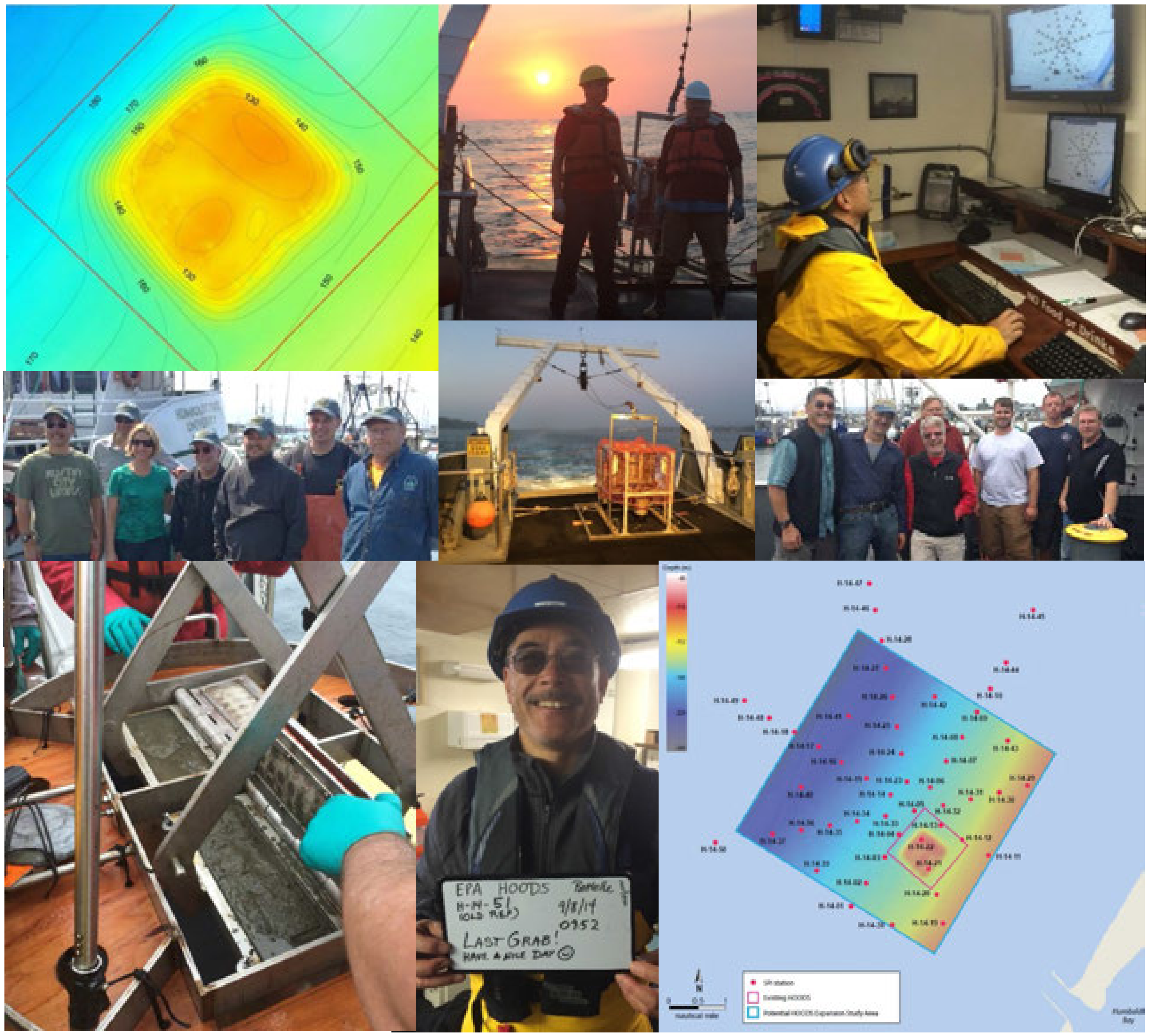
Humboldt Open Ocean Disposal Site (HOODS)
2008 and 2014 Monitoring
SYNTHESIS REPORT



Prepared by

U.S. EPA Region 9
Dredging & Sediment Management Team
San Francisco, CA

September 2016

Table of Contents

EXECUTIVE SUMMARY ii

1. **INTRODUCTION AND BACKGROUND** 1
   - 1.1 HOODS Designation 1
   - 1.2 Historic Disposal Volumes 4
   - 1.3 Mounding at HOODS 5

2. **2008 SITE MONITORING** 10
   - 2.1 2008 Sediment Physical and Chemical Monitoring 12
   - 2.2 2008 Benthic Infaunal Community Monitoring 12

3. **2014 SITE MONITORING** 17
   - 3.1 2014 Monitoring Goals and Objectives 17
   - 3.2 2014 Multibeam Echo Sounder Survey 19
   - 3.3 2014 Sediment Profile Imaging and Plan View Photography Survey 22
   - 3.4 2014 Sediment Chemistry and Infaunal Community Survey 34
     - 3.4.1 2014 Sediment chemistry results 37
     - 3.4.2 2014 Benthic community analysis results 37

4. **COMPARISON TO BASELINE CONDITIONS** 46
   - 4.1 Physical Conditions 47
   - 4.2 Biological Community 47
     - 4.2.1 Infaunal community 47
     - 4.2.2 Benthic fish and macroinvertebrates 49
   - 4.3 Discussion 49

5. **CONCLUSIONS AND RECOMMENDATIONS** 54

6. **REFERENCES** 56

APPENDICES

- A: Sediment Sampling Station Coordinates for the HOODS Monitoring Surveys, 2008 59
- B: Benthic Invertebrate Taxa and Counts from the HOODS Study Area, 2008 61
- C: Sediment Sampling Station Coordinates for the HOODS Monitoring Surveys, 2014 67
- D: Benthic Invertebrate Taxa and Counts from the HOODS Study Area, 2014 69

Table of Contents, continued

FIGURES

1. General location of the Humboldt Open Ocean Disposal Site (HOODS, red box) 2
2. Detail of HOODS, showing the four quadrants and 36 individual cells 3
3. Shaded relief depiction of MBES survey results showing mounding at HOODS 6
4. Map of HOODS disposal cells overlain on MBES survey of the mound 7
5. Open and closed disposal cells at HOODS starting in 2015 9
6. Locations of actual disposal events at HOODS in 2015 10
7. Sediment sampling stations occupied in the 2008 EPA monitoring survey 11
8. Density (organisms/m2, Panel A) and Richness (# of taxa, Panel B) of infaunal organisms captured around HOODS in 2008 16
9. 2008 infaunal organism density and richness around HOODS by depth (Panels A and B) and by location south to north at the same depth (Panels C and D) 18
10. Sampling grid for the 2014 EPA monitoring and baseline surveys at HOODS 20
11. Surface sediment physical classification in and surrounding HOODS, 2014 21
12. SPI/PVP camera system being deployed from the Coral Sea in 2014 22
13. Schematic of deployment and collection of plan view and sediment profile photographs 23
14. Soft-bottom benthic community response to physical disturbance (top panel) or organic enrichment (bottom panel) 24
15. Planned (black triangles) vs actual sample locations in and around HOODS in 2014 25
16. Plan view images showing typical views of the seafloor on and around HOODS in 2014 27
17. SPI (cross-sectional) images showing typical native seafloor sediments near HOODS in 2014 28
18. SPI (cross-sectional) images of dredged sand on top of the mound at HOODS in 2014 29
19. Average penetration depths of the SPI camera throughout the expanded study area at HOODS in 2014 30
20. Maximum bioturbation depths in sediments throughout the expanded study area at HOODS in 2014 31
21. SPI-based “footprint map” of the dredged material deposit at HOODS in 2014 32
22. Infaunal community successional stages across the study area around HOODS in 2014 33
23. Double Van Veen sediment grab sampler being deployed from the Coral Sea 35
24. Subsampling from one side of the Van Veen grab, for sediment chemistry 36
25. Processing a sediment sample for benthic community analysis, on the Coral Sea 36
26. Density (Panel A), richness (Panel B), and diversity (Panel C) of infaunal organisms captured at each station around HOODS in 2014 42
27. 2014 infaunal organism density and richness around HOODS by depth (Panels A and B) and by location south to north at similar depths (Panels C and D) 44
28. Infaunal organism density and richness around HOODS in the same depth range Sampled in both 2008 and 2014, by depth (Panels A and B) and by location south to north (Panels C and D) 45

Table of Contents, continued

FIGURES, continued

29. Locations of alternative ocean disposal sites evaluated for the HOODS site designation EIS 46
30. Sediment and benthic community sampling stations (solid red squares) evaluated in the HOODS baseline studies, 1989-1990 48
31. Benthic infaunal community differences sorted by depth, identified during the HOODS baseline studies in 1989-1990 50
32. Demersal fish trawl transects sampled as part of the HOODS baseline surveys in 1989 (Panel A) and 1990 (Panel B) 51
33. Abundance versus depth for smelt and all other fishes collected during demersal fish trawls conducted as part of the HOODS baseline surveys in 1989-1990 52
34. Abundance vs depth for flatfish species collected during demersal fish trawls conducted as part of the HOODS baseline surveys in 1989-1990 52
35. Abundance versus depth for decapod crustaceans (chiefly shrimp and Dungeness crab) collected during trawls conducted during the HOODS baseline surveys in 1989-1990 53

TABLES

1. Disposal volumes at HOODS since designation in 1995 4
2. Remaining capacity per disposal cell at HOODS, to three different mound depths in August, 2014 8
3. Summary of sediment physical and chemical composition at and in the vicinity of HOODS in 2008 13-14
4. Abundance of benthic infauna collected from stations inside (orange) and outside (blue) the HOODS boundary in 2008 16
5. Sediment physical and chemical composition at and in the vicinity of HOODS in 2014 38-39
6. Averages and ranges of sediment physical and chemical parameters at “Inside vs “Outside” sampling stations in 2014 40
7. Summary of the dominant (5 most abundant) taxa in each major group of benthic invertebrates collected around HOODS in 2014 41
8. Summary of benthic invertebrates collected around HOODS in the 1989-1990 baseline survey 48

SYNTHESIS REPORT: 2008 and 2014 Monitoring of the Humboldt Open Ocean Disposal Site (HOODS)

EXECUTIVE SUMMARY

In July, 1995, the Environmental Protection Agency (EPA) published a final Environmental Impact Statement (EIS) recommending that a new "permanent" ocean disposal site for dredged material be designated offshore of Humboldt Bay near Eureka, California. On September 28, 1995 EPA published a Final Rule designating the Humboldt Open Ocean Disposal Site (HOODS) (EPA, 1995). The EIS included a Site Management and Monitoring Plan (SMMP) providing guidance on use of the new disposal site. SMMPs are intended to be updated approximately every 10 years. In 2006, EPA updated the SMMP for HOODS (EPA, 2006) based on bathymetric surveys which showed mounding at the site. These surveys are conducted annually by the US Army Corps of Engineers (USACE), the primary user of the HOODS. EPA then conducted more extensive physical, chemical, and biological monitoring at and in the vicinity of the HOODS in 2008 using the EPA oceanography vessel the R/V BOLD. Although the 2008 monitoring confirmed that there were no significant chemical impacts from disposal, and that the benthic community surrounding the site was healthy, by that time substantial mounding of dredged material was obvious at the site. EPA therefore intensified the management of individual disposal events, in conjunction with annual bathymetric surveys, in order to minimize further mounding and extend the useful life of the site. Each year as needed, individual "cells" within the disposal site were closed, leaving fewer and fewer cells over time available for ongoing disposal operations.

In 2014, EPA conducted the most intensive monitoring of the HOODS and its surrounding area since the original site designation baseline surveys. This monitoring was intended to serve as the basis for updating the SMMP again as appropriate, and included a high-resolution multibeam bathymetric survey, sediment profile and plan view imaging, and sediment grain size, chemistry, and benthic community sampling. However, the 2014 monitoring also sampled an expanded area to the west and north of HOODS, to support the possibility of expanding the size of HOODS in the future. (Site expansion requires a separate formal rulemaking process; updating the SMMP alone would not expand the site.)

The results of both the 2008 and 2014 monitoring of HOODS are presented in this report. It is clear that the bulk of dredged material discharged at HOODS in the last decade or more has been deposited properly within the site boundaries. There are minor and localized physical impacts from dredged material disposal, as expected, but there has been no significant contaminant loading and no significant adverse impacts are apparent to the benthic environment outside of the site boundaries. It therefore appears that the EPA/USACE pre-disposal sediment testing program, coupled with a strict site management approach, has protected HOODS and its environs from adverse chemical or biological impacts. However, mounding of dredged material (primarily due to the large volumes of clean sand dredged annually from the Humboldt Bay Entrance Channel) has resulted in the site, as it is currently configured, effectively reaching capacity. Continuation of the past management approach would result in additional mounding that could eventually affect the local wave climate, particularly during large storm events. This in turn could at times adversely affect navigation safety for vessels entering and leaving this important harbor of refuge. Unless and until beneficial reuse options increase for sediments dredged from the Humboldt area, the need for ongoing disposal of similar quantities of dredged material (particularly entrance channel sand) must be anticipated. It is therefore recommended that expansion of HOODS be pursued, and that management of ongoing disposal occur under an updated SMMP.

1. INTRODUCTION AND BACKGROUND

Ocean dredged material disposal sites (ODMDS) around the nation are designated by the Environmental Protection Agency (EPA) under authority of the Marine Protection, Research and Sanctuaries Act (U.S.C. 1401 et seq., 1972) and the Ocean Dumping Regulations at 40 CFR 220-228. Disposal site locations are chosen to minimize cumulative environmental effects of disposal to the area or region in which the site is located, and disposal operations must be conducted in a manner that allows each site to operate without significant adverse impacts to the marine environment. Many ocean disposal sites are located near major ports, harbors, and marinas and are very important for maintaining safe navigation for commercial, military, and private vessels.

EPA and the US Army Corps of Engineers (USACE) share responsibility for managing ocean disposal of dredged sediments. First, there is a pre-disposal sediment testing program that is jointly administered by the agencies to ensure that only clean (non-toxic) sediments are permitted for ocean disposal. EPA must concur that sediments meet ocean dumping suitability requirements, and that there are no feasible alternatives to ocean disposal such as beneficial reuse of the sediments, before USACE can issue a permit for or other authorize ocean disposal. Post-disposal site monitoring then allows EPA and USACE to confirm the environmental protectiveness of the pre-disposal testing. The agencies also jointly manage the ocean disposal sites themselves. All sites are operated under a site management and monitoring plan (SMMP), and the Agencies cooperate on updating the SMMPs if needed, based on the results of periodic site monitoring. Finally, EPA is also responsible for enforcement of potential ocean dumping violations at each site.

The site use requirements in SMMPs for each specific ODMDS can be based on any issues of concern identified in the original site designation environmental impact statement (EIS) or environment assessment (EA), and/or on the results of subsequent (post-disposal) monitoring. Each SMMP typically incorporates a compliance monitoring component to ensure that individual disposal operations are conducted properly (for example, that material is not dumped outside the site, or leaked or spilled during transit to the site), as well as a requirement for periodic monitoring surveys to confirm that the site is performing as expected and that long term adverse impacts are not occurring.

1.1 HOODS Designation

The Humboldt Open Ocean Disposal Site (HOODS) was designated by EPA as a permanent ocean disposal site in 1995. It is located between approximately 3 and 4 nautical miles offshore of the entrance to Humboldt Bay (Figure 1), in water depths ranging from about 150 to 180 feet (45-55 m). It is a square ocean disposal site, covering 1 square nautical mile (nmi) on the sea floor, with its four corners located at the following coordinates (NAD 83):

40° 48' 24" N by 124° 16' 22" W
40° 49' 03" N by 124° 17' 22" W
40° 48' 17" N by 124° 18' 13" W
40° 47' 38" N by 124° 17' 13" W

Although the overall site is 1 square nmi in size, it is divided into 4 equal-size quadrants which are in turn each divided into 9 individual disposal “cells” (for a total of 36 cells) (Figure 2). All disposal actions must take place within particular cells inside the site, as specified in individual permits.

Figure 1. General location of the Humboldt Open Ocean Disposal Site (HOODS, red box), in relation to the City of Eureka, California, Humboldt Bay, and the three-mile limit. (Map source: NOAA chart 18620.)

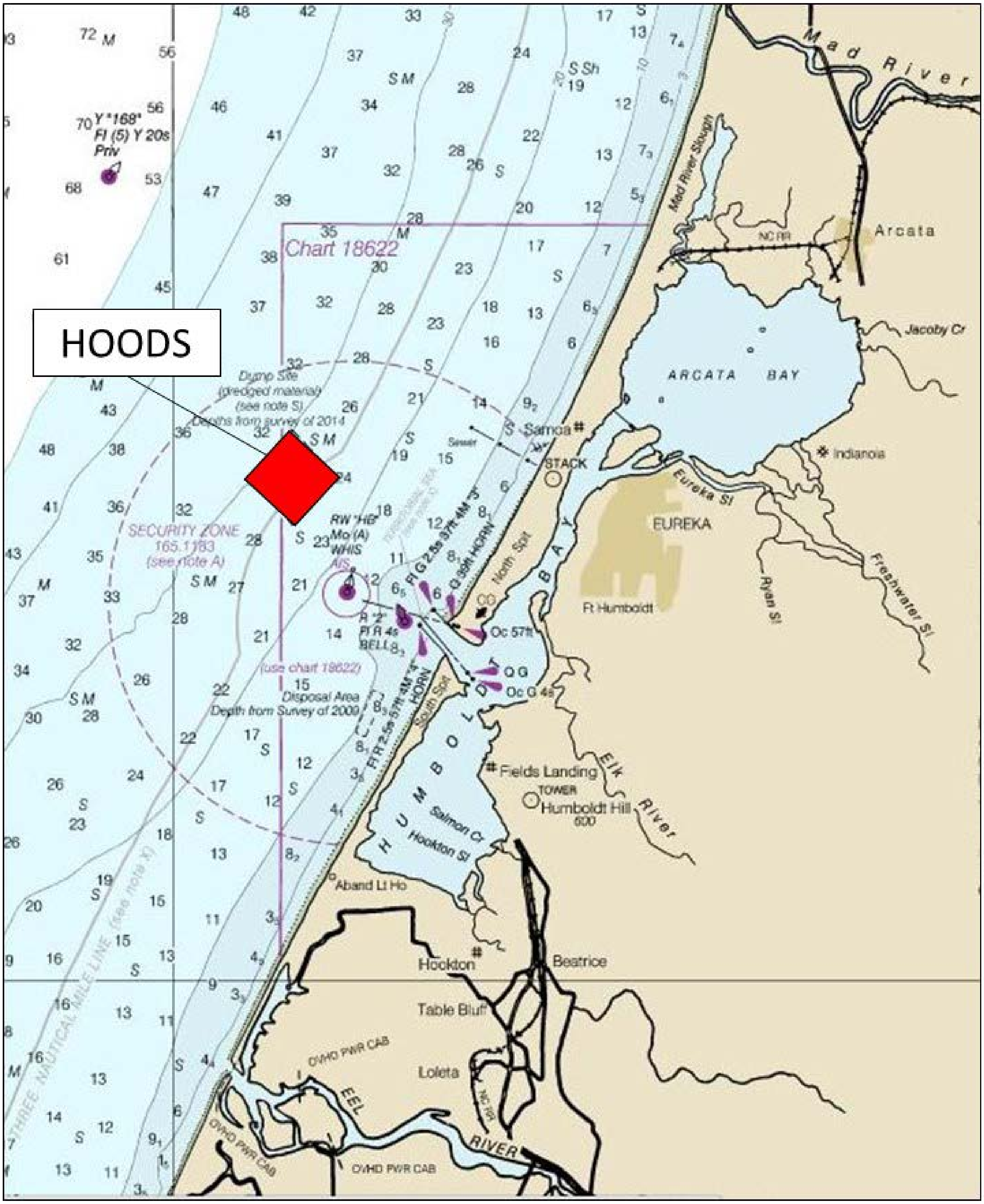
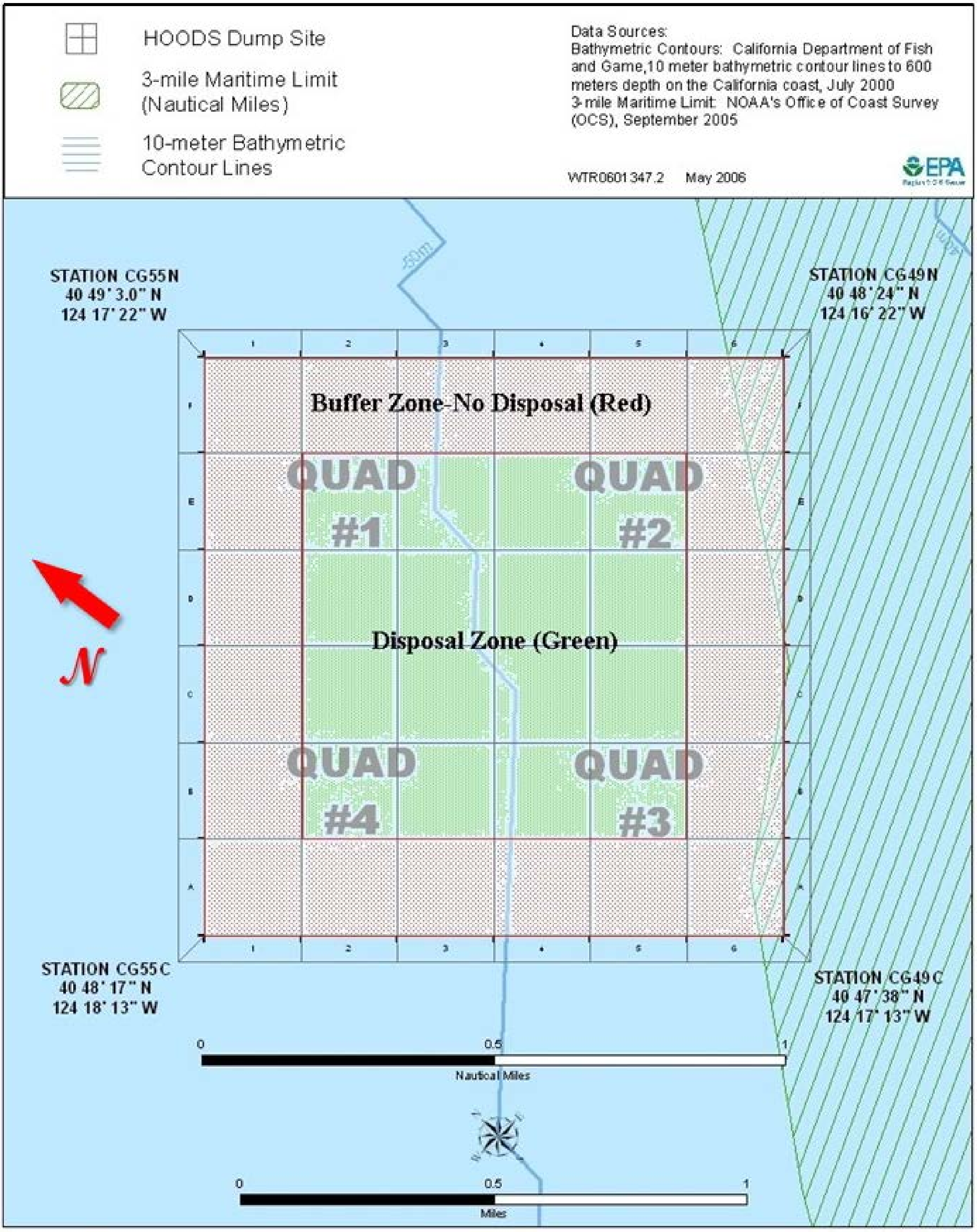


Figure 2. Detail of HOODS, showing the four quadrants and 36 individual cells within the overall site. In general, disposal is only allowed in specified internal cells within the "Disposal Zone" (16 green cells), and not in the 20 red "Buffer Zone" cells.



The 1995 EIS and site designation reflected a design capacity of 50 million cubic yards (cy) of dredged material and a 50 year life of the site. Presuming that no material dispersed away from the site, 50 million cy of sediment, evenly distributed across the site, would result in a mound averaging 36 feet (11 m) thick (EPA, 1995). Starting from an average water depth of approximately 165 feet (50 m), the top of the mound, at site capacity, would be estimated to be at approximately 130 feet (40 m). This was considered to be an acceptable mound height, because large winter waves would not be expected to interact significantly with bottom sediments below this depth. (At shallower depths, larger waves could interact with the bottom sufficiently to begin to transport or erode finer sediments from the site). If the mound were to grow substantially above this depth, wave interaction with the bottom would become more and more significant, until at some point larger waves could be influenced by the site and become a navigation hazard. EPA's management goal for mounding at HOODS has therefore been to carefully manage individual disposal operations in order to keep the mound height as even as possible across the site, and to keep it below approximately 130 feet.

1.2 Historic Disposal Volumes at HOODS

From 1990-1994, 2.58 million cy of material was disposed at the "interim" HOODS site (EPA, 1995). Disposal volumes at HOODS since its designation in 1995 are summarized in Table 1. In the 21 years since site designation, there has been a total of approximately 24 million cy of dredged material disposed at HOODS. The vast majority of this material has come from USACE's annual maintenance dredging of the federal channels serving Humboldt Bay and the City of Eureka waterfront facilities. In addition, in 1999 and 2000 USACE deepened the federal channels, generating over 4 million cy of sediments that were also disposed at HOODS. Approximately 300,000 cy of suitable material from Crescent City, CA were disposed in 2011 and 2013, following the tsunami that hit the west coast in 2011. Most of the material placed at HOODS has been sand from the Humboldt Bay entrance channel. Sand would not be expected to disperse at the depth of HOODS, and indeed this material has largely remained in place (see Section 1.3, below).

Table 1. Disposal volumes at HOODS since designation in 1995. All volumes are from federal channel maintenance ("O&M") dredging, except * = deepening project volume, and **= post-tsunami material from Crescent City. (Source: USACE 2006 and 2015; EPA records.)

Year	Volume Disposed (cy)	Year	Volume Disposed (cy)
1995	281,145	2006	1,175,584
1996	634,631	2007	1,274,822
1997	562,231	2008	1,311,658
1998	260,687	2009	1,062,737
1999	416,642	2010	553,278
1999-2000*	4,339,232	2011-2013**	301,210
2000	712,910	2011	1,320,279
2001	1,287,155	2012	1,182,620
2002	1,204,210	2013	674,928
2003	1,794,555	2014	432,490
2004	1,368,276	2015	715,296
2005	1,130,473	**Total**	**23,997,049**
		Average O&M/Yr	**921,743**

1.3 Mounding at HOODS

HOODS was originally sized for 50,000,000 cy over a 50-year period, or an average disposal rate of approximately 1 million cy/year. As of 2015, approximately 24 million cy had been disposed in 21 years (an average of 921,743 cy per year not including the one-time channel deepening, a rate very similar to that forecast in the EIS). However, mounding has been more pronounced than expected. Although the EIS predicted that the mound top would reach a depth of 130 feet after 50 years and 50 million cy of disposal, in practice the mound at HOODS has reached this depth much sooner. The main reason is that dredged material has not been allowed to be disposed across the entire site. In order to contain the majority of the dredged material deposit within the overall site boundaries, disposal vessels were always required to discharge only within the 16 interior cells (the green "Disposal Zone" shown in Figure 2), which represents just over 44 percent of the area of the overall site, while discharge was prohibited in the 20 cells abutting the site boundaries (the red "Buffer Zone" in Figure 2).

Annual bathymetric surveys at HOODS indicated that mounding to -130 feet had occurred in small portions of the site by the early 2000s. Consequently, in 2005 EPA closed two interior cells (B4 and C4), and required that ongoing disposal occur sequentially among the remaining 14 interior cells (rather than repeatedly in any one cell). However, mounding continued rapidly in the following years forcing EPA to actively managed disposal within the site each year. In 2008, EPA closed two additional interior cells (D3 and D4), leaving only 12 interior cells available for continued disposal. In 2011, three cells were closed to disposal (C4, D3, and D4), and in 2012 four cells at the center of the site (C3, C4, D3, and D4) were closed. In 2013 and 2014, 6 interior cells were closed (C3, C4, D3, D4, E3 and E4), leaving only 10 cells available for disposal.

A high-resolution multibeam echo sounder (MBES) survey was conducted in late August, 2014, immediately in advance of the major site monitoring surveys described in Section 3 below. The status of mounding at HOODS as of late 2014, as determined by the MBES survey, is shown on Figure 3. Figure 4 shows an overlay of the individual cells in relation to the mound. Table 2 lists the remaining capacity of each cell (both Buffer Zone cells and interior disposal cells) to three different design depths (-125 feet, -130 feet, and -135 feet MLLW).

As shown in Table 2, after 2014 there was still theoretically capacity for over 26 million cy of additional disposal at HOODS before the maximum desired mound elevation of -130 feet would be reached uniformly across the site. However, this would require disposal throughout all the Buffer Zone cells, which would result in significant accumulation outside the disposal site boundaries from the slopes of the mound. Without using Buffer Zone cells, the available disposal capacity of the 16 interior cells was only about 2.5 million cy. This remaining volume could only accommodate approximately 2 years of typical USACE entrance channel maintenance dredging, so without a change in management of the site, HOODS was effectively at capacity.

Therefore, beginning in 2015, EPA started allowing limited disposal in portions of some Buffer Zone cells in order to prolong the useful short-term life of the existing site. As shown in Figure 5, half the area of eight Buffer Zone cells over the north and west slopes of the existing mound are now available for disposal. Figure 6 shows successful placement in the modified cells in 2015, despite their each being only ½ the size of the original disposal cells. Use of the north and west side slopes and ½ the area of these Buffer Zone cells is expected to retain the majority of the dredged material within the overall boundaries of the existing site, while increasing short-term capacity by approximately 5.5 million cy, to a total of 8 million cy. This capacity should be sufficient for approximately five years, and in the meantime, a site expansion proposal can be prepared and acted upon.

Figure 3. Shaded relief depiction of MBES survey results showing mounding at HOODS as of August, 2014. Red box is the existing disposal site boundary. Depth contours are labeled in feet MLLW. (Reproduced from eTrac, 2014.)

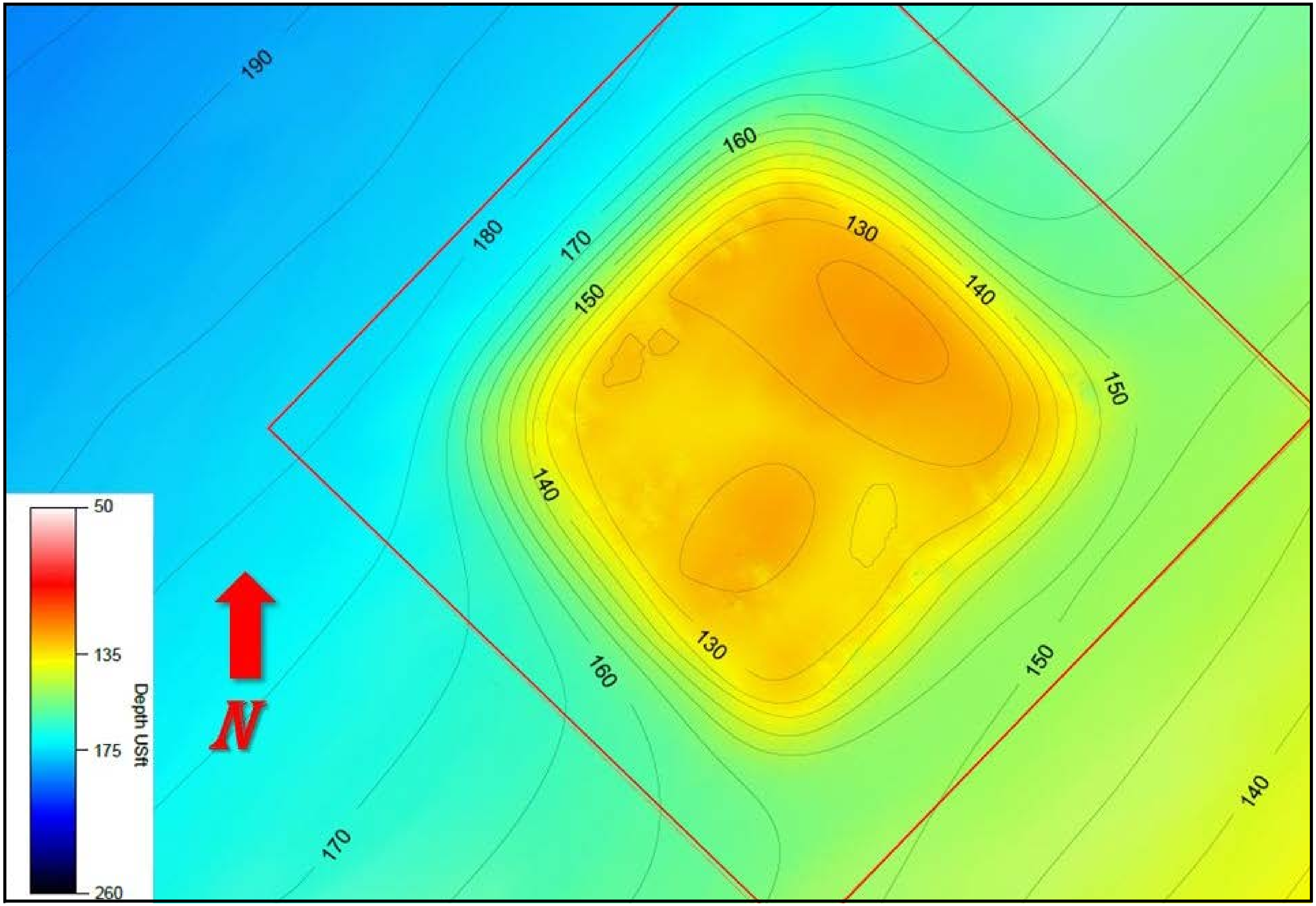


Figure 4. Map of HOODS disposal cells overlain on MBES survey of the mound, as of August, 2014. Until 2015, disposal vessels were required to discharge material only in the interior cells. Perimeter cells were used as a buffer for spreading, to ensure that most dredged material would be deposited on the seafloor within the overall site boundary. Depth contours are in feet MLLW. (Reproduced from eTrac, 2014.)

