Field Report

Intertidal Habitat and Marine Biota Survey of Treasure Island and the West Side of Yerba Buena Island, California

JULY 2-3, 2008
JULY 17, 2008

Prepared for:

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&

The Treasure Island Redevelopment Project
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June 2009

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APPLIED
marine
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1.0 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. The planned redevelopment of Treasure Island includes not only the removal and replacement of many former U.S. Navy buildings and roads adjacent to the man-made rocky shoreline, but new construction, as well (Figure 1-1). One planned addition is the construction of a new ferry terminal located along the southwest corner of the island. Additionally, to effectively address both potential seismic as well as global sea-level rise issues, some repair or modifications of the rocky shoreline may be required as part of the islands redevelopment.

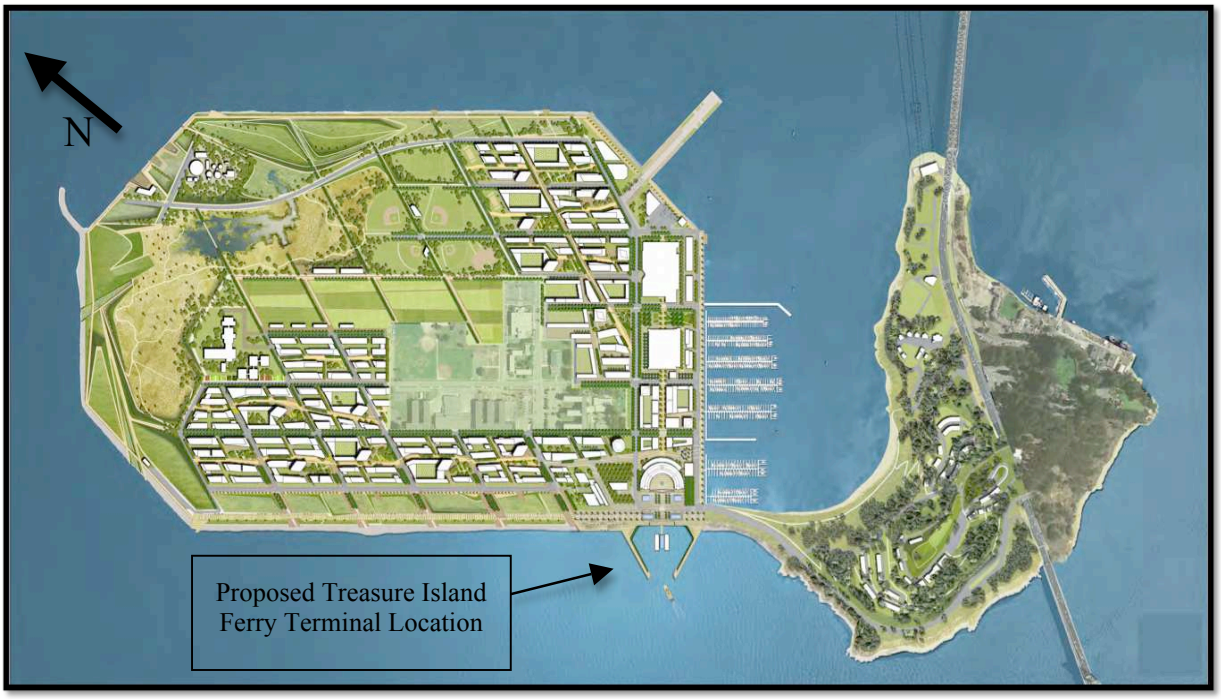
Any disturbance to the rocky intertidal habitat surrounding the island will result in the temporary disturbance and potential loss of benthic intertidal habitat and associated biological communities. Natural rocky intertidal habitat in San Francisco Bay-Delta is primarily limited to Central Bay, with artificial habitat (shoreline armoring, pilings, piers, etc.) found throughout the Bay-Delta (NOAA 2007). To effectively evaluate the potential environmental impact on the flora and fauna inhabiting the shorelines of Treasure Island and Yerba Buena Island, from planned redevelopment activities, as well as any indirect affects their loss or disturbance could have on Bay ecology, especially special status species, it is necessary to have an understanding of the species composition and community structure of the taxa inhabiting the intertidal habitat areas of the islands.

The intertidal communities of San Francisco Bay-Delta, like those inhabiting most estuaries, are highly diverse and responsive to site-specific ecological conditions. The lack of sufficient data concerning the marine flora and fauna inhabiting the intertidal areas of Treasure Island and the western shoreline of Yerba Buena Island, prompted the need for a site-specific assessment. The objectives of this biological assessment were:

- To characterize and map intertidal habitat types present,
- To qualitatively characterize the associated flora and fauna inhabiting the intertidal areas.
- Identify the presence of any species of significant concern or sensitivity, such as eelgrass beds, native oysters, or invasive species of concern.

This report presents the results of the assessment of the intertidal habitat surrounding Treasure Island conducted by Applied Marine Sciences, Inc. on July 2-3, 2008 and the western shoreline of Yerba Buena Island on July 17, 2008.

Figure 1-1. Proposed redevelopment plan for Treasure Island, California



Source: Treasure Island Community Development, 2008

2.0 Survey Information

A qualitative assessment of the upper, mid and low intertidal zones of Treasure Island (TI) and the western shoreline of Yerba Buena Island (YBI) was conducted by marine scientists from Applied Marine Sciences, Inc. (AMS) on July 2-3, 2008 and July 17, 2008, respectively. At the time of the survey, the low tide ranged between -0.2 and -0.5 m (-0.66—1.64 ft.).

2.1 Objectives

Shoreline survey locations were selected prior to the field survey such that a minimum of two survey locations located along each segment (N, NW, W, SW, S, SE, E, NE) of Treasure Island was assessed. Because the west shoreline of YBI is only accessible by boat, the field crew assessed the intertidal habitat in each accessible pocket cove. As needed, survey locations were shifted slightly in the field to accommodate safe access and field observations. Figures 2-1 and 2-2 illustrate survey locations along the TI and YBI shorelines that intertidal habitat and associated biota were assessed.

2.2 Personnel

Personnel who participated in the field surveys are presented in Table 2-1.

Table 2-1. Personnel for the Treasure Island and Yerba Buena Island Intertidal Habitat and Marine Biota Assessment

Name	Affiliation	Duties
Jay A. Johnson	Applied Marine Scie0nces, Inc. (AMS)	Mar, Biologist, Field Team Lead 7/3-4/08
Dane D. Harding	Applied Marine Sciences, Inc. (AMS)	Lead Mar. Biologist 7/3-4/08, Field Team Lead 7/17/08
Clare Dominik	Applied Marine Sciences, Inc. (AMS)	Lead Mar. Botanist
David Morgan	Romberg Tiburon Center for Environmental Studies	Skipper R/V Twin Vee
Tom Roberts	ESA	Observer 7/17/08

2.3 Sampling Activities

The schedule of sampling activities is presented in Table 2-2. Figures 2-1 and 2-2 illustrate the locations of each sample site.

Table 2-2. Sampling Activities at Treasure Island and Yerba Buena Island on July 2-3 and July 17, 2008.

