STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER QUALITY, OCEAN UNIT
P.O. BOX 100
SACRAMENTO, CA 95812-0100

INITIAL STUDY

Background

Project Title: Exception to the California Ocean Plan for the University of California, Davis Bodega Marine Laboratory Discharge into the Bodega Area of Special Biological Significance

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Introduction

The State Water Resources Control Board (State Water Board), under its Resolution No. 74-28, designated certain Areas of Special Biological Significance (ASBS) in the adoption of water quality control plans for the control of wastes discharged to ocean waters. To date, thirty-four coastal and offshore island sites have been designated ASBS. Among the ASBS designated was the Bodega Marine Life Refuge ASBS. The State Water Board changed the name of this ASBS in April 2005 to the Bodega ASBS (Resolution 2005-0035).

Since 1983, the California Ocean Plan (Ocean Plan) has prohibited waste discharges to ASBS (SWRCB 1983). Similar to previous versions of the Ocean Plan, the 2005 Ocean Plan (SWRCB 2005) states: "Waste shall not be discharged to areas designated as being of special biological significance. Discharges shall be located a sufficient distance from such designated areas to assure maintenance of natural water quality conditions in these areas."

The Bodega ASBS was included in this designation for the following reasons: (1). It has a diversity of habitat and biological assemblages; (2). Bodega Head is the northern-most exposure of granitic rock along the California coast; (3). It is a transition zone between temperate zone species and typically boreal fauna; and (4). It is designated "type" locality for several newly described marine species circa the date of designation (SWRCB 1979).

Assembly Bill 2800 (Chapter 385, Statutes of 2000), the Marine Managed Areas Improvement Act, was approved by the Governor on September 8, 2000. This law added sections to the Public Resources Code (PRC) that are relevant to ASBS. Section 36700(f) of the PRC defines a State Water Quality Protection Area (SWQPA) as "a nonterrestrial marine or estuarine area designated to protect marine species or biological communities from an undesirable alteration in natural water quality, including, but not limited to, areas of special biological significance that have been designated by the State Water Board through its water quality control planning process." Section 36710(f) of the PRC stated: "In a state water quality protection area, point source waste and thermal discharges shall be prohibited or limited by special conditions. Nonpoint source pollution shall be controlled to the extent practicable. No other use is restricted." The classification of ASBS as SWQPAs went into effect on January 1, 2003 (without Board action) pursuant to Section 36750 of the PRC (SWRCB 1979).

Senate Bill (SB) 512 (Chapter 854, Statutes of 2004) amended the marine managed areas portion of the PRC, effective January 1, 2005, to clarify that ASBS are a subset of SWQPAs and require special protection as determined by the State Water Board pursuant to the Ocean Plan and the California Thermal Plan (Thermal Plan). Specifically, SB 512 amended the PRC section 36700 (f) definition of SWQPA to add the following: "Areas of special biological significance are a subset of state water quality protection areas, and require special protection as determined by the State Water Board pursuant to the

California Ocean Plan adopted and reviewed pursuant to Article 4 (commencing with Section 13160) of Chapter 3 of Division 7 of the Water Code and pursuant to the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (California Thermal Plan) adopted by the State Board."

Section 36710(f) of the PRC was also amended as follows: "In a State Water Quality Protection Area, waste discharges shall be prohibited or limited by the imposition of special conditions in accordance with the Porter-Cologne Water Quality Control Act (Division 7 (commencing with Section 13000) of the Water Code) and implementing regulations, including, but not limited to, the California Ocean Plan adopted and reviewed pursuant to Article 4 (commencing with Section 13160) of Chapter 3 of Division 7 of the Water Code and the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (California Thermal Plan) adopted by the state board. No other use is restricted." This language replaced the prior wording stating that point sources into ASBS must be prohibited or limited by special conditions, and that nonpoint sources must be controlled to the extent practicable. In other words, the absolute discharge prohibition in the Ocean Plan stands, unless of course an exception is granted. The classification of ASBS as a subset of SWQPAs does not change the ASBS designated use for these areas. Practically speaking, this means that waste discharges to ASBS are prohibited under the Ocean Plan and Thermal Plan unless an exception is granted. The terms and conditions in the mitigated negative declaration and in this initial study are special protections recommended by staff for the Bodega ASBS, and constitute the special conditions referred to in Section 36710(f) of the PRC.

The prime use of the Project Area is for scientific study initiated largely out of the Bodega Marine Laboratory (BML) of the University of California, Davis (UCD). Numerous field courses and special studies are carried out in the area.

The BML was originally regulated under Waste Discharge Requirements (WDR) Order No. 75-88 issued by the North Coast Regional Water Quality Control Board (North Coast Water Board). The North Coast Water Board renewed the permit in WDR Order No.'s 78-162, 84-35, 89-11, and 94-102 (RWQCB 2000). WDR Order No. 94-102 expired in 1999. UCD/BML submitted a Report of Waste Discharge February 9, 1999, and applied for renewal of its Permit to discharge circulated seawater under the National Pollutant Discharge Elimination System (NPDES) from the BML. On March 23, 2000, the North Coast Water Board issued WDR Order No. R1-2000-23 (NPDES Permit # CA0024333). An application for renewal of the permit, including a Report of Waste Discharge in accordance with Title 23, California Code of Regulations, was required to be received by the Regional Water Board no later than September 23, 2004 [40 CFR 122.41 (b)] (RWQCB 2000). The State Water Board sent a letter on October 18, 2004 informing UCD/BML that its discharges into the ASBS are subject to the waste discharge prohibition. That letter gave a deadline of February 1, 2005 for UCD/BML to submit an exception application. The North Coast Water Board received UCD/BML's application on January 31, 2005 (RWQCB 2000). The permit expired on March 23, 2005. However, the North Coast Water Board may not issue a new NPDES permit unless the State Water Board issues an exception from the Ocean Plan's prohibition of waste discharges into an ASBS.

Section III (I)(1) of the 2005 Ocean Plan states: "The State Board may, in compliance with the California Environmental Quality Act, subsequent to a public hearing, and with the concurrence of the U.S. Environmental Protection Agency, grant exceptions where the Board determines: a. The exception will not compromise protection of ocean waters for beneficial uses, and, b. The public interest will be served."

Project Description

UCD/BML seeks an exception from the Ocean Plan's prohibition on discharges into ASBS. The exception with conditions, if approved, would allow their continued waste seawater and storm water discharge into the Bodega ASBS. This would provide additional protections for beneficial uses that are not currently provided.

Environmental Setting

Physical Description

Bodega Marine Reserve (BMR), and the terrestrial portion of the 362-acres surrounding the Bodega Marine Laboratory, provides a protected area for research and education. The habitats of BMR are remarkably diverse for such a small area. Subtidal, rocky intertidal, mudflat, sandy beach, fresh and saltwater marsh, coastal grassland and dune communities are all within walking distance. The site is well known for the strength of wind-driven coastal upwelling and the complex geology of the San Andreas Fault. The BMR is part of the UC Natural Reserve System, a network of 36 field stations throughout the State.

BMR includes all of the 326 acre UC property except for two development enclaves in the immediate vicinities of existing laboratory and dormitory buildings. The adjoining Bodega State Marine Reserve (BSMR) (formerly Bodega Marine Life Refuge) and leased tidelands in Bodega Harbor are managed as part of the BMR, adding important intertidal and subtidal habitats. The Bodega ASBS boundaries and those of BSMR are almost identical, and overlap. BSMR boundary extends slightly north. A 20-acre section of adjacent State Park lands support a representative California native dune scrub community and is set aside for BMR research use.

Seasonal marker buoys and moorings were deployed in 2005 to begin delineating the boundaries of the BSMR, which is a no-take zone, extending 1000 feet offshore alongside the BMR. These seasonal buoys are lifted before the winter storms each year and redeployed the following spring. They serve to help inform fishing boats of the location of Refuge boundaries.

Location and Size

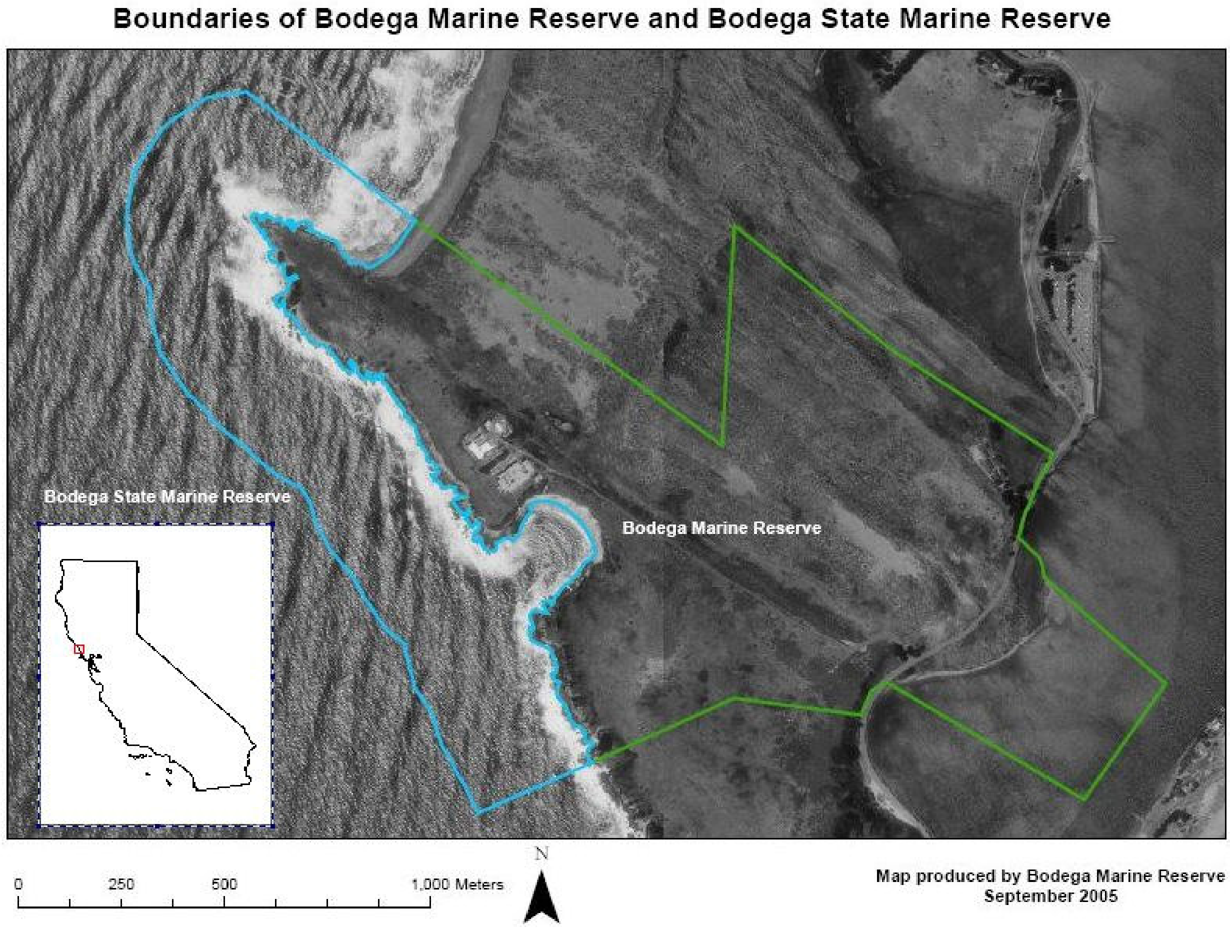
The Bodega Area of Special Biological Significance (ASBS) is located adjacent to Bodega Head (38^{o}19' north latitude, 123^{o}04' west longitude), approximately 1.7 mi. (2.8 km) from the town of Bodega Bay, in Sonoma County, California (see figure 1). The ASBS includes the coastline from 462 yards (420 m) south of Horseshoe Cove to 264 yards (240 m) northeast of Mussel Point (SWRCB 1979). Approximately 150 acres (61 ha) of water area are contained in the 1.6 mi. (2.6 km) stretch of shoreline that comprises the ASBS. The Bodega Head ASBS shoreline constitutes about 0.10percent of California's entire shoreline.

The official boundary description, as stated in the California State Water Resources Control Board publication Areas of Special Biological Significance (June, 2003), is as follows:

> "Ocean waters within that portion of District 10 consisting of that certain parcel of land bounded by the line of mean high tide of the Pacific Ocean lying between the northern boundary extended northwesterly and the southern boundary extended southwesterly of the lands of the Regents of the University of California according to the final order of condemnation in Case No. 47,617 in the Superior Court of the State of California in and for the County of Sonoma, recorded in Book 1930, at pages 656 and 659, inclusive, Office Records, Sonoma County, California, and extending into and including the state waters of the State of California for a distance of 1000 feet into the Pacific Ocean from the line of mean high tide. "

Bodega Head is mainly a granitic peninsula approximately 1.9 mi. (3.1 km) long and 0.5 mi. (0.8 km) wide. It is connected to the mainland by a dune-covered stretch of land that marks the zone of the San Andreas Fault. The fault zone in this area is 1.5 mi. (2.4 km) wide. Although lateral movement of 7 to 10 ft. (2 to 3 m) occurred in the area as a result of the 1906 San Francisco Earthquake, relatively little movement has been detected along this portion of the fault zone within the past 70 years (SWRCB 1979).

Figure 1. Boundary Description



Bodega ASBS boundary is outlined in blue. UCD/BML Bodega Marine Reserve is outlined in green.

Habitats

BMR is located on the Sonoma County coast 60 miles north of San Francisco (see figure 1). Part of the University of California's Natural Reserve System and the site of BML, this 362-acre research and teaching reserve include a rich mix of coastal habitats protected for long-term studies. Rocky intertidal areas are within 100 meters of the Laboratory buildings and extend over 2 km along the BMR boundaries. Other intertidal habitats on the BMR include protected and exposed sandy beaches, extensive lagoon mudflats and sandflats, and tidal saltmarshes.

Terrestrial

BMR terrestrial habitats include sand dunes, coastal bluffs, coastal prairie/coastal scrub and freshwater wetlands. Plant communities, soils and microclimates vary sharply over relatively small distances on the BMR because of a variety of geological factors associated with the BMR's contact with the Pacific Ocean and the San Andreas Fault Zone. To protect long-term field research sites from external disturbances, the BMR is fenced and posted to limit unauthorized access. However, public hiking and recreation are available in adjacent State Park areas. Researchers wishing to access BMR are required to contact the BMR Manager.

Coastal Prairie/Coastal Scrub
Over much of the BMR uplands, coastal grasslands merge with areas dominated by the yellow bush lupine, *Lupinus arboreus*. Grasslands vary from areas with a diverse native flora to patches of weedy invasive species. These systems have been the focus of numerous studies, many continuing, of plant-insect interactions and plant community dynamics on the BMR.

Coastal Bluffs
The bluff tops of the BMR support a mainly native plant community with many colorful wildflowers. To maintain the high native biodiversity, BMR staff actively control invasive species such as the South African iceplants (*Carpobrotus* spp.).

Sand Dunes
The BMR dunes are largely covered with yellow bush lupine and the introduced dune grass, *Ammophila arenaria*, planted in the 1920s-1950s to stabilize actively blowing dunes. Some areas, however, still support a mostly native dune scrub community, with *Lupinus chamissonis* and *Ericameria ericoides* as the dominant shrubs, surrounded by a rich mixture of grasses and forbs. BMR has an agreement with State Parks for researcher access to a 20-acre area of native dune adjacent to the BMR.

Marine Habitat

Adjoining the terrestrial BMR is the Bodega ASBS and Bodega State Marine Reserve (BSMR). The BSMR is a fully protected no-take reserve extending 1000 feet offshore, established by the state legislature and managed by the California Department of Fish and Game (DFG) and UCD/BML. Located in the southern portion of one of the most significant upwelling systems in the world, these marine waters add intertidal and subtidal habitats remarkable for their diversity and abundance of flora and fauna, creating excellent opportunities for underwater research. The Bodega BSMR boundaries are north of the National Oceanic and Atmospheric Administration (NOAA) Gulf of the Farallones National Marine Sanctuary.

Rocky Intertidal Coast
UCD/BML laboratory facilities are located adjacent to Horseshoe Cove and the outer coast. An almost continuous shoreline bench of dioritic granite, most of it exposed to the pounding waves characteristic of the Sonoma coast, supports a diverse community of marine algae and invertebrates. Numerous tidepools and adjacent waters harbor a rich array of fish species, and shorebirds forage on the rocks and in extensive mussel beds during low tides.

Sandy Beach
Two beaches border the BMR. Horseshoe Cove is a small pocket beach near the Laboratory, partly protected by the Cove shorelines. Salmon Creek State Beach is a 4 km stretch of exposed sandy beach from north of the BMR boundary and Mussel Point to Salmon Creek. This area is also available for field research.

Saltmarsh
An unusually diverse saltmarsh community occupies the high intertidal zone bordering the BMR sandflats. Several native saltmarsh plants of limited distribution occur there. Another marsh, more brackish in nature, occurs at the lower edge of the freshwater wetlands near the BML Housing. Swamp sparrows and rails can be seen there in December and January (MAS 1997).

Mudflats and Sandflats
UCD/BML leases approximately 90 acres of the nearby Bodega Harbor intertidal flats, with a third of the area closed to the public to protect research sites. Thousands of migrant shorebirds winter at Bodega Bay each year, attracted by the wide range of benthic invertebrates living in these soft sediments (UCD/BML 2006).

In August, Elegant, Forsters, and Caspian Terns may be seen flying or loafing within the harbor. In September, migrating shorebirds arrive. In November, Eurasian Wigeon can be found in the harbor. Emperor Goose and Steller's Eider can also be found. Late in November, Rough-legged and

Ferruginous Hawks may be seen. In July, non-breeding loons, Willets, Marbled Godwits, and occasional early migrating phalaropes, are found in the mudflats of the harbor. Also in July, early migrating shorebirds, such as Semipalmated Plovers, Black and Ruddy Turnstones, and pelicans, especially 'White' on UCD/BML mudflats. Baird, Buff-breasted, and other species of Sandpipers arrive at the mudflats in late August. Migratory birds arrive in the mudflats in September and leave in March and April for migration (MAS 1997).

Freshwater Wetlands

Small, seasonal or permanent, freshwater wetlands occur at many sites within the dunes on the BMR. A wetland grades from fresh to brackish near BML Housing.

Climate

The climate of the Bodega Head area is considered to be cool Mediterranean, typified by cool, wet winters and dry, foggy summers (SWRCB 1979). September is usually the warmest month, with a mean temperature of 55.9°F (13.3°C). December and January are usually the coldest months with the mean temperature of 48.5°F (9.2°C). Annual temperatures generally range from 41.4°F to 64.6°F (5.2°C to 18.1°C) (UCD/BML 2007). Snow and frost occur infrequently. Fog is seasonal, occurring on approximately 10 percent of the winter days and 80 percent of the summer days (SWRCB 1979).

Rainfall between 1967 and 2003 averaged 33.5 inches (85 cm) per year; over 90percent of the precipitation between 1967 and 2003 occurred between October and April. The wettest winters in the past forty years occurred during 1982-83 (55 in/140 cm), 1994-95 (65 in/165 cm), 1995-96 (49 in/124.5 cm), and 1997-1998 (73 in/185 cm) (See Appendix A). Each of these noted periods of time coincided with strong El Nino Southern Oscillation (ENSO) events (NOAA 2006).

Geological Setting

Submarine Topography

Granitic rock accounts for an estimated 80percent of the subtidal substrate in the entire area. Unstable, homogenous sandy areas and sand-filled channels account for the remaining 20percent of the subtidal substrate. The rock-to-sand ratio for intertidal areas is estimated at 9 to 1 (SWRCB 1979).

Except for the surge channels, the bottom topography near Horseshoe Cove is fairly uniform. It appears that this area, to at least 1,000 ft. (300 m) offshore, was terraced by wave action during a lower stand of sea level. Vertical topographical relief in the area is usually on the order of 3 to 7 ft. (1 to 2 m). The intertidal and subtidal topography near the northern portion of the ASBS (west of Mussel Point) is much more rugged than the area near the cove in the northern portion, well-defined, wave-cut features are not as evident. Subtidal topography west of Mussel Point consists of ridges and channels that often have 10 to 15 ft. (3 to 5 m) of vertical relief. The lack of wave-cut features in this area suggests that this portion of Bodega Head may be tectonically more active than the area near Horseshoe Cove.

The intertidal and subtidal substrate of the section of Salmon Creek each included in the ASBS has been mapped as fine sand. Sand distribution in the area appears to be in a continual state of flux. Maximum sand abundance on Horseshoe Cove beach and in shallow subtidal areas normally occurs during the months of July and August; minimum sand cover usually occurs in January or February. The annual deposition/erosion cycle in the shallow subtidal areas of Horseshoe Cove usually shows a variation of 3 to 5 ft. (1.0 to 1.5 m) in sand height. Superimposed on the annual cycle are minor, short-term fluctuations in sand height that generally range from 12 to 28 inches (0.3 to 0.7 m). The short-term fluctuations may be due to several factors such as local swell intensity, and direction of swell, and tidal range. These short-term sand movements, together with periodic annual movements, markedly affect the nature and degree of exposed subtidal and intertidal substrate (SWRCB 1979).

Above Shoreline Land Mass

The mainland adjacent to Bodega Head is composed of sandstone, shale, chert and conglomerate of the Franciscan Formation. These rocks form part of the Coast Range foothills and rise to an elevation of approximately 700 ft. (213 m) in the area near Bodega Bay. Portions of these foothills are developed as sites for single-family residences (Robinson 1996). The undeveloped sections support coastal grasslands and are grazed by livestock.

The granitic rock of Bodega Head is quartz diorite (granodiorite) and intrusive igneous rock composed largely of plagioclase feldspar, quartz, hornblende and biotite. In composition and appearance, the granodiorite of Bodega Head is similar to the granitic rocks of Point Reyes, Tomales Point, and the Farallon Islands. These rocks are all considered to be part of the Coast Range Batholith and have been potassium/argon dated at 80 to 90 million years old. Structurally, Bodega Head appears to be an extension of the Point Reyes granitic block and represents the northern-most exposure of granitic rock, west of the San Andreas Fault, along the California coastline. The granodiorite of Bodega Head is highly sheared and faulted, cut by two major sets of joints and intruded by pegmatite, aplte, and lamprophyre dikes. The maximum elevation of Bodega Head, 266 feet (81 m), is located near the southern limit of the ASBS.

Quaternary marine terraces overlie portions of the Bodega Head granodiorite. These deposits consist of sands, silts, gravels and minor amounts of clay. The Quaternary deposits are considered to have been laid down on a shallow submarine surface, and the thickest sedimentary exposure on the Head measures about 128 ft. (39 m).

Horseshoe Cove is one of the more prominent features of the Bodega Head Peninsula. The cove marks an area where the granitic basement rocks have been breached. The occurrence of a major zone of weakness, produced by faulting and jointing, may offer one explanation as to the origin of breaching in this area.

The northwest and southeast sides of Horseshoe Cove consist of granitic rocks that have been partially terraced by wave activity. The northeast end of the cove terminates as a sandy pocket beach, which is bounded by a 10 to 16 ft. (3 to 5 m) high cliff of slightly tilted Quaternary marine sediments. The sand of the pocket beach is a bimodal mixture of a coarse-grained fraction (-0.77 phi), derived from the granitic rocks of the Head, and a fine-grained fraction (2.52 phi), derived from mainland Franciscan material. The cove is approximately 460 ft. (140 m) wide and reaches a maximum depth of 30 ft. (9 m) near its mouth on the southeast side. Portions of the bottom of the inner cove area are entirely sandy, while the remaining inner areas and the central and outer areas of the cove are floored by granitic rock and occasional sand patches.

Numerous surge channels which predominately follow the major trends of jointing dissect the intertidal and subtidal granitic rock of the ASBS. Surge channels in intertidal and shallow subtidal areas at depths up to 15 ft. (5 m) are commonly floored with either medium to coarse-grained sand or granitic cobbles. A fine to medium-grained sand usually floors the surge channels and larger joints in the deeper offshore areas where depths range from 15 to 40 ft. (5 to 13 m) (SWRCB 1979).

Oceanographic Conditions and Marine Water Quality

Currents

Bodega Head is subjected to intense wave activity. The average daily wave height for the area is approximately 8.2 ft. (2.5 m). During periods of winter storm activity, waves with heights of 16 to 23 ft. (5 to 7 m) are not uncommon, and waves up to 33 ft. (10 m) high have been observed occasionally in the area (SWRCB 1979). Significant wave heights average between 1 and 2.5 meters in the months of July through September and between 1.5 and 4 meters in the months of December through March (NOAA 2005). The presence of a subtidal sill across the mouth of Horseshoe Cove at about 20 ft. (6m) depth tends to reduce the intensity of wave action in the cove. Waves, however, do enter the cove and are frequently 5 to 7 ft. (1.5 to 2.0 m) high. Wave activity is usually more pronounced on the northwest side of the cove.

Seventy five percent (75 percent) of the swells in the Bodega Head area approach from a northwest or west-northwest direction and have periods of 8 to 12 seconds. Waves with a 10 second period generally have deep-water wavelengths of 260 ft. (80 m) and subsequently begin to feel wavebase at depths of approximately 100 ft. (30 m). Thus, bottom material 1100 yards (1000 m) offshore may be affected by the majority of waves striking Bodega Head (SWRCB 1979). Average wave periods vary between 5 and 7.5 second in the months of June through August and between 6.25 and 10.25 seconds in the months of December through February. Dominant wave periods average between 5.5 and 12.5 seconds in the months of June through August and between 9.5 and 16.5 seconds in the months of December through February (NOAA 2005). Winds in the area are generally out of the northwest and average 8 to 10 miles per hour (mph). Storm-induced winds normally approach from the southwest or southeast and commonly have velocities of 40 mph.

Because of the prominent wave and wind activity, the water in the ASBS is normally very turbid. Visibility (measured in a vertical direction) is usually only 3 to 7 ft. (1 to 2 m). Days when the visibility may reach 33 to 39 ft. (10 to 12 m) are rare and generally occur during fall months.

The prevailing current direction along Bodega Head is from north to south. Coastal current velocities and directions are largely influenced by local wave activity. A northward-flowing longshore current may also exist off Bodega Head. Longshore current velocities are usually in the range of 0.25 to 1.0 knots. Depending upon the size and direction of swell, localized gyres may develop off certain areas of Horseshoe Cove. The Davidson Current, a northward-flowing, relatively warm, low-salinity current, is usually evident off this area during the fall months of October and November (SWRCB 1979). Equator-directed flow dominates, especially over the shelf edge, during periods of upwelling-favorable winds. Poleward flow is substantial over the inner- and mid-shelf during periods of wind reduction (Kaplan et al. 2006).

Water Quality and Temperature

The seawater of the area can be characterized as a coastal water mass in a transitional area. The coastal water is apparently influenced by the subarctic Pacific and Eastern North Pacific Central water masses, which are carried into the area by the southward flowing California current. Salinities in the area are generally constant and range from 33 percent to 34 percent throughout the year. Periods of maximum temperature generally occur during the months of August and September (SWRCB 1979), averaging between 12 and 13^{O}C (see Appendix B) (NOAA 2005).

Air and sea temperature fluctuations follow similar trends throughout the year (NOAA 2005). Periods of minimum temperature occur during March, April or May, depending upon the occurrence of localized upwelling. Upwelling in the area results from strong northwest or northeast winds, which displace coastal surface water offshore and drive deeper, cold, nutrient-rich water to the surface.

Water quality is generally good in the vicinity of Bodega Head. The closest stream is Salmon Creek, which discharges about two miles from the northern boundary of the ASBS. There is agricultural land use within the Salmon Creek watershed, and Highway One crosses the creek about a half-mile upstream from the coast. Citizen-based habitat restoration and water quality monitoring have been taking place in

Salmon Creek for the past several years (Bleifuss, bodeganet.com). While Salmon Creek may carry some amount of anthropogenic wastes it is generally considered to have good water quality.

Bodega Bay discharges to the ocean one mile from the southern boundary of the ASBS. Bodega Bay is a harbor and vessel wastes are associated with harbor waters. There are runoff contributions from local land uses as well. In addition it is 303(d) listed for exotic species. It is possible that at times tidal flushing from Bodega Bay may contribute some wastes into the ASBS.

About four miles from the southern ASBS boundary is another 303(d) listed water body, Estero Americano, which includes Americano Creek and its estuary. Nutrient loading occurs through riparian and upland pasture and range grazing, intensive animal feeding operations, and manure lagoons. Sedimentation and siltation occurs through riparian range grazing, hydromodification, removal of riparian vegetation, streambank modification/destabilization, erosion, and nonpoint sources. The mouth of Tomales Bay, which is also under 303(d) listing, is located about six miles from the southern boundary of the ASBS. It is impaired for mercury, nutrients, and sedimentation/siltation. Again, tidal flushing may allow pollutants into near coastal ocean waters which may be transported into the ASBS, but if so, likely at very low or non-detectable levels.

The mouth of San Francisco Bay is located about 46 miles from the southern boundary of the ASBS. The bay contains a variety of identified pollutants such as chlordane, DDT, dieldrin, dioxin compounds, exotic species, furan compounds, mercury, polycholorinated biphenyls (PCBs), and selenium. (2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments).

The closest permitted point source, located near Estero Americano, is Bodega Bay Fish Farm, which historically discharged about 6.5 mgd of aquaculture waste. The facility is currently operating at a much reduced mode (J.Short 2007). The majority of aquaculture wastes are biodegradable but there is the possibility of chemical treatments and inadvertent exotic species releases.

The closest wastewater treatment facility is the Mendocino County Wastewater District. It is located about 44 miles away from the northern boundary of the ASBS and discharges about 0.0196 mgd of treated sanitary wastewater. The City and County of San Francisco Oceanside Waste Water Treatment Plant (WWTP) outfall, located about 50 miles from the southern ASBS border, is a combined outfall discharging sewage and storm water and is a significant potential source of wastes into the marine water outside of San Francisco Bay. The North San Mateo WWTP outfall is located less than four miles from the Oceanside WWTP. Because of their distance from the ASBS and the direction of the currents along the coast (see above section), it is unlikely that these sewage plant outfalls contribute significant waste loading to the Bodega Headland area.

California's Mussel Watch Program, in operation since 1977, has had a monitoring station in place at Bodega Head. This data set is presented in Appendix H for the years 1997 through 1999. Measurements for the suite of Ocean Plan metals are included along with chlorinated pesticides and DDT. Mussel Watch Data is considered to be the best source of consistent information to document trends in contaminants such as heavy metals, and to study environmental degradation within the aquatic environment and track trends in local contamination levels.

Mussel Watch Data results are represented in parts per million (ppm) wet weight and are calculated as elevated data levels (EDL). The EDL is calculated by ranking all of the results for a species and a given chemical using a set of data. A cumulative distribution in constructed and percentiles are calculated. The 85^{th} percentile (EDL 85) may be used as an indication that a chemical is elevated and the 95^{th} percentile (EDL 95) may be used as an indication that the data is highly elevated.

At Bodega Head ASBS station, results for four metals (cadmium, mercury, copper, selenium), at times indicated elevated levels above the EDL 85. Of the 36 metals analyses performed, 16 results for cadmium and two results for copper, nickel, mercury, and selenium were above the EDL 95 during the period 1986 to 1999.

Substrate

Subtidal Substrate

The subtidal area is exposed to large swell and disturbance, which creates large ripples and grain size in the sandy patches surrounding the patchy reefs (Maloney 2006). Granitic rock accounts for an estimated 80 percent of the subtidal substrate in the entire area. Unstable, homogeneous sandy areas and sand-filled channels account for the remaining 20percent of the subtidal substrate. The rock-to-sand ratio for intertidal areas is estimated at 9 to 1 (SWRCB 1979).

Intertidal Substrate

The intertidal region of the ASBS has primarily rocky substrate. The rocky intertidal zone consists almost entirely of a weathered quartz diorite (i.e. decomposed granite). The exceptions to this are the sandy beaches at the head of Horseshoe Cove and the several hundred feet of Salmon Creek Beach included within the ASBS. The sediment of the sandy beach of Horseshoe Cove is of larger grain size than that of Salmon Creek Beach (SWRCB 1979). The rocky shores within Horseshoe Cove, especially the north shore, experience waves of slightly less intensity due to the orientation of the cove; at Mussel Point, wave intensity is decreased due to the presence of some offshore rocks.

It is not uncommon during the winter for spray to break over the crests of the bluffs facing the ocean, or for chunks of the cliff at the head of Horseshoe Cove to collapse due to erosion caused by wave battering. Although qualitative differences in wave intensity between the outer coast and the shore of Horseshoe Cove are apparent, there are no substantial differences between the flora and fauna of these two regions of the ASBS. Through geological time, waves have cut away the cliffs near sea level, producing an intertidal shelf region of variable width. These platforms are found along the entire frontage of the ASBS (SWRCB 1979).

When Moss Landing Marine Lab conducted their recent underwater survey in 2004, it was noted that the beach at Horseshoe Cove was steep and that the high zone of the beach had a well-defined wrack line with abundant hopper holes, flies, and other insects (Maloney 2006). The rocky shores within Horseshoe Cove, especially the north shore, experience waves of slightly less intensity due to the orientation of the cove (SWRCB 1979), but depending on swell direction is still fairly exposed to waves (Maloney 2006). Mussel Point wave intensity is decreased due to the presence of some offshore rocks (SWRCB 1979).

Biological Resources of the ASBS

ASBS Intertidal Biota

Algae
A rich algal flora characterizes (Appendix C) the Bodega ASBS intertidal region; over 100 species of algae have been identified in the Bodega ASBS. Many species of Chlorophyta (green algae), Phaecophyta (brown algae), and Rhodophyta (red algae) are present within the intertidal region (UCD/BML 2005, SWRCB 1979).

Anthophyta
Two species of vascular plants (Appendix C) that are common to the ASBS intertidal region are the surfgrasses *Phyllospadix torreyi* and *P. scouleri*. The surfgrass, *P. torreyi* is characteristic of tidepool habitats, while the especially common surfgrass, *P. scouleri*, grows on exposed rocks at zero tide level and below (SWRCB 1979).

Porifera
Sponges (Porifera) are common representatives of the low intertidal zone in the ASBS (Appendix D). Species from the two classes Demospongiae and Calcispongiae are found in this region, generally on hard substrate. Sponges, along with bryozoans and sea squirts, are spatial dominants in low intertidal habitats of crevices, caves, and overhangs. Species diversity of sponges increases with decreasing tidal exposure. More species are present subtidally than intertidally (SWRCB 1979).

Cnidaria
The phylum Cnidaria includes jellies, sea anemones, and hydroids. Representatives of the three classes of Cnidarians (Scyphozoa, Hydrozoa, and Anthozoa), all occur within the boundaries of the ASBS.

Scyphozoans, or the true jelly, appear washed up on the sand beaches in great numbers at certain times of the year. Although the vast majority of jellies are pelagic (free floating), there is a group of sessile jellies called the Stauromedusae that are rarely found within the ASBS, but are usually found on algae or surfgrass *Phyllospadix*.

Hydroids have both a polyp and a medusoid stage at times within their life cycle. Because the medusa stage is pelagic, the polyp stage is more readily observed within the ASBS. A rich fauna of hydroids is known from this region with more species being discovered as of 1979. A complication in the identification of hydroid polyps results from the uncertainty of their systematics. Hydroids are usually found within the low intertidal zone, although the by-the-wind-sailor, *Vellela vellela*, a pelagic form, washes up in large numbers in the spring. A hydrocoral, *Stylantheca porphyra*, is rarely found in the lowest reaches of the intertidal on rocky substrate.

Anthozoan sea anemones, which lack a medusa stage, are commonly found intertidally on rocky substrate within the ASBS. Several anemone species are common. The anemone, *Anthopleura elegantissima*, forms huge clonal masses blanketing the upper mid zone, while the solitary giant, green anemone, *Anthopleura xanthogrammica*, is common in pools and in surge channels below mussel beds (SWRCB 1979).

Platyhelminthes
The flatworms (Platyhelminthes) are small, flattened carnivorous worms that are commonly found gliding along the underside of rocks in the mid and low intertidal zones of the ASBS. Because of their bland coloration and cryptic habits, they are easily overlooked. Taxonomic difficulties preclude all but the simplest identifications (SWRCB 1979).

Nemertea
Ribbon worms (Nemerteans) are also common inhabitants of the ASBS. Although their species diversity is not great, some species like the *Amphiporus* spp. are present in large numbers in mussel beds where they prey upon the bristle worms (SWRCB 1979).

Sipuncula
The peanut worms (Sipuncula) are represented by two species within the ASBS. One of these peanut worms, *Phascalosoma agassizi*, is an exceedingly common member of the community of animals living within the three-dimensional habitat of the mussel bed (SWRCB 1979).

Annelida
The Annelids are segmented worms of diverse body form and habitat. One class, the bristle worms (Polychaeta), is very abundant in all tidal levels on rocky substrate within the ASBS. Most noticeable are sedentary tube-dwelling forms that include species that form large aggregations (*Phragmatopoma californica*, *Dodecaceria fewkesi*). Other tube-dwelling worms often encountered are worms that live in lime tubes (*Serpula*). Close relatives, forms allied with the genus *Spirorbis*, form small, coiled tubes on mussels, coralline algae, shells, and rocks. The taxonomy of the genus *Spirorbis* is confused; however, there seems to be as many as 10 recognizable species within the ASBS.

More mobile bristle worms are also common within the ASBS. Their cryptic nature makes it hard for the casual observer to see them in great numbers, but, in some situations, Nereid bristle worms, *Nereis vexillosa*, are very common in mussel beds. Other bristle worms are abundant within the holdfasts of the surfgrass, *Phyllospadix* (SWRCB 1979).

Arthropoda
The joint-legged animals (Arthropods) are another group of segmented organisms that are exceedingly abundant within the ASBS. The class Crustacea contains many common forms. Several species of barnacles are very common within the ASBS intertidal zone. The acorn barnacles, *Balanus glandula* and *Chthamalus dalli*, are spatial dominants in the rocky high tidal zone and can

occur at densities as high as several thousand per square meter. Several other species of acorn barnacles, *Balanus*, can also be found in the intertidal zone.

Water lice (Isopods) are also present within the ASBS. Perhaps the most common are species of rock louses, *Ligia*, which scurry about in the splash zone. The water louse, *Cirolana*, is common within mussel beds. Salt water fleas (Amphipods) reach great abundances at all intertidal levels. Because of the difficulties they pose for the non-expert, no attempt has been made to identify them. They are common in nearly all habitats of the intertidal region. One group of salt water fleas, the beach hoppers, is common members of the sandy beach community. Others, such as the skeleton shrimp or caprellids, can often be found in rocky habitat on algae, hydroids, and bryozoans.

Crabs and shrimp belonging to the Order Decapoda are also quite common intertidally. Crabs of the genera *Pachygrapsus* and *Hemigrapsus* are abundant in crevices and beneath rocks in the high and mid zones. Cancer crabs, Cancer spp., are found beneath rocks at the lower tidal levels. Hermit crabs, *Pagurus* spp., can be found in any tidepool, while porcelain crabs, *Petrolisthes*, are abundant in mussel beds. Sand crabs, *Emerita analoga*, are sometimes plentiful on Salmon Creek Beach. Other crabs are frequently encountered, while shrimp are sometimes seen in low zone tidepools.

Insects are an often-overlooked component of the intertidal biota. Fly larvae are important herbivores in certain high intertidal situations, while rove beetles, Family Staphylinidae, are characteristic predators in the drift community of sandy beaches (SWRCB 1979).

Mollusca
Molluscs are another phylum common within the ASBS. Four classes of mollusks are seen: the octopods and squids, Cephalopoda; the chitons, Polyplacophora; the snails and slugs, Gastropoda; and the clams and mussels, Bivalvia.

The only common cephalopod found within the ASBS is the octopus, *Octopus dofleini martini*. Octopods are crevice dwellers, and are nocturnal predators. For these reasons, they are not often encountered, although they are probably reasonably common.

The chiton fauna within the ASBS is a rich one. Most chitons are herbivores and are found at all rocky intertidal zones except the highest. The gumboot chiton, *Cryptochiton stellari*, is sometimes seen in protected spots; the chiton, *Katharina tunicata*, and the chiton species of *Mopalia* are also common.

Various snails and slugs (gastropods) are conspicuous members of the ASBS rocky intertidal biota. The snails, or prosobranchs, are exceedingly common at all tidal levels. In the high rocky intertidal “splash zone”, the two periwinkles, *Littorina planaxis* and *L. scutulata*, are common, and along with barnacles, are often the most conspicuous animals present.

Found slightly lower in the rocky intertidal zone, and extending into the subtidal zone, are limpets, which are snails with uncoiled cap-shaped shells. Locally, there are three genera of limpets found intertidally; especially common are species of *Collisella* and *Notoacmea*. Where they are found, limpets are often the most abundant snails present. They dwell in a variety of habitats, and some live specifically on other snails, or on one species of alga or marine plant.

Other important snails that are common within the rocky intertidal zone are the whelk, *Nucella emarginata*, and the black turban snail, *Tegula funebralis*. The whelk preys upon barnacles and is responsible for a considerable fraction of the mortality in the acorn barnacles, *Balanus* and *Chthamalus*. The turban snail is an herbivore found in high zone pools and mid-intertidally. Abalones, *Haliotis* spp., are sometimes encountered in crevices in the low rocky intertidal zone, but are more abundant subtidally.

The pulmonates, another group of gastropods, are occasionally seen. They are crevice dwellers, also found in caves and algal holdfasts. Thus, they are not very conspicuous. The sea slugs, or opisthobranchs, are the final group of gastropods found within the ASBS. Most belong to the order Nudibranchia and, despite their seasonality, are obvious members of the intertidal biota. Sea slugs

(Nudibranchs) are found mostly in the low intertidal zone, dwelling on a variety of prey items, including sponges, hydroids, brozoans, sea squirts, and algae.

The diversity of another molluscan class, the clams and mussels (Bivalvia), is not great within the ASBS, but one species, the California mussel, *Mytilus californianus*, is easily the most conspicuous organism in the mid and high zone of wave-swept rocky regions. It is probably the dominant biomass among the mollusks. Within the ASBS, mussels form large beds, often more than a foot thick, and spread over several feet of vertical tidal height. Mussel beds serve as shelter for a variety of other organisms including worms and various arthropods. The mussel, *Mytilus*, in turn, is the prey of the ochre star, *Pisaster ochraceus* (SWRCB 1979).

Ectoprocta (Bryozoa)

Bryozoans, often referred to as Ectoprocts, are a group of small colonial animals of great diversity within the ASBS. Along with the sponges and sea squirts, bryozoans are spatial dominants in cryptic, dimly lit habitats of the lower intertidal region. Bryozoans also utilize shells, crabs, and algae as substrate (SWRCB 1979).

Echinodermata

Echinoderms are a common and ecologically important group within the ASBS. Four classes of echinoderms occur locally: the seastar (Asteroidea), the brittle stars (Ophiuroidea), the urchins (Echinoidea), and the sea cucumbers (Holothuroidea). Ten species of seastar have been found intertidally in the ASBS. The ochre star, *Pisaster ochraceus*, is by far the most common. It is a conspicuous predator upon mussels and barnacles in the rocky mid and low tidal zone. It is thought that seastar predation serves to control the lower boundary of mussel beds. Other common seastars include *Leptasterias* spp., the batstar, *Patiria miniata*, and the leather star, *Dermasterias imbricata*. The many-armed seastar, *Pycnopodia helianthoides*, is a voracious predator that is occasionally seen. Brittle stars are probably abundant within the ASBS but are not seen very often due to their habitat. They live in sediment at the bases of boulders and are difficult to collect.

