PRE-CONTRUCTION SEDIMENT CHARACTERIZATION STUDY
DENNY WAY/LAKE UNION CSO CONTROL PROJECT

Sediment Profile Imaging and Video Survey
Data Report

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LIST OF ACRONYMS

CSO	Combined Sewer Overflow
DGPS	Differential Global Positioning System
DNR	Department of Natural Resources
MLLW	Mean Lower Low Water
NAD	North American Datum
NMFS	National Marine Fisheries Service
RPD	Redox Potential Discontinuity
SAP	Sampling and Analysis Plan
SEA	Striplin Environmental Associates
SPC	Sediment Profile Camera
SPI	Sediment Profile Imaging

1.0 INTRODUCTION

The King County Department of Natural Resources (DNR) requested that Striplin Environmental Associates (SEA) conduct a Sediment Profile Imaging (SPI) and a video survey as part of the pre-construction characterization study of sediment quality in the vicinity of King County's Denny Way/Lake Union combined sewer overflow (CSO) control project in Elliott Bay. This work is being performed as part of a long-term sediment-monitoring program to meet requirements of the Biological Opinion WSB-00-039 [National Marine Fisheries Service (NMFS) 2000] issued for the project by NMFS under the Endangered Species Act (16 U.S.C. 1531 et seq.).

1.1 GOALS AND OBJECTIVES

The primary goal of the sediment-monitoring plan necessary to meet the requirements of the Biological Opinion WSB-00-039 (NMFS 2000) was to:

- Determine the condition of the benthic and epibenthic communities in the area surrounding the Denny Way CSO through the use of:
    - Video Surveys
    - Sediment Profile Imaging

There were two objectives to the video survey:

- Document presence or absence of eel grass and kelp beds in the CSO area
- Document the community of large macroinvertebrates in the CSO area

The objectives of the SPI survey were to:

- Qualitatively document the condition of the sediment in the CSO area as related to:
    - Grain Size
    - Redox Potential Discontinuity
    - Infauna Successional Stage

To accomplish these objectives King County staff prepared a Sampling and Analysis Plan (SAP) with input from SEA for the SPI and video surveys (King County DNR 2001). A complete description of the methods used in the surveys can be found there and will be summarized in this document.

This data report includes the introduction and objectives of the video and SPI surveys in Section 1. A brief description of the methods used to conduct the surveys and to analyze the resulting data is in Section 2. The results of the surveys are presented in Section 3. Section 4 includes a summary of conditions in the vicinity of the Denny Way CSO area.

2.0 METHODS

2.1 VIDEO SURVEYS

The video survey was conducted on April 18, 2001 aboard King County's research vessel the RV *Liberty*. The survey was performed along six transect lines, parallel to the shoreline (Figure 1). The transect lines were approximately 300 meters in length and spaced approximately 50 meters apart. During the surveys, a DeepSea Power & Light SeaCam 4000™ color video camera was towed behind the *Liberty* at a speed between 1 and 3 knots. The video camera was towed approximately one meter above the sediment surface and was adjusted depending on visibility in the water column. The video camera was towed higher than one meter from the bottom if the visibility was good (to get a wide view), and it was towed closer to the bottom if visibility was poor. Video images were recorded in VHS format using a Panasonic Model PV-M1338 combination TV/VCR. The survey vessel employed a Trimble® Differential Global Positioning System (DGPS) for station positioning. The actual location of the survey vessel was electronically recorded in real time from the beginning to end of each transect. Coordinates were recorded in Washington State Plane North [North American Datum (NAD) 1983]. The date and local time that a position was collected were also recorded along with the coordinate information.

2.2 SEDIMENT PROFILE IMAGING

The SPI survey was completed in two days, started on April 11 and concluded on April 18, 2001. The SPI system used to collect the images was deployed from the RV *Liberty*. A Hulcher Model 200-SEA™ Sediment Profile Camera (SPC) was initially used to collect the sediment-profile images. However, because of technical problems associated with the Hulcher camera the survey was completed using a Benthos™ Model 3731-A Sediment Profile Camera. Two replicate images were collected at each of 32 stations (see Figure 1). Positioning was performed using the same Trimble® DGPS as used during the video survey. Coordinates were collected at each replicate station (see Table 2).

At the end of each survey day, film from the SPC was developed to ensure adequate image acquisition. Both replicate images were analyzed from each station. Qualitative measurements of physical and biological SPC parameters were made visually as described in the project SAP. The following measurements were made from the SPI images:

- **Prism Penetration Depth** -- This measurment represents the average depth of penetration of SPC prism into the sediment column. Because the weight of the descending camera prism is fixed throughout a survey, differences in penetration

depths across the survey area provide a relative measure of sediment-water content (porosity) and shear strength.

- **Boundary Roughness** -- Boundary roughness represents the apparent topography of the sediment surface. The relief caan be designated as being derived from either physical (e.g., sand ripples) or biological processes (e.g., feeding pockets). Boundary roughness values can be indicative of bedform heights or the relief of biogenic structures such as fecal mounds or surface burrows.

- **Sediment Type and Grain Size** -- SPC grain size is reported as the grain size major-mode. The grain size major-mode is the grain size class that comprises the largest percentage of the optical sample. Grain-size ranges are reported as phi units. The limit of this optical technique for differentiating individual grains is approximately 0.062 mm, or 4 phi, which corresponds to the break between very fine sand and silt. Using this technique, silts and clays are combined as the ≥4 phi-size fraction.

- **Apparent Redox Potential Discontinuity Depth (RPD)** -- Oxidized sediments at the sediment-water interface have a higher reflectance and, frequently, a different color than underlying reduced sediments. Typically, oxidized sediments exist as a thin surface band of olive to tan sediment overlying reduced grey to black sediment at depth. This thin band of olive to tan oxidized sediment is called the apparent RPD. Apparent RPD depths associated with oxygenation by the diffusion of molecular oxygen are typically on the order of one to three millimeters, while in the presence of bioturbating infauna, the apparent RPD may extend to a depth of several centimeters in the sediment column.