Date	Activity
July 2, 2008	Surveyed West Side of Isthmus connecting Yerba Buena Island to Treasure island; Surveyed West, Northwest, North, and Northeast sides of Treasure Island
July 3, 2008	Surveyed East, southeast, South, and East sides of Treasure Island; Surveyed East side of Isthmus connecting Yerba Buena Island to Treasure Island
July 17, 2008	Surveyed West side of Yerba Buena Island between the Isthmus to Treasure Island and the West span of the San Francisco Bay Bridge

2.4 Sampling and Analysis

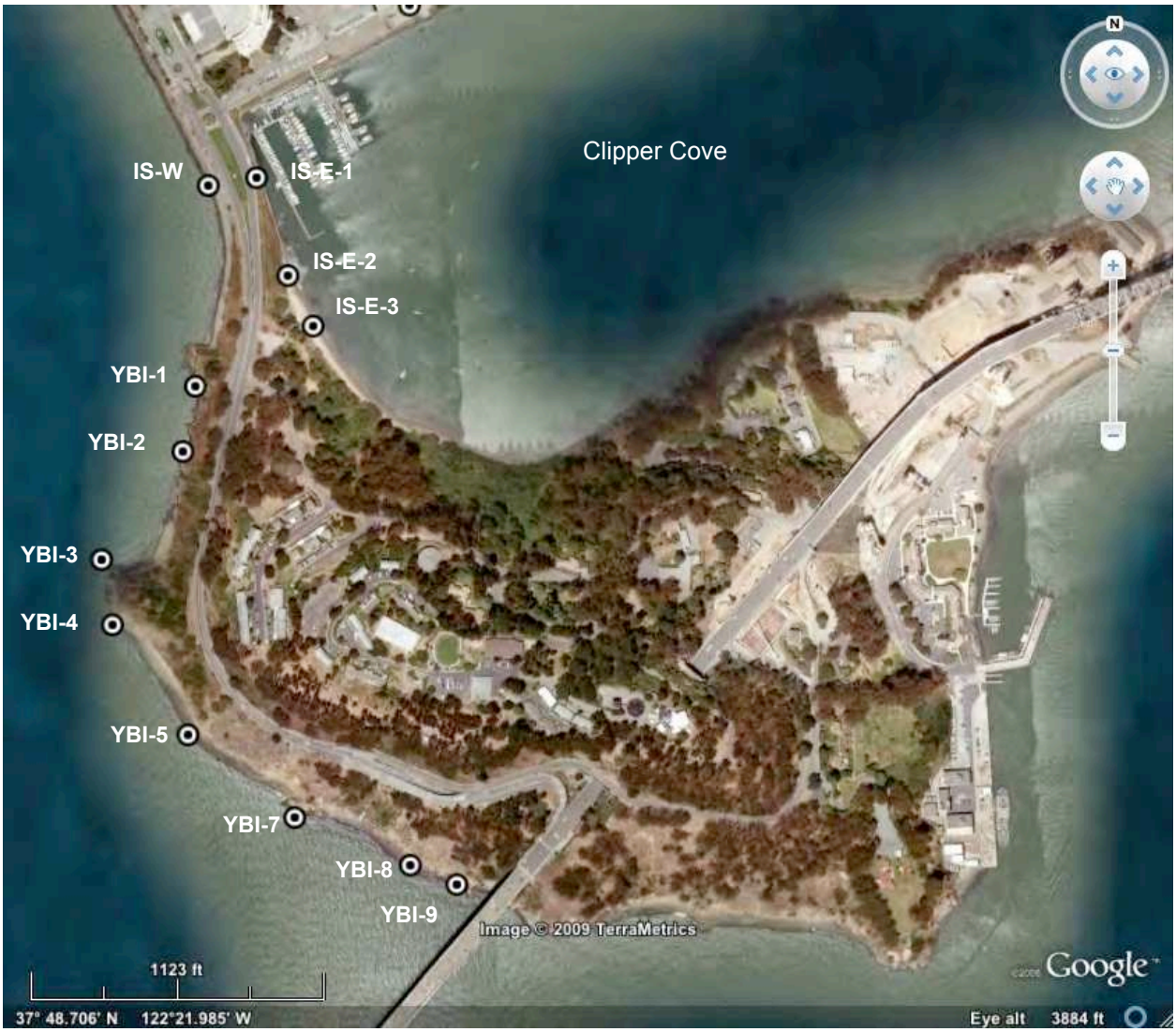
At each survey location, the field team surveyed the shoreline between the splash zone/high intertidal and the lower intertidal area within an approximately 5-10m (16-32 ft.) horizontal area. Within each sample site, they:

- Identified and described the intertidal habitat(s) present in the high, mid and low intertidal zones,
- Identified the visually dominant biota (flora and fauna) inhabiting each zone and habitat type,
- Estimated overall abundance of dominant biota and characterized as either dominant, common or present,
- Identified the presence and estimated density or aerial coverage of any sensitive or important species such as eelgrass (*Zostera spp*) or native oysters (*Ostrea conchaphila*),
- Identified the presence of any non-native, invasive species such as Pacific oysters (*Crassostrea gigas*), European Green Crab (*Carcinus maenus*), and the Chinese Mitten crab (*Eriochir sinensis*), etc.

Observations were recorded on data sheets for each survey site along with the latitude/longitude location.

Figure 2-1. Treasure Island survey site locations.

Figure 2-2. Yerba Buena Island survey site locations.



3.0 Results (Observations)

The shoreline habitat and intertidal zones of Treasure Island (TI) and Yerba Buena Island (YBI) are significantly different. The shoreline of Treasure Island is man-made and consists primarily of quarry rock of assorted sizes whereas the shoreline of Yerba Buena Island is natural and consists of pocket beaches, exposed shelf rock and isolated boulders.

The intertidal zone is defined as that area of the shoreline that undergoes periodic exposure to air during low tide and is submerged by water or exposed to wave splash during high tide. The intertidal area is divided into different vertical zones, which are generally the result of the amount of time the shoreline area is exposed to air or kept submerged by water (Ricketts 1985). The most common or frequent vertical zonation used along the west coast consists of four zones:

- Littorine or Splash zone
- High Intertidal
- Mussel Zone or Middle Intertidal
- Low Intertidal

Shorelines that are very steep, such as at Treasure Island tend to have fairly narrow zonal bands with less clear demarcation between each zone. As a result, this study divided the intertidal region into three zones, by combining the Splash zone with the High Intertidal into one zone. The other two zones for which the habitat and associated biota were characterized were the Middle Intertidal and the Low Intertidal.

Tables 3-1, 3-2, and 3-3 present species lists for all taxa observed inhabiting the High, Middle, and Low Intertidal zones, respectively, at each of the survey site at Treasure Island and Tables 3-3, 3-4 and 3-5 present similar information for YBI. The following sections present the observed intertidal communities inhabiting each geographic area (N, W, S, E, NE, SE, NW, SW) of TI and along the west shore of YBI.

3.1 Treasure Island

3.1.1 Habitat (Artificial Riprap)

The majority of the intertidal shoreline surrounding the man-made Treasure Island consisted of artificial rip-rap (Figure 2-1). Quarried rock of assorted sizes was placed along the shoreline as armoring. In some locations, concrete debris was also used to stabilize and protect the Islands perimeter from wave action. In general, the height of the riprap shoreline was higher along the west and north sides of the island and less high and steep along the east and south sides of the island. Depending on the specific location the boulders were laid at a steep angle, often approaching 45 degrees. The Low Intertidal region often included small cobbles and sandy mud habitat.

