Benthic Survey
of
Proposed Treasure Island, California
Redevelopment Ferry Terminal Location



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Executive Summary

Integral to the Treasure Island Community Development (TICD) is a land use plan that emphasizes compact and sustainable development with the intense consolidation of residential and visitor-serving infrastructure around a ferry and intermodal transit hub. The construction of a new ferry terminal will require the building of rock jetties, modifying the protective riprap break wall of the island at the proposed ferry terminal site, and the dredging of San Francisco Bay sediments at the proposed terminal location to provide adequate water depth for safe navigation.

Construction of the proposed ferry terminal will result in the temporary disturbance and potential loss of benthic habitat and associated biological communities. To more adequately assess the potential effect of this disturbance and loss of habitat on the ecosystem of San Francisco Bay, a survey and assessment was conducted of the benthic fauna inhabiting the Bay sediments at the proposed ferry terminal site.

Applied Marine Sciences, Inc. conducted field sampling on August 18, 2008. A total of five (5) stations were sampled for benthic infauna, sediment grain size, and total organic carbon (TOC) concentration. In addition, a water-column profile of physical parameters (temperature, depth, salinity, conductivity, pH, and dissolved oxygen) was collected at each sample site. Sampling sites were randomly selected before the survey and spatially distributed within the area that will encompass the proposed new Ferry Terminal.

Study findings were:

- Two separate benthic infaunal communities were observed inhabiting the study site with the first located immediately offshore in coarse sand and gravel sediments. The second was located slightly farther offshore in sediments with no gravel and little to no coarse sands, slightly higher fine sediment fractions and TOC concentrations, and in water depths generally deeper than 10 feet.

- The shallower infaunal community was dominated by the bivalve *Rochefortia coani*, the polychaetes, *Ameana occidentalis* and *Mediomastus* spp*.,* the cnidarian, *Stylatula elongata*, and the amphipod, *Ampelisca abdita,* The dominant taxa in this community were more diverse than the dominant taxa in the second observed community, which were predominantly polychaetes.

- The second benthic infaunal community was dominated by the polychaetes *Mediomastus* spp*., Euchonia limnicola,* and *Ameana occidentalis* along with by the amphipod, *A. abdita*, and the cnidarian, *S. elongata.* Two more polychaetes, *Spiophanes duplex* and *Dorvillea longicornis* and the mollusk, *R. coani* were the eight most dominant taxa in this community. Unlike the infaunal community inhabiting the coarser sediments inshore, this community was dominated by polychaetes. In addition, two taxa, the polychaete, *E. limnicola*, and the nemertean, *Micrura alaksensis*, were only observed as members of the second benthic community.

  Based on sediment composition, it would appear that the habitat occupied by the first benthic infaunal community is subject to regular wave action or strong tidal currents that prevent the deposition of sediment fines or subject them to resuspension and removal. The habitat occupied by the second benthic community appears to be less subject to physical disturbance from wave action or tidal currents, possible because of the slightly deeper water.

- Based on published lists of taxa that are sensitive and tolerant to habitat degradation, the benthic habitat in the area of the proposed ferry terminal appears to be subject to some regular physical disturbance.

- The benthic infaunal taxa in the area of the proposed ferry terminal are similar to taxa observed in other areas of Central San Francisco Bay as reported by the RMP (Thompson *et al.* 2000) and NOAA (2007). The benthic infaunal communities observed at the proposed ferry terminal site, although not identical in composition and abundance to benthic communities reported for other locations in Central Bay, are sufficiently similar in taxonomic composition to be considered part of the same, larger, Central Bay-wide benthic infaunal community.

- Finally, no protected or species of special concern were observed and the observed taxa, although providing forage for many demersal fish species, are not important prey items for any protected species.

1 Introduction

Integral to the Treasure Island Community Development (TICD) is a land use plan that emphasizes compact and sustainable development with the intense consolidation of residential and visitor-serving infrastructure around a ferry and intermodal transit hub. At present, there is no ferry service to Treasure Island. As a result, part of the redevelopment plan for Treasure Island includes the construction of a new ferry terminal on the southwest corner of the island adjacent to the administration building and Treasure Island Marina in Clipper Cove (Figure 1-1). The construction of the new ferry terminal will require the building of rock jetties, modifying the protective rip-rap break wall of the island at the proposed ferry terminal site, and the dredging of Bay sediments within the nearshore portion of the terminal to provide adequate water depth for the ferries.

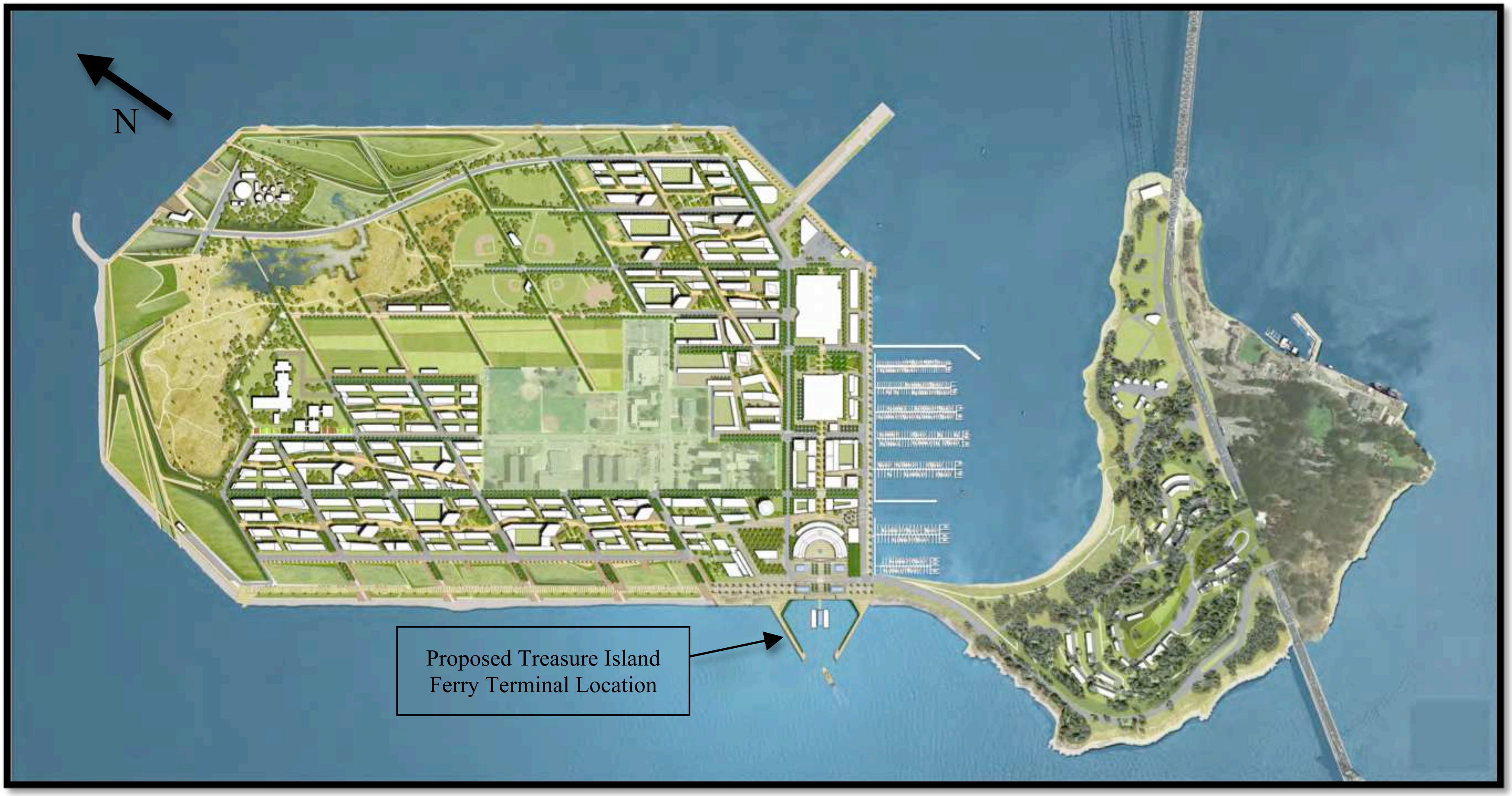
Construction of the proposed ferry terminal will result in the temporary disturbance and potential loss of benthic habitat and associated biological communities. In order to effectively evaluate the potential environmental impact on the benthic communities inhabiting the area of disturbance, as well as any indirect affects their loss or disturbance could have on other food-web taxa, especially special status species, it is necessary to have information on the species composition and community structure of the taxa composing the benthic community. The benthic communities of San Francisco Bay-Delta, like those inhabiting most estuaries, are highly diverse and responsive to site-specific ecological conditions. A lack of sufficient data concerning the marine flora and fauna inhabiting the nearshore subtidal areas of Treasure Island, and more specifically the region of San Francisco Bay where the proposed ferry terminal is to be constructed, prompted the need for a survey and assessment of the benthic community inhabiting the proposed ferry terminal site.