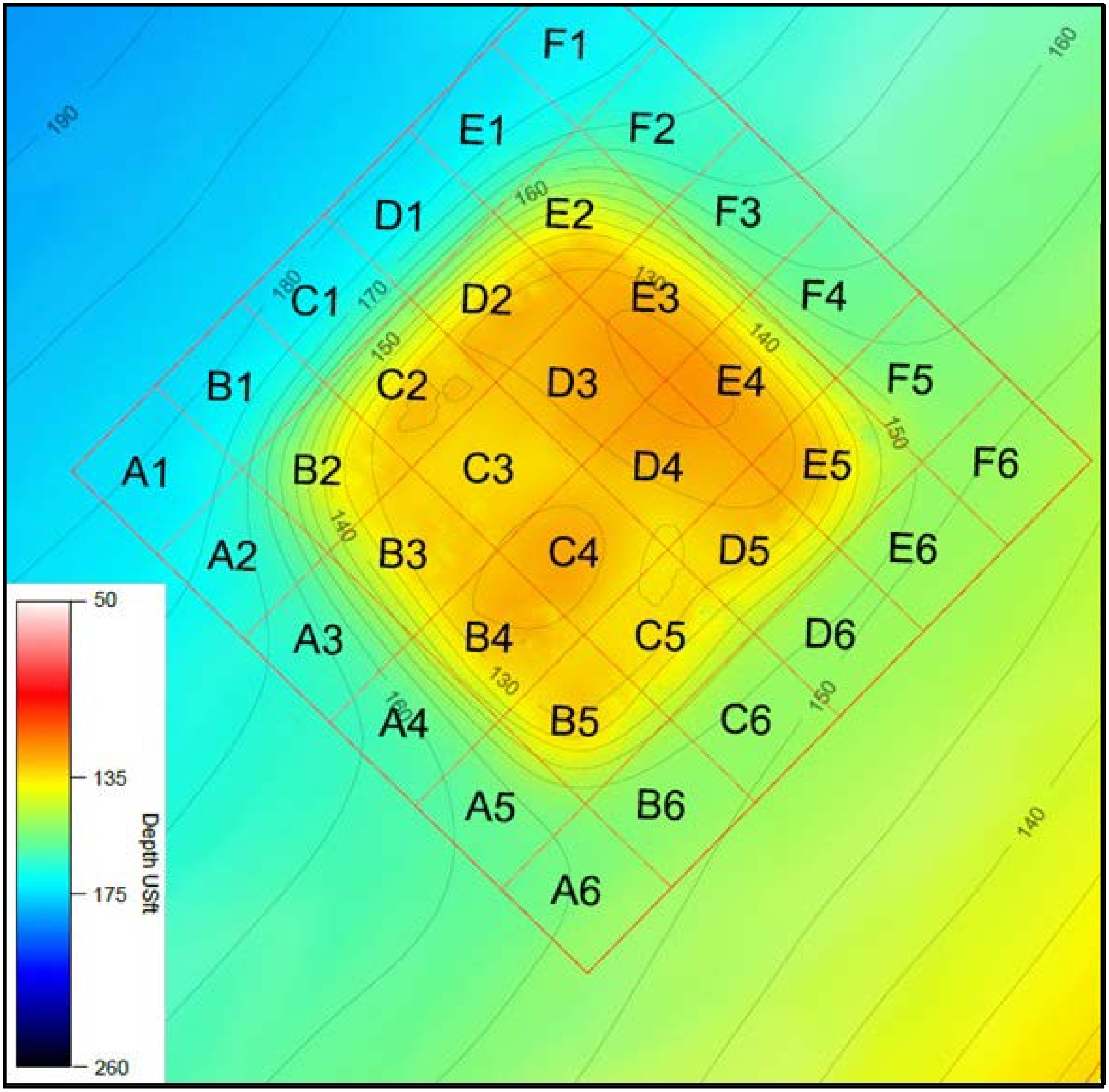


Table 2. Remaining capacity per disposal cell at HOODS, to three different mound depths in August, 2014. Although over 26 million cy of capacity is shown as being available from all cells combined to a mound depth of -130 feet, in reality only the 16 interior cells (highlighted in yellow) have been approved for disposal. Remaining capacity to -130 feet in these 16 interior cells was only ~2.5 million cy as of late 2014. (Modified from eTrac, 2014.)

Remaining Capacity (cy) Per Disposal Cell at HOODS, to Three Different Mound Surface Depths (mllw)			
Disposal Cell	125	130	135
A1	2,046,825	1,856,919	1,667,013
A2	1,699,347	1,509,441	1,319,535
A3	1,418,799	1,228,893	1,038,987
A4	1,250,537	1,060,631	870,725
A5	1,155,986	966,080	776,174
A6	1,120,277	930,370	740,464
B1	1,920,416	1,730,510	1,540,604
B2	689,266	508,851	362,166
B3	273,258	133,110	65,119
B4	147,448	62,860	20,698
B5	335,343	177,630	83,435
B6	982,293	792,387	602,480
C1	1,838,929	1,649,023	1,459,117
C2	323,179	206,862	129,515
C3	107,362	0	0
C4	30,936	714	0
C5	304,536	124,614	47,526
C6	927,397	737,490	547,584
D1	1,836,965	1,647,059	1,457,153
D2	303,170	202,596	127,886
D3	6,897	0	0
D4	27,922	591	0
D5	230,081	105,215	41,185
D6	910,367	720,461	530,554
E1	1,885,462	1,695,556	1,505,649
E2	684,442	524,934	384,198
E3	204,107	124,825	66,495
E4	170,257	96,672	45,991
E5	350,810	216,546	115,063
E6	918,294	728,388	538,482
F1	1,977,076	1,787,170	1,597,264
F2	1,634,988	1,445,081	1,255,175
F3	1,386,909	1,197,003	1,007,097
F4	1,221,466	1,031,560	841,653
F5	1,046,768	856,862	666,956
F6	930,482	740,576	550,669
TOTAL	**32,298,596**	**26,797,479**	**22,002,611**

Figure 5. Open and closed disposal cells at HOODS starting in 2015. Disposal is now only allowed over the north and west slopes of the mound, including in portions of eight Buffer Zone cells on those sides. The majority of the dredged material deposit is still expected to remain contained within the existing overall site boundary, while increasing effective short-term disposal capacity by approximately 5.6 million cy, to 8 million cy. (Depth contours are in feet MLLW.)

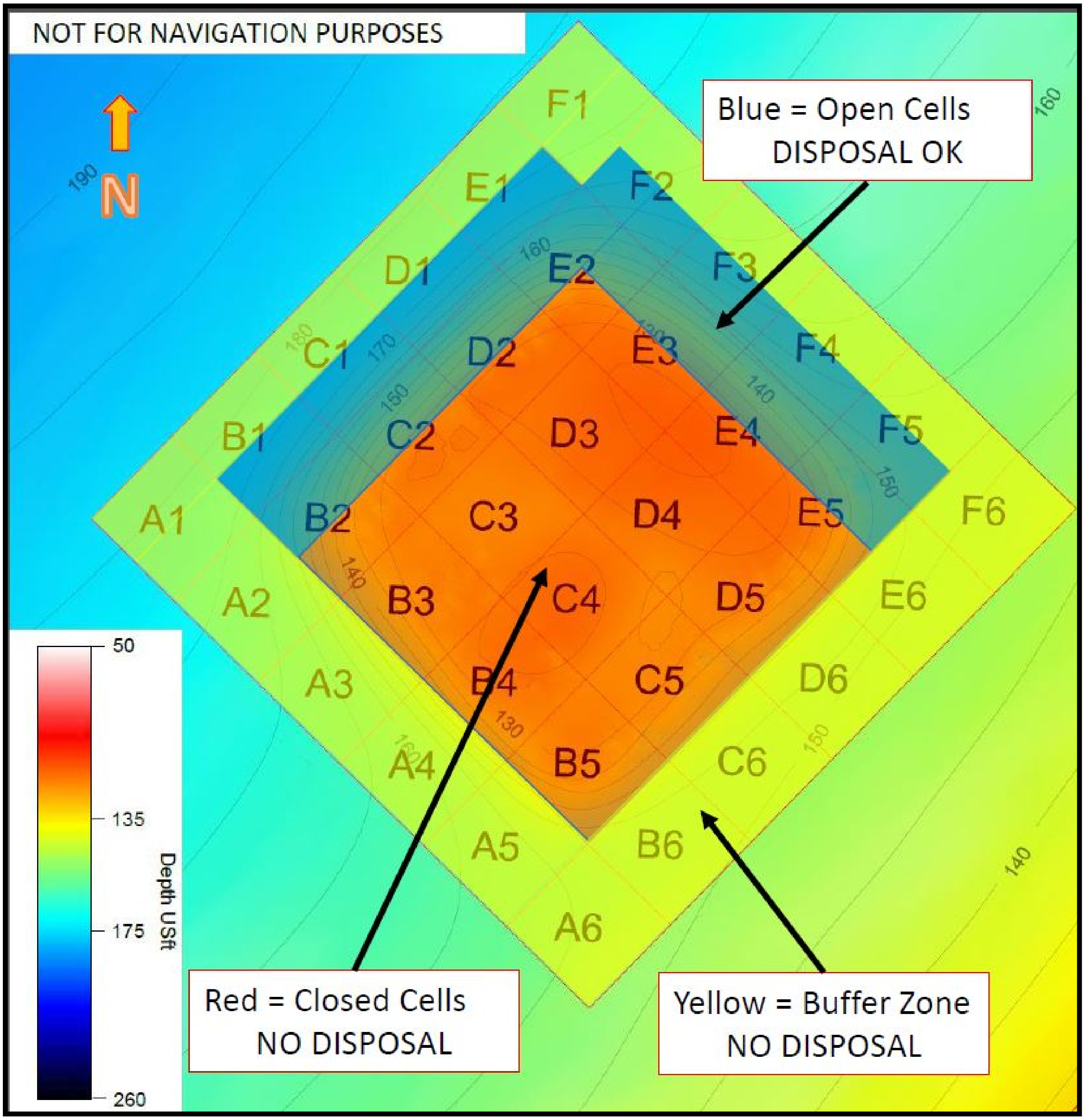
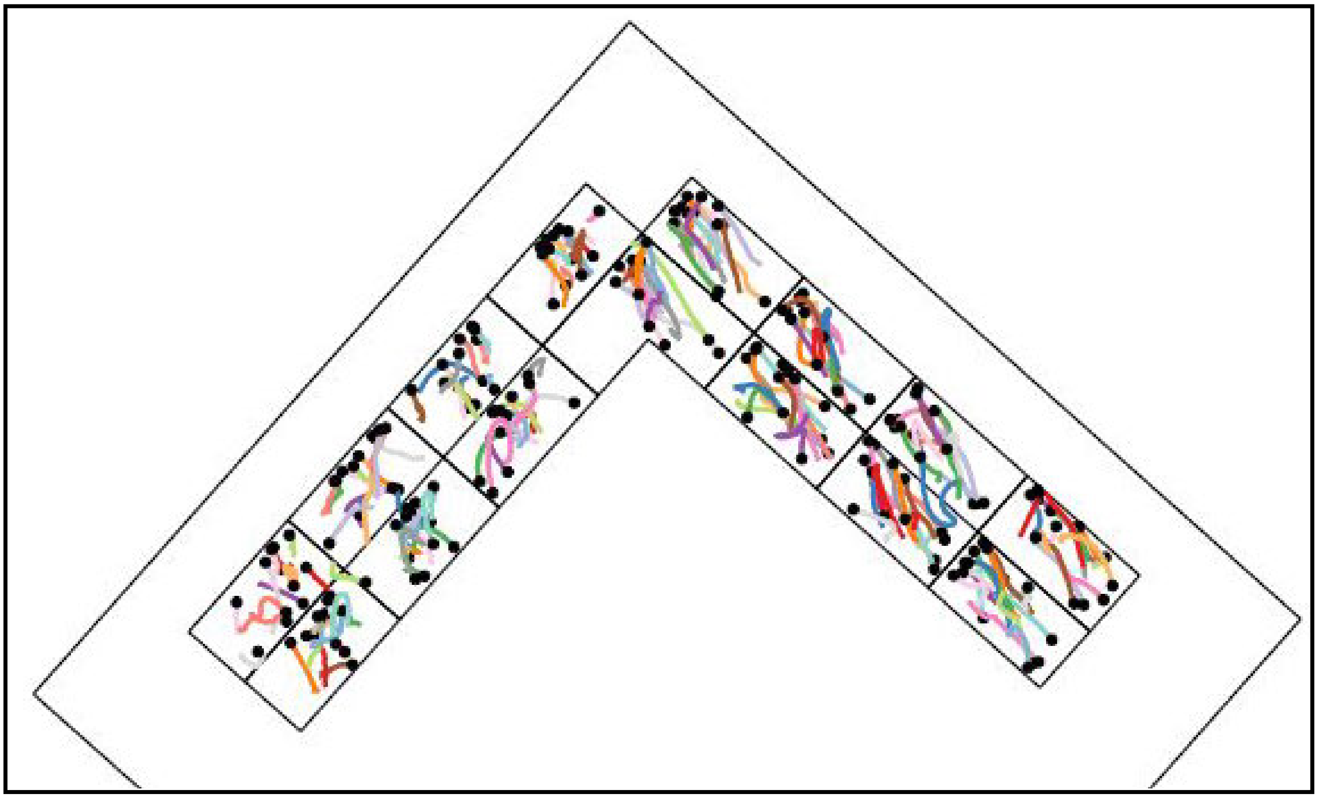


Figure 6. Locations of actual disposal events at HOODS in 2015. All disposal actions occurred successfully, entirely within the modified disposal cells, despite most of them being only ½ the size of previously-allowed disposal cells. Dots with lines show starting point and track of individual disposal events. (Source: EPA compliance records for USACE 2015 West Coast Hopper contract no. W9127N-15-C-0006.)

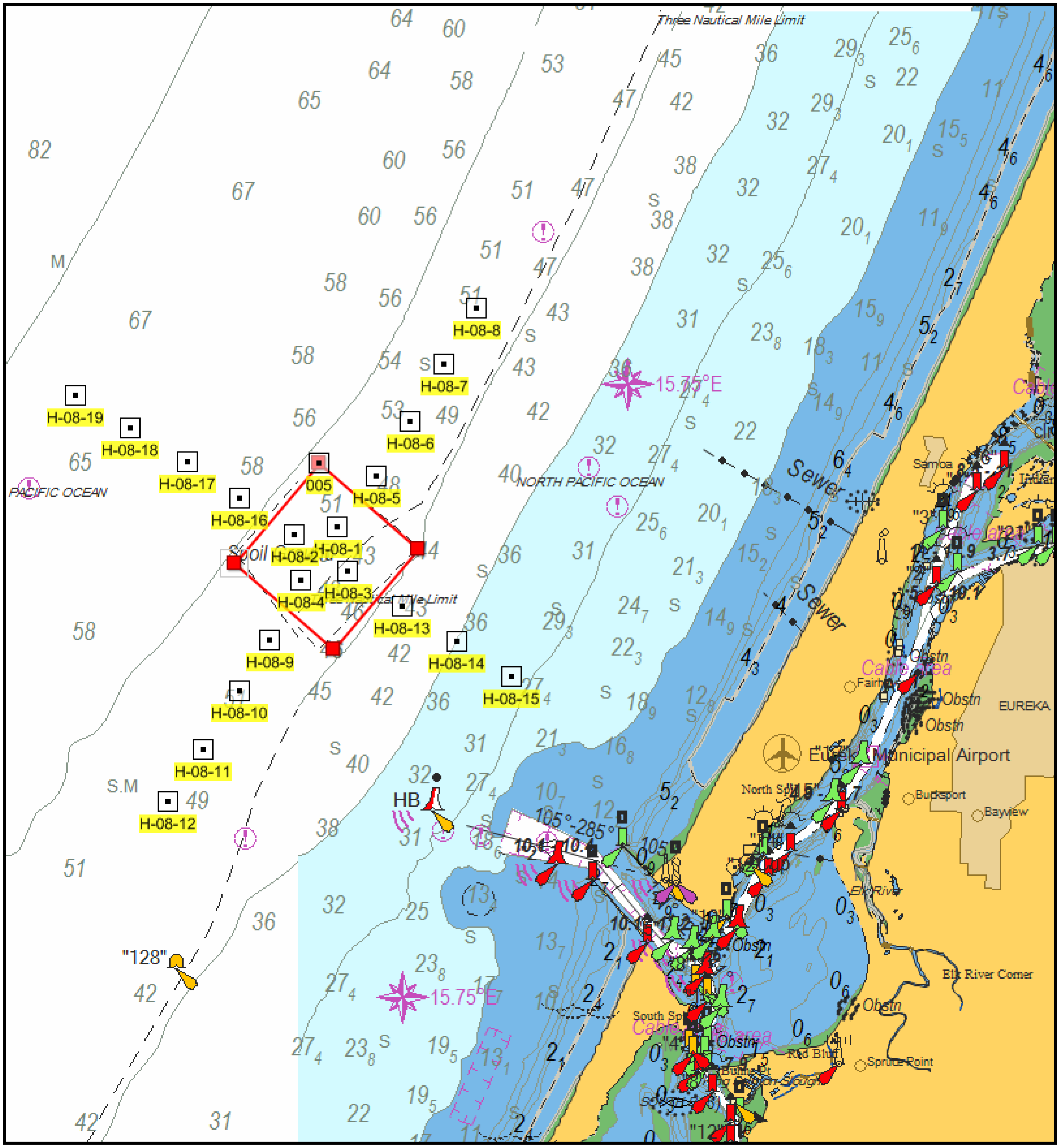


2. 2008 SITE MONITORING

Baseline surveys were conducted in the early 1990s to support the original site designation action. These are presented in Pequegnat et al. (1990) and summarized in the 1995 EIS (EPA, 1995). They are also discussed further in Section 4, below. Since then, and until 2008, the only monitoring conducted in most years had been bathymetric surveys by USACE.

EPA conducted the first comprehensive post-designation monitoring at HOODS in 2008, using the EPA vessel the R/V BOLD. Results of the 2008 monitoring are summarized in this section. The overall site management goal is that there should be only physical impacts inside the disposal site and no significant adverse impacts outside the disposal site. The purpose of the 2008 monitoring was therefore to determine whether HOODS had been performing as expected under existing site management practices by: mapping the dredged material deposit ("footprint"); confirming the sediment chemistry of disposed material; and evaluating the health of the benthic community around the disposal site. The detailed monitoring plan is provided in the 2008 Quality Assurance Project Plan (QAPP) prepared by EPA (EPA, 2008), and all monitoring activities were conducted by EPA scientists. The 2008 monitoring survey collected sediment samples from 19 stations (four stations inside the disposal site, and 15 stations outside the site for comparison) which were processed for grain size, chemistry, and benthic community analyses. Figure 7 shows the sampling stations occupied in 2008 – see Appendix A for coordinates.

Figure 7. Sediment sampling stations occupied in the 2008 EPA monitoring survey at HOODS. Surface sediment grab samples were obtained from 19 stations (4 inside the site boundary - red box) for physical, chemical, and bethic community analysis. (Map background NOAA chart 18620A, 10-19-2009 update; soundings in meters.)



2.1 2008 Sediment Physical and Chemical Monitoring

Table 3 presents the results of the physical and chemical testing for stations "Inside" vs "Outside" the disposal site boundaries in 2008. Stations inside the HOODS boundary were uniformly and predominantly sand (97%), indicative of recent disposal of entrance channel dredged material (well over 1 million cy had been disposed by USACE in the months just prior to the monitoring survey). In contrast, the native sediments outside the disposal site in a similar depth range (along a transect parallel to shore, including stations H-08-5 through H-08-12) are generally in the 30-60% sand range. Native sediments in deeper water farther offshore (H-08-16 through H-08-19) are much finer (10% sand or less). Only the native sediments in the shallowest water closest to shore (H-08-14 and H-08-15, with 88-94% sand) approached the coarseness of the dredged material within the disposal site itself.

Despite the grain size differences between the dredged material inside the site and the native sediments outside the site, sediment chemistry was quite similar across all stations. Concentrations of metals, hydrocarbons, pesticides, PCBs, and dioxin compounds were uniformly quite low. No samples exceeded NOAA's Effects Range-Low (ER-L) or Effects Range-Median (ER-M)[1] screening levels (Long et al. 1995), with the exception of nickel (which naturally exceeded the ER-M at all stations, and does not represent contamination), and chromium (which slightly exceeded the ER-L only at two "outside" stations where there was no dredged material present, and thus also does not represent contamination from disposed sediments). These results indicate that dredged material disposal at HOODS had not resulted in chemical contamination at levels of concern (or indeed to levels substantially different from background concentrations in the native sediments). This in turn indicates that the sediment sampling and testing program that EPA and USACE has required in advance of dredging to ensure that sediments are suitable for disposal at HOODS (EPA and USACE, 1991), had in fact been protective of the marine environment from adverse levels of chemical contamination.

2.2 2008 Benthic Infaunal Community Monitoring

Sediment samples from each of the 19 stations monitored in 2008 were also processed to evaluate the benthic infaunal community. The overall results are summarized in Table 4 and Figure 8, and the full counts are presented in Appendix B (MTS, 2010). A total of 9,685 organisms were collected from the 19 stations, representing 219 individual taxa. As shown in Table 4, the infaunal community was dominated by polychaetes with 6,986 individuals collected (72% of all individuals from all taxa), representing 122 taxa (55.7% of all taxa found).[2] Crustaceans were next most abundant (1,545 individuals representing 38 taxa), followed by mollusks (921 individuals representing 36 taxa). "Other" taxa included 233 individuals representing 23 species.

The four "Inside" stations (on the dredged material mound) had a relatively depauperate infaunal community, as would be expected following repeated thick depositions of sand on the mound. An average of only about 108 individuals from all taxa combined were collected from these "Inside" stations (yellow shading on Figure 8), and polychaetes (which can recolonize especially rapidly)

---

1 ER-Ls and ER-Ms represent relationships between sediment bulk chemical concentrations and toxicity effects compiled from numerous studies. The 10th percentile of ranked data is defined as the ER-L, and is considered indicative of concentrations below which adverse effects are expected to occur only rarely. The 50th percentile is identified as the ER-M, and is considered indicative of concentrations above which adverse effects are expected to frequently occur.

2 "Density" (organisms/m^2) is the same as the abundance numbers shown in Table 4 multiplied by 10, since a 0.1 m^2 sampler was used to collect the infaunal samples.

Table 3. Summary of sediment physical and chemical composition at and in the vicinity of HOODS in 2008. "Inside" stations are within the existing disposal site boundary, while "Outside" stations are outside the existing site boundary including stations along extended transects. NOAA ER-L and ER-M sediment chemistry screening values are included for comparison; results highlighted in green exceed their corresponding ER-L value, while results highlighted in yellow exceed their corresponding ER-M. (Refer to Figure 6 for location of survey stations in 2008.)

		Survey Station:											
		"Inside"				"Outside"						NOAA Screening	
Analyte	Units (dw)	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	ER-L	ER-M
Gravel	%	0.00	0.70	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--	--
Sand	%	97.50	97.60	97.30	97.50	27.50	47.50	51.80	56.30	57.40	33.10	--	--
Silt	%	1.00	0.60	0.20	1.10	66.00	46.50	41.00	34.60	37.90	62.20	--	--
Clay	%	1.50	1.00	1.30	1.40	6.50	6.00	7.20	9.10	4.70	4.70	--	--
Total Organic Carbon	%	0.16	0.12	0.14	0.14	0.53	0.43	0.38	0.43	0.54	0.55	--	--
Arsenic	mg/kg	3.9	4.1	3.9	3.6	5.1	5.4	5.2	4.8	5.1	4.5	8.2	70
Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	9.6
Chromium	mg/kg	62	52	52	57	76	74	72	80	73	70	81	370
Copper	mg/kg	13	7.7	7.1	7.5	14	11	11	12	12	14	34	270
Lead	mg/kg	4.0	3.8	3.8	4.1	5.0	4.8	4.9	4.9	5.0	4.9	46.7	218
Mercury	mg/kg	0.018	0.021	0.016	0.018	0.032	0.037	0.040	0.042	0.037	0.041	0.15	0.71
Nickel	mg/kg	56	53	55	58	79	74	71	71	79	75	20.9	51.6
Zinc	mg/kg	36	34	35	37	54	50	48	49	52	52	150	410
Dioxins - Total TEQ	ng/kg	0.003	ND	0.055	0.005	ND	ND	0.004	0.004	0.004	0.005	--	--
Total DDTs	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.58	46.1
Total Organotins	ug/kg	2	1.9	2	2	2.3	2.2	2.1	2.1	2.3	2.2	--	--
Total PAHs	ug/kg	16.5	8.5	16.1	16.7	22.6	34.3	13.4	15.4	9.7	38	4022	44792
Total PCB Congeners	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	22.7	180

"Inside" stations are both within the disposal site boundary AND on the dredged material deposit as determined by the SPI-PVP survey. "Outside" stations are both outside the site boundary AND off the dredged material deposit.

* Field duplicate sample from a separate grab taken at a different time at the same station

Table 3, continued. Summary of sediment physical and chemical composition at and in the vicinity of HOODS in 2008. "Inside" stations are within the existing disposal site boundary, while "Outside" stations are outside the existing site boundary including stations along extended transects. NOAA ER-L and ER-M sediment chemistry screening values are included for comparison; results highlighted in green exceed their corresponding ER-L value, while results highlighted in yellow exceed their corresponding ER-M. (See Figure 6 for location of survey stations in 2008.)

		Survey Station:											
		"Outside" (continued)										NOAA Screening	
Analyte	**Units (dw)**	**S-11**	**S-12**	**S-13**	**S-14**	**S-15**	**S-16**	**S-17**	**S-18**	**S-19**	**S-17 QC***	**ER-L**	**ER-M**
Gravel	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--	--
Sand	%	51.20	43.90	66.30	88.40	94.30	10.00	4.20	2.40	1.50	9.90	--	--
Silt	%	45.00	53.70	28.40	9.20	4.40	70.20	72.30	80.10	81.40	70.50	--	--
Clay	%	3.80	2.40	5.30	2.40	1.40	19.80	23.50	17.50	17.10	19.50	--	--
Total Organic Carbon	%	0.4	0.41	0.45	0.28	0.22	0.7	0.76	0.86	0.85	0.67	--	--
Arsenic	mg/kg	4.6	4.8	4.9	4.1	4.1	5.5	5.1	4.9	4.8	5.2	8.2	70
Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	9.6
Chromium	mg/kg	71	74	70	70	69	82	82	76	79	82	81	370
Copper	mg/kg	11	12	10	10	8.5	21	24	21	20	22	34	270
Lead	mg/kg	4.9	5.2	4.3	4.0	4.3	7.0	7.3	6.6	6.7	7.0	46.7	218
Mercury	mg/kg	0.046	0.044	0.036	0.047	0.028	0.063	0.050	0.054	0.056	0.051	0.15	0.71
Nickel	mg/kg	75	79	73	73	69	90	89	82	85	90	20.9	51.6
Zinc	mg/kg	52	52	49	47	43	64	66	60	64	65	150	410
Dioxins - Total TEQ	ng/kg	0.003	0.004	0.005	ND	0.002	0.672	0.651	0.007	0.007	0.428	--	--
Total DDTs	ug/kg	ND	ND	ND	ND	2.9	ND	ND	ND	ND	ND	1.58	46.1
Total Organotins	ug/kg	2.2	2.1	2.2	2.1	1.9	2.3	2.3	2.5	2.4	2.2	--	--
Total PAHs	ug/kg	31.7	57.8	27	32.3	33.1	4.3	56	37.1	11.7	69.5	4022	44792
Total PCB Congeners	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	22.7	180

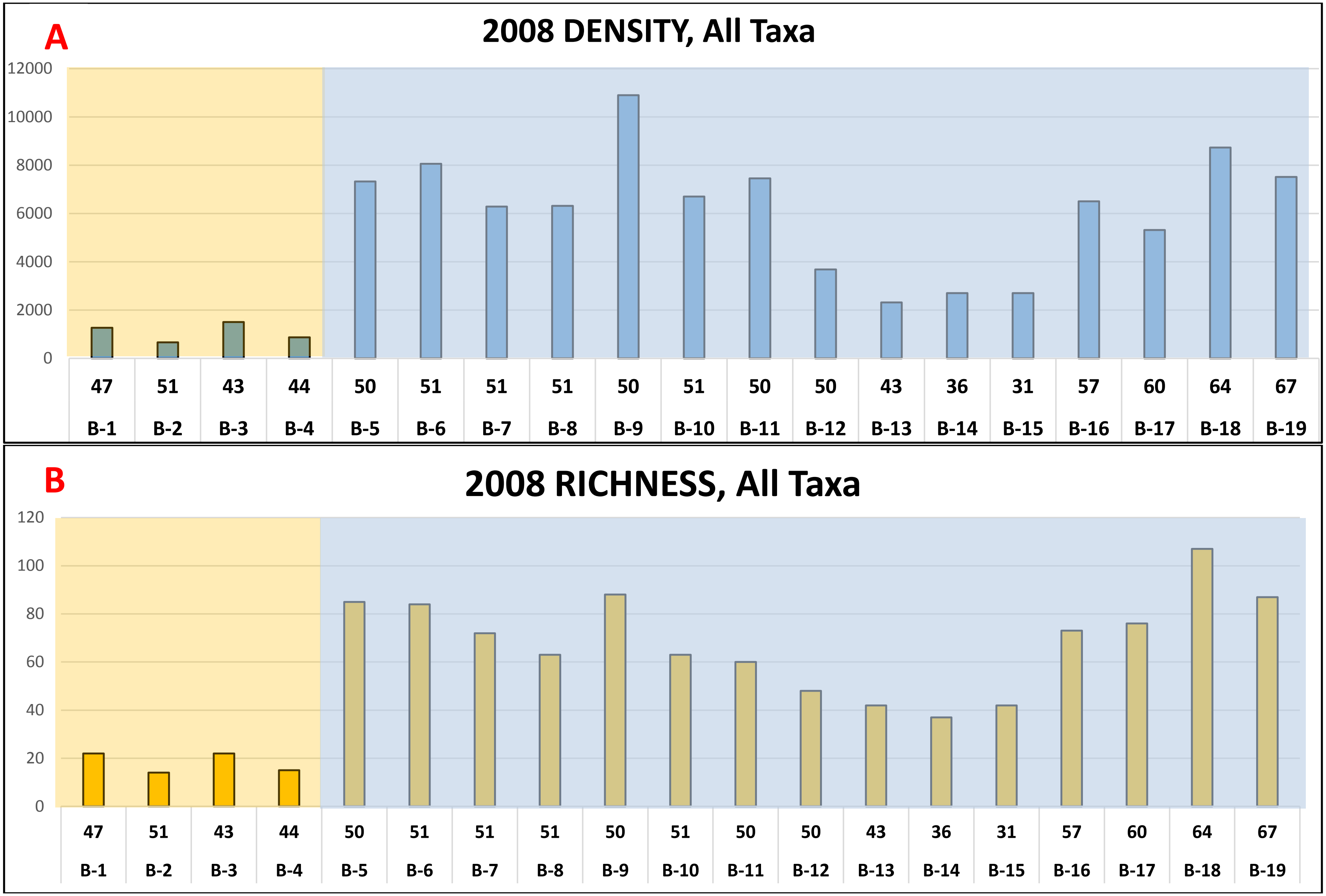
"Inside" stations are both within the disposal site boundary and ON the dredged material deposit as determined by the SPI-PVP survey. "Outside" stations are both outside the site boundary AND off the dredged material deposit.

* Field duplicate sample from a separate grab taken at a different time at the same station

Table 4. Abundance of benthic infauna collected from stations inside (orange) and outside (blue) the HOODS boundary in 2008. Infauna are grouped by type, with the dominant individual taxa listed. Polychaete worms were dominant overall, followed by crustaceans, mollusks, and "other" taxa. Infauna were substantially less abundant on the disposal mound itself compared to stations outside HOODS.

