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# 2016 Seafloor Sediment Analysis and Mapping: Midcoast Maine

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**Disclaimer**

This report is preliminary, but data and information published herein are accurate to the best of our knowledge. Data synthesis, summaries and related conclusions may be subject to change as additional data are collected and evaluated. While the Maine Coastal Program makes every effort to provide useful and accurate information, investigations are site-specific and applicability of results to other regions in the state is not yet warranted. The Maine Coastal Program does not endorse conclusions based on subsequent use of the data by individuals not under their employment. The Maine Coastal Program disclaims any liability, incurred as a consequence, directly or indirectly, resulting from the use and application of any of the data and reports produced by staff. Any use of trade names is for descriptive purposes only and does not imply endorsement by The State of Maine.

For an overview of the Maine Coastal Mapping Initiative (MCMI) information products, including maps, data, imagery, and reports visit http://www.maine.gov/dacf/mcp/planning/mcmi/index.htm.

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**Table of Contents**

Acknowledgements ..... iii
ABSTRACT ..... 1
Introduction ..... 2
Purpose ..... 2
Focus Area and Previous Work ..... 2
Methods ..... 4
Multibeam surveys/bathymetry and backscatter collection ..... 4
Bottom sampling ..... 4
Results ..... 8
Discussion and Conclusions ..... 15
References ..... 17
Appendix A – MCMI sample site data (GIS Database) ..... 20
Appendix B – MCMI 2016 sample site sediment data ..... 21
Appendix C – Graphical plots of grain-size data ..... 23
Appendix D – Grab sample field pictures and/or bottom photographs ..... 59

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## ABSTRACT

As part of a multi-year, multi-agency cooperative, the Maine Coastal Mapping Initiative (MCMI) has been addressing the need for comprehensive resource assessment through high-resolution seafloor mapping using a multibeam echosounder (MBES) and by collecting additional seafloor substrate data. The purpose of this investigation was to collect additional seafloor substrate data within the 2015/2016 focus area, which when combined with existing data has helped accomplish the following objectives: perform benthic habitat classification, modeling and mapping via the federally-approved Coastal and Marine Ecological Classification Standard (CMECS) (FGDC, 2012), generate seafloor sediment maps using advanced GIS techniques, and conduct volumetric assessment of potential sand and gravel reservoirs within federal waters. The data presented in this report represent the seafloor sampling efforts and sediment analyses conducted by the MCMI during the 2016 field season (April to October), which included bathymetric mapping for approximately 57 $mi^2$ (148 $km^2$) of seafloor and the collection of bottom samples in 54 locations, 43 in state water and 11 in federal waters, in the vicinity of the Kennebec River paleodelta. The methods and results used to accomplish each objective within the 2015/2016 focus area, as well as all related data and GIS products, are outlined in the following technical reports: Ozmon, 2017 and Dobbs, 2016a; 2016b; 2017a; 2017b; 2017c.

## Introduction

The collection and analysis of geophysical and seafloor sediment data allow state and federal agencies to proactively identify resources available to enhance resiliency, improve management of resources within their jurisdiction, and develop a more comprehensive understanding of potential resources. A key component of coastal resiliency and conservation efforts in Maine's coastal zone is access to quality, near-shore and off-shore sand and gravel resources. The Bureau of Ocean Energy Management (BOEM) has recognized the need to identify additional outer continental shelf (OCS) sand resources for beach nourishment and coastal restoration projects because sand resources in state waters of most U.S. states are either diminishing, of poor quality, or otherwise unavailable (U.S. Department of the Interior, 2014). In Maine, quantitative assessments for these resources have only been conducted in nearshore waters within state jurisdiction (e.g. waters landward of 3-nautical mile line) (Kelley et al., 1997, 1998; 2003). Geological and geophysical data (e.g. cores and seismic reflection profiles) in the region extends into waters of federal jurisdiction, albeit with very poor spatial resolution. When supplemented with high-resolution multibeam echosounder (MBES) data (e.g. bathymetry and backscatter intensity) and additional information about seafloor substrate (e.g. sediment samples, video, benthic fauna, etc.), these data can be combined to develop a more thorough assessment of geologic resources and the biologic communities among them. These MBES and seafloor substrate data can also be utilized to better understand coastal processes and sediment dynamics in nearshore areas.

As part of a multi-year, multi-agency cooperative, the Maine Coastal Mapping Initiative (MCMI) has been addressing the need for comprehensive resource assessment through high-resolution seafloor mapping using a MBES and by collecting additional seafloor substrate data. Data presented in this report represent the seafloor sampling efforts and sediment analyses conducted by the MCMI during the 2016 field season (April to October). Descriptions and summaries of previous year's (2015) efforts within the 2015/2016 focus area are outlined in separate reports (see Dobbs, 2016a; 2016b and Ozmon, 2017).

## Purpose

The purpose of this investigation was to collect additional seafloor substrate data within the 2015/2016 focus area (Figure 1), which when combined with existing data has helped accomplish the following objectives: perform benthic habitat classification, modeling and mapping via the federally-approved Coastal and Marine Ecological Classification Standard (CMECS; FGDC, 2012), generate seafloor sediment maps using advanced GIS techniques, and conduct volumetric assessment of potential sand and gravel reservoirs within federal waters. The methods and results used to accomplish each objective, as well as the data products generated from them, are outlined in the following technical reports (listed with respect to the order listed above): Ozmon, 2017 and Dobbs, 2016a; 2016b; 2017a; 2017b, 2017c.

## Focus Area and Previous Work

The 2015/2016 focus area (Figure 1) is located in Maine's mid-coast region in waters just offshore of the Kennebec River mouth, and was selected due to the high probability of being able to identify sand resources at this location. Previous work in this area is extensive and describes

the overall morphology as the submerged Kennebec River paleodelta (Figure 1) (Barnhardt, 1994; Kelley et al., 1987; 1997; 1998; 2003; 2007). The lobate submarine expression of this feature contains a sandy, gently-sloping nearshore ramp that is abruptly terminated to the east and south around the 55-meter isobath (Figure 2), which has been interpreted as the early Holocene lowstand sea-level (Schnitker, 1974; Kelley et al., 1992; Barnhardt et al., 1995). Beyond the 65-meter isobaths the seabed consists of muddy shelf valleys bound by steep, rocky outcrops. The full extent of the paleodelta sediments were mapped using seismic reflection profiles, bottom samples, and side-scan sonar (Kelley et al., 1987; Belknap et al., 1989). The additional seafloor sediment samples and high-resolution multibeam data collected by the MCMI in 2016 will supplement existing data resources and enable considerable refinement of sediment distribution and (sand and gravel reservoir) volume estimates for this region.

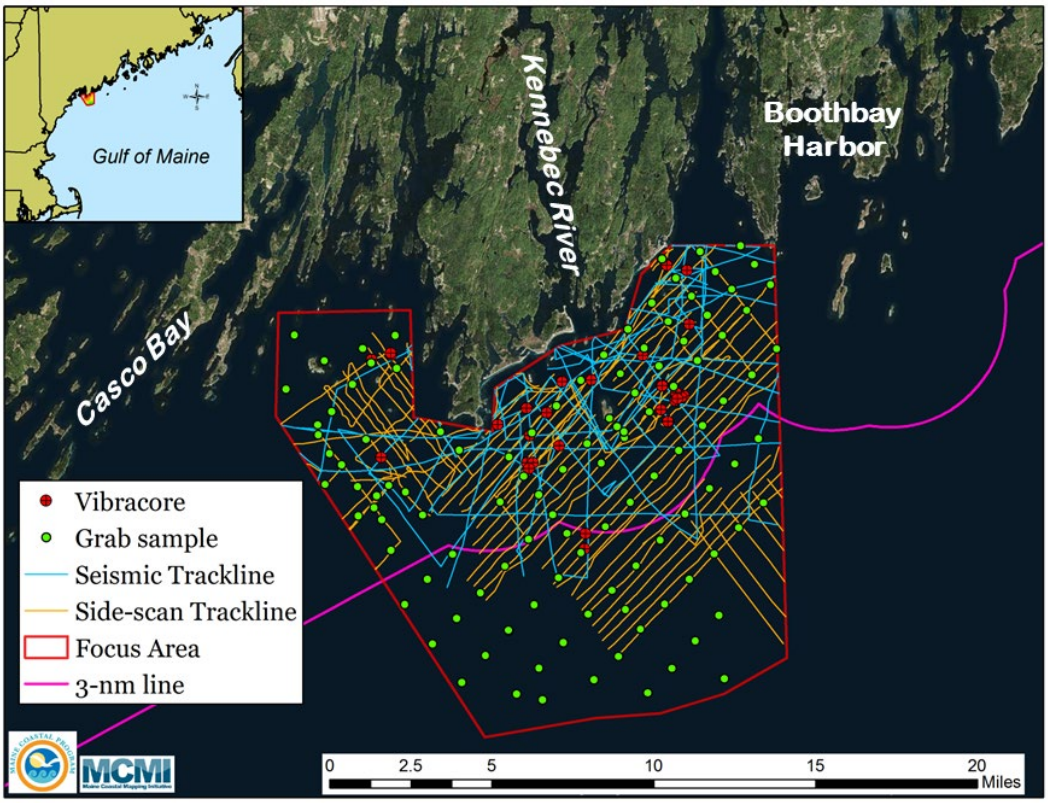


Figure 1. Overview of geological (e.g. vibracores and grab samples) and geophysical (e.g. seismic reflection profiles and side-scan sonar) data collected previously (Barnhardt, 1994; Kelley et al., 1987; 1997; 1998; 2003; 2007) in the 2015/2016 mid-coast Maine focus area (red outline).

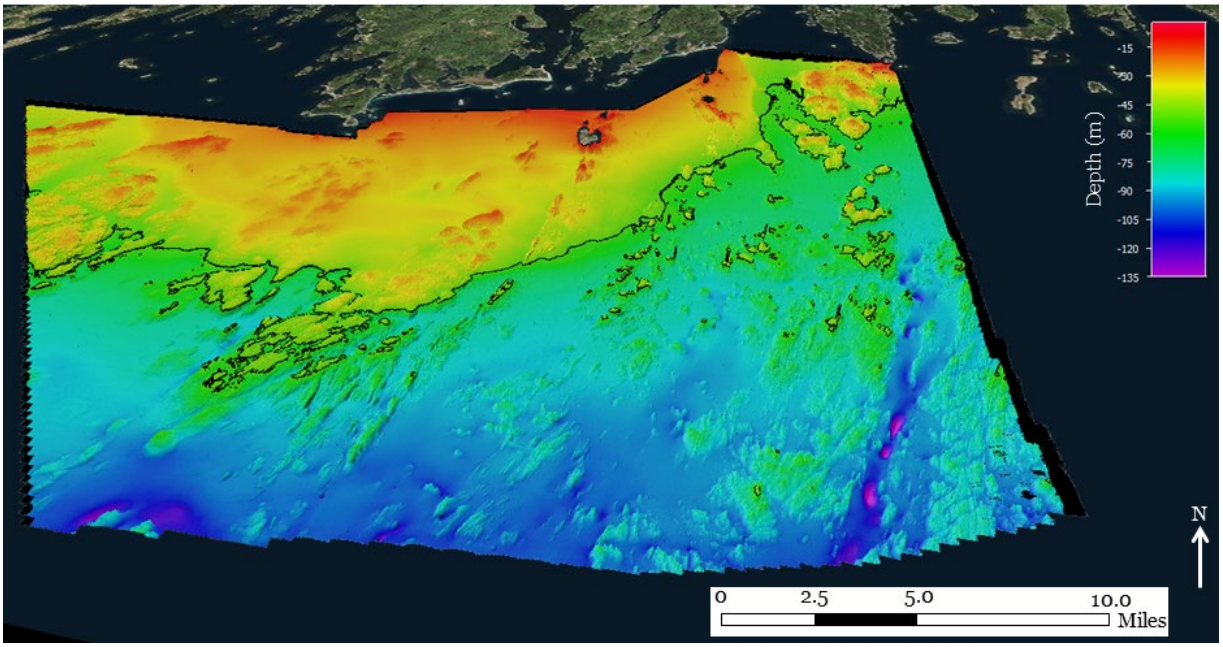

Figure 2. Oblique view (towards north-northeast) of focus area bathymetry and 55-meter isobaths (black lines)/early Holocene lowstand shoreline (Schnitker, 1974; Kelley et al., 1992; Barnhardt et al., 1995). Vertical exaggeration = 5x.

## Methods

Field methods used during this investigation consisted of collecting high-resolution bathymetry and backscatter data using a MBES and bottom sampling.

### Multibeam surveys/bathymetry and backscatter collection

MBES data (bathymetry and backscatter) were acquired aboard the R/V Amy Gale with a Kongsberg EM2040c set to a survey frequency of 300 kHz and high-density beam forming with 400 beams per ping. Parallel lines with consistent spacing (based on depth) were run at 6 - 6.5 knots throughout the survey area. Data acquisition was performed using the Quality Positioning Services (QPS) QINSy (Quality Integrated Navigation System; v.8.12) acquisition software. The modules within QINSy integrated all systems and were used for real-time navigation, survey line planning, data time tagging, data logging, and visualization. Bathymetric data were processed using Qimera (v.1.3.6) and time-series backscatter data were processed using QPS' Fledermaus Geocoder Tool (FMGT; v.7.7.0) software. For complete details pertaining to the multibeam data collection and processing for the 2015 and 2016 field seasons refer to Dobbs 2016b and Dobbs, 2017a, respectively.

### Bottom sampling

In federal waters, sample locations were selected in areas where preliminary analyses of multibeam backscatter intensity data suggested the presence of a predominantly sandy and/or gravelly seafloor. In state waters, sampling locations were distributed in an attempt to obtain

samples from a broad range of benthic habitat types (e.g. variety of substrates, depths, morphologies, etc.; inferred from a review of MBES data), as well as to fill in spatial data gaps in the pre-existing data sets.

The bottom sampler was a single platform rig (Figure 3) outfitted with a clamshell style Ponar grab sampler, GoPro Hero 3+ digital video camera inside a Group B Inc. dive housing, Keldan underwater dive light, dive lasers spaced at 10 cm for scale, and a Xylem Exo 1 to collect water column data (salinity, temperature, pH, dissolved oxygen, and chlorophyll concentrations; see Ozmon, 2017 for details). The 23 x 23 cm Ponar grab was capable of collecting a maximum volume of 8.2 liters of unconsolidated sediment per sampling attempt. Immediately upon retrieval, the sediment surface was photographed and partitioned into two subsamples; a minimum of 1000 $cm^3$ was set aside for grain-size analysis and the remainder was processed to collect infauna samples (see Ozmon, 2017). Sub-samples were divided so each contained portions of the entire depth of the original grab sample. Sediment subsamples were then bagged, labeled, transported in coolers, and held in refrigerators until being processed at the sedimentology laboratory at the University of Maine (UMaine). At each location where the sampler returned empty after three attempts, a hard substrate (e.g. bedrock, boulders, etc.) was inferred and confirmed later with video footage captured during each sampling attempt. Coordinates (WGS84, UTM Zone 19N meters; GPS horizontal accuracy at surface ±3 m) were recorded when the sampler reached bottom and when the wench tether was visually confirmed to have a vertical/near-vertical orientation relative to a flat sea surface. The real-time depth for each location was determined using a hull-mounted single-beam fathometer and was not referenced to a specific vertical datum (e.g. mean lower low water, MLLW). As a result, the vertical uncertainty associated with real-time depths recorded in field notes for each site was as much ±3 m (approximate mean tidal range). However, true depth (referenced to MLLW in meters) at each sample site was extracted from the final bathymetric surface (4-m grid) and was included with the data in this report.

Sediment samples were analyzed using standard laboratory techniques for the textural analyses of marine sediments (Poppe et al., 2005) by the sedimentology laboratory at the University of Maine. The proportion of gravel-, sand-, silt-, and clay-sized particles were used to classify the overall sample using Folk (1974). Samples were also categorized by geologic substrate group and subgroup (Figure 4), as defined by the Coastal and Marine Ecological Classification Standard (FGDC, 2012). The Wentworth (1922) grain-size scale for major textural splits, and in instances where the silt/clay ratio could not be determined accurately (e.g. mud-sized (silt + clay) portion was less than 5% of total weight) total mud was divided evenly between silt (phi size 4 - 8) and clay (phi size 8 - 12) fractions.

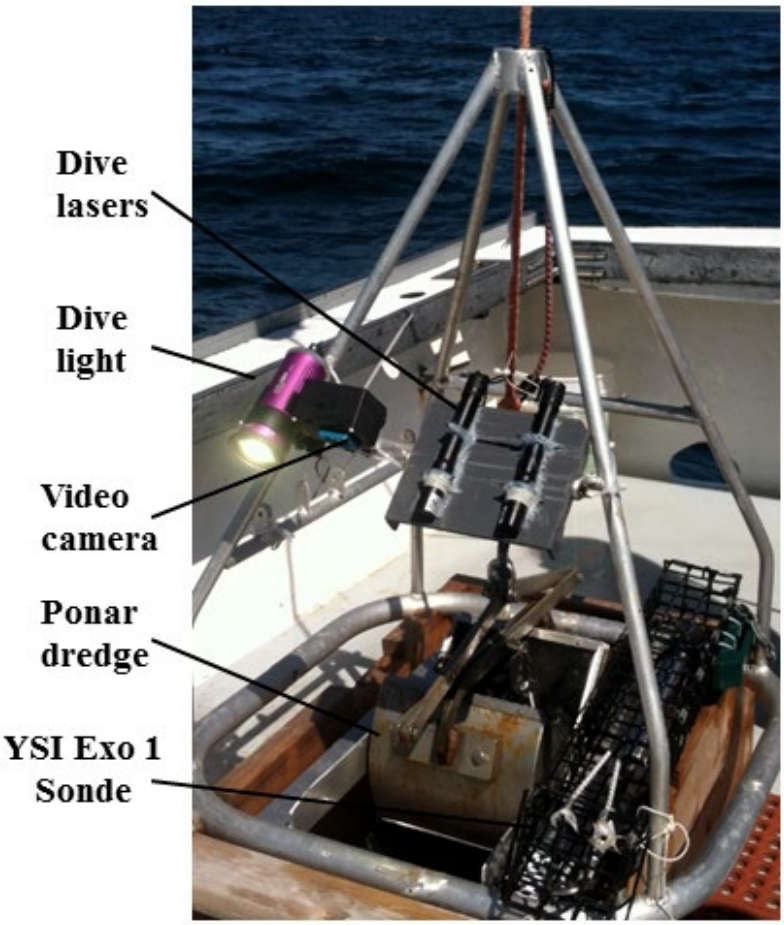


Figure 3. MCMI grab sampling platform.

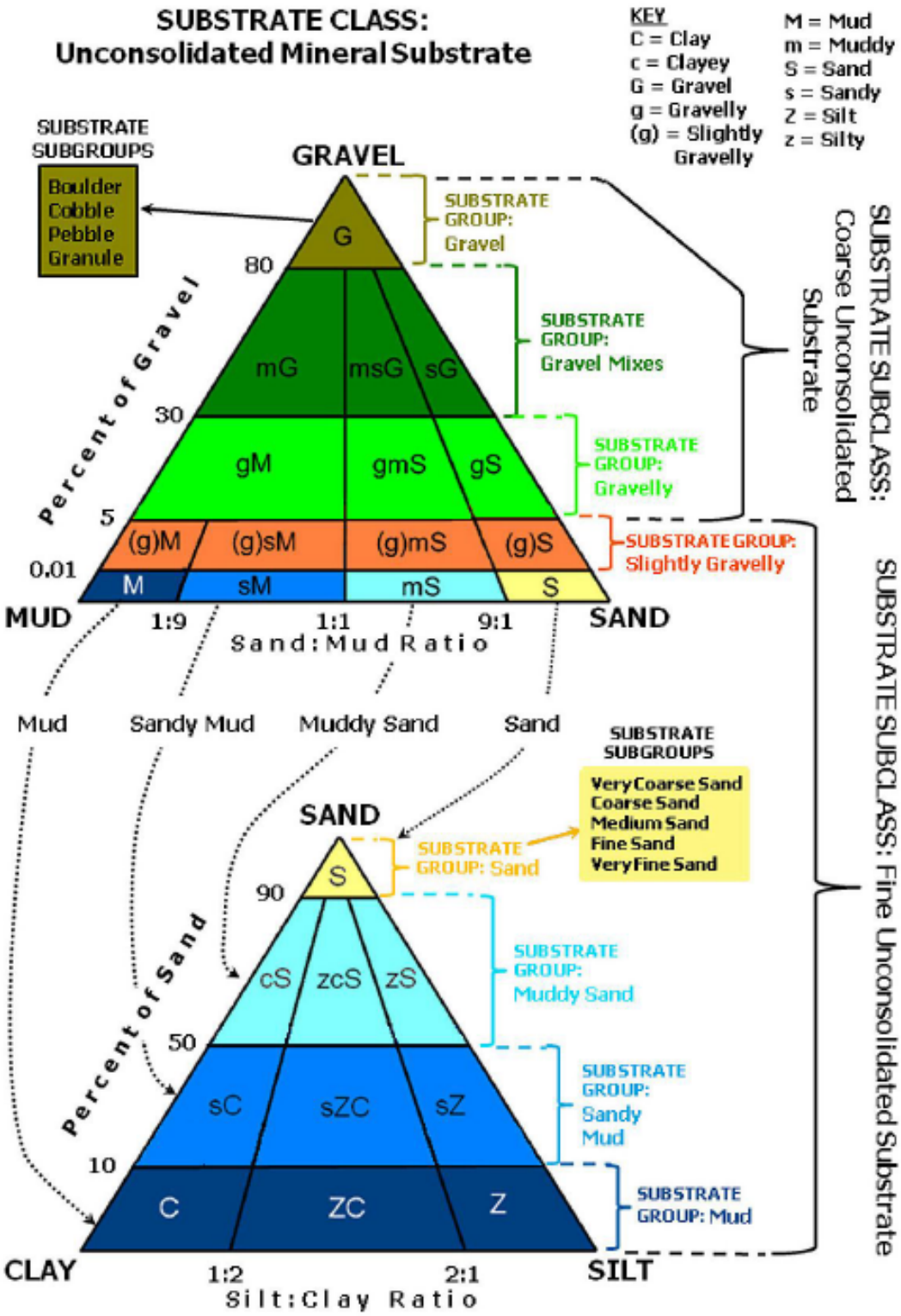


Figure 4. Sediment classification ternary diagrams. (Image from FGDC, 2012; modified from Folk, 1974). G = gravel, S = sand, M = mud, Z = silt, C = clay, s = sandy, m = muddy, z = silty, c = clayey, (g) = slightly gravelly.

## Results

A total of 54 sites, 43 in state water and 11 in federal water, were visited in the 2015/2016 focus area between May and November 2016 (Figure 5). Unconsolidated sediment samples were retrieved from 36 sites and rocky substrates were observed at 18 sites (e.g. no physical sample was retrieved). Table 1 contains a summary of sample location, water depth, sediment penetration depth, and textural properties. Additional sample site data are available in Appendix A (GIS database) and Appendix B (Excel spreadsheet). Graphical plots of grain-size data are located in Appendix C. Sediment field pictures and/or bottom photographs and at each site are in Appendix D.

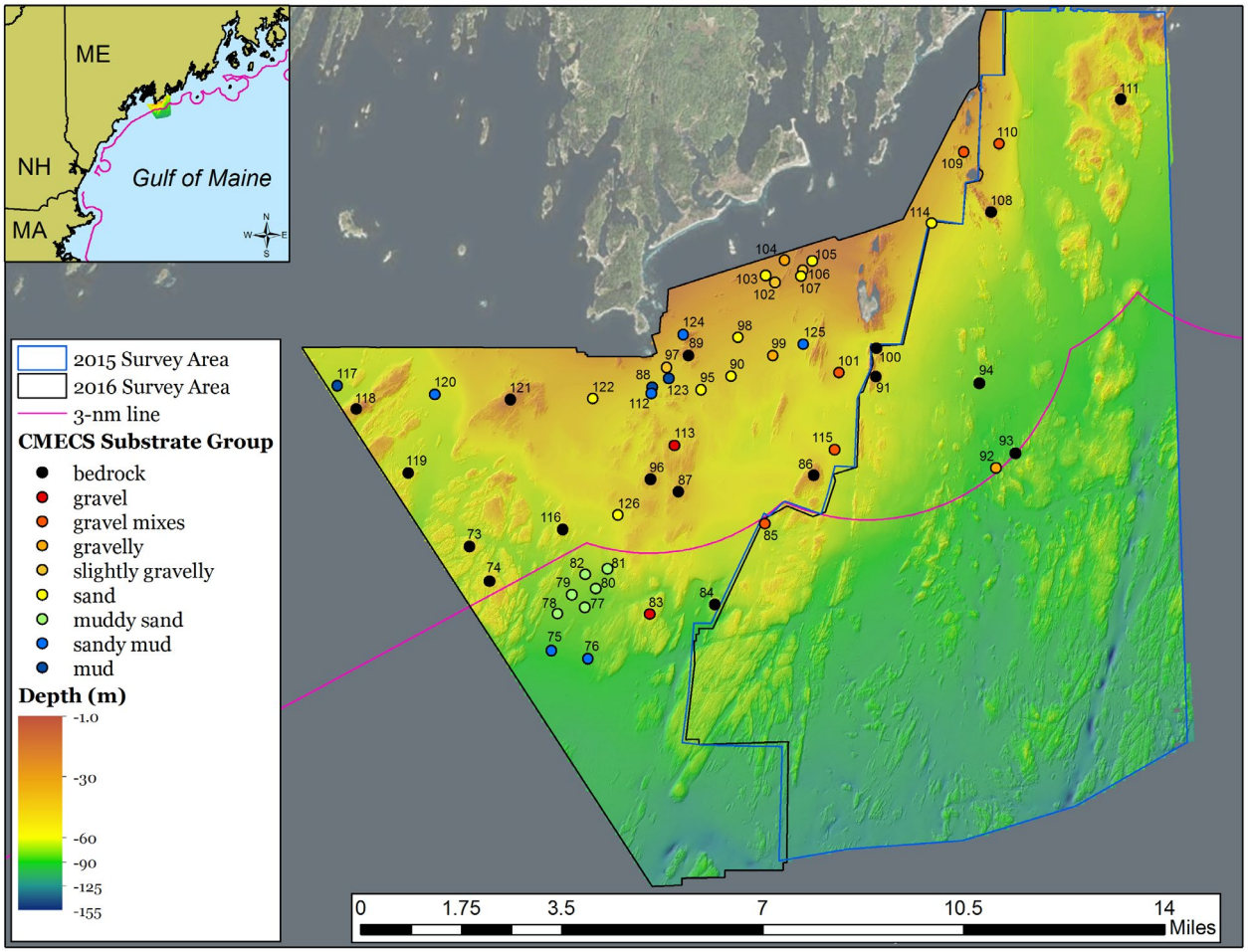


Figure 5. Sample sites visited during 2016 field season with shaded relief bathymetry (4-meter grid). Circles represent sample sites and are shown with sample ID number. Multibeam coverage for 2015 and 2016 field seasons are outlined in black and blue, respectively.

Table 1. Location, depth, and textural properties for bottom samples collected during 2016 field season. Additional sediment data are available in Appendix A (GIS database) and Appendix B (Excel spreadsheet). Graphical grain-size plots are located in Appendix C. Sediment field pictures and/or bottom photographs and at each site are in Appendix D.

| Sample ID | Easting[1] (m) | Northing[1] (m) | Water Depth[2] (m) | Penetration Depth (cm) | Gravel % | Sand % | Silt % | Clay % | Folk (1974) |
|---|---|---|---|---|---|---|---|---|---|
| M0073 | 427835 | 4832930 | 31.0 | no retrieval/hard bottom | | | | | R |
| M0074 | 428394 | 4831950 | 30.3 | no retrieval/hard bottom | | | | | R |
| M0075 | 430138 | 4830012 | 72.4 | not recorded | 0.0 | 34.2 | 27.4 | 38.4 | sM |
| M0076 | 431155 | 4829781 | 71.7 | not recorded | 0.0 | 26.4 | 29.9 | 43.7 | sM |
| M0077 | 431066 | 4831232 | 62.6 | not recorded | 0.0 | 62.4 | 13.0 | 24.7 | mS |
| M0078 | 430307 | 4831040 | 64.0 | not recorded | 0.2 | 65.1 | 13.9 | 20.8 | mS |
| M0079 | 430700 | 4831580 | 58.9 | not recorded | 0.0 | 78.1 | 7.1 | 14.8 | mS |
| M0080 | 431378 | 4831756 | 59.8 | not recorded | 0.1 | 68.7 | 13.4 | 17.8 | mS |
| M0081 | 431700 | 4832303 | 52.9 | not recorded | 0.2 | 75.6 | 8.8 | 15.4 | mS |
| M0082 | 431072 | 4832143 | 52.8 | not recorded | 0.4 | 86.4 | 3.4 | 9.8 | cS |
| M0083 | 432886 | 4831039 | 39.6 | no retrieval/hard bottom | | | | | R |
| M0084 | 434721 | 4831308 | 44.9 | no retrieval/hard bottom | | | | | R |
| M0085 | 436113 | 4833569 | 38.7 | not recorded | 56.9 | 39.0 | 0.2 | 4.0 | sG |
| M0086 | 437493 | 4834930 | 13.6 | no retrieval/hard bottom | | | | | R |
| M0087 | 433689 | 4834472 | 19.2 | no retrieval/hard bottom | | | | | R |
| M0088 | 432950 | 4837408 | 29.8 | not recorded | 0.0 | 9.8 | 38.5 | 51.7 | M |
| M0089 | 433978 | 4838294 | 10.5 | no retrieval/hard bottom | | | | | R |
| M0090 | 435169 | 4837714 | 28.0 | not recorded | 0.7 | 98.3 | 0.5 | 0.5 | S |
| M0091 | 439231 | 4837696 | 28.3 | no retrieval/hard bottom | | | | | R |
| M0092 | 442601 | 4835134 | 69.2 | not recorded | 29.5 | 44.1 | 5.7 | 20.7 | gmS |
| M0093 | 443138 | 4835550 | 65.6 | no retrieval/hard bottom | | | | | R |
| M0094 | 442135 | 4837519 | 50.3 | no retrieval/hard bottom | | | | | R |
| M0095 | 434333 | 4837339 | 29.1 | 8.5 | 0.1 | 90.3 | 2.7 | 6.9 | S |
| M0096 | 432913 | 4834821 | 21.8 | no retrieval/hard bottom | | | | | R |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| M0097 | 433361 | 4837960 | 26.9 | 6.0 | 2.2 | 83.9 | 5.0 | 8.9 | (g)mS |
| M0098 | 435365 | 4838804 | 23.5 | 6.0 | 0.4 | 95.8 | 1.2 | 2.6 | S |
| M0099 | 436338 | 4838284 | 28.6 | 5.0 | 25.1 | 73.4 | 0.2 | 1.3 | gS |
| M0100 | 439244 | 4838490 | 19.0 | no retrieval/hard bottom | | | | | R |
| M0101 | 438193 | 4837811 | 28.6 | 10.0 | 40.3 | 56.7 | 0.0 | 0.0 | sG |
| M0102 | 436402 | 4840351 | 19.2 | 5.0 | 1.1 | 91.1 | 1.5 | 6.3 | (g)S |
| M0103 | 436139 | 4840544 | 16.9 | 4.0 | 0.0 | 97.7 | 0.7 | 1.7 | S |
| M0104 | 436671 | 4840971 | 15.3 | 4.0 | 13.0 | 86.2 | 0.0 | 0.0 | gS |
| M0105 | 437448 | 4840954 | 13.0 | 5.0 | 0.1 | 98.2 | 0.0 | 0.0 | S |
| M0106 | 437183 | 4840692 | 15.1 | 3.5 | 1.1 | 95.7 | 0.0 | 0.0 | (g)S |
| M0107 | 437126 | 4840513 | 15.3 | 8.0 | 0.8 | 97.8 | 0.0 | 0.0 | S |
| M0108 | 442460 | 4842312 | 13.6 | no retrieval/hard bottom | | | | | R |
| M0109 | 441695 | 4844004 | 24.0 | 9.0 | 38.5 | 55.9 | 0.0 | 0.0 | sG |
| M0110 | 442685 | 4844239 | 27.5 | 9.0 | 33.0 | 67.0 | 0.0 | 0.0 | sG |
| M0111 | 446095 | 4845486 | 18.3 | no retrieval/hard bottom | | | | | R |
| M0112 | 432929 | 4837234 | 30.4 | 13.5 | 0.0 | 15.6 | 41.9 | 42.5 | sM |
| M0113 | 433581 | 4835769 | 27.0 | not recorded | 99.3 | 0.6 | 0.0 | 0.0 | G |
| M0114 | 440791 | 4842003 | 25.7 | 5.0 | 1.3 | 96.0 | 0.4 | 2.4 | S |
| M0115 | 438070 | 4835651 | 35.5 | 5.5 | 46.7 | 52.8 | 0.0 | 0.0 | sG |
| M0116 | 430456 | 4833406 | 33.0 | no retrieval/hard bottom | | | | | R |
| M0117 | 424130 | 4837446 | 44.5 | 13.5 | 0.0 | 5.4 | 31.2 | 63.4 | C |
| M0118 | 424664 | 4836784 | 13.9 | no retrieval/hard bottom | | | | | R |
| M0119 | 426115 | 4834993 | 30.6 | no retrieval/hard bottom | | | | | R |
| M0120 | 426856 | 4837193 | 37.7 | 13.5 | 0.0 | 41.3 | 27.5 | 31.2 | sM |
| M0121 | 428981 | 4837064 | 13.7 | no retrieval/hard bottom | | | | | R |
| M0122 | 431289 | 4837079 | 26.0 | 10.0 | 0.4 | 99.6 | 0.0 | 0.0 | S |
| M0123 | 433415 | 4837650 | 28.5 | 13.5 | 0.0 | 5.1 | 41.8 | 53.1 | M |
| M0124 | 433825 | 4838881 | 22.1 | 13.5 | 0.0 | 36.4 | 38.8 | 24.9 | sM |
| M0125 | 437201 | 4838606 | 31.8 | 12.5 | 0.0 | 12.0 | 52.8 | 35.2 | sM |
| M0126* | 432002 | 4833820 | 33.2 | 3.5 | no laboratory analysis | | | | S |

[1]WGS84 UTM Zone 19N meters

[2]Depth vertical datum is meters relative to mean lower low water (MLLW). These values were extracted from the final bathymetric (4-meter grid) raster in ArcMap.

*Qualitative textural field description only. No grain size analysis.

The seafloor in the coverage areas is characterized by distinct zones of high and low backscatter intensity that reflect differences in seafloor substrate (Figure 6). In general, coarse sand and/or gravel are represented by high backscatter intensity (light grey/white areas in Figure 6) and muddy material is represented by the lowest backscatter intensity (darkest tones in Figure 6). Rocky areas contain irregular, heterogeneous patches of high and low intensity. Although a variety of environmental, geometric, and other external factors must be considered when interpreting backscatter data, the signal has been shown to directly relate to unconsolidated sediment grain size and seafloor roughness (Lurton and Lamarche, 2015). This relationship is illustrated in Figure 7 by regressing sample site textural classification (by decreasing coarseness) with the mean backscatter value of samples within representative classes. Tables 2 lists the distribution of sample sites within each CMECS geologic substrate group, Folk (1974) textural classifications, as well as mean backscatter intensity values calculated for each Folk class. As expected, the highest standard deviations are observed within variably surfaced (e.g. smooth or irregular, bare or covered with biota, etc.) rocky substrates and the most heterogeneous textural classes. Although all textural classes are not represented and sample sizes within each class are small, the positive correlation between increasing grain size and higher intensity backscatter may be used as a basis when using backscatter to infer gross scale distribution of unconsolidated substrates.