Echinoids are represented by the purple sea urchin, *Strongylocentrotus purpuratus*. Urchins are found in pools and on rocky intertidal platforms where they graze on drifting and attached algae. There are several species of sea cucumbers found in the ASBS. The most common of these is a small black form found in mussel beds, *Cucumaria pseudocurata* (SWRCB 1979).

Chordata

Sea squirts (Ascidians) are suspension-feeding tunicates that occur either singly or colonially. Sea squirts are common in the rocky lower intertidal region, especially beneath ledges and in crevices. They bear a strong superficial resemblance to sponges. The most common solitary sea squirt is *Styela montereyensis*, while some common colonial forms include species of the genera *Aplidium*, *Archidistoma*, and *Didemnum* (SWRCB 1979).

ASBS Subtidal Biota

The biota of the shallow subtidal zone is dominated by individuals from 12 groups (12 phyla). The shallow subtidal zone is considered to include depths ranging from 1 to 40 ft. (0.3 to 13 m). The dominant groups are comprised of the marine plants (Division Chlorophyta, Phaeophyta, Rhodophyta, and Anthophyta), sponges (Porifera), Cnidaria, Ectoprocta, segmented worms (Annelida), Mollusca, Arthropoda, spiny-skinned animals (Echinodermata), sea squirts (Chordata), fishes (Chordata), birds (Chordata), and marine mammals (Chordata). Mammals and birds have been included as members of the subtidal and intertidal communities because of their utilization of these areas in foraging, nesting, resting, or migrating activities. A brief ecological discussion of each of these groups will be presented.

Most plants and animals of the major groups are characteristic of rocky areas and appear to represent the dominant competitors for substrate and resources in the area. The biota of the sand bottom areas of the subtidal zone is generally sparse, especially in Horseshoe Cove, because of the unstable and transitory nature of the sand substrate.

The pelagic (non-attached) component of the subtidal fauna has been difficult to comprehensively define because many pelagic individuals are seasonal in occurrence or are difficult to observe because of their mobility. Pelagic larvae from most local species are commonly present in the ASBS but are not readily observable. Very little information concerning the larval component of this area was available (as of 1979). Observable members of the pelagic component consist primarily of cnidarians, fish, birds, and mammals (SWRCB 1979).

Marine Plants

Marine plants (both algae and rooted vascular plants) are prominent members of the ASBS subtidal community. This autotrophic group appears to represent the dominant competitor for rock substrate in shallow subtidal areas of 1 to 20 ft. (0.3 to 6 m). Although the diversity of plant species decreases markedly below the 25 ft. (7.6 m) depth, encrusting coralline algae still covers large areas of granitic bedrock in the deeper regions of the ASBS (Appendix C).

Factors affecting the distribution of subtidal algae are not as obvious as those determining intertidal zonation. In comparison to the intertidal environment, subtidal habitats experience only small fluctuations in environmental conditions. Among the parameters which are generally thought to be important determinants of subtidal algal distributions, and which are relevant to the portions of Bodega Head involved in this study, are: variation in light quality and intensity with depth, type and stability of substrate, wave exposure, and predation (SWRCB 1979).

Light intensity decreases with depth because of scattering and absorption by the water and by suspended organic and inorganic materials in the water. The nearshore waters of Bodega Head are commonly clouded with suspended material. This turbidity results in poor light penetration, which is in turn reflected in a small algal standing crop. The greatest standing crops found during the 1979 reconnaissance survey were shallower than 20 ft. (-6 m). Suitable substrates deeper than 33 ft. (10 m) are only sparsely occupied. Variation in the spectral composition of light with depth is also often cited as a controlling factor of algal zonation. Generally, green and brown algae occur in greatest abundance in the intertidal and shallow subtidal zones. The red algae, which are better adapted to utilize longer wavelengths of light, are more commonly found in deeper water or shaded shallow areas, where shorter wavelength light is lacking.

Types of substrata are important to marine plant growth. Solid rock usually offers greatest growth potential. Sandy or silty areas are less favorable to growth because sediment substrates generally are not stable. The sediment in these areas may be brought into suspension during periods of high wave action, resulting in the abrasion of the algae. In the absence of extreme wave surge activity, boulders or cobble-bottoms may provide favorable habitats for plant colonization (SWRCB 1979).

In areas subject to extreme exposure and wave shock, only the most robust forms of plant cover can exist; typically, these would include certain brown algae, or the surfgrass *Phyllospadix scouleri*. Wave and surge action may also reduce algal or vascular plant growth in these areas through the movement of boulders and cobbles and through abrasion by suspended material.

Aggregations of algal grazers (i.e., the giant red urchin, *Strongylocentrotus franciscanus*) may reduce large areas of suitable plant substrate to virtually barren zones. Evidence of predation is occasionally observed through the ASBS (SWRCB 1979).

Porifera

Porifera, the sponges, are well represented in the ASBS at Bodega Head. Fifty-two species, from the two classes Demospongiae and Calcispongiae, are known to occur near Horseshoe Cove. Members of the Demospongiae comprise 94 percent of this fauna. The sponges represent a major component of the invertebrate fauna in the area and, together with algae and sea squirts, are dominant competitors for rock or shell substrate.

Individuals or colonies of sponges are generally epibenthic, sessile filter feeders, feeding on bacteria or microscopic detrital material. Substrate availability, oceanographic conditions and competition probably are the major factors controlling the distribution and abundance of this group. Substrates utilized by sponges include rock, shell, and plant material.

As with some other sessile invertebrates, species diversity of the group usually decreases with an increase in turbidity or sediment deposition. Some sponges are morphologically adapted to inhabit areas near sediment/rock interfaces; however, most species live in areas where there is a lessened threat of burial or fouling by sediment (i.e., on vertical rock faces, in high energy regimes, or in cryptic environments). Species diversity of the group in the ASBS generally increases with an increase in vertical topographical relief. Sponge distributions in the ASBS are often patchy, and the fauna below 25 to 30 ft. (8 to 9 m) is slightly different in composition and abundance from that of the shallower subtidal areas (SWRCB 1979).

Cnidaria
The cnidarians represent a morphologically diverse group of organisms and members from the three classes Hydrozoa, Anthozoa, and Scyphozoa, which are common to the ASBS. While not especially dominant in terms of covering large areas of substrate, some members of the phylum (most notably the Anthazoan giant green anemone, *Anthopleura xanthogrammica*) are very common in rocky, shallow subtidal areas.

Members of the group are generally considered to be predatory. However, the majority are "passive" predators, in that they depend upon water currents to supply them with a wide array of food items. The parameters, which appear to be important to the success of the sessile members of the phylum, include exposure and availability of dependable currents and availability of appropriate substrate. Both rock and shell materials are frequently colonized by hydrozoans and sea anemones. Algal substrates generally appear to be more commonly inhabited by hydrozoans than by the sea anemones.

Hydrozoans display the greatest polymorphism in the phylum; commonly, the hydrozoans alternate generations between attached, sessile polyps and pelagic medusoid forms. Polyp stages of varied forms and structures are the most readily observable and are frequently encountered subtidally. Most local hydroids possess flexible, chitonous skeletons, although one species of "hydrocoral" with a calcareous skeleton occasionally occurs in the deeper regions of the ASBS. Taxonomically, the hydrozoans pose severe problems in their identification and many of the characters used to classify them have been found to vary markedly with changes in environmental conditions and/or developmental stages. For this reason, only the most well known species have been included in the biota list (See Appendix D).

Anthozoans comprise the largest class of cnidarians and locally are represented by a number of sea anemones, a solitary stony coral, and an alcyonarian. Members of this class lack pelagic medusoid stages, although extensive dispersal may still result from the planktonic larval stage (SWRCB 1979).

The Scyphozoa predominantly consist of the jellyfish and seasonally may be present in large numbers in the ASBS.

Bryozoa (Ectoprocta)
The Bryozoa comprises a diverse group of some 4,000 described living species and are common elements of marine and freshwater communities where firm substrates are present for colonization. Most species are found in moderately agitated, well-oxygenated waters of normal marine salinity. These animals flourish in the relatively shallow waters of the continental shelf, 30 to 230 ft. (10 to 70 m) deep.

Bryozoans are ciliary suspension feeders, which extract diatoms and other phytoplanktonic algae, protozoans, and organic detritus from the water. Although individuals are small, usually less than 0.04 inches (1 mm), their colonies of calcium carbonate ($CaCO_3$) or thickened cuticle are constructed so that they may be several tenths of a yard across. Competitions for substrate, along with sedimentation, are key factors in controlling their distribution. Diverse associations of species are generally restricted to clear, non-turbid waters where sedimentation is low. With increasing sedimentation, the diversity of encrusting species declines relative to erect forms. Although there are a few encrusting species tolerant to sedimentation, these species generally do not compete successfully against sponges and sea squirts. Substrates utilized by bryozoans include rocks, mollusk shells, crab carapaces, and algae (SWRCB 1979).

Annelida
The Annelida, or segmented worms, are a large and diverse phylum consisting of some 8,700 described species. The majority of marine species fall within the class of the bristle worms (Polychaeta), which consists of some 5,300 known species. This diversity is not often apparent to the casual observer because of the cryptic or infaunal habitats of the majority of species. The polychaetes show an impressive range or morphological diversity, which matches the equally impressive range of life modes that characterize the group. Such diversity makes for difficulty in generalizing about the ecology and distribution of the segmented worms. The bristle worms (Polychaeta) have achieved a wide habitat distribution and although their greatest diversity is found in areas of soft, sandy, or muddy bottoms, they are well represented in rocky intertidal and subtidal areas.

The bristle worms are usually divided into two sub-classes, based upon their mobility during life. The Errantia, or free-moving bristle worms, are characterized by numerous, generally similar segments, each bearing paired appendages. Errant bristle worm species are primarily swimmers, crawlers, or burrowers. The second sub-class of bristle worms is the Sedentaria, or sedentary forms, which inhabit permanent burrows or tubes. In these species, the body segmentation is less pronounced, and there is usually some regional differentiation of the body. These sessile forms are usually adapted for suspension feeding or indirect deposit feeding. In the ASBS, the sedentary bristle worms are those most frequently noticed, although their distributions are patchy. Occasionally, certain species are present in such abundance that large areas of the substrate, 10 square feet (1 m^2) or more, are covered with their tubes (SWRCB 1979).

Mollusca
The phylum Mollusca is well represented in the ASBS. Four classes of molluscs are present: the snails and slugs, (Gastropoda); clams and oysters, (Bivalvia); chitons (Polyplacophora); and octopuses and squids (Cephalopoda). The snails and slugs are the most abundant and diverse class of molluscs in the area.

The snails and slugs are broken into the sub-classes Prosobranchia, Ophisthobranchia, and Pulmonata. The few pulmonates that may occasionally occur subtidally are found in holes, caves or kelp holdfasts, and therefore are not readily observable.

Prosobranchs and opisthobranchs are common to the area. Prosobranchs are found on rocks, algae, or sandy bottoms. Ophisthobranchs are generally found on sponges, bryozoans, or hydroids. The Prosobranchia consist of three orders: Archaeogastropoda, Mesogastropoda, and Neogastropoda. Archaeogastropods include the abalone, keyhole limpets, true limpets and top and turban snails. These animals primarily feed on algae, although a few feed on sponges.

Mesogastropods are able to inhabit sandy and muddy substrates, although many are often found on rocks as well. This group contains mostly herbivores, but also includes muco- and ciliary feeders (slipper shells), ectoparasites (wentletraps) and carnivores (moon snails).

Neogastropods are the most highly evolved of the Prosobranchs and are entirely carnivorous. Examples of this order are found in both rocky and sandy areas of the ASBS.

The ophisthobranchs are easily the most conspicuous and abundant of the snails and slugs at Bodega Head. These belong almost entirely to the order Nudibranchia, which in turn is subdivided into two groups - dorids and eolids. Dorids feed primarily on sponges and bryozoans, and the eolids feed mostly on hydroids. The brilliant colors exhibited by the nudibranchs make these animals conspicuous, and the group may be very numerous at times.

Bivalves, being mostly infaunal filter feeders, are generally not seen by divers. However, the rock scallop and jingle shell are occasionally seen attached to rocks in semi-cryptic areas.

The Pacific coast of North America possesses the world's most diverse chiton fauna. This is reflected by the abundance and diversity of chiton species found in the ASBS. Chitons are almost all herbivores except for the carnivorous chiton, *Placiphorella velata*, which is rare at Bodega Head.

Most of the chitons listed may not be readily observable because of their small size or their habit of living beneath rocks. Several of the species, however, do reach considerable size.

The only cephalopod likely to be observed in the area is the octopus, *Octopus dofleini martini*. This species is generally nocturnal in nature, emerging at night to feed on crabs and shrimp; thus most divers are not likely to encounter this animal (SWRCB 1979).

Arthropoda

In the ASBS, the dominant classes of Arthropods are the Crustacea. This class comprises a large group of marine invertebrates and plays an important role in the subtidal community. The two most important groups of Crustacea in the area are the barnacles (Cirripedia) and the crabs and shrimp (Decapoda). The water lice (Isopoda) and salt water fleas (Amphipoda), while being common and including a large number of species, are small and difficult to observe in the field. Water lice (Isopods) are generally benthic, cryptic individuals. Salt water fleas (Amphipods) are often found on algae, sea grasses, sponges, hydroids, and bryozoans and may be herbivores, carnivores, or scavengers.

Barnacles are more abundant intertidally, but a few species of *Balanus* are found subtidally, attached to rock or shell substrates.

Most other observable crustaceans in the ASBS are the free-living crabs and shrimp (Decapoda). These are primarily nocturnal animals but can often be seen during the day in crevices and hidden among algae. A few species, like the decorator and hermit crabs, live in exposed areas but protect themselves by means of camouflage or by inhabiting vacant mollusc shells.

Anomuran and brachyuran crabs are the most diverse crustaceans in the area. Depending upon the species, these crabs may be herbivores, omnivores, or carnivores. Reproduction is sexual, and females brood eggs which hatch into pelagic larvae. Individual species often show seasonality in breeding, but one or more species will be reproducing at almost any time during the year.

Only a few species of shrimps are seen in the ASBS, and they are usually colored to match the sea grass or kelp on which they live. Occasionally, large schools of the small, shrimp-like mysids, opossum shrimp, are seen in the water column in the area (SWRCB 1979).

Echinodermata

Echinoderms, while not especially diverse in the area, are numerous and occupy several important niches in the local subtidal community. Most forms are generally sedentary or slow moving animals that may be filter feeders, grazers, scavengers, or predators.

Four classes of echinoderms occur locally: the brittle stars (Ophiuroidea), sea urchins and sand dollars (Echinoidea), sea cucumbers (Holothuroidea), and the starfish (Asteroidea). The brittle stars are small animals, which commonly live under rocks or buried in the sediment, and thus are not often observed by divers. Unlike most other echinoderms, this group can move about quite rapidly. Brittle stars may be suspension feeders, detritus feeders, or ciliary feeders.

Echinoids are represented in the ASBS by two species of sea urchins and one species of sand dollar. Most echinoids are omnivorous grazers and scavengers that scrape algae and encrusting animals from rocks. Some forms may also remove drifting algae from the water with their extended tube feet. Subtidal sea urchins may grow to very considerable sizes of over 8 inches (20 cm) in diameter and large groups of individuals, covering 150 square ft. (15 m^2) or more, are occasionally found in the ASBS. Occurrences of such abundance markedly affect the nature and degree of exposed substrate around these animals.

Holothuroids differ from other echinoderms in having soft bodies and worm-like shapes; these characteristics have earned them the name of sea cucumbers. Sea cucumbers are occasionally found partially buried, with plume-like tentacles extended, as they filter out particulate organic food material. Members of this group locally range in size from less than 0.4 inches (1 cm) to over 12 inches (30 cm) long.

The most diverse local echinoderm class is the seastar (Asteroidea). These animals have a distinctive appearance and are frequently found in a wide variety of areas. They may be active predators, herbivores, scavengers, or filter feeders (SWRCB 1979).

Sea Squirts (Chordata)
Of all the invertebrates in the ASBS, sea squirts are probably the most frequently encountered. Individuals or colonies are sessile, muco-ciliary filter feeders, feeding on suspended detrital material and microplankton. A few species occur as solitary individuals, but the majority are colonial, of social and compound forms; they are often so variable in size, shape, and color that it is necessary to confirm species identifications by examining their internal anatomy. In external morphology, some compound forms show a remarkable resemblance to sponges, making field distinctions sometimes difficult.

Sea squirts are especially abundant on the sides and undersides of rocks, but also commonly inhabit shell and algal substrates. Most members of the group are hermaphroditic. Eggs are brooded and pelagic tadpole larvae are released; these metamorphose into adult forms, which can be thin encrustations, amorphous, gelatinous or sand encrusted masses, or well defined erect individuals.

Although the group is ubiquitous, the list of species from this area is relatively small when compared to other ecologically similar groups (i.e., sponges). As the sea squirts have not been studied to any great extent in the ASBS, detailed taxonomic and distributional studies would presumably confirm the existence of many more species, some of which would probably be new (SWRCB 1979).

Fish Community

Fish are difficult to observe in the ASBS at Bodega Head, primarily because of the poor visibility of the water and because the fish are widely dispersed. Many of the fishes are found inshore seasonally, either for purposes of feeding or breeding. Bottom fishes and various rockfishes are seen most often because they are not easily frightened when approached. Other fish that are seasonally common to the area, such as surfperches, may be difficult to observe because they remain at the fringe of the diver’s range of vision. Consequently, a diver in this area is likely to observe few fishes relative to such other locales as Monterey.

The species list in the Appendix E has been drawn from 10 years diving experience in the area and from data obtained using a twenty-five foot otter trawl at depths of 39 to 82 ft. (12 to 25 m) near Bodega Head.

This area has been noted for the seasonal presence of the white shark, *Carcharodon carcharias*; this large predator may be relatively common in areas just south of Bodega Head at Bodega Rock and Tomales Bay. Another potentially dangerous fish, the wolf eel, *Anarricthys ocellatus*, is also known to occur in the ASBS.

Fish are also seen intertidally in the ASBS, primarily within pools. Some are probably stranded with the falling tide, and others, especially sculpins of the cottid family, are characteristically intertidal (SWRCB 1979).

Commercial Fisheries

No major resource harvesting activities occur within the limits of the ASBS. The BSMR is a fully protected no-take reserve extending 1000 feet offshore, established by the state legislature and managed by the DFG and UCD/BML. Commercial fishing boats normally fish several miles or more away from the ASBS. Sport fishermen in charter boats and private boats likewise normally work well outside the area of the preserve. UCD/BML staff routinely observes these boats fish up to and often cross over the BMR boundaries (K. Brown and P. Conners, pers. comm. 2007). However, an impact analysis has not been performed to consider the influence of these activities on the biota.

The entire Bodega ASBS is within the boundaries of BSMR, which is classified as a protected area under the Marine Life Protection Act Initiative. According to PRC 36710(a), “it is unlawful to injure, damage, take or possess any living, geological or cultural marine resource" from a state marine reserve, "except under a permit or specific authorization from the managing agency for research, restoration or monitoring purposes"

Threatened, Endangered, and Other Wildlife

Many of the following marine reptile, bird, and mammal species are federally and/or state-listed as endangered (FE, SE), threatened (FT, ST), or species of special concern (SSC). U.S. Fish and Wildlife Service Endangered and Threatened Species List for Bodega Head (503D) U.S. Geologic Service 71/2 Minute Quad (December 1, 2006) and DFG Natural Diversity Database for Bodega Head (January 4, 2007) are referenced. (Appendices N and O).

Marine Reptiles

Marine sea turtles occur in California waters. Four species of federally protected sea turtles may be found in the Bodega ASBS: green (*Chelonia mydas* FE), leatherback (*Dermochelys coriacea* FE), loggerhead (*Caretta caretta* FE), and olive ridley sea turtles (*Lepidochelys olivacea* FE). These marine turtles are circum-global in distribution, but breeding colonies have not been observed in California (Coastal Conservancy 2005).

Marine Birds

Birds comprise the most conspicuous group of animals occurring within the ASBS, in that many individuals are easily visible from land during all seasons and tidal conditions. Bird populations within the area are seasonal; heaviest use occurs during spring and fall migrations, and in winter. During the summer, most of the listed species are nesting elsewhere.

A few species nest close to the intertidal zone and are present as year-round residents. The black oystercatcher, the largest shore-bird occurring on the ASBS, probably nests on rocks just above the reach of the waves. A smaller shorebird, the snowy plover, is a potential nester on the upper areas of the two beaches within the ASBS. Among seabirds, pelagic cormorants nest in scattered colonies of up to 30 nests at several sites along the sea cliffs. This species builds nests on rock shelves along the cliff faces above the surf. Although most colonial nesting seabirds are highly traditional in choice of colony site in successive years, the pelagic cormorants of Bodega Head often change colony location annually, choosing each year only a few of the many available cliffs. One other seabird, the pigeon guillemot, probably nests occasionally in crevices in the cliffs of Bodega Head.

The largest seabird breeding colony in the immediate vicinity is just outside the ASBS, on Bodega Rock. Here, several hundred Brandt's cormorants, a larger species which typically selects flat areas on islands for colony sites, nest each year. Individuals of this species forage within the ASBS regularly. A few western gulls nest on Bodega Rock, and black oystercatcher nests are likely here also.

Of the 59 other species occurring somewhat regularly within the ASBS, the great majority nest outside of California, with many species migrating annually to the Arctic to breed. Small numbers of some of theses species, often immature birds, remain here throughout the summer.

Most of the species seen regularly along Bodega Head are typical of other rocky headland and sandy beach areas of northern and central California. This area does, however, present a very rich and diverse example of the coastal avifauna and is esteemed by California birders (Appendix I). In fact, one species of shorebird occurring regularly in the ASBS is seldom seen anywhere south of Bodega Head – the rock sandpiper, which nests in Alaska and winters along the coast from Alaska to northern California. Individuals of this species forage on the rocks with flocks of black turnstones and surfbirds each winter.

In the rocky intertidal zone, several species of shorebirds (especially black turnstones, surfbirds, rock sandpipers, black oystercatchers, willets, and whimbrels) prey on water lice, salt water fleas, and other small crustaceans. Bristle worms, a variety of small mollusks, and occasionally representatives of other invertebrate taxa are also preyed upon. Gulls feed on crab, seastars, *Pisaster ochraceus*, and sea urchins. On the sandy beach, sanderlings and marbled godwits probe for water lice, *Excirolana*, salt water fleas, *Orchestoidea* and *Paraphoxus*, the sandcrab, *Emerita analoga*, and adult and larval insects. Seabirds that capture food near the water surface (pelicans, phlaropes, terns, and gulls) or dive beneath the surface (loons, grebes, cormorants, sea ducks, and alcids) forage on zooplankton, squid and fish, as well as mollusks and crustaceans taken from the seafloor. Aside from this general information, the diets of most seabird species in habitats comparable to the ASBS are not well known; it is, however, clear that birds are important predators of many of the fish and invertebrates inhabiting the area (SWRCB 1979).

The bald eagle *(Haliaeetus leucocephalu)* was federally listed as endangered in 1967 and state listed as endangered in 1971. The federal listing of *H. leucocephalus* was changed to threatened in 1995 and its status has been proposed for delisting since 1999 (DFG 2006).

Marine Mammals

Members of this group are predominantly carnivorous and represent the upper end of the marine food chain in the ASBS. The two orders of marine mammals found locally are the seals and sea lions (Pinnipedia) and the dolphins, porpoises and whales (Cetacea); the seals and sea lions are the most easily observed and abundant (SWRCB 1979) (Appendix F).

Of the three families of Pinnipedia, two are represented in the ASBS, the Otariidae and Phocidae. The former are commonly known as the walking seals, and the latter are known as the crawling seals. Two species of the crawling seals have been observed in the area: the elephant seal, *Mirounga angustirostris* and the harbor seal, *Phoca vitulina*. *M. angustirostris*, the largest of all seals, is usually rare in the ASBS, being commonly found to the south between December and March in island rookeries off Mexico. Although the total California population of *M. angustirostris* is thought to be considerably greater than that of *P. vitulina*, over 10,000 versus less than 2,000, *P. vitulina* is much more readily sighted in the ASBS. It is not unusual to see several individuals of this species on any particular day, and individuals appear to maintain favorite hauling places within the ASBS. Sizable resident populations of harbor seal, *P. vitulina*, occur on nearby Bodega Rock and in Tomales Bay.

Walking seals are locally represented by the Stellar sea lion, *Eumetopias jubata*, and the California sea lion, *Zalophus californianus*. The latter are seasonal in occurrence, leaving this area in June and July to breed primarily on offshore islands from the Santa Barbara Channel Islands south into Mexico. *E. jubata* frequents the same areas around the ASBS as *Z. californianus*. However, its breeding grounds extend from the Channel Islands northward to the Pribilof Islands, with breeding also taking place in June and early July (SWRCB 1979).

The cetaceans are divided into two suborders: the toothed whales (Odontoceti) and the baleen whales (Mysticeti). During the SWRCB 1979 Survey, only two species of baleen whales were observed in the area of the ASBS - the fin-backed whale, *Balaenoptera physalus*, and the gray whale, *Eschrictius gibbosus*. Only one specimen of *B. physalus* has been seen; that particular animal was over 65 feet (20 m) long and was washed ashore dead into Horseshoe Cove in December 1969. *E. gibbosus* is commonly seen passing by the ASBS during its southerly migration, which begins in late November and continues into February. The bulk of the herd normally passes in late December, and it is not unusual to see as many as 50 to 75 animals a day. The northern migration starts as early as late February for some individuals and extends into May and June for females with newborn young. Females and calves often hug the coastline, entering bays and inlets as they progress north to the Bering Sea. Because of this, many sightings have occurred within the confines of Horseshoe Cove in the ASBS (SWRCB 1979). Other baleen whales commonly sighted in the waters offshore are the humpback, *Megaptera novaeangliae* and blue, *Balaenoptera* (UCD/BML pers. comm., 2007).

Members of the toothed whales have been observed within the ASBS and its immediate vicinity in greater diversity than the baleen whales. During the SWRCB 1979 Survey, only one species was on record to have been found alive: the northern right whale dolphin, *Lissodelphis borealis*. Less than a dozen specimens of this species have been found along the California coast. The individual from this area was beached at the base of Mussel Point and subsequently died after being transported to the California Academy of Science. Dead beached animals of other species of toothed whales found along the shore of the ASBS have been identified as Risso's dolphin, *Grampus griseus*, Pacific striped or white-sided dolphin, *Lagenorhyneus obliquidens*, killer whale or orca, *Orcinus orca*, Dall's porpoise, *Phocoenoides dalli*, and the porpoise, *Phocoena vomerina* (SWRCB 1979). In 1980, a Cuvier's beaked whale, *Ziphius cavirostris,* was found washed ashore at UCD/BML (UCD/BML 2007).

Estuarine Species

Salmon Creek lies just north of BSMR, within State Park lands (see *Habitat* section). A one mile stretch of this creek habitat consists of a small estuary, where the mouth is closed all summer, forming brackish water habitat in shallow lagoons and a lower stream reach forming fairly still but not stagnant water with high oxygen levels. Although currently presumed to be extant in this area, the tidewater goby, *Eucyclogobius newberryi*, a fish species endemic to California (USFWS 2007) formerly occurred here. Surveys conducted in 1984 and 1990 found small populations and subsequent surveys in 1996 confirmed populations to be extant (DFG 2006).

USFWS designated critical habitat for the tidewater goby as part of its 2005 Recovery Plan. Salmon Creek has been designated as critical habitat within Sonoma County to promote the conservation and recovery of this species.

Fisheries, Marine Protected Areas, and Prohibitions on the Take of Marine Life

As noted in the Commercial Fisheries section of this document, the Bodega ASBS/BSMR is a fully protected, no-take zone (Figure 2). However, commercial and recreational fishing does occur in the waters surrounding the BSMR. DFG has divided California fishing areas into nine regions for the purpose of reporting fisheries statistics. Each statistical area is named for a major port within its boundaries. The Bodega Bay area consists of the following ports: Bodega Bay, Bolinas, Point Reyes, Marshall, Tomales Bay, Marconi Cove, and other minor ports.

Figure 2. State Ocean Waters Management Zones Around UCD/BML (UCSB 2006)

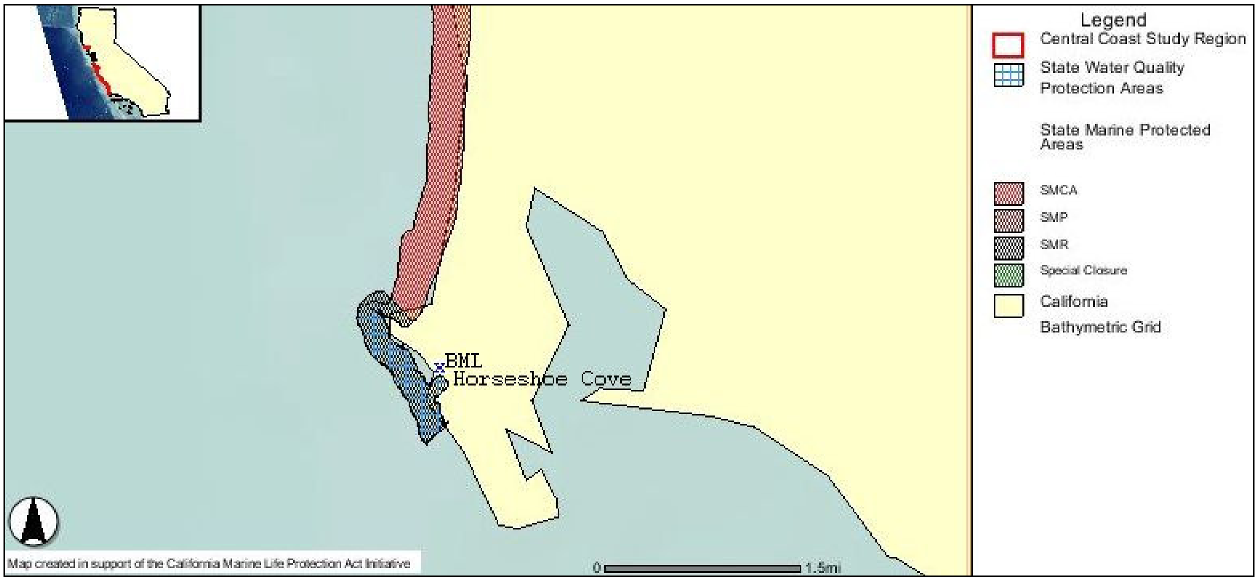


Table 1 displays the harvested species from the Bodega Bay statistical region in 2005, which have also been identified within the Bodega ASBS (see Appendices D and E). In 2005, a total of 1,931,168 lbs were landed in the Bodega Bay statistical region. The total value of the 2005 landing was $4,064,615. It should be noted that the weights were reported without regard to the condition of the fish and that parts of certain species of fish are thrown out before being unloaded at port (DFG 2005).

Table 1. Harvested Species in 2005 from the Bodega Bay Area also found in the Bodega ASBS, California Department of Fish and Game landing records recorded for 2005.

Species Name	Common Name	Total Landings (lbs)
Cancer magister	dungeness crab	1,275,122
Ophiodon elongatus	lingcod	3,611
Scorpaenichthys marmoratus	cabezon	1,138
Strongylocentrotus franciscanus	red urchin	830
Sebastes auriculatus	brown rockfish	695
Sebastes caurinus	copper rockfish	485
Sebastes flavidus	yellowtail rockfish	297
Sebastes mystinus	blue rockfish	218
Cymatogaster aggregata	shiner perch	130
Hexagrammos decagrammus	kelp greenling	93
Parophrys vetulus	English sole	36

Other routine harvesting of marine species around Bodega ASBS include those of UCD/BML's Aquatic Resources Group (ARG). ARG collects marine species for shipment to other research and educational facilities. ARG's activity is further discussed in the *Scientific Study Uses* section.

Surrounding Land Use

There are no major municipalities within 1 mile (1.6 km) of the ASBS. Bodega Bay, a small, unincorporated town of some 800 people lies 1.7 miles (2.8 km) east of the ASBS. The only major industry of the area consists of a small commercial fishing fleet that works out of Bodega Harbor. This "industrial" activity does not appear to affect the ASBS, and it is not expected to expand to a point where it potentially could impact the area. No other industry is at present expected to be developed in the vicinity.

Cattle and sheep lightly graze portions of the grasslands of the Coast Range foothills above Bodega Bay. Ranches in the area are small and therefore not considered to have any substantial effect on the marine waters of Bodega Harbor, Bodega Bay, or Bodega Head (SWRCB 1979).

In late 1994, the county approved the Harbor View (formerly Romancia) subdivision, which will add 70 single family and 14 affordable housing units to the housing inventory. As of mid 1999, the developers were in the process of developing the roads and utilities. Legal challenges held up development. Recent (2005) court decisions will now finally allow completion of this project. Harbor View is the only significant new housing development included in current county planning documents, including the Coastal Plan and the General Plan. The 1980 Local Coastal Plan identified Harbor View in Bodega as a future housing site with up to 10 houses per acre permitted to be built. In December of 1994, Sonoma County supervisors approved a plan for 84 housing units (70 luxury homes, 10 apartments, and 4 townhouses) on 27 acres. Two lots have been set aside for preservation. A 2.8-acre lot contains natural wetlands and the other 1.3-acre lot will serve as a groundwater recharge area for the wetlands. As of 1996, there were over 100 housing lots identified in the Bodega Harbor area (Robinson 1996).

Scientific Study Uses

Infrastructure

Research

UCD/BML is considered to be among the major marine research institutions in the country. Its scientists are investigating population dynamics of marine invertebrates and fishes, fisheries management, fish health, aquaculture, invertebrate diseases, introduced species effects, nearshore oceanography, physiology, developmental biology, genetics, endocrinology of marine invertebrates, ecological processes and community dynamics of invertebrates and algae, captive breeding and conservation biology of endangered species, and many other topics. These studies benefit agencies, industry and the general public by solving problems, providing management guidance, and expanding our understanding of nearshore marine systems. The University of California (UC), the State of California, and various funding and regulatory agencies of the federal, state, and county governments have invested tens of millions of dollars over the years in facilities and programs to support this research. The National Science Foundation has twice provided major funding for improvements and upgrades to UCD/BML's flowing seawater system, recognizing that this system provides a resource of national significance for marine scientists at UC and for scientists from other institutions who visit to conduct research. In 2003, 110 scientists used UCD/BML's seawater systems (UCD/BML 2005).

Teaching

*UCD/*BML's seawater system is used in almost all of their undergraduate classes in marine science (253 students used the seawater system in 2003) and is essential to most of the marine science graduate students conducting their thesis research (66 graduate students in 2003). Approximately 1,000 undergraduates use/visit the Lab or BMR on an annual basis for resident classes and field trips. To train the next generation of marine scientists, UCD/BML must maintain its seawater system (UCD/BML 2005).

BML Dive Program

The UCD/BML Scientific Diving Program is an organizational member of the American Academy of Underwater Sciences. As a member, UCD/BML follows the Academy's guidelines for scientific diving and diver training. The goal of the diving program is to facilitate subtidal research in as safe a manner as is possible. While the purpose of the program is to provide instruction for scientific divers, UCD/BML also offers diver training from introductory through leadership levels. Other ancillary courses such as emergency care and boating are also taught.

UCD/BML works with many other diving programs to develop coordination and standardization of curriculum and methods. They also share subtidal research techniques and tools, personnel, ideas, and equipment with other programs to ensure that researchers not only have the latest technology and methods available, but also that they can rely on their staff and students to be able to work effectively underwater. This cooperation and reciprocity provides researchers with a much larger pool of skilled and qualified divers (UCD/BML 2006).

Public Education

Although UCD/BML is not a public aquarium, approximately 12,000 public visitors (K-12 to adult) per year visit the Laboratory for guided tours to learn about the science conducted there. They observe local fishes and invertebrates in several displays and experimental animals in wet labs, all maintained as healthy organisms in the flowing seawater system. Educating the public to the problems that confront the state and the nation in maintaining healthy marine ecosystems along our coast is of great importance (UCD/BML 2005).

Bodega Marine Reserve

Bodega Marine Reserve is one of the scientifically most active and productive reserves in the UC Natural Reserve System. During 2005-06, field researchers at UCD/BML totaled 150 scientists, including 65 graduate students and numerous field research assistants and undergraduates conducting short-term research. The BMR hosted nine resident field classes and 49 class field trips from UCD and other campuses, plus eight workshops and conferences. BMR researchers and classes represented 50 universities, including six UC campuses, two agencies and four non-profits/non governmental organizations. During the year, 40 publications reported results of field research at the site. There were 127 active field research projects using the BMR, the highest total ever.

Of the field research conducted at the Laboratory, 67 percent occurs on BMR lands. To continue to protect BMR resources and respond to increasing research and class requests, UCD/BML developed a new research tracking system that uses GPS and GIS technology to track the location of projects, sensitive resources, weed distribution, and other land management issues on the BMR. In conjunction with this project, they upgraded their annual BMR aerial photography to include a digital topographic layer that can be used to reconfigure their 20-year aerial photo library for digital analysis. The system planning provides a long-term record of environmental conditions on the BMR for land management (UCD/BML 2006).

Housing Facilities

The UCD/BML Housing Enclave is located approximately one mile from the Laboratory. Accommodations include a 6-bedroom visiting scientist Lodge, two 2-bedroom apartments, a 4-bedroom cottage, two dormitories (20 bedrooms), and a bunkroom and are supported by a seasonally staffed dining hall. Current housing capabilities total 63 beds plus bunkroom space. BML Housing is available for classes, researchers and conference attendees, but some units are reserved for faculty, families, or long-term visitors.

Laboratory Facilities

Pathology Laboratories: There are two adjacent pathology laboratories with separate programs. The two pathology laboratories are located in the northeastern corner of the North Wing with separate drains from the rest of the building. Effluent from these two laboratories is chlorinated and de-chlorinated before being released. Species held in the laboratories are listed in Appendix G. The pathology laboratories are:

> **The Fish Health Laboratory** focuses on species diseases in federally listed salmonid species, white sea bass, and sardines. Effluent is chlorinated and de-chlorinated before being released into the seawater discharge (UCD/BML 2005).
>
> **DFG Pathogen Containment Facility** represents the only approved quarantine and holding facility for known or potentially diseased shellfish in California. Research includes species of importance to commercial and sport fisheries and also endangered species such as the white abalone (UCD/BML 2005).

Salmon Research Facility: Salmon research at BML can entail raising newly hatched or young fish to adult salmon. Depending on the project, some salmon are reared their entire life cycle in fresh water, while other projects may include introducing the young salmon slowly to seawater when they are at smolting age. Smolting is a physiological hormonal process that allows salmon to gradually transition from fresh water to seawater.

Smoltification periods are infrequent (maximum of 21 days per year), during which fish are held in tanks with gradually increasing salinity. UCD/BML mixes water from their own well (not chlorinated, and slightly saline at 3 ppt) with seawater in a semi-closed system, with makeup water at a maximum rate of 5 gallons per minute (gpm). Mixing proportions are set and controlled by the computer monitoring and control system to achieve the desired salinities. Following are two salinity schedules (Tables 2 and 3) for smolting two different species of salmon.

In the mixed salinity system in the Salmon Research Facility, freshwater and seawater flows in individual tanks are automatically adjusted daily to ensure the proper proportion of salinity according to the smolting schedule. Total freshwater added to the seawater flow during these short periods vary up to a maximum of 1 percent of total flow for 2-3 weeks annually.

Table 2. BML Winter Run Chinook Salmon Smolting Schedule.

Days	**1-2**	**3-5**	**6-8**	**9-10**	**11-12**	**13-14**	**15**
Salinity (ppt)	4-5	7-8	10-11	13-14	16-17	20-21	26

Table 3. BML Russian River Coho and Olema Creek Coho Salmon Smolting Schedule.

Days	**1-2**	**3-5**	**6-7**	**8-9**	**10-12**	**13-14**	**15-16**	**17-19**	**20**	**21**	**22**
Salinity (ppt)	4-5	7-8	10-11	13-14	16-17	20-21	23-24	26-27	29-30	32-33	seawater

Flow-through Seawater Laboratories

The South Wing flow-through seawater system distributes seawater to one shared-use wet lab (Room 20), two classrooms, and five research labs (Rooms 22 A & B, 47, 59, 67, 69).

The North Wing flow-through seawater system distributes seawater to one shared-use wet lab (Room 328), and four research labs (Rooms 324 A & B, 326 A & B, 328).

The West Wing flow-through seawater system distributes seawater to public education exhibits (three aquaria and one outdoor educational tidepool.)

Outside Areas

Various areas surrounding the buildings contain outside seawater tanks with flow-through seawater.

Aquatic Resources Group

ARG is an on-site group of staff generalists, biologists, and technicians who, in addition to maintaining the labs' core functions, also facilitate research for remote and in-house scientists. This includes the design and assembly of custom aquatic systems, the culture of study animals and food items, specimen collection outside of the ASBS and BMR for agencies and researchers, scientific diving, instrumentation and the collection environmental data, and marine operations. This unit is responsible for providing facility wide animal husbandry/life support services to research staff, graduate and undergraduate students, as well as off-site and visiting researchers. ARG supervises and performs the routine health care and environmental maintenance work directly related to the collection, receiving, housing, handling, evaluation, culture, nutrition, disease treatment, and disposition of a wide variety of research and public education animals. This group manages all BML research wet space, ensures the all Institutional Animal Care & Use Committee and Association for Assessment & Accreditation of Laboratory Animals requirements are met including the training and record maintenance for all on-site researchers, staff, and students. ARG participates in campus, state, and federal vertebrate research inspections and is responsible for implementing all applicable requirements to ensure facility wide compliance (UCD/BML 2007).

ARG collaborates with UCD/BML Physical Plant on seawater system design, construction, maintenance, and repair, in addition to designing and constructing specific experimental/life support systems for research. ARG is responsible for live scientific specimen collections for on site research as well as for shipment to off-site research institutions on a rechargeable basis. ARG provides over sight and daily responsibility for research animals including data collection, live specimen housing, storage, care and feeding, food stuff procurement, and shipping on a rechargeable basis. ARG has primary responsibility for the design, fabrication, modification, and maintenance of public display aquaria/vivaria including associated life support systems on a daily basis year round. ARG also provides vessel maintenance and preparation as well as scuba diving in support of research (UCD/BML 2007).

The ARG is permitted by the DFG to collect and ship a wide variety of marine organisms to research and educational facilities. Collected specimens are packed and shipped locally, nationally and even internationally. Normal areas of operation extend from San Francisco Bay to Mendocino County. ARG is equipped with the proper collection equipment, including fish traps, crab pots, seines, trawl nets, and hook and line gear. A list of species collected and shipped by ARG is listed in Appendix P.

Boating Safety Program
The new UCD Boating Safety Program, established at BML in 2005, trains researchers in boat operation and is affiliated with the Scientific Boating Safety Association and the National Safe Boating Council. Program staff are certified boating instructors for the Department of Interior and the U.S. Coast Guard. The Boating Safety Program was developed to address the needs of university boaters in a variety of locations and environmental conditions. Approximately 50 researchers were trained in 2005-06 (UCD/BML 2006). The motorized vessels used in this program are not launched in the ASBS but are instead launched in Bodega Bay.