In order to assess the effects of construction and operation of a ferry terminal at Treasure Island on benthic communities, this study was designed to achieve the following objectives:

- Characterize the benthic infaunal community inhabiting the nearshore subtidal area of Central San Francisco Bay where the proposed Treasure Island ferry terminal is to be constructed,
- Identify any physical environmental conditions that may be influencing benthic community composition,
- Assess the benthic infaunal community for use as important prey for special status species, and
- Determine if the benthic infaunal community reflects the presence of sediment contamination.

This report presents the results of sediment sampling and benthic analysis conducted in Central San Francisco adjacent to Treasure Island where the proposed Treasure Island ferry terminal is to be constructed.

Figure 1-1. Proposed location of Treasure Island ferry terminal



Source: Treasure Island Community Development, 2008

2 Sampling and Analytical Methodologies

2.1 Field Sampling

AMS conducted field sampling on August 19, 2008. A total of five (5) stations were sampled for benthic infauna, sediment grain size, and total organic carbon (TOC) concentration (Figure 2-1). In addition, a water-column profile for temperature, water depth, salinity, conductivity, pH, and dissolved oxygen was collected at each site with a Sea-Bird SBE19 CTD profiler. Sampling sites were randomly positioned prior to the cruise, along a stratified grid, such that samples were collected spatially with increasing depth and from North to South within the area that will encompass the proposed new Ferry Terminal (Figure 2-1).

The crew and schedule for field sampling are shown in Table 2-1 and Table 2-2, respectively. Table 2-3 provides details on each sample location, including sediment characteristics, Table 2-4 shows sea and weather conditions and Table 2-5 shows water quality conditions.

Table 2-1. Personnel for Treasure Island benthic survey on August 19, 2008

Name	Affiliation	Duties
Jay Johnson	Applied Marine Sciences, Inc. (AMS)	Cruise Manager
Bryan Bemis	Applied Marine Sciences, Inc. (AMS)	Sample collection
Clare Dominik	Applied Marine Sciences, Inc. (AMS)	Sample collection
Sarah Lowe	San Francisco Estuary Institute (SFEI)	Sample collection
David Morgan	Romberg Tiburon Center (RTC)	Captain; *RV Questuary*

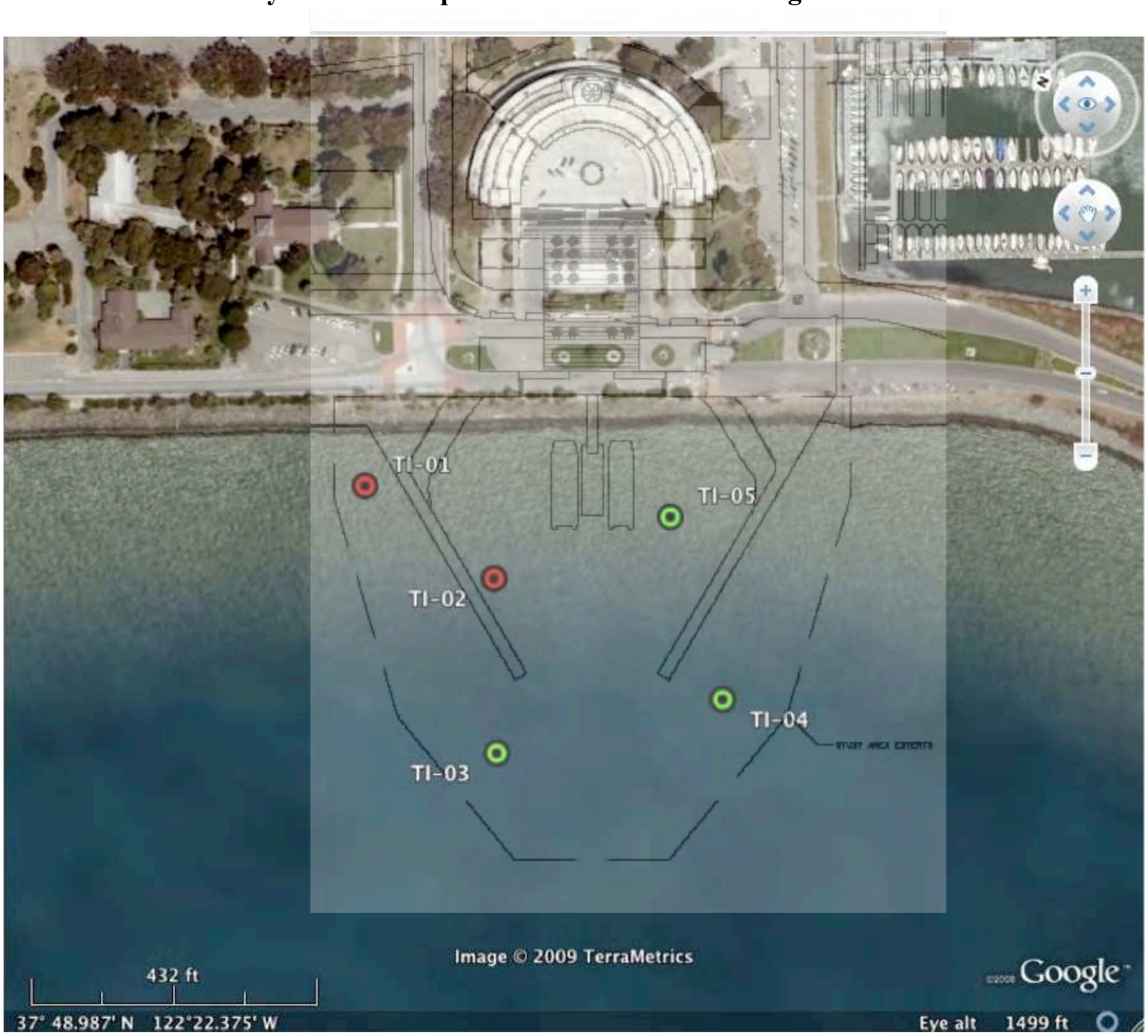
Table 2-2. Sampling activities for Treasure Island benthic survey on August 19, 2008

Time	Activity
0700-0808	Mobilized gear at Paradise Cay Marina
0850-0907	Sampled site TI-B-03
0950-1000	Sampled site TI-B-04
1058-1100	Sampled site TI-B-02
1110	Sampled site TI-B-05
1121-1122	Sampled site TI-B-01
1303-1515	Processed remaining samples at Paradise Cay Marina

2.1.1 Sample Evaluation

Sediment samples were collected using a 0.1 m^2 modified Van Veen grab. In the field, the grab was split into two closely equal portions, with one side of the grab used for collecting physical and chemical analysis samples and the other half for benthic infauna.

**Figure 2-1. Sample locations for the Treasure Island benthic survey on August 19, 2008
Colors of round site symbols correspond to clusters shown in Figure 3-1.**



Source: Ferry Terminal Conceptual Design from Moffat & Nichols

Quality control procedures were used to ensure the collection of undisturbed samples of adequate volume. Upon retrieval of the grab, the acceptability of the sample was determined by evaluating the type of sediment, sample condition, and depth of penetration. Sample condition was judged using criteria for surface disturbance due to sediment leakage from the grab. An acceptable sample condition was characterized by an even surface with minimal disturbance and little or no leakage of the overlying water, which washes sediment from the grab surface. Samples with heavily canted surfaces were deemed unacceptable. Samples with a large amount of "humping" along the midline of the grab, which indicates washing from the sample periphery during retrieval, were also unacceptable. Although some humping will be evident in samples taken from firm sediment where penetration has been poor, this can be due to the closing action of the grab and is not necessarily evidence of unacceptable washing.

The following conditions led to sample rejection:

- There was a rock, shell fragment, or bivalve wedged between the jaws of the grab, allowing the sample to wash out,
- The sample surface was significantly disturbed,
- The sample was uneven from side to side, indicating that the grab was tilted when it penetrated the sediment,
- The surface of the sample was in contact with the top doors of the grab, indicating over-penetration of the grab and possible loss of material around the doors,
- The penetration depth of the grab was insufficient to provide enough sediment for analyses.

If sample condition was acceptable, then overlying water was carefully drained off into a sample tray and the depth of penetration was determined by inserting a plastic ruler into the sediment at the grab midline and measuring to the nearest 0.5 cm. Sediment penetration depth was required to be at least 5 cm. Overlying water in samples intended for infaunal analyses was drained by slightly opening the jaws of the grab and allowing the water to run off into the sample tray.