The isthmus connecting Treasure Island to Yerba Buena Island presented the transition between natural and man-made riprap shoreline. Along the west side of the isthmus the artificial shoreline was not as steeply sloped as along the rest of the island and as a result had a wider High Intertidal zone and more small rock and sandy mud in the Low Intertidal zone. Along the east side of the isthmus, the broad sandy beach of Clipper Cove merged into very steep rock rip-rap with a broad mud flat in the Low Intertidal zone.

3.1.2 Intertidal Community

The High Intertidal Zone, which is typically splashed by waves but rarely submerged, was characterized by several algae species. The green algae, *Ulva spp*. (including *Enteromorpha*) which is highly tolerant

to desiccation as well as low salinity conditions, was observed inhabiting this zone around the entire island. On the northwest side of the island, the red algae, *Porphyra* sp. was also commonly observed in the high intertidal zone, with its abundance and dominance in the community increasing as you went lower in the zone, as it is less tolerant to desiccation than *Ulva* spp. Along the eastern sides of the island, the red algae *Mastocarpus papillatus* appeared to replace *Porphyra* spp., and along the southern sides of the island the brown alga, *Fucus* sp. was observed (Table 3-1). The dominant invertebrate animals inhabiting the High Intertidal Zone were two species of barnacles (*Balanus* spp. and *Chthamalus* spp.) and isopods. Limpets were also common in some of the High Intertidal zones surrounding the island (N, S and the east Isthmus) (Table 3-1).

The Middle Intertidal zone is that shoreline area that tends to spend fairly equal periods of time either exposed to air or submerged under water. The steep slope of the artificial rip-rap along Treasure Island's shoreline results in a fairly narrow vertical area that encompasses the Middle Intertidal zone. This narrow band of rock appears to be dominated by several species of red algae with the most abundant species being *M. papillatus* and *Mazaella* sp. (Table 3-2). *Porphyra* sp. was observed to be very abundant and a dominant taxa along the west and northern sides of the island, but absent from this zone in the other sections of the island. The brown alga, Fucus sp., was also observed to be a key community member in some areas of the island within the Middle Intertidal Zone (W, NE, E, and S). Finally most sites had a red turf that covered the primary layer of substrate within the Middle Intertidal zone, which was comprised of multiple red algae species including *Pikea californica, Dilsea californica, and Ceramium* spp.

The invertebrate community in the Middle Intertidal zone was very similar to that observed in the High Intertidal zone with both species of barnacles (*Balanus* spp. *and Chthamalus* spp.) and limpets dominating the community. Depending on the availability of bare space and the amount of crevices that could be occupied, the California mussel was a commonly or abundantly observed taxa on the more exposed north and west sides of the island and the Bay mussel (*M. trossulus/gallopprovinicalis*) was observed along the east and south sides of the island (Table 3-2). The crab, *Pachgrapsus crassipes*, was also observed inhabiting this intertidal zone along with occasional occurrences of the native oyster, *Ostrea conchaphila*. One interesting observation was the presence of the mossy chiton (*Mopalia muscosa*) along the west side of the island. The field team observed it being eaten by a north American raccoon, *Procyon lotor*, that traveled along the rocks, stopping to eat a chiton at regular intervals, until sunrise, at which point it wandered off (Tables 3-2 and 3-3).

The Low Intertidal zone is that zone along the shoreline that spends the most time submerged. As such, it tends to contain the most diverse algae and invertebrate communities (Table 3-3). A total of 30 algae species and 27 invertebrate species were identified inhabiting this zone of the treasure Island shoreline in comparison to the 5-12 algae taxa and 7-11 invertebrate taxa observed in the High and Middle Intertidal zones (Tables 3-1, 3-2, and 3-3). The Low Intertidal zone faunal community was dominated by the red algae, *Mazaella* sp., *Mastocarpus* sp., *Cryptopleura farlowianum*, *Cryptopleura* spp., and red turf (Table 3-3). The green algae, *Ulva* spp. was also present throughout the island. Along the south side of the island, it was observed as a mat covering the exposed tidal mud flats.

In addition*, Prionitis* spp. was very common along the west, north and east sides of the island and *Chondracanthus* spp. was present, but in low abundance, around the entire island (Table 3-3). Likewise, the brown algae, *Fucus* spp., was commonly observed along the east and south sides of the island. In addition to the red turf species mentioned above, *Nitophyllum* sp. *Pterosiphonia* sp. and *Ceramium* spp. were components of the abundant red turf that covered much of the rock surfaces. Finally, the invasive brown algae species, *Sargassum muticum,* was observed in the very low to shallow subtidal zone attached to rocks along the eastern side of the island and a large eel grass (*Zostera* spp.) bed was observed in the near shore subtidal area along the east side of the island (Table 3-3).

The invertebrate community in the Low Intertidal zone was very developed in the riprap areas. Almost every patch of bare space that was not covered by algae was occupied by encrusting colonial or solitary invertebrates, including several non-native, invasive species to San Francisco Bay. Ectoprocts, bryozoans, limpets, chitons, native oysters, barnacles, and mussels appeared to dominate the invertebrate community, especially the vertical and under rock surfaces. Dominant taxa included the bryozoan, *Waterispora subtorquata,* the bryozoan*, Cryptosula pallasiana,* an unidentified encrusting orange ectoproct, unidentified species of limpets and chitons, the barnacles *Balanus* spp. and *Chtamalus* spp., and the native oyster *Ostrea conchaphila (*Table 3-3*)*. In addition, multiple species of sponges, the invasive, non-native tunicate *Botryllus schlosseri*, and both species of mussels were observed inhabiting select Low Intertidal zones around the island. As observed in the Middle Intertidal zone, the California mussel, *M. californianus*, was observed along the west and north sides of the island and the Bay mussel, *M. trossulus/galloprovincialis*, inhabited the east and south sides of the island. The invasive tunicate, B. schlosseri, was only observed on the north, east and south shores of the island, and no sponges were observed along the south side of the island. Finally, the lined shore crab *Pachygrapsus crassipes* was very common throughout the Low Intertidal zone.

3.2 Clipper Cove (Isthmus East Side)

Clipper Cove is bounded on the north by Treasure Island, on the south by Yerba Buena Island and by the Isthmus that connects the two islands on the west (Figure 2-2). The intertidal area of Clipper Cove that defines the east side of the isthmus was included in this survey and characterization. A large portion of the isthmus' eastern shoreline consists of a large sandy beach that continues out into the cove as a tidal mud flat. Diatom mats and *Ulva* sp. were observed in large patches covering much of the tidal flat. Large indentations or shallow excavations were prominent throughout the lower intertidal reaches of the sand beach and exposed tidal flat and were suspected to be the result of rays (*Raja spp.)* feeding on benthic invertebrates, such as clams. These clams produce siphon mounds in the mud and fine sand, which were also observed. In addition, a dead ray was observed in one exposed pit near the docks, having been stranded by the low tide.