	INSIDE				OUTSIDE															
Station	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-16	B-17	B-18	B-19	
Depth (m)	47	51	43	44	50	51	51	51	50	51	50	50	43	36	31	57	60	64	67	
POLYCHAETA																				**TOTALS**
Chaetozone sp	21	18	34	5	140	199	104	84	182	201	297	69	27	13	58	42	20	12	10	1536
Magelona longicornis	5			3	36	35	35	75	57	46	65	15	22	23	1	18	22	45	56	559
Mediomastus sp			2		21	73	26	52	111	33	32	2	9	11	7	53	17	26	49	524
Scoletoma luti					56	40	23	18	73	41	21	9			4	83	55	16	30	469
Aphelochaeta monilaris					2	2	1	4	21	1	6		2			67	74	136	89	405
All Other Polychaete Taxa	92	44	106	54	205	240	193	213	325	152	154	135	136	189	148	229	204	366	308	3493
SUB TOTALS	118	62	142	62	460	589	382	446	769	474	575	230	196	236	218	492	392	601	542	**6986**
	INSIDE MEAN: 96.00				**OUTSIDE MEAN: 440.13**															
CRUSTACEA																				**TOTALS**
Cheirimedeia sp					57	47	29	1	53	62	1	1	1		10	6	4	7		279
Ampelisca unsocalae					17	12	24	25	18	13	43	39	8		1	16	5	23	15	259
Protomedeia sp					15	27	9	31	29	13	5	2	7		3	19	10	4	10	184
Protomedeia articulata					15	5	29	17	27	12	11	6				2				124
Rhepoxynius variatus					10	8	21	14	18	13	8		1	1	1		9	13		117
All Other Crustacea Taxa	1	1	2	1	85	48	70	17	63	56	20	12	10	9	13	46	53	35	40	582
SUB TOTALS	1	1	2	1	199	147	182	105	208	169	88	60	27	10	28	89	81	82	65	**1545**
	INSIDE MEAN: 1.25				**OUTSIDE MEAN: 102.67**															
MOLLUSCA																				**TOTALS**
Axinopsida serricata					35	34	27	61	49	19	75	72	1	3		21	13	96	89	595
All Other Mollusk Taxa	5	3	4	22	30	25	23	13	55	5	0	1	3	15	16	12	17	51	26	326
SUB TOTALS	5	3	4	22	65	59	50	74	104	24	75	73	4	18	16	33	30	147	115	**921**
	INSIDE MEAN: 8.50				**OUTSIDE MEAN: 59.13**															
MISCELLANEOUS																				**TOTALS**
Nematoda						5	4	6	5		2					30	21	22	20	115
All Other Misc. Taxa	3	0	3	2	9	6	11	1	4	3	6	5	5	6	8	7	8	21	10	118
SUB TOTALS	3	0	3	2	9	11	15	7	9	3	8	5	5	6	8	37	29	43	30	**233**
	INSIDE MEAN: 2				**OUTSIDE MEAN: 15.00**															
TOTALS, ALL TAXA																				**TOTAL**
	127	66	151	87	733	806	629	632	1090	670	746	368	232	270	270	651	532	873	752	**9685**
	INSIDE MEAN: 107.75				**OUTSIDE MEAN: 616.93**															

Figure 8. Density (organisms/m^2, Panel A) and Richness (# of taxa, Panel B) of infaunal organisms captured around HOODS in 2008. Yellow shading indicates stations on the disposal mound; blue shading indicates off-site stations. Depth in meters is shown above each station name.



accounted for nearly 90 percent of these. In contrast, an average of over 600 individuals were collected at each of the relatively undisturbed “Outside” stations (blue shading on Figure 8). Taxon richness (species diversity) showed a similar pattern, with the number of taxa being much lower on the disposal mound compared to undisturbed stations outside the disposal site.

To evaluate the influence of depth and location on the undisturbed infaunal community, Figure 9 presents density and richness information for stations along a 4 nautical mile (nmi) shallow-to-deep transect, and along a 4.5 nmi south-to-north transect at the same depth, excluding the four stations on the disposal mound itself. Samples were collected from a depth range of 31-67 m. As shown in Figure 9, there was a fairly distinct trend toward increasing organism density, as well as increasing taxon richness, at deeper sampling stations in this range. This is consistent with findings from the baseline studies in 1989-90 (discussed further in Section 4 below), and reflects expected natural differences in infaunal community make-up between sandy, higher-energy stations in shallower nearshore locations, versus finer grained, more carbon-rich stations in lower-energy deeper waters offshore.

In contrast, there was no significant trend in density or richness from south to north at the same depth as the disposal site, across the transect sampled. It is possible that infaunal community differences at similar depths might exist across a larger south-north transect, particularly nearer to the influence of major river discharges that would influence offshore sediment quality and dynamics. But the 2008 sampling results indicate that benthic conditions in the immediate vicinity of HOODS are quite consistent, with no indication that significantly more or less productive benthic habitats occur nearby.

Based on the 2008 results, the 2014 survey (Section 3.4) was designed to study a larger area, including deeper waters further offshore as well as an expanded area to the north parallel to the shoreline.

3. 2014 SITE MONITORING

3.1 2014 Monitoring Goals and Objectives

The basic objectives of the 2014 site monitoring at HOODS were the same as in 2008:

- determine the extent of the dredged material deposit (footprint mapping);
- identify any adverse impacts of disposal of dredged material on or off site; and
- confirm the protectiveness of pre-disposal sediment testing in avoiding disposal of contaminated or toxic sediments.

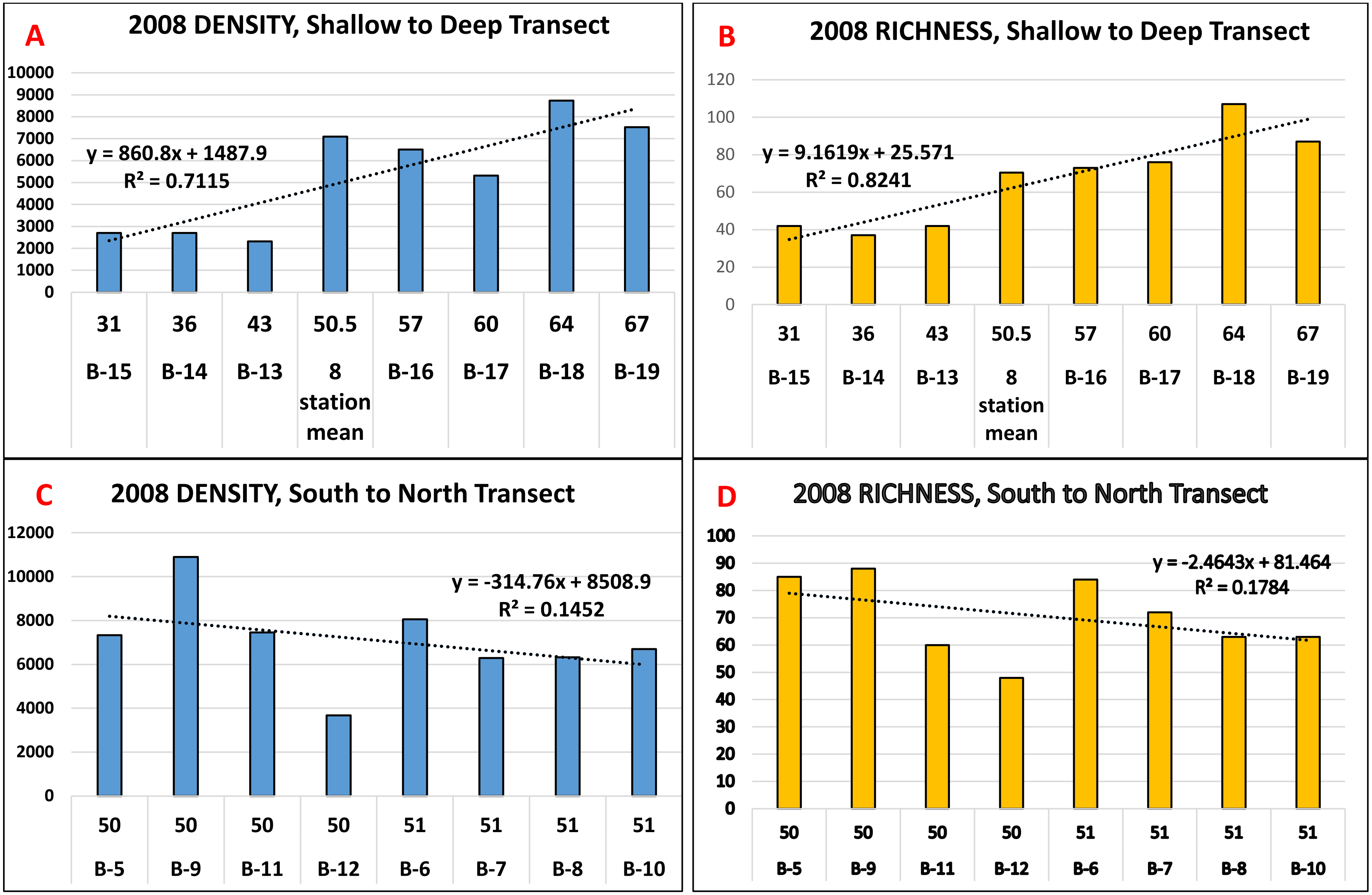
These issues were addressed by the several site monitoring activities, which included: a high-resolution multi-beam echo sounder (MBES) survey of area bathymetry; a Sediment Profile Imaging and Plan View Photography (SPI/PVP) survey; and sediment sampling to document sediment physical, chemical, and benthic community characteristics on-site versus off-site.

However, the 2014 monitoring went beyond the “standard” monitoring approach by including an additional objective:

- provide baseline information in support of an expected proposal to enlarge HOODS to the west and/or north.

This additional objective was addressed by significantly expanding the survey area to cover several square miles of adjacent habitat well outside any influence from the existing 1 square nmi disposal site. All of the monitoring surveys types listed above were conducted across the expanded study area.

Figure 9. 2008 infaunal organism density and richness around HOODS by depth (Panels A and B) and by location south to north at the same depth (Panels C and D) for stations outside the disposal mound. Mean density and richness values are used for the 8 south-to-north stations that are all at 50-51 m depth. Depth in meters is shown above each station name.



The 16 square nmi expanded survey area was established based in part on information from the less intensive (19 station) surveys in 2008 (described in Section 2, above). Those surveys indicated that away from the immediate vicinity of the existing disposal site there was an absence of adverse physical, chemical, or biological effects from dredged material. Therefore a much larger 51 station sampling array was used in 2014 (Figure 10 - see Appendix C for station coordinates) that sampled only two stations on the sandy mound and six more around the boundary of the existing disposal site, and instead emphasized characterizing the expanded study area. Samples were also collected from several stations beyond (to the west and north of) the expanded study area, in part to provide data on potential new reference sediment sites if HOODS is expanded in the future.

EPA's prime contractor for the 2014 monitoring was Battelle Memorial Institute (Battelle) (contract EP-W-09-024/WA 4-16). With EPA oversight, they developed the overall survey plan and quality assurance project plan (QAPP) for the HOODS monitoring (Battelle, 2014), incorporating the work to be done by each of the sub-contractors. Subcontractors included eTrac Engineering (for the MBES survey), Germano and Assoc. (for the SPI/PVP survey), and Marine Taxonomic Services (for benthic community analysis). The MBES survey was conducted separately in late August, 2014, while the SPI/PVP and sediment collection surveys were conducted in early September, 2014 using the Humboldt State University (HSU) research vessel Coral Sea, stationed in Eureka.

3.2 2014 Multibeam Echo Sounder Survey

The MBES survey, conducted from August 20-24, 2014, provided precision bathymetric and backscatter information for the HOODS site, as well as throughout the expanded study area (Figure 10). High-resolution bathymetric data was a critical component of the 2014 monitoring program for two primary reasons: First, it confirmed there were no unexpected physical seafloor features in the expanded study area. This helped identify appropriate sampling locations in advance for the SPI/PVP and sediment sampling surveys (as shown on Figure 10). It is also important information for considering whether any proposed future expansion of HOODS may have adverse impacts to unique or important habitats. Second, it gave EPA information necessary to manage ongoing disposal operations in the short run, until an expansion of the HOODS site could be proposed and implemented. Specifically, as discussed in Section 1.3, the MBES identified where and how much disposal capacity remained within the existing disposal cells at HOODS (Figure 4 and Table 2). This in turn allowed EPA to implement a short-term management approach to minimize further mounding (Figure 5), while other monitoring results were analyzed and long-term site expansion proposals could be developed.

In addition to bathymetry, the MBES also provided information about the texture of surface sediments in and surrounding HOODS. Figure 11 shows differences in surface sediment physical textures throughout the expanded study area (based on acoustic backscatter data, re-processed and groundtruthed with grab sample grain size data). In the absence of the disposal site, it would be expected that grain sizes in this area would grade fairly smoothly (in uniform bands or zones parallel to shore), from coarser sediments in the higher energy regime of the nearshore waters to finer, softer sediments in the lower energy environments of the deeper regions farther offshore. However, the surface sediments on the mound are comprised of medium and fine sand (shown in yellow and orange), while to the north and south of HOODS at the same depth, very fine sand (shown in blue) would be the native sediment type. Silt and clay grain sizes (shown in light green) naturally occur in deeper waters (greater than 180 feet) offshore, but in the immediate vicinity of HOODS jagged intrusions of very fine sand extend to a depth of nearly 200 feet, indicating likely transport and deposition of some material initially discharged at HOODS.

Figure 10. Sampling grid for the 2014 EPA monitoring and baseline surveys at HOODS. Red box is the extisting HOODS boundary, while the larger blue box shows the expanded study area within which possible future expansion of HOODS will be considered. Shaded relief bathymetry depicted within the expanded study area was obtained from a separate MBES survey in August 2014. September 2014 sampling included SPI/PVP images obtained from all 51 stations, sediment grab samples for physical and chemical analysis collected from 26 stations, and benthic community samples collected at 25 of those stations.

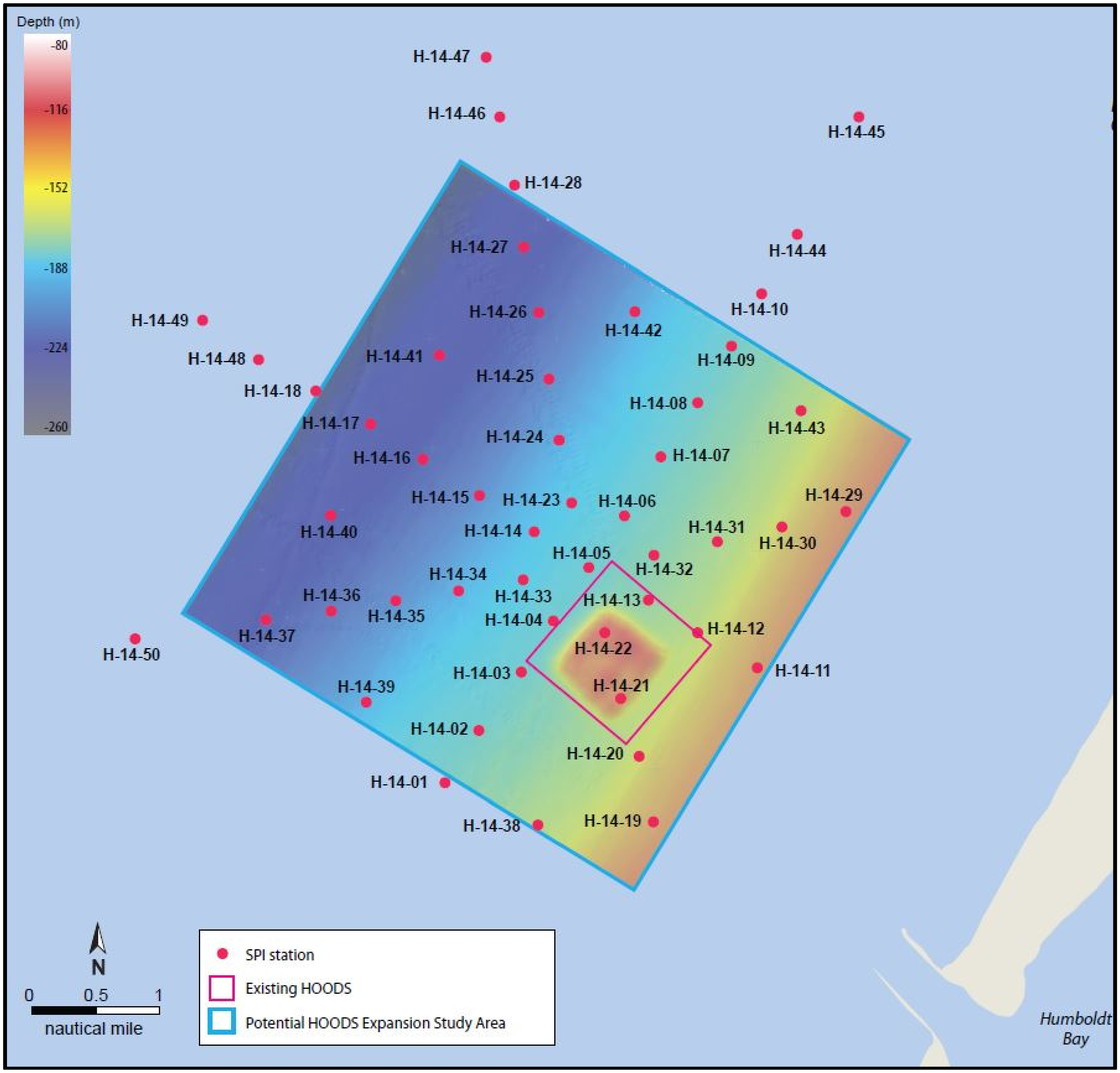
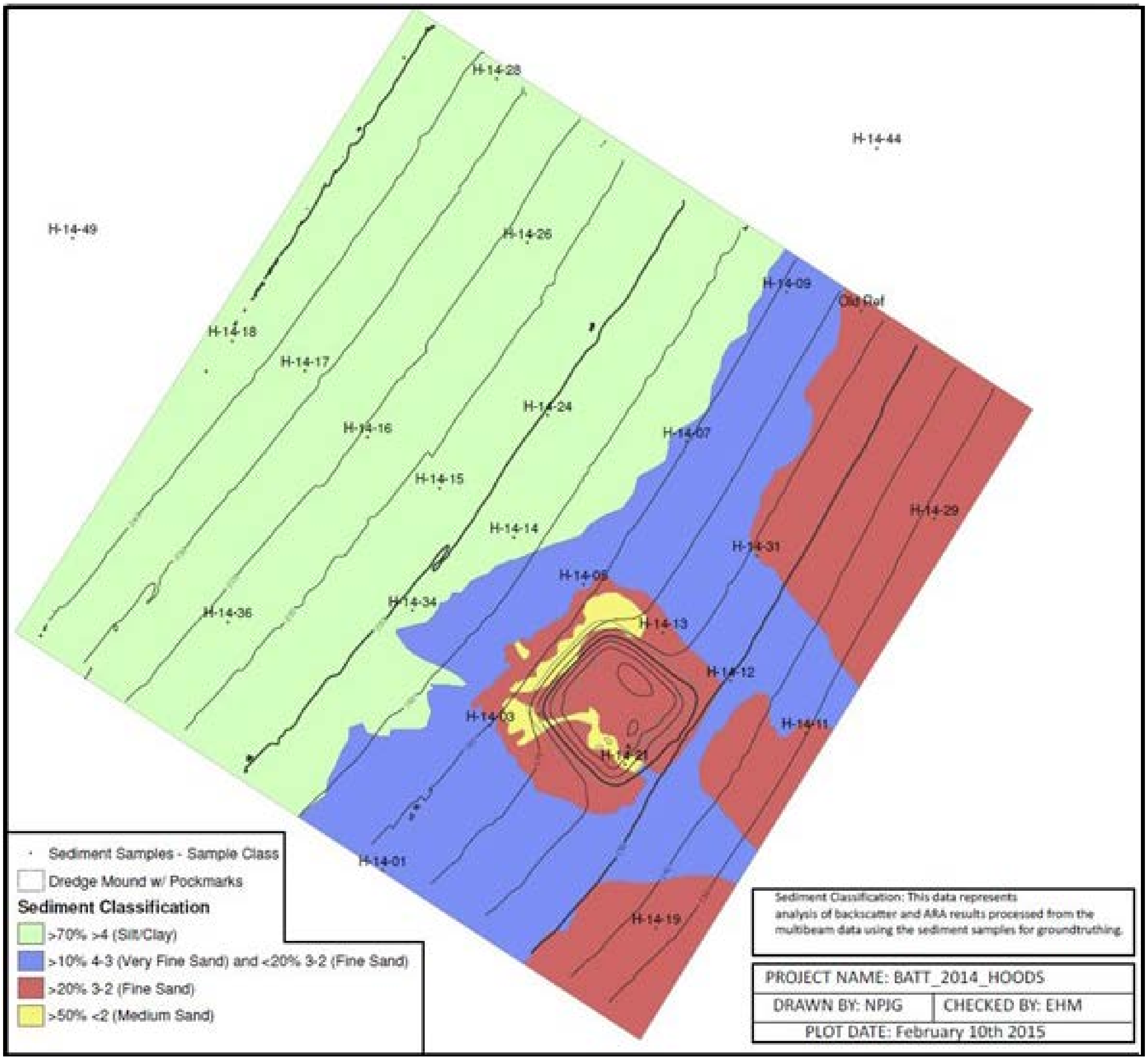


Figure 11. Surface sediment physical classification in and surrounding HOODS, 2014. From MBES survey conducted in August, 2014. (Reproduced from eTrac Engineering, 2014.)



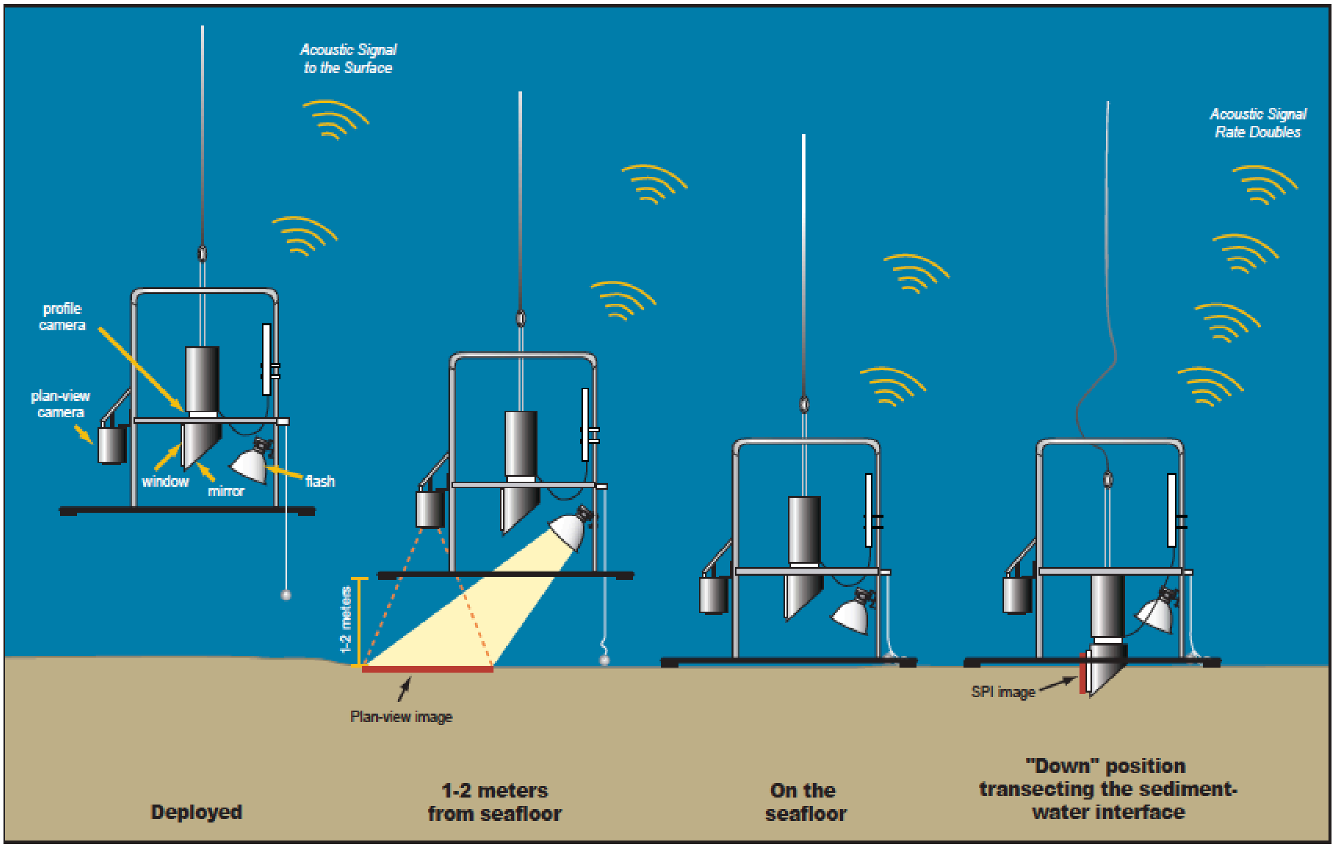
The MBES information can be considered, together with the dredged material "footprint" map delineated from the discrete SPI/PVP stations (Section 3.3 below) and the discrete chemistry and benthic community samples (Sections 3.4 and 3.5 below), to help identify the overall zone of physical influence from disposal at HOODS. Note however that the backscatter differences depicted on Figure 11 represent only surficial sediments, while both SPI and grab sample results include sediment several centimeters below the surface. Thus a backscatter result indicating some change in surface texture compared to similar depth contours away from the influence of the disposal site, may equate to only a "trace" deposit in the SPI survey, or even be indiscernible based on grain size analytical results from depth-homogenized grab samples. Also note that the EIS expected localized physical effects around HOODS, and such changes alone do not indicate whether an adverse impact to the benthic community outside the disposal site may have occurred.

3.3 2014 Sediment Profile Imaging and Plan View Photography (SPI/PVP) Survey

The SPI/PVP system (Figures 12 and 13) provides both a surface and a cross-sectional photographic record of selected locations on the seafloor, to allow a general description of conditions both on and off dredged material deposits. With resolution on the order of millimeters, the cross-section images from the SPI system are especially useful for identifying the spatial extent and thickness of the dredged material footprint overlying the native sediments, both within and outside the site boundaries. It is also capable of visually documenting the status of benthic recolonization on the deposited material.

Figure 12. SPI/PVP camera system being deployed from the Coral Sea in 2014.

Figure 13. Schematic of deployment and collection of plan view and sediment profile photographs. (Reproduced from Germano & Assoc., 2014).



SPI images also identify the level of disturbance and recolonization, as indicated by the depth of bioturbation, the apparent depth of the redox discontinuity, and the presence of certain classes of benthic organisms (Figure 14). PVP, in turn, is useful for identifying surface features and epibenthic marine life in the immediate vicinity of where the SPI photos are taken, thereby providing important context for the vertical profiles at each station. Scale information provided by underwater lasers allows accurate density counts (number per m^2) of, for example, sediment burrow openings or larger macrofauna or fish which may be missed by the sediment profile cross-sections.

The following discussion summarizes the results of the SPI/PVP survey (detailed discussion is provided in Germano & Assoc., 2014). While some example images are included here for illustrative purposes, all of the SPI and PVP images for every station can be viewed at https://www.epa.gov/ocean-dumping/managing-ocean-dumping-epa-region-9#ODMDS.

The SPI-PVP survey was conducted from September 4-6, 2014. The camera system was successfully deployed at all 51 stations, including within the existing HOODS site, throughout the expanded study area, and at the additional stations outside the expanded study area. At each station, a minimum of four SPI photos were taken coupled with a similar number of PVP photos. The planned vs actual station locations are shown in Figure 15.

Figure 14. Soft-bottom benthic community response to physical disturbance (top panel) or organic enrichment (bottom panel). From Rhoads and Germano (1982).

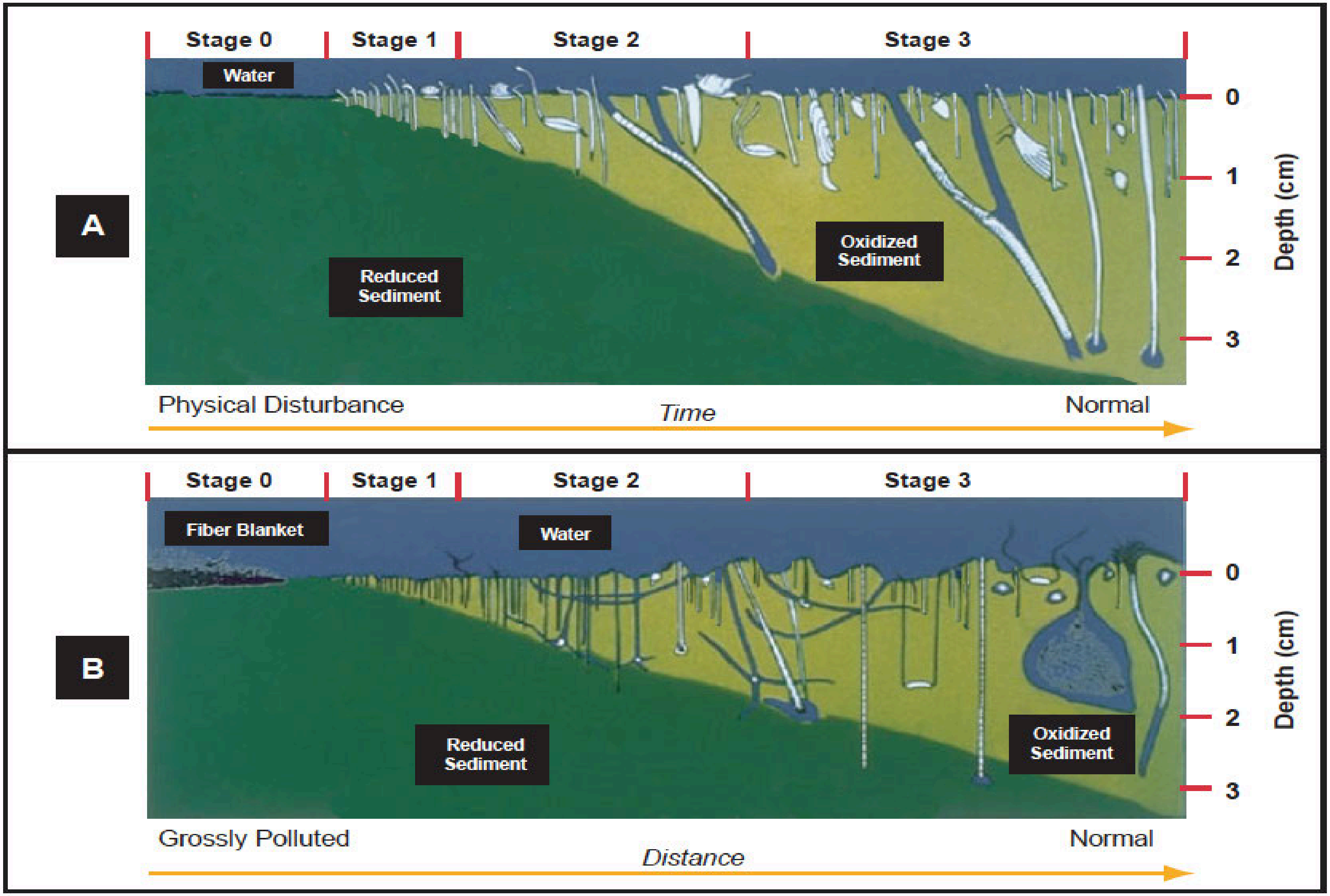


Figure 15. Planned (black triangles) vs actual sample locations in and around HOODS in 2014. Purple box is the existing HOODS boundary; larger blue box is the expansion study area. White circles are the 51 SPI/PVP stations, and red plusses indicate the 26 stations at which sediment grab samples were taken (see Section 3.4 below regarding grab samples). All grab samples were collected from within 50 meters of their target station location.

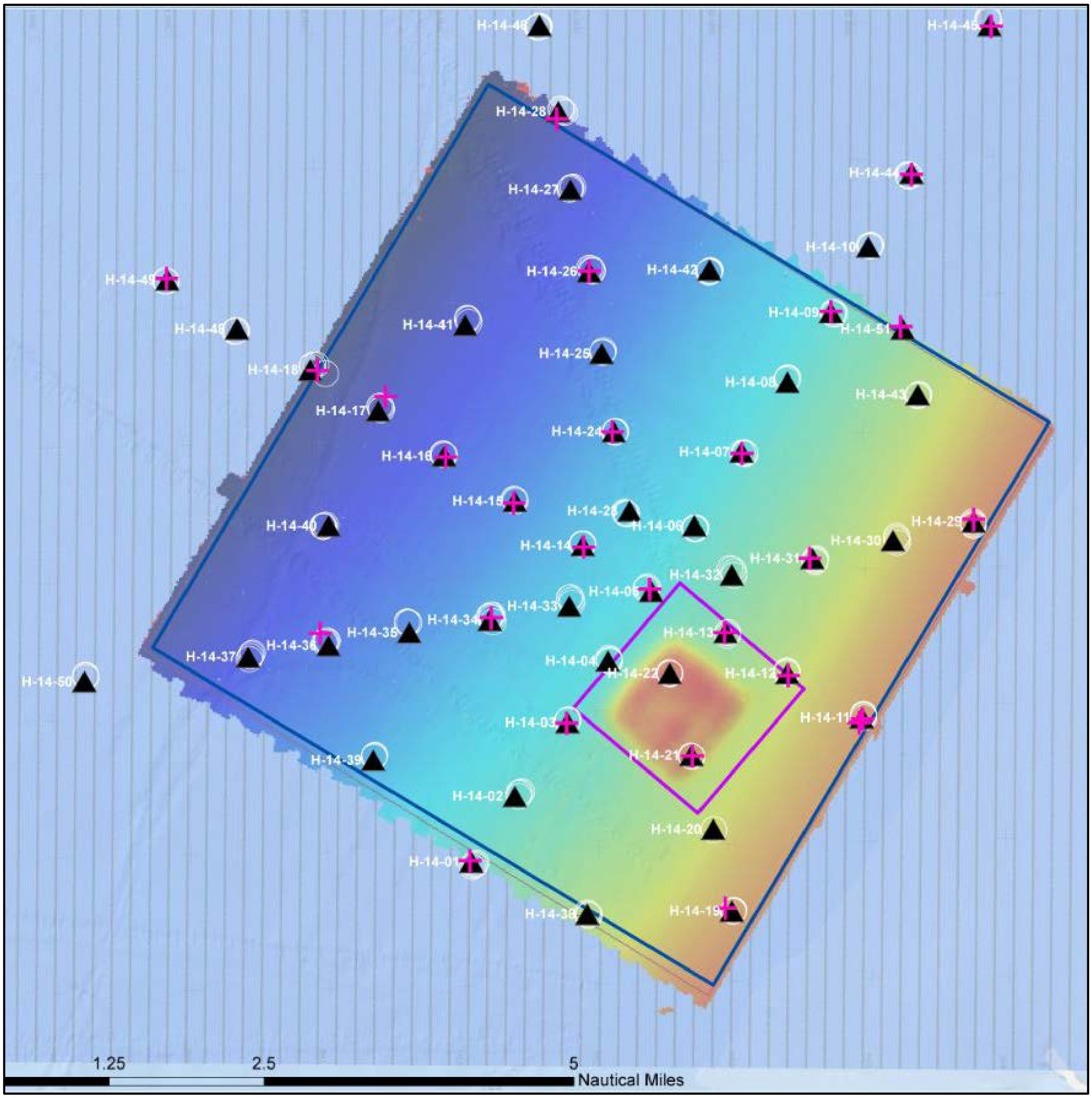


Figure 16 shows typical PVP (plan view) images from atop the HOODS disposal mound, and of the native seafloor off the mound (with no dredged material deposition). Figure 17 shows SPI (cross-sectional) views of native sediment (without dredged material) at stations with silt and clay versus very fine sand. Figure 18 shows SPI views from the top of the mound within HOODS, showing the deposit of fairly uniform fine-to-medium dredged sand.