2.1.2 In-Field Processing of Benthic Infaunal Samples

With the grab jaws still closed, a thin metal plate was inserted into the sediment at the mid-line of the grab, directly above and in line with the jaw opening. This plate split the sample into two subsamples. One subsample was used to collect the sediment grain size and TOC samples, and the other subsample was used to collect benthic infauna, resulting in a sampler area of approximately 0.05 m^2.

With the dividing plate inserted and held in place, the subsample for grain size and TOC was removed from the grab. After this, all sediment material on that half of the grab was removed with spoons or by hand, ensuring that the dividing plate remained in position. After all sediment material was removed from the first subsample, the dividing plate was removed, the grab jaws were opened, and the remaining subsample was washed from the grab into a plastic tub for processing of infauna.

All collected sediment was washed through a 2.0 mm screen to capture any large bivalves, worms, gastropods and other large benthic organisms, as well as to remove any shell fragments, or other large debris. Organisms captured on the 2.0 mm screen were placed into a 1.0 mm-labeled sample jar. Infauna subsamples were transferred to an infauna-processing chamber that gently washed and lifted coarse sediments, allowing benthic infauna to rise to the water surface and float through a sluice gate into nestled 1.0 and 0.5 mm nylon mesh bags. The nested 0.5 and 1.0 mm mesh bags were placed into a full bucket of water while samples were being processed, to prevent impingement of organisms on the nets. After the sediment in the infauna-processing chamber was sufficiently washed to float all visible organisms, the remaining sand was also carefully washed into a labeled 2-gallon bucket and preserved with 70% isopropyl alcohol and Rose Bengal stain. Any organisms observed in the sand were carefully removed to the 1.0 mm jar.

At the conclusion of processing a sample, the nested nylon bags were removed and the contents of the 0.5 and 1.0 mm bags were carefully washed and transferred onto separate 0.5 mm sieves for further screening, prior to placement into labeled sample jars. Once each sample was washed through the screen, the material (debris, coarse sediment, and organisms) retained on the screen was transferred to a sample container. All sample containers were labeled with an external label containing the station name, sample ID, date, time, and "split number" (*i.e.,* 1 of 1, 2 of 3, etc.) if required. A label bearing the same information was placed inside the jars containing infaunal samples. The sample containers had a screw-cap closure and were sufficiently large to accommodate the sample material with a head-space of at least 30% of the container volume. Some samples were split among multiple containers. The sample containers were filled to approximately 50 to 70% of capacity with screened material. After the bulk of material had been transferred to the container, any organisms remaining on the screens were removed with forceps and added to the sample container. The screens were washed thoroughly between samples.

Table 2-3. Sampling coordinates, depth, grab penetration, and sediment character of sampling sites for Treasure Island benthic survey on August 19, 2008

Site Name	TI-B-01	TI-B-02	TI-B-03	TI-B-04	TI-B-05
Latitude (WGS84)	37° 39.036	37° 49.000	37° 48.974	37° 48.937	37° 48.967
Longitude (WGS84)	122° 22.393	122° 22.393	122° 22.438	122° 22.398	122° 22.356
Water Depth (m)	3.0	3.2	6.5	5.1	3.1
Grab Penetration Depth (cm)	11	13	11	13	13
Sediment Character	Unconsolidated sand	Semi-consolidated fines and sand with thin layer of silt on top	Semi-consolidated fines, sand, silt, clay	Semi-consolidated fines, sand, silt, clay; sea pens	Semi-consolidated fines and sand with thin layer of silt on top

Note[1] Corrected to Mean Mean Water (MMW)

Table 2-4. Sea and weather conditions at sampling sites during Treasure Island benthic survey on August 19, 2008

Site Name	Date Sampled	Sea State	% Overcast	Wind (speed, direction from)	Current (speed, direction toward)
TI-B-01	8/19/2008	<1 ft chop	100	9 knots 250°	0.9 knots 119°
TI-B-02	8/19/2008	<1 ft chop	100	6 knots 263°	0.9 knots 119°
TI-B-03	8/19/2008	<1 ft chop	100	5 knots 227°	9 knots 126°
TI-B-04	8/19/2008	calm	100	9 knots 238°	1.1 knots 134°
TI-B-01	8/19/2008	<1 ft chop	100	9 knots 250°	0.9 knots 119°

All infaunal samples were treated with an isotonic relaxant solution (Epsom salts, $MgSO_4$) for approximately 10-30 minutes prior to fixation to facilitate handling during taxonomic identification. After the relaxant treatment, the relaxant was decanted from the sample through a screen with a mesh size of 0.5 mm or less. Any animals adhering to the screen were carefully removed and placed back in the sample container. The container was then filled with sodium borate-buffered 10% formalin and stored for return to the laboratory. The samples were stored in formalin for no less than 72 hours, after which they were transferred to 70% isopropyl alcohol preservative.

Table 2-5. Summary of physical water quality parameters during Treasure Island benthic survey on August 19, 2008

Depth Group[1]	Analytes	TI-B-01	TI-B-02	TI-B-03	TI-B-04	TI-B-05
Surface	Temperature (°C)	17.5	17.3	17.5	17.2	17.4
	Conductivity (S/m)	4.2	4.2	4.2	4.1	4.2
	Salinity (psu)	31.9	31.9	31.7	31.8	31.9
	Oxygen (mg/L)	6.0	7.6	7.5	7.5	6.8
	Backscatter (ftu)	3.1	4.6	5.1	4.6	4.4
Mid-water	Temperature (°C)	17.4	17.3	17.4	17.1	17.4
	Conductivity (S/m)	4.2	4.2	4.2	4.1	4.2
	Salinity (psu)	31.9	31.9	31.9	31.9	31.9
	Oxygen (mg/L)	6.4	7.2	6.4	7.1	6.8
	Backscatter (ftu)	4.2	4.4	4.6	4.4	4.5
Bottom	Temperature (°C)	17.4	17.2	17.3	17.1	17.4
	Conductivity (S/m)	4.2	4.1	4.2	4.1	4.2
	Salinity (psu)	31.9	31.9	31.9	31.9	31.9
	Oxygen (mg/L)	6.4	7.2	6.6	6.6	6.9
	Backscatter (ftu)	4.2	4.6	4.8	4.7	4.5

Note[1] Surface, Mid-water, and Bottom refer to average values measured for the top, middle, and bottom 1/3 of depths sampled at a site, respectively.

2.1.3 Sediment Chemistry Samples

For sediment grain size analysis, approximately 100 g of sediment was collected at each station and placed in an 8 oz (250 mL) plastic container, taking care to leave an air space at the top. Samples were stored on wet ice until returned to the laboratory. For TOC analysis, approximately 200 g of sediment was collected at each station and placed in an 8 oz (250 mL) glass container with a Teflon-lined lid. The container was filled 80% full. Samples were stored on wet ice initially, but frozen within 24 hours.

2.2 Analytical Procedures

2.2.1 Benthic Infauna Samples

Upon receipt at the taxonomic lab, each sample was initially decanted of alcohol through a 0.5 mm screen, gently rinsed with water and then washed from the screen into a holding container. A small portion of each sample was spooned into a gridded Petri dish and sorted under 10x power of a dissecting microscope. Removed organisms were placed into pre-labeled vials according to taxonomic group, *i.e.,* Polychaeta (polychaete worms), crustaceans (amphipods, isopods, crabs and other “shellfish”), Mollusca (snails and clams), Oligochaeta (round worms), Polychaete fragments (body pieces without heads), and Other. When multiple containers were required to preserve retained material in the field, all jars from the same station and screen size were combined during the sorting phase.

Each vial was labeled with taxonomic group name, station number, collection date, screen size, and sorter’s initials using 100% rag paper or provided labels. Sample debris was placed back into the original sample container using recycled ETOH for preservation. Sorted taxa were then identified to the lowest taxon practicable. Reference specimens were kept for future use and validation, where required.

Ten percent of all samples (minimum one sample) from each sorter were re-sorted by a second sorter to verify quality control. In addition, 10% of the buckets containing field-processed sand collected from each lease grouping (Central Bay, Middle Ground Shoal, Suisun Marsh) were carefully viewed under a microscope to determine if any organisms remained within the processed sand. Five buckets of sand were reprocessed in the lab and >97% of all collected organisms were removed from the sand and placed into sample jars in the field.

2.2.2 Sediment Chemistry Samples

Columbia Analytical in Kelso, WA analyzed sediment particle size and TOC. Particle size determinations were performed according to ASTM method D422 Modified, providing size categories of medium gravel, fine gravel, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay. TOC was analyzed according to ASTM method D4129-82M.