- **Infaunal Successional Stage** -- The identification of infaunal successional stages in SPC images is based on observations that animal-sediment interactions follow a predictable sequence after a seafloor disturbance. Three successional stages have been identified. Stage 1 species are small in size, short lived, rapid reproducers, and produce numerous larvae. Because Stage 1 functional types are typically surface-dwelling and shallow bioturbators, they are usually associated with shallow RPDs. Stage 2 assemblages consists of burrowing surface detritivores and shallow deposit feeders such as shallow-dwelling bivalves. Tubicolus amphipods and some tubicolus polychaetes, occurring in dense mats, may also be designated as stage 2 assemblages. Stage 3 assemblages represent the highest order of succession and are characterized by the presence of relatively deep burrowing, head-down, deposit feeders. These fauna generally ingest particles at depth and in the process excavate distinct feeding voids within the sediment column, which are the primary diagnostic criteria in the SPC analysis for determining the presence of a Stage 3 assemblage.

3.0 RESULTS

3.1 VIDEO SURVEYS

The video survey tracks are presented in Figure 1. The duration of the video transects ranged from eight to twelve minutes with an average of ten minutes (Table 1). All transects ran from a northwestern to a southeastern direction. Water depth across the survey area ranged from 3 to approximately 32 meters (MLLW). The substrate ranged from coarse sand, gravel, and rocks in the shallow areas to silt/clay along the south margin of the area and in deeper waters. A detailed description of each video transect can be found in Appendix A.

Table 1. Duration and water depth range of the six video transects.

Video Transect	Start Time	Stop Time	Duration (Min)	Water Depth Range (m)
VT – 1	1626	1636	10	4 – 9
VT – 2	1647	1659	12	11 – 15
VT – 3	1706	1716	10	19 – 22
VT – 4	1723	1734	11	23 – 27
VT – 5	1750	1758	8	28 – 31
VT – 6	1805	1814	9	32 +

Video Transect 1 (VT – 1)

The duration of VT – 1 was ten minutes with water depths ranging from three to nine meters (MLLW). The substrate consisted of coarse sand, gravel, cobble, and small rocks. Overall there was a substantial amount of low growing algae with the percent cover ranging from 0-25 to 50-75. Three *Nereocystis* beds were identified along this transect and the densest amounts of low growing algae was found under these beds. A partial list of the low growing genera include: *Laminaria*, *Ulva*, *Gigartina*, *Costaria*, and *Cystoseira*. As a result of the algal cover it was difficult to find and identify the smaller macroinvertebrates, however, there were a large number of seastars moving among the algae. These include members of the genera: *Solaster*, *Pycnopodia*, *Pisaster*, and *Evasterias* (?). One kelp crab in the genus *Pugettia* was found at the start of the transect. Two genera of fish were observed among the kelp. These include the rat fish (*Hydrolagus colliei*) and an unidentifiable member in the Sculpinidae family.

Video Transect 2 (VT-2)

VT-2 was 12 minutes in duration and ranged from 11 to 15 meters (MLLW) in depth. The substrate was mostly sandy silt with the addition of small cobbles at the southeastern half. The amount of macro-algal cover was greatly reduced compared to the first transect

and were only present for a short stretch in the middle of the transect. An algal/diatom film was present on the sediment surface throughout the transect and represented up to 100 percent cover at times. Individuals of the anemone genus *Metridium* were also present throughout the transect as well as numerous burrows from an unidentified organism. Four seastars were observed. Two were unidentified (one with five rays, the other with many rays), one was *Mediaster aequalis*, and the fourth was of the genus *Solaster*.

Video Transect 3 (VT-3)

The duration of the third transect was ten minutes and ranged from 19 to 22 meters (MLLW) in depth. Silt was the primary surface substrate. An unidentified, stringy, perhaps filamentous, gray alga was the only macro alga observed. It was sparse and when present, only represented up to 25 percent cover. Only a small amount of the algal/diatom film and a few of the burrows observed throughout the previous transect were observed. Ten anemones of the genus *Metridium* and 36 seastars were observed. Three of the seastars were of the genus *Pycnopodia*, one *Solaster*, three unidentified, and the remaining were *Mediaster aequalis*.

Video Transect 4 (VT-4)

The fourth transect was 11 minutes in duration with water depths ranging from 23 to 27 meters (MLLW). The primary surface substrate was silt. No macro algae and no algal/diatom film were observed. Burrows of an unknown organism and the seastar *Mediaster aequalis* were present throughout the transect. Six anemones of the genus *Metridium* were dispersed along the transect. The other organisms observed included two unidentified, 5-rayed seastars, a seastar tentatively identified as belonging to the genus *Evasterias*, two *Cancer* crabs, and a pleuronectid fish.

Video Transect 5 (VT-5)

The duration of VT-5 was eight minutes with water depth ranging from 28 to 31 meters (MLLW). Silt was the primary surface substrate. No macro algae and no algal/diatom film were observed. Burrows of an unknown organism and the seastar *Mediaster aequalis* were present throughout the transect. One other unidentified, multi-rayed seastar was observed near the center of the transect. Two anemones of the genus *Metridium* were observed near the beginning of the transect. An unidentified holothuroid (sea cucumber) and two pleuronectid fish were the only other organisms observed.

Video Transect 6 (VT-6)

VT-6 was nine minutes in duration and at a water depth close to and greater than 32 meters (MLLW). The surface substrate was primarily silt. No macro algae and no algal/diatom film were observed. Burrows of an unknown organism were present

throughout the transect. Five seastars were observed, including one *Pycnopodia* and four *Mediaster aequalis*. Four individuals of the anemone genus *Metridium*, one *Cancer* crab, and two pleuronectid fish were also observed.

3.2 SEDIMENT PROFILE IMAGING

The SPI data presented in this report (Figure 2) are based on a rapid, qualitative evaluation of two replicate images from each sampling location. The SPI measurements were not generated with a digitized version of each image on a computer image system. As a result, the data presented here (e.g., penetration depths, boundary roughness, RPD depths) are approximations of the actual measurements that would be obtained using the computer image analysis system.

Surface boundary roughness was low to medium throughout the surveyed area. The camera prism's penetration depths were typically good except for several stations located within the area of the sediment cap. These eight stations, SPC02, SPC03, SPC04, SPC05, SPC07, SPC08, SPC09, and SPC10, were characterized by medium to fine sand while the surrounding stations were very fine sand or smaller. The shallow penetration at these stations precluded the determination of RPD depth and infaunal successional stage, but there were no indications of major disturbances that would adversely affect these parameters. Two stations immediately offshore of the sediment cap, SPC13 and SPC14, showed possible evidence of downhill migration cap sediments in the form of layers of coarser sediments overlying finer sediments.