The beach transitions into steep riprap rock along the east side of the isthmus, adjacent to the marina, and as a result most likely is only submerged at the highest of tides. As a result, the High Intertidal zone in this area of the isthmus' shoreline was very sparse consisting primarily of barnacles, limpets and isopods (Table 3-1). *Fucus* sp. and *Ulva* spp. were the most common algae taxa in the rocky Middle Intertidal zone as well as *Mazaella* sp. and *Mastocarpus papillatus* (Table 3-2). The diatom mat observed on the sandy beach was also abundant in the rocky Middle Intertidal zone, as well as the lined shore crab (*Pachygraspus crassipes*) and the California mussel (*M. californianus*). This presence of the California mussel and not the Bay mussel in this location was interesting since the Bay mussel was observed to be more prevalent along the east and south sides of Treasure Island (Table 3-2).

The Low Intertidal zone in the rocky riprap was again dominated by the algae *Fucus* sp. and *Ulva* spp. as as well as *Nitophyllum* sp. (Table 3-3). The unidentified diatom mat was also an abundant community member. Finally, as elsewhere observed in the rock riprap of Treasure Island, the native oyster (*Ostrea conchaphilla*) and the lined shore crab (*Pachygraspus crassipes*) were very common along with the reoccurrence of the Bay mussel (*M. trossulus/galloprovincialis*).

3.3 Yerba Buena Island

3.3.1 Habitat (Natural Rocky Intertidal Benches)

The shoreline of the west side of Yerba Buena Island (YBI), between the isthmus to Treasure Island and the San Francisco Bay Bridge, is not easily accessibly from land and was therefore accessed by boat during the survey. The shoreline and intertidal zones consist of steep rocky outcropping that quickly transitions into steep island cliffs and narrow pocket beaches that are exposed only at low tide. The hard substrate consisted of natural rock benches in contrast to the quarried rock of Treasure Island. As a result, there were fewer crevices and protected under rock surfaces for organisms to attach and thrive than at Treasure Island (Figure 2-2).

3.3.2 Intertidal Community

The algae and invertebrate communities inhabiting the intertidal zones of the west side of YBI resembled those typically observed along the Central California coastal region. These coastal species tend to disappear within San Francisco Bay the greater the distance from the Golden Gate, and the entrance to the Pacific Ocean, you are. The presence of many of these species, such as the feather boa kelp, *Egregia meanzinni*, along the west side of YBI, attests to the significant flow of ocean waters along this side of the island. The reduced amount of available surface area on the natural hard substrate intertidal area along the west side of YBI resulted in lower total abundances of both algae and invertebrate taxa than observed along the artificial riprap shoreline of Treasure Island.

The algae and invertebrate taxa inhabiting the High Intertidal zone along the west side of YBI were similar to those observed along the west side of Treasure Island, with the green algae, *Ulva* spp. and the red algae, *Porphyra* sp., being the most abundant. The brown algae, *Fucus* sp., and the red algae *Mastocarpus papillatus* and *Endocladia muricata* were also commonly observed (Table 3-4). At one location (Site YBI-2) the brown algae, *Pelvitiopsis* sp., was observed in high abundance. Like at Treasure Island, the barnacles *Balanus spp*. and *Chthmalus s*pp. were the dominant invertebrate animals present along with the gastropod snail, *Littorina scutulata* and unidentified limpets. The California mussel (*M. californianus*) was also present but observed in low abundances

The Middle Intertidal zone of YBI was dominated by the brown algae *Fucus* sp. and the green algae *Ulva* spp., with a secondary red algal community being very common throughout the zone but occurring in lower abundances than *Fucus* and *Ulva*. This red algae community included *Mastocarpus papillatus*, *Mazzaella* sp., and *Porphyra* sp. (Table 3-5). The invertebrate community of the Middle Intertidal zone of the western side of YBI increased substantially from the number of taxa present in the High Intertidal zone, with 13 taxa observed. As observed throughout Treasure Island, barnacles (*Balanus* spp. and *Chthmalus s*pp.) along with limpets were the dominant taxa (Table 3-5). Some encrusting bryozoans, gastropod snails, crabs, and mollusks, including the California mussel (*M. californianus*) and the native oyster (*O. conchaphila*) were observed, but in very low abundances and patchy distribution. Most of the available surface area was covered with macro algae.

The Low Intertidal zone along YBI (Table 3-6) had equally as diverse algae and invertebrate communities as observed at Treasure Island, with similar dominant taxa. The red algae, *Mastocarpus papillatus* and a red turf consisting of *Pikea californica, Dilsea californica, Ceramium* spp. *Pterosiphonia* sp. and *Polysiphonia* sp. appeared to be the dominant floral taxa. Other commonly observed taxa included the green algae *Ulva* spp. and the red algae *Porphyra* spp. The brown algae, *Sargassum muticum* and *Egregia meanzinni* were observed at some sample sites in high abundances. Other commonly observed taxa of coastal Low Intertidal zones, including *Cryptopleura* spp., *Rhodomenyia* spp., and encrusting coralline algae were observed in patchy distribution and abundances.

Table 3-1. High Intertidal flora and fauna observed along the shoreline of Treasure Island. (A=abundant, C=common, P=present, R=rare).

Species Name	General Taxonomic Group	IS-W	W				NW			N			NE		E					SE			S		IS-E		
		1	4	3	2	1	3	2	1	2	1b	1	2	1	4	3	2	1b	1	3	2	1	2	1	3	2	1
FLORA																											
Fucus sp.	Brown Algae																						P	P	C		C
Ulva spp.	Green Algae	*C*	C	C	*C*	C	C	C	C	P	P	P	C	C	R	P	C	C	C	C	C	C	C	C	C		C
Porphyra spp.	Red Algae						C	C	C					P													
Hematocelis sp.	Red Algae												P	P	C	C	C								C		P
Mastocarpus papillatus	Red Algae												P			P							C	C	C		C
FAUNA																											
Balanus spp.	Barnacle			A	A		A	A	A				C	C		C			C	C			C	C	C	C	C
Chthamalus spp.	Barnacle			A	A		A	A	A				C	C		C			C	C			C	C	C	C	C
Littorina scutulata	Gastropod							P															P			P	
Limpets unidentified	Limpet							C					C	C			C	C	C	C			C	C		C	
Pachygrapsus crassipes	Crab									C															C		C
Isopods, unidentified	Isopod	P	P	P																			P	P	P	P	P
Mytilus trossulus/galloprovincialis [1]	Mussel																						P		C		A

Note[1]= Invasive species
Note[2]= Species of concern

Table 3-2. Middle Intertidal flora and fauna observed along the shoreline of Treasure Island. (A=abundant, C=common, P=present, R=rare).