2.2.3 Statistical Procedures

Several statistical procedures were used to analyze both biological and chemistry data in order to:

- Characterize the benthic infauna community adjacent to Treasure Island that might be affected by the building of break walls, groins and dredging,
- Compare community composition, species diversity and abundances to benthic infaunal communities reported for other areas of Central Bay, and
- Determine as best as possible the physical factors that could be responsible for the benthic community structure *i.e.*, water depth, contamination, grain size, disturbance, currents, etc.

Descriptive, agglomerative and parametric statistical procedures were applied sequentially to examine the data for broad patterns and then to determine the causes for those patterns. Agglomerative and parametric procedures were performed with JMP statistical software (SAS Institute, 2000). First, the data were tabulated and examined for obvious patterns that might guide the following statistical procedures. Second, the biological data were used to produce site clusters using Ward's minimum variance method, in which the distance between two clusters is the analysis of variance (ANOVA) sum of squares between the two clusters added up over all the variables. The software was allowed to define clusters using the default algorithm that delineates clusters based upon the inflection point in the curve describing the distance between successive cluster nodes. Third, ANOVA was performed to test for differences in benthic organisms and physical parameters among the identified clusters. ANOVA compares the amount of variation between samples within groups with the amount of variation between groups to determine whether the differences between groups are significant (*i.e.*, the probability of achieving the result by chance is less than 5%). Consequently, it is possible that high variability among samples within one group would result in no significant difference between two groups, even if a species were absent from all samples in the second group. To minimize effects of rare species, only those taxa that were both common (*i.e.,* found in >60% of samples) and abundant (*i.e.*, constituted >1.5% of total abundances across all sites) were used in the statistical analyses.

Finally, stepwise linear regressions were performed to determine whether spatial patterns of benthic organism abundances (dependent variables) were associated with physical variables, such as depth and sediment grain size and TOC (independent variables). These tests enable determination of which independent variables are significantly correlated with the dependent variable when the effects of all other independent variables are considered. For example, bivariate correlations that appear to be positive might actually be negative when the effects of all other variables are taken into account. A mixed stepwise process was used, which alternates forward and backward steps, including the most significant term that satisfies the selected probability to enter, and removes the least significant term satisfying the selected probability to leave. It continues removing terms until the remaining terms are significant and then it changes to the forward direction until all significant terms have been added. The probabilities to enter and leave were set to the program default of 0.25 in each case. Finally, partial correlations were calculated between each dependent variable and each significant independent variable to determine which independent variables exerted the strongest influence on the dependent variables.

3 Data Results

3.1 Treasure Island Benthic Community

The benthic biota inhabiting the nearshore area adjacent to Treasure Island, where the proposed ferry terminal is to be constructed, consists of a diverse community dominated by polychaetes, bivalves, amphipods, cnidarians, and nemerteans (Table 3-1). Between 2,563 and 8,790 individuals per m^2, representing 31 to 52 taxa, were reported from the five samples collected in water depths ranging from 3.0 meters (9.8 feet) to 6.5 meters (21.3 feet) in water depth. Seafloor composition ranged from sandy sediments with some gravel to sandy silts (Table 3-2).

The polychaete *Mediomastus* spp. was the most abundant organism observed, accounting for 19.5% of the total number of organisms (abundance), followed by the polychaetes *Euchonia limnicola* (8.5% of total abundance) and *Ameana occidentalis* (7.2% of total abundance). The amphipod *Ampelisca abdita* (6.7% of total abundance) was the next most abundant organism sampled, followed by the cnidarian *Stylatula elongata*, which is a suspension feeder. The bivalve *Rochefortia coani*, and the polychaete *Spiophanes duplex* were the next most abundant species accounting for roughly 5.85%, 5.36%, and 4.37% of total abundance, respectively.

In all, polychaetes accounted for approximately 63% of the total abundance observed and 9 of the 15 dominant taxa. Molluscs accounted for approximately 16% of the total abundance and three (3) of the 15 dominant species. Amphipods accounted for 8% of the total abundance and 1 of 15 species, while cnidaria and nemertea accounted for 6 and 4%, respectively and also accounted for one (1) each of the top 15 species. The 15 dominant taxa accounted for approximately 75.9% of the total abundance observed across all samples.

There were slight differences in the physical characteristics of the benthic sampling sites. Sampling depths ranged from 3.0–6.5 meters and averaged 4.2 meters (13.8 feet) (Table 3-2). Visual observations suggested sediment textures included mostly sand, silt and clay with some gravel. Shallower sites had some fine and medium gravel and a greater percentage of very coarse sand, while the deeper sites had no gravel and very little very coarse sand. Percent TOC increased with depth, with the highest value of 1.45% occurring at a depth of 6.5 m. Silt and clay percentages also generally increased with depth.

Table 3-1. Abundances of all taxa (numbers/m^2) found in samples at each of the sample sites.

Taxa	Cluster 1		Cluster 2			Mean
	TI-B-01	TI-B-02	TI-B-03	TI-B-04	TI-B-05	
Cnidaria						
Edwardsia californiensis?	0	0	0	0	36.1	7.22
Hydrozoa	0	0	+	+	+	0
Stylatula elongatus	72.2	288.8	505.4	505.4	342.95	342.95
Actiniaria attached	18.05	0	0	0	0	3.61
Nematoda	0	0	54.15	180.5	0	46.93
Nemertea						
Cerebratulus californiensis	36.1	0	0	0	162.45	39.71
Micrura alaskensis	0	0	72.2	559.55	0	126.35
Paranemertes californica	0	0	18.05	0	54.15	14.44
Tubulanus cingularis	0	0	0	0	18.05	3.61
Tubulanus ?pellucidus	0	0	0	0	18.05	3.61
Tubulanus ?polymorphus	0	0	0	0	36.1	7.22

Taxa	Cluster 1		Cluster 2			Mean
	TI-B-01	TI-B-02	TI-B-03	TI-B-04	TI-B-05	
Unidentified Nemertea	144.4	18.05	0	0	36.1	39.71
Annelida						
Oligochaeta	36.1	0	0	0	0	7.22
Polychaeta						
Ampharete acutifrons	0	0	36.1	0	0	7.22
Ampharete labrops	0	0	36.1	18.05	18.05	14.44
Amphicteis scaphobranchiata	0	0	0	18.05	0	3.61
Ameana occidentalis	505.4	54.15	397.1	1064.95	90.25	422.37
Ameana sp. A	72.2	0	108.3	180.5	108.3	93.86
Ameana spp. [2]	0	0	306.85	0	0	61.37
Apoprionospio pygmaea	18.05	0	0	0	0	3.61
Armandia brevis	0	0	0	18.05	0	3.61
Sabaco elongatus	0	0	18.05	18.05	108.3	28.88
Capetella capitata complex	0	36.1	0	54.15	198.55	57.76
Chaetozone bansei	0	0	0	54.15	36.1	18.05
Chone spp.[2]	0	144.4	0	0	0	28.88
Cirratulidae	0	0	0	18.05	0	3.61
Cirriformia cf. moorei	0	0	0	0	18.05	3.61
Cossura spp.	0	0	72.2	54.15	36.1	32.49
Dipolydora sp. SF2	0	0	0	0	72.2	14.44
Dorvillea longicornis	54.15	18.05	0	361	631.75	212.99
Eteone californica/spilotus	0	18.05	18.05	0	0	7.22
Euchonia limnicola	0	0	1425.95	866.4	198.55	498.18
Exogone lourei	90.25	0	18.05	18.05	90.25	43.32
Glycinde picta	0	90.25	0	36.1	36.1	32.49
Glycinde spp.[2]	54.15	252.7	144.4	72.2	234.65	151.62
Heteromastus filiformis	0	18.05	0	0	0	3.61
Heteromastus filibranchus	0	0	36.1	72.2	0	21.66
Heteropodarke heteromorpha	36.1	0	0	0	0	7.22
Leitoscoloplos pugettensis	18.05	18.05	0	54.15	18.05	21.66
Magelona sacculata	18.05	0	0	0	0	3.61
Maldanidae unidentified [2]	0	0	0	0	0	0
Malmgreniella macginitiei	54.15	162.45	144.4	180.5	0	108.3
Mediomastus spp.	415.15	18.05	1462.05	1678.65	2147.95	1144.37
Nephtys caecoides	18.05	72.2	72.2	18.05	0	36.1
Nephtys cornuta	0	108.3	216.6	216.6	180.5	144.4
Nereis spp. [2]	18.05	0	0	0	0	3.61
Nereidae unidentified [2]	18.05	0	0	0	0	3.61
Notomastus tenuis	18.05	18.05	0	36.1	90.25	32.49
Pectinaria californiensis	0	0	90.25	18.05	0	21.66
Pherusa spp. [2]	0	18.05	0	0	0	3.61
Pholoe glabra	0	0	0	18.05	0	3.61
Pista wui	0	0	0	0	18.05	3.61
Podarkiopsis glabra	0	0	0	0	18.05	3.61
Polydora socialis	0	18.05	0	0	0	3.61
Polydora sp. SF2	0	0	0	36.1	0	7.22
Polynoidae unidentified	0	0	0	0	108.3	21.66
Pseudopolydora paucibranchiata	0	0	36.1	0	18.05	10.83
Scoletoma luti	36.1	0	0	0	0	7.22

