAE monitoring activities. Analytical methods, detection limits, and QA procedures are contained in the EPA Region 1 and USACE-NAE Regional Implementation Manual for the Evaluation of Dredged Material Proposed for Disposal in New England Waters (RIM, EPA/USACE, 2004). Additional sources of information include the Ocean Testing Manual (OTM, or Green Book, EPA/USACE, 1991)

7.0 ANTICIPATED SITE USE

MPRSA § 102(c)(3)(D) and (E) requires that the SMMP include consideration of the quantity of the material to be placed in the site and the presence, nature, and bioavailability of the contaminants in the material, as well as the anticipated use of the site over the long term. The proposed IOSN is designated to receive dredged material only. No other types of material may be placed at the site.

Projected dredging volumes for the southern Maine, New Hampshire, and northern Massachusetts coastline include a mix of large and small federal navigation projects and many small private dredging projects (from marinas, boatyards, and harbors). A complete list of federal dredging projects that may use the proposed IOSN is provided in the EA (EPA Region 1, 2019). A large fraction of the potential dredging volume is from the planned improvement of the Portsmouth Harbor and Piscataqua River Federal Navigation Project. This project is anticipated to yield approximately 576,000 cubic meters (754,000 cubic yards) of dredged material which would be placed at the proposed IOSN.

Dredging and dredged material disposal at the proposed IOSN will be accomplished using a bucket dredge to fill split hull or pocket scows for transport to the disposal site. These types of equipment are expected to be the primary mode of any ocean disposal at the proposed IOSN, although disposal is not specifically limited to this equipment.

National guidance for determining whether dredged material is acceptable for ocean disposal is provided in the OTM or Green Book (EPA/USACE, 1991) and for disposal in state waters in the

ITM (EPA/USACE, 1998). The Regional Implementation Manual (RIM), which builds on and is consistent with the Green Book and the ITM, provides specific testing and evaluation methods for dredged material projects at the proposed IOSN and elsewhere in New England. The quality of MPRSA-regulated material will be consistent with EPA's Ocean Dumping Regulations (40 CFR Part 227), as implemented under the Green Book and the RIM (EPA Region 1/USACE-NAE, 2004).

Because of its depth (90 m [300 ft]) and size (5.3 km² [1.5 nmi²]), the potential capacity of the proposed IOSN is far in excess of the potential site use over the next 20 years and does not pose a hazard to navigation.

8.0 REVIEW AND REVISION OF THE PLAN

MPRSA 102 (c)(3)(F) requires that the SMMP include a schedule for its review and revision, which should be consistent with the requirement that SMMPs be reviewed and, as necessary, revised no less frequently than 10 years after adoption of the plan, and every 10 years thereafter. EPA Region 1 and the USACE-NAE have agreed to review this plan annually as part of an annual agency planning meeting. A more comprehensive, formal review and revision of this SMMP will take place every 10 years unless the agencies agree to do so more frequently at an annual agency planning meeting. Based on that schedule, and anticipated completion of the final SMMP in 2020, EPA Region 1 and the USACE-NAE would then expect to undertake the next review and revision in 2030. EPA Region 1 and the USACE-NAE will coordinate with the USFWS, NMFS, and other federal and state agencies through the NERDT and other established regional networks for these reviews.

Section 102(c)(3) requires that "the Administrator and the Secretary shall provide opportunity for public comment" in developing SMMPs for each EPA-designated dredged material disposal site. EPA Region 1 and the USACE-NAE will provide an opportunity for public comment for future SMMP revisions, as will occur for the current SMMP.

In addition to the 10-year review and revision process, EPA Region 1 and the USACE-NAE will continue to inform and involve the public regarding the monitoring program. The USACE-NAE monitoring reports are available at the USACE-NAE website (http://www.USACE-NAE

.usace.army.mil/Missions/Disposal-Area-Monitoring-System-DAMOS/Disposal-Sites/), and information on the SMMP may be found at the EPA Region 1 website (http://www.epa.gov/ocean-dumping/).

9.0 FUNDING

The costs involved in site management and monitoring will be shared by EPA Region 1 and the USACE-NAE. This SMMP will be in effect until it is further revised or the site is de-designated.

Those monitoring efforts conducted under other agencies and programs will depend solely on funds allocated to those programs by those agencies or other supporting agencies.

The timing and scope of monitoring surveys and other related activities will be determined by funding levels, the frequency of disposal at the site, and the results of previous monitoring.

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