Marine Operations
The marine operations at UCD/BML include vessel operations and marine instrumentation, an extensive dive program, and boating safety program described above. UCD/BML's fleet of small vessels is varied, from kayaks for paddling the calm inner harbors and esteros, to inflatable and other dive boats suited for Bodega and Tomales Bays, to a 20-foot, comprehensively-equipped, center-console workboat, The Cape Horn. BML's 42 foot premiere research vessel, the Mussel Point, is specifically designed to gather oceanographic data in the demanding waters nearshore and offshore of northern California's rugged coast. It is comprehensively equipped with state-of-the-art marine electronics and communications. The Mussel Point's back deck is outfitted with a hydraulic A-frame and winch, and its transom is hydraulically raised and lowered for personnel and equipment deployment and recovery. It is designed to be SCUBA diver friendly, convertible and appropriate for diverse research efforts (UCD/BML 2007). All motorized vessels that are kept in the water are docked in Bodega Bay. All other motorized vessels that are trailered are launched in Bodega Bay. Motorized vessels are not currently launched in the ASBS.

Monitoring the Ocean/Seawater System Monitoring
Bodega Ocean Observing Node is a coastal ocean observing system, within the Central and Northern California Ocean Observing System and part of the national Integrated Ocean Observing System (IOOS), and centered at BML (38º19.110' N 123º04.294' W). Meteorological sensors measure wind, air temperature, humidity, barometric pressure, solar and photosynthetically-active radiation, and rainfall. The Coastal Oceans Currents Monitoring Program is a state multi-institution, interagency collaboration with the goal of integrated monitoring of currents in the coastal ocean for weather agencies, salmon restoration and fisheries management, marine sanctuaries and marine protected areas, coastal water quality, search and rescue, oil spill response and risk assessment, and national security. The three existing high frequency radar units have been operating for over four years (UCD/BML 2005).

UCD/BML's flowing seawater system is part of the Laboratory's coastal ocean observing node. Seawater is pumped from the intake in Horseshoe Cove to the intake pump house where automated systems measure salinity and temperature. A fluorometer has been installed to measure chlorophyll in the ambient seawater. These data are stored, summarized, and used to support research at BML as well as forming a node of a statewide monitoring network. The state and federal governments have been investing money in networks of ocean monitoring systems as a necessary step in gathering the data needed to guide management of the ocean and its fisheries (UCD/BML 2005).

UCD/BML Seawater System Physical Plant Operations

Volume and Seasonal Characteristics

The seawater flow is monitored at two central points within the seawater system, after the water has passed through the clarifier but before it is distributed to end-user laboratories. (See Appendices T and U for plant facilities maps.) Previously UCD/BML also attempted to measure flow at the outfall, but difficulties of measuring flow in partially full pipes caused UCD/BML to remove the flow meter at that site. Discharge flow rate at the ocean outfall is approximately the same as the centrally measured flow rate, but it can differ from time to time if any of these three circumstances applies:

(1) Discharge rate may be lessened because other organizations have permission to withdraw seawater from the system into tanker trucks for transport to their facilities. This difference is barely measurable, amounting to less than 10,000 gallons per month, or less than 0.1 percent of total flow.

(2) Discharge will be higher when raw (unfiltered) seawater is shunted around the clarifier directly to a laboratory. This occurs only part of the time, and may amount to anywhere from 0 to 15 percent of total flow. If raw seawater is diverted in the future at a rate above 5 percent of total flow, BML will install a separate flow meter to measure this diversion and will include it in total flow.

(3) Discharge will be higher when the salmon research program is adding brackish water to the discharge. This event may occur either when the program is transitioning fish through the smoltification process from fresh to saltwater, or when salmon are held in the Fish Pathology Laboratory for studies of diseases. Total brackish water added to the seawater flow during these short periods varies up to a maximum of 1percent of total flow.

When salmon are held in the Fish Pathology Laboratory in low salinity water, all effluent from this lab must pass through the chlorination-dechlorination system. These occurrences can require up to a maximum of 21 gpm of 3 ppt water (almost fresh), contributing a maximum of 4 percent to the discharge. This flow could lower the discharge salinity by slightly more than 1 ppt, within the normal range of salinities of the ambient ocean water in the ASBS (31 to 34 ppt). The contribution of low salinity water only reached this maximum level of 21 gpm during one 10-day period in 2004; at other times, it has ranged between 0 and 16 gpm.

Seawater flow data averaged 0.74 million gallons per day (mgd) in 2004. The pumping system is capable of pumping up to 1.5 mgd, but operates well below this limit. Initially, the system was designed and planned to accommodate a facilities expansion for the National Marine Fisheries Service (NMFS). UCD/BML's existing permit is for 3.0 mgd. The source is a dual-pipe intake line that draws water from within Horseshoe Cove adjacent to the laboratory (Figure 3) (listed as BOD012 in the SWQPA Discharge Survey). Flow does not fluctuate dramatically with season because most of the laboratory systems require fairly constant flow to maintain organisms, but an influx of visiting scientists and students during summer months usually contributes to an increase of about 20 percent during summer. There is no stormwater mingled with the seawater discharge (UCD/BML 2005).

Intake Lines and Pumping System

Two 8" diameter PVC (schedule 80) seawater intake lines extend 266' into Horseshoe Cove. Each line has two 3' long x 8" diameter PVC intake screens that are removed, cleaned, and replaced three to four times a year. A concrete pump house, located on the northwest bluff of Horseshoe Cove, contains pumps and controls. Seawater is pumped by two 40 hp stainless steel centrifugal pumps at a maximum rate of 500 gpm per pump. Pumps are controlled by two Variable Frequency Drives (VFDs) that are further controlled by UCD/BML's Programmable Logic Controllers (PLCs). Pumps operate at a variable rate to keep the laboratory supplied with full storage tanks. As usage changes, flow rate adjusts to correspond to demand. Most of the seawater flows directly to the clarifier, but a portion can be directed to some laboratory areas via a pressure line when raw seawater is required for experimental use (UCD/BML 2005).

Clarifier and Pumping System
The two pressure supply lines from the Horseshoe Cove pump house supply this new system. Clarification of raw seawater is accomplished by moving the seawater in a passive upwelling motion through multiple lightweight gravel beds. The seawater clarifier removes large debris with screens, and contains a settling pre-chamber for large-grained sediment. Eight side-by-side additional gravel beds filter the seawater before it is pumped to the seawater storage tanks. The settling pre-chamber is cleaned by shovel and stored above ground for later removal or grounds keeping. Gravel beds are backwashed once a week using high volume low-pressure air, and then the backwash drains to the waste seawater outfall. Adjacent to the clarifier is a pump house containing three stainless steel 15 hp centrifugal pumps to supply the North Wing and South Wing seawater holding tanks on the roofs of the laboratory. The pumps are controlled in the same manner as the Horseshoe Cove pumps, via VFDs and PLCs. This allows for pumping only the amount of seawater needed at any given time.

Distribution System
Seawater is pressure-supplied to the holding tanks on the North Wing (24,000 gallons) and South Wing (10,000 gallons) roofs. Interior and exterior tanks and seawater tables throughout the Laboratory, including the salmon research facility, are supplied with seawater via gravity lines from the holding tanks. Subsystems can supply seawater that is chilled, heated, of variable salinities, or ultra pure to meet the requirements of researchers. The principal need is for chilling to counteract the slight increase in temperature while seawater is in the clarifier and storage tanks. The demand for heating of seawater is small and is in semi-closed systems with a low flow rate of makeup water.

Monitoring and Control System
All essential elements of the seawater system are controlled using PLCs. These units interface with parameters and controls or respond to alarms 24/7. Alarms are set to automatically activate backup systems and contact staff at the lab or at home. Staff can monitor and adjust controls from home via the internet.

Pathology Laboratory Chlorination-dechlorination System
The pathology laboratories are located adjacent to the North Wing. The two pathology laboratories studying fish health and invertebrate health are supplied with up to 80 gpm of seawater, approximately 15 percent of total flow to the laboratory when they operate at maximum flow. To preclude the escape of any disease-causing microorganisms, all effluent from these two labs is treated with chlorine according to requirements set by the DFG. Liquid chlorine (12.5 percent sodium hypochlorite solution, bleach) is injected into the effluent seawater for 2 hours contact time. Chlorine concentration in the treatment system is computer-controlled between 12 and 15 ppm, with chlorine concentration sensors and alarms at three points.

Chlorine treatment takes place in a cascade system through successive tanks. After treatment, the effluent is exposed to gaseous hydrogen sulfide as a dechlorination process. Flow from the pathology laboratories through the chlorination-dechlorination system then joins the main seawater discharge line. At this point, the seawater is monitored for any residual chlorine, using a USEPA-approved monitoring device connected to the monitoring and control system. In Section II, these monitoring results are presented in Table 7 Seawater System Residual Chlorine Monitoring, January 2004, and discussed next in the *Waste Seawater Discharge* section.

Alarms activate backup systems when chlorine concentration falls outside desired parameters (12 to 15 ppm (mg/L) in treatment tanks and <0.05 ppm (mg/L) at final outfall measurement), and an automated service telephones Physical Plant staff at work or at home at all hours (UCD/BML 2005).

The BML is developing plans for one additional laboratory system that will require chlorine treatment and dechlorination prior to release of seawater. This new laboratory system will be dedicated to research with invasive marine species and will be the only laboratory in California capable of safely addressing this important issue. Depending on the species involved, chlorine concentration may be higher than in the pathology laboratory treatment, but flow rates will be less. The total amount of chlorine used will probably range up to the amount currently used in the pathology laboratory treatment system. The new invasive species treatment system will be separate from and independent of the existing treatment system, with all effluent chlorinated and then dechlorinated prior to joining the main seawater discharge for the final chlorine sensor measurement (UCD/BML 2005).

Waste Seawater Discharge
All seawater from all laboratory systems is returned via gravity flow in discharge lines to the ocean outfall located in the low intertidal zone of a surge channel just outside of Horseshoe Cove. The main discharge line is a 12" PVC drain line. Various laterals from experimental areas flow into this main line (UCD/BML 2005).

Experimental Freshwater System

Source and Treatment
To supply the untreated, unchlorinated freshwater needed for maintenance of freshwater stages of anadromous fish in the Salmon Research Facility, BML has developed a well on University property approximately 0.7 mile from the Laboratory. This well does not meet potable standards because of the 3 ppt salinity, but it is filtered to 30 microns and satisfies the needs of highly sensitive fish such as salmon fry. It is first clarified using a small gravel filter system, and then distributed via pressure lines to the salmon facility and the Fish Health (pathology) Laboratory. Four 30-inch pleated cartridge filters are removed and rinsed weekly at an outside area into a groundwater drain that recharges the north end of the wetland. Researchers have access to 100 gpm of the filtered, unchlorinated freshwater.

Freshwater Discharge
The NPDES permit currently allows UCD/BML to discharge a small amount of the freshwater discharge from the salmon research projects to the wetland during the dry weather, but this practice stopped in 2005. All of the freshwater (3 ppt) drainage from the Salmon Research Facility is discharged via NPDES Permitted Discharge Serial 002 to a groundwater recharge area in the sand dunes northeast of the salmon facility (K. Brown pers. comm. 2007).

As described in the Salmon Research Facility description, occasionally a portion of the freshwater flow is mixed with seawater at varying salinities to transition salmon from freshwater to seawater or for holding salmon during pathology studies. This brackish water is discharged into the seawater drain lines (UCD/BML 2005).

Waterfront Facilities
A boat ramp provides access to Horseshoe Cove Beach for small, human-powered watercraft and diving gear and is only used about 12 times per year on average. Kayaks and boats are carried across the sand. All vehicles must remain on the ramp (UCD/BML 2005, UCD/BML 2007). More detailed information is located in the S*tormwater and Other Discharges* section of this document.

UCD/BML On-site Sewage Treatment
Septic tank-leachfield systems are used to deal with wastes from the BML's research and administration facilities and housing facilities. Small quantities of chemicals used in the research laboratories are transported for off-site disposal in accordance with state and federal regulations. In May 1988, BML proposed to the North Coast Water Board the construction of two septic tank-leachfield systems to handle domestic wastewater generated by the research and administration facilities and housing facilities. Both proposed subsurface systems included a pressure distribution system for uniform dosing (North Coast Water Board, Order No. 89-117). The new septic systems for both the laboratory and housing facilities were completed in 1991. The laboratory septic tank and lift station are located on the northeast side of the main driveway, near the main parking lot. The septic line runs along the eastern side of the main driveway, and extends 0.5 miles to the southeast. The laboratory leachfield is located on the northwest side of the public trail. The housing leachfield is located in the dunes southwest of the housing facilities. There is no surface drainage from these leachfields to the ASBS.

The system for the research and administration facilities includes one septic tank, a lift station and a conventional leachfield trench system designed to handle an average daily flow of 12,120 gallons per day (gpd) and a peak flow of 20,000 gpd. The North Coast Water Board specified that the daily dry-weather flow of wastewater to the research and administration facilities system was not to exceed 12,120 gpd averaged over a period of 30 consecutive days. The peak wastewater flow to the research and administration facilities system was not to exceed 20,000 gpd. The laboratory "standard" leachfield is 3,080 linear feet of leachline. The average flow between July 2005 and January 2007 (not including September through October 2006) was 4,913 gpd (see Table 4) (K. Brown 2007).

The system for the housing facilities includes a combined gravity/pressure collection system, a central lift station, and four subsurface absorption beds. The housing system is designed to handle an average daily flow of 6,000 gpd and a peak flow of 9,600 gpd. The North Coast Water Board specified that the average daily dry-weather flow of wastewater to the housing system shall not exceed 6,000 gpd averaged over a period of 30 consecutive days. The peak wastewater flow to the housing system was not to exceed 9,600 gpd. The housing absorption bed leachfield consists of four absorption beds. Each absorption bed is 20 by 115 feet (with 4 distribution lines in each bed), totaling 9,200 square feet of absorption bed. The average flow between July 2005 and January 2007 was 2,735 gpd (K. Brown 2007).

The North Coast Water Board also required that monitoring be conducted. Chemical, bacteriological, and bioassay analyses are conducted at a laboratory certified for such analysis by the State Department of Health Services. BML's plant manager is to inspect the septic tanks annually. BML was also required to quarterly sample standing water in monitoring wells for total coliform, fecal coliform, and nitrate (North Coast Water Board, Order No. 89-117).

Maintenance for both systems includes routine inspections of drains within buildings to the septic tanks. Monthly septic tank maintenance includes checks on lift station pumps and floats. Monthly dose meter readings are recorded to calculate average daily flows. The next septic tank inspection and pumping (if required) was scheduled for April 2007. The leachfields are monitored monthly for groundwater depth, surface water, and odor. Groundwater is sampled for nitrates, total coliform, and fecal coliform on a quarterly basis. Quarterly and annual monitoring reports are sent to the Water Board.

In 2002-04, UCD/BML collaborated with the North Coast Water Board and Sonoma County Environmental Health to determine the source of high levels of coliform bacteria in Campbell Cove in Bodega Harbor. The State Water Board Clean Beaches Initiative funded this program. UCD/BML assisted with water samples, and partners from UC Scripps Institution of Oceanography conducted a study of the harbor circulation to determine the potential for contaminants to be transported, dispersed, and accumulated in the harbor. The source and dispersion of coliform contamination was tracked. UCD/BML volunteered eleven years of leachfield groundwater monitoring data, which were submitted to Sonoma County Environmental Health Division and the North Coast Water Board for groundwater movement analysis. DNA analysis performed by the University of Washington revealed that the high coliform levels in Campbell Cove were from birds and marine mammals and not from human sources. (K. Brown 2007).

In June 2006, UCD/BML registered a Notice of Intent to comply with the statewide general waste discharge requirements for sanitary sewer systems (Water Quality Order # 2006-0003.)

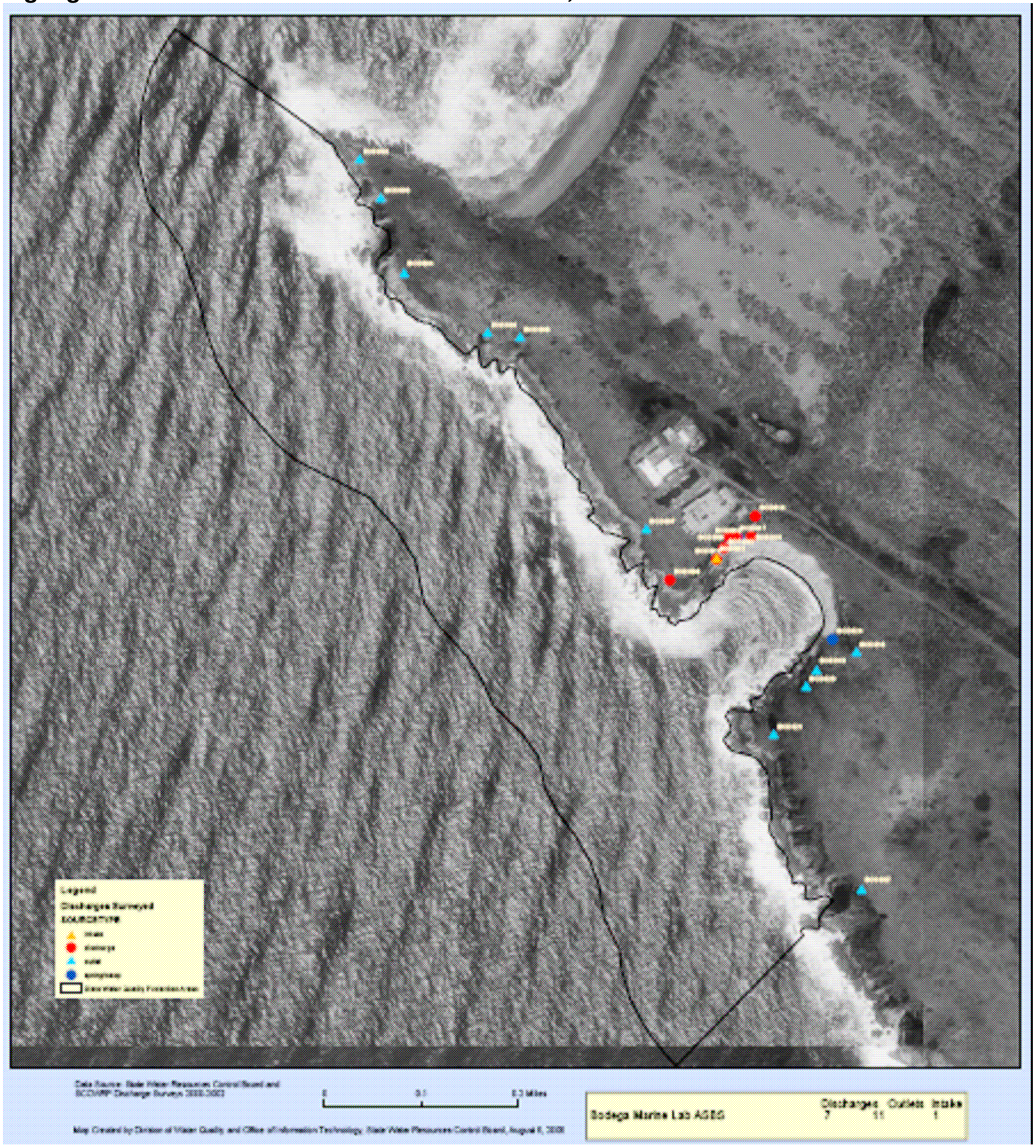
Table 4. BML Septic System Daily Average Flows (gallons per day).

Month	Lab Wastewater Flow (gpd)	Housing Wastewater Flow (gpd)	Notes
Jul-05	5595	5261	
Aug-05	3441	3330	
Sep-05	2560	3760	
Oct-05	3381	1104	
Nov-05	3352	1058	
Dec-05	3366	1080	
Jan-06	8330	3249	
Feb-06	8925	1928	
Mar-06	9337	2360	
Apr-06	5617	3237	
May-06	5500	3125	
Jun-06	3939	2848	
Jul-06	7711	5926	
Aug-06	4127	3058	
Sep-06	286	1999	Dose meter broken
Oct-06	repair	3141	Dose meter repair
Nov-06	3165	2166	
Dec-06	2650	1850	
Jan-07	2523	1479	

Existing Surface Discharges into the ASBS

The Southern California Coastal Water Research Project (SCCWRP), under contract to the State Water Board, conducted a survey of all discharges into SWQPAs. SCCWRP's (2003) final report identified 21 drainages into the Bodega ASBS, consisting of seven discharges, 11 outlets (natural ephemeral streams), one intake line, and two seeps (Figure 3).

Figure 3. UCD/BML Existing Discharges into Bodega ASBS (SCCWRP 2003). The discharges highlighted in red include waste seawater effluent, storm water and non-storm water runoff.



UCD/BML Waste Seawater Discharge

Seawater is pumped from an intake in Horseshoe Cove, circulated from a flow-through aquarium system that maintains numerous marine aquatic species used for a variety of research projects at the laboratory, and then discharged at drain **BOD008**. Based on the current pumping capacity, the maximum waste seawater discharged from the facility is 1.5 mgd. An isolated fraction of seawater is chlorinated, de-chlorinated, and then commingled with flow-through untreated seawater. This water is discharged to the near shore waters of the Pacific Ocean near Horseshoe Cove (NPDES Permitted Discharge Serial 008). This facility is a minor discharger as defined by the U.S. EPA (North Coast Water Board 2000).

During toxicity testing conducted in February 2006 (see Table 5) in support of the UCD/BML exception application, waste seawater was observed to have depressed salinity of 28.2 ppt. UCD/BML determined that the cause of their low salinity sample and discharge was due to fresh water from the Russian River Coho Salmon Recovery Project commingling with the waste seawater drainage (UCD/BML 2006). This practice has since been changed. Freshwater drainage from the Salmon Recovery Project is now diverted to the main freshwater discharge line and no freshwater is discharged to the ocean outfall. (K. Brown 2007). In addition, until 2003, five gray water sinks from labs in the South Wing drained into and commingled with seawater discharge at Horseshoe Cove, but this practice was discontinued.

UCD/BML Storm Water Discharge
The SCCWRP discharge survey report identified several storm water or other possible discharge locations. Descriptions of these drainages and their status were provided by UCD/BML (2005) according to the SCCWRP ID numbers (Figure 3).

Discharge site ***BOD009*** is the wood and sand stairway, ending on a concrete step and retaining wall that provides access to the sandy beach of Horseshoe Cove. It has been in place since the 1960s. Each step is a weathered redwood board holding back the sand-filled step. It gathers water only from the immediate area of the steps, and its porous construction results in almost no surface flow down the steps. The redwood and concrete have been in place for many years and are unlikely to contribute to any deterioration of water quality.

Site ***BOD010*** is a natural seep in the coastal bluff. When the marine lab was constructed in the 1960s, a small concrete catch basin and grate were installed in the grassland on the bluff above the seep to gather natural drainage from the grassland and direct it to the seep underground, to reduce the risk of surface erosion. With the area now covered with vegetation, the laboratory has examined the basin and grate during the winter 2004-2005 rains and has concluded that they are no longer necessary. The laboratory sealed and filled the drain and removed the grate during summer 2005. There is no anthropogenic input to this seep.

Discharge site ***BOD011*** is the weathered concrete and wood pump house and stairs for the intake end of the seawater system. It does not drain any area beyond the surface of the concrete structure. It has freshwater surface flow only when raining. It has a minor flow of seawater (approx. 1.5 gpm) that is overflow from monitoring instruments inside the pump house, measuring salinity and temperature of the intake seawater. This seawater has passed through the intake lines and pump to the instrument sensors and back by gravity flow to the intertidal rocks. It has not been treated or exposed to any pollutants. A similar concrete structure of wood and weathered concrete is part of the seawater system outfall (***BOD008***) and also drains only the immediate structure, with runoff only when raining.

Site ***BOD013*** is an inactive drain, originally a seawater discharge from some seawater tanks in the laboratory. The seawater was redirected to the main outfall during the 1980s, and this drain was sealed at its upper end. The drain has now been plugged at its lower end, and the pipe that was visible on the beach has been removed.

BOD014 is a boat ramp that provides access to Horseshoe Cove Beach for small, human-powered watercraft and diving gear. It is used about 12 times per year on average. Kayaks and boats are carried across the sand. All vehicles must remain on the ramp. In the past ten years, no motorboats have been launched from the cove. There are no plans to do so in the future.

Discharge site ***BOD016*** is the only significant storm water drain, a culvert pipe and concrete trough emptying onto the sands of Horseshoe Cove Beach. Water flowing through this system comes from a natural freshwater wetland approximately 220 feet from the beach. Rainwater falling on the buildings, road and parking lots flows as sheet runoff over the surrounding soil (sandy loam to loamy sand) and vegetation before draining into the freshwater marsh. This combination of runoff over vegetated soil and through the marsh may constitute treatment through natural processes prior to draining to the ASBS. It then moves through the wetland to the downstream end where the culvert and trough carry it to the beach.

BOD017 is a terra cotta pipe, installed when the laboratory was built in the 1960s and drained a small service and parking area near the Laboratory. As the BML investigated this discharge, they discovered that it also contained a trickle of seawater from a leaking seawater tank fitting. They have repaired the tank leak so that seawater now only enters the main ocean outfall line, and the storm water drain from the service and parking area has been re-engineered so that it is directed into a rock-filled underground dry well. These two changes have stopped all flows from this pipe to the ASBS, and the old pipe has been sealed at its lower end.

ENVIRONMENTAL IMPACTS

The environmental factors checked below could be potentially affected by this project. See the checklist on the following pages for more details.

☐	Land Use and Planning	☐	Transportation/Circulation	☐	Public Services
☐	Population & Housing	☑	Biological Resources	☐	Utilities & Service Systems
☐	Geological Problems /Soils	☐	Energy & Mineral Resources	☐	Aesthetics
☑	Hydrology/Water Quality	☐	Hazards	☐	Cultural Resources
☐	Air Quality	☐	Noise	☐	Recreation
☐	Agriculture Resources	☐	Mandatory Findings of Significance		

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
GEOLOGY and SOILS. Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:	☐	☐	☐	☑
i) Rupture of a known earthquake fault, as delineated in the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines & Geology Special Publication 42.	☐	☐	☐	☑
ii) Strong seismic ground shaking?	☐	☐	☐	☑
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☑
iv) Landslides?	☐	☐	☐	☑
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☐	☑
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☑
d) Be located on expansive soils, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☑
e) Have soils incapable of adequately supporting the use of septic tanks or alternate wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☑

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact

AIR QUALITY. Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:

a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☑
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☐	☑
c) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☑
d) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions that exceed quantitative thresholds for ozone precursors)?	☐	☐	☐	☑
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☑

HYDROLOGY and WATER QUALITY. Would the project:

a) Violate any water quality standards or waste discharge requirements?	☐	☑	☐	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (*e.g.*, the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☐	☐	☑
c) Substantially alter the existing drainage pattern of the site, including through alteration of the course of a stream or river, or substantially increase the rate or volume of surface runoff in a manner that would:				
i) result in flooding on- or off-site	☐	☐	☐	☑
ii) create or contribute runoff water that would exceed the capacity of existing or planned stormwater discharge	☐	☐	☐	☑
iii) provide substantial additional sources of polluted runoff	☐	☐	☐	☑
iv) result in substantial erosion or siltation on-or off-site?	☐	☐	☐	☑
d) Otherwise substantially degrade water quality?	☐	☑	☐	☐

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
e) Place housing or other structures, which would impede or re-direct flood flows within a 100-yr. flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☑
f) Expose people or structures to a significant risk of loss, injury, or death involving flooding:				
i) as a result of the failure of a dam or levee?	☐	☐	☐	☑
ii) from inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☑
g) Would the change in the water volume and/or the pattern of seasonal flows in the affected watercourse result in:				
i) a significant cumulative reduction in the water supply downstream of the diversion?	☐	☐	☐	☑
ii) a significant reduction in water supply, either on an annual or seasonal basis, to senior water right holders downstream of the diversion?	☐	☐	☐	☑
iii) a significant reduction in the available aquatic habitat or riparian habitat for native species of plants and animals?	☐	☐	☐	☑
iv) a significant change in seasonal water temperatures due to changes in the patterns of water flow in the stream?	☐	☐	☐	☑
v) a substantial increase or threat from invasive, non-native plants and wildlife	☐	☑	☐	☐
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☑

Laboratory Facilities Storm Water Runoff

Bodega Marine Laboratory received the Southern California Coastal Water Research Project of 2003 survey results identifying storm water discharges into the ASBS and met with John Short of the North Coast Regional Board to determine best management practices (BMPs) and engineering modifications to eliminate detrimental effects on water quality in the ASBS. The laboratory has removed two discharge outlets, rerouting one of them to a rock-filled underground dry well, repaired a leak, and modified their management practices to minimize parking lot contaminants entering the freshwater wetland that drains into the ocean. With these changes, UCD/BML anticipates that there will be no dry-season discharges from any of the stormwater locations.

Except for three very small, local areas where sheet flow is exposed to weathered concrete or wood, all wet weather storm water will be processed through a vegetated wetland prior to release. Discharge site ***BOD016*** is the only significant stormwater drain, a culvert pipe and concrete trough emptying onto the sands of Horseshoe Cove Beach. Water flowing through this system comes from a natural freshwater wetland approximately 220 feet from the beach. Rainwater falling on the buildings, road and parking lots flows as sheet runoff over the surrounding soil (sandy loam to loamy sand) and vegetation before draining into the freshwater marsh. This combination of runoff over vegetated soil and through the marsh may constitute treatment through natural processes prior to draining to the ASBS. It then moves through the wetland to the downstream end where the culvert and trough carry it to the beach.

UCD/BML has adopted these management practices to minimize the potential for pollution in the wetland:

1. UCD/BML staff and students are asked to make certain their cars do not have oil leaks.

2. Washing of private vehicles is prohibited at UCD/BML. State vehicles and boats may be rinsed only, without soap, in two designated areas.

3. No chemicals, including fertilizers, can be used in areas where they might wash from parking lots or Laboratory ground into the wetland.

In addition to these rules governing runoff, UCD/BML does not allow dogs or other pets on the BMR surrounding the Laboratory and does not keep any mammals, either marine or terrestrial on the premises for research (UCD/BML 2005). Wild terrestrial mammals that frequent the wetland and surrounding BMR include black-tailed deer, raccoons, foxes, skunks, rabbits and small rodents. About 100 harbor seals haul out in the rocky intertidal zone of the ASBS near the outfall and in Horseshoe Cove, and California sea lions and elephant seals occur in the adjacent waters and on Horseshoe Cove beach (K. Brown 2007).

Herbicide and insecticide use policies of Bodega Marine Laboratory and Reserve

Herbicide and pesticide applications are considered in this Initial Study, as they are a potential source of wastes in runoff to the ASBS. The Bodega Marine Laboratory and Reserve follows an integrated pest management approach. All management alternatives are evaluated for safety, environmental impacts, and effectiveness. Chemical control is chosen as a last resort, and only when benefits outweigh the risks. If chemical control is chosen as the best alternative, chemicals are thoroughly reviewed, the least toxic chemical is chosen, and standard protocols are developed to minimize risks. Assessments are conducted to monitor results and to insure that management goals are being met, e.g., preservation of native biodiversity or protection of ecological research.

To preserve biodiversity of native plants in upland grasslands, BMR staff currently use three herbicides, Roundup (glyphosate), Poast, and Garlon to control invasive weedy plants. Roundup is a non-specific herbicide, and is applied by hand-carried or backpack sprayer in areas where almost all vegetation is invasive and needs to be controlled. Poast is a monocot-specific herbicide, and is applied by hand-carried or backpack sprayer in research habitats harboring invasive grasses mixed with native forbs, for the purpose of eliminating the invasive grasses without harming the forbs. Garlon is used in very limited quantities for stump-painting of shrubs after cutting, to prevent re-sprouting. Researchers may apply to the Bodega Marine Reserve Research Coordinator for permission to use small quantities of herbicides and insecticides to control weeds or insects as part of the scientific manipulation of an experiment. All of the limitations above will apply, and additional limitations may be imposed.

Herbicides for weed control or research applications are only used in upland, terrestrial portions of the Reserve. To protect water quality and aquatic species, no use of herbicides or insecticides is permitted in or adjacent to marine or freshwater wetland areas, or where they can drift or move into marine or freshwater wetland areas. Herbicide use is mainly during the late spring to autumn dry season, and never when rain is forecast for the next few days.

All chemicals are applied in accordance with labeling and MSDS application guidelines to minimize disturbance to untargeted species and to water quality. No use of herbicides or pesticides is permitted when winds exceed 8 mph. All use, storage, and disposal of these chemicals require permission, training, and oversight by Bodega Marine Reserve staff familiar with local, state, and federal regulations. Standard chemical safety practices established by the University of California are followed for storage, mixing, transportation, and disposal. All herbicides and insecticides are stored in secondary containment in the locked Potting Shed. Reserve staff controls access. There are no drains to the seawater system in the Potting Shed.

Summary, Storm Runoff

BML has made strides toward improving its control of storm water runoff. The laboratory has performed many physical modifications and modified their management practices to minimize storm water pollution. It is anticipated that the freshwater marsh will provide treatment for the majority of the storm runoff prior to entering the ASBS. In terms of runoff from the Reserve, except for the laboratory, housing areas, and roads, the Reserve is primarily natural open space. This natural open space should not contribute pollutants into the ASBS. The one potential source of wastes is herbicide and pesticide applications. Three herbicides have been identified that are used to control weeds or for small applications in research. These are Roundup, Poast and Garlon. According to existing BML procedures these chemicals are applied mainly during the late spring to autumn dry season, and never when rain is forecast for the next few days.

The following mitigating conditions will be required for the exception in relation to non-storm runoff and storm water management plans:

- *The discharge must comply with all other applicable provisions, including water quality standards, of the Ocean Plan. Natural water quality conditions in the receiving water, seaward of the surf zone, must not be altered as a result of the discharge. The surf zone is defined as the area between the breaking waves and the shoreline at any one time. Natural water quality will be defined, based on a review of the monitoring data, by Regional Water Board staff in consultation with the Division of Water Quality of the State Water Board. For constituents other than indicator bacteria, natural water quality will be determined using the reference station in the ocean near Mussel Point. For indicator bacteria, the Ocean Plan bacteria objectives will be used.*

- *UCD/BML must continue to prevent all discharges of non-storm water facility runoff (i.e., any discharge of facility runoff that reaches the ocean that is not composed entirely of storm water), except those associated with the waste seawater system and emergency fire fighting.*

- *UCD/BML must specifically address the prohibition of non-storm water runoff and the reduction of pollutants in storm water discharges draining to the ASBS in a Storm Water Management Plan/Program (SWMP). UCD/BML is required to submit their final SWMP to the Regional Water Board.*

- *The SWMP must describe the measures by which non-storm water discharges have been eliminated, how these measures will be maintained over time, and how these measures are monitored and documented.*

- *The SWMP must include a map of surface drainage of storm water runoff, including areas of sheet runoff, and any structural Best Management Practices (BMPs) employed. The map must also show the storm water conveyances in relation to other facility features such as the laboratory seawater system and discharges, service areas, sewage treatment, and waste and hazardous materials storage areas. The SWMP must also include a procedure for updating the map and plan when other changes are made to the facilities.*

- *The SWMP must also address storm water discharges, and how pollutants have been and will be reduced in storm water runoff into the ASBS through the implementation of BMPs. The SWMP must describe the BMPs currently employed and BMPs planned (including those for construction activities) and an implementation schedule. The BMPs and implementation schedule must be designed to ensure natural water quality conditions in the receiving water due to either a restriction of flows from impervious surfaces, or reduction in pollutants, or some combination thereof. The BMPs must include the measures taken to prevent the runoff of herbicides or pesticides, from BML and the Reserve, into the ASBS. The implementation schedule must be developed to ensure that the BMPs are implemented within one year of the approval date of the SWMP by the Regional Water Board.*

- *At least once annually, during wet weather (i.e. storm event), the runoff from the outfall draining the marsh, and the receiving water adjacent to the storm water marsh outfall, in Horseshoe Cove, must be sampled and analyzed for Ocean Plan Table B constituents. The storm water runoff and the Horseshoe Cove receiving water must also be monitored for Ocean Plan indicator bacteria water quality objectives. The sample location for the receiving water will be immediately seaward of the surf zone in Horseshoe Cove adjacent to the outfall location. Storm water runoff and Horseshoe Cove receiving water must be sampled at the same time as the wet weather seawater effluent and reference sampling. Based on the first year sample results the Regional Water Board will determine specific constituents in the storm water runoff and receiving water (that were at or above Table B objectives) to be tested during the remainder of the permit cycle, except that chronic toxicity (three species initially and thereafter the most sensitive species) for receiving water must be tested annually during a storm event.*

- *Once annually, the subtidal sediment in Horseshoe Cove must be sampled and analyzed for Ocean Plan Table B constituents. For sediment toxicity testing, an acute toxicity test using the amphipod Eohaustorius estuarius must be performed during the first year of the permit cycle. Based on the first year sample results the Regional Water Board will determine specific constituents in the sediment to be tested during the remainder of each permit cycle, except that acute toxicity for sediment must be tested annually.*

- *For metals analysis, waste seawater effluent, storm water effluent, reference samples, and receiving water samples must be analyzed by the approved analytical method with the lowest minimum detection limits (currently Inductively Coupled Plasma/Mass Spectrometry) described in the Ocean Plan.*

- *Once during the upcoming permit cycle, a bioaccumulation study using resident California mussels (Mytilus californianus) must be conducted to determine the concentrations of metals near field (outfall station) and far field (Mussel Point). The Regional Water Board, in consultation with the Division of Water Quality, must approve the study design. The results of the survey must be completed and submitted to the Regional Water Board at least six months prior to the end of the permit cycle (permit expiration). Based on the study results, the Regional Water Board, in consultation with the Division of Water Quality, may adjust the study design in subsequent permits, or add additional test organisms.*

- *If the results of Horseshoe Cove receiving water monitoring indicate that the storm water runoff is causing or contributing to an alteration of natural water quality in the ASBS, as measured at the reference station at Mussel Point, UCD/BML is required to submit a report to the Regional Water Board within 30 days of receiving the results. Those constituents in storm water that alter natural water quality or receiving water objectives must be identified in that report. The report must describe BMPs that are currently being implemented, BMPs that are planned for in the SWMP, and additional BMPs that may be added to the SWMP. The report shall include a new or modified implementation schedule. The Regional Water Board may require modifications to the report. Within 30 days following approval of the report by the Regional Water Board, UCD/BML must revise its SWMP to incorporate any new or modified BMPs that have been and will be implemented, the implementation schedule, and any additional monitoring required. As long as UCD/BML has complied with the procedures described above and is implementing the revised SWMP, then UCD/BML does not have to repeat the same procedure for continuing or recurring exceedances of the same constituent.*

- *The Regional Water Board will include all the above listed mitigating conditions in one NPDES permit that regulates both the seawater effluent and storm water. Alternatively, the Regional Water Board may regulate the storm water discharge in a storm water NPDES permit, and in that case would include those conditions relative to storm water in that storm water NPDES permit. In the latter case, all conditions would be included, in some combination, in the waste seawater effluent permit and the storm water permit, and through its storm water management plan.*

Waterfront and Marine Nonpoint Source Pollution

Discharge point ***BOD014*** is an area of vegetated gravel road and a concrete boat ramp. The boat ramp that provides access to Horseshoe Cove Beach for small, human-powered watercraft and diving gear. It is used about 12 times per year on average. Kayaks and boats are carried across the sand. All vehicles must remain on the ramp. In the past ten years no motorboats have been launched from the cove. There are no plans to do so in the future. To minimize the potential for pollution from vehicles on the boat ramp, Bodega Marine Laboratory has the following policies:

1. The Boating Safety Officer or his designee will review and approve any plans to launch boats in the cove.

2. Vehicles may not use the boat ramp if they are leaking any fluids where they were parked last.

3. Vehicles and boats may not be rinsed or washed on the boat ramp (UCD/BML 2005, UCD/BML 2007).

Occasional inspections by the Bodega Marine Laboratory staff have not found any indication of oil or grease, so this area may be considered as clean as the other weathered concrete structures on the laboratory site (UCD/BML 2005).

There is also a small (80 square feet) air-sampling laboratory near the boat ramp. Signs are posted prohibiting any disposal or external use of soap or other contaminants. Currently, there is plumbing for both freshwater and seawater to the location of this laboratory, but there are no taps in the laboratory, and these are not needed for the air sampling projects (UCD/BML 2005).

The following mitigating conditions will be required for the exception in relation to nonpoint source pollution from the waterfront and marine operations:

- *UCD/BML shall prepare a waterfront and marine operations non-point source management plan containing appropriate management practices to address non-point source pollutant discharges. The Plan must address the current prohibition on launching motorized vessels, restrictions on motor vehicles, and other appropriate management measures including those described in the State's Non-point Source Program Implementation Plan for marinas and recreational boating, as applicable. The Regional Water Board, in consultation with the State Water Board's Division of Water Quality, will review the plan. Non-point source discharges will be appropriately regulated by the Regional Water Board in accordance with the State Water Board's Policy for Implementation and Enforcement of the Non-point Source Pollution Control Program. The waterfront plan must be implemented within six months of its approval.*

- *UCD/BML will notify the Regional Water Board within 180 days prior to any construction activity that could result in any discharge or habitat modification in the ASBS. Furthermore, UCD/BML must receive approval and appropriate conditions from the Regional Water Board prior to performing any significant modification, re-building or renovation of the waterfront facilities, including the boat launch, per the requirements of Section III.E.2 of the Ocean Plan.*

Waste Seawater Discharge

Chronic Toxicity Testing

Chronic toxicity tests evaluate the biological response of an organism to the effluent and measure the acceptability of waters for supporting a healthy marine biota. The Ocean Plan Table B Water Quality Objectives, for the protection of marine aquatic life, limiting concentration for chronic toxicity is 1.0 chronic toxicity unit (TUc). The No-Observed-Effect-Concentration (NOEC) is the highest concentration of toxicant to which organisms are exposed in a full life cycle or partial life-cycle (short-term) test that causes no observable adverse effects on the test organism. NOECs of 100percent indicate that there was no observed toxicity. NOECs less than 100percent indicate that there is observed toxicity.

The following are results of the chronic toxicity tests performed on the UCD/BML seawater effluent (waste seawater discharge) for samples in February 2006. The seawater effluent samples were received by Pacific Ecorisk at 28.2 ppt salinity, which was acceptable without adjustment for the silverside (fish) testing, but required the addition of artificial sea salts for the urchin and kelp tests to bring the salinity to 32 ppt. Results are presented in Table 5. The effluent resulted in 68.6percent germination of *Macrocystis* that was significantly less than for the Control results of 75.4percent germination. Therefore the chronic toxicity test results show that there was a significant reduction in the proportion of the kelp sporophytes germinated in the 100percent seawater effluent sample, compared to the Control, with a resulting TUc of >1.0. As stated above, artificial sea salt was added to the 100percent effluent to adjust the salinity to comply with the correct test range. Pacific Ecorisk indicated, "that the reduced normal development observed in the seawater effluent sample may be attributed to the artificial sea salt and not the effluent" (UCD/BML June 2006). However, there is no way to absolutely confirm that the artificial sea salt caused or contributed to the reduced normal development.

Table 5. UCD/BML Chronic Toxicity Waste Seawater Discharge Analysis February 2006.