Taxa	Cluster 1		Cluster 2			Mean
	TI-B-01	TI-B-02	TI-B-03	TI-B-04	TI-B-05	
Sigambra nr. Bassi	0	0	36.1	0	18.05	10.83
Sphaerosyllis californiensis	0	18.05	36.1	18.05	18.05	18.05
Spiophanes berkeleyorum	0	0	36.1	90.25	0	25.27
Spiophanes duplex	72.2	90.25	180.5	667.85	270.75	256.31
Sthenelais spp.	0	0	0	18.05	0	3.61
Tharyx parvus	18.05	0	0	0	0	3.61
Arthropoda						
Ostracoda						
Eusarsiella zostericola	0	18.05	18.05	0	0	7.22
Cirripedia						
Balanus crenatus	0	0	0	0	0	0
Cumacea						
Cumella vulgaris	0	0	36.1	0	36.1	14.44
Eudorella pacifica	0	36.1	108.3	0	54.15	39.71
Nippoleucon hinumensis	0	18.05	90.25	0	18.05	25.27
Isopoda						
Paranthura japonica	0	18.05	0	0	0	3.61
Munnidae sp. A	0	18.05	0	0	0	3.61
Tanaidacea						
Leptochelia spp. (= *L. dubia*)	0	18.05	0	0	0	3.61
Amphipoda						
Ampelisca abdita	0	342.95	830.3	288.8	505.4	393.49
Americhelidium shoemakeri	0	0	18.05	18.05	0	7.22
Corophium heteroceratum	0	0	18.05	36.1	0	10.83
Monocorophium acherusicum	0	18.05	0	36.1	0	10.83
Moncorophium spp.	0	0	0	0	18.05	3.61
Photis brevipes (male)	0	0	0	0	18.05	3.61
Photis spp. (female, juvenile)	0	54.15	0	0	72.2	25.27
Caprella spp. [2]	0	18.05	0	0	36.1	10.83
Caprellidae [2]	0	18.05	0	36.1	0	10.83
Tritella pilimana	0	18.05	0	0	0	3.61
Decapoda						
Crangon nigricauda	18.05	18.05	18.05	0	0	10.83
Neotrypaea spp.	18.05	0	0	0	0	3.61
Mollusca						
Bivalvia						
Axinopsida serricata	0	0	0	36.1	36.1	14.44
Clinocardium nuttallii	36.1	18.05	72.2	36.1	18.05	36.1
Cooperella subdiaphana	18.05	0	0	0	0	3.61
Cryptomya californica	0	18.05	0	0	0	3.61
Lyonsia californica	0	54.15	36.1	126.35	90.25	61.37
Mactromeris catilliformis	0	90.25	162.45	72.2	0	64.98
Mactridae [2]	0	54.15	18.05	0	0	14.44
Modiolus spp. [2]	18.05	0	36.1	18.05	0	14.44
Mytillidae [2]	0	36.1	0	0	0	7.22
Nuculana taphria	0	0	54.15	0	0	10.83
Nutricola confusa	0	0	18.05	0	0	3.61
Protothaca staminea	0	18.05	18.05	0	0	7.22
Rochefortia coani	505.4	198.55	234.65	342.95	288.8	314.07

Taxa	Cluster 1		Cluster 2			Mean
	TI-B-01	TI-B-02	TI-B-03	TI-B-04	TI-B-05	
Rochefortia tumida	0	0	18.05	0	18.05	7.22
Rochefortia sp. A	0	0	0	0	90.25	18.05
Siliqua lucida	72.2	144.4	162.45	162.45	72.2	122.74
Siliqua sp. SF1	0	0	0	36.1	0	7.22
Solen sicarius	0	0	36.1	0	0	7.22
Theora lubrica	0	108.3	216.6	144.4	108.3	115.52
Tresus nuttallii	0	0	18.05	90.25	0	21.66
Tellinidae unidentified (=Bivalvia A)	0	72.2	90.25	0	126.35	57.76
Gastropoda						
Unidentified Acmeidae	0	0	0	0	18.05	3.61
Philine spp.	0	0	18.05	18.05	0	7.22
Nudibranchia	0	0	0	0	0	0
Cuthona rolleri	36.1	0	18.05	54.15	0	21.66
Echinodermata						
Ophiuroidea	0	0	0	0	0	0
Amphiodia spp. [2]	0	0	18.05	18.05	0	7.22
Total Number of Individuals	**2563.1**	**2906.05**	**7960.05**	**8790.35**	**7077.6**	**4 5859.43**
Number of Taxa[1]	**31**	**44**	**52**	**50**	**51**	**45.6**

Note[1]: Not adjusted for spp.
Note[2]: Specimens too small to identify to species, without characteristics necessary for identification, or in very poor shape

Table 3-2 Sediment grain size compositions for Treasure Island benthic samples.

	Cluster 1		Cluster 2			
Grain Size Analysis	**TI-B-01**	**TI-B-02**	**TI-B-03**	**TI-B-04**	**TI-B-05**	**Mean**
Gravel, Medium (%)	0.00	0.05	0.00	0.00	0.00	0.01
Gravel, Fine (%)	0.67	0.45	0.00	0.00	0.00	0.224
Sand, Very Coarse (%)	1.22	1.69	0.22	0.10	0.54	0.754
Sand, Coarse (%)	5.03	1.11	6.75	4.94	3.97	4.36
Sand, Medium (%)	42.40	1.83	3.67	1.82	3.83	10.71
Sand, Fine (%)	48.60	27.30	12.60	13.10	28.10	25.94
Sand, Very Fine (%)	0.70	8.73	7.48	8.51	10.10	7.104
Silt (%)	3.04	42.60	44.60	51.90	40.00	36.428
Clay (%)	2.33	17.60	26.40	19.80	13.70	15.966
TOC (%)	0.26	1.01	1.45	1.11	1	0.966
Depth (m)	3.0	3.2	6.5	5.1	3.1	4.2

Hierarchical cluster analysis of infaunal densities revealed two groupings of the sample sites. Similar dendrograms were produced when using either all species found or only the 15 most common and abundant species, which clustered sample sites 1 and 2 together and sample sites 3, 4, and 5 together (Figure 3-1). Sampling site locations are shown in Figure 2-1 and are color-coded according to which cluster each station grouped with, with red showing Cluster 1 and green showing Cluster 2.

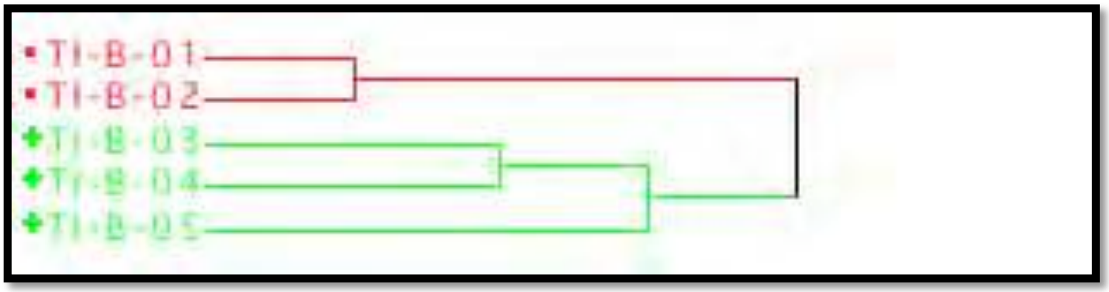


Figure 3-1. Clustering dendrogram based upon the fifteen most common and abundant taxa present at five Treasure Island sample sites, sampled on August 19, 2008.

Cluster 1 includes sample sites 1 and 2, which are two of the shallower sites with higher concentrations of very coarse sand and gravel than the other shallow sample site, Site 5, and the two deeper sites (sample sites 3 and 4) (Table 3-2). The sites in Cluster 1 also had lower TOC concentrations than the deeper stations and lower total numbers of individuals than those in Cluster 2 (Table 3-3). The dominant species in Cluster 1 was the bivalve *Rochefortia coani*, followed by the polychaetes *Ameana occidentalis* and *Mediomastus* spp., the cnidarian *Stylatula elongata,* and the amphipod *Ampelisca abdita* (Figure 3-2). The nemertean *Micrura alaskensis* and the polychaete *Euchonia limnicola* were not present at either of the sample sites in Cluster 1.