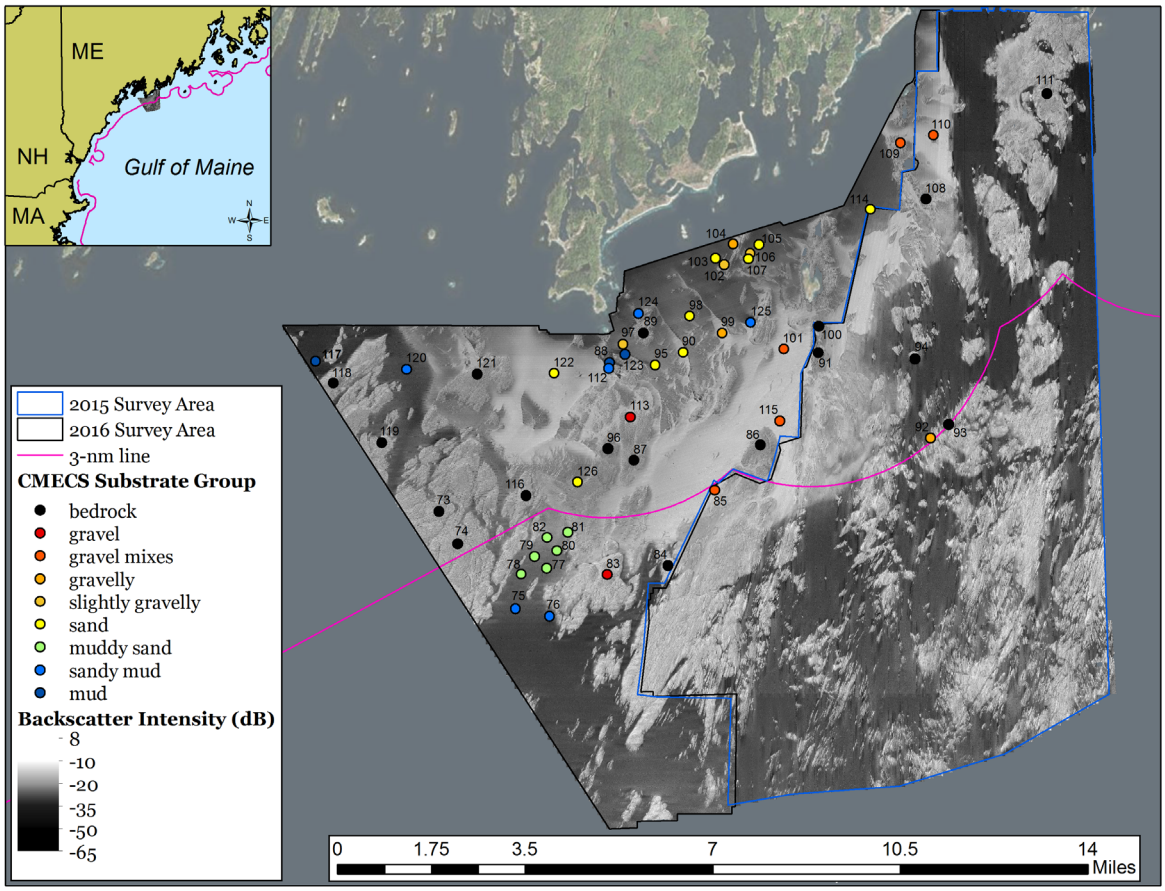


Figure 6. Sample sites with backscatter intensity mosaic (4-meter pixels).

The ternary diagrams shown in Figure 8 illustrate the textural diversity of unconsolidated sediment collected within the 2015/2016 coverage areas. One sample, M0126, was not included in the ternary plots because a laboratory analysis was not performed due to time constraints. Many of the samples contained a polymodal mix of sediment types, which makes the mean, standard deviation, skewness, etc. less meaningful, as they are based on the assumption of being close to a standard normal distribution. Thus, the intrinsically broader Folk-Ward polymodal names are most useful when describing the sediments in this region.

Predominantly muddy sediment (e.g. silt- and clay-sized particles less than 0.062 mm in diameter; Folk class M, sM, and C) was typically collected from depths greater than 50 meters, very poorly sorted, and of glacial-marine origin. However, several predominantly muddy samples (M0088, M0112, M0123, M0124, and M0125) of presumable estuarine origin were recovered from isolated pockets of low-intensity backscatter adjacent to nearshore rocky outcrops in relatively shallow water (22-32 meters). The loss on ignition (LOI) for these samples was at least twice the amount observed for all muddy sediment collected in the coverage area, which is consistent with their noticeably higher organic detrital content noted in field logs. Kelly et al. (1997) also noted that outcrops of this unit occur over wide areas in 15 – 25m depth range.

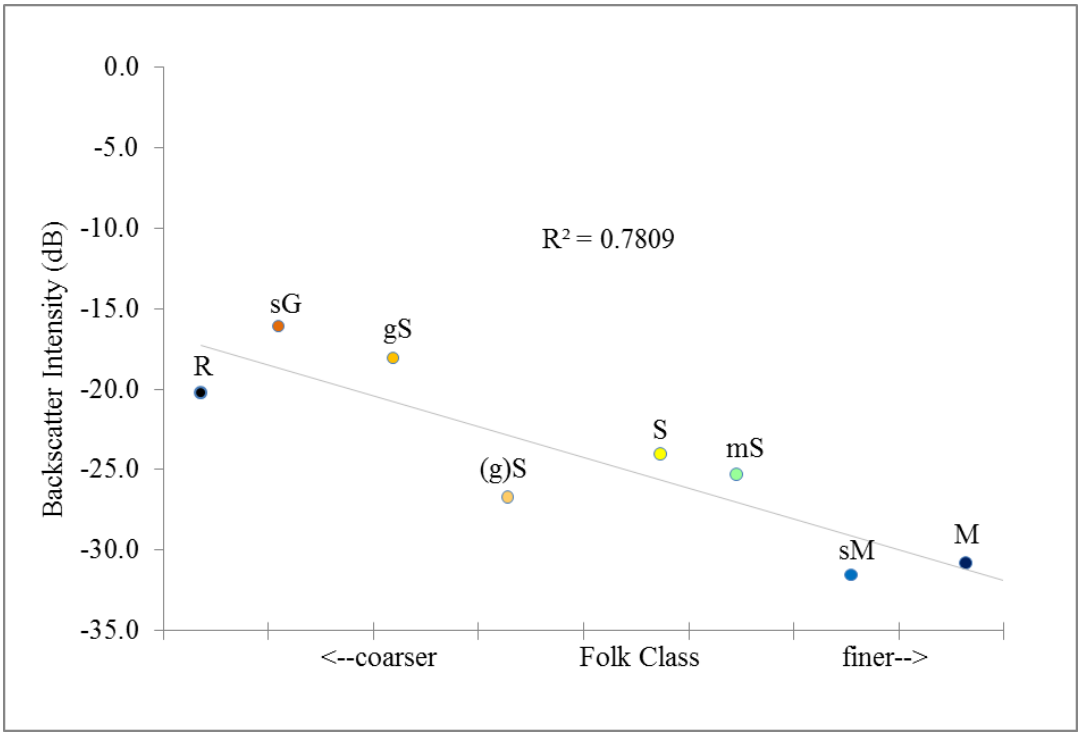


Figure 7. Linear regression of mean backscatter intensity vs. Folk (1974) classes containing at least 2 sample sites. See Table 2 for mean backscatter intensity values and standard deviation within in class.

Table 2. Sample site CMECS geologic substrate group, Folk (1974) textural classification, and mean backscatter intensity values.

| CMECS Geologic Substrate Group[1] | Folk (1974) Class | # of Samples | Mean Backscatter Intensity[2] (dB) | Standard Deviation |
|---|---|---|---|---|
| Bedrock | R | 18 | -20.2 | 3.6 |
| Gravel | G | 1 | - | - |
| Gravel Mixes | sG | 5 | -16.1 | 2.5 |
| | mG | 0 | - | - |
| | msG | 0 | - | - |
| Gravelly | gS | 2 | -18.0 | 0.3 |
| | gmS | 1 | - | - |
| | gM | 0 | - | - |
| Slightly Gravelly | (g)S | 2 | -26.7 | 2.1 |
| | (g)mS | 1 | - | - |
| | (g)sM | 0 | - | - |
| | (g)M | 0 | - | - |
| Sand | S | 9 | -24.0 | 4.6 |
| Muddy Sand | zS | 0 | - | - |
| | mS | 5 | -25.3 | 1.7 |
| | cS | 1 | - | - |
| Sandy Mud | sZ | 0 | - | - |
| | sM | 6 | -31.5 | 2.2 |
| | sC | 0 | - | - |
| Mud | Z | 0 | - | - |
| | M | 2 | -30.8 | 2.7 |
| | C | 1 | - | - |

[1]All sample sites within the within the CMECS (FGDC, 2012) rock substrate class were grouped as bedrock.

[2]Mean backscatter intensity value represents the mean value of cells containing sample sites in the sample textural class within the backscatter mosaic (4-meter pixels). Classes containing ≤1 sample were not included.

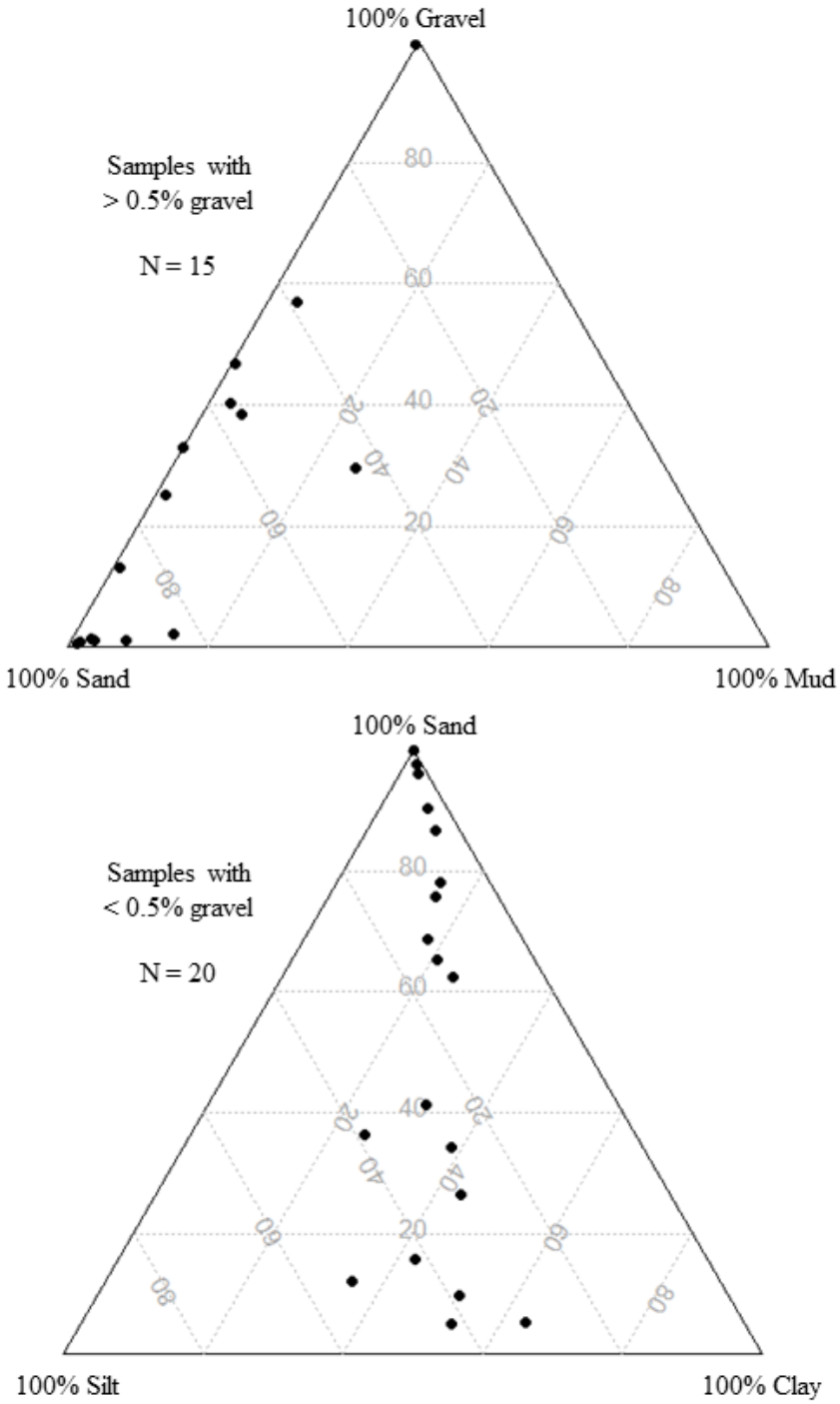


Figure 8. Ternary diagrams of sediment texture. Apexes represent 100 percent of the labeled size component (e.g. gravel, sand, silt, clay). Upper plot for 15 samples containing at least 0.5 percent gravel. Lower plot for 20 samples that lacked gravel.

Sand was the most common sediment type found in samples collected during 2016 within the 2015/2016 coverage areas, with 83 percent of samples containing more than 20 percent sand and 51 percent of samples in a predominantly sand (e.g. gS, gmS, (g)S, (g)mS, cS, mS,, zS, or S) Folk (1974) classification. Sand-sized particles (0.062 to 2 mm in diameter) comprised an average of 61 percent by weight in all samples analyzed, with a minimum of 0.6 percent to a maximum of 99.6 percent. The highest sand content was generally found in samples collected from nearshore areas at depths less than 50 meters. With the exception of one sample (M0122; well-sorted), all predominantly sandy samples were poorly or very-poorly sorted. Very fine to fine sand was the most common in nearshore areas between Small Point and the Kennebec River mouth at depths less than 30 m. It should be noted that sample site M0107 represents an outlier in terms of depositional environment and geomorphology in the region because the sample was recovered from the former Jackknife Ledge nearshore sediment disposal site (see USACE, 2011).

Gravel-sized particles (2 mm to 64 mm in diameter) were fairly common and comprised an average of 11 percent by weight in all samples analyzed. Eight samples contained more than 20 percent gravel, 17 percent of samples were classified as gravel-based (e.g. G, sG, msG, or mG) using the Folk (1974) classification, and 76 percent of samples contained at least some gravel-size material. Gravel and gravel mixtures were most common in the southern and eastern portions of the paleodelta between depths of 30 to 50 meters. Although very few gravel-based sample sites were targeted during this investigation it is possible that gravel and gravel mixtures are underrepresented in grab samples collected in this region due to the difficulty of recovering coarse, gravelly (e.g >64 mm) sediment types with small sampling devices (e.g. Ponar dredge). Barnhardt et al. (2009) used a similar sampler (e.g. Smith-McIntyre) in geologically comparable sites located in nearshore areas off Massachusetts and noted that video and camera observations suggest that “gravel is probably more abundant than the weight percentages indicated by sampling alone”.

## Discussion and Conclusions

During the 2016 survey season the MCMI sampled 54 locations, 43 in state water and 11 in federal water, in the 2015/2016 focus area. Grain-size analyses of sediment samples combined with interpretations of backscatter intensity and bathymetric data are consistent with general interpretations of seafloor sediment distribution and morphology in the region (e.g. Barnhardt et al., 1998 and Kelley, et al., 1997; 1998). Within the survey area, laterally extensive surficial deposits of predominantly sandy and/or gravelly material were mostly restricted to depths less than 55 m and were most commonly associated with the Kennebec river paleodelta/nearshore ramp. Similarly, backscatter and grab sample data suggest these deposits were even more scarce within federal waters of the survey area. Muddy sediment and rocky outcrops were the most common at depths greater than 55 m.

To accomplish the overall objectives established for the 2015/2016 mid-coast focus area, the MCMI has combined and synthesized all relevant data (e.g. bathymetric, backscatter, infauna, geological, and geophysical) collected by the MCMI and by other agencies. Benthic community analyses, CMECS benthic habitat classifications (FGDC 2012), and benthic habitat modeling and mapping are outlined in Ozmon (2017). The advanced GIS techniques employed to perform seafloor textural classification and substrate mapping are outlined in Dobbs (2017b). The results

of the textural mapping were a critical component of the volumetric assessment of potential sand and gravel reservoirs within federal waters, which is described in Dobbs (2017c). Additionally, textural maps inform complete CMECS substrate component classifications for benthic habitat in this mid-coast focus area.

Overall, these data have a variety of applications and are an invaluable resource to public and private agencies who wish to more effectively manage and understand coastal and marine resources. To facilitate these management efforts, the MCMI has compiled all grab sample data (e.g. grain-size analyses, sediment field pictures, and seafloor video), geospatial data products (e.g. bathymetric rasters, backscatter mosaics, textural classification rasters, shapefiles, etc.), and all associated metadata into a user-friendly geodatabase. These data were formatted in accordance with standards set forth by the Federal Geographic Data Committee (FGDC) and are for use within geographic information systems (GIS).

These data can be accessed and/or downloaded on the MCMI website at http://www.maine.gov/dacf/mcp/planning/mcmi/index.htm.

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## Appendix A – MCMI sample site data (GIS Database)

(GIS database available for download at http://www.maine.gov/dacf/mcp/planning/mcmi/index.htm)

# Appendix B – MCMI 2016 sample site sediment data

| Sample ID[1] | Easting[2] (m) | Northing[2] (m) | Depth[3] (m) | Folk[4] (1974) | Gravel % | Sand % | Silt % | Clay % | Mud % | Phi Mean | Phi SD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| M0073 | 427835 | 4832930 | 31.0 | R | | | | | | | |
| M0074 | 428394 | 4831950 | 30.3 | R | | | | | | | |
| M0075 | 430138 | 4830012 | 72.4 | sM | 0.0 | 34.2 | 27.4 | 38.4 | 65.8 | 7.8 | 3.8 |
| M0076 | 431155 | 4829781 | 71.7 | sM | 0.0 | 26.4 | 29.9 | 43.7 | 73.6 | 8.4 | 3.7 |
| M0077 | 431066 | 4831232 | 62.6 | mS | 0.0 | 62.4 | 13.0 | 24.7 | 37.6 | 5.8 | 3.9 |
| M0078 | 430307 | 4831040 | 64.0 | mS | 0.2 | 65.1 | 13.9 | 20.8 | 34.7 | 5.7 | 3.7 |
| M0079 | 430700 | 4831580 | 58.9 | mS | 0.0 | 78.1 | 7.1 | 14.8 | 21.9 | 4.7 | 3.4 |
| M0080 | 431378 | 4831756 | 59.8 | mS | 0.1 | 68.7 | 13.4 | 17.8 | 31.2 | 5.1 | 3.7 |
| M0081 | 431700 | 4832303 | 52.9 | mS | 0.2 | 75.6 | 8.8 | 15.4 | 24.2 | 4.4 | 3.6 |
| M0082 | 431072 | 4832143 | 52.8 | cS | 0.4 | 86.4 | 3.4 | 9.8 | 13.2 | 3.9 | 2.9 |
| M0083 | 432886 | 4831039 | 39.6 | R | | | | | | | |
| M0084 | 434721 | 4831308 | 44.9 | R | | | | | | | |
| M0085 | 436113 | 4833569 | 38.7 | gS | 56.9 | 39.0 | 0.2 | 4.0 | 4.2 | 0.5 | 2.7 |
| M0086 | 437493 | 4834930 | 13.6 | R | | | | | | | |
| M0087 | 433689 | 4834472 | 19.2 | R | | | | | | | |
| M0088 | 432950 | 4837408 | 29.8 | sM | 0.0 | 9.8 | 38.5 | 51.7 | 90.2 | 9.9 | 2.5 |
| M0089 | 433978 | 4838294 | 10.5 | R | | | | | | | |
| M0090 | 435169 | 4837714 | 28.0 | S | 0.7 | 98.3 | 0.0 | 0.0 | 1.0 | 0.3 | 1.1 |
| M0091 | 439231 | 4837696 | 28.3 | R | | | | | | | |
| M0092 | 442601 | 4835134 | 69.2 | msG | 29.5 | 44.1 | 5.7 | 20.7 | 26.4 | 2.9 | 5.4 |
| M0093 | 443138 | 4835550 | 65.6 | R | | | | | | | |
| M0094 | 442135 | 4837519 | 50.3 | R | | | | | | | |
| M0095 | 434333 | 4837339 | 29.1 | S | 0.1 | 90.3 | 2.7 | 6.9 | 9.6 | 1.4 | 3.2 |
| M0096 | 432913 | 4834821 | 21.8 | R | | | | | | | |
| M0097 | 433361 | 4837960 | 26.9 | (g)mS | 2.2 | 83.9 | 5.0 | 8.9 | 13.9 | 3.5 | 3.1 |
| M0098 | 435365 | 4838804 | 23.5 | S | 0.4 | 95.8 | 1.2 | 2.6 | 3.8 | 2.8 | 1.8 |
| M0099 | 436338 | 4838284 | 28.6 | gS | 25.1 | 73.4 | 0.2 | 1.3 | 1.5 | 0.1 | 1.9 |
| M0100 | 439244 | 4838490 | 19.0 | R | | | | | | | |
| M0101 | 438193 | 4837811 | 28.6 | sG | 40.3 | 56.7 | 0.0 | 0.0 | 3.0 | 0.2 | 2.2 |
| M0102 | 436402 | 4840351 | 19.2 | (g)S | 1.1 | 91.1 | 1.5 | 6.3 | 7.8 | 3.5 | 2.4 |
| M0103 | 436139 | 4840544 | 16.9 | S | 0.0 | 97.7 | 0.7 | 1.7 | 2.4 | 3.1 | 1.3 |
| M0104 | 436671 | 4840971 | 15.3 | gS | 13.0 | 86.2 | 0.0 | 0.0 | 0.8 | 0.2 | 1.7 |
| M0105 | 437448 | 4840954 | 13.0 | S | 0.1 | 98.2 | 0.0 | 0.0 | 0.0 | 2.9 | 1.1 |
| M0106 | 437183 | 4840692 | 15.1 | (g)S | 1.1 | 95.7 | 0.0 | 0.0 | 3.2 | 1.4 | 1.7 |
| M0107 | 437126 | 4840513 | 15.3 | S | 0.8 | 97.8 | 0.0 | 0.0 | 1.4 | 1.3 | 1.2 |
| M0108 | 442460 | 4842312 | 13.6 | R | | | | | | | |
| M0109 | 441695 | 4844004 | 24.0 | sG | 38.5 | 55.9 | 0.0 | 0.0 | 5.5 | 0.0 | 2.8 |
| M0110 | 442685 | 4844239 | 27.5 | sG | 33.0 | 67.0 | 0.0 | 0.0 | 0.0 | 0.6 | 1.0 |
| M0111 | 446095 | 4845486 | 18.3 | R | | | | | | | |
| M0112 | 432929 | 4837234 | 30.4 | sM | 0.0 | 15.6 | 41.9 | 42.5 | 84.4 | 8.8 | 3.3 |
| M0113 | 433581 | 4835769 | 27.0 | G | 99.3 | 0.6 | 0.0 | 0.0 | 0.0 | 4.6 | 0.9 |
| M0114 | 440791 | 4842003 | 25.7 | S | 1.3 | 96.0 | 0.4 | 2.4 | 2.7 | 2.9 | 1.6 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| M0115 | 438070 | 4835651 | 35.5 | sG | 46.7 | 52.8 | 0.0 | 0.0 | 0.5 | 0.7 | 1.5 |
| M0116 | 430456 | 4833406 | 33.0 | R | | | | | | | |
| M0117 | 424130 | 4837446 | 44.5 | C | 0.0 | 5.4 | 31.2 | 63.4 | 94.6 | 10.3 | 2.5 |
| M0118 | 424664 | 4836784 | 13.9 | R | | | | | | | |
| M0119 | 426115 | 4834993 | 30.6 | R | | | | | | | |
| M0120 | 426856 | 4837193 | 37.7 | sM | 0.0 | 41.3 | 27.5 | 31.2 | 58.7 | 7.3 | 3.7 |
| M0121 | 428981 | 4837064 | 13.7 | R | | | | | | | |
| M0122 | 431289 | 4837079 | 26.0 | S | 0.4 | 99.6 | 0.0 | 0.0 | 0.0 | 0.6 | 0.4 |
| M0123 | 433415 | 4837650 | 28.5 | M | 0.0 | 5.1 | 41.8 | 53.1 | 94.9 | 9.9 | 2.5 |
| M0124 | 433825 | 4838881 | 22.1 | sM | 0.0 | 36.4 | 38.8 | 24.9 | 63.7 | 8.0 | 3.2 |
| M0125 | 437201 | 4838606 | 31.8 | sM | 0.0 | 12.0 | 52.8 | 35.2 | 88.0 | 8.2 | 3.2 |
| M0126 | 432002 | 4833820 | 33.2 | S* | | | | | | | |

[1]Sample ID M0001 through M0072 collected/visited by MCMI during the 2015 field season.

[2]WGS84 UTM Zone 19N meters

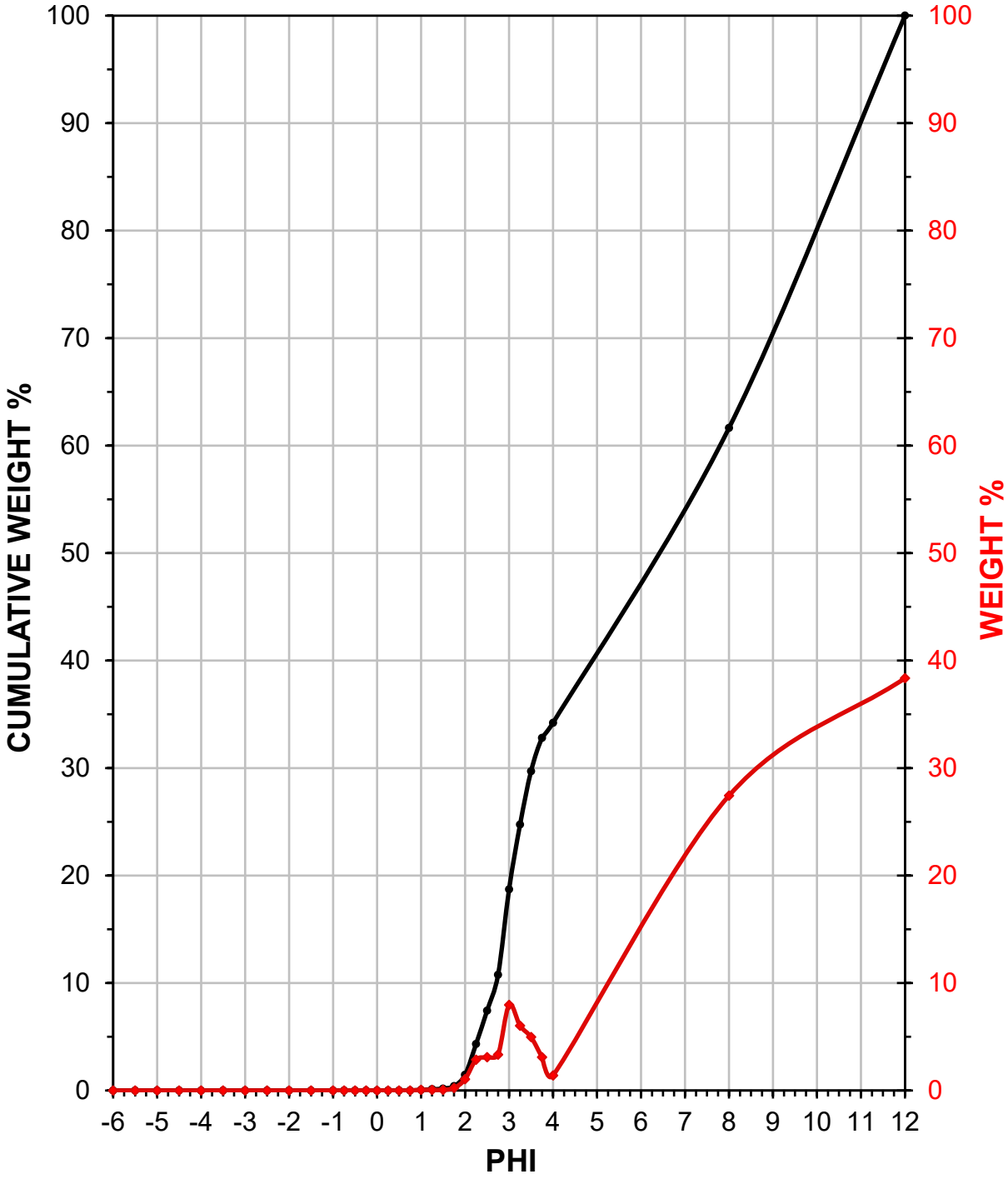
[3]Depths are referenced to mean lower low water in meters.

[4]Samples denoted with an asterisk represent sites for which a grain-size analysis was not performed and/or were classified based on video observations only.

## Appendix C – Graphical plots of grain-size data

# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0075



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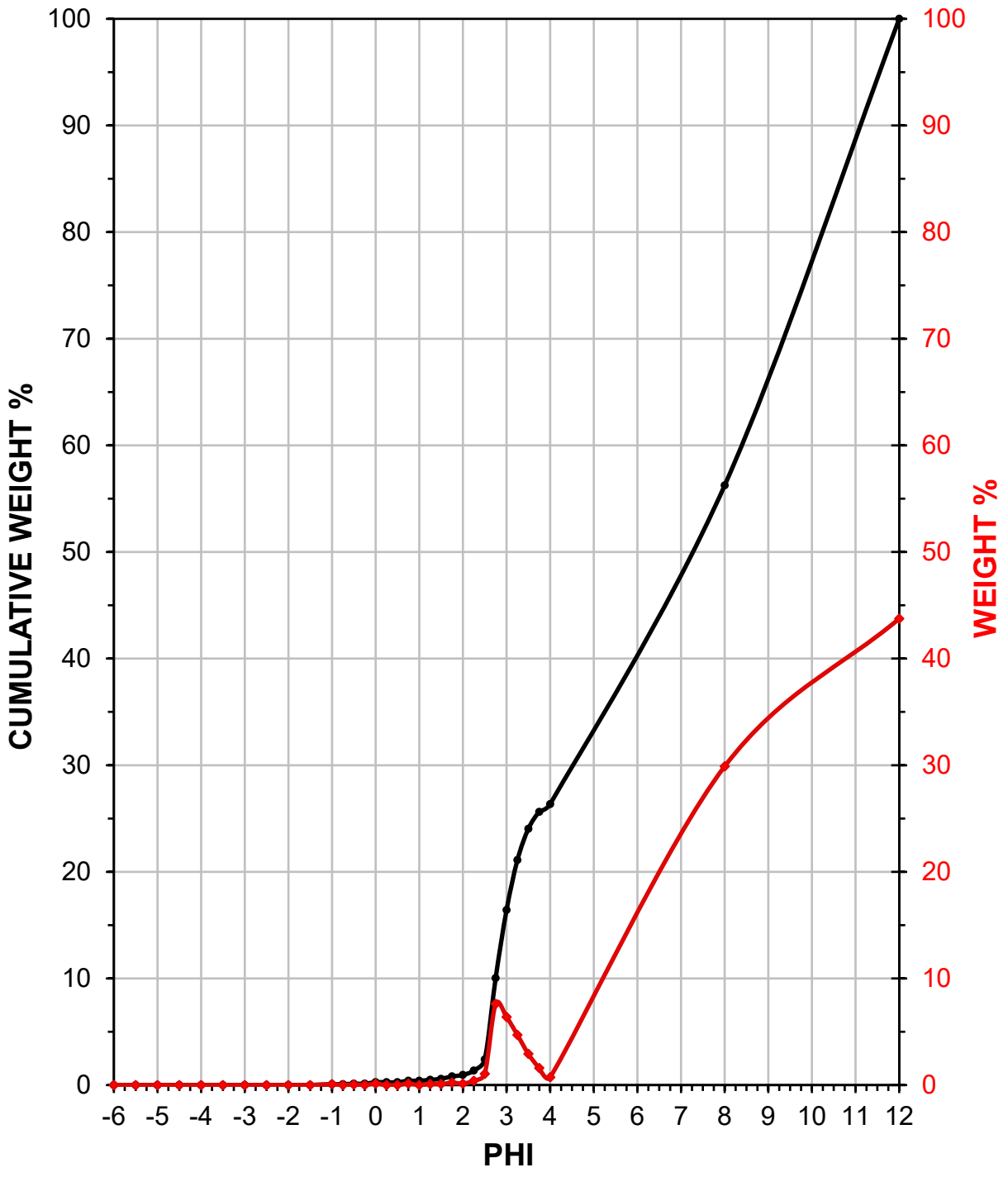