From such images, several kinds of important information can be compiled for the study area as a whole. Typical parameters collected in SPI surveys include:

- sediment physical type (grain size major mode);
- prism penetration depth;
- biological mixing (bioturbation) depth;
- surface boundary roughness;
- abundance, distribution, oxidative state, and angularity of mud clasts;
- presence of methanogenesis and thiophillic (sulfur reducing) bacterial colonies;
- the overall dredged material deposit (“footprint map”); and
- infaunal successional stage.

For example, Figure 19 shows the average penetration depths of the SPI camera throughout the expanded study area. Coarser or more consolidated sediments allow less penetration of the camera compared to finer or less consolidated sediments. These penetration depths are quite consistent with the MBES surface sediment texture results shown on Figure 11. Similarly, Figure 20 shows the maximum biological mixing (bioturbation) depth throughout the survey area. For similar physical sediment types, deeper bioturbation depths are associated with relatively undisturbed conditions, or longer time periods since a disturbance has occurred (see Figure 14). Many of the profile images showed evidence of bioturbation exceeding the prism penetration depth. Only on the disposal mound itself, where annual sand disposal repeatedly disrupts any recolonization, is bioturbation depth substantially limited.

Figure 21 shows the extent and thickness of the overall dredged material “footprint” as indicated by SPI images at each station. The majority of the expanded study area showed no indication of dredged material presence. Dredged material was generally confined within the disposal site boundary. The thickness of dredged material exceeded the prism penetration depth at those stations within the site boundary (Stations 13, 21, 22) or immediately adjacent to it (Stations 4, 5, and 20) while some thinner layers of material extended somewhat beyond the north (Station 23) and southeast (Station 11) boundaries of the site. Only three other locations (Stations 19, 33, and 35) had trace (< 0.5 mm) deposits. The remaining 40 stations across the survey area showed no dredged material deposition at all. It is possible that small amounts of dredged material have deposited more broadly around the existing disposal site over the years. However, thin layers of dredged material away from the mound itself appeared to be rapidly incorporated into the ambient sediment column through the bioturbation activities of the resident infauna, quickly becoming indistinguishable from the native sediment.

Finally, Figure 22 depicts the successional stages of infaunal organisms across the study area. As discussed in Germano & Assoc. (2014), mapping of successional stages is based on the theory that organism-sediment interactions in fine-grained sediments follow a predictable sequence after a major seafloor perturbation (Figure 14). The continuum of change in animal communities after a disturbance (primary succession) has been divided subjectively into four stages:

Figure 16. Plan view images showing typical views of the seafloor on and around HOODS in 2014. Panel A (Station 22) is on the active disposal mound, showing bedforms in the sandy sediment caused by bottom currents and no obvious macrobenthic organisms. All other images are from stations off the disposal site and show the presence of various organisms: Panel B (Station 14) shows an octopus (magnified in box) and flatfish (arrows); sea pens are visible in Panel C (Station 38); and burrow openings of deposit-feeding infauna (arrows) are visible in Panel D (Station 18). Each image shows an area approximately 1.8 m wide. (Images from Germano & Assoc., 2014.)

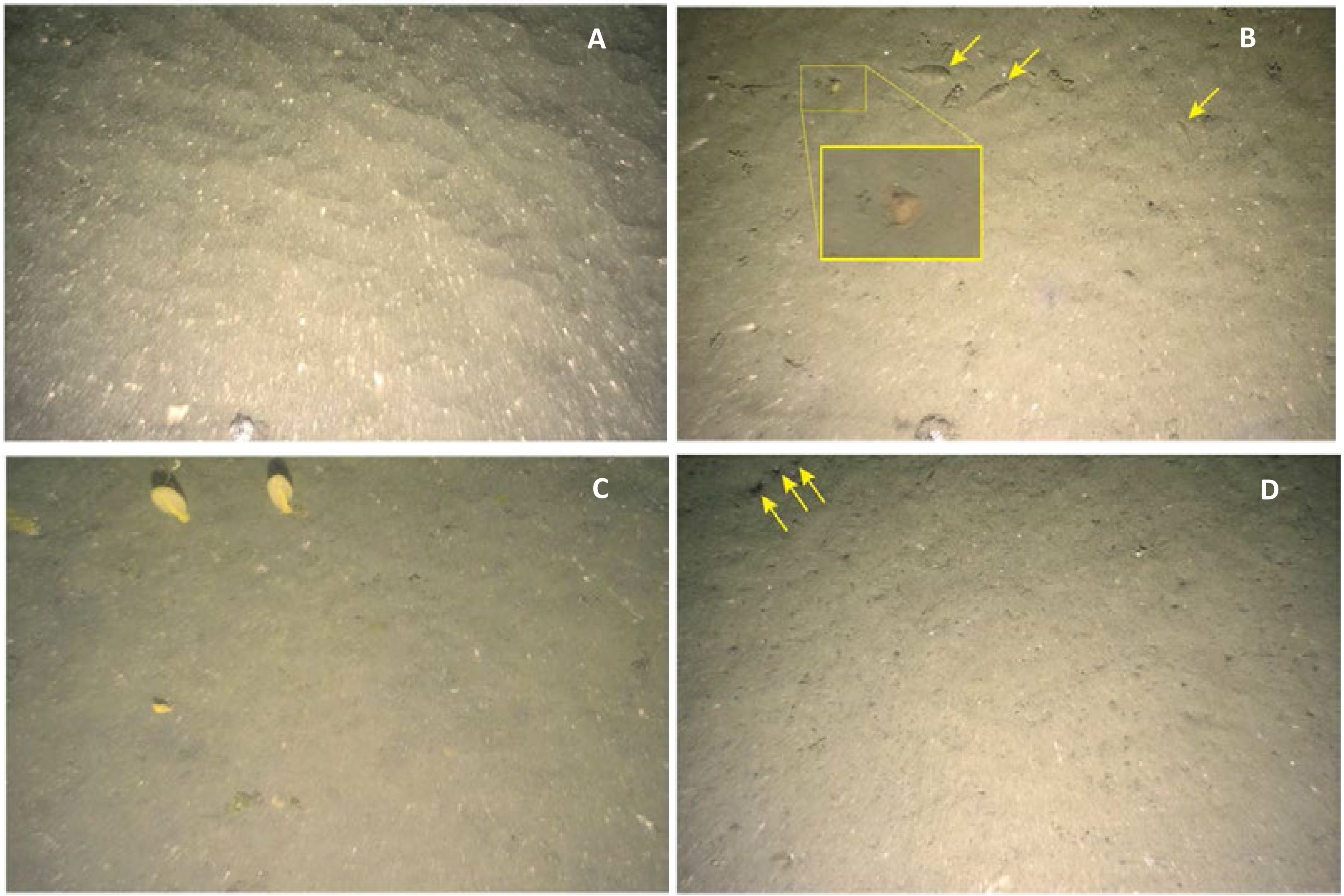


Figure 17. SPI (cross-sectional) images showing typical native seafloor sediments near HOODS in 2014. Panel A (Station 18) is at a depth of ~250 feet and is comprised of silt and clay, while Panel B (Station 12) is at a depth of ~150 feet and is coarser (silty very fine sand) with correspondingly less camera penetration depth. Neither station has received any dredged material deposition. Images show an area approximately 14 cm wide and 20 cm high. (Images from Germano & Assoc., 2014.)

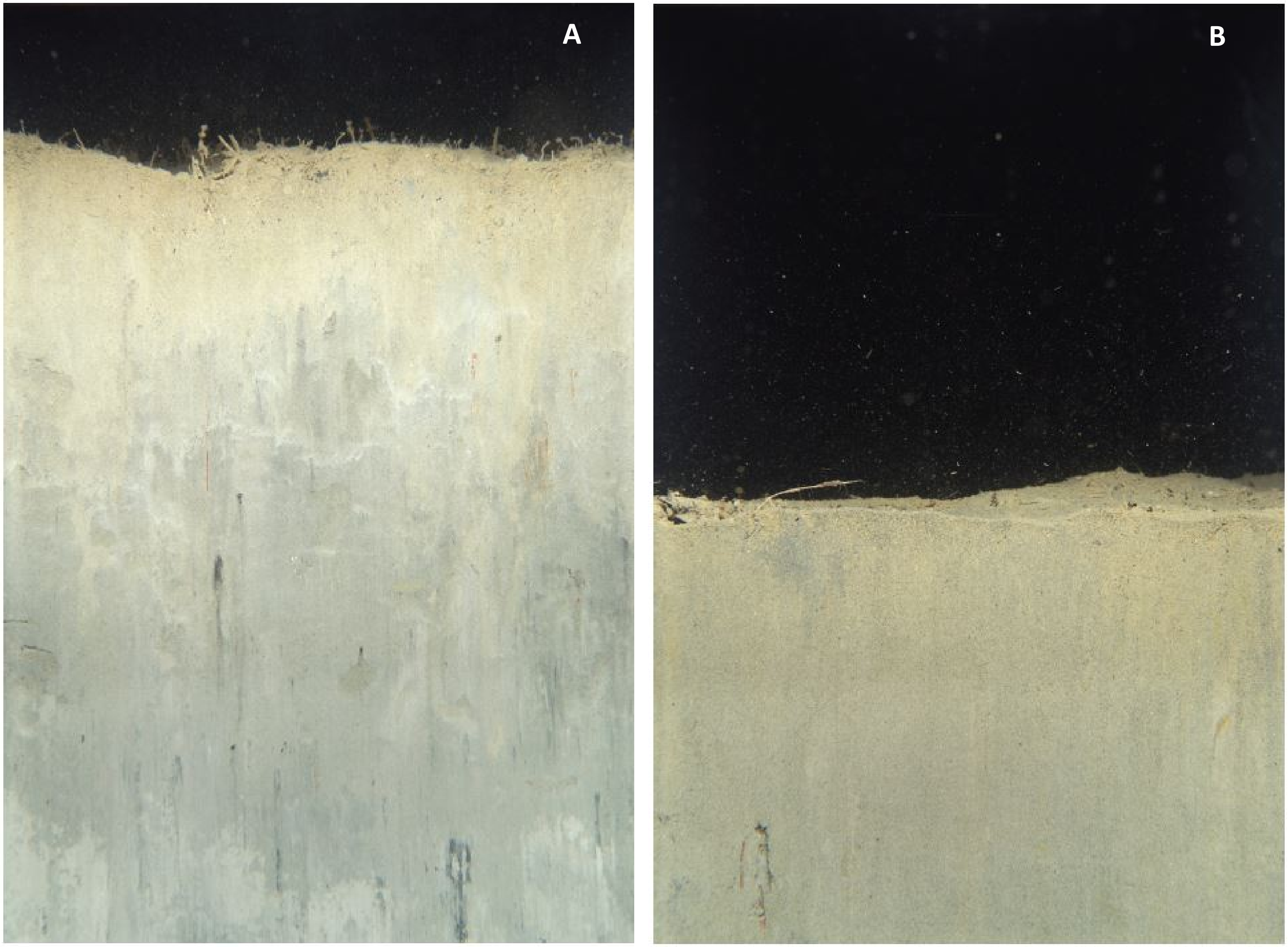


Figure 18. SPI (cross-sectional) images of dredged sand on top of the mound at HOODS in 2014. Panel A (Station 21) and Panel B (Station 22) both show well-sorted fine to medium sand placed during recent disposal operations. Camera penetration is even less in this compact sandy sediment. (Images from Germano & Assoc., 2014.)

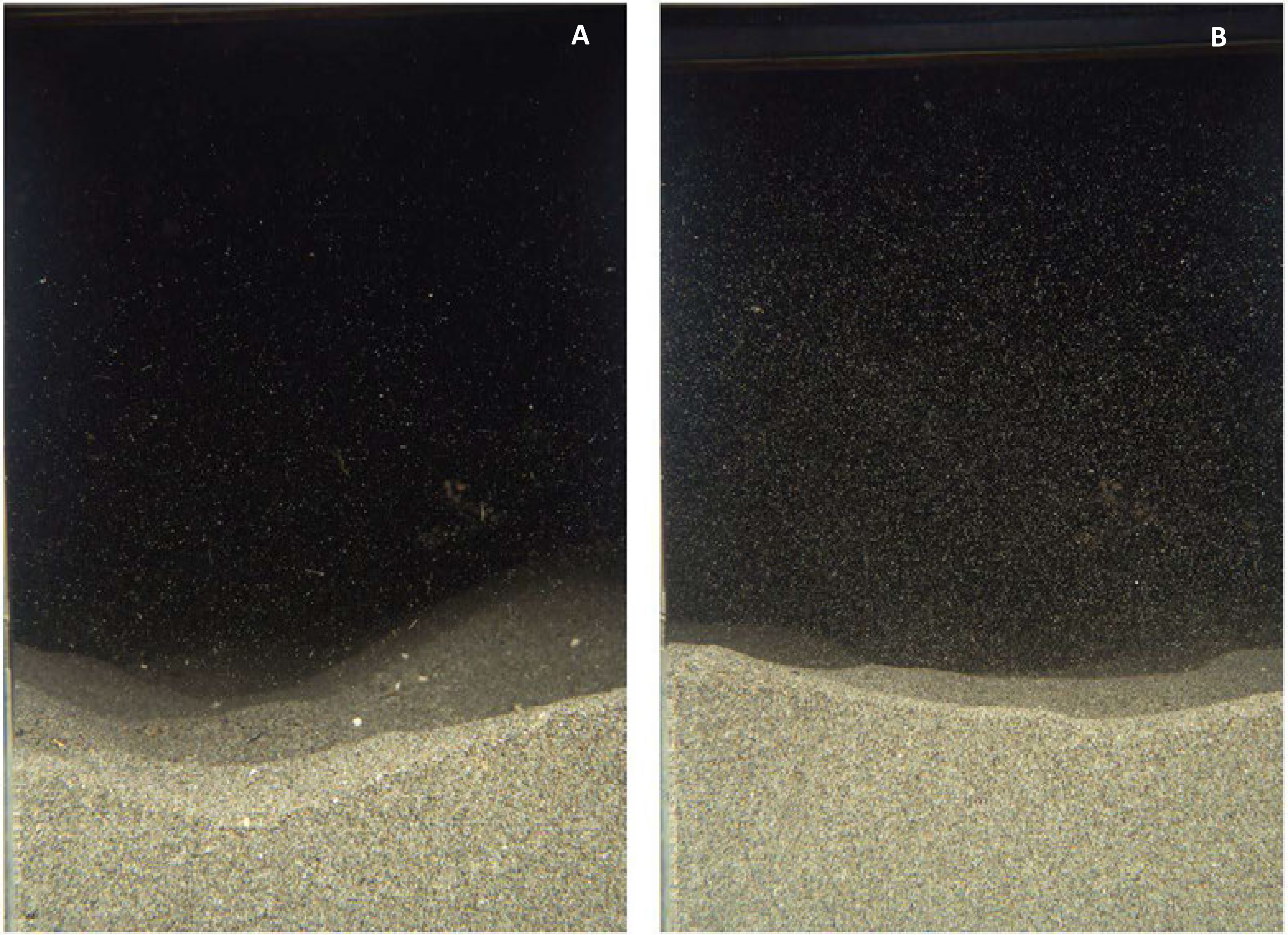


Figure 19. Average penetration depths of the SPI camera throughout the expanded study area at HOODS in 2014. Compare to MBES sediment classification results in Figure 11. (Reproduced from Germano & Assoc., 2014.)

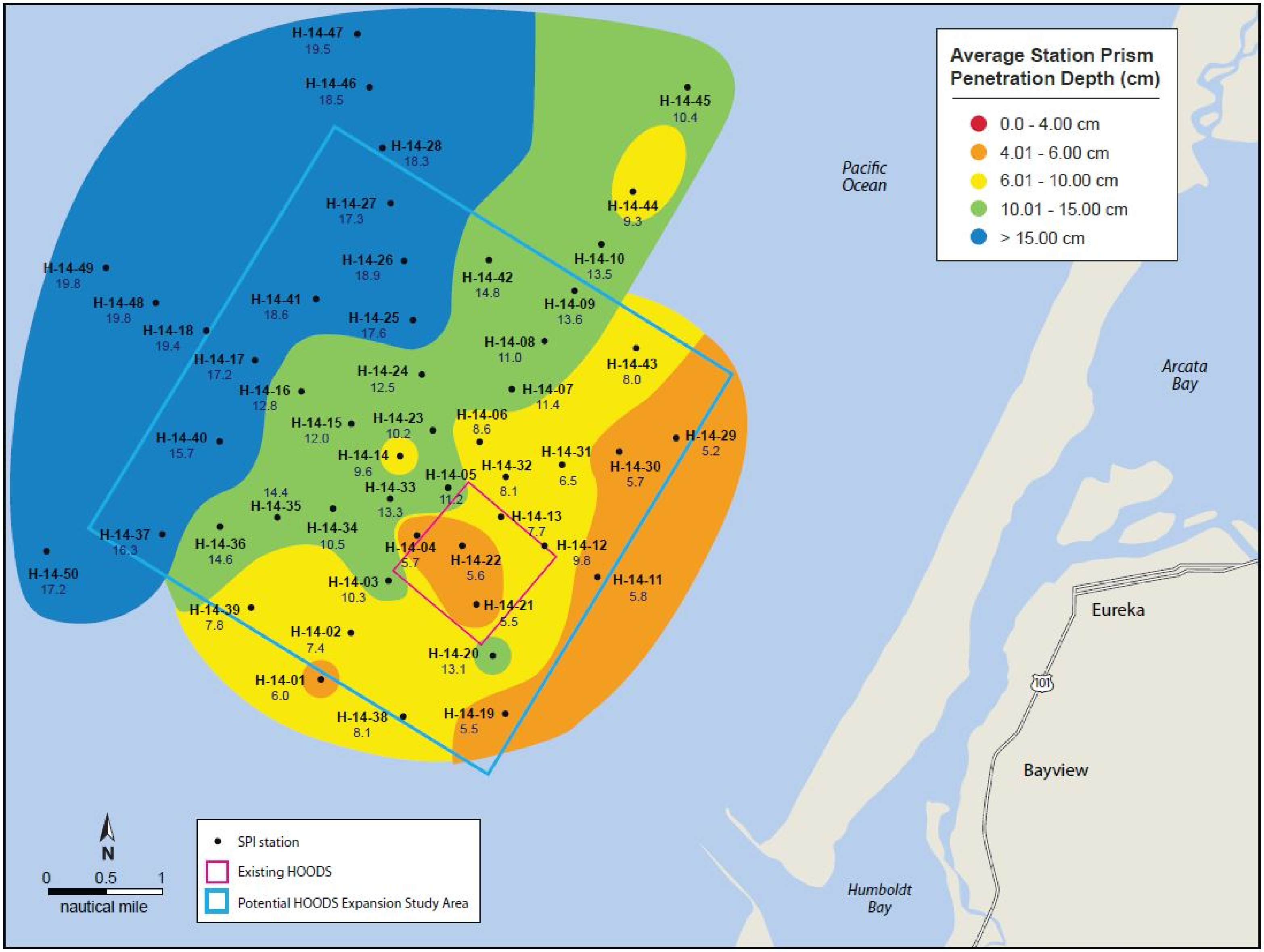


Figure 20. Maximum bioturbation depths in sediments throughout the expanded study area at HOODS in 2014. (Reproduced from Germano & Assoc., 2014.)

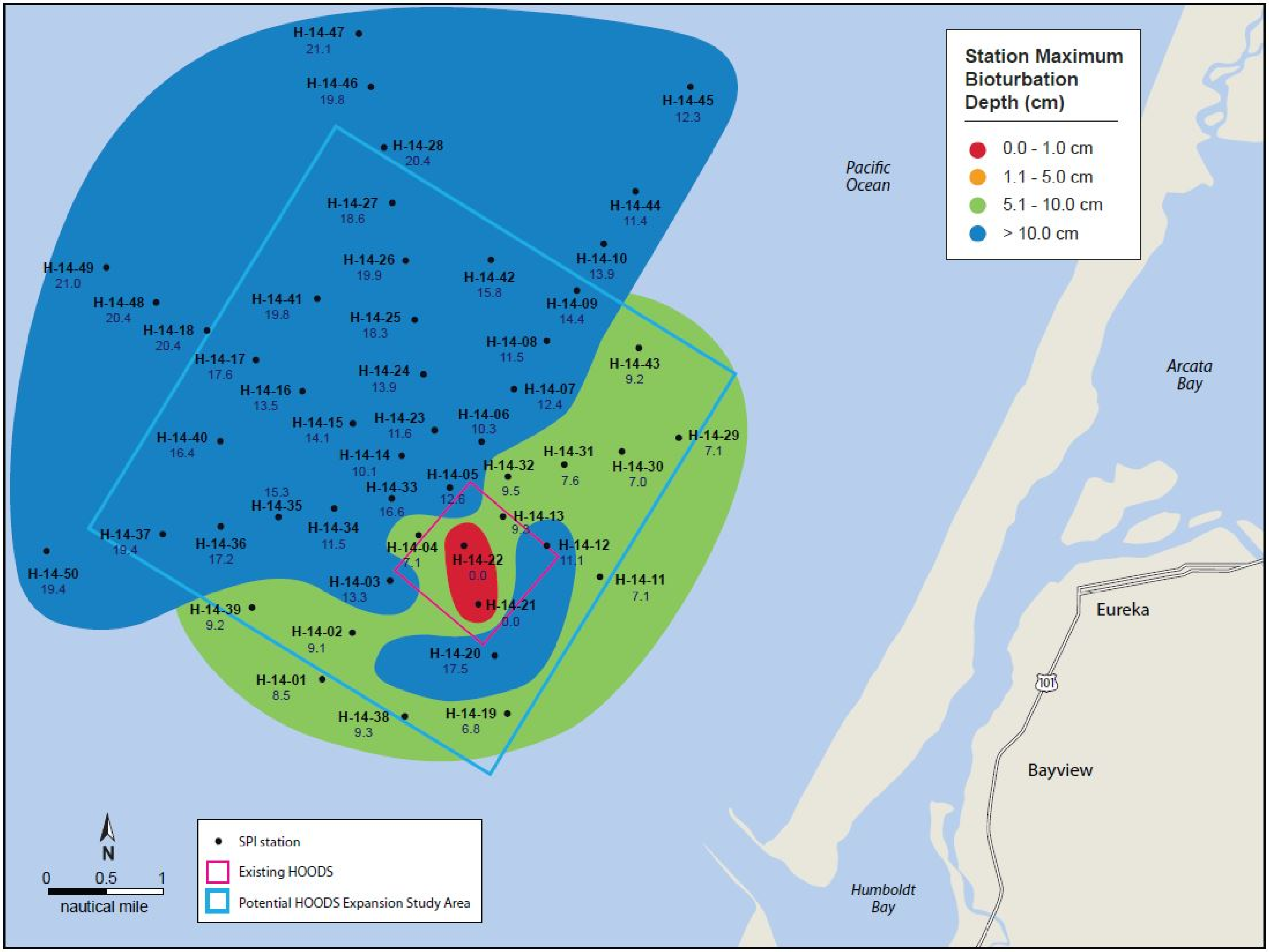


Figure 21. SPI-based "footprint map" of the dredged material deposit at HOODS in 2014. Red box shows the HOODS boundary. SPI detects the thin deposits of dredged material that settle outside the disposal site, as opposed to just the large physical mound identified by the MBES survey inside the site. (Reproduced from Germano & Assoc., 2014.)

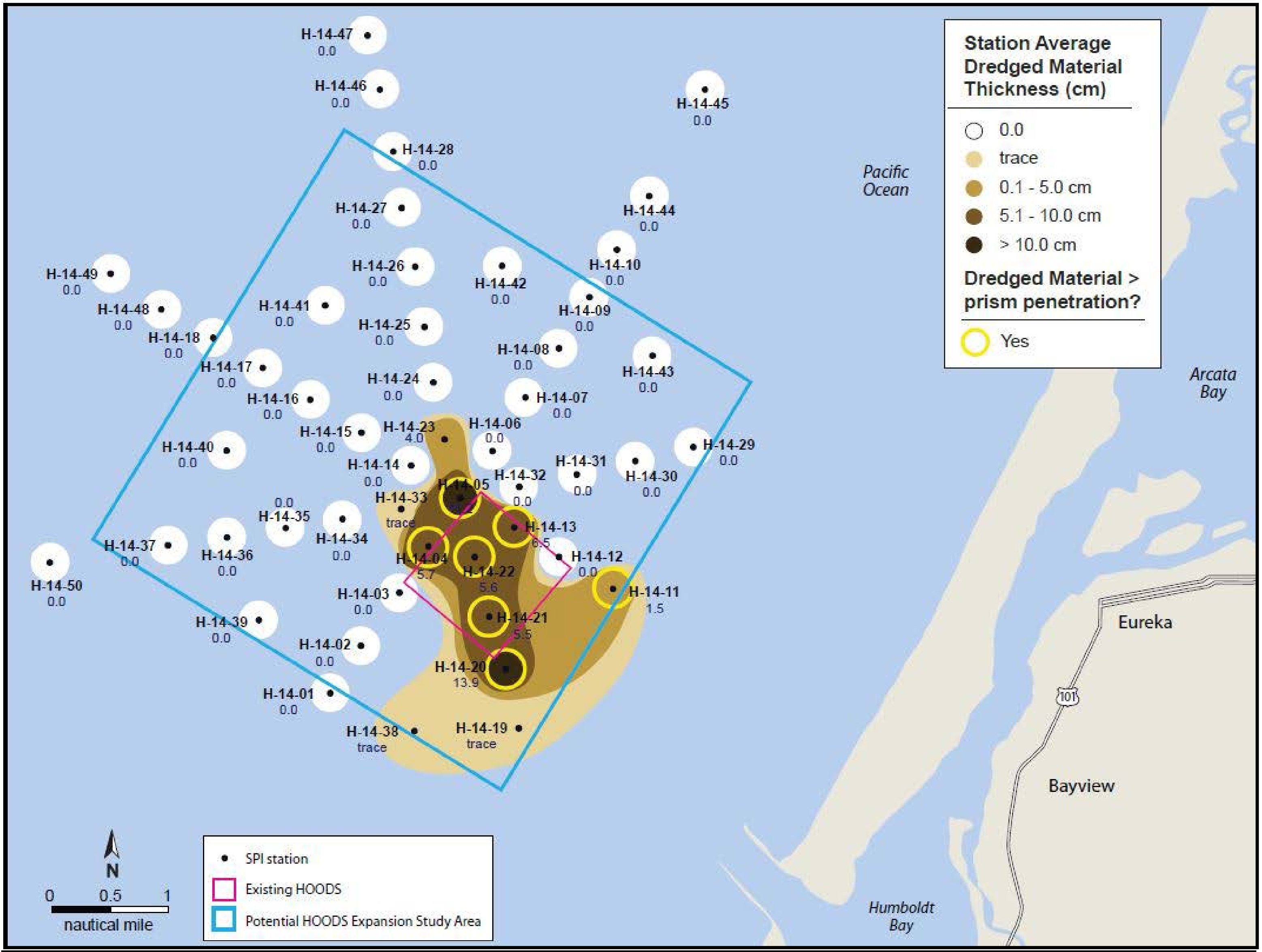
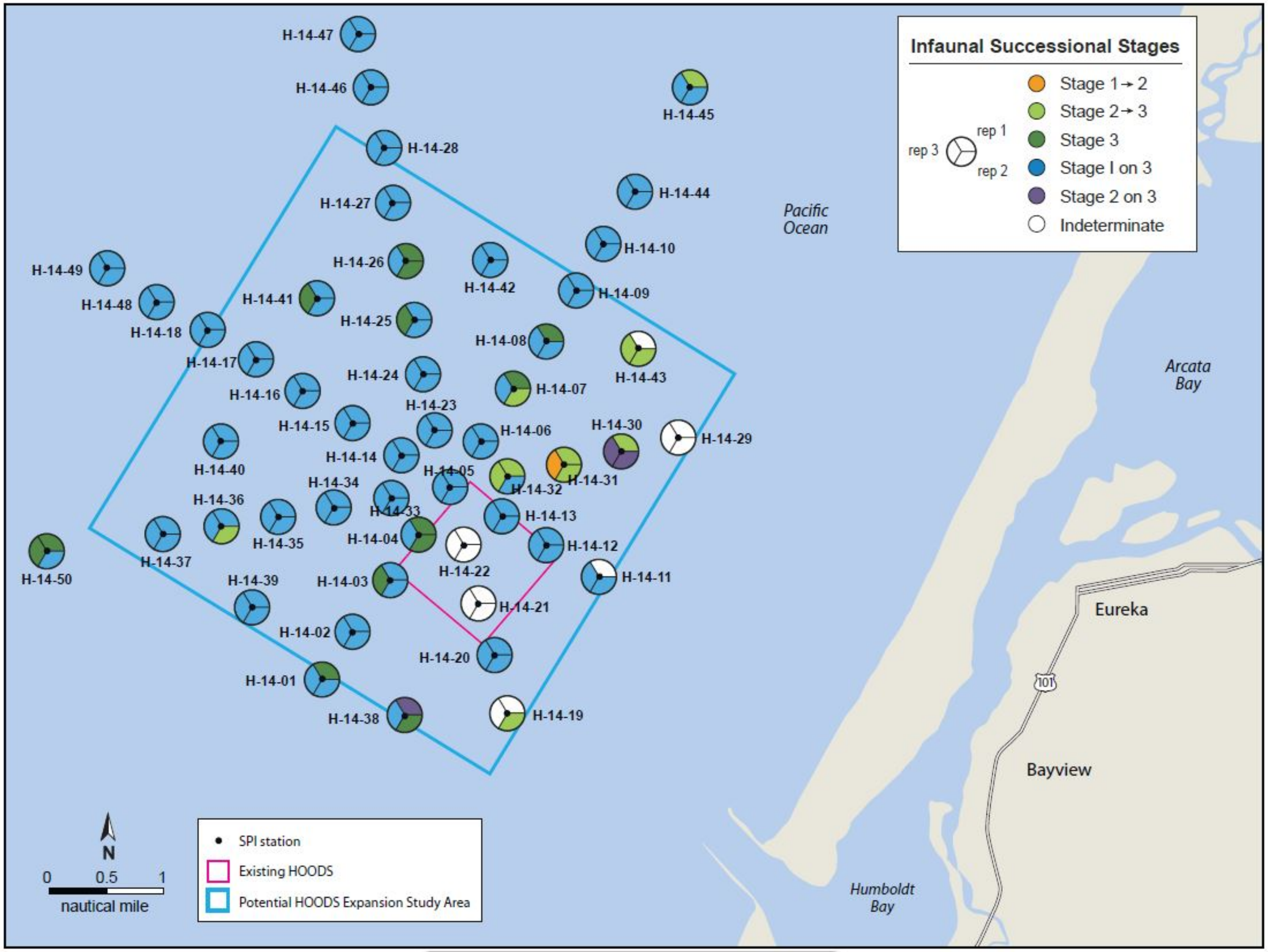


Figure 22. Infaunal community successional stages across the study area around HOODS in 2014. Mature, Stage 3 communities were present at all stations, except on the active disposal mound (Stations 21 and 22) and at one other sandy, shallow inshore station (Station 29). (Reproduced from Germano & Assoc., 2014.)



- Stage 0 is a sediment column that is largely devoid of macrofauna, found immediately following a physical disturbance (or in close proximity to an organic enrichment source);
- Stage 1 is the initial community of tiny, densely populated polychaete assemblages;
- Stage 2 is the start of the transition to head-down deposit feeders; and
- Stage 3 is the mature, equilibrium community of deep-dwelling, head-down deposit feeders.

After an area of bottom is disturbed by natural or anthropogenic events, the first invertebrate assemblage (Stage 1) appears within days after the disturbance, consisting of assemblages of tiny tube-dwelling marine polychaetes that can reach population densities of 10^4 to 10^6 individuals per m^2. If there are no repeated disturbances to the newly colonized area, then these initial tube dwelling taxa are followed by burrowing, head down deposit-feeders that rework the sediment deeper and deeper over time and mix oxygen from the overlying water into the sediment. The animals in these later-appearing communities (Stage 2 or 3) are larger, have lower overall population densities (10 to 100 individuals per m^2), and can rework the sediments to depths of 3 to 20 cm or more. Various combinations of these basic successional stages are also possible. For example, secondary succession can occur resulting in surface-dwelling Stage 1 or 2 organisms co-existing at the same time and place with Stage 3, resulting in the assignment of a “Stage 1 on 3” or “Stage 2 on 3” designation. The distribution of successional stages in the context of the mapped disturbance gradients is one of the most sensitive indicators of the ecological quality of the seafloor (Rhoads and Germano 1986). A Stage 3 assemblage indicates that the sediment surrounding these organisms has not been disturbed severely in the recent past and that the inventory of bioavailable contaminants is relatively small.