As discussed above, Cluster 2 had sediments with no gravel and less very coarse sand, when compared with Cluster 1, and the deeper sample sites in Cluster 2 (sample sites 3 and 4) had higher silt, clay and TOC concentrations than the sites in Cluster 1 (Table 3-2). Cluster 2 was dominated by the polychaetes *Mediomastus* spp. and *Euchonia limnicola,* followed by the amphipod *Ampelisca abdita,* the polychaetes *Ameana occidentalis*, *Spiophanes duplex*, *Dorvilea longicornis*, the cnidarian, *Stylatula elongata and* the bivalve, *Rochefortia coani* (Figure 3-3). The polychaete *Euchonia limnicola* and the nemertean *Micrura alaskensis* were present at all sample sites in Cluster 2 but were absent from both sample sites in Cluster 1 (Figures 3-2 and 3-3). The total number of individuals per square meter of seafloor was higher for the sample sites in Cluster 2 than for those in Cluster 1 (Table 3-3).

Table 3-3. Values for species abundance compared with % TOC and water depth.

Sample Station Number	Cluster	Number of Taxa	Total Number of Organisms/m^2	Sediment Characterization	TOC %	Water Depth (m)
1	1	31	2563.1	sand	0.26	3.0
2	1	44	2906.1	sandy silt	1.01	3.2
3	2	52	7960.1	clayey silt	1.45	6.5
4	2	50	8790.1	clayey silt	1.11	5.1
5	2	51	7078.0	sandy silt	1.0	3.1

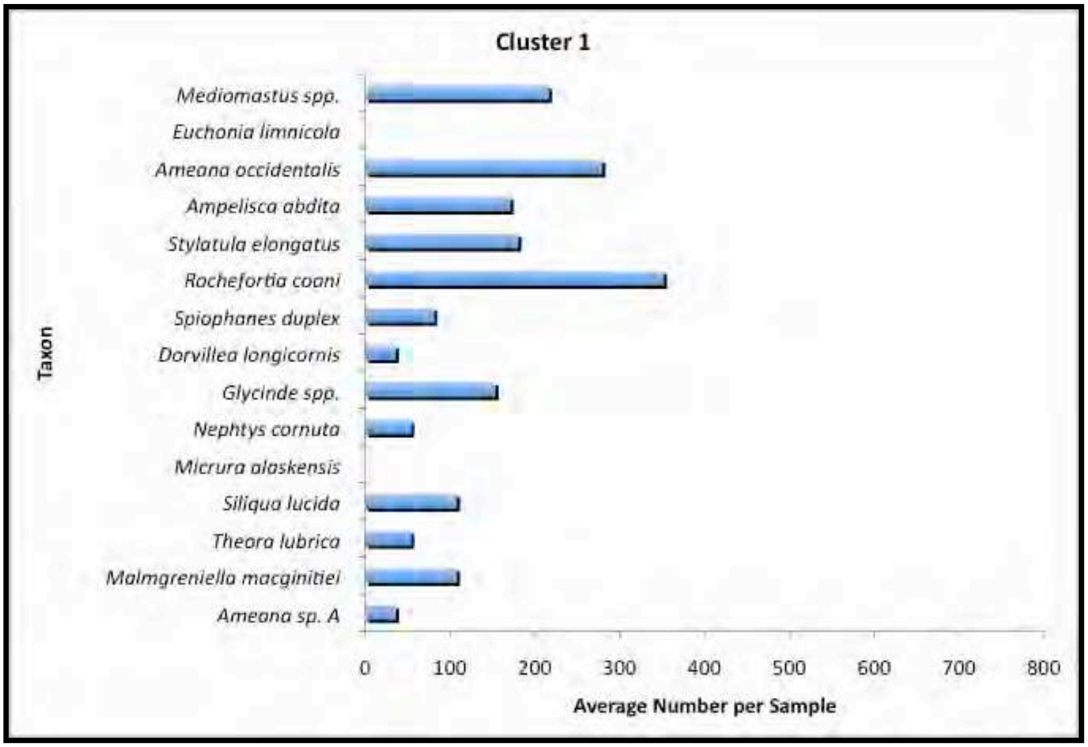


Figure 3-2. Cluster 1 and the 15 most abundant taxa.

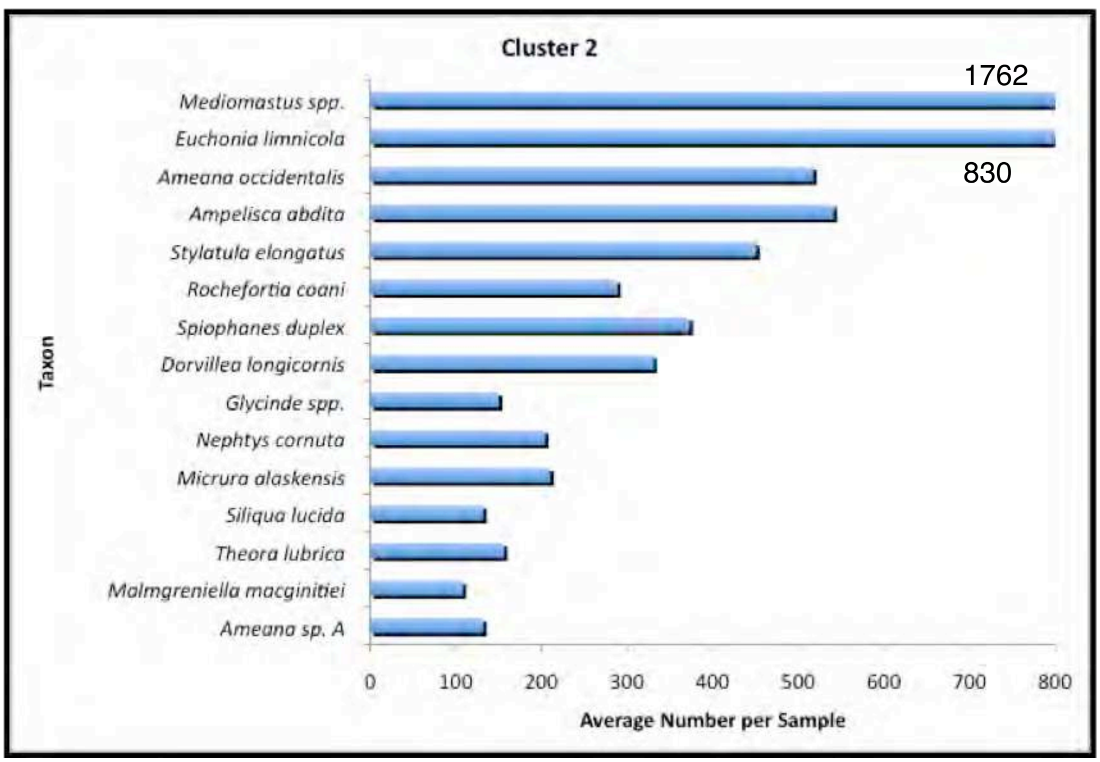


Figure 3-3. Cluster 2 and the 15 most abundant taxa.

An analysis of variance (ANOVA) comparing the number of individuals per taxa (density) of the fifteen most abundant taxa at all stations between each of the two clusters indicated that the polychaetes *Mediomastus* spp. ($p<0.0142$) and *Nephtys cornuta* ($p<0.0401$) were both significantly different between clusters (0.05 significance level), but that the other thirteen were not. (Table 3-4) . A similar ANOVA conducted to assess differences in sediment grain size composition, TOC and water depth between the two clusters (Table 3-5), indicates that there were also significant differences in the percent of fine gravel ($p<0.0064$) as well as very coarse sand ($p<0.0173$) between clusters with Cluster 1 having higher concentrations of both.

Stepwise linear regressions revealed that taxonomic abundances for some of the fifteen most abundant benthic species or taxonomic groups observed in the nearshore region of Treasure Island were strongly associated with physical parameters (Table 3-6). The polychaete *Mediomastus* spp. was negatively correlated with silt, clay and fine gravel (partial correlation = -1.0), suggesting that this species has higher abundances in sandy sediments with little to no gravel. Abundances of the polychaete *Euchonia limnicola* were positively associated with depth (partial correlation = 0.9906), while the amphipod *Ampelisca abdita* was positively associated with organic content (% TOC) (partial correlation = 0.9534) and was most abundant in sediments with little silt (partial correlation = -0.8543). The cnidarian, *Stylatula elongata* was negatively correlated with fine sand (partial correlation = -1.0) and very coarse sand and fine gravel sediments (partial correlations = -0.997) whereas the bivalve *Rochefortia coani,* had greater abundances in medium sand sediments (partial correlation = 0.8874). The polychaete, *Nephtys cornuta* was associated with sediments that had little or no fine sand and fine gravel (partial correlation = -1.0) or medium sand (partial correlation = -0.9999) and the bivalve *Siliqua lucida* was associated with high clay (partial correlation = 0.9999) and silt (partial correlation = 0.9991) fractions and low TOC concentrations (partial correlation = -0.9999), whereas the bivalve *Theora lubrica* was correlated with organically enriched (high %TOC) sediments (partial correlation = 0.9848). Finally, the polychaete *Ameana* sp. A was correlated with sediments containing little or no very coarse sand (partial correlation = -0.9267).