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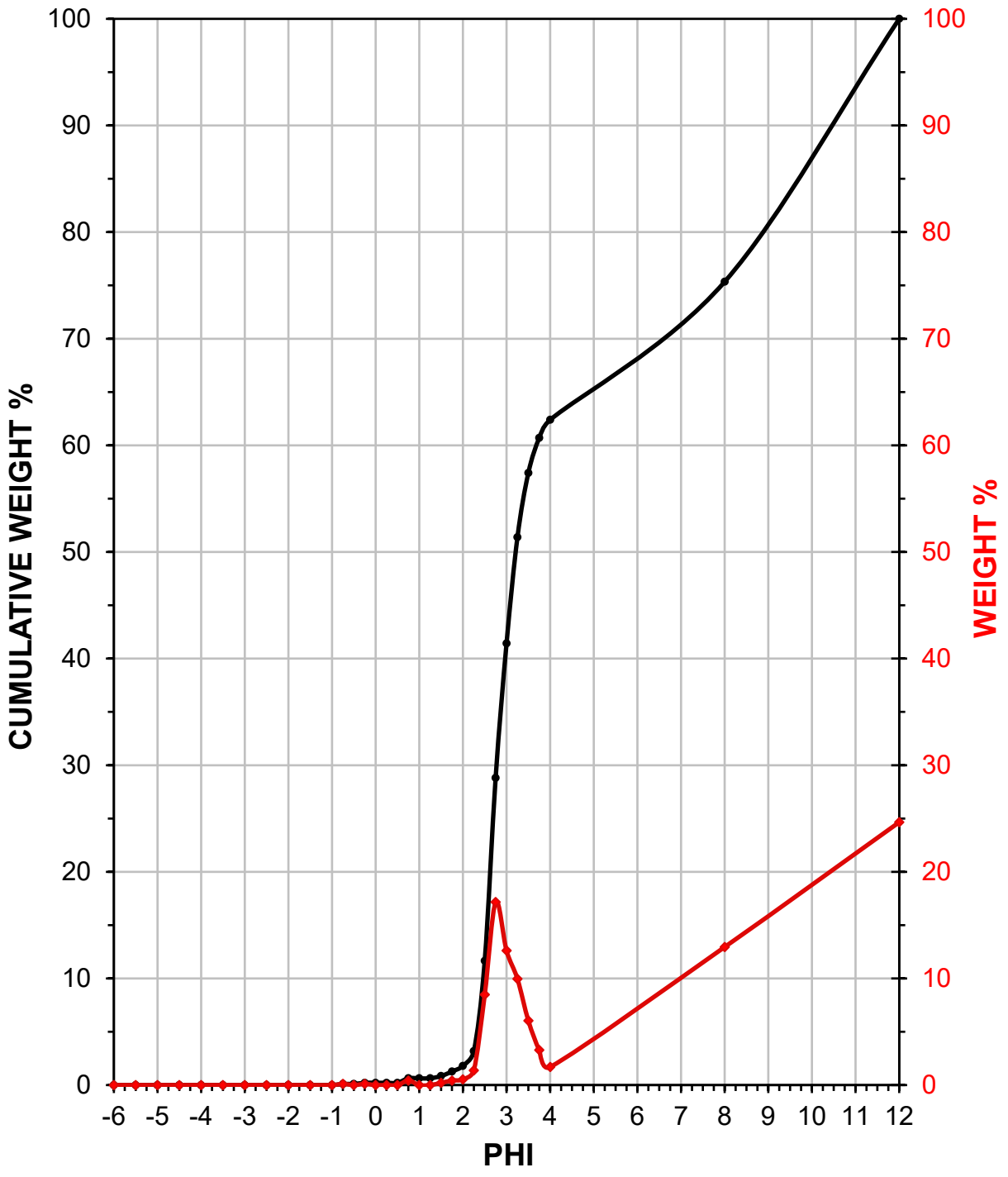
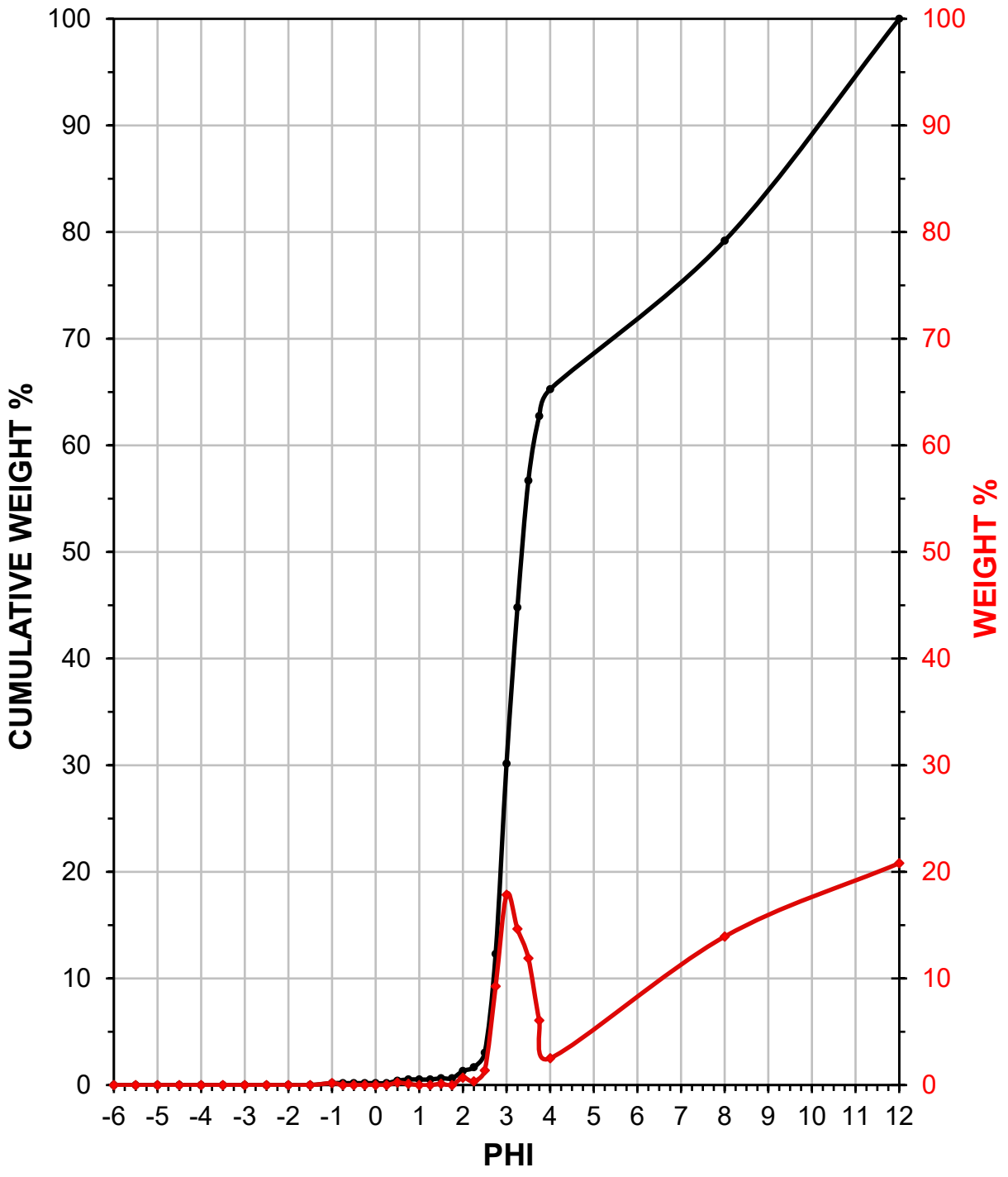


# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0078



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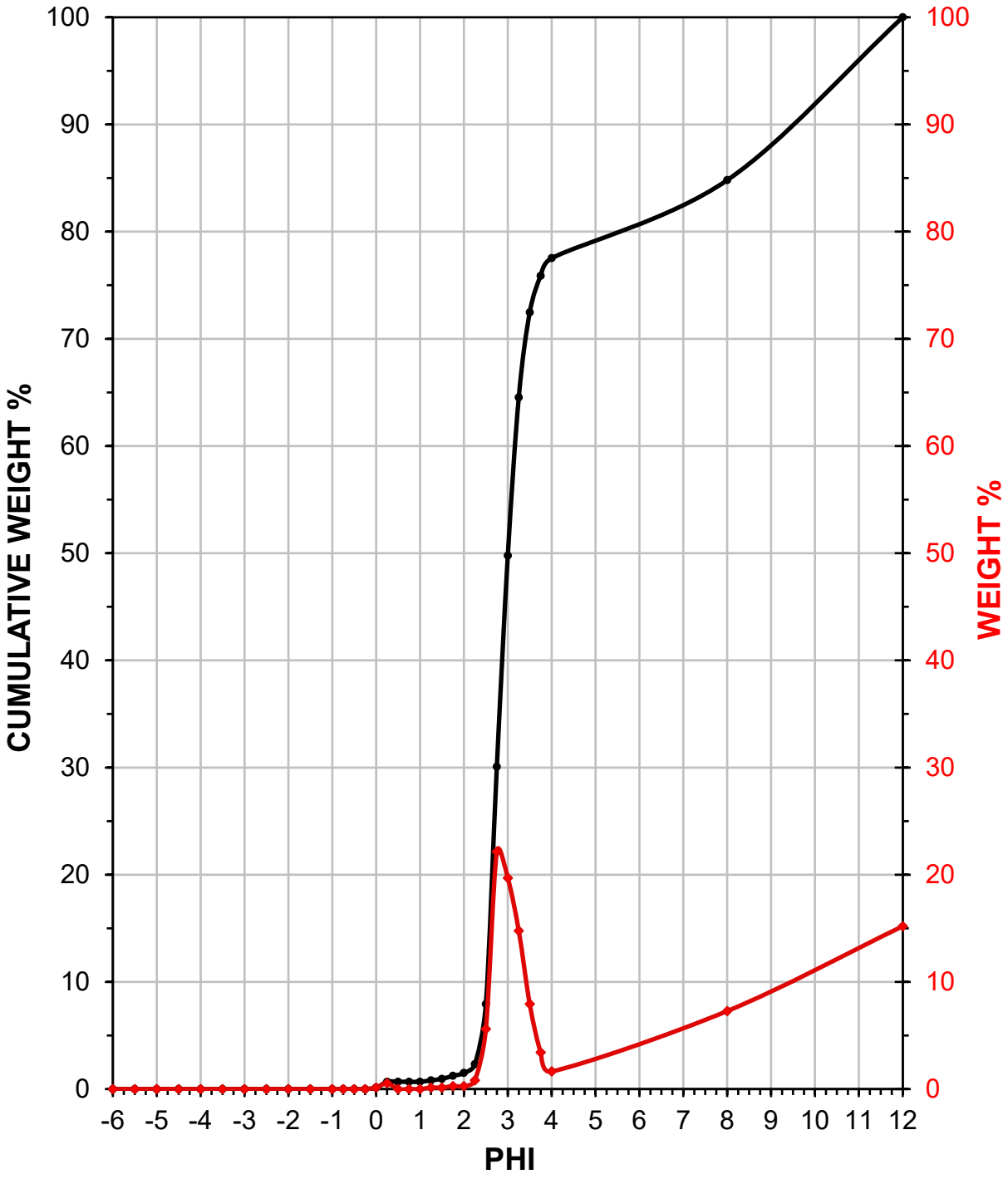
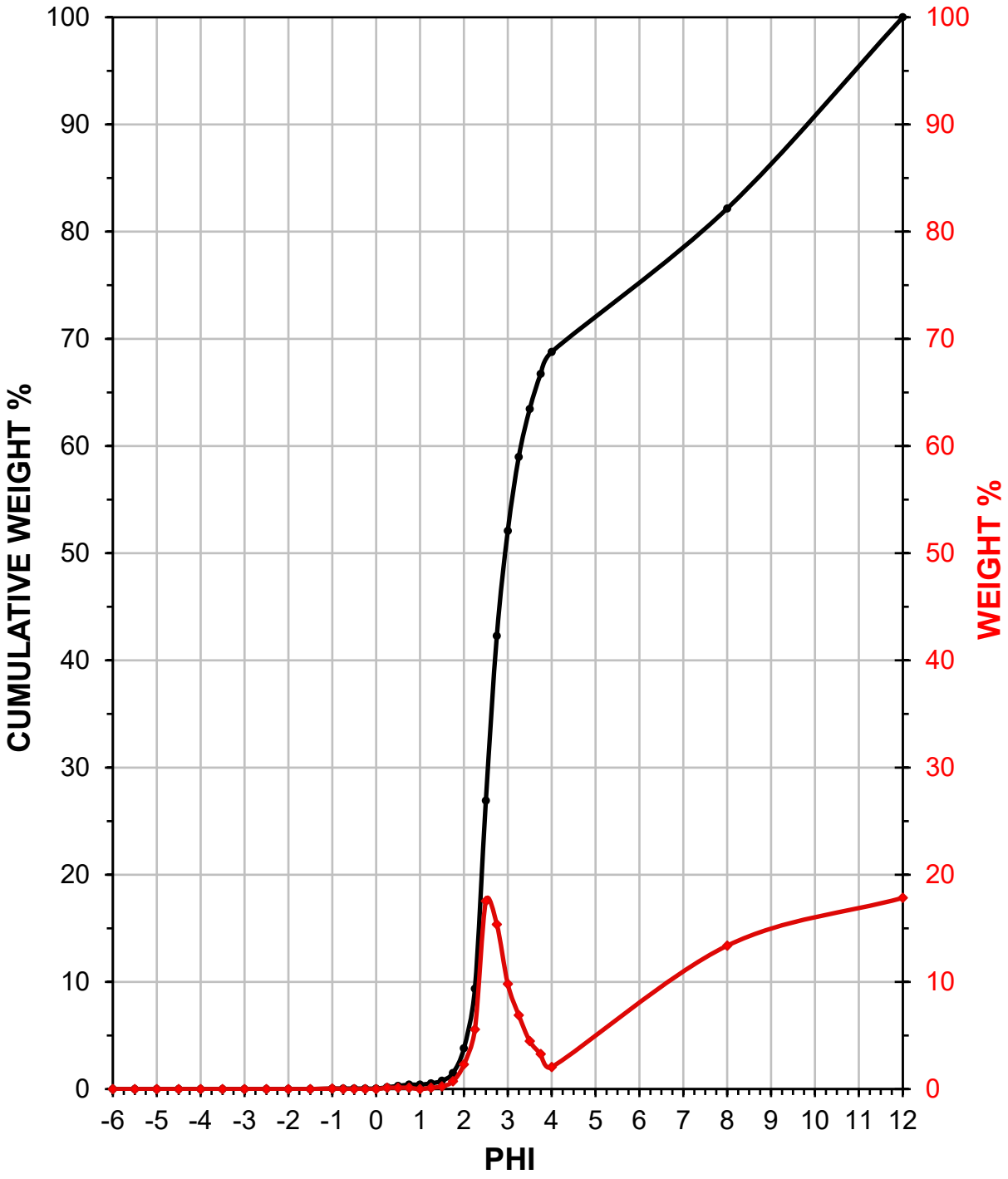
## Offshore Sediments 2016 - M0079



# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0080



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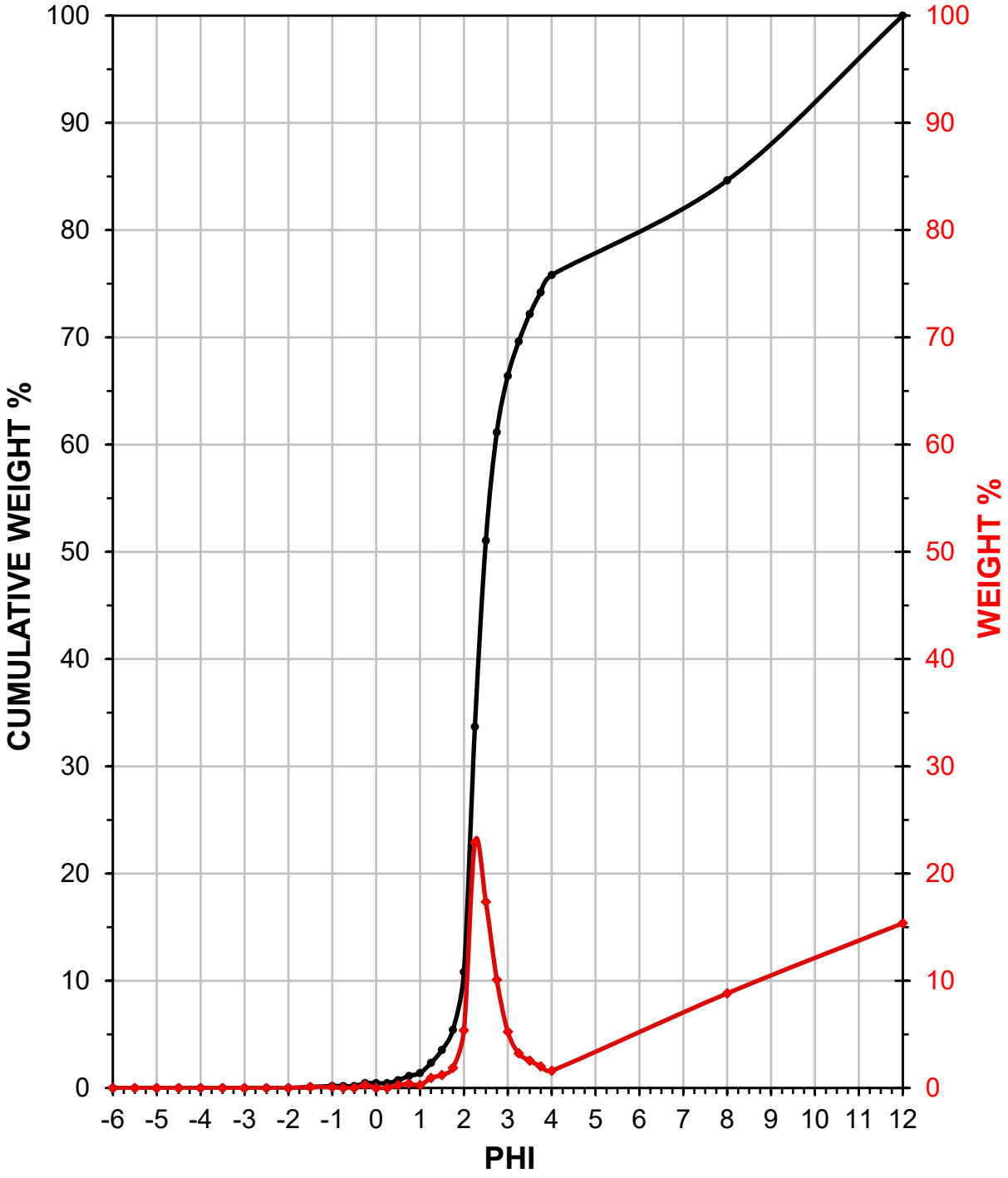
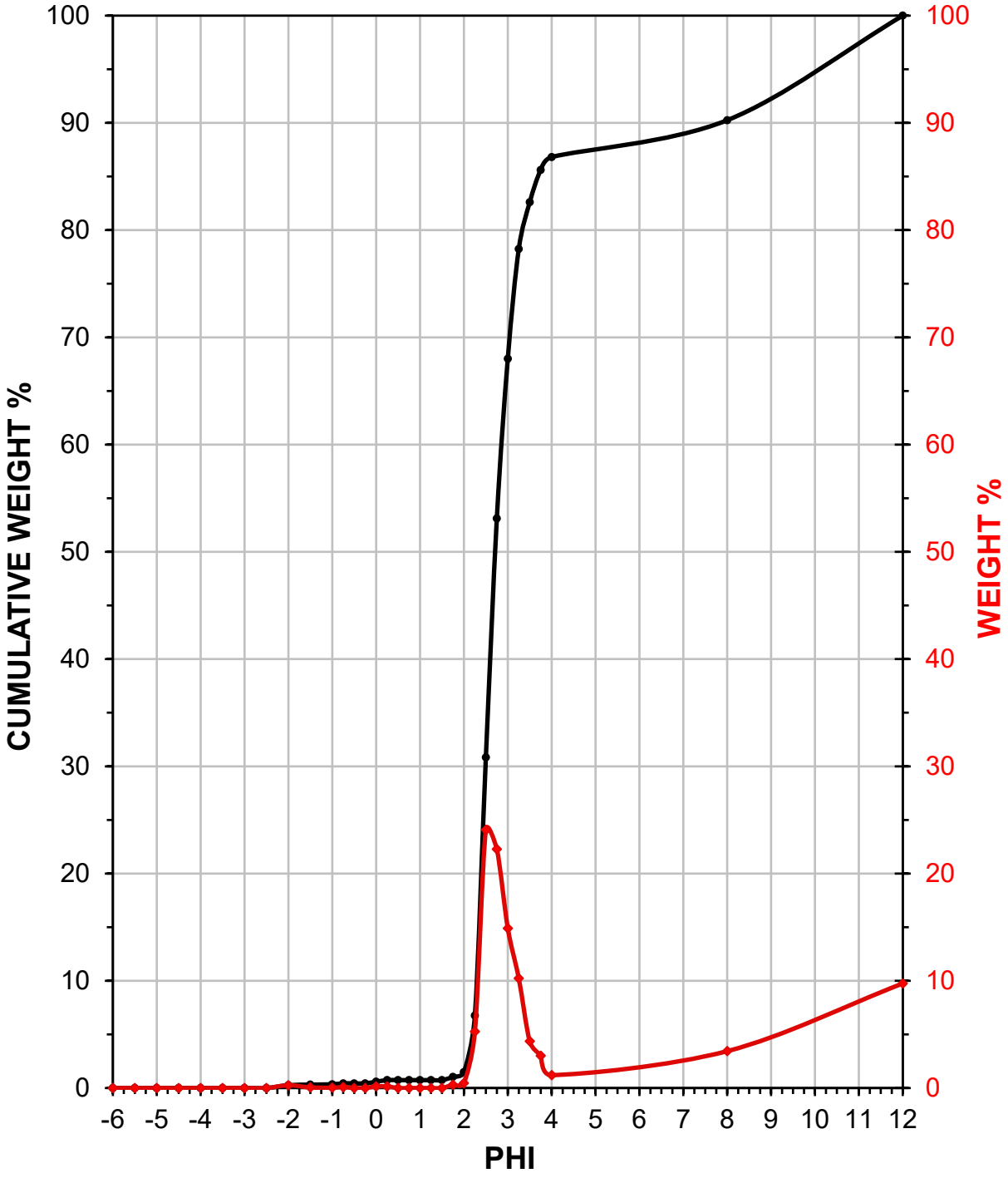
## Offshore Sediments 2016 - M0081



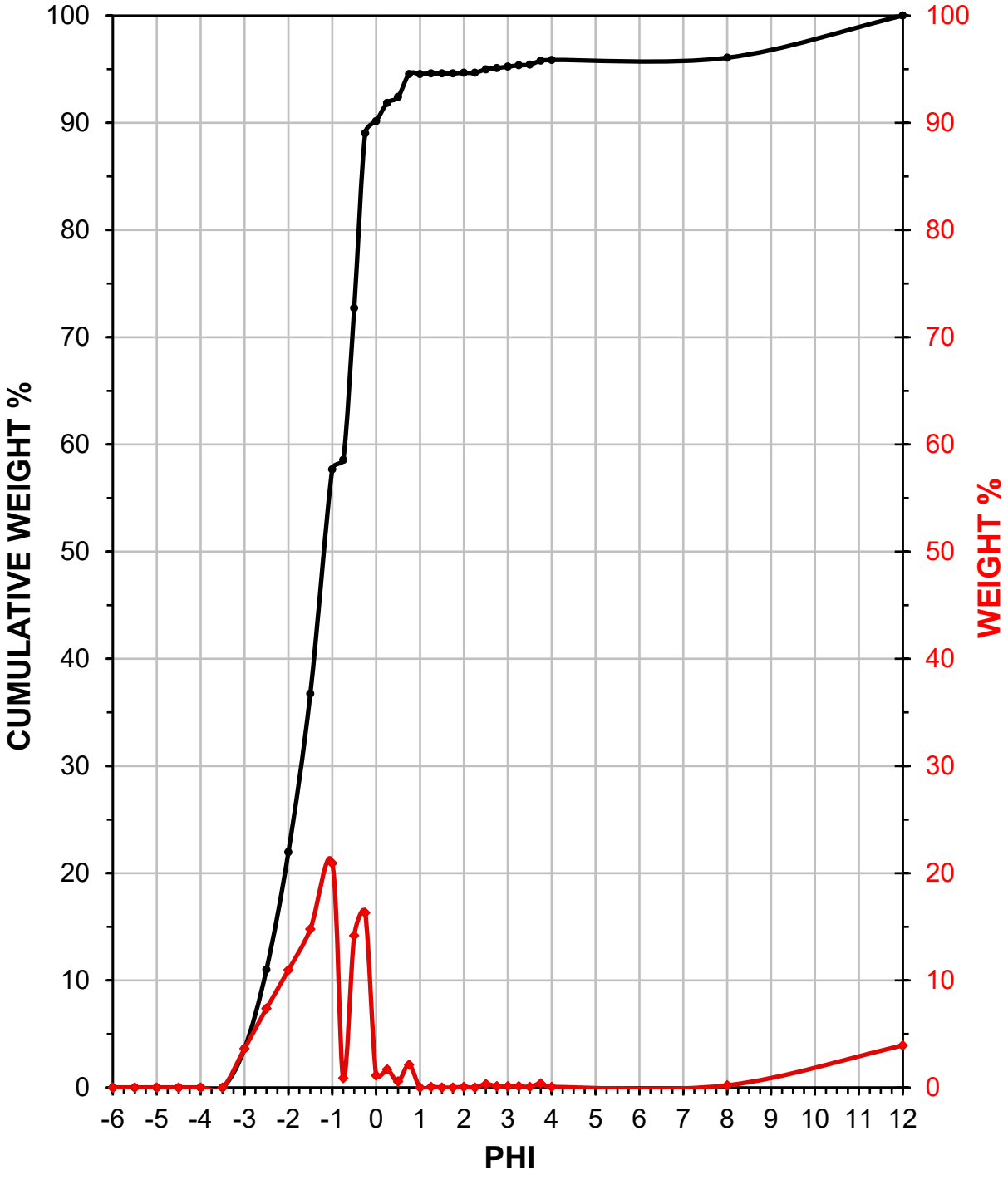
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0082



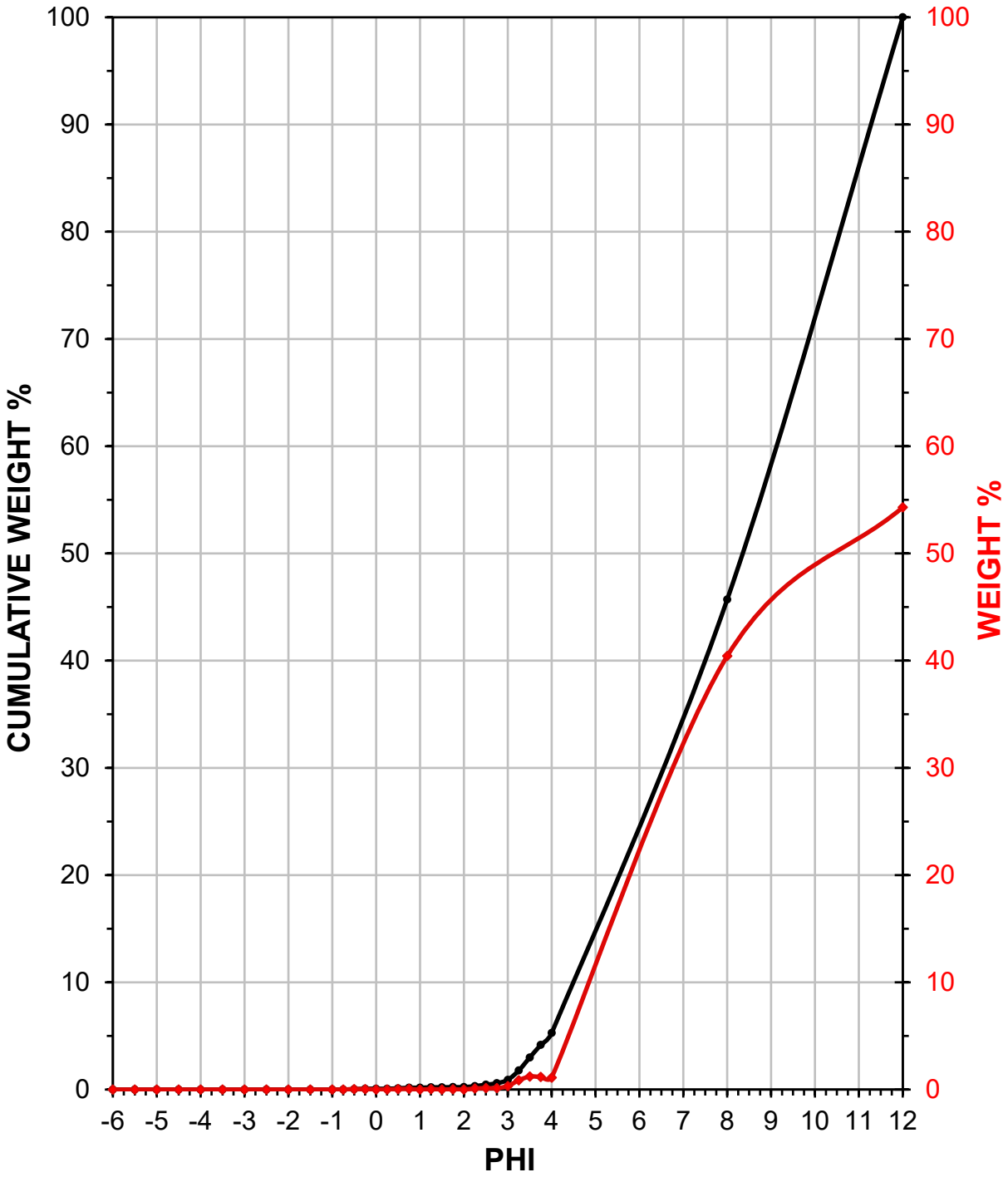
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0085



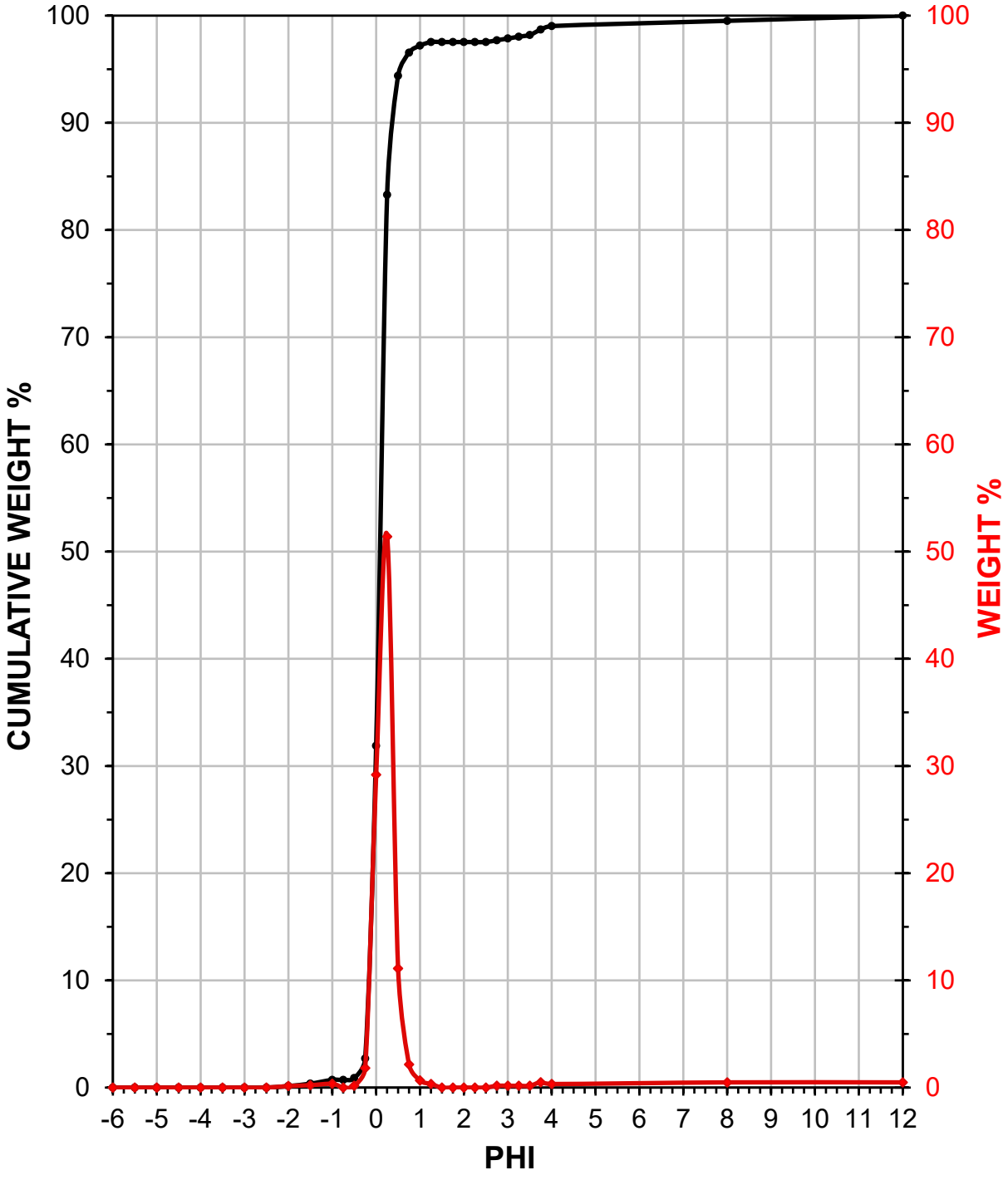
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0088



# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0090



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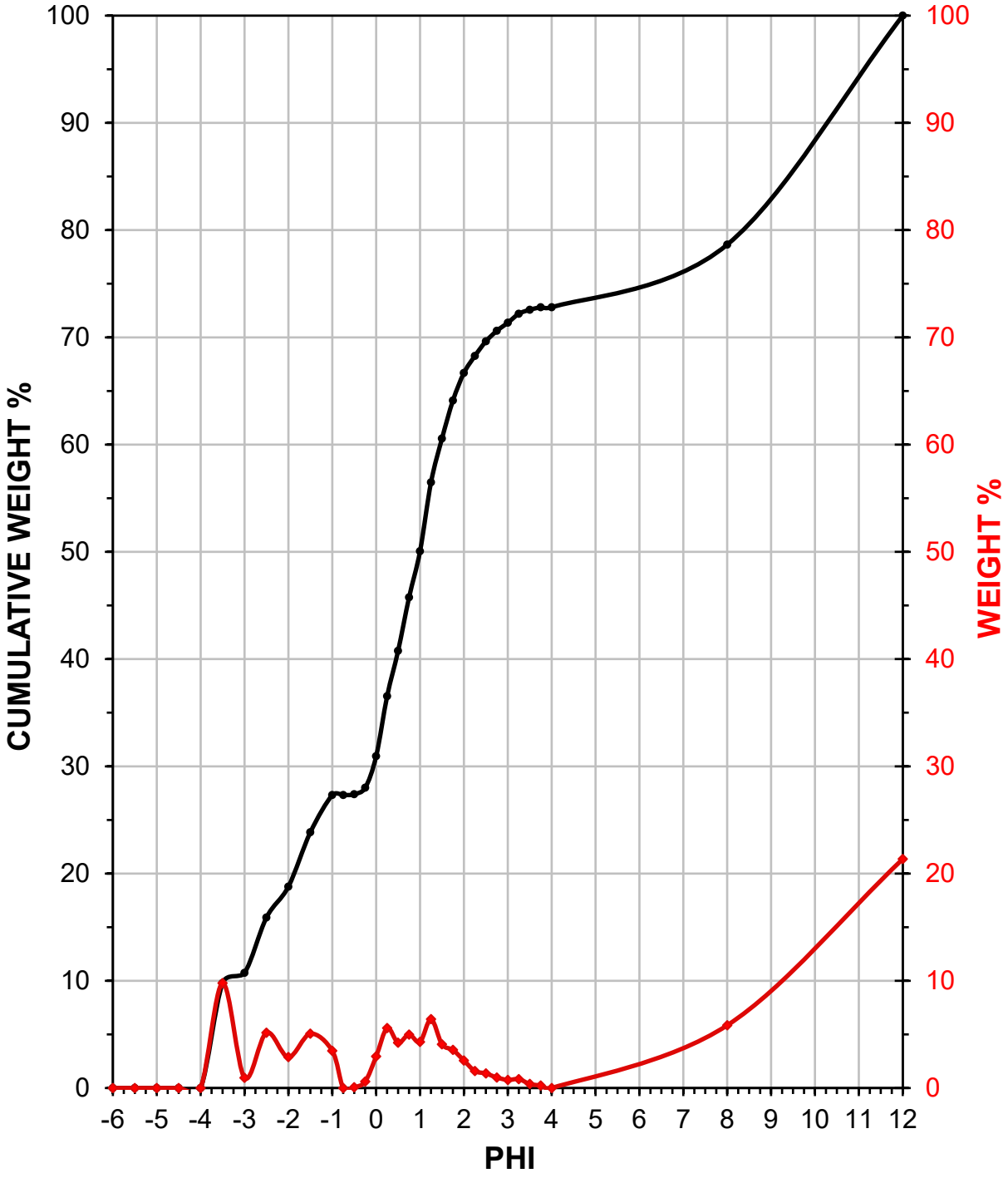
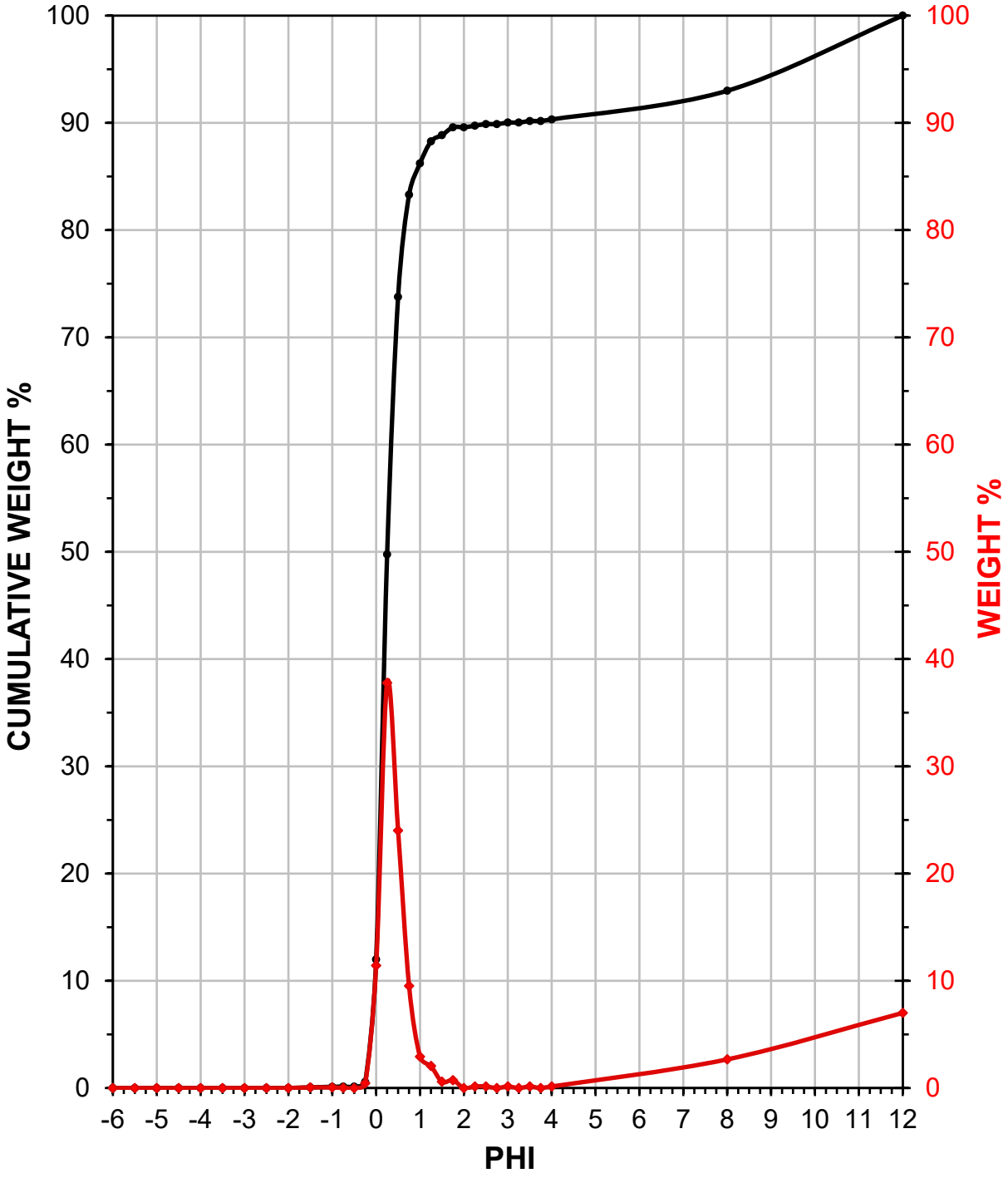
## Offshore Sediments 2016 - M0092