The RPD depths were typically one to two centimeters at stations surrounding the sediment cap. These stations generally showed evidence of deep-burrowing, deposit feeders (stage 3 infaunal successional stage) in at least one of the replicate images. Three stations situated to the south of the cap area, SPC06, SPC15, and DWMP07, showed evidence of only surface-dwelling infauna (stage 1 infaunal assemblages). Each of these three stations exhibited qualities that made them different from the majority of the surrounding stations. At Stations SPC06 and SPC15, high contrast, reduced (dark gray to black) sediments were apparent at depth in the images. Some reduced sediments were also present to a lesser degree at several other stations. At DWMP07, a light gray, apparently clayey material, seen in small patches at other stations, was present throughout the sediment profile. Overall, these three stations appear to have lower overall benthic habitat quality than the other stations surveyed.

4.0 SUMMARY

Based on the video surveys, there was no indication of eel grass within the vicinity of the Denny Way/Lake Union CSO. Kelp beds were limited to several species of under-story and turf forming algae and a few patches of the canopy-forming species *Nereocystis luetkeana*. The algae were limited to the shallow, near-shore area where hard substrate, in the form of rocks and cobbles, was available. The macroinvertebrates observed in the video throughout the project area included seastars, anemones (*Metridium* spp.), and crabs (*Cancer* spp.). Several epibenthic fish and many burrows from unidentified organisms were also observed.

Images from the SPC showed cobbles in the near-shore area and an area of sandy sediments corresponding to the location of the sediment cap. Camera penetration on the sediment cap was not good, but there were no obvious indications of disturbances that would cause adverse effects to the benthic community. At stations surrounding the sediment cap, the sediments were mostly silt with very fine sand. The RPDs were one to two centimeters deep and the infaunal community was well developed with evidence of deep burrowing, head-down, deposit feeders.

5.0 REFERENCES

King County Department of Natural Resources. 2001. Sampling and Analysis Plan for the Pre-Construction Sediment Characterization Study: Denny Way/Lake Union CSO Control Project. King County Department of Natural Resources, Seattle, WA. 27 pp.

National Marine Fisheries Service. 2000. Biological Opinion WSB-00-039.