The distribution of infaunal successional stages in Figure 22 shows only three stations (Stations 21, 22, and 29) where sandy sediments precluded any determination of infaunal successional status. Two of these were on the top of the active dredged material mound (see Figure 18), where thick layers of disposed sand physically disrupt recolonization on an annual basis. Evidence of Stage 3 deposit-feeding taxa was found at every other station surveyed. The widespread presence of mature successional assemblages revealed a lack of either physical or anthropogenic disturbances that were severe enough to have an ecologically meaningful impact on the infaunal community in the study area.

3.4 2014 Sediment Chemistry and Infaunal Community Survey

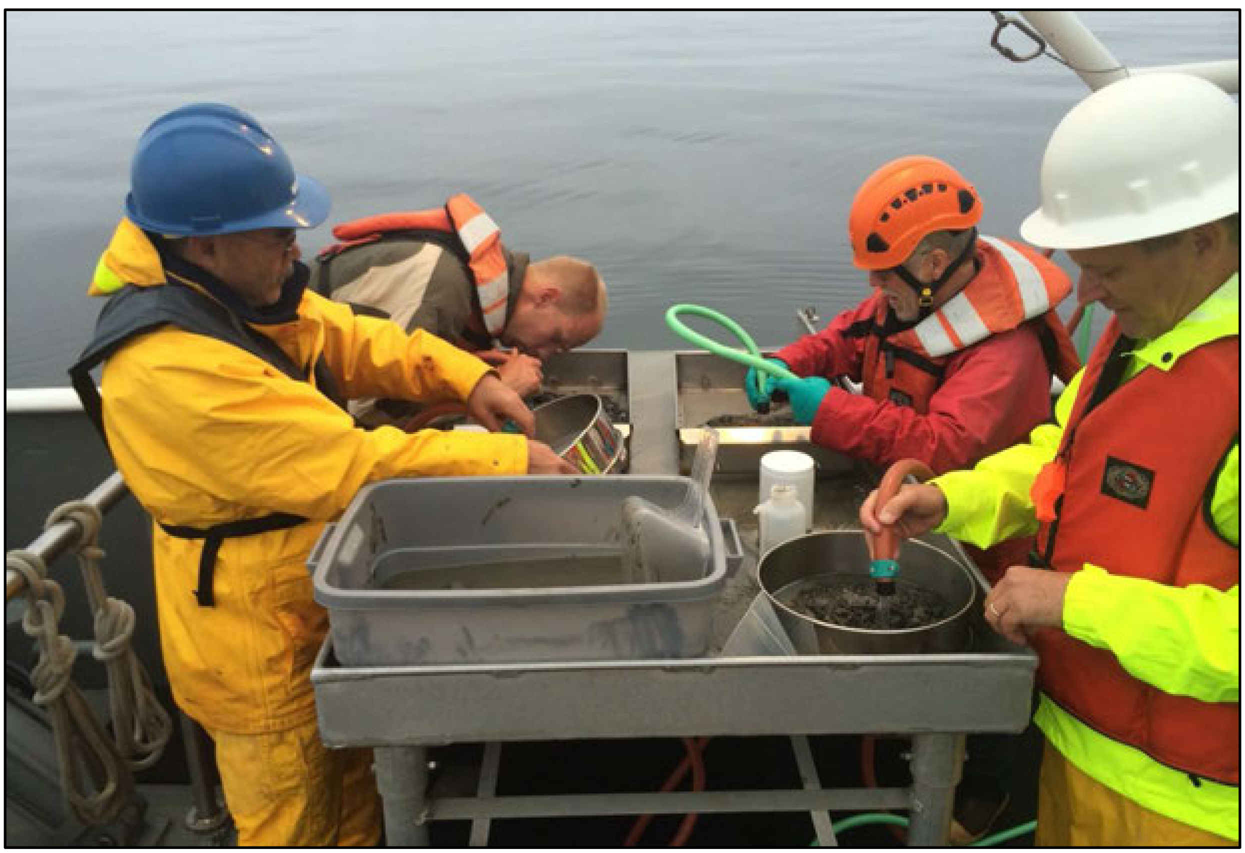
Sediment samples were collected on September 6-8, 2014, immediately following the SPI/PVP survey. Twenty six stations were sampled for sediment grain size and chemistry analysis, and 25 of those were sampled for benthic community analysis (see Figure 15). Samples were collected using a stainless steel double Van Veen sediment grab (Figure 23, showing side-by-side configuration) capable of penetrating a maximum of 20 centimeters below the sediment surface. Detailed methods for performing the sampling for chemistry and benthic community analyses are described in the QAPP (Battelle, 2014).

After each acceptable grab sample was measured for depth of penetration and photographed, a subsample for chemistry was extracted from one side of the grab sampler with a stainless steel spoon (Figure 24). This subsample was homogenized and divided into separate jars for laboratory chemistry analyses (grain size, metals and organics). After the chemistry subsample was removed, the entire volume of the other side of the grab was processed to collect a benthic community sample for that station (Figure 25). A 500 micron sieve was used to separate organisms from the sediment, and the separated organisms were placed into bottles where they were initially preserved with 10% buffered formalin. These samples were later transferred to ethanol at the laboratory.

Figure 23. Double Van Veen sediment grab sampler being deployed from the Coral Sea.

Figure 24. Subsampling from one side of the Van Veen grab, for sediment chemistry.

Figure 25. Processing a sediment sample for benthic community analysis, on the Coral Sea.



3.4.1 2014 Sediment chemistry results

Results of chemical analyses on the 26 sediment samples collected on and around HOODS in 2014 are presented in Table 5. These samples included 5 "Inside" stations (on dredged material, either within the existing disposal site or just outside the existing site boundary), and 21 "Outside" stations (outside the existing disposal site boundary AND where dredged material was not present, as indicated by the prior SPI/PVP survey). Table 6 summarizes these data, showing averages and ranges based on Table 5 values.

As was the case in 2008, sediments directly on top of the active disposal mound (represented in 2014 by Station 21) were over 90% sand with a very low organic carbon content (as would be expected from entrance channel sand recently dredged and disposed at the site). The other "Inside" stations (5, 11, 13, and 19), while on dredged material, were on the periphery of the active disposal mound, and were physically much more similar to native sediments at similar depth ranges, both in terms of grain size and organic carbon. This is consistent with thinner deposits of dredged material (not too thick to completely smother the resident infauna) being actively mixed into the sediment column via bioturbation (e.g., by organisms living in the sediment).

Also like in 2008, sediment chemistry was quite similar across all stations. Concentrations of metals, hydrocarbons, pesticides, PCBs, and dioxin compounds remained uniformly quite low. No samples exceeded NOAA's ER-L or ER-M screening levels, again with the exception of nickel (which naturally exceeded the ER-M at all stations, and does not represent contamination), and chromium (which in 2014 slightly exceeded the ER-L at one "Inside" station and seven "Outside" stations, again not indicative of contamination from dredged material). These results again indicate that ongoing dredged material disposal at HOODS has not resulted in chemical contamination at levels of concern - or indeed to levels substantially different from background concentrations in the native sediments.

EPA and USACE require that all sediments discharged at ocean disposal sites are fully characterized in advance in accordance with national sediment testing guidelines (EPA and USACE, 1991) before approval for ocean disposal is granted. Sediments that contain toxic pollutants in toxic amounts, or that contain elevated levels of compounds that will readily bioaccumulate into tissues of organisms exposed to them on the seafloor, are prohibited from being discharged. The 2008 and 2014 monitoring of sediment chemistry on and surrounding HOODS provides important confirmation that the sediment sampling and testing program is continuing to protect the marine environment from adverse levels of chemical contamination by identifying and excluding toxic or highly contaminated sediments from being disposed.

3.4.2 2014 Benthic community analysis results

Following initial processing for gross identification and enumeration, groups of sorted taxa from each station were reviewed by specialist taxonomists. The object of the taxonomic analysis is to accurately identify all organisms contained within each sample to the lowest possible taxonomic category (target is to species level) and to provide an accurate count of the organisms in each identified taxon. The number of individuals counted within each taxon reflected the number of organisms alive at the time of sampling so counts are based on the number of heads found. (Empty mollusk shells, arthropod molts, and posterior body fragments alone were not counted.) Benthic indices and statistics were then calculated for each station, as described in MTS (2015).

Table 5. Sediment physical and chemical composition at and in the vicinity of HOODS in 2014. "Inside" stations are within the existing disposal site boundary or at locations with some dredged material deposition, while "Outside" stations are outside the existing site boundary and without dredged material present, including an expanded study area within which future site expansion may be proposed. NOAA ER-L and ER-M sediment chemistry screening values are included for comparison; results highlighted in green exceed their corresponding ER-L value, while results highlighted in yellow exceed their corresponding ER-M. (See Figures 10 and 15 for location of survey stations in 2014.)

		EPA Survey Station, 2014																
Analyte	Units (dw)	"Inside"						"Outside"									NOAA Screening	
		H-14-05	H-14-11	H-14-11 dup*	H-14-13	H-14-19	H-14-21	H-14-01	H-14-03	H-14-03 dup*	H-14-07	H-14-09	H-14-12	H-14-14	H-14-15	H-14-16	ER-L	ER-M
Gravel	%	0.16	0	0	0.15	0	0.05	0	0.56	0.36	0	0	0	0.21	0.13	0.32	--	--
Sand	%	27.75	49.93	51.41	56.93	56.88	92.1	27.31	37.09	43.04	18.14	25.76	29.51	7.84	6.75	2.84	--	--
Silt	%	60.07	38.57	36.4	30.34	36.19	6.81	63.42	53.05	45.9	68.02	62.87	61.52	72.97	76.8	75.08	--	--
Clay	%	12.02	11.5	12.19	12.58	6.93	1.04	9.27	9.3	10.7	13.84	11.37	8.97	18.98	16.32	21.76	--	--
Total Organic Carbon	%	1.14	0.56	0.54	0.61	1.23	0.16	0.69	1.11	1.28	0.8	0.74	0.6	1.12	1.12	1.23	--	--
Arsenic	mg/kg	6.8	5.4	5.7	7.1	6.4	4.4	6	6.9	6.4	5.7	6.4	6	5.4	6.4	6.2	8.2	70
Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	9.6
Chromium	mg/kg	74	75	71	69	84	48	70	79	76	77	74	75	72	81	83	81	370
Copper	mg/kg	19	16	16	16	20	7.5	19	17	16	23	18	18	23	26	30	34	270
Lead	mg/kg	7.1	5.3	4.5	6.4	7.5	3.9	5.9	6.9	6.5	7.2	7.2	6.1	7.3	9.1	9.4	46.7	218
Mercury	mg/kg	0.057	0.039	0.052	0.36	0.05	ND	0.069	0.056	0.069	0.059	0.046	0.043	0.058	0.073	0.085	0.15	0.71
Nickel	mg/kg	90	87	84	83	99	54	85	95	92	92	87	89	88	99	100	20.9	51.6
Zinc	mg/kg	61	61	61	55	67	37	62	59	59	69	62	61	66	73	79	150	410
Dioxins - Total TEQ	ng/kg	0.15	0.182	0.136	0.104	0.078	0.007	0.038	0.065	0.496	0.594	0.08	0.074	0.136	0.055	0.12	--	--
Total DDTs	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.58	46.1
Total Organotins	ug/kg	2.56	1.51	1.9	2.07	1.98	1.48	3.7	3.11	2.74	2.09	1.6	1.83	1.86	2.62	1.7	--	--
Total PAHs	ug/kg	17.4	14.6	23.1	19.5	31.8	1.6	13.3	19.1	33.2	23	14.9	37	14.3	11.6	10.5	4022	44792
Total PCB Congeners	ug/kg	0	0.05	2.17	0	0	0.11	0	0	0	0	0	0	0	0	0	22.7	180

"Inside" stations are both within the disposal site boundary AND on the dredged material deposit as determined by the SPI-PVP survey. "Outside" stations are both outside the site boundary AND off the dredged material deposit.

* Field duplicate sample from a separate grab taken at a different time at the same station

Table 5, continued. Sediment physical and chemical composition at and in the vicinity of HOODS in 2014. "Inside" stations are within the existing disposal site boundary or at locations with some dredged material deposition, while "Outside" stations are outside the existing site boundary and without dredged material present, including an expanded study area within which future site expansion may be proposed. NOAA ER-L and ER-M sediment chemistry screening values are included for comparison; results highlighted in green exceed their corresponding ER-L value, while results highlighted in yellow exceed their corresponding ER-M. (See Figures 10 and 15 for location of survey stations in 2014.)

		EPA Survey Station, 2014															
Analyte	Units (dw)	"Outside" (continued)														NOAA Screening	
		H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	H-14-51	H-14-51 dup*	ER-L	ER-M
Gravel	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
Sand	%	2.35	2.17	6.24	2.05	1.07	78.94	41.56	8.41	4.91	32.96	30.69	1.87	47.14	59.62	--	--
Silt	%	75.47	75.71	76.66	74.67	72.04	13.1	53.46	74.24	76.69	58.81	59.81	66.58	48.96	31.19	--	--
Clay	%	22.18	22.12	17.1	23.28	26.89	7.96	4.98	17.35	18.4	8.23	9.5	31.55	3.9	9.19	--	--
Total Organic Carbon	%	1.36	1.51	0.88	0.97	0.99	0.31	0.58	0.97	0.97	0.62	0.59	1.49	0.38	0.38	--	--
Arsenic	mg/kg	6	6.9	6.7	6.2	7	5.4	6.6	7.8	6.5	7	6.2	6.2	6.6	6.3	8.2	70
Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	9.6
Chromium	mg/kg	79	79	82	89	88	80	74	83	85	74	71	82	73	75	81	370
Copper	mg/kg	27	28	27	31	31	11	16	29	27	16	17	31	13	14	34	270
Lead	mg/kg	8.2	9.6	8.5	9.4	9.7	5.7	6.2	9.1	8.7	6.5	6.6	10	6.1	6.1	46.7	218
Mercury	mg/kg	0.083	0.095	0.096	0.079	0.085	0.026	0.06	0.07	0.055	0.046	0.055	0.087	0.041	0.035	0.15	0.71
Nickel	mg/kg	95	97	100	110	110	80	84	100	100	85	82	100	76	77	20.9	51.6
Zinc	mg/kg	75	73	75	83	84	56	58	76	77	62	59	77	56	56	150	410
Dioxins - Total TEQ	ng/kg	0.069	0.071	0.202	0.05	0.098	0.013	0.242	0.069	0.038	0.075	0.044	0.032	0.034	0.182	--	--
Total DDTs	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.58	46.1
Total Organotins	ug/kg	2.05	1.83	2.18	1.93	2.16	2.52	2.08	1.79	1.83	1.87	1.54	4.280	2.43	1.96	--	--
Total PAHs	ug/kg	15.1	11.9	19.7	14.8	17	16.3	21.6	44.3	13.4	11	9.8	11.5	16.5	22.7	4022	44792
Total PCB Congeners	ug/kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22.7	180

"Inside" stations are both within the disposal site boundary and ON the dredged material deposit as determined by the SPI-PVP survey. "Outside" stations are both outside the site boundary AND off the dredged material deposit.

* Field duplicate sample from a separate grab taken at a different time at the same station

Table 6. Averages and ranges of sediment physical and chemical parameters at "Inside" vs "Outside" sampling stations in 2014. "Inside" stations are within the existing disposal site boundary or at locations with some dredged material deposit, while "Outside" stations are outside the existing site boundary and without dredged material present. NOAA ER-L and ER-M sediment chemistry screening values are included for comparison; results highlighted in green exceed their corresponding ER-L value, while results highlighted in yellow exceed their corresponding ER-M. (See Figures 10 and 15 for location of survey stations in 2014.)

		"Inside"		"Outside"		NOAA Screening	
Analyte	**Units (dw)**	**Average**	**Range**	**Average**	**Range**	**ER-L**	**ER-M**
Gravel	%	0.06	0-0.16	0.07	0-0.56	--	--
Sand	%	48.58	27.75-56.93	22.53	1.07-78.94	--	--
Silt	%	40.31	30.34-60.07	62.48	13.1-76.8	--	--
Clay	%	11.04	6.93-12.58	14.92	3.9-31.55	--	--
Total Organic Carbon	%	0.82	0.54-1.23	0.90	0.31-1.51	--	--
Arsenic	mg/kg	6.28	5.4-7.1	6.38	5.4-7.8	8.2	70
Cadmium	mg/kg	ND	ND	ND	ND	1.2	9.6
Chromium	mg/kg	74.60	69-84	78.30	70-89	81	370
Copper	mg/kg	17.40	16-20	22.09	11-31	34	270
Lead	mg/kg	6.16	4.5-7.5	7.65	5.7-10	46.7	218
Mercury	mg/kg	0.11	0.05-0.36	0.06	0.026-0.096	0.15	0.71
Nickel	mg/kg	88.60	83-99	92.30	76-110	20.9	51.6
Zinc	mg/kg	61.00	55-67	67.70	56-84	150	410
Dioxins - Total TEQ	ng/kg	0.13	0.078-0.182	0.13	0.013-0.594	--	--
Total DDTs	ug/kg	ND	ND	ND	ND	1.58	46.1
Total Organotins	ug/kg	2.00	1.51-2.56	2.25	1.54-4.28	--	--
Total PAHs	ug/kg	21.28	14.6-31.8	18.37	9.8-44.3	4022	44792
Total PCB Congeners	ug/kg	0.44	0-2.17	0.00	0	22.7	180

The calculated benthic community statistics and indices included:

- infaunal abundance and density (regarding total number of organisms present);
- species richness (the number of unique taxa per station);
- species diversity (Shannon-Wiener index, H' - related to each taxon's proportion in the sample);
- species evenness index (Pielou index, J' – calculated from H' and richness); and
- similarity co-efficient (between station pairs - Bray Curtis measure).

From the 25 stations, an overall total of 61,215 individual organisms were collected and 323 unique benthic invertebrate taxa were identified (see Appendix D). As in 2008, the infaunal communities throughout the area were dominated by polychaetes (138 total taxa; 42.7 % of all taxa), crustaceans (69 total taxa; 21.4% of all taxa), and mollusks (58 taxa, 18% of all taxa). Table 7 summarizes the dominant taxa in each group. Results of benthic community analyses for density (number of organisms per m^2), taxon richness, and diversity at each station are summarized in Figure 26.

Table 7. Summary of the dominant (5 most abundant) taxa in each major group of benthic invertebrates collected around HOODS in 2014. In all, 61,215 individual organisms and 323 taxa were collected. (Data source: MTS, 2015.)

Polychaetes n=32,461 individuals (53.0% of all individuals); 138 taxa (42.7% of all taxa)

Taxon (# species lines incl. from Appendix D)	Count	Percent of total Annelids
Siophanes spp (2)	5,745	17.7
Cirratulidae (1)	2,719	8.4
Mediomastus spp (1)	2,571	8.0
Owenia f. (1)	1,684	5.2
Maldanidae (1)	1,472	4.5
Total	14,191	43.7

Crustaceans n=10,247 individuals (16.7% of all individuals); 69 taxa (21.4% of all taxa)

Taxon (# species lines incl. from Appendix D)	Count	Percent of total Arthropods
Photis spp (5)	2,515	24.5
Diastylis spp (2)	996	9.7
Cheirimedeia spp (2)	892	8.7
Isaeidae spp (1)	800	7.8
Protomedeia spp (2)	796	7.8
Total	5,999	58.5

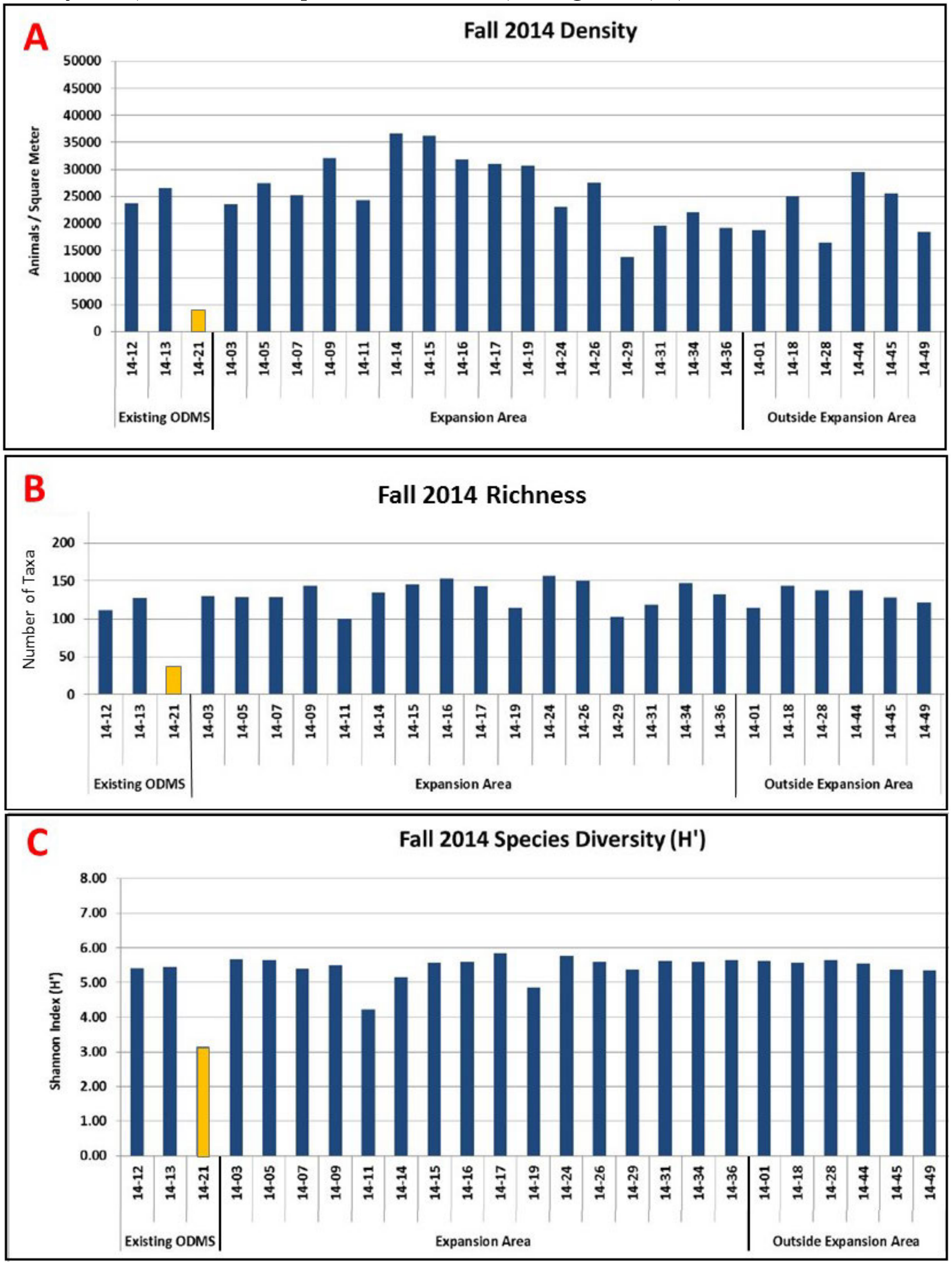
Mollusks n=9,999 individuals (16.3% of all individuals); 58 taxa (18.0% of all taxa)

Taxon (# spp lines incl. from Appendix D)	Count	Percent of total Mollusks
Axinopsida (1)	3,470	34.7
Bivalva spp (1)	1,986	19.9
Ennucula (1)	923	9.2
Macoma spp (3)	620	6.2
Gastropoda app (1)	567	5.7
Total	7,566	75.7

Other Taxa n=8,508 individuals (13.9% of all individuals); 58 taxa (18.0% of all taxa)

Taxon (# spp lines incl. from Appendix D)	Count	Percent of total Other Taxa
Edwardsiidae spp (2)	4,075	47.9
Nematoda spp (1)	1,985	23.3
Echiuridae (1)	955	11.2
Ophiurida spp (1)	353	4.1
Echinoidia (1)	208	2.4
Total	7,576	89.0

Figure 26. Density (Panel A), richness (Panel B), and diversity (Panel C) of infaunal organisms captured at each station around HOODS in 2014, grouped by stations within the existing disposal site, in the expansion area, and outside the expansion area**.** Stations 12 and 13 were inside the HOODS boundary but on the periphery; only Station 21 (shown in yellow) was on the disposal mound itself (see Figure 13). (Modified from MTS, 2015.)



Far more organisms were collected in 2014 (61,125) compared to the 2008 survey (9,685) (see Figure 7 and Section 2.2, above). The 2014 survey sampled more stations, covered a greater depth range, and covered a greater distance south to north. Nevertheless, even though both surveys were conducted at the identical time of year (September 7-8 in 2008, and September 6-8 in 2014), on average roughly 4 times the number of organisms were collected from each undisturbed “outside” station in 2014 (mean per station = 2,496, see Appendix D) compared to 2008 (mean per station = 617, see Appendix B). Specific reasons for the difference in abundance are unknown, but other studies (Ambrose and Renaud, 1995; Fontanier et al., 2003; Meyer et al., 2013; Laguionie-Marchais et al., 2013) have found up to an order of magnitude difference in inter-annual abundance of benthic organisms, typically ascribed to increased detrital input from periodic pulses of primary productivity in the water column. Whatever the specific reason, the greater abundance in 2014 was apparent at all stations (outside the disposal mound itself) and therefore reflected a regional phenomenon rather than any effect associated with dredged material disposal at HOODS.

As shown in Figure 27, there was no overall trend of increasing organism density with depth in 2014, in contrast to 2008 (see Figure 9). However, samples in 2014 were collected from a depth range of 41-92 m, compared to a shallower and narrower depth range of 31-67 m in 2008. Within the same depth range sampled in both surveys (41-67 m), a strong correlation between depth and density is apparent in both years (Figure 28). The same holds true for taxon richness: only a slight trend toward increasing richness with depth is apparent across all depths surveyed in 2014 (Figure 27), but a much stronger correlation exists in both surveys within their overlapping depth ranges (Figure 28).

There was a modest correlation in 2014 for increasing infaunal density and richness by location from south to north at the same depth as the disposal site (Figure 27), where no clear trend had been apparent in 2008 (Figure 9). The longer south-north transect that was sampled in 2014 (about 6.25 nmi, versus 4.5 nmi in 2008) may at least partially explain the difference. But in any event this trend was not strong, and the 2014 sampling results again indicate that benthic conditions in the immediate vicinity of HOODS are quite consistent, with no indication that significantly more or less productive benthic habitats occur nearby.

From these and other measurements MTS (2015) determined that, except for one station, the benthic communities present throughout and outside the study area in 2014, including stations with dredged material present (5, 11, 13, and 19; see Figure 21 and Table 5), were similar. Only at Station 21 was there a substantially different benthic community (with abundance, richness, and diversity values as much as an order of magnitude below those of other stations across the study area). Station 21 is on top of the active disposal mound and subjected to repeated disposal of thick layers of sand which has disrupted the otherwise rapid process of benthic recolonization at that location.

MTS (2015) also concluded: “Given potential for rapid recolonization and turnover in benthic infaunal communities, it is probably safe to assume that the most important mechanisms for long-term change in community structure relate to pollution and sediment characteristics. For this reason, careful consideration should be given to the results of physical and chemical sediment testing performed as part of the current study of the HOODS ODMDS. ... Overall, the invertebrate community within the region seems only slightly disturbed by dredge material placement. *If there are no notable differences with regards to the physical or chemical sediment qualities associated with the ODMDS then there are not likely to be lasting impacts to the invertebrate community based on the currently available information*” (emphasis added).

Figure 27. 2014 infaunal organism density and richness around HOODS by depth (Panels A and B) and by location south to north at similar depths (Panels C and D) for station transects outside the disposal mound. Depth in meters is shown above each station name. See Figures 10 and 15 for location of survey stations. (Data source: MTS, 2015.)

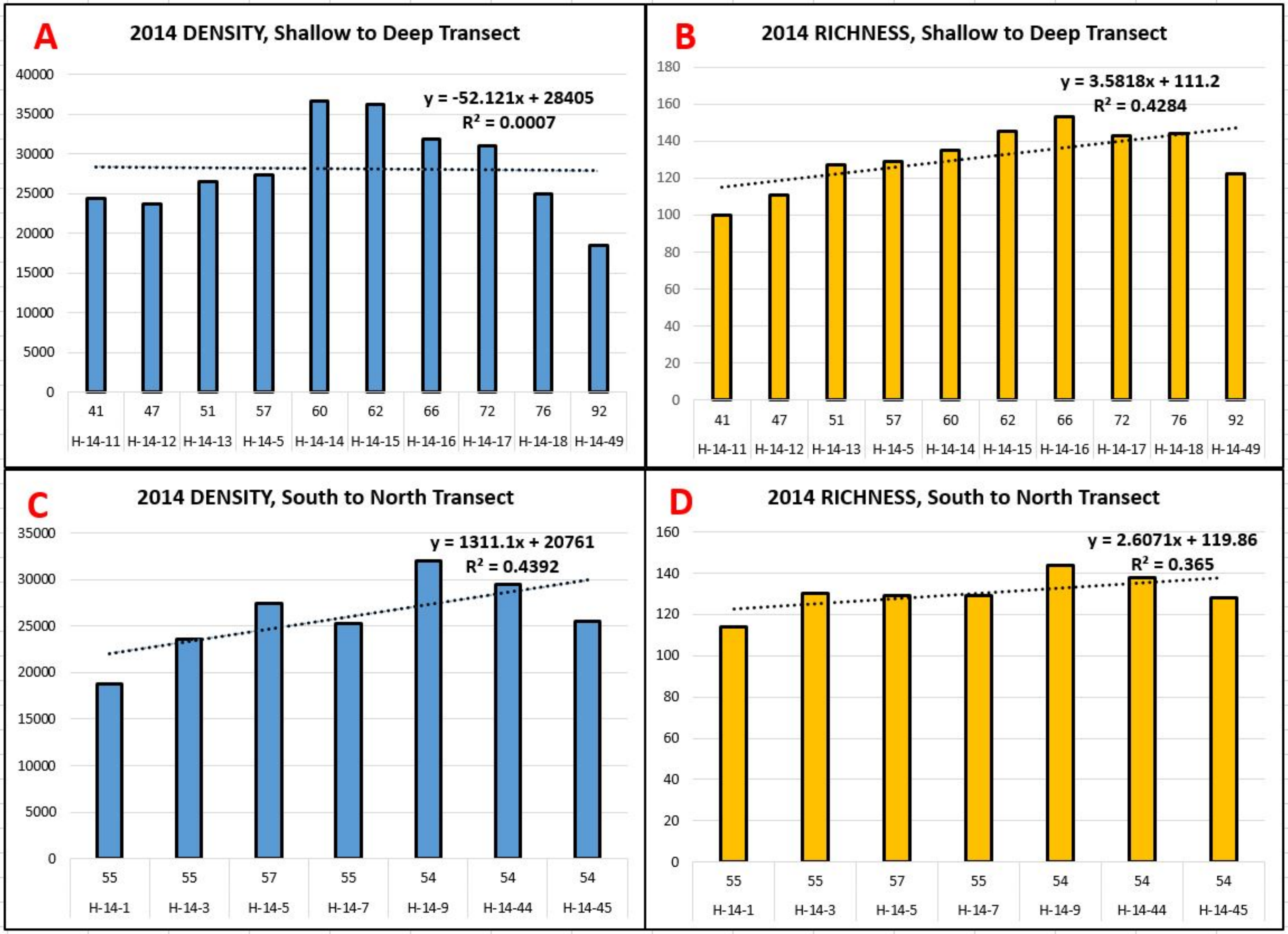
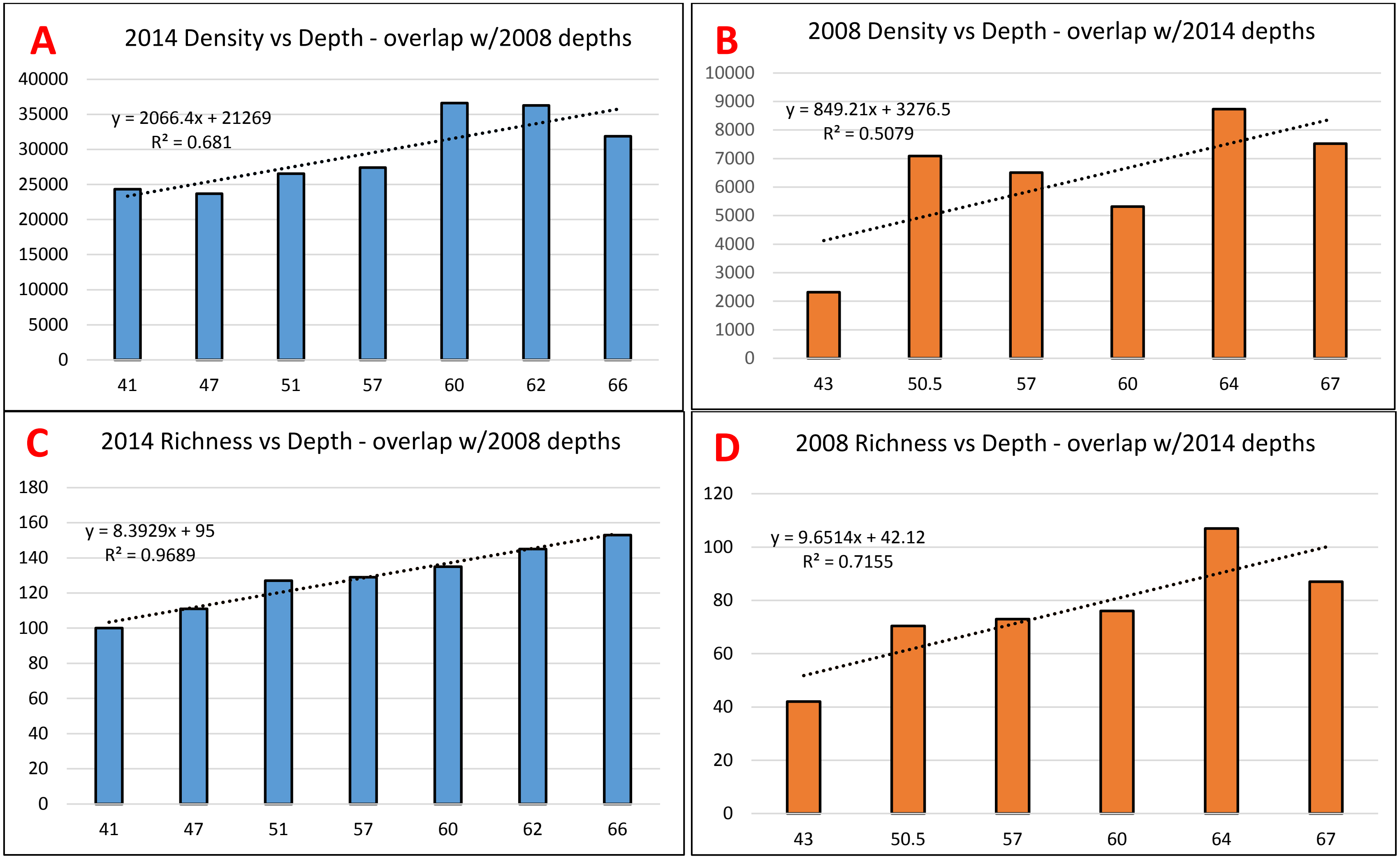


Figure 28. Infaunal organism density (Panels A and B) and richness (Panels C and D) around HOODS for the same depth range sampled in both 2008 and 2014 for station transects outside the disposal mound. Depth in meters is shown for each sample. Similar trends are apparent in each year, in similar depth ranges. (Data source: MTS, 2010 and 2015.)

