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1.0 INTRODUCTION

In February 2004, the U.S. Army Corps of Engineers, Seattle District (USACE) placed approximately 25,000 cubic yards of sandy dredged material along a 700-foot long stretch of shoreline in Half Moon Bay, Westport, Grays Harbor County, Washington (Figure 1). Prior to placing this material, Science Applications International Corporation (SAIC) assisted the USACE in obtaining data on benthic invertebrates in and adjacent to the project footprint. Accelerated erosion in Half Moon Bay threatens the fill placed at the south jetty where a breach occurred in 1994, and re-nourished in 2002. The interim sand placement in 2004 is intended to prevent another breach from forming and threatening the stability of the south jetty and federal navigation channel until a long-term maintenance strategy is implemented.

This Draft Report provides a summary of the baseline benthic invertebrate community measurements in Half Moon Bay, South Beach, and subtidal, open-water disposal sites adjacent to Half Moon Bay. This pre-placement baseline data will be used to document changes in population density and community composition, which may occur as a result of the placement. The next round of benthic infauna community monitoring is scheduled for late June 2004.

2.0 METHODS

2.1 Benthic Invertebrate Sampling and Analysis

Benthic invertebrate sampling at Half Moon Bay and South Beach, Westport, Washington was conducted by SAIC on January 20 and 21, 2004. Intertidal core samples were collected at thirteen sample sites in western Half Moon Bay, and eight sites on South Beach (Figure 1). Intertidal benthic samples were collected at four elevations (+12 feet, +8 feet, +4 feet, and 0 feet MLLW) and were collected by hand at low tide. Subtidal core samples were collected at eight sample sites in western Half Moon Bay. Subtidal benthic samples were collected at three elevations (-4 feet, -8 feet, and -12 feet MLLW) at high tide using the M/V *Shoalhunter*. A modified 0.1 m² Young van Veen sampler was deployed from the M/V *Shoalhunter* to collect subtidal samples. A summary of station coordinates and elevations is provided in the Field Data Overview Report (Appendix A).

At each intertidal and subtidal station, a total of ten replicate core samples were collected. The samples were collected using a cylindrical coring device 5 cm in diameter and 15 cm long. For subtidal samples, the coring device was inserted into the van Veen sampler to collect samples similar in size to the intertidal samples. The number of samples collected and analyzed is summarized in Table 1. A minimum of three replicates from each station was analyzed for benthic infauna. At three of the Half Moon Bay stations, all ten replicates were analyzed.

Each sediment core sample was preserved in 10% formalin solution in the field and transferred to 70% ethanol prior to analysis. Samples to be archived were also transferred to 70% ethanol for long-term storage. Samples that were analyzed were washed through a series of nested sieves of 1.0 mm, 0.5 mm, and 0.25 mm. Each fraction was retained in separate containers and submitted to Columbia Sciences, of Royston B.C., for identification and enumeration. The number of individuals of each species, total number of individuals, number of individuals by major

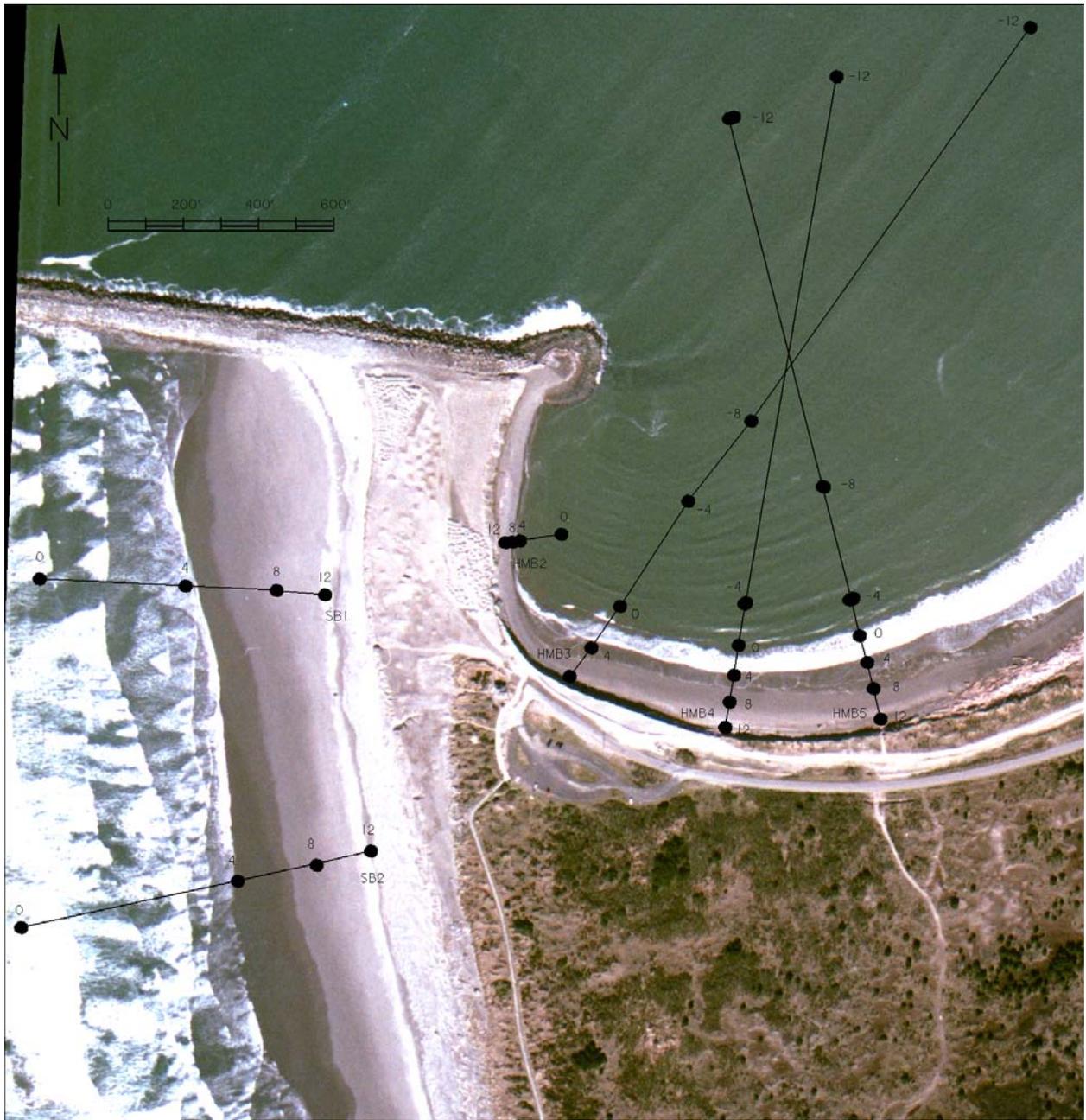


Figure 1. Half Moon Bay and South Beach sampling locations.

Table 1. Number of samples collected and analyzed.

Transect	Elev. (ft)	Sample ID	Replicate Samples	Replicates Analyzed	Grain Size Analysis
Half Moon Bay Intertidal					
HMB2	0	HMB2+0	10	10	1
HMB2	4	HMB2+4	10	3	1
HMB3	0	HMB3+0	10	3	1
HMB3	4	HMB3+4	10	3	1
HMB3	8	HMB3+8	10	3	1
HMB4	0	HMB4+0	10	3	1
HMB4	4	HMB4+4	10	3	1
HMB4	8	HMB4+8	10	10	1
HMB4	12	HMB4+12	10	3	1
HMB5	0	HMB5+0	10	3	1
HMB5	4	HMB5+4	10	3	1
HMB5	8	HMB5+8	10	3	1
HMB5	12	HMB5+12	10	3	1
Half Moon Bay Subtidal					
HMB3	-4	HMBsub1	10	3	1
HMB3	-8	HMBsub2	10	3	1
HMB3	-12	HMBsub3	10	3	1
HMB4	-4	HMBsub4	10	3	1
HMB4	-12	HMBsub5	10	3	1
HMB5	-4	HMBsub6	10	3	1
HMB5	-8	HMBsub7	10	10	1
HMB5	-12	HMBsub8	10	3	1
South Beach Intertidal					
SB1	0	SB1+0	10	3	1
SB1	4	SB1+4	10	3	1
SB1	8	SB1+8	10	3	1
SB1	12	SB1+12	10	3	1
SB2	0	SB2+0	10	3	1
SB2	4	SB2+4	10	3	1
SB2	8	SB2+8	10	3	1
SB2	12	SB2+12	10	3	1
Totals:			290	108	29

taxa, total wet weight biomass, and wet weight biomass by major taxa were reported for each sample. The laboratory data report is provided in Appendix B. A quality assurance (QA) review of the benthic data performed by SAIC is provided in Appendix C.