Table 3-4. ANOVA results of significant differences in the density of the fifteen most abundant taxa between the two clusters

Species	R^2 value	P value
Mediomastus spp.	0.8983	**0.0142**[2]
Euchonia limnicola	0.5227	0.1675
Ameana occidentalis	0.1017	0.6009
Ampelisca abdita	0.4420	0.2208
Stylatula elongatus	0.6818	0.0850
Rochefortia coani	0.0829	0.6384
Spiophanes duplex	0.4315	0.2284
Dorvillea longicornis	0.3410	0.3012
Glycinde spp.[1]	0.0003	0.9769
Nephtys cornuta	0.8012	**0.0401**[2]
Micrura alaskensis	0.2231	0.4217
Siliqua lucida	0.0796	0.6456
Theora lubrica	0.5124	0.1739
Malmgreniella macginitiei	$3x10^{-16}$	1.0
Ameana sp. A	0.6464	0.1010

Note[1]: Specimens too small to identify to species, without characteristics necessary for identification, or in very poor shape
Note[2]: Denotes significant p value (<0.05)

Table 3-5. ANOVA results of the physical parameters (grain size, depth, TOC%) among clusters.

Physical Parameter	R^2 value	P Value
Gravel, Fine (%)	0.9395	**0.0064**[2]
Gravel, Medium (%)	0.375	0.2722
Sand, Very Coarse (%)	0.8844	**0.0173**[2]
Sand, Coarse (%)	0.3222	0.3181
Sand, Medium (%)	0.3443	0.2982
Sand, Fine (%)	0.5572	0.1473
Sand, Very Fine (%)	0.3474	0.2955
Silt (%)	0.4193	0.2374
Clay (%)	0.3783	0.2695
TOC (%)	0.4827	0.1929
Depth (m)	0.3988	0.2531

Note[2]: Denotes significant p value <0.05

Table 3-6. Results of stepwise linear regression analysis determining which physical factors had an effect on community taxonomic composition.

Species	1st Most Important Variable		2nd Most Important Variable	
	Name	Partial Correlation	Name	Partial Correlation
Mediomastus spp.	Silt, Clay, Fine Gravel	-1.0		
Euchonia limnicola	Depth	0.9906		
Ameana occidentalis	NE			
Ampelisca abdita	% TOC	0.9534	Silt	-0.8543
Stylatula elongatus	Fine Sand	-1.0	Very Coarse Sand, Fine Gravel	-0.997
Rochefortia coani	Medium Sand	0.8874		
Spiophanes duplex	NE			
Dorvillea longicornis	NE			
Glycinde spp.	NE			
Nephtys cornuta	Fine Sand, Fine Gravel	-1.0	Medium Sand	-0.9999
Micrura alaskensis	NE			
Siliqua lucida	Clay, TOC	(+/-) 0.9999	Silt	0.9991
Theora lubrica	TOC	0.9848		
Malmgreniella macginitiei	NE			
Ameana sp A	Very Coarse Sand	-0.9267		

3.2 Comparison with other Benthic Studies

A literature review of available information on benthic infaunal communities in Central San Francisco Bay revealed little information for the nearshore subtidal areas surrounding Treasure Island. The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) has been studying benthic communities throughout the Bay-Delta since 1993, in conjunction with a status and trends monitoring of organic and inorganic contaminants in Bay-Delta waters and sediments. The nearest RMP benthic station to the current study area is on the southeast side of Yerba Buena Island (RMP Station BC-11). The seafloor habitat at this station was characterized as “marine muddy” with sediments containing 30-97% silt and clay fractions and TOC concentrations of 0.33-2.22% (Thompson *et al*. 2000). These ranges encompass the sediment characteristics of sample sites 2 through 5 of the current study (Table 3-2). Thompson *et al*. (2000) reported the benthos inhabiting all the sites characterized as marine muddy habitat included both marine and estuarine taxa, with amphipods being the most abundant along with the polychaete *Euchone linmicola*, based on samples collected between 1994 and 1997 (Tables 3-7 and 3-8). The potential influence of increased marine water flow along the west side of Treasure Island and the higher sand content of the sampled sites might account for some differences in taxonomic composition between the marine muddy stations described by Thompson *et al.* (2000) and those in the current study.

Another, more recent, report that characterizes San Francisco Bay-Delta infaunal communities was produced by NOAA (2007). This report describes habitat types according to salinity regimes such as euhaline for the more salty marine environments in the shallow subtidal areas of Central Bay. This report bases its characterizations on both RMP data as well as Regional Effects Monitoring Program (REM) data collected between 1986 and 1989. The sediment habitat in the shallow subtidal locations is described as either sandy-mud or muddy-sand in the lee of Central Bay islands and sandy in the channels. The invertebrate taxa in the sandy substrate were characterized by the polychaetes *Medomastus* spp, and *Sphaerosyllis californiensis* , several low abundance amphipod species (*Ampelisca abdita*, *Corophiumm acherusicum*, *C. heteroceratun*, and *C. insidiosum)*, cumaceans, and the low occurrence mollusk, *Musculista senhousia.* The muddy-sand benthic community had a diverse polychaete community represented by several subsurface deposit feeders, the tube dwelling filter-feeding species *Euchonia limnicola*, and the carnivorous species *Exogone lourei*,. In most of the Central Bay soft-substrate benthic habitat, the cnidarian, *Stylatula elongata*, was present. There were also several surface deposit feeders, such as *Ameana spp*., present throughout the year (Table 3-8). Most of these taxa were observed at the Treasure Island benthic survey area sample sites.

Finally, a recent evaluation using best professional judgment to assess aquatic environmental condition, as employed by recognized benthic biologists in California (Weisberg et al., 2008), suggested the use of species that were either sensitive or tolerant to degraded benthic habitats. The evaluation was based on examination of datasets representing a range of organic enrichment, chemical contaminants and physical disturbances, and may be applicable to the general condition of benthic habitats in near Treasure Island. Among the taxa found in the current study, the authors placed high value on *Capitella capitata*, oligochaetes, *Mediomastus* spp., *Dorvillea* spp., *Notomastus* spp., *Exogone* spp. and *Monocorophium* spp. as taxa that were tolerant of degraded habitats, and ophiuroids, amphipods, *Spiophanes duplex* and *berkleyorum* and molluscs as taxa that were sensitive to degraded habitats (Table 3-9) (Weisberg *et al*. 2008).

When these taxa and groups are totaled for the current study, sensitive taxa (average of 31% of total organisms per site) were found in slightly higher densities than tolerant taxa (average of 23% of total organisms per site) (Table 3-10). Sensitive taxa ranged from 25–47% of total organisms and averaged 95/sample over all sites. Tolerant taxa ranged from 4–45% of total organisms and averaged 84/sample.

Statistical analyses to determine spatial patterns in densities of sensitive and tolerant organisms revealed very few differences between these two groups (Table 3-10, Table 3-11). Both sensitive and tolerant organisms had their highest densities (number or organisms) in Cluster 2 (Table 3-10), although ANOVA revealed that the percentages of neither sensitive nor tolerant organisms differed between clusters. Nevertheless, percentages of sensitive organisms were positively correlated with medium gravel, whereas percentages of tolerant organisms were negatively correlated with medium gravel, although the regression model was marginally not significant (Table 3-11).

Consequently, analyses based on densities of sensitive and tolerant organisms indicate that none of the sites were dominated (*i.e.*, >50%) by organisms tolerant of degraded benthic habitat. These results suggest that benthic habitats at the site of the proposed ferry terminal on Treasure Island are generally not substantially degraded.

Table 3-7. Average abundance of taxa found in the current study (15 most abundant) and Thompson *et al*. (2000) (only those characteristically found in marine muddy habitats).