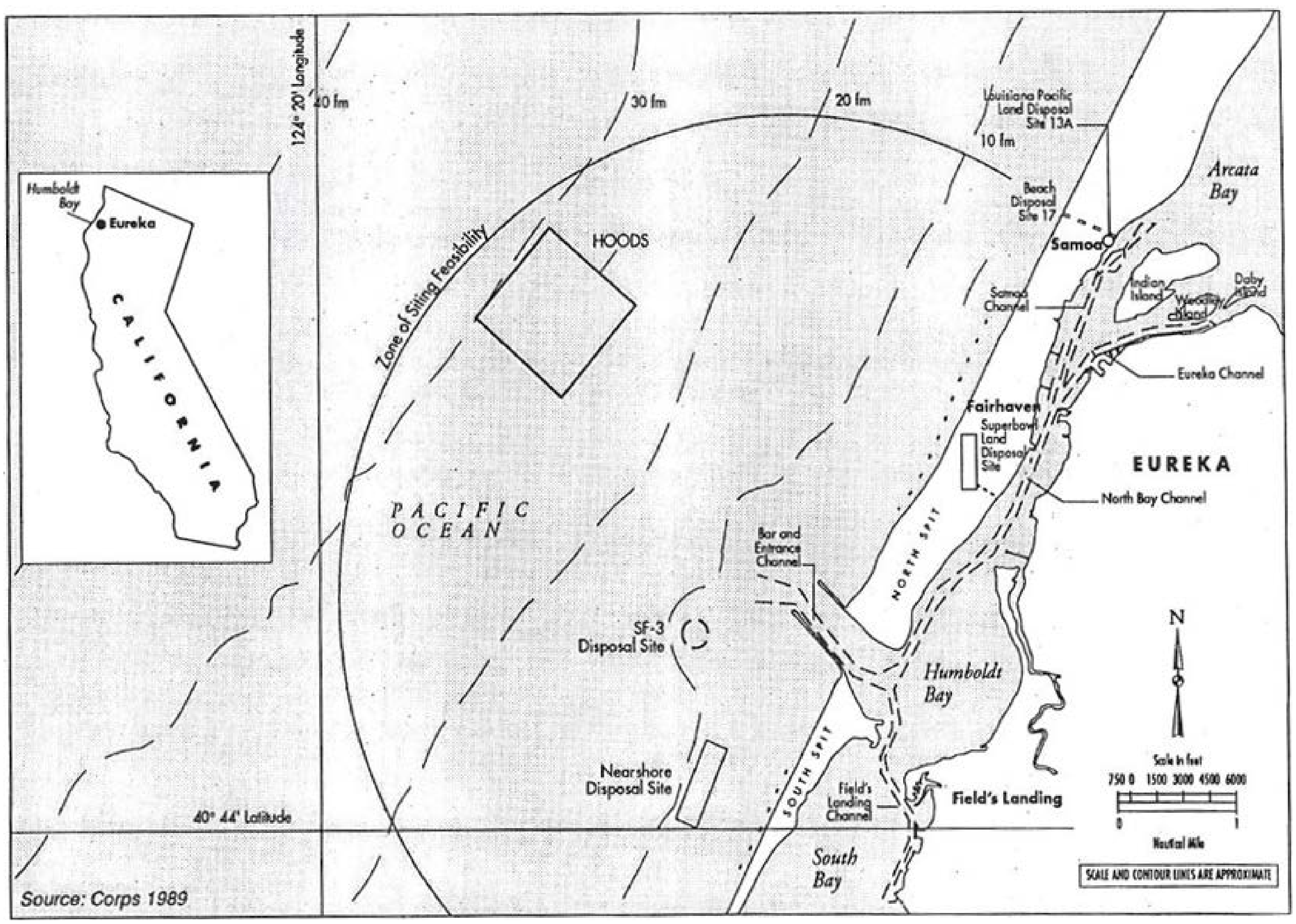


The physical and chemical sediment qualities at and around HOODS have been assessed, as described in Section 3.4.1 above (e.g., see Tables 5 and 6). That assessment confirmed that contaminated sediments have not been disposed at the site. The primary effect on benthic community structure is therefore limited to physical smothering atop the main body of the active disposal mound. Spreading out disposal so that the depth of deposition in any one year does not exceed the ability of benthic organisms to migrate through the deposit or to successfully recolonize on it, could substantially reduce if not eliminate even this physical effect on the benthic community.

4. COMPARISON TO BASELINE CONDITIONS

In support of the permanent designation of HOODS in 1995, baseline studies were conducted in 1989-1991 of regional current and wave conditions, water column and sediment characteristics, benthic macroinvertebrates and infauna, and demersal fish (EPA, 1995; Pequagnat et al., 1990). These studies covered not only the HOODS site, but two alternative locations including the previously used disposal sites known as "SF-3" and the "Nearshore Disposal Site" (NDS) (Figure 29).

Figure 29. Locations of alternative ocean disposal sites evaluated for the HOODS site designation EIS. Baseline studies covered SF-3 and the Nearshore Disposal Site" sites as well as HOODS. (Reproduced from EPA, 1995)



Both SF-3 and the NDS were south of the entrance to Humboldt Bay in shallow water less than 60 ft (18 m) deep, and both of these sites were ultimately eliminated in favor of HOODS due to concerns about mounding near the entrance channel and/or dispersal of dredged sand back into the navigation channel.

The following sections discuss whether and how dredged material disposal at HOODS has affected sediment characteristics and the benthic invertebrate community within the study area, by comparing the results of the pre-designation baseline studies with the comprehensive 2014 monitoring surveys.

4.1 Physical Conditions

Very similar physical conditions were documented during the 2014 monitoring surveys across the study area, compared to the 1989-1990 baseline surveys. Except for the disposal mound itself, both surveys indicate a generally featureless, gradually sloping seafloor comprised of fine sand in the shallower areas transitioning to mixed sand and silt at mid depths, and fine sediments further offshore.

The primary physical change over the past 20 years of disposal operations at HOODS has been the physical growth of the mound within the disposal site boundary itself. Before disposal operations commenced at HOODS, the native seafloor depth ranged from approximately 160-180 feet (50-55 m). After 20 years and roughly 25 million cy of disposal, 30 to 50 feet (10-15 m) of sediment has accumulated (to an average depth of approximately 130 feet). Physical effects outside the disposal site boundary have been negligible, and measurements of both sediment chemistry and benthic communities outside the site boundary (see discussions below) reflect this lack of physical effect.

4.2 Biological Community

Baseline biological studies conducted in 1989 and 1990 included sediment grabs for infaunal community analysis, and bottom trawls for demersal fish and macroinvertebrates (Pequegnat et al., 1990).

4.2.1 Infaunal Community

Infaunal community composition data were collected from a total of 76 grab samples taken at 13 sediment sampling stations in the 1989-1990 baseline surveys (Figure 30). The baseline infaunal community was dominated by polychaetes, crustaceans, and mollusks (Table 8), as was the case in both 2008 and 2014 (see Tables 4 and 7).

The most apparent difference between the surveys is that far more individual organisms were collected in 2014 compared to the baseline surveys (61,215 vs 22,848, respectively), despite the 2014 survey collecting only a third as many grab samples as the baseline surveys (25 vs 76). However, there were important differences in sampling methods between the 1989-1990 baseline and the 2014 survey that make any quantitative comparison of the results difficult. First the baseline survey included several stations in much shallower water than the 2014 survey, and the numbers of both individuals and taxa were much lower in these sandy shallower sediments compared to the offshore locations surveyed in 2014. Second, the baseline surveys used a coarser sieve to collect infauna from the sediment (1.0 mm, vs 0.5 mm used in 2014), and thus would have missed many of the smaller infaunal organisms present.

Figure 30. Sediment and benthic community sampling stations (solid red squares) evaluated in the HOODS baseline studies, 1989-1990. Four of the 1989-90 sampling stations (49N, 49C, 55N, and 55C) are close to the corners of HOODS as it was later designated (red box). Soundings and station names in meters. (Modified from Pequegnat et al., 1990.)

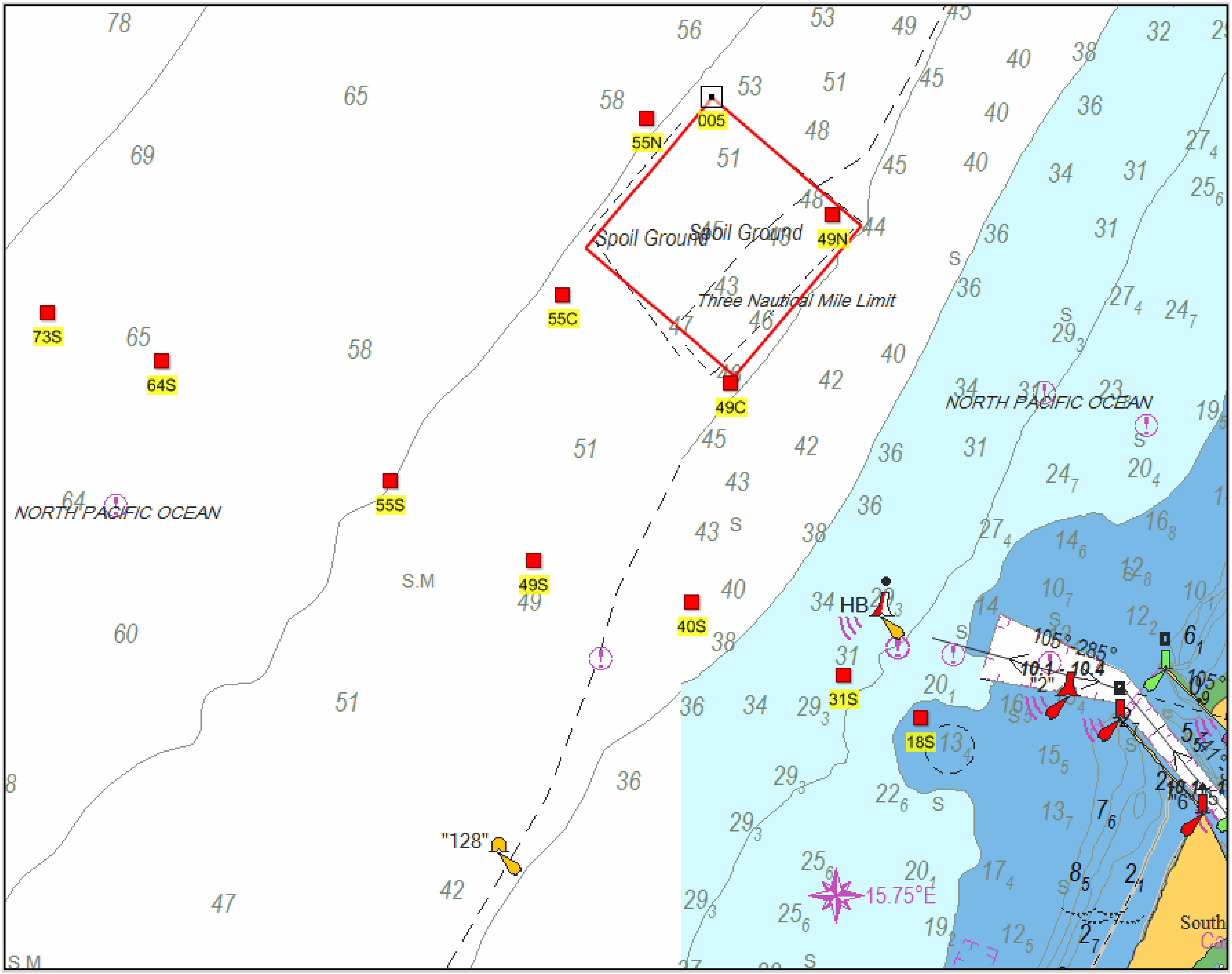


Table 8. Summary of benthic invertebrates collected around HOODS in the 1989-1990 baseline surveys. In all, 22,848 individual organisms and 295 taxa were collected. Although fewer individuals and slightly fewer taxa were identified compared to the 2014 monitoring survey, this is likely attributable to the use of a coarser sieve in the baseline surveys (1.0 mm, vs 0.5 mm in 2014) that would have missed smaller organisms. (Data source: Pequegnat et al., 1990.)

Polychaetes	139	47.1	16,901	74
Crustaceans	89	30.2	2,271	9.9
Mollusks	39	13.2	3,327	14.6
Other Taxa	28	9.5	349	1.5

These differences aside, when comparing the same depth ranges, the 2008 and 2014 monitoring surveys each identified patterns of increasing abundance and increasing taxon richness with depth (Figure 28), just as the baseline surveys did (Figure 31). This held true across the study area, as would be expected in this depth range where the sandier sediments transition to mud. (Infaunal community indices became more stable at the deeper depths surveyed in 2014.)

4.2.2 Benthic Fish and Macroinvertebrates

Bottom trawls for fish and benthic macroinvertebrates such as (Dungeness crab) were conducted during the 1989-90 baseline studies (Pequegnat et al. 1990, and EPA 1995). Figure 32 shows the locations of the trawls, which corresponded to the 13 sediment sampling stations discussed above and shown on Figure 30. Twenty individual trawls were conducted in 1989 (duplicate trawls near 10 stations), and 18 individual trawls were conducted in 1990 (duplicate trawls near 9 stations). Of these 38 total trawls, 26 occurred at “offshore” stations in water greater than 130 feet (40m), corresponding most closely with the depth range of HOODS and the 2014 expanded study area.

Demersal Fishes. Although results varied somewhat seasonally, the demersal fish identified during the baseline surveys within the depth range of the existing HOODS included a mid-depth assemblage occurring from about 130 to 160 feet (40-49 m), and a deeper water assemblage occurring at greater than 180 feet (55 m). The mid-depth assemblage was dominated by Pacific sanddab, Rex sole, and Dover sole (Figure 33). Dominant fishes in the deeper water assemblage reported in the vicinity of HOODS included Dover sole, English sole, Pacific Tomcod, and juvenile stages of several rockfish species. Other species in this assemblage, including Pacific halibut and lingcod, could occur in the area as well. A nearshore assemblage was also identified as occurring at 60 to 100 feet (18 to 30 m) that was dominated by smelt. This assemblage included more individuals caught than from any other assemblage. But the presence of these species dropped away dramatically with water depth and distance from shore (Figure 34).

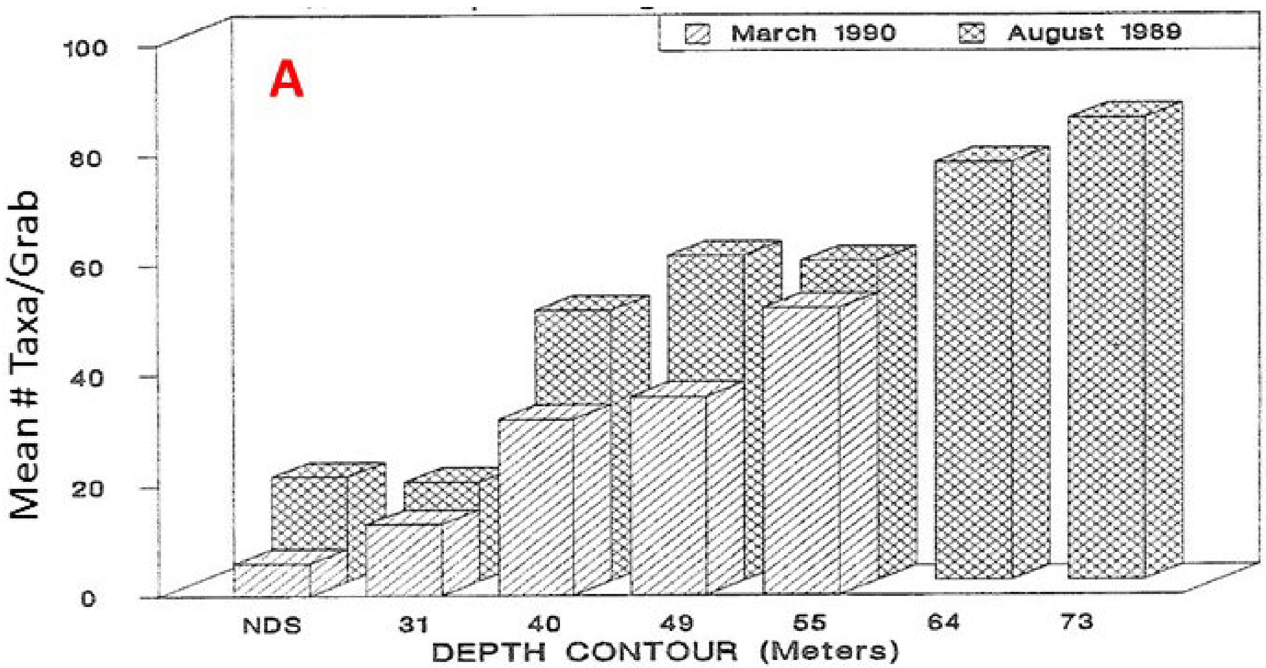
Benthic Macroinvertebrates. The offshore trawls in 1989 and 1990 also collected benthic macroinvertebrates. Chief among these were decapod crustacean (three species of crangonid shrimp, one species of pandalid shrimp, and Dungeness crab) and echinoderms (sand dollars and two species of starfish). As with fish, decapod crustacean numbers generally declined with depth offshore (Figure 35).

4.3 Discussion

Overall, the 2014 (and 2008) physical, chemical, and infaunal community sampling results were quite consistent with the comparable baseline data collected in 1989 and 1990 before the HOODS site was designated. The results indicate that no substantive changes have occurred as a result of disposal operations at HOODS (other than physical burial of infauna on the active disposal mound itself). Furthermore, the 2014 survey covered a much larger area than the baseline surveys, and indicated that from a sediment quality and benthic infaunal community standpoint conditions are quite similar across the site expansion study area.

Trawling for demersal fish and benthic macroinvertebrates done during the baseline studies was not repeated during the 2008 or 2014 surveys. The purpose of the baseline trawls was to identify whether the alternative locations being considered for designation of the permanent disposal site differed significantly in terms of their fish habitat value or fishery use.

Figure 31. Benthic infaunal community differences sorted by depth, identified during the HOODS baseline studies in 1989-1990. Panel "A" shows the mean number of infaunal taxa found per grab, while Panel "B" shows the mean number of individual organisms collected per grab. The increasing numbers of both taxa and individuals found with increasing depth was not repeated in the 2014 survey. However, the 2014 survey did not include shallow stations (less than ~40 m), which in the baseline surveys had the fewest taxa and individuals. (Modified from Pequegnat et al., 1990.)



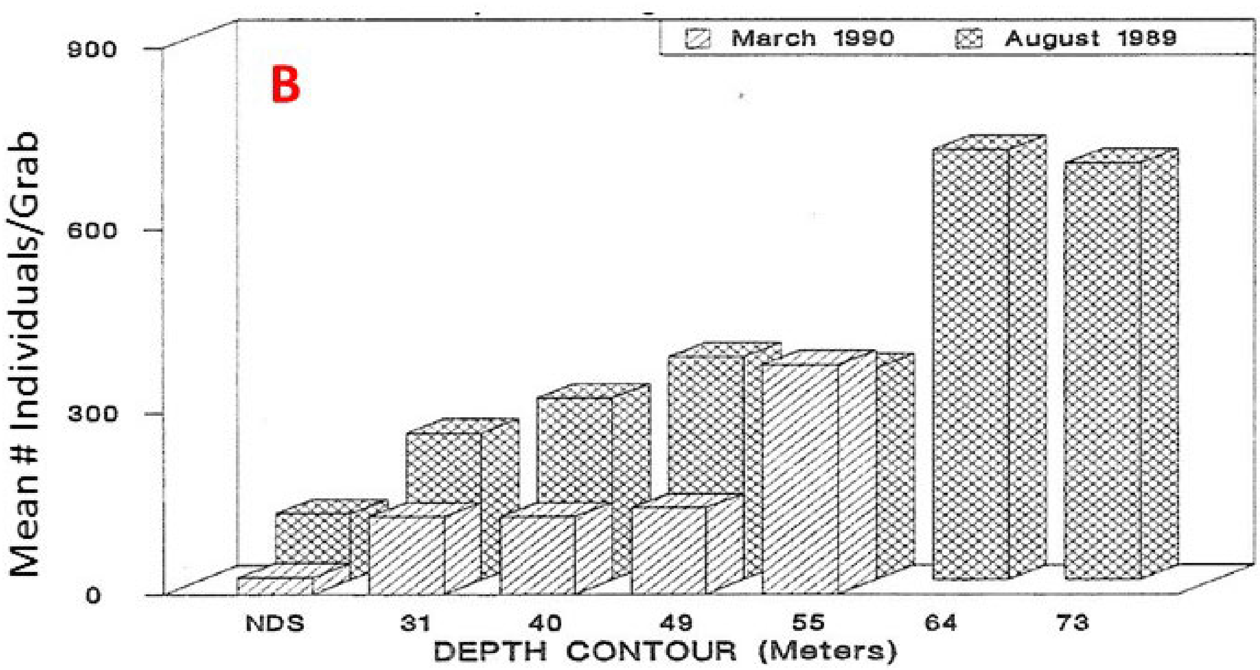


Figure 32. Demersal fish trawl transects sampled as part of the HOODS baseline surveys in 1989 (Panel A) and 1990 (Panel B). HOODS, as it was later designated, is indicated by the red box. Contour lines in fathoms; station names based on depth in meters. (Modified from Pequegnat et al., 1990.)

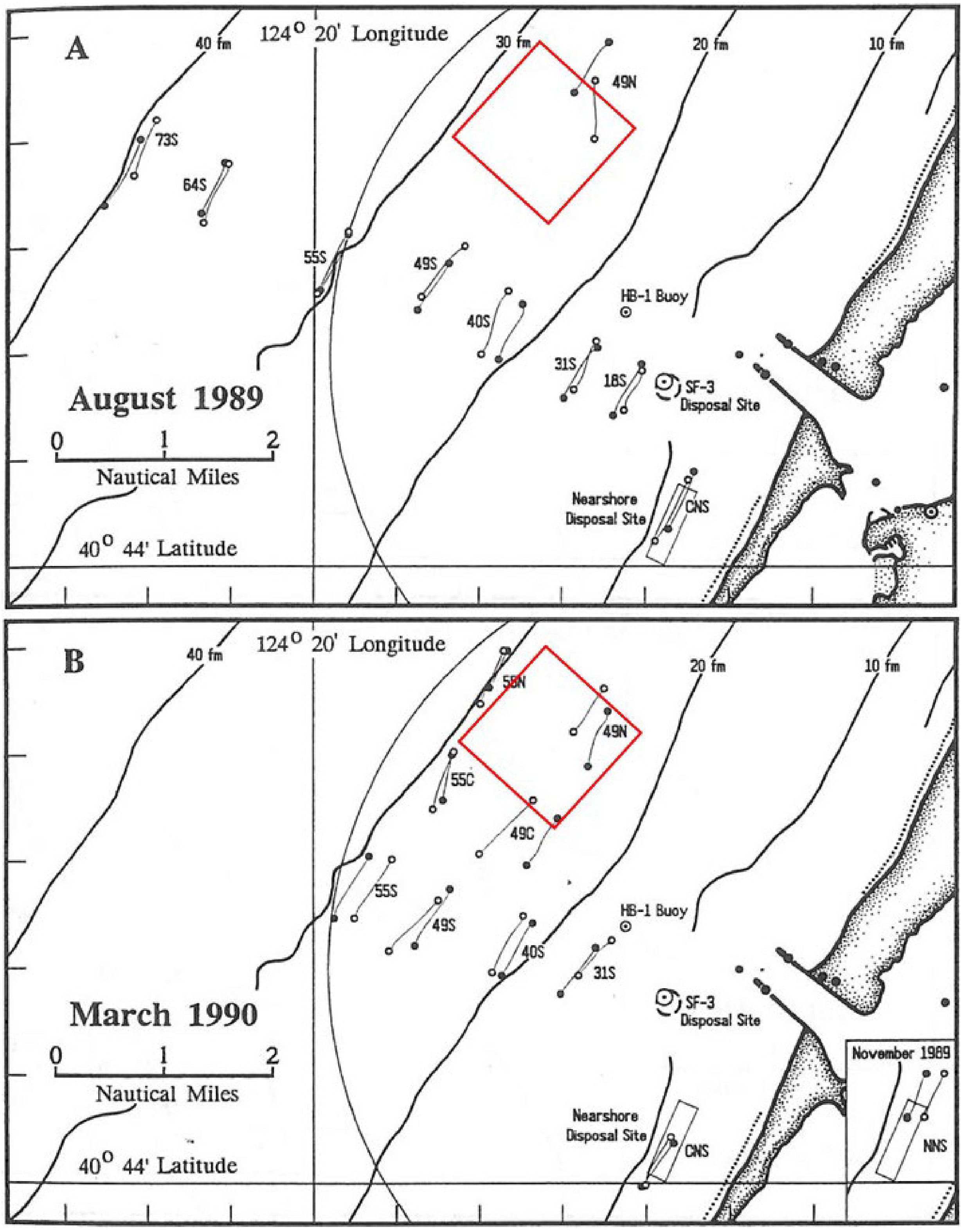


Figure 33. Abundance versus depth for smelt and all other fishes collected during demersal fish trawls conducted as part of the HOODS baseline surveys in 1989-1990. While smelt dominated in the shallower water stations (less than 40 m deep), they were nearly absent in deeper offshore transects. (From Pequegnat et al., 1990.)

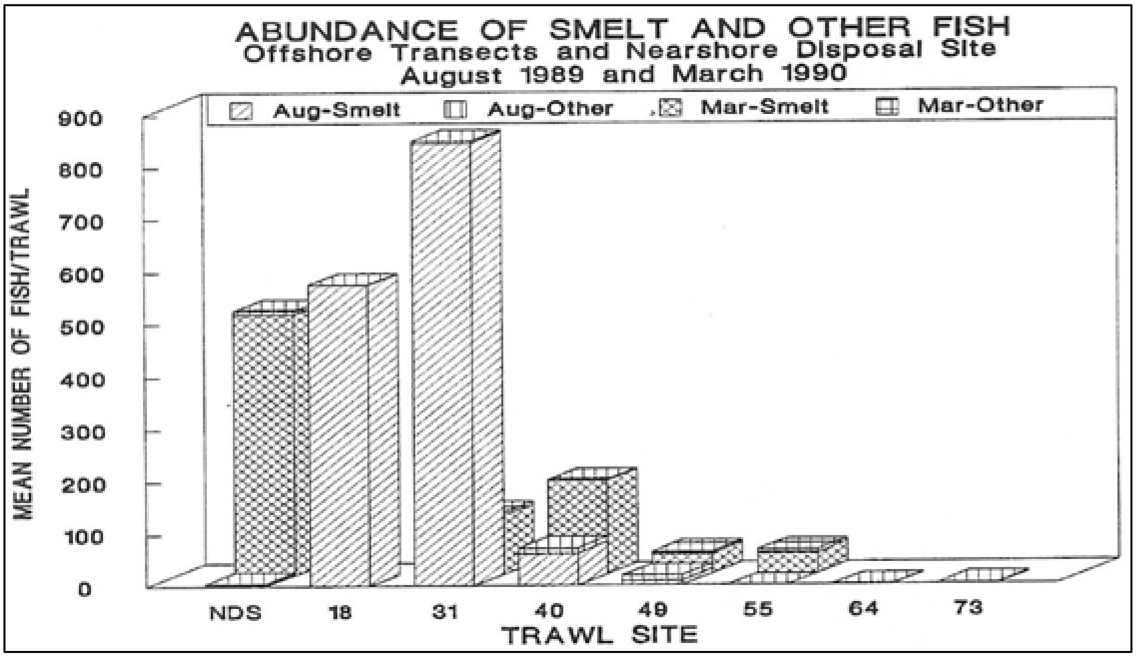


Figure 34. Abundance vs depth for flatfish species collected during demersal fish trawls conducted as part of the HOODS baseline surveys in 1989-1990. Flatfish dominated the mid-depth fish assemblage (including the depth range of the shallowest portions of HOODS), but their numbers dropped off dramatically beyond 160 feet (49 m). (From Pequegnat et al., 1990.)

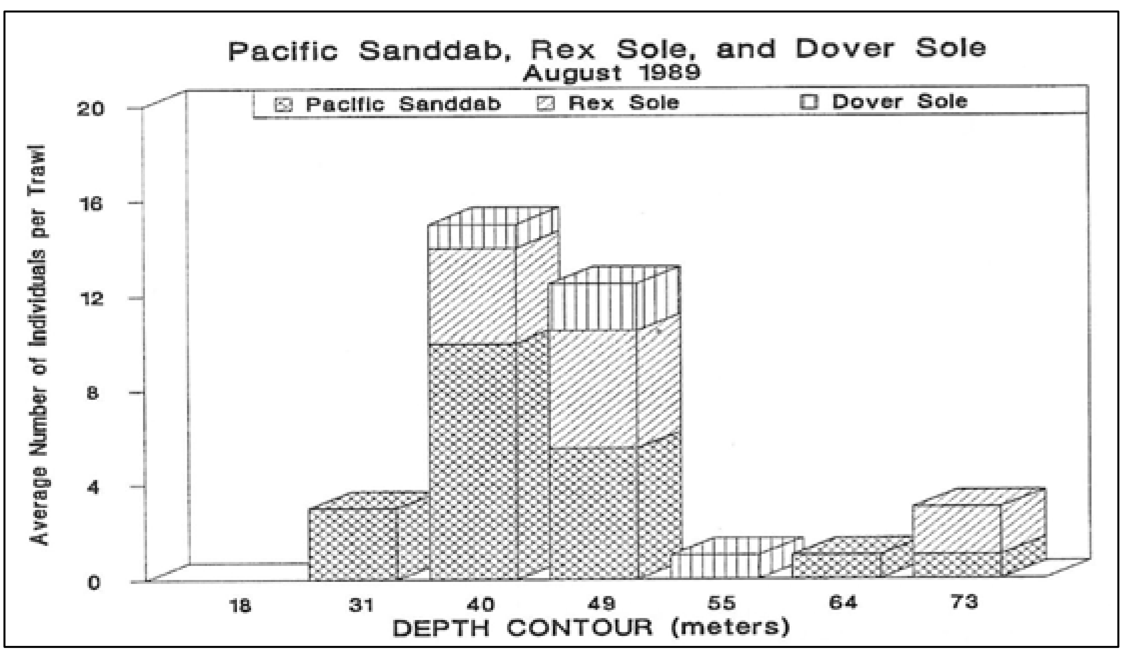
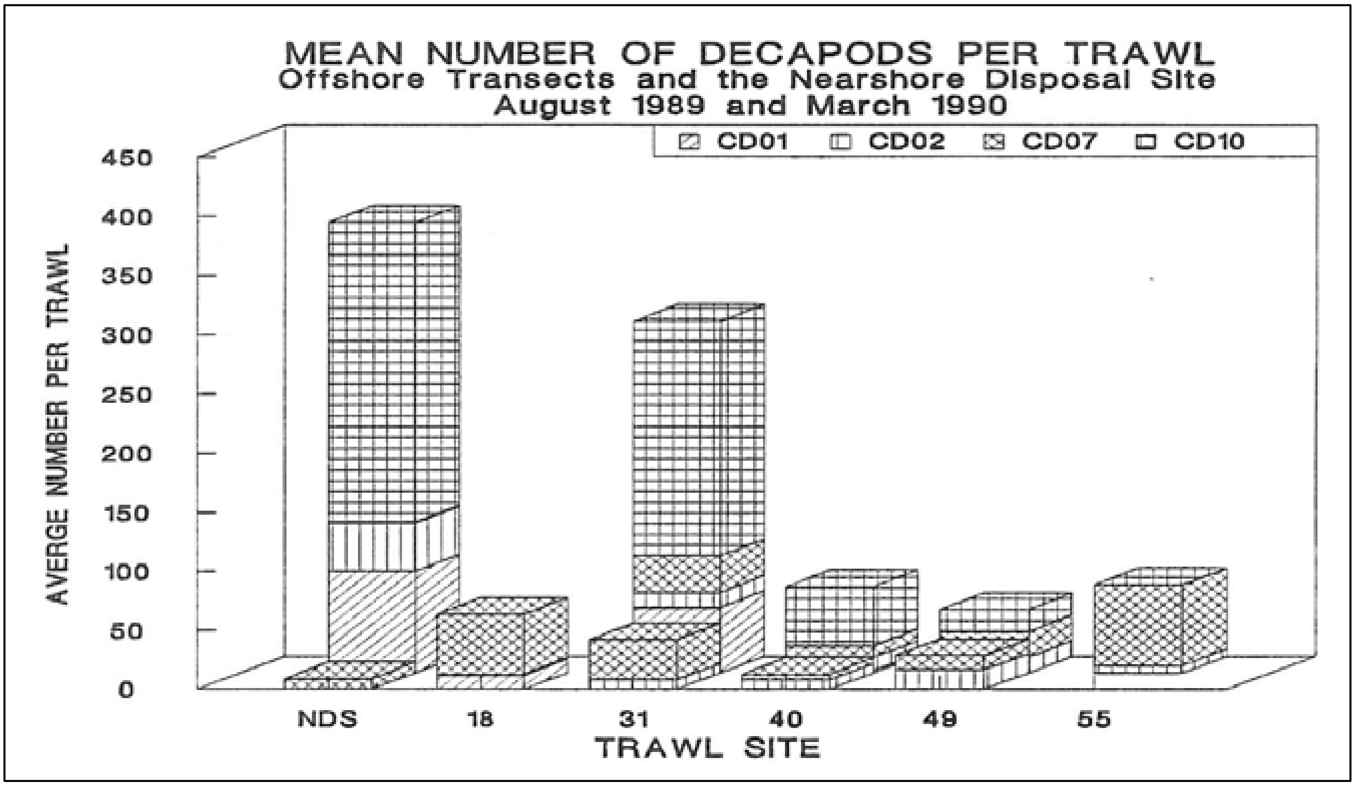


Figure 35. Abundance versus depth for decapod crustaceans (chiefly shrimp and Dungeness crab) collected during trawls conducted during the HOODS baseline surveys in 1989-1990. While quite abundant in the shallower water stations (less than 40 m deep), decapod crustaceans were nearly absent in deeper offshore transects. (From Pequegnat et al., 1990.)