Samples to be archived were washed through the 0.25 mm sieve only. The archived samples will remain in custody of SAIC until the completion of this study, after which any archived benthic samples will be transferred to the USACE. Some or all of the archived samples may be analyzed at a later date, depending on the results of the baseline analysis and/or future monitoring surveys. At each intertidal and subtidal station, a separate sediment sample was also collected and submitted to Soil Technology of Bainbridge Island, Washington for grain size analysis (Appendix C).

2.2 Intertidal Bivalve Sampling

A semi-quantitative assessment of bivalves in the lower intertidal zone of Half Moon Bay was conducted on January 21, 2004, by excavating sediments along the four station transects at 0 feet MLLW (HMB-2, HMB-3, HMB-4, and HMB-5). A 0.25 m² quadrat made of PVC was placed randomly at each site, and sediment was excavated from within the quadrat to a depth of at least 30 cm. The sediment was washed through a 2.0 mm sieve and inspected for bivalves. Significant amounts of fine shell debris were retained within the sieve at each station, but no living bivalves were collected. However, several heart cockles (*Clinocardium nuttallii*) were observed at station HMB2 +0 (transect HMB-2, 0 feet MMLW elevation) during the collection of benthic infauna samples. Additional biological observations during sampling are provided in the Field Data Overview Report (Appendix A).

3.0 DATA SUMMARY

The following sections provide a summary of the baseline benthic infauna and sediment grain size results in Half Moon Bay and South Beach. The raw data for the benthic infauna analysis and sediment grain size analysis are provided in Appendix B and D, respectively. Data validation for the benthic infauna analysis results is provided in Appendix C.

3.1 Half Moon Bay Benthic Infauna

Benthic infauna samples were collected at 21 stations within Half Moon Bay. Triplicate samples were analyzed at all stations, with the exception of stations HMB2 +0, HMB4 +8, and HMB5 -8, where ten replicate samples were analyzed (Table 1). Each sample consisted of three size classes (1.0 mm, 0.5 mm, and 0.25 mm). Benthic organisms in each size class were identified to the lowest possible taxon and the number of individuals counted. Organism counts were also pooled based on adult versus juvenile identification.

Adult organisms were found primarily in the 1.0 mm and 0.5 mm size classes, and at relatively low abundances relative to juveniles. Juveniles in the 0.25 mm size class dominated abundance measurements. Therefore, the summary tables in the following sections are organized into three categories: 1) pooled adult and juvenile data, 2) juvenile data only, and 3) adult data only.

3.1.1 Pooled Adult and Juvenile

Mean abundance and number of taxa (pooled to include both adult and juvenile organisms) for stations sampled in Half Moon Bay are summarized in Table 2. Abundance and number of taxa by major taxonomic group (phylum) are also provided. Values are reported in proportion to the surface area collected by the 5 cm diameter core sampler (19.6 cm²).

Total abundance and total number of taxa in Half Moon Bay varied by transect and elevation, and were higher overall at subtidal locations (-4 to -12 feet MLLW). Subtidal stations had a mean total abundance of 46.3 individuals per 19.6 cm² and a mean of 4.7 for total number of taxa. For subtidal stations, higher mean abundance and number of taxa were observed at -4 and -8 feet MLLW, with the highest values for both parameters measured at subtidal station HMB3 -8 (Transect HMB3, elevation -8 feet MLLW). Station HMB3 -8 had a mean total abundance of 208.3 individuals and 7.0 for total number of taxa. Abundance was dominated by an annelid of the class Archiannelida (*Protodrilus flabellifer*) with a mean of 174 individuals. Intertidal stations (+12 to 0 feet MLLW) had a mean of 17.6 individuals per 19.6 cm² for total abundance and a mean of 2.0 for total number of taxa.

Transects located in the inner bay protected by the jetty generally had higher abundance than transects located further to the east. Stations along transect HMB3 had a mean total abundance of 60.3 individuals, whereas stations along transects HMB4 and HMB5 had mean total abundances of 17.6 and 14.7 individuals, respectively.

The ribbon worm (*Nemertea* indet.) was the dominant organism at every station within Half Moon Bay with the exception of stations HMB3 -8, HMB4 -4, and HMB5 +12 (Table 3). The annelid *Protodrilus flabellifer* was the dominant organism at stations HMB3 -8 and HMB4 -4, and an annelid of the class Oligochaeta (*Marionina* sp.) was the dominant organism at intertidal station HMB5 +12.

Biomass measurements in Half Moon Bay are relatively low at all stations due to the small sample size, dominance of small juvenile organisms, and low abundance (Table 4). Subtidal stations had a higher mean total biomass (0.013 grams per 19.6 cm²) than the intertidal stations (0.002 grams per 19.6 cm²). Subtidal station HMB4 -4 had the highest mean total biomass (0.023 grams per 19.6 cm²) of all Half Moon Bay stations. Station HMB3 -8, which had the highest abundance and number of taxa, had the second highest mean total biomass of 0.022 grams per 19.6 cm². Biomass was dominated by polychaetes at both stations. Stations HMB4 -4 and HMB3 -8 had 0.0203 grams and 0.0208 grams of polychaete biomass, respectively.

3.1.2 Juvenile Size Class

Mean abundance and number of taxa measured for juvenile organisms at stations sampled in Half Moon Bay are summarized in Table 5. Juvenile organisms dominate the benthic infauna, comprising 95.7% of the total abundance measurements in Half Moon Bay. The 0.25 mm size class of each Half Moon Bay sample was composed almost entirely of juvenile organisms and contained 94.9% of all of the organisms observed.

Since juveniles make up the majority of organisms observed in Half Moon Bay samples, total abundance and total number of taxa measurements are very similar to the pooled adult and juvenile measurements (Section 3.1.1). Total abundance and number of taxa were higher at subtidal stations (-4 to -12 feet MLLW) than at intertidal stations (+12 to 0 feet MLLW). Total abundance for subtidal stations averaged 43.7 individuals per 19.6 cm², versus 17.2 individuals per 19.6 cm² at the intertidal stations. Similarly, total number of taxa at subtidal stations averaged 3.4, versus 1.6 at the intertidal stations.

The highest total abundance of taxa for juveniles was also observed at station HMB3 -8, with 201.3 individuals. Abundance was dominated by the annelid *Protodrilus flabellifer*. However, the highest total number of taxa for juveniles was observed at station HMB3 -4, with a mean of 5.3 taxa.

3.1.3 Adult Size Class

Mean abundance and number of taxa measured for adult organisms at stations sampled in Half Moon Bay are summarized in Table 6. Adult organisms were observed at very low abundances in the 1.0 mm and 0.5 mm size fractions, and at subtidal stations in the 0.25 mm size fraction. At the intertidal stations, mean total abundance was 0.4 adults per 19.6 cm² versus 2.6 adults per 19.6 cm² at the subtidal stations. The highest abundance was measured in the subtidal at -8 feet MLLW. Station HMB3 -8 had the highest total mean abundance of 7.0 adults, followed by station HMB5 -8 with a mean total abundance of 5.1 adults. The crustacean *Harpacticoida* indet. was the most abundant adult species at both stations. Adult organisms were not observed at any intertidal stations along transect HMB4.