Species Name	General Taxonomic Group	IS-W	W				NW			N			NE		E					SE			S		IS-E		
		1	4	3	2	1	3	2	1	2	1b	1	2	1	4	3	2	1b	1	3	2	1	2	1	3	2	1
FLORA																											
Fucus sp.	Brown Algae	*C*	C										C	C		C	A	A	A				C	P			C
Ulva spp.	Green Algae					C	A	A									A		A	A			A				C
Pikea californica	Red Algae													*P*		P		P	*P*								
Dilsea californica	Red Algae													*P*		P		P	*P*								
Ceramium spp.	Red Algae													C		C		A	A								
Hematocelis sp.	Red Algae									C	C	C															
Polysiphonia spp.	Red Algae													P													
Endocladia muricata	Red Algae												C														
Mastocarpus papillatus	Red Algae	*A*	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	C			A				A
Mazzaella sp.	Red Algae	*P*	P	P	P	P	P	P	P	P	P	P	C	A	P	P	P	P	P	P			P				P
Porphyra sp.	Red Algae	*C*	A	*A*	A	A			A	A		A															
Diatom mat, unidentified	Diatom															P	P	P	P	C	C	C	C	C	A	A	A
FAUNA																											
Balanus spp.	Barnacle	*A*	A	A	A	A	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A				A
Chthamalus spp.	Barnacle	*A*	A	A	A	A	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A				A
Littorina scutulata	Gastropod																							P			
Tegula funebralis	Gastropod	P	P																								
Limpets unidentified	Limpet	*A*	A	A	A	A		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A				A
Ostrea conchaphila (native oyster)[2]	Oyster												C									A					
Pachygrapsus crassipes	Crab					A						A			A	A										A	A
Mytilus trossulus/galloprovincialis[1]	Mussel														P	P							C	C			
Mytilus californianus	Mussel	C	C			A	A	A	A	A	A		P	P												A	A
Mopalia muscosa	Chiton	C	C					A															P				
Notoacmaea scabra	Limpet				P																						

Note[1]= Invasive species
Note[2]= Species of concern

Table 3-3. Low Intertidal flora and fauna observed along the shoreline of Treasure Island. (A=abundant, C=common, P=present, R=rare).

Species Name	General Taxonomic Group	IS-W	W				NW			N			NE		E					SE			S		I-E		
			4	3	2	1	3	2	1	2	1b	1	2	1	4	3	2	1b	1	3	2	1	2	1	3	2	1
FLORA																											
Fucus sp.	Brown Algae															C			A			C	C	C			C
Sargassum muticum[1]	Brown Algae	*A*											P		P	P	C	P	P	P	P	P					
Ulva spp.	Green Algae	*C*	C	P	A	A	P	P	P	C	C	C	A	P	A	A	A	A	A	P	A	A	A	A	C	C	
Zostera spp. [2]	Eelgrass															C	A	A	A								
Nitophyllum sp.	Red Algae				A			A	A	A.	A	A	A	A	A	A	A		A	A	A	A	A	A		C	A
Pterosiphonia sp.	Red Algae	*P*									P		P	P													
Ceramium spp.	Red Algae							P	P	A		P				P	P			P							
Ahnfeltiopsis sp.	Red Algae					P							P														
Grateloupia setchellii	Red Algae																			P	P	P					
Polysiphonia spp.	Red Algae	*C*	C	*A*							P																
Pikea californica	Red Algae													*P*		P		P	*P*								
Dilsea californica	Red Algae													*P*		P		P	*P*								
Callithamnion sp.	Red Algae									P																	
Mazzaella volans	Red Algae									P	P																
Hematocelis sp.	Red Algae													P		P	P		P								
Callophyllis spp.	Red Algae	*A*				A			C	C																	
Cryptopleura farlowianum	Red Algae		P	A	A	A	A	A	A	A	A	A							P				P				
Cryptopleura spp.	Red Algae		P	A	A	A	A	A	A	A	A	A															
Endocladia muricata	Red Algae																		P	C	C		C				
Encrusting coralline algae	Red Algae			P																							
Chondracanthus spp.	Red Algae	*P*				P	P	P	P	P			P	P	P		P			P	P	P					
Gracilaria sp.	Red Algae																	P					A	A		A	
Gelidium sp.	Red Algae																	P					A	A		A	
Mastocarpus papillatus	Red Algae	*C*	A	*A*	A				P		C	A	A	A	A	A	P	C	C	P	P	C	C				
Mazzaella spp.	Red Algae	*A*	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	C	A	A	A	A		A		A	
Microcladia sp. (algae epiphyte)	Red Algae												P				P	P	P								

Species Name	General Taxonomic Group	IS-W	W				NW			N			NE		E					SE			S		I-E		
			4	3	2	1	3	2	1	2	1b	1	2	1	4	3	2	1b	1	3	2	1	2	1	3	2	1
Plocamium sp. (epiphyte on algae)	Red Algae	*P*	A		P	A		P									P										
Porphyra spp.	Red Algae	*A*	A																								
Prionitis sp.	Red Algae		C	*C*	C	*C*	C	*C*		*C*	C	C	C	C			C										
Rhodomynia pacifica	Red Algae		P	*P*				P										P									
Diatom mat, unidentified	Diatom	*C*																							C	C	
FAUNA																											
Diadumene sp. [1]	Cnidarian															P	P	P									
Diadumene lineata[1]	Cnidarian																		P								
Ascidian, purple encrusting unidentified	Ascidian												P														
Botryllus schlosseri[1]	Tunicate												P	P		P	P		P	P	P	P		P		P	P
Balanus spp.	Barnacle	A	A	A	A					A					A		C		C						P		
Chthamalus spp.	Barnacle	*A*	A	A	A					A					A		C		C						P		
Chitons, unidentified	Chiton	*A*	A	A			C	C	C	C	C		C				C					C					
Cryptosula pallasiana[1]	Bryozoan	*P*	P	P						C												C		C			
Watersipora subtorquata[1]	Bryozoan	*C*	*C*	C		C	C	P	C	C		C	C	C	C	C	C	C	C	C	C	C	C	C			
Bugula neritina[1]	Bryozoan	*P*	P	P																				P			P
Ectoproct, orange encrusting	Ectoproct	*C*	C	C		C		P		C	C		C	C	C	C	C	C	C	C	C	C	C	C		C	C
Ectoptoct, pink encrusting	Ectoproct						P																				
Ectoproct, tan encrusting	Ectoproct																							P			
Tegula funebralis	Gastropod	P	P	P																							
Hydroid, unidentified	Hydroid	*P*	P	P									P														
Limpets unidentified	Limpet		A	A	A			A	A		C				A	A	A		A							C	
Ostrea conchaphila (native oyster) [2]	Mollusk	A	A	A	A	A	A	A	A	C	C	P	A	P	A	C	C	A	A	A	A	C	C	A		C	C
Pachygrapsus crassipes	Crab	A	A	A						A			A	A	A	A	A	A	A	A	A	A				C	C
Pagurida unident. (Hermit crab)	Crab											P			P												
Polychaete, tube building unidentified.	Polychaete	A	A	A																							
Mytilus trossulus/	Mollusk																C	C	C	C	C	C	P			A	C

Species Name	General Taxonomic Group	IS-W	W				NW			N			NE		E					SE			S		I-E		
			4	3	2	1	3	2	1	2	1b	1	2	1	4	3	2	1b	1	3	2	1	2	1	3	2	1
galloprovincialis[1]																											
Mytilus californianus	Mollusk		A	A	A	A	A	A	A			P															
Mopalia muscosa	Chiton	A	C	C										P		C											
Sponge, yellow encrusting	Sponge			P					P	P		P															P
Sponge, orange encrusting	Sponge	P	P	P	P	P	P	P				P			P	P											
Sponge, pink encrusting	Sponge	P	P	P	P	P		P	P		P																

Note[1]= Invasive species
Note[2]= Species of concern

Table 3-4. High Intertidal Zone flora and fauna along the western shoreline of Yerba Buena Island. (A=abundant, C=common, P=present, R=rare).