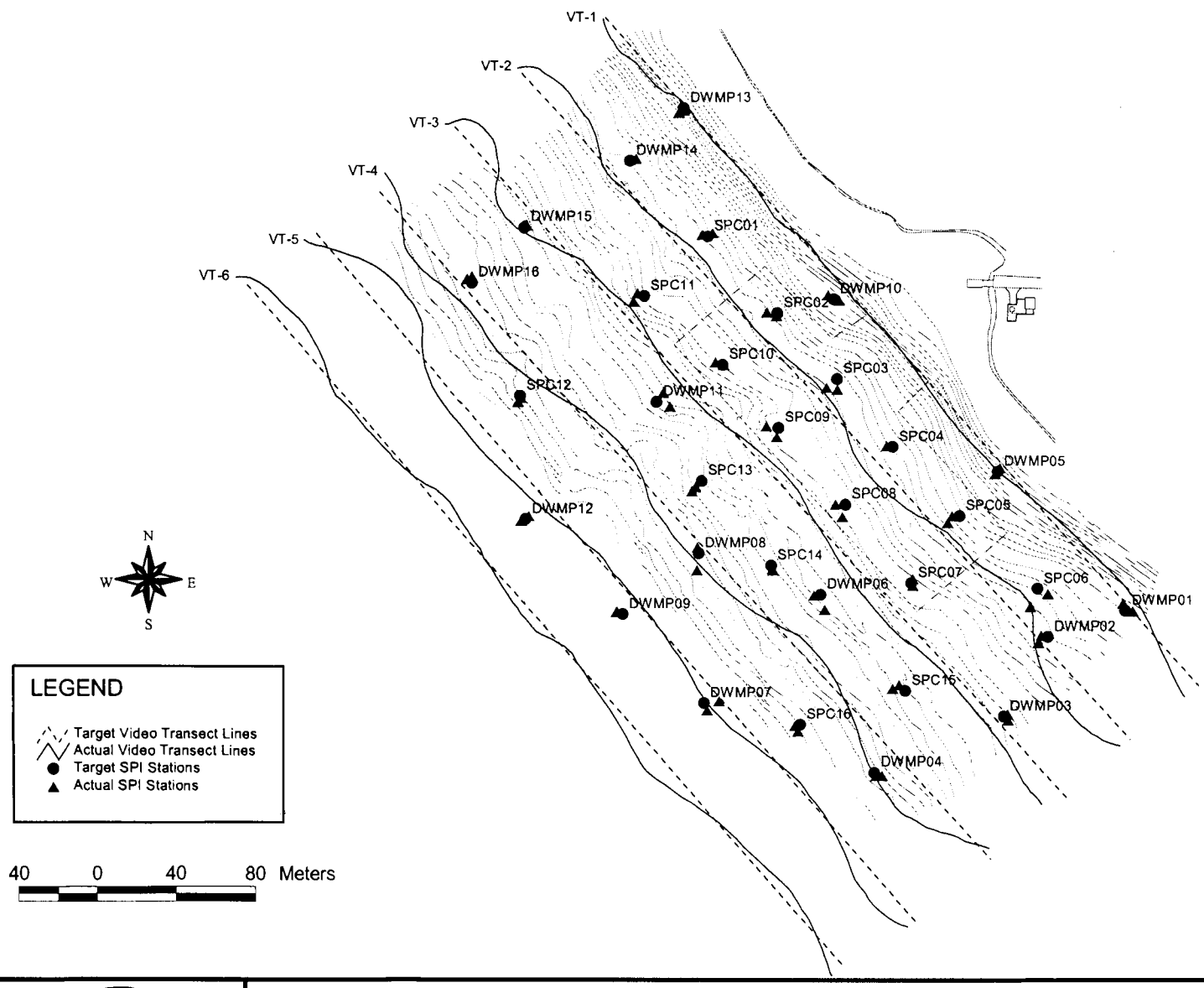
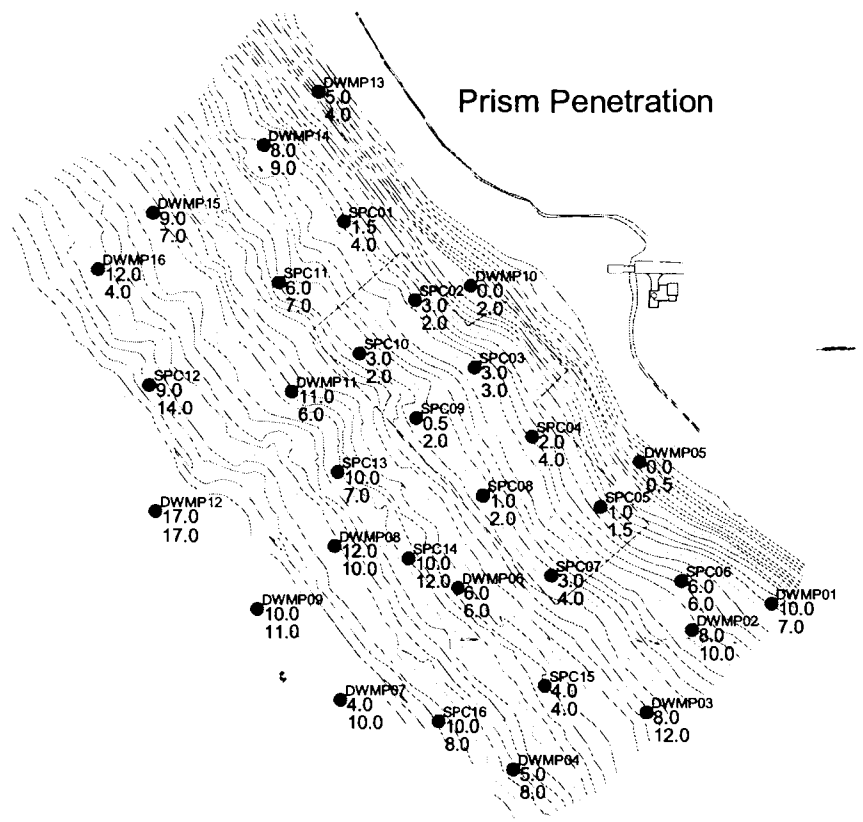
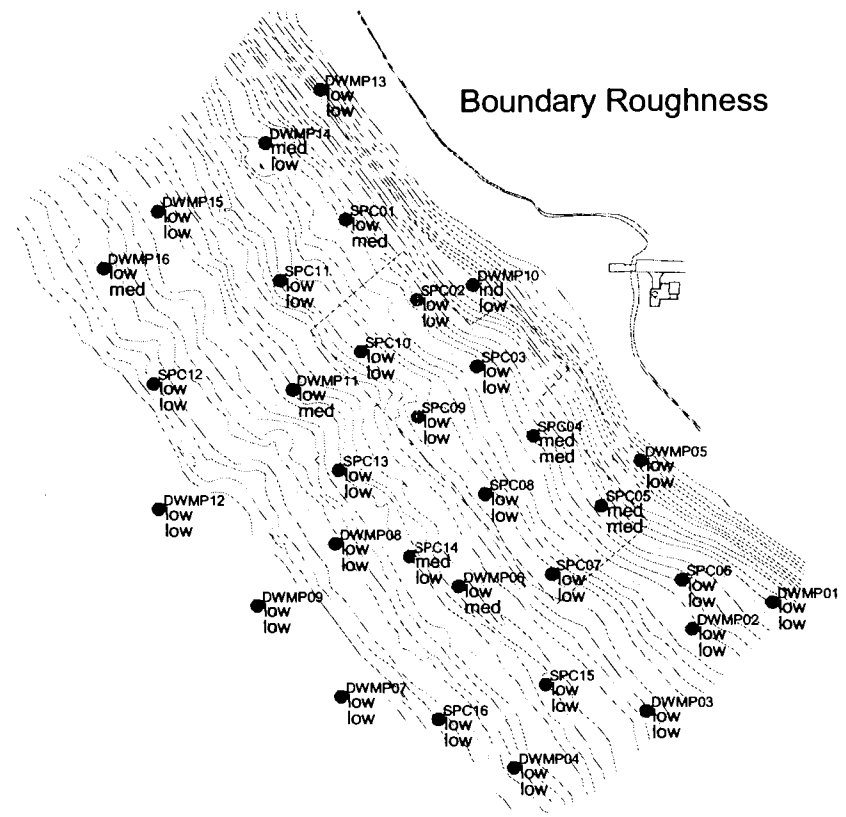
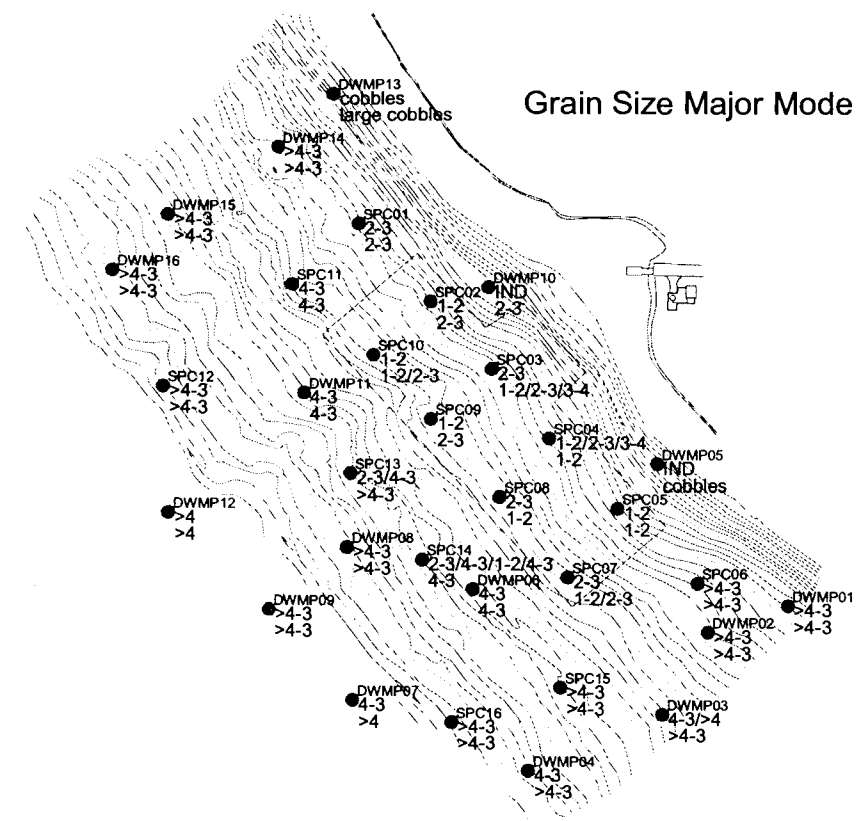