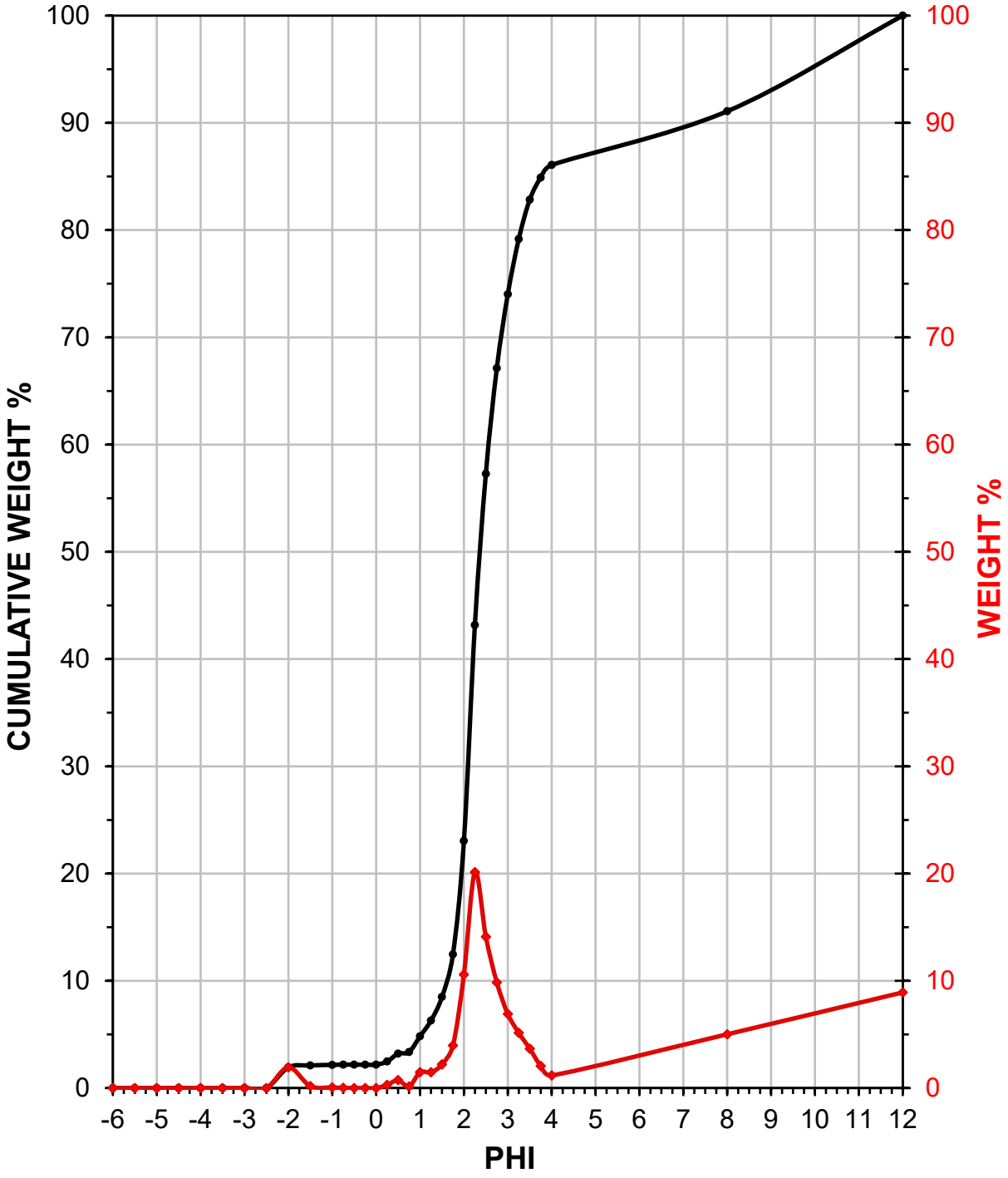
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0095



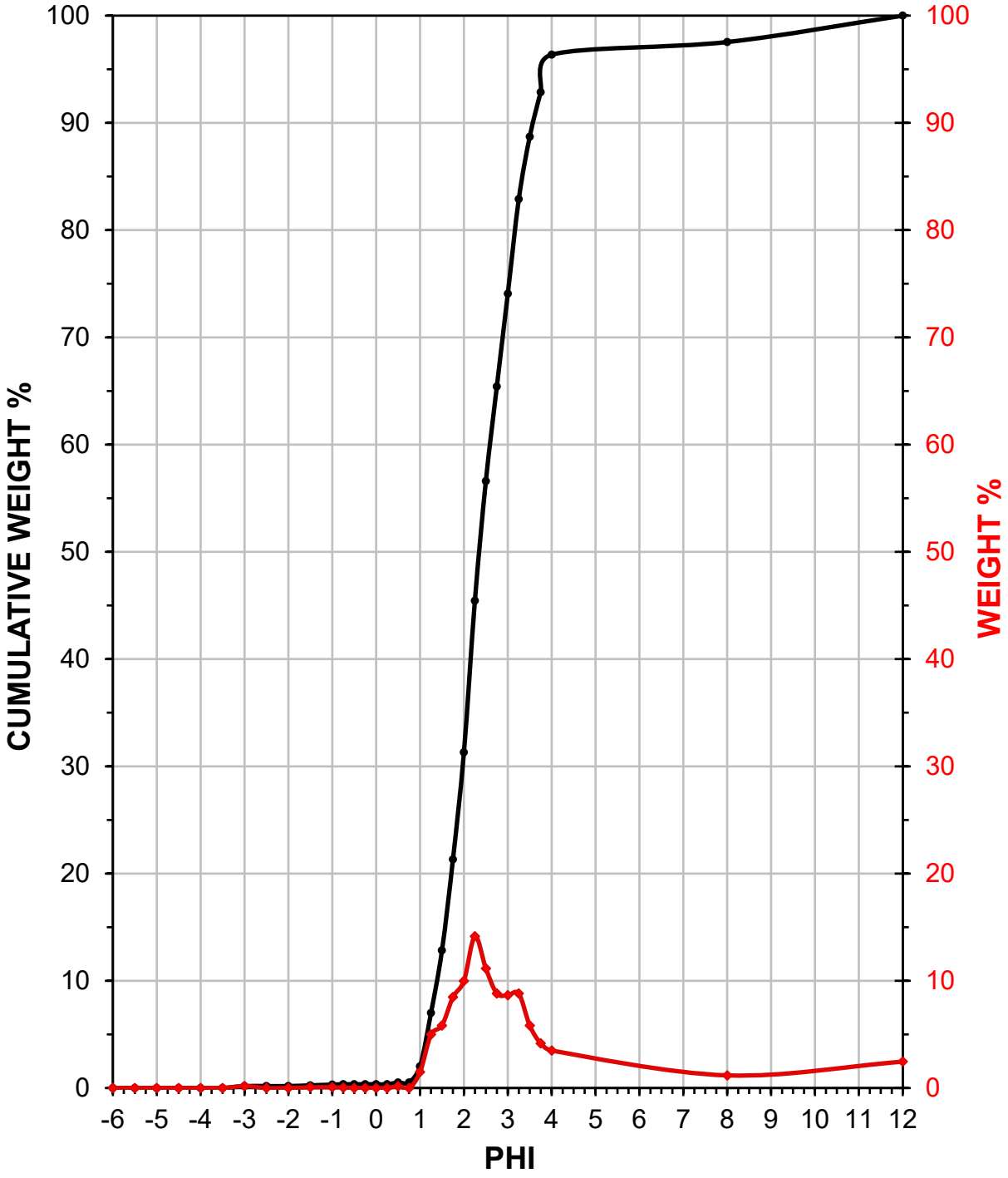
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0097



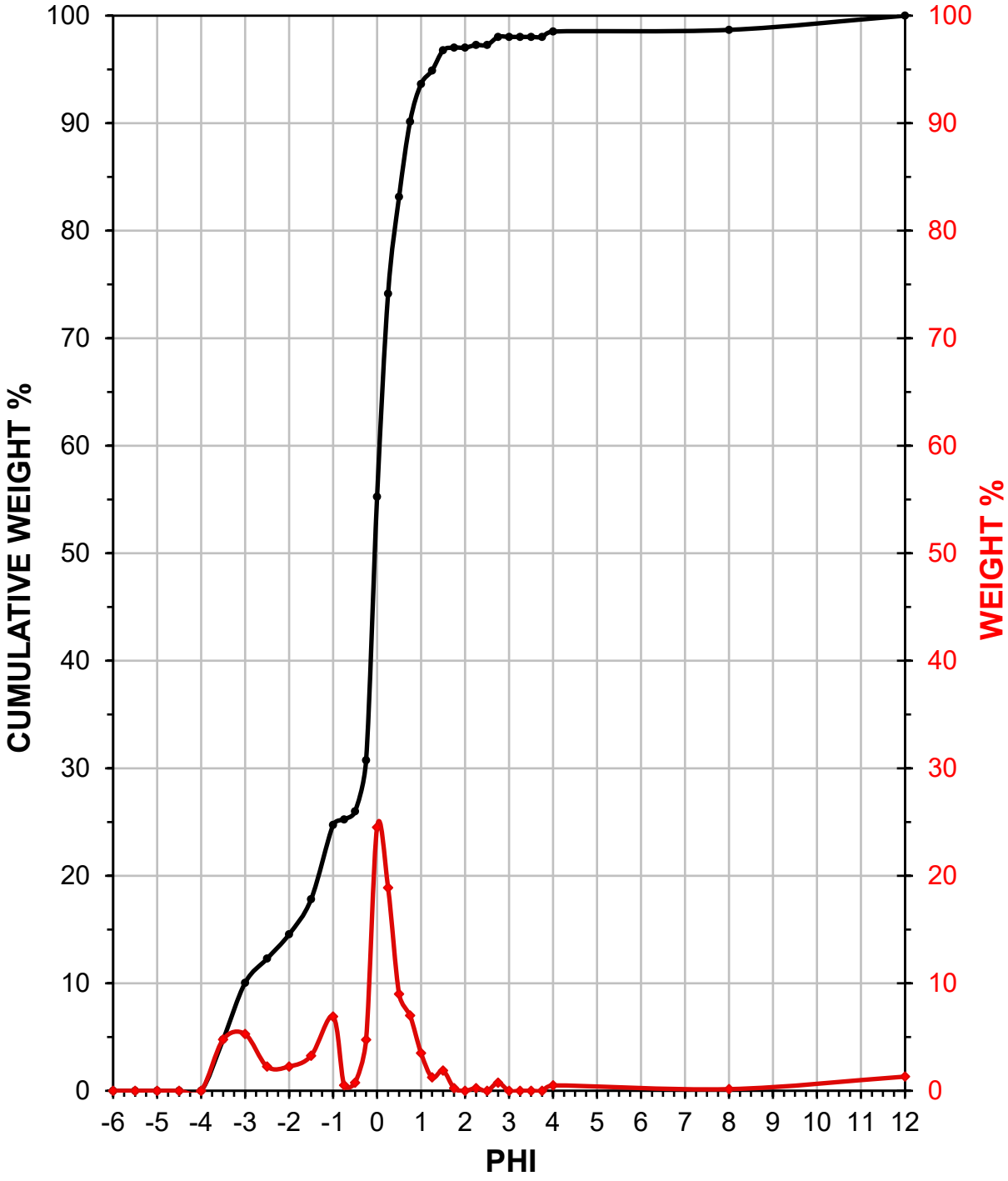
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0098



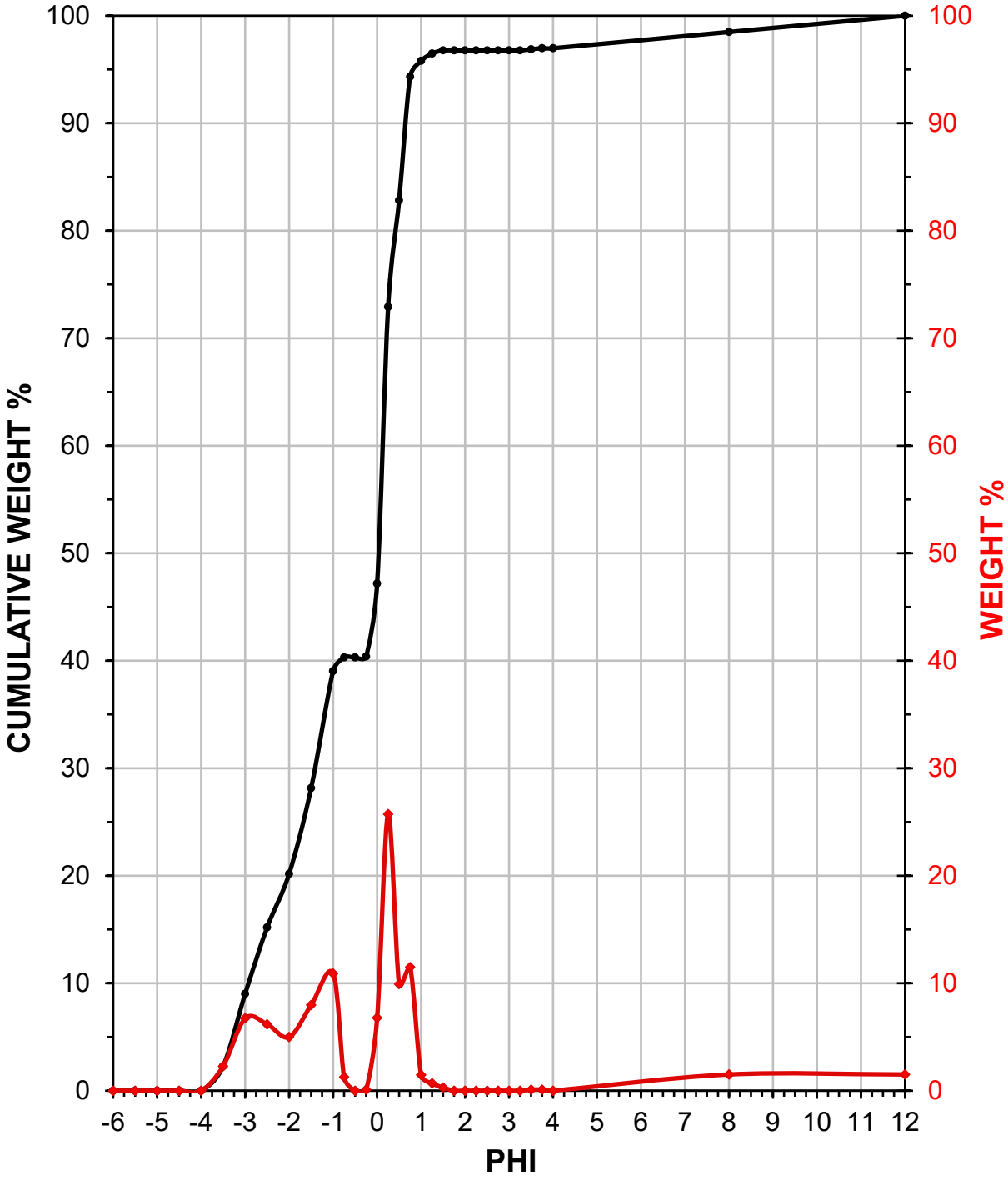
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0099



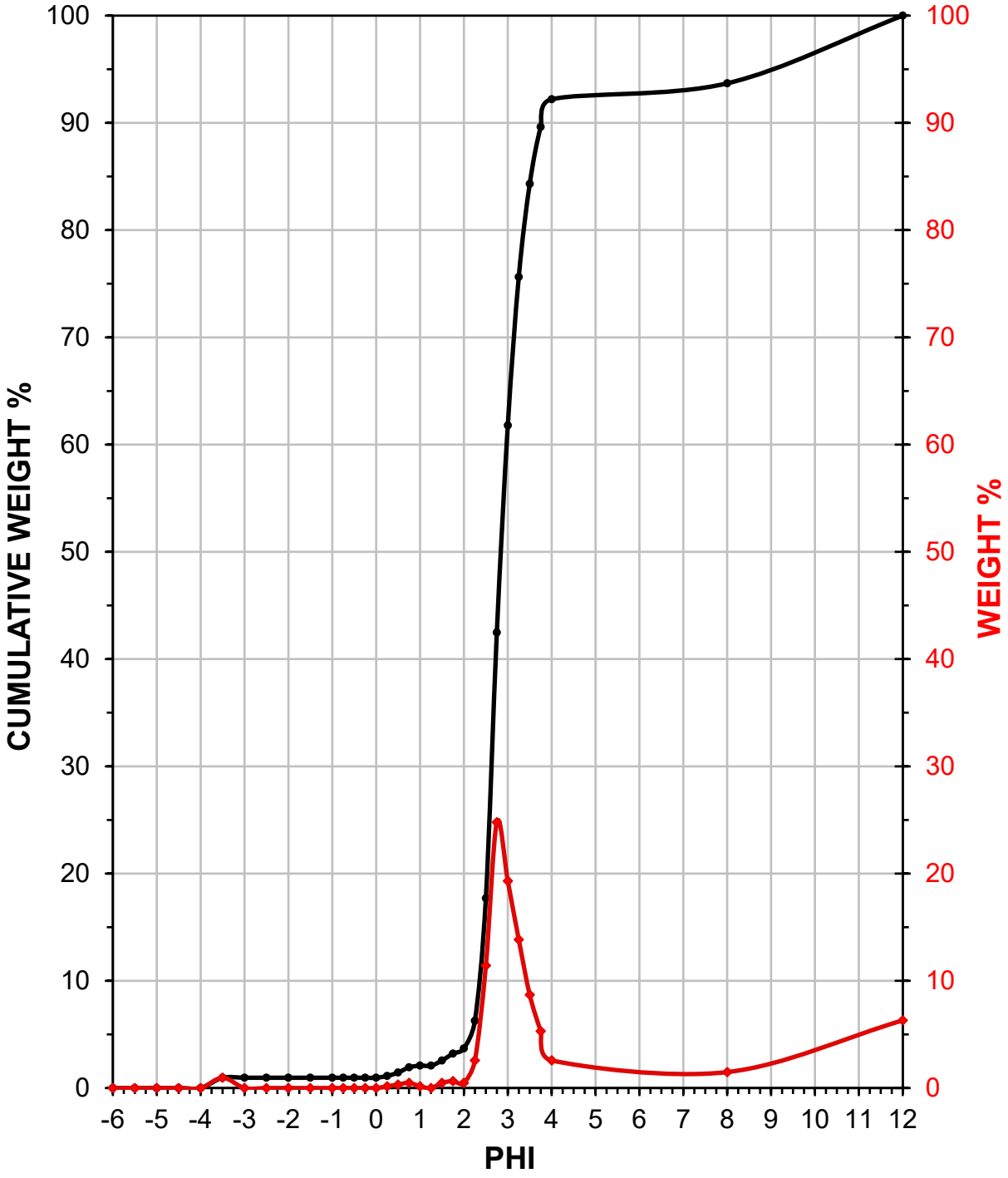
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0101



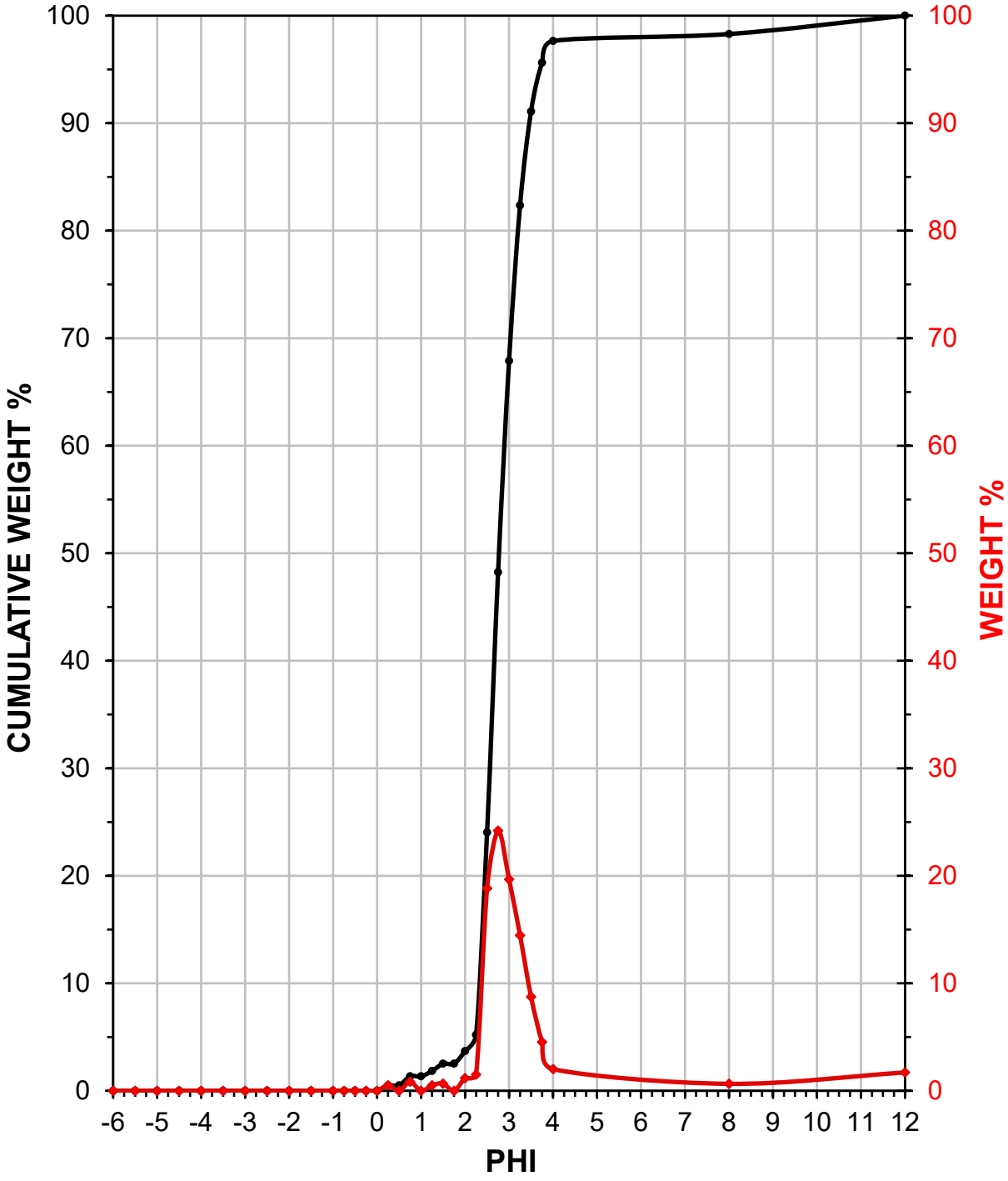
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0102



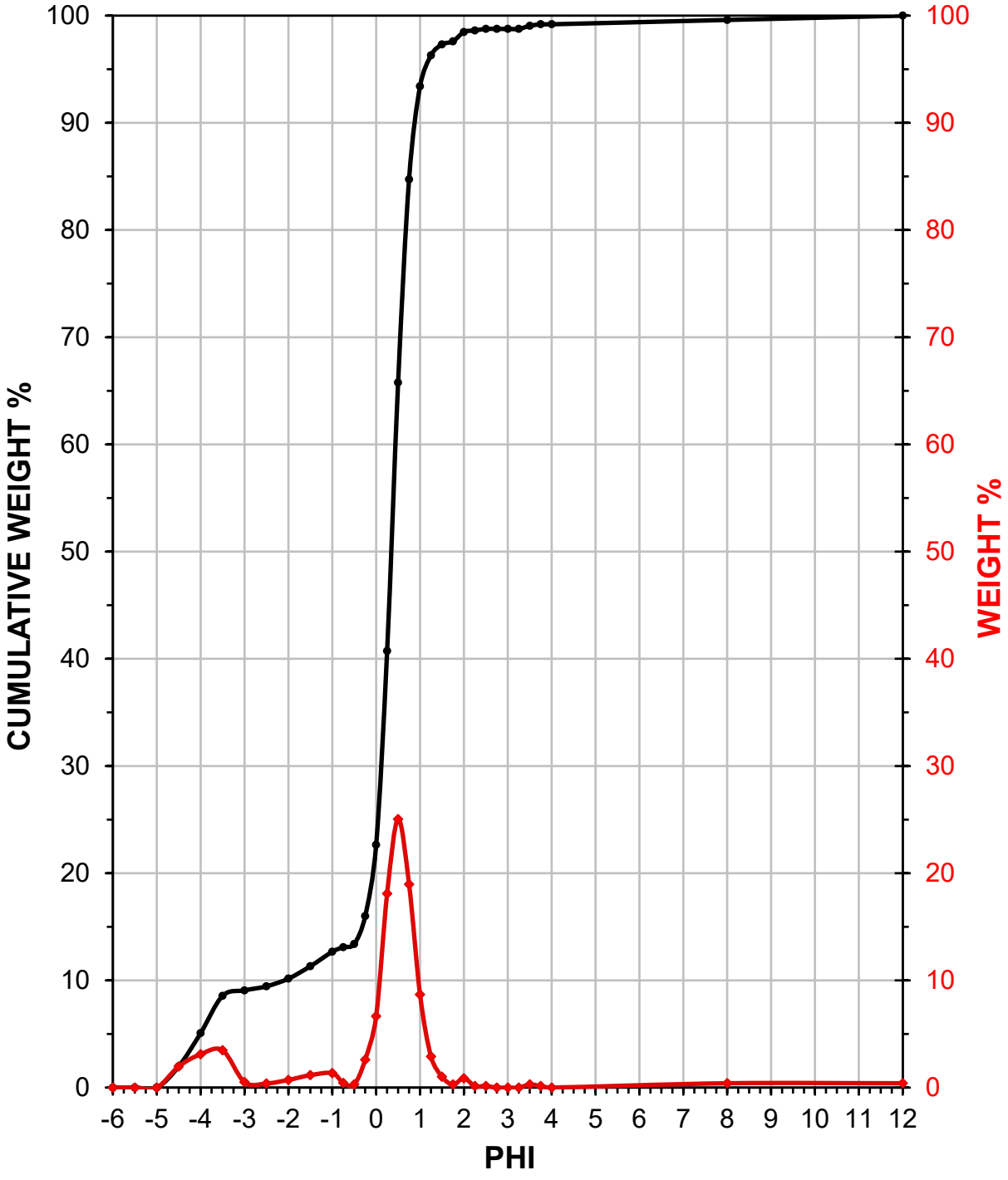
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0103



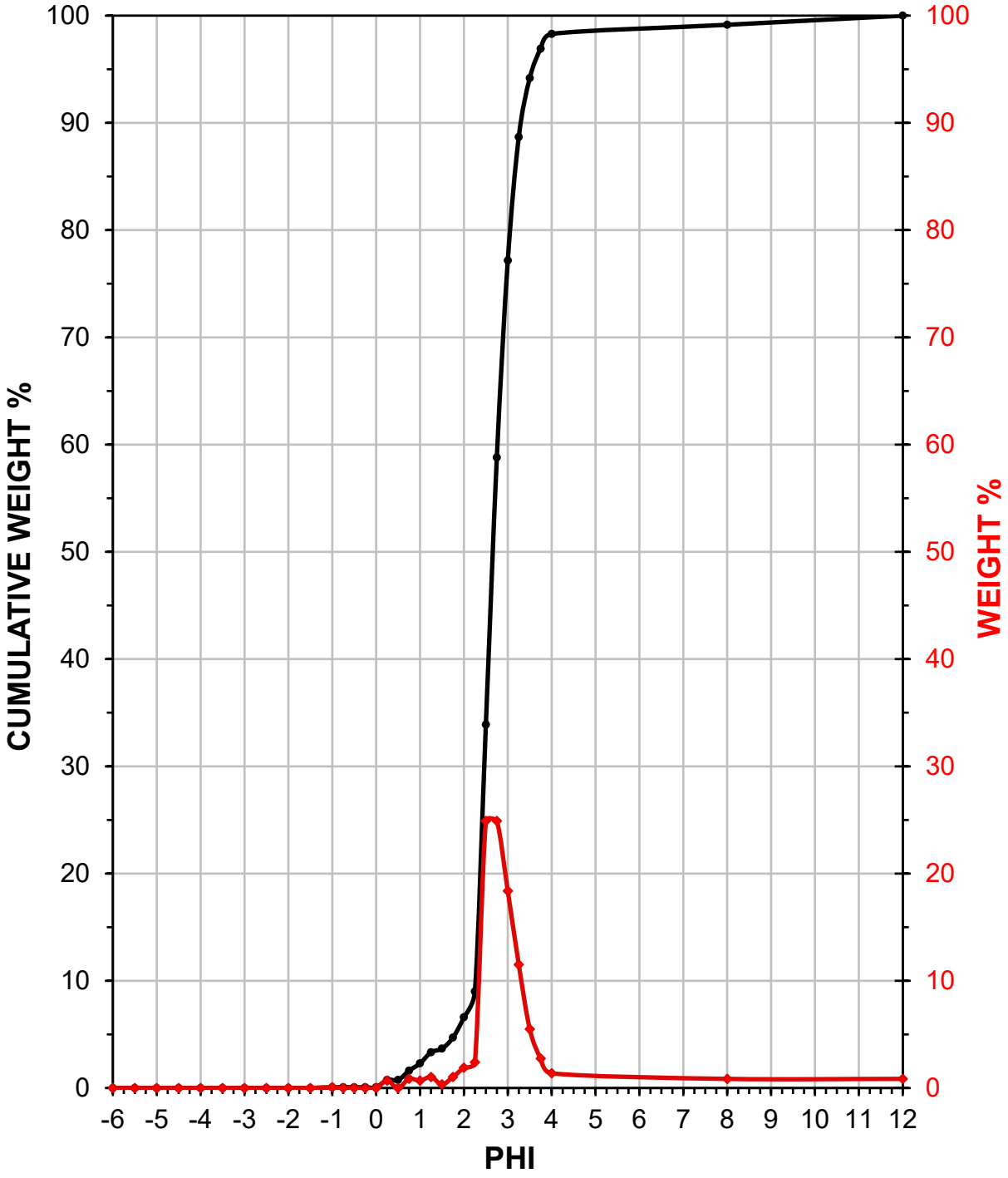
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0104



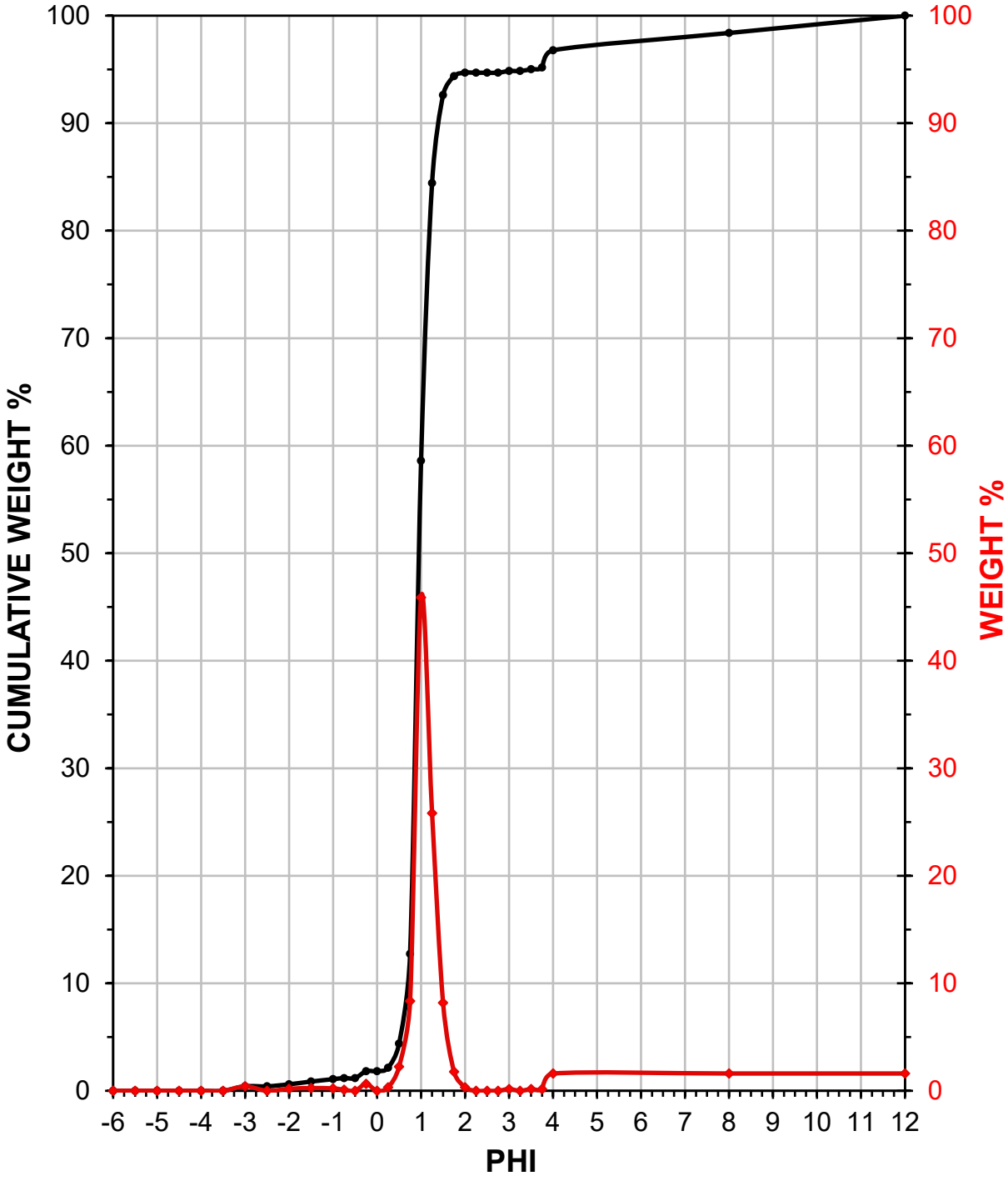
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0105