Species	Test	NOEC	TUc
Algae			
Macrocystis pyrifera	Germination	<100percent	>1.0
Macrocystis pyrifera	Growth	100percent	1.0
Invertebrate			
Strongylocentrotus purpuratus	Development	100percent effluent	1.0
Vertebrate			
Menidia beryllina	Survival	100 percent effluent	1.0
Menidia beryllina	Growth	100percent effluent	1.0

Chemical and Physical Characteristics

Monitoring data for conventional constituents are required under the UCD/BML NPDES permit for the waste seawater effluent. Flow rate, pH, settleable solids and suspended solids are measured monthly. The results for the 2004 monitoring period are presented below in Table 6. Monthly flow rates averaged about 0.74 million gallons per day (mgd). UCD/BML's pumping system is capable of pumping up to 1.5 mgd per day, but at this time operates well below this limit. For effluent pH limits, the Ocean Plan requires that pH must be within the range of 6.0 to 9.0 pH units at all times (Table A Effluent Limitations). UCD/BML's effluent during this 12 month 2004 monitoring period ranged from 7.2 to 8.0, well within the Ocean Plan limits.

Settleable solids are measured and reported in milliliters per liter per hour. The Ocean plan effluent limits (Table A) for settleable solids are 1.0 ml/L (30 day average), 1.5 ml/L (7 day average) and 3.0 ml/L (Maximum at any time). UCD/BML's effluent is shown to be less than 0.1 ml/l/hr, well below the Ocean Plan limits. For suspended solids, the Ocean Plan requires that dischargers, as a 30-day average, remove 75percent of suspended solids from the influent stream before discharging to the ocean, except that the effluent limitation to be met shall not be lower than 60 mg/L. UCD/BML's effluent measurements for suspended solids were below the Ocean Plan's 60 mg/L low limitation (Table 6) requirement for ten months of 2004, and were above 60 mg/L (74 mg/L and 79 mg/L) for two months.

Table 6. UCD/BML Waste Seawater Effluent Monitoring Data for Flow and Physical Constituents 2004. Reported results from January 2004 to December 2004 were in compliance within the UCD/BML NPDES permitted effluent limits.

Month	Flow (mgd)	pH (pH units)	Settleable Solids (ml/L/hr)	Suspended Solids (mg/L)
Jan-04	0.70	7.8	<0.1	74
Feb-04	0.70	7.8	<0.1	47
Mar-04	0.74	7.9	<0.1	79
Apr-04	0.74	8.0	0.2	30
May-04	0.74	8.0	0.2	41
Jun-04	0.74	8.0	<0.1	11
Jul-04	0.84	7.8	<0.1	13
Aug-04	0.86	8.2	<0.1	20
Sep-04	0.78	7.9	<0.1	11
Oct-04	0.68	8.0	<0.1	20
Nov-04	0.68	8.0	<0.1	37
Dec-04	0.62	8.0	<0.1	22
mean	0.74	8.0	0.2	34

Seawater flow is monitored at two central points within the seawater system, after the water has passed through the clarifier, but before it is distributed to end-user laboratories. UCD/BML has attempted to measure flow also at the seawater discharge outfall, but difficulties of measuring flow in partially full pipes caused them to remove the flow meter at that site. Thus, data is provided for 2004 only. Discharge flow rate at the waste seawater outfall is approximately the same as the centrally measured flow rate, but can vary, as discussed in the *Volume and Seasonal Characteristics* section.

Residual Chlorine

As discussed in the *Volume and Seasonal Characteristics* section, there are two pathology labs on site studying fish and invertebrate health. These labs are supplied with up to 80 gpm of seawater from the UCD/BML seawater system, or approximately 15percent of the total flow at the lab. All pathology lab seawater waste effluent is treated with chlorine in accordance with the requirements set forth by the California Department of Fish and Game. A 12.5percent sodium hypochlorite solution (bleach) is injected into the effluent seawater for a 2-hour contact time. After treatment, the effluent is exposed to gaseous sulfur dioxide as a dechlorination process. Flow from the pathology laboratories through the chlorination-dechlorination system then joins the main seawater discharge line. At this point, the seawater is monitored for any residual chlorine, using an EPA-approved monitoring device connected to the monitoring and control system.

Alarms activate backup systems when chlorine concentration falls outside the system's existing parameters of 12 to 15 ppm (mg/L) in treatment tanks and <0.05 ppm (mg/L) at the outfall. All seawater from all laboratory systems is returned via gravity flow in discharge lines to the ocean outfall located in the intertidal zone of a surge channel just outside of Horseshoe Cove. The main discharge line is a 12" PVC drain line. Various laterals from experimental areas flow into this main line. The chlorine sensor resolution is 0.01 mg/L (10 µg/L), and the outfall alarm turns on at 0.05 mg/L (50 µg/L). The hand titration detection limit is 0.1 mg/L (100.0 µg/L). By comparison, the Ocean Plan instantaneous maximum objective is 60 µg/L, the daily maximum is 8.0 µg /L, and the 6-month median is 2 µg/L. While the UCD/BML's existing chlorine sensor can accurately measure under the Ocean Plan's instantaneous maximum objective, the detection limit is still above the daily maximum and 6-month median objectives for chlorine residual.

UCD/BMLs seawater system residual chlorine monitoring results for 2004 are presented in Table 7. The nondetects account for about 98percent of the year, but the reported detection limit (100.0 µg/L, set by the laboratory titration method) was 40 µg/L greater than the Ocean Plan's instantaneous maximum objective for residual chlorine.

The method detection limit for total chlorine residual in UCD/BML's existing permit, issued by the North Coast Regional Board (Order No. R1-2000-23) is 0.1 mg/L. Existing permit limiting concentrations are calculated as the arithmetic mean of the values for effluent samples collected in a period of 30 consecutive days.

On December 3, 2003 a spill of liquid chlorine was discovered, from the previous evening, which entered the wetland via a driveway drain. The spill resulted from a broken drain valve. BML staff took remedial action and notified the North Coast Water Board. On the next day (Dec. 4) BML staff measured chlorine in the wetland and found 1.0 mg/L total free chlorine. On the next day (Dec. 5) the level in the wetland had risen to 2mg/L, but by Dec. 8 total free chlorine was not detectable in the wetland. Total free chlorine at the wetland's discharge culvert into the ASBS was not detectable (at a concentration of < 0.1 mg/L) when measured during the period December 4 through 8, 2003.

Brief discharges of ≤ 0.3 mg/L occurred while maintenance staff adjusted injection levels and re-calibrated chlorine sensors (UCD/BML 2005). On February 24th residual chlorine was 0.3 mg/L (300 µg /L). On February 25th, June 14th, and October 29th residual chlorine was 0.2 mg/L (200 µg /L). Six additional monitoring days (June 4th, August 2nd and 3rd, September 13th, October 15th, and December 23rd) show results between 0.13 mg/L and 0.19 mg.L (130 µg /L and 190 µg /L). These all exceed the Ocean Plan instantaneous maximum objective of 60.0 µg /L.

Staff recommends that UCD/BML continuously monitor residual chlorine using an instrument capable of a minimum detection limit of 5 µg/L. The reporting limit shall be 50 µg/L. This reporting limit is based on the approximation factors set forth in the Standard Methods for the Examination of Waste and Wastewater (20th Edition, 1998), which can estimate method detection limits from instrument detection limits. In addition bench top residual chlorine measurements should be performed monthly using an automatic chlorine amperometric titrator with a manufacturer minimum method detection limit of 10 µg/L total residual chlorine. The reporting limit should be 12 µg/L. This reporting limit is based on a method detection limit of 10 µg/L and a 25percent uncertainty factor to account for the complexity of the analysis.

Table 7. UCD/BML Seawater System Residual Chlorine Monitoring, 2004. Units are in mg/L, n.d. = none detected or below the chlorine detection limit of 0.1 mg/L.

Date	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.19	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.19	n.d.	n.d.	n.d.	n.d.
4	n.d.	n.d.	n.d.	n.d.	n.d.	0.13	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
8	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
9	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
10	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
11	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
12	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
13	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.15	n.d.	n.d.	n.d.
14	n.d.	n.d.	n.d.	n.d.	n.d.	0.2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.17	n.d.	n.d.
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
17	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
18	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
19	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
20	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
21	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
22	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
23	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.19
24	n.d.	0.3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
25	n.d.	0.2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
26	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
27	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.2	n.d.	n.d.
30	n.d.		n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
31	n.d.		n.d.	n.d.			n.d.	n.d.		n.d.		n.d.

Halomethanes

The Ocean Plan defines Halomethanes as the sum of bromoform, bromomethane (methyl bromide) and chloromethane (methyl chloride). UCD/BML's effluent concentrations must not exceed the Ocean Plan's 30- day average of 130 µg /l for Total Trihalomethanes (TTHM). The Ocean Plan's 30-day average water quality objective for TTHM is in place for the protection of human health, as the current Ocean Plan (2005) has not established criteria for the protection of marine aquatic life.

Trihalomathanes are produced in water treatment processes as a result of chlorination. The formation of these compounds is a function of precursor concentration, contact time, chlorine dose and pH. Typically, only four THM compounds are normally found and analyzed in the lab. They are: chloroform ($CHCl_3$), bromodichloromethane ($CHBrCl_2$), dibromochloromethane ($CHBr_2Cl$), and bromoform ($CHBr_3$). TTHM is the sum of all four THM compounds concentrations produced at any time. Toxicological studies suggest that chloroform is a potential human carcinogen (Standard Methods 19th Ed. 2005).

As discussed in the *Residual Chlorine* section, approximately 15percent of the seawater supply is diverted to the campus pathology labs . This effluent is then disinfected with chlorine. After treatment, the effluent is exposed to gaseous hydrogen sulfide as a dechlorination process. Flow from the pathology laboratories through the chlorination-dechlorination system then joins the main seawater discharge line. It should be noted that variables such as temperature, alkaline pH, and free chlorine residuals might affect THM formation.

UCD/BML Seawater system intake and waste seawater effluent were sampled for TTHMs using Standard Method 524.2 as the laboratory testing method which screens for the four anthropogenically produced THM compounds normally found.

Waste seawater system effluent was sampled two times, on 2/14/06 and 8/17/06. One sample was collected at the seawater system intake on 8/17/06 (Table 8, below).

Table 8. UCD/BML Seawater Intake and Waste Seawater Effluent Analytical Results for Total Trihalomethanes 2006.

TTHM	Ocean Plan 130 µg/L	Effluent 2/14/2006	Intake 8/17/2006	Effluent 8/17/2006
Halomethanes	µg/L	4.1	<0.5	2.7
Brodichlormethane		ND (<0.5)	ND	ND
Bromoform		4.1	<0.5	2.7
Chloroform (Trichloromethane)		ND	ND	ND
Dibromochloromethane		ND	ND	ND

Of the four halomethanes analyzed, only one, Bromoform ($CHBr_3$) was detected in all three samples, and at levels well below the Ocean Plan limits. Bromoform may be anthropogenic or biogenic in origin.

Some species of marine algae are sources of polyhalomethanes including but not limited to bromoform ($CHBr_3$), brodichlormethane (dichlorobromomethane, $CHBrCl_2$), chloroform (trichloromethane, $CHCl_3$), and dibromochloromethane ($CHBr_2Cl$) (Nightingale et al. 1995; Moore, 2003). Productive coastal waters are enriched with bromoform due in part to their production by marine macroalgae and possibly by marine microbes (Manley, Goodwin and North 1992). Seaweeds appear to be the dominant natural oceanic source of bromoform and methylene bromide. The marine coastal zone is a major source of bromoform produced by cyanobacteria (‘blue green algae’), and microalgae including phytoplankton and forms attached to sand and rocks. A major environmental source of chloromethane is the decomposition of seaweeds. Salt marsh flowering plants also produce methyl halides (Murray 2002). Rock pool and shallow subtidal seaweeds in the genera *Laminaria, Fucus, Pelvetia, Gigartina, Polysiphonia, Enteromorpha, Chaetomorpha, Ulva, and Cladophora,* all of which occur in the Bodega Marine Reserve, have been specifically identified as trihalomethane producers (Nightingale et al. 1995).

It is interesting to note that bromoform was not detected in the intake but only in the effluent, indicating that in this case bromoform is anthropogenic as a result of the chlorination process. Acute toxicity to saltwater aquatic life from methyl bromide occurs at concentrations as low as 12,000 µg/L (12 mg/L or ppm); chronic toxicity to saltwater aquatic life occurs at concentrations as low as 6,400 µg/L. A decrease in algal cell numbers occurs at concentrations as low as 11,500 µg/L. Brominated compounds are more toxic than chlorinated analogs to tested saltwater species (USEPA 1980). The bromoform detected in BML’s effluent was highest on 2/14/2006 at 4.1 µg/L, which is a level that is not acutely or chronically toxic to marine species. Although it appears that the bromoform in BML’s effluent is anthropogenic, the levels at which it occurs are not toxic. Therefore, staffs recommends regular analyses of halomethanes to better monitor and manage effluent, assuring that halomethanes are not discharged at levels harmful to marine life.

Waste Seawater Effluent Thermal Impacts

Historically, warmer seawater discharge from BML was of concern (SWRCB 1979). Current data show that there is no significant difference in seawater temperature between the discharge and intake pipes (range of 1°C per date, see Table 9). In February 2001, a temperature monitor was placed in the seawater effluent line that measures hourly seawater temperature (K. Brown pers. comm., 2007).

Table 9. Monthly Monitoring of Seawater Temperatures at UCD/BML.

Date	Seawater Intake at Horseshoe Cove Surge Channel (°C)	Seawater Outfall at Discharge Pipe Before Surge Channel (°C)	Average Seawater Temperature at Bodega Head* (°C)
01/31/2006	13	13	12
02/24/2006	13	14	12
03/29/2006	12	12	11.5
04/18/2006	14	14	11
05/24/2006	15	15	10.5
06/28/2006	15	16	10.5
07/28/2006	16	17	11.5
08/16/2006	not recorded	not recorded	12
09/27/2006	not recorded	not recorded	13
10/25/2006	12	12	13
11/21/2006	12	12	12.5
12/14/2006	12	13	12

*Average temperature from 1981 to 2001 at NOAA Buoy Station 46013 (38°13'30" N 123°19'00" W)

Seawater System Intake and Waste Seawater Analysis

Metals

UCD/BML seawater system intake (influent) was sampled at the surface in Horseshoe Cove on 4/4/06 and 8/17/06. Seawater system effluent (waste seawater) was sampled at the discharge point *BOD008* on 2/14/06, 4/4/06, and 8/17/06. Influent and effluent samples collected on 2/14/06 and 4/4/06 were submitted to Brelje & Race Laboratory for metals and halomethane analysis. Influent and effluent samples collected on 8/17/06 were submitted to Brelje & Race for repeat halomethane analysis, and also submitted to Caltest Analytical Laboratories for repeat copper and mercury analysis (UCD/BML October 2006). The seawater system intake is in Horseshoe Cove and the waste seawater effluent discharges outside of the cove, seaward and into the rocky intertidal zone (Figure 3).

Analytical results, presented below in Table 10, show high levels of metals in the project location yet provide a very limited snapshot of the existing conditions. The months of February and April, being in the storm season, generally receive higher amounts of rain than August does, and had received average amounts of rainfall during 2005 (see Appendix A). However, August of 2005 received less than average rainfall. There is a possibility that the high levels found in the February and April samples were due to contributions from storm water runoff. More sampling in the future is needed to adequately characterize the water quality conditions within the area of the intake line at Horseshoe Cove; at the waste seawater effluent at end of pipe; at the receiving water below this effluent; and at a reference location away from these areas.

Table 10. UCD/BML Seawater Intake and Waste Seawater Effluent Analytical Results for Metals 2006. Seawater samples for influent (intake) were sampled at the surface in Horseshoe Cove. Effluent was grab-sampled and analyzed at the discharge point BOD008.

Component	Ocean Plan 6 Month Median (µg/L)	Effluent 2/14/2006 (µg/L)	Intake 4/4/2006 (µg/L)	Effluent 4/4/2006 (µg/L)	Influent 8/17/2006 (µg/L)	Effluent 8/17/2006 (µg/L)
Arsenic	8	<2.0	-	-	-	-
Cadmium	1	1.4	1.7	1.2	-	-
Chromium	2	<1.0	-	-	-	-
Copper	3	48	-	-	<10	<10
Lead	2	<5.0	-	-	-	-
Mercury	0.04	<1.0	-	-	<0.2	<0.2
Nickel	5	<10	-	-	-	-
Selenium	15	<5.0	-	-	-	-
Silver	0.7	28	41	41	-	-
Zinc	20	<50	-	-	-	-
Ammonia N-ug	600	<200	-	-	-	-

* Dash mark (-) indicates "no data"

Arsenic
Effluent detected less that 2.0 µg /L for arsenic, well below the Ocean Plan six month median objective of 8.0 µg /L.

Cadmium
Cadmium found in the effluent and intake samples ranged from 1.2 µg/L to 1.7 µg/L. The Ocean Plan six-month median objective is 1.0 µg/L. Effluent and intake results were slightly higher that the Ocean Plan six-month median objective for cadmium. The source of cadmium appears to be the intake at Horseshoe Cove.

Chromium
The Ocean Plan six-month median objective for chromium is 2.0 µg/L. Seawater system effluent sampled on 2/14/06 detected a value of less than 1.0 µg/L, below the Ocean Plan objectives.

Copper
Seawater discharge results for copper were 48.0 µg/L on 2/14/06. This is much higher than the Ocean Plan instantaneous maximum objective of 30.0 µg/L. Subsequent analysis of intake and effluent samples performed on 8/17/06 did not detect copper (detection limit 10.0 µg/L). For the 8/17/06 laboratory analysis the result provided was not at a detection limit low enough to compare to the Ocean Plan six-month median objective of 3.0 µg/L.

Copper at high levels (above the Ocean Plan standards) is toxic to critical life stages of marine life including the brown alga *Macrocystis pyrifera* and echinoderms (see Table 11). In abalone, copper accumulates in the gill, digestive gland and foot muscle. The gill is the primary site of copper accumulation and toxicity, while the foot and adductor muscles are secondarily impacted. Mucus accumulation or cytological damage at the gill from the accumulation of copper inhibits sufficient oxygen delivery to the muscles. Since their survival is dependent on adherence to rock surfaces, a reduction of muscle function could be fatal. In addition, abalone exposed to copper may develop asphyxial hypoxia (Viant, Walton, TenBrook, Tjeerdema 2001). Thickening of the gill from prolonged exposure to copper has also been observed in crabs, mussels and oysters. Several species of brown algae, abalone, crab, mussels, oysters and echinoderms are present in Bodega ASBS.

Table 11. Data derived from a comparison of critical life stage bioassays performed by several different laboratories (Saiz, 1996).

Test Species	Mean NOEC µg/L	st. dev.
Giant kelp *Macrocystis pyrifera* gametophyte growth	16.7	3.4
Giant kelp *Macrocystis pyrifera* gametophyte fertilization	36.2	14.7
Sand dollar *Dendraster excentricus* fertilization	11.6	3.4
Purple Sea Urchin *Strongylocentrotus purpuratus* fertilization	9.1	4.0

Lead, mercury and nickel
The laboratory analytical results provided were not at detection limits low enough to compare to the Ocean Plan six-month median objective for these constituents. For example, as shown in the table, Ocean Plan six month median objective for mercury is a very low limit of 0.04 µg /L, when compared to the detection limits of 1.0 and 2.0.

Silver
The Ocean Plan six month median objective for silver is 0.7 µg /L. The seawater effluent sample on 2/14/06 detected 28.0 µg/L of silver, four times higher than the Ocean Plan instantaneous maximum objective of 7.0 µg/L. A subsequent test at both the seawater intake and seawater effluent sampled two months later, on 4/4/06, detected even higher levels of silver at 41.0 µg/L in both influent and effluent samples.

Silver is acutely toxic to some forms of marine life at levels comparable to the BML effluent results. A concentration of 2.6 µg/L of silver reduced female growth rate and growth of tetrasporangia in *Champia parvula*, a red algae, and a concentration of 5.6 µg/L of silver caused abnormal embryotic development in *Crassostrea gigas*, an oyster (SWRCB 1988). Table 12 provides USEPA acute toxicity data for marine fish and invertebrates. Marine invertebrate species are generally more sensitive than marine fish species are to silver.

Table 12. Mean Acute Toxicity Values (USEPA 1980).

Species Name	Common Name	Species Mean Acute Value (µg/L)
Cyprinodon variegatus	sheepshead minnow	1,400
Apeltes quadracus	fourspine stickleback	550
Pseudopleuronectes americanus	winter flounder	500
Mysidopsis bahia	mysid shrimp	250
Menidia menidia	Atlantic silversides	210
Acartia tonsa	copepod	36
Argopecten irradians	bay scallop	33
Mercenaria mercenaria	hard shell clam	21
Crassostrea virginica	American oyster	20
Paralichthys dentatus	summer flounder	4.7

Zinc
Seawater effluent analyzed for the sample collected on 2/14/06 detected a result of less than 50.0 µg /L. This is lower than the daily maximum (80 µg /L) and instantaneous maximum (200 µg /L) Ocean Plan objectives, the detection limit was greater than the six-month median objective (20.0 µg /L).

Staff recommends that to adequately characterize the effluent additional sampling needs to be performed and analyzed at detection limits of those required in the Ocean Plan. Furthermore, particular attention should be given to silver and copper concentrations as these have so far been measured at high concentrations relative to Ocean Plan objectives.

The following mitigating conditions will be required for the exception in relation to the waste seawater effluent:

- *The discharge must comply with all other applicable provisions, including water quality standards, of the Ocean Plan. Natural water quality conditions in the receiving water, seaward of the surf zone, must not be altered as a result of the discharge. The surf zone is defined as the area between the breaking waves and the shoreline at any one time. Natural water quality will be defined, based on a review of the monitoring data, by Regional Water Board staff in consultation with the Division of Water Quality of the State Water Board. For constituents other than indicator bacteria, natural water quality will be determined using the reference station in the ocean near Mussel Point. For indicator bacteria, the Ocean Plan bacteria objectives will be used.*

- *UCD/BML shall not discharge any constituents at levels in excess of the objectives in Table B water quality objectives as required in Section III.C. of the Ocean Plan. Chemical additives, including but not limited to antibiotics, shall not be discharged in the seawater system effluent. UCD/BML must minimize its discharge of halomethanes and total residual chlorine (TRC).*

- *UCD/BML shall continuously monitor TRC using an instrument capable of a minimum detection limit of 5 µg/L. The reporting limit shall be 50 µg/L. In addition, bench top TRC measurements shall be performed at least once monthly with a minimum method detection limit of 10 µg/L TRC and a reporting limit of 12 µg/L.*

- *During the first year of each permit cycle, at least two effluent samples must be collected from the waste seawater discharge (with at least one collected during dry weather and one collected during wet weather, i.e. a storm event). In addition, reference samples must also be collected along with the effluent samples. Reference samples will be collected in the ocean at a station near Mussel Point. Samples collected at the reference station will represent natural water quality for all Ocean Plan constituents. Wet weather samples at the reference station may be collected immediately following a storm event, but in no case more than 24 hours after, if sampling conditions are unsafe during the storm. All of these samples must be analyzed for all Ocean Plan Table B constituents, pH, salinity, and temperature. Based on the results from the first year, the Regional Water Board will determine the frequency of sampling (at a minimum, once annually during wet weather) and the constituents to be tested during the remainder of the permit cycle, except that halomethanes, residual chlorine, ammonia nitrogen, pH, salinity and temperature must be tested at least monthly, and Ocean Plan metals and chronic toxicity (three species initially and thereafter the most sensitive species) must be tested at least annually for the waste seawater effluent.*

- *Once annually, the subtidal sediment in Horseshoe Cove must be sampled and analyzed for Ocean Plan Table B constituents. For sediment toxicity testing, an acute toxicity test using the amphipod Eohaustorius estuarius must be performed during the first year of the permit cycle. Based on the first year sample results the Regional Water Board will determine specific constituents in the sediment to be tested during the remainder of each permit cycle, except that acute toxicity for sediment must be tested annually.*

- *For metals analysis, waste seawater effluent, storm water effluent, reference samples, and receiving water samples must be analyzed by the approved analytical method with the lowest minimum detection limits (currently Inductively Coupled Plasma/Mass Spectrometry) described in the Ocean Plan.*

- *Once during the upcoming permit cycle, a bioaccumulation study using resident California mussels (Mytilus californianus) must be conducted to determine the concentrations of metals* *near field (outfall station) and far field (Mussel Point). The Regional Water Board, in consultation with the Division of Water Quality, must approve the study design. The results of the survey must be completed and submitted to the Regional Water Board at least six months prior to the end of the permit cycle (permit expiration). Based on the study results, the Regional Water Board, in consultation with the Division of Water Quality, may adjust the study design in subsequent permits, or add additional test organisms.*

- *The seawater system will not flow at a rate greater than 1.5 mgd. Flows for the waste seawater effluent and storm water runoff (by storm event) must be reported at least quarterly to the Regional Water Board. The storm water runoff may be calculated, rather than measured directly, using a method approved by the Regional Water Board.*
- *Freshwater discharged from the Salmon Research Facility must be discharged to a groundwater recharge area in the sand dunes adjacent to the laboratory and not to the marsh or the ASBS.*

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
BIOLOGICAL RESOURCES. Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the DFG or USFWS?	☐	☑	☐	☐
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations or by the DFG or USFWS?	☐	☑	☐	☐
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the federal Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, *etc.*) through direct removal, filling, hydrological interruption or other means?	☐	☐	☐	☑
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory corridors, or impede the use of native wildlife nursery sites?	☐	☐	☐	☑
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☑
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☑

Marine Biological Pollutants (Invasive Species or non-indigenous)

Any marine organism not indigenous to the Bodega coastline that may possibly be introduced through the laboratory or aquarium discharges is considered a biological pollutant. Invasive species in the marine environment generally 'arrive' to a location by one of these methods: 1) they are discharged as part of the ballast water from a docked or passing ship; 2) they are inadvertently released; 3) they come in as a 'stowaway' on another species; or 4) they are deliberately released (DFG 2001). The pathways that are most applicable to UCD/BML are inadvertent releases or "stowaways" on another species. Prior to 2004, the invasive algae *Caulerpa* was in culture at the lab, but has since been removed to prevent inadvertent release. Currently available information (California Department of Fish and Game (DFG) 2006) indicates that there are no invasive species that would be associated with a possible introduction from the UC Davis Bodega Marine Lab discharges. Still, the potential for such introductions of potentially invasive species or pathogenic organisms does exist, and such accidental introductions could alter the marine community in an undesirable way.

Examples of marine invasive species that have been found in the Bodega region include, but are not be limited to: *Carcinus maenas*, the European Green crab, a voracious predator on native invertebrates (GFNMS 2007, DFG 2005); *Sargassum muticum*, British wireweed, an invasive brown algae; and *Undaria pinnatifida*, Wakame, another exotic brown algae (GFNMS 2007).

NOAA has compiled a list of invasive species (see Appendix Q) that have been identified in the Gulf of the Farallones National Marine Sanctuary (GFNMS). The northern boundary of GFNMS is approximately 1.5 miles (2.4 km) south of UCD/BML Bodega ASBS. Eighteen invasive species have been identified in Bodega Bay and listed in the California Aquatic Non-Native Organism Database (CANOD). These species are listed in Appendix S of this document. One invasive species, *Pontogeneia rostrata*, has been identified north of Bodega Bay in the sandy intertidal area near BLM (see Appendix R) (Maloney 2006).

All organisms imported from other states must be approved by the California Department of Fish & Game (DFG). Organisms from outside the local area may not be transported to BML without specific permission and approval by Dr. Jim Moore, DFG Senior Fish Pathologist and BML Resident. Dr. Moore supervises the resident Fish & Game Shellfish Pathology Laboratory at BML and serves on the DFG Aquaculture Committee.

All new scientific projects and organism transfers must be registered through a web application that alerts numerous staff for permit requirements, tank space, species, and species origin. All transfer requests from outside (and depending on species, within) the general Bodega Bay Area are referred to Dr. Jim Moore for approval.

The general Bodega Bay Area is conservatively defined as the region from Tomales Bay to Point Arena. In some instances, organisms from well beyond this geographic zone can be held at Bodega Marine Laboratory without restrictions. There are four major concerns about working with organisms that are not locally collected:

1. The species is not locally present and could become established.
2. The species is locally present but the source population differs substantially.
3. The proposed source population harbors parasites or pathogens that are not locally present.
4. Other species in the source locale are incidentally collected and introduced with the organism of interest.

Collections determined by BML to pose any of the above risks must not be held in flow-through seawater, and the risk must be mitigated by appropriate containment and disposal methods. The Animal Resources Group manages holding units that use flowing seawater. All requests for holding units will be reviewed for the above risks; information on life history, stock structures etc. must be provided by the researcher. If denied flowing seawater, it will be necessary to hold the organisms in static, isolated system in a dry lab (no seawater drains) in space provided by the Principal Investigator. These procedures must also be used for organisms that are processed (and euthanized) on the same day that they are brought to BML.

Requirements for Holding (or Processing) Organisms in Isolation from Flowing Seawater

1. Bring to BML in sealed containers.
2. Do not travel through wet labs in transit to holding or processing room.
3. Holding or processing room must have no flowing seawater or seawater return drains.
4. Holding containers must be labeled with the species, source location, collection date, contact person and phone number.
5. When studies are completed, all organisms and organic material must be sieved and autoclaved (121ºC, 30min). Invertebrates can be humanely euthanized beforehand by freezing. For vertebrates, follow procedures listed in your protocol. Do not return any organisms to the site of collection or any other habitat. Autoclaved remains must be disposed of in trash pickup or hazardous materials, depending on experiment.
6. Seawater or freshwater (and equipment) that has contacted the organisms must be sterilized using BML chlorination/dechlorination sterilizations procedures. Following demonstration that appropriate chlorination and dechlorination levels have been reached, disposal approval is granted by ARG staff. The disposal method/site is approved during application process to either seawater, septic, or transported for disposal by private hauler.

Staff recommends that if during the biological surveys required as required by the exception, any of the above species or any other invasives that are not listed above are detected, UC Davis Bodega Marine Lab must notify the State Water Board and the California Department of Fish and Game (Marine Division) immediately.

The following mitigating condition will be required for the exception as they relate to biological pollutants:

- *UCD/BML must pursue and implement a program for prevention of Biological Pollutants (non-native invasive species) in consultation with the California Department of Fish and Game Marine Resources Division. This program must be submitted to the State and Regional Water Boards no later than two years following the approval of this Exception. Any non-native species found in the ASBS must be reported to the State and Regional Water Boards and the California Department of Fish and Game.*

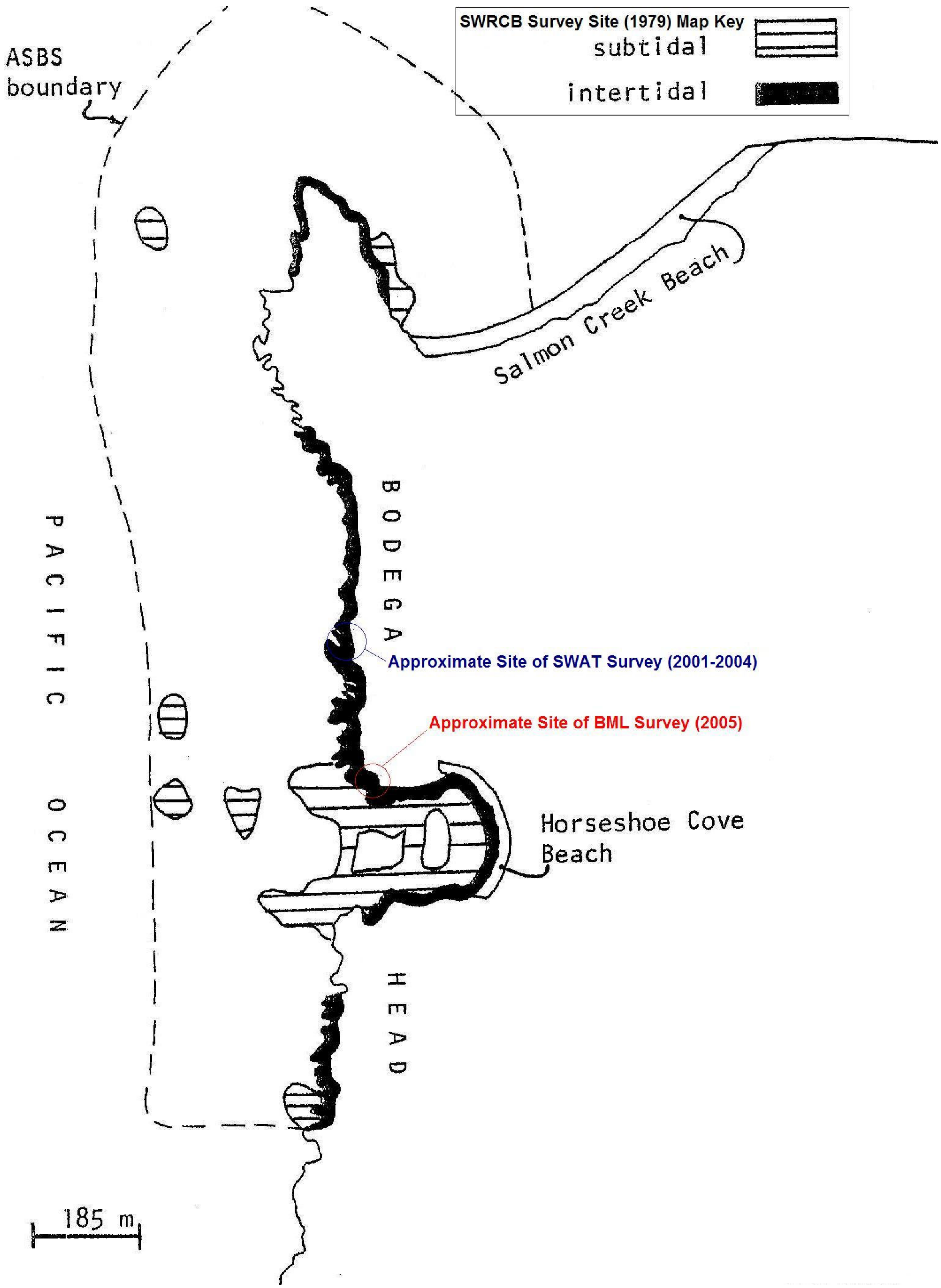
Marine Biotic Community

Seven surveys were compared for this Initial Study. The surveys were:

1) Bodega Marine Laboratory, Donn A. Ristau, Chris Tarp, and Dr. Cadet Hand, for the State Water Resources Control Board (SWRCB) 1979 Reconnaissance Survey , field work in 1977,
2) SWAT Coastal Biodiversity Survey, Peter Raimondi et al, and (see cbsurveys.ucsc.edu/people/people.html for team member detail) fieldwork in 2001,
3) SWAT Coastal Biodiversity Survey, Raimondi et al, and fieldwork in 2003,
4) SWAT Coastal Biodiversity Survey, Raimondi et al, and fieldwork in 2004,
5) Matthew Bracken and Jay Stachowicz for UCD/BML in July 2004,
6) Christopher Harley and Jenna Shinen for UCD/BML in January 2005, and
7) Peter Connors, Jackie Sones, and Matt Bracken for UCD/BML in November 2005.

Assemblage analysis in the SWRCB 1977 survey was reported as slightly weighted data (common/occasional/rare/seasonal), without numerical definition of weighted categories. The 1977 survey was conducted in both the intertidal and subtidal zones, and was intended to characterize the entire ASBS. All of the other surveys were conducted in the intertidal zone only, and focused only on specific sampling sites. Assemblage analyses in the SWAT/Coastal Biodiversity 2001, 2003, 2004 surveys were reported as presence/absence. Assemblage analysis in the UCD/BML July 2004 survey was reported as quantitative data for only seven taxa (*Pelvetiopsis limitata, Endocladia muricata, Mastocarpus papillatus, Cladophora columbiana, Mytilus californicus, Littorina scutulata* and all *Lottia spp.) as well as total algal cover and bare rock,* in the middle tide zone only. The BML January 2005 survey provided only presence/absence information throughout the intertidal zone for the outfall surge channel and two reference surge channels. Assemblage analysis in the UCD/BML November 2005 survey was reported as quantitative data. The quantitative data from the UCD/BML July and November 2005 surveys are presented in Appendices J, K, L, and M.

Figure 4. Bodega ASBS biological survey locations.



Temporal Marine Biotic Community Trends

Benthic Macrophytes

The identifications of algae and anthophytes (vascular plants) from the surveys are presented in Appendix C. The numbers of algae species reported in the SWRCB 1979 survey were 92 in the subtidal zone and 163 in the intertidal zone. In the SWAT surveys from 2001, 2003 and 2004, the numbers of intertidal species were reported as 43, 46 and 54, respectively. The UCD/BML January 2005 survey reported 17 intertidal species and the November 2005 survey reported a total of 29 intertidal species.

The variation in reported species is a function of survey design. The 1977 survey was oriented more toward biodiversity throughout the ASBS. The SWAT biodiversity surveys were performed at a specific location (see Figure 4). The January and November 2005 BML surveys focused only on three intertidal surge channel stations (see Figure 5).

From a temporal perspective, only the three SWAT surveys were performed using the same basic protocols and therefore are comparable over time. The SWAT results indicate an increase in plant species during the period of 2001-2004, which is one indication of ecological health at a location north of the discharge site but within the ASBS.

Benthic Invertebrates

The identifications of benthic invertebrates from the surveys are presented in Appendix D. In the SWRCB 1979 survey, 221 invertebrate species were identified in the subtidal zone, and 227 invertebrate species were counted in the intertidal zone. The number of intertidal invertebrate species reported in the SWAT surveys from 2001, 2003 and 2004 were 48, 51 and 52, respectively. The UCD/BML January 2005 survey reported 27 intertidal species and the UCD/BML November 2005 survey reported a total of 31 species along the three transects.

Similar to the algal survey data, the variation in reported species is a function of survey design. The 1979 survey was oriented more toward biodiversity throughout the ASBS. The SWAT biodiversity surveys were performed at a specific location (see Figure 4). The January and November 2005 BML surveys focused only on three intertidal surge channel stations (see Figure 5).

From a temporal perspective, only the three SWAT surveys were performed using the same basic protocols and therefore is comparable. The SWAT results indicate an increase in invertebrate species during the period of 2001-2004, which again is an indication of ecological health at a location north of the discharge site but within the ASBS.

Red abalone (*Haliotis rufescens*) was considered to commonly occur during the 1979 SWRCB survey. Two other species of abalone (USFWS 2006), white (*H. sorenseni*) and black (*H. cracherodii*) are also known to occur at Bodega ASBS. White abalone is listed as an endangered species, and black abalone is listed as a candidate to become a proposed species (USFWS 2006). It should be noted that due to the sensitivity of these species and poaching, subsequent surveys (PISCO/SWAT 2001-2004) purposely do not list their presence or absence, however this does not mean that abalone were not present during the SWAT surveys.

Fish Community

Fish are motile and can swim in and out of an area in pursuit of prey, or even if water quality conditions temporarily degrade. Fishing pressures in surrounding areas may also reduce their numbers locally. Therefore, fish community comparison data may not reflect environmental perturbations as well as less motile species (such as benthic invertebrates or primary producers). The fish identified in the SWRCB 1979 Reconnaissance Survey Report (1977 field work) survey are presented in Appendix E. The 1979 Reconnaissance Survey Report listed 44 species in the ASBS, 40 subtidal and four intertidal. In 2001 and 2003 the SWAT surveys reported unidentified sculpins in the intertidal zone. No other new information is available on fish species.

Of the 40 subtidal fish species identified in the Bodega ASBS, 20 species were considered to be common to the area. The Embiotocids (perches) are seasonal members of the community, and they are common when present, except for *Micrometrus minimus*. *Carcharodon carcharias* is another seasonal species, but listed as an occasional member of the community.

When initially requested by State Water Board staff to perform new quantitative marine biological surveys in support of this CEQA review, UCD/BML personnel in turn requested that their marine community survey work be limited to intertidal surveys only. The reasons were primarily safety related, for example high wave energy in the shallow subtidal habitat, and the occasional presence of great white sharks. State Water Board staff allowed the surveys, conducted in 2005 in support of the Initial Study, to be limited to the intertidal habitat.

Spatial Assessment: Waste Seawater Impact Analysis to the Intertidal Community

<u>July 2004 Intertidal Survey</u>

In July 2004 UCD/BML performed a survey in middle intertidal zone plots near the outfall (average of 20 meters distance) and at reference plots (average distance of 41 meters from the outfall) providing measures of population densities and percent cover for some species. These results provided by UCD/BML are presented in Appendix J. It should be noted that percent cover data adds up to greater than 100percent, but this may be due to overlapping coverage, e.g., algae growing on mussels, etc.

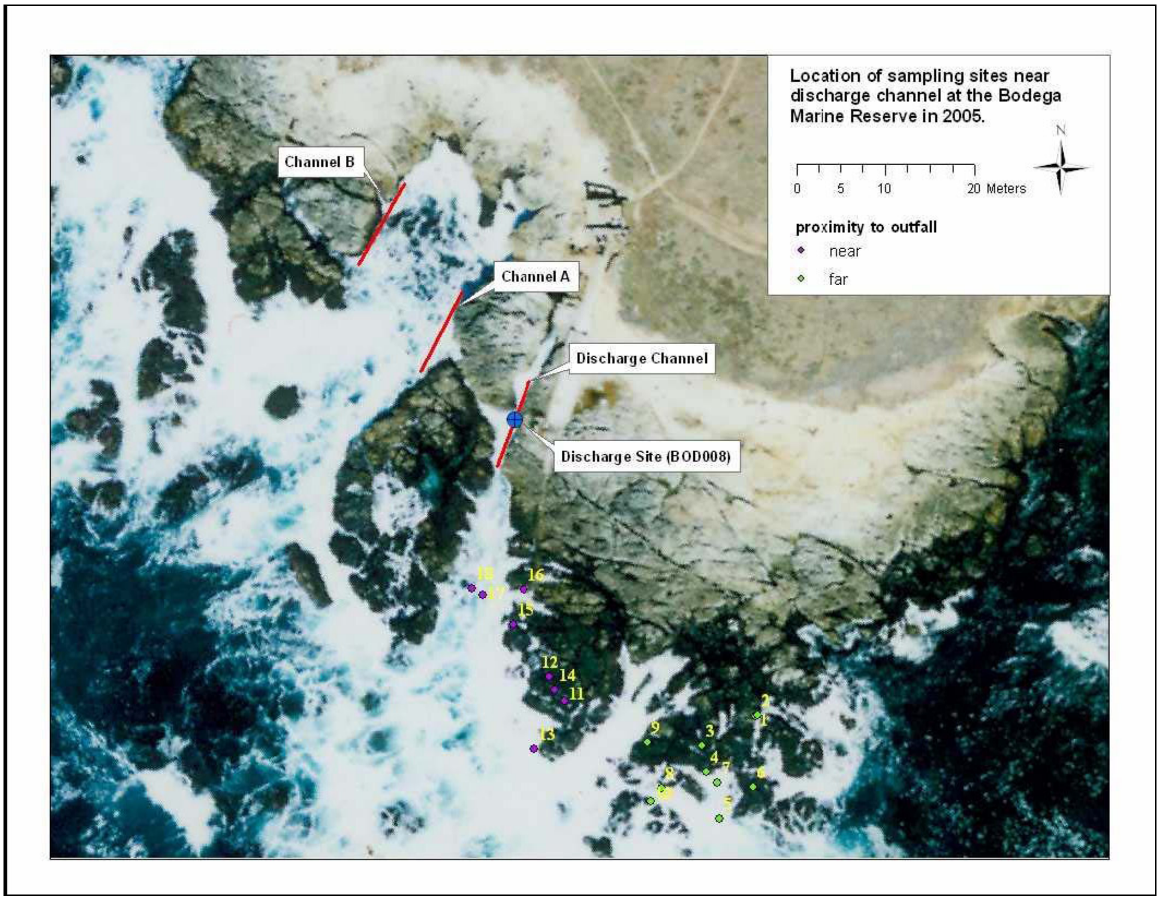
Percent cover of the algae species *Pelvetiopsis limitata, Endocladia muricata, Mastocarpus papillatus, and Cladophora columbiana,* and the abundance of limpets were relatively similar near the outfall and at the reference sites. The average density of the gastropod *Littorina scutulata* was much higher at reference sites (13.6 individuals/.04m^2) vs. the outfall plots (3.5 individuals/.04m^2), and the highest density of *Littorina scutulata,* 38 individuals/.04m^2, was found at a reference plot. Two possible interpretations of this information is that either the discharge caused conditions to be unfavorable to *Littorina*, or there was some other physical characteristic near the outfall but unrelated to the discharge that may have been unfavorable to *Littorina.* A third interpretation may be that these limited results may simply represent natural patchiness.