Species Name	Common Name	Sample Site							
		YBI-9	YBI-8	YBI-7	YBI-5	YBI-	YBI-3	YBI-2	YBI-1
FLORA									
Ulva spp.	Green Algae	A	A		A	A	A	A	C
Fucus sp.	Brown Algae	C					C	C	C
Pelvitiopsis sp.	Brown Algae							C	
Endocladia muricata	Red Algae	C		C			C		
Mastocarpus papillatus	Red Algae	C		C	C	C		P	P
Porphyra spp.	Red Algae	A	A		A	A			A
FAUNA									
Balanus spp.	Barnacle	C	C	C	C	C	C	C	C
Chthamalus spp.	Barnacle	C	C	C	C	C	C	C	C
Pollicipes spp.	Barnacle							P	
Littorina scutulata	Gastropod	P	C	C	P	C	P	P	P
Limpets unident.	Limpet	P	C	C	P	P	P	P	P
Ostrea conchaphila (native oyster)[2]	Mollusk	P							
Mytilus californianus	Mollusk	P	P	P		P	P	P	
Isopods, unidentified	Isopod								P

Note[1]= Invasive species
Note[2]= Species of concern

Table 3-5. Middle Intertidal Zone flora and fauna along the western shoreline of Yerba Buena Island. (A=abundant, C=common, P=present, R=rare).

Species Name	Common Name	Sample Site							
		YBI-9	YBI-8	YBI-7	YBI-5	YBI-4	YBI-3	YBI-2	YBI-1
FLORA									
Fucus sp.	Brown Algae	A	A		A	A	A	A	C
Ulva spp.	Green Algae	A	A	A	A		A	A	A
Ceramium spp.	Red Algae	P		P					A
Polysiphonia spp.	Red Algae	P		P					A
Endocladia muricata	Red Algae	P		P	P	P	A	P	P
Mastocarpus papillatus	Red Algae	P	C	C	C	C	C	C	C
Mazzaella sp.	Red Algae	C	C	C	C		C	C	C
Porphyra sp.	Red Algae	C	C	C	C	C	A	C	C
FAUNA									
Balanus spp.	Mollusk	P	C	C	P	P	P	P	P
Chthamalus spp.	Mollusk	P	C	C	P	P	P	P	P
Orange encrusting ectoproct	Ectoproct				P				
Watersipora subtorquata[1]	Bryozoan	P			P				
Chitons unidentified	Mollusk						P		
Urosalpinx cinerea[1]	Gastropod				P				
Limpets, unidentified.	Mollusk	P	C	C	P	P	P	C	P
Littorina sp.	Gastropod							C	
Tegula spp.	Gastropod		P				P	P	
Pisaster ochraceus	Echinoderm		P						
Mytilus californianaus	Mollusk						P	P	P
Pachygrapsus crassipes	Crustacean		P						
Ostrea conchaphila (native oyster)[2]	Mollusk	P							

Note[1]= Invasive species
Note[2]= Species of concern

Table 3-6. Low Intertidal Zone flora and fauna along the western shoreline of Yerba Buena Island. (A=abundant, C=common, P=present, R=rare).

Species Name	Common Name	Sample Site							
		YBI-9	YBI-8	YBI-7	YBI-5	YBI-4	YBI-3	YBI-2	YBI-1
FLORA									
Fucus sp.	Brown Algae	P	P						
Sargassum muticum[1]	Brown Algae			P		A	C	P	A
Egregia meanzinni	Brown Algae						A	C	C
Ulva spp.	Green Algae	A	C	C	C	C	P	P	C
Nitophyllum sp.	Red Algae	A	A				A	A	A
Pterosiphonia sp.	Red Algae	A	A				A	A	A
Ceramium spp.	Red Algae	A	A	A	A	A	A	A	
Ahnfeltiopsis sp.	Red Algae		P			P			
Grateloupia setchellii	Red Algae		P			P	P	P	
Polysiphonia spp.	Red Algae		A	A	P	A	A	A	C
Pikea californica	Red Algae	A	A	A	P	P		P	
Dilsea californica	Red Algae	A	A	A	P	P		P	
Mazzaella volans	Red Algae	C	A	A	C	C		C	A
Callophyllis spp.	Red Algae							P	P
Cryptopleura farlowianum	Red Algae		P		P				
Cryptopleura spp.	Red Algae		P		P	P		P	P
Endocladia muricata	Red Algae	A	P	P					
Encrusting coralline algae	Red Algae							P	P
Chondracanthus spp.	Red Algae		P				P		
Gracilaria sp.	Red Algae						P		
Gelidium sp.	Red Algae				P				
Mastocarpus papillatus	Red Algae	A	A	A	C	A	A	A	C
Mazzaella spp.	Red Algae			P	P	P	P	P	A
Microcladia sp. (epiphyte on algae)	Red Algae	P			P	P	P	P	X
Plocamium sp. (epiphyte on algae)	Red Algae	P		P	P	P	P	P	P
Porphyra spp.	Red Algae	A	C	C	C	P	P	P	A
Prionitis sp.	Red Algae			P					
Rhodomynia pacifica	Red Algae			P	C		P	P	P
Juvenile red, unknown	Red Algae	P		P		P			

Species Name	Common Name	Sample Site							
		YBI-9	YBI-8	YBI-7	YBI-5	YBI-4	YBI-3	YBI-2	YBI-1
FAUNA									
Diadumene lineata[1]	Cnidarian						P	P	C
Botryllus schlosseri[1]	Tunicate	P	P					P	
Balanus spp.	Barnacle	P	P	P	P				A
Chthamalus spp.	Barnacle	P	P	P	P				A
Orange encrusting ascidian	Ascidian	P	P			C	C	C	C
Chitons, unident.	Chiton				P	P	P	P	P
Mopalia muscosa	Chiton	P							
Cryptosula pallasiana[1]	Bryozoan	P							P
Watersipora subtorquata[1]	Bryozoan		C	P	C	C	C	C	C
Bugula neritina[1]	Bryozoan					P	P	P	P
Membranipora membranipora	Bryozoan	P	P	P	P	P			
Ectoproct, orange encrusting	Ectoproct	C	C	C	P	C	P	P	C
Hydroid, unidentified	Hydroid								P
Limpets, unidentified	Mollusk	P	P	P	P	P			
Ostrea conchaphila (native oyster)[2]	Mollusk	C	C		P				A
Mytilus californianus	Mollusk	P	P						
Pachygrapsus crassipes	Crustacean		P						A
Polychaete, tube building unidentified	Polychaete								A
Sponge, orange encrusting	Sponge								P
Sponge, pink encrusting	Sponge					P	P		P
Sponge, tan encrusting	Sponge				P	P	P		
Sponge, red encrusting	Sponge							P	P
Tegula funebralis	Gastropod	P	P						P
Urosalpinx cinerea[1]	Gastropod		P		C	C			
Hermit crab	Crustacean				P			P	P
Pisaster ochraceus	Echinoderm			P	P	P			

Note[1]= Invasive species
Note[2]= Species of concern

The invertebrate community inhabiting the Low Intertidal zone along the west side of YBI was observed in much lower abundances than at Treasure Island, primarily because of the lack available surface area to attach to and the general absence of the undersides of rocks which are not utilized by plants for attachment, as present at Treasure Island. The dominant invertebrate taxa were the bryozoan *Waterispora subtorquata* and an orange encrusting Ectoproct (Table 3-6). An orange encrusting ascidian was observed in higher numbers at some locations. Limpets, barnacles, tunicates, sponges, and gastropod snails were also present but in very low numbers and in patchy distribution among the surveyed locations. Native oysters (*O. conchaphila*) were observed but in very low numbers as were the California mussel (*M. californicus*) (Table 3-6). Finally, the predatory sea star, *Pisaster ochraceous*, was observed at several stations.