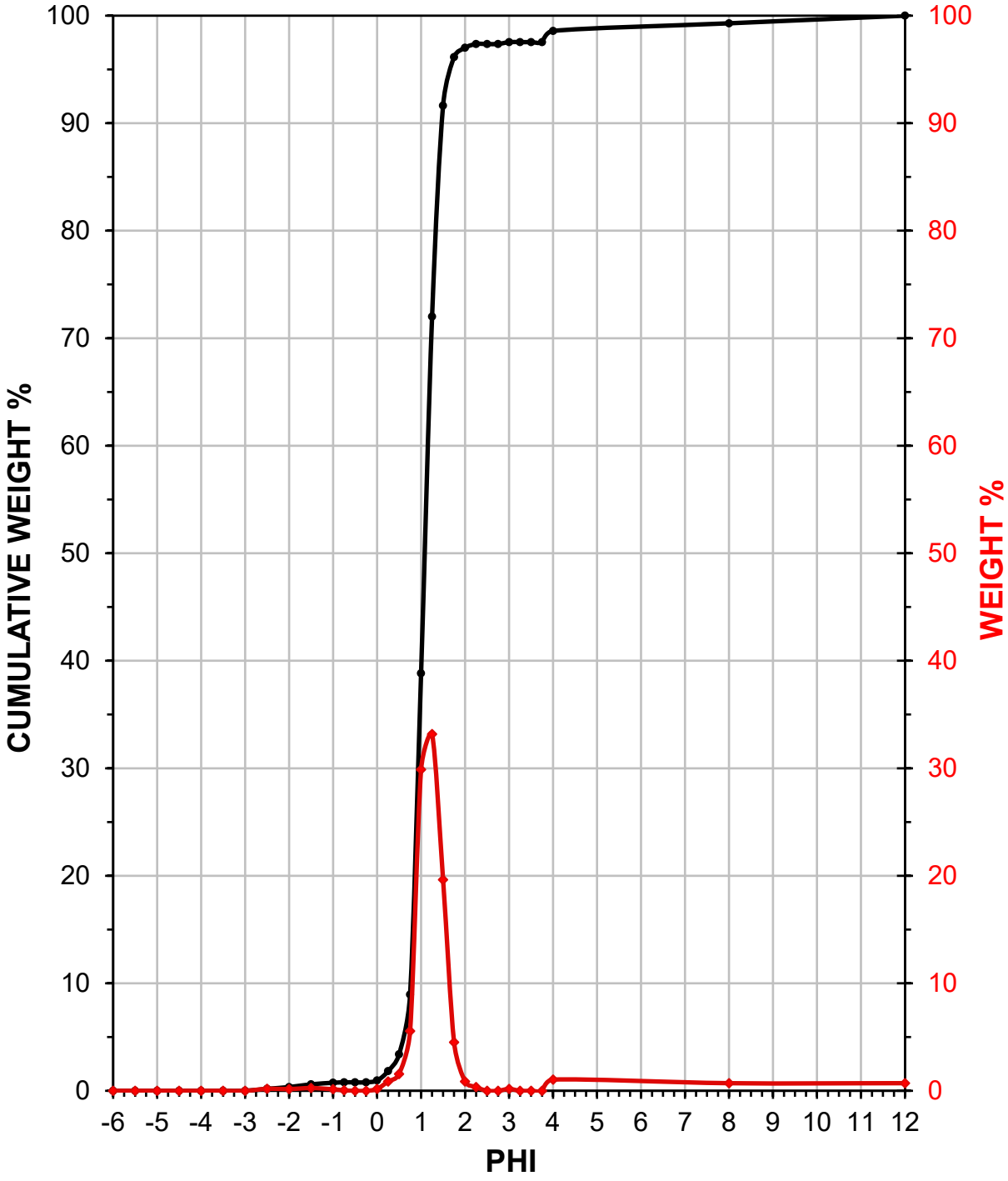
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0106



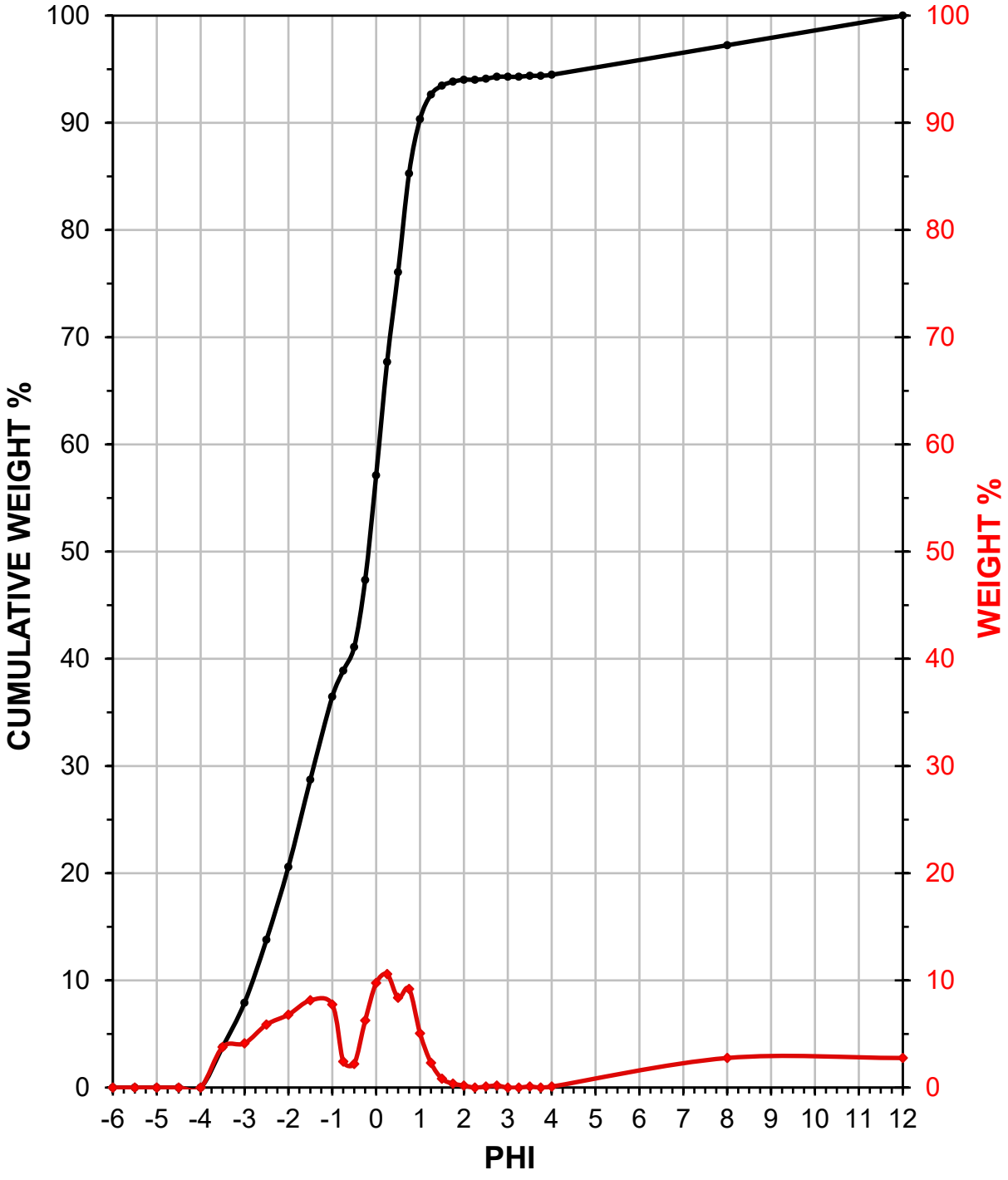
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0107



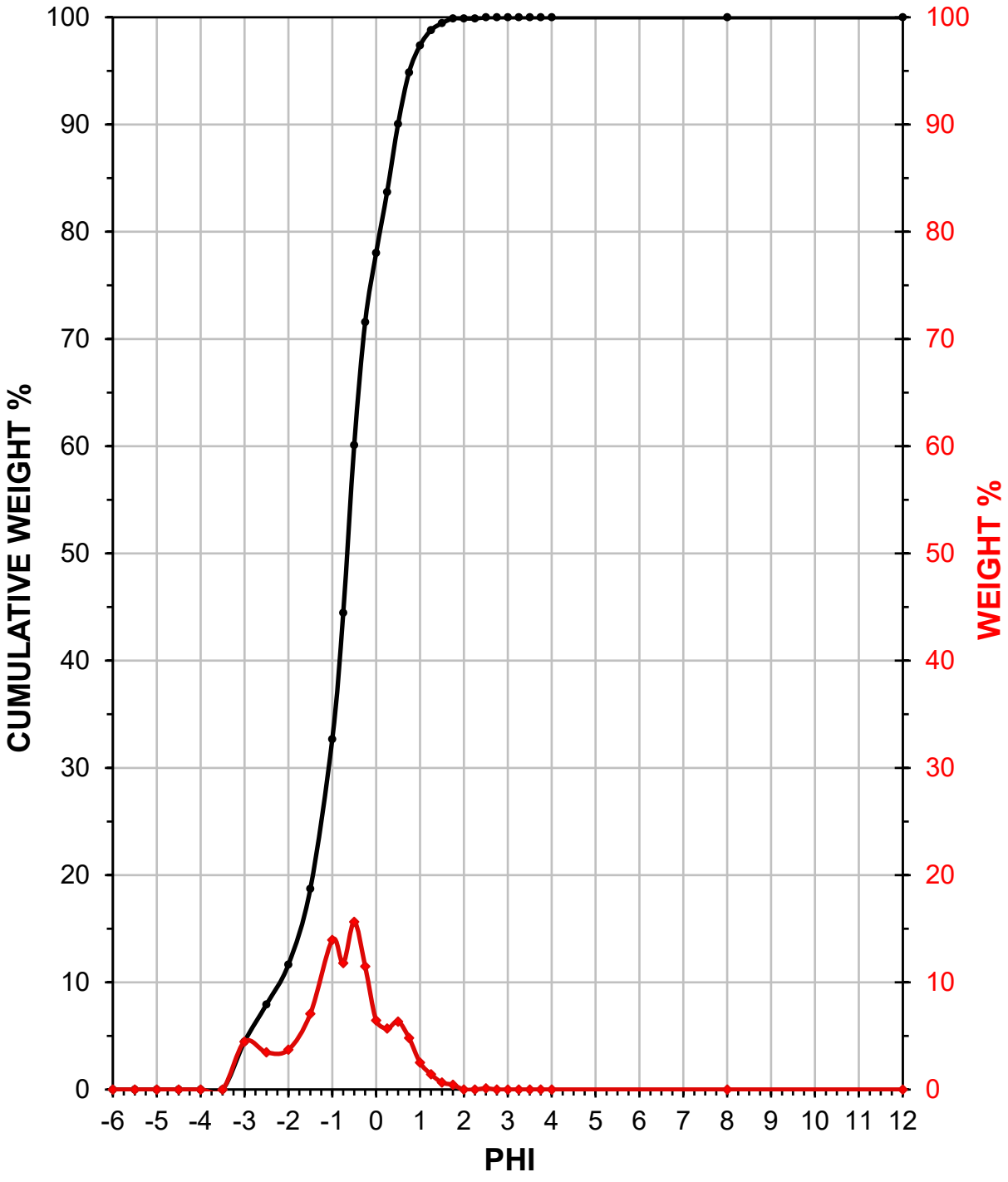
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0109



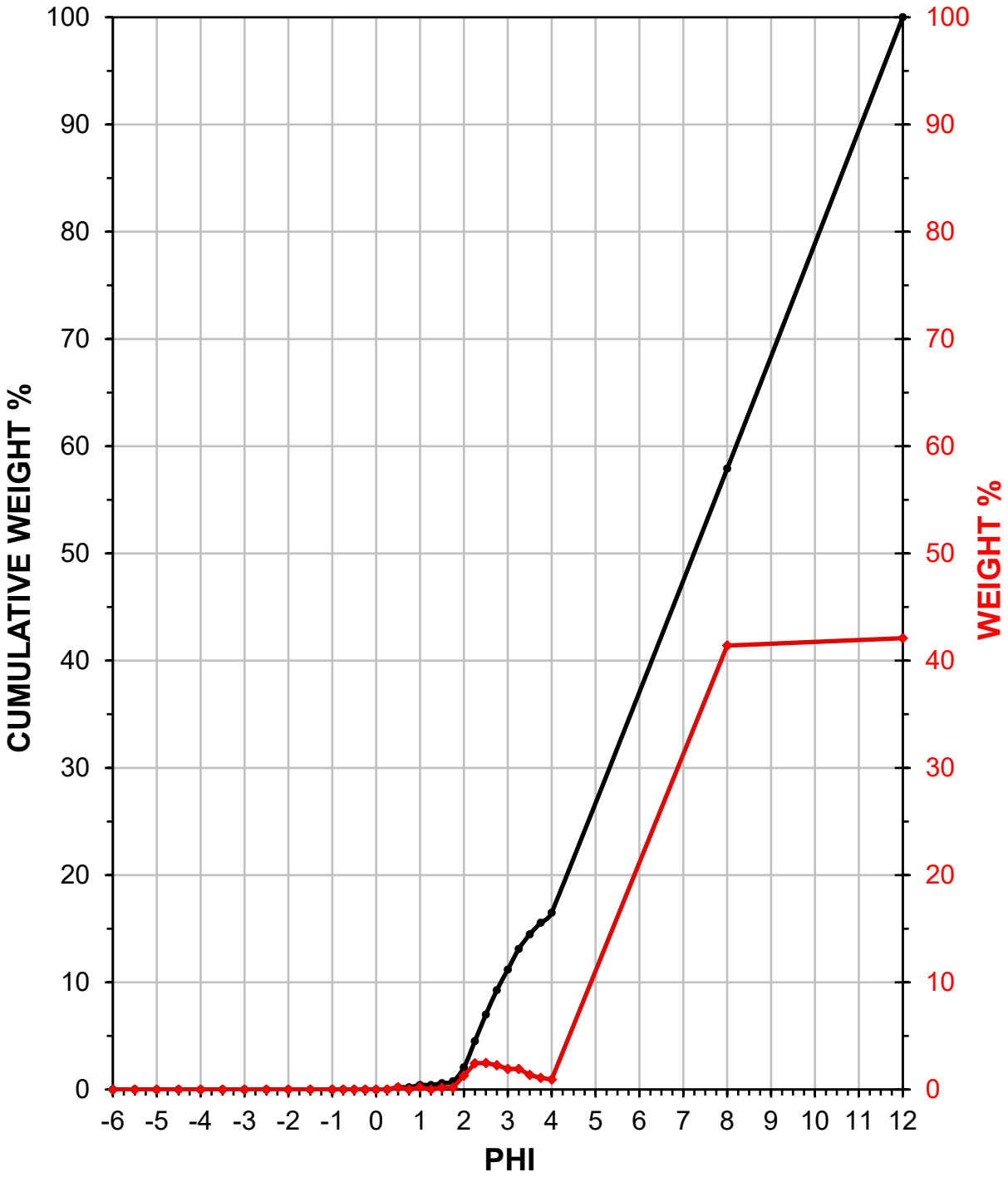
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0110



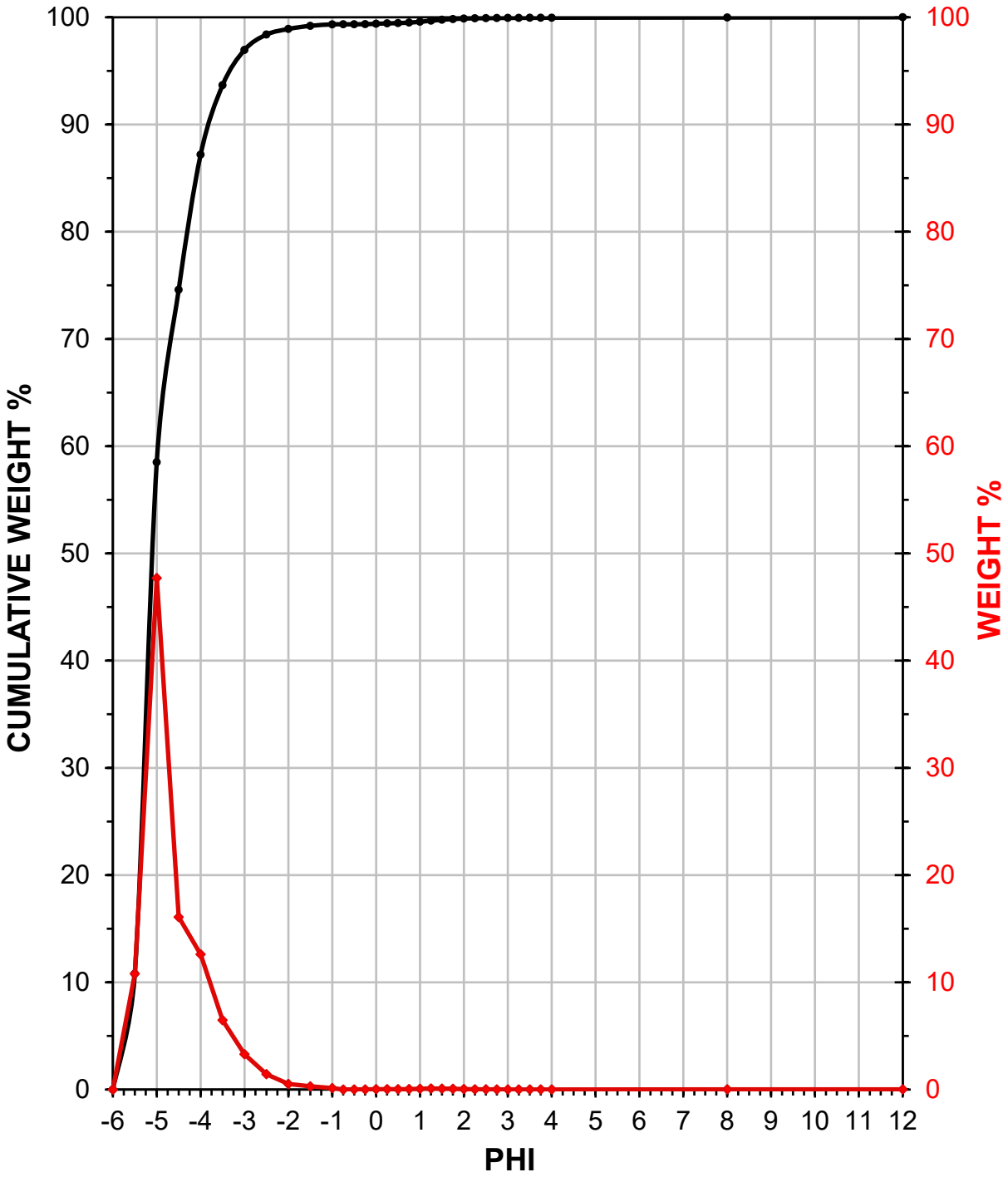
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0112



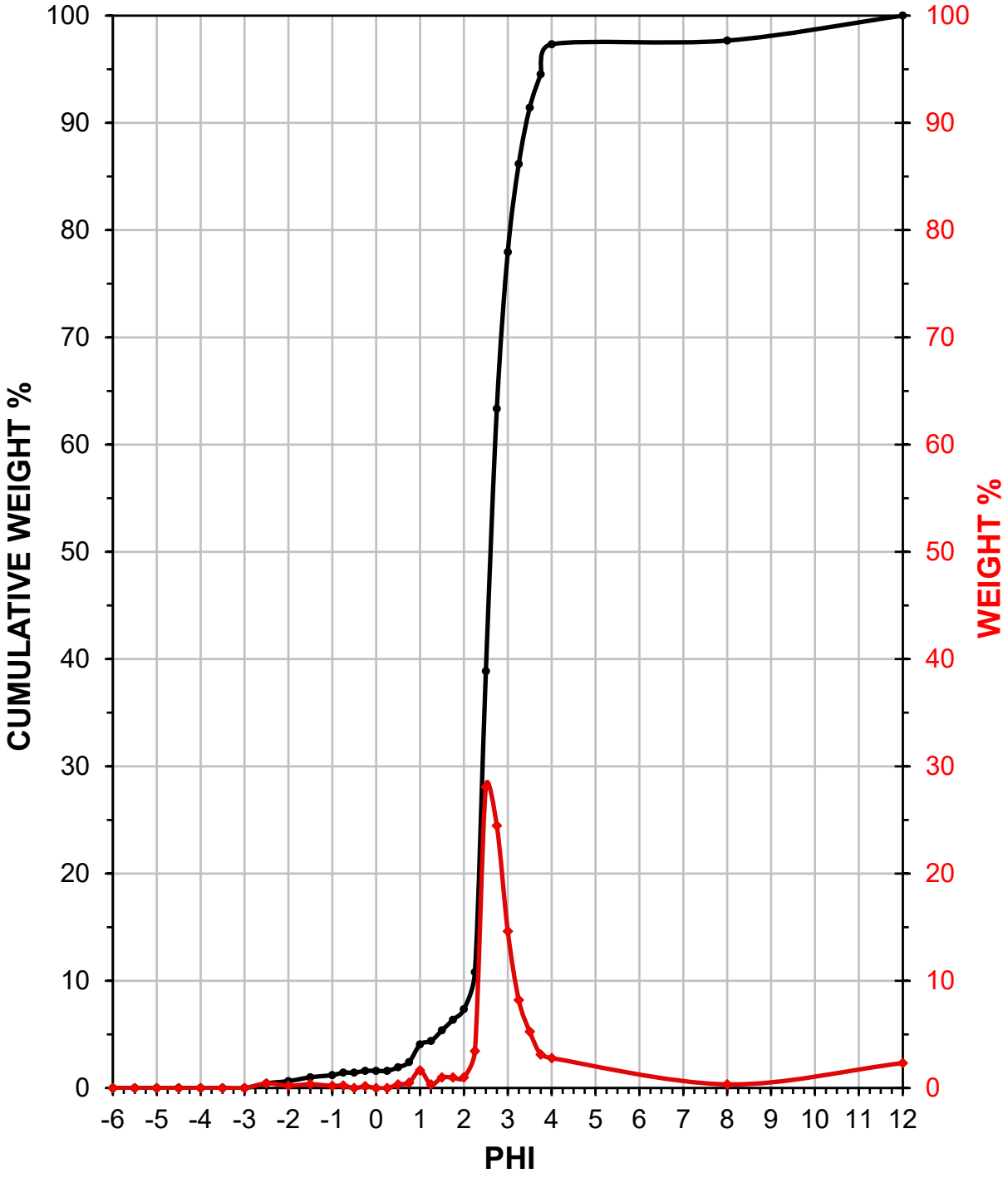
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0113



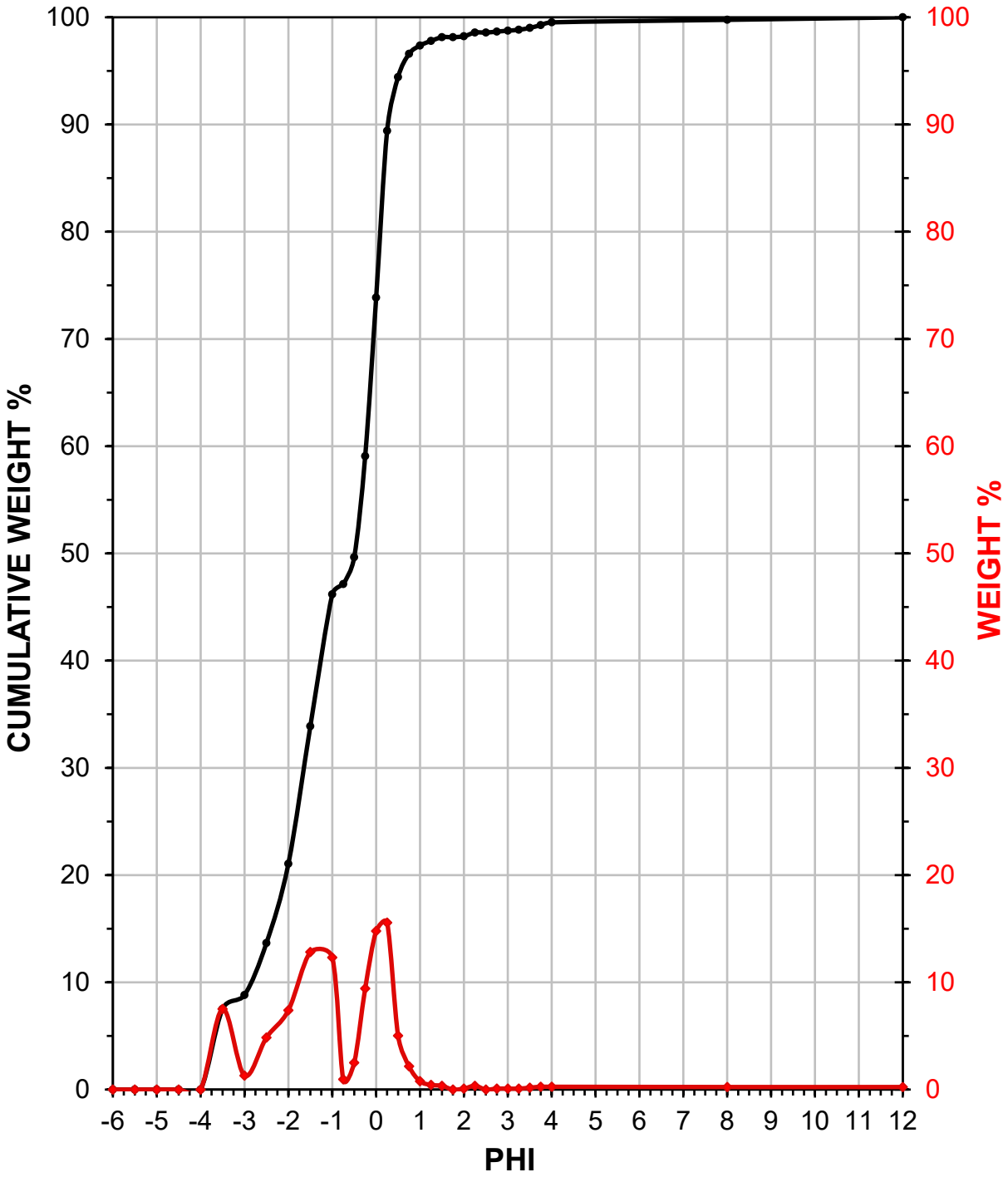
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0114



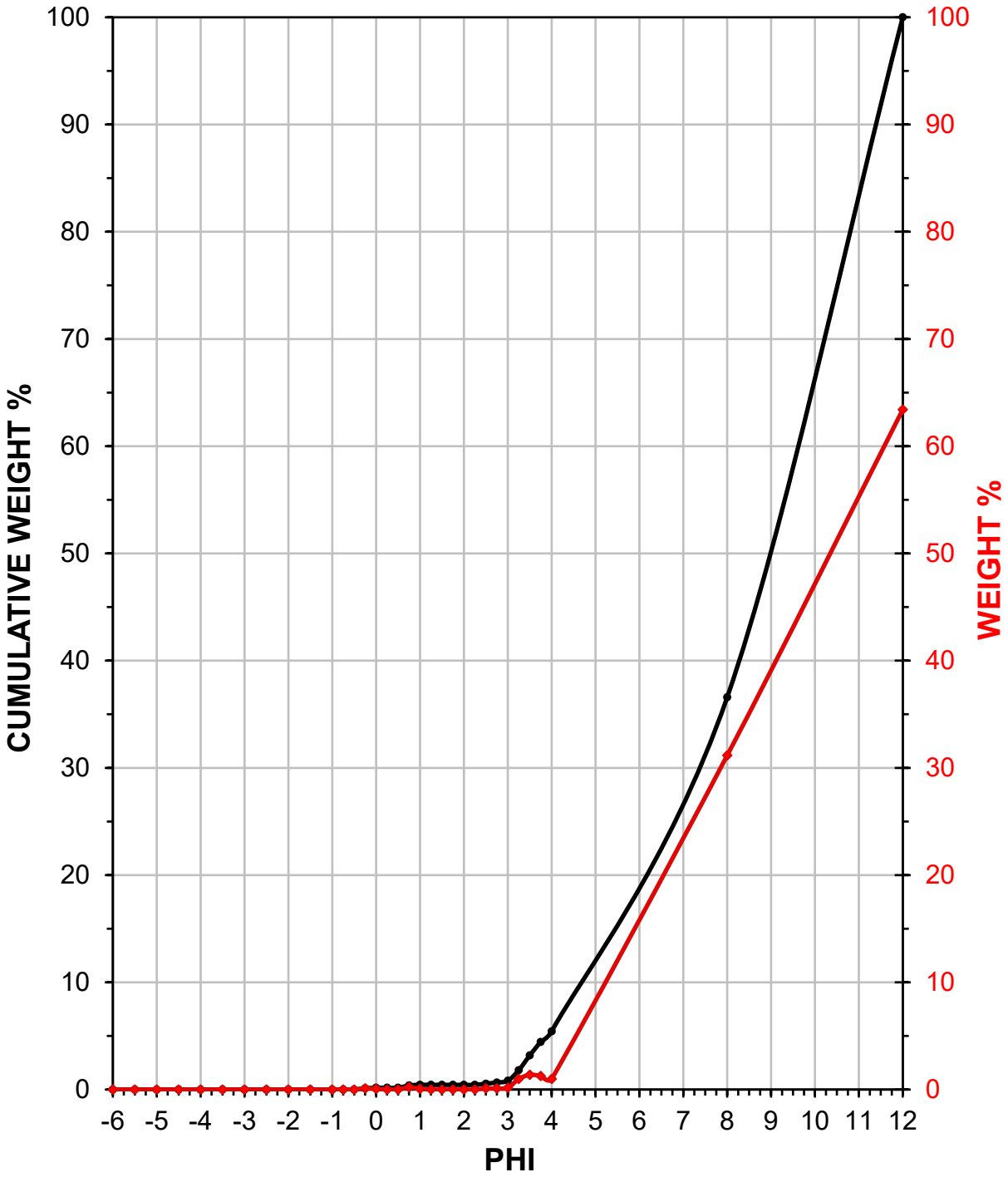
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0115



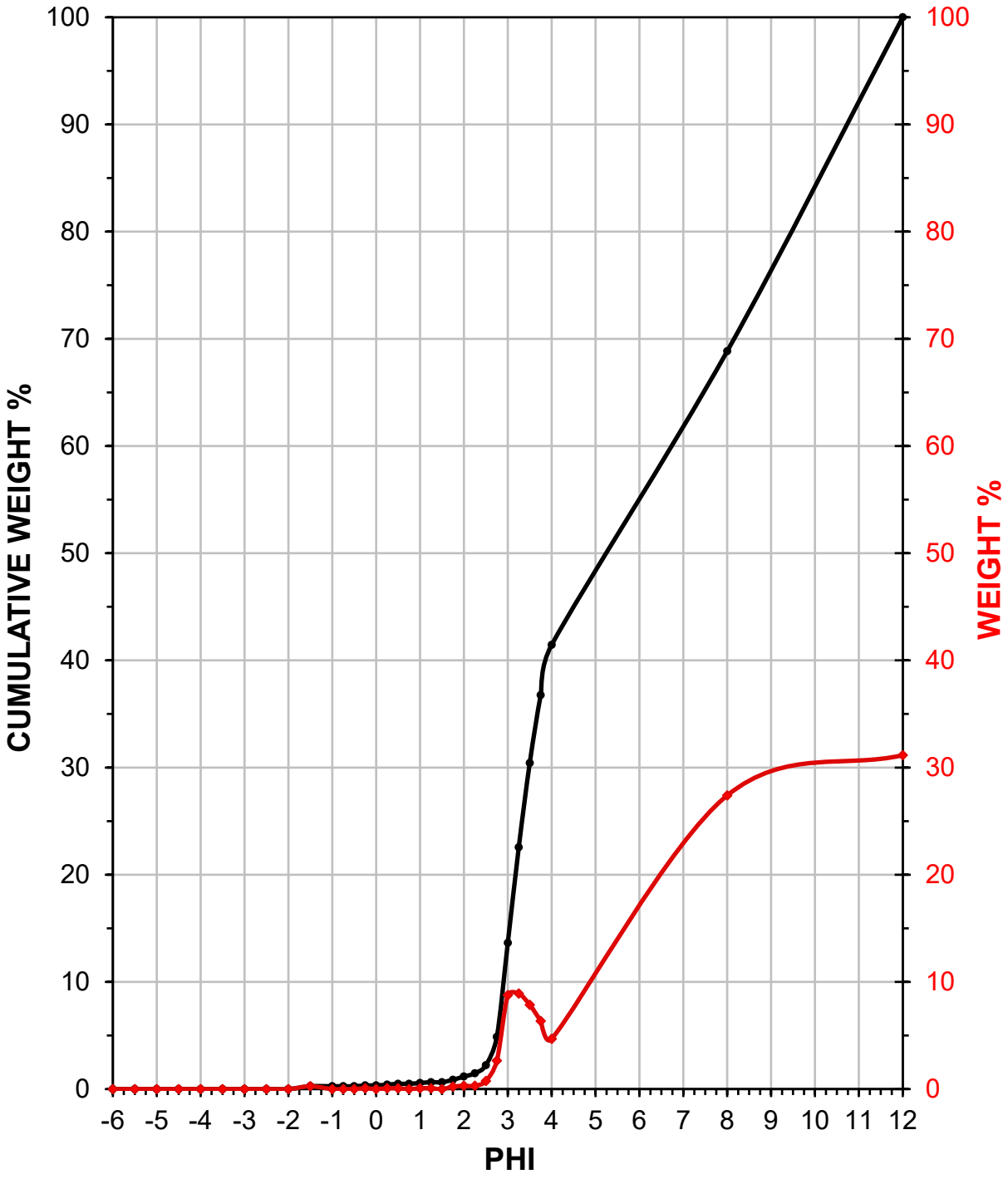
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0117