The percent cover of bare rock was higher near the outfall (average of 54.6percent) than at reference plots away from the outfall (average of 46.3percent). The percent cover of mussels (*Mytilus californianus*) was also higher near the outfall (average of 31.9percent) than at reference plots away from the outfall (average of 26.3percent). The average percent algal cover was lower (80.1percent) near the outfall than at the reference plots (88.5percent) away from the outfall. A possible interpretation of this data is that algae was slightly depressed near the outfall, hence more bare rock and less algal cover, and that mussels may be encouraged by additional food particles near the outfall. Again, another interpretation may be that these limited results may simply represent natural patchiness.

<u>January 2005 Intertidal Survey</u>

In January 2005 UCD/BML performed a qualitative species presence/absence survey for the entire intertidal zone at the waste seawater outfall surge channel and two reference surge channel sites (channel A and channel B located 25 meters and 70 meters north of the outfall channel respectively). There were more (37) species identified in the outfall surge channel, as compared to 32 and 29 respectively in the reference surge channels A and B. UCD/BML reported species similarity coefficients of 0.60 between the outfall and channel A, and 0.65 between the outfall and channel B. Channels A and B had a similarity coefficient of 0.68. The similarity coefficient for all three channels was reported as 0.52. While this provides an indication that there were not great differences in species presence/absence between the outfall and reference stations, these results were not based on quantitative data and were not statistically significant. Regarding *Littorina scutulata, it* was absent near the discharge in January 2005 and at Channel B, but was present at Channel A. It is also worth noting that *Littorina scutulata* was present at the SWAT sites in 2001, 2003 and 2004.

Figure 5. Intertidal sampling locations UCD/BML 2005. Red lines show location of transects in the surge channel and adjacent sampling areas from which raw data in Appendices K, L, and M were collected. The yellow numbers show the location of mid intertidal sampling locations from which raw data in Appendix J. were collected. Note that the prevailing current direction is from the northwest.



November 2005 Intertidal Survey

Based on this initial UCD/BML work from July 2004 and January 2005, State water Board staff requested additional data. A quantitative survey was performed by UCD/BML in November 2005 for the entire intertidal zone, at the waste seawater outfall surge channel and two reference surge channel sites (the same reference surge channels, A and B, surveyed in January 2005). The survey was designed by UCD/BML following Murray et al. (2002). The technique maximizes number of species sampled by including high, mid and low intertidal sampling areas at multiple sites in the surge channel and adjacent areas. In the waste seawater outfall channel and at two adjacent sites (channel A and channel B located 25 m and 70 m north of the outfall channel respectively), 10-meter belt transects were established (Figure 5). Using restricted random placement (points located randomly within 2-meter segments of the transect), 5 points were located along the 10-meter transect for sampling. PVC Quadrats were laid down, and then the species were visually counted. One person identified and made the counts, and one person recorded the data. All species were identified and recorded; it was not necessary to photograph any unidentifiable species for future ID. At each of the 5 sampling sites, the intertidal zones were divided into high, mid, and low intertidal zones. In each zone, a 20-cm x 20-cm quadrat was placed and measured:

- percent cover of algae, sessile invertebrates (sponges, anemonies, polychaetes, barnacles, bivalves, tuncates, and bryozoans), and total cover
- abundance (total number) of mobile invertebrates (crabs, limpets, snails, sea stars, and sea urchins)

This design resulted in a total sample size of 45 quadrats (3 quadrats per point, 5 points per transect, and 1 transect in each of the 3 sampling locations). Data were collected during low tides in 2005 on Nov 14, 29 and 30, 2005. Raw data are provided in Appendices K, L and M.

Intertidal Invertebrate and Algal Community Results

An initial statistical comparison of invertebrate and algal communities using data from the outfall channel and the two combined reference sites was performed. The seven community measures were sessile invertebrate cover, sessile invertebrate diversity, mobile invertebrate abundance, mobile invertebrate diversity, total algal cover, algal diversity, and total cover. Units of diversity are in common logarithm Shannon-Weiner Index units. Diversity is an important community measure. Generally, healthy pollution-free communities would be expected to have higher species diversity than a stressed or polluted community.

From that comparison (Table 13), there were no significant differences between discharge and the combined reference sites, with respect to seven measures of the intertidal community structure, when all tidal zones were combined. In all cases, the *p*-value was $\geq$ 0.18, and significant differences were considered to be those less than 0.05 (i.e., 95percent confidence level).

Table 13. Statistical comparison the outfall channel versus the combined reference sites on seven measures of intertidal community structure.

	Intertidal Community Structure Measure	Discharge (mean ± standard deviation)	Non-discharge (mean ± standard deviation)	*P*-value
1.	Sessile invertebrate cover	20.2 ± 26.3percent	16.3 ± 18.7percent	0.57
2.	Sessile invertebrate diversity	0.10 ± 0.15	0.17 ± 0.18	0.18
3.	Mobile invertebrate abundance	14.3 ± 16.2 individuals/quadrat	12.9 ± 12.8 individuals/quadrat	0.75
4.	Mobile invertebrate diversity	0.22 ± 0.22	0.21 ± 0.18	0.99
5.	Total algal cover	44.7 ± 33.7percent	53.8 ± 30.8percent	0.37
6.	Algal diversity	0.41 ± 0.22	0.46 ± 0.18	0.43
7.	Total cover	64.9 ± 35.6percent	70.2 ± 31.3percent	0.61

Some questions, however, arise from further exploration of the data. The study design separately measured low, medium, and high intertidal zones. These tide height data, however, were combined in the initial analysis. In the same way, the Channel A and Channel B data were combined. This merging of data may reduce precision and mask differences in means for the seven measures, especially those with the smaller p-values (e.g., sessile invertebrate density). In addition, there may be a resolution issue as some of the algal cover values added up to more than 100percent.

Therefore, a two-way analysis of variance test (ANOVA) was then performed for the seven measures of community structure (Appendix V). Summary statistics for the seven measures are presented in Appendix W. Results of the two-way ANOVA tests showed that the only community metric that varied significantly across sites is sessile invertebrate diversity (Table 14). This, however, was driven by the Channel A reference site mean being significantly higher than either the discharge site mean or the Channel B reference site mean. This indicates that there is natural variability between surge channels, even those in close proximity to one another.

Mobile invertebrate and algal diversity means varied significantly across tide heights but also exhibited a significant interaction between the two factors, site and tide height. All measures of abundance and percent cover (for all taxa) showed no significant effect of site, either directly or as an interaction with tide height. This indicates that there are differences in percent cover and diversity when comparing the low, middle, and high tide zones.

Table 14. Summary of two-way ANOVA test results for seven measures of invertebrate and algal communities in the outfall channel versus two reference sites. Details of the ANOVA results are in Appendix V. *p*-values significant at the 95percent level or greater are marked with an asterisk.

Intertidal Community Structure Measure	Site *P*-value	Tide Height *P*-value	Site x Tide Height Interaction *P*-value
1. Sessile invertebrate cover	0.390	0.098	0.582
2. Sessile invertebrate diversity	0.024*	0.170	0.134
3. Mobile invertebrate abundance	0.394	0.037*	0.606
4. Mobile invertebrate diversity	0.386	0.002*	0.023*
5. Total algal cover	0.463	<0.0001*	0.119
6. Algal diversity	0.214	0.070	0.024*
7. Total cover	0.307	<0.001*	0.280

Further statistical analyses were conducted to compare community measures at the outfall and at the reference sites. One way ANOVAs were performed for each tidal zone on each of seven community measures (Table 15). Mean sessile invertebrate diversity was significantly different in the low tide zone, but that difference was due to a significant difference between the two reference sites and not the outfall site.

Mean algal diversity in the low tide zone was significantly lower at the outfall as compared to either of the reference sites, indicating a possible impact from the discharge. The mean algal diversity in the low tide zone at the discharge site was 0.212 diversity units, and was 0.422 and 0.556 respectively for reference sites A and B.

Table 15. Summary of one-way ANOVA test results for seven measures of invertebrate and algal communities in the outfall channel versus two reference sites by tidal zone. Details of the ANOVA results are in Appendix X. *p*-values significant at the 95percent level or greater are marked with an asterisk.

Intertidal Community Structure Measure	Low Tide Zone *P*-value	Middle Tide Zone *P*-value	High Tide Zone *P*-value
1. Sessile invertebrate cover	0.367	0.347	0.233
2. Sessile invertebrate diversity	0.028*	0.272	0.302
3. Mobile invertebrate abundance	0.361	0.415	0.863
4. Mobile invertebrate diversity	0.226	0.064	0.216
5. Total algal cover	0.138	0.333	0.258
6. Algal diversity	0.001*	0.071	0.947
7. Total cover	0.178	0.342	0.567

Littorina scutulata was not found at the discharge site in the November 2005 survey, but was present at both the reference sites in low numbers. However, the difference in means between the reference and outfall sites was not statistically significant.

Biological Community Summary

From the review of this data, the intertidal community in the ASBS is generally healthy. However, when comparing the results from all studies there are some possible localized impacts detected at the waste seawater outfall when compared with the reference sites. While the low intertidal zone algal community at the outfall is statistically lower in species diversity, this condition was minor and was not widespread.

Given that dive surveys are considered dangerous by UCD/BML staff in the Bodega headland area, required quantitative surveys of biota may be limited at this time to intertidal habitat. The intertidal discharge and reference stations should be quantitatively surveyed again during each permit cycle to evaluate the health of the community and the effectiveness of controls. Furthermore, any data from subtidal surveys performed by researchers in the ASBS must be reported to the State and Regional Boards. Depending on a review of the water quality data, results from intertidal surveys, and subtidal surveys if available, the State and Regional Water Boards may decide at a later time to require subtidal monitoring.

Mitigating Terms and Conditions

The following mitigating condition will be required to monitor the ongoing status and protection of marine aquatic life:

- *At least once every permit cycle (every five years), a quantitative survey of intertidal benthic marine life must be performed near the discharge and at a reference site. The Regional Water Board, in consultation with the State Water Board's Division of Water Quality, must approve the survey design. The results of the survey must be completed and submitted to the Regional Water Board within six months before the end of the permit cycle. Furthermore, any data from other intertidal and subtidal surveys performed by researchers in the ASBS must be reported to the State and Regional Water Boards.*

AGRICULTURAL RESOURCES. In determining whether impacts to agricultural resources are significant environmental impacts, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping & Monitoring Program of the California Resources Agency, to non-agricultural uses?	☐	☐	☐	☑
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☑
c) Involve other changes in the existing environment that, due to their location or nature, could result in conversion of Farmland to non-agricultural use?	☐	☐	☐	☑

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
NOISE. Would the project result in:				
a) Exposure of persons to, or generation of, noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☐	☑
b) Exposure of persons to, or generation of, excessive ground borne vibration or ground borne noise levels?	☐	☐	☐	☑
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☑
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☑
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing in or working in the project area to excessive noise levels?	☐	☐	☐	☑
f) For a project within the vicinity of a private airstrip, would the project expose people residing in or working in the project area to excessive noise levels?	☐	☐	☐	☑
LAND USE AND PLANNING. Would the project:				
a) Physically divide an established community?	☐	☐	☐	☑
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to, the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☑
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☑
MINERAL RESOURCES. Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of future value to the region and the residents of the State?	☐	☐	☐	☑
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?	☐	☐	☐	☑

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
HAZARDS and HAZARDOUS MATERIALS. Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☐	☑
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☐	☑
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within ¼ mile of an existing or proposed school?	☐	☐	☐	☑
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code §65962.5 and, as a result, would it create a significant hazard to the public or to the environment?	☐	☐	☐	☑
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or a public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☑
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☑
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☑
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wild lands are adjacent to urbanized areas or where residences are intermixed with wild lands?	☐	☐	☐	☑
POPULATION and HOUSING. Would the project:				
a) Induce substantial population growth in an area either directly (*e.g.*, by proposing new homes and businesses) or indirectly (*e.g.*, through extension of roads or other infrastructure)?	☐	☐	☐	☑
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☑
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☑

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact

TRANSPORTATION / CIRCULATION. Would the project:

a) Cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (*i.e.*, result in a substantial increase in either the number of vehicle trips, the volume-to-capacity ratio on roads, or congestion at intersections)?	☐	☐	☐	☑
b) Substantially increase hazards due to a design feature (*e.g.*, sharp curves or dangerous intersections) or incompatible uses (*e.g.*, farm equipment)?	☐	☐	☐	☑
c) Result in inadequate emergency access?	☐	☐	☐	☑
d) Result in inadequate parking capacity?	☐	☐	☐	☑
e) Exceed, either individually or cumulatively, a level-of-service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☑
f) Conflict with adopted policies supporting alternative transportation (*e.g.*, bus turnouts, bicycle racks)?	☐	☐	☐	☑
g) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☑

PUBLIC SERVICES. Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service rations, response times or other performance objectives for any of the public services:

a) Fire protection?	☐	☐	☐	☑
b) Police protection?	☐	☐	☐	☑
c) Schools?	☐	☐	☐	☑
d) Parks?	☐	☐	☐	☑
e) Other public facilities?	☐	☐	☐	☑

UTILITIES and SERVICE SYSTEMS. Would the project:

a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☑
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental impacts?	☐	☐	☐	☑
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental impacts?	☐	☐	☐	☑

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☑
e) Result in a determination by the wastewater treatment provider that serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☑
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☐	☑
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	☑
AESTHETICS. Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☑
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☑
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☐	☑
d) Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area?	☐	☐	☐	☑
CULTURAL RESOURCES. Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☐	☑
b) Cause a substantial adverse change in the significance of an archaeological resource as defined in §15064.5?	☐	☐	☐	☑
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	☑
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☐	☑
RECREATION. Would the project:				
a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☑
b) Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment?	☐	☐	☐	☑

MANDATORY FINDINGS OF SIGNIFICANCE.

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☑	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)	☐	☑	☐	☐
c) Does the project have environmental effects that will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☑

CONCLUSION

Under the less stringent and somewhat inadequate controls currently in force, UCD/BML discharges waste into the ASBS and are in violation of the ASBS discharge prohibition. The project, granting an exception with special mitigating conditions (i.e. special protections), will allow the continued discharge of waste seawater and storm water runoff, and therefore has some potential to degrade water quality unless mitigating conditions are implemented. Under the mitigating conditions composing special protections, the quality of the discharge will improve from current conditions, with an important reduction in the potential to degrade water quality. If all of the special protections designed to limit the discharge are met, as described in this Initial Study, the UCD/BML discharge will not compromise the protection of ocean waters of the ASBS for beneficial uses, and the public interest will be served.

Granting the conditional exception, likewise, will not violate federal antidegradation requirements because water quality will not be lowered, but rather will be improved. Further, allowance of the exception will not violate the State Water Board's antidegradation policy (SWRCB 1968) since water quality conditions will improve; the discharge will not unreasonably affect present and anticipated beneficial uses; the discharge will not result in water quality lower than that prescribed in the Ocean Plan; and, the people of California benefit from the research and education provided by UCD/BML while beneficial uses will still be protected.

DETERMINATION

Based on this initial evaluation, we find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because mitigation measures have been incorporated into the project. A MITIGATED NEGATIVE DECLARATION will be prepared.

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List of Acronyms and Abbreviations

ASBS	Area of Special Biological Significance
BLM	Bureau of Land Management
BMPs	Best Management Practices
Caltrans	California Department of Transportation
CBI	Clean Beaches Initiative
CCC	California Coastal Commission
CCA	Critical Coastal Area
CDO	Cease and Desist Order
CEQA	California Environmental Quality Act
COP	California Ocean Plan
CTR	California Toxics Rule
Cu	Copper
CWA	Clean Water Act
CWC	California Water Code
DFG	California Department of Fish and Game
DO	Dissolved Oxygen
FWS	United States Fish and Wildlife Service
GPD	Gallons Per Day
GPM	Gallons Per Minute
MARINe	Multi Agency Rocky Intertidal Network
MMA	Marine Managed Area
MMs	Management Measures
MS4	Municipal Separate Storm Sewer Systems
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge and Elimination System
PPT	Parts Per Thousand
PRC	Public Resources Code
Regional Water Board	California Regional Water Quality Control Board
SCCWRP	Southern California Coastal Water Research Project
State Water Board	State Water Resources Control Board
SWAMP	Storm Water Ambient Monitoring Program
SWMP	Storm Water Management Plan/Program
SWQPA	State Water Quality Protected Area
TUc	Chronic Toxicity Unit
USEPA	United States Environmental Protection Agency
WDR	Waste Discharge Requirements

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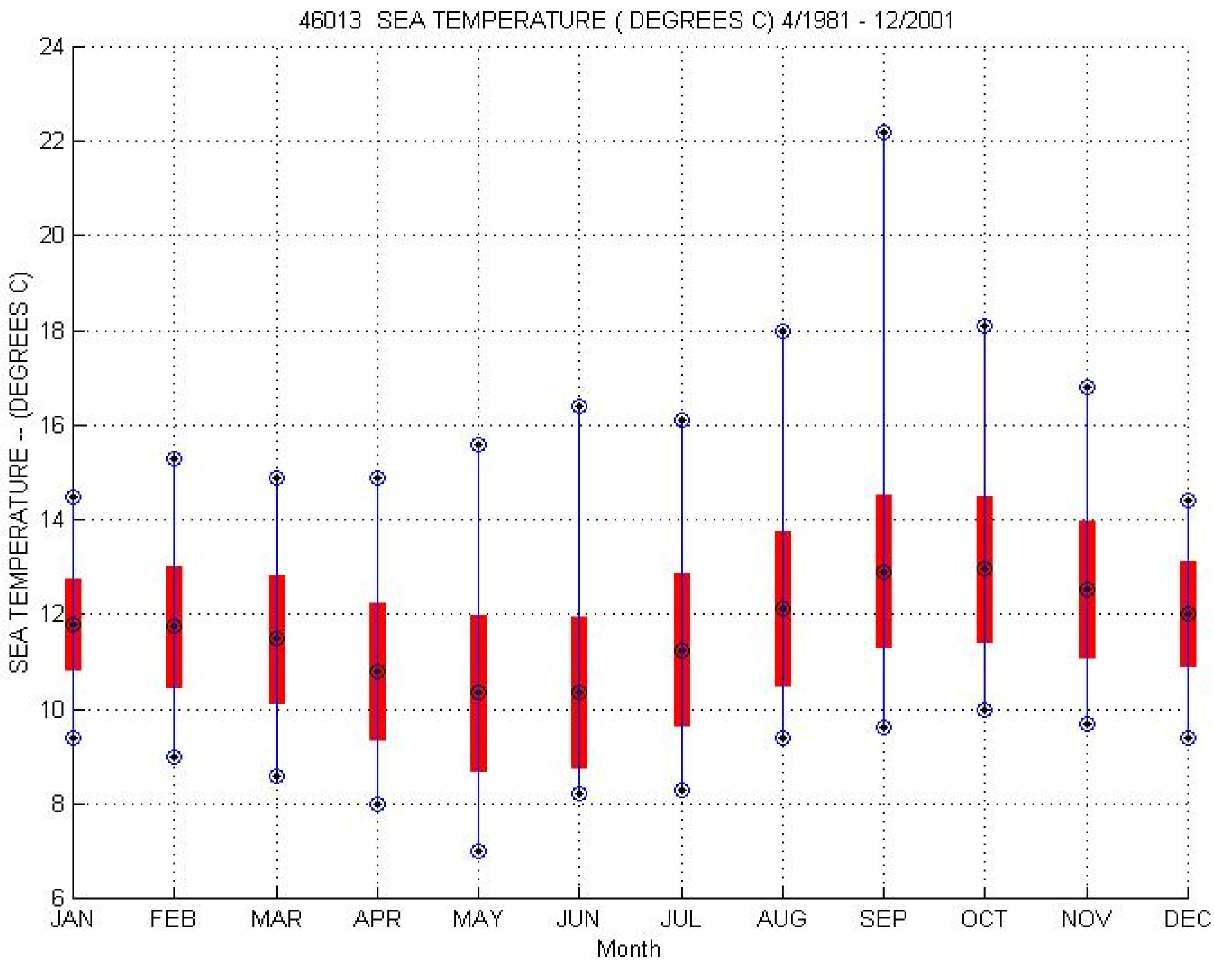
Appendix A. Monthly Rainfall Data (*rain in inches*). Bodega Marine Laboratory. Last Updated 2/6/2007.

	MONTH												
	July	August	September	October	November	December	January	February	March	April	May	June	TOTAL
Month Mean	0.10	0.20	0.44	1.79	4.62	6.09	7.14	5.69	4.54	2.08	0.81	0.26	33.56
YEAR													
67-68						3.13	7.19	5.29	2.39	0.93	0.46	0.11	
68-69	0.04	0.55	0.22	2.16	4.44	11.43	9.07	8.55	2.09	2.66	0.20	0.14	41.55
69-70	0.13	0.13	1.51	4.12	1.90	8.95	13.64	2.18	2.58	0.33	0.05	0.51	36.03
70-71	0.09	0.12	0.14	2.05	6.57	6.59	5.05	0.39	4.40	1.44	0.81	0.22	27.87
71-72	0.14	0.24	0.31	0.64	2.95	6.17	1.60	2.91	1.37	1.32	0.20	0.32	18.17
72-73	0.17	0.19	0.63	2.85	8.69	5.26	11.89	7.01	3.59	0.25	0.20	0.06	40.79
73-74	0.17	0.20	0.96	1.99	10.13	6.31	7.14	4.67	5.25	4.49	0.08	0.05	41.44
74-75	1.70	0.08	0.14	1.38	0.95	5.09	2.31	10.04	6.25	1.33	0.10	0.22	29.59
75-76	0.25	0.20	0.13	3.67	1.56	1.54	0.82	1.71	1.68	2.95	0.02	0.12	14.65
76-77	0.08	1.20	0.31	0.43	2.35	0.55	2.94	1.76	1.73	0.35	1.19	0.11	13.00
77-78	0.03	0.26	1.86	1.18	5.41	5.33	10.76	7.40	3.83	3.70	0.14	0.00	39.90
78-79	0.06	0.02	1.49	0.21	1.10	0.80	8.55	5.69	3.34	1.82	0.58	0.02	23.68
79-80	0.09	0.02	0.14	3.59	6.65	7.96	4.97	7.50	1.34	1.83	0.17	0.23	34.49
80-81	0.06	0.04	0.11	0.90	0.60	4.46	8.06	3.23	5.48	0.16	0.54	0.09	23.73
81-82	0.21	0.08	0.38	3.09	5.95	7.51	14.58	3.59	5.69	3.39	0.00	0.09	44.56
82-83	0.00	0.00	0.14	2.40	9.75	3.09	9.64	8.80	15.90	4.08	1.29	0.00	55.09
83-84	0.00	0.46	0.98	0.50	9.05	4.35	5.92	2.83	1.86	2.10	0.35	0.54	28.94
84-85	0.01	0.11	0.19	3.71	11.28	3.24	1.77	1.96	4.78	0.00	0.00	0.00	27.05
85-86	0.06	0.00	1.30	1.50	4.75	2.90	10.10	11.07	4.88	0.85	0.74	0.09	38.24
86-87	0.04	0.00	2.24	0.89	0.42	3.65	6.80	4.67	4.78	0.14	0.05	0.00	23.68
87-88	0.00	0.00	0.00	0.96	4.81	5.25	9.61	0.55	0.22	2.42	0.92	0.60	25.34
88-89	0.03	0.06	0.00	0.18	4.26	3.99	2.14	1.92	10.45	1.54	0.50	0.29	25.36
89-90	0.00	0.18	1.10	2.44	1.96	0.13	5.49	2.48	2.00	0.77	1.08	0.07	17.70
90-91	0.00	0.03	0.14	0.24	0.63	2.01	0.98	3.28	9.51	0.91	0.35	0.00	18.08
91-92	0.00	0.05	0.00	2.85	1.35	3.45	3.00	9.45	3.65	1.40	0.00	1.05	26.25
92-93	0.00	0.00	0.06	5.62	1.90	10.24	10.40	6.42	4.50	1.78	1.80	1.11	43.83
93-94	0.00	0.00	0.00	3.19	3.74	5.09	4.45	7.90	0.46	2.64	1.15	0.08	28.70
94-95	0.09	0.11	0.10	1.00	10.62	6.31	23.08	0.46	16.32	4.72	1.74	0.57	65.12
95-96	0.00	0.00	0.00	0.30	1.04	18.47	9.65	8.79	3.58	3.23	4.03	0.00	49.09
96-97	0.02	0.00	0.53	1.58	4.55	15.32	11.40	1.04	2.42	2.17	0.93	0.72	40.68
97-98	0.03	2.32	0.70	1.73	11.05	4.58	16.48	24.40	4.78	2.92	3.74	0.04	72.77
98-99	0.00	0.00	0.04	1.80	9.80	3.28	6.23	15.85	6.70	3.14	0.12	0.15	47.11
99-00	0.00	0.06	0.24	0.83	3.78	0.62	6.38	8.58	3.06	2.60	1.42	0.44	28.01
00-01	0.00	0.37	0.09	2.44	1.17	1.32	4.38	5.75	1.83	0.97	0.08	0.33	18.73
01-02	0.07	0.06	0.44	1.31	8.38	11.32	4.58	2.75	2.95	0.93	0.81	0.19	33.79
02-03	0.21	0.23	0.20	0.28	3.13	13.20	3.15	2.56	2.90	5.23	1.54	0.17	32.80
03-04	0.11	0.18	0.26	0.26	3.63	11.47	4.42	8.87	1.41	0.47	0.11	0.00	31.19
04-05	0.13	0.09	0.09	2.60	1.76	7.55	3.72	5.13	6.15	2.14	3.85	1.53	34.74
05-06	0.03	0.05	0.02	1.05	3.61	15.41	6.14	4.52	10.90	6.88	0.35	0.04	
06-07	0.00	0.00	0.01										

Appendix B. Sea Temperature Data at Bodega Bay, Captured by NOAA's National Data Buoy Center from April of 1981 to December of 2004.



Appendix C. Macrophyte Species found at Bodega ASBS. Presence listed by survey.

Macrophyte Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Cyanobacteria	blue-green algae				X	X						
Liliopsida	*Phyllospadix scouleri*	X	X	X	X	X						
	Phyllospadix torreyi	X	X	X	X							
Algae	Diatoms				X	X						
Brown Algae	*Alaria marginata*	X	X	X	X	X						
	Analipus japonicus		X	X	X	X						
	Coilodesme californica		X									
	Colpomenia/Leathesia sp.			X	X							
	Costaria costata	X	X									
	Cylindrocarpus rugosus		X									
	Cystoseira osmundacea	X	X									
	Desmarestia herbacea	X	X									
	Desmarestia munda	X	X									
	Dictyoneurum californicum		X									
	Ectocarpus dimorphus	X										
	Ectocarpus parvus		X									
	Egregia menziesii	X	X	X	X	X	X	X	X	X	X	
	encrusting brown algae									X		X
	Fucus distichus		X									
	Fucus sp.			X	X	X						
	Hedophyllum sessile		X	X	X	X						
	Laminaria dentigera	X	X									
	Laminaria ephemera	X	X									
	Laminaria farlowii	X										
	Laminaria setchellii			X	X	X	X					
	Laminaria sinclairii			X	X	X						
	Leathesia difformis		X									
	Lessoniopsis littoralis	X	X									
	Macrocystis integrifolia	X	X									
	Pelvetia fastigiata	X	X									
	Pelvetiopsis limitata		X					X	X			
	Pelvetiopsis sp.			X	X	X						
	Petalonia fascia		X									

Appendix C (cont'd). Macrophyte Species found at Bodega ASBS. Presence listed by survey.

Macrophyte Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
	Petrospongium rugosum				X	X						
	Phaeostrophion irregulare		X									
	Pilayella gardneri		X									
	Postelsia palmaeformis		X									
	Pterygophora californica		X									
	Ralfsiaceae			X	X	X						
	Scytosiphon lomentaria		X									
	Scytosiphon sp.									X		
	Silvetia compressa			X	X							
	Soranthera ulvoidea		X									
Green Algae	*Blidingia minima minima*		X									
	Bolbocoleon piliferum		X									
	Cladophora columbiana		X	X	X	X	X	X	X	X	X	X
	Codium fragile	X	X									
	Codium setchellii		X									
	Collinsiella tuberculata	X	X									
	Derbesia marina		X									
	Endophyton ramosum		X									
	Enteromorpha intestinalis		X									
	Enteromorpha linza		X									
	Enteromorpha prolifera	X	X									
	Entocladia viridis		X									
	Prasinocladus ascus		X									
	Prasiola meridionalis		X									
	Spongomorpha coalita	X	X									
	Ulva californica		X									
	Ulva lobata		X									
	Ulva sp.			X	X	X	X	X	X			X
	Urospora penicilliformis		X									
Red Algae	*Acrochaetium subimmersum*		X									
	Ahnfeltia gigartinoides	X	X									
	Ahnfeltia plicata	X	X									

Appendix C (cont'd). Macrophyte Species found at Bodega ASBS. Presence listed by survey.

Macrophyte Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Red Algae	*Amplisiphonia pacifica*	X										
	Bangia fusco-purpurea		X									
	Bossiella californica	X	X									
	Bossiella orbigniana dichotoma		X									
	Bossiella orbigniana orbigniana	X										
	Bossiella plumosa	X										X
	Bossiella sp.			X	X	X						
	Botryoglossum farlowianum anomalum	X										
	Calliarthron tuberculosum	X	X				X			X		
	Calliarthron sp.			X	X	X						
	Calliarthron acutum		X									
	Callithamnion lejolisea		X									
	Callithamnion pikeanum		X	X	X	X	X	X		X		
	Callophyllis crenulata	X	X									
	Callophyllis firma		X									
	Callophyllis flabellulata	X	X									
	Callophyllis obtusifolia	X	X									
	Callophyllis pinnata	X	X									
	Callophyllis stenophylla		X									
	Callophyllis violacea	X	X									
	Ceramium eatonianum		X									
	Ceramium sp.			X	X	X				X		
	Chiharaea bodegensis	X	X									
	Clathromophum parcum		X									
	Constantinea simplex	X	X	X								
	Corallina frondescens	X	X									
	Corallina officinalis chilensis	X	X									
	Corallina vancouveriensis	X	X				X	X	X	X	X	X
	Corallina sp.			X	X	X						
	Cryptonemia ovalifolia	X	X									
	Cryptopleura lobulifera	X	X				X			X	X	X

Appendix C (cont'd). Macrophyte Species found at Bodega ASBS. Presence listed by survey.

Macrophyte Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Red Algae	*Cryptopleura violacea*		X									
	Cryptopleura/Hymenena sp.			X	X	X						
	Crytosiphonia woodii	X	X			X						
	Cumagloia andersonii		X			X						
	Delesseria decipiens	X	X									
	Dilsea californica	X	X	X	X	X						
	encrusting coralline algae			X	X	X				X	X	X
	Endocladia muricata	X	X	X	X	X	X	X	X	X	X	X
	Erythrocladia subintegra		X									
	Erythrophyllum delesserioides		X	X	X	X						
	Erythrophyllum sp.										X	X
	Farlowia compressa	X										
	Farlowia mollis	X	X									
	Gardneriella tuberifera		X									
	Gastroclonium coulteri	X										
	Gelidium coulteri	X	X		X	X					X	X
	Gelidium purpurascens		X									
	Gelidium pusillum	X	X		X							
	Gigartina agardhii		X									
	Gigartina canaliculata		X									
	Gigartina corymbifera	X	X									
	Gigartina exasperata	X	X									
	Gigartina harveyana	X	X									
	Gigartina papillata		X									
	Gigartina volans	X	X									
	Gloiopeltis furcata		X									
	Gloiosiphonia californica				X							
	Gloiosiphonia capillaris					X						
	Gloiosiphonia verticillaris	X	X									
	Gonimophyllum skottsbergii		X									
	Gracilariopsis sjoestedtii	X	X									
	Grateloupia doryphora					X						
	Grateloupia schizophylla		X									

Appendix C (cont'd). Macrophyte Species found at Bodega ASBS. Presence listed by survey.

Macrophyte Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Red Algae	*Grateloupia/Prionitis* sp.					X						
	Gymnogongrus leptophyllus	X	X									
	Gymnogongrus linearis		X									
	Gymnogongrus platyphyllus	X	X									
	Halosaccion glandiforme		X	X	X	X						
	Halymenia californica	X	X									
	Halymenia coccinea	X										
	Halymenia/Schizymenia sp.			X	X	X						
	Hildenbrandia occidentalis		X									
	Hildenbrandia sp.			X	X	X	X	X	X	X	X	
	Hydrolithon decipiens	X	X									
	Hymenena cuneifolia	X	X									
	Hymenena flabelligera	X	X									
	Hymenena multiloba		X									
	Iridaea cordata splendens	X	X									
	Irideae coriacea		X									
	Irideae cornucopiae		X									
	Irideae flaccida		X									
	Iridaea lineare	X										
	Janczewskia gardneri		X									
	Kylinia arcuata		X									
	Laurencia spectabilis spectabilis	X	X									
	Lithothamnium pacificum	X	X									
	Lithothamnium phymatodoum	X	X									
	Lithothrix aspergillum					X						
	Lobocolax deformans		X									
	Mastocarpus jardinii			X	X	X						
	Mastocarpus papillatus			X	X	X	X	X	X	X	X	X
	Mazzaella affinis			X		X						
	Mazzaella flaccida						X	X	X	X	X	X
	Mazzella heterocarpa											X

Appendix C (cont'd). Macrophyte Species found at Bodega ASBS. Presence listed by survey.

Macrophyte Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Red Algae	*Mazzaella linearis*					X						
	Mazzaella parksii				X	X						
	Mazzaella splendens						X	X	X	X		
	Mazzaella sp.			X	X	X						
	Melobesia marginata	X	X									
	Melobesia mediocris	X	X									
	Membranoptera dimorpha		X									
	Mesophyllum conchatum		X									
	Mesophyllum lamellatum		X									
	Microcladia borealis		X	X	X	X	X			X	X	X
	Microcladia californica		X									
	Microcladia coulteri	X	X								X	
	Neoagardhiella baileyi		X									
	Neopolyporolithon reclinatum		X									
	Neoptilota densa		X									
	Neoptilota hypnoides		X									
	Neorhodomela larix			X	X	X						
	Neorhodomela oregona				X							
	Odonthalia floccosa	X	X	X	X	X	X	X	X	X	X	X
	Odonthalia oregona		X									
	Opuntiella californica	X										
	Osmundea spectabilis			X		X						
	Petrocelis franciscana		X									
	Petrocelis sp.			X	X	X				X	X	
	Peyssonellia pacifica		X									
	Phycodrys setchellii	X										
	Pikea californica		X									
	Pikea robusta	X										
	Plocamium cartilagineum	X		X		X						
	Plocamium oregonum	X	X									
	Plocamium violaceum		X	X	X	X						

Appendix C (cont'd). Macrophyte Species found at Bodega ASBS. Presence listed by survey.

Macrophyte Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Red Algae	*Plocamium* sp.									X		
	Plocamiocolax pulvinata	X										
	Polyneura latissima		X			X						
	Polysiphonia hendryi gardneri		X									
	Polysiphonia pacifica disticha		X									
	Polysiphonia paniculata	X	X									
	Polysiphonia sp.					X						X
	Porphyra lanceolata		X									
	Porphyra perforata		X									
	Porphyra sp.			X	X	X					X	
	Porphyrella gardneri	X	X									
	Prionitis cornea	X	X									
	Prionitis filiformis	X										
	Prionitis lanceolata	X	X	X	X	X					X	
	Prionitis lyallii	X	X	X		X				X		
	Pseudolithophyllum neofarlowii	X					X	X	X			
	Pterosiphonia bipinnata	X	X			X						
	Pterosiphonia dendroidea	X	X			X						
	Pterochondria woodii woodii	X										
	Ptilota filicina	X	X									
	Rhodochorton purpureum		X									
	Rhodoglossum affine		X									
	Rhodoglossum californicum		X									
	Rhodoglossum roseum		X									
	Rhodophsema elegans polystromatica		X									
	Rhodomela larix		X									
	Rhodymenia pacifica	X	X									
	Rhodymenia palmata mollis	X	X									
	Schizymenia pacifica	X										
	Serraticardia macmillanii		X	X	X							

Appendix C (cont'd). Macrophyte Species found at Bodega ASBS. Presence listed by survey.

Macrophyte Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Red Algae	*Smithora naiadum*	X	X									
	Stenogramme interrupta	X	X									
	Tenarea dispar		X									
	Tiffaniella snyderiae		X									

Appendix D. Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Anopla	*Tubulanus polymorphus*		X									
	Tubulanus sexlineatus		X									
Anthozoid	*Anthopleura artemisia*		X									
	Anthopleura elegantissima	X	X	X	X	X	X	X	X	X	X	X
	Anthopleura sola			X	X	X	X		X		X	
	Anthopleura xanthogrammica	X	X	X	X	X	X	X	X	X	X	
	Balanophyllia elegans	X	X									
	Clavularia sp.	X	X									
	Cnidopus ritteri	X	X									
	Corynactis californica	X	X									
	Epiactis prolifera		X									
	Epiactis ritteri											
	Metridium senile	X										
	Tealia coriacea	X	X									
	Tealia lofotensis	X										
	Tealia sp.	X										
Ascidiacea	*Aplidium californicum*	X	X									
	Aplidium solidum	X										
	Aplidium sp.	X										
	Archidistoma psammion	X	X									
	Archidistoma ritteri	X	X									
	Boltenia villosa	X										
	Botryllus sp.		X	X								
	Clavelina huntsmani	X	X									
	Cystodytes lobatus	X										
	Cystodytes sp.	X										
	Didemnum carnulentum	X	X									
	Diplosoma macdonaldi	X										
	Distaplia occidentalis	X										
	Distaplia smithi	X	X									
	Euherdmania claviformis	X	X									
	Metandrocarpa dura	X										

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Ascidiacea	*Metandrocarpa taylori*	X	X									
	Perophora annectens	X										
	Polyclinum planum	X	X									
	Pyura haustor	X	X									
	Ritterella sp.			X		X						
	Styela montereyensis	X	X									
	Synoicum parfustis	X										
	Synoicum pellucidum	X										
	Trididemnum opacum	X	X									
Asteroid	*Dermasterias imbricata*	X	X									
	Evasterias troschelii		X									
	Henricia leviuscula	X	X									
	Leptasterias hexactis	X	X							X	X	X
	Leptasterias pusilla		X									
	Leptasterias sp.			X	X	X						
	Orthasterias koehleri	X										
	Patiria miniata	X	X									
	Pisaster brevispinus	X	X									
	Pisaster ochraceus	X	X	X	X	X	X	X	X			X
	Pycnopodia helianthoides	X	X									
	Solaster dawsoni	X	X									
Bivalve	*Hiatella artica*	X	X									
	Hinnites giganteus	X	X									
	Lasaea (Lasia) rubra						X	X	X			
	Mytilimeria nuttalii		X									
	Mytilus californianus		X	X	X	X	X	X	X	X	X	X
	Mytilus galloprovincialis/trossulus			X	X							
	Pholadidae penita		X									
	Pododesmus cepio	X	X									
	Protothaca staminea		X									
Calcarid	*Clathrina* sp.	X										
	Leucilla nuttingi	X	X									

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Calcarid	*Leucosolenia eleanor*	X	X									
Cephalopod	*Enteroctopus dofleini*											
	Octopus dofleini martini	X	X									
Crustacea	*Acanthomysis* sp.	X										
	Allooniscus perconvexus		X									
	Balanus cariosus		X									
	Balanus crenatus	X	X									
	Balanus glandula		X	X	X	X		X	X			
	Balanus nubilus	X	X									
	Caprella gracilior		X									
	Carpella verrucosa		X									
	Cancer antennarius	X	X	X	X							
	Cancer gracilis	X										
	Cancer magister	X										
	Cancer productus	X	X									
	Chondracanthus canaliculatus			X	X	X						
	Chondracanthus spinosus				X							
	Chthamalus dalli		X				X	X	X			
	Chthamalus sp.			X	X	X						
	Cirolana harfordi		X									
	Cirolana sp.				X	X						
	Crangon handi	X										
	Cryptolithodes sitchensis	X										
	Emerita analoga		X									
	Escirolana linguifrons		X									
	Fabia subquadrata		X									
	Hemigrapsus nudas		X			X						
	Heptacarpus brevirostris	X	X									
	Heptacarpus cristatus	X	X									
	Heptacarpus taylori		X									
	Idotea montereyensis	X	X									
	Idotea wosnesenskii		X									

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Crustacea	*Idotea* sp.			X	X	X						
	Ligia occidentalis		X									
	Ligia pallasii		X									
	Ligia sp.					X						
	Lopholithodes mandtii	X										
	Loxorhynchus crispatus	X	X									
	Metacaprella kennerlyi		X									
	Mimulus foliatus	X	X									
	Oedignathus inermis		X			X						
	Opisthopus transversus		X									
	Orchestia traskiana		X									
	Orchestoidea californiana		X									
	Orchestoidea corniculata		X									
	Pachycheles rudis		X									
	Pachycheles sp.			X								
	Pachygrapsus crassipes		X	X	X	X	X	X		X	X	
	Pagurus granosimanus	X	X									
	Pagurus hemphilli		X									
	Pagurus hirsutiusculus	X	X	X	X							
	Pagurus samuelis	X	X		X							
	*Pagurus*sp.											X
	Petrolisthes cinctipes		X					X				X
	Petrolisthes sp.				X							
	Pollicipes polymerus		X	X	X	X	X	X	X	X	X	X
	Pugettia producta	X	X	X	X	X						
	Pugettia richii	X										
	Scyra acutifrons	X										
	Semibalanus cariosus			X	X	X			X			X
	small barnacles									X	X	X
	Tecticeps convexus	X										
	Tetraclita rubescens			X		X	X					
	Tetraclita squamosa		X									
	Tigriopus californicus		X									

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

(C = Common; O = Occasional; R = Rare; (S) = Seasonal; X = Present).