3.1.4 Sediment Grain Size

Sediment grain size for Half Moon Bay samples are summarized in Table 7. All stations in Half Moon Bay consisted almost entirely of sands and gravels. Percent fines ranged from a high of 1.9% at station HMB2 +0, to 0% fines at HMB4 +12. Subtidal stations in Half Moon Bay consisted of 98 to 99% sand. Intertidal stations were also predominantly sand, although five of thirteen stations contained appreciable portions of gravel. The highest percentage of gravel (31%) was measured at station HMB3 +4.

Table 2. Half Moon Bay mean abundance and taxa – Combined adults and juveniles.

Station	HMB2 +4	HMB2 +0*
Total Abundance	9.3	19.4
Annelida Abundance	0.0	7.3
Arthropoda Abundance	0.3	2.2
Mollusca Abundance	1.3	0.6
Miscellaneous Abundance	7.7	9.4
Total No. of Taxa	1.7	4.9
Annelida No. Taxa	0.0	1.7
Arthropoda No. Taxa	0.3	1.6
Mollusca No. Taxa	0.3	0.5
Miscellaneous No. Taxa	1.0	1.1

Station	HMB3 +8	HMB3 +4	HMB3+0	HMB3 -4	HMB3 -8	HMB3 -12
Total Abundance	10.0	83.3	23.7	21.7	208.3	14.7
Annelida Abundance	0.3	2.3	3.0	7.3	179.0	3.7
Arthropoda Abundance	0.0	0.3	1.0	1.7	4.3	0.7
Mollusca Abundance	0.0	0.0	0.0	2.0	1.0	0.0
Miscellaneous Abundance	9.7	80.7	19.3	10.7	24.0	10.3
Total No. of Taxa	1.3	2.0	3.7	6.7	7.0	3.3
Annelida No. Taxa	0.3	0.7	1.7	2.3	3.7	1.7
Arthropoda No. Taxa	0.0	0.3	1.0	1.0	1.3	0.7
Mollusca No. Taxa	0.0	0.0	0.0	2.0	1.0	0.0
Miscellaneous No. Taxa	1.0	1.0	1.0	1.3	1.0	1.0

Station	HMB4 +12	HMB4 +8*	HMB4 +4	HMB4 +0	HMB4 -4	**	HMB4 -12
Total Abundance	1.7	7.8	8.7	30.7	14.7		42.0
Annelida Abundance	0.3	0.1	0.7	0.7	8.0		6.0
Arthropoda Abundance	0.0	0.0	0.0	0.0	2.0		0.0
Mollusca Abundance	0.0	0.0	0.0	0.0	0.0		0.0
Miscellaneous Abundance	1.3	7.7	8.0	30.0	4.7		36.0
Total No. of Taxa	1.0	1.1	1.7	1.7	4.3		4.7
Annelida No. Taxa	0.3	0.1	0.7	0.7	1.7		3.7
Arthropoda No. Taxa	0.0	0.0	0.0	0.0	1.7		0.0
Mollusca No. Taxa	0.0	0.0	0.0	0.0	0.0		0.0
Miscellaneous No. Taxa	0.7	1.0	1.0	1.0	1.0		1.0

Station	HMB5 +12	HMB5 +8	HMB5 +4	HMB5 +0	HMB5 -4	HMB5 -8*	HMB5 -12
Total Abundance	14.3	3.0	10.3	6.0	41.7	19.1	8.3
Annelida Abundance	10.3	0.3	2.0	0.0	8.7	6.9	1.7
Arthropoda Abundance	0.0	0.0	0.0	0.0	4.3	3.5	0.3
Mollusca Abundance	0.0	0.0	0.0	1.3	0.3	0.0	0.0
Miscellaneous Abundance	4.0	2.7	8.3	4.7	28.3	8.7	6.3
Total No. of Taxa	1.0	1.3	2.3	2.3	5.0	4.3	2.0
Annelida No. Taxa	0.7	0.3	1.3	0.0	3.0	2.6	0.7
Arthropoda No. Taxa	0.0	0.0	0.0	0.0	0.7	0.8	0.3
Mollusca No. Taxa	0.0	0.0	0.0	1.3	0.3	0.0	0.0
Miscellaneous No. Taxa	0.3	1.0	1.0	1.0	1.0	0.9	1.0

* Mean of ten replicate samples. All others are mean of triplicate samples.

** Transects overlap in the subtidal, so the -8 foot MLLW station on transect HMB4 was eliminated.

Note: Abundance of individual replicate samples are found in Appendix B, Table B-1.

Table 3. Most abundant species for Half Moon Bay stations.

Station	HMB 2 +4			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	6	3	14	23	7.67	5.69
Ostracoda Indet.	1	0	0	1	0.33	0.58
Bivalvia Indet.	0	4	0	4	1.33	2.31
Opheliidae Indet.	0	0	0	0	0.00	0.00
Harpacticoida Indet.	0	0	0	0	0.00	0.00
Eohaustorius washingtonianus	0	0	0	0	0.00	0.00

Station	HMB 2 +0										Pooled	Mean	St. Dev.
Rep	A	B	C	D	E	F	G	H	I	J			
Nemertea Indet.	10	23	13	7	13	7	3	8	3	6	93	9.3	5.95
Opheliidae Indet.	12	8	5	11	7	4	3	6	0	7	63	6.3	3.59
Harpacticoida Indet.	3	4	1	0	1	2	1	1	1	0	14	1.4	1.26
Eohaustorius washingtonianus	0	1	0	1	0	1	1	0	0	0	4	0.4	0.52
Bivalvia Indet.	2	0	0	1	1	0	0	0	1	0	5	0.5	0.71
Spio butleri	1	0	0	0	1	0	0	0	0	0	2	0.2	0.42

Station	HMB 3 +8			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	14	10	5	29	9.67	4.51
Eteone columbiensis	0	1	0	1	0.33	0.58
Opheliidae Indet.	0	0	0	0	0.00	0.00
Harpacticoida Indet.	0	0	0	0	0.00	0.00
Polychaeta Indet.	0	0	0	0	0.00	0.00
Ostracoda Indet.	0	0	0	0	0.00	0.00

Table 3. Most abundant species for Half Moon Bay stations (continued).

Station	HMB 3 +4			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	53	24	165	242	80.67	74.46
Opheliidae Indet.	6	1	0	7	2.33	3.21
Harpacticoida Indet.	0	1	0	1	0.33	0.58
Polychaeta Indet.	0	0	0	0	0.00	0.00
Ostracoda Indet.	0	0	0	0	0.00	0.00
Paraonella platybranchia	0	0	0	0	0.00	0.00

Station	HMB 3 +0			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	20	23	15	58	19.33	4.04
Opheliidae Indet.	2	1	0	3	1.00	1.00
Harpacticoida Indet.	1	1	0	2	0.67	0.58
Polychaeta Indet.	1	0	4	5	1.67	2.08
Ostracoda Indet.	1	0	0	1	0.33	0.58
Paraonella platybranchia	1	0	0	1	0.33	0.58

Station	HMB 3 -4			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	6	14	11	31	10.33	4.04
Protodrilus flabellifer	0	7	7	3	1.00	4.04
Mytilidae Indet.	1	1	0	2	0.67	0.58
Tellinidae Indet.	0	1	0	1	0.33	0.58
Ostracoda Indet.	0	1	0	1	0.33	0.58
Opheliidae Indet.	0	1	0	14	4.67	0.58

Station	HMB 3 -8			Pooled	Mean	St. Dev.
Rep	A	B	C			
Protodrilus flabellifer	211	144	167	522	174.00	34.04
Nemertea Indet.	12	36	24	72	24.00	12.00
Ostracoda Indet.	1	0	2	8	2.67	1.00
Opheliidae Indet.	1	3	1	3	1.00	1.15
Odostomia sp.	1	1	0	1	0.33	0.58
Harpacticoida Indet.	0	4	6	10	3.33	3.06

Station	HMB 3 -12			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	9	13	9	31	10.33	2.31
Protodrilus flabellifer	0	2	4	2	0.67	2.00
Opheliidae Indet.	2	0	2	1	0.33	1.15
Eohaustorius washingtonianus	1	0	0	6	2.00	0.58
Acarina Indet.	0	0	1	2	0.67	0.58
Spio butleri	0	0	1	1	0.33	0.58

Station	HMB 4 +12			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	2	2	0	4	1.33	1.15
Amphipoda Indet. (fragment)	0	0	1	1	0.33	0.58
Polychaeta Indet.	0	0	0	0	0.00	0.00
Euzonus mucronata	0	0	0	0	0.00	0.00
Canalipalpa Indet.	0	0	0	0	0.00	0.00
Eteone sp. fragment	0	0	0	0	0.00	0.00

Table 3. Most abundant species for Half Moon Bay stations (continued).