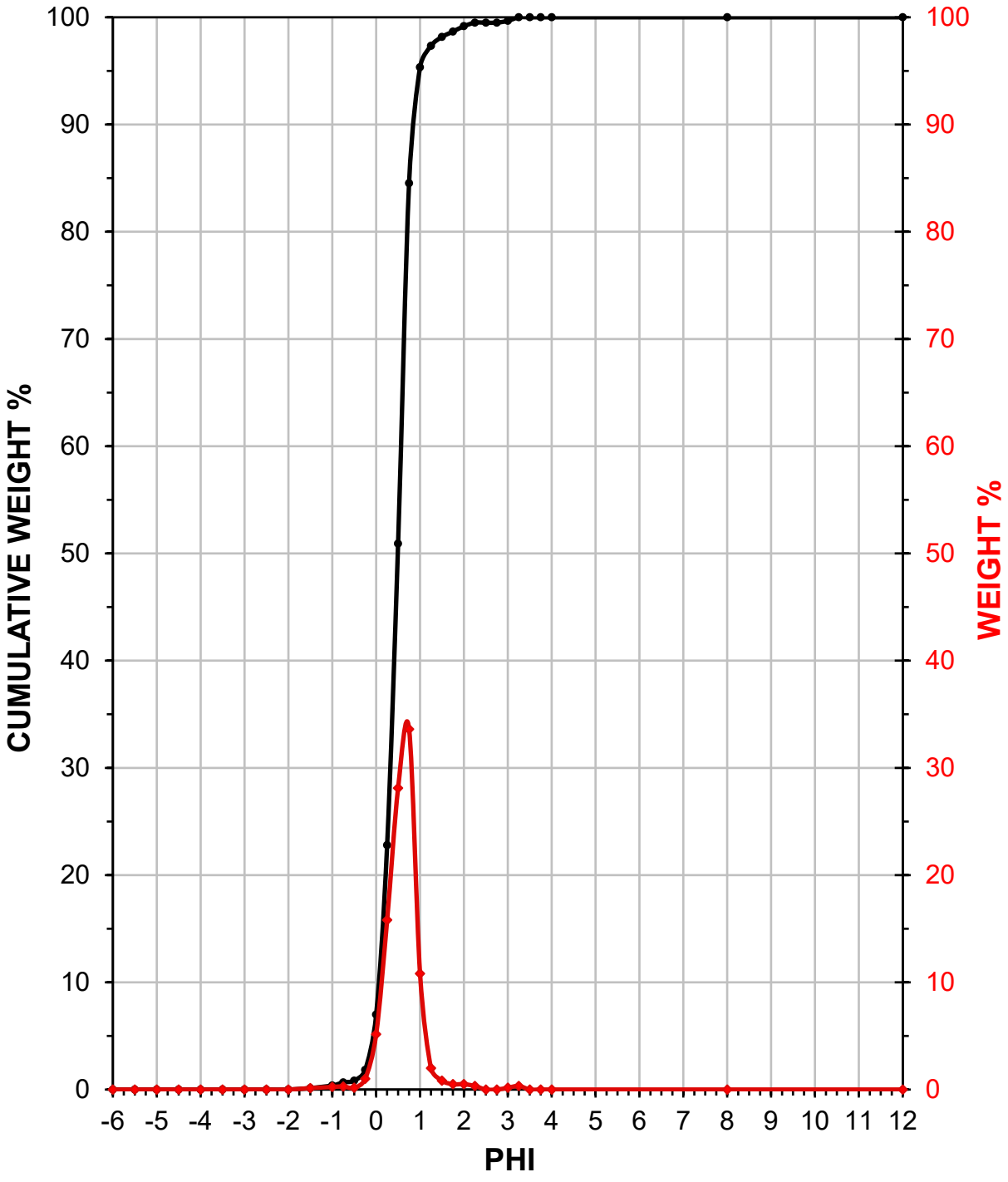
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0120



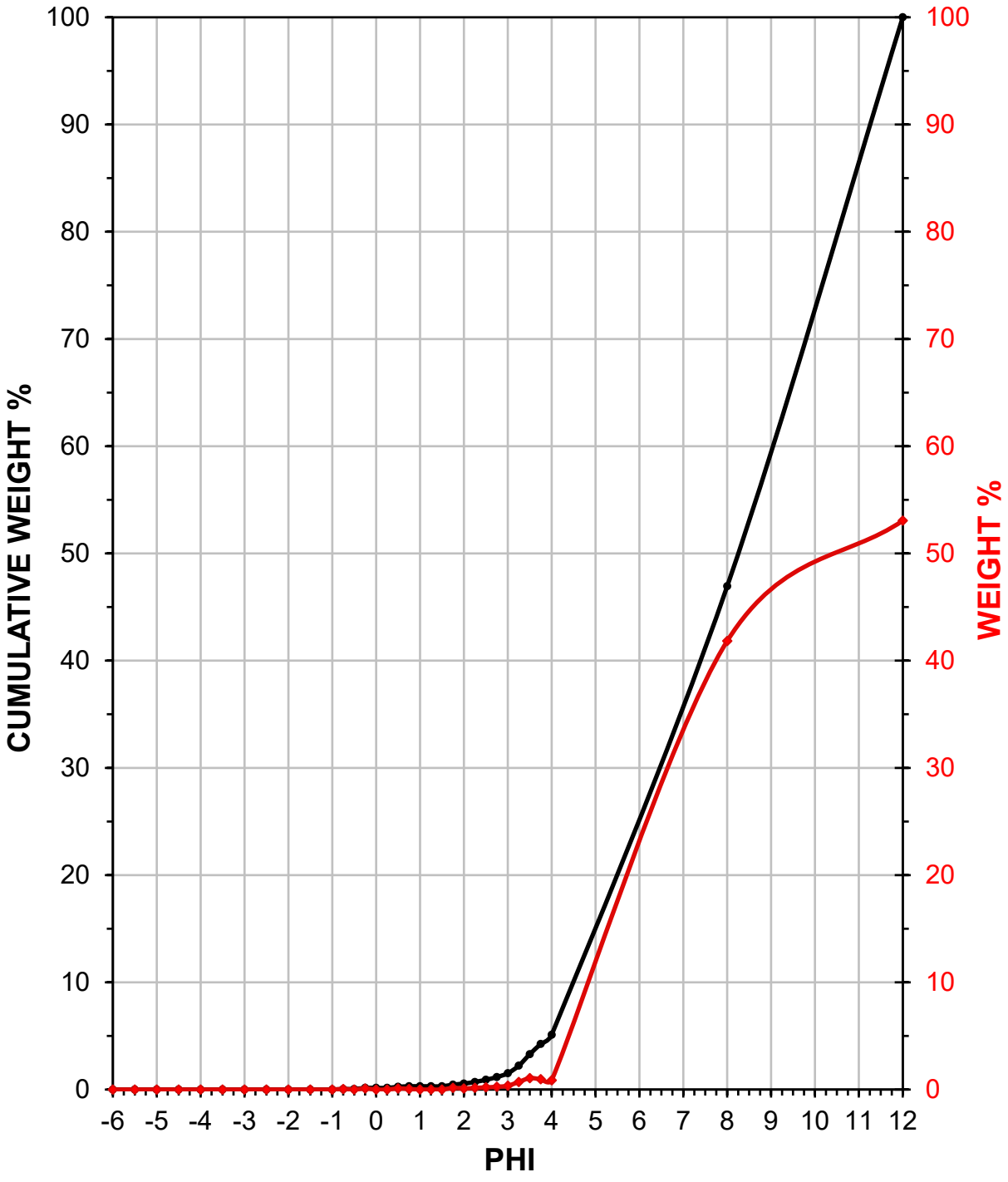
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0122



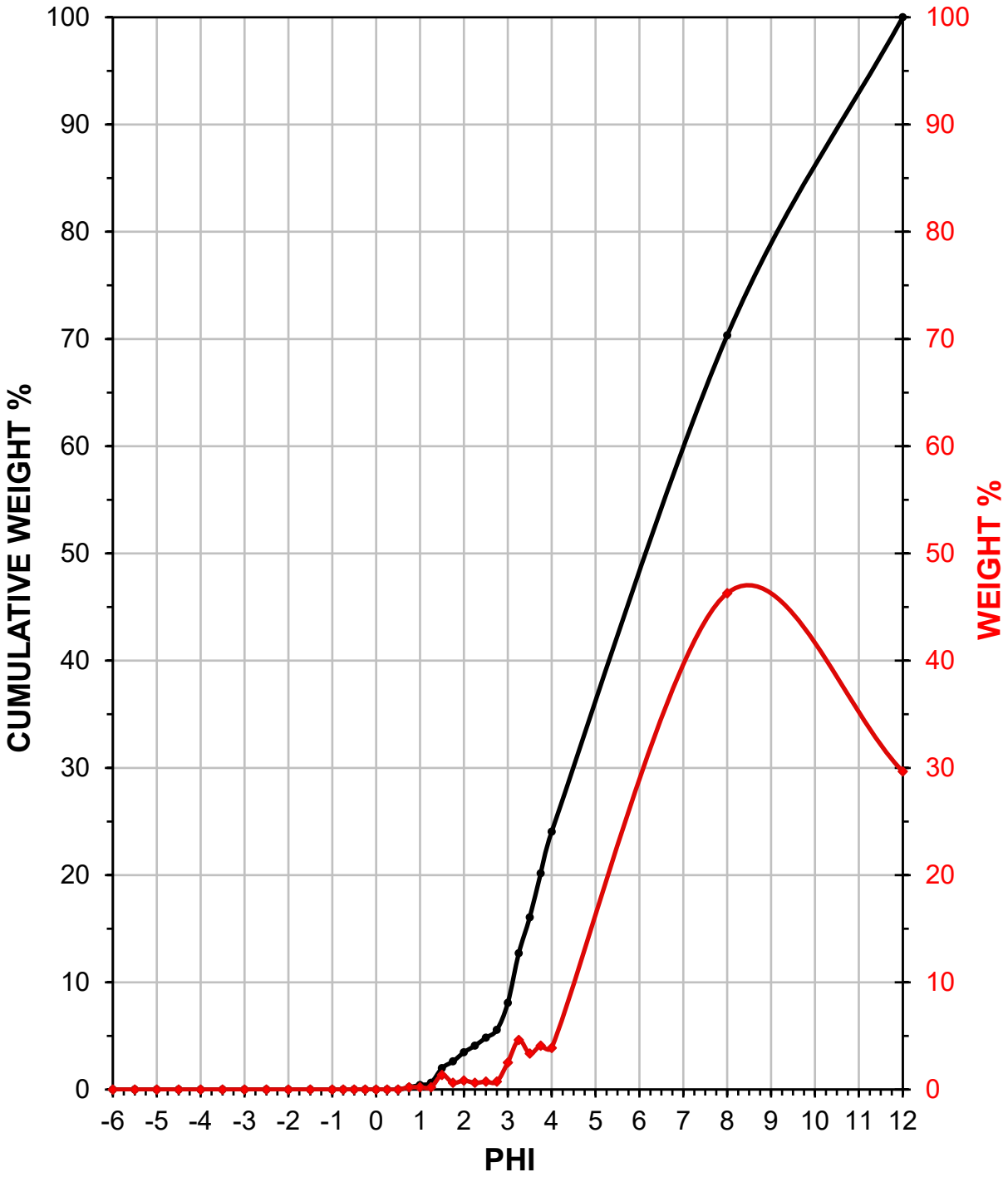
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0123



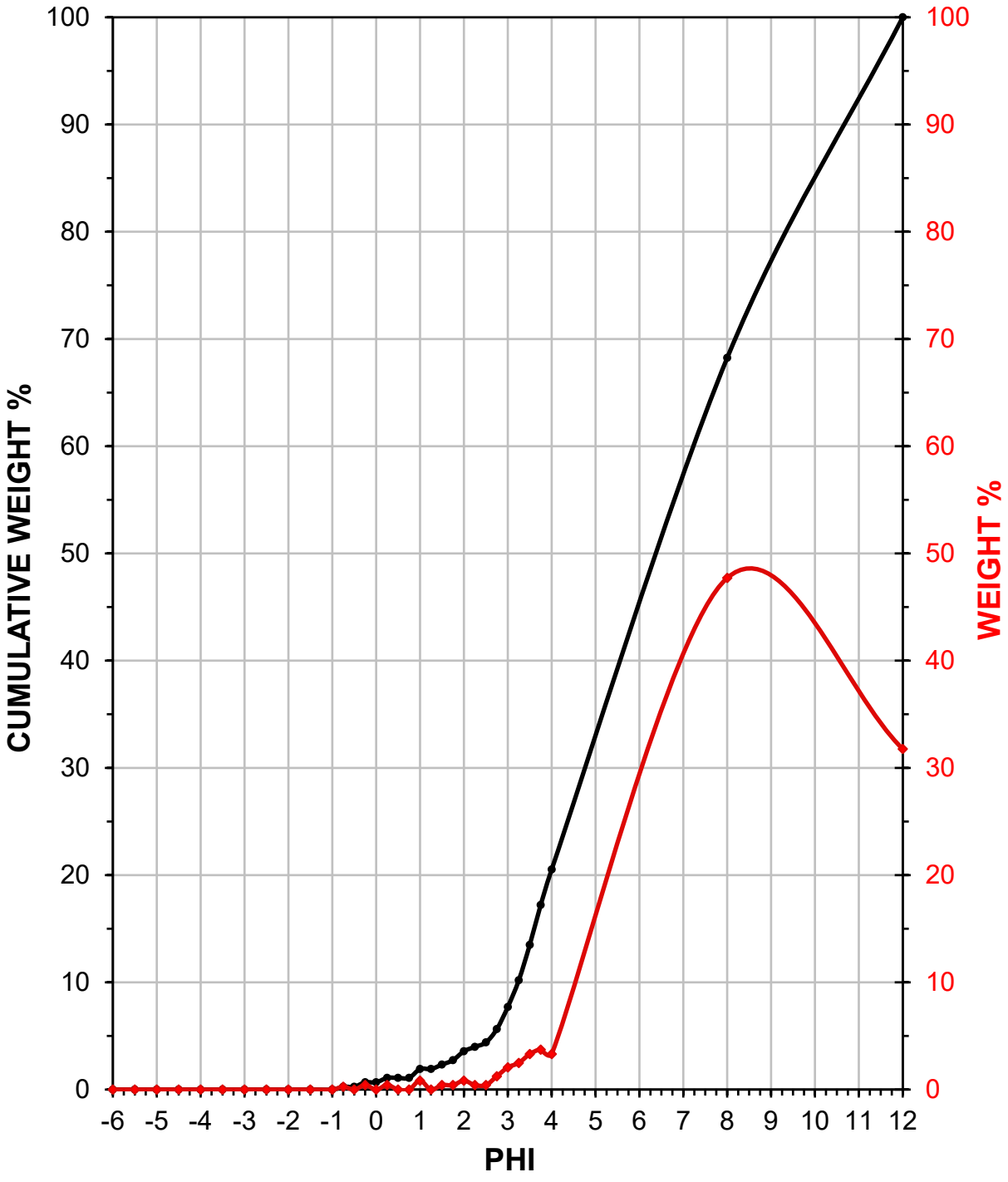
# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0124

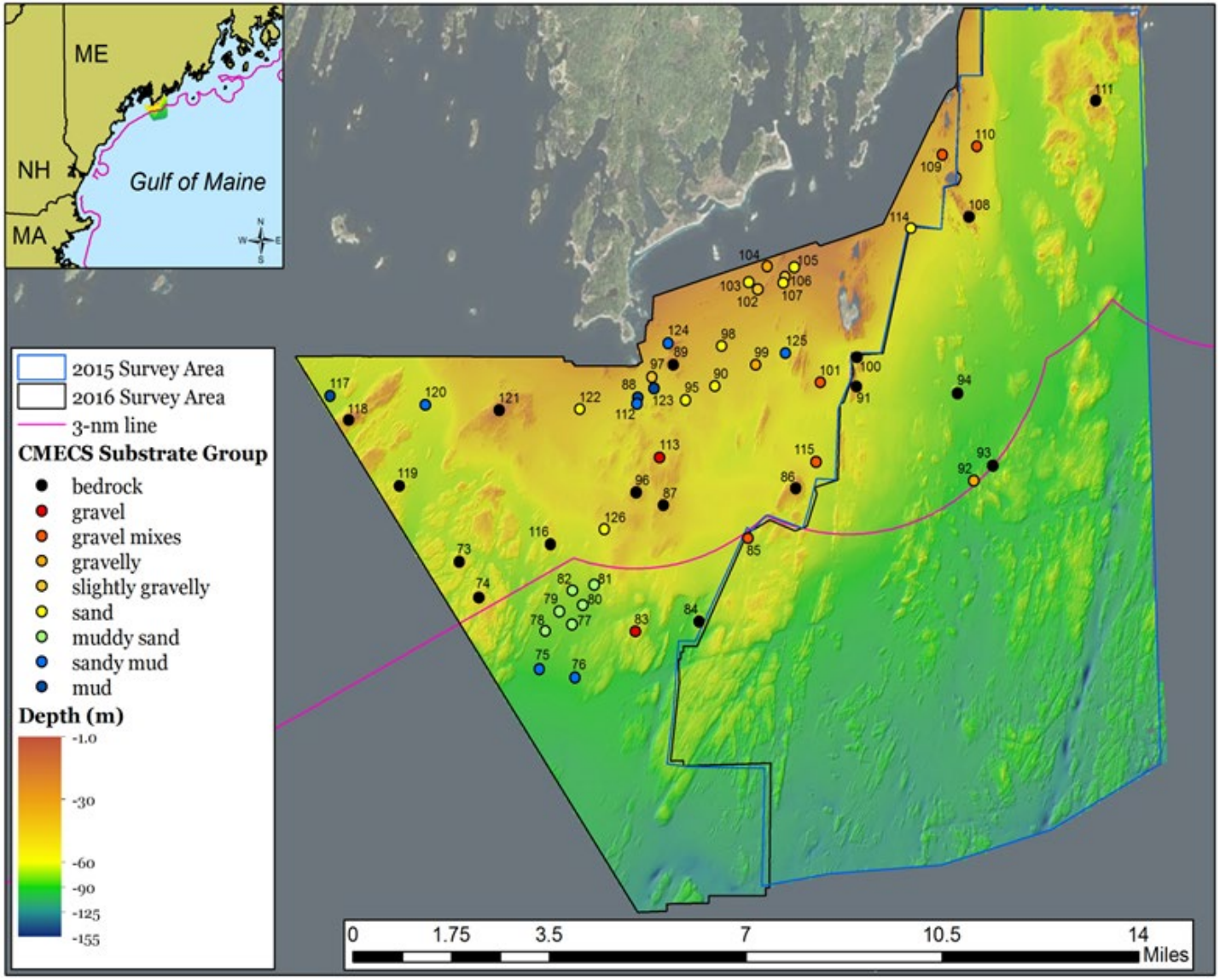


# GRAINSIZE ANALYSIS:

## Offshore Sediments 2016 - M0125



## Appendix D – Grab sample field pictures and/or bottom photographs




Overview map of sample locations with ID number, CMECS substrate group, and bathymetry. Blue and black outline delineate 2015 and 2016 MBES coverage boundaries, respectively.

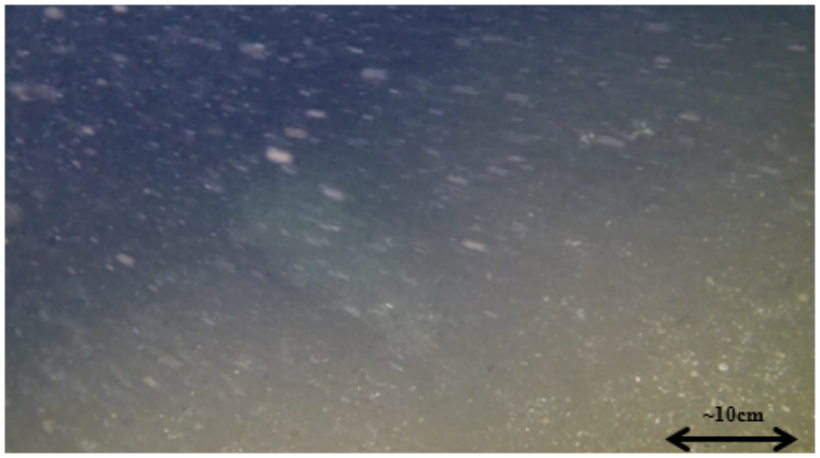
| Still Image from Video | Field Picture |
|---|---|

# EXAMPLE LAYOUT DESCRIPTIONS

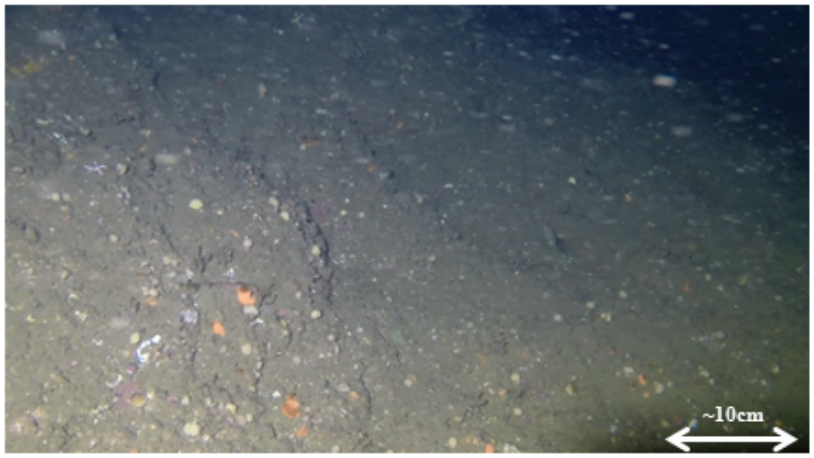
| | |
|---|---|
| *Image of seafloor extracted from video file. Green lasers are spaced 10 cm apart for scale. Scale is approximate for images/video lacking true reference scale (e.g. lasers).*<br><br>***Note:*** *Lasers are obscured in some images as a result of turbidity.* | *Field picture of sediment sample taken immediately upon retrieval. This block will appear as NO SAMPLE RECOVERED for sites where no physical sample was recovered; typically rocky or gravelly sites too coarse for retrieval with sampler.* |

**Substrate Type:** Sediment textural class (Folk, 1974) or substrate type (e.g. rocky) if no sample recovered. Textural classification based on grain-size analysis.

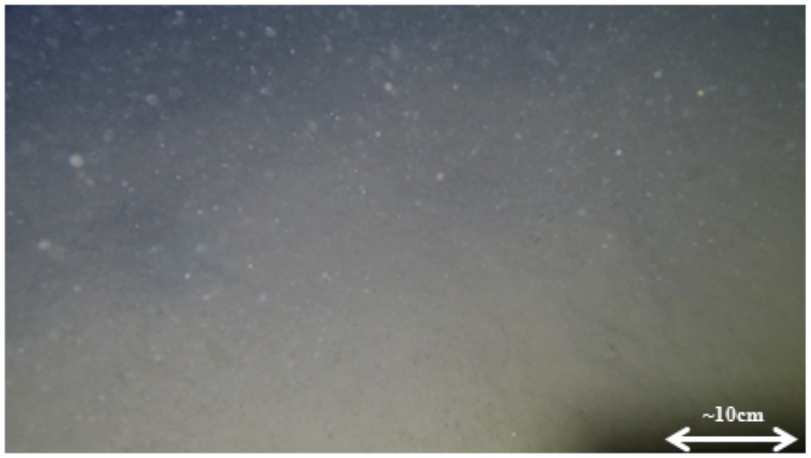
| | |
|---|---|
| Sample ID: | M0000 (sample identification number) |
| Date/Time (EST): | Date and time (eastern-standard time, 24-hr) of sampling event |
| Depth (real-time, m): | Real-time depth (meters) observed by hull-mounted, single-beam fathometer |
| Easting (WGS84 UTM Zone 19N, m): | Approximate horizontal position uncertainty ± 10 meters |
| Northing (WGS84 UTM Zone 19N, m): | Approximate horizontal position uncertainty ± 10 meters |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate<br><br>**Substrate Type:** bedrock / rocky | **NO SAMPLE RECOVERED** |

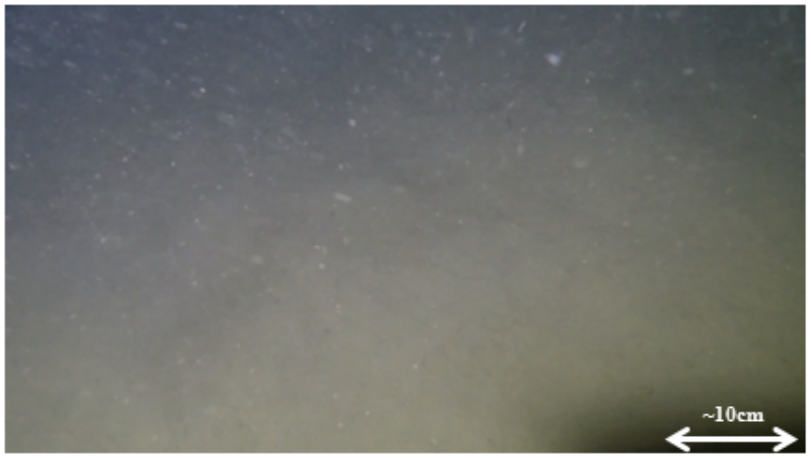
| | |
|---|---|
| Sample ID: | M0073 |
| Date/Time (EST): | 8/24/16 07:44 |
| Depth (real-time, m): | 32.1 |
| Easting (WGS84 UTM Zone 19N, m): | 427835 |
| Northing (WGS84 UTM Zone 19N, m): | 4832930 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate<br><br>**Substrate Type:** bedrock / rocky | **NO SAMPLE RECOVERED** |

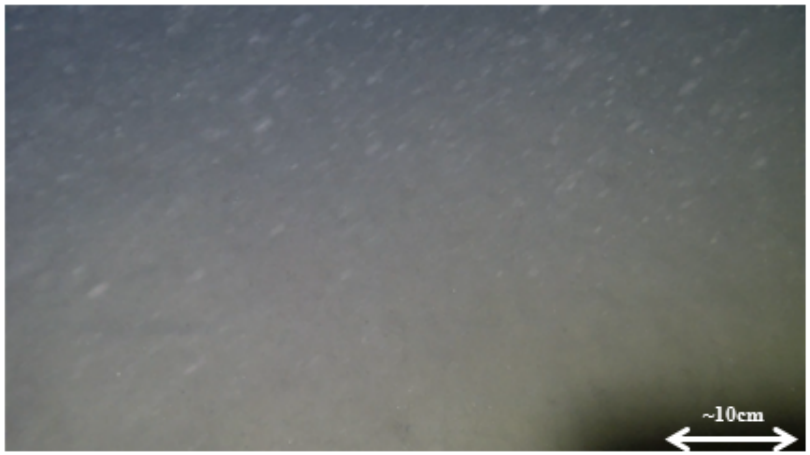
| | |
|---|---|
| Sample ID: | M0074 |
| Date/Time (EST): | 8/24/16 08:00 |
| Depth (real-time, m): | 30.7 |
| Easting (WGS84 UTM Zone 19N, m): | 428394 |
| Northing (WGS84 UTM Zone 19N, m): | 4831950 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate<br><br>**Substrate Type:** sandy mud |  |

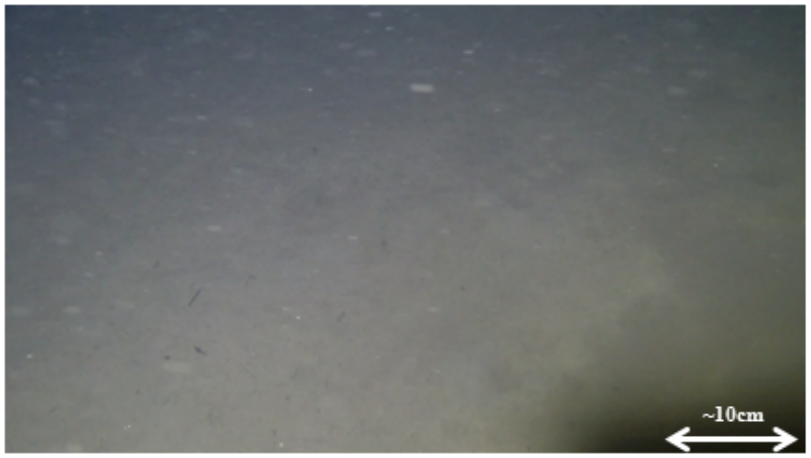
| | |
|---|---|
| Sample ID: | M0075 |
| Date/Time (EST): | 8/24/16 08:13 |
| Depth (real-time, m): | 72.7 |
| Easting (WGS84 UTM Zone 19N, m): | 430138 |
| Northing (WGS84 UTM Zone 19N, m): | 4830012 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate<br><br>**Substrate Type:** sandy mud |  |

| | |
|---|---|
| Sample ID: | M0076 |
| Date/Time (EST): | 8/24/16 09:01 |
| Depth (real-time, m): | 71.8 |
| Easting (WGS84 UTM Zone 19N, m): | 431155 |
| Northing (WGS84 UTM Zone 19N, m): | 4829781 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate<br><br>**Substrate Type:** muddy sand |  |

| | |
|---|---|
| Sample ID: | M0077 |
| Date/Time (EST): | 8/24/16 09:40 |
| Depth (real-time, m): | 62.5 |
| Easting (WGS84 UTM Zone 19N, m): | 431066 |
| Northing (WGS84 UTM Zone 19N, m): | 4831232 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate<br><br>**Substrate Type:** muddy sand |  |

| | |
|---|---|
| Sample ID: | M0078 |
| Date/Time (EST): | 8/24/16 10:22 |
| Depth (real-time, m): | 63.7 |
| Easting (WGS84 UTM Zone 19N, m): | 430307 |
| Northing (WGS84 UTM Zone 19N, m): | 4831040 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate<br><br>**Substrate Type:** muddy sand |  |

| | |
|---|---|
| Sample ID: | M0079 |
| Date/Time (EST): | 8/24/16 11:05 |
| Depth (real-time, m): | 58.8 |
| Easting (WGS84 UTM Zone 19N, m): | 430700 |
| Northing (WGS84 UTM Zone 19N, m): | 4831580 |

| Still Image from Video | Field Picture |
|---|---|
| **VIDEO NOT RECORDED**<br><br>**Substrate Type:** muddy sand |  |

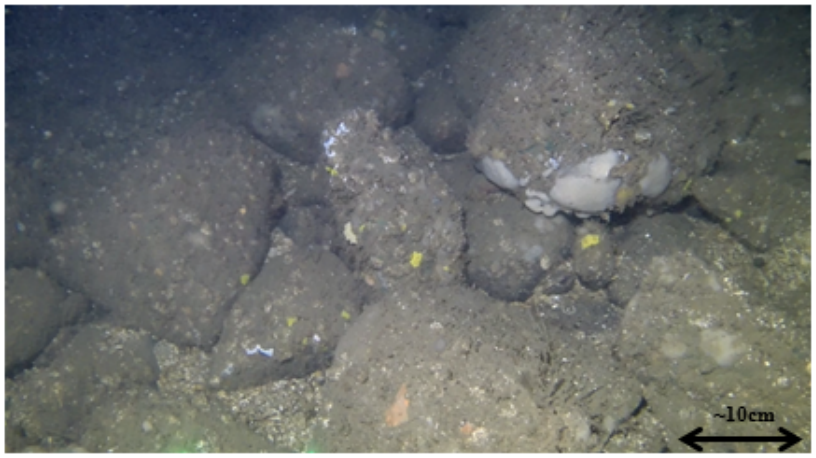
| | |
|---|---|
| Sample ID: | M0080 |
| Date/Time (EST): | 8/24/16 11:44 |
| Depth (real-time, m): | 60.0 |
| Easting (WGS84 UTM Zone 19N, m): | 431378 |
| Northing (WGS84 UTM Zone 19N, m): | 4831756 |

| Still Image from Video | Field Picture |
|---|---|
| **VIDEO NOT RECORDED**<br><br>**Substrate Type:** muddy sand |  |

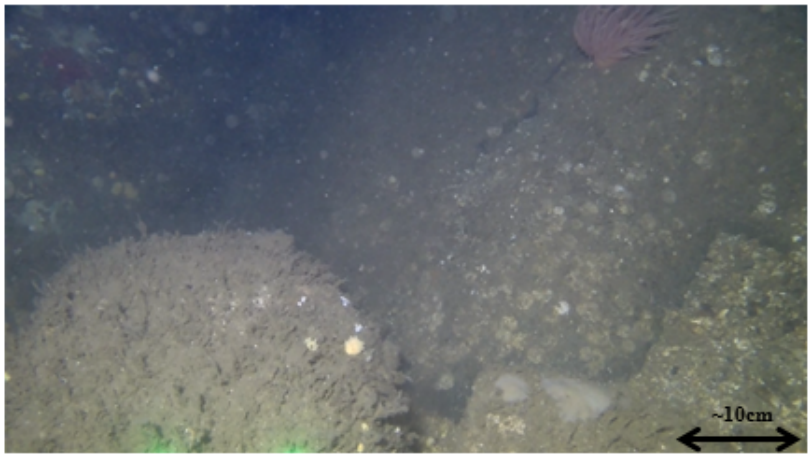
| | |
|---|---|
| Sample ID: | M0081 |
| Date/Time (EST): | 8/24/16 12:18 |
| Depth (real-time, m): | 53.6 |
| Easting (WGS84 UTM Zone 19N, m): | 431700 |
| Northing (WGS84 UTM Zone 19N, m): | 4832303 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate<br><br>**Substrate Type:** clayey sand |  |

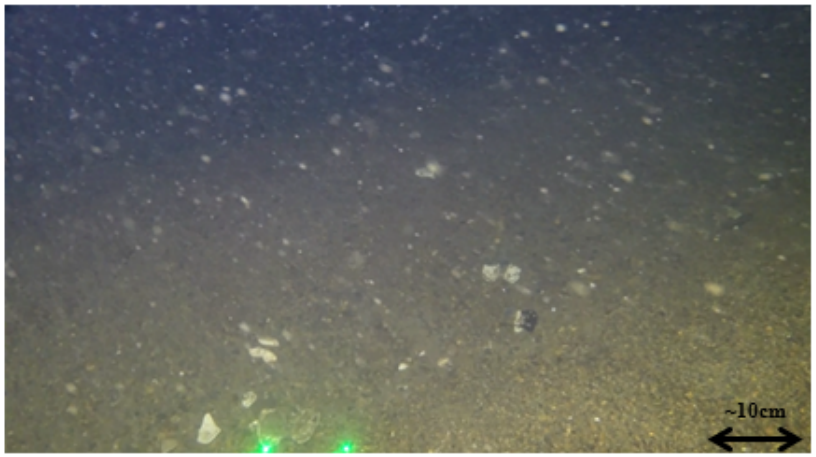
| | |
|---|---|
| Sample ID: | M0082 |
| Date/Time (EST): | 8/24/16 13:03 |
| Depth (real-time, m): | 53.5 |
| Easting (WGS84 UTM Zone 19N, m): | 431072 |
| Northing (WGS84 UTM Zone 19N, m): | 4832143 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** small-medium boulders / rocky | **NO SAMPLE RECOVERED** |