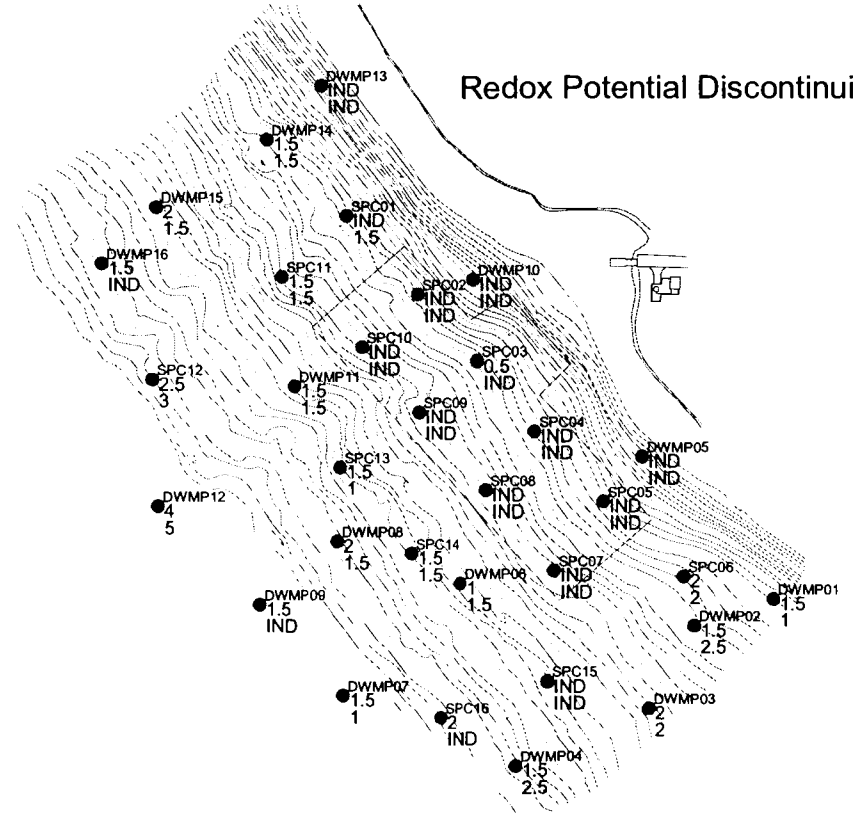
Figure 1 Sediment profile imaging locations and video transect lines.

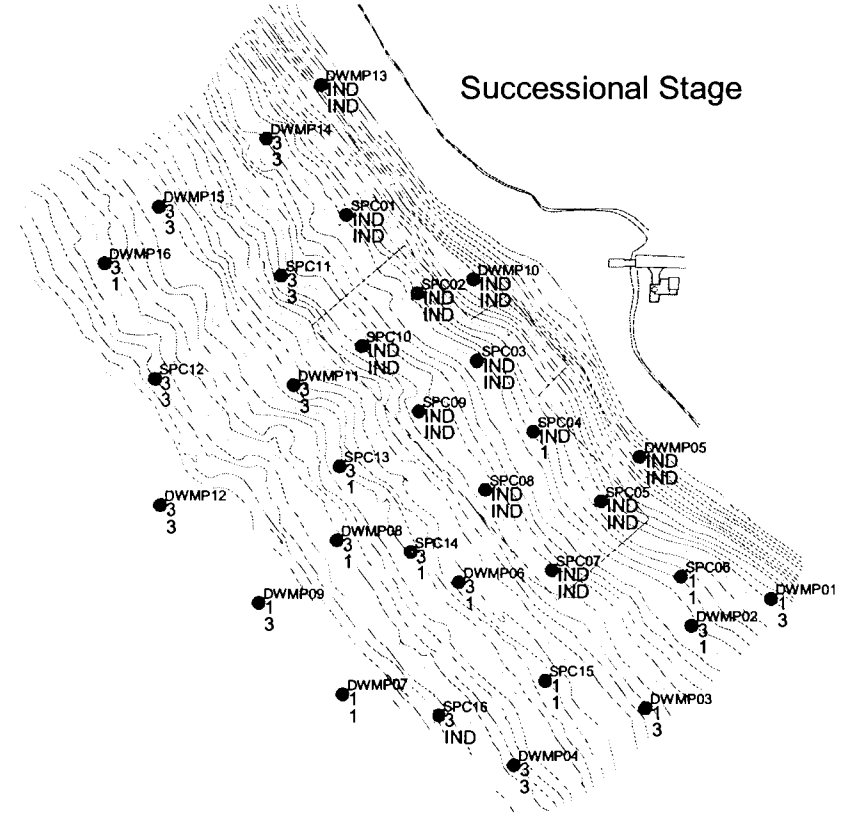
Denny Way CSO
18 May 2001
spi_april2001.apr











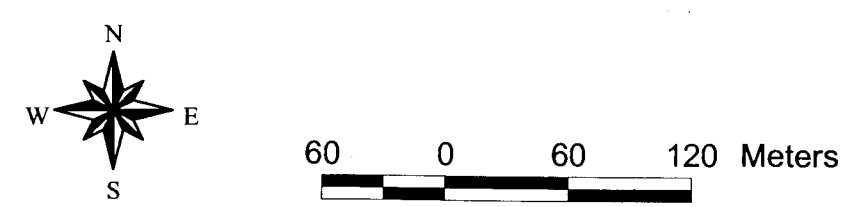


Figure 2 Sediment Profile Imaging parameters measured at each sampling station.