Station	HMB 4+8										Pooled	Mean	St. Dev.
Rep	A	B	C	D	E	F	G	H	I	J			
Nemertea Indet.	5	5	10	14	7	7	12	6	4	7	77	7.7	3.27
Polychaeta Indet.	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Euzonus mucronata	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Canalipalpata Indet.	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Eteone sp. fragment	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Opheliidae Indet.	0	1	0	0	0	0	0	0	0	0	1	0.1	0.32

Station	HMB 4 +4			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	9	11	4	24	8.00	3.61
Polychaeta Indet.	0	1	0	1	0.33	0.58
Euzonus sp. 1	0	0	1	1	0.33	0.58
Protodrilus flabellifer	0	0	0	0	0.00	0.00
Eteone columbiensis	0	0	0	0	0.00	0.00
Opheliidae Indet.	0	0	0	0	0.00	0.00

Station	HMB 4 +0			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	25	47	18	90	30.00	15.13
Protodrilus flabellifer	1	1	0	2	0.67	0.58
Eteone columbiensis	0	0	0	0	0.00	0.00
Opheliidae Indet.	0	0	0	0	0.00	0.00
Harpacticoida Indet.	0	0	0	0	0.00	0.00
Polychaeta Indet.	0	0	0	0	0.00	0.00

Table 3. Most abundant species for Half Moon Bay stations (continued).

Station	HMB 4 -4			Pooled	Mean	St. Dev.
Rep	A	B	C			
Protodrilus flabellifer	9	8	4	21	7.00	2.65
Nemertea Indet.	3	7	4	14	4.67	2.08
Polychaeta Indet.	2	0	0	2	0.67	1.15
Acarina Indet.	1	0	2	3	1.00	1.00
Harpacticoida Indet.	1	0	1	2	0.67	0.58
Glycera macrobranchia	1	0	0	1	0.33	0.58

Station	HMB 4 -12			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	10	80	18	108	36.00	38.31
Syllidae Indet.	0	5	0	5	1.67	2.89
Polychaeta Indet.	2	2	1	2	0.67	0.58
Eteone columbiensis	0	1	0	1	0.33	0.58
Spiophanes bombyx	0	1	0	1	0.33	0.58
Spionidae Indet.	2	0	0	1	0.33	1.15

Station	HMB 5 +12			Pooled	Mean	St. Dev.
Rep	A	B	C			
Marionina sp.	0	10	21	31	10.33	10.50
Nemertea Indet.	12	0	0	12	4.00	6.93
Porifera Indet.	0	0	0	0	0.00	0.00
Bivalvia Indet.	0	0	0	0	0.00	0.00
Musculus sp.	0	0	0	0	0.00	0.00
Tellina nukuloides	0	0	0	0	0.00	0.00

Station	HMB 5 +8			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	2	2	4	8	2.67	1.15
Pygospio californica	0	0	1	1	0.33	0.58
Euzonus mucronata	0	0	0	0	0.00	0.00
Opheliidae Indet.	0	0	0	0	0.00	0.00
Musculus sp.	0	0	0	0	0.00	0.00
Bivalvia Indet.	0	0	0	0	0.00	0.00

Station	HMB 5 +4			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	14	7	4	25	8.33	5.13
Euzonus mucronata	1	0	1	2	0.67	0.58
Opheliidae Indet.	0	1	3	4	1.33	1.53
Musculus sp.	0	0	0	0	0.00	0.00
Bivalvia Indet.	0	0	0	0	0.00	0.00
Porifera Indet.	0	0	0	0	0.00	0.00

Station	HMB 5 +0			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	2	8	4	14	4.67	3.06
Musculus sp.	1	1	1	3	1.00	0.00
Bivalvia Indet.	0	1	0	1	0.33	0.58
Porifera Indet.	0	0	0	0	0.00	0.00
Tellina nukuloides	0	0	0	0	0.00	0.00
Acarina Indet.	0	0	0	0	0.00	0.00

Table 3. Most abundant species for Half Moon Bay stations (continued).

Station Rep	HMB 5 -4			Pooled	Mean	St. Dev.
	A	B	C			
Nemertea Indet.	28	38	19	85	28.33	9.50
Harpacticoida Indet.	0	5	8	9	3.00	4.04
Marionina sp.	0	4	2	1	0.33	2.00
Opheliidae Indet.	3	2	4	1	0.33	1.00
Nudibranchia Indet.	0	1	0	1	0.33	0.58
Protodrilus flabellifer	0	0	8	13	4.33	4.62

Station Rep	HMB 5 -8										Pooled	Mean	St. Dev.
	A	B	C	D	E	F	G	H	I	J			
Harpacticoida Indet.	15	6	6	1	1	0	1	3	2	0	35	3.50	4.60
Nemertea Indet.	11	9	10	7	7	2	9	26	6	0	87	8.70	6.99
Polychaeta Indet.	8	0	1	1	0	0	1	0	0	0	11	1.10	2.47
Ophelia limacina	1	3	6	8	0	0	8	2	1	0	29	2.90	3.25
Glycera macrobranchia	0	1	0	0	0	0	0	1	1	0	3	0.30	0.48
Magelona sp.	0	0	1	11	0	0	0	0	0	0	12	1.20	3.46

Station Rep	HMB 5 -12			Pooled	Mean	St. Dev.
	A	B	C			
Nemertea Indet.	8	9	2	19	6.33	3.79
Eohaustorius washingtonianus	1	0	0	1	0.33	0.58
Oligochaeta Indet.	1	0	0	1	0.33	0.58
Cirratulidae Indet.	0	4	0	4	1.33	2.31
Harpacticoida Indet.	0	0	0	0	0.00	0.00
Polychaeta Indet.	0	0	0	0	0.00	0.00

Table 4. Biomass summary data for Half Moon Bay stations.

Station	HMB 2 +4			Station	HMB 3 +0		
	pooled	mean	st dev		pooled	mean	st dev
Miscellaneous weight (gm)	0.001900	0.000633	0.000751	Miscellaneous weight (gm)	0.002100	0.000700	0.000265
Mollusca weight (gm)	0.000200	0.000067	0.000115	Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.000200	0.000067	0.000115	Crustacea weight (gm)	0.000300	0.000100	0.000100
Polychaeta weight (gm)	0	0	0	Polychaeta weight (gm)	0.004400	0.001467	0.002281

Station	HMB 2 +0			Station	HMB 3 -4		
	pooled	mean	st dev		pooled	mean	st dev
Miscellaneous weight (gm)	0.005700	0.000570	0.000558	Miscellaneous weight (gm)	0.004600	0.001533	0.001550
Mollusca weight (gm)	0.009500	0.000950	0.002899	Mollusca weight (gm)	0.036500	0.012167	0.019870
Crustacea weight (gm)	0.007100	0.000710	0.001024	Crustacea weight (gm)	0.000500	0.000167	0.000153
Polychaeta weight (gm)	0.046500	0.004650	0.009913	Polychaeta weight (gm)	0.004600	0.001533	0.001026

Station	HMB 3 +8			Station	HMB 3 -8		
	pooled	mean	st dev		pooled	mean	st dev
Miscellaneous weight (gm)	0.000900	0.000300	0.000100	Miscellaneous weight (gm)	0.023800	0.007933	0.002926
Mollusca weight (gm)	0	0	0	Mollusca weight (gm)	0.001400	0.000467	0.000462
Crustacea weight (gm)	0	0	0	Crustacea weight (gm)	0.000900	0.000300	0.000265
Polychaeta weight (gm)	0.003000	0.001000	0.001732	Polychaeta weight (gm)	0.011600	0.003867	0.003443

Station	HMB 3 +4			Station	HMB 3 -12		
	pooled	mean	st dev		pooled	mean	st dev
Miscellaneous weight (gm)	0.008100	0.002700	0.002476	Miscellaneous weight (gm)	0.001700	0.000567	0.000306
Mollusca weight (gm)	0	0	0	Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.000100	0.000033	0.000058	Crustacea weight (gm)	0.000800	0.000267	0.000379
Polychaeta weight (gm)	0.000600	0.000200	0.000265	Polychaeta weight (gm)	0.004300	0.001433	0.002397

Note: Weights include adults and juveniles. Biomass data for individual replicate samples are found in Appendix B, Table B-2.