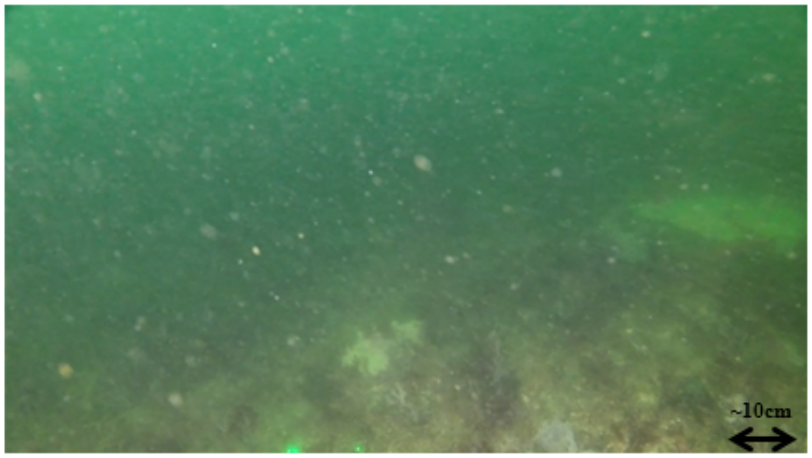
| | |
|---|---|
| Sample ID: | M0083 |
| Date/Time (EST): | 9/12/16 07:21 |
| Depth (real-time, m): | 41.0 |
| Easting (WGS84 UTM Zone 19N, m): | 432886 |
| Northing (WGS84 UTM Zone 19N, m): | 4831039 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** very large boulders / rocky | **NO SAMPLE RECOVERED** |

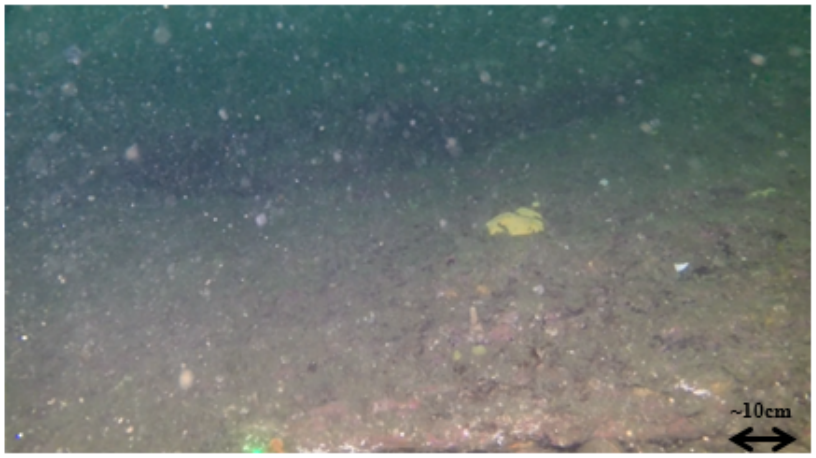
| | |
|---|---|
| Sample ID: | M0084 |
| Date/Time (EST): | 9/12/16 07:33 |
| Depth (real-time, m): | 45.8 |
| Easting (WGS84 UTM Zone 19N, m): | 434721 |
| Northing (WGS84 UTM Zone 19N, m): | 4831308 |

| Still Image from Video | Field Picture |
|---|---|
|   Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sandy gravel |   |

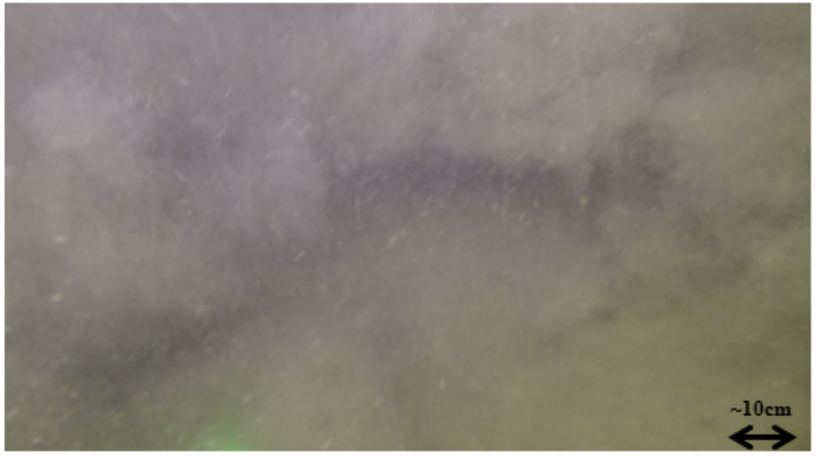
| | |
|---|---|
| Sample ID: | M0085 |
| Date/Time (EST): | 9/12/16 07:50 |
| Depth (real-time, m): | 40.7 |
| Easting (WGS84 UTM Zone 19N, m): | 436113 |
| Northing (WGS84 UTM Zone 19N, m): | 4833569 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

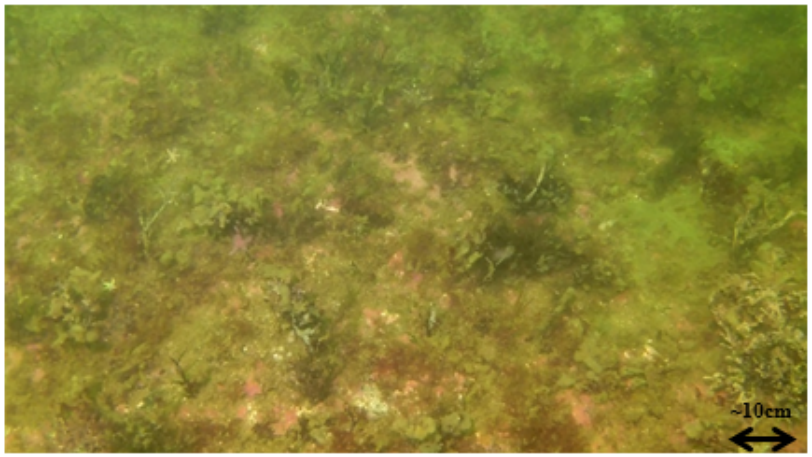
| | |
|---|---|
| Sample ID: | M0086 |
| Date/Time (EST): | 9/12/16 08:15 |
| Depth (real-time, m): | 14.7 |
| Easting (WGS84 UTM Zone 19N, m): | 437493 |
| Northing (WGS84 UTM Zone 19N, m): | 4834930 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate due to laser obstruction<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

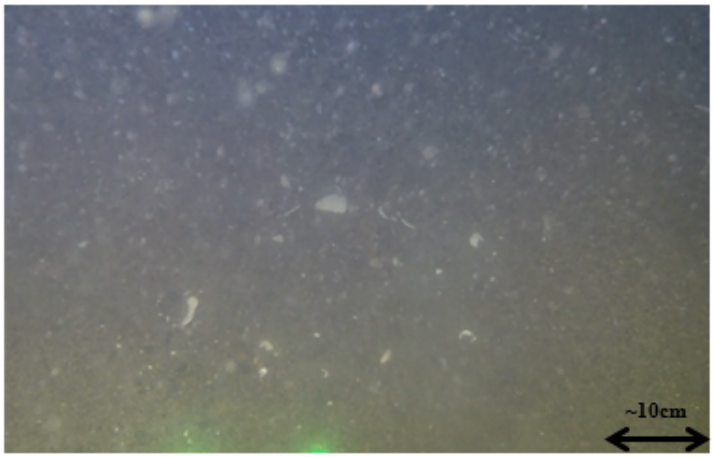
| | |
|---|---|
| Sample ID: | M0087 |
| Date/Time (EST): | 9/12/16 08:38 |
| Depth (real-time, m): | 21.0 |
| Easting (WGS84 UTM Zone 19N, m): | 433689 |
| Northing (WGS84 UTM Zone 19N, m): | 4834472 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate due to laser obstruction<br>Poor water/image clarity due to sediment resuspension upon sampler impact<br><br>**Substrate Type:** mud |  |

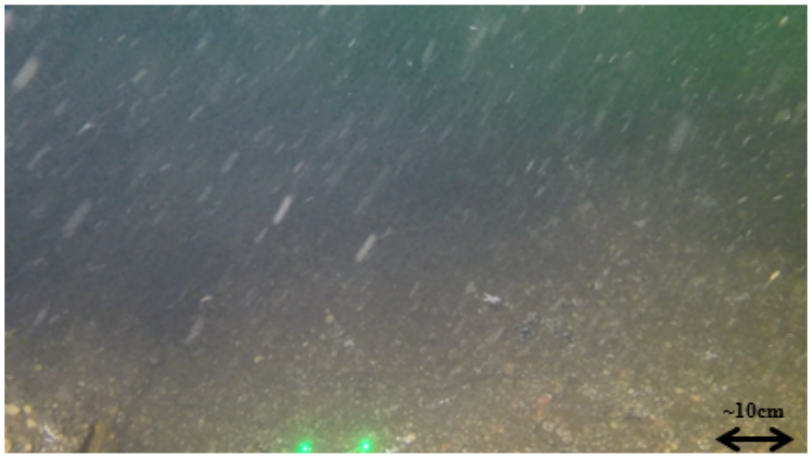
| | |
|---|---|
| Sample ID: | M0088 |
| Date/Time (EST): | 9/12/16 08:53 |
| Depth (real-time, m): | 31.5 |
| Easting (WGS84 UTM Zone 19N, m): | 432950 |
| Northing (WGS84 UTM Zone 19N, m): | 4837408 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

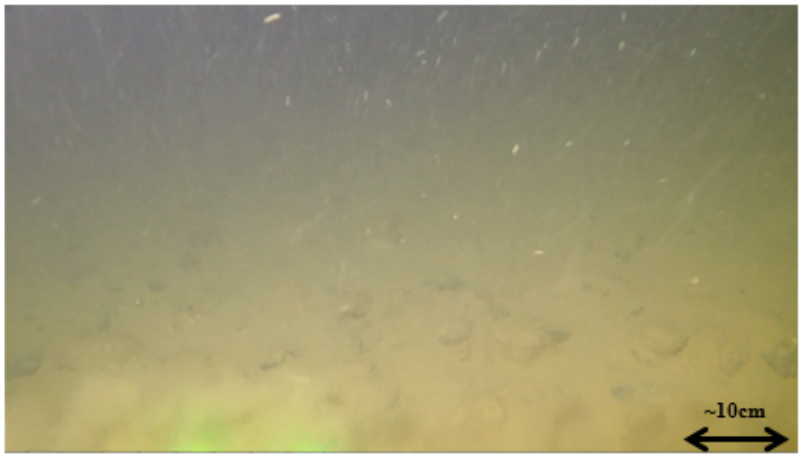
| | |
|---|---|
| Sample ID: | M0089 |
| Date/Time (EST): | 9/12/16 09:35 |
| Depth (real-time, m): | 11.4 |
| Easting (WGS84 UTM Zone 19N, m): | 433978 |
| Northing (WGS84 UTM Zone 19N, m): | 4838294 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sand |  |

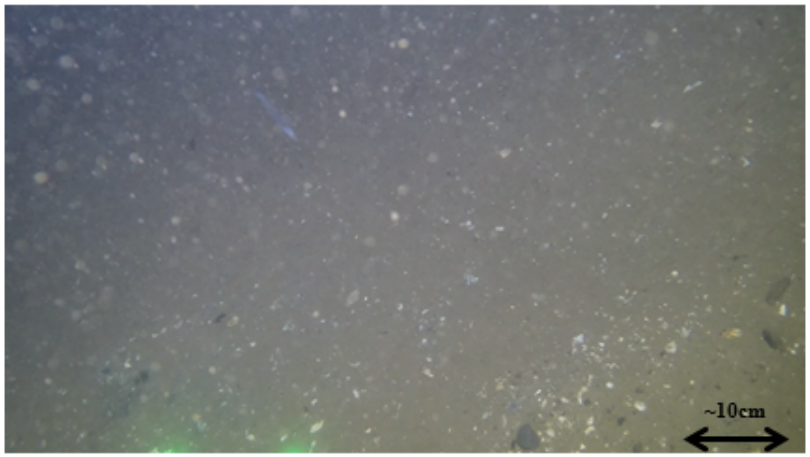
| | |
|---|---|
| Sample ID: | M0090 |
| Date/Time (EST): | 9/12/16 09:59 |
| Depth (real-time, m): | 29.7 |
| Easting (WGS84 UTM Zone 19N, m): | 435169 |
| Northing (WGS84 UTM Zone 19N, m): | 4837714 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

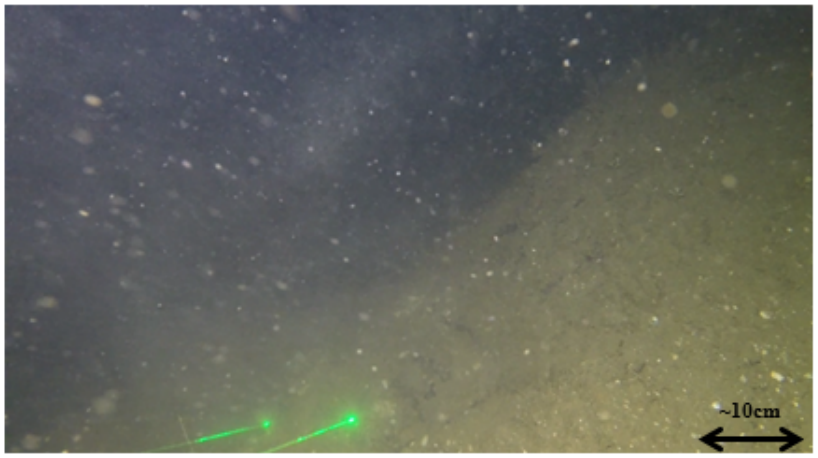
| | |
|---|---|
| Sample ID: | M0091 |
| Date/Time (EST): | 9/12/16 10:29 |
| Depth (real-time, m): | 27.5 |
| Easting (WGS84 UTM Zone 19N, m): | 439231 |
| Northing (WGS84 UTM Zone 19N, m): | 4837696 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** gravelly muddy sand |  |

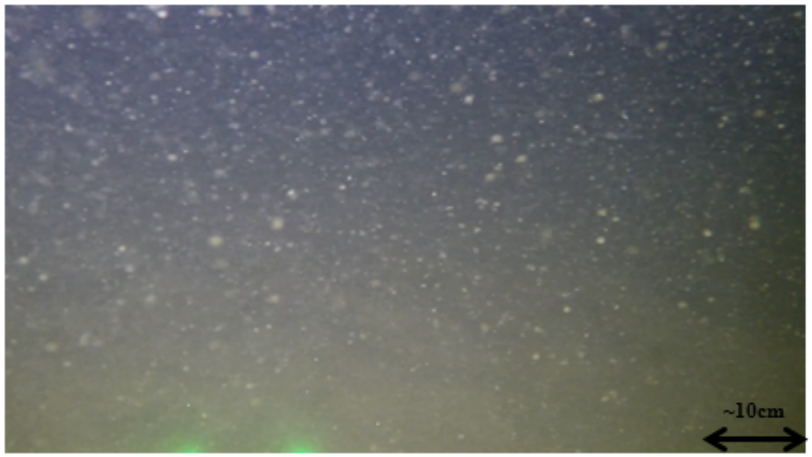
| | |
|---|---|
| Sample ID: | M0092 |
| Date/Time (EST): | 9/12/16 10:45 |
| Depth (real-time, m): | 68.6 |
| Easting (WGS84 UTM Zone 19N, m): | 442601 |
| Northing (WGS84 UTM Zone 19N, m): | 4835134 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

| | |
|---|---|
| Sample ID: | M0093 |
| Date/Time (EST): | 9/12/16 11:22 |
| Depth (real-time, m): | 67.4 |
| Easting (WGS84 UTM Zone 19N, m): | 443138 |
| Northing (WGS84 UTM Zone 19N, m): | 4835550 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

| | |
|---|---|
| Sample ID: | M0094 |
| Date/Time (EST): | 9/12/16 11:39 |
| Depth (real-time, m): | 50.7 |
| Easting (WGS84 UTM Zone 19N, m): | 442135 |
| Northing (WGS84 UTM Zone 19N, m): | 4837519 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sand |  |

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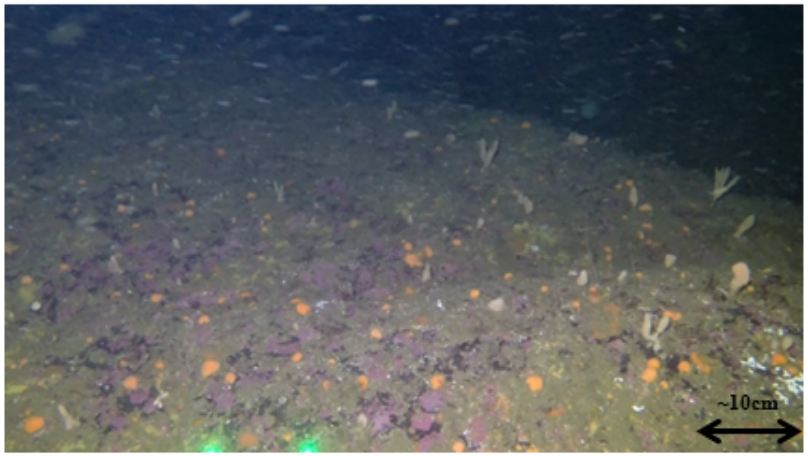
|---|---|
| Sample ID: | M0095 |
| Date/Time (EST): | 9/20/16 07:28 |
| Depth (real-time, m): | 28.6 |
| Easting (WGS84 UTM Zone 19N, m): | 434333 |
| Northing (WGS84 UTM Zone 19N, m): | 4837339 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

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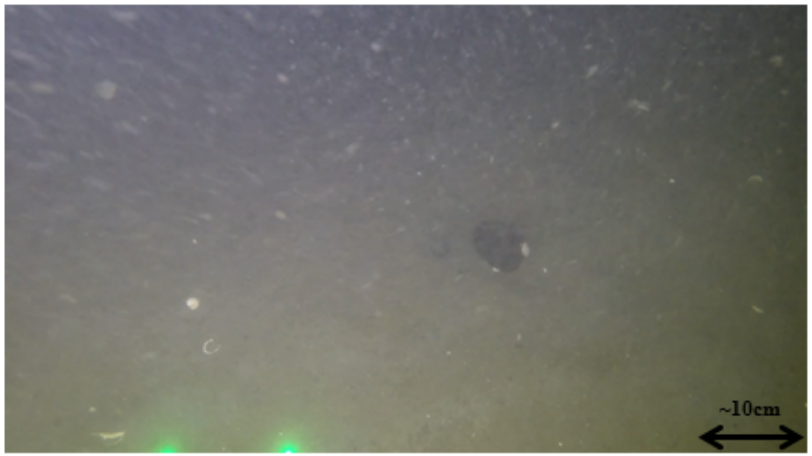
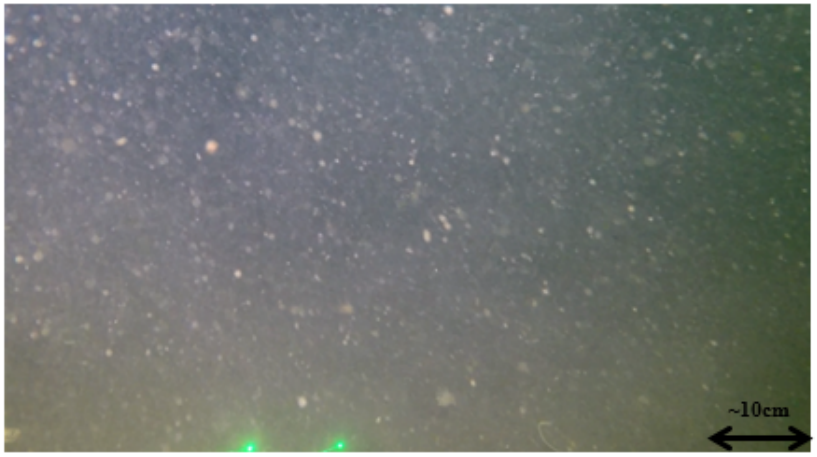
|---|---|
| Sample ID: | M0096 |
| Date/Time (EST): | 9/20/16 07:52 |
| Depth (real-time, m): | 20.8 |
| Easting (WGS84 UTM Zone 19N, m): | 432913 |
| Northing (WGS84 UTM Zone 19N, m): | 4834821 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** slightly gravelly muddy sand |  |

| | |
|---|---|
| Sample ID: | M0097 |
| Date/Time (EST): | 9/20/16 08:16 |
| Depth (real-time, m): | 26.0 |
| Easting (WGS84 UTM Zone 19N, m): | 433361 |
| Northing (WGS84 UTM Zone 19N, m): | 4837960 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sand |  |

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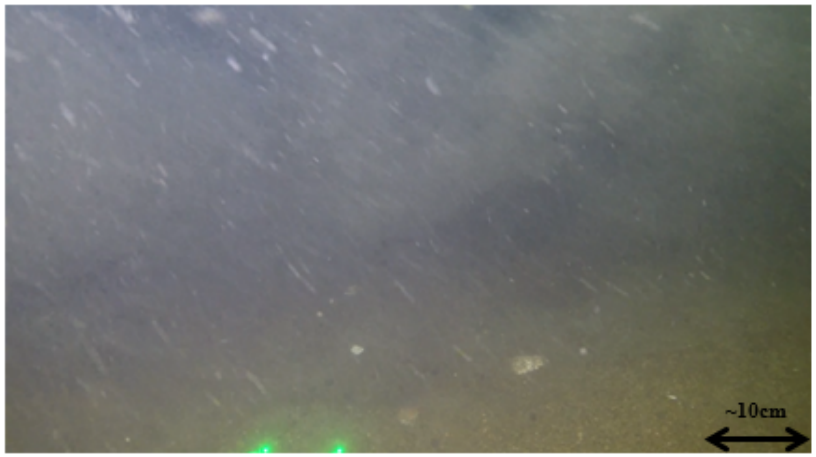
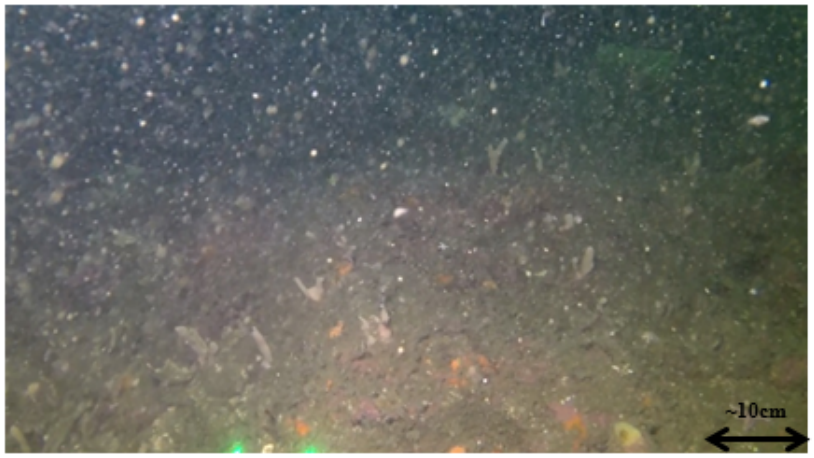
|---|---|
| Sample ID: | M0098 |
| Date/Time (EST): | 9/20/16 08:47 |
| Depth (real-time, m): | 23.2 |
| Easting (WGS84 UTM Zone 19N, m): | 435365 |
| Northing (WGS84 UTM Zone 19N, m): | 4838804 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** gravelly sand |  |

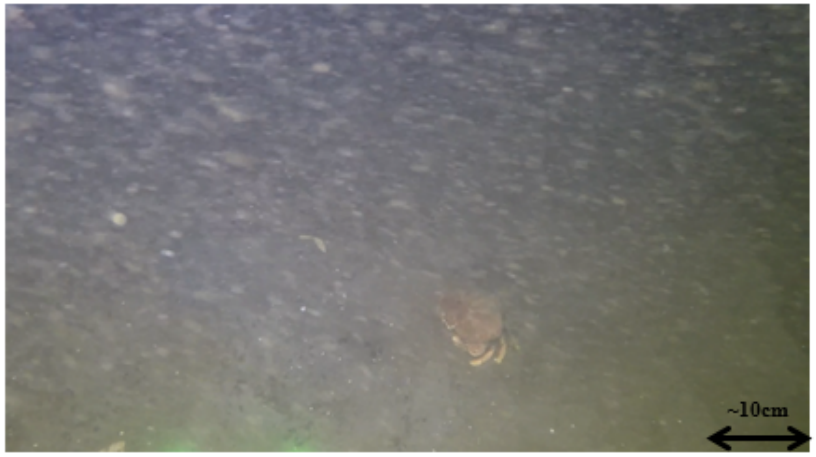
| | |
|---|---|
| Sample ID: | M0099 |
| Date/Time (EST): | 9/20/16 09:10 |
| Depth (real-time, m): | 28.2 |
| Easting (WGS84 UTM Zone 19N, m): | 436338 |
| Northing (WGS84 UTM Zone 19N, m): | 4838284 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

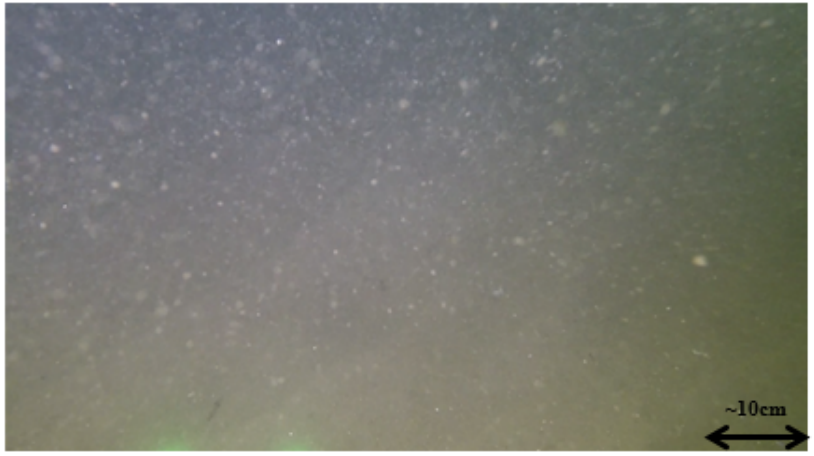
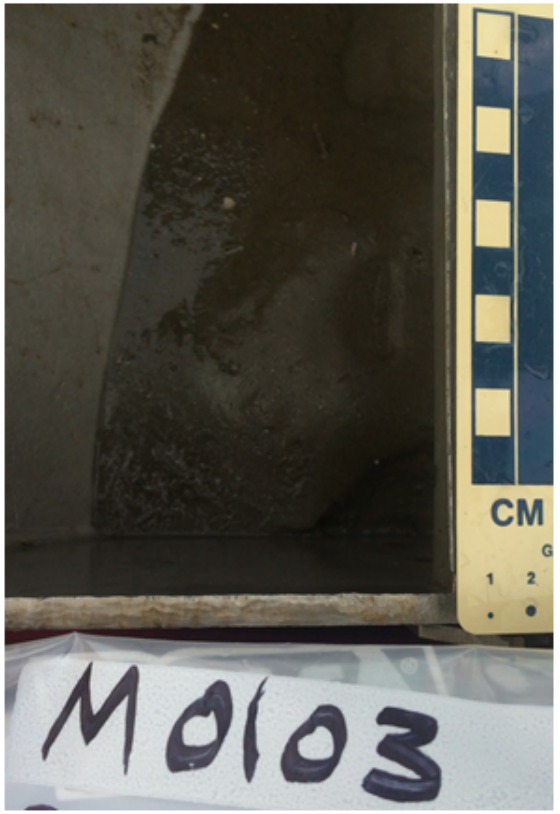
| | |
|---|---|
| Sample ID: | M0100 |
| Date/Time (EST): | 9/20/16 09:33 |
| Depth (real-time, m): | 19.2 |
| Easting (WGS84 UTM Zone 19N, m): | 439244 |
| Northing (WGS84 UTM Zone 19N, m): | 4838490 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sandy gravel |  |

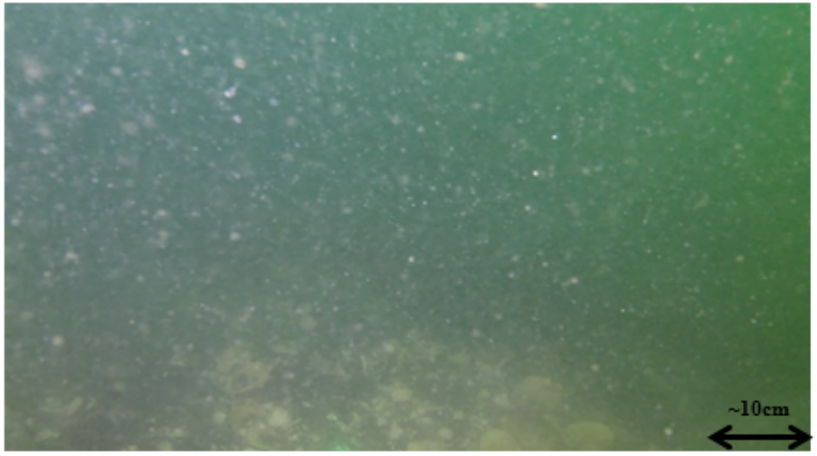
| | |
|---|---|
| Sample ID: | M0101 |
| Date/Time (EST): | 9/20/16 09:43 |
| Depth (real-time, m): | 28.7 |
| Easting (WGS84 UTM Zone 19N, m): | 438193 |
| Northing (WGS84 UTM Zone 19N, m): | 4837811 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** slightly gravelly sand |  |

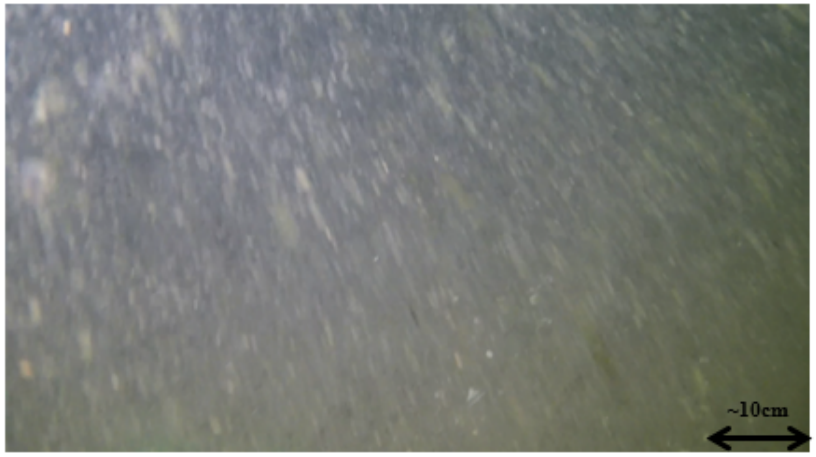
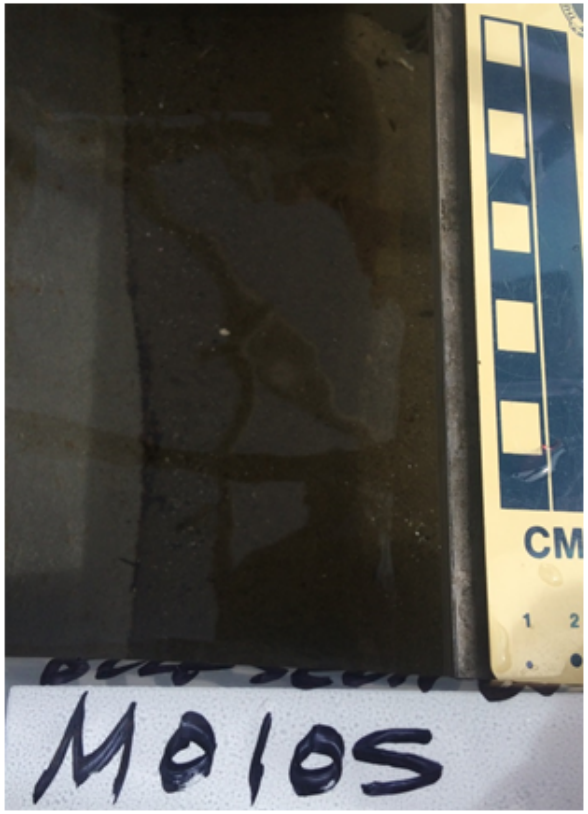
| | |
|---|---|
| Sample ID: | M0102 |
| Date/Time (EST): | 9/20/16 10:10 |
| Depth (real-time, m): | 19.5 |
| Easting (WGS84 UTM Zone 19N, m): | 436402 |
| Northing (WGS84 UTM Zone 19N, m): | 4840351 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sand |  |

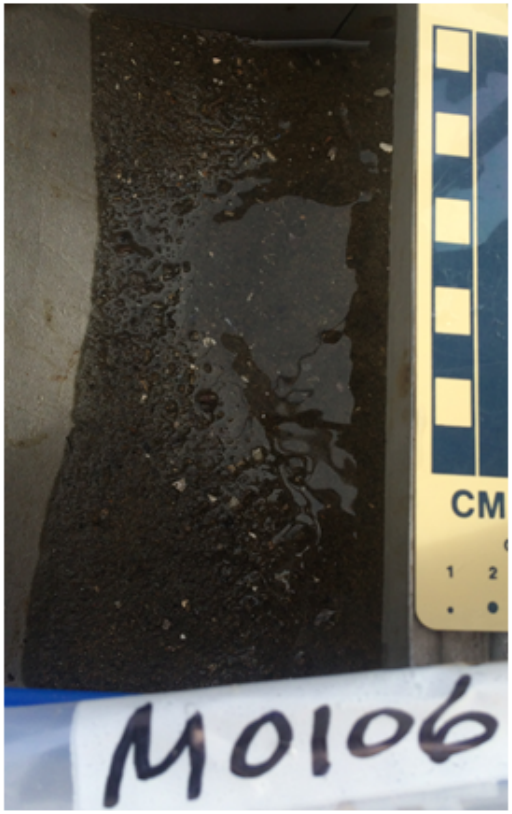
| | |
|---|---|
| Sample ID: | M0103 |
| Date/Time (EST): | 9/20/16 10:50 |
| Depth (real-time, m): | 17.9 |
| Easting (WGS84 UTM Zone 19N, m): | 436139 |
| Northing (WGS84 UTM Zone 19N, m): | 4840544 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** gravelly sand; very shelly |  |