Table 2. Sediment Profile Imaging parameters measured at each sampling station.

Station	Rep	WA North NAD83 Easting	Northing	Pene-tration	Boundary Roughness	Grain Size Major Mode	RPD	Successional Stage	Comment
SPC01	1	1263365	229435	1.5	low	2-3	IND	IND	WT, algae
SPC01	2	1263348	229433	4	med	2-3	1.5	IND	WT, algae, reduced at depth
SPC02	1	1263455	229304	3	low	1-2	IND	IND	shell, reduced at depth
SPC02	2	1263471	229298	2	low	2-3	IND	IND	WT, algae
SPC03	1	1263553	229180	3	low	2-3	0.5	IND	algae
SPC03	2	1263571	229177	3	low	1-2/2-3/3-4	IND	IND	WT, algae
SPC04	1	1263652	229083	2	med	1-2/2-3/3-4	IND	IND	WT, algae
SPC04	2	1263659	229084	4	med	1-2	IND	1	WT
SPC05	1	1263760	228969	1	med	1-2	IND	IND	WT, algae
SPC05	2	1263753	228958	1.5	med	1-2	IND	IND	WT, algae
SPC06	1	1263919	228841	6	low	>4-3	2	1	reduced at depth
SPC06	2	1263890	228819	6	low	>4-3	2	1	algae, reduced at depth
SPC07	1	1263695	228854	3	low	2-3	IND	IND	WT, wood
SPC07	2	1263695	228865	4	low	1-2/2-3	IND	IND	WT
SPC08	1	1263568	228988	1	low	2-3	IND	IND	
SPC08	2	1263579	228968	2	low	1-2	IND	IND	WT
SPC09	1	1263471	229098	0.5	low	1-2	IND	IND	WT
SPC09	2	1263454	229116	2	low	2-3	IND	IND	
SPC10	1	1263370	229222	3	low	1-2	IND	IND	WT, not well sorted
SPC10	2	1263384	229217	2	low	1-2/2-3	IND	IND	not well sorted, sponge?
SPC11	1	1263241	229336	6	low	4-3	1.5	3	WT, worms at depth, no voids
SPC11	2	1263234	229322	7	low	4-3	1.5	3	WT, wood
SPC12	1	1263043	229156	9	low	>4-3	2.5	3	WT, reduced at depth
SPC12	2	1263047	229163	14	low	>4-3	3	3	WT, light gray clayey
SPC13	1	1263330	229009	10	low	2-3/4-3	1.5	3	WT, thin surf sand layer
SPC13	2	1263336	229016	7	low	>4-3	1	1	WT, reduced at depth
SPC14	1	1263463	228881	10	med	2-3/4-3/1-2/4-3	1.5	3	WT, reworking edge of cap
SPC14	2	1263464	228879	12	low	4-3	1.5	1	WT
SPC15	1	1263672	228690	4	low	>4-3	IND	1	WT, interface disturbed
SPC15	2	1263661	228684	4	low	>4-3	IND	1	interface disturbed
SPC16	1	1263505	228613	10	low	>4-3	2	3	WT, low contrast
SPC16	2	1263500	228622	8	low	>4-3	IND	IND	interface disturbed
DWMP01	1	1264043	228825	10	low	>4-3	1.5	1	algae, reduced at depth
DWMP01	2	1264059	228812	7	low	>4-3	1	3	WT, algae

Table 2. Sediment Profile Imaging parameters measured at each sampling station.

Station	Rep	WA North NAD83 Easting	Northing	Pene-tration	Boundary Roughness	Grain Size Major Mode	RPD	Successional Stage	Comment
DWMP02	1	1263903	228760	8	low	>4-3	1.5	3	WT, algal mat, worms at depth
DWMP02	2	1263908	228772	10	low	>4-3	2.5	1	algae / hydroid
DWMP03	1	1263853	228632	8	low	4-3/>4	2	1	interface disturbed, light gray clayey
DWMP03	2	1263852	228642	12	low	>4-3	2	3	worm at depth
DWMP04	1	1263644	228541	5	low	4-3	1.5	3	WT, light gray at depth
DWMP04	2	1263634	228541	8	low	>4-3	2.5	3	light gray at depth
DWMP05	1	1263840	229047	0	low	IND	IND	IND	algae
DWMP05	2	1263832	229037	0.5	low	cobbles	IND	IND	WT, algae, shell
DWMP06	1	1263549	228814	6	low	4-3	1	3	WT
DWMP06	2	1263531	228838	6	med	4-3	1.5	1	WT, wood
DWMP07	1	1263375	228663	4	low	4-3	1.5	1	WT
DWMP07	2	1263355	228648	10	low	>4	1	1	WT, light gray clayey
DWMP08	1	1263338	228879	12	low	>4-3	2	3	WT, reduced at depth
DWMP08	2	1263339	228917	10	low	>4-3	1.5	1	WT, light gray at depth
DWMP09	1	1263205	228811	10	low	>4-3	1.5	1	WT
DWMP09	2	1263204	228810	11	low	>4-3	IND	3	interface disturbed
DWMP10	1	1263574	229324	0	IND	IND	IND	IND	algae
DWMP10	2	1263556	229333	2	low	2-3	IND	IND	algae, well sorted
DWMP11	1	1263294	229148	11	low	4-3	1.5	3	WT, seastar
DWMP11	2	1263283	229171	6	med	4-3	1.5	3	voids not distinct
DWMP12	1	1263047	228960	17	low	>4	4	3	WT, low contrast
DWMP12	2	1263060	228968	17	low	>4	5	3	WT, patch reduced at depth
DWMP13	1	1263318	229636	5	low	cobbles	IND	IND	algae, shell
DWMP13	2	1263309	229632	4	low	large cobbles	IND	IND	algae, shell, hydroid?
DWMP14	1	1263228	229555	8	med	>4-3	1.5	3	WT, algal mat
DWMP14	2	1263238	229556	9	low	>4-3	1.5	3	algae
DWMP15	1	1263057	229448	9	low	>4-3	2	3	light gray clayey
DWMP15	2	1263053	229447	7	low	>4-3	1.5	3	light gray clayey
DWMP16	1	1262958	229359	12	low	>4-3	1.5	3	light gray at depth
DWMP16	2	1262966	229363	4	med	>4-3	IND	1	disturbed, light gray clayey

Notes: RPD = Redox Potential Discontinuity
IND = Indeterminate
WT = Worm Tube

APPENDIX A – VIDEO TRANSECT DESCRIPTIONS

Table 1. Marine organism and algal species and algal percent cover for VT-1 (Inshore Denny Way Transect).