Those studies indeed indicated that fish and macroinvertebrates were much more abundant in shallower, nearshore waters, and the HOODS site (in deeper water farther offshore) was selected in part in order to avoid those higher value habitats.

However, the 2014 (and 2008) surveys also confirmed that there are no unique physical habitats in the deeper offshore waters near HOODS or throughout the expanded study area that might be expected to support substantially different fish and macroinvertebrate communities than those found during the baseline studies. The entire area, for several miles offshore and several miles north-to-south around HOODS, is a gently sloping soft-bottom substrate without reef features or other hard-bottom outcrops. Furthermore, the benthic infaunal community throughout this area is quite uniform, and would also be expected to support a similar demersal fish and benthic macroinvertebrate community. Therefore, since no adverse impacts to regional habitat quality for demersal fish or benthic macroinvertebrates could be identified (other than the physical presence of the active disposal mound itself), EPA determined that no further fish or macroinvertebrate sampling is necessary to characterize the expanded study area at this time.

5. CONCLUSIONS AND RECOMMENDATIONS

Multiple survey activities were conducted in 2008 and 2014 to assess the condition and performance of the EPA-designated Humboldt Open Ocean Disposal Site (HOODS). The survey results were designed to identify whether any adverse impacts of dredged material disposal are occurring compared to baseline conditions, to confirm the protectiveness of the pre-disposal sediment testing required by EPA and USACE, and to serve as a basis for updating the Site Management and Monitoring Plan (SMMP) as appropriate. These goals were achieved. The results also provide a new baseline for a proposal to expand the site boundaries.

The dredged material deposit (footprint) was successfully mapped. Almost all of the dredged material footprint is contained within the existing site boundary. Disposal has occurred at a rate quite consistent with that predicted by the EIS, and mounding has also occurred within the disposal site as predicted. However, the mound has reached the -130 foot (mllw) elevation target across the site much sooner than predicted, as a result of disposal being allowed only over the inner portions of the site. While EPA has managed, and continues to manage the disposal site to minimize mounding above this depth, it is clear that HOODS as it is currently configured has effectively reached its physical capacity. There is very little room remaining within the existing site boundaries for ongoing disposal of the volumes of material (especially sand) that are typically placed at HOODS, without beginning to increase the mound substantially above the -130 foot depth. Therefore, for physical reasons alone, significant changes to the management of HOODS are indicated.

In contrast, extensive sediment sampling confirms that there have been no adverse chemical or biological impacts on site or off site as a result of dredged material disposal operations. Chemical analysis of both on-site and off-site stations indicate only low concentrations of chemicals of concern. Benthic community analyses show that recolonization occurs rapidly after dredged material is deposited (except at the center of the site where thick deposits occur each year), and similar infaunal and epifaunal communities occupy both on-site and off-site areas. Taken together, these results also provide support that the pre-disposal sediment testing program is effective in not allowing sediments with substantial contaminant loads to be discharged at the site.

Finally, physical mapping (via the MBES survey) of an expanded study area covering several square miles west and north of the existing HOODS boundaries confirms that there are no features (such as reefs or other hard-bottom outcrops) that would indicate potential areas of special fish habitat value compared to the baseline studies, in the depth range of HOODS or in the deeper waters of the expanded study area. The baseline studies identified the shallower nearshore waters as having higher habitat value for demersal fish and benthic marcroinvertebrates, and HOODS was designated in deeper offshore waters to avoid this higher value habitat.

Overall, these findings suggest that if the HOODS boundaries were expanded to the west and/or north in the future, no significant adverse chemical or biological effects would be expected. Physical effects would be expected to be substantially reduced if the site were expanded, because dredged material could be managed so that much thinner deposits would occur each year in any one place. Ongoing disturbance from multiple disposal events would also occur less frequently in any one location. These effects work in concert to allow existing benthic organisms to survive and to recolonize more rapidly and fully between disposal events. Of course, site expansion would also allow HOODS to be managed for many years without increasing the risk of any potential navigation hazard developing from ongoing mounding.

It is therefore recommended that the HOODS boundaries be expanded as quickly as possible so that further physical mounding, and any related potential risks to navigation safety, will be minimized. Of course, this recommendation is based on two assumptions:

1. that USACE will need to continue to dredge similar volumes of sand from the Humboldt Bay entrance channel each year, as it has for the past 20+ years; and
2. that beneficial reuse alternatives in the area for this clean sand (such as beach or littoral cell nourishment) will continue to be unavailable or limited in both the near term and the long term.

There is no reason to believe that the dredging needs will significantly decrease in the future. To the contrary, USACE has not always had sufficient funding to fully dredge the entrance channel and interior federal channels of Humboldt Bay. Thus there is a "backlog" of several million cubic yards of material that could be dredged in Humboldt Bay if additional federal funding were to be made available.

Similarly, practicable and reliable opportunities for beneficial reuse of Humboldt Bay entrance channel sand currently do not exist. USACE and the state of California are internally considering the possibility of developing a demonstration project for nearshore (shallow water) placement of sand to nourish the littoral cell north of the entrance channel. However, formal planning has not yet begun and it could be a number of years before a demonstration is performed. It could then take several more years following a successful demonstration before approval for ongoing reuse might be finalized. In the meantime, approximately 1 million cy of sand per year would need to be managed. Prudent planning dictates that expansion of the HOODS boundaries, which is needed now, be pursued now even if reuse opportunities may be actively pursued in the future. Ultimately, if reuse can be successfully implemented in the area, ongoing use of the expanded HOODS site could be curtailed. Mere expansion of the site does not mean the expanded area must be used; EPA and USACE would continue to allow disposal at HOODS on a case-by-case basis, only when other alternatives including beneficial reuse are not practicable.

The recommendation to expand the HOODS boundary would be pursued by EPA via a formal rulemaking process accompanied by the appropriate NEPA documentation and coordination with the California Coastal Commission and state and federal resource agencies. EPA and USACE intend to initiate this process beginning in Fiscal Year 2017. Once the process is completed a revised SMMP would be published for HOODS. Until that time, EPA will continue to manage HOODS under the current SMMP, modified as necessary to minimize mounding risks within the existing boundaries in the short term.

6. REFERENCES

Ambrose, W.G., Jr and P.E. Renaud, 1995. Benthic response to water column productivity patterns: Evidence for benthic-pelagic coupling in the Northeast Water Polynya. Journal of Geophysical Research Vol 100 No. C3. March 15, 1995.

Battelle, 2014. Final Quality Assurance Project Plan (QAPP) for Oceanographic Survey of the EPA-Designated Humboldt Open Ocean Disposal Site (HOODS) Located off Eureka, California. July, 2014. Submitted to EPA Region IX, by Battelle, Columbus, OH. WA 4-16, EPA contract EP-W-04-024.

EPA, 1995. Designation of an ocean dredged material disposal site off Humboldt Bay, California. Final Environmental Impact Statement. San Francisco, CA. Prepared in association with Jones & Stokes Associates, Inc., Bellevue, WA (JSA 93-197 and 94-253).

EPA, 2006. Site Management and Monitoring Plan (SMMP) for the Humboldt Open Ocean Disposal Site. January 2006 Update. EPA Region IX, San Francisco, CA. https://www3.epa.gov/region9/water/dredging/hoods/HOODS-SMMP-2006.pdf

EPA, 2008. Quality Assurance Project Plan for the Humboldt Open Ocean Disposal Site (HOODS) Fall 2008 Survey off Eureka, California: Confirmatory Sediment Chemistry Analysis and Benthic Community Analysis for Ocean Disposal Site Monitoring. September 2008. EPA Region IX, Water Division, Dredging and Sediment Management Team, San Francisco, CA.

EPA and USACE, 1991. Evaluation of Dredged Material Proposed for Ocean Disposal – Testing Manual. EPA 503/8-91/001. EPA Office of Water, Washington, D.C.

eTrac Engineering, 2014. Humboldt Open Ocean Disposal Site Survey, August 2014. Multibeam Survey and Sediment Classification. Prepared for Battelle, San Diego, CA. eTrac, San Rafael, CA.

Fontanier, C., F.J. Jorissen, G. Chaillou, C. David, P Anschutz, and V. Lafon, 2003. Seasonal and interannual variability of benthic foraminiferal faunas at 550 m depth in the Bay of Biscay. Deep-Sea Research I, 50.

Germano & Associates, 2014. Sediment Profile Imaging Report; Oceanographic Survey of the EPA-Designated Humboldt Open Ocean Disposal Site (HOODS), Located off Eureka, California. Prepared for Battelle Memorial Institute, Columbus, OH Contract # EP-w-09-024/WA 4-16 Option Period IV, Subcontract # 433067. Germano and Assoc., Bellevue, WA.

Laguionie-Marchais, C., D.S.M. Billett, G.L.D. Paterson, H.A. Ruhl, E.H. Soto, K.L. Smith Jr., and S. Thatje, 2013. Inter-annual dynamics of abyssal polychaete communities in the North East Pacific and North East Atlantic – a family-level study. Deep-Sea Research I, 75.

Long, E.R., Macdonald, D.D., Smith, S.L. and F.D. Calder, 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management 19: 81.

Marine Taxonomic Services, Ltd., 2010. Results of 2008 Benthic Infaunal Sampling at the Humboldt Open Ocean Disposal Site. Prepared for EPA Region 9. MTS, San Marcos, CA.

Marine Taxonomic Services, Ltd., 2015 (Rev. May 2016). Results of 2014 Benthic Infaunal Sampling at the Humboldt Open Ocean Disposal Site. Prepared for Battelle Memorial Institute, Columbus, OH. PO# US001-0000459042. MTS, San Marcos, CA.

Meyer, K.S., M. Bergmann, and T. Soltwedel, 2013. Interannual variation in the epibenthic megafauna at the shallowest station of the HAUSGARTEN observatory (79°N, 6°E). Biogeosciences 10, June 2013.

NOAA, 2008. Sediment Quick Reference Tables (SQuiRT), NOAA OR&R Report 08-1, Office of Response and Restoration Division, Seattle, WA.

Pequegnat, J.E., D. Mondeel-Jarvis, and J.C. Borgeld, 1990. Sediment characteristics, benthic infauna, demersal fish and macroinvertebrates: Analysis of communities found offshore in waters between 18 and 73 meters deep west of Humboldt Bay, California and at the Nearshore Disposal Site (August 1989, November 1989, and March 1990). Department of Oceanography, Telonicher Marine Laboratory. Humboldt State University, Arcata, CA. Prepared for U.S. Army Corps of Engineers, San Francisco District, San Francisco, CA.

Rhoads, 1974. Organism-sediment relations on the muddy seafloor. Oceanography and Marine Biology: An Annual Review; 12:263-300.

Rhoads and Germano. 1982. Characterization of benthic processes using sediment profile imaging: An efficient method of remote ecological monitoring of the seafloor (REMOTS™ System). Mar. Ecol. Prog. Ser. 8:115-128.

Rhoads, D.C. and J.D. Germano. 1986. Interpreting long-term changes in benthic community structure: A new protocol. Hydrobiologia. 142:291-308.

USACE, 2006. Draft Programmatic 5-Year Environmental Assessment; Humboldt Harbor and Bay Operations and Maintenance Dredging. Prepared by San Francisco District. February, 2006.

USACE, 2015. Humboldt Harbor and Bay Sampling and Analysis Plan (SAP), Grain Size Verification, and Tier III Evaluation. Prepared by San Francisco District, Engineering and Technical Services Division, Planning Branch, Environmental Section A. January, 2015.

APPENDICES

APPENDIX A

Sediment Sampling Station Coordinates
for the
HOODS Monitoring Surveys, 2008

Appendix A. Coordinates (NAD 83) of the 19 sediment sampling stations occupied in 2008 during monitoring surveys at and in the vicinity of HOODS.

Station ID	**Latitude (Degrees-Decimal Minutes)**	**Longitude (Degrees-Decimal Minutes**
HOODS - 1	40-48.561 N	124-17.185 W
HOODS – 2	40-48.504 N	124-17.616 W
HOODS - 3	40-48.229 N	124-17.077 W
HOODS – 4	40-48.156 N	124-17.546 W
HOODS – 5	40-48.950 N	124-16.786 W
HOODS – 6	40-49.368 N	124-16.452 W
HOODS – 7	40 49.802 N	124-16.107 W
HOODS – 8	40-50.232 N	124-15.783 W
HOODS - 9	40-47.705 N	124-17.864 W
HOODS – 10	40-47.312 N	124-18.166 W
HOODS – 11	40-46.886 N	124-18.521 W
HOODS – 12	40-46.476 N	124.18.882 W
HOODS - 13	40-47.963 N	124-16.532 W
HOODS – 14	40-47.689 N	124-15.985 W
HOODS – 15	40-47.424 N	124-15.436 W
HOODS – 16	40-48.786 N	124-18.156 W
HOODS – 17	40-49.057 N	124-18.688 W
HOODS – 18	40-49.317 N	124-19.252 W
HOODS - 19	40-49.572 N	124-19.804 W

APPENDIX B

Benthic Invertebrate Taxa and Counts
from the
HOODS Study Area, 2008

(Data from MTS, 2010)

APPENDIX B

Humboldt Open Ocean Disposal Site (HOODS)
2008 INVERTEBRATE SPECIES DATA
For US EPA - Req # PROAOTA-7TXMU QT-CA-09-000326
By Marine Taxonomic Services, Ltd.
April, 2010

	INSIDE				OUTSIDE															
Station	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-16	B-17	B-18	B-19	
POLYCHAETA																				**TOTALS**
Amaeana occidentalis					14	17	31	27	19	9	2	10	2	1	1	16	16	11	7	183
Ampharete acutifrons						1			2	2	4	2		1				1		13
Ampharete finmarchica																		3		3
Ampharete labrops					1				1											2
Ampharete sp juv					1			1	1				2	1				3	6	15
Amphicteis glabra								1												1
Aphelochaeta monilaris					2	2	1	4	21	1	6		2			67	74	136	89	405
Aphelochaeta sp								6	6									2		14
Apistobranchus ornatus																1	1	7	4	13
Aricidea antennata									2	1	4	1	2							10
Aricidea lopezi					9	18	6	16	16	8	21	14	2			14	9	16	7	156
Aricidea ramosa																			6	6
Aricidea sp 1								1	13	6	9									29
Artacama coniferi					1	2			1								2			6
Autolytus sp					2	4														6
Barantolla americana					2															2
Boccardia polybranchia						2	2	1	3		1	1				1				11
Capitella capitata hyperspecies					2						1									3
Capitellidae			2													1		1		4
Chaetoderma sp																			1	1
Chaetozone nr setosa																			1	1
Chaetozone sp	21	18	34	5	140	199	104	84	182	201	297	69	27	13	58	42	20	12	10	1536
Chone dunneri					6	8	6	6	7	3	8	5				2		1	1	53
Chone sp				1																1
Cirratulidae	1		1	1	7	14	6	4	21	7	8	6	11		1	30	17	26	18	179
Cirrophorus branchiatus					5		1	4	12	2	2					1		1	1	29
Cossura pygodactylata																12	2	21	6	41
Decamastus gracilis	2		6	1	24	18	11	8	29	14	14	11			1	19	10	10	14	192
Diopatra ornata					4	2	1		4	3							2	1	1	18
Dipolydora socialis						1				1										2
Dorvillea sp 1									1		2					1		1	3	8
Drilonereis falcata							2	1	2	3	1	1								10
Eranno bicirrata						1											1			2
Eteone sp	3				13	15	12	12	12	7	5	3	7	2	1	9	11	4	2	118
Euchone sp juv											1									1
Euclymeninae						1		1			2					3	8	12	8	35
Eulalia sp 1																		1		1
Exogone molesta																		1		1
Galathowenia oculata																3	9	10	5	27
Glycera nana					3	2	3		2	2	2	1			1	4	2	5	2	29
Glycera oxycephala	6	3	7	17											1					34
Glycera pacifica											1									1
Glycinde americana					10	2	5	2	4	3	1	1			1	5	4	2		40
Goniada maculata					1	5	2	7	8	4	2	3					2	2	2	38

2008 INVERTEBRATE SPECIES DATA, continued

	INSIDE				OUTSIDE															
Station	**B-1**	**B-2**	**B-3**	**B-4**	**B-5**	**B-6**	**B-7**	**B-8**	**B-9**	**B-10**	**B-11**	**B-12**	**B-13**	**B-14**	**B-15**	**B-16**	**B-17**	**B-18**	**B-19**	
POLYCHAETA, continued																				**TOTALS**
Heteromastus filobranchus						1	2	1	7	1	2					10		4	1	29
Heteromastus filiformis	1	1	1																	3
Heteropodarke heteromorpha	4	3	12	4					21											44
Lanassa venusta											1	1						1		3
Laonice cirrata							2	2	1									2	2	9
Leitoscoloplos pugettensis	1				13	17	20	17	10	20	6	10	8	15	2	2				141
Lepidasthenia berkeleyae					1	1			1								1			4
Levinsenia gracilis					10	7	4	1	10	1	5					5	6	26	30	105
Lumbrineridae		1			11	9	6	5	8	4	1	1	3	1	3	15	9	11	3	91
Lumbrineris limicola					4	8	10	13	10	4	3	3	4			1	3	2	3	68
Macrophthalmus sczelkowii					2	8	3		1			1	1							16
Magelona longicornis	5			3	36	35	35	75	57	46	65	15	22	23	1	18	22	45	56	559
Magelona sacculata	15	12	45	3	4			5				8	30	101	59					282
Maldane glebifex																		4	8	12
Mediomastus sp			2		21	73	26	52	111	33	32	2	9	11	7	53	17	26	49	524
Melinna elisabethae																			1	1
Metasychis disparadentata									3								2		1	6
Myriochele olgae																		2		2
Naineris quadricuspida						4														4
Nephtys caecoides			1		8	12	4	9	15	8	15	20	30	18	7	6	2	9	3	167
Nephtys cornuta					1															1
Nephtys ferruginea					4	1	2		1		1					1	5	6	2	23
Nephtys sp juv	1		1	1	1	3		2	4	3	3	4	5	1		1	4			34
Nereis procera					1		1											1	2	5
Ninoe palmata																13	12	23	16	64
Notomastus latericius		1													1					2
Oligochaeta		2			1															3
Onuphidae juv				2	1	1		2												6
Onuphis iridescens	1				5	5	9	7	15	1	2		5	1		1		1	4	57
Ophelia limacina			1																	1
Ophelina acuminata						1										4				5
Orbiniidae juv					3	3		1												7
Owenia fusiformis														29		2				31
Paraprionospio pinnata					1	1			1		3									6
Pectinaria californiensis								1												1
Pherusa plumosa					1		2			1										4
Pholoe minuta					3	4			1	3								1		12
Pholoe sp N-1									1								4	3	1	9
Phyllodoce groenlandica																	1	1	1	3
Phyllodoce hartmanae	1																			1
Phyllodoce sp juv					2	3				1								3		9
Phylo felix									1		1	8	4	1	9					24
Phylo sp						1	6	6	2	2	1							1		19
Pilargis maculata					1				1										2	4
Pista bansei																		1	2	3
Pista elongata														1						1
Pista moorei																		1	1	2
Pista wui																	1	3	5	9
Podarkeopsis perkinsi					3	5	3	1	6	1	2	1	2		1					25
Polycirrus sp complex	7	4	8		3	4	9	9	12	7	9	7	7	10	12	8	13	11	37	177
Polydora brachycephala					1			1												2

2008 INVERTEBRATE SPECIES DATA, continued

	INSIDE				OUTSIDE															
Station	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-16	B-17	B-18	B-19	
POLYCHAETA, continued																				**TOTALS**
Polydora caulleryi									1		1					1				3
Polynoidae	3		2		5	10	11	14	10	9		6	5	2		5	2	1	2	87
Praxillella affinis																			1	1
Praxillella gracilis																		4	5	9
Prionospio jubata						3	2		2		1	1			1	2	3		2	17
Prionospio lighti					4	11	3	13	12	7						10				60
Rhodine bitorquata																1	3	20	16	40
Sabellidae juv					1		1	1			1					1		2		7
Scalibregma californica																1	2	1	4	8
Scoletoma luti					56	40	23	18	73	41	21	9			4	83	55	16	30	469
Scoloplos armiger															34					34
Sigalion spinosus							2					1								3
Sigambra sp 1																		5	4	9
Sphaerodoropsis sphaerulifer																	1	1		2
Spio filicornis	20	5	13	3							1	1	1	2	5					51
Spiophanes berkeleyorum	3					1		2	1	2	4	1	5	1		6	16	25	15	82
Spiophanes bombyx	23	12	6	21										1	5		1	2		71
Spiophanes sp					2	1														3
Sternaspis nr. fossor							1									6	12	32	28	79
Sthenalais tertiaglabra																	1			1
Syllidae sp juv					1										2					3
Tenonia priops								2	1	2										5
Terebellidae juv					1	2	2					2				4		1		12
Terebellides californica																		2	1	3
Terebellides stroemi					1											1	1	5	6	14
Trichobranchus glacialis																	2	5	1	8
Typosyllis elongatus																	1	1	3	5
Polychaete Count Totals	**118**	**62**	**142**	**62**	**460**	**589**	**382**	**446**	**769**	**474**	**575**	**230**	**196**	**236**	**218**	**492**	**392**	**601**	**542**	**6986**
Polychaete Richness (# taxa)	**18**	**11**	**16**	**12**	**53**	**49**	**40**	**43**	**54**	**39**	**45**	**34**	**24**	**21**	**24**	**45**	**45**	**65**	**57**	
	INSIDE MEANS:				**OUTSIDE MEANS:**															
	Counts: 96.00				**Counts: 440.1**															
	Richness: 14.3				**Richness: 42.5**															

MOLLUSCA	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-16	B-17	B-18	B-19	**TOTALS**
Astyris gausapata					20	6	3	2	42			1				4	2		1	81
Astyris? sp juv						2														2
Axinopsida serricata					35	34	27	61	49	19	75	72	1	3		21	13	96	89	595
Bivalvia sp. broken										1										1
Chaetoderma sp																	1	9	1	11
Compsomyax subdiaphana																	1			1
Cyclocardia ventricosa																		1	2	3
Cylichna attonsa																1				1
Ennucula tenuis					1	1		5	3								6	18	8	42
Gastropoda sp broken					1															1
Macoma carlottensis																1		4	2	7
Macoma elimata									1							2	1	1	1 dead	5
Macoma nasuta									3	1										4
Macoma sp						2	1									2	2	13	10	30
Macoma yoldiformis							1	1												2
Mysella cf. pedroana																	1			1
Mytilus sp juv					3	1	4		3	2						1		1		15

2008 INVERTEBRATE SPECIES DATA, continued

	INSIDE				OUTSIDE															
Station	**B-1**	**B-2**	**B-3**	**B-4**	**B-5**	**B-6**	**B-7**	**B-8**	**B-9**	**B-10**	**B-11**	**B-12**	**B-13**	**B-14**	**B-15**	**B-16**	**B-17**	**B-18**	**B-19**	
MOLLUSCA, continued																				**TOTALS**
Nuculana sp juv																	2			2
Nuculanoidea sp juv					1	6														7
Olivella baetica	4	2	3	22											1					32
Olivella biplicata			1																	1
Olivella sp juv														1	2					3
Pandora filosa																		1		1
Parvilucina tenuisculpta																			1	1
Pulsellum salishorum																		1		1
Rochefortia cf. coani						1														1
Rochefortia sp juv															5					5
Rochefortia tumida						3	6		1	1				2			1	1	1	16
Siliqua cf. alta					1			2							2					5
Siliqua sp						1							2	10	6					19
Solen sicarius							1	1	2		frag.									4
Tellina modesta													1	2						3
Tellina nuculoides	1	1																		2
Thracia trapezoides																		1		1
Xylophaga washingtona					2															2
Yoldia seminuda					1	2	7	2								1				13
Mollusk Count Totals	**5**	**3**	**4**	**22**	**65**	**59**	**50**	**74**	**104**	**24**	**75**	**73**	**4**	**18**	**16**	**33**	**30**	**147**	**115**	**921**
Mollusk Richness (# taxa)	**2**	**2**	**2**	**1**	**9**	**11**	**8**	**7**	**8**	**5**	**2**	**2**	**3**	**5**	**5**	**8**	**10**	**12**	**10**	
	INSIDE MEANS:				**OUTSIDE MEANS:**															
	Counts: 8.50				**Counts: 59.1**															
	Richness: 1.75				**Richness: 7.0**															

CRUSTACEA																				**TOTALS**
Ampelisca unsocalae					17	12	24	25	18	13	43	39	8		1	16	5	23	15	259
Aoroides secundus														1	1					2
Argissidae sp									1											1
Calanoida sp							1		1							13	1	3	14	33
Cancer magister			1		1				1											3
Caprella laeviscula					4	14	3		3							3	17	2	1	47
Cheirimedeia macrocarpa					16	7	7	2	7	15	10				2		2	1		69
Cheirimedeia sp					57	47	29	1	53	62	1	1	1		10	6	4	7		279
Crangon alaskensis			1																	1
Desdimelita desdichada					8	2	1		3	12		1					6	3		36
Diastylis abbotti					1	1		2	3	3							1	8	4	23
Diastylis dawsoni					8	6	2	8	5	3	5	2	2	1	9	1		2	3	57
Eudorella pacifica																		2	4	6
Euphilomedes producta																1	1		4	6
Gammaropsis shoemakeri					9				10	9							2			30
Gammaropsis sp					21	1	19		7								14	1		63
Gnorimosphaeroma noblei														1						1
Hemilamprops californicus						2		2	3				1				1			9
Ischyrocerus sp													1					1		2
Kamptopleustes coquillus						1			3	1			1			1		1		8
Mysidacea																		1		1
Pacifoculodes spinipes	1				1	2								2		1				7
Pagurus armatus		1																		1
Photis brevipes																	2	1	3	6
Photis lacia						2	4	1	10	1						3	1			22
Photis sp					10	7	29	2		6	5	2	2			12	2	2	6	85

2008 INVERTEBRATE SPECIES DATA, continued

	INSIDE				OUTSIDE															
Station	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-16	B-17	B-18	B-19	
CRUSTACEA, continued																				**TOTALS**
Pinnixa schmitti									2							5				7
Prachynella lodo																		2		2
Protomedeia articulata					15	5	29	17	27	12	11	6				2				124
Protomedeia nr. prudens									2	1										3
Protomedeia sp					15	27	9	31	29	13	5	2	7		3	19	10	4	10	184
Resupinus sp				1																1
Rhepoxynius daboius												7	1	1						9
Rhepoxynius sp														3		3				6
Rhepoxynius variatus					10	8	21	14	18	13	8		1	1	1		9	13		117
Synidotea harfordi					1	2	1		2	3					1	3	3	1		17
Tiron biocellata					4					1			2							7
Uromunna ubiquita					1	1	3			1								4	1	11
Crustacean Count Totals	**1**	**1**	**2**	**1**	**199**	**147**	**182**	**105**	**208**	**169**	**88**	**60**	**27**	**10**	**28**	**89**	**81**	**82**	**65**	**1545**
Crustacean Richness (# taxa)	**1**	**1**	**2**	**1**	**18**	**18**	**15**	**11**	**21**	**17**	**8**	**8**	**11**	**7**	**8**	**15**	**17**	**20**	**11**	

INSIDE MEANS:		OUTSIDE MEANS:	
Counts:	1.25	Counts:	102.7
Richness:	1.25	Richness:	13.7

MISCELLANEOUS SPECIES	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-16	B-17	B-18	B-19	**Totals**
Amphiodia periercta					1	1			1			1								4
Amphiodia sp juv					4		2	1			3	2	1				2	5	1	21
Amphiodia urtica					1	1	3		1		1							1	1	9
Amphioplus sp																		1		1
Amphioplus strongyloplax																1				1
Amphiuridae juv							1		1	2	1			3					1	9
Carinoma mutabilis			2	2									1		3					8
Cerebratulus sp															1					1
Cerianthidae																			1	1
Golfingia sp																				0
Micrura sp	3		1				1		1			1	2		1	2	5		1	18
Nematoda						5	4	6	5		2					30	21	22	20	115
Nemertinea														1					3	4
Ophiurida juv											1	1	1	1	2			1		7
Pachycerianthus sp																		2	1	3
Paranemertes californica					2	2	1											1		6
Peachia quinquecapitata							1							1				1		3
Phoronis sp																2				2
Tetrastemma nigrifrons						1	1			1										3
Tetrastemma sp															1	2				3
Thysanocardia nigra																	1	3		4
Tubulanus polymorphus					1	1												6	1	9
Urticina coriacea							1													1
Misc. Spp. Count Totals	**3**	**0**	**3**	**2**	**9**	**11**	**15**	**7**	**9**	**3**	**8**	**5**	**5**	**6**	**8**	**37**	**29**	**43**	**30**	**233**
Misc. Spp. Richness (# taxa)	**1**	**0**	**2**	**1**	**5**	**6**	**9**	**2**	**5**	**2**	**5**	**4**	**4**	**4**	**5**	**5**	**4**	**10**	**9**	

INSIDE MEANS:		OUTSIDE MEANS:	
Counts:	2.0	Counts:	15.0
Richness:	1.0	Richness:	5.3

	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-16	B-17	B-18	B-19	
TOTAL COUNTS, ALL TAXA	**127**	**66**	**151**	**87**	**733**	**806**	**629**	**632**	**1090**	**670**	**746**	**368**	**232**	**270**	**270**	**651**	**532**	**873**	**752**	**9685**
RICHNESS, ALL TAXA	**22**	**14**	**22**	**15**	**85**	**84**	**72**	**63**	**88**	**63**	**60**	**48**	**42**	**37**	**42**	**73**	**76**	**107**	**87**	

INSIDE MEANS:		OUTSIDE MEANS:	
Counts:	107.8	Counts:	616.9
Richness:	18.3	Richness:	68.5

APPENDIX C

Sediment Sampling Station Coordinates
for the
HOODS Monitoring Surveys, 2014

Appendix C. Coordinates (NAD 83) of the 51 sediment sampling stations occupied in 2014 during monitoring surveys at and in the vicinity of HOODS and the expanded study area.