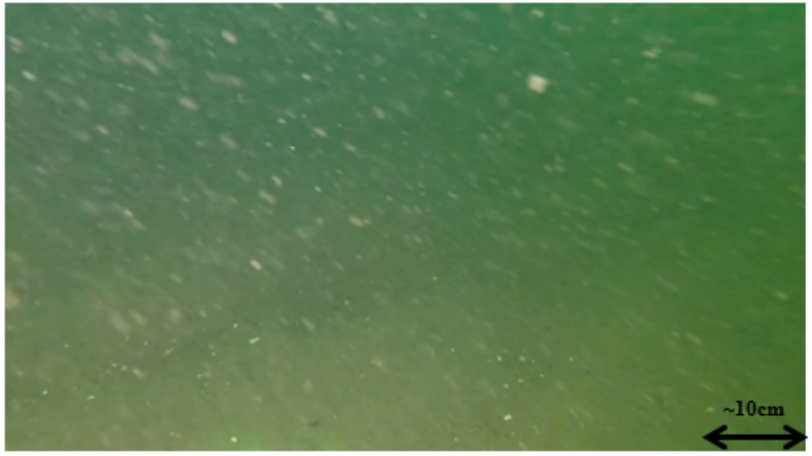
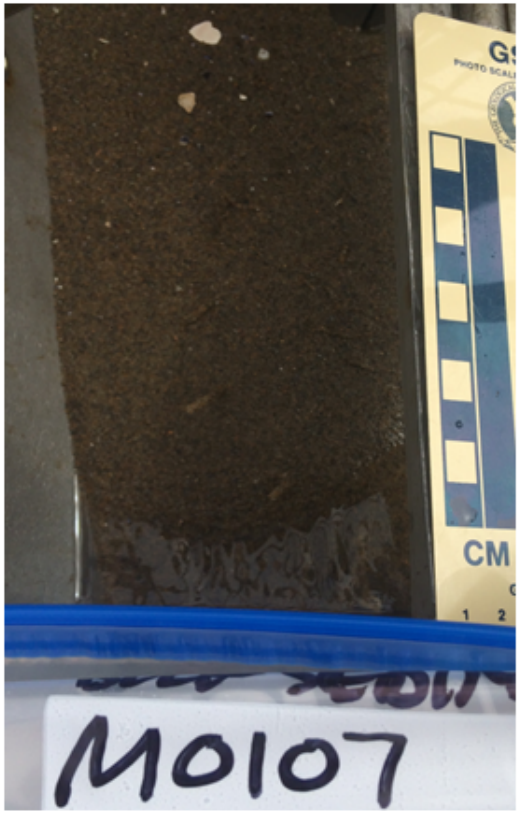
| | |
|---|---|
| Sample ID: | M0104 |
| Date/Time (EST): | 9/20/16 11:06 |
| Depth (real-time, m): | 16.5 |
| Easting (WGS84 UTM Zone 19N, m): | 436671 |
| Northing (WGS84 UTM Zone 19N, m): | 4840971 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sand |  |

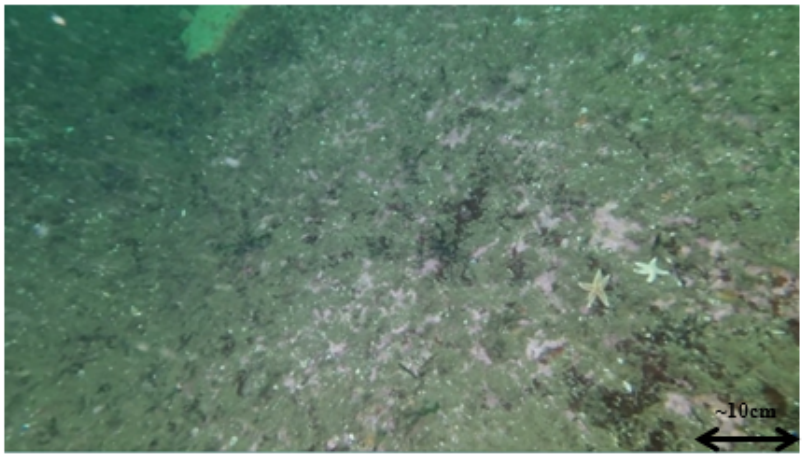
| | |
|---|---|
| Sample ID: | M0105 |
| Date/Time (EST): | 9/20/16 11:24 |
| Depth (real-time, m): | 14.3 |
| Easting (WGS84 UTM Zone 19N, m): | 437448 |
| Northing (WGS84 UTM Zone 19N, m): | 4840954 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** slightly gravelly sand |  |

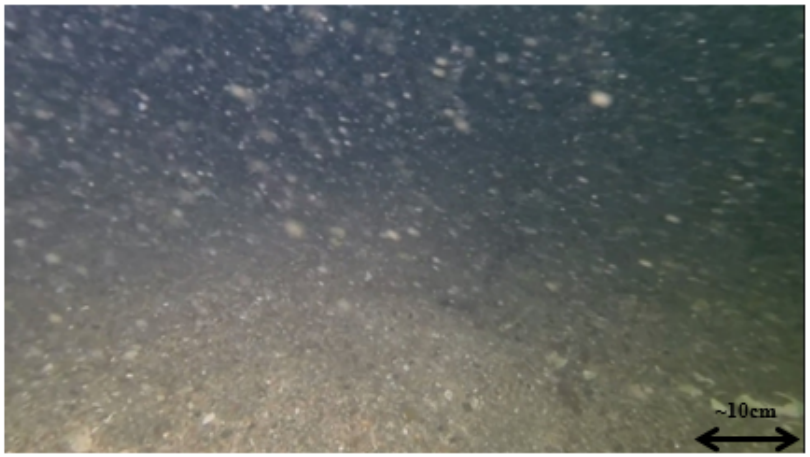
| | |
|---|---|
| Sample ID: | M0106 |
| Date/Time (EST): | 9/20/16 11:41 |
| Depth (real-time, m): | 16.6 |
| Easting (WGS84 UTM Zone 19N, m): | 437183 |
| Northing (WGS84 UTM Zone 19N, m): | 4840692 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sand |  |

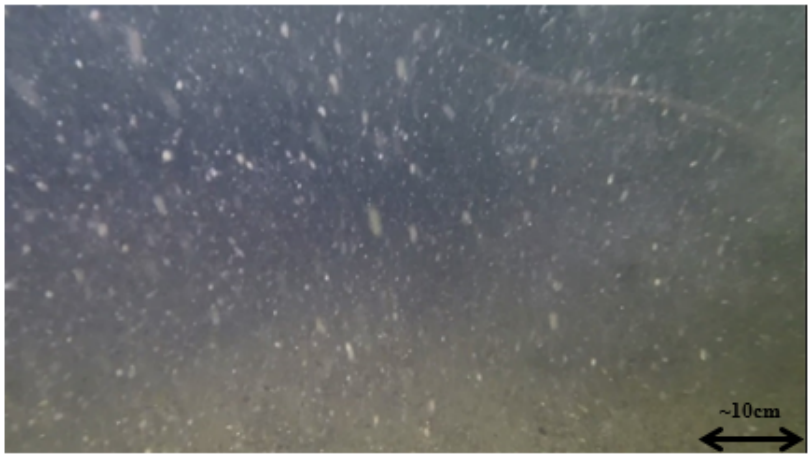
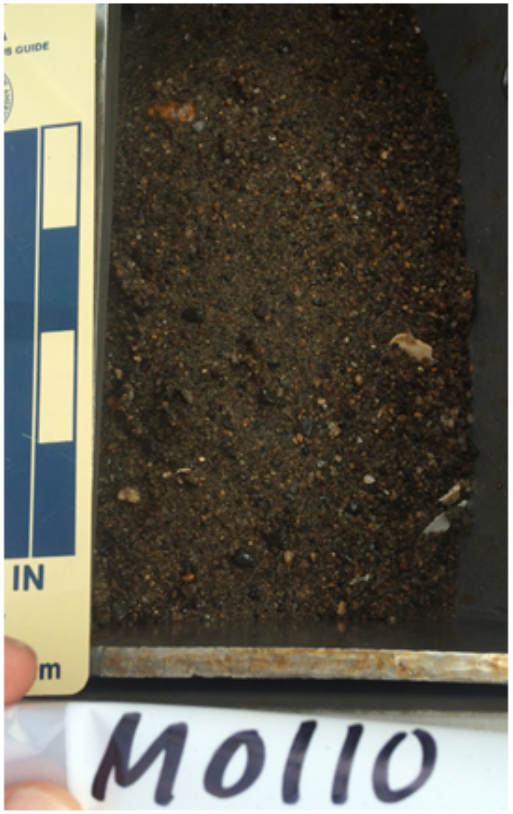
| | |
|---|---|
| Sample ID: | M0107 |
| Date/Time (EST): | 9/20/16 12:00 |
| Depth (real-time, m): | 17.1 |
| Easting (WGS84 UTM Zone 19N, m): | 437126 |
| Northing (WGS84 UTM Zone 19N, m): | 4840513 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

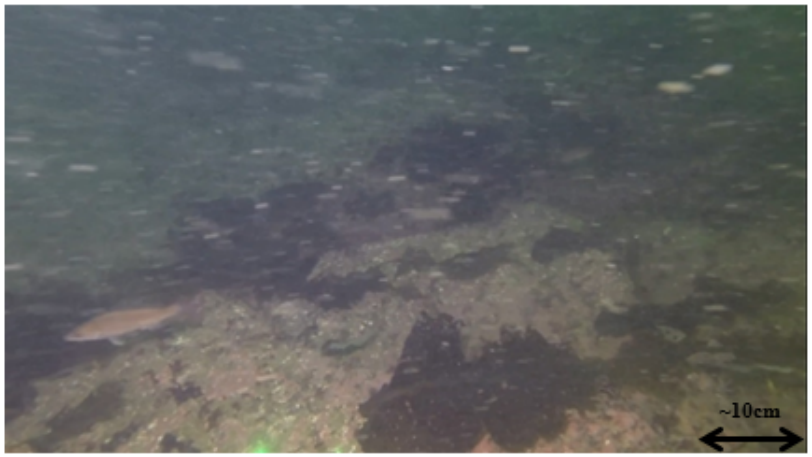
| | |
|---|---|
| Sample ID: | M0108 |
| Date/Time (EST): | 9/20/16 12:28 |
| Depth (real-time, m): | 15.5 |
| Easting (WGS84 UTM Zone 19N, m): | 442460 |
| Northing (WGS84 UTM Zone 19N, m): | 4842312 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sandy gravel (gravelly shell hash) |  |

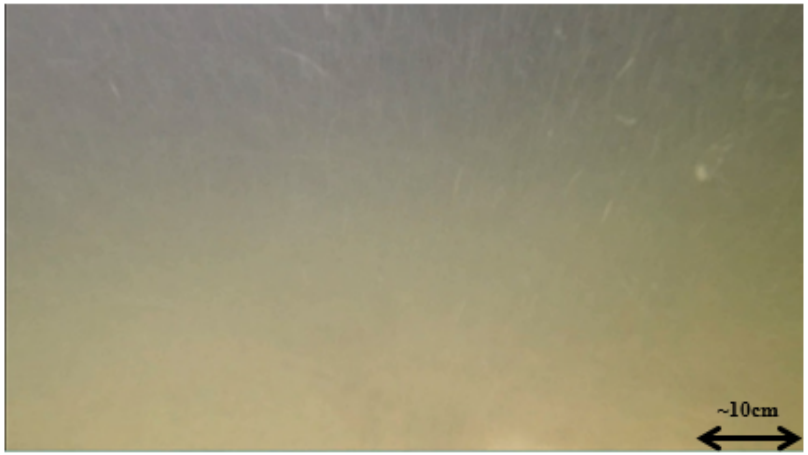
| | |
|---|---|
| Sample ID: | M0109 |
| Date/Time (EST): | 9/20/16 12:41 |
| Depth (real-time, m): | 26.7 |
| Easting (WGS84 UTM Zone 19N, m): | 441695 |
| Northing (WGS84 UTM Zone 19N, m): | 4844004 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sandy gravel |  |

| | |
|---|---|
| Sample ID: | M0110 |
| Date/Time (EST): | 9/20/16 13:03 |
| Depth (real-time, m): | 30.4 |
| Easting (WGS84 UTM Zone 19N, m): | 442685 |
| Northing (WGS84 UTM Zone 19N, m): | 4844239 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

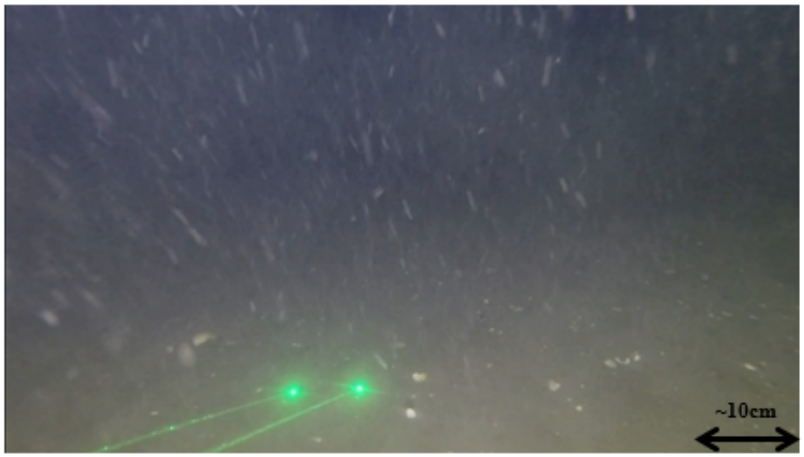
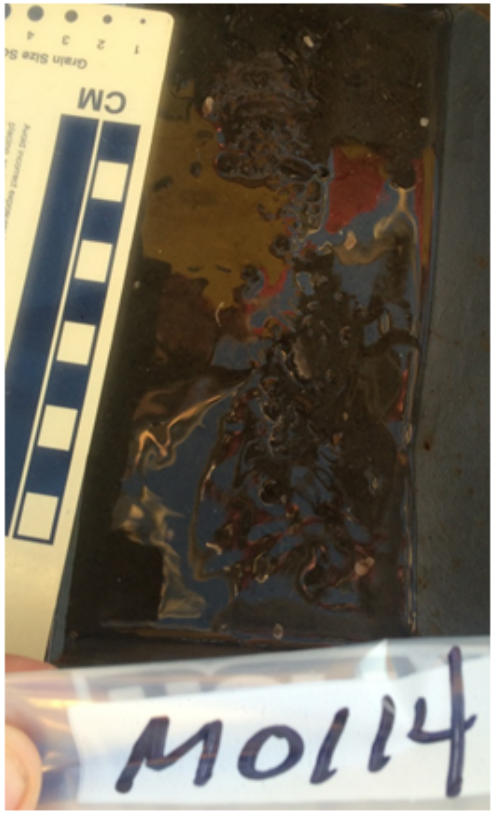
| | |
|---|---|
| Sample ID: | M0111 |
| Date/Time (EST): | 9/20/16 13:29 |
| Depth (real-time, m): | 20.8 |
| Easting (WGS84 UTM Zone 19N, m): | 446095 |
| Northing (WGS84 UTM Zone 19N, m): | 4845486 |

| Still Image from Video | Field Picture |
|---|---|
|  <br>Scale is approximate due to laser obstruction<br>Poor water/image clarity due to sediment resuspension upon sampler impact<br><br>**Substrate Type:** sandy mud | **NO PICTURE TAKEN** |

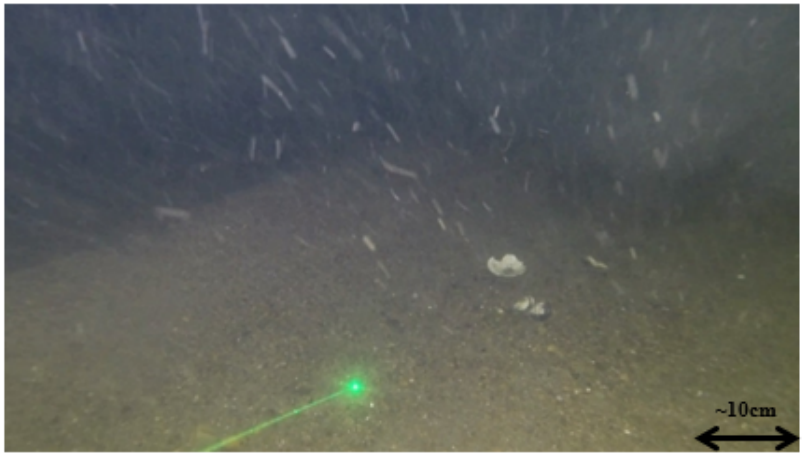
| | |
|---|---|
| Sample ID: | M0112 |
| Date/Time (EST): | 9/26/16 06:53 |
| Depth (real-time, m): | 32.5 |
| Easting (WGS84 UTM Zone 19N, m): | 432929 |
| Northing (WGS84 UTM Zone 19N, m): | 4837324 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** gravel | **NO PICTURE TAKEN** |

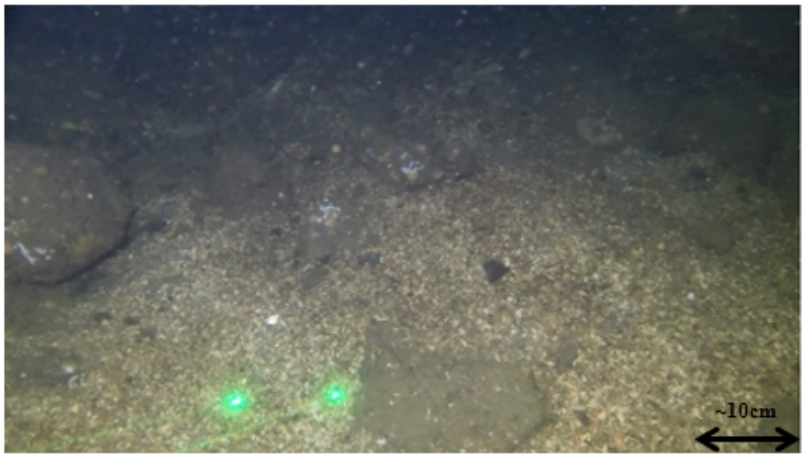
| | |
|---|---|
| Sample ID: | M0113 |
| Date/Time (EST): | 9/26/16 07:22 |
| Depth (real-time, m): | 29.5 |
| Easting (WGS84 UTM Zone 19N, m): | 433581 |
| Northing (WGS84 UTM Zone 19N, m): | 4835769 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sand |  |

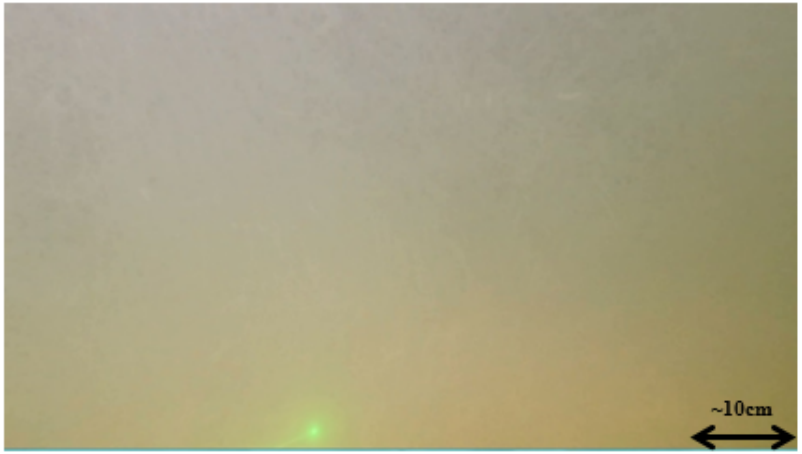
| | |
|---|---|
| Sample ID: | M0114 |
| Date/Time (EST): | 10/05/16 07:06 |
| Depth (real-time, m): | 26.0 |
| Easting (WGS84 UTM Zone 19N, m): | 440791 |
| Northing (WGS84 UTM Zone 19N, m): | 4842003 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sandy gravel |  |

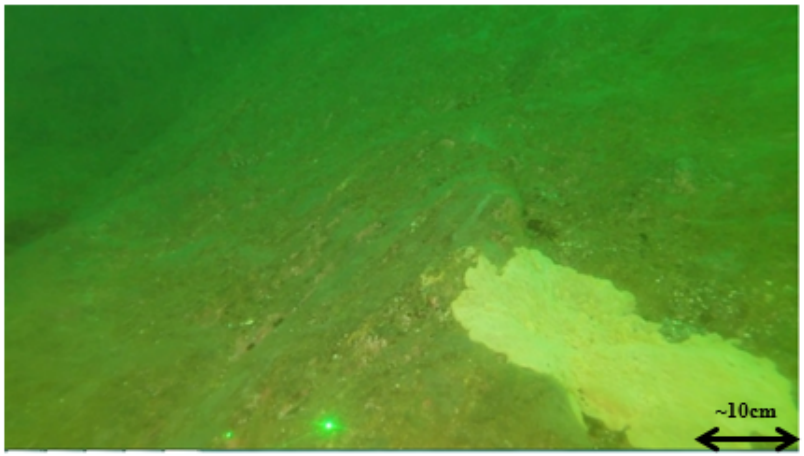
| | |
|---|---|
| Sample ID: | M0115 |
| Date/Time (EST): | 10/05/16 07:34 |
| Depth (real-time, m): | 35.6 |
| Easting (WGS84 UTM Zone 19N, m): | 438070 |
| Northing (WGS84 UTM Zone 19N, m): | 4835651 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** boulders / rocky | **NO SAMPLE RECOVERED** |

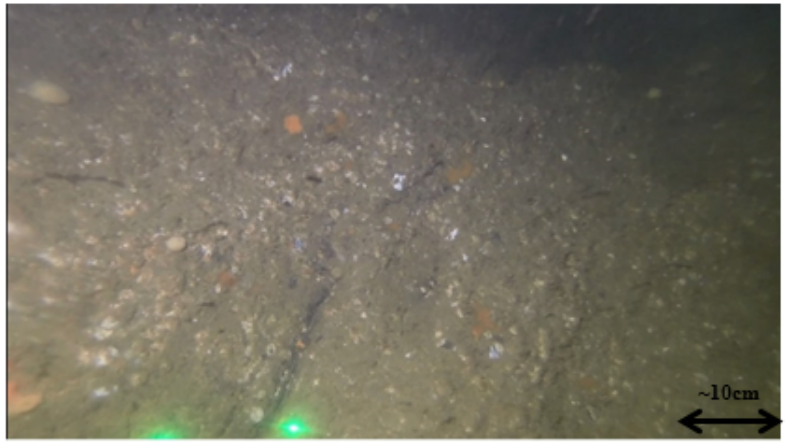
| | |
|---|---|
| Sample ID: | M0116 |
| Date/Time (EST): | 10/05/16 08:02 |
| Depth (real-time, m): | 32.3 |
| Easting (WGS84 UTM Zone 19N, m): | 430456 |
| Northing (WGS84 UTM Zone 19N, m): | 4833406 |

| Still Image from Video | Field Picture |
|---|---|
|  Scale is approximate due to laser obstruction<br>Poor water/image clarity due to sediment resuspension upon sampler impact<br><br>**Substrate Type:** clay |  |

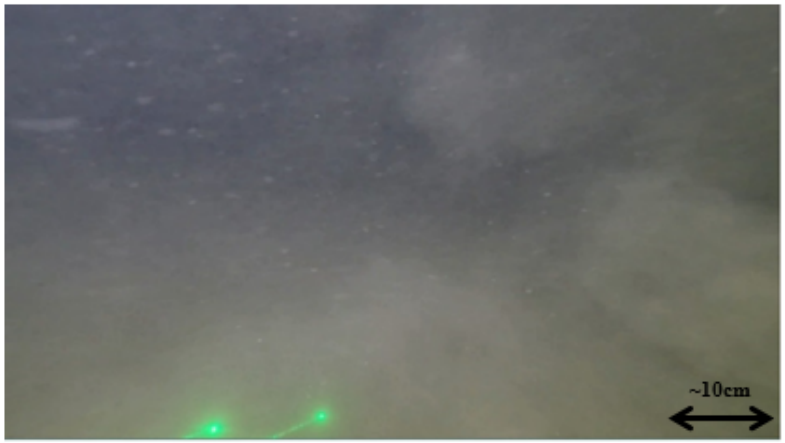
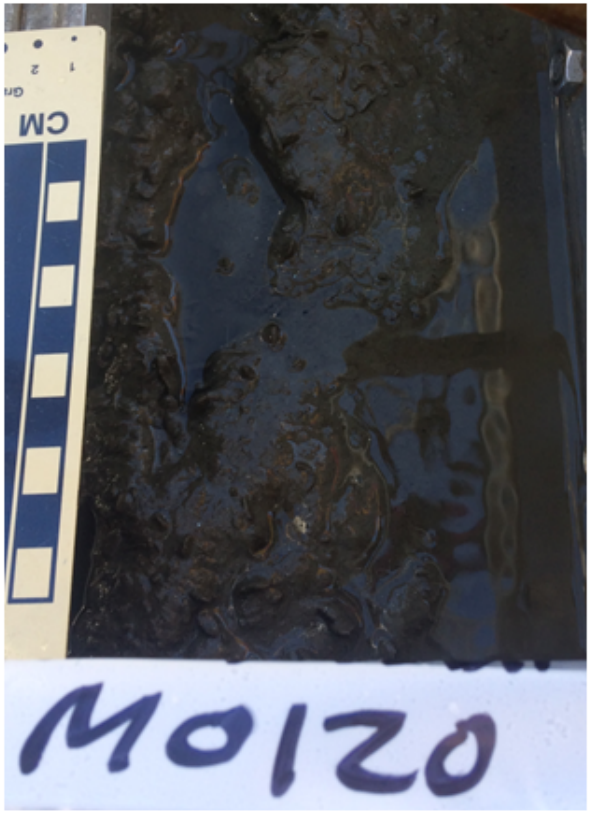
| | |
|---|---|
| Sample ID: | M0117 |
| Date/Time (EST): | 10/05/16 08:25 |
| Depth (real-time, m): | 44.4 |
| Easting (WGS84 UTM Zone 19N, m): | 424130 |
| Northing (WGS84 UTM Zone 19N, m): | 4837446 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

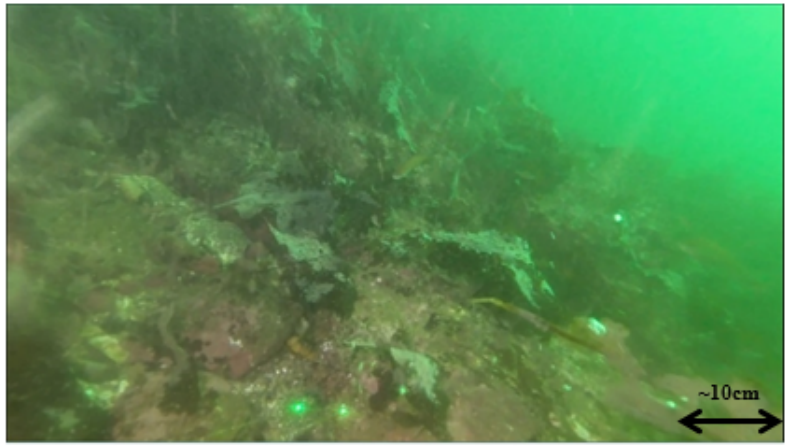
| | |
|---|---|
| Sample ID: | M0118 |
| Date/Time (EST): | 10/05/16 08:39 |
| Depth (real-time, m): | 13.9 |
| Easting (WGS84 UTM Zone 19N, m): | 424664 |
| Northing (WGS84 UTM Zone 19N, m): | 4836784 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

| | |
|---|---|
| Sample ID: | M0119 |
| Date/Time (EST): | 10/05/16 08:52 |
| Depth (real-time, m): | 30.2 |
| Easting (WGS84 UTM Zone 19N, m): | 426115 |
| Northing (WGS84 UTM Zone 19N, m): | 4834993 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sandy mud |  |

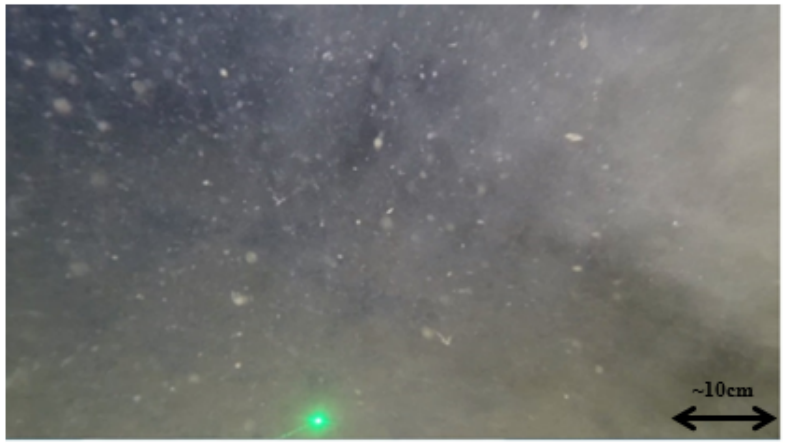
| | |
|---|---|
| Sample ID: | M0120 |
| Date/Time (EST): | 10/05/16 09:03 |
| Depth (real-time, m): | 38.1 |
| Easting (WGS84 UTM Zone 19N, m): | 426856 |
| Northing (WGS84 UTM Zone 19N, m): | 4837193 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** bedrock outcrop / rocky | **NO SAMPLE RECOVERED** |

| | |
|---|---|
| Sample ID: | M0121 |
| Date/Time (EST): | 10/05/16 09:22 |
| Depth (real-time, m): | 13.7 |
| Easting (WGS84 UTM Zone 19N, m): | 428981 |
| Northing (WGS84 UTM Zone 19N, m): | 4837064 |

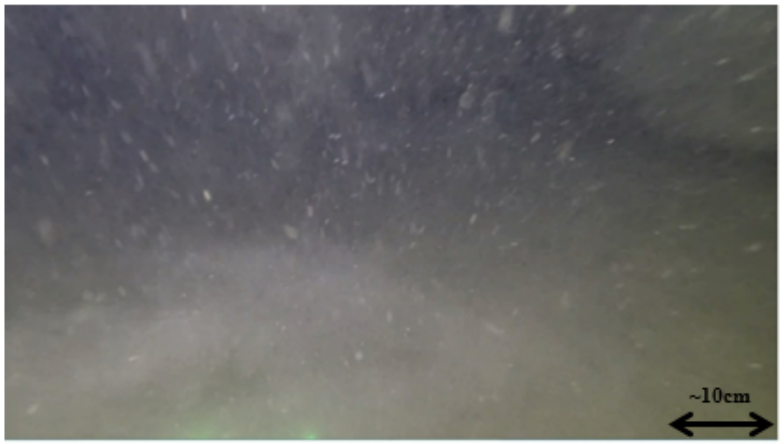
| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sand |  |

| | |
|---|---|
| Sample ID: | M0122 |
| Date/Time (EST): | 10/05/16 09:36 |
| Depth (real-time, m): | 26.2 |
| Easting (WGS84 UTM Zone 19N, m): | 431289 |
| Northing (WGS84 UTM Zone 19N, m): | 4837079 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** mud |  |

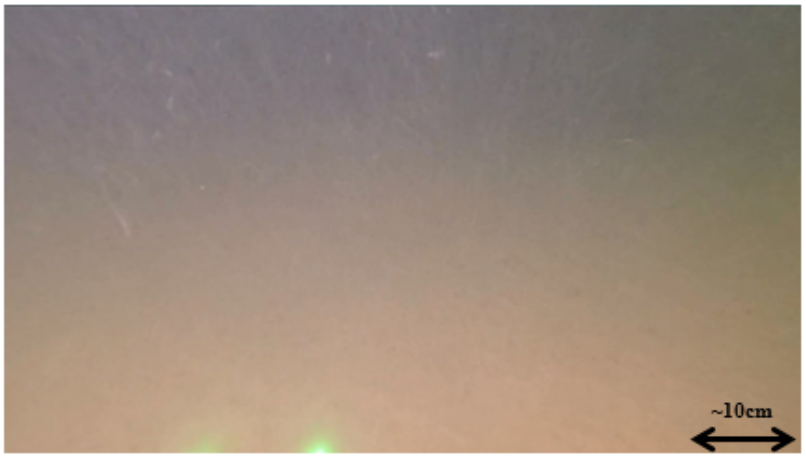
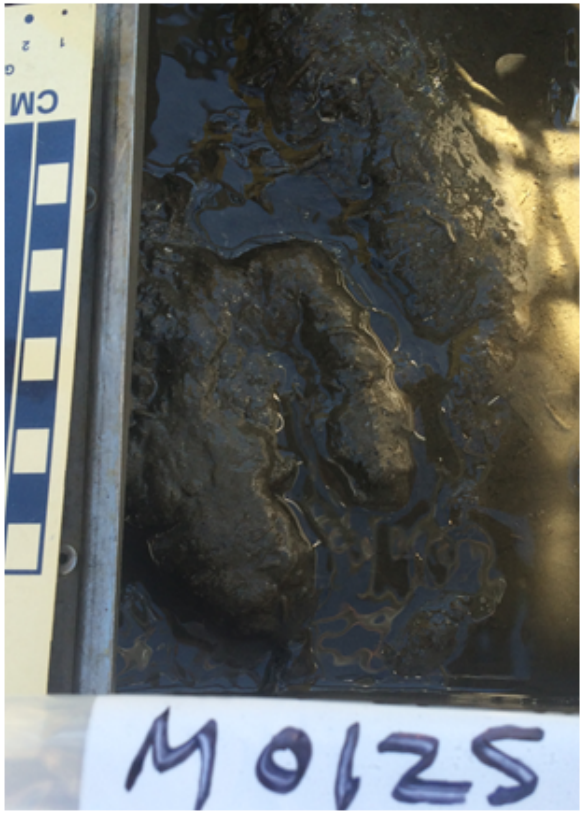
| | |
|---|---|
| Sample ID: | M0123 |
| Date/Time (EST): | 10/05/16 09:59 |
| Depth (real-time, m): | 28.7 |
| Easting (WGS84 UTM Zone 19N, m): | 433415 |
| Northing (WGS84 UTM Zone 19N, m): | 4837650 |

Maine Coastal Mapping Initiative

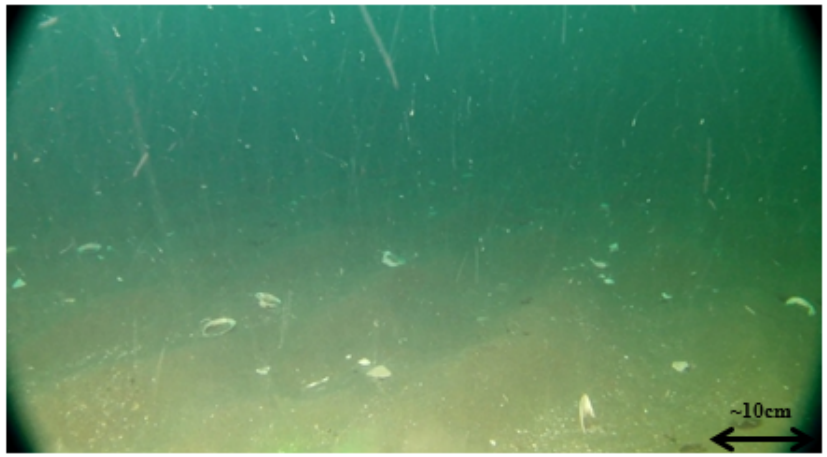
| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sandy mud |  |

| | |
|---|---|
| Sample ID: | M0124 |
| Date/Time (EST): | 10/05/16 10:14 |
| Depth (real-time, m): | 22.7 |
| Easting (WGS84 UTM Zone 19N, m): | 433825 |
| Northing (WGS84 UTM Zone 19N, m): | 4838881 |

Maine Coastal Mapping Initiative

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** sandy mud |  |

| | |
|---|---|
| Sample ID: | M0125 |
| Date/Time (EST): | 10/05/16 10:35 |
| Depth (real-time, m): | 33.2 |
| Easting (WGS84 UTM Zone 19N, m): | 437201 |
| Northing (WGS84 UTM Zone 19N, m): | 4838606 |

| Still Image from Video | Field Picture |
|---|---|
|  Distance between lasers (green dots) = 10 cm<br><br>**Substrate Type:** Medium-Coarse Sand*<br>(*textural field description only; no GSA) |  |

| | |
|---|---|
| Sample ID: | M0126 |
| Date/Time (EST): | 11/14/16 08:41 |
| Depth (real-time, m): | 36.1 |
| Easting (WGS84 UTM Zone 19N, m): | 432002 |
| Northing (WGS84 UTM Zone 19N, m): | 4833820 |