VHS Time	Marine Species	Macroalgal Species	Percent Macroalgal Cover	Substrate
:05	*Pugettia* spp. (Kelp Crab)	*Nereocystis luetkeana* Laminariales *Ulva* spp. Algal/diatom film (?)	25 – 50%	Small rocks and Cobble
:21	*Solaster* spp.	Laminariales *Ulva* spp. Algal/diatom film (?)	0 – 25%	Small rocks and Cobble
:37	*Pycnopodia* spp.	Laminariales *Ulva* spp. Algal/diatom film (?)	0 – 25%	Small rocks and Cobble
:39	*Pisaster* spp.	Laminariales *Ulva* spp. *Gigartina* spp. Algal/diatom film (?)	0 – 25%	Small rocks and Cobble
1:04	*Hydrolagus colliei* (Rat Fish)	Laminariales *Ulva* spp. *Gigartina* spp. Algal/diatom film (?)	0 – 25%	Small rocks and Cobble
1:45 – 3:22	No Visible Macrofauna	*Nereocystis luetkeana* Laminariales *Costaria costata* *Cystoseira* spp. *Ulva* spp. *Gigartina* spp. Algal/diatom film (?)	Ranged from 25 – 50% and 50 – 75%	Sand (Lots), Rocks Cobble, gravel
2:57	*Pisaster* spp.	See Above	Understory algae 25 – 50%	Small rocks, cobble and some sand
3:04	*Pisaster* spp	See Above	Understory algae 50 – 75%	Small rocks, cobble and some sand
4:05	*Evasterias* spp.	Laminariales *Ulva* spp. (sparce)	0 – 25%	Cobble and small rocks
5:19	*Solaster* spp.	Laminariales *Ulva* spp. (sparce)	0 – 25%	Cobble and small rocks
5:40	*Evasterias* spp.	Laminariales *Ulva* spp.	0 – 25%	Cobble and small rocks
6:15 – 7:15	No Visible Macrofauna	*Nereocystis luetkeana* Laminariales *Costaria costata* *Cystoseira* spp. *Ulva* spp. *Gigartina* spp. Algal/diatom film (?)	Ranged from 25 – 50% and 50 – 75%	Sand, Rocks Cobble, gravel
8:08	*Hydrolagus colliei* (Rat Fish)	Laminariales *Ulva* spp.	25 – 50%	Cobble and small rocks
8:34	Sculpinidae	Laminariales *Ulva* spp.	0 – 25%	Cobble and small rocks
8:55	*Hydrolagus colliei* (Rat Fish)	Laminariales *Ulva* spp.	0 – 25%	Cobble and small rocks

Table 2. Marine organism and algal species and algal percent cover for VT-2.

VHS Time	Marine Species	Macroalgal Species	Percent Macroalgal Cover	Substrate
10:02	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
10:30	*Mediaster aequalis* Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
10:39	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
10:44	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
10:55	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
10:57	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
11:08	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
11:11	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25%	Sandy silt
11:17	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
11:22	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
11:24	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
11:35	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
11:37	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
11:43	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
11:47	*Metridium* spp. Numerous burrows	Algal/diatom film (?)	75-100%	Sandy silt
12:30	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt
12:42	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt
13:10	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt
13:30	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt
13:35	None Observed Numerous burrows	Algal/diatom film (?) *Nereocystis luetkeana*	75-100% Isolated fronds	Sandy silt
14:05	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	75-100% 0-25%	Sandy silt
14:15	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?) Laminariales *Ulva* spp. *Gigartina* spp.	0-25% 25 50% Single frond Single frond Single frond	Sandy silt Cans, bricks, boards

VHS Time	Marine Species	Macroalgal Species	Percent Macroalgal Cover	Substrate
14:49	*Metridium* spp. *Solaster* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?) Laminariales *Ulva* spp. *Gigartina* spp.	0-25% 25 50% Single frond Single frond Single frond	Sandy silt Small cobble Cans, bricks, boards
15:09	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?) Laminariales *Ulva* spp. *Gigartina* spp.	0-25% 25 50% Single frond Single frond Single frond	Sandy silt Small cobble Cans, bricks, boards
16:20	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?) Laminariales *Ulva* spp. *Gigartina* spp.	0-25% 25 50% Single frond Single frond Single frond	Sandy silt Small cobble Cans, bricks, boards
18:53	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt Small cobble
19:39	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt Small cobble
19:51	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt Small cobble
19:59	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt Small cobble
20:08	*Metridium* spp. Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt Small cobble
20:20	Asteroidea (5 Rays) UI Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt Small cobble
20:21	Asteroidea (Multirayed) UI Numerous burrows	Algal/diatom film (?) Filamentous gray Algae (?)	0-25% 0-25%	Sandy silt Small cobble
20:25 – 20:38	*Numerous* burrows None Observed	None Observed	None	Black/dark Area Rocks

Table 3. Marine organism and algal species and algal percent cover for VT-3.