Table 4. Biomass summary data for Half Moon Bay stations (continued).

Station	HMB 4 +12			Station	HMB 4 -4		
	pooled	mean	st dev		pooled	mean	st dev
Miscellaneous weight (gm)	0.000200	0.000067	0.000058	Miscellaneous weight (gm)	0.001300	0.000433	0.000058
Mollusca weight (gm)	0	0	0	Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0	0	0	Crustacea weight (gm)	0.007300	0.002433	0.004128
Polychaeta weight (gm)	0.000100	0.000033	0.000058	Polychaeta weight (gm)	0.060900	0.020300	0.035161

Station	HMB 4 +8			Station	HMB 4 -12		
	pooled	mean	st dev		pooled	mean	st dev
Miscellaneous weight (gm)	0.004400	0.000440	0.000212	Miscellaneous weight (gm)	0.013900	0.004633	0.005084
Mollusca weight (gm)	0	0	0	Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0	0	0	Crustacea weight (gm)	0	0	0
Polychaeta weight (gm)	0.000100	0.000010	0.000032	Polychaeta weight (gm)	0.038900	0.012967	0.016946

Station	HMB 4 +4			Station	HMB 5 +12		
	pooled	mean	st dev		pooled	mean	st dev
Miscellaneous weight (gm)	0.001000	0.000333	0.000153	Miscellaneous weight (gm)	0.003300	0.001100	0.000436
Mollusca weight (gm)	0	0	0	Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0	0	0	Crustacea weight (gm)	0	0	0
Polychaeta weight (gm)	0.016600	0.005533	0.009498	Polychaeta weight (gm)	0	0	0

Station	HMB 4 +0			Station	HMB 5 +8		
	pooled	mean	st dev		pooled	mean	st dev
Miscellaneous weight (gm)	0.003300	0.001100	0.000624	Miscellaneous weight (gm)	0.000500	0.000167	0.000058
Mollusca weight (gm)	0	0	0	Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0	0	0	Crustacea weight (gm)	0	0	0
Polychaeta weight (gm)	0	0	0	Polychaeta weight (gm)	0.001100	0.000367	0.000635

Note: Weights include adults and juveniles. Biomass data for individual replicate samples are found in Appendix B, Table B-2.

Table 4. Biomass summary data for Half Moon Bay stations (continued).

Station	HMB 5 +4		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.001800	0.000600	0.000361
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0	0	0
Polychaeta weight (gm)	0.008600	0.002867	0.003879

Station	HMB 5 +0		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.000500	0.000167	0.000058
Mollusca weight (gm)	0.000500	0.000167	0.000058
Crustacea weight (gm)	0	0	0
Polychaeta weight (gm)	0	0	0

Station	HMB 5 -4		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.004000	0.001333	0.000115
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.000400	0.000133	0.000115
Polychaeta weight (gm)	0.010300	0.003433	0.005090

Station	HMB 5 -8		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.007000	0.000700	0.000604
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.002000	0.000200	0.000231
Polychaeta weight (gm)	0.208100	0.020810	0.016094

Station	HMB 5 -12		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.006700	0.002233	0.001206
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.000300	0.000100	0.000173
Polychaeta weight (gm)	0.000900	0.000300	0.000520

Note: Weights include adults and juveniles. Biomass data for individual replicate samples are found in Appendix B, Table B-2.

Table 5. Half Moon Bay mean abundance and taxa – Juveniles only.

Station	HMB2 +4	HMB2 +0*				
Total Abundance	9.0	17.3				
Annelida Abundance	0.0	7				
Arthropoda Abundance	0.0	1				
Mollusca Abundance	1.3	0.5				
Miscellaneous Abundance	7.7	9.4				
Total No. of Taxa	1.3	3.1				
Annelida No. Taxa	0.0	1.4				
Arthropoda No. Taxa	0.0	0.2				
Mollusca No. Taxa	0.3	0.4				
Miscellaneous No. Taxa	1.0	1.1				

Station	HMB3 +8	HMB3 +4	HMB3+0	HMB3 -4	HMB3 -8	HMB3 -12
Total Abundance	9.7	83.3	22.0	21.0	201.3	14.0
Annelida Abundance	0.0	2.3	2.3	7.3	176.3	3.3
Arthropoda Abundance	0.0	0.0	0.0	1.3	0.0	0.3
Mollusca Abundance	0.0	0.0	0.0	1.7	1.0	0.0
Miscellaneous Abundance	9.7	80.7	19.3	10.7	24.0	10.3
Total No. of Taxa	1.0	1.7	2.0	5.3	4.3	2.7
Annelida No. Taxa	0.0	0.7	1.0	2.3	2.3	1.3
Arthropoda No. Taxa	0.0	0.0	0.0	0.3	0.0	0.3
Mollusca No. Taxa	0.0	0.0	0.0	1.7	1.0	0.0
Miscellaneous No. Taxa	1.0	1.0	1.0	1.3	1.0	1.0

Station	HMB4 +12	HMB4 +8*	HMB4 +4	HMB4 +0	HMB4 -4	HMB4 -12
Total Abundance	1.7	7.8	8.7	30.7	13.0	41.0
Annelida Abundance	0.3	0.1	0.7	0.7	7.7	5.0
Arthropoda Abundance	0.0	0.0	0.0	0.0	0.7	0.0
Mollusca Abundance	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Abundance	1.3	7.7	8.0	30.0	4.7	36.0
Total No. of Taxa	1.0	1.1	1.7	1.7	2.7	3.7
Annelida No. Taxa	0.3	0.1	0.7	0.7	1.3	2.7
Arthropoda No. Taxa	0.0	0.0	0.0	0.0	0.3	0.0
Mollusca No. Taxa	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous No. Taxa	0.7	1.0	1.0	1.0	1.0	

Station	HMB5 +12	HMB5 +8	HMB5 +4	HMB5 +0	HMB5 -4	HMB5 -8*	HMB5 -12
Total Abundance	14.3	2.7	10.0	6.0	37.3	14.0	8.0
Annelida Abundance	10.3	0.0	1.7	0.0	8.0	5.3	1.7
Arthropoda Abundance	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Mollusca Abundance	0.0	0.0	0.0	1.3	0.3	0.0	0.0
Miscellaneous Abundance	4.0	2.7	8.3	4.7	28.3	8.7	6.3
Total No. of Taxa	1.0	1.0	2.0	2.3	4.0	2.5	1.7
Annelida No. Taxa	0.7	0.0	1.0	0.0	2.3	1.6	0.7
Arthropoda No. Taxa	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Mollusca No. Taxa	0.0	0.0	0.0	1.3	0.3	0.0	0.0
Miscellaneous No. Taxa	0.3	1.0	1.0	1.0	1.0	0.9	1.0

* Mean of ten replicate samples. All others are mean of triplicate samples.

Note: Abundance of individual replicate samples are found in Appendix B, Table B-1.

Table 6. Half Moon Bay mean abundance and taxa – Adults only.