Station ID	Latitude (Deg-Dec.Min)	Longitude (Deg-Dec.Min)
H-14-01	40 47.350 N	124 19.050 W
H-14-02	40 47.750 N	124 18.700 W
H-14-03	40 48.200 N	124 18.275 W
H-14-04	40 48.575 N	124 17.950 W
H-14-05	40 49.000 N	124 17.600 W
H-14-06	40 49.400 N	124 17.250 W
H-14-07	40 49.850 N	124 16.870 W
H-14-08	40 50.275 N	124 16.500 W
H-14-09	40 50.700 N	124 16.150 W
H-14-10	40 51.100 N	124 15.850 W
H-14-11	40 48.230 N	124 15.900 W
H-14-12	40 48.500 N	124 16.500 W
H-14-13	40 48.750 N	124 17.000 W
H-14-14	40 49.280 N	124 18.150 W
H-14-15	40 49.550 N	124 18.700 W
H-14-16	40 49.825 N	124 19.270 W
H-14-17	40 50.100 N	124 19.800 W
H-14-18	40 50.350 N	124 20.350 W
H-14-19	40 47.050 N	124 16.950 W
H-14-20	40 47.550 N	124 17.100 W
H-14-21	40 48.000 N	124 17.275 W
H-14-22	40 48.500 N	124 17.450 W
H-14-23	40 49.490 N	124 17.775 W
H-14-24	40 49.975 N	124 17.900 W
H-14-25	40 50.450 N	124 18.000 W
H-14-26	40 50.950 N	124 18.100 W
H-14-27	40 51.450 N	124 18.250 W
H-14-28	40 51.925 N	124 18.350 W
H-14-29	40 49.425 N	124 15.000 W
H-14-30	40 49.310 N	124 15.650 W
H-14-31	40 49.200 N	124 16.300 W
H-14-32	40 49.100 N	124 16.950 W
H-14-33	40 48.910 N	124 18.260 W
H-14-34	40 48.825 N	124 18.900 W
H-14-35	40 48.750 N	124 19.550 W
H-14-36	40 48.670 N	124 20.200 W
H-14-37	40 48.600 N	124 20.850 W
H-14-38	40 47.030 N	124 18.115 W
H-14-39	40 47.970 N	124 19.840 W
H-14-40	40 49.400 N	124 20.200 W
H-14-41	40 50.625 N	124 19.100 W
H-14-42	40 50.960 N	124 17.130 W
H-14-43	40 50.200 N	124 15.450 W
H-14-44	40 51.550 N	124 15.500 W
H-14-45	40 52.450 N	124 14.870 W
H-14-46	40 52.450 N	124 18.500 W
H-14-47	40 52.900 N	124 18.630 W
H-14-48	40 50.600 N	124 20.940 W
H-14-49	40 50.900 N	124 21.500 W
H-14-50	40 48.450 N	124 22.170 W
H-14-51	40 50.600 N	124 15.570 W

APPENDIX D

Benthic Invertebrate Taxa and Counts from the HOODS Study Area, 2014

(Data from MTS, 2015)

APPENDIX D

Marine Taxonomic Services

HOODS 2014 INVERTEBRATE SPECIES DATA

MASTER LIST

	2014 STATION																									
	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	
Depth (m)	57	41	51	41	42	55	55	55	54	47	60	62	66	72	76	62	67	71	39	50	62	66	54	54	92	
POLYCHAETA	"Inside" Stations					"Outside" Stations																				TOTALS
Amage anops											1														2	3
Ampharete acutifrons	2		1	1												1										5
Ampharete finmarchica									1				2	5	1	1	1	3			2	4			1	21
Ampharete labrops			1																							1
Ampharete sp.									1		6	2	7	1											2	19
Ampharetidae		2					5	2	3	1	11	27	9	20	18	11	12	7		1	15	16	14	8	19	201
Amphicties sp.						1						1	1		3										1	7
Anobothrus gracilis								2								2					1	1		2		8
Aphelochaeta monilaris			1								1															2
Aphelochaeta sp.		2								2																4
Apistobranchus ornatus						2	1	8	7		15	5	3	4	6	32	2	2			56		8	10	6	167
Aricidea pacifica	2	1						4	1				3		2										10	23
Aricidea sp.	15	3	3	2		23	12	45	36	7	36	28	45	47	53	29	22	23	6	15	33	25	33	18	94	653
Armandia brevis			1																							1
Artacama coniferi						1							1	1			1	1		1	1					7
Asabellides sp.														1												1
Barantolla americana			1																							1
Boccardia pugettensis	4			1						3									1							9
Brada sp.															1			1			1					3
Capitella capitata	2			7					1														2	1		13
Capitellidae	1	5	6	3			5	2	7	7	4							1	1			2		3	4	51
Chaetozone sp.	24	20	72	25	2	17	22	17	28	21	23	35	26	26	18	26	27	23	15	37	32	15	25	16	27	619
Choloe entypa													1					1								2
Chone sp.	35	1	28	2	1	28	53	21	17	3	1					3			2	9	2		21	21		248
Cirratulidae	102	20	33	28		43	48	61	99	36	277	454	298	98	122	243	103	57	4	13	281	117	84	40	58	2719
Cossura sp.	23			1		2	10	12	9		74	61	41	29	23	12	16	8			24	7	5	1	26	384
Decamastus gracilis	33		13	1		10	7	23	15	5	18	21	18	11	6	16	1	4		14	21	3	15	7	10	272
Dentinephtys glabra															1											1
Diopatra ornata	2					2			1		1	1	1	2	8	3				1	1	1				24
Dipolydora caulleryi	1	1	5	3		1		1		1										3	2		2			20
Dipolydora socialis	22	1	17	6		1			4	4	4	1	6			4	1		4	1	7		1	7	3	94
Dorvilleidae	2		2				2		1		1	9	18	18	16	4	9	8		1	2	7	1		14	115
Driloneris sp.							1	1	1				1										1			5
Eranno bicirrata	1										4	2	3	4	1	3	2	1	1		1	1	1			25
Eteone sp.	10	4	15	36		33	22	7	14	33	17	15	23	17	10	16	12	9	7	14	8	9	4	4	6	345
Euchone sp.													12	4				2				1			4	23
Euclymeninae	24		8	3		8	17	10	12	2	91	50	35	52	25	40	49	52	3	11	57	55	38	32	22	696

HOODS 2014 INVERTEBRATE SPECIES DATA, continued

	2014 STATION																									
	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	
Depth (m)	57	41	51	41	42	55	55	55	54	47	60	62	66	72	76	62	67	71	39	50	62	66	54	54	92	
POLYCHAETA, continued	"Inside" Stations					"Outside" Stations																				TOTALS
Eulalia sp	9	1	7																							17
Flabelligeridae	3		8	1		5	2	1	3	3	1						1			7			7		3	45
Galathowenia oculata	4		2				2	1	7		5					7	1				4		5	2		40
Glycera macrobranchia		1																								1
Glycera nana	5		2			4	6	11	6		7	2	4	2	6	7	3	4	1	3	6	5	7	9	2	102
Glyceridae					1						1															2
Glycera sp.							5			1																6
Glycinde armigera	10	1	5			12	8	16	7		6	7	2	5	1	7	1		5	7	2		11	16		129
Glycinde picta		3	5	3			4		3	8	5						2							1		34
Glycinde sp.									5	4								1								10
Goniada maculata	3	1	1			7	23	4	5		4	2			3		2		1	4	4	2	6	6		78
Goniadidae				1			1	1		2		2	2			1	1				1					12
Hesionidae	10	3	8	3		8	11	6	3	12	5	8		3		2			3	9	2		4	2	1	103
Heteromastus filobranchus	7					1				2	3					2						1				16
Heterpodarke heteromorpha					32																					32
Hirudinea									1				1					3				1				6
Laonice cirrata	1		2			3	6	1	2		6		1	1	3	8	2	2			6	2	4	4	1	55
Leitoscoloplos pugettensis	4	4	4	69	1	4	22	7	22	4	1	5	3		1	1		1	7	6	2		10	17		195
Levensenia gracilis	13		10			24	5	6	8		44	73	95	99	116	45	42	26		5	18	47	6	4	100	786
Lumbrineris californiensis											1															1
Lumbrineris lagunae	3		3						2	3						1					2		4	3		21
Lumbrineridae	38	12	45	32		81	67	84	28	57	21	35	33	41	38	20	50	11	11	86	47	9	38	27	55	966
Lysippe labiata														1	1										1	3
Magelona longicornis	12	10	8	2		5	8	33	79	24	26	44	52	19	24	53	39	18		12	47	46	113	30	7	711
Magelona sacculata		1			4														4							9
Magelona sp.	30		22	14	12	39	53	49	44	37	34	48	48	29	9	24	9	2	3	42	27	7	17	79		678
Maldane sarsi											2	15	10	29	24	7	20	15			2	22			2	148
Maldanidae	19	2	13	14		25	23	44	38	9	70	84	187	178	193	108	45	60	1	31	34	51	23	25	195	1472
Mediomastus sp.	121	178	240	390		73	100	71	94	58	145	143	94	68	63	100	30	32	181	117	75	44	80	54	20	2571
Megalomma splendida																2										2
Melinna elisabethae								1						4		1							1	1		8
Metasychis disparadentata			1								1	4	4	7		9		2				6				34
Microphthalmus sp.				1			1												1	1				1		5
Myriochele heeri																		1							3	4
Nephtys caeca												1														1
Nephtys caecoides	9	31	15	62	2	5	4	9	11	27	11	11	7	17	13	17	6	10	49	21	15	11	8	13	15	399
Nephtys cornuta	2			1			1	4	6								3	3			2	1	8	2		33
Nephtys ferruginea	3		1			4	12	8	9	4	7	10	17	15	15	12	4	7		5	14	2	12	12	13	186
Nephtys punctata																						1	1			2
Nephtys sp.	9	12	1	1		16	19		6	38	6	4	4	5	5			1		5	1		5	3	1	142
Nereiphylla castanea																	1								1	2
Nereis procera			2	4								1		1	1	2	1					4				16

HOODS 2014 INVERTEBRATE SPECIES DATA, continued

	2014 STATION																									
	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	
Depth (m)	57	41	51	41	42	55	55	55	54	47	60	62	66	72	76	62	67	71	39	50	62	66	54	54	92	
POLYCHAETA, continued	"Inside" Stations					"Outside" Stations																				TOTALS
Ninoe gemmea	12					1	3	9	8		15	28	27	26	22	21	18	14			11	13	7	3	11	249
Notomastus lineatus			2	4															6							12
Oligochaeta							3		1		2					1	3					1		1	7	19
Onuphidae				1		5	1	4	4		3	2		8	4		7	8					1	1	9	58
Onuphis iridescens	14	6	8			14	11	18	10	1	5	6	7	8	22	5	4	10	12	10	5	11	13	5	20	225
Ophelia sp.										1																1
Ophelina acuminata								1									1						1	4		7
Orbiniidae	12	46	22	155		9	9	8	8	37	2	3	3	2	4		2			18	3	1	5	3	1	353
Owenia fusiformis	3	887	7	725				2	2	37									3	12			5	1		1684
Paradoneis lyra					1																					1
Paraonidae			6			10	30	15	28	5	1	11	44	52	30	1	22	14		8	19	19	41	17	13	386
Paraprionospio pinnata	22	6	28	17		14	16	33	54	24	25	29	19	17	31	25	40	49	3	26	29	27	52	38	26	650
Pectinaria sp.	1	25	1	3			2			2	1		1		3		1			1				1	1	43
Pholoe sp.	12	1	8	20		18	52	13	22	17	14	11	8	5	5	11	15	8		12	7	4	13	14	2	292
Phyllodoce groenlandica												1	1	2	1						4	1	1			11
Phyllodoce hartmanae	6			15	10	6	21	26	30		7	12	16	18	15	9	20	29	30	6	12	9	23	17	13	350
Phyllodoce sp.	28	22	24	68		27	10	3	8	61	32	24	5	15	10	4	20	1	3	28	10	6	10		2	421
Phyllodocidae		1		1	2	4	4	1	7			3	6	1	7	1	1		3	4	1					47
Phylo felix		1	5	16				2		1	1	1				2			3	5			3			40
Pilargis maculata	1								5				1		4	1		1					1			14
Pista bansei																		2				1				3
Pista moorei														1	1			1			1	3				7
Pista sp.														1												1
Pista wui												2	2	13	19	4	1	5			3	1		1	8	59
Platynereis bicanaliculata			2																							2
Poecilochaetidae	3				1					1																5
Polycirrus sp.														3												3
Polynoidae	34	42	128	54	1	115	54	26	42	50	11	14	11	27	19	11	10	6	48	40	3	7	28	28	15	824
Praxillella gracilis												7	26	20	25	6	11	11			1	4			17	128
Praxillella pacifica								2	7			3			2	4	1	3			1	4	17	2	2	48
Prionospio jubata	18		4	3		1	6	6	17		31	31	32	19	12	23	14	10			22	18	10	7	3	287
Prionospio lighti	7	8	10	17			1		1	4		3	5	1	3	10	1		1		3	1	8	4		88
Prionospio sp.	59	2	16	23		30	66	39	61	28	70	86	68	63	42	20	32	14	3	38	56	22	48	40	17	943
Rhodine bitorquata							2	2	3		11	15	25	21	27	21	6	23			4	15	6	1	9	191
Sabellidae	10		14			11	29	7	19	6	34	18	32	28	35	6	5	6		4	13	4	11	3	17	312
Scalbregma californicum	10	4	1	32	1		2	1	2	7	2	8	9	3	4	9	15	9	1	2		5			7	134
Scoletoma luti	109		22	2		16	113	40	79	16	55	20	18	18	13	34	13	15	9	26	32	17	65	64	12	808
Sigalion sp.		2	1						1											1						5
Sigambra tentaculata						1			4			7	1	2	1	2	2				1		1			22
Sphaerodoropsis minuta							1							2	1	1	7	1							1	14
Sphaerodoropsis sp.	2											4			2											8
Sphaerodoropsis sphaerulifer											1	3	2	1	2		1	4			1	1			3	19

HOODS 2014 INVERTEBRATE SPECIES DATA, continued

	2014 STATION																									
	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	
Depth (m)	57	41	51	41	42	55	55	55	54	47	60	62	66	72	76	62	67	71	39	50	62	66	54	54	92	
POLYCHAETA, continued	**"Inside" Stations**					**"Outside" Stations**																				**TOTALS**
Spiochaetopterus pottsi	5	7	17	14	5	4	1	1	1	1	1	3	1		3	3		1	4	2	2	4	4	3	2	89
Spio filicornis	4				7		1	6	8		14	19	25	10	10	9	11	4			10	11	5	1	9	164
Spionidae	3	2	5			8	6	6		17	12	7	9	3	1				1	8	1	1	9	2	4	105
Spiophanes berkeleyorum	128	166	179	216	1	89	108	238	258	219	730	204	283	202	273	159	436	241	61	156	118	117	309	225	197	5313
Spiophanes bombyx	11	20	6	11	62	20	17	9	28	2	13	25	7	4	3	13	5		91	7	12	4	37	25		432
Sternaspis fossor	1					1		1	3		23	30	18	17	10	24	19	25			11	34	2	2	14	235
Sthenalais sp.									2							1			1	1		1		1		7
Syllidae	16	3	6	7		5	22	12	19	3	41	50	34	51	37	11	35	14	9	2	22	10	16	11	42	478
Tenonia priops	4		6	4		3	7	5	4	1	3	1	1	1	1	5			4	2	3		5	7		67
Tererbellidae	32	17	49	29	2	43	35	25	22	31	47	47	44	35	47	35	11	14	30	33	34	17	33	19	22	753
Terebellides californica													2			1		2				4				9
Terebellides sp.						1		1					4	4												10
Terebellides stroemi											2	13	4	13	9	1	5	5			1	5			14	72
Thalenessa sp.	2																									2
Trichobranchus glacialis													1	3	1			1			1	1			1	9
Trochochaeta franciscanum							2	1								3	1	2					1			10
Typosyllis sp.									2			3	8	9	7	8	6	4			4	5		1		57
Polychaeta Total Counts	**1189**	**1588**	**1189**	**2154**	**148**	**944**	**1223**	**1136**	**1417**	**990**	**2206**	**1965**	**1928**	**1593**	**1598**	**1387**	**1323**	**959**	**637**	**934**	**1319**	**935**	**1416**	**1033**	**1250**	**32461**
Polychaeta Richness (# taxa)	**68**	**45**	**48**	**52**	**19**	**56**	**65**	**66**	**75**	**54**	**71**	**71**	**76**	**74**	**75**	**76**	**70**	**69**	**43**	**54**	**74**	**70**	**70**	**67**	**66**	
	"Inside" Means:					**"Outside" Means:**																				
	Count: 1254					**Count: 1310**																				
	Richness: 46.4					**Richness: 67.1**																				

MOLLUSCA																										**TOTALS**
Acila castrensis													1	13	16	1	1	8				1			8	49
Adontorhina cyclia													2	10	7	1	2	8				3			14	47
Aeolidiacea spp.																			1						1	2
Alvania compacta		1										2		1	3				1							8
Alvania rosana																	8					7				15
Astyris gausapata	86	9	39	2		19	56	31	9	4	1	10	4	21	2	6	29	5	6	36	82	11	72	248		788
Axinopsida serricata	42	25	60	37		81	83	146	229	161	128	244	269	145	165	169	112	122	4	127	224	279	252	254	112	3470
Bivalvia spp.	47	29	22	61	4	64	101	110	110		165	171	110	152	183	59	122	102	1	9	48	72	56	12	176	1986
Caesia fossata		1												4				1								6
Callianax pycna		3	2	9	8					5									3	1						31
Callianax sp. Juv.		3		2	1					7									90							103
Cardiomya pectinata												1	1									3				5
Chaetoderma spp.	1					5	4	1	6		3	2	1	1	1	2				1	1	2	3		1	35
Clinocardium sp.		2		8	9														1							20
Compsomyax subdiaphana								1	2		3		1	4	2	6	4	3			2	2	1	1		32
Cyclocardia ventricosa												8	2	1	1		16	2			2	8				40
Cylichna attonsa		1							2					1	3		3	1		1	1		2		2	17
Cylichna sp. Juv,																								1		1

HOODS 2014 INVERTEBRATE SPECIES DATA, continued

	2014 STATION																									
	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	
Depth (m)	57	41	51	41	42	55	55	55	54	47	60	62	66	72	76	62	67	71	39	50	62	66	54	54	92	
MOLLUSCA, continued	**"Inside" Stations**					**"Outside" Stations**																				**TOTALS**
Ennucula tenuis	24		7			28	21	53	49	1	53	57	55	93	77	28	66	79		4	57	69	48	26	28	923
Epitonium tinctum					1	1	2				2		1	1	1	1					2					12
Gadila aberrans	1						1	1	1									1								5
Gastropoda spp.	16	29	18	37	2	39	30	51	36		20	32	6	19	19	6	58	12	27	44	4	8	27	10	17	567
Gastropteron pacificum	2		1			1	2				2	1						1				1	1			12
Kurtzia arteaga							1																			1
Lasaeidae sp.		2								2		1		2							1					8
Lyonsia californica	5	1	3				3	2	4	3	4	4	9	2	2	3	6	4		2	6	12	10	7		92
Macoma carlottensis			5			1	2	2	24			6	9	7	7	19	4				11	14	4	9	8	132
Macoma elimata	7					2	3	11	11		1		2	1	1	2	1				3	6	18	13		82
Macoma sp. Juv.	17	9	3	11		11	3	9	26	6	24	53	18			34	15	6	3	3	49	49	17	39		405
Macoma yoldiformis								1																		1
Mactridae sp.																			9							9
Mytilidae sp. Juv.	4	5	4	8		3	1	1			1								1	1	1		2			32
Mysella pedroana																						1		16		17
Nassariidae spp.					1												2		4		3					10
Neptunea tabulata													1													1
Nuculana hamata											2		3	6			4				3	6				24
Nuculanidae sp. Juv.		2		4			1	6	5	5		1		1		2			1	7			10	6		51
Nudibranchia spp.							1				1															2
Odostomia spp.	9	4		1		3		1	4	18		1	1	4	5	2	4	4	1	10	1	5	12	15	1	106
Ophiodermella sp.												1	1		1			4				2				9
Pandora bilirata												5	6				2				2	14				29
Pandora filosa									1		3	1	2		1	2	1	1			1	2	1			16
Pandora spp. Juv.																2	2				2	1				7
Pusellum salishorum													1			2	2						3			8
Rhabus rectius														3	2			5							1	11
Rictaxis punctocaelatus		3												1	1	1		1			1	2				10
Rochefortia tumida	7	8	53	13		14	7	6		7	7	2	27	6	15	1	18	7	9	11	1	12	5	6	1	243
Saxidomus gigantea																	1									1
Scaphopoda spp.							2	1	2		2	1		2			1							1	1	13
Siliqua alta		23	3	2	1		1			4									11	4				1		50
Siliqua sp. Juv.		1			5														3							9
Solamen columbianum											2	2	3	2				1								10
Solen cf. sicarius										1																1
Solen sp. Juv.	frag			8		1		1		1							1		3							15
Tellina modesta		179	3	11			1		1	9	1								55	3			1	2		266
Tellina nuculoides				1	8																					9
Turbonilla spp.	4			1		4	1	4	7	5	5	5	5	3		1	12	32		1	2	1	10	7		110
Yoldia seminuda	4		2				1	1	2	1		2	3	3			4				1	10	1			35

HOODS 2014 INVERTEBRATE SPECIES DATA, continued

	2014 STATION																									
	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	
Depth (m)	57	41	51	41	42	55	55	55	54	47	60	62	66	72	76	62	67	71	39	50	62	66	54	54	92	
MOLLUSCA. Continued	"Inside" Stations					"Outside" Stations																				
																										TOTALS
Mollusca Total Counts	276	340	225	216	40	277	328	440	531	240	430	613	544	509	515	350	501	410	234	265	511	603	556	674	371	9999
Mollusca Richness (# taxa)	16	21	15	17	10	16	23	21	20	17	21	24	27	28	22	22	28	23	20	17	26	28	22	19	14	
	"Inside" Means:					"Outside" Means:																				
	Count: 219.4					Count: 445.1																				
	Richness: 15.8					Richness: 21.9																				

CRUSTACEA																										**TOTALS**
Americhelidium shoemakeri		10	1	4			5	3		9		2	1		1	1	5	2	13	2		2	3	2	2	68
Americhelidium sp. - Immatures	1					3			1											3						8
Ampelisca careyi	2	15	10	2			2	8	5	31	16	38	28	19	12	15	20	7	33	12	14	10	3	3	9	314
Ampelisca hancocki									1							7	20	1				2				31
Ampelisca sp. - Immatures	6					2		2	9		16		37	16	10	11	18	10	30	12	16	12	9	5	4	225
Aoridae sp.	1		1			2					4		2		1	2										13
Argissa hamatipes							4	6	4					4	2	7	5	1			3		5			41
Callianassidae sp.		1		11				2	1	1		1				1			6	2		1	1			28
Cancer sp.									1																	1
Cancridae sp.			1																							1
Caprella californica	4		1			2																				7
Caprella mendax																2							2			4
Caprellidae spp. - Immatures	37	2	16	4		39	12	11	24	1	27	46	7	60	14	22	77	39	2	6	4	71	6	11	45	583
Cheirimedeia sp.	216		73	15		2	17	18	11	42	33	4	15		1	10			14	30	12	6	8	20		547
Cheirimedeia zotea	148		71	2				12	12	13	20	6	12			4			8	14	7		4	12		345
Cirripedia sp.						6	5				1						2									14
Copepoda - Calanoida	1	1	1					7	3		6	10	3	5		3	3			5	2		3	3		56
Copepoda - Harpacticoda			1	1																						2
Crangon sp.			1															1								2
Crangon stylirostris																			2							2
Cumella vulgaris												12	1	3	1		12	1							2	32
Cylindroleberidinae sp.															2		1	1							4	8
Decapoda sp. - Larvae				3												1	2				1			1		8
Desdimalita desdichada	16		7	1		17	7	9	2	4	4	6	19	3	5	5	8	2	1	2	3	4		3	1	129
Diastylis santamariensis	70	26	107	50		51	2	59	84	68	30	56	2	13	2	54	84	14	17	37	38	26	55	46	3	994
Diastylis setosa																									2	2
Diastylopsis dawsoni	12	18	31	7		5	14	6	10	38	2			1		6	4		44	35			15	17		265
Dyopedos arcticus	1	10	6	48		6	3	6		27	1	2		2		3	5		9	8	6		5	6		154
Ericthonius brasiliensis			3													1										4
Eudorella pacifica				1		4	7	4			2	4	8	13	16	3	17	9			1	6	4	2	6	107
Eudorellopsis longirostris																1										1
Euphilomedes producta											15	31	37	26	25	19	13	7			12	14				199
Foriphalus similis							4	6	5		7	39	15	41	12	10	16	11	7		8	16	11	6		214
Gammaridae sp. - Immatures												4	3	13												20
Gammaropsis ociosa													75	72	4											151
Gammaropsis sp.	1						1							48		6							1			57
Haliophasma nr geminatga									1																	1
Heterphoxus affinis															2			1							10	13

HOODS 2014 INVERTEBRATE SPECIES DATA, continued

	2014 STATION																									
	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	
Depth (m)	57	41	51	41	42	55	55	55	54	47	60	62	66	72	76	62	67	71	39	50	62	66	54	54	92	
CRUSTACEA, continued	"Inside" Stations					"Outside" Stations																				TOTALS
Hippolyte sp.	1			1						1							1									4
Isaeidae spp.- Immatures	29	43	245	20		39			1	76	46	15	30	71	21		76	6	57	25						800
Ischyrocerus pelagops		15	2			1				5	4								5	1						33
Ischyrocerus sp. - Immatures				6					6							12	4				5	3	3		13	52
Kamptopleustes coquillus	7	3	12	80		6	8		7	33	9	5					4		4		3	4	12	16		213
Leptochelia savignyi															1										10	11
Lysianassidae sp. - Immatures	1			2				3	3		2	2	2			3		2					7	4	2	33
Mesanthura occidentalis									1														1		1	3
Monocludes sp.						1																				1
Munna sp.		1				12	2	18	18			32		27	3	6	38	5		1	2	7	12	11	10	205
nr Mayerella banksia														9		2	7	2				2				22
Pacificanthomysis nephrophthalma						5			1	1					1				1				3	1		13
Paguridae sp. - Immatures	2																									2
Photis brevipes	109	18	54	7		17	18	21	12	53	36	9	21	71	18	2	1	1	6	16	7	4	9	22	4	536
Photis nr lacia	88		35	4		11	4	13	38	1	59	47	10	10		13	11	3	5	13	14	1	29	17		426
Photis parvidons									1																	1
Photis spp.	74	19	53	34		43	200	230	174	56	63	65	40	113	19	47	1	15	32	36	51	31	70	79	7	1552
Phoxocephalidae spp. - Immatures			3	1			2	9	12	1		15	12	12	16	5	17	9	20		5	17	3	16	10	185
Pinnixa schmitti	1	2	2	36		1		3	9	2		2	4	2	2	6	1	1		6	3	2	9	6	3	103
Pleurogonium sp.	13	22	9	31			12	14	9	19	28	108	1	9	10		73	9	2	8	6	6	11	2		402
Protomedeia articulata	13	22	36	8		20	14	19	39	48	11	3	23	10	3	7	10	3	25	27	7		30	27	2	407
Protomedeia sp.	11	8	12	15		11	38	2	62	21	13	8	6	6	2	16	2	4	41	62	11		11	17	10	389
Rhepoxynius variatus							7									1			7	2	5					22
Scleroconcha sp.															7			1							7	15
Stenothoidae sp.	1					3			1	1				1		1	2			1					1	12
Synidotea harfordi	1		3			1	1			4					1				1	2				1		15
Tanadiacea sp. - Immatures								1						25	6		1	3	1						2	39
Tiron biocellata	9	1	3				1	1		1											1		1			18
Tritella laevis			8							23		1					4									36
Tritella pilimana				6			13											4	2		1					26
Westwoodilla tone			3			4	5	1	2	1										2	1				1	20
Crustacea Total Counts	**839**	**176**	**552**	**293**	**0**	**268**	**400**	**494**	**556**	**466**	**396**	**553**	**384**	**634**	**199**	**303**	**480**	**169**	**329**	**344**	**241**	**240**	**331**	**340**	**158**	**9145**
Crustacea Richness (# taxa)	**29**	**19**	**31**	**27**	**0**	**28**	**27**	**28**	**34**	**28**	**25**	**28**	**26**	**29**	**30**	**36**	**35**	**30**	**28**	**27**	**29**	**22**	**31**	**27**	**26**	
	"Inside" Means:					**"Outside" Means:**																				
	Count: 372					**Count: 364.3**																				
	Richness: 21.2					**Richness: 28.7**																				

MISCELLANEOUS SPECIES	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	TOTALS
Amphiuridae, juv	1	3	1	1						1		3	3			2	4		2	4	2	1	3	1	1	33
Amphiodia sp, juv		2	2	3		2	1			2			4	3		2	2			2					1	26
Amphiodia urtica													3		2			3					1			9
Amphiodia periercta				1													2			2						5
Amphipholis sp											1			2	1	1	1				1					7
Amphipholis squamata													2		5											7
Amphioplus sp																					1				1	2

HOODS 2014 INVERTEBRATE SPECIES DATA, continued

	2014 STATION																									
	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	
Depth (m)	57	41	51	41	42	55	55	55	54	47	60	62	66	72	76	62	67	71	39	50	62	66	54	54	92	
MISCELLANEOUS SPP, continued	**"Inside" Stations**					**"Outside" Stations**																				**TOTALS**
Amphioplus strongyloplax			1																							1
Asteroidea, juv												1			1	1										3
Athenaria, juv				3	3		1	10	9		11	3				2	2			16	1		11			72
Baseodiscus sp															1	4					2					7
Bougainvilliidae						1																				1
Campanulariidae																										0
Carinoma mutabilis																			2	1						3
Caulibugula sp																	1									1
Cerebratulus sp												1	1			1										3
Dendraster excentricus					3																					3
Edwardsia sp	8	21	12	44		7	3		17	18			1			3	1	1		1			7	2		146
Edwardsiidae, juv	232	30	191	61	14	237	206	334	457	276	351	230	41	26	9	137	131	21	16	157	39	55	372	293	3	3919
Echinoidea, juv		7	1		180					12									7	1						208
Echiuridae, juv	13	118	81	69		26	25	30	86	50	16	7	3	2	1	13	6	7	45	97	4	3	132	117	4	955
Enteropneusta, juv				2								1						1								4
Euphysa sp	2				5	3	4	1	2		5		2			1				8	1		3	3		40
Glossobalanus sp													1								1	1			1	4
Glottidia sp	1		2								1	1														5
Golfingiidae, juv	1						3	1	2		2	3						1					1	2		16
Hoplonemertea, juv			1										1													2
Leptoplanidae	1		1									1		2			1									6
Lineidae	3	5	9	5	2	9	16	8	4	3	3	3	1	3	15		8	5	2	3	1	4	23	14	13	162
Lineus sp													1													1
Micrura sp		4	4	5	1		1	3	2		6	13	3	5	1	5	2	1	3	3	3	1		1	2	69
Nematoda	102	25	104	17		18	23	47	79	160	150	157	203	235	111	60	181	43	18	63	58	54	43	18	16	1985
Obelia sp						1																				1
Oerstedia dorsalis												1	2													3
Ophiura sp.															1											1
Ophiurida, juv	14	42	11	38		19	44	21	21	28	1	12	1	5	3	4	12	9	11	16	4	2	15	18	1	352
Ophiura luetkeni															1			2								3
Pachycerianthus sp							2	1	1		2	1											1		1	9
Paracaudina chilensis		1								1																2
Paranemertes californica	6	4	3	22	1	3	1	1		3	10	19	13	9	5	4	6	5	2	8	2	6	1		1	135
Peachia quinquecapitata													1						1	1						3
Pentamera populifera																		1								1
Phoronis sp	3	1		5		1	2	1	4			1				1							14	13		46
Plumularia sp						1																		1		2
Ptilosarcus gurneyi								1												2						3
Rhabdocoela		1					63									1				1						66
Saccoglossus sp				4									1	1	1	1		1								9
Tetrastemma nigrifrons	3		1	3		1						1														9
Tetrastemma sp											1	3	1			1	1	2			1	4				14
Thenaria, juv											1															1
Thysanocardia nigra									1		1					2					2		1	3		10

HOODS 2014 INVERTEBRATE SPECIES DATA, continued

	2014 STATION																									
	H-14-5	H-14-11	H-14-13	H-14-19	H-14-21	H-14-1	H-14-3	H-14-7	H-14-9	H-14-12	H-14-14	H-14-15	H-14-16	H-14-17	H-14-18	H-14-24	H-14-26	H-14-28	H-14-29	H-14-31	H-14-34	H-14-36	H-14-44	H-14-45	H-14-49	
Depth (m)	57	41	51	41	42	55	55	55	54	47	60	62	66	72	76	62	67	71	39	50	62	66	54	54	92	
MISCELLANEOUS SPP, continued	**"Inside" Stations**					**"Outside" Stations**																				**TOTALS**
Tubulanus cingulatus																1										1
Tubulanus polymorphus	8	3	6	1					1	5	5	5	2		3	4		2	3	2	2	3		1	1	57
Tubulanus sp				7		13		2	1		4	8	9	2	5	3	3			1	4	4		1	3	70
Tubulanus sp nr nothus													2													2
Virgularriidae	1																									1
Virgularia sp																									1	1
Zygonemertes virescens																									1	1
Miscellaneous Spp Total Counts	**399**	**267**	**431**	**291**	**209**	**342**	**395**	**461**	**687**	**559**	**571**	**475**	**302**	**295**	**166**	**254**	**364**	**105**	**112**	**389**	**129**	**138**	**628**	**488**	**51**	**8508**
Misc. Spp. Richness (# taxa)	**16**	**15**	**17**	**18**	**8**	**14**	**15**	**14**	**15**	**12**	**18**	**22**	**24**	**12**	**17**	**23**	**17**	**16**	**12**	**20**	**18**	**12**	**15**	**15**	**16**	
	"Inside" Means:					**"Outside" Means:**																				
	Count: 319.4					**Count: 345.6**																				
	Richness: 14.8					**Richness: 16.35**																				

TOTAL COUNTS, ALL TAXA	**2703**	**2371**	**2397**	**2954**	**397**	**1831**	**2346**	**2531**	**3191**	**2255**	**3603**	**3606**	**3158**	**3031**	**2478**	**2294**	**2668**	**1643**	**1312**	**1932**	**2200**	**1916**	**2931**	**2535**	**1830**	**60113**
RICHNESS, ALL TAXA	**113**	**79**	**96**	**97**	**27**	**98**	**107**	**108**	**124**	**94**	**114**	**121**	**126**	**115**	**122**	**135**	**122**	**115**	**83**	**101**	**121**	**104**	**116**	**109**	**108**	
	"Inside" Means:					**"Outside" Means:**																				
	Count: 2164					**Count: 2465**																				
	Richness: 82.4					**Richness: 112.2**																				