			Mean Number per Sample ($0.05m^2$)	
Taxon	**Group**	**Feeding Mode**	**Average during this current study**	**Thompson *et al.* (2000)** (RMP site BC11, Yerba Buena Island)
Mediomastus spp.	Polychaete	Subsurface deposit feeder	63	37
Euchonia limnicola	Polychaete	Filter feeder	28	58
Amaena occidentalis	Polychaete		23	NR
Ampelisca abdita	Amphipod	Filter feeder	22	697
Stylatula elongatus	Cnidaria	Filter feeder	19	NR
Rochefortia coani	Bivalve	Filter feeder	17	NR
Spiophanes duplex	Polychaete		14	NR
Dorvillea longicornis	Polychaete	Carnivore	12	NR
Glycinde spp.	Polychaete	Carnivore	8	NR
Nephtys cornuta	Polychaete	Carnivore	8	NR
Micrura alaskensis	Nemertea	Carnivore	7	NR
Siliqua lucida	Bivalve		7	NR
Theora lubrica	Bivalve	Surface deposit	6	NR
Malmgreniella macginitiei	Polychaete		6	NR
Amaena sp. A	Polychaete		5	NR
Eusarsiella zostericola	Ostracod		1	1
Nippoleucon hinumensis	Cumacean	Surface deposit	1	8
Corophium heteroceratum	Amphipod	Filter and deposit feeder	1	133
Leptochelia dubai	Tanaid		1	50
Exogone lourei	Polychaete	Carnivore	2	26

NR=Not Reported as one of the most common or abundant taxa

Table 3-8. Taxa found in the current study (15 most abundant) and Thompson *et al*. (2000) (only those characteristically found in marine muddy habitats) and NOAA (2007) (only those characteristically found in euhaline shallow subtidal habitats).

Taxon	Taxonomic Group	Current Study[1]	Thompson *et al.* 2000	NOAA 2007
Ampelisca abdita	Amphipod	X	X	X
Corophium heteroceratum	Amphipod	X	X	X
Mediomastus spp.	Polychaete	X	X	X
Euchonia limnicola	Polychaete	X	X	X
Leptochelia dubai	Tanaid	X	X	X
Ameana sp. A	Polychaete	X		
Ameana occidentalis	Polychaete	X		
Stylatula elongatus	Cnidaria	X		X
Rochefortia coani	Mollusc	X		
Spiophanes duplex	Polychaete	X		
Dorvillea longicornis	Polychaete	X		
Glycinde spp.	Polychaete	X		
Nephtys cornuta	Polychaete	X		
Micrura alaskensis	Nemertea	X		
Siliqua lucida	Bivalve	X		
Theora lubrica	Bivalve	X		
Malmgreniella macginitiei	Polychaete	X		
Corophium acherusicum	Amphipod		X	X
Corophium insidiosum	Amphipod		X	X
Musculista senhousia	Bivalve			X
Glycinde polygnatha	Polychaete			X
Exogone lourei	Polychaete	X	X	X
Tubificid*a*e - unidentified	Oligochaete		X	X
Photis spp.	Amphipod		X	
Nematoda	Nematode	X	X	
Corophium spp.	Amphipod		X	
Corophium alienese	Amphipod		X	
Potamocorbula amurensis	Pelecypod			
Balanus improvisus	Cirriped			
Neanthes succinea	Polychaete			
Nippoleucon hinumensis	Cumacean	X	X	
Grandiderella japonica	Amphipod		X	
Eusarsiella zostericola	Ostracod	X	X	
Gemma gemma	Pelecypod		X	
Pseudopolydora kempi	Polychaete		X	
Streblospio benedicti	Polychaete		X	
Phoronis spp.	Phoronid			X
Tubificidae-unident	Oligochaete		X	X

Note[1]: X=Observed;

Table 3-9. Comparison of benthic taxa observed in the current study with potential indicator species of physically disturbed or chemical contaminated benthic habitat.

Weisberg *et al.* (2008)			Current Study[2]
Indicator Taxon		Importance[1]	
Tolerant Taxa	*Capitella capitata* complex	1.0	X
	Oligochaeta	1.3	X
	Streblospio benedicti	2.0	
	Dorvillea (Schistomeringos) spp.	2.2	X
	Mediomastus spp.	2.3	X
	Armandia brevis	2.6	X
	Pseudopolydora spp.	3.0	
	Exogone spp.	3.0	X
	Grandiderella japonica	3.0	
	Euphilomedes spp.	3.1	
	Monocorophium spp.	3.1	X
	Neanthes acuminata complex	3.2	
	Musculista senhousia	3.2	
	Notomastus spp.	3.4	X
	Ophiura spp.	4.7	X
Sensitive Taxa	Ophiuroidea	1.4	X
	Amphipoda	1.8	X
	Gammaridea (most species)	1.9	
	Mollusca	2.2	X
	Ampelisca abdita	2.7	X
	Nemertea, Cnidaria, opistobranchia, and Sipuncula	3.0	X
	Corophiidae	3.2	X
	Spiophanes duplex and *S. berkeleyorum*	3.2	X
	Crustacea	3.7	X
	Amphiuridae (long-arm brittle stars)	4.1	

Note[1]: Importance is the average importance for all experts, where: 1,very important; 2, important, but secondary; 3, marginally important; 4, useful, but only to interpret the other factors; 5, not used. N is the number of experts that identified the taxon as an indicator.

Note[2]: X=Observed;

Table 3-10. The numbers and percentages of organisms per sample from Treasure Island sites judged to be sensitive or tolerant of degraded benthic habitat by Weisberg et al. (2007).

	Cluster 1		Cluster 2			
	TI-B-01	TI-B-02	TI-B-03	TI-B-04	TI-B-05	Average
# Tolerant Organisms	34	6	82	121	175	84
# Sensitive Organisms	42	76	129	129	99	95
% Tolerant Organisms	24%	4%	19%	25%	45%	23%
% Sensitive Organisms	29%	47%	29%	26%	25%	31%

Table 3-11. Stepwise linear regression results for effects of depth, sediment grain size and total organic carbon on organism abundances at Treasure Island sites.

Taxa	(r^2)	(P)	Regression Model
% Sensitive organisms	0.999	0.0224	y = 0.24 + 4.98 med gravel + 0.011 coarse sand – 0.004 very fine sand
% Tolerant organisms	0.871	0.1287	y = 0.71 – 11.6 med gravel – 0.08 coarse sand

4 Discussion

Although they were located in a fairly small geographic area at the location of the proposed ferry terminal, with slight depth differences, the five sites sampled in his study appeared to include two slightly different communities. The first community was located immediately offshore in sediments containing coarse sand and gravel in water depths less of than 10 feet. The second community inhabited sediments with no gravel and little or no coarse sands, relatively higher fine sediment fractions and TOC concentrations, and was found in water depths generally deeper than 10 feet.

The first benthic infaunal community was dominated by the bivalve *Rochefortia coani*, the polychaetes, *Ameana occidentalis* and *Mediomastus* spp*.,* the cnidarian, *Stylatula elongata*, and the amphipod, *Ampelisca abdita*. *Ampelisca* and *Stylalatula* are both suspension feeders whereas Mediomastus is a detrital feeder.

The second benthic community was dominated by the polychaetes *Mediomastus* spp*., Euchonia limnicola,* and *Ameana occidentalis* along with the amphipod, *A. abdita,* and the cnidarian, *S. elongata*. Two more polychaetes, *Spiophanes duplex* and *Dorvillea longicornis* and the mollusk, *R. coani* are the eight most dominant taxa in this community. Unlike the infaunal community inhabiting the coarser sediments inshore, this community is dominated by polychaetes. In addition, two taxa, the polychaete, *E. limnicola*, and the nemertean, *Micrura alaksensis*, were only observed in the second benthic community.

Both communities have dominant taxa that include suspension feeders, most notably the cnidarian *Stylatula elongata*, suggesting relatively high water flow through the study site. Based on sediment composition, it would appear that the habitat occupied by the first infaunal community is subject to regular wave action or strong currents that prevent the deposition of sediment fines or subject them to resuspension and removal. The higher overall abundances in the second, deeper community, compared to the shallower community, may reflect less disturbance from wave action or surface currents or greater concentrations of organic matter. Higher sediment fines and TOC concentrations in the two deeper sample sites are indicative of increased deposition compared to the shallow sample sites immediately offshore of the island.

Consideration of each taxon's potential sensitivity or tolerance to habitat degradation (Weisberg *et al*. 2008), suggests that the shallow benthic habitats in the area of the proposed ferry terminal may be subject to some regular physical disturbance but are generally not substantially degraded.

The infaunal taxa inhabiting the sediments within the area proposed for a new ferry terminal at Treasure Island are similar to taxa observed in other areas of Central Bay as reported by the RMP (Thompson *et al.* 2000) and NOAA (2007). Benthic communities are known to be distributed spatially in response to microhabitat conditions. The infaunal communities observed at the proposed ferry terminal site, although not identical in composition and abundance to benthic communities reported for other locations in central San Francisco Bay, are sufficiently similar in taxonomic composition to be considered part of a larger Central San Francisco Bay infaunal community.

Finally, no protected or species of special concern were observed and the taxa observed, although used as fish forage by many demersal fish species, are not important prey items for any protected species.

5 References

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