Station	HMB2 +4	HMB2 +0*				
Total Abundance	0.3	2.1				
Annelida Abundance	0.0	0.3				
Arthropoda Abundance	0.3	1.7				
Mollusca Abundance	0.0	0.1				
Miscellaneous Abundance	0.0	0				
Total No. of Taxa	0.3	1.3				
Annelida No. Taxa	0.0	0.2				
Arthropoda No. Taxa	0.3	1				
Mollusca No. Taxa	0.0	0.1				
Miscellaneous No. Taxa	0.0	0				

Station	HMB3 +8	HMB3 +4	HMB3+0	HMB3 -4	HMB3 -8	HMB3 -12
Total Abundance	0.3	0.0	1.7	0.7	7.0	0.7
Annelida Abundance	0.3	0.0	0.7	0.0	2.7	0.3
Arthropoda Abundance	0.0	0.3	1.0	0.3	4.3	0.3
Mollusca Abundance	0.0	0.0	0.0	0.3	0.0	0.0
Miscellaneous Abundance	0.0	0.0	0.0	0.0	0.0	0.0
Total No. of Taxa	0.3	0.3	1.0	0.7	1.7	0.7
Annelida No. Taxa	0.3	0.0	0.3	0.0	0.7	0.3
Arthropoda No. Taxa	0.0	0.3	0.7	0.3	1.0	0.3
Mollusca No. Taxa	0.0	0.0	0.0	0.3	0.0	0.0
Miscellaneous No. Taxa	0.0	0.0	0.0	0.0	0.0	0.0

Station	HMB4 +12	HMB4 +8*	HMB4 +4	HMB4 +0	HMB4 -4	HMB4 -12
Total Abundance	0.0	0.0	0.0	0.0	1.7	1.0
Annelida Abundance	0.0	0.0	0.0	0.0	0.3	1.0
Arthropoda Abundance	0.0	0.0	0.0	0.0	1.3	0.0
Mollusca Abundance	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Abundance	0.0	0.0	0.0	0.0	0.0	0.0
Total No. of Taxa	0.0	0.0	0.0	0.0	1.0	0.7
Annelida No. Taxa	0.0	0.0	0.0	0.0	0.3	0.7
Arthropoda No. Taxa	0.0	0.0	0.0	0.0	0.7	0.0
Mollusca No. Taxa	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous No. Taxa	0.0	0.0	0.0	0.0	0.0	0.0

Station	HMB5 +12	HMB5 +8	HMB5 +4	HMB5 +0	HMB5 -4	HMB5 -8*	HMB5 -12
Total Abundance	0.0	0.3	0.3	0.0	4.3	5.1	0.3
Annelida Abundance	0.0	0.3	0.3	0.0	0.7	1.6	0.0
Arthropoda Abundance	0.0	0.0	0.0	0.0	3.7	3.5	0.3
Mollusca Abundance	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous Abundance	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total No. of Taxa	0.0	0.3	0.3	0.0	1.0	1.5	0.3
Annelida No. Taxa	0.0	0.3	0.3	0.0	0.3	0.7	0.0
Arthropoda No. Taxa	0.0	0.0	0.0	0.0	0.7	0.8	0.3
Mollusca No. Taxa	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous No. Taxa	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* Mean of ten replicate samples. All others are mean of triplicate samples.

Note: Abundance of individual replicate samples are found in Appendix B, Table B-1.

Table 7. Sediment grain size results.

Half Moon Bay

Station	HMB2 +4	HMB2 +0
% gravel	16.5	0.2
% sand	83.4	97.9
% fines	0.1	1.9

Station	HMB3 +8	HMB3 +4	HMB3+0	HMB3 -4	HMB3 -8	HMB3 -12
% gravel	20.9	31	0	1.8	0.2	0.6
% sand	78.9	68.7	99.2	97.3	98.7	98.5
% fines	0.2	0.3	0.8	0.9	1.1	0.9

Station	HMB4 +12	HMB4 +8	HMB4 +4	HMB4 +0	HMB4 -4	HMB4 -12
% gravel	0	0	4	8.50	1	1.3
% sand	100	99.4	95.5	91.30	97.7	98
% fines	0	0.6	0.5	0.20	1.3	0.7

Station	HMB5 +12	HMB5 +8	HMB5 +4	HMB5 +0	HMB5 -4	HMB5 -8	HMB5 -12
% gravel	0	0	2.2	14.6	0	0	0
% sand	99.6	99.5	96.9	84.9	99.1	98.8	99.3
% fines	0.4	0.5	0.9	0.5	0.9	1.2	0.7

South Beach

Station	SB1 +12	SB1 +8	SB1 +4	SB1 +0
% gravel	0	0	0.1	0
% sand	99.5	99.4	99.2	99.3
% fines	0.5	0.6	0.7	0.7

Station	SB2 +12	SB2 +8	SB2 +4	SB2 +0
% gravel	0	0	0	0
% sand	99.4	99.4	99.2	99.5
% fines	0.6	0.6	0.8	0.5

3.2 South Beach Benthic Infauna

Benthic infauna samples were collected at 8 intertidal stations (+12 to 0 feet MLLW) along South Beach (see Figure 1). Triplicate samples were analyzed at each station. Total abundance and number of taxa were relatively low at South Beach, similar to intertidal measurements in Half Moon Bay. Summary tables in the following sections are organized into three categories: 1) pooled adult and juvenile data, 2) only juvenile data, and 3) only adult data.

3.2.1 Pooled Adult and Juvenile

Mean abundance and number of taxa (pooled to include both adult and juvenile organisms) for South Beach intertidal stations are summarized in Table 8. The mean total abundance for all South Beach stations was 21.2 individuals per 19.6 cm². One or two organisms dominated most stations. Total number of taxa ranged from 1.0 at station SB2 +0 to 5.7 at station SB1 +0. Station SB2 +12 had the highest total abundance, with a mean of 50.3 individuals per 19.6 cm².

Total abundance distribution varied by elevation rather than by transect location. Higher total abundance was observed in the upper intertidal (+12 feet MLLW), averaging 44.1 individuals per 19.6 cm². Stations in the middle to lower intertidal (+8 to 0 feet MLLW) averaged 13.6 individuals. The ribbon worm (*Nemertea* indet.) was the dominant organism at all South Beach stations, with the exception of station SB1 +8, where the amphipod *Eohaustorius bevicuspis* was the dominant organism (Table 9).

Although total abundance is low in South Beach, biomass measurements are relatively high compared to biomass measurements Half Moon Bay (Table 10). South Beach intertidal stations had a mean total biomass of 0.014 grams per 19.6 cm², versus 0.002 grams for intertidal stations in Half Moon Bay. South Beach stations had a higher proportion of adult organisms in the 1.0 mm and 0.5 mm size classes, which resulted in higher biomass. Station SB1 +0 had the highest mean total biomass (0.05 grams per 19.6 cm²) of all South Beach stations, due to the presence of a bivalve (*Tellina nucloides*) with a weight of 0.035 grams.

3.2.2 Juvenile Size Class

Mean abundance and number of taxa measured for juvenile organisms at stations sampled in South Beach are summarized in Table 11. Juvenile organisms are also dominant in South Beach, comprising 87.1% of the total abundance measurements. However, a slightly higher proportion of adult organisms are present in the 1.0 mm and 0.5 mm size classes, which resulted in higher biomass measurements in South Beach (see Section 3.2.1). Since juveniles make up the majority of organisms South Beach samples, total abundance and total number of taxa measurements are very similar to the pooled adult and juvenile distributions. The highest total abundance of taxa for juveniles was also observed at station SB2 +12, with a mean of 50.3 individuals per 19.6 cm².

3.2.3 Adult Size Class

Mean abundance and number of taxa measured for adult organisms at stations sampled in South Beach are summarized in Table 12. Adult organisms were mainly observed at low abundances

in the 1.0 mm and 0.5 mm size fractions, but at slightly higher numbers than at Half Moon Bay. Mean total abundance was 2.8 adults per 19.6 cm² at South Beach, versus 0.4 adults per 19.6 cm² in Half Moon Bay intertidal samples.

Total abundance for adults in South Beach is highest at the middle upper intertidal (+8 feet MLLW). Total abundance at +8 feet MLLW had a mean of 5.5 adults per 19.6 cm², versus a mean total abundance of 1.8 adults at all other stations. The dominant adult species at this elevation were the amphipods *Eohaustorius bevicuspis* and *Eohaustorius washingtonianus*. Adult organisms were not observed at station SB2 +0.