3.4 Species of Special Concern

One of the objectives of the intertidal survey of both Treasure Island and the west side of Yerba Buena Island was to determine presence of any species of special concern. This included not only protected species or species of ecological importance within the Bay-Delta ecosystem, but the presence of non-native species as well. As presented in Tables 3-1 through 3-6, several species of ecological importance or special concern were observed, specifically native oysters (*Ostrea conchaphila*) and eelgrass (*Zostera* spp.). In addition, there were several non-native invasive species observed.

3.4.1 Eelgrass (Zostera spp.)

Along the more protected eastern side of Treasure Island there exists a fairly extensive eelgrass (*Zostera spp*.) bed that extends approximately 600 meters up from the southeast corner of the island and 8-10 meters offshore to a water depth of several meters. This bed was reported in the 2007 eelgrass inventory of the San Francisco Bay Delta (Merkel and Assoc. 2004). The presence and size of an eelgrass bed is typically directly related to water depth, water turbidity, and light transmission. Eelgrass beds are known to provide important fish habitat for many juvenile species of fish common to San Francisco Bay, especially Pacific herring (*Clupea pallasii*), which use the beds for spawning (Merkel and Assoc. 2005). Eelgrass (*Zostera marina*) is also an important resource to all marine mammals that occur in the Bay as they tend to concentrate food items and provide an ideal place for harbor seals, seas lions and gray whales to feed on schooling fishes during the winter months when herring are in their highest abundance in the Bay (NOAA 2007).

3.4.2 Native Oysters (Ostrea conchaphila)

The reoccurrence of the native or Olympia oyster (*Ostrea conchaphila*) to San Francisco Bay, after being unrecorded for decades, has made this previously key stone species an important success to Bay restoration efforts. Over-harvesting, habitat loss, and degraded water quality all contributed to this species decline in San Francisco Bay and other north Pacific coast estuaries (Couch and Hassler 1989). The native oyster is found both subtidally and intertidally. At Treasure Island it was observed in the lower portion of the Middle Intertidal zone along the east side of the island and extensively throughout the Low Intertidal zone all around the island. The highest abundances were observed in the Low Intertidal zone with densities of live oysters averaging 8-10/m^2 and ranging in size from 1.5-4.0 cm. Densities as high as 16/m^2 were observed in some locations and individuals approaching 5 cm in size were also observed. Empty shells were also widely observed with densities equal to or slightly less than observed live animals. Most live animals were found in close approximation to other live animals and most frequently on the underside of rocks or tucked into protective crevices where predation by Black Oystercatchers (*Haematopus bachmani*) is reduced and reduced exposure to desiccation also occurs.

Native oysters were also observed in the Low Intertidal zone along the western shoreline of Yerba Buena Island, but in much lower abundances and more infrequently than at Treasure Island.

3.4.3 Invasive Species

Several non-native or invasive species were observed inhabiting the intertidal habitat of Treasure Island and the west side of Yerba Buena Island. They include:

- *Sargassum muticum* (Brown Algae)
- *Cryptosula pallasiana* (Bryozoan)
- *Watersipora subtorquata* (Bryozoan)
- *Bugula neritina* (Bryozoan)
- *Urosalpinx cinerea* (Gastropod)
- *Diadumene lineata* (Cnidarian)
- *Diadumene* sp. (Cnidarian)
- *Botryllus schlosseri* (Tunicate)
- *Mytilus trossulus/galloprovincialis* (Mollusk)

Sargassum muticum, *Cryptosula pallasiana,* and *Watersipora subtorquata* were observed in the Low Intertidal zone at both Treasure Island and Yerba Buena Island and *Mytilus trossulus/galloprovincialis* in the Middle and Low Intertidal zones on both islands*. Diadumene lineata and Diadumene sp.* were only observed in the Low Intertidal zone on Treasure Island. Finally*, Urosalpinx cinerea, Botryllus schlosseri, and Bugula neritina* were observed only on Yerba Buena Island in the Middle, Low, and Low Intertidal zones, respectively.

Although some of these invasive species have been in the Bay for centuries, such as *Urosalpinx*, others are recent newcomers (Ray 2005)

3.5 Comparison with Other Studies

The rocky intertidal biota of central and northern California is among the most luxuriant in the world, as a result of a mild temperate climate, cool nutrient rich waters, and highly variable hard substrate habitat that is favorable for colonization (Foster et. al 1988). A brief review and comparison of this studies results with those of several relevant San Francisco Bay and central California coast intertidal characterization studies was conducted to establish a perspective on biological community observations made at Treasure Island and Yerba Buena Island.

Silva (1979) provides a detailed description of the benthic algae of San Francisco Bay and despite name changes for many taxa which have resulted from scientific advances in taxonomic delineation, most notable genetic mapping, and the introduction of new invasive species, his findings remain true. For example, the high intertidal species *Enteromorpha* spp., which is common throughout coastal California, was reclassified as *Ulva*. Updating Silva's Taxonomic characterizations of algal communities inhabiting the High, Middle and Low Intertidal zones at his Yerba Buena Island study site, and comparing them to this studies observations, indicate that the algal communities observed at Treasure Island and Yerba Buena Island are similar to those described by Silva in 1979 and are typical for Central San Francisco Bay (Table 3-7).

Both studies report the High Intertidal zone algal community as consisting of *Fucus, Porphyra, Ulva, and Mastocarpus (Table 3-7).* In the Middle Intertidal zone, the community includes *Microcladia borealis,*

Gelidium coulteri, and *Cryptosiphonia woodii.* In the Low Intertidal zone those species found in both studies consisted of *Egregia menziesii, Pikea californica, Pterosiphonia* sp., *Ahnfeltiopsis* sp., *Polysiphonia* spp., *Callithamnion* sp., *Callophyllis* spp., *Chondracanthus* spp., and *Gracilaria* sp. As noted above, the increased surface area provided by the riprap rocks at Treasure Island resulted in a more diverse algal and invertebrate community that what is typically observed with natural rock substrate, as observed at the Yerba Buena Island study sites in the current study.

Interestingly in 1979 there was only one sighting of the invasive brown algae *Sargassum muticum* by Silva at the Berkeley Wharf. In the current study it was patchy but somewhat widely distributed throughout Treasure Island and Yerba Buena Island in the lower intertidal.

Table 3-7. Comparison of algal communities inhabiting San Francisco Bay intertidal habitats as observed in the current study and as reported by Silva (1979).

Species	Current Study	Silva 1979 (YBI Station)
High Intertidal		
Blidingia minima var. *vexata*		X
Urospora penicilliformis		X
Bangia vermicularis		X
Blidingia minima var. minima		X
Fucus gardneri	X	X
Mastocarpus papillatus	X	X
Porphyra perforata	X	X
Ulva spp.	X	X
Pelvitiopsis sp.	X	
Endocladia muricata	X	
Petalonia fascia	X	
Middle Intertidal		
Callithamnion pikeanum		X
Microcladia borealis	X	X
Cryptosiphonia woodii	X	X
Gelidium coulteri	X	X
Fucus sp.	X	
Ulva spp.	X	
Pikea californica	X	
Dilsea californica	X	
Ceramium spp.	X	
Polysiphonia spp.	X	
Diatom mat, unident.	X	
Endocladia muricata	X	
Mastocarpus papillatus	X	
Mazzaella sp.	X	
Porphyra sp.	X	
Low Intertidal		
Egregia menziesii	X	X
Gymnogongrus chiton		X
Ahnfeltiopsis leptophylla		X

Species	Current Study	Silva 1979 (YBI Station)
Halymenia schizymenioides		X
Pikea californica	X	X
Psammophyllum californicum		X
Tiffaniella snyderae		X
Cryptopleura violacea		X
Chondrocanthus exasperatus		X
Gracilaria sjoestedtii		X
Antithamnionella glandulifera		X
Platythamnion villosum		X
Polyneura latissirna		X
Polysiphonia paniculata		X
Pterosiphonia dendroidea		X
Fucus sp.	X	
Ulva spp.	X	
Nitophyllum sp.	X	
Pterosiphonia sp.	X	X
Ceramium spp.	X	
Ahnfeltiopsis sp.	X	X
Grateloupia setchellii	X	
Polysiphonia spp.	X	X
Dilsea californica	X	
Callithamnion sp.	X	X
Mazzaella volans	X	
Callophyllis spp.	X	X
Cryptopleura farlowianum	X	
Cryptopleura spp.	X	
Diatom mat, unident.	X	
Endocladia muricata	X	
Encrusting coralline algae	X	
Chondracanthus spp.	X	X
Gracilaria sp.	X	X
Gelidium sp.	X	
Mastocarpus papillatus	X	
Mazzaella spp.	X	
Microcladia sp.	X	
Plocamium sp.	X	
Porphyra spp.	X	
Prionitis sp.	X	
Rhodomynia pacifica	X	
Sargassum muticum	X	
Zostera spp.	X	

A second study by Foster *et. al.* (1988) presents findings of six rocky intertidal studies along the central California coast conducted between 1967 and 1985. Although these studies were of open coast intertidal communities, as indicated in the discussions above, the close proximity of Treasure Island to the Golden Gate and Pacific Ocean water, which flow through Central San Francisco Bay daily, will result in many commonalities in intertidal biota and communities.

The studies reported by Foster *et. al.* characterized the algal and invertebrate community in the High Intertidal zone as containing gastropods (*Littorina* and *Tegula)*, barnacles (*Balanus*, *Chthmalus*, *Tetraclina*), the algae, *Porphyra, Cladophora*, and *Ulva*, the isopod, *Ligia*, and the crab *Pachygraspus*. In the Middle Intertidal Zone, key invertebrate taxa included barnacles (*Pollicpes*, *Balanus*, and *Chthalamus*), mussels (*Mytilus*), gastropods (*Nucella*, *Thais*, and *Tegula*), chitons (*Nuttallina* and *Klatharina*), limpets (*Lottia*, *Collisella*), and the sea star *Pisaster ocracheus*. In the Low Intertidal zone, key taxa included assorted brown algae including *Egregia*, chitons, including *Mopalia*, sea stars, sponges, bryozoans, and tunicates (Foster *et. al* 1988). The intertidal community taxa reported by the studies presented in Foster *et. al.* are similar and consistent with the taxa observed inhabiting both Treasure Island and the western shoreline of Yerba Buena Island that are known to inhabit intertidal areas with similar ecological conditions. Also, the increased and often protected surface area presented by the rocky riprap on Treasure Island provides additional habitat for increased taxonomic diversity than typically observed on natural rocky habitat and as observed in the current study at Yerba Buena Island.

4.0 Discussion of Observations

The shoreline and associated intertidal areas of Treasure Island and the west side of Yerba Buena Island contain extensive hard substrate habitat that is inhabited by a diverse community of algal and invertebrate taxa. The shoreline and intertidal zones of Treasure island consists almost entirely of quarried rock riprap in contrast to the natural exposed shelf, boulders, and pocket beaches along the west side of Yerba Buena Island. The riprap on Treasure Island provides additional surface area on the underside of rocks and in the crevices created between the piled rocks that provide additional habitat for a more diverse invertebrate community. The north and west sides of Treasure Island appear to be exposed to higher wind waves than the east and south sides of the Island as corroborated by the higher and steeper sloped riprap along those sides of the island and the increased vertical zonation in the Middle and High Intertidal zones.

The invertebrate and algal taxa observed inhabiting the High, Middle, and Low Intertidal zones of both islands are consistent with communities reported inhabiting the central California coast rocky intertidal areas and within Central San Francisco Bay (Silva, 1979, Rickets 1985, Foster *et. al* 1988). There was an observed shift in floral composition as you transited from the west to the north and then to the south concurrent with a comparable shift from more exposed to more protected intertidal zones occurred. This floral shift was characterized by the rockweed species *Fucus* and *Pelvetia* which were observed to be more common in the High Intertidal zone on the west side of the island and were more common in the Middle and Low Intertidal zones on the east and south sides of the Island. Similarly there was a shift in mussel species with California mussels (*M. californianus*) being replaced by the Bay mussel (*M. trossulus/ galloprovincialis)* on the east and south sides. The one exception appears to be the east side of the isthmus where the mussel *M. californianus* was observed in the Middle Intertidal zone along with *M. trossulus/galloprovincialis* in the Low Intertidal Zone. This latter observation suggests that wind fetch may push water spray into the High Intertidal zone in this location. Eelgrass (*Zostera*) was also only found on the more protected east side of the island.

Although both the west side of Yerba Buena Island and Treasure Island contain similar floral and faunal taxa in the High, Middle, and Low Intertidal zones, there were some subtle differences between Treasure Island and Yerba Buena Island. The most obvious is that Yerba Buena Island is composed of natural rocky shelf outcropping, boulders, and pocket beaches, which is representative of typical substrates for most of coastal central California. Overall the species composition was similar with slight changes in distribution and abundance of certain species. It appeared that the overall determining physical factor for these observations was the availability or lack of bare space to occupy. On the west side of Yerba Buena

Island there was very little evidence of sedimentation on the rocky substrate and almost all bare space was covered with flora or fauna. This is in contrast to the observed fine sedimentation on the boulders and rocks in the Lower Intertidal zone along the east and south sides of Treasure Island. Some sedimentation on the rocks was observed along the north and west sides of Treasure Island but to a much lesser extent.

The invertebrate and algal communities observed inhabiting the intertidal zones of both Treasure Island and the west side of Yerba Buena Island include non-native invasive species and species of special concern. An extensive eelgrass (*Zostera*) bed was observed along most of the east side of Treasure Island and the native oyster (*Ostrea conchaphila*) was observed along the entire shoreline of Treasure Island and on Yerba Buena Island. Oyster densities were observed to be higher along the west and north sides of the Island than on the siltier east and south sides. The oysters observed along the west and north sides of the island also appeared to be larger in size than those observed on the east and south sides of the island and the ratio of live to dead oysters was also higher. All of the non-native invasive species observed have been previously reported and did not appear to occur in abundances greater than observed or reported for other locations in San Francisco Bay.

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