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Demospongid	*Acarnus erithacus*	X	X									
	Adocia dubia	X	X									
	Anaata spongigartina	X										
	Anthoarcuata graceae	X										
	Antho lithophoenix	X	X									
	Aplysilla glacialis	X	X									
	Aplysilla polyraphis	X	X									
	Axinella vermiculata	X	X									
	Axinomimus tuscarus	X										
	Axocielita originalis	X	X									
	Cliona celata californiana	X	X									
	Halichondria panicea	X	X									
	Halichondria sp.			X	X	X	X		X	X	X	X
	Haliclona permollis	X	X									
	Haliclona sp.			X		X	X		X	X		X
	Higginsia higginissima		X									
	Hymedesmia brepha	X										
	Hymendectyon lyoni	X	X									
	Isodictya quatsinoensis	X										
	Leptoclathria asodes	X										
	Leucophloeus actites		X									
	Lissodendoryx firma	X	X									
	Lissodendoryx topsenti	X	X									
	Microciona microjoanna	X	X									
	Microciona parthena	X										
	Mycale lobata	X	X									
	Mycale macginitiei	X	X									
	Mycale psila	X	X									
	Mycale richardsoni	X	X									
	Myxilla agennes	X										
	Myxilla incrustans	X										
	Ophlitaspongia pennata	X	X	X	X	X						

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Demospongid	*Ophlitaspongia* sp.						X	X	X	X	X	X
	Pachychalina lunisimilis	X	X									
	Plocamissa igzo	X										
	Plocamia karykina	X	X									
	Polymastia pachymastia	X	X									
	Prianos problematicus	X										
	Reniera sp.	X	X									
	Sigmadocia edaphus	X										
	Sigmadocia sp.	X										
	Spongia idia	X										
	Stelletta clarella	X										
	Stylopus versicolor californiana	X										
	Suberites sp.	X	X									
	Tedania fragilis	X										
	Tedania toxicalis	X										
	Tedanione obscurata	X	X									
	Tethya aurantia californiana	X										
	Tetilla sp.	X	X									
	Xestospongia trindanea	X	X									
	Xestospongia vanilla	X	X									
Echinoid	*Dendraster excentricus*	X										
	Strongylocentrotus franciscanus	X										
	Strongylocentrotus purpuratus	X	X	X	X	X					X	
Enopla	*Amphiporus fromidabilis*		X									
	Amphiporus imparispinosus		X									
	Emplectonema gracile		X									
	Paranemertes peregrina		X									
	Phascolosoma agassizi		X									
Enopla	*Themiste dyscritum*		X									
Entoprocta	*Barentsia gracilis*		X									
Gastropod	*Acanthina spirata*		X									
	Acanthodoris brunnea		X									

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Gastropod	*Acanthodoris nanaimoensis*	X										
	Acmaea mitra	X	X							X		
	Aegires albopunctata	X										
	Aeolidia papillosa		X									
	Aldisia sanguinea	X										
	Amphissa columbiana	X										
	Amphissa versicolor		X		X							
	Anisodoris montereyensis		X									
	Anisodoris nobilis	X	X		X							
	Ancula pacifica		X									
	Antiopella barbarensis	X										
	Aplysiopsis smithi		X									
	Archidoris montereyensis	X										
	Archidoris odhneri	X										
	Barleeia sp.		X									
	Bittium sp.		X									
	Cadlina luteomarginata	X										
	Cadlina modesta		X									
	Calliostoma ligatum	X	X									
	Ceratostoma foliatum	X	X									
	Coryphella trilineata	X	X									
	Crepidula adunca	X	X									
	Crepidula nummaria		X									
	Dendronotus frondosus		X									
	Diaulula sandiegensis	X	X									
Gastropod	*Diodora aspera*	X	X									

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
	Dirona albolineata	X										
	Dirona picta		X			X						
	Discodoris heathi	X										
	Doriopsilla albopunctata	X	X									
	Doto kya		X									
	Epitonium tinctum	X	X									
	Euspira lewisii											
	Fissurella volcano	X										
	Flabellina trilineata											
	Haliotis cracherodii		X									
	Haliotis rufescens	X	X									
	Hancockia californica		X									
	Hermissenda crassicornis	X	X									
	Hipponix cranioides	X	X									
	Homalopoma baculum/luridum				X							
	Hopkinsia rosacea	X										
	Janolus barbarensis											
	Lacuna marmorata	X										
	Lacuna sp.		X			X						
	Laila cockerelli	X										
	Lamellaria sp.	X	X									
	Lirabuccinum dirum											
	Lirularia succincta		X									
	Littorina keenae			X	X	X						
	Littorina planaxis		X									
	Littorina scutulata		X	X	X	X		X			X	X
	Littorina sitkana/subrotunda				X	X						
	Littorina sp.			X	X							
	Lottia (Collisella) instabilis	X	X									
	Lottia (Collisella) strigatella		X									
	Lottia (Collisella) asima	X	X									X
	Lottia (Collisella) digitalis/austrodigitalis		X	X	X	X	X	X	X	X	X	X
	Lottia gigantea							X			X	

Gastropod	*Lottia (Collisella)limatula*		X	X	X	X						
	Lottia ochracea				X							
	Lottia paradigitalis/strigatella			X	X	X	X	X				
	Lottia (Collisella) pelta		X	X	X	X	X	X	X		X	X
	Lottia (Maclintockia/ Collisella) scabra/conus		X	X	X	X	X	X	X	X	X	X
	Lottia scutum			X	X	X						
	Megatebennus bimaculatus	X	X									
	Megathura crenulata	X										
	Mitrella aurantiaca	X										
	Mitrella carinata	X	X									
	Nassarius mendicus	X										
	Nitidiscala tincta											
	Notoacmea insessa	X	X									
	Notoacmea paleacea	X	X									
	Notoacmea persona		X									
	Notoacmea scutum		X									
	Nucella canaliculata	X	X	X	X	X	X					
	Nucella ostrina/emarginata		X	X	X	X				X		X
	Ocenebra circumtexta		X									
	Ocenebra interfossa	X										
	Olivella biplicata	X										
	Onchidella borealis		X	X	X	X						
	Petaloconchus montereyensis					X						
	Polinices lewisii	X										
	Polycera atra		X									
	Precuthona divae	X										
	pyramidellid snails		X									
	Rostanga pulchra	X	X									
	Searlesia dira	X	X									
	Serpulorbis squamigerus			X								
	small limpets									X	X	X
	Tegula brunnea	X	X								X	X

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Gastropod	*Tegula funebralis*	X	X	X	X	X	X	X	X	X	X	X
	Trimusculus reticulatus		X									
	Trinchesia flavovulta	X										
	Trinchesia lagunae	X										
	Trinchesia sp.		X									
	Triopha carpenteri	X	X									
	Triopha maculata	X	X									
	Tritonia festiva	X	X									
Gymno-	*Alcyonidium parasiticum*	X										
laemate	*Alcyonidium polyoum*		X									
	Arthropoma cecili		X									
	Bugula californica		X									
	Costazia robertsonae	X										
	Dendrobeania lichenoides	X	X									
	Electra crustulenta		X									
	Eurystomella bilabiata	X	X									
	Flustrellidra corniculata	X	X									
	Hippothoa hyalina	X	X									
	Lichenopora hispida											
	Membranipora membranacea	X	X									
	Microporella californica	X	X									
	Microporella cribosa	X										
	Parasmittina collifera											
	Schizoporella errata	X										
	Scrupocellaria californica	X	X									
	Tricellaria ternata		X									
	Triticella elongata		X									
	Tritonia festiva											
Holothurid	*Cucumaria miniata*	X	X									
	Cucumaria pseudocurata	X	X	X								
	Eupentacta quinquesemita	X	X									
	Parastichopus californicus											

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Holothurid	*Stichopus californicus*	X										
Hydrozoid	*Abietenaria amphora*		X									
	Abietenaria filicula		X									
	Abietenaria greenei		X									
	Aglaophenia inconspicua	X	X									
	Aglaophenia latirostris		X		X	X						
	Aglaophenia struthionides	X	X									
	Campanularia urceolata		X									
	Campanularia volubilis		X									
Hydrozoid	*Eudendrium californicum*		X									
	Garveia annulata		X									
	Halecium sp.		X									
	Hydractinia sp.		X									
	Hydroid					X						
	Leuckartiara octona		X									
	Orthopyxis sp.		X									
	Phialidium sp.		X									
	Plumularia setacea		X									
	Plumularia plumularoides	X	X									
	Sertularella pinnata		X									
	Sertularella turgida	X	X									
	Sertularia furcata	X										
	Stylantheca porphyra	X	X									
	Tubularia marina		X									
	Velella velella	X	X									
Merostamte	mites		X									
Ophiurid	*Amphiodia occidentalis*	X	X									
	Ophionereis eurybrachyplax	X	X									
Polychaete	*Arabella iricolor*		X									
	Arctonoe fragilis		X									
	Arctonoe vittata		X									
	Boccardia proboscidea		X									

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Polychaete	*Chone ecaudata*		X									
	Cirriformia luxuriosa		X									
	Dexiospira spirillum											
	Dodecaceria fewkesi	X	X	X	X	X						
	Eudistylia polymorpha	X	X									
	Eulalia aviculiseta		X									
	Halosydna brevisetosa		X									
	Haplosyllis spongicola		X									
	Lumbrineris sp.		X									
	Naineris dendritica	X	X									
	Neoamphitrite robusta		X									
	Nereis latescens											
	Nereis vexillosa		X									
	Ophiodromus pugettensis		X									
	Phragmatopoma californica	X	X	X	X	X	X			X	X	X
	Phyllochaetopterus prolifica	X										
	Platynereis bicanaliculata		X									
	Sabella crassicornis	X										
	Sabellaria cementarium	X										
	Salmacina tribranchiata	X										
	Serpula vermicularis	X	X									
	Spirorbis spirillum	X										
	Spirorbis sp.		X			X						
	Sthenelais fusca		X									
	Thelepus crispus		X									
Polyplaco-	*Basiliochiton heathii*	X										
phorid	*Cyanoplax hartwegii*		X									
	Cryptochiton stelleri	X	X									
	Dendrochiton thamnoporus	X										
	Ischnochiton radians		X									
	Katharina tunicata	X	X	X	X	X	X					
	Lepidochitona dentiens			X	X	X						

Appendix D (cont'd). Invertebrate Species found at Bodega ASBS. Presence listed by survey.

Invertebrate Group	Species Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	BML Outfall Channel Intertidal January 2005	BML Channel A Intertidal January 2005	BML Channel B Intertidal January 2005	BML Outfall Channel Intertidal Nov. 2005	BML Channel A Intertidal Nov. 2005	BML Channel B Intertidal Nov. 2005
Polyplaco-	*Lepidochitona flectens*											
phorid	*Lepidochitona hartwegii*			X	X							
	Lepidochitona thamnopora											
	Lepidozona cooperi		X									
	Lepidozona sp.					X						
	Mopalia ciliata	X	X									
	Mopalia hindsii	X	X									
	Mopalia lignosa		X									
	Mopalia muscosa	X	X									
	Mopalia sp.			X	X	X				X		X
	Nuttalina californica		X					X		X		X
	Nuttalina sp.			X	X	X						
	Placiphorella velata		X									
	Tonicella lineata	X	X	X	X	X					X	
Pycnogonida	*Achelia chelata*		X									
	Phoxichilidium quadridentatum		X									
	Pycnogonida					X						
	Pycnogonum stearnsi		X									
	Tanystylum californicum		X									
Scyphozoid	*Aurelia aurita*	X										
	Pelagia noctiluca	X										
Stenolaemate	*Crisia maxima*		X									
	Crisia occidentalis	X										
	Diaperoecia californica	X										
	Disporella californica	X										
	Disporella hispida	X										
	Oncousoecia sp.	X										
	Filicrisia geniculata		X									
Turbellarian	*Notoplana* sp.		X									

Appendix E. Fish Species found at Bodega ASBS. Presence listed by survey.

Fish Group	Species Name	Common Name	SWRCB Subtidal 1979	SWRCB Intertidal 1979	SWAT Intertidal July 2001	SWAT Intertidal June 2003	SWAT Intertidal May 2004	Substrate
Agonid	*Chesnonia verrucosa*	warty poacher	X					rock/algae
	Odontopyxis trispinosa	pygmy poacher	X					sand
	Pallasina barbata	tubenose poacher	X					sand
	Stellerina xyosterna	pricklebreast poacher	X					rock/algae
Anarhichadid	*Anarrhichthys ocellatus*	wolf-eel	X					rock
Aulorhynchid	*Aulorhynchus flavidus*	tube-snout	X					sand
Batrachoid	*Porichthys notatus*	plainfin midshipman	X					rock/sand
Clinid	*Gibbonsia metzi*	striped kelpfish	X					algae
Cottid	*Scorpaenichthys marmoratus*	cabezon	X					rock
	Oligocottus maculosus	tidepool sculpin		X				pools
	Cottidae family, no further identification	sculpin			X	X		pools
	Clinocottus sp.	sculpin		X				pools
Embiotocid	*Brachyistius frenatus*	kelp perch	X					algae
	Cymatogaster aggregata	shiner perch	X					over rock/sand
	Embiotoca jacksoni	black perch	X					over rock
	Hyperprosopon anale	spotfin surfperch	X					sand
	Hypsurus caryi	rainbow seaperch	X					over rock/sand
	Micrometrus minimus	dwarf perch	X					over sand
	Phanerodon furcatus	white seaperch	X					over sand/algae
	Rhacochilus toxotes	rubberlip seaperch	X					over rock
Gadid	*Microgadus proximus*	Pacific tomcod	X					over sand
Gobiesocid	*Gobiesox maeandricus*	northern clingfish		X				pools
Hexagrammid	*Hexagrammos decagrammus*	kelp greenling	X					rock/algae
	Hexagrammos lagocephalus	rock greenling	X					rock/algae
	Ophiodon elongatus	lingcod	X					rock
Lamnid	*Carcharodon carcharias*	great white shark	X					pelagic
Liparid	*Liparis pulchellus*	showy snailfish	X					sand
Ophidiid	*Chilara taylori*	spotted cusk-eel	X					over sand
Paralichthyid	*Citharichthys sordidus*	Pacific sanddab	X					sand
	Citharichthys stigmaeus	speckled sanddab	X					sand
Pholid	*Apodichthys flavidus*	penpoint gunnel	X					rock/algae
Pleuronectid	*Isopsetta isolepis*	butter sole	X					sand
	Parophrys vetulus	English sole	X					sand
	Platichthys stellatus	starry flounder	X					sand
	Pleuronichthys decurrens	curlfin sole	X					sand
Rajid	*Raja inornata*	California skate	X					over sand
	Raja rhina	lungnose skate	X					over sand
Sciaenid	*Genyonemus lineatus*	white croaker	X					over sand
Scorpaenid	*Sebastes auriculatus*	Brown rockfish	X					rock
	Sebastes caurinus	copper rockfish	X					rock
	Sebastes flavidus	yellowtail rockfish	X					rock
	Sebastes mystinus	blue rockfish	X					rock
Squatinid	*Squatina californica*	Pacific angel shark	X					over sand
Stichaeid	*Xiphister altropurpureus*	black prickleback		X				pools
Torpedinid	*Torpedo californica*	Pacific electric ray	X					over sand

* No fish reported in BML 2005 survey

Appendix F. Marine Mammals of Bodega Head.
X Present; T Threatened; E Endangered

Order	Scientific Name	Common Name	FWS 12/1/06	Barbour et al., 1973	SWRCB 1979	NCCOS 2003
Fissiped	*Enhydra lutris neresis*	southern sea otter				X
Pinnipedia	*Arctocephalus townsendi*	Guadalupe fur seal	T			
	Callorhinus ursinus	northern fur seal				X
	Eumetopias jubatus	Steller sea lion	T	X	X	X
	Mirounga angustirostris	northern elephant seal		X	X	X
	Phoca vitulina	harbor seal		X	X	X
	Zalopphus californianus	California sea lion		X	X	X
Cetacea	*Balaenoptera acutorostrata*	minke whale				X
	Balaenoptera borealis	sei whale	E			
	Balaenoptera musculus	blue whale	E			X
	Balaenoptera physalus	fin whale	E		X	X
	Berardius bairdii	Baird's beaked whale				X
	Delphinus delphis	short-beaked common dolphin				X
	Eschrichtius robustus	gray whale		X	X	X
	Eubalaena glacialis	right whale	E			
	Grampus griseus	Risso's dolphin			X	X
	Lagenorhynchus obliquidens	Pacific white-sided dolphin			X	X
	Lissodelphis borealis	northern right whale dolphin			X	X
	Megaptera novaeangliae	humpback whale	E	X		X
	Mesoplodon spp.	beaked whales (mesoplodonts)				X
	Orcinus orca	killer whale			X	X
	Phocoena phocoena	harbor porpoise				X
	Phocoena vomerina	harbor porpoise			X	
	Phocoenoides dalli	Dall's porpoise			X	X
	Physeter catodon	sperm whale	E			X
	Tursiops truncatus	bottlenose dolphin				X
	Ziphius cavirostris	Cuvier's beaked whale				X

Appendix G. UCD Bodega Marine Laboratory Maximum Annual Captive Species List 2005.

Species Group	Species Name	Common Name	Non-native Origin
Fish	*Oncorhynchus tshawytscha*[1]	Winter-run Chinook salmon (endangered)	
	Oncorhynchus kisutch[1]	Coho Salmon (endangered)	
	Atractoscion nobilis[2]	White Sea Bass	
	Sardinops sagax[2]	Sardine	
	Sebastes spp.	Rockfish	
	Paralichthys californicus	California Halibut	
	Gillichthys mirabilis	Longjaw mudsucker	
	Embiotoca lateralis	Striped surf perch	
	Various subtidal native fishes		
Molluscs	*Haliotis sorenseni*[3]	White Abalone (endangered)	Oxnard
	Haliotis rufescens[3]	Red Abalone	Cayucus
	Haliotis cracherodii[3]	Black Abalone	Vandenberg & Diablo Canyon
	Haliotis corrugata[3]	Pink Abalone	Southern California
	Haliotis fulgens[3]	Green Abalone	Southern California
	Ostrea conchaphila[4]	Native Oysters	
	Crassostrea gigas[4]	Japanese Oysters	
	Mytilus sp.	Mussels	
	Lacuna, Tegula, Nucella, and others	Snails-Whelks, Turbans, Horn-mouthed	
	Phyllaplysia sp.	Sea Hare	
Crustaceans	*Homarus americanus*	Maine Lobster	Broodstock from Massachusetts
	Carcinus maenas	European Green Crab	
	Cancer antennarius	Rock Crab	
	Cancer magister	Dungeness Crab	
	Pugettia species	Kelp Crab	
	Petrolisthes cinctipes	Porcelain crab	
	Idotea resecata	Green Isopod	
Echinoderms	*Strongylocentrotus purpuratus*	Purple Sea Urchin	
	Strongylocentrotus franciscanus	Red Sea Urchin	
	Lytechinus anamesus	White Sea Urchin	Central & Southern California
	Pisaster ochraceus	Ochre Sea Star	
	Leptasterias hexactis	6-armed Sea Star	
	Asterina miniata	Bat Star	

[1]Species in fish pathology lab (chlorination/dechlorination system) and salmon reasearch lab (semi-closed recirculating system)

[2]Species in fish pathology lab only (chlorination/dechlorination system)

[3]Species in DFG shellfish pathology lab only (chlorination/dechlorination system)

[4]Species in DFG shellfish pathology lab (chlorination/dechlorination system) and wet lab

Appendix H. Mussel Watch Data from Bodega Head.

Constituent	Jul-77	Nov-77	Aug-78	Dec-78	Oct-79	May-80	Jul-80	Feb-81	Aug-81	Oct-81	Feb-82
Cadmium	1.38	1.77	1.17	1.97	2.79	2.36	1.7	2.09	2.06	1.97	2.55
Chromium	0.31	0.51	0.22	0.44	0.3	0.33	0.29	0.45	0.32	0.29	0.36
Copper	1.01	1	0.67	0.74	0.69	0.92	0.87	1.39	0.86	1.02	0.94
Mercury	0.034	0.039	0.051	0.071	0.076	0.06	0.03	0.046	na	0.016	0.029
Nickel	0.37	0.64	na	na	0.48	0.6	na	na	na	na	na
Lead	0.18	0.23	0.26	0.19	0.34	0.28	0.14	0.34	0.15	0.18	0.24
Selenium	na	na	na	na	na	na	na	na	na	0.32	0.35
Silver	0.011	0.024	0.033	0.045	0.025	0.021	0.015	0.03	0.015	0.018	0.023
Zinc	19.2	20	16.4	22.1	20	15.4	15.4	19.2	22.9	26.4	26.2
(units measured in ppm, wet weight)											
Total Chlordane	na	na	na	na	ns	ns	3.2	ns	1.7	1.5	1.5
Total DDT	4.4	nd	2.3	4.2	ns	ns	4.6	ns	3.7	2.3	17.4
Total of PCB arochlors	4.1	2.1	3.4	3	ns	ns	7.6	ns	nd	nd	nd
Total of Endosulfan	na	na	na	na	ns	ns	0.4	ns	nd	nd	nd
(units measured in ppb, wet weight)											

nd=not detected (-8)
na=not analyzed (-9)
ns=not sampled

Appendix H (cont'd). Mussel Watch Data from Bodega Head.

Constituent	Aug-82	Aug-82	Sep-83	Apr-84	Aug-84	Sep-84	Jul-85	Aug-85	Aug-86	Aug-87	Aug-88
Cadmium	1.52	ns	1.63	1.33	1.42	1.12	0.93	0.96	1.41	1.44	1.87
Chromium	0.3	ns	0.49	0.23	0.34	0.24	0.26	0.31	0.34	0.53	0.23
Copper	0.96	ns	0.96	0.74	0.75	1.9	0.66	0.78	0.8	0.81	1.08
Mercury	0.044	ns	0.05	0.045	0.058	0.042	0.024	0.029	0.061	0.023	0.035
Nickel	na	ns	na	0.46	na	na	na	0.3	0.4	0.26	0.26
Lead	0.19	ns	0.34	0.14	0.15	0.14	0.17	0.14	0.11	0.14	0.1
Selenium	0.52	ns	na	na	na	na	na	0.3	0.4	0.26	0.26
Silver	0.016	ns	0.023	0.014	0.026	0.016	0.018	0.017	0.019	0.018	0.011
Zinc	20.1	ns	28.1	18.4	19.3	18.3	16.4	12.7	21.8	16.6	20.9
(units measured in ppm, wet weight)											
Total Chlordane	0.4	2.6	ns	ns	1	1.1	ns	nd	nd	0.4	nd
Total DDT	2.4	4.3	ns	ns	1.3	1.4	ns	1	0.7	0.6	0.8
Total of PCB arochlors	nd	nd	ns	ns	nd	nd	ns	nd	1.6	nd	nd
Total of Endosulfan	nd	1.4	ns	ns	nd	nd	ns	nd	nd	nd	nd
(units measured in ppb, wet weight)											

nd=not detected (-8)
na=not analyzed (-9)
ns=not sampled

Appendix H (cont'd). Mussel Watch Data from Bodega Head.

Constituent	Aug-89	Nov-89	Aug-90	Aug-91	Sep-92	Sep-93	Sep-94	Sep-95	Aug-96	Oct-97	Oct-98
Cadmium	1.82	1.31	1.8	1.9	2	1.9	2.9	1.5	1.4	1.26	0.64
Chromium	0.19	0.26	0.24	0.15	0.32	0.27	1.4	0.6	0.4	1.39	0.4
Copper	0.91	1.42	0.8	1	0.9	1.1	1.1	4.5	0.94	1.04	0.52
Mercury	0.028	0.037	0.03	0.03	0.025	0.037	0.036	0.021	0.025	0.042	0.012
Nickel	0.27	0.41	0.4	0.3	0.27	na	1.2	0.76	0.39	1.16	0.36
Lead	0.1	0.2	0.17	0.11	0.17	0.25	0.19	0.15	0.14	0.12	0.08
Selenium	0.27	0.41	0.4	0.3	0.27	na	1.2	0.76	0.39	1.16	0.36
Silver	0.008	0.015	0.01	0.007	0.007	0.019	0.013	0.009	0.005	0.008	0.007
Zinc	19.5	29.8	25	23	25	24	29	24	22	18.2	9.3
(units measured in ppm, wet weight)											
Total Chlordane	0.2	0.4	0.9	0.6	0.2	0.5	0.3	nd	nd	0.2	0.5
Total DDT	1.8	1.6	1.7	1.2	0.7	1	0.8	1.3	0.9	1.4	1.5
Total of PCB arochlors	nd	nd	nd	nd	nd	nd	4.3	2.1	4.8	3.5	nd
Total of Endosulfan	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
(units measured in ppb, wet weight)											

nd=not detected (-8)
na=not analyzed (-9)
ns=not sampled

Appendix H (cont'd). Mussel Watch Data from Bodega Head.

Constituent	Sep-99	N	Median	Mean	Standard Deviation
Cadmium	ns	32	1.67	1.68	0.517
Chromium	ns	32	0.315	0.397	0.281
Copper	ns	32	0.93	1.06	0.679
Mercury	ns	31	0.036	0.038	0.015
Nickel	ns	19	0.4	0.489	0.279
Lead	ns	32	0.17	0.182	0.07
Selenium	ns	19	0.36	0.466	0.295
Silver	ns	32	0.016	0.017	0.009
Zinc	ns	32	20.1	20.8	4.66
(units measured in ppm, wet weight)					
Total Chlordane	0.2	19	0.5	0.916	0.852
Total DDT	0.7	27	1.4	2.44	3.24
Total of PCB arochlors	5.1	11	3.5	3.78	1.7
Total of Endosulfan	0.6	3	0.6	0.8	0.529
(units measured in ppb, wet weight)					

nd=not detected (-8)
na=not analyzed (-9)
ns=not sampled

Appendix I. Birds of Bodega Region.

BIRDS OF BODEGA HARBOR, BODEGA HEAD AND BODEGA DUNES

Area covered by this list includes all of Bodega Harbor and the Harbor edge west of Highway 1; Doran Spit; Bodega Head and Bodega Dunes up to Salmon Creek; and the adjacent waters as seen from land.

Abundance codes: C = common, U = uncommon, R = rare, A = accidental.

Status codes: PR = permanent resident, SR = summer resident, WR = winter resident, M = migrant. The listed code refers to the predominant status of each species in the list area. Many species occur occasionally in other seasons as well.

Breeding: ** denotes a species known to breed within the list area.
* denotes a species probably breeding within the list area.

SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	STATUS
Family Gaviidae	Loon Family		
Gavia stellata	Red-throated Loon	U	WR
Gavia arctica	Arctic Loon	A	—
Gavia pacifica	Pacific Loon	C	M, WR
Gavia immer	Common Loon	C	WR
Gavia adamsii	Yellow-billed Loon	A	—
Family Podicipedidae	Grebe Family		
Podilymbus podiceps	Pied-billed Grebe **	U	PR
Podiceps auritus	Horned Grebe	C	WR
Podiceps grisegena	Red-necked Grebe	U	WR
Podiceps nigricollis	Eared Grebe	C	WR
Aechmophorus occidentalis	Western Grebe	C	WR
Aechmophorus clarkii	Clark's Grebe	U	WR
Family Procellariidae	Shearwater and Petrel Family		
Diomedea nigripes	Black-footed Albatross	A	—
Fulmarus glacialis	Northern Fulmar	U	WR
Puffinus creatopus	Pink-footed Shearwater	R	M
Puffinus bulleri	Buller's Shearwater	R	M
Puffinus griseus	Sooty Shearwater	C	M
Puffinus opisthomelas	Black-vented Shearwater	R	M
Family Hydrobatidae	Storm-Petrel family		
Oceanodroma furcata	Fork-tailed Storm-Petrel	R	M
Family Pelecanidae	Pelican Family		
Pelecanus erythrorhynchos	American White Pelican	C	SR
Pelecanus occidentalis	Brown Pelican	C	SR
Family Phalacrocoracidae	Cormorant Family		
Phalacrocorax penicillatus	Brandt's Cormorant **	C	PR
Phalacrocorax auritus	Double-crested Cormorant	C	PR
Phalacrocorax pelagicus	Pelagic Cormorant **	C	PR
Family Fregatidae	Frigatebird Family		
Fregata magnificens	Magnificent Frigatebird	A	—

Appendix I (cont'd). Birds of Bodega Region.

Family Ardeidae	Heron and Bittern Family		
Ardea herodias	Great Blue Heron **	C	PR
Ardea alba	Great Egret **	C	PR
Egretta thula	Snowy Egret	C	PR
Egretta caerulea	Little Blue Heron	A	—
Egretta tricolor	Tricolored Heron	A	—
Bubulcus ibis	Cattle Egret	A	—
Nycticorax nycticorax	Black-crowned Night Heron **	C	PR
Family Threskiornithidae	Ibis and Spoonbill Family		
Plegadis chihi	White-faced Ibis	A	—
Family Cathartidae	New World Vulture Family		
Cathartes aura	Turkey Vulture	C	PR
Family Anatidae	Duck, Goose and Swan Family		
Anser albifrons	Greater White-fronted Goose	R	M
Chen canagica	Emperor Goose	A	—
Chen caerulescens	Snow Goose	R	M
Chen rossii	Ross's Goose	R	M
Branta canadensis	Canada Goose **	U	PR
Branta bernicla	Brant	C	WR
Cygnus columbianus	Tundra Swan	R	M
Anas strepera	Gadwall	U	WR
Anas penelope	Eurasian Wigeon	R	WR
Anas americana	American Wigeon	C	WR
Anas platyrhynchos	Mallard **	C	WR
Anas discors	Blue-winged Teal	R	M
Anas cyanoptera	Cinnamon Teal	U	WR
Anas clypeata	Northern Shoveler	C	WR
Anas acuta	Northern Pintail	C	WR
Anas crecca	Green-winged Teal	U	WR
Aythya valisineria	Canvasback	U	WR
Aythya americana	Redhead	R	M
Aythya collaris	Ring-necked Duck	R	WR
Aythya marila	Greater Scaup	C	WR
Aythya affinis	Lesser Scaup	U	WR
Polysticta stelleri.	Steller's Eider	A	—
Somateria spectabilis	King Eider	A	—
Histrionicus histrionicus	Harlequin Duck.	R	WR
Melanitta perspicillata	Surf Scoter	C	M, WR
Melanitta fusca	White-winged Scoter	U	M, WR
Melanitta nigra	Black Scoter	U	WR
Clangula hyemalis	Long-tailed Duck	R	WR
Bucephala albeola	Bufflehead	C	WR
Bucephala clangula	Common Goldeneye	C	WR
Bucephala islandica	Barrow's Goldeneye	R	WR
Lophodytes cucullatus	Hooded Merganser	R	WR
Mergus serrator	Red-breasted Merganser	C	WR
Oxyura jamaicensis	Ruddy Duck	C	WR

Appendix I (cont'd). Birds of Bodega Region.

Family Accipitridae	Kite, Hawk and Eagle Family		
Pandion haliaetus	Osprey	U	SR
Elanus leucurus	White-tailed Kite	U	PR
Haliaeetus leucocephalus	Bald Eagle	R	WR
Circus cyaneus	Northern Harrier **	C	PR
Accipiter striatus	Sharp-shinned Hawk	U	M, WR
Accipiter cooperii	Cooper's Hawk	U	M, WR
Buteo lineatus	Red-shouldered Hawk	U	PR
Buteo platypterus	Broad-winged Hawk	A	—
Buteo swainsoni	Swainson's Hawk	A	—
Buteo jamaicensis	Red-tailed Hawk **	C	PR
Buteo regalis	Ferruginous Hawk	R	WR
Buteo lagopus	Rough-legged Hawk	U	WR
Aquila chrysaetos	Golden Eagle	R	PR
Family Falconidae	Falcon Family		
Falco sparverius	American Kestrel	C	PR
Falco columbarius	Merlin	R	M, WR
Falco peregrinus	Peregrine Falcon	U	WR
Falco mexicanus	Prairie Falcon	R	M
Family Phasianidae	Partridge and Pheasant Family		
Phasianus colchicus	Ring-necked Pheasant	R	PR
Meleagris gallopavo	Wild Turkey	U	PR
Family Odontophoridae	New World Quail Family		
Callipepla californica	California Quail **	C	PR
Family Rallidae	Coot and Rail Family		
Coturnicops noveboracensis	Yellow Rail	A	—
Laterallus jamaicensis	Black Rail *	R	SR
Rallus longirostris	Clapper Rail	A	—
Rallus limicola	Virginia Rail **	U	PR
Porzana carolina	Sora	U	WR
Gallinula chloropus	Common Moorhen	R	PR
Fulica americana	American Coot **	C	WR
Family Gruidae	Crane Family		
Grus canadensis	Sandhill Crane	A	—
Family Charadriidae	Plover Family		
Pluvialis squatarola	Black-bellied Plover	C	WR
Pluvialis dominica	American Golden-Plover	R	M
Pluvialis fulva	Pacific Golden-Plover	R	M, WR
Charadrius mongolus	Mongolian Plover	A	—
Charadrius alexandrinus	Snowy Plover **	U	PR
Charadrius semipalmatus	Semipalmated Plover	C	M, WR
Charadrius vociferus	Killdeer **	U	PR
Family Haematopodidae	Oystercatcher Family		
Haematopus bachmani	Black Oystercatcher **	C	PR
Family Recurvirostridae	Stilt and Avocet Family		
Himantopus mexicanus	Black-necked Stilt	R	M
Recurvirostra americana	American Avocet	C	WR

Appendix I (cont'd). Birds of Bodega Region.

Family Scolopacidae	Sandpiper Family		
Tringa melanoleuca	Greater Yellowlegs	U	M, WR
Catoptrophorus semipalmatus	Willet	C	WR
Heteroscelus incanus	Wandering Tattler	U	M, WR
Actitis macularia	Spotted Sandpiper	R	M
Numenius phaeopus	Whimbrel	U	M, WR
Numenius americanus	Long-billed Curlew	R	M
Limosa lapponica	Bar-tailed Godwit	A	—
Limosa fedoa	Marbled Godwit	C	WR
Arenaria interpres	Ruddy Turnstone	U	M, WR
Arenaria melanocephala	Black Turnstone	C	WR
Aphriza virgata	Surfbird	C	M, WR
Calidris canutus	Red Knot	U	M
Calidris alba	Sanderling	C	WR
Calidris pusilla	Semipalmated Sandpiper	A	—
Calidris mauri	Western Sandpiper	C	WR
Calidris minutilla	Least Sandpiper	C	WR
Calidris bairdii	Baird's Sandpiper	R	M
Calidris melanotos	Pectoral Sandpiper	R	M
Calidris acuminata	Sharp-tailed Sandpiper	A	—
Calidris ptilocnemis	Rock Sandpiper	R	WR
Calidris alpina	Dunlin	C	WR
Calidris himantopus	Stilt Sandpiper	A	—
Tryngites subruficollis	Buff-breasted Sandpiper	A	—
Philomachus pugnax	Ruff	A	—
Limnodromus griseus	Short-billed Dowitcher	C	M, WR
Limnodromus scolopaceus	Long-billed Dowitcher	U	M
Gallinago gallinago	Common Snipe	R	WR
Phalaropus tricolor	Wilson's Phalarope	R	M
Phalaropus lobatus	Red-necked Phalarope	U	M
Phalaropus fulicarius	Red Phalarope	R	M
Family Laridae	Gull Family		
Stercorarius pomarinus	Pomarine Jaeger	R	M
Stercorarius parasiticus	Parasitic Jaeger	R	M
Larus atricilla	Laughing Gull	A	—
Larus pipixcan	Franklin's Gull	A	—
Larus philadelphia	Bonaparte's Gull	U	M
Larus heermanni	Heermann's Gull	C	SR
Larus canus	Mew Gull	C	WR
Larus delawarensis	Ring-billed Gull	C	WR
Larus californicus	California Gull	C	WR
Larus argentatus	Herring Gull	U	WR
Larus thayeri	Thayer's Gull	U	WR
Larus glaucoides	Iceland Gull	A	—
Larus occidentalis	Western Gull **	C	PR
Larus glaucescens	Glaucous-winged Gull	C	WR
Larus hyperboreus	Glaucous Gull	R	WR
Xema sabini	Sabine's Gull	R	M
Rissa tridactyla	Black-legged Kittiwake	R	WR
Sterna caspia	Caspian Tern	C	SR
Sterna elegans	Elegant Tern	C	SR
Sterna hirundo	Common Tern	R	M
Sterna paradisaea	Arctic Tern	R	M
Sterna forsteri	Forster's Tern	C	WR
Sterna antillarum	Least Tern	R	SR

Appendix I (cont'd). Birds of Bodega Region.

Chlidonias niger	Black Tern	R	M
Rynchops niger	Black Skimmer	R	SR
Family Alcidae	Auk and Puffin Family		
Uria aalge	Common Murre	C	PR
Cepphus columba	Pigeon Guillemot **	U	PR
Brachyramphus marmoratus	Marbled Murrelet	U	WR
Synthliboramphus hypoleucus	Xantus's Murrelet	A	—
Synthliboramphus craveri	Craveri's Murrelet	A	—
Synthliboramphus antiquus	Ancient Murrelet	U	WR
Ptychoramphus aleuticus	Cassin's Auklet	R	WR
Aethia cristatella	Crested Auklet	A	—
Cerorhinca monocerata	Rhinoceros Auklet *	R	PR
Fratercula cirrhata	Tufted Puffin	R	PR
Family Columbidae	Pigeon and Dove Family		
Columba livia	Rock Dove	U	PR
Columba fasciata	Band-tailed Pigeon	U	PR
Zenaida asiatica	White-winged Dove	A	—
Zenaida macroura	Mourning Dove	C	PR
Family Tytonidae	Barn Owl Family		
Tyto alba	Barn Owl *	U	PR
Family Strigidae	Typical Owl Family		
Bubo virginianus	Great Horned Owl **	U	PR
Nyctea scandiaca	Snowy Owl	A	—
Athene cunicularia	Burrowing Owl	R	WR
Asio otus	Long-eared Owl	A	—
Asio flammeus	Short-eared Owl	R	WR
Family Caprimulgidae	Goatsucker Family		
Chordeiles acutipennis	Lesser Nighthawk	A	—
Family Apodidae	Swift Family		
Cypseloides niger	Black Swift	A	—
Chaetura vauxi	Vaux's Swift	U	M
Family Trochilidae	Hummingbird Family		
Archilochus alexandri	Black-chinned Hummingbird	A	—
Calypte anna	Anna's Hummingbird **	C	PR
Calypte costae	Costa's Hummingbird	A	—
Selasphorus rufus	Rufous Hummingbird	U	M
Selasphorus sasin	Allen's Hummingbird **	C	SR
Family Alcedinidae	Kingfisher Family		
Ceryle alcyon	Belted Kingfisher **	U	PR
Family Picidae	Woodpecker Family		
Melanerpes lewis	Lewis's Woodpecker	A	—
Melanerpes formicivorus	Acorn Woodpecker	R	M
Picoides nuttallii	Nuttall's Woodpecker**	R	PR
Picoides pubescens	Downy Woodpecker*	U	PR
Picoides villosus	Hairy Woodpecker	R	WR
Colaptes auratus	Northern Flicker	U	WR
Dryocopus pileatus	Pileated Woodpecker	A	—

Appendix I (cont'd). Birds of Bodega Region.

Family Tyrannidae	Tyrant Flycatcher Family		
Contopus cooperi	Olive-sided Flycatcher	R	M
Contopus sordidulus	Western Wood-Pewee	U	M
Contopus virens	Eastern Wood-Pewee	A	—
Empidonax traillii	Willow Flycatcher	R	M
Empidonax minimus	Least Flycatcher	A	—
Empidonax hammondii	Hammond's Flycatcher	A	—
Empidonax wrightii	Gray Flycatcher	A	—
Empidonax oberholseri	Dusky Flycatcher	A	—
Empidonax difficilis	Pacific-slope Flycatcher*	U	M
Sayornis nigricans	Black Phoebe **	C	PR
Sayornis phoebe	Eastern Phoebe	R	M
Sayornis saya	Say's Phoebe	U	WR
Myiarchus tuberculifer	Dusky-capped Flycatcher	A	—
Myiarchus cinerascens	Ash-throated Flycatcher	R	M
Myiarchus crinitus	Great Crested Flycatcher	A	—
Myiodynastes luteiventris	Sulphur-bellied Flycatcher	A	—
Tyrannus melancholicus	Tropical Kingbird	R	M
Tyrannus verticalis	Western Kingbird	R	M
Tyrannus tyrannus	Eastern Kingbird	A	—
Tyrannus forficatus	Scissor-tailed Flycatcher	A	—
Family Laniidae	Shrike Family		
Lanius ludovicianus	Loggerhead Shrike	R	PR
Lanius excubitor	Northern Shrike	R	WR
Family Vireonidae	Vireo Family		
Vireo plumbeus	Plumbeous Vireo	A	—
Vireo cassinii	Cassin's Vireo	R	M
Vireo huttoni	Hutton's Vireo *	U	PR
Vireo gilvus	Warbling Vireo	R	SR
Vireo philadelphicus	Philadelphia Vireo	A	—
Vireo olivaceus	Red-eyed Vireo	R	M
Family Corvidae	Crow and Jay Family		
Aphelocoma californica	Western Scrub-Jay **	C	PR
Pica nuttalli	Yellow-billed Magpie	A	—
Corvus brachyrhynchos	American Crow	R	PR
Corvus corax	Common Raven **	U	PR
Family Alaudidae	Lark Family		
Eremophila alpestris	Horned Lark	R	WR
Family Hirundinidae	Swallow Family		
Progne subis	Purple Martin	R	M
Tachycineta bicolor	Tree Swallow	U	M
Tachycineta thalassina	Violet-green Swallow	U	M
Stelgidopteryx serripennis	Northern Rough-winged Swallow**	U	M
Riparia riparia	Bank Swallow	A	—
Petrochelidon pyrrhonota	Cliff Swallow **	C	SR
Hirundo rustica	Barn Swallow **	C	SR
Family Paridae	Chickadee and Titmouse Family		
Poecile rufescens	Chestnut-backed Chickadee *	C	PR
Baeolophus inornatus	Oak Titmouse	U	PR

Appendix I (cont'd). Birds of Bodega Region.

Family Aegithalidae	Bushtit Family		
Psaltriparus minimus	Bushtit **	C	PR
Family Sittidae	Nuthatch Family		
Sitta canadensis	Red-breasted Nuthatch	U	M
Sitta carolinensis	White-breasted Nuthatch	R	M
Sitta pygmaea	Pygmy Nuthatch	R	M
Family Certhiidae	Creeper Family		
Certhia americana	Brown Creeper	U	WR
Family Troglodytidae	Wren Family		
Salpinctes obsoletus	Rock Wren	R	M
Thyromanes bewickii	Bewick's Wren **	C	PR
Troglodytes aedon	House Wren	R	M, WR
Troglodytes troglodytes	Winter Wren	U	WR
Cistothorus palustris	Marsh Wren **	C	PR
Family Regulidae	Kinglet Family		
Regulus satrapa	Golden-crowned Kinglet	U	WR
Regulus calendula	Ruby-crowned Kinglet	C	WR
Family Silviidae	Gnatcatcher Family		
Polioptila caerulea	Blue-gray Gnatcatcher	R	M
Family Turdidae	Thrush Family		
Oenanthe oenanthe	Northern Wheatear	A	—
Sialia mexicana	Western Bluebird	U	PR
Sialia currucoides	Mountain Bluebird	A	—
Catharus ustulatus	Swainson's Thrush *	U	SR
Catharus guttatus	Hermit Thrush	U	M, WR
Turdus migratorius	American Robin	C	PR
Ixoreus naevius	Varied Thrush	U	WR
Family Timaliidae	Babbler Family		
Chamaea fasciata	Wrentit *	U	PR
Family Mimidae	Mimic Thrush Family		
Dumetella carolinensis	Gray Catbird	A	—
Mimus polyglottus	Northern Mockingbird	U	PR
Oreoscoptes montanus	Sage Thrasher	A	—
Toxostoma rufum	Brown Thrasher	A	—
Family Sturnidae	Starling Family		
Sturnus vulgaris	European Starling **	C	PR
Family Motacillidae	Wagtail and Pipit Family		
Motacilla flava	Yellow Wagtail	A	—
Anthus cervinus	Red-throated Pipit	A	—
Anthus rubescens	American Pipit	C	WR
Family Bombycillidae	Waxwing Family		
Bombycilla cedrorum	Cedar Waxwing	R	M, WR
Family Parulidae	Wood Warbler Family		
Vermivora peregrina	Tennessee Warbler	R	M
Vermivora celata	Orange-crowned Warbler *	U	M, SR

Appendix I (cont'd). Birds of Bodega Region.