3.2.4 Sediment Grain Size

Sediment grain size in South Beach was very uniform at all stations and elevations, consisting of over 99% sand and less than 1% fines (Table 7).

3.3 Summary of Distribution Patterns

3.3.1 Half Moon Bay

- Highest abundance and number of taxa were found at subtidal stations (-4 to -8 feet MLLW). Station HMB3 -8 had the highest values for both parameters with a mean total abundance of 208.3 individuals per 19.6 cm² and 7.0 for total number of taxa.
- Subtidal stations had a mean total abundance of 46.3 individuals per 19.6 cm² and a mean of 4.7 for total number of taxa. Intertidal stations had a mean of 17.6 individuals per 19.6 cm² and a mean 2.0 for total number of taxa.
- Transects located in the inner bay protected by the jetty generally had higher abundance than transects located further to the west. Stations along transect HMB3 had a mean total abundance of 60.3 individuals, whereas stations along transects HMB4 and HMB5 had mean total abundances of 17.6 and 14.7 individuals, respectively.
- The ribbon worm (*Nemertea* indet.) was the dominant organism at every station within Half Moon Bay with the exception of three stations, where the annelids *Protodrilus flabellifer* and *Marionina* sp. were dominant.
- Juvenile organisms in the 0.25 mm size class dominated abundance measurements in Half Moon Bay. A small number of adult organisms were found, primarily in the 1.0 mm and 0.5 mm size classes.
- Subtidal stations had a higher mean total biomass (0.013 grams per 19.6 cm²) than the intertidal stations (0.002 grams per 19.6 cm²). Biomass was dominated by polychaetes.

3.3.2 South Beach

- Intertidal stations in South Beach were similar in mean total abundance and taxa to the Half Moon Bay intertidal stations. Intertidal stations in South Beach had a mean total abundance of 21.2 individuals per 19.6 cm².

- Total abundance varied by elevation at the South Beach intertidal. The upper intertidal (+12 feet MLLW) had higher mean abundance (44.1 individuals per 19.6 cm²) than the middle to lower intertidal (13.6 individuals per 19.6 cm²).
- Total number of taxa ranged from 1.0 at station SB2 +0 to 5.7 at station SB1 +0. Station SB2 +12 had the highest total abundance, with a mean of 50.3 individuals per 19.6 cm².
- Similar to Half Moon Bay, the ribbon worm (*Nemertea* indet.) was the dominant organism at all South Beach stations, with the exception of one station, where the amphipod *Eohaustorius bevicuspis* was dominant.
- Compared to Half Moon Bay, South Beach has a slightly higher proportion of adult organisms present in the 1.0 mm and 0.5 m size classes, which resulted in higher biomass. Station SB1 +0 had the highest mean total biomass of 0.05 grams per 19.6 cm².

Table 8. South Beach mean abundance and taxa – Combined adults and juveniles.

Station	SB1 +12	SB1 +8	SB1 +4	SB1 +0
Total Abundance	38.0	12.0	10.7	12.3
Annelida Abundance	10.0	0.7	0.7	3.0
Arthropoda Abundance	3.0	6.0	2.0	2.7
Mollusca Abundance	0.0	0.0	0.0	1.3
Miscellaneous Abundance	25.0	5.3	8.0	5.3
Total No. of Taxa	4.0	2.7	2.7	5.7
Annelida No. Taxa	1.7	0.7	0.7	2.0
Arthropoda No. Taxa	1.0	1.0	1.0	1.7
Mollusca No. Taxa	0.0	0.0	0.0	1.0
Miscellaneous No. Taxa	1.0	1.0	1.0	1.0

Station	SB2 +12	SB2 +8	SB2 +4	SB2 +0
Total Abundance	50.3	15.7	8.3	22.7
Annelida Abundance	5.3	0.7	0.3	0.0
Arthropoda Abundance	0.3	6.0	1.7	0.0
Mollusca Abundance	0.0	0.0	0.0	0.0
Miscellaneous Abundance	44.7	9.0	6.3	22.7
Total No. of Taxa	2.3	3.0	2.3	1.0
Annelida No. Taxa	1.0	0.7	0.3	0.0
Arthropoda No. Taxa	0.3	1.3	1.0	0.0
Mollusca No. Taxa	0.0	0.0	0.0	0.0
Miscellaneous No. Taxa	1.0	1.0	1.0	1.0

Note: Abundance of individual replicate samples are found in Appendix B, Table B-1.

Table 9. Most abundant species for South Beach stations.

Station	SB 1 +12			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	30	25	20	75	25.00	5.00
Oligochaeta Indet.	5	12	7	24	8.00	3.61
Eohaustorius brevicuspis	1	5	2	8	2.67	2.08
Euzonus sp. 1	1	0	0	1	0.33	0.58
Excirrolana sp.	1	0	0	1	0.33	0.58
Pygospio californica	0	5	0	5	1.67	2.89

Station	SB 1 +8			Pooled	Mean	St. Dev.
Rep	A	B	C			
Eohaustorius brevicuspis	10	5	3	18	6.00	3.61
Nemertea Indet.	4	5	7	16	5.33	1.53
Euzonus sp. 1	1	0	0	1	0.33	0.58
Nephtys californiensis	0	1	0	1	0.33	0.58
Eohaustorius washingtonianus	0	0	0	0	0.00	0.00
Eteone columbiensis	0	0	0	0	0.00	0.00

Station	SB 1 +4			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	6	6	12	24	8.00	3.46
Eohaustorius washingtonianus	1	4	0	5	1.67	2.08
Eteone columbiensis	1	0	0	1	0.33	0.58
Polychaeta Indet.	0	0	1	1	0.33	0.58
Harpacticoida Indet.	0	0	1	1	0.33	0.58
Protodrilus flabellifer	0	0	0	0	0.00	0.00

Station	SB 1 +0			Pooled	Mean	St. Dev.
Rep	B	C	F			
Nemertea Indet.	11	4	1	16	5.33	5.13
Protodrilus flabellifer	3	1	1	5	1.67	1.15
Opheliidae Indet.	2	0	1	3	1.00	1.00
Siliqua patula	1	2	1	4	1.33	0.58
Eohaustorius washingtonianus	1	1	4	6	2.00	1.73
Polychaeta Indet.	0	1	0	1	0.33	0.58

Table 9. Most abundant species for South Beach stations (continued).

Station	SB 2 +12			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	29	47	58	134	44.67	14.64
Oligochaeta Indet.	11	3	2	16	5.33	4.93
Harpacticoida Indet.	0	0	1	1	0.33	0.58
Eohaustorius brevicuspis	0	0	0	0	0.00	0.00
Opheliidae Indet.	0	0	0	0	0.00	0.00
Eohaustorius washingtonianus	0	0	0	0	0.00	0.00

Station	SB 2 +8			Pooled	Mean	St. Dev.
Rep	B	C	D			
Nemertea Indet.	4	13	10	27	9.00	4.58
Eohaustorius brevicuspis	2	8	7	17	5.67	3.21
Opheliidae Indet.	1	0	0	1	0.33	0.58
Eohaustorius washingtonianus	0	1	0	1	0.33	0.58
Protodrilus flabellifer	0	1	0	1	0.33	0.58
Harpacticoida Indet.	0	0	0	0	0.00	0.00

Station	SB 2 +4			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	4	2	13	19	6.33	5.86
Eohaustorius washingtonianus	0	2	2	4	1.33	1.15
Opheliidae Indet.	0	1	0	1	0.33	0.58
Harpacticoida Indet.	0	0	1	1	0.33	0.58
Diptera Indet	0	0	0	0	0.00	0.00
Oligochaeta Indet.	0	0	0	0	0.00	0.00

Station	SB 2 +0			Pooled	Mean	St. Dev.
Rep	A	B	C			
Nemertea Indet.	30	19	19	68	22.67	6.35
Diptera Indet	0	1	0	1	0.33	0.58
Oligochaeta Indet.	0	0	0	0	0.00	0.00
Eohaustorius brevicuspis	0	0	0	0	0.00	0.00
Euzonus sp. 1	0	0	0	0	0.00	0.00
Excirelana sp.	0	0	0	0	0.00	0.00

Table 10. Biomass summary data for South Beach stations.