VHS Time	Marine Species	Macroalgal Species	Percent Macroalgal Cover	Substrate
21:05	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
21:07	*Mediaster aequalis* (2)	None Observed	N/A	Silt
21:10	*Mediaster aequalis*	None Observed	N/A	Silt
21:21	*Mediaster aequalis*	None Observed	N/A	Silt
21:24	*Mediaster aequalis*	None Observed	N/A	Silt
21:28	*Metridium* spp.	None Observed	N/A	Silt
21:50	*Mediaster aequalis*	None Observed	N/A	Silt
21:54	*Mediaster aequalis*	None Observed	N/A	Silt
21:59	*Mediaster aequalis*	None Observed	N/A	Silt
22:00	*Pycnopodia* spp.	None Observed	N/A	Silt
22:12	*Metridium* spp.	None Observed	N/A	Silt
22:47	Asteroidea	None Observed	N/A	Silt
22:50	*Mediaster aequalis*	None Observed	N/A	Silt
23:08	*Metridium* spp.	None Observed	N/A	Silt
23:29	*Metridium* spp.	None Observed	N/A	Silt
23:36	*Mediaster aequalis*	None Observed	N/A	Silt
23:43	*Metridium* spp.	None Observed	N/A	Silt
23:56	*Metridium* spp.	None Observed	N/A	Silt
24:31	*Mediaster aequalis* Asteroidea UI	None Observed	N/A	Silt
24:51	*Mediaster aequalis*	None Observed	N/A	Silt
25:36	*Mediaster aequalis*	Filamentous gray Algae (?)	0-25%	Silt
25:46	*Mediaster aequalis*	Filamentous gray Algae (?)	0-25%	Silt
26:06	*Mediaster aequalis*	Filamentous gray Algae (?)	0-25%	Silt
27:08	*Metridium* spp.	None Observed	N/A	Silt
27:21	*Mediaster aequalis*	None Observed	N/A	Silt
28:10	*Mediaster aequalis*	None Observed	N/A	Silt
28:12	*Mediaster aequalis*	None Observed	N/A	Silt
28:24	*Pycnopodia* spp.	None Observed	N/A	Silt
28:30	*Mediaster aequalis*	None Observed	N/A	Silt
28:50	*Mediaster aequalis*	None Observed	N/A	Silt
29:04	*Mediaster aequalis* (2) *Solaster* spp.	None Observed	N/A	Silt
29:07	Asteroidea UI	None Observed	N/A	Silt
29:14	*Pycnopodia* spp.	None Observed	N/A	Silt
29:23	None observed	Filamentous gray Algae (?)	0-25%	Silt
29:34	*Metridium* spp.	Filamentous gray Algae (?)	0-25%	Silt
29:36	*Metridium* spp.	None Observed	N/A	Silt
29:50	*Mediaster aequalis*	Algal/diatom film (?)	N/A	Silt
29:56	*Mediaster aequalis*	Algal/diatom film (?)	N/A	Silt
29:57	*Mediaster aequalis*	Algal/diatom film (?)	N/A	Silt
30:08	*Mediaster aequalis*	Filamentous gray Algae (?)	0-25%	Silt
30:12	*Metridium* spp.	None Observed	N/A	Silt
30:16	*Mediaster aequalis*	None Observed	N/A	Silt
30:19	*Mediaster aequalis*	None Observed	N/A	Silt
30:48	None observed	Filamentous gray Algae (?)	0-25%	Silt

Table 4. Marine organism and algal species and algal percent cover for VT-4.

VHS Time	Marine Species	Macroalgal Species	Percent Macroalgal Cover	Substrate
31:10	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
31:17	*Metridium* spp. Burrows	None Observed	N/A	Silt
31:20	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
32:13	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
32:28	Asteroidea UI (5 rays) Burrows	None Observed	N/A	Silt
32:32	*Metridium* spp Burrows	None Observed	N/A	Silt
32:45	*Metridium* spp Burrows	None Observed	N/A	Silt
33:01	*Mediaster aequalis* (2) Burrows	None Observed	N/A	Silt
33:04	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
33:12	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
33:27	*Metridium* spp. Burrows	None Observed	N/A	Silt
33:52	Asteroidea Burrows	None Observed	N/A	Silt
34:14	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
34:45	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
34:35	*Mediaster aequalis* *Metridium* spp. Burrows	None Observed	N/A	Silt
34:38	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
34:41	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
34:46	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
35:04	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
35:06	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
35:08	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
35:16	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
35:21	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
35:24	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
35:50	*Mediaster aequalis* Burrows	None Observed	N/A	Silt

VHS Time	Marine Species	Macroalgal Species	Percent Macroalgal Cover	Substrate
35:55	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
35:57	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
36:04	*Mediaster aequalis* (2) Burrows	None Observed	N/A	Silt
36:13	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
36:27	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
36:29	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
36:39	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
37:12	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
37:58	Pleuronectidae Burrows	None Observed	N/A	Silt
38:01	*Cancer* spp. Burrows	None Observed	N/A	Silt
38:02	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
38:19	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
38:35	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
38:52	*Evasterias* spp. (?) Burrows	None Observed	N/A	Silt
39:50	*Cancer* spp. (C. *gracilis*?) Burrows	None Observed	N/A	Silt
39:53	*Metridium* spp. Burrows	None Observed	N/A	Silt
41:03	*Mediaster aequalis* Burrows	None Observed	N/A	Silt

Table 5. Marine organism and algal species and algal percent cover for VT-5.

VHS Time	Marine Species	Macroalgal Species	Percent Macroalgal Cover	Substrate
41:35	*Metridium* spp. Burrows	None Observed	N/A	Silt
42:16	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
42:45	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
43:02	*Metridium* spp. Burrows	None Observed	N/A	Silt
43:46	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
44:00	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
45:41	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
45:45	Asteroidea UI (Multirayed) Burrows	None Observed	N/A	Silt
45:48	Pleuronectidae Burrows	None Observed	N/A	Silt
45:53	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
46:10	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
46:12	Pleuronectidae Burrows	None Observed	N/A	Silt
47:07	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
47:56	Holothuroidea UI Burrows	None Observed	N/A	Silt
49:16	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
49:21	*Mediaster aequalis* Burrows	None Observed	N/A	Silt

Table 6. Marine organism and algal species and algal percent cover for VT-6.

VHS Time	Marine Species	Macroalgal Species	Percent Macroalgal Cover	Substrate
50:06	*Metridium* spp. Burrows	None Observed	N/A	Silt
50:08	*Pycnopodia* spp. Burrows	None Observed	N/A	Silt
50:21	Pleuronectidae Burrows	None Observed	N/A	Silt
50:47	Pleuronectidae Burrows	None Observed	N/A	Silt
52:08	*Metridium* spp. *Cancer* spp. Burrows	None Observed	N/A	Silt
52:29	*Metridium* spp.	None Observed	N/A	Silt
52:30 – 55:50	Could not see sediment surface due to sediment in water column			
55:51	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
56:07	*Metridium* spp. Burrows	None Observed	N/A	Silt
56:16	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
56:46	*Mediaster aequalis* Burrows	None Observed	N/A	Silt
57:07	*Mediaster aequalis* Burrows	None Observed	N/A	Silt