Vermivora ruficapilla	Nashville Warbler	R	M
Vermivora virginiae	Virginia's Warbler	A	—
Vermivora luciae	Lucy's Warbler	A	—
Parula americana	Northern Parula	R	M
Dendroica petechia	Yellow Warbler	U	M, SR
Dendroica pensylvanica	Chestnut-sided Warbler	R	M
Dendroica magnolia	Magnolia Warbler	R	M
Dendroica tigrina	Cape May Warbler	A	—
Dendroica caerulescens	Black-throated Blue Warbler.	R	M
Dendroica coronata	Yellow-rumped Warbler	C	M, WR
Dendroica nigrescens	Black-throated Gray Warbler	U	M, WR
Dendroica townsendi	Townsend's Warbler	U	M
Dendroica occidentalis	Hermit Warbler	U	M
Dendroica fusca	Blackburnian Warbler	A	—
Dendroica discolor.	Prairie Warbler	R	M
Dendroica palmarum	Palm Warbler	R	M
Dendroica castanea	Bay-breasted Warbler	A	—
Dendroica striata	Blackpoll Warbler	R	M
Mniotilta varia	Black-and-white Warbler	R	M
Setophaga ruticilla	American Redstart	R	M
Protonotaria citrea	Prothonotary Warbler	A	—
Helmitheros vermivorus	Worm-eating Warbler	A	—
Seiurus aurocapillus	Ovenbird	A	—
Seiurus noveboracensis	Northern Waterthrush	R	M
Oporornis formosus	Kentucky Warbler	A	—
Oporornis agilis	Connecticut Warbler	A	—
Oporornis tolmiei	MacGillivray's Warbler	U	M
Geothlypis trichas	Common Yellowthroat *	U	M, PR
Wilsonia citrina	Hooded Warbler	A	—
Wilsonia pusilla	Wilson's Warbler *	U	M, SR
Wilsonia canadensis	Canada Warbler	A	—
Icteria virens	Yellow-breasted Chat	R	M
Family Thraupidae	Tanager Family		
Piranga rubra	Summer Tanager	A	—
Piranga ludoviciana	Western Tanager	U	M
Family Emberizidae	Sparrow Family		
Pipilo chlorurus	Green-tailed Towhee	A	—
Pipilo maculatus	Spotted Towhee	U	PR
Pipilo crissalis	California Towhee *	C	PR
Spizella arborea	American Tree Sparrow	A	—
Spizella passerina	Chipping Sparrow	U	M
Spizella pallida	Clay-colored Sparrow	R	M
Spizella breweri	Brewer's Sparrow	A	—
Pooecetes gramineus	Vesper Sparrow	A	—
Chondestes grammacus	Lark Sparrow	R	M
Calamospiza melanocorys	Lark Bunting	A	—
Passerculus sandwichensis	Savannah Sparrow **	C	PR
Passerella iliaca	Fox Sparrow	C	WR
Melospiza melodia	Song Sparrow **	C	PR
Melospiza lincolnii	Lincoln's Sparrow	U	M, WR
Melospiza georgiana	Swamp Sparrow	R	WR
Zonotrichia albicollis	White-throated Sparrow	R	M, WR
Zonotrichia leucophrys	White-crowned Sparrow **	C	PR
Zonotrichia atricapilla	Golden-crowned Sparrow	C	WR
Junco hyemalis	Dark-eyed Junco	U	WR

Calcarius lapponicus	Lapland Longspur	A	—
Plectrophenax nivalis	Snow Bunting	A	—
Family Cardinalidae	Cardinal Family		
Pheucticus ludovicianus	Rose-breasted Grosbeak	R	M
Pheucticus melanocephalus	Black-headed Grosbeak	U	M
Passerina caerulea	Blue Grosbeak	A	—
Passerina amoena	Lazuli Bunting	R	M
Passerina cyanea	Indigo Bunting	A	—
Family Icteridae	New World Blackbird Family		
Dolichonyx oryzivorus	Bobolink	A	—
Agelaius phoeniceus	Red-winged Blackbird *	C	PR
Agelaius tricolor	Tricolored Blackbird	R	M
Sturnella neglecta	Western Meadowlark	C	WR
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	A	—
Euphagus cyanocephalus	Brewer's Blackbird *	C	PR
Molothrus ater	Brown-headed Cowbird *	U	PR
Icterus spurius	Orchard Oriole	R	M
Icterus cucullatus	Hooded Oriole	R	M
Icterus bullockii	Bullock's Oriole	R	M
Icterus galbula	Baltimore Oriole	A	—
Icterus parisorum	Scott's Oriole	A	—
Family Fringillidae	Finch Family		
Carpodacus purpureus	Purple Finch	U	WR
Carpodacus cassinii	Cassin's Finch	A	—
Carpodacus mexicanus	House Finch **	C	PR
Loxia curvirostra	Red Crossbill	A	—
Carduelis pinus	Pine Siskin	U	WR
Carduelis psaltria	Lesser Goldfinch	R	M
Carduelis lawrencei	Lawrence's Goldfinch	A	—
Carduelis tristis	American Goldfinch **	C	SR
Coccothraustes vespertinus	Evening Grosbeak	A	—
Family Passeridae	Old World Sparrow Family		
Passer domesticus	House Sparrow *	C	PR

Sources: This list derives in large part from the data in *Birds of Sonoma County California* by G.L. Bolander and B.D. Parmeter as revised by B.D. Parmeter in 2000 (Redwood Region Ornithological Society, Napa, CA). In particular, the large number of accidentals listed would not have been possible without Dr. Parmeter's careful record-keeping. Additional records come from censuses and observations by Bodega Marine Reserve staff and from *The Sonoma County Breeding Bird Atlas* (B. Burridge, editor. Madrone Audubon Society, Santa Rosa, CA, 1995).

Total species on list: 352

List date: 1 April 2003

Appendix J. Raw data showing percent cover and density for the 18 middle-intertidal plots. Mobile species are recorded as # individuals/.04m^2. Sessile species are recorded as % cover. July 2004. Provided by UCD/BML.

Plot	% Cover Pel_lim	% Cover End_mur	% Cover Mas_pap	% Cover Cla_col	% Cover Bare	% Cover Myt_cal	Invertebrate Diversity	Invertebrate Richness	% Cover alg_cover	% Cover prim_Myt	Density All Limpets	Density Lit_scu	Reference Or Outfall
1	10.80	8.80	28.40	0.00	60.80	0.00	0.27	5.00	40.20	0.00	1.25	11.25	Ref
2	18.63	15.69	16.67	0.00	73.53	0.00	0.18	5.00	45.10	0.00	2.50	32.50	Ref
3	37.25	26.47	50.98	19.61	39.22	3.92	0.36	10.00	87.25	0.00	3.75	38.00	Ref
4	20.59	18.63	50.00	5.88	52.94	11.76	0.67	9.00	77.45	4.00	13.25	16.00	Ref
5	27.45	11.76	46.08	4.90	23.53	63.73	0.81	12.00	92.16	9.00	9.75	0.00	Ref
6	19.61	24.51	17.65	15.69	32.35	36.27	0.64	10.00	83.33	23.00	14.75	25.00	Ref
7	25.49	25.49	41.18	3.92	34.31	38.24	0.84	10.00	93.14	8.00	10.00	1.00	Ref
8	17.65	15.69	35.29	7.84	8.82	81.37	0.77	9.00	99.02	29.00	4.50	0.00	Ref
9	43.14	23.53	33.33	5.88	71.57	9.80	0.76	12.00	89.22	3.00	12.75	6.50	Ref
10	26.47	8.82	60.78	7.84	65.69	17.65	0.75	10.00	94.12	4.00	5.50	5.50	Ref
Mean Reference	24.71	17.94	38.04	7.16	46.28	26.27	0.61	9.20	80.10	8.00	7.80	13.58	Ref
11	12.75	16.67	70.59	6.86	71.57	8.82	0.68	7.00	88.24	1.00	10.00	2.00	Outfall
12	13.73	32.35	10.78	0.98	14.71	80.39	0.71	6.00	90.20	29.00	7.75	0.00	Outfall
13	13.73	32.35	10.78	0.98	14.71	80.39	0.90	13.00	92.16	11.00	19.00	0.75	Outfall
14	18.63	27.45	51.96	5.88	46.08	35.29	0.81	9.00	93.14	3.00	4.00	1.00	Outfall
15	28.43	24.51	53.92	11.76	76.47	2.94	0.78	9.00	91.18	2.00	2.25	3.50	Outfall
16	8.91	16.83	51.49	7.92	60.40	30.69	0.92	13.00	86.14	5.00	12.75	1.00	Outfall
17	51.96	11.76	26.47	0.98	96.08	0.00	0.63	8.00	75.49	0.00	7.00	9.75	Outfall
18	11.76	11.76	50.98	21.57	56.86	16.67	0.83	12.00	91.18	3.00	8.75	9.75	Outfall
Mean Outfall	19.99	21.71	40.87	7.12	54.61	31.90	0.78	9.63	88.47	6.75	8.94	3.47	Outfall

Key

Pel_lim	=	*Pelvetiopsis limitata*
End_mur	=	*Endocladia muricata*
Mas_pap	=	*Mastocarpus papillatus*
Cla_col	=	*Cladophora columbiana*
Bare	=	Bare rock
Myt_cal	=	*Mytilus californianus*
alg_cov	=	Algal cover

prim_Myt	=	primary *Mytilus* (% covered by *Mytilus* that serves as substrate for other organisms)
Lit_scu	=	*Littorina scutulata*

Appendix K. BML Raw Data showing percent cover and density for the Discharge Channel transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site Discharge Quadrat #1 Location 0.4m			Site Discharge Quadrat #2 Location 3.4m			Site Discharge Quadrat #3 Location 4.8m			Site Discharge Quadrat #4 Location 7.6m			Site Discharge Quadrat #5 Location 8.7m		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
INVERTEBRATES															
Sponges															
Haliclona sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Halichondria sp.	0	0	0	0	4	0	30	0	0	0	0	0	0	0	0
Ophlitospongia sp.	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anemones															
Anthopleura elegantissima	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Anthopleura sola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthopleura xanthogrammica	0	0	0	50	0	0	5	0	0	2	0	0	0	0	0
Polychaetes															
Phragmatopoma californica	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Barnacles															
Balanus glandula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chthamalus dalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pollicipes polymerus	0	0	0	0	0	0	0	0	0	0	8	0	0	1	0
Semibalanus cariosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
small barnacles	0	6	12	0	35	10	0	10	0	0	6	0	0	0	0
Tetraclita rubescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crabs*															
Pachygrapsus crassipes	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Pagurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrolisthes cinctipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limpets and snails*															
Acmaea mitra	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
Littorina scutulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lottia asmi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix K (cont'd). BML Raw Data showing percent cover and density for the Discharge Channel transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site Discharge Quadrat #1 Location 0.4m			Site Discharge Quadrat #2 Location 3.4m			Site Discharge Quadrat #3 Location 4.8m			Site Discharge Quadrat #4 Location 7.6m			Site Discharge Quadrat #5 Location 8.7m		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
INVERTEBRATES (cont'd)															
Limpets and snails* (cont'd)															
Lottia digitalis	0	0	0	0	0	0	0	0	1	0	0	0	0	0	26
Lottia gigantea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lottia pelta	0	0	2	0	1	2	0	0	2	2	2	0	1	0	0
Lottia paradigitalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lottia scabra	0	1	6	0	0	0	0	0	0	0	0	8	0	0	14
Nucella ostrina	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
small limpets	0	0	15	0	14	5	0	0	3	0	4	0	0	0	0
Tegula brunnea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tegula funebralis	0	0	0	0	0	0	0	1	0	49	2	0	36	6	0
Tonicella lineata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalves															
Lasia rubra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mytilus californianus	0	0	0	0	0	0	0	0	1	0	30	0	0	0	0
Chitons*															
Katharina tunicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mopalia sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Nuttalina californica	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Sea Stars*															
Leptasterias sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisaster ochraceus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sea Urchins*															
Strongylocentrotus purpuratus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tunicates															
encrusting tunicate	40	0	0	40	0	0	0	0	0	0	0	0	0	0	0

Appendix K (cont'd). BML Raw Data showing percent cover and density for the Discharge Channel transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site Discharge Quadrat #1 Location 0.4m			Site Discharge Quadrat #2 Location 3.4m			Site Discharge Quadrat #3 Location 4.8m			Site Discharge Quadrat #4 Location 7.6m			Site Discharge Quadrat #5 Location 8.7m		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
INVERTEBRATES (cont'd)															
Bryozoans															
encrusting bryozoan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALGAE															
Green Algae															
Cladophora columbiana	0	0	5	0	0	6	0	2	50	0	0	0	0	0	0
Ulva sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown Algae															
Egregia menziesii	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
encrusting brown algae	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laminaria setchellii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pelvetiopsis limitata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scytosiphon sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Red Algae															
Bossiella plumosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calliarthron tuberculosum	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Callithamnion pikeanum	0	0	0	0	0	3	0	0	10	0	0	0	0	0	0
Ceramium sp.	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0
Corallina vancouveriensis	0	4	0	0	6	0	3	0	0	0	3	0	0	6	0
Cryptopleura lobulifera	25	0	0	0	20	0	0	0	0	0	0	0	2	0	0
encrusting coralline algae	2	15	18	0	10	0	0	0	19	40	15	10	2	40	0
Endocladia muricata	0	0	9	0	0	0	0	0	0	0	0	8	0	0	2
Erythrophyllum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gelidium coulteri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hildenbrandia sp.	0	0	0	0	0	0	60	0	0	6	0	0	0	0	0
Mastocarpus papillatus	0	0	5	0	0	0	0	0	0	0	0	4	0	0	2

Appendix K (cont'd). BML Raw Data showing percent cover and density for the Discharge Channel transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site Discharge Quadrat #1 Location 0.4m			Site Discharge Quadrat #2 Location 3.4m			Site Discharge Quadrat #3 Location 4.8m			Site Discharge Quadrat #4 Location 7.6m			Site Discharge Quadrat #5 Location 8.7m		
	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High
ALGAE (cont'd)															
Red Algae (cont'd)															
Mazzaella flaccida	0	15	0	0	1	0	0	4	0	0	0	0	0	0	0
Mazzaella heterocarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mazzaella splendens	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Microcladia borealis	0	8	0	0	4	5	0	30	0	0	5	0	0	0	0
Microcladia coulteri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonthalia floccosa	0	0	0	0	0	0	0	15	15	0	12	0	0	80	0
Petrocelis	0	2	6	0	8	0	0	0	0	0	0	0	0	0	0
Plocamium sp.	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0
Polysiphonia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porphyra sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prionitis lanceolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prionitis lyallii	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0
Pseudolithophyllum neofarlowii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix L. BML Raw data showing percent cover and density for the Comparison Site A transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site A Quadrat #1 Location 0.6m			Site A Quadrat #2 Location 2.3m			Site A Quadrat #3 Location 4.2m			Site A Quadrat #4 Location 7.5m			Site A Quadrat #5 Location 9.3m		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
INVERTEBRATES															
Sponges															
Haliclona sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Halichondria sp.	0	0	0	0	0	0	25	0	0	0	1	0	0	0	0
Ophlitospongia sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anemones															
Anthopleura elegantissima	4	0	0	0	0	0	20	0	0	6	0	0	1	0	0
Anthopleura sola	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthopleura xanthogrammica	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0
Polychaetes															
Phragmatopoma californica	0	3	0	1	0	0	5	0	0	8	0	0	0	0	0
Barnacles															
Balanus glandula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chthamalus dalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pollicipes polymerus	0	0	1	0	0	0	0	2	0	0	1	0	0	1	2
Semibalanus cariosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
small barnacles	0	4	2	5	0	20	0	50	0	10	0	7	0	4	15
Tetraclita rubescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crabs*															
Pachygrapsus crassipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pagurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrolisthes cinctipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limpets and snails*															
Acmaea mitra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Littorina scutulata	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
Lottia asmi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix L (cont'd). BML Raw data showing percent cover and density for the Comparison Site A transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site A Quadrat #1 Location 0.6m			**Site A Quadrat #2 Location 2.3m**			**Site A Quadrat #3 Location 4.2m**			**Site A Quadrat #4 Location 7.5m**			**Site A Quadrat #5 Location 9.3m**		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
INVERTEBRATES (cont'd)															
Limpets and snails* (cont'd)															
Lottia digitalis	0	0	5	0	0	0	0	0	6	0	0	1	0	0	2
Lottia gigantea	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Lottia pelta	0	0	1	0	0	6	0	0	0	0	0	7	0	0	2
Lottia paradigitalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lottia scabra	0	0	4	0	0	3	0	0	10	0	0	2	0	0	1
Nucella ostrina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
small limpets	0	5	5	0	0	17	0	0	2	0	0	0	0	10	25
Tegula brunnea	0	0	0	4	0	0	5	0	0	5	0	0	0	0	0
Tegula funebralis	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Tonicella lineata	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Bivalves															
Lasia rubra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mytilus californianus	0	0	51	0	0	0	0	0	0	0	0	0	0	1	3
Chitons*															
Katharina tunicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mopalia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nuttalina californica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sea Stars*															
Leptasterias sp.	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0
Pisaster ochraceus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sea Urchins*															
Strongylocentrotus purpuratus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tunicates															
encrusting tunicate	0	0	0	30	0	0	6	0	0	0	0	0	0	0	0

Appendix L (cont'd). BML Raw data showing percent cover and density for the Comparison Site A transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site A Quadrat #1 Location 0.6m			Site A Quadrat #2 Location 2.3m			Site A Quadrat #3 Location 4.2m			Site A Quadrat #4 Location 7.5m			Site A Quadrat #5 Location 9.3m		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
INVERTEBRATES (cont'd)															
Bryozoans															
encrusting bryozoan	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALGAE															
Green Algae															
Cladophora columbiana	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Ulva sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown Algae															
Egregia menziesii	0	1	0	0	0	0	0	0	0	8	0	0	0	0	0
encrusting brown algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laminaria setchellii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pelvetiopsis limitata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scytosiphon sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red Algae															
Bossiella plumosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calliarthron tuberculosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callithamnion pikeanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceramium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corallina vancouveriensis	4	1	0	0	1	0	0	0	0	0	55	1	0	40	1
Cryptopleura lobulifera	3	0	0	0	4	0	40	0	0	8	10	0	0	0	0
encrusting coralline algae	50	2	1	12	10	0	16	6	4	12	5	3	13	1	4
Endocladia muricata	0	0	5	0	0	14	0	0	5	0	0	6	0	8	15
Erythrophyllum	0	0	0	10	0	0		0	0	0	0	0	0	0	0
Gelidium coulteri	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
Hildenbrandia sp.	0	1	0	10	0	2	0	0	1	60	0	10	8	0	0
Mastocarpus papillatus	0	0	0	0	0	6	0	0	1	0	0	1	0	1	1

Appendix L (cont'd). BML Raw data showing percent cover and density for the Comparison Site A transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site A Quadrat #1 Location 0.6m			Site A Quadrat #2 Location 2.3m			Site A Quadrat #3 Location 4.2m			Site A Quadrat #4 Location 7.5m			Site A Quadrat #5 Location 9.3m		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
ALGAE (cont'd)															
Red Algae (cont'd)															
Mazzaella flaccida	0	1	0	0	3	0	0	0	0	0	0	1	20	10	0
Mazzaella heterocarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mazzaella splendens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microcladia borealis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Microcladia coulteri	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonthalia floccosa	0	90	0	0	85	0	0	80	0	0	35	0	0	0	0
Petrocelis	0	0	3	0	6	0	0	0	0	0	0	0	0	0	0
Plocamium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polysiphonia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porphyra sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Prionitis lanceolata	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prionitis lyallii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudolithophyllum neofarlowii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix M. BML Raw data showing percent cover and density for the Comparison Site B transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site B Quadrat #1 Location 0.8m			Site B Quadrat #2 Location 2.0m			Site B Quadrat #3 Location 4.6m			Site B Quadrat #4 Location 7.1m			Site B Quadrat #5 Location 8.7m		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
INVERTEBRATES															
Sponges															
Haliclona sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Halichondria sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ophlitospongia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anemones															
Anthopleura elegantissima	1	0	0	10	0	0	1	2	0	25	0	0	50	1	0
Anthopleura sola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthopleura xanthogrammica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaetes															
Phragmatopoma californica	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Barnacles															
Balanus glandula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chthamalus dalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pollicipes polymerus	0	0	0	0	0	0	0	0	1	0	0	1	0	0	4
Semibalanus cariosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
small barnacles	0	0	10	0	0	1	0	1	12	0	5	25	0	10	6
Tetraclita rubescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crabs*															
Pachygrapsus crassipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pagurus sp.	0	1	0	0	0	0	0	0	0	4	0	0	7	0	0
Petrolisthes cinctipes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Limpets and snails*															
Acmaea mitra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Littorina scutulata	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Lottia asmia	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

Appendix M (cont'd). BML Raw data showing percent cover and density for the Comparison Site B transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site B Quadrat #1 Location 0.8m			Site B Quadrat #2 Location 2.0m			Site B Quadrat #3 Location 4.6m			Site B Quadrat #4 Location 7.1m			Site B Quadrat #5 Location 8.7m		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
INVERTEBRATES (cont'd)															
Limpets and snails* (cont'd)															
Lottia digitalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lottia gigantea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lottia pelta	0	0	2	0	0	0	0	0	2	0	1	1	0	1	2
Lottia paradigitalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lottia scabra	0	0	0	0	0	1	0	0	1	0	0	2	0	0	0
Nucella ostrina	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0
small limpets	0	0	20	0	0	0	0	2	40	0	0	20	0	1	6
Tegula brunnea	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tegula funebralis	1	1	0	8	0	4	2	12	1	38	6	0	25	14	3
Tonicella lineata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalves															
Lasia rubra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mytilus californianus	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1
Chitons*															
Katharina tunicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mopalia sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Nuttalina californica	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Sea Stars*															
Leptasterias sp.	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Pisaster ochraceus	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Sea Urchins*															
Strongylocentrotus purpuratus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tunicates															
encrusting tunicate	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Appendix M (cont'd). BML Raw data showing percent cover and density for the Comparison Site B transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site B Quadrat #1 Location 0.8m			Site B Quadrat #2 Location 2.0m			Site B Quadrat #3 Location 4.6m			Site B Quadrat #4 Location 7.1m			Site B Quadrat #5 Location 8.7m		
	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High
INVERTEBRATES (cont'd)															
Bryozoans															
encrusting bryozoan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALGAE															
Green Algae															
Cladophora columbiana	0	0	0	0	0	0	0	0	2	0	0	2	0	0	4
Ulva sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Brown Algae															
Egregia menziesii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
encrusting brown algae	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Laminaria setchellii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pelvetiopsis limitata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scytosiphon sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red Algae															
Bossiella plumosa	4	0	2	5	0	0	0	0	0	0	0	0	0	0	0
Calliarthron tuberculosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callithamnion pikeanum	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Ceramium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corallina vancouveriensis	8	50	0	2	60	4	2	1	0	0	7	5	0	2	2
Cryptopleura lobulifera	0	0	0	0	0	0	4	0	0	2	0	0	0	0	0
encrusting coralline algae	8	4	1	10	2	1	25	4	0	6	10	1	9	1	4
Endocladia muricata	0	0	40	0	0	40	0	60	40	0	3	10	0	30	4
Erythrophyllum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Gelidium coulteri	0	0	0	0	0	0	0	0	0	2	2	1	0	1	0
Hildenbrandia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mastocarpus papillatus	4	25	0	0	1	10	5	4	1	28	1	0	11	7	0

Appendix M (cont'd). BML Raw data showing percent cover and density for the Comparison Site B transect from Intertidal Surveys in Discharge Channel and Comparison Sites. Low, Mid, and High refer to the the quadrat's vertical placement in the intertidal zone. Quadrat locations are indicated as distance along the 10m transect. Mobile species (all species in groups marked with an *) are recorded as # individuals/.04m2. Sessile species (all species in groups lacking an *) are recorded as % cover.

	Site B Quadrat #1 Location 0.8m			Site B Quadrat #2 Location 2.0m			Site B Quadrat #3 Location 4.6m			Site B Quadrat #4 Location 7.1m			Site B Quadrat #5 Location 8.7m		
	Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
ALGAE (cont'd)															
Red Algae (cont'd)															
Mazzaella flaccida	7	25	1	3	45	6	6	2	1	24	30	4	3	1	3
Mazzaella heterocarpa	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Mazzaella splendens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microcladia borealis	0	0	0	0	1	0	0	0	0	0	0	2	0	0	2
Microcladia coulteri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonthalia floccosa	0	0	0	0	0	0	0	0	0	0	0	3	0	0	4
Petrocelis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plocamium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polysiphonia sp.	0	0	0	0	0	1	0	0	0	0	0	4	0	0	1
Porphyra sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prionitis lanceolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prionitis lyallii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudolithophyllum neofarlowii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix N. United States of America Fish and Wildlife Service Federal Endangered and Threatened Species List for Bodega Head (503D) U.S.G.S. 7½ Minute Quad. Last Updated December 1, 2006.

	Species Name	Common Name	Status
Listed Species	**Invertebrates**		
	Haliotes sorenseni	white abalone	(E) (NMFS)
	Speyeria zerene myrtleae	Myrtle's silverspot butterfly	(E)
	Syncaris pacifica	California freshwater shrimp	(E)
	Fish		
	Eucyclogobius newberryi	tidewater goby	(E)
	Oncorhynchus kisutch	coho salmon, central CA coast	(E) (NMFS)
	Critical habitat - coho salmon, central CA coast		(X) (NMFS)
	Oncorhynchus mykiss	Central California Coastal steelhead	(T) (NMFS)
	Central Valley steelhead		(T) (NMFS)
	Critical habitat, Central California coastal steelhead		(X) (NMFS)
	Oncorhynchus tshawytscha	California coastal chinook salmon	(T) (NMFS)
	Amphibians		
	Rana aurora draytonii	California red-legged frog	(T)
	Reptiles		
	Caretta caretta	loggerhead turtle	(T) (NMFS)
	Chelonia mydas (incl. agassizi)	green turtle	(T) (NMFS)
	Dermochelys coriacea	leatherback turtle	(E) (NMFS)
	Lepidochelys olivacea	olive (=Pacific) ridley sea turtle	(T) (NMFS)
	Birds		
	Brachyramphus marmoratus	marbled murrelet	(T)
	Charadrius alexandrinus nivosus	western snowy plover	(T)
	Diomedea albatrus	short-tailed albatross	(E)
	Haliaeetus leucocephalus	bald eagle	(T)
	Pelecanus occidentalis californicus	California brown pelican	(E)
	Strix occidentalis caurina	northern spotted owl	(T)
	Mammals		
	Arctocephalus townsendi	Guadalupe fur seal	(T) (NMFS)
	Balaenoptera borealis	sei whale	(E) (NMFS)
	Balaenoptera musculus	blue whale	(E) (NMFS)
	Balaenoptera physalus	finback (=fin) whale	(E) (NMFS)
	Eubalaena (=*Balaena*) *glacialis*	right whale	(E) (NMFS)
	Eumetopias jubatus	Steller (=northern) sea-lion	(T) (NMFS)
	Physeter catodon (=*macrocephalus*)	sperm whale	(E) (NMFS)
Proposed Species	**Fish**		
	Eucyclogobius newberryi	Critical habitat, tidewater goby	(PX)
Candidate Species	**Invertebrates**		
	Haliotes cracherodii	black abalone	(C) (NMFS)

(E) Endangered - Listed (in the Federal Register) as being in danger of extinction.
(T) Threatened - Listed as likely to become endangered within the foreseeable future.
(NMFS) - Species under the Jurisdiction of the National Marine Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) Proposed Critical Habitat - The species is already listed. Critical habitat is being proposed for it.
(C) Candidate - Candidate to become a proposed species.
(X) Critical Habitat designated for this species.

*For more information, go to **www.fws.gov/sacramento/es/spp_lists/auto_list_form.cfm**
*Species of Concern - See **www.fws.gov/sacramento/es/spp_concern.htm** for more information.

Appendix O. California Department of Fish and Game Natural Diversity Database (CNDDB) for Bodega Head.

California Department of Fish and Game
Natural Diversity Database
Bodega Head CNDDB Wide Tabular Report

Name (Scientific/Common)	CNDDB Ranks	Other Lists	Listing Status	Total EO's	Element Occ Ranks A	B	C	D	X	U	Population Status Historic >20 yr	Recent <=20 yr	Presence Pres. Extant	Poss. Extirp.	Extirp.
Abronia umbellata ssp. breviflora pink sand-verbena	G4G5T2 S2.1	CNPS: 1B.1	Fed: None Cal: None	51 S:3	0	0	0	0	0	3	3	0	3	0	0
Agrostis blasdalei Blasdale's bent grass	G2 S2.2	CNPS: 1B.2	Fed: None Cal: None	34 S:1	0	0	0	0	0	1	0	1	1	0	0
Allium peninsulare var. franciscanum Franciscan onion	G5T2 S2.2	CNPS: 1B.2	Fed: None Cal: None	12 S:1	0	0	0	0	0	1	1	0	1	0	0
Amorpha californica var. napensis Napa false indigo	G4T2 S2.2	CNPS: 1B.2	Fed: None Cal: None	45 S:1	0	0	0	0	0	1	1	0	1	0	0
Calystegia purpurata ssp. saxicola coastal bluff morning-glory	G4T2 S2.2	CNPS: 1B.2	Fed: None Cal: None	27 S:3	0	0	0	0	0	3	3	0	3	0	0
Campanula californica swamp harebell	G3 S3.2	CNPS: 1B.2	Fed: None Cal: None	106 S:1	0	0	0	0	1	0	1	0	0	1	0
Carex comosa bristly sedge	G5 S2?	CNPS: 2.1	Fed: None Cal: None	9 S:1	0	0	0	0	0	1	1	0	1	0	0
Charadrius alexandrinus nivosus western snowy plover	G4T3 S2	CDFG: SC	Fed: Threatened Cal: None	110 S:2	0	0	0	0	1	1	2	0	1	1	0
Chorizanthe cuspidata var. cuspidata San Francisco Bay spineflower	G2T2 S2.2	CNPS: 1B.2	Fed: None Cal: None	20 S:1	0	0	0	0	0	1	1	0	1	0	0
Chorizanthe cuspidata var. villosa woolly-headed spineflower	G2T1 S1.2	CNPS: 1B.2	Fed: None Cal: None	7 S:1	0	0	0	0	0	1	1	0	1	0	0
Cirsium andrewsii Franciscan thistle	G2 S2.2	CNPS: 1B.2	Fed: None Cal: None	27 S:1	0	0	0	0	1	0	1	0	0	1	0
Coastal Brackish Marsh	G2 S2.1		Fed: None Cal: None	30 S:1	0	0	0	0	0	1	1	0	1	0	0
Coastal and Valley Freshwater Marsh	G3 S2.1		Fed: None Cal: None	60 S:1	0	0	0	0	0	1	1	0	1	0	0
Cordylanthus maritimus ssp. palustris Point Reyes bird's-beak	G4?T2 S2.2	CNPS: 1B.2	Fed: None Cal: None	62 S:3	0	0	0	0	0	3	3	0	3	0	0
Danaus plexippus monarch butterfly	G5 S3	CDFG:	Fed: None Cal: None	335 S:4	0	2	0	0	0	2	2	2	4	0	0

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Appendix O (cont'd). California Department of Fish and Game Natural Diversity Database (CNDDB) for Bodega Head.

California Department of Fish and Game
Natural Diversity Database
Bodega Head CNDDB Wide Tabular Report

					Element Occ Ranks						Population Status		Presence		
Name (Scientific/Common)	CNDDB Ranks	Other Lists	Listing Status	Total EO's	A	B	C	D	X	U	Historic >20 yr	Recent <=20 yr	Pres. Extant	Poss. Extirp.	Extirp.
Delphinium luteum yellow larkspur	G1 S1.1	CNPS: 1B.1	Fed: Endangered Cal: Rare	12 S:4	0	2	0	0	0	2	3	1	4	0	0
Dirca occidentalis western leatherwood	G2G3 S2S3	CNPS: 1B.2	Fed: None Cal: None	46 S:2	0	2	0	0	0	0	0	2	2	0	0
Emys (=Clemmys) marmorata marmorata northwestern pond turtle	G3G4T3 S3	CDFG: SC	Fed: None Cal: None	251 S:2	0	1	0	0	0	1	1	1	2	0	0
Eucyclogobius newberryi tidewater goby	G3 S2S3	CDFG: SC	Fed: Endangered Cal: None	113 S:2	0	1	0	0	1	0	1	1	1	0	1
Gilia capitata ssp. chamissonis dune gilia	G5T2 S2.1	CNPS: 1B.1	Fed: None Cal: None	29 S:3	0	0	0	0	0	3	3	0	3	0	0
Gilia capitata ssp. tomentosa woolly-headed gilia	G5T1 S1.1	CNPS: 1B.1	Fed: None Cal: None	11 S:2	0	0	0	0	2	0	2	0	0	2	0
Gilia millefoliata dark-eyed gilia	G2 S2.2	CNPS: 1B.2	Fed: None Cal: None	30 S:2	0	0	0	0	0	2	2	0	2	0	0
Horkelia marinensis Point Reyes horkelia	G2 S2.2	CNPS: 1B.2	Fed: None Cal: None	22 S:1	0	0	0	0	0	1	1	0	1	0	0
Lasthenia macrantha ssp. bakeri Baker's goldfields	G3TH SH	CNPS: 1B.2	Fed: None Cal: None	14 S:3	0	0	0	0	0	3	3	0	3	0	0
Lasthenia macrantha ssp. macrantha perennial goldfields	G3T2 S2.2	CNPS: 1B.2	Fed: None Cal: None	32 S:4	0	0	0	0	0	4	4	0	4	0	0
Lichnanthe ursina bumblebee scarab beetle	G2 S2	CDFG:	Fed: None Cal: None	7 S:2	0	0	0	0	0	2	2	0	2	0	0
Lupinus tidestromii Tidestrom's lupine	G2 S2.1	CNPS: 1B.1	Fed: Endangered Cal: Endangered	23 S:1	0	0	0	0	0	1	1	0	1	0	0
Monardella villosa ssp. globosa robust monardella	G5T2 S2.2	CNPS: 1B.2	Fed: None Cal: None	25 S:1	0	0	0	0	0	1	1	0	1	0	0
Northern Coastal Salt Marsh	G3 S3.2		Fed: None Cal: None	53 S:1	0	0	0	0	0	1	1	0	1	0	0
Polygonum marinense Marin knotweed	G1Q S1.1	CNPS: 3.1	Fed: None Cal: None	17 S:1	0	0	0	0	0	1	1	0	1	0	0

Appendix O (cont'd). California Department of Fish and Game Natural Diversity Database (CNDDB) for Bodega Head.

California Department of Fish and Game
Natural Diversity Database
Bodega Head CNDDB Wide Tabular Report

Name (Scientific/Common)	CNDDB Ranks	Other Lists	Listing Status	Total EO's	Element Occ Ranks A	B	C	D	X	U	Population Status Historic >20 yr	Recent <=20 yr	Presence Pres. Extant	Poss. Extirp.	Extirp.
Rana aurora draytonii California red-legged frog	G4T2T3 S2S3	CDFG: SC	Fed: Threatened Cal: None	868 S:2	0	2	0	0	0	0	0	2	2	0	0
Sidalcea malviflora ssp. purpurea purple-stemmed checkerbloom	G5T2 S2.2	CNPS: 1B.2	Fed: None Cal: None	17 S:1	0	0	0	0	0	1	1	0	1	0	0
Speyeria zerene myrtleae Myrtle's silverspot	G5T1 S1	CDFG:	Fed: Endangered Cal: None	16 S:4	0	0	0	0	0	4	4	0	4	0	0
Syncaris pacifica California freshwater shrimp	G1 S1	CDFG:	Fed: Endangered Cal: Endangered	17 S:1	1	0	0	0	0	0	0	1	1	0	0
Tryonia imitator mimic tryonia (=California brackishwater snail)	G2G3 S2S3	CDFG:	Fed: None Cal: None	33 S:1	0	0	0	0	1	0	1	0	0	0	1

Appendix P. BML Aquatic Resources Group's Selected Specimen Collections List.

Invertebrates	
sponges	
fouling organisims	
jellies	*Aurelia*
	Chrysaora
anemones	*Metridium*
	Tealia
	Anthopleura
	Corynactis
urchins	*Strongylocentrotus*
sea stars	*Pisaster*
	Asterina
	Henricia
	Dermasterias
	Solaster
sea cucumber	*Parastichopus*
	Cucumaria
clams	*Saxidomus*
nudibranchs	many genera
snails	many
scallops	*Hinnites*
barnacles	*Balanus*
mussels	*Mytilus*
chitons	*Cryptochiton*
polychaetes	
fat innkeeper worms	*Urechis*
olympia oysters	*Ostrea*
crabs	*Cancer*
	Emerita
	Pagurus
	Petrolisthes
	Loxorhynchus
	Pugettia
shrimp	

Fishes	
leopard sharks	*Triakis semifasciata*
rockfishes	*Sebastes*
Pacific Herring	*Clupea pallisi*
Ling Cod	*Ophiodon elongatus*
Greenling	*Hexagrammos*
	Oxylebius
True smelts	*Osmeridae*
Surf perch	*Embiotocidae*
plainfin midshipmen	*Porichthys notatus*

Appendix Q. NOAA's Invasive Species Recorded in the Gulf of the Farallones National Marine Sanctuary.

Species Name	Common Name	Trophic Group	Reference
Aglaothamnion cordatum	Rhodophycota	algae	
Codium fragile tomentosoides	Dead Man's Fingers	algae	
Gelidium vagum	red algae	algae	
Polysiphonia denudata	Red Siphonweed	algae	
Sargassum muticum	British Wireweed	algae	
Undaria pinnatifida	Wakame	algae	Brusca and Brusca 1990
Acanthogobius flavimanus	Yellowfin goby	consumer	FishBase
Alosa sapidissima	Atlantic Shad	consumer	Cohen and Carlton 1995
Carcinus maenas	Green Crab	consumer	Cohen and Carlton 1995
Ceratostoma inornatum	Japanese oyster drill	consumer	Morris *et al.* 1992
Exogone lourei	polychaete	consumer	Rupert and Barnes 1994
Glycera americana	polychate	consumer	Sarda *et al.* 1998
Harmothoe imbricata	polychate	consumer	CalAcademy
Okenia plana	Flat Okenia (nudibranch)	consumer	Seaslug Forum
Palaemon macrodactylus	Korean Shrimp	consumer	Cohen and Carlton 1995
Philine auriformis	nudibranch	consumer	Cohen and Carlton 1995
Philine orientalis	nudibranch	consumer	Morton and Chiu 1990
Tenellia adspersa	Miniature aeolis (nudibranch)	consumer	Cohen and Carlton 1995
Urosalpinx cinerea	Atlantic Oyster Drill	consumer	Cohen and Carlton 1995
Caprella californica	amphipod	consumer omnivore	Morris *et al.* 1992
Jassa slatteryi	amphipod	consumer omnivore	Sano *et al.* 2003
Melita nitida	amphipod	consumer omnivore	Cohen and Carlton 1995
Neanthes succinea	pileworm	consumer omnivore	NEMESIS
Parapleustes derzhavini	amphipod	consumer omnivore	Cohen and Carlton 1995
Nassarius obsoletus	Easterm Mud Snail	consumer omnivore, detritivore	Pace *et al.* 1979
Notomastus hemipodus	polychate	consumer omnivore, detritivore	Livingston *et al.* 1997
Cyprinus carpio	European Carp	consumer, deposit feeder	Cohen and Carlton 1995
Apoprionospio pygmaea	spionid	deposit feeder	Brusca and Brusca 1990
Capitella capitata Complex	Bristleworm	deposit feeder	Morris *et al.* 1992
Ctenodrilus serratus	teribellid polychaete	deposit feeder	Brusca and Brusca 1990

Appendix Q (cont'd). NOAA's Invasive Species Recorded in the Gulf of the Farallones National Marine Sanctuary.

Species Name	Common Name	Trophic Group	Reference
Dipolydora socialis	spionid polychaete	deposit feeder	Brusca and Brusca 1990
Euchone limnicola	fan worm polychate	deposit feeder	NEMESIS
Heteromastus filiformis	polychate	deposit feeder	NOAA
Leptochelia dubia	tanaid	deposit feeder	Brusca and Brusca 1990
Mediomastus ambiseta	polychate	deposit feeder	Wheatcroft *et al.* 1998
Polydora ligni	Mud Worm	deposit feeder	Fuller and O'Connell 2006
Pseudopolydora paucibranchiat	spionid	deposit feeder	NIMPIS
Cumella vulgaris	cumacean	deposit feeder, maroplanktivore	Rupert and Barnes 1994
Ampithoe lacertosa	amphipod	detritivore	Dethiera and Schochb 2005
Iais californica	isopod	detritivore	Cohen and Carlton 1995
Limnoria quadripunctata	isopod	detritivore	Cohen and Carlton 1995
Limnoria tripunctata	isopod	detritivore	Cohen and Carlton 1995
Streblospio benedicti	spionid	detritivore	Brusca and Brusca 1990
Ampelisca abdita	amphipod	detritivore, macroplanktivore	NEMESIS
Ampelisca agassizi	amphipod	detritivore, macroplanktivore	BFSI
Caprella mutica	Skeleton Shrimp (amphipod)	detritivore, macroplanktivore	Cohen and Carlton 1995
Nippoleucon hinumensis	Asian cumacean	detritivore, macroplanktivore	Brusca and Brusca
Caprella acanthogaster	amphipod	herbivore	Edgar 1997
Corophium uenoi	amphipod	herbivore	Aikins and Kikuchi 2002
Ianiropsis tridens	isopod	herbivore	Rupert and Barnes 1994
Jassa carltoni	amphipod	herbivore	NIMPIS
Myosotella myosotis	European Melampus	herbivore	Cohen 2005
Paranthura elegans	isopod	herbivore	Brusca and Brusca 1990
Platynereis bicanaliculata	polychate	herbivore	Sano *et al.* 2003
Sinocorophium alienense	amphipod	herbivore	Brusca and Brusca 1990
Sinocorophium heteroceratum	amphipod	herbivore	Brusca and Brusca 1990
Batillaria attramentaria	Japanese False Cerith	herbivore, deposit feeder	Yamada 1982
Ampithoe valida	amphipod	herbivore, macroplanktivore, detritvore	NEMESIS
Venerupis philippinarum	Japanese Littleneck Clam	macropanktivore	Cohen 2005
Acanthomysis bowmani	mysid	macroplanktivore	
Alcyonidium gelatinosum	bryozoan	macroplanktivore	Brusca and Brusca 1990

Appendix Q (cont'd). NOAA's Invasive Species Recorded in the Gulf of the Farallones National Marine Sanctuary.