Station	SB1 +12		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.006400	0.002133	0.001079
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.051400	0.017133	0.025631
Polychaeta weight (gm)	0.009400	0.003133	0.002802

Station	SB 1 +8		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.001100	0.000367	0.000115
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.017100	0.005700	0.004993
Polychaeta weight (gm)	0.063000	0.021000	0.034570

Station	SB 1 +4		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.015000	0.005000	0.005311
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.004900	0.001633	0.001858
Polychaeta weight (gm)	0.001600	0.000533	0.000839

Station	SB 1 +0		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.001500	0.000500	0.000529
Mollusca weight (gm)	0.137800	0.045933	0.025332
Crustacea weight (gm)	0.010100	0.003367	0.004110
Polychaeta weight (gm)	0.000500	0.000167	0.000058

Station	SB2 +12		
	Pooled	mean	st dev
Miscellaneous weight (gm)	0.011900	0.003967	0.000808
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.000100	0.000033	0.000058
Polychaeta weight (gm)	0	0	0

Station	SB 2 +8		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.001700	0.000567	0.000306
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.004600	0.001533	0.001159
Polychaeta weight (gm)	0.000100	0.000033	0.000058

Station	SB 2 +4		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.001100	0.000367	0.000208
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0.003500	0.001167	0.001021
Polychaeta weight (gm)	0.000100	0.000033	0.000058

Station	SB 2 +0		
	pooled	mean	st dev
Miscellaneous weight (gm)	0.006100	0.002033	0.000306
Mollusca weight (gm)	0	0	0
Crustacea weight (gm)	0	0	0
Polychaeta weight (gm)	0	0	0

Note: Weights include adults and juveniles. Biomass data for individual replicate samples are found in Appendix B, Table B-2.

Table 11. South Beach mean abundance and taxa – Juveniles only.

Station	SB1 +12	SB1 +8	SB1 +4	SB1 +0
Total Abundance	34.3	7.0	8.0	9.7
Annelida Abundance	8.3	0.0	0.3	3.0
Arthropoda Abundance	1.3	1.7	0.0	0.0
Mollusca Abundance	0.0	0.0	0.0	1.3
Miscellaneous Abundance	25.0	5.3	7.7	5.3
Total No. of Taxa	2.7	1.3	1.3	4.0
Annelida No. Taxa	1.0	0.0	0.3	2.0
Arthropoda No. Taxa	0.7	0.3	0.0	0.0
Mollusca No. Taxa	0.0	0.0	0.0	1.0
Miscellaneous No. Taxa	1.0	1.0	1.0	1.0

Station	SB2 +12	SB2 +8	SB2 +4	SB2 +0
Total Abundance	50.0	9.7	6.7	22.7
Annelida Abundance	5.3	0.7	0.3	0.0
Arthropoda Abundance	0.0	0.0	0.0	0.0
Mollusca Abundance	0.0	0.0	0.0	0.0
Miscellaneous Abundance	44.7	9.0	6.3	22.7
Total No. of Taxa	2.0	1.7	1.3	1.0
Annelida No. Taxa	1.0	0.7	0.3	0.0
Arthropoda No. Taxa	0.0	0.0	0.0	0.0
Mollusca No. Taxa	0.0	0.0	0.0	0.0
Miscellaneous No. Taxa	1.0	1.0	1.0	1.0

Note: Abundance of individual replicate samples are found in Appendix B, Table B-1.

Table 12. South Beach mean abundance and taxa – Adults only.

Station	SB1 +12	SB1 +8	SB1 +4	SB1 +0
Total Abundance	3.7	5.0	2.7	2.7
Annelida Abundance	2.0	0.7	0.3	0.0
Arthropoda Abundance	1.7	4.3	2.0	2.7
Mollusca Abundance	0.0	0.0	0.0	0.0
Miscellaneous Abundance	0.0	0.0	0.3	0.0
Total No. of Taxa	1.3	1.3	2.0	1.0
Annelida No. Taxa	0.7	0.7	0.3	0.0
Arthropoda No. Taxa	0.7	0.7	1.0	1.0
Mollusca No. Taxa	0.0	0.0	0.0	0.0
Miscellaneous No. Taxa	0.0	0.0	0.7	0.0

Station	SB2 +12	SB2 +8	SB2 +4	SB2 +0
Total Abundance	0.3	6.0	1.7	0.0
Annelida Abundance	0.0	0.0	0.0	0.0
Arthropoda Abundance	0.3	6.0	1.7	0.0
Mollusca Abundance	0.0	0.0	0.0	0.0
Miscellaneous Abundance	0.0	0.0	0.0	0.0
Total No. of Taxa	0.3	1.0	0.7	0.0
Annelida No. Taxa	0.0	0.0	0.0	0.0
Arthropoda No. Taxa	0.3	1.0	0.7	0.0
Mollusca No. Taxa	0.0	0.0	0.0	0.0
Miscellaneous No. Taxa	0.0	0.0	0.0	0.0

Note: Abundance of individual replicate samples are found in Appendix B, Table B-1.

4.0 DISCUSSION

The ribbon worm (*Nemertea* indet.) was the most abundant benthic infaunal organism observed in Half Moon Bay, followed by polychaetes and other annelids. Since the ribbon worm and polychaetes generally live within the sediment, a benthic assemblage of this type is more suited as a food source for shorebirds and bottom fish, rather than for salmonids. Juvenile salmonids are known to feed on crustaceans such as harpacticoides, or *Corophium* sp., which are generally found living at the sediment-water interface. In January, crustaceans were the next most abundant organisms in Half Moon Bay, but at much lower numbers in comparison to the ribbon worms and polychaetes.

For a sandy beach, the productivity of Half Moon Bay is likely good, but additional survey data is needed to conduct a proper evaluation of production potential. The baseline survey was conducted in January, when benthic productivity is expected to be low. The upcoming early summer survey will likely yield higher numbers of organisms, which will allow for a better assessment of the production potential in Half Moon Bay. A limited computer literature search was conducted, however, comparable studies could not be found within the geographic limits of the search (i.e., Pacific Northwest ocean beaches).

Most of the benthic organisms observed in January were juveniles and found in the smallest fraction of sand. The early summer survey may show a higher number of adults in higher size classes, and a higher proportion of crustaceans may also be expected in early summer, during the juvenile salmonid migration. Often times, predators time their seasonal migrations to take advantage of seasonally abundant prey populations. Comparing the early summer benthic infaunal survey results to the stomach content of juvenile salmonids found in Half Moon Bay could also help determine the importance of Half Moon Bay as a feeding area during salmonid migration. To this end, juvenile salmon could be collected via beach seining during the same period that benthic samples will be collected in early summer.

5.0 STATISTICAL POWER AND RECOMMENDATIONS

The analysis of three sample replicates at each station in Half Moon Bay and South Beach provided a good screening tool to assess the abundance and composition of the benthic communities along different transects and elevations. However, the analysis of only three of ten sample replicates at each station may not provide adequate statistical power to assess whether changes observed in the benthic community over time are considered significant. Due to the small sample size and low abundance measurements, even the analysis of six replicates may not provide adequate statistical power due to data variability.

At stations where temporal comparisons are proposed, it is recommended that all ten replicate samples be collected and analyzed for baseline and future monitoring events. If a similar level of effort is proposed for the next round of benthic infauna community monitoring, the following approaches are proposed for consideration:

- 1) Based on the distribution of benthic infauna measured during this baseline survey, select a subset of stations that would be representative of different elevations and transects in

Half Moon Bay. All ten replicates would be analyzed at only these stations. Baseline samples would also be analyzed if ten replicates were not analyzed as part of the baseline survey.

- 2) Utilize a tiered analysis approach to determine the subset of stations where all ten replicates would be analyzed. Analyze three of ten replicate samples initially from the same stations sampled during the baseline survey. Compare the monitoring results to the baseline and select a subset of samples where differences are observed. Analyze the remaining seven samples from each station to allow for statistical comparison.