Species Name	Common Name	Trophic Group	Reference
Alcyonidium parasiticum	bryozoan	macroplanktivore	Brusca and Brusca 1990
Alcyonidium polyoum	bryozoan	macroplanktivore	Cohen and Carlton 1995
Amathia vidovici	bryozoan	macroplanktivore	Smithsonian
Amphinema sp.	hydrozoan	macroplanktivore	Rees 2000
Ascidia zara	ascidian	macroplanktivore	Brusca and Brusca 1990
Aurelia aurita	Moon Jelly	macroplanktivore	Cohen and Carlton 1995
Balanus amphitrite	barnacle	macroplanktivore	NIMPIS
Balanus improvisus	barnacle	macroplanktivore	NIMPIS
Barentsia benedeni	bryozoan	macroplanktivore	Brusca and Brusca 1990
Botrylloides perspicuum	tunicate	macroplanktivore	Cohen 2004
Botrylloides violaceus	tunicate	macroplanktivore	Cohen 2005
Botryllus schlosseri	tunicate	macroplanktivore	Morris *et al.* 1992
Bowerbankia gracilis	bryozoan	macroplanktivore	Cohen and Carlton 1995
Bugula neritina	bryozoan	macroplanktivore	Cohen and Carlton 1995
Bugula stolonifera	bryozoan	macroplanktivore	Cohen and Carlton 1995
Ciona intestinalis	tunicate	macroplanktivore	Morris *et al.* 1992
Ciona savignyi	tunicate	macroplanktivore	NIMPIS
Cliona celata	sponge	macroplanktivore	Morris *et al.* 1992
Cliona lobata	sponge	macroplanktivore	Morris *et al.* 1992
Conopeum tenuissimum	bryozoan	macroplanktivore	Cohen and Carlton 1995
Cordylophora caspia	hydrozoan	macroplanktivore	Cohen and Carlton 1995
Crassostrea gigas	Pacific Giant Oyster	macroplanktivore	Morris *et al.* 1992
Cryptosula pallasiana	bryozoan	macroplanktivore	Cohen and Carlton 1995
Diadumene franciscana	San Francisco Anemone	macroplanktivore	Cohen and Carlton 1995
Diadumene leucolena	White Anemone	macroplanktivore	Cohen and Carlton 1995
Didemnum sp.	tunicate	macroplanktivore	Cohen 2005
Diplosoma listerianum	tunicate	macroplanktivore	NEMESIS
Ericthonius brasiliensis	amphipod	macroplanktivore	Sotka *et al.* 1999
Ficopomatus enigmaticus	Tube Worm	macroplanktivore	Cohen 2005
Halichondria bowerbanki	sponge	macroplanktivore	Cohen and Carlton 1995
Haliclona loosanoffi	sponge	macroplanktivore	Morris *et al.* 1992

Appendix Q (cont'd). NOAA's Invasive Species Recorded in the Gulf of the Farallones National Marine Sanctuary.

Species Name	**Common Name**	**Trophic Group**	**Reference**
Haliplanella lineata	anemone	macroplanktivore	CalAcademy
Hymeniacidon sinapium	sponge	macroplanktivore	Rupert and Barnes 1994
Jassa marmorata	amphipod	macroplanktivore	Brusca and Brusca 1990
Laticorophium baconi	amphipod	macroplanktivore	NEMESIS
Leucothoe alata	amphipod	macroplanktivore	Laurens and Karaman 1991
Lyrodus pedicellatus	Blacktip Shipworm (mollusc)	macroplanktivore	Pechenik and Perron 1979
Macoma balthica	Baltic Macoma	macroplanktivore	MBL
Mercenaria mercenaria	Northern Quahog	macroplanktivore	CIESM
Molgula manhattensis	tunicate	macroplanktivore	Cohen and Carlton 1995
Monocorophium acherusicum	amphipod	macroplanktivore	NEMESIS
Monocorophium insidiosum	amphipod	macroplanktivore	NEMESIS
Monocorophium uenoi	amphipod	macroplanktivore	NEMESIS
Musculista senhousia	Green Mussel	macroplanktivore	Cohen and Carlton 1995
Mya arenaria	Softshell Clam	macroplanktivore	Cohen 2005
Mytilus galloprovincialis	Mediterranean mussel	macroplanktivore	Jeong *et al.* 2004
Nutallia nutallia	Mahogany Clam	macroplanktivore	Brusca and Brusca 1990
Nuttallia obscurata	Purple-Mahogany Clam	macroplanktivore	Brusca and Brusca 1990
Obelia bidentata	Doubletoothed Hydroid	macroplanktivore	MarLIN
Obelia dichotoma	Sea Thread Hydroid	macroplanktivore	Cohen and Carlton 1995
Ostrea edulis	Edible oyster	macroplanktivore	Brusca and Brusca 1990
Ostrea lurida	Olympia Oyster	macroplanktivore	Brusca and Brusca 1990
Polyandrocarpa zorritensis	tunicate	macroplanktivore	Brusca and Brusca 1990
Prosuberites sp.	sponge	macroplanktivore	Cohen and Carlton 1995
Pteria sterna	Wing Oyster	macroplanktivore	Brusca and Brusca 1990
Sarsia tubulosa	Clapper Hydromedusa	macroplanktivore	Schuchert 2005
Schizoporella unicornis	Single Horn Bryozoan	macroplanktivore	Cohen and Carlton 1995
Styela clava	tunicate	macroplanktivore	Cohen and Carlton 1995
Theora lubrica	Asian semele	macroplanktivore	NIMPIS
Trochammina hadai	foraminifera	macroplanktivore	Brusca and Brusca 1990
Tubularia crocea	hydrozoan	macroplanktivore	Cohen and Carlton 1995
Victorella pavida	bryozoan	macroplanktivore	Cohen and Carlton 1995

Appendix Q (cont'd). NOAA's Invasive Species Recorded in the Gulf of the Farallones National Marine Sanctuary.

Species Name	Common Name	Trophic Group	Reference
Watersipora subtorquata	bryozoan	macroplanktivore	Cohen and Carlton 1995
Pseudopolydora kempi	spionid	macroplanktivore, deposit feeder	Carlton 1979
Corophium acherusicum	amphipod	macroplanktivore, deposit feeder, detritivore	NIMPIS
Corophium alienense	amphipod	macroplanktivore, deposit feeder, detritivore	NIMPIS
Corophium insidiosum	amphipod	macroplanktivore, deposit feeder, detritivore	NIMPIS
Acanthomysis aspera	mysid	macroplanktivore, detritivore	Brusca and Brusca 1990
Gemma gemma	Amethyst Gemclam	macroplanktivore, detritivore	NOAA
Grandidierella japonica	amphipod	macroplanktivore, detritivore	NIMPIS
Sinelobus sp.	tanaid	macroplanktivore, detritivore	Cohen and Carlton 1995
Sphaeroma quoyanum	Sphaeromatid Isopod	macroplanktivore, detritivore	Cohen and Carlton 1995
Cercaria batillariae	Trematode	parasite	Torchin *et al.* 2005
Mytilicola orientalis	Red Worm (copepod)	parasite	Cohen and Carlton 1995
Pseudodiaptomus marinus	copepod	planktivore	NAS
Cakile maritima	European Sea Rocket	plant	
Cotula coronopifola	Brassbuttons	plant	
Salsola soda	Russian Thistle	plant	
Gambusia affinis	Mosquitofish	predator	Cohen and Carlton 1995
Lucania parva	Rainwater Killifish	predator	FishBase
Morone saxatilis	Striped Bass	predator	Fishbase

Appendix R. Number of species and percentages of total phylum taxa, native vs non-native, for each classification found by Moss Landing Marine Laboratories (MLML) during a 17-Aug-2004 survey of Bodega Bay. Epifaunal samples were collected quantitatively from rocky intertidal and subtidal substrate, by scraping clear and collecting the biological contents from quadrats (0.05 m² each in size) of known areas. Four (0.05 m²) quadrats were cleared for a total area of 0.2m². The intertidal sampling location was right out from Bodega Marine Lab, starting adjacent to Horseshoe Cove and wrapping upcoast along the extensive rocky reef [Latitude (DD) = 38.31638, Longitude (DD) = -123.07204]. The four intertidal quadrat clearings were distributed in the intertidal as follows: 1) one clearingfrom the mid-zone mussel bed; 2) one clearing from the mid zone, non-mussel bed, in what appeared to be the most diverse habitat; 3) one clearing from the low zone, oriented horizontally, in the most seemingly diverse habitat; 4) one clearing from the low zone on a vertical surface or under an overhanging rock. Subtidal sampling occurred offshore from the intertidal sampling reef, in approximately 35 ft. of water [Latitude (DD) = 38.539167, Longitude (DD) = -123.19889]. The four subtidal quadrat clearings were distributed in the intertidal as follows: 1) one clearing from the mid-zone mussel bed; 2) one clearing from the mid zone, non-mussel bed, in what appeared to be the most diverse habitat; 3) one clearing from the low zone, oriented horizontally, in the most seemingly diverse habitat; 4) one rocky quadrat clearing (Maloney 2006).

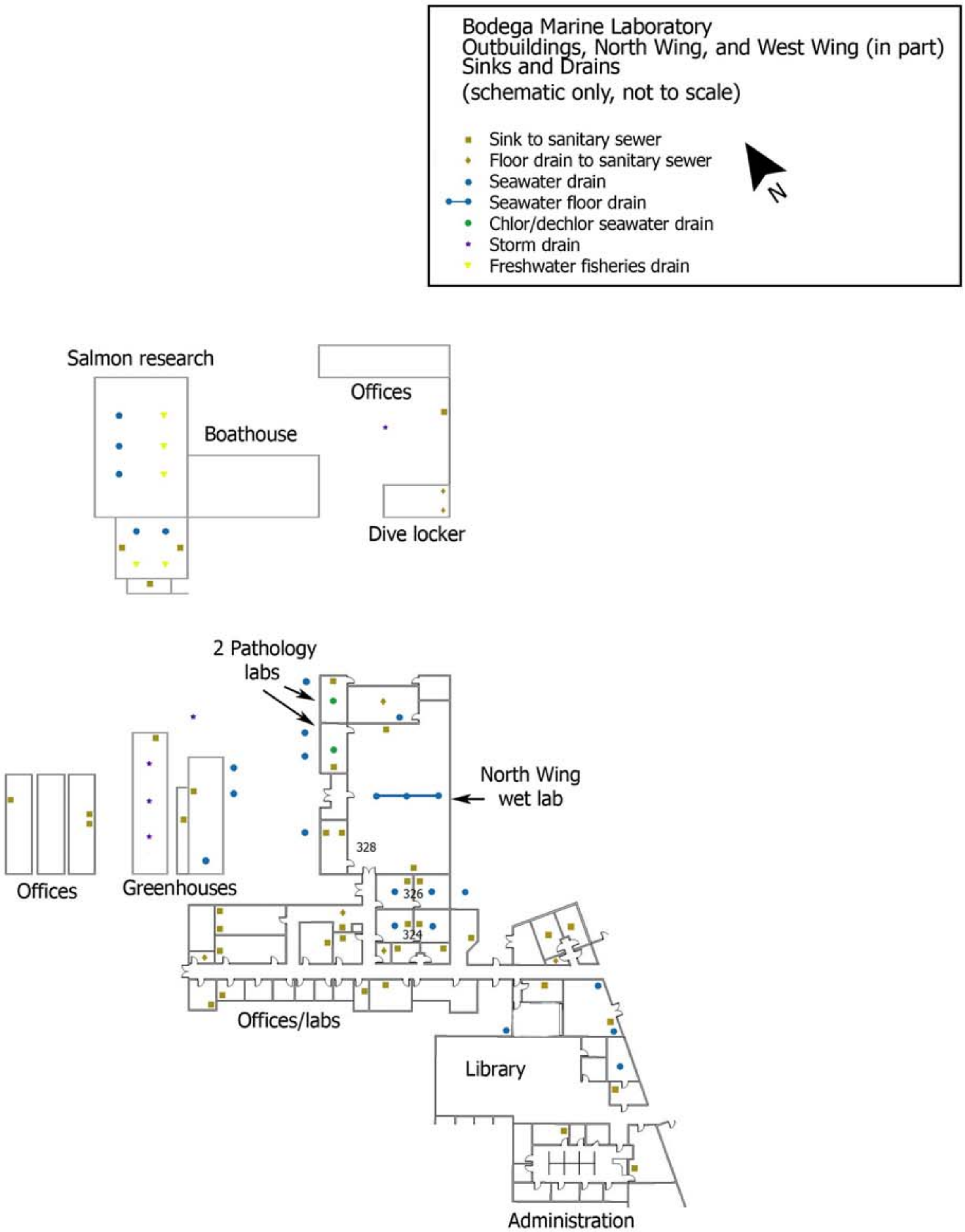
Phylum	Total Taxa	Introduced	Cryptogenic	Native	Unressolved
Animals					
Annelid	100		5 (5%)	42 (42%)	53 (53%)
Arthropod[1]	77	1 (1%)	8 (10%)	57 (74%)	11 (14%)
Chordata	20		1 (5%)	15 (75%)	4 (20%)
Cnidarian	15			7 (47%)	8 (53%)
Echinoderm	11		1 (9%)	6 (55%)	4 (36%)
Ectoproct	5			5 (100%)	
Mollusc	48			39 (81%)	9 (19%)
Nemertean	9			3 (33%)	6 (67%)
Platyhelinthes	2				2 (100%)
Porifera	20		3 (15%)	16 (80%)	1 (5%)
Sipunculid	1		1 (100%)		
Algae					
Chlorophyta	1			1 (100%)	
Heterokontophyta	1			1 (100%)	
Rhodophyta	7			7 (100%)	
Total					
Rocky Intertidal	136		9 (7%)	87 (64%)	40 (29%)
Sandy Intertidal	35	1 (3%)	1 (3%)	16 (46%)	17 (49%)
Rocky Subtidal	174		8 (5%)	119 (68%)	47 (27%)
Sandy Subtidal	41		4 (10%)	11 (27%)	26 (63%)

[1] Invasive species identified as *Pontogeneia rostrata*

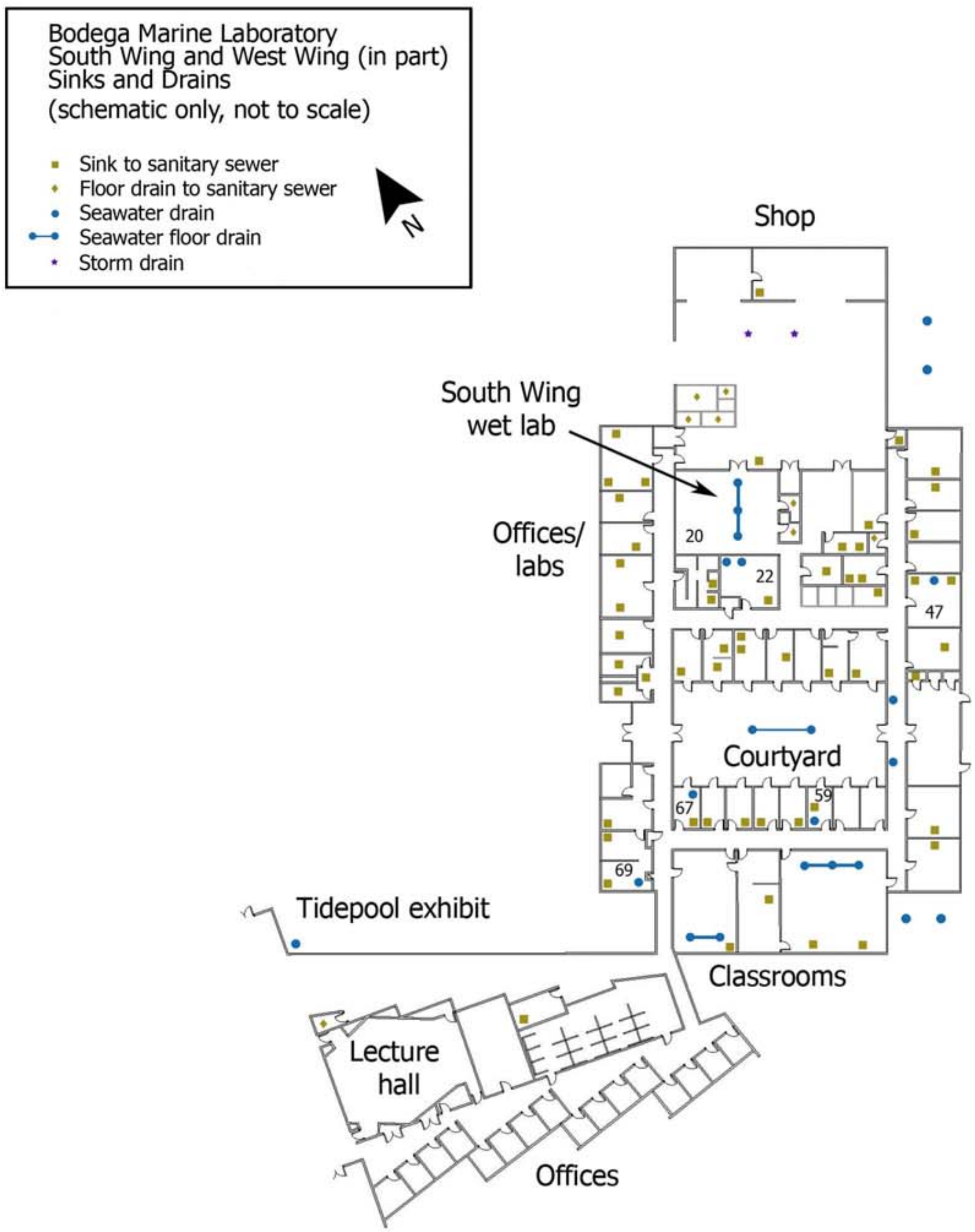
Appendix S. California Department of Fish and Game 2002 California Aquatic Non-Native Organism Database (CANOD) List for Bodega Bay. (DFG, 2002).

OSPR Location		*Bodega Bay*		***County***	*Marin*			
General Region		*North Coast Region*		***Latitude***	*38.2774*			
Site Category		*Minor Port*		***Longitude***	*122.9981*			
Kingdom	Animalia							
Phylum	***SubPhylum***	***Class***	***Super Order***	***Order***	***SubOrder***	***Family***	***Genus***	***Species***
Arthropoda	Crustacea	Malacostraca	Peracarida	Isopoda	Aseallota	Janiridae	*Ianiropsis*	*Ianiropsis tridens*
Arthropoda	Crustacea	Malacostraca		Amphipoda		Podoceridae	*Podocerus*	*Podocerus fulans*
Arthropoda	Crustacea	Malacostraca	Peracarida	Isopoda	Flabellifera	Sphaeromatidae	*Paracerceis*	*Paracerceis sculpta*
Urochordata	Tunicata	Ascidiacea		Aplousobranchia		Didemnidae	*Diplosoma*	*Diplosoma listeianum*
Ectoprocta		Gymnolaemata		Cheilostomata		Watersiporidae	*Waterispora*	*Waterispora subtorquata*
Arthropoda	Crustacea	Malacostraca	Peracarida	Mysida		Mysidae	*Siriella*	*Siriella pacifica*
Arthropoda	Crustacea	Malacostraca		Isopoda		Paranthuridae	*Paranthura*	*Paranthura elegans*
Annelida		Polychaeta		Capitellidae		Capitellidae	*Caprella*	*Caprella acanthogaster*
Arthropoda	Crustacea	Malacostraca	Peracarida	Tanaidacea	Tanaidomorpha	Tanaidae	*Zeuxo*	*Zeuxo paranormani*
Chordata	Tunicata	Ascidiacea		Phlebobranchia		Coinidae	*Ciona*	*Cionaintestinalis*
Annelida		Polychaeta		Capitellidae		Capitellidae	*Caprella*	*Caprella californica*
Arthropoda	Crustacea	Malacostraca		Amphipoda		Ampithoidae	*Ampithoe*	*Ampithoe lacertosa*
Chordata	Tunicata	Ascidiacea		Stolidobranchia		Styelidae	*Botrylloides*	*Botrylloides perspicuum*
Ectoprocta		Gymnolaemata		Cheilostomata	Anasca	Bugulidae	*Bugula*	*Bugula californica*
Arthropoda	Crustacea	Malacostraca	Peracarida	Amphipoda	Gammaridea	Melphidippidae	*Melphidippa*	*Melphidippa borealis*
Ectoprocta		Gymnolaemata		Cheilostomata		Cryptosulidae	*Cryptosula*	*Cryptosula pallasiana*
Arthropoda	Crustacea	Malacostraca	Peracarida	Amphipoda	Gammaridea	Aoridae	*Aoroides*	*Aoroides columbiae*
Arthropoda	Crustacea	Malacostraca	Peracarida	Amphipoda	Gammaridea	Gammarida	*Elasmopus*	*Elasmopus bampo*

Appendix T. BML Schematic North Wing Floor Plan.



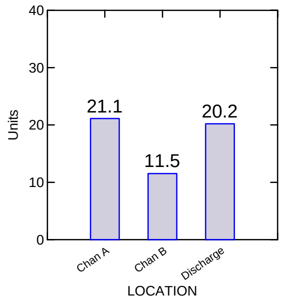
Appendix U. BML Schematic South Wing Floor Plan.

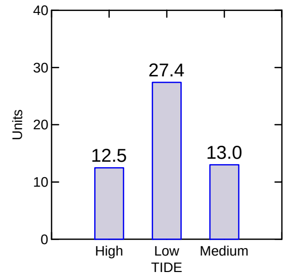


Appendix V. Two-way ANOVA results using two fixed factors 'tide height' and 'site.' Levels of site are Discharge, Channel A, and Channel B. Levels of tide height are Low, Medium, and High. *P*-values significant at the 95% level or greater are marked with an asterisk. Bar charts indicate mean values.

1. Sessile invertebrate cover, N = 45

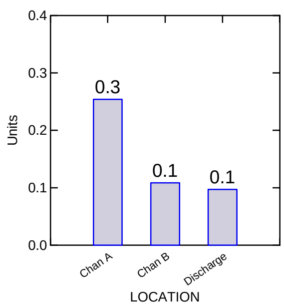
Source	df	Sum of Squares	Mean Square	*F*-statistic	*P*-value
Site	2	840.7	420.4	0.967	0.390
Tide height	2	2153.2	1076.6	2.477	0.98
Site x tide height	4	1257.4	314.4	0.723	0.582
Error	36	15645.2	343.6		

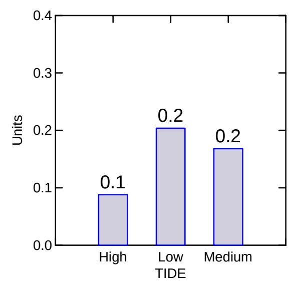




2. Sessile invertebrate diversity, N = 41

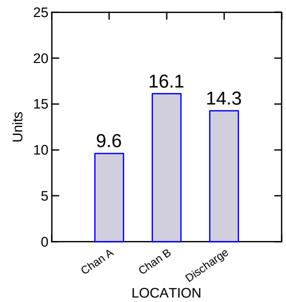
Source	df	Sum of Squares	Mean Square	*F*-statistic	*P*-value
Site	2	0.199	0.100	4.185	0.024*
Tide height	2	0.089	0.045	1.877	0.170
Site x tide height	4	0.181	0.045	1.904	0.134
Error	32	0.761	0.024		

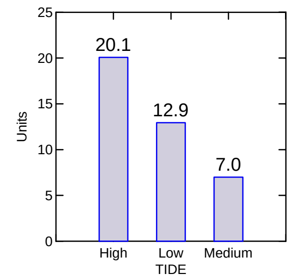




3. Mobile invertebrate abundance, N = 45

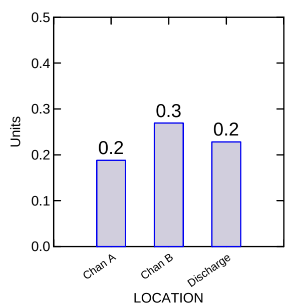
Source	df	Sum of Squares	Mean Square	*F*-statistic	*P*-value
Site	2	339.7	169.9	0.957	0.394
Tide height	2	1284.1	642.1	3.618	0.037*
Site x tide height	4	486.9	121.7	0.686	0.606
Error	36	6389.2	177.5		

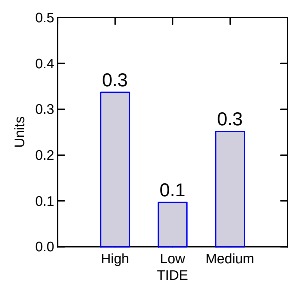




4. Mobile invertebrate diversity, N = 40

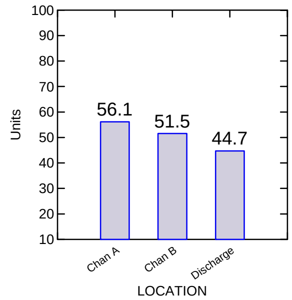
Source	df	Sum of Squares	Mean Square	*F*-statistic	*P*-value
Site	2	0.046	0.023	1.031	0.368
Tide height	2	0.335	0.168	7.533	0.002*
Site x tide height	4	0.293	0.073	3.288	0.023*
Error	31	0.690	0.022		

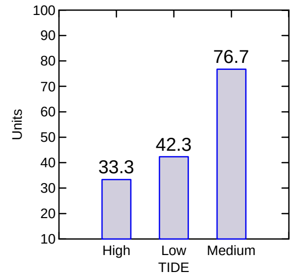




5. Total algal cover, N = 45

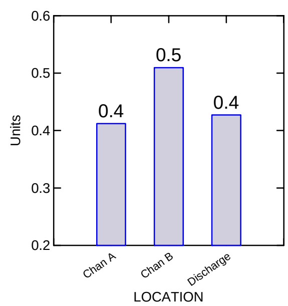
Source	df	Sum of Squares	Mean Square	*F*-statistic	*P*-value
Site	2	986.8	493.4	0.788	0.463
Tide height	2	15739.6	7869.8	12.564	<0.0001*
Site x tide height	4	4955.2	1238.8	1.978	0.119
Error	36	22549.6	626.4		

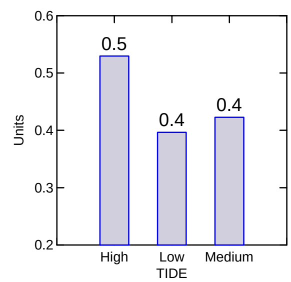




6. Algal diversity, N = 44

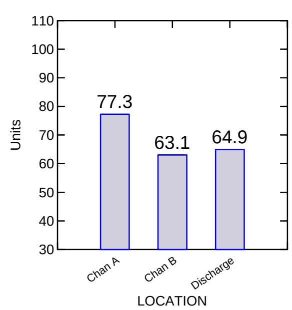
Source	df	Sum of Squares	Mean Square	*F*-statistic	*P*-value
Site	2	0.082	0.041	1.614	0.214
Tide height	2	0.146	0.073	2.869	0.070
Site x tide height	4	0.328	0.082	3.220	0.024*
Error	35	0.891	0.025		

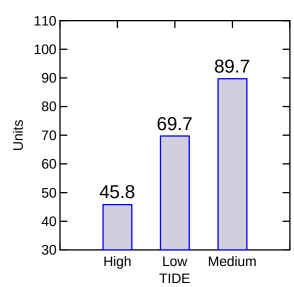




7. Total cover, N = 45

Source	df	Sum of Squares	Mean Square	*F*-statistic	*P*-value
Site	2	1786.2	893.1	1.222	0.307
Tide height	2	14514.7	7257.4	9.931	<0.001*
Site*tide height	4	3870.5	967.6	1.324	0.28
Error	36	26307.6	730.8		





Appendix W. Summary statistics for seven metrics of community structure from the November 2005 Intertidal Survey. Units of cover are percentages. Units of abundance are individuals per quadrat. Units of diversity are common logarithm Shannon-Weiner Index units.

Location	*Tide*	*Measure Community Structure*	*N*	*Min*	*Max*	*Mean*	*SD*
Discharge	Low	Sessile Invertebrate Cover	5	1	90	34.6	36.6
		Mobile Invertebrate Abundance	5	0	51	17.6	24.6
		Total Algal Cover	5	0	63	32.0	24.4
		Total Cover	5	20	98	66.6	32.0
		Sessile Invertebrate Diversity	5	0.000	0.298	0.130	0.129
		Mobile Invertebrate Diversity	2	0.054	0.072	0.063	0.013
		Algal Diversity	4	0.083	0.287	0.212	0.092

Location	*Tide*	*Measure Community Structure*	*N*	*Min*	*Max*	*Mean*	*SD*
Discharge	Medium	Sessile Invertebrate Cover	5	1	50	21.4	21.7
		Mobile Invertebrate Abundance	5	3	15	7.8	4.5
		Total Algal Cover	5	44	126	63.0	35.3
		Total Cover	5	51	127	84.4	30.0
		Sessile Invertebrate Diversity	5	0.000	0.481	0.161	0.197
		Mobile Invertebrate Diversity	5	0.000	0.553	0.303	0.239
		Algal Diversity	5	0.346	0.663	0.539	0.141

Location	*Tide*	*Measure Community Structure*	*N*	*Min*	*Max*	*Mean*	*SD*
Discharge	High	Sessile Invertebrate Cover	5	0	12	4.6	5.9
		Mobile Invertebrate Abundance	5	6	40	17.4	14.8
		Total Algal Cover	5	4	103	39.2	38.2
		Total Cover	5	4	104	43.8	38.4
		Sessile Invertebrate Diversity	3	0.000	0.000	0.000	0.000
		Mobile Invertebrate Diversity	5	0.000	0.481	0.319	0.193
		Algal Diversity	5	0.301	0.654	0.531	0.152

Location	*Tide*	*Measure Community Structure*	*N*	*Min*	*Max*	*Mean*	*SD*
Channel A	Low	Sessile Invertebrate Cover	5	1	56	29.8	25.3
		Mobile Invertebrate Abundance	5	0	6	3.2	2.6
		Total Algal Cover	5	32	88	59.0	22.0
		Total Cover	5	47	112	88.8	26.6
		Sessile Invertebrate Diversity	5	0.000	0.559	0.394	0.225
		Mobile Invertebrate Diversity	4	0.000	0.196	0.049	0.098
		Algal Diversity	5	0.260	0.549	0.422	0.107

Location	*Tide*	*Measure Community Structure*	*N*	*Min*	*Max*	*Mean*	*SD*
Channel A	Medium	Sessile Invertebrate Cover	5	0	52	13.4	21.8
		Mobile Invertebrate Abundance	5	1	11	4.2	4.1
		Total Algal Cover	5	61	109	91.4	19.2
		Total Cover	5	67	138	104.8	25.3
		Sessile Invertebrate Diversity	4	0.071	0.377	0.261	0.132
		Mobile Invertebrate Diversity	5	0.000	0.276	0.082	0.123
		Algal Diversity	5	0.110	0.466	0.307	0.170

Location	Tide	Measure Community Structure	N	Min	Max	Mean	SD
Channel A	High	Sessile Invertebrate Cover	5	0	54	20.2	20.8
		Mobile Invertebrate Abundance	5	10	33	21.4	9.7
		Total Algal Cover	5	10	24	18.0	6.9
		Total Cover	5	11	64	38.2	19.3
		Sessile Invertebrate Diversity	4	0.000	0.317	0.106	0.150
		Mobile Invertebrate Diversity	5	0.272	0.617	0.433	0.137
		Algal Diversity	5	0.373	0.684	0.507	0.113

Location	Tide	Measure Community Structure	N	Min	Max	Mean	SD
Channel B	Low	Sessile Invertebrate Cover	5	1	50	17.8	20.4
		Mobile Invertebrate Abundance	5	2	42	18.0	18.7
		Total Algal Cover	5	22	62	36.0	16.6
		Total Cover	5	33	87	53.8	24.8
		Sessile Invertebrate Diversity	5	0.000	0.301	0.087	0.133
		Mobile Invertebrate Diversity	5	0.000	0.330	0.179	0.129
		Algal Diversity	5	0.428	0.679	0.556	0.101

Location	Tide	Measure Community Structure	N	Min	Max	Mean	SD
Channel B	Medium	Sessile Invertebrate Cover	5	1	11	4.2	4.1
		Mobile Invertebrate Abundance	5	0	17	9.0	7.8
		Total Algal Cover	5	42	109	75.8	29.9
		Total Cover	5	53	110	80.0	26.3
		Sessile Invertebrate Diversity	5	0.000	0.276	0.082	0.123
		Mobile Invertebrate Diversity	4	0.287	0.533	0.369	0.113
		Algal Diversity	5	0.272	0.550	0.422	0.110

Location	Tide	Measure Community Structure	N	Min	Max	Mean	SD
Channel B	High	Sessile Invertebrate Cover	5	1	27	12.6	9.3
		Mobile Invertebrate Abundance	5	5	44	21.4	15.0
		Total Algal Cover	5	24	66	42.8	16.1
		Total Cover	5	35	67	55.4	12.0
		Sessile Invertebrate Diversity	5	0.000	0.398	0.157	0.146
		Mobile Invertebrate Diversity	5	0.173	0.432	0.260	0.103
		Algal Diversity	5	0.173	0.869	0.551	0.313

Location	Tide	Measure Community Structure	N	Min	Max	Mean	SD
Channel A & B	Low	Sessile Invertebrate Cover	10	1	56	23.8	22.6
		Mobile Invertebrate Abundance	10	0	42	10.6	14.8
		Total Algal Cover	10	22	88	47.5	22.0
		Total Cover	10	33	112	71.3	30.5
		Sessile Invertebrate Diversity	10	0.000	0.559	0.240	0.238
		Mobile Invertebrate Diversity	9	0.000	0.330	0.121	0.129
		Algal Diversity	10	0.260	0.679	0.489	0.121

Location	***Tide***	***Measure Community Structure***	***N***	***Min***	***Max***	***Mean***	***SD***
Channel A & B	Medium	Sessile Invertebrate Cover	10	0	52	8.8	15.5
		Mobile Invertebrate Abundance	10	0	17	6.6	6.4
		Total Algal Cover	10	42	109	83.6	25.1
		Total Cover	10	53	138	92.4	27.6
		Sessile Invertebrate Diversity	9	0.000	0.377	0.162	0.152
		Mobile Invertebrate Diversity	9	0.000	0.533	0.210	0.188
		Algal Diversity	10	0.110	0.550	0.365	0.148

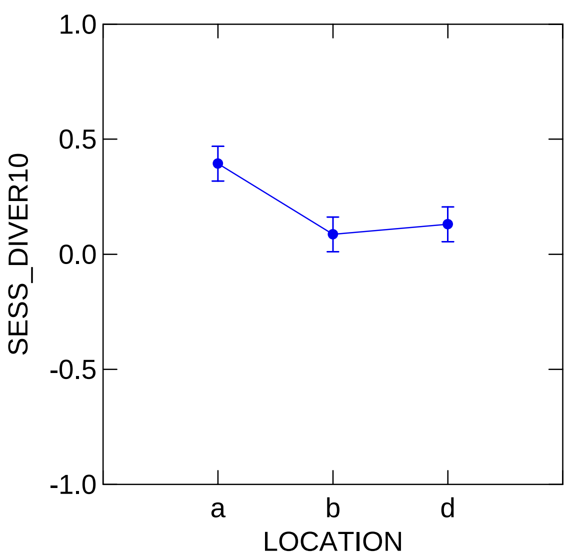
Location	***Tide***	***Measure Community Structure***	***N***	***Min***	***Max***	***Mean***	***SD***
Channel A & B	High	Sessile Invertebrate Cover	10	0	54	16.4	15.7
		Mobile Invertebrate Abundance	10	5	44	21.4	11.9
		Total Algal Cover	10	10	66	30.4	17.5
		Total Cover	10	11	67	46.8	17.7
		Sessile Invertebrate Diversity	9	0.000	0.398	0.135	0.141
		Mobile Invertebrate Diversity	10	0.173	0.617	0.346	0.146
		Algal Diversity	10	0.173	0.869	0.529	0.223

Appendix X. 21 Analysis of variance results to test for differences between mean values for Site by Tidal Zone. Results having P-values significant at the 95% level or greater also include post-hoc multiple comparisons.

```
The following results are for:
   TIDE$        = Low

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: SESS_INVERTS   N: 15   Multiple R: 0.269   Squared multiple R: 0.072

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$                 748.800     2      374.400       0.469       0.637

Error                    9588.800    12      799.067

-------------------------------------------------------------------------------

The following results are for:
   TIDE$        = Mid

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: SESS_INVERTS   N: 15   Multiple R: 0.402   Squared multiple R: 0.162

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$                 740.800     2      370.400       1.156       0.347

Error                    3845.200    12      320.433

-------------------------------------------------------------------------------

The following results are for:
   TIDE$        = High

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: SESS_INVERTS   N: 15   Multiple R: 0.465   Squared multiple R: 0.216

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$                 608.533     2      304.267       1.651       0.233

Error                    2211.200    12      184.267

-------------------------------------------------------------------------------
```

```
The following results are for:
   TIDE$        = Low

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: SESS_DIVER10   N: 15   Multiple R: 0.669   Squared multiple R: 0.448

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$                   0.276    2        0.138       4.871       0.028

Error                       0.340   12        0.028
```

Least Squares Means




```
*** WARNING ***
Case           20 is an outlier        (Studentized Residual =       -3.818)

Durbin-Watson D Statistic          2.376
First Order Autocorrelation       -0.202
COL/
ROW LOCATION$
  1  a
  2  b
  3  d
Using least squares means.
Post Hoc test of SESS_DIVER1

Using model MSE of 0.028 with 12 df.
```

Matrix of pairwise mean differences:

	1	2	3
1	0.000		
2	-0.307	0.000	
3	-0.264	0.044	0.000

Bonferroni Adjustment.

Matrix of pairwise comparison probabilities:

	1	2	3
1	1.000		
2	0.041	1.000	
3	0.088	1.000	1.000

The following results are for:
TIDE$ = Mid

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d
1 case(s) deleted due to missing data.

Dep Var: SESS_DIVER10 N: 14 Multiple R: 0.459 Squared multiple R: 0.211

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	0.072	2	0.036	1.470	0.272
Error	0.268	11	0.024		

The following results are for:
TIDE$ = High

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d
3 case(s) deleted due to missing data.

Dep Var: SESS_DIVER10 N: 12 Multiple R: 0.483 Squared multiple R: 0.233

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	0.046	2	0.023	1.370	0.302
Error	0.152	9	0.017		

The following results are for:
TIDE$ = Low

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d

Dep Var: MOB_INVERTS   N: 15   Multiple R: 0.395   Squared multiple R: 0.156

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	710.933	2	355.467	1.110	0.361
Error	3842.000	12	320.167		

The following results are for:
TIDE$ = Mid

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d

Dep Var: MOB_INVERTS   N: 15   Multiple R: 0.369   Squared multiple R: 0.136

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	62.400	2	31.200	0.946	0.415
Error	395.600	12	32.967		

The following results are for:
TIDE$ = High

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d

Dep Var: MOB_INVERTS   N: 15   Multiple R: 0.156   Squared multiple R: 0.024

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	53.333	2	26.667	0.149	0.863
Error	2151.600	12	179.300		

The following results are for:
TIDE$ = Low

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d
4 case(s) deleted due to missing data.

Dep Var: MOB_DIVER10 N: 11 Multiple R: 0.557 Squared multiple R: 0.310

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	0.043	2	0.022	1.800	0.226
Error	0.096	8	0.012		

The following results are for:
TIDE$ = Mid

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d
1 case(s) deleted due to missing data.

Dep Var: MOB_DIVER10 N: 14 Multiple R: 0.627 Squared multiple R: 0.393

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	0.212	2	0.106	3.555	0.064
Error	0.328	11	0.030		

The following results are for:
TIDE$ = High

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d

Dep Var: MOB_DIVER10 N: 15 Multiple R: 0.475 Squared multiple R: 0.226

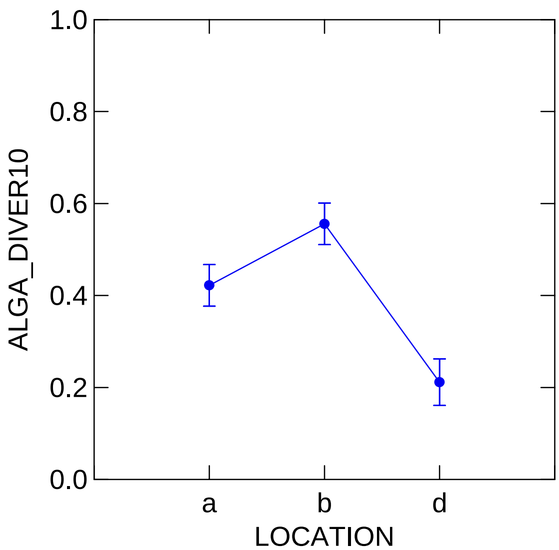
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	0.078	2	0.039	1.747	0.216
Error	0.267	12	0.022		

```
The following results are for:
   TIDE$        = Low

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: ALGAE   N: 15   Multiple R: 0.530   Squared multiple R: 0.281

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$               2123.333     2     1061.667       2.348       0.138

Error                   5426.000    12      452.167

-------------------------------------------------------------------------------

The following results are for:
   TIDE$        = Mid

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: ALGAE   N: 15   Multiple R: 0.409   Squared multiple R: 0.168

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$               2022.933     2     1011.467       1.208       0.333

Error                  10046.000    12      837.167

-------------------------------------------------------------------------------

The following results are for:
   TIDE$        = High

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: ALGAE   N: 15   Multiple R: 0.450   Squared multiple R: 0.202

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$               1795.733     2      897.867       1.522       0.258

Error                   7077.600    12      589.800

-------------------------------------------------------------------------------
```

```
The following results are for:
   TIDE$        = Low

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d
1 case(s) deleted due to missing data.

Dep Var: ALGA_DIVER10   N: 14   Multiple R: 0.838   Squared multiple R: 0.703

Analysis of Variance
Source              Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$                   0.264     2        0.132      12.991       0.001

Error                       0.112    11        0.010
```

Least Squares Means




```
Durbin-Watson D Statistic          1.600
First Order Autocorrelation        0.113
COL/
ROW LOCATION$
  1  a
  2  b
  3  d
Using least squares means.
Post Hoc test of ALGA_DIVER1

Using model MSE of 0.010 with 11 df.

Matrix of pairwise mean differences:
                         1           2            3
             1           0.000
             2           0.134       0.000
             3          -0.211      -0.344        0.000
```

Bonferroni Adjustment.

Matrix of pairwise comparison probabilities:

	1	2	3
1	1.000		
2	0.181	1.000	
3	0.030	0.001	1.000

The following results are for:
TIDE$ = Mid

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d

Dep Var: ALGA_DIVER10 N: 15 Multiple R: 0.597 Squared multiple R: 0.356

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	0.134	2	0.067	3.321	0.071
Error	0.242	12	0.020		

The following results are for:
TIDE$ = High

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
a, b, d

Dep Var: ALGA_DIVER10 N: 15 Multiple R: 0.095 Squared multiple R: 0.009

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
LOCATION$	0.005	2	0.002	0.055	0.947
Error	0.536	12	0.045		

```
The following results are for:
   TIDE$        = Low

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: TOT_COVER   N: 15   Multiple R: 0.500   Squared multiple R: 0.250

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$                3136.133     2     1568.067       2.003       0.178

Error                    9394.800    12      782.900

-------------------------------------------------------------------------------

The following results are for:
   TIDE$        = Mid

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: TOT_COVER   N: 15   Multiple R: 0.405   Squared multiple R: 0.164

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$                1750.933     2      875.467       1.176       0.342

Error                    8934.000    12      744.500

-------------------------------------------------------------------------------

The following results are for:
   TIDE$        = High

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
LOCATION$ (3 levels)
   a, b, d

Dep Var: TOT_COVER   N: 15   Multiple R: 0.297   Squared multiple R: 0.088

Analysis of Variance
Source             Sum-of-Squares   df  Mean-Square     F-ratio       P

LOCATION$                 769.600     2      384.800       0.579       0.576

Error                    7978.800    12      664.900

-------------------------------------------------